An Aquatic/Semi-aquatic Herpetofaunal Inventory of Hot Springs National Park

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9 September 2003

Technical report NPS/HTLN/P6370010459

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Summary

No information on current species composition, distribution, and abundance existed for the Hot Springs NP prior the inventory. Information is needed for park managers to make appropriate decisions to ensure the long-term sustainability of species and abide by the National Park Service (NPS) mission statement. Surveys were conducted in the summer and fall of 2001 and spring and summer of 2002 via cover boards, general search and seizure, and road cruising. Aquatic methods included dip netting, seining, and the use of turtle traps. An expected species list incorrectly listed 28 amphibians and 51 reptiles; twenty amphibians and 15 reptiles were expected aquatic species. Based on the results of this inventory, 65% of the aquatic amphibians (13 of 20) and 53% of the aquatic reptiles (8 of 15) were documented. Hot Springs National Park possesses a typical Ouachita Mountain herpetofaunal community; the most productive site was Stone Bridge Pond. One voucher displaying typical phenotypic variation for each species was collected. Management implications and recommendations identify possible steps to ensure the long-term sustainability of herpetofauna at Hot Springs NP.

Acknowledgments

The authors wish to thank the staff at Hot Springs NP for their kindness and willing support of the project. Thanks also go to the National Park Service' Heartland Network Inventory and Monitoring Program and Regional Offices who funded the project and to staff who assisted with project logistics. We also thank Vernon Hoffman, Robyn Konvalinka, and Ben Wheeler for their field assistance.

Introduction

In 1998 Congress passed the National Parks Omnibus Management Act in response to concerns about the condition of natural resources within the national parks. The act requires each park to gather baseline inventory data on pertinent natural resources, data that will provide a pivotal step toward establishing an effective monitoring program furthering the ability to effectively manage and protect park resources. The National Park Service (NPS) responded with the Natural Resource Challenge program, including the establishment of biome-based inventory and monitoring networks. The Heartland Network, as part of the NPS Inventory and Monitoring (I&M) program, has undertaken inventories of vascular plants and vertebrates within fifteen parks in eight Midwestern states.

Stemming from this challenge and a widespread concern regarding the status of herpetofaunal populations at Hot Springs NP, an inventory was deemed necessary to determine resident amphibians and reptiles. Historic records (Strecker 1908; 1924) reported the presence of several aquatic species (Table 1) yet prior to the inventory there was no current data documenting species composition, distribution, and abundance. Many amphibian and reptile populations are best described as metapopulations (Levins 1969; Hanski and Gilpin 1997) whose stability is dependent on a balance between population extirpation and recolonization (Johnson et al. 2002). Pollution and introduced species are considered to be major contributors to biodiversity declines (Stebbins and Cohen 1995).

Although the habitats of the park are not virgin lands, their setting in the Ouachita Mountains makes this national park an important conservation area. Their management may allow Hot Springs NP to act as an ecological source for refueling adjacent populations (Wiens 1996).

We conducted a thorough, one-year aquatic herpetofaunal survey in 2001-2002. The inventory had three objectives: 1) document at least 90% of the amphibian and reptile species reasonably expected to occur at Hot Springs NP and provide an up-to-date assessment of species richness; 2) estimation of relative abundance and local ranges; and 3) collection and deposition of voucher specimens.

Study Area

Hot Springs National Park is located in west central Arkansas at the southeastern edge of the Ouachita Mountains, approximately 80 km (50 m) west and south of Little Rock. The park spans approximately 2,247 ha (5,550 ac) and is dominated by hardwood forests and the riparian habitats of four streams. Vegetation in the region is within a transition zone of pine/oak forests, between the upland hardwood forests characteristic of the Ozark Plateau to the north and west, and the southern shortleaf pine associations of the Gulf Coastal Plain to the south. The park encircles the city of Hot Springs and has been a major tourist attraction (due to its namesake "hot springs") since the mid 1800's. The area has been heavily developed for residential and commercial purposes; three major highways, as well as numerous paved streets, cut through or border park property heavily fragmenting and impacting the natural habitat. A landfill falls within the boundaries of the park.

The natural thermal springs are the primary resource of Hot Springs National Park. The presence of the hot springs is a result of the unique geology of the area in combination with the present topography. The water is geothermally heated at an unusually shallow depth of several thousand feet. The water then rises through faults in the Hot Springs sandstone formation to emerge from the thermal springs. Through radiocarbon dating, this process has been determined to take over 4,000 years. In relation to the springs' function, park lands are viewed as two interrelated units: the discharge zone and the recharge zone.

The springs have been managed to conserve the production of uncontaminated hot water for public use. The park's mountain lands have also been managed under this conservation philosophy to preserve the hydrologic system that feeds the springs. In fact, the park's enabling legislation mandates that the thermal waters be preserved and provided to the public in an unending and unaltered supply. As such, Hot Springs National Park may be the only park in the system required by law to give away its primary resource.

Materials and Methods

The inventory began during the summer 2001 and extended into the summer of 2002 (7 July 2001, 2-3 November 2001, 12-13 December 2001, 13-14 March 2002, 7-8 May 2002, and 14-15 June 2002. Inventories were conducted by 2-7 member teams during most visits.

Search methods included road cruising (Karns 1986), cover boards, general search and seizure methods (Vogt and Hine 1982), dip netting and seining (Karns 1986), and the use of turtle traps (Legler 1960). Coverboard use, adapted from Grant et al. (1992), utilized two wood and two tin cover boards placed in an open field along one stream. Most common and scientific names are based on Moriarty (2000).

Transects along creeks consisted of walking the stream bed or bank for 90 m while turning rocks, logs, leaves, etc. and then a 10 minute intensive search for 10 m. A hand-held Turtox sampling dip net (Karns 1986) was used in appropriate habitats as well as four-tine metal potato rakes. The dip net was held just downstream while investigators kicked up the gravel at the location. Spot searches were conducted in appropriate habitats, and every attempt was made to search the area as thoroughly as possible. Turtle trapping (Legler 1960) was conducted in Gulpha Gorge Creek and in Stone Bridge Pond in the eastern portion of the park (Fig. 1). Five turtle nets were placed throughout the pond near basking sites for turtles (e.g., Figs. 6 and 7).

Each search location was recorded with a Trimble GeoExplorer 3 Global Positioning System (GPS) portable hand-held unit at the highest accuracy possible given the conditions at the time. At least 130 data points were recorded for each search location.

An expected species list (Boetsch et al. 2000) was revised based on species documented via this inventory and the authors' professional opinion.

