

**Study Plan for the Inventory of Mammalian Species in National Park Units of the
Northeast Region: Northeast Temperate Network & Select Historical Sites**

- Acadia National Park (NP)
- Marsh-Billings-Rockefeller National Historical Park (NHP)
 - Minute Man National Historical Park (NHP)
 - Morristown National Historical Park (NHP)
- Roosevelt Vanderbilt National Historical Park (NHP)
 - Saratoga National Historical Park (NHP)
 - Saint Gaudens National Historical Site (NHS)
- Saugus Iron Works National Historic Site (NHS)
 - Weir Farm National Historical Park (NHP)
- &
- Sagamore Hill National Historical Park (NHP)
- Martin van Buren National Historic Site (NHS)

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Introduction

Phase I of the National Park Service (NPS) Inventory & Monitoring (I&M) program involves conducting inventories to document occurrence (presence/absence), and under certain circumstances, a variety of abundance categories for vertebrates and vascular plants (NPS 1999). Using existing verifiable data (e.g., voucher specimens) and field investigations, this effort will attempt to document 90% of the terrestrial mammal species expected to occur within park boundaries (NPS 1999). This information may be used to develop monitoring strategies for select species that will be conducted as part of a long-term monitoring program.

This study plan describes an inventory of terrestrial mammal species and limited reconnaissance for bats expected to occur within 9 national park units of the Northeast Temperate Network (Johnson et al. 2000), one Coastal and Barrier Network park (Sagamore Hill NHS) and one non-I&M park (Martin van Buren NHS). This plan does not include an inventory of marine mammals. Some parks within the network have had research or inventories of mammals, but these efforts usually have been limited in scope, focusing on either individual species or issues of concern to the NPS.

The parks under study offer a diversity of habitats and physiography throughout the northeastern United States (Figure 1).

The parks range from the boreal forest to mixed deciduous woodlands some of which lie along the transition zone between the two biomes, theoretically harboring a diverse flora and fauna. The parks vary greatly in size, ranging from 4 to 19,000 hectares. Most parks within the network were created to protect cultural resources but they include a variety of significant natural systems. Generally speaking, with the exception of Acadia NP in Maine, quantitative information on mammals throughout the network is lacking (Johnson et al. 2000). Information on the presence, abundance, and distribution of mammalian species is necessary for the proper management of this diverse taxa and, except for white-tailed deer populations, is not available. A brief summary on the status of information on mammals throughout the network follows below. Acadia has had a variety of work done within the last decade, including some inventory efforts, notably for terrestrial mammals on Isle au Haut (Cole 1993), and carnivores (Harrison 1989) and small mammals (Hazen et al. 1993, O'Connell et al. 2000) on Mount Desert Island (MDI). Inventories were initially conducted on MDI by Manville (1942), but many of the voucher specimens were lost and are no longer available. Further, information collected for some of these studies is limited due to the subjective nature of the technique (i.e., interpretation of tracks in snow) and use of more

