

**A Herpetofaunal Inventory of Hopewell Culture National Historical Park, Ross County,
Ohio**

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Summary

A thirteen-month herpetofauna survey was conducted at Hopewell Culture National Historical Park (NHP) in Chillicothe, Ohio. Prior to the inventory, no data was available to document the reptiles and amphibian species found within the park boundary. The objective of this survey was to document the herpetological species occurring within the five non-contiguous park units. The survey yielded 12 amphibian (5 salamanders and 7 anurans) and 11 reptilian species (5 turtle and 6 snakes). Based on the results of the inventory, 46 % of the likely reptiles (11 of 24) and 57 % of the likely amphibians (12 of 21) were documented. Four species of amphibians were added to the list. Management recommendations identify the need for long term monitoring of reptile and amphibian populations in order to document additional species and monitor existing populations.

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Introduction

In recent years, biologists have documented declines in amphibian and reptile populations worldwide. The declines have been reported from protected, pristine habitats such as national parks and preserves, leading researchers to believe that global factors may be to blame. The exact cause of these declines is unknown; however, a number of factors have been implicated such as pollution, disease, parasites, UV-B radiation, climatic changes, habitat destruction, and habitat fragmentation. Amphibians are excellent bio-indicators of the surrounding environment's health. Most amphibian species have complex life cycles which are composed of an egg, aquatic larvae, and terrestrial adult. The complex life cycle coupled with permeable skin cause amphibians to act much like sponges; absorbing environmental contaminants from water, air, and land.

Ohio is home to two Federally listed threatened reptile species, one candidate reptile species, and six species of concern (5 reptiles, 1 amphibian) (U.S. Fish and Wildlife 2004). The state is also home to five state-listed endangered reptiles (snakes) and five state-listed endangered amphibians (4 salamanders and 1 anuran) (ODNR 2003a). A decline in suitable habitats may be to blame for these endangered Ohio herpetological species. Most of Ohio has undergone extensive logging and agricultural development, leaving many amphibian and reptile habitats absent or severely altered. Nearly 90% of Ohio's wetland habitats have been altered for development and agriculture, putting stress on water dependent species (Davis and Menze 2002). Agriculture in west-central Ohio may be to blame for declining frog and toad populations (Davis and Menze 2002). Run-off from agricultural wastes, fertilizers, as well as pesticides can make water uninhabitable for tadpoles and other aquatic life.

National Parks often serve as refuges for many species of amphibians and reptiles. For this reason, it is important that the National Park Service achieve at minimum, a baseline understanding of the biological diversity within the parks thereby enabling them to make informed management and conservation decisions for the future. Without baseline data, the accurate measurement of population changes is impossible. Those concerned with amphibian and reptile populations have long understood the need to establish long-term studies, using standardized methods to monitor natural populations. In 1998, the U.S. Congress passed the National Park Omnibus Management Act in response to concerns about the condition of natural resources within National Parks. The act requires each park throughout the United States to gather baseline inventory data on pertinent natural resources. This herpetofauna survey is the first of several surveys taking place to help determine the biological diversity present within Hopewell Culture National Historical Park.

The objectives of the 13-month survey include: document the herpetological species occurring at Hopewell Culture National Historical Park, describe species abundance, and collection of voucher specimens for each common species.

Study Area

Ohio's history of glacial activity has resulted in a wide variety of distinct habitats with differing topography. The study area, located in Ross County, is a mixture of Till Plains, Glaciated Allegheny Plateau, and Unglaciated Allegheny Plateau Physiographic Regions. Hopewell Culture National Historical Park lies totally within the Till Plains and Glaciated Allegheny Plateau regions of Ohio. The park units are, therefore, characterized by flat to rolling land covered by sand, gravel, and soil (Till Plains) to rolling, rounded land (Glaciated Allegheny Plateau) (Pfingsten and Downs 1989). The park lacks the exposed bedrock gorges typical of the Glaciated Allegheny Plateau.

Hopewell Culture National Historical Park includes five non-contiguous park units located in south-central Ohio near the city of Chillicothe in Ross County. The location of the five units is presented in Figure 1. The park contains significant prehistoric archeological resources such as earthworks built by the Hopewell Culture (200 BC - AD 500). The total area of the park encompasses approximately 440 ha (1,086.31 ac) and is comprised of the following five park units:

Mound City Group is located in Union Township approximately three miles north of Chillicothe on St. Rt. 104, along the Scioto River. The Scioto River is the eastern boundary of this unit. The site is comprised of approximately 49 ha (120 ac). A large portion of the unit consists of mowed lawn (12 ha, 30 ac) which encompasses the earthworks, visitor center, maintenance facility and administration buildings (Figure 2). Approximately 18 ha (45 ac) is in agricultural production and is periodically harvested for hay. Additional habitats consist of early successional mixed mesophytic woodlot, and a fairly mature riparian zone along the Scioto River (Figure 3). The canopy within the mesophytic forest is relatively open, allowing thick undergrowth of invasive exotic plant species including honeysuckle species (*Lonicera japonica* and *L. tartarica*) and multiflora rose (*Rosa multiflora*).

Hopeton Earthworks is located in Springfield Township on Hopetown Road along State Route 159, approximately two miles from Chillicothe. The 118 ha (292 ac) site is closed to the public. Approximately 71 ha (175 ac) of this unit consists of agricultural fields which were periodically harvested for hay. An additional 18 ha (45 ac) of land were used for soybean and corn production through the 2003 growing season (Figure 4). This section of land now lies fallow. The unit also consists of an early successional woodlot approximately 15 ha (36 ac) in size (Figure 5). Within this woodlot lies an intermittent stream (Dry Run) which contains aquatic life (Figure 6). Though not within the park, a large quarry lies at the boundary of the park making aquatic species possible within this park unit (Figure 7). It is also worth noting the existence of isolated pools located on top of quarry fill at this site (Figure 8).

High Bank Works is located in Liberty Township, approximately four miles southeast of Chillicothe on U.S. Route 35, along the Scioto River. The 77 ha (190 ac) site is closed to the public. Habitats consist primarily of agricultural hayfields, with secondary habitats including a small fallow field as well as a riparian zone along the Scioto River (Figure 9).

Seip Earthworks is located in Paxton Township, 18 miles southwest of Chillicothe on U.S. Route 50, along Paint Creek. The 68 ha (168 ac) unit is open to the public, but offers no trails or visitor facilities. In the past a large portion of this park unit was in agricultural production for hay, corn, soybean, or winter wheat. During the survey the park began to decrease the amount agricultural use of this land. A strip of riparian zone is present along Paint Creek which borders the park (Figure 10). It should be noted that Paint Creek is considered a high-quality warmwater watershed of the Scioto River (Sanders and Zimmerman 2001).

Hopewell Mound Group is located approximately 6 miles west of Chillicothe, in Union Township on the corner of Sulphur Lick and Maple Grove Road near the North Fork of Paint Creek. The site encompasses 128 ha (316.31 ac) and is open to the public, but currently offers no visitor facilities. A section of the Tri-county bike trail is located within the park. The dominant habitat consists of fields in agricultural production which were periodically harvested for hay through the 2002 growing season. This acreage now lies fallow. Additional habitats include a semi-mature mesophytic mixed woodlot, small portions of grassland, and fallow fields (Figure 11 & 12). Within the mesophytic woodlot is a woodland pond approximately 1/3 acre in size which contains aquatic life (Figure 13).

Materials and Methods

Due to the variety of habitats and the number of species targeted, several sampling techniques were used to ensure that every potential species was sampled appropriately. The primary sampling techniques were as follows: visual encounter survey (VES), quadrant sampling, drift fences and funnel traps, artificial cover, turtle traps, and general search and seizure methods.

The inventory began in May, 2002 and continued for a field season of thirteen months. Very little monitoring was conducted during the winter months due to reptile and amphibian inactivity. Habitats within the park were divided into four categories: 1) Fallow fields, 2) Agricultural fields, 3) Grasslands, 4) Woodlots (including Riparian Zones). All locations of quadrants, plots, and artificial cover were randomly selected (via GIS using ArcView; NAD27) among particular habitat areas, located, and marked using a Trimble Pro XR GPS unit. Locations of drift fences, plots, and coverboards are illustrated in Figures 14 through 18.

The visual encounter survey includes field personnel walking through an area for a prescribed time period systematically searching for targeted species. The time spent is expressed as the number of person hours of searching in each area. This sampling technique has been proven to be useful for sampling herpetological species that live on the surface of forest litter or emerge after rain (Pough et al. 1987; Corn and Bury 1990).

In large uniform areas, such as second growth deciduous woodlots, a randomized walk design was used. Before going out into the field to collect data using the VES method, the observer chose a random number of sequential compass readings and a random number of meters to walk. The observer then used a compass to walk the random directions, searching for animals. All reptiles and amphibians seen within one meter on either side of the path were recorded.