A single voucher specimen of each species was taken during the inventory. Specimens prepared for museum storage were body positioned, fixed in 10% formalin, and preserved in 70% ethanol following Pisani (1973). All specimens were deposited in the National Park Service Heartland Division Special Collection within the Arkansas State University Museum of Zoology herpetology collection. Specimen accession numbers were entered into a Microsoft Access database for reference.

Results

Expected Species

Twenty-eight amphibians and 51 reptiles were listed in the original expected species list (Tables 11 & 12); twenty amphibians and 15 reptiles were expected aquatic species. Based on the results of this inventory, 65% of the aquatic amphibians (13 of 20) and 53% of the aquatic reptiles (8 of 15) were documented.

Species Richness and Abundance

Hot Springs National Park possesses a typical Ouachita Mountain herpetofaunal community. The inventory yielded 13 aquatic/semi-aquatic amphibian species (11 anurans and two salamanders--Tables 2 and 3) and eight aquatic/ semi-aquatic reptilian species (four snakes and four turtles--Tables 4 and 5). Two species were represented by a single observation or specimen. These were the common snapping turtle (*Chelydra serpentina serpentina*) and rough green snake (*Opheodrys aestivus*). Of the 25 species previously identified as being present at the park, we observed 16. In addition, we observed four species that had not previously been recorded. These were Fowler's toad (*Bufo woodhousii fowleri*), green treefrog (*Hyla cinerea*), northern spring peeper (*Pseudacris crucifer crucifer*), and common musk turtle or stinkpot (*Sternotherus odoratus*).

The most productive site was Stone Bridge Pond (Tables 6 & 7; Fig. 4). Seven of the 21 species observed were only recorded in or around Stone Bridge Pond. These include Fowler's toad, common snapping turtle, Cope's gray treefrog (*Hyla chrysoscelis*), green tree frog (*Hyla cinerus*), yellowbelly water snake (*Nerodia erythrogaster flavigaster*), eastern river cooter (*Pseudemys concinna*), and red-eared slider (*Trachemys scripta elegans*). Two other sites were also highly productive: Fox Pass Road wetland (Table 8; Fig. 5) and Gulpha Gorge Creek (Table 9; Fig 6). In addition to the aquatic species observed during the course of this study, nine terrestrial species were noted in association with riparian searches (Table 10). Tables 2-10 include estimates of relative abundance for each species.

Discussion

Expected Species

Twenty-eight amphibians and 51 reptiles were listed in the original expected species list (Tables 2 & 3). Twenty amphibians and 15 reptiles were expected aquatic species. Based on the results of this inventory, 65% of the aquatic amphibians (13 of 20) and 53% of the aquatic reptiles (8 of 15) were documented.

Four aquatic amphibians were incorrectly listed as possible based on range. No county records exist for two: the dwarf salamander (*Eurycea quadridigitata*) and the eastern spadefoot (*Scaphiopus holbrooki*). Historical status for the other two is questionable. One county record for the mole salamander (*Ambystoma talpoideum*) exists but is outside of the park. This is a very scattered species, and the inventory may have missed it; no larvae were found at the pond checked and the pond should be rechecked. The pickerel frog (*Rana palustris*) should be treated as an incidental transient as there are only two records for Garland County.

Five aquatic amphibians do not occur due to lack of, or marginal, habitat. Lack of habitat restricts the occurrence of the three-toed salamander (*Amphiuma tridactylum*), smallmouth salamander (*Ambystoma texanum*), and the marbled salamander (*Ambystoma opacum*). Smallmouth salamanders have been documented southwest of the park, and marbled salamanders are possibly in Garland County but absent from the park due to lack of habitat (ponds). Habitat for the many-ribbed salamander (*Eurycea multiplicata griseogaster*) is marginal, whereas habitat (at Stone Bridge pond) is not conducive for the lesser siren (*Siren intermedia nettingi*) due to an abundance of fish. Predation likely excludes sirens from becoming established here, but they may occur in the backwater areas.

Four other aquatic amphibians not found (but still expected) include the ringed salamander (*Ambystoma annulatum*), mudpuppy (*Necturus maculosus louisianensis*), central newt (*Notophthalmus viridescens louisianensis*) (a species that should have been in the pond surveyed), and four-toed salamander (*Hemidactylium scutatum*). It was surprising that no larvae or adults of the ringed salamander were found. A thorough search for the mudpuppy was not conducted because of labor intensive methods required (diving or electroshocking); the species is possibly in Bull Bayou. Among the terrestrial species still expected include both the southern red-backed salamander (*Plethodon serratus*) and western slimy salamander (*Plethodon albagula*).

Three aquatic reptile species were incorrectly listed as expected based on range and include two that do not occur in Arkansas: Missouri cooter (*Pseudemys floridana*) and the false map turtle (*Graptemys pseudogeographica*). Graham's crayfish snake (*Regina grahamii*) does not occur within 75 miles of the park.

No aquatic habitat exists for the chicken turtle (*Deirochelys reticularia*), whereas habitat is not conducive for the gulf crayfish (*Regina rigida sinicola*) and the painted turtle (*Chrysemys picta*), the latter documented with just five records in southern Arkansas. The Mississippi mud turtle (*Kinosternon subrubrum hippocrepis*) has been displaced by the stinkpot (*Sternotherus odoratus*)

and may or may not occur due to non-conducive habitat in Bull Bayou. The terrestrial ornate box turtle (*Terrapene ornata*) is absent from the park due to atypical habitat (hilly).

Other aquatic reptiles not found in the inventory include several that are likely to be found in Bull Bayou. These include the alligator snapping turtle (*Macrochelys temminckii*), the spiny softshell turtle (*Apalone spinifera hartwegi*), smooth softshell turtle (*Apalone mutica mutica*), common map turtle (*Graptemys geographica*), and the razorback musk turtle (*Sternotherus carinatus*). The Mississippi map turtle (*Graptemys kohnii*) is documented in Garland County with three records, one south of the park near a large river. A large river species, it is possible to occur in the southern end of Bull Bayou. Two others not found (but are still expected) include the western ribbon snake (*Thamnophis proximus proximus*) documented with one county record, and the timber rattlesnake (*Crotalus horridus*) documented in the county and near the park. Two other aquatic species not documented (but still expected) include, broad-banded water snake (*Nerodia fasciata confluens*), and the diamondback water snake (*Nerodia rhombifer rhombifer*).