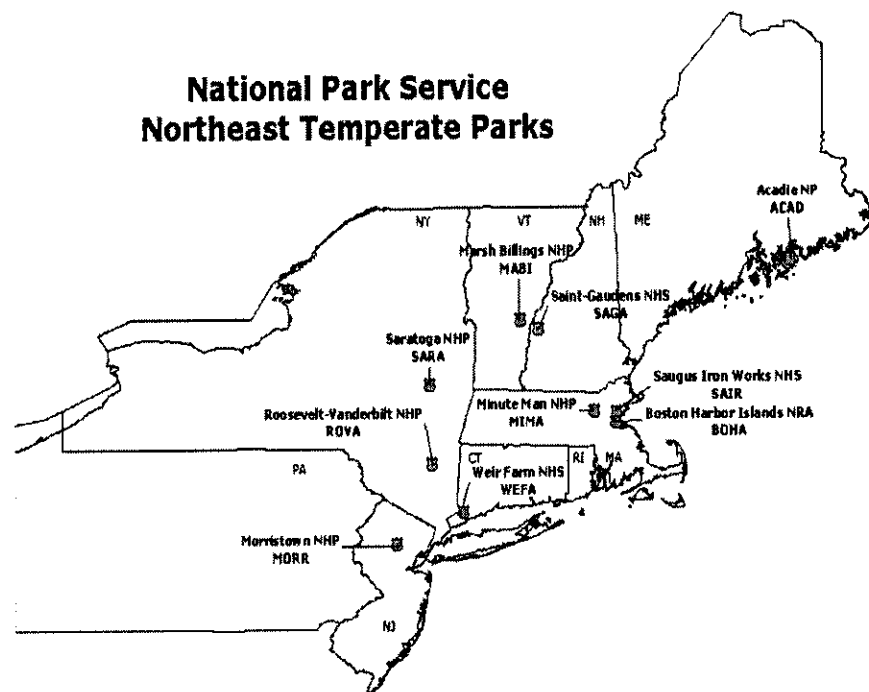


Figure 1. Map of northeastern United States showing national park units within the Northeast Temperate Network. Boston Harbor Islands NRA is part of the Network, but not included in this project. Sagamore Hill NHS on Long Island is in the Coastal and Barrier Network and Martin van Buren is not an I&M park, but both will be sampled as part of this project.

objective methods (e.g., remote cameras) would be helpful to validate species occurrence. Marsh-Billings NHP is a relatively new unit and information is limited, although a bat survey has been conducted (Reynolds and McFarland 2000). Large mammal occurrence is well documented in Minute Man NHP, but more information is needed on small mammals, including bats. Systematic inventory data on mammals at Morristown NHP is lacking because records are available only from wildlife observation cards and their accuracy is questionable (Stohlgren and Quinn 1992). Morristown has high densities of deer and the population has been well-studied (Christie and Sayre 1989). A small mammal survey has been conducted at Saratoga NHP and a list of vertebrates exists for the Park, but whether it is complete or well documented for mammals is unclear. Saratoga also has had extensive research on the deer population (Underwood et al. 1994). Mammals were inventoried during the 1980's at St. Gaudens NHS as part of a larger effort to document vertebrates and other important resources (Cook 1987). Some voucher specimens and other

forms of documentation (e.g., photos) exist and are currently located at the Park (R. Cook, pers. commun.). The status of mammal information was not reported for Saugus Iron Works NHS. Weir Farm NHP, another new park established in 1990, has little resource information available, and data on mammals are lacking. Information on mammal species located at Martin Van Buren NHP also is lacking; a reconnaissance of the area is needed to evaluate the resources, what species may occur, and the most suitable inventory techniques. The park is about to undergo planning for a General Management Plan and some reconnaissance will be conducted as part of this project, but formal sampling will not be conducted as part of this project. Roosevelt Vanderbilt NHP has had an inventory of small mammals but information on other taxonomic groups is lacking. Mammal data for Sagamore Hill NHP also is lacking.

Goals and Purpose

The principal goal of the NPS Inventory Program and this study plan is to document 90% of the extant mammal species found within park boundaries (Table 1). Based on a review of taxonomic and geographic references, 62 terrestrial mammal species, including bats, theoretically could occur in parks of the Northeast Temperate Network (Godin 1977, Degraff and Rudis 1986, Whitaker and Hamilton 1998) and Sagamore Hill. This number does not include marine mammals or those species long extinct in the region (e.g., woodland caribou, mountain lion, see Appendix 2). Therefore, documenting 90% of the species in each park would require verification of a different number of species for each park (see Table 1).

Secondary goals include documenting the distribution and abundance of species of special concern to each park, developing a better understanding of mammalian communities and interactions with the local environment, and how the mammal community has been affected by NPS management activities. Compiling current information allows for a comparison to the historical record, thereby increasing our knowledge of how communities change, especially when subjected to management actions.

Table 1. Number of mammal species that may occur in each park in this study and the 90% documentation goal of the NPS I&M program.

