

**Herpetofaunal Inventory of the King's
Mountain National Military
Park: Final Report**

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INTRODUCTION:

Currently, there is a paucity of information on the distribution and abundance of reptiles and amphibians that inhabit the Piedmont of South Carolina (Platt et al., 1999). Meanwhile, many species of reptiles and amphibians are considered threatened and/or endangered, and concern for the global decline of amphibian and reptile populations is growing (Gibbons et al., 2000; Houlahan et al., 2000). Baseline inventories of reptiles and amphibians are necessary to provide information relevant to conservation and resource management (Oliver and Beattie, 1993; Platt et al., 1999). Also, the identification of populations of rare/threatened species that occur on federal lands is necessary to ensure protection from visitor-use impacts and other anthropogenic factors. Systematic surveys are often necessary to provide baseline data that may allow for monitoring long-term trends in local diversity and abundance (McDiarmid, 1994). The reptiles and amphibians of the King's Mountain National Military Park had not been surveyed prior to this study. Consequently, the occurrence and distribution of these animals within park boundaries were not known.

The primary objective of this project was to begin a systematic inventory of the herpetofauna within the boundaries of the King's Mountain National Military Park. Specific goals included: (1) begin the process of developing an accurate list of reptile and amphibian species inhabiting the park through a one-year inventory, and (2) provide information relevant to the distribution of reptiles and amphibians among the various habitats within the park.

METHODS:

Reptiles and amphibians inhabit a diverse array of environments/habitats (e.g., terrestrial, fossorial, aquatic, semi-aquatic, and arboreal), and one sampling method is usually not sufficient to completely inventory herpetofaunal diversity. Several methods were used in this survey including artificial cover board (ACB) arrays, dipnetting, turning natural cover objects, glue boards, and visual searches. ACB sampling was conducted in a systematic manner (detailed description below) to allow for comparisons among habitat types, and for the possibility of others repeating these methods in the future for monitoring temporal changes in herpetofaunal diversity. The other methods were not conducted in a systematic fashion, and the sole purpose of

these efforts was to build a more complete species list (i.e, species inventory). Various collecting methods were used during these nonsystematic efforts, e.g., dipnetting, turning natural cover objects, road surveys, glue boards, and basic visual searches. Three trips were made specifically with the purpose of conducting nonsystematic searches (22 April 2002, 8 July 2002, and 4 October 2002). Park staff provided additional assistance with collecting and freezing road-killed animals for voucher purposes. All specimen incidentally encountered (e.g., found while walking to cover board arrays) were recorded and added to the list of species inhabiting the park.

Thirteen sites were established for placement of ACB arrays. Six of these sites were located within upland deciduous forests, and 6 in bottomland deciduous forests adjacent to creeks. These two habitats represented the two most common habitat types within park boundaries (C. Revels, Pers. Comm.). One unreplicated site was established on the powerline right-of-way at the request of park management. The powerline right-of-way was thought to represent a somewhat unique habitat on the park, and thus, worthy of additional sampling effort. Animals were captured within this habitat, however, nothing was found under an ACB on this site during this survey. Therefore, the ACB results obtained within this unreplicated site were not included in any of the statistical analyses.

The location of each ACB array and a few selected landmarks were illustrated in Figure 1, and GPS coordinates listed in Table 1. Two types of artificial cover boards were used on each of the 13 transects: 8 (4 ft x 2 ft) 1/4 in plyboards, and 34 (1 ft x 1 ft) 2 x 12's (total = 42 ACB/site) were distributed at ca. 1.5 m intervals along each transect (42 boards x 13 transects = 546 cover boards on the entire park). Artificial cover boards were placed in two parallel rows about 3 - 5 m apart with the rows being about 10 – 20 m apart. However, due to habitat considerations, the boards on site W6 were distributed into 3 parallel rows. The amount of bottomland forest habitat at this particular site was not large enough to permit two parallel rows of boards. The specific placement/order of the plywood and 2 x 12's was random within each row, however, an equal number of plywood and 2 x 12's were used in each row. Setup of the ACB arrays began during June 2001 and was completed on all sites by 10 August 2001. All boards were subsequently checked once during each month for 10 months (specific dates: 16 September 2001, 15 October 2001, 5 November 2001, 25 February 2002, 25

March 2002, 29 April 2002, 17 May 2002, 21 June 2002, 3 July 2002, and 28 August 2002). December and January were the only months in which ACB arrays were not checked.