A VES is also carried out in transects following the perimeter of waterways in order to search for basking turtles. However, waterways were not extensively surveyed because they lie outside of park property. Identification of basking turtles was difficult to perform due to the distance from specimens. Only species with distinct visual characteristics that could be seen from a distance were recorded.

The quadrant sampling technique consists of laying out randomly chosen quadrants (small squares) with stakes and twine within a habitat of interest and searching for and recording all herpetological species encountered. The quadrant sampling technique is especially useful in sampling species that live in forest litter or under debris along streams that might not be seen using the VES method (Scott 1976; Lloyd et al. 1968).

Plots of 2 m x 2 m were used with two people searching for specimens. The individuals searched the plots by turning over rocks and other objects, dismantling decomposing logs, and raking through leaf litter. All objects turned over were replaced to their original position to minimize disturbance to the habitat.

Drift fences with pitfall or funnel traps are used commonly to inventory reptile and amphibian populations in a variety of habitats (Szaro et al. 1988). Drift fences serve the purpose of redirecting the direction of animals into traps that can be monitored throughout the year. This technique is useful to determine the presence or absence of many rare amphibian species that otherwise may not be encountered (Heyer et al. 1994).

Drift fences were placed in the woodland habitat of the five park units. The drift fences were constructed of 50 cm high aluminum flashing in a T-like 20 m x 10 m sections (Figure 19). No digging or disturbance of the ground was permitted due to the sensitive archeological sites. For this reason, pit falls were not used and drift fences were kept in place with wooden stakes and surface dirt and debris.

The funnel traps consist of rounded tubes with inwardly directed funnel openings at both ends. The funnel traps were formed by taking a 71.12 cm x 45.72 cm piece of rigid hardware cloth and securing in the shape of a tube with staples. The funnel portions of the trap are formed by cutting a 22.86 cm x 40.64 cm half circle pattern out of fiberglass screening with a 3.81 cm x 10.16 cm inner circle on the flat portion of the half moon. The inner circle provides the hole to the funnel. The funnels are then secured using staples to the tube portion of the trap. The funnels were placed parallel to the drift fence, midway along each side and were shaded with loose debris such as leaf litter. The traps were checked the following day before noon to prevent predation and dehydration of specimens.

Both amphibians and reptiles often take cover under natural or man-made debris. For this reason artificial covers are systematically placed and checked for specimens. Due to differences in the quality of cover for amphibian and reptiles, both wooden and corrugated asphalt boards measuring 121.92 cm x 60.96 cm were used for coverboards (Figure 20 & 21). Coverboards were placed in all habitat types within the five park units. Coverboards were checked periodically throughout the field season by quickly flipping the boards and catching all specimens (Figure 22). The coverboards were placed directly back on the ground after checking. Specimens not retained for voucher collection were released after data collection, and placed near the coverboard.

Other types of traps were used to sample the herpetofauna of the park units. Minnow traps commonly used for collecting bait fish are an effective way to collect aquatic specimens such as salamanders and tadpoles. The pond at Hopewell Mound Group was sampled with this method. Aquatic basking traps were also used to sample turtle species along the Scioto River at Mound City Group. The basking traps consists of 5.08 cm PVC pipe constructed to form a 86.36 cm x 86.36 cm square. Chicken wire is fitted to the frame in order to catch turtles that fall into the trap. A 2.54 cm x 15.24 cm board is placed on top of the PVC frame to serve as a basking area. When turtles are disturbed and drop into the water, they are caught in the netting. These traps were set in the morning and checked the same afternoon.

Many amphibian and reptile species were collected by searching areas that exhibited good habitat

characteristics or by finding them while walking through the park units. Several of the amphibian and reptile species were collected while searching for GPS coordinates, placing drift fences, or by park employees during their routine duties.

When species were encountered, the following data were collected: collector's full name, time, date, weather, species encountered, specific specimen information (weight, length, etc.). One voucher specimen of each species encountered was collected (excluding turtles and any rare or endangered species). Voucher photographs in the form of digital photographs were taken of any turtle specimens and rare or endangered species.

In the event that deformed or diseased individuals were encountered during the course of the inventory, the specimen were to be assessed based on NARCAM (North American Reporting Center for Amphibian Malformations) protocols and the finding were to be reported immediately to the Heartland Network Office.

Euthanizing of specimens was done in the most humane way possible that leaves the specimens undamaged and relaxed. Reptiles and amphibians were euthanized by immersion in warm water or a 10% solution of ethyl alcohol (Heyer et al. 1994). Specimens were removed immediately after death.

Preservation of specimens was done in two steps. The specimens were placed in a position which aids in the viewing of key identifying characteristics and placed in a solution of 10% formalin with a neutral pH. Once fixed, the specimens were placed in a solution of 3 parts of 95% alcohol to 1 part water. Injection of formalin or small slits in some specimens were made to help prevent decomposition.

Labels with a unique field number, scientific name, locality (park unit, county, and state), date and time of collection, as well as collector's name, were placed on all voucher specimens. Tags were attached by a square knot above the right knee for frogs and larger salamanders. The tags were placed around the neck of smaller specimens of salamanders and all snakes. Voucher specimens, including both biological and photographic specimens, were deposited at Hopewell Culture National Historical Park.

Results

The inventory yielded twelve amphibian species (five salamanders and seven anurans) and eleven reptilian species (five turtles and six snakes) (Tables 1 and 2). Five species were represented by a single observation/specimen. These species included the map turtle, false map turtle, brown snake, northern water snake, and milk snake. Species observed and their relative abundances are provided in Tables 3 and 4. No deformed amphibian or reptiles were encountered during the survey.

Expected Species

An expected species list incorrectly listed five amphibians and six reptiles due to incorrect species range and/or habitat requirements. Upon revising this list, the inventory yielded 57 % of the amphibians (12 of 21) and 46 % of the reptiles (11 of 24) (Tables 1 & 2). Four amphibian species were added to the list.

Species Richness and Abundance

Overall species richness was highest at Hopewell Mound Group, yielding twelve species of amphibians (five salamanders and seven anurans) and six species of reptiles (five snakes and one turtle species). Mound City Group yielded four species of amphibians and six species of reptiles. Hopeton Earthworks yielded one species of reptile and seven species of amphibian. High Bank Works yielded two species of amphibian and four species of reptile. The lowest overall species richness was at Seip Earthworks, which yielded a total of four species. The species were comprised of three amphibians (three anurans) and one reptile species (one snake) (Table 5).

Discussion

The objective of the herpetofauna survey was to document 90% of the herpetological species reasonably expected to occur at Hopewell Culture National Historical Park. Long sampling periods (usually several years) are needed in order to sample sites that have highly seasonal climatic changes and where individual specimens are highly scarce (Heyer et al. 1994). Ohio has a seasonal temperate climate. In addition, some of the habitat within the park is agricultural, yielding low overall diversity, making additional sampling necessary to document the greatest amount of herpetological species present.

The expected and observed list provided by the Heartland Network listed a number of species as “expected in the park” that are not found within range of the study sites, such as the eastern diamond back rattlesnake (*Crotalus adamanteus*). The list also lacked species that were observed during the study, such as the northern ravine salamander (*Plethodon electromorphus*). For this reason, the original list was altered to reflect only those species found within Ohio. Those species listed as “expected” are defined as species with known ranges that overlapped park areas and that habitat specifications could be found within park boundaries. A number of species have historical records found in Ross County, but requires specific habitat requirements that was not found within the park, making the observation of this species in the park unlikely. These species were listed as “not expected in the park.”

A number of aquatic species, such as the eastern hellbender (*Cryptobranchus alleganiensis*) and the mudpuppy (*Necturus maculosus*) may be found in waterways adjacent to park boundaries. Because these species are strictly aquatic and the waterways do not fall within the park boundaries, the species are “not expected in the park.” Historically, both of these species have been documented in Ross County waterways, such as Paint Creek (Pfingsten and Downs 1989). Although strictly aquatic species found in waterways outside of the park were eliminated from the expected list, partially aquatic species, such as turtles, were not. Turtles spend much of their time in the waterways outside of the parks boundaries; but they may be using the park property as nesting and breeding sites and are, therefore, listed as “expected within the park”.

The success of surveying was dependent upon the sampling technique used. Drift fences and plots were not found to be helpful in searching for specimens. The drift fences and funnel traps were difficult to keep in place for long periods of time and were often removed by wind or deer activity. The funnel traps allowed gaps between drift fence and trap, proving them to be inferior to pit falls traps. Though pit falls would have probably served as superior traps for drift fences, they were not permitted due to the sensitive archeological features of the park. Few amphibians or reptile species were found within plots. Those species that were recovered within plots, were also found by search and seizure methods. Coverboards proved to be very useful in surveying snake species within open habitats such as agricultural fields. The amount of species found beneath coverboards increased the longer the coverboards were kept in place. Overall, the

majority of the species were surveyed by simple search and seizure methods, allowing the researcher to search areas that exhibited good reptile and amphibian habitat.