Park Code	Total Mammals (1)	Probable mammals (2)	90% probable	Probable w/o bats (3)	90% probable w/o bats	Notes
ACAD	63	57	51	48	43	Derived number species from SAGA list
BOHA	71	57	51	48	43	Derived number species from MIMA list
MIMA	71	57	51	48	43	
MORR	69	61	55	51	46	
ROVA	71	65	59	55	50	
SAGA	63	59	53	50	45	
SAHI	71	65	59	55	50	
SAIR	71	57	51	48	43	
SARA	71	65	59	55	50	
WEFA	65	58	52	49	44	

Objectives

The primary objective of this project is to augment existing information on the occurrence of terrestrial mammal species and fill gaps in knowledge through targeted field sampling within each park. Inventory priorities can be based on a variety of criteria that include: taxonomic group, legal status, endemism, indicator status, and rarity (Geissler 2002), all within a context of specific NPS resource management priorities. The project may include more focused efforts to gather distribution or abundance information on species that are uncommon, rare, of special concern to the NPS, or species considered locally or regionally enigmatic (e.g., southern bog lemming). Ubiquitous species or those that have been the subject of recent research will dictate a lower priority for gathering detailed information beyond presence/absence, as will species that are already well documented or have home ranges that are very large.

The list of species compiled during this project will represent both recent (<10 years) work previously conducted and current field investigations. We will document as many mammal species as possible that currently reside within park boundaries. An historical species list (work >10 years old) will be compiled from voucher specimen data (A. O'Connell and A. Gilbert, unpubl. data) for comparative purposes and to attempt to document the occurrence of 90% of the possible species. Primary objectives also include examination of unique habitats to determine their potential for harboring mammals, particularly rare, endangered (and threatened), or locally enigmatic species. Collection of distribution (i.e.,

across habitats) and abundance information on species of concern may serve as indicators of ecosystem health.

Secondary objectives involve estimating species richness based on the accumulation of previously unrecorded species (Cam et al. 2002). Spatial variation in species richness is important in understanding ecological patterns (Nichols et al. 1998) and future biodiversity inventories need to be designed around estimates of species richness, particularly in 'park-sized units' where most land-use decisions are made, often with great impact (Colwell and Coddington 1994).

Methodologies

Prior to sampling, resource managers from each park will be interviewed to prioritize information needs for mammal species in each park. This information will provide criteria for determining the need to collect abundance or distribution information on select species.

Because this plan is attempting to study mammals within several different taxonomic categories, no one technique will work for all groups, nor will a single technique be equally effective for all species within a group. As a result, multiple techniques have been proposed, and to the extent possible (constraints are imposed by the amount of personnel and logistics), will be implemented simultaneously and repeatedly at sampling locations to permit use of statistical estimators of species diversity (Conroy 1996), which is typically thought of in terms of species richness and species evenness (Williams et al. 2002:555). Collection of presence/absence information in animal inventories can be used to estimate species richness, thus allowing for a community-wide perspective of biodiversity. However, estimation of species richness can be troublesome when the number of species is <15 (J. Nichols, pers. commun.). It is unlikely that any one group of mammals in the subject parks approaches that number. Therefore, mammal species documented will be compiled into a single group that will be used to estimate species richness.

Sampling methods have two primary components: protocols (methods of sampling at selected sites) and sample frames (spatial dispersion of sites). Many of the methods proposed here have well-established protocols, but their uses are often focused on estimation of abundance for a single species (e.g., capture-recapture techniques, Williams et al. 2002: 289). Here, we propose use of these methods for documenting species in the context of estimating species richness. Because the composite estimate of species richness is the variable of interest, only general guidelines for sample size can be developed. Pilot data from Cape Cod National Seashore are available for some of the methods from recent efforts to evaluate

protocols techniques for mammal inventories in coastal parks (A. O'Connell and N. Talancy, unpubl. data,) allowing guidelines to be established for determining the numbers of traps and trapping sessions for estimating abundance. For species richness estimation, general guidelines available in Otis et al. (1996) and elsewhere can be applied to determine the needed number of trapping occasions and sample sites. Each park has its own sampling constraints and species pools, and until the proposed techniques are implemented in this network, these general guidelines will be followed. Following collection of data during the first sampling session, revised needs for samples will be evaluated. Geographic information data available for each park will be used in the development of sample frames using a geographic information system (GIS). This approach will insure an effective design with respect to NPS management needs.

