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Northeast Region
Philadelphia, Pennsylvania

Inventory of Bat Community Composition at Gettysburg National Military Park and Eisenhower National Historic Site

Technical Report NPS/NER/NRTR--2006/052



ON THE COVER

Photographs of a big brown bat (*Eptesicus fuscus*) and a eastern red bat (*Lasiurus borealis*) caught at the Gettysburg National Military Park during the 2004–05 bat inventory.

Photographs by: James A. Hart

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Abstract and Keywords

During 2004–2005, mist netting surveys were conducted in both the Gettysburg National Military Park and the Eisenhower National Historic Site. Six sites were mist-netted for bats during 12 nights resulting in an average capture of 1.2 bats per netnight (the total of nets set up multiplied by the total number of nights). A total of 55 bats comprised of 4 species were captured including 18 little brown bats, *Myotis lucifugus* (4 males and 14 females), 24 big brown bats, *Eptesicus fuscus* (7 males and 17 females), 7 red bats, *Lasiurus borealis* (3 males and 4 females) and 5 eastern pipistrelle bats, *Pipistrellus subflavus* (1 male and 4 females). No federal or state listed species were captured. Although all sites were set up along likely travel and foraging corridors, those sites where canopy closure and bank vegetation was greatest produced the most bats and the greater diversity of species. Possible maternity colony sites in barns and outbuildings were also investigated through visual inspection. Although every site checked showed some sign of use by bats, ranging from the establishment of colonies to probable intermittent use, only the Sherfy Barn had bats presently using the site. It is likely that historic renovation has altered the temperature and humidity in the buildings such that they are now unusable by bats.

Recommendations for future research include surveys for Indiana bats during the spring and fall to ascertain whether this species uses parts of the parks as “temporary stopover” sites as well as more intensive surveys for use of forests by tree bats, including the red and hoary, *L. cinereus*, bats. These surveys could be used to create a management plan that ensures that adequate habitat remains for these species as well as to promote continued survival of other species. Artificial habitat in the form of bat boxes and bat “condos” could also be set up to sustain the present populations.

Keywords: NPS, inventory, monitoring, bats, *Myotis lucifugus*, *M. sodalis*, *M. septentrionalis*, *Eptesicus fuscus*, *Lasiurus borealis*, *Pipistrellus subflavus*, Gettysburg National Military Park, Eisenhower National Historic Site, endangered, conservation

Summary

Although the fauna of Pennsylvania has been studied extensively across much of the state it has only recently been investigated in NPS properties such as the Gettysburg National Military Park and the Eisenhower National Historic Site. This study was initiated to predict and determine the bat communities within both park units and to generate recommendations that would ensure that adequate habitat exists for these species without impacting the historical significance of both sites. To that end, six sites were surveyed over the course of 12 nights for a total of 45 “netnights” and resulted in the capture of 55 bats of four species. The most common species captured were the little brown (*Myotis lucifugus*) and big brown (*Eptesicus fuscus*) bats. The preponderance of both species captured were females, which may indicate that several maternity colonies exist within the confines of the parks. The information gathered during this study, coupled with that of previous Resource Manager, Dr. Bert Frost, demonstrates that of the nine species that could possibly occur within GETT/EISE six have recently been captured, including the red bat, *Lasiurus borealis*, hoary bat, *L. cinereus*, eastern pipistrelle, *Pipistrellus subflavus*, and northern long-eared bat, *M. septentrionalis*, bats, and another has been radio tracked (the federally endangered Indiana bat, *M. sodalis*) within the vicinity of the parks during spring migration.

Recommendations for continued research include more surveys in forested habitat to assess use of forests by tree species such as the red and hoary bats, spring and fall mist-netting for the Indiana bat, and continued monitoring of possible maternity sites. Recommendations also include the creation of artificial roost sites for bats in areas where the historical significance of the parks will not be impaired.

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Introduction

Background and Rationale

During the early 1970s Charles Mohr reported that bat species across the United States appeared to be in a serious decline (Mohr 1972). Although this study focused primarily on those species found hibernating in caves, mines, tunnels, and other underground sites, the article signaled an awareness that all bat species were most likely at risk due to a variety of factors, including habitat loss, disturbance to hibernacula and other winter sites, and loss of summer roosting habitat. A concerted effort was begun throughout the United States to assess bat populations through visual inspection of winter hibernacula as well as examinations of buildings for indications of use by maternity colonies (O'Shea and Bogan 2003). In Pennsylvania, surveys took the form of mid-winter bat hibernacula surveys conducted by PA Game Commission personnel and summer concentration counts primarily conducted by volunteers (See Pennsylvania Game Commission 1984–present).

During the summer of 1999, the federally endangered Indiana bat (*Myotis sodalis*) was found roosting in an old church in Blair County along with over 20,000 little brown bats (*Myotis lucifugus*) (Butchkoski and Hassinger 2001). Although Cheng (2003) reported the discovery of Indiana bats using an historical barn in Iowa, the detection of the colony in Blair County, Pennsylvania, indicated a need to survey for alternative summer roosting sites in the northeastern portion of the United States where known Indiana bat maternity sites normally occur in more traditional natural settings. Mist-netting surveys were begun across the state as well as radio-tracking of banded Indiana and little brown bats in order to determine the habitats used by this species and other summer resident bat species. Although the majority of these surveys and studies were conducted on private as well as state-owned property, comparative effort did not occur until relatively recently on property owned by federal agencies such as the National Park Service, although several intensive studies were conducted in the Allegheny National Forest (Sanders Environmental, Inc. 2005; USDA-FS 2005).

Inventorying and monitoring programs and surveys are underway or have been completed at many Department of the Interior properties including the Gettysburg National Military Park (GETT) and the Eisenhower National Historic Site (EISE). Surveys conducted at GETT/EISE include Van Fleet and Kirkland (1995) and Yahner et al. (1997), which were directed at either assessing small mammal communities or describing terrestrial vertebrate survey protocols, Yahner et al. (2001a), an assessment of the amphibian and reptile communities, and Yahner et al. (2001b), an inventory of birds. Although Yahner et al. (2005) surveyed mammal communities at Valley Forge National Historical Park, they did not survey chiropteran communities due to the nature of conducting these types of surveys and the need for specially trained personnel, an assertion also pertinent to Gettysburg NMP and Eisenhower NHS. Although there have been some preliminary mist-netting surveys conducted at both Gettysburg NMP and Eisenhower NHS by Bert Frost (Park Science 2000), previous Natural Resource Manager, the present study was initiated to more fully assess bat species occurring within these units and not to establish population numbers.

The primary objectives of the present study were to conduct thorough inventories within Gettysburg NMP and Eisenhower NHS to 1) provide a list of species occurrence; 2) confirm the presence of previously documented species; 3) determine the presence of any species listed as “rare, threatened, or endangered;” and 4) provide some estimate of measure of occurrence for each species.

Predicted Species Occurrence

Eleven species of bats have been reported historically from Pennsylvania (Merritt 1987). Of these, the Seminole bat (*Lasiurus seminolis*) is considered an “accidental,” most likely having entered the state from farther south during periods of stormy weather (Doutt et al. 1977). There are currently only a few historic records for this species from the southeastern portion of the state (Roberts and Early 1952), and it would not be expected to occur within GETT or EISE. Another species, the silver-haired bat (*Lasionycteris noctivagans*), is considered a “migratory” species, only occurring within the state during its migration to and from Canada and the New England states (Whitaker and Hamilton 1998). Although there are several records from the interior portion of Pennsylvania (Pennsylvania Game Commission, C. Butchkoski, pers. Comm.), all of these are during the migratory period and it remains unknown whether this species breeds in Pennsylvania or is resident during the summer months. Historical records are also reported by Poole (1932) and Roberts and Early (1952). The evening bat (*Nycticeius humeralis*) has been reported from the southwestern (Grimm and Roberts 1950) and the southeastern (Rhoads 1903) portions of Pennsylvania, but there are no recently confirmed records for this species anywhere in Pennsylvania. The remaining eight species all have been reported recently from many portions of Pennsylvania and include the little brown bat, northern long-eared bat (*M. septentrionalis*), eastern small-footed bat (*M. leibii*), Indiana bat, big brown bat (*Eptesicus fuscus*), eastern pipistrelle (*Pipistrellus subflavus*), eastern red bat (*Lasiurus borealis*), and hoary bat (*L. cinereus*). Of these eight species, it is unlikely that the Indiana bat would form summer colonies within GETT/EISE, due to an appreciable lack of mature forest roosting habitat and large floodplain foraging habitat; although there is the possibility that migrating individuals may show up during spring or fall.

Historical Information

Although many NPS properties within Pennsylvania do not have any recent information on bat species occurrences within their units, both GETT and EISE have some background data. The previous Resource Manager, Dr. Bert Frost, conducted limited mist-netting surveys during 1999 and 2000 (Frost, unpublished data).

The results of these surveys can be found in Table 1 and included 39 captures of six of the seven likely occurring species. The only species lacking, the eastern small-footed bat, is mainly a resident of mountainous regions (Whitaker and Hamilton 1998). Recent information suggests that this species uses rock crevices for roosting sites during the summer (Veilleux 2005). There have been several incidences of summer captures within the immediate vicinity of large rock outcrops by the author as well as other researchers across Pennsylvania (Pennsylvania Game Commission, C. Butchkoski, pers. comm.). Mist netting in the area known as Devil’s Den, a site with large rock outcrops composed of diabase rock, failed to produce any records.

Table 1. Results of mist-netting surveys carried out by Bert Frost, NPS, during 1999–2000.