The Ohio endangered eastern spadefoot toad (*Scaphiopus holbrookii*) was listed as “not expected within the park.” The species is only known from five counties (Morgan, Lawrence, Washington, Athens, and Pike Co.) in Ohio. Human disturbances have altered or extirpated populations in four of the five counties. Though the range of the eastern spadefoot toad reaches into western Ross County, no current populations are known to exist. Portions of Hopewell Culture National Historical Park property includes potential spadefoot toad habitat. Their habitat includes open fields within valleys containing loose sandy soil. They breed in temporary pools in flooded fields or depressions after unusually heavy rains between April and August (Davis and Menze 2002). Due to the frog’s unpredictable mating period and fossorial habits, undocumented populations may exist in Ohio.

The Ohio endangered timber rattlesnake (*Crotalus horridus*) was listed as “not expected in the park” for similar reason as the eastern spadefoot toad. Due to harvesting, habitat destruction, and fragmentation, the range of the timber rattlesnake has been limited to only eight southern Ohio counties. The only viable populations (> 50) exist in Vinton and Scioto Counties. Although a small population of timber rattlesnakes is located in Tar Hollow State Forest in the eastern portion of Ross County, no documented observation of the species has occurred near Hopewell Culture National Historical Park (ODNR 2003b). Hopewell Culture National Historical Park lacks much of the habitat needed for timber rattlesnake establishment. The snakes require three types of habitat for long term establishment. The dening habitat consists of rocky hillsides with underground crevices many times located on southern slopes with relatively open canopy cover. A summer habitat is typically mixed deciduous or coniferous forests with nearly closed canopy, heavy leaf litter, and little herbaceous cover, and few rocks or fallen trees. A transient habitat is an area near the den much like the summer or denning habitat which is used by pregnant females. Due to the average home range size for timber rattlesnakes (160 acres for males, 42 acres for barren females, and 9 acres for pregnant females) and the distance of known established populations, the observation of a timber rattlesnake has been listed as “not expected within the park” (ODNR 2003c). It should be mentioned that the timber rattlesnake's shy, secretive behavior makes observation of this species difficult and additional unknown populations in Ross County may exist.

All species observed during the survey were expected species typical for habitats provided by park land, such as eastern deciduous forest, agricultural hayfields, and fallow fields. Hopewell Mound Group contained 18 of the 24 species observed during the survey, accounting for 75% of the herpetological species found within the park boundaries. This may be a result of the diverse amount of habitat provided at this site. Hopewell Mound Group boasts the largest continuous stretch of mature eastern deciduous woodlot of any of the other four sites, as well as a large quantity of fallow fields and agricultural fields. The site also contains unique features such as a woodland pond and seep which reaches into the dry fallow field area. These factors, along with several riparian areas adjacent to the park allows for a combination of habitats to be used by a number of herpetological species. It should be mentioned that limited search efforts at some of

the sites located farther away, such as Seip Earthworks, may have resulted in bias of the amount of species found within each site.

The high percentage of agricultural use on park property has developed habitats lower in biological diversity than other habitat types. Certain species of reptiles adapt well in agricultural fields, such as black rat snakes (*Elaphe obsoleta*) and are therefore, expected to be found at fairly high abundance. Snakes use the agricultural habitat to feed upon the abundant rodent populations and nesting bird species. However, agricultural areas generally provide a low diversity of amphibians. With the limited amount of canopy coverage offered by agricultural crops, amphibians tend to dehydrate. Proximity to moisture tends to be the largest variable in amphibian diversity. With large watersheds bordering a number of sites, riparian zones and moist leaf litter yielded the most amphibian species. An example of the necessity of aquatic habitat was found at Hopeton Earthworks and Hopewell Mound Group. Though Hopeton Earthworks unit contains a small intermittent stream and a bordering quarry, some species require small bodies of stagnant water absent of other predatory aquatic life, such as fish. Located in the Hopeton Earthworks park unit is a large mound of quarry fill dirt. The movement of this material has developed man-made shallow pools ideal for gray tree frog (*Hyla chrysoscelis/versicolor*), American toad (*Bufo americanus*), and Fowler's toad (*Bufo woodhousii fowleri*), all of which have been found to be breeding within these small pools (Figure 23). Similarly, Hopewell Mound Group contains a woodland pond which provides a unique breeding habitat for a number of species that would otherwise be absent from the park unit such as the red-spotted newt (*Notophthalmus viridescens*), northern green frog (*Rana clamitans melanota*), American bullfrog (*Rana catesbeiana*), and the Jefferson salamander (*Ambystoma jeffersonianum*).

Due to the destruction and fragmentation of *Ambystoma* habitat, many populations have decreased or ceased to exist where they once thrived. A population of Jefferson salamander appears to be using the Hopewell Mound Group woodland pond as a breeding site. Though no voucher specimen of the salamander was collected; *Ambystoma* egg masses were documented in the pond during late winter and early spring (Figure 24). Several decomposed *Ambystomas* which resembled specimens of Jefferson salamander were observed around the perimeter of the pond.

The spotted salamander (*Ambystoma maculatum*) was listed as possibly present and is considered common in Ohio. It is less common in highly cultivated areas of Ohio and more common in southern and eastern areas of Ohio. There are records of this species from Ross County, specifically Scioto Township. Therefore this species range overlaps the park. Its need for vernal or semi-permanent ponds may be the deciding factor as to where the populations are found. Hopewell Mound Group's small vernal pools (flooded borrow pits) and woodland pond were surveyed for this species during the time of mass migration but this species was not found to occupy the park. Destruction and clearing of surrounding forest land, forest fragmentation, or inadequate breeding sites may explain why this species was not found within the park boundaries. However, the park does have appropriate habitat and is within the range of this species.

The marbled salamander (*Ambystoma opacum*) occurs throughout Ohio except in the very northwest corner of the state. The marbled salamander has been recorded in Ross County in Townships such as Scioto and Twin Twp., making the park within range of this species. Though, typically found in swampy forest, they may also be found in other wet areas. Much like other species of the *Ambystoma* genus, they tend to spend much of their lives underground and usually only found during the mass migration to breeding pools. The marbled salamander breeds in pools during the fall that will retain some water during the growth of the larvae. Due to the secretive nature of this species, this species may not have been encountered during the one year survey. It is more likely that the park does not have adequate breeding pools to sustain a population of this species.

Jefferson salamanders commonly use semi-permanent to permanent water holes with adequate depth. They often share their pools with red-spotted newts, green frogs, bullfrogs, and some fish species. The Hopewell Mound Group woodland pond is indicative of the breeding pools used by the Jefferson salamander species. Furthermore, no other Ohio species of salamander migrate to breeding pools in early to late winter except small mouth salamanders and perhaps the tiger salamander (Pfungsten and Downs 1989). Neither of these species is expected in park boundaries. These observations in conjunction with the habitat description and the month in which the eggs were laid indicates the Jefferson salamander species. Park staff should establish a monitoring program for the Hopewell Mound Group *Ambystoma* population to positively identify the species and ensure the health of the population.

Two turtle species found within the park, the eastern box turtle (*Terrapene carolina*) and the false map turtle (*Graptemys pseudogeographica*), are listed on Ohio Fish and Wildlife species of interest list (Figure 25 & 26). The Ohio Department of Natural Resources defines a species of interest as a species or subspecies which might become threatened in Ohio under continued or increased stress. Also, a species or subspecies for which there is some concern but for which information is insufficient to permit an adequate status evaluation (ODNR 2002).

The eastern box turtle spends the majority of its time in mature woods, preferring the moist ground litter. Ohio's populations of eastern box turtles have become stressed due to habitat loss and fragmentation from extensive logging and agriculture. Declines may also be linked to mortality due to vehicles, collection for the pet trade, as well as introduced diseases.

The false map turtle may be listed for different reasons. It is not fully understood if this species, which is mainly found in the Mississippi River drainage, is a remnant natural population within the Scioto River watershed or an introduced species due to the pet trade (Conant 1951; Conant and Collins 1998). The discrepancy of origin and limited range within Ohio makes this turtle a species of special interest.

Several species listed as "expected but not observed" were documented near park sites. The fivelined skink (*Eumeces fasciatus*) was observed three miles from Hopewell Mound Group on State Route 50 in Moore Cemetery. Photos were taken and included in report voucher photos. Though the skink was not found in the park, it does indicate that observations of this species

within park boundary are likely to occur. The skink has been recorded for a number of locations in Ohio. It can be found under logs and other debris, but rarely strays far from moist woodland habitat. Because a specimen was found so close to the park unit and near a riparian zone similar to those found within the park, it is my opinion that this species may inhabit one or more of the park units.

Another species that was expected but not observed within the park was the Blanchard's cricket frog (*Acris crepitans blanchardi*). A chorus was heard calling from wet ditches along the bike trail within a half mile of Hopewell Mound Group. The park unit contains adequate habitat for the cricket frog, but this species was not observed in the park during the survey. The reason for the absence within the park is unknown.