Among the terrestrial reptiles not inventoried but occur are the brown snake (*Storeria dekayi wrightorum*), redbelly snake (*Storeria occipitomaculata occipitomaculata*), common garter snake (*Thamnophis sirtalis sirtalis*), flathead snake (*Tantilla gracilis*), northern copperhead (*Agkistrodon contortrix contortrix*), green anole *(Anolis carolinensis*), six-lined racerunner (*Cnemidophorus sexlineatus viridis*), western worm snake (*Carphophis vermis*), ringneck snake (*Diadophis punctatus stictogenys*), black rat snake (*Elaphe obsoleta*), rough earth snake (*Virginia striatula*), Great Plains rat snake (*Elaphe guttata emoryi*), eastern hognose snake (*Heterodon platirhinos*), smooth earth snake (*Virginia valeriae*), and milk snake (*Lampropeltis triangulum syspila*). The speckled kingsnake (*Lampropeltis getula holbrooki*), eastern coachwhip (*Masticophis flagellum flagellum*) and western diamondback rattlesnake (*Crotalus atrox*) had previously been documented at the park, but present status is unknown. The slender glass lizard (*Ophisaurus attenuatus attenuatus*) is documented with a historical record (southeastern Garland County) but not at the park. The queen snake (*Regina septemvittata*), was historically (1896 records) very common at the park but has since been extirpated from southern Arkansas (south of the Arkansas River). Reasons for this extirpation are unknown. Additional terrestrial species that should be listed as still expected include: the coal skink (*Eumeces anthracinus*), broadhead skink (*Eumeces laticeps*), five-lined skink (*Eumeces fasciatus*), scarlet snake (*Cemophora coccinea copei*) (one record in the western part of Garland County), prairie kingsnake (*Lampropeltis calligaster calligaster*), three-toed box turtle (*Terrapene carolina triunguis*), fence lizard (*Sceloporus undulatus*), ground skink (*Scincella lateralis*), and racer (*Coluber constrictor priapus*).

Species Richness and Abundance

Three areas at the park are the most important in terms of aquatic/semi-aquatic species richness. The most import site is the Stone Bridge Pond area. Sixteen species were found in this area, accounting for 77% of the total richness. Nine species of amphibians were found at Stone Bridge Pond, representing 69% of the total amphibian diversity. Seven species of reptiles were found in the area, representing 88% of the total reptile diversity.

Stone Bridge Pond is the largest body of standing water on the park. This undoubtedly is a primary reason for the high diversity seen here. In addition to being large enough to sustain

large fish populations, which serve as prey for the snakes, there are abundant basking opportunities for the turtles as well as a dense aquatic plant population. Also, the northern portion of the pond is shallow and forms a marshy wetland with ideal habitat for many amphibians.
The Fox Pass Road pond area was a second site of particular importance, primarily for amphibians. Nine species of amphibians were found in this area, representing 69% of total amphibian diversity. One reptile species, western cottonmouth (*Agkistrodon piscivorus leucostoma*) was observed here in abundance, but was not observed at any other site.

The wide diversity of aquatic habitats at the Fox Pass Road site is of extreme importance to the local amphibian populations. A spring-fed pond drains into a marshy area consisting of alternating rivulets and shallow ponds. This area presented ideal habitat for many anuran species and, undoubtedly, their presence contributed to the very healthy population of western cottonmouth. Although this was the only pond which did not have resident fish populations, only two salamander species were observed here-- spotted salamander (*Ambystoma maculatum*) and Ouachita dusky salamander (*Desmognathus brimleyorum*). The apparent lack of other ambystomatid salamanders from this site, primarily eastern tiger salamander (*Ambystoma tigrinum*) and ringed salamander (*Ambystoma annulatum*), could not be explained. Further investigation into the status of the ambystomatid salamanders at the park would be beneficial.

The third site, which contributed to the overall species richness, was the Gulpha Gorge Creek area. Four species of amphibians were observed in this area, representing 31% of the total amphibian diversity. Three species of reptiles were observed in the Gulpha Gorge Creek area, representing 38% of the total reptilian diversity. In addition, six of the nine terrestrial reptiles were found in this area.

The Gulpha Gorge Creek flows through a campground and along side a busy highway for much of its length. Yet, it still supports a wide variety of aquatic and riparian habitats typically associated with the Ouachita Mountain region. The combination of a permanent stream with numerous ephemeral tributaries with talus/boulder bottoms is characteristically an excellent habitat for several species of salamanders, including the Ouachita dusky salamander (*Desmognathus brimleyorum*) and the many-ribbed salamander. The Ouachita dusky salamander was found proportionate with the our expectations; however, the many-ribbed salamander was not observed at all during the course of this study, despite intentionally searching areas that would be considered appropriate habitat. The lack of any observations of this particular salamander was probably due to coincidence, but further investigation would be appropriate.

Although much of the habitat of Gulpha Gorge Creek is the same throughout its course, one area did stand out as offering a diverse habitat type. This area was a steep, rocky-bluff outcrop with ephemeral springs which supported healthy populations of western slimy salamanders (*Plethodon albagula*) and southern redback salamanders (*Plethodon serratus*). Other salamanders could occupy this wet area as well, although we found no other species during the present survey.

One other site was indicated as one of special concern by the administration of the National Park Service in Hot Springs. This area was a landfill that existed within the boundaries of the park and was described as a disposal site for toxic chemicals for some time in the past. Investigation of this area indicated that there were very few amphibians or reptiles in the area. The only species observed was the American toad in tadpole and metamorph stages. Many metamorphs demonstrated inflammation of the lymph glands.

Of the 25 species previously identified as occurring at the park, 16 were observed during the course of this study. Those not observed include three salamanders: ringed salamander (*Ambystoma annulatum*), many-ribbed salamander, and four-toed salamander (*Hemidactylium scutatum*). One turtle was not observed, midland softshell turtle, and five species of snakes--broad-banded water snake, diamondback water snake, queen snake (*Regina septemvittata*), western ribbon snake, and common garter snake.

Both the ringed salamander and many-ribbed salamanders have been discussed previously. The four-toed salamander is a rare species and, thus, may have eluded detection. The Fox Pass Road wetland area would be the most likely habitat to find this species. Of the remaining six species which were not observed during the course of this study, the queen snake is one of special concern. It was one of the most abundant water snakes of the region in the late 1800's, but Strecker (1924) only found two dead and decomposing individuals. Trauth (1991) was not able to locate any individuals in the Hot Springs area and neither were any observed during the present study. It is likely that with increasing development and alteration of the landscape, the queen snake was replaced by the midland water snake at the park.