Sampling Protocols

Sampling will be partitioned according to life history strategies of the target species that include novel physical characteristics (e.g., mode of locomotion). Using these criteria, mammals found within this network can be divided into several different groups:

small mammals (voles, mice),
 insectivores (shrews),
 small carnivores (weasels, mink),
 medium-sized carnivores (raccoons, skunks, coyotes, foxes, opossum),
 fossorial (moles),
 semi-fossorial (groundhogs),
 medium-sized herbivores (lagomorphs, squirrels),
 aquatic rodents and carnivores (otter, beaver, muskrat)
 large herbivores (deer)
 large omnivores (bear)

Trapping devices proposed for use in this study and those species likely to be captured:

<i>Remote cameras:</i>	medium-sized carnivores, aquatic rodents, lagomorphs, and large herbivores
<i>Live-trapping:</i>	small mammals, squirrels, lagomorphs, small and medium-sized carnivores, aquatic rodents
<i>Pit-fall traps:</i>	insectivores (shrews), small mammals

<i>Cubby boxes:</i>	small and medium-sized carnivores, small mammals, lagomorphs (i.e., tracks)
<i>Hair catchers:</i>	small and medium-sized carnivores (hair samples)
<i>Direct searches:</i>	All species
<i>Observations:</i>	All species
<i>Physical sign:</i>	All species (for some groups may not allow exact species identification)

We will use a trap array of several different trap types to capture as many target species as possible. Traps will include remote cameras fitted with infrared sensors, small and medium-sized live traps, pitfalls with drift fences, track plates within a cubby box (i.e., sooted track plates with covers on the top and sides, one end open for entrance)¹, and hair catchers. The number and spacing design (see next section) is dependent on the type and size of the community sampled (Jones et al. 1996). Over two-years each park will receive 4 sessions of sampling in the major vegetation communities, one during each season. Upon sampling each area 4 times, we will have accumulated a minimum of 500 trap nights for each community. Unique habitats also will receive trapping that will be repeated until 500 trap nights have been accumulated. A minimum of 500 trap nights are recommended for sampling in a preliminary inventory of a habitat (Jones et al. 1996). Sampling sessions will be conducted over a two-week period during which time remote cameras, hair catchers, and live-traps in trees (see below) will be operable. Some traps (i.e., live-traps and pit-falls) will be limited to shorter-trapping sessions within the two-week period to realistically meet logistics and expenses. This approach also will allow for multiple (2-3) habitats to be sampled simultaneously as well as providing the opportunity to sample unique species requiring different techniques (see below). Two individuals will comprise a team with individual teams working in different parks.

For other species, we will modify our techniques to insure the most effective sampling protocol to capture a species. For example, we will use a modification of a Victor trap for moles (Jensen 1982) and moles will be trapped in areas where sign is evident. It is not easy in some areas to live-trap moles, however. In such cases, standard Victor traps may have to be used. These traps will be left operable for 3 consecutive nights during each sampling session. The exact number of traps used for a particular site will be evaluated during the first sampling session. For flying squirrels, inventory efforts should trap for 14 consecutive days (O'Connell et al.

¹ Open, sooted track plates have proved to be ineffective during inclement weather (A. O'Connell and N. Talancy, unpubl. data).

2000) to insure maximum coverage in attracting individuals. For this group, traps set in tree boles will be left operable for the full two-week period.

Directed searches will be undertaken in major vegetation communities to determine physical sign of animals not likely to be trapped by proposed techniques or for species not sampled or missed by these trapping sessions but for which circumstantial evidence suggests that they occur in an area. cursory inspections will be conducted at each park unit to assess the potential for documenting other mammalian species like bats that are not sampled as part of this investigation, and rare species missed by these methods.