The spotted dusky salamander (*Desmognathus fuscus*) is mainly confined to the Allegheny Plateau Sections of Ohio which includes Ross County. This species has been found in areas of Ross County such as Colerain Twp, Harrison Twp, Jefferson Twp., Paint Twp., Union Twp, and Chillicothe. This species is typically found along gorge-bottom streams. However, at times they may be found in other areas that stay moist such as seeps and spring-banks. Hopeton Earthworks contain a small stream but it is not located in a gorge-like setting. Seip Earthworks borders Paint Creek which has a cliff located on the opposite side of the river, but lacks the two-sided gorge habitat and contains a large creek verses a smaller stream ideal for this species. This species was designated as expected but not observed because several of the park units contain moist areas that may house populations of this species, especially since they have been found in the surrounding areas. It is my opinion that though the species may be expected within the park and the park has viable habitat, the park lacks habitat which is ideal to the species which may explain why this species was not observed.

The longtail salamander (*Eurycea longicauda*) is found throughout most of Ohio, with the exception of central and northern sections of the Great Lakes areas. It can be found under pieces of rock such as shale near stream banks or under forest leaf litter near streams. This species has been located in Ross County in areas such as Colerain Twp., Harrison Twp., and Chillicothe. The park contains adequate habitat to support this species. The species was not encountered during the survey, but may be encountered if more extensive surveying took place over a longer period of time. The park does have limited stream side habitat which could also diminish the chances of encountering this species. Dry Run is the only small stream located within the park boundaries and it is intermittent during the hot summer months.

The slimy salamander (*Plethodon glutinosus*) is found in the Glaciated and Unglaciated Allegheny Plateaus which includes Ross County. It has been located in Colerian Twp., Green Twp, and Harrison Twp. within Ross County. The slimy salamander is typically found under large objects on slopes and ravines, but does not utilize habitat that floods periodically. The park contains some woodland habitat that contains ravines and gorges, but the majority of the park's woodland habitat is not mature or floods periodically from nearby waterways. The park is within range of this species and contains appropriate habitat, though it is limited. Additional surveys may yield an observation of this species or the park may not have adequate habitat to sustain a population.

The western chorus frog (*Pseudacris triseriata*) is found throughout most of the western two-thirds of the state. They are typically found on the sparsely vegetated shorelines of ponds, lakes, gravel pits, rivers, and creeks. They may inhabit temporary pools of water if permanent areas of water are near. The park units have rivers bordering several of the sites and Hopeton contains a gravel pit. The park lies within the range of this species and contains the correct habitat. This species should be closely monitored in Ohio since surrounding states have experienced a population decline in the recent past. The reason this species was not encountered during the survey is unknown.

The pickerel frog (*Rana palustris*) is considered common in eastern and south-central Ohio. They utilize forest ravines, rocky streams, and springs for their habitat. They may also occur in wet meadow and fens. During summer months they can often be found in fields far away from water. Though the park has limited wet meadow and forest ravine habitat, the park does border several rocky streams and contains much open agricultural fields. Additional surveys may yield this species.

The wood frog (*Rana sylvatica*) is considered common throughout much of Ohio with the exception of the Till Plain region in western-central Ohio where deforestation has caused many populations to disappear. This species requires forest habitat, spending much of their time under leaf litter and logs. They are easily found during their mass migration to breeding sites on the first warm rainy nights of the season. The only park site which contains the appropriate habitat and breeding site would be Hopewell Mound Group. This park site contains a woodland pond (man-made) surrounding by a semi-mature track of woodland. The pond was extensively surveyed for wood frogs and their egg masses during their breeding season. The park is well within range of the wood frog and contains adequate habitat at one of the park units, yet this species was not encountered during the survey. This species may be in low numbers within the park causing this species to be over looked during the survey or the area does not contain enough un-fragmented mature forest with breeding sites.

The worm snake (*Carphophis amoenus helenae*) is only found in southern counties of Ohio. The worm snake has been documented in Ross County in the past. The worm snake typically inhabits moist woodland habit where it spends most of its life under fallen debris and rocks. It is considered a secretive species and is rarely encountered. The park is within range of this species and has limited moist woodland habitat. Due to the secretive habits of this species, additional surveys may yield an observation within the park.

The ringneck snake (*Diadophis punctatus*) has been recently documented in Ross County. It has been located in such areas as Bainbridge, Colerain Twp, and Huntington Twp. Within its range it may be the most abundant woodland snake, though rarely seen. It spends much of its time beneath rocks and woody debris. Due to its secretive nature, this species may be observed with additional surveys.

The eastern hognose snake (*Heterodon platyrhinos*) in southern Ohio occurs in most of the hilly counties and tends to prefer sandy soil with dry open areas or dry deciduous or conifer species. It is not considered a common species in the area. Due to its strange display and appearance, they are often believed to be venomous and are killed by humans. They have been located in Ross County in the past. The park does lie within range of the E. hognose snake and has limited dry sandy habitat. Additional surveys may yield an observation of this species in the park.

The rough green snake (*Opheodrys aestivus*) is not considered rare in many areas of southern Ohio. Adults can be found on the ground or low branches or vines. They often inhabit deciduous or conifer forest, but at times can be found in meadows and prairies. This species can be very difficult to detect when not in motion. They can climb well and are often found in arboreal habitat. This coupled with its cryptic coloration makes them difficult to observe. The park lies within the range of this species and has adequate habitat. It is my opinion that this species may be encountered within the park if additional surveys took place.

The queen snake (*Regina septemvittata*) is found in every county in Ohio and has been found in several areas within Ross County. It tends to spend much of its time in or around water and prefers slow moving or shallow rocky streams. Less commonly, it can be found in ponds, lakes, and large rivers. They can be found sunning themselves along banks, but are difficult to catch at times due to their swimming and diving ability. The park is within range of this species and has adequate habitat for this species. The waterways bordering the park were searched for both queen snakes and northern water snakes. No water snakes were ever observed during the survey near waterways. The single northern water snake specimen was found dead near a waterway. The reason for these two species not being observed is unknown. Additional surveys may yield an observation of this species within the park boundaries, especially if the survey methods focused primarily on waterways and adjacent riparian zones.

The eastern ribbon snake (*Thamnophis sauritus*) is found sporadically throughout Ohio, except south-western Ohio, though it is found in more abundance in more northern counties. It generally lives near water and at times can be found in moist woodland habitat. Though this species was not found, the park does have adequate aquatic habitat and lies within range of the species, making an observation of this species possible.

The smooth earth snake (*Virginia valeriae*) is found in the unglaciated plateau and in the till plains near the Ohio River. It has locality records in Ross County, Ohio. It is considered one of the rarest of Ohio species. The specimens observed were found under rocks. Due to its secretive behavior and low number of individuals, this species is difficult to observe. Additional surveys may yield this species in the park.

The fence lizard's (*Sceloporus undulatus*) range in Ohio is restricted to the unglaciated area of Ohio and the counties lying just north of the Ohio River. This species is usually not found far from dry woodland habitat and can often be found sunning themselves on rocks piles or logs. This species has been collected in Ross County, Ohio. The park lies within range of this species and has limited habitat for this species. The park lies on the edge of the unglaciated area of Ohio,

making the habitat for this species possible, but marginal. If this species is present, it is probably at low densities and not widely spread throughout the park.

The northern copperhead (*Agkistrodon contortrix*) in Ohio is typically in the range of the unglaciated portion of the state. When found outside of these areas, they are usually associated with valleys containing large streams that flow into the unglaciated portion of the state. They utilize a variety of habitat from moist stream valleys to the dry hills sides. Though not rare in some portions of Ohio, they are not considered common. Due to their venom, they are often killed by humans when encountered. During the hotter summer months of the year, they spend the majority of their time hidden and tend to only come out during the night time hours. The park has adequate habitat and is within range of this species. It is unknown why this species was not observed. Because the park lies on the edge of the unglaciated portion of Ohio, they may not be in high densities within the park.

The rivers bordering the park units were not extensively surveyed because they do not lie within park boundaries. However, the turtles that were expected to utilize the adjacent rivers were marked as "expected" because the park land may serve as nesting grounds for those species of turtles. The painted turtle (*Chrysemys picta*) is abundantly found throughout Ohio. This species has been found in waterways within Ross County. If adjacent waterways to the park were surveyed, this species should be observed. Similar to the painted turtle, the red eared slider (*Trachemys scripta*) can be found in waterways in Ross County. It was marked as expected but not found because waterways were not extensively surveyed since they lie outside the boundaries of the park. Like many of the turtles in Ohio, the musk turtle (*Sternotherus odoratus*) is widespread. It is not considered abundant in number. It usually inhabits ponds, lakes, and sluggish streams. Several of the waterways adjacent to the park contain sluggish areas that would serve as appropriate habitat for the musk turtle.