Species diversity is the variety of species present combined with their relative abundances. Species diversity is believed to decrease when ecological integrity is compromised (Feinsinger 2001). It is, therefore, important that continued long-term monitoring occur at the park in order to insure the accuracy and precision of the resultant data set supporting future decision-making. Our brief one-year study is primarily a species inventory and, except in a few cases, provides limited abundance information.

Conclusion

Based on this inventory and the authors' professional opinion, several management recommendations are made to secure and/or promote species diversity.

1) Construct several small, temporary wildlife ponds in forested areas to promote mole salamander populations.
2) The marshy end of Stone Bridge Pond, the Fox Pass Road wetland, and the bluff site along Gulpha Gorge Creek should all be protected from draining or alteration.
3) Timber management should include a forest floor management plan so that sufficient logs, woody debris, and other refugia are available as amphibian and reptilian habitats.
4) Establishment of a long-term, population monitoring plan for the park.
5) The landfill site should be evaluated by a toxicological team to determine possible impacts upon organisms within the park.

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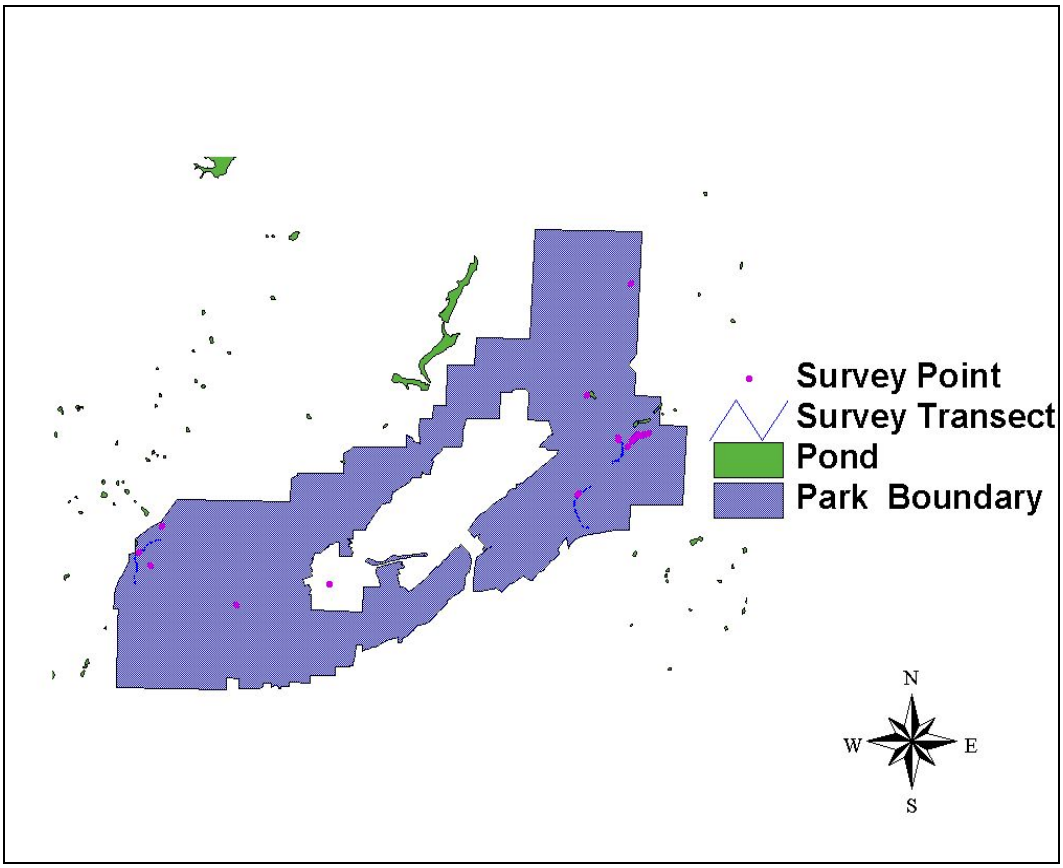

Figure 1. Map of Hot Springs NP, indicating survey locations.

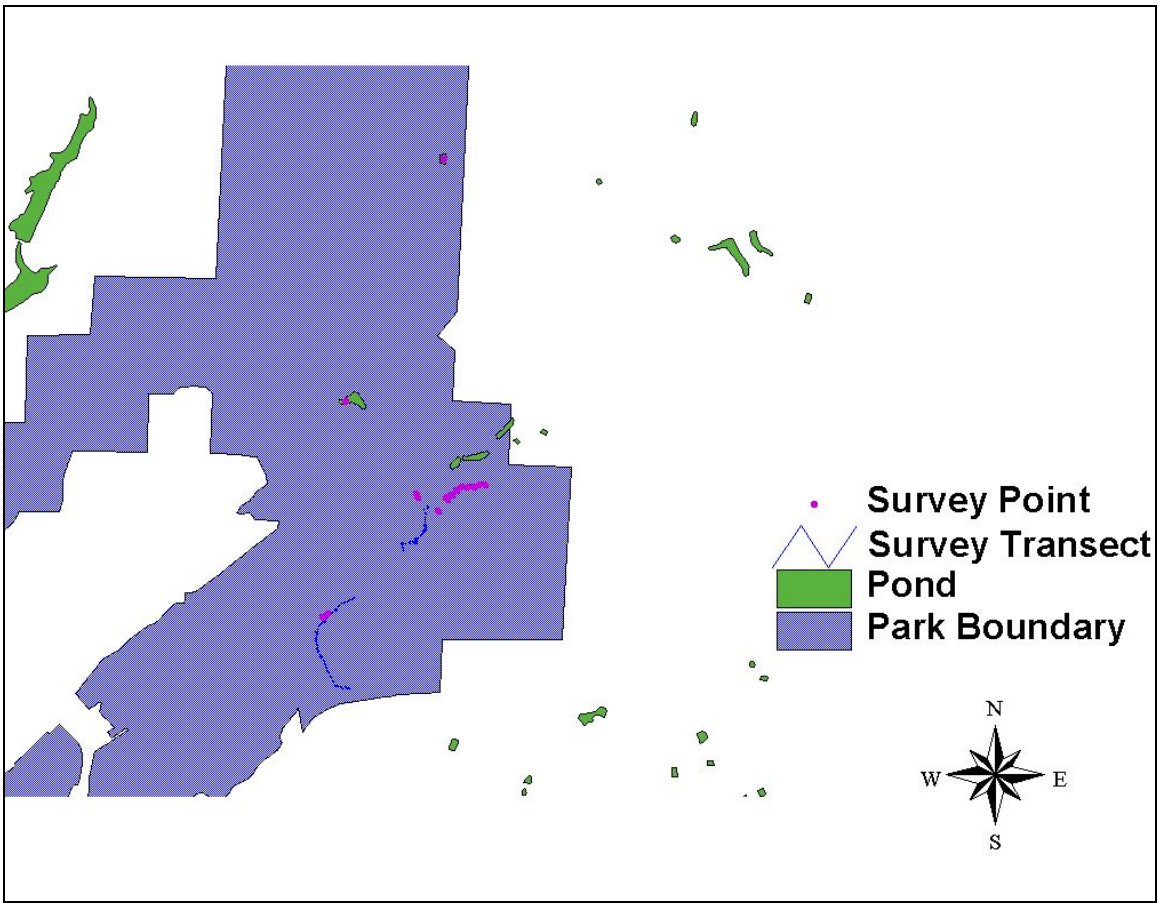

Figure 2. Map of the eastern portion of Hot Springs NP, indicating survey locations.