Site	Effort ¹	Date	Bats/ Net- hour	Species ²						Total
				Mylu	Myse	Epfu	Labo	Laci	Pisu	
Devil's Den (Plum Run)	N/A	7/14/1999	N/A		1	1	3			5
	N/A	8/18/1999	N/A		1		1			2
Culp's Hill (Rock Creek)	N/A	9/05/1999	N/A	1			1			2
	105.0	6/22/2000	0.02			1				1
Plum Run, East Conferate Ave.	67.5	7/22/1999	0.01			1				1
Redding Farm (Mash Creek)	69.75	7/15/1999	0.08	2	1	2	1			6
Cordori Barn	6.0	6/30/1999	0.33			2				2
	3.0	7/19/1999	0.66			2				2
U. S. Avenue, Plum Run	112.5	7/13/1999	0.03		3	1				4
	101.5	7/18/2000	0.13	1			10	1	1	13
Cyclorama		5/21/2000	N/A			1				1
Totals	465.25	26 Nights	0.08	4	6	11	16	1	1	39

¹Effort is reported as net-meter hours (nmh) where information is known.

²MyLu- *Myotis lucifugus*, Myse- *M. septentrionalis*, Epfu- *Eptesicus fuscus*, Labo- *Lasiurus borealis*, Laci- *Lasiurus cinereus*, Pisu- *Pipistrellus subflavus*

The hoary bat is a species that is very rarely captured in Pennsylvania although it is known to be a summer resident. The Pennsylvania Game Commission (PGC) Bat Trapping and Netting Database contains only 24 records for this species. Hart et al. (1993) reported on the capture of two specimens of this species during research conducted by the Shippensburg University Vertebrate Museum. This bat is a fast flyer that is not very maneuverable and is usually not captured in net sets that are positioned to increase the chances of capture of greater numbers of species during basic inventories. The site along Plum Run where the one specimen was captured during 1999 was fairly open with a small patch of trees along the stream. A single net was placed over the small stream in a fairly open area where the flight patterns of hoary bats would be less obstructed.

The information listed above is the only known information to exist on the bats of GETT/EISE.

Although bats have suffered from an unjustified reputation because of a wealth of bad press, the truth is that Pennsylvania's bat fauna is wholly beneficial to agriculture as well as to visitors at Gettysburg NMP and Eisenhower NHS. Able to consume upwards of 30 percent of its body weight in small insects, a little brown bat can consume as many as 150 mosquitoes in less than 15 minutes (Fenton 1983; Tuttle 1988). It has been reported that large concentrations of bats are capable of controlling agricultural pests by consuming upwards of 250,000 lbs of insects in a single evening of foraging (Tuttle 1988), as is the case at Bracken Cave, Texas. Although the species of bats found in Pennsylvania differ significantly from those occurring in Texas, they are still capable of having a substantially positive economic impact on agriculture, if conserved in sufficient numbers.

Study Area

General Description of Study Area

Gettysburg NMP and the Eisenhower NHS comprise over 1,700 ha (4,200 ac) of land occurring along the Gettysburg-Newark Lowland Section of the Piedmont Province in Pennsylvania. Although the highest point in both parks is Big Round Top at 240 m (787 ft), the mean elevation is just over 160 m (525 ft) (Yahner et al. 1991). The drainages of Rock Creek, Marsh Creek, Plum Run, and Willoughby Run dominate the hydrology of the area; however, there are many small streams, mostly intermittent in nature, throughout the area. The general topography consists primarily of rolling hills (Yahner et al. 1991) with approximately 55% in agriculture or managed grasslands, 31% in forest, and 14% in some form of development (i.e., maintained, residential or commercial properties). The Lowland Submontane Cold Deciduous Forest is the predominant forest formation (Perles et al. 2005) and includes species of oak (*Quercus* spp.), hickory (*Carya* spp.), and tulip poplar (*Liriodendron tulipifera*).

Site Selection

During late winter and early spring, site selection was begun by reviewing ArcGIS layers including Mr. SID images, digital ortho-quarter quads (DOQQ), and relative vegetation layers as compiled by Pennsylvania Natural Heritage Program personnel (Perles et al. 2005). This resulted in the identification of eight likely survey sites as depicted in Figure 1. Although these sites were originally selected based upon currently available spatial information, actual survey sites were then selected following site visits and visual inspection of actual habitat available. Selection of sites was based upon general mist-netting guidelines as established by Kunz and Kurta (1988). Mist-netting of bats is more productive when canopy closure is between 50–100%, shrub cover along streambanks is appreciably thick, and there is some form of vegetative structure to the area where the net will be placed. This structure can take the form of either downed trees or tree limbs or shrubs over-hanging the stream and serving to break up the outline of the nets. Although forested roadways, trails, and other corridor-type openings are sometimes mist-netted, they often do not result in the capture of significant numbers of bats. In order to ensure that the probability of catching bats was improved, these sites were not the focus of this investigation, although some sites were very comparable to these types as was the case with the Devil's Den site. Figure 2 shows an example of such a survey site. Upon completion of site visits several of the proposed sites were deemed not suitable due to either an appreciable lack of canopy or because access to the site would be problematical. Sites were also selected where an elevated netting system could be used. In this case, the canopy was higher and more open than at sites where a single high net was used. Figure 3 is an unobstructed view of the elevated, or canopy, netting system, and is intended as an illustrative example of the placement of the system. Upon completion of site inspections six sites were selected for sampling. Table 2 lists the sampling locations, along with general habitat and stream descriptions.

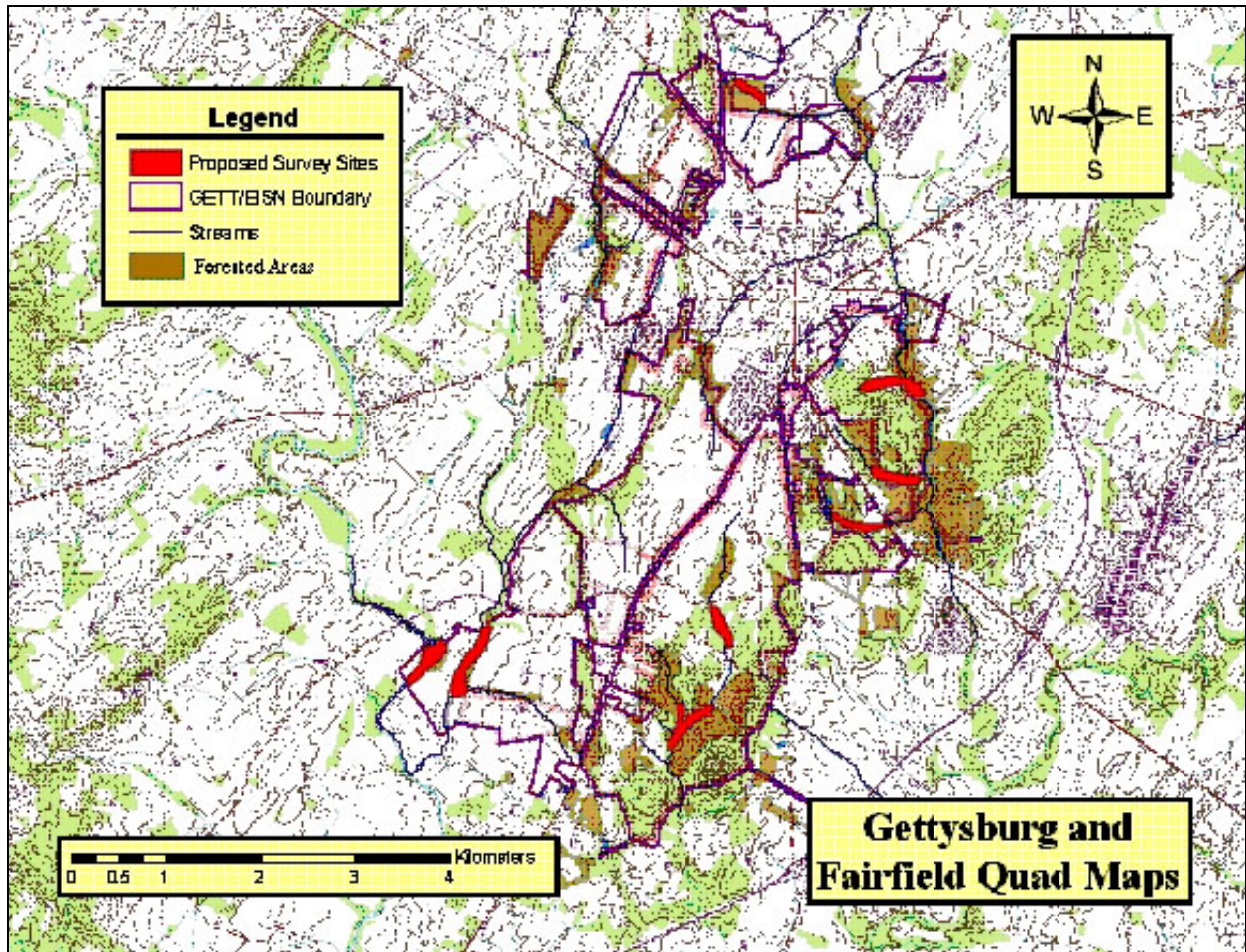


Figure 1. Potential sampling sites identified for the bat inventory at Gettysburg NMP and Eisenhower NHS conducted in 2004 and 2005.



Figure 2. An example of a site in the Eisenhower National Historic Site where mist nets would be placed. The canopy closure for this site is approximately 75% and the downed tree toward the rear of the picture serves to break up the outline of the net. Shrub cover along the banks acts to funnel bats into the net.



Figure 3. Example of a 9 m high elevated/canopy system erected with three 6 m wide nets attached. This is similar to how the system was set up at a predetermined mist-netting site.

Table 2. Habitat and stream descriptions for all sites surveyed during the bat inventory of Gettysburg NMP and Eisenhower NHS of 2005.