Several species are listed as not to be expected due to limited range, habitat, or a combination of these two factors. The southern two-lined salamander (*Eurycea cirrigera*). This species should have been labeled as expected and observed within the park. The other species of two-lined salamander (*E. bislineata*) should have been marked as not expected within the park. This species is still being sorted out. Guttman and Karlin (1986) found that there were two species of two-lined salamanders within Ohio. All populations north of 40 degree north latitude form one group (northern two-lined) and those below 40 degree north latitude form a different group (southern two-lined). Those between these locations are either one or the other of the two species. Other research is currently being done to better understand this species.

The four toed salamander (*Hemidactylium scutatum*) is not considered abundant in any portion of Ohio. It has a scattered distribution and is probably at its greatest abundance in the extreme south and in the northeast portion of Ohio. This species requires undisturbed or mature forest with bogs. The park contains little mature or undisturbed tracks of forest and does not contain any bog habitat. As of 1989 there were no locality records from Ross County.

The mud salamander (*Pseudotriton montanus*) has been recorded from 29 localities in nine south central counties within Ohio since 1989. Because of the limited range and rarity it was placed on the ODNR endangered and threatened species list. This species is typically found in lowland swampy forest or slow moving streams, and lowland springs in deciduous forest. Though the park has a number of waterways bordering the park, none of them fit the description of boggy or sluggish springs or streams. This species has been located in Ross County in areas such as Colerain and Harrison Twp. These areas of Ross County are located near the edge of the Glaciated Allegheny Plateau and the Unglaciated Allegheny Plateau meet providing more habitat containing the swampy, sluggish seeps and springs needed for this species. Though the park lies within this species range, the park does not have adequate habitat to support a sustainable population.

The redbelly snake (*Storeria occipitomaculata*) is the smallest snake in Ohio. This snake may be found in sphagnum bogs, wet meadows, or swamp forests, as well as dry, open wooded areas in the eastern half of the state. Very secretive, the northern redbelly spends most of its life hidden beneath boards, rotting logs, brush piles, and leaves, where it seeks out slugs, earthworms, and beetle larvae. Sphagnum bogs, swamps, and wet meadows are lacking at the five sites. This species is not considered to be expected.

Kirtland's snake (*Clonophis kirtlandii*) is typically found in the unglaciated portions of Ohio. They are usually associated with open wet areas such as bogs or wet prairie habitat. The park lies on the edge of the unglaciated portion of Ohio and does not contain adequate habitat to sustain this species.

Very little is known about the distribution of the coal skink (*Eumeces anthracinus*) in Ohio. The Ohio Department of Natural Resources lists this species as species of special concern. There are no Ross County records and the habitat that has been listed for this species is not clearly identifiable at any of the five Hopewell Culture NHP sites.

The broadhead skink (*Eumeces laticeps*) has been found in southern counties, especially in the unglaciated areas and those counties bordering the Ohio River. It prefers dry upland wooded habitat. Though the park contains limited upland woods, this species is more characteristic of the hilly upland found in the unglaciated portion of Ohio. The park units lie on the edge of the unglaciated areas of Ohio and no records have been located showing this species within Ross County.

The ground skink (*Scincella lateralis*) is a very small skink limited to the extreme southern part of the state, where it seems to prefer open areas in or adjacent to woods. According to the Ohio Department of Natural Resources it is the least common lizard encountered in Ohio, a number have been reported in Scioto County. It is not expected to be found in Ross County or at any of the Hopewell Culture NHP sites.

During the survey, tree frogs were encountered that require further investigation for adequate species identification. There are two species of gray tree frog in Ohio, Cope's gray tree frog (*Hyla*

chrysoscelis) and the gray tree frog (*Hyla versicolor*). The two species are identical in appearance and can only be distinguished by DNA analysis or blood tests (Davis and Menze 2002). For the purpose of this study gray tree frogs encountered during the survey were recorded as *Hyla chrysoscelis/versicolor*.

In conclusion, Hopewell Culture National Historical Park contained herpetological species common to the parks location and habitat provided. Additional studies are required to document reptile and amphibian species overlooked during the survey. Management recommendations identify the need for long term monitoring of reptile and amphibian populations in order to document additional species and monitor existing populations.

Conclusion

The following serves as recommendations for the management of reptile and amphibian populations found within Hopewell Culture National Historical Park. This does not serve as a comprehensive list of possible management practices, but merely as baseline recommendations for park staff when planning park activities and management. The following guidelines are based on the publication “Habitat Management Guidelines for Amphibians and Reptiles of the Midwest” (Kingsbury and Gibson 2002).

Monitoring

- 1) Participate in annual frog calling surveys and salamander surveys to monitor the existing established populations.
- 2) Perform additional surveys to collect species missed during the course of this survey.

Waterways

- 1) Avoid clearing native vegetation along wetland edges (ponds, streams, seeps, and rivers) and maintain a minimum of a 15.24 m buffer of vegetation around bodies of water. These areas provide essential habitat to herpetological species as well as protect water quality and prevent erosion.
- 2) If possible, increase diversity of herpetological species by creating shallow ephemeral wetlands near permanent water.

Forested Areas

- 1) Do not clear cut forested areas or plant monocultures. Allow understory to remain complex.
- 2) Protect unique breeding sites, such as woodland ponds.
- 3) Avoid isolating forest patches and restore connectivity where possible.
- 4) Remove invasive, non-native plant species when possible.

Grassland Areas

- 1) Limit complete removal of cover during succession control.
- 2) Promote the growth of diverse, native vegetation.

Agricultural Areas

- 1) Protect and buffer any non-agricultural areas. These are the areas where most herpetological species will persist.
- 2) Avoid the use of pesticides, herbicides, fertilizers, or rodenticides. If chemicals must be used, avoid broadcast spraying, and use banding or spot treatment instead. Always follow manufacturer’s recommendations for use.

Mowing

- 1) Avoid manicured, park-like substrates when possible. In most cases, it does not provide necessary cover for herpetological species.
- 2) Mow in rows from left to right as opposed to circular mowing. This allows

opportunity for wildlife to seek safety.

3) Raise mower deck height to at least 20.32 cm to 30.48 cm above the ground. This will reduce the number of animals killed by mowing and will leave additional cover.

4) Areas that do not need to be constantly maintained should be mowed during times of inactivity for reptiles and amphibians (during winter months).

5) When mowing areas to control shrubs, brush, and small tree growth mow sections at a time. No more than 1/3rd of the area should be mowed at one time.

6) In areas where shorter grass must be maintained (lawns, trails), keep grass constantly short (5 inches or less). This will limit the areas from becoming habitat for reptiles and amphibians that may later be destroyed.

Prescribed Burns

1) Prescribed burns should be conducted between fall and early spring, when amphibian and reptile species are least likely to be active.

2) Burn habitat in patches (no more than 1/3rd of the area a year) in order to reduce animal losses and maintain adequate cover.

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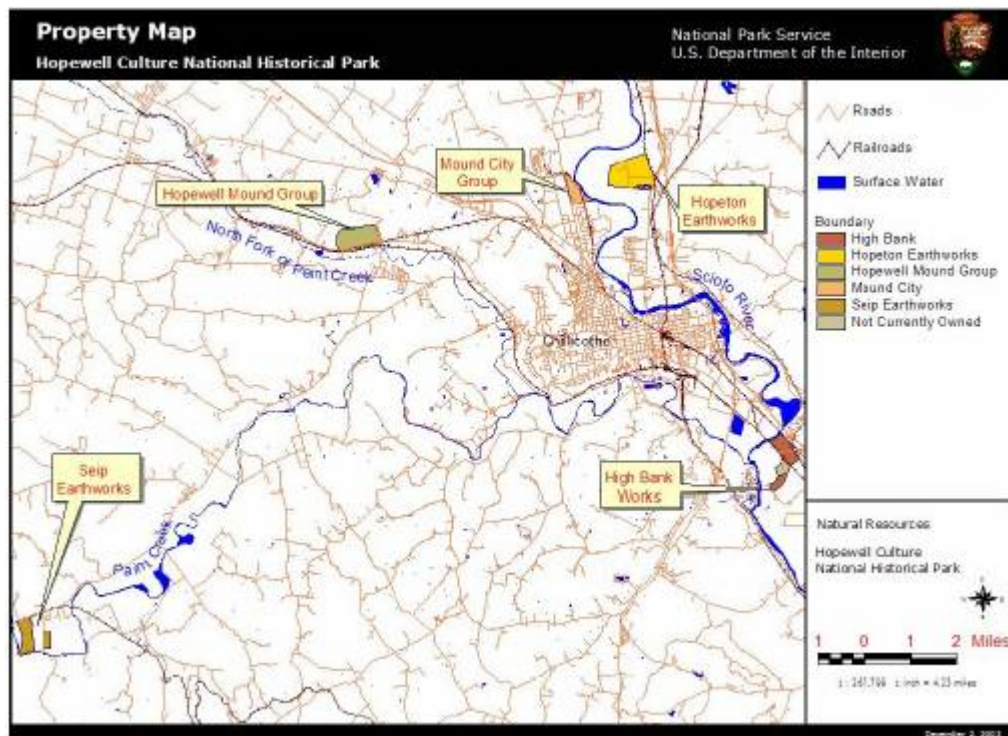


Figure 1. Map of Hopewell Culture National Historical Park's Five Park Units.