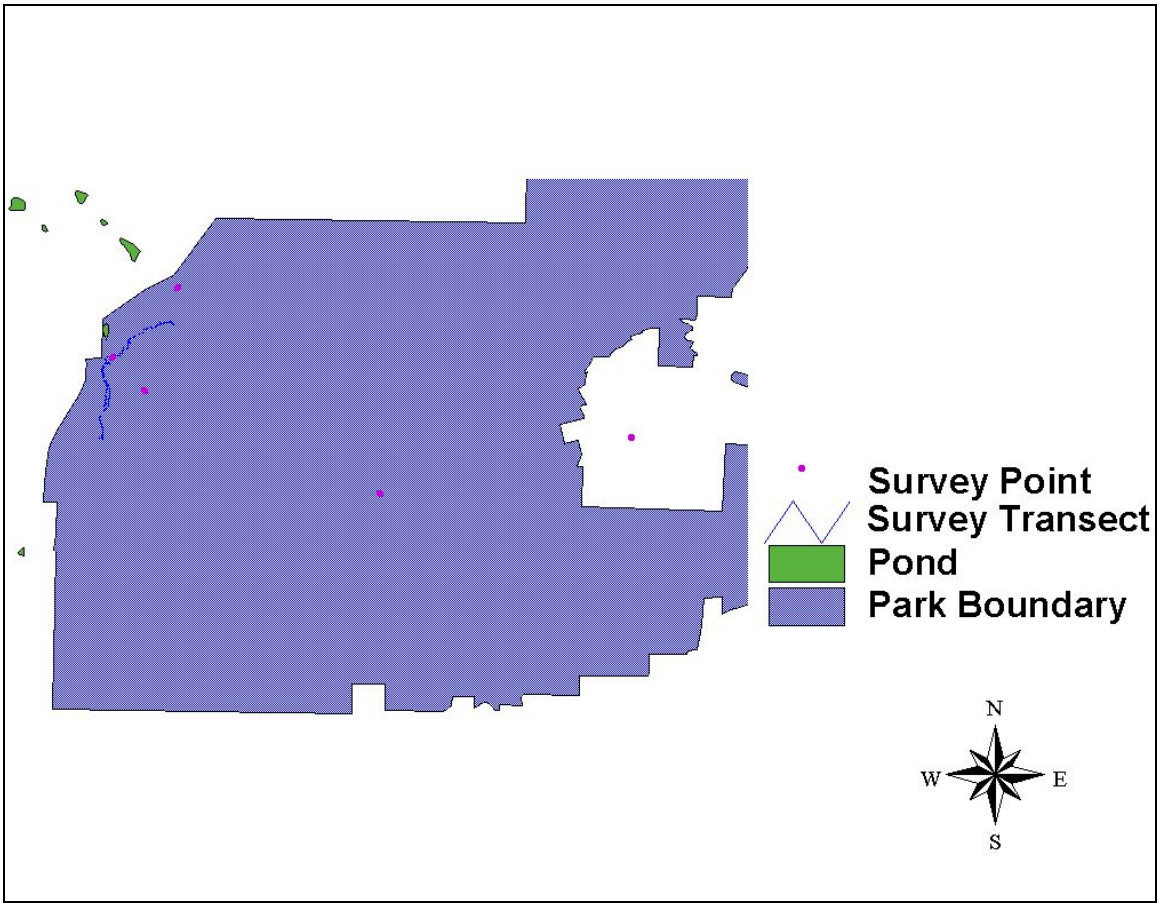

Figure 3. Map of the western portion of Hot Springs NP, indicating survey locations.

Table 1. Aquatic/ semi-aquatic amphibians and reptiles of Hot Springs NP (Strecker 1908, 1924). An "X" denotes presence at that survey year.

Scientific Name	**Common Name**	**1908**	**1924**
Acris crepitans blanchardi	N. cricket frog		X
Agkistrodon piscivorus leucostoma	Western cottonmouth	X	X
Ambystoma annulatum	Ringed salamander	X	X
Apalone mutica mutica	Midland smooth softshell		X
Bufo americanus charlesmithi	American toad	X	X
Chelydra serpentina serpentina	Common snapping turtle	X	X
Desmognathus brimleyorum	Ouachita dusky salamander	X	X
Eurycea multiplicata griseogaster	Many-ribbed salamander		X
Gastrophryne carolinensis	E. narrowmouth toad	X	X
Hemidactylium scutatum	Four-toed salamander		X
Hyla chrysoscelis	Gray treefrog		X
Hyla versicolor/chrysoscelis	Gray treefrog	X	
Nerodia erythrogaster flavigaster	Yellowbelly water snake	X	X
Nerodia fasciata confluens	Broad banded water snake		X
Nerodia rhombifer rhombifer	Diamondback water snake		X
Nerodia sipedon pleuralis	Midland water snake	X	X
Opheodrys aestivus	Rough green snake		X
Pseudacris triseriata feriarum	Western chorus frog	X	X
Pseudemys concinna	Eastern river cooter	X	X
Rana catesbeiana	Bullfrog	X	X
Rana clamitans melanota	Green frog	X	X
Rana sphenocephala	Northern leopard frog	X	X
Regina septemvittata	Queen snake	X	X
Thamnophis proximus proximus	Western ribbon snake	X	X
Thamnophis sirtalis sirtalis	Common garter snake	X	X
Trachemys scripta elegans	Red-eared slider		X

Table 2. Anurans of Hot Springs NP. Relative abundance: + = rare, +++++ = common.