Site Code	Lat/Long, Elevation (m)	Cardinal Directions	Basic Habitat Description	Habitat Formation	Stream Description
EISE_BATS_EISE01	39-47-55/ 77-16-08 140 m	3.5km S., 3.3km W. of Gettysburg	A wide but fairly shallow stream running between small woodlots and agricultural lands. Forest is primarily red maple, ash, some small poplar, box elder, black locust, walnut, elm, and catalpa. Shrubs consist of multi-flora rose, poison ivy, and serviceberry, while groundcover consists of downed logs, many forbs, such as goldenrods and spring beauties, ferns, and other plants.	I.B.2.N.d Temporarily flooded cold deciduous forest	Stream is fairly wide but shallow and slow moving. It is prone to flood events and is noted to rise steeply as indicated by the debris found along the banks. Banks are primarily shallow and gently sloping in vicinity of nets. Further down in the agricultural field the banks become steeper and muddy.
EISE_BATS_EISE02	39-47-43/ 77-16-32 140 m	0.8km N., 8.2km E. of Fairfield	Riparian corridor along Marsh Creek at NW edge of Reddig Farm. Stream bordered by small floodplain forest and shrubs consisting of sycamore, sugar maple, hickory, locust, box elder, silver maple, black cherry, ash, iron wood, poison ivy, multi-flora rose, and saplings of most overstory species	I.B.2.N.d Temporarily flooded cold deciduous forest	Marsh Creek is a fairly wide stream with low to medium height banks. Rocks and cobblestone make up most of the substrate. The canopy closes over the stream in spots but is open in others. Several downed trees create spots where nets can be put up.
GETT_BATS_GETT01	39-47-25/ 77-14-37 150	4.5km S., 1.1km W. of Gettysburg.	An area dominated by large diabase rock outcrops and boulders along a very small stream. The woodland bordering the stream is made up of medium-age trees of mostly small diameters. Forest consists primarily of cedar, red maple, white oak, catalpa, ash, box elder, and yellow birch with an understory of birch seedlings, ironwood, witch hazel, black gum, serviceberry, goldenrods, multiflora rose, greenbrier, various forbs, including cardinal flower, downed logs, and leaf and limb litter.	I.B.2.N.d Temporarily flooded cold deciduous forest	A very small stream running through a boulder-strewn area. The stream meanders through and around the boulders at the foot of a large diabase outcrop. It is not deep and is mainly of a silt substrate. Stream banks are somewhat none-defined as the boulders border the stream and cover the banks. Where the banks are evident, they are shallow and gradually sloping in the vicinity of the site.

Table 2. Habitat and stream descriptions for all sites surveyed during the bat inventory of Gettysburg NMP and Eisenhower NHS of 2005 (continued).

Site Code	Lat/Long, Elevation (m)	Cardinal Directions	Basic Habitat Description	Habitat Formation	Stream Description
GETT_BATS_GETT02	39-47-04/ 77-14-41 140 m	5.1km S., 1.2km W. of Gettysburg.	Small, very rocky stream just downstream from a historic bridge. A moderately aged riparian-type forest consisting of red oak, white oak, sycamore, locust, hickory, and yellow birch dominate the area. Witch hazel, sassafras, multi-flora rose, and barberry occur in the shrub layer with barberry, stiltgrass, various ferns, and forbs (including cardinal flower and great lobelia), with heavy leaf and limb litter as groundcover.	I.B.2.N.a Lowland or submontane cold deciduous-forest	Plum Run at this point is very rocky in nature and only about 3–6 m wide. There are several pools up to 0.5 m in depth formed by boulder dams. Rocks and boulders are very common throughout this portion of the stream and range in size from 0.25–1 m. Banks are from 0.5 to 1.5 m high and range from gently sloping to very steep and rocky. Large boulders form some of the bank.
GETT_BATS_GETT03	39-48-54/ 77-12-54 135 m	1.8km S., 1.3km E. of Gettysburg	A wide stream bordered by floodplain forest and some meadows. Banks high and steep with boulders and rocks very prevalent. A floodplain deciduous forest occurs to northwest and east and a grassland/meadow to the southwest. Culp's Hill lies to the northwest by about 0.7 km.	I.B.2.N.d Temporarily flooded cold deciduous forest	Rock Creek is a fairly wide stream from 9–12 m. There are boulders and rocks scattered throughout the stream, which is fairly rocky and silty on the bottom. Banks are fairly steep and deep. Much erosion is noted along the banks which are very steep along this portion of the stream. Banks are overgrown with shrubs and grasses in most spots making access to the stream somewhat difficult.
GETT_BATS_GETT04	39-47-01/ 77-14-37 140 m	5.2km S., 1.2km W. of Gettysburg	Plum Run, in this section, is wider than Plum Run #1 and has much more canopy closure. Although still fairly small and shallow, the presence of small pools and slow moving water creates a fairly good site for surveying bats. Surrounding forest provides better habitat than spots upstream.	I.B.2.N.a Lowland or submontane cold-deciduous forest	Plum Run in this section is fairly wide compared to other spots, and very shallow with gently sloping banks. Some areas of the banks are incised due to erosion. Banks are fairly heavily covered with vegetation consisting of both forbs and shrubs.

Methods

USFWS Guidelines and Basic Netting Protocols

The United States Fish and Wildlife Service (1999) created specific guidelines for the survey of Indiana bats (See Appendix A). Due to the nature of this particular survey, however, these guidelines were modified somewhat to suit a baseline inventory of general bat species occurrence.

Field sampling was conducted between July and September of 2004 and in May of 2005. Two to four ground net sets and either stacked (two or more nets stacked one above the other) or elevated nets (extended poles with a pulley system as depicted in Figure 3) were employed in places where the canopy closure permitted set up of a higher system. The nets were 50 denier and ranged in size from 4–9 m (13–30 ft) in width. The nets were opened at dusk and closed no later than 2400 hrs. Each site was surveyed for two nights. Presence of bats was confirmed by being either seen foraging in the vicinity of the netting site or heard on a Skye[®] (Skye Instruments Ltd.) bat detector. The nets were checked every 10 minutes or less, depending on the activity level of the bats and the number being captured. Bats were put into holding bags after being identified as to species, sex, age, and reproductive condition. Bats were held until the end of the evening to preclude the chances of being recaptured. Prior to release all bats were measured and weighed.

Although this method of survey basically follows the accepted protocols used by the USFWS in surveying for the federally endangered Indiana bat, it does differ somewhat in that mist netting was not extended past 2400 hrs. Also, it is unlikely that the Indiana bat occupies any permanent roosts during the summer, due to a lack of available summer roosting habitat at GETT/EISE. It is possible, however, that the Indiana bat may stop over during its migrations to and from hibernacula throughout central Pennsylvania to summer sites in Maryland (Pennsylvania Game Commission, Cal Butchkoski, pers. comm.).

It should be noted that the use of an Anabat (Titely Electronics[®]) bat detecting system was not employed. The goal of this project was to provide an inventory of species occurring within GETT/EISE. The Anabat system is unable to differentiate between the *Myotis* species that occur in Pennsylvania without the creation of an extensive call database with which statistical comparisons can be made. Since the cost of the system and the creation of the call library would be prohibitive, it was decided that traditional methods using mist nets would produce adequate results.

Data Acquisition and Recording

Habitat data, weather information, site location, and other pertinent information was recorded on standard forms created by the Wildlife Diversity Section of the PGC Bureau of Wildlife Management. The survey sites were GPS'd with a Garmin GPS III+ to an estimated precision of 3–9 m and Positional Dilution of Precision of 1.5–2. All GIS information was saved in UTM NAD 83, Zone 18. The nature of these surveys did not require any closer precision than mentioned, so acquired GPS points were not differentially corrected.

Individual bats were measured with digital calipers (Sylvac S.A., Switzerland) and data directly input into an Excel spreadsheet (Microsoft®) using Gagewedge® (Fred V. Fowler Co., Inc) software. Just prior to release bats were weighed on an Ohaus® CS 200 scales (Ohaus Corporation, NJ). Figure 4 shows a researcher taking measurements with digital calipers. Other data entered included the species captured, age (classified as either juvenile or adult based upon presence of epiphyseal closure [Anthony 1988]), sex, and reproductive condition. Reproductive condition included either active or inactive males based on the condition of the epididymis, or pregnant, lactating, post-lactating, and inactive females. Voucher digital photographs were taken of all PA State Listed species. No federal species were captured.

Habitat information collected included stream width and depth in meters, percent canopy closure, condition of streambanks, percent shrub and ground cover, description of typical vegetation, and general descriptions of habitat within 100 m (328 ft) of site and that greater than 100 m (328 ft), if different (Table 2).

Database Creation

Data collected during the surveys was entered into the PGC's Bat Trapping and Netting Database. A copy of this database was created containing only the information gathered during the present survey. All information entered was submitted to the Wildlife Diversity Section, Bureau of Wildlife Management, PA Game Commission, for inclusion with the PGC database and as general information for the PGC Annual Report concerning bat surveys conducted in Pennsylvania (Pennsylvania Game Commission 1984 to present; for copies of all reports and databases).

A habitat profile database was created using Microsoft Access XP® (Microsoft Corporation). This database has fields containing information on the descriptions of the habitat surveyed and several habitat variables, such as stream width, depth, canopy closure, vegetation types, and community classifications according to Perles et al. (2005). The database is set up to be linkable with the PGC database and includes descriptive photos of the sites surveyed.

Maternity Colony Investigations

Two species expected to occur in GETT/EISE, little brown and big brown bats, are known to form maternity colonies in buildings. These colonies can range in size from a couple dozen to well over 20,000 bats. Information concerning summer bat colony surveys can be found in the Pennsylvania Game Commission (1984 to present). As part of this inventory barns and outbuildings were checked for signs of use by bats. This sign normally takes the form of large guano deposits or bats are actually seen and counted during evening counts. Temperature readings were taken at each site investigated.