Figure 2. Earthworks at Mound City Group.



Figure 3. The Scioto River bordering Mound City Group.



Figure 4. Agricultural hay field at Hopeton Earthwork.



Figure 5. Early successional woodlot at Hopeton Earthwork.



Figure 6. Intermittent stream at Hopeton Earthwork.



Figure 7. Quarry bordering Hopeton Earthworks.



Figure 8. Pools on top of quarry fill at Hopeton Earthworks.



Figure 9. Agricultural hay field with coverboard at High Bank Works.



Figure 10. Paint Creek bordering Seip Earthworks.



Figure 11. Semi-mature mesophytic mixed woodlot at Hopewell Mound Group.



Figure 12. Fallow field at Hopewell Mound Group.



Figure 13. Woodland pond at Hopewell Mound Group.

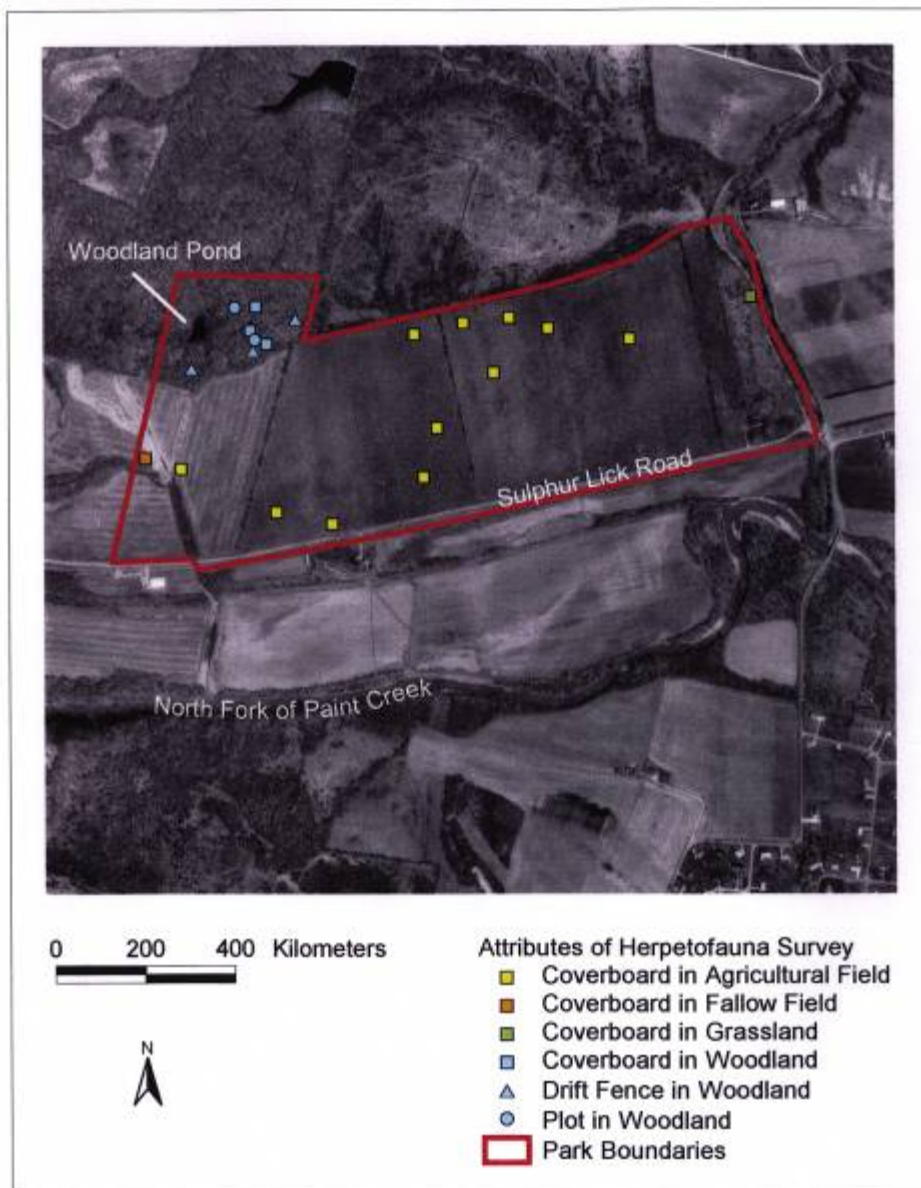


Figure 14. Map of Hopewell Mound Group Unit.

30

Figure 14. Map of Hopewell Mound Group showing locations of drift fences, plots, and coverboards.

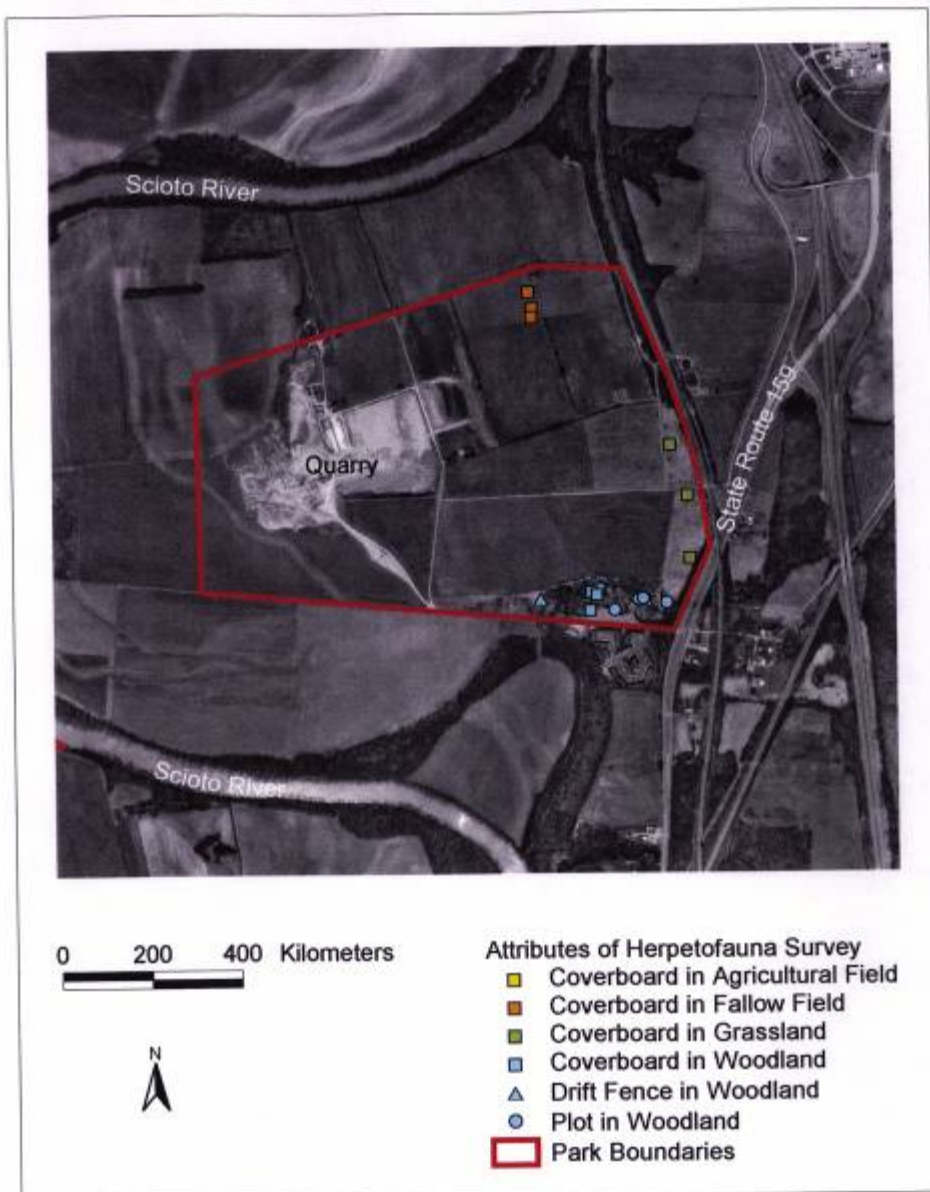


Figure 15. Map of Hopeton Earthworks Unit.

Figure 15. Map of Hopeton Earthworks showing location of drift fences, plots, and coverboards.