Scientific Name	Common Name	Nov-2001	Dec-2001	Mar-2002	May-2002	Jun-2002	Relative Abundance
Acris crepitans blanchardi	N. cricket frog		X	X	X	X	++++
Bufo americanus charlesmithi	American toad			X			++++
Bufo woodhousii fowleri	Fowler's toad				X		+
Gastrophryne carolinensis	E. narrowmouth toad					X	++
Hyla chrysoscelis	Cope's gray treefrog				X	X	+++
Hyla cinerea	Green treefrog				X		++++
Pseudacris crucifer crucifer	N. spring peeper			X			+++++
Pseudacris triseriata feriarum	Upland chorus frog			X			++
Rana catesbeiana	Bullfrog	X	X	X	X	X	+++++
Rana clamitans melanota	Green frog		X	X	X	X	+++++
Rana sphenocephala	S. Leopard frog		X	X		X	++++

Table 3. Salamanders of Hot Springs NP. Relative abundance: + = rare, +++++ = common.

Scientific Name	Common Name	Nov-2001	Dec-2001	Mar-2002	May-2002	Jun-2002	Relative Abundance
Ambystoma maculatum	Spotted salamander			X		X	++
Desmognathus brimleyorum	Ouachita dusky salamander		X	X		X	+++

Table 4. Aquatic/ semi-aquatic snakes of Hot Springs NP. Relative abundance: + = rare, +++++ = common.

Scientific Name	Common Name	Nov-2001	Dec-2001	Mar-2002	May-2002	June-2002	Relative Abundance
Agkistrodon piscivorus leucostoma	Western cottonmouth			X		X	+++
Nerodia erythrogaster flavigaster	Yellowbelly water snake				X	X	++
Nerodia sipedon pleuralis	Midland water snake	X		X	X		++++
Opheodrys aestivus	Rough green snake				X		?

Table 5. Turtles of Hot Springs NP. Relative abundance: + = rare, +++++ = common.

Scientific Name	Common Name	Nov-2001	Dec-2001	Mar-2002	May-2002	June-2002	Relative Abundance
Chelydra serpentina serpentina	Common snapping turtle				X		+++
Pseudemys concinna	Eastern river cooter			X			++++
Sternotherus odoratus	Common musk turtle				X	X	+++
Trachemys scripta elegans	Red-eared slider				X	X	+++++

Table 6. Aquatic/ semi-aquatic amphibians of the Stone Bridge Pond area, Hot Springs NP. + = rare, +++++ = common.

Scientific Name	Common Name	Nov-2001	Dec-2001	Mar-2002	May-2002	June-2002	Relative Abundance
Acris crepitans blanchardi	Northern cricket frog			X	X	X	+++++
Bufo woodhousii fowleri	Fowler's toad				X		+
Gastrophryne carolinensis	E. narrowmouth toad					X	++
Hyla chrysoscelis	Cope's gray treefrog				X		+++
Hyla cinerea	Green treefrog				X		++++
Pseudacris crucifer crucifer	N. spring peeper			X			+++++
Rana catesbeiana	Bullfrog			X	X	X	+++++
Rana clamitans melanota	Green frog				X	X	++++
Rana sphenocephala	S. leopard frog			X			++++

Table 7. Aquatic/ semi-aquatic reptiles of the Stone Bridge Pond area, Hot Springs NP. Relative abundance: + = rare, +++++ = common.

Scientific Name	Common Name	Nov-2001	Dec-2001	Mar-2002	May-2002	June-2002	Relative Abundance
Chelydra serpentina serpentina	Common snapping turtle				X		+++
Nerodia erythrogaster flavigaster	Yellowbelly water snake				X	X	++
Nerodia sipedon pleuralis	Midland water snake			X	X		+++
Opheodrys aestivus	Rough green snake				X		+
Pseudemys concinna	Eastern river cooter			X	X	X	++++
Sternotherus odoratus	Common musk turtle				X	X	++++
Trachemys scripta elegans	Red-eared slider				X	X	+++++

Table 8. Aquatic/ semi-aquatic amphibians and reptiles of the Fox Pass Rd. Pond area, Hot Springs NP. Relative abundance: + = rare, +++++ = common.

Scientific Name	Common Name	Nov-2001	Dec-2001	Mar-2002	May-2002	June-2002	Relative Abundance
Acris crepitans blanchardi	N. cricket frog					X	++++
Agkistrodon piscivorus leucostoma	W. cottonmouth			X		X	+++++
Ambystoma maculatum	Spotted salamander			X		X	+++
Bufo americanus charlesmithi	American toad			X			+++
Desmognathus brimleyorum	Ouachita dusky salamander			X			++
Pseudacris crucifer crucifer	N. spring peeper			X			+++
Pseudacris triseriata feriarum	Upland chorus frog			X			++
Rana catesbeiana	Bullfrog					X	+++
Rana clamitans melanota	Green frog			X		X	++++
Rana sphenocephala	S. leopard frog			X			+++

Table 9. Aquatic/ semi-aquatic amphibians and reptiles of the Gulpha Gorge Creek area, Hot Springs NP. Relative abundance: + = rare, +++++ = common.

Scientific Name	Common Name	Nov-2001	Dec-2001	Mar-2002	May-2002	June-2002	Relative Abundance
Rana catesbeiana	Bullfrog				X	X	++++
Rana clamitans melanota	Green frog	X					+++
Rana sphenocephala	Southern leopard frog	X					+++
Desmognathus brimleyorum	Ouachita dusky salamander			X		X	++++
Nerodia sipedon pleuralis	Midland water snake	X		X			+++++
Pseudemys concinna	Eastern river cooter					X	+
Sternotherus odoratus	Common musk turtle				X		++++

Table 10. Terrestrial amphibians and reptiles of Hot Springs NP. Relative abundance: + = rare, +++++ = common.

Scientific Name	Common Name	Nov-2001	Dec-2001	Mar-2002	May-2002	June-2002	Relative Abundance
Plethodon albagula	Western slimy salamander	X		X		X	++++
Plethodon serratus	Southern redback salamander	X		X			++
Cnemidophorus sexlineatus viridis	Eastern six-lined racerunner					X	++
Eumeces fasciatus	Five-lined skink				X		++++
Scincella lateralis	Ground skink			X			++++
Carphophis vermis	Western worm snake					X	++
Diadophis punctatus stictogenys	Prairie ringneck snake					X	+++
Lampropeltis getula holbrooki	Speckled kingsnake				X		+++
Terrapene carolina triunguis	Three-toed box turtle				X		++++

Table 11. List of amphibian expected and current status of occurrence at Hot Springs NP.