Figure 4. A researcher taking the measurement of the forearm of a big brown bat (*Eptesicus fuscus*) during inventories at GETT/EISE, 2005.

Results

Six sites were surveyed for bats during the project, four sites in GETT and two in EISE (Figure 5). The disposition of nets at each site are shown in images in Appendix C.

Over the course of twelve nights of surveys, 45 “netnights” were accumulated. A “netnight” can be described as the total number of nets put up at a site multiplied by the number of nights the site was surveyed. The results of these surveys are depicted in Table 3. A total of 55 bats of 4 species were captured for an average of 1.2 bats/netnight or 0.07 bats/net-meter hour. The capture rate in this study is comparable to that as noted in Frost’s work (0.08 bats/net-meter hour) as depicted in Table 1. The species captured included 24 big brown bats comprising 7 males and 17 females, 18 little brown bats comprising 4 males and 14 females, 7 eastern red bats comprising 3 males and 4 females, and 5 eastern pipistrelles comprising 1 male and 4 females. No State or Federally listed species were captured.

Six barns were investigated for summer concentrations of bats, the locations of these barns is shown in Figure 6. Although evidence of bat use in the form of guano was found to some degree in every barn, only one, the Sherfy Barn, had bats occupying it. Eight big brown bats were seen hanging in the screened vents at the ends of the barn and two were found under several beams along the south side of the barn. A bat box, similar to the one in Figure 7, is located on the southwest corner of the barn but did not seem to be occupied. The Codori Barn, renovated during 1977, reportedly had a large colony of bats occupying it in the past, but, although a moderate amount of guano was noted in the middle of the barn, the guano appeared to be fairly old and no bats were found. It is likely that the renovations of this barn affected the climate within the barn and unstable temperatures and humidity affected its use by bats. It should be noted that during the investigations of these barns, the exterior ambient temperature was 20.5°C (68.9°F) while temperatures at the peaks of the barns ranged from 20–23.3°C (68–79.9°F).

The sites mist netted ranged from a small stream (Plum Run) of no more than 1–1.5 m (3.3–5 ft) in width with depths of less than 0.5 m (1.6 ft) to a larger stream (Rock Creek) over 9 m (30 ft) wide and up to 1 m (3.2 ft) deep. Marsh Creek had depths ranging from 0.5–1.5 m (1.6–5 ft) and appeared fairly complex in terms of surrounding habitat, with floodplain forest, openland, and many meanders. Canopy closure ranged from <25% around Devil’s Den to over 90% along Plum Run. The Devil’s Den site was the only site that had an appreciable amount of rock surrounding it.

Descriptive statistics for all adult specimens captured during the project are contained in Table 4. In several cases the means were different from those found in the pertinent literature cited in Table 3, falling below the range of measurements listed. While this may be due partially to the method of measurement used by the researcher in this case and the fact that all measurements were taken on live animals, these differences may be also be partially attributed to geographic variation as well as the time of year the bat was captured. It is likely that several of the specimens measured were misidentified as to age resulting in a lowering of the mean.

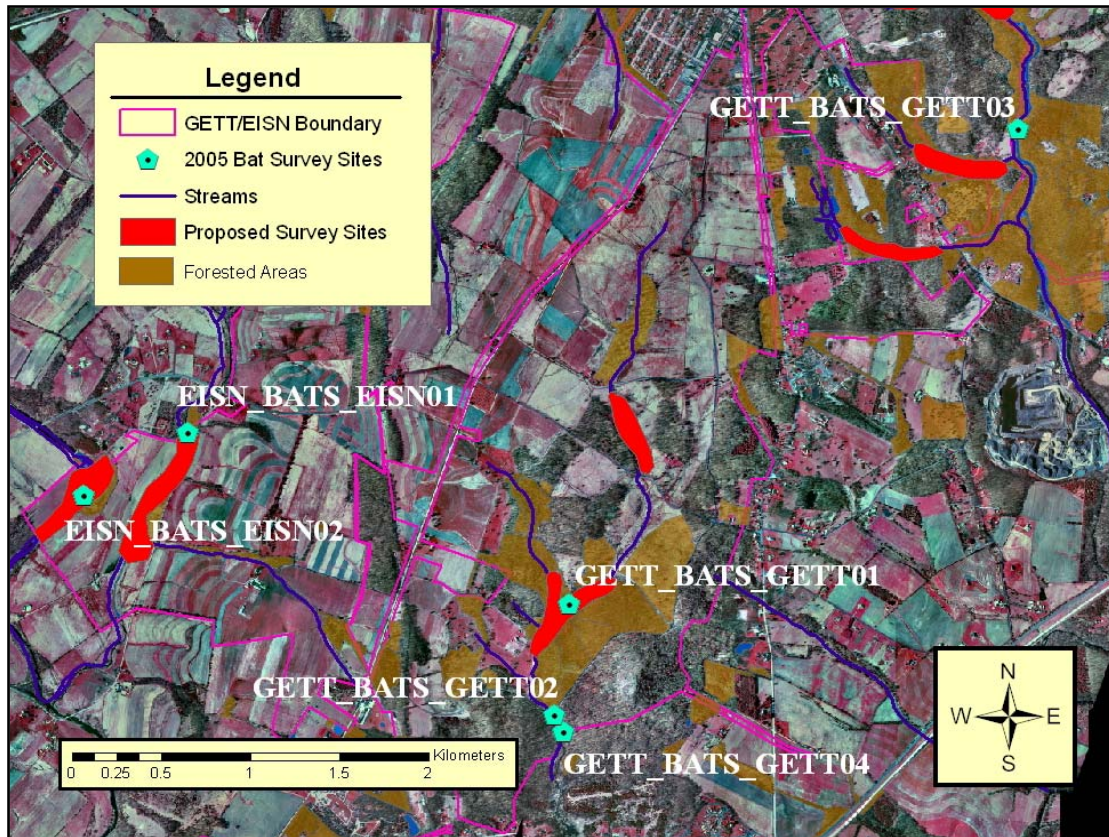


Figure 5. Location of mist-netting survey sites in Gettysburg NMP and Eisenhower NHS during the bat inventory of 2004–2005.

Table 3. Results of mist-netting surveys at six sites in Gettysburg NMP and Eisenhower NHS during 2004 and 2005.

Site Name	Site #	Effort ¹	Dates	Species ²								Other ³	Totals	
				Labo		Mylu		Epfu		Pisu				
				M	F	M	F	M	F	M	F			
Devil's Den	GETT01	88.0	7/28-7/29/2004	1										1
Plum Run #1	GETT02	25.0	8/18/2004	1	2									3
Rock Creek	GETT03	180.0	9/21-9/22/2004											0
Plum Run #2	GETT04	126.0	9/13, 9/14, 9/16/2004				1	6	16				1	24
J. D. Eisenhower Bridge	EISE01	204.0	8/16-8/17/2004	1	1		1		1					4
Marsh Creek	EISE02	148.5	5/31-6/1/2005			4	12	1		1	4			23
Subtotals (by sex)				3	4	4	14	7	17	1	4			
Totals		771.5	45 Netnights	7		18		24		5		1		55

¹Effort is reported as net-meter hours.

²Mylu- *Myotis lucifugus*, Epfu- *Eptesicus fuscus*, Labo- *Lasiurus borealis*, Pisu- *Pipistrellus subflavus*.