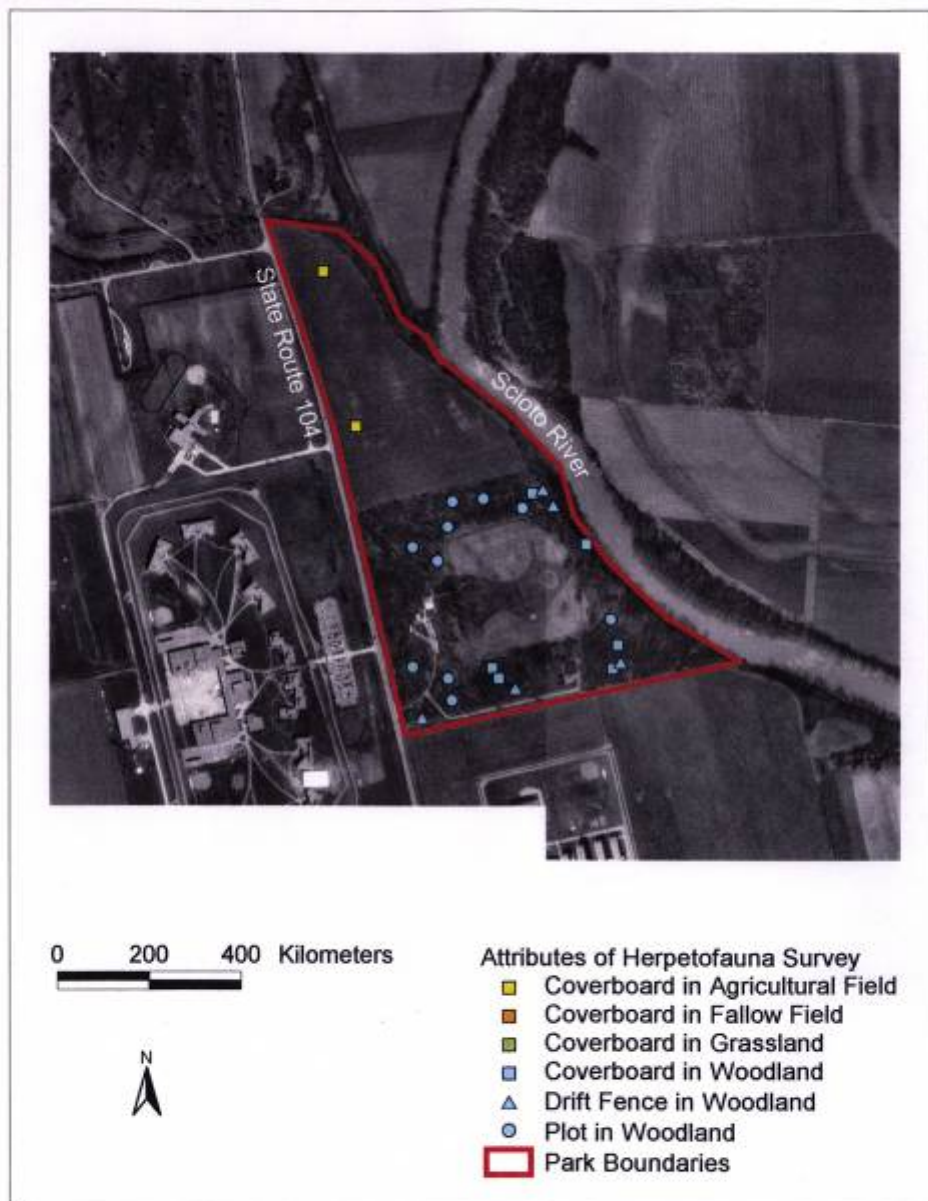


Figure 16. Map of Mound City Group Unit.

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Figure 16. Map of Mound City Group showing location of drift fences, plots, and coverboards.

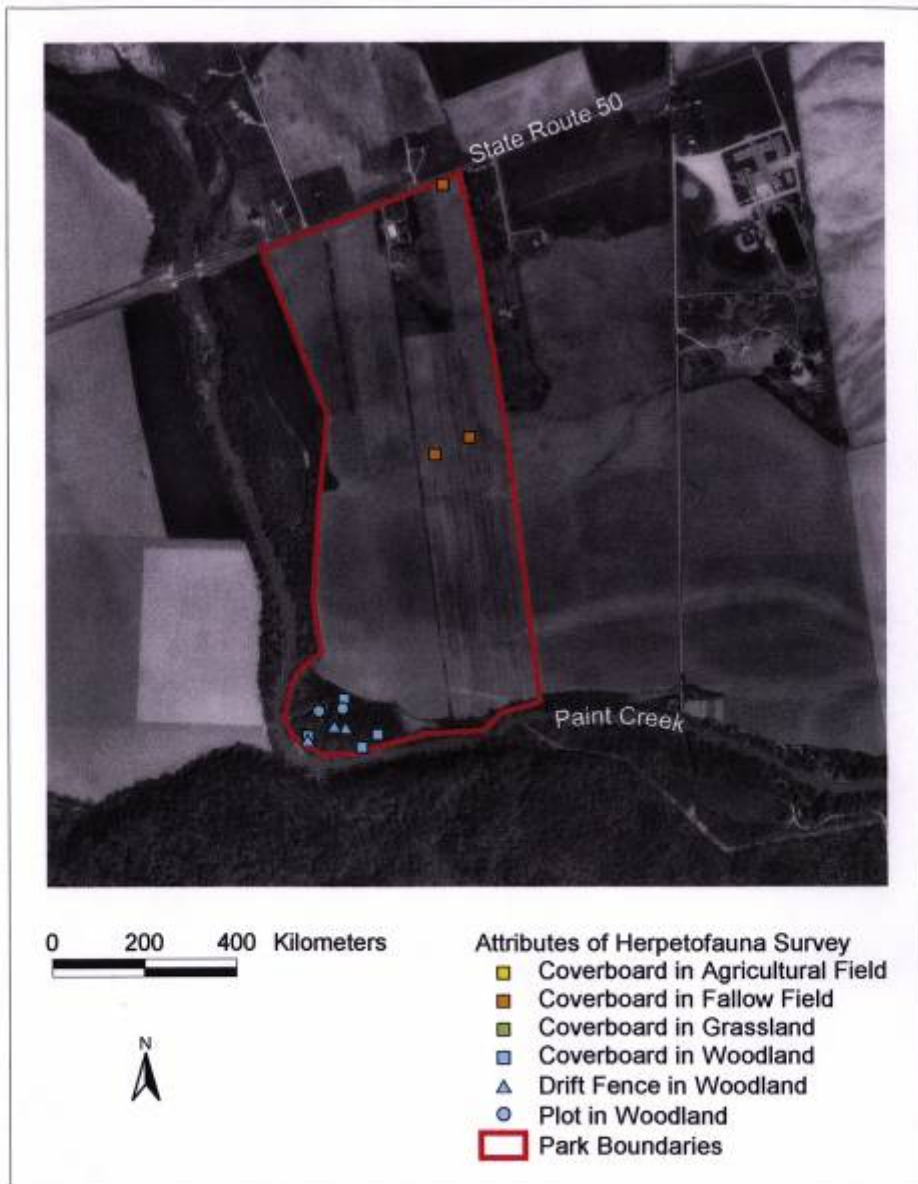


Figure 17. Map of Seip Earthworks Unit.

Figure 17. Map of Seip Earthworks showing location of drift fences, plots, and coverboards.