Incidental observations are often an important means of obtaining sightings of mammal species that are difficult to encounter in standard surveys (Yahner et al. 1997). We will attempt to standardize the collection of incidental sightings of wildlife, using only park personnel, by instituting area-specific checklists within the parks. This information is not to be confused with wildlife observation cards, routinely used by the NPS to record sightings by staff and the general public. Although some have suggested that these cards can be of value in recording species occurrence (Yahner et al. 1997), they are poorly scrutinized and their validity is questionable (Stohlgren and Quinn 1992). Sightings of mammals will be voluntarily recorded by park personnel and reviewed by investigators to insure authenticity. Cards will be included with other data to determine species richness estimates.

Although we will not inventory of bat species, a brief reconnaissance effort will be conducted at each park to offer guidance for future work for this taxa. Anabat® recorders will be used to record some information in spots where bats are likely to reside and provide the NPS information from which to pursue a network wide bat inventory.

Sampling Design (i.e., Sample Frames)

The general goal of the sampling design is to establish a series of sampling sites at which multiple sampling procedures can be implemented. Although estimates of population size or percent of area occupied can be calculated from information at individual sites, the primary goal will be to document species occurrence and estimation of species richness over the sites. Sample sites will be established using randomly selected cells from a grid (Fancy 2000) and within each grid cell employ live traps (sizes to accommodate small and medium-size species), pit-falls, remote cameras, track plates (cubby boxes), and hair catchers. Exact sampling points and the schematic under which the traps are laid out will be dependent on the configuration of the community being sampled. The number of traps should be

dependent on the type and size of the community sampled (Jones et al. 1996). We will establish a framework of sampling sites that encompasses entire park units (Fancy 2000). Using this approach, the design will include several levels of sampling that will allow for flexibility with respect to future studies and provide the opportunity to examine habitats or resources of special interest like wetlands (Fancy 2000, design #1). The drawback to this approach is restrictive sampling and the inability to make inferences about areas that cannot be sampled.

.At a minimum, representative vegetative associations (based on physiognomy and documented using the National Vegetation Classification) will be sampled within each park: forest (deciduous and boreal), woodland, shrub/thicket, and grassland (Whitaker 1975) in addition to unique habitats. Information on major habitat types, physical features, and structures will be used to define strata relevant for sampling for each of the sampling methods. These features can be categorized as (1) unique habitats, (2) specific locations (such as specific fields or other features that can be individually located), and (3) widespread habitats (such as habitats that cover significant areas of the park). All habitats need to be represented, to develop a comprehensive sample frame that samples the entire park.

For each park, GIS data will be obtained and used to develop a complete sampling frame. Depending on the site, it may be possible to conduct all sampling within the grid cell framework, implementing unequal probability sampling to ensure adequate sampling of unique habitats and specific locations. However, it may be more efficient in some cases to sample unique habitats separately for particular species, allowing a simpler sampling design for the grid cell samples (Fancy 2000). This can only be determined after evaluating maps and making site visits.

Widespread Habitats: For most habitats, it will be possible to sample using a systematically developed grid of sampling locations. Sample sites can be selected from the grid cells, and these "cells" form the replicates for the sampling. In each cell selected for sampling, an array of sampling methods will be implemented. At the selected grid cells, we will implement sampling methods for most taxa that occur in the park. To implement estimation procedures for species richness, "capture histories" must be collected for each species at each site, in which the presence or non-detection of a species is indicated by a string of "1's" and "0's." Consequently, each grid cell will have to be sampled for 5 trapping occasions, and at each trapping occasion the presence or non-detection of each species will have to be noted by checking traps.

Unique Habitats: Unequal sampling probability design will be used to insure that these unique habitats are sufficiently sampled. Some species are only found in specific habitats, and specialized sampling can be conducted at these habitats to

assess the occurrence of these species. Unique habitats often exist in parks that are of special interest to managers. Examples include: sensitive or unique habitats, and any habitat identified as an area requiring special management. In these sites a remote video camera/recorder will be used to record animal activity at baited stations.

Specific Locations: These represent spots that are localized in nature, and may be missed in the gridded sampling design. Examples might include fields used for agriculture where a particular species may reside or edge or transitional areas that may harbor a particular species but are representative of more than one habitat.