Success rate of ACB arrays was calculated as the percent of boards that yielded animals during the survey. The success rate of all ACB arrays as well as success rate within each habitat type for both reptiles and amphibians was reported as mean success rate $\pm$ 1 SE. Success rates of ACB arrays were compared using Mann-Whitney *U* tests (Sokal and Rohlf, 1995). Also, the proportion of reptiles and amphibians found under ACB arrays within the two habitat types were compared with a chi-square test (Sokal and Rohlf, 1995). Level of significance (α) was set at 0.05 for all statistical tests.

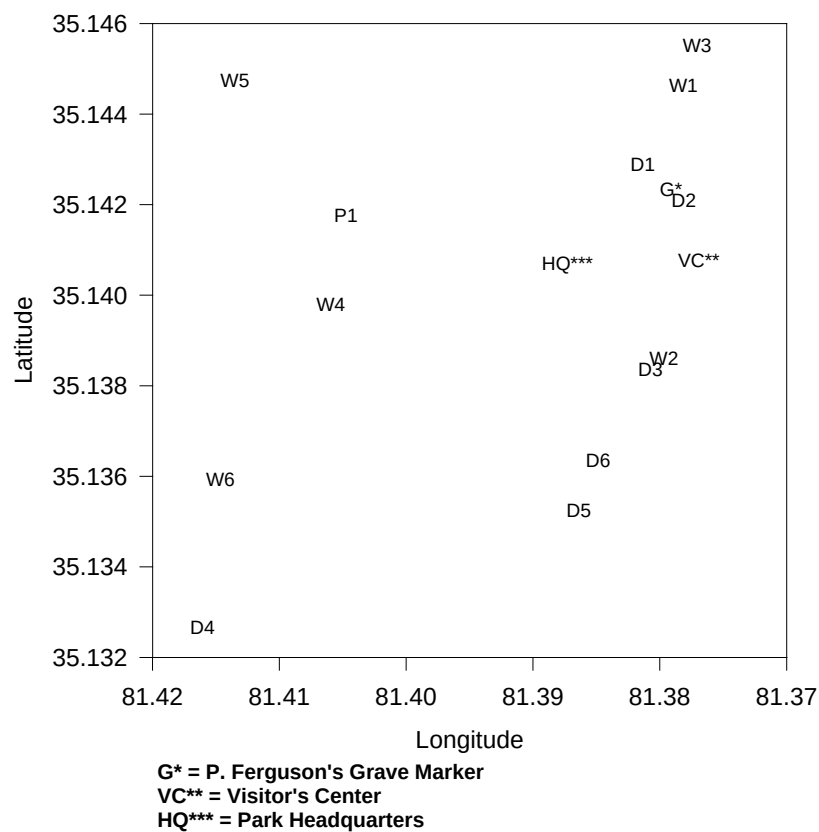
Animals were identified to species and released unharmed at their point of capture (with the exception of a few voucher specimen). Photographic or actual specimen were deposited into the University of South Carolina Spartanburg Museum of Natural History reptile and amphibian collection. Scientific and common names follow those used in Conant and Collins (1998). Capture locations of most individuals were obtained with a Garmin 12[®] handheld GPS unit. All coordinates were presented as latitude/longitude using the North American Datum Standard of 1927 (NAD27) and the ellipsoid was the Geodetic Reference System 80 (GRS80). All guidelines for the use of live amphibians and reptiles in field research outlined by the American Society of Ichthyologists and Herpetologists, Herpetologists League, and the Society for the Study of Amphibians and Reptiles (ASIH et al., 1997) were followed.

TABLE 1. GPS coordinates¹ for each of the thirteen sites with artificial cover board arrays at the King's Mountain National Military Park. Coordinates taken near the middle of each array. (Letters within each of the site designates habitat type ;W = bottomland deciduous forest; D = upland deciduous forest; P = powerline).

Site#	° North	° West
W1	35.14463	81.37813
W2	35.13860	81.37967
W3	35.14551	81.37705
W4	35.13979	81.40594
W5	35.14473	81.41349
W6	35.13592	81.41464
D1	35.14288	81.38135
D2	35.14208	81.37811
D3	35.13835	81.38074
D4	35.13267	81.41607
D5	35.13525	81.38639
D6	35.13635	81.38486
P1	35.14176	81.40474

¹Coordinates were obtained with a Garmin 12[®] handheld GPS unit. All coordinates were presented as latitude/longitude using the North American Datum Standard of 1927 (NAD27) and the elipsoid was the Geodetic Reference System 80 (GRS80).

Figure 1. A rough map of selected landmarks and the locations of the thirteen coverboard arrays at King's Mountain National Military Park.