³EPFU Escaped before processing. M- Male, F- Female

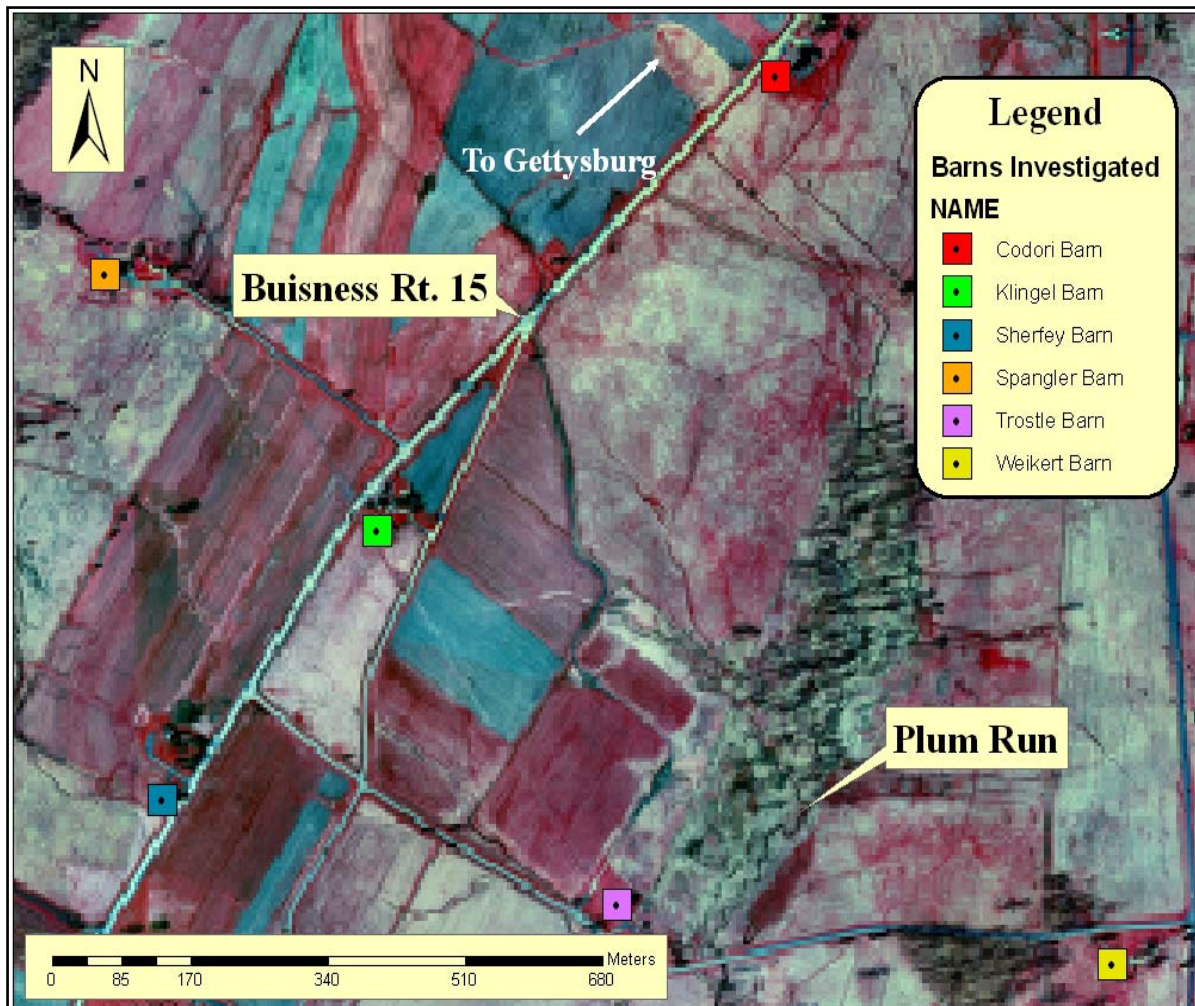


Figure 6. Buildings reviewed for evidence of use by bats during the 2004–2005 bat inventory at Gettysburg NMP.



Figure 7. An example of a bat box placed on the end of a barn. The box on the right is similar to the one found on the Sherfy Barn, Gettysburg NMP.

Table 4. Descriptive statistics (in millimeters) for all bats captured during 2004 and 2005 mist-netting surveys at Gettysburg NMP and Eisenhower NHS.

Species	Stat	Ear			Tragus	Weight
		Hind Foot	(from notch)	Forearm		
<i>Myotis lucifugus</i>	Mean	6.86	13.10	37.55	6.51	8.12
	Medium	6.77	13.27	37.43	6.38	8.40
	Maximum	7.93	15.17	39.45	7.51	9.40
	Minimum	5.10	10.58	35.47	5.22	6.10
<i>Eptesicus fuscus</i>	Mean	8.63	14.41	45.96	6.29	21.07
	Medium	8.85	14.40	46.13	6.27	21.60
	Maximum	10.04	16.61	49.00	7.78	25.30
	Minimum	5.14	11.51	41.09	3.74	12.94
<i>Lasiurus borealis</i>	Mean	6.75	8.98	42.06	4.60	12.82
	Medium	6.78	8.90	42.18	4.72	13.87
	Maximum	7.45	9.74	43.92	5.43	15.20
	Minimum	5.72	8.47	39.24	3.52	9.50
<i>Pipistrellus subflavus</i>	Mean	5.72	10.87	34.62	5.16	6.58
	Medium	5.48	10.71	35.20	5.06	6.60
	Maximum	7.44	12.20	36.41	5.88	7.30
	Minimum	4.14	9.56	32.69	4.33	5.60

Note- Mean measurements in **bold italics** from those means as listed in various publications including Fenton and Barclay (1980) for *Myotis lucifugus*, Fujita and Kunz (1984) for *Pipistrellus subflavus*, Kurta and Baker (1990) for *Eptesicus fuscus*, Shump and Shump (1982a) for *Lasiurus borealis*, and Whitaker and Hamilton (1998) for general morphological descriptions of all species.

Discussion

In a landscape where habitat is being lost at alarming rates everyday (Steiner et al. 2000) any protected setting that may serve as refugia for native wildlife should be comprehensively inventoried and a plan for monitoring of the results initiated. The NPS has been charged with “preserving, conserving, and managing natural resources in all of the national parks.” Although, in some cases, various species assemblages may be overlooked due to their secretive nature or the fact that basic inventories may be difficult and time consuming. Historically, National Park Service units in Pennsylvania have not garnered the attention that National Forest lands have when it comes to inventories of the faunas occurring on them. In order to meet the requirements of future wildlife conservation of both federal- and state-listed species of concern, inventorying and monitoring strategies have been or are being developed for all NPS Units, including the Gettysburg National Military Park and the Eisenhower National Historic Site.

Cultural parks such as Gettysburg NMP and Eisenhower NHS are managed, to a great degree, for their historical significance and, in some cases, when wildlife issues are addressed, it is due to human-wildlife conflicts such as the growth of deer populations and the ensuing problems associated with these large deer herds. Recently, several studies have addressed other wildlife issues including Yahner et al. (1994) and Yahner et al. (1997) regarding inventory protocols for vertebrates, Yahner et al (2001a) regarding amphibian and reptile communities, and Yahner et al (2001b) regarding bird communities. The present report covers a project undertaken as an outgrowth of previous vertebrate studies to gather baseline information on the bat species occurring at Gettysburg National Military Park and Eisenhower National Historic Site.

During the period between June 2004 and September 2005 mist-netting surveys to inventory bat species occurrence within Gettysburg NMP and Eisenhower NHS were conducted primarily along streams within the two units. Although only 55 individuals of four species were captured, a diversity and rate lower than expected, the results are encouraging in that the two units are primarily non-forested habitats within a matrix of forest blocks and agricultural land surrounding them. In a comparison of previous survey work conducted by Dr. Bert Frost, former Resource Manager for the two units, the overall capture rates were comparable (0.07 bats/net meter-hour in the present study compared to 0.08 bats/net meter-hour in Frost’s work). Although the present study did not capture two of the species that Frost did, the hoary bat and the northern long-eared bat, it is likely that this was the result of a number of factors, including net placement, timing of survey periods, or coincidence, and not that the two species are absent from the park. The only two known resident Pennsylvania species that remain unreported from GETT/EISE are the Indiana bat and eastern small footed bat, two species that are predominantly associated with large tracts of mature forest (Barbour and Davis 1969), a primary habitat type lacking within the confines of both Gettysburg NMP and Eisenhower NHS. Mist-netting was conducted in the vicinity of Devil’s Den, an area of GETT that approximates likely eastern small-footed bat summer roosting habitat (Veilleux 2005) without any captures of that species. It is highly likely that the high volume of tourist traffic to one of the park’s more well known and appealing sites prevents the use of crevices in the large outcrops by the small-footed bat.

Of particular interest, with regard to the Indiana bat, is radio-tracking research conducted by Pennsylvania Game Commission personnel during the early spring of 2005 (Cal Butchkoski,

pers. comm.). During a study of the spring migration of Indiana bats using the Canoe Creek Mine (Canoe Creek State Park, Blair County, Pennsylvania), two radio-tagged females were tracked to Taneytown (to a sycamore tree) and Wentz (to a shagbark hickory), just over the Pennsylvania/Maryland border. Their tracked flight path took them over the present study sites (Pennsylvania Game Commission 1984 to present). Although the present study did not reveal the presence of the Indiana bat during the course of the summer, further investigations are to be conducted during the early spring and mid-fall periods to ascertain whether this species temporarily uses habitats within the units as temporary stopover roosts during migration between summer and winter roosts.

Yahner et al. (1994) based the prediction of occurrence of a bat species on range maps found in Burt and Grossenheider (1980), a relatively poor source for this type of information due to the scale of maps used and the out-of-date nature of the publication. More current and accurate information is available in Hall (1981), Kurta (1995), and Whitaker and Hamilton (1998).

Another factor determining predicted bat community structure in a given area is the availability of both foraging and roosting habitat (Findley 1993). Although the range of a species may extend into the study area, the lack of specific temporal roost sites (maternity roosts during summer for females, temporary night roosts used between feeding bouts, winter hibernacula, etc.) serve to restrict the number of species that may occur within a specific portion of the species' predicted range.

In many instances, the community present at a specific point in time will be determined by a variety of factors, including temperature, prey availability, and overall habitat structure (Barclay 1985). Because of these factors, predicting the overall bat community expected to occur within the two park units surveyed at any given point in time may be problematical. Although this may best be overcome by increasing the number of sites surveyed and spreading the survey of a single site over an extended seasonal timeframe, varying insect hatches offsite, temperature, wind speed, and many other factors may hinder the capture of rarer species.

Yahner's original list (1994) was flawed in predicting that the silver-haired, evening, and Seminole bats would occur based on the Burt and Grossenheider maps, as the circumstances under which a species was noted or the historical significance of where and when a species was reported was not taken into consideration.

The silver-haired bat has only been recently documented from specimens collected by former Shippensburg University Vertebrate Museum personnel from forested wetlands in the central and southwestern portion of Pennsylvania during the fall migration period (Kirkland and Hart 1999). Pennsylvania Game Commission personnel (Cal Butchkoski, pers. comm.) have also reported it sporadically during fall harp trapping and mist-netting from the northern and western portions of the state, although no recently acquired or reported specimens exist to substantiate this. Single individuals may be encountered during the fall using buildings as temporary roost sites, as evinced by the capture of an individual from a building on the Shippensburg University campus. Although historical records for this species are reported from the southeast (Poole 1932; Roberts and Early 1952), no recent records or specimens exist. A review of existing Pennsylvania specimens held by museums throughout the United States (Hart 2004) failed to produce any new information concerning this species.

The evening bat has been historically reported from the Waynesburg College, Green County (Grimm and Roberts 1950) and from the Carlisle area in Cumberland Co. (Rhoads 1903) but has not been encountered recently. Whitaker and Hamilton (1998) note that this is a more southerly-occurring species which rarely appears in the northern states. No records have been taken anywhere in Pennsylvania since this species was reported on by Grimm and Roberts (1950), although extensive summer surveys have been conducted in Pennsylvania (PGC Annual Job Report for Project Code 06714, Job Code 70008), nor have any recent specimens been collected (Hart 2004).