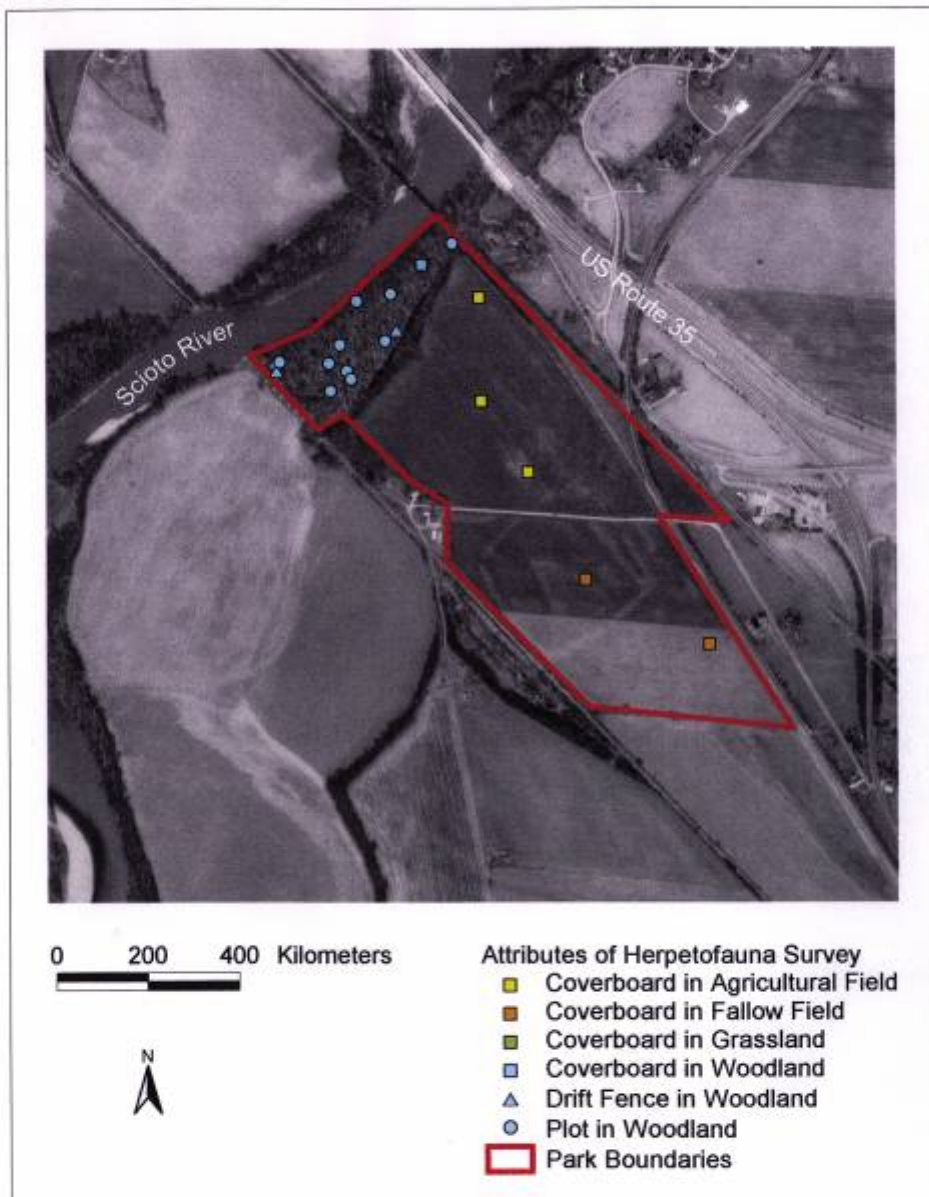


Figure 18. Map of High Bank Works Unit.

Figure 18. Map of Highbank Works showing location of drift fences, plots, and coverboards.



Figure 19. Drift fence located at Mound City Group.



Figure 20. Wooden coverboard at Hopeton Earthworks.



Figure 21. Corrugated asphalt coverboard at Hopeton Earthworks.



Figure 22. Rick Perkins checking coverboard at High Bank Works.



Figure 23. Grey tree frog (*Hyla chrysoscelis/versicolor*) tadpole collected from pools at Hopeton Earthworks.



Figure 24. *Ambystoma* eggs found in Hopewell Mound Group woodland pond.



Figure 25. Eastern box turtle (*Terrapene carolina*) collected at High Bank Earthworks.



Figure 26. False map turtle (*Graptemys pseudogeographica*) collected at Mound City Group.

Table 1. List of amphibian expected and current status of occurrence at Hopewell Culture NHP.

Order Caudata	Scientific Name	Common Name	Old	New	Voucher	Abundance
Ambystomatidae	Ambystoma jeffersonianum	Jefferson salamander	-	3	Yes*	+
	Ambystoma maculatum	Spotted salamander	1	1	No	
	Ambystoma opacum	Marbled salamander	1	1	No	
Plethodontidae	Desmognathus fuscus conanti	Spotted dusky salamander	1	1	No	
	Eurycea bislineata	N. two-lined salamander	-	3	Yes	++++
	Eurycea cirrigera	S. two-lined salamander	1	0	No	
	Eurycea longicauda	Longtail salamander	1	1	No	
	Hemidactylium scutatum	Four-toed salamander	1	0	No	
	Plethodon cinereus	Redback salamander	1	2	Yes	+++
	Plethodon glutinosus	Slimy salamander	1	1	No	
	Pseudotriton montanus	Mud salamander	1	0	No	
	Plethodon electromorphus	Ravine salamander	-	3	yes	++
Proteidae	Necturus maculosus	Mudpuppy	1	0	No	
Salamandridae	Notophthalmus viridescens	Central newt	1	2	Yes	++++
Order Anura						
Bufonidae	Bufo americanus	American toad	1	2	Yes	+++++
	Bufo woodhousii fowleri	Fowler's toad	-	3	Yes	+++++
Hylidae	Acris crepitans	Cricket frog	1	1	No	
	Hyla chrysoscelis/versicolor	Gray treefrog	1	2	Yes	+++++
	Pseudacris crucifer	Northern spring peeper	1	2	Yes	+++++
	Pseudacris triseriata	Western chorus frog	1	1	No	
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	1	No	
	Rana pipiens	Northern leopard frog	1	2	Yes	++
	Rana sylvatica	Wood frog	1	1	No	

“Old” indicates the status prior the inventory, “New” the status after the inventory, and “Voucher” indicates whether the authors 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.

+++++=Commonly found, +=Rare; *egg masses observed

Table 2. List of reptilian expected and current status of occurrence at Hopewell Culture NHP.

Order Squamata	Scientific Name	Common Name	Old	New	Voucher	Abundance
Colubridae	Carphophis amoenus helenae	Worm snake	1	1	No	
	Clonophis kirtlandii	Kirtland's snake	1	0	No	
	Coluber constrictor	Racer	1	2	Yes	+++
	Diadophis punctatus	Ringneck snake	1	1	No	
	Elaphe obsoleta	Black rat snake	1	2	Yes	+++++
	Heterodon platyrhinos	E. hognose snake	1	1	No	
	Lampropeltis getula	*Common kingsnake	1	?	No	
	Lampropeltis triangulum	Milk snake	1	2	Yes	+
	Nerodia sipedon sipedon	*N. water snake	1	2	Yes	+
	Opheodrys aestivus	Rough green snake	1	1	No	
	Regina septemvittata	Queen snake	1	1	No	
	Storeria dekayi	Brown snake*	1	2	Yes	+
	Storeria occipitomaculata	Redbelly snake	1	0	No	
	Thamnophis sauritus	E. ribbon snake	1	1	No	
	Thamnophis sirtalis	Common garter snake	1	2	Yes	++++
	Virginia valeriae	Smooth earth snake	1	1	No	
Phrynosomatidae	Sceloporus undulatus	Fence lizard	1	1	No	
Scincidae	Eumeces anthracinus	Coal skink	1	0	No	
	Eumeces fasciatus	Five-lined Skink	1	1	No	
	Eumeces laticeps	Broadhead skink	1	0	No	
	Scincella lateralis	Ground skink	1	0	No	
Viperidae	Agkistrodon contortrix	N. copperhead	1	1	No	
	Crotalus horridus	Timber rattlesnake	1	0	No	
Order Testudines						
Chelydridae	Chelydra serpentina	Snapping turtle	1	2	Yes	++++
Emydidae	Chrysemys picta	Painted turtle	1	1	No	
	Graptemys geographica	Map turtle	1	2	Yes	++

Table 2. List of reptilian expected and current status of occurrence at Hopewell Culture NHP (cont.).

	Scientific Name	Common Name	Old	New	Voucher	Abundance
Emydidae	Graptemys pseudogeographica	*False map turtle	1	2	Yes	+
	Terrapene carolina	Three-toed box turtle	1	2	Yes	++++
	Trachemys scripta	Red-eared slider	1	1	No	
Kinosternidae	Sternotherus odoratus	Musk turtle	1	1	No	
Trionychidae	Trionyx spinifer	Spiny softshell	1	2	Yes	+++

*single specimen

Table 3. Reptile species observed and relative abundance.

Common Name	Relative Abundance
Racer species	(+++)
Black rat snake	(+++++)
*Milk snake	(+)
*Brown snake	(+)
Common garter snake	(++++)
*False map turtle	(+)
*Northern water snake	(+)
Map turtle	(++)
Snapping turtle	(++++)
Spiny softshell	(+++)
Eastern box turtle	(++++)

(+++++) = commonly encountered, (+)=Rare

*single specimen

Table 4. Amphibian species observed and relative abundance.

Common Name	Relative Abundance
Jefferson salamander	(+)
Fowler's toad	(+++++)
American toad	(+++++)
Gray treefrog	(+++++)
Northern spring peeper	(+++++)
Ravine salamander	(++)
Redback salamander	(+++)
Northern Two-lined salamander	(++++)
Bullfrog	(+++++)
Green frog	(+++++)
Northern leopard frog	(++)
Red-spotted newt	(++++)

(+++++) = commonly encountered, (+) = rare

Table 5. Species richness of herpetofauna at Hopewell Culture NHP's five park units.

	Park Unit					
Common Name	High Bank Works	Hopeton Earthworks	Hopewell Mound Group	Mound City	Seip Earthworks	Total
American toad	X	X	X	X	X	5
Black rat snake			X	X		2
Brown snake	X					1
Bullfrog		X	X	X	X	4
Common garter snake	X		X	X	X	4
Eastern box turtle	X		X			2
False map turtle				X		1
Fowler's toad	X	X	X	X	X	5
Gray treefrog		X	X			2
Green frog			X			1
Jefferson salamander			X			1
Map Turtle				X		1
Milk snake			X			1
N. Two-lined salamander		X	X			2
N. water snake			X			1
Northern leopard frog			X			1
Northern spring peeper		X	X	X		3
Racer			X			1
Ravine salamander			X			1
Red spotted newt			X			1
Redback salamander		X	X			2
Snapping turtle	X	X		X		3
Spiny softshell				X		1
Total	4	8	18	10	4	44