RESULTS:

A total of 160 individuals (72 amphibians; 88 reptiles) were captured during the course of the inventory (Table 2). Appendix 1 provides specific data with respect to each of the 160 individual captures (including GPS coordinates for most individuals). When all survey methods were combined, 35 different species (20 reptiles; 15 amphibians; Table 2) were found within the park. All of these species were expected to occur within this region of South Carolina (see Conant and Collins, 1998).

Nonsystematic methods (e.g., hand collecting, dipnetting, glue traps, etc.) yielded 110 individuals of 33 different species (Table 3). Cover boards yielded a total of 50 individuals (25 reptiles; 25 amphibians) of 9 different species (7 reptiles; 2 amphibians; Table 4). The bottomland deciduous forests yielded 32 individuals of 6 different species, while upland deciduous forests yielded 18 individuals of 5 different species (Table 5). Overall average success rate of ACB arrays for capturing both reptiles and amphibians on all 12 sites was $0.99\% \forall 0.183$. Mean success rate of ACB arrays in upland deciduous sites was $0.71\% \forall 0.317$, and $1.27\% \forall 0.123$ within the bottomland habitats. But, success rate of ACB arrays within the two habitat types was not significantly different (Mann-Whitney *U*-test: $U = 10.50$; $N_1 = 6$; $N_2 = 6$; $P = 0.212$). Average success rate for capturing reptiles was $0.595\% \forall 0.171$ within upland habitats and $0.397\% \forall 0.159$ within bottomland habitats. However, the ACB success rate for reptiles within these two habitats was not significantly different (Mann-Whitney *U*-test: $U = 23.00$; $N_1 = 6$; $N_2 = 6$; $P = 0.411$). Average success rate for amphibian captures was $0.119\% \forall 0.119$ within upland habitats and $0.873\% \forall 0.340$ within bottomland habitats. ACB success rate for capturing amphibians was significantly different between the two habitat types (Mann-Whitney *U*-test: $U = 6.000$; $N_1 = 6$; $N_2 = 6$; $P = 0.039$). Also, overall proportions of reptiles and amphibians found under ACB arrays within the two habitat types were significantly different between bottomland deciduous forests and upland deciduous habitats ($\chi^2 = 12.5$; $df = 1$; $P = 0.0001$), with a higher proportion of the reptiles being caught within the upland habitats, and a higher proportion of amphibians within the bottomland sites (Table 6).

TABLE 2. List of reptiles and amphibians collected at King's Mountain National Military Park during a one-year survey conducted from Fall 2001 through Fall 2002. This list includes all species collected regardless of collection method.

AMPHIBIANS

Frogs:

Scientific Name ¹	Common Name ¹	Voucher ²
<i>Acris crepitans</i>	Northern Cricket Frog	Yes
<i>Bufo americanus</i>	American Toad	Yes
<i>Bufo woodhousei</i>	Fowler's Toad	Yes
<i>Hyla chrysoscelis / versicolor</i>	Gray Treefrog	Yes
<i>Pseudacris triseriata</i>	Upland Chorus Frog	Yes
<i>Rana catesbeiana</i>	Bullfrog	Yes
<i>Rana clamitans</i>	Green Frog	Yes
<i>Rana utricularia</i>	Southern Leopard Frog	Yes

Salamanders:

<i>Ambystoma maculatum</i>	Spotted Salamander	Yes
<i>Ambystoma opacum</i>	Marbled Salamander	Yes
<i>Desmognathus fuscus</i>	Dusky Salamander	Yes
<i>Eurycea cirrigera</i>	Southern two-lined Salamander	Yes
<i>Eurycea longicauda guttolineata</i>	Three-lined Salamander	Yes
<i>Gyrinophilus porphyriticus</i>	Carolina Spring Salamander	Yes
<i>Plethodon cylindraceus (glutinosus complex)</i>	White-spotted Slimy Salamander	Yes

REPTILES

Snakes:

<i>Agkistrodon contortrix</i>	Copperhead	Yes
<i>Carhophis amoenus</i>	Eastern Worm Snake	Yes
<i>Coluber constrictor</i>	Northern Black Racer	Yes
<i>Crotalus horridus</i>	Timber Rattlesnake	Yes
<i>Diadophis punctatus</i>	Southern Ringneck Snake	Yes
<i>Elaphe guttata</i>	Corn Snake	Yes
<i>Elaphe obsoleta</i>	Black Rat Snake	Yes
<i>Heterodon platyrhinos</i>	Eastern Hognose Snake	Yes
<i>Nerodia sipedon</i>	Midland Water Snake	Yes
<i>Opheodrys aestivus</i>	Rough Green Snake	Yes
<i>Regina septemvittata</i>	Queen Snake	Yes
<i>Storeria occipitomaculata</i>	Redbelly Snake	Yes
<i>Virginia valeriae</i>	Smooth Earth Snake	Yes

Turtles:

<i>Terrapene carolina</i>	Eastern Box Turtle	Yes
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TABLE 2. Continued...