Recently, the taxonomy of the Lasiurine bats has been called into question due to problems arising from geographic pelage variations (See comments on bats of the Genus *Lasiurus* in Baker et al. 2003). It is likely that bats reported as *Lasiurus seminolis* in much of the historic literature were actually *Lasiurus borealis*, although some of these may have been wandering migrants that occurred in Pennsylvania after storms or were brought ashore from oceangoing vessels. There are no recent records to support any claim that this species would occur in GETT/EISE (Hart 2004).

As mentioned previously, habitat availability is one of the more limiting factors in GETT/EISE when considering species occurrence, temporal occurrence, and population numbers. Primarily an agricultural and grassland landscape, forested habitat has been either altered in historic restoration efforts or is relatively young in age and does not occur in large enough amounts to effectively provide prime roosting sites in the form of cavities or large snags. Forest tracts serve a number of purposes including foraging, travel corridors, and roosting habitat (Barclay and Brigham 1996). The greater the canopy closure, the more likely most bat species are to use a specific area, as the canopy serves to protect bats from predation and having to deal with the effects of high winds on foraging success. Areas with high canopy closure also serve to funnel most bat species into nets, but may also exclude species that are less maneuverable such as the hoary bat (Shump and Shump 1985b). A problem with netting in open areas with the express intention of sampling for a fast moving species such as the hoary is that the chances of capturing other species declines.

The two most common species, the little and big brown bats, have altered their primary mode of roosting in cavities to take advantage of old structures such as barns and outbuildings as well as portions of structures such as attics in dwellings. This has led to conflicts between man and bat and has been one of the problems in bat conservation in general. At GETT/EISE, although there are no reports of large maternity colonies of bats using the many residences across the landscape, there are several barns that either have recent colonies or have been reported to contain such colonies in the past. Renovation of these sites has reduced the functionality of these as maternity roost sites. Only one barn, the Sherfy Barn, still contains what appears to be a fairly significant population of big brown bats.

Plum Run #2 (GETT_BATS_GETT04) and Marsh Creek (EISE_BATS_EISE02) accounted for over 85% of bats captured during the project (Table 2). Four species were captured at Marsh Creek while only two were captured at Plum Run. The only other site that had as many species captured as at Marsh Creek was the J. D. Eisenhower Bridge (EISE_BATS_EISE02) along Willoughby Run and not far from the Marsh Creek site. Habitat condition likely influenced both the numbers taken and the species occurring at these sites. When compared to all other sites,

both sites studied on EISE had more canopy closure and structure than the sites in GETT, exclusive of Plum Run #2. Canopy closure along Plum Run was greater than 50–70% in most areas and >90% at site Plum Run #2. While canopy closure and structure serves to funnel bats into the nets and increases the chances of capture, it also serves to protect foraging bats from predation by raptors and from the effects of wind on foraging success (Barbour and Davis 1969). It should be noted that mist-netting surveys cannot be used to assess population levels and, in many cases, does not completely indicate community structure, as noted previously.

The number of big brown bats captured at Plum Run #2 may indicate the presence of a maternity colony nearby. In many cases these colonies occur in buildings. In this case, anecdotal information suggests the occurrence of a maternity colony in a small woodlot approximately 420 m (1,378 ft) NW of the survey sites along Plum Run. Several big brown bats were seen flying during daylight in the small woodlot during a site visit by Resource Manager Zach Bolitho. Upon checking the tree from which they seem to have flown, a black rat snake was noted climbing the tree and likely foraging on the bats. The number of bats seen would indicate the probability of a nearby maternity colony of big brown bats, although the actual sex of the bats was unknown.

One question that remains is why certain species appear to be more successful in establishing and maintaining populations at both Gettysburg NMP and Eisenhower NHS. The little brown bat and big brown bat both occur fairly regularly along the watercourses and wetland areas throughout the units. The females of these species occur somewhat commensally with mankind, occupying structures that provide the temperature and humidity required for rearing young (Barbour and Davis 1969). As noted in Table 2, females comprised the majority of specimens captured in both species. Although surrounding habitat throughout much of the Gettysburg and Eisenhower properties is primarily agricultural openland, the presence of old structures in the form of barns and other outbuildings as well as old farmhouses provide ideal roosting habitat as noted by the number of barns with evidence of some form of use by bats. These sites are often situated in areas where protected corridors in the form of small woodlots provide travel lanes for bats to and from foraging areas. These woodlots may also provide adequate night roosts for use by bats during the time when they rest between feeding bouts and build up energy reserves necessary for rearing young. Cockrum (1964) was one of the first researchers to note that the occurrence of bats over watercourses appeared to reflect two periods of activity with an intervening period when activity was low. Barclay (1982) found a night roost of little brown bats in a barn in Ontario that was used between 11:30 p.m. and 2:00 a.m. He postulated that the lack of adequate night roosts located near prime foraging areas may be a limiting factor in bats. In the present study, the number of females of both species captured would seem to indicate that night roosts occur throughout much of the two units and provide adequate roosting opportunities for foraging bats.

Another factor that may explain the number of little brown bats captured is that these bats appear to favor edge habitat during foraging (Hogberg et al. 2002). This species is more maneuverable than the other species captured and tends to follow the edges of small forests and through patches of small woodlots. Both Gettysburg Battlefield and Eisenhower NHS have large amounts of edge habitat due to the patchy nature of agricultural fields interspersed between small woodlots and forestland. These areas are normally situated close to watercourses that serve as prime foraging areas.

Large, open areas in the form of agricultural fields may provide sources of prey for insectivorous bats. The landscape of the area studied forms a matrix of shelter woods and fields providing travel and dispersal corridors to and from both day and night roosts, thereby providing optimal resources for several bat species taken during this survey. Other species such as the red bat and hoary bat may use the woodland corridors to reach good foraging grounds from further away in the forested sections of Adams County. Hart et al. (1993) found that hoary bats were most often found along wooded streams with small openings along borders of the stream. In comparison of the habitat where the single hoary bat was taken by Frost, the area is an open field bordered by woodlands with a small semi-wooded stream running through it, approximating the habitat as outlined by Hart et al. (1993).

Conclusions

Although the number of bats and species captured during this investigation was low, the fact that bat populations across Pennsylvania and much of the United States have declined warrants that any habitat supporting bat populations be conserved to some degree. There is adequate habitat, albeit in the form of a great deal of edge habitat, to support a stable bat community in both NPS units. This habitat is situated primarily along the southern portion of Plum Run in GETT and along Willoughby Run and Marsh Creek in EISE. These sites most likely serve as foraging areas and travel corridors to and from daily roosts that may be scattered in small pockets throughout the units. Other sites that most likely support small colonies of various bat species include the forests along the slopes of Culp's Hill and within the forests on both Little and Big Round Tops.

Historic restoration of various sites within GETT is reducing the amount of woodland available to bats for roost sites. This is taking place primarily in areas where small woodlots occur. As this trend progresses the remaining forests become more important as foraging and roosting habitat. A plan that promotes management of remaining forests for bats as well as other forest species should be created and reviewed on an annual basis. Forested stream corridors should remain as intact as possible to facilitate dispersal of bats between foraging and roosting sites.

Another consideration is the possible presence during migration of the Indiana bat to and from its summer and winter roosting sites. During the spring two radio-tagged female Indiana bats were tracked to two sites in Maryland just south of Gettysburg (PGC, Cal Butchkoski, pers. comm.). In the course of their migration they most likely flew over GETT and EISE. Further studies will be initiated during 2006 to try to assess possible use of GETT as a temporary stopover during migration. This work will be conducted by the author of this report using funds provided by a State Wildlife Grant allocated by the Pennsylvania Game Commission.

Several isolated fields found in both Gettysburg NMP and Eisenhower NHS could provide the space needed to erect a "bat condo" such as that shown in Appendix C, provided they don't detract from the historic nature of the locale. These "condos" have been set up at several sites throughout Pennsylvania and provide maternity housing for over 2,000 bats, including both big brown and little brown bats. They have also served as points of educational interest and garnered support from the public as awareness of bat conservation increases. Also in the forests surrounding these "out-of-the-way" sites, large, unwanted trees could be girdled so that as they die, they provide roosting space as bark separates from the tree and cavities form.

Another form of artificial roosting habitat are "rocket boxes" (Burke 1999). These are narrow but deep boxes set on 3–4 m (10–13 ft) poles amid forested patches of the landscape. These boxes can serve as maternal roosting sites for northern long-eared bats, as well as night roosts for bats during dispersal or while they are foraging.

Basic artificial bat boxes like those designed by the PGC can be set up on various barns in the appropriate manner and painted to be unobtrusive to the cultural landscape and historical integrity of the structures. These boxes are extremely successful when placed properly and can house between 500 to 1,000 bats, including the northern long-eared and little brown and big brown bats. These boxes may also serve as habitat for the eastern pipistrelle.

Management Recommendations

Create a management plan that enhances natural roost site availability within the remaining forest tracts of GETT and EISE. This could include the management of undesirable tree species by girdling for the creation of natural cavity roost sites.

Decide on sites to build artificial bat roosts. There are areas within both GETT and EISE that are rarely visited by the public. A “bat condo” such as the one in Appendix D could be built to hold a population in excess of 1,500 bats, including both little and big brown bats.

Conventional bat boxes built to Bat Conservation International, Inc and PGC standards should be put on all barns that exhibited any usage by bats, both past and present. These boxes can be painted in such a manner as to be unnoticed by the public.

Monitor, through mist-netting, various sites in GETT for use during migration by the Indiana bat. Preliminary investigations will begin in the spring of 2006 but should be continued to assess whether Indiana bats use any sites in GETT. Marsh Creek in EISE should also be monitored.