Small mammal trap arrays will consist of 10 stations containing 2 live-traps and at stations 1, 5 and 10 pitfall traps with drift fences will be placed between the live-traps (Yahner et al. 1997). A trapping session for small mammals will involve 3 nights of trapping. All small mammal trap stations will be separated by 30 m (Jones et al. 1996) with a maximum of 30 traps in any one sampling cell. Within each grid or along each transect (i.e., sample cell) 3 medium/large live-traps will be employed to capture larger mammals expected to be in an area. For example, in forested areas, larger traps (Havahart® or Tomahawk®, dimensions: 50 x 50 x 180 cm) are likely to be set to accommodate flying squirrels and will be set on the ground and in the bole of a tree (O'Connell et al. 2001). Two sets (each set contains two devices) of hair catchers, three cubby boxes, and two remote cameras will complete the array. Live traps and cubby boxes will operate for 4 nights and remote cameras the entire two-week period. With the exception of the small mammal live traps, all other devices will be separated by at least 100 m. This approach will allow for simultaneous operation of different types of traps. The techniques, exclusive of the live-traps and pitfalls will be used simultaneously for a period of two weeks.

Data Collection and Analysis

Collection of presence/absence data from repeated sampling of communities will be used to calculate species richness (Nichols and Conroy 1996, Nichols et al. 1998). To determine species richness, we propose to use program CAPTURE (Otis et al. 1988), and other capture-recapture-based models that use capture history information. This quantity will be estimated at the scale of the grid-cell sample sites. The program COMDYN (Hines et al. 1999) will be used to estimate change in species richness and community composition between grid cell sampling locations. Use of this program allows for subdividing the total area (i.e., park) into "secondary sampling units of consistent habitats, and for evaluation of change in species composition among habitats and more generally among sampled areas within the

park (Nichols et al. 1998). Data will meet specifications as written in "Product Specifications for the Northeast Region".

GPS Data - GPS coordinates will be recorded at all trap sites and for all specimens recorded, that can be downloaded to and compatible with ArcView® (ESRI, Redlands, CA).

Metadata - Will be provided according to Product Specifications (non-spatial data) and in Federal Geographic Data Committee format for spatial data (www.fgdc.gov/metadata/metadata.html).

Electronic Data - All data collected will be stored in a Microsoft Access database that will be compatible with NPS templates and companion projects collecting inventory data within other regional networks. The NPSpecies database entries for mammals will be certified by project personnel for each park in this study.

Voucher Specimens - All species, unless threatened or endangered at either the state or federal levels, for which no previous verification exists will be documented via the collection of a voucher specimen via preparation of study skins and skeletal material. If opportunistic collecting results in dead individuals of the desired species, additional voucher specimens will not be necessary and under this scenario individuals subsequently trapped will not be sacrificed. Information recorded from voucher specimens will be catalogued in ANCS+ (Automated National Cataloging System) and stored in a Microsoft Access database. All specimens collected as part of this project will be placed into the natural history collection at Acadia National Park in Maine. Data collected from all specimens will follow NPS curatorial guidelines.

Animal Use and Care - The ethical treatment of mammals is an important aspect of mammalian inventory and monitoring projects (Rudran and Kunz 1996). All work involving the handling and use of vertebrate animals must comply with the Animal Welfare Act, as amended (& U.S. C. §§ 2131). Therefore, this study plan will be submitted to the Patuxent Institutional Animal Care and Use Committee (IACUC) for review and approval. In addition, the most current guidelines as set forth by the American Society of Mammalogists (ASM) (1998) and recommended practices for euthanasia (American Veterinary Medical Association 2000) will be followed accordingly. Pit-fall traps, the most efficient method for capturing shrews (Schemnitz 1994), will employ a moist sponge in the bottom of each container to maximize the survival of non-target mammal species and herps. In the case of both pit-falls and live-traps (e.g., Tomahawk, Sherman), traps will be set at dusk and checked as soon as possible after sunrise (ASM 1998) to identify, record appropriate information, and release captured individuals. Traps will be rendered

inoperable during the daytime period. If protocol changes are needed to capture diurnal species, this plan will be resubmitted to Patuxent's ACUC.

Hazard Assessment - Human safety is paramount in all research activities.