Order Anura	**Scientific Name**	**Common Name**	**Old**	**New**	**Trauth**
Bufonidae	Bufo americanus charlesmithi	American toad	1	2	Yes
	Bufo woodhousii fowleri	Fowler's toad	1	2	Yes
Hylidae	Acris crepitans blanchardi	Cricket frog	1	2	Yes
	Hyla chrysoscelis	Gray treefrog	1	2	Yes
	Hyla cinerea	Green treefrog	1	2	Yes
	Pseudacris crucifer crucifer	Northern spring peeper	1	2	Yes
	Pseudacris triseriata feriarum	Western chorus frog	1	2	Yes
Microhylidae	Gastrophryne carolinensis	Eastern narrowmouth toad	1	2	Yes
Pelobatidae	Scaphiopus holbrooki	Eastern spadefoot	1	0	No
Ranidae	Rana catesbeiana	Bullfrog	1	2	Yes
	Rana clamitans melanota	Green frog	1	2	Yes
	Rana palustris	Pickerel frog	1	0	No
	Rana utricularia	Southern leopard frog	1	2	Yes
Order Caudata					
Ambystomatidae	Ambystoma annulatum	Ringed salamander	1	1	No
	Ambystoma maculatum	Spotted salamander	1	2	Yes
	Ambystoma opacum	Marbled salamander	1	0	No
	Ambystoma talpoideum	Mole salamander	1	1	No
	Ambystoma texanum	Smallmouth salamander	1	0	No
Amphiumidae	Amphiuma tridactylum	Three-toed amphiuma	1	0	No
Plethodontidae	Desmognathus brimleyorum	Ouachita dusky salamander	1	2	Yes
	Eurycea multiplicata griseogaster	Many-ribbed salamander	1	1	No
	Eurycea quadridigitata	Dwarf salamander	1	0	No
	Hemidactylium scutatum	Four-toed salamander	1	1	No
	Plethodon albagula	Western slimy salamander	1	1	Yes
	Plethodon serratus	S. red-backed salamander	1	1	No
Proteidae	Necturus maculosus louisianensis	Mudpuppy	1	1	No
Salamandridae	Notophthalmus viridescens louisianensis	Central newt	1	1	No
Sirenidae	Siren intermedia nettingi	Lesser siren	1	1	No

"Old" indicates the status prior the inventory, "New" the status after the inventory, and "Trauth" indicates whether the author vouchered the species. Values for Old and New follow Boetsch et al (2000): a "1" is used to indicate that a given species is expected, "2" indicates that the species was observed (documented within the park), "3" indicates species that were not on the expected species list but were observed, and "4" indicates an extinct or regionally extirpated species.

Table 12. List of reptiles expected and current status of occurrence at Hot Springs NP.

Order Squamata	Scientific Name	Common Name	Old	New	Trauth
Anguidae	Ophisaurus attenuatus attenuatus	Slender glass lizard	1	1	No
Colubridae	Carphophis vermis	Western worm snake	0	2	No
	Cemophora coccinea copei	Scarlet snake	1	1	No
	Coluber constrictor priapus	Racer	1	1	No
	Diadophis punctatus stictogenys	Ringneck snake	0	1	No
	Elaphe guttata emoryi	Great Plains rat snake	1	1	No
	Elaphe obsolete	Black rat snake	1	1	No
	Heterodon platirhinos	Eastern hognose snake	0	1	No
	Lampropeltis calligaster calligaster	Prairie kingsnake	1	1	No
	Lampropeltis getula holbrooki	Speckled kingsnake	2	?	No
	Lampropeltis triangulum syspila	Milk snake	1	1	No
	Masticophis flagellum flagellum	Eastern coachwhip	1	?	No
	Nerodia erythrogaster flavigaster	Plainbelly water snake	1	2	Yes
	Nerodia fasciata confluens	Broad-banded water snake	1	1	No
	Nerodia rhombifer rhombifer	Diamondback water snake	1	1	No
	Nerodia sipedon pleuralis	Northern water snake	1	2	Yes
	Opheodrys aestivus	Rough green snake	1	2	Yes
	Regina grahamii	Graham's crayfish snake	1	0	No
	Regina rigida sinicola	Gulf crayfish snake	1	0	No
	Regina septemvittata	Queen snake	1	4	No
	Storeria dekayi wrightorum	Brown snake	1	2	No
	Storeria occipitomaculata occipitomaculata	Redbelly snake	1	2	No
	Tantilla gracilis	Flathead snake	1	2	No
	Thamnophis proximus proximus	Western ribbon snake	1	1	No
	Thamnophis sirtalis sirtalis	Common garter snake	1	2	No
	Virginia striatula	Rough earth Snake	1	1	No
	Virginia valeriae	Smooth earth snake	1	1	No
Phrynosomatidae	Sceloporus undulatus	Fence lizard	1	1	No
Polychrotidae	Anolis carolinensis	Green anole	1	2	No
Scincidae	Eumeces anthracinus pluvialis	Coal skink	1	1	No
	Eumeces fasciatus	Five-lined skink	1	1	No
	Eumeces laticeps	Broadhead skink	1	1	No
	Scincella lateralis	Ground skink	1	1	No
Teiidae	Cnemidophorus sexlineatus viridis	Six-lined racerunner	1	2	No
Viperidae	Agkistrodon contortrix contortrix	Northern copperhead	2	2	No
	Agkistrodon piscivorus leucostoma	Cottonmouth	2	2	Yes
	Crotalus atrox	W. diamondback rattlesnake	2	?	No

Table 12. List of reptiles expected and current status of occurrence at Hot Springs NP (cont.).

Order Squamata	**Scientific Name**	**Common Name**	**Old**	**New**	**Trauth**
Viperidae	Crotalus horridus	Timber rattlesnake	0	1	No
Order Testudines					
Chelydridae	Chelydra serpentina serpentina	Snapping turtle	1	2	Yes
	Deirochelys reticularia	Chicken turtle	1	0	No
	Macrochelys temminckii	Alligator snapping turtle	1	1	No
Emydidae	Graptemys geographica	Map turtle	1	1	No
	Graptemys kohnii	Mississippi map turtle	1	1	No
	Graptemys pseudogeographica	False map turtle	1	0	No
	Pseudemys concinna	River cooter	1	2	Yes
	Pseudemys floridana	Missouri slider	1	0	No
	Pseudemys picta	Painted turtle	1	0	No
	Terrapene carolina triunguis	Three-toed box turtle	1	1	No
	Terrapene ornata	Ornate box turtle	1	0	No
	Trachemys scripta elegans	Red-eared slider	1	2	Yes
Kinosternidae	Kinosternon subrubrum hippocrepis	Mississippi mud turtle	1	1	No
	Sternotherus carinatus	Razorback musk turtle	1	1	No
	Sternotherus odoratus	Musk turtle (stinkpot)	1	2	Yes
Trionychidae	Apalone mutica mutica	Smooth softshell	1	1	No
	Apalone spinifera hartwegi	Spiny softshell	1	1	No

Table 13. List of amphibians and reptiles park status, abundance, and residency at Wilson's Creek NB.