Summer maternity colony surveys should be conducted at any barn or outbuilding that contains bats.

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Appendix A. USFWS Mist Netting Guidelines for surveying for Indiana bats as suggested by the Indiana Bat Recovery Team, 1999, Fort Snelling, Colorado.

MIST NETTING GUIDELINES

Rationale

A typical mist net survey is an attempt to determine presence or probable absence of the species; it does not provide sufficient data to determine population size or structure. Following these guidelines will standardize procedures for mist netting. It will help maximize the potential for capture of Indiana bats at a minimum acceptable level of effort. Although the capture of bats confirms their presence, failure to catch bats does not absolutely confirm their absence. Netting effort as extensive as outlined below usually is sufficient to capture Indiana bats. However, there have been instances in which additional effort was necessary to detect the presence of the species.

Netting Season

May 15–August 15

These dates define acceptable limits for documenting the presence of summer populations of Indiana bats, especially maternity colonies. Several captures, including adult females and young of the year, indicate that a nursery colony is active in the area. Outside these dates, even when Indiana bats are caught, data should be carefully interpreted: If only a single bat is captured, it may be a transient or migratory individual.

Equipment

Mist nets - Use the finest, lowest visibility mesh commercially available:

1. In the past, this was 1 ply, 40 denier monofilament - denoted 40/1
2. Currently, monofilament is not available and the finest on the market is 2 ply, 50-denier nylon - denoted 50/2
3. Mesh of approximately 1½ (1¼ – 1%) in (~38 mm)

Hardware - No specific hardware is required. There are many suitable systems of ropes and/or poles to hold the nets. See NET PLACEMENT below for minimum net heights, habitats, and other netting requirements that affect the choice of hardware. The system of Gardner, *et al.* (1989) has met the test of time.

Net Placement

Potential travel corridors such as streams or logging trails typically are the most effective places to net. Place the nets approximately perpendicular across the corridor. Nets should fill the corridor from side to side and from stream (or ground) level up to the overhanging canopy. A

typical set is seven meters high consisting of three or more nets “stacked” on top one another and up to 20 m wide. (Different width nets may be purchased and used as the situation dictates.) Occasionally it may be desirable to net where there is no good corridor. Take caution to get the nets up into the canopy. The typical equipment described in the section above may be inadequate for these situations, requiring innovation on the part of the observers.

Recommended Net Site Spacing

- Stream Corridors - one net site per km of stream.
- Non-corridor Land Tracts - two net sites per square km of forested habitat.

Minimum Level of Effort

Netting at each site should consist of;

- At least three net nights (unless bats are caught sooner) (one net set up for one night = one net night)
- A minimum of two net locations at each site (at least 30m apart, especially in linear habitat such as a stream corridor)
- A minimum of two nights of netting
- Sample Period: begin at sunset; net for at least 5 hr
- Each net should be checked approximately every 20 min
- No disturbance near the nets, other than to check nets and remove bats

Weather Conditions

Severe weather adversely affects capture of bats. If Indiana bats are caught during weather extremes, it is probably because they are at the site and active despite inclement weather. On the other hand, if bats are not caught, it may be that there are bats at the site but they may be inactive due to the weather. Negative results combined with any of the following weather conditions throughout all or most of a sampling period are likely to require additional netting:

- Precipitation
- Temperatures below 10°C
- Strong winds (Use good judgment: moving nets are more likely to be detected by bats.)
- Moonlight

There is some evidence that small myotis bats avoid brightly-lit areas, perhaps as predator avoidance. It is typically best to set nets under the canopy where they are out of the moonlight, particularly when the moon is half-full or greater.

Appendix B. List of voucher photographs included with this report

Folder- **EISE02**

EISE02-15 Pipistrellus-subflavus.JPG - Photo of an eastern pipistrelle bat, *Pipistrellus subflavus*, caught along Marsh Creek.

Biologist weighing bat.JPG - Photo of biologist weighing a bat in a cotton holding bag.

releasing bat.JPG - A big brown bat, *Eptesicus fuscus*, being released from the holding bag after capture along Marsh Creek.

Folder- **GETT01**

GETT01-01 Lasiurus borealis.JPG - Photo of a captured non-reproductive female red bat, *Lasiurus borealis*, captured along Plum Run at Devil's Den

Folder- **GETT02**

GETT02-01 Lasiurus-borealis.JPG - Photo of a captured non-reproductive female red bat, *Lasiurus borealis* captured along Plum Run south of West Confederate Avenue.

GETT02-02 Lasiurus borealis.JPG- A photo of the second red bat, *L. borealis*, captured along Plum Run south of West Confederate Avenue.

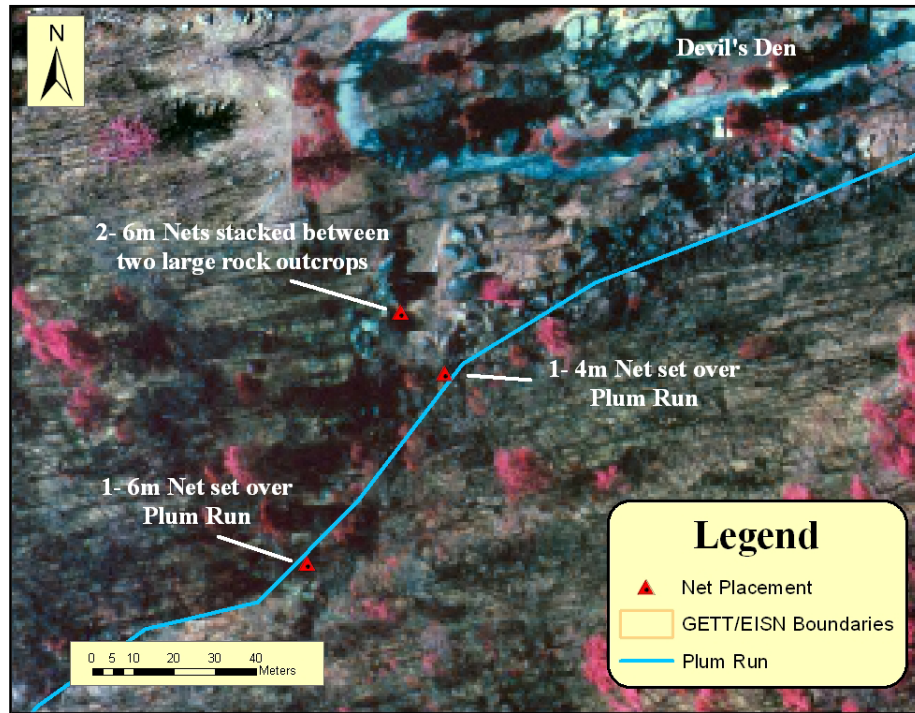
Folder- **GETT04**

GETT04-03 Eptesicus-fuscus.JPG - A photo of a big brown bat, *Eptesicus fuscus*, captured along Plum Run at the second site during 2005.

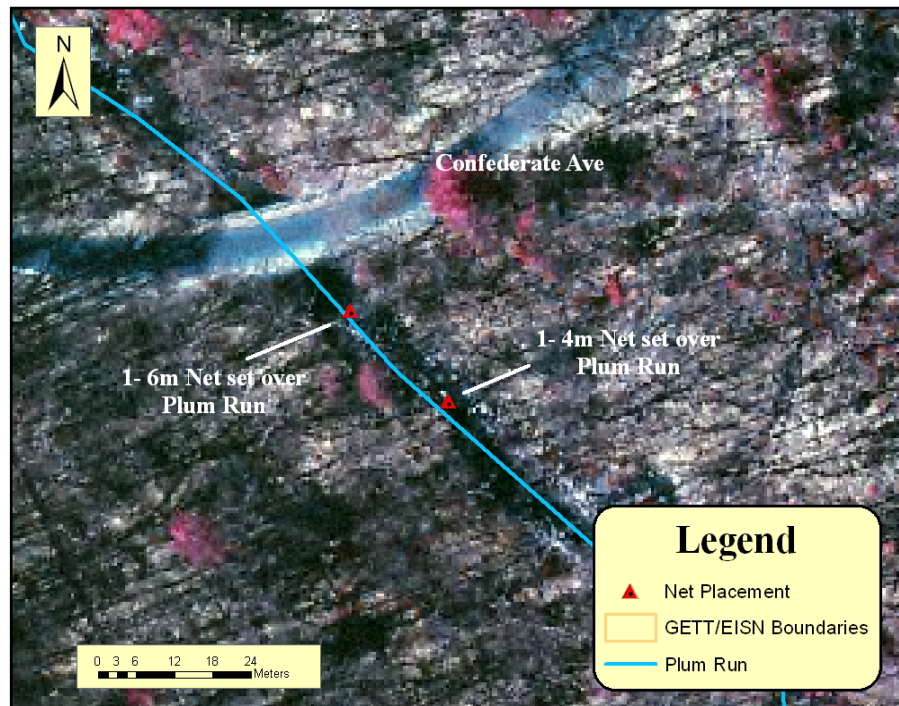
GETT04-23 Myotis-lucifugus.JPG - A photo of a little brown bat, *Myotis lucifugus*, captured along Plum Run at the second site during 2005.

Measuring_bats_Epfu.JPG - Photo of a biologist measuring a bat.