Handling of wild mammals can result in the transmission of a variety of zoonotic diseases. All personnel will receive a pre-rabies vaccination (3 shots) and if they have received the vaccination previously, will have their titer tested to insure an adequate level of immunity. Additional immunity testing will be evaluated every 24-month period (Maryland Department of Human health Services). Additional precautions will be taken to guard against Hanta virus, Lyme disease, human ehrlichiosis and other vector-borne zoonoses (Gage et al. 1995, Mills et al. 1995).

Project Coordination

The principal investigator will secure permits, IACUC authorization and will make an on-site initial assessment at each park prior to sampling to delineate the exact number of habitat associations and configuration of sample layouts. This individual will also meet with NPS resource managers to evaluate park priorities. Additional investigators will construct direct sampling regime using GIS information and guide data analyses. Field staff will consist of four individuals, research associate, graduate student, and two interns. The GIS specialist at Patuxent will prepare sampling schematics using park GIS coverages. Field staff will generate output for data analyses. The Research Associate will coordinate field sampling and work with the GIS technician to insure proper input of field data. The investigators will prepare a species checklist for use by park staff.

Project Timetable

March - April 2003

- Initiate hiring process and hire Research Associate
- Design mammal/habitat observation card
- Lay groundwork for graduate student to begin in January
- Contact all resource managers re: sampling
- Order equipment
- Advertise for interns
- Secure GSA vehicles

May - June 2003

- Visit all parks and meet with NPS resource managers
- Hand out observation Cards

Design Microsoft Access Database template and data sheets
 Hire interns
 Secure GSA Vehicles
 Map sampling sites on GIS system

July - September 2003

Commence sampling session #1 - in southernmost parks
 Graduate Student begins at CESU
 Prepare progress report due October 1, 2003

October 2003 - May 2004

Sampling and data collection continues, preliminary data analysis

May - Aug 2004

Continue inventory sampling
 Final data analysis and preparation of thesis; preparation of final reports and recommendations to NPS

March 2005

Submit individual draft final report

May 2005

Submit individual final reports for eleven parks (Northeast Temperate Network, SAHI and MAVIA) and all other deliverables.

Deliverables

Species data in database template, ANCS+ and NPSSpecies

Copies of capture and habitat data as recorded on field data sheets will be provided to the NPS I&M Program as part of the archives for the project.

Data will be submitted electronically and on CD-ROM in Microsoft Access using the NPS I&M database template or one specifically developed for this particular project by an I&M Data Manager. A data dictionary describing field names and values must accompany each database. All data will be entered by the Research Associate hired for this project and verified by the principal investigators. The investigator is responsible for implementing and documenting quality assurance/quality control (QA/QC) measures used to assure the accuracy of their data. QA/QC documentation will be provided to the NPS with all databases in MS Word format.

Metadata for all biological data sets will be provided following the Federal Geographic Data Committee (FGDC) Metadata Biological Data Profile. All metadata will be parsed following the NPS GIS guidelines and provided in the following three file formats ASCII text, HTML and SGML on CD-ROM.

Graduate student thesis that will compare the species assemblages throughout the network, and using habitat variables collected in the major communities sampled, quantify and evaluate factors affecting the observed differences.

GIS data

Differentially corrected GPS coordinates (UTM NAD83) for all sampling locations will be provided as an ArcInfo coverage. The investigators will provide GPS coordinates of all captures. GIS coverages will include all sampling locations overlaid with habitat type coverages. Each location will have an associated data table containing a list of species captured. At a minimum, all spatial data is to be supplied as an ArcInfo coverage and ArcInfo interchange file, e00, compatible with the current version of ArcInfo for the MS Windows operating system, both electronically and on CD-ROM.

Federal Geographic Data Committee (FGDC) compliant metadata for all spatial data sets will be created. All metadata will be parsed following the NPS GIS guidelines and provided in the following three file formats ASCII text, HTML and SGML on CD-ROM.

Voucher specimens

Photo documentation will be the primary voucher source, except for those species not previously documented in the park or for those species whose identification can be questionable without physical evidence (e.