Category	Order	Family	Standard Scientific Name	Park Status	Abundance	Residency
Amphibian	Anura	Bufonidae	Bufo americanus charlesmithi	Present in Park	Common	Resident
			Bufo woodhousii fowleri	Present in Park	Rare	Resident
		Hylidae	Acris crepitans blanchardi	Present in Park	Common	Resident
			Hyla chrysoscelis	Present in Park	Common	Resident
			Hyla cinerea	Present in Park	Common	Resident
			Pseudacris crucifer crucifer	Present in Park	Common	Resident
			Pseudacris triseriata feriarum	Present in Park	Uncommon	Resident
		Microhylidae	Gastrophryne carolinensis	Present in Park	Uncommon	Resident
		Ranidae	Rana catesbeiana	Present in Park	Common	Resident
			Rana clamitans melanota	Present in Park	Common	Resident
			Rana sphenocephala	Present in Park	Common	Resident
	Caudata	Ambystomatidae	Ambystoma annulatum	Probably Present	Unknown	Unknown
			Ambystoma maculatum	Present in Park	Uncommon	Resident
			Ambystoma talpoideum	Probably Present	Unknown	Unknown
		Plethodontidae	Desmognathus brimleyorum	Present in Park	Uncommon	Resident
			Eurycea multiplicata griseogaster	Probably Present	Unknown	Unknown
			Hemidactylium scutatum	Probably Present	Unknown	Unknown
			Plethodon albagula	Probably Present	Unknown	Unknown
			Plethodon serratus	Probably Present	Unknown	Unknown
		Proteidae	Necturus maculosus louisianensis	Probably Present	Unknown	Unknown
		Salamandridae	Notophthalmus viridescens louisianensis	Probably Present	Unknown	Unknown
		Sirenidae	Siren intermedia nettingi	Probably Present	Unknown	Unknown
Reptile	Squamata	Anguidae	Ophisaurus attenuatus attenuatus	Probably Present	Unknown	Unknown
		Colubridae	Carphophis vermis	Present in Park	Uncommon	Resident
			Cemophora coccinea copei	Probably Present	Unknown	Unknown
			Coluber constrictor priapus	Probably Present	Unknown	Unknown
			Diadophis punctatus stictogenys	Probably Present	Unknown	Resident
			Elaphe guttata emoryi	Probably Present	Unknown	Resident
			Elaphe obsoleta	Probably Present	Unknown	Resident

Table 13. List of amphibians and reptiles park status, abundance, and residency at Wilson's Creek NB (cont.).

Category	Order	Family	Standard Scientific Name	Park Status	Abundance	Residency
Reptile	Squamata	Colubridae	Heterodon platyrhinos	Present in Park	Unknown	Resident
			Lampropeltis calligaster calligaster	Probably Present	Unknown	Unknown
			Lampropeltis getula holbrooki	Present in Park	Unknown	Resident
			Lampropeltis triangulum syspila	Probably Present	Unknown	Resident
			Masticophis flagellum flagellum	Unconfirmed	Unknown	Unknown
			Nerodia erythrogaster flavigaster	Present in Park	Uncommon	Resident
			Nerodia fasciata confluens	Probably Present	Unknown	Unknown
			Nerodia rhombifer rhombifer	Probably Present	Unknown	Unknown
			Nerodia sipedon pleuralis	Present in Park	Common	Resident
			Opheodrys aestivus	Present in Park	Unknown	Resident
			Regina septemvittata	Historic	Unknown	Unknown
			Storeria dekayi wrightorum	Present in Park	Unknown	Resident
			Storeria occipitomaculata occipitomaculata	Present in Park	Unknown	Resident
			Tantilla gracilis	Present in Park	Unknown	Resident
			Thamnophis proximus proximus	Probably Present	Unknown	Unknown
			Thamnophis sirtalis sirtalis	Present in Park	Unknown	Resident
			Virginia striatula	Probably Present	Unknown	Resident
			Virginia valeriae elegans	Probably Present	Unknown	Resident
		Phrynosomatidae	Sceloporus undulatus hyacinthinus	Probably Present	Unknown	Unknown
		Polychrotidae	Anolis carolinensis	Present in Park	Unknown	Resident
		Scincidae	Eumeces anthracinus pluvialis	Probably Present	Unknown	Unknown
			Eumeces fasciatus	Probably Present	Unknown	Unknown
			Eumeces laticeps	Probably Present	Unknown	Unknown
			Scincella lateralis	Probably Present	Unknown	Unknown
		Teiidae	Cnemidophorus sexlineatus viridis	Present in Park	Uncommon	Resident
		Viperidae	Agkistrodon contortrix contortrix	Present in Park	Unknown	Resident
			Agkistrodon piscivorus leucostoma	Present in Park	Common	Resident
			Crotalus atrox	Unconfirmed	Unknown	Resident

Table 13. List of amphibians and reptiles park status, abundance, and residency at Wilson's Creek NB (cont.).

Category	Order	Family	Standard Scientific Name	Park Status	Abundance	Residency
Reptile	Squamata	Viperidae	Crotalus horridus	Probably Present	Unknown	Unknown
	Testudines	Chelydridae	Chelydra serpentina serpentina	Present in Park	Common	Resident
			Macroclemys temminckii	Probably Present	Unknown	Unknown
		Emydidae	Graptemys geographica	Probably Present	Unknown	Unknown
			Graptemys kohnii	Probably Present	Unknown	Unknown
			Pseudemys concinna	Present in Park	Common	Resident
			Terrapene carolina triunguis	Probably Present	Unknown	Unknown
			Trachemys scripta elegans	Present in Park	Common	Resident
		Kinosternidae	Kinosternon subrubrum hippocrepis	Probably Present	Unknown	Unknown
			Sternotherus carinatus	Probably Present	Unknown	Unknown
			Sternotherus odoratus	Present in Park	Common	Resident
		Trionychidae	Apalone mutica mutica	Probably Present	Unknown	Unknown
			Apalone spinifera hartwegi	Probably Present	Unknown	Unknown