Lizards:

Scientific Name ¹	Common Name ¹	Voucher ²
<i>Anolis carolinensis</i>	Green Anole	Yes
<i>Cnemidophorus sexlineatus</i>	Six-lined Racerunner	Yes
<i>Eumeces fasciatus</i>	Five-lined Skink	Yes
<i>Eumeces inexpectatus</i>	Southeastern Five-lined Skink	Yes
<i>Sceloporus undulatus</i>	Northern Fence Lizard	Yes
<i>Scincella lateralis</i>	Ground Skink	Yes

¹ = Scientific and common names follow those used in Conanat, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern/Central North America (3rd Edition). Houghton Mifflin Company, New York.

² = All specimen have been deposited into the reptile and amphibian collection at the University of South Carolina Spartanburg's Museum of Natural History.

TABLE 3. List of species and number of individuals captured during nonsystematic collecting efforts at King’s Mountain National Military Park. Nonsystematic efforts included turning natural cover objects, dipnetting within streams, glue boards, and visual searches.

Scientific name ¹	common name ¹	#individuals
<i>Acris crepitans</i>	Northern Cricket Frog	4
<i>Agkistrodon contortrix</i>	Copperhead	1
<i>Ambystoma maculatum</i>	Spotted Salamander	1
<i>Ambystoma opacum</i>	Marbled Salamander	1
<i>Anolis carolinensis</i>	Green Anole	11
<i>Bufo americanus</i>	American Toad	4
<i>Bufo woodhousei</i>	Fowler’s Toad	3
<i>Carhophis amoenus</i>	Eastern Worm Snake	4
<i>Cnemidophorus sexlineatus</i>	Six-lined Racerunner	4
<i>Coluber constrictor</i>	Northern Black Racer	1
<i>Crotalus horridus</i>	Timber Rattlesnake	4
<i>Desmognathus fuscus</i>	Dusky Salamander	5
<i>Elaphe guttata</i>	Corn Snake	1
<i>Elaphe obsoleta</i>	Black Rat Snake	3
<i>Eumeces fasciatus</i>	Five-lined Skink	3
<i>Eurycea cirrigera</i>	Southern Two-lined Salamander	4
<i>Eurycea longicauda guttolineata</i>	Three-lined Salamander	2
<i>Gyrinophylus porphyriticus</i>	Carolina Spring Salamander	1
<i>Heterodon platyrhinus</i>	Eastern Hognose Snake	4
<i>Hyla chrysoscelis/ versicolor</i>	Gray Treefrog	1
<i>Nerodia sipedon</i>	Midland Water Snake	6
<i>Opheodrys aestivus</i>	Rough Green Snake	1
<i>Plethodon cylindraceus</i>	White-spotted Slimy Salamander	3
<i>Pseudacris triseriata</i>	Upland Chorus Frog	9
<i>Rana catesbeiana</i>	Bullfrog	1
<i>Rana clamitans</i>	Green Frog	3
<i>Rana utricularia</i>	Southern Leopard Frog	7
<i>Regina septemvittata</i>	Queen Snake	3
<i>Sceloporus undulatus</i>	Northern Fence Lizard	3
<i>Scincella lateralis</i>	Ground Skink	2
<i>Storeria occipitomaculata</i>	Redbelly Snake	1
<i>Terrapene carolina</i>	Eastern Box Turtle	7
<i>Virginia valeriae</i>	Smooth Earth Snake	2

¹ = Scientific and common names follow those used in Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern/Central North America (3rd Edition). Houghton Mifflin Company, New York.

TABLE 4. Diversity of reptiles and amphibians found under artificial cover boards on the 13 artificial cover board arrays and the total number of individuals of each that were captured.

Scientific name ¹	common name ¹	#individuals
<i>Agkistrodon contortrix</i>	Copperhead	2
<i>Anolis carolinensis</i>	Green Anole	1
<i>Carhophis amoenus</i>	Eastern Worm Snake	4
<i>Diadophis punctatus</i>	Southern Ringneck Snake	1
<i>Eumeces fasciatus</i>	Five-lined Skink	14
<i>Eumeces inexpectatus</i>	Southeastern Five-lined Skink	2
<i>Scincella lateralis</i>	Ground Skink	1
<i>Euryces cirrigera</i>	Southern Two-lined Salamander	9
<i>Plethodon cylindraceus</i>	White-spotted Slimy Salamander	16

¹ = Scientific and common names follow those used in Conanat, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern/Central North America (3rd Edition). Houghton Mifflin Company, New York.