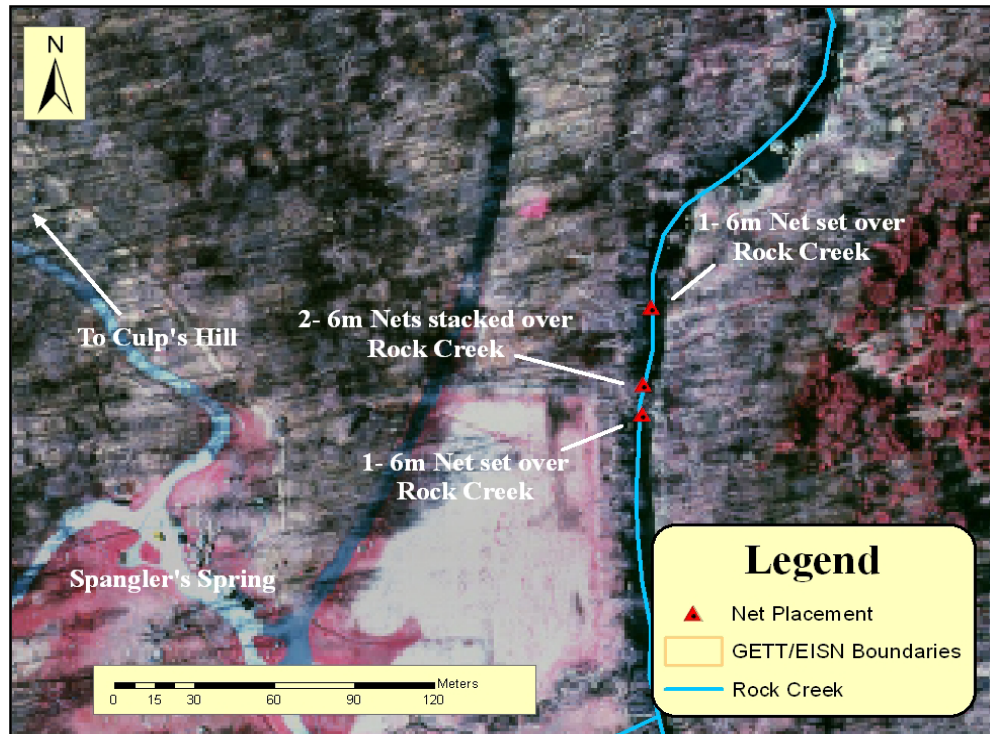
Appendix C. Placement of mist nets at the four survey sites in Gettysburg National Military Park.



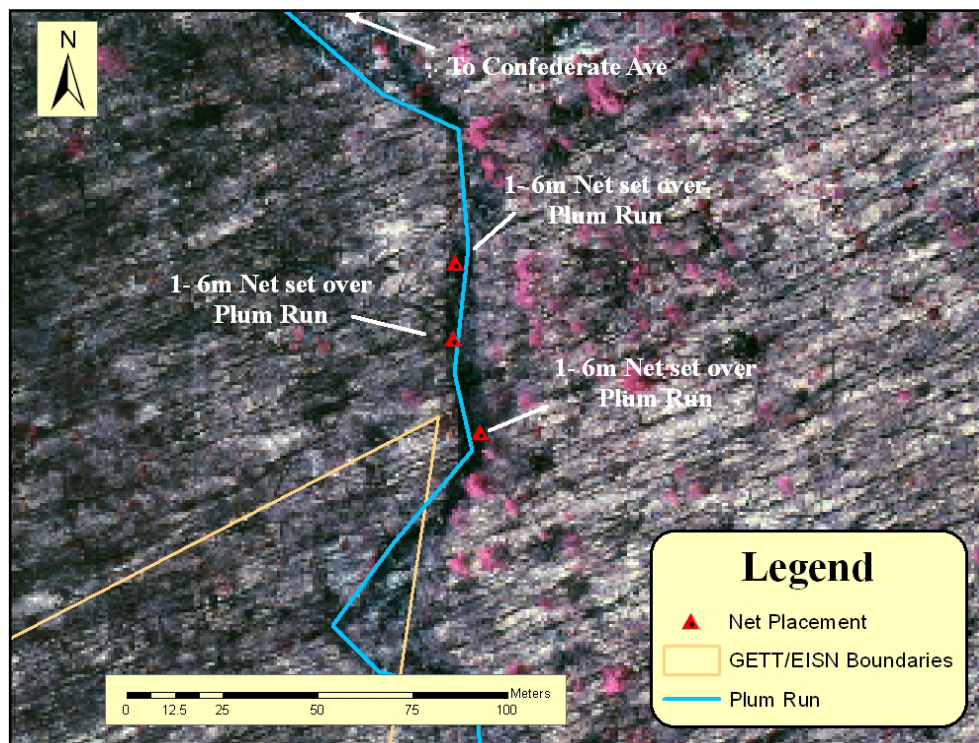
Devil's Den, Site GETT_BATS_GETT01.



Plum Run, Site GETT_BATS_GETT02.

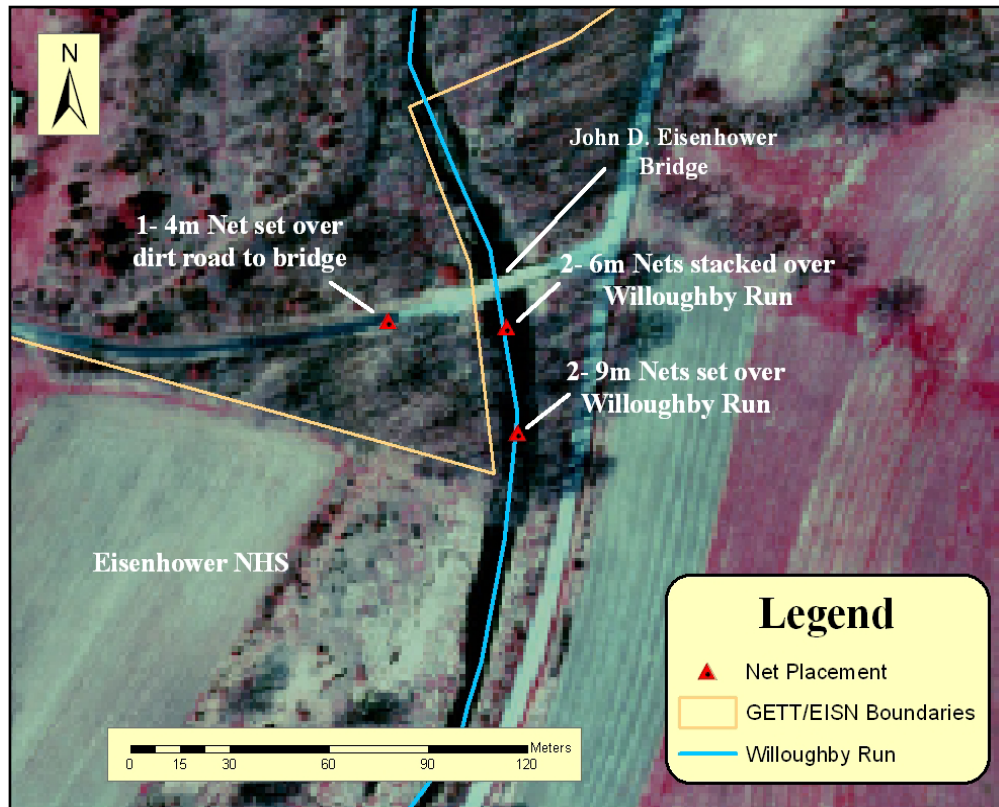


Rock Creek, Site GETT_BATS_GETT03.

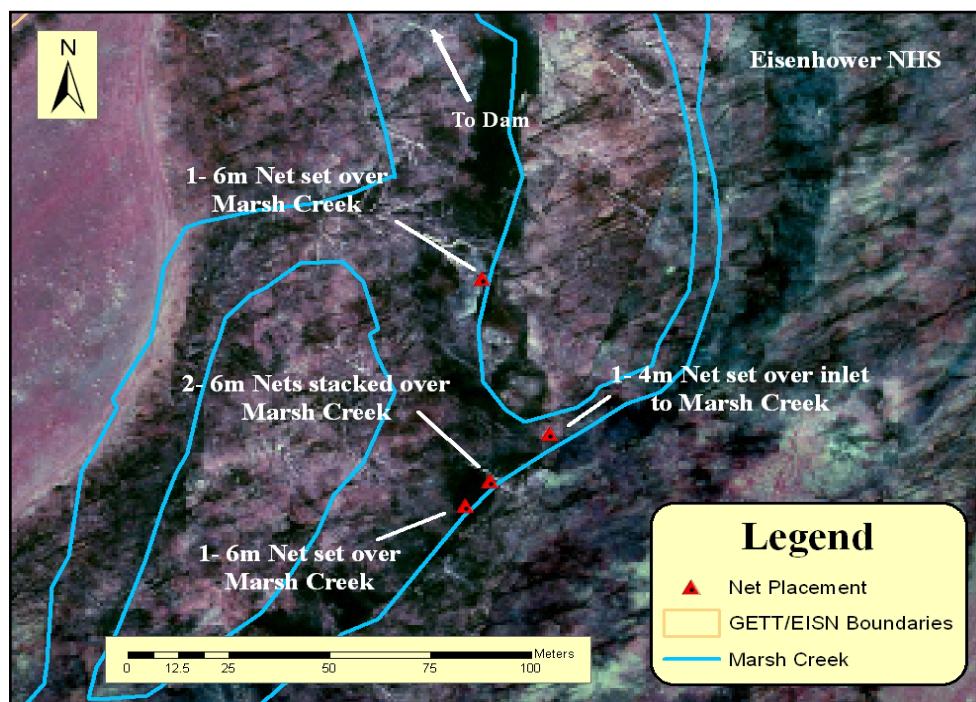


Plum Run #2, Site GETT_BATS_GETT04.

Appendix D. Placement of mist nets at the two survey sites in Eisenhower National Historic Site.



J. D. Eisenhower Bridge, Site EISE_BATS_EISE01.



Marsh Creek, Site EISE_BATS_EISE02.

Appendix E. A photo of a “Bat Condo” built by the Pennsylvania Game Commission at Canoe Creek State Park, Blair County.



As the nation's primary conservation agency, the Department of the Interior has responsibility for most of our nationally owned public land and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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