TABLE 5. Results of artificial cover board sampling within the two most common habitat types at the King’s Mountain National Military Park (i.e., upland deciduous forest and bottomland forest). Table includes a list of species as well as the number of individuals captured within each habitat type.

Scientific name ¹	Common Name ¹	Upland Forest	Bottomland Forest
<i>Agkistrodon contortrix</i>	Copperhead	0	2
<i>Anolis carolinensis</i>	Green Anole	1	0
<i>Carhophis amoenus</i>	Eastern Worm Snake	0	4
<i>Diadophis punctatus</i>	Southern Ringneck Snake	0	1
<i>Eumeces fasciatus</i>	Five-lined Skink	11	3
<i>Eumeces inexpectatus</i>	Southeastern Five-lined Skink	2	0
<i>Scincella lateralis</i>	Ground Skink	1	0
<i>Euryces cirrigera</i>	Southern Two-lined Salamander	0	9
<i>Plethodon cylindraceus</i>	White-spotted Slimy Salamander	3	13

¹ = Scientific and common names follow those used in Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern/Central North America (3rd Edition). Houghton Mifflin Company, New York.

Table 6. The number of individual reptiles and amphibians captured within each of the two habitat types (i.e., upland deciduous forest and bottomland deciduous forest) using artificial cover boards.

<u>Habitat</u>	<u>Amphibians</u>	<u>Reptiles</u>
Upland Forest	3	15
Bottomland Forest	22	10

DISCUSSION:

Short term (e.g., one-year) surveys are usually not sufficient to document >90% of the reptile and amphibian species that reside within an area the size of King's Mountain National Military Park (Gibbons, 2002). However, the results of this one-year survey provided a foundation that can be built upon in order to develop a complete inventory of the herpetofauna inhabiting the King's Mountain National Military Park. There were species that were expected to occur within this region of South Carolina that were not found (e.g., *Thamnophis sirtalis*; *Storeria dekayi*; *Masticophis flagellum*; *Pituophis melanoleucus*; *Lampropeltis getula*; and many others; see Conant and Collins, 1998). Some of these species will probably be captured during subsequent inventory and monitoring efforts. However, some species that inhabit the South Carolina Piedmont may not exist within the park due to the lack of certain habitats within park boundaries. For example, the absence of aquatic turtles may have been related to the lack of suitable aquatic habitat. However, beaver (*Castor canadensis*) dams that have recently been constructed along sections of King's Creek may provide suitable aquatic turtle habitat in the future (Metts et al., 2001).

Given the greater susceptibility of amphibians to desiccation, the greater proportion of amphibians captured in association with ACB arrays located within bottomland habitats was not surprising. However, the relatively poor success rate of ACB arrays (overall $\theta = 0.99\%$), relatively low diversity found under ACB arrays (i.e., only 9 species), burning activities on some of the transects, and the severe drought during the study period made confident interpretation of ACB results difficult.

The various nonsystematic methods of collection yielded more than twice the number of individual captures and three times the number of species yielded by ACB arrays. The apparent greater success of the nonsystematic methods relative to ACB arrays was particularly striking given that there were only 3 trips made with the specific purpose of collecting via nonsystematic methods. However, it is important to note that many of these animals were collected incidentally while traveling between sites while checking ACB arrays, driving between sites, and other activities. In other words, nonsystematic efforts were conducted (to some degree) during every trip to the park, and not just on the 3 days specifically scheduled for such efforts. The relatively poor success of ACB arrays suggests that such arrays may not represent the "best" method for an inventory of

the herpetofauna on this park. However, the severity of the drought may have negatively impacted the success rate of ACB arrays. In other words, ACB arrays may yield more individuals and greater diversity during years with normal rainfall. Also, ACB arrays have been used effectively during other studies (e.g., Monti et al., 2000). Therefore, ACB arrays may still be useful for monitoring populations of some species (e.g., *Plethodon cylindraceus*) within this park.

I suggest that future inventory and monitoring efforts include systematic frog call surveys, as well as more aggressive hand collecting efforts. I also recommend a more systematic (quantitative) approach with respect to hand collecting efforts during future surveys (e.g., see Smith and Petranksa, 2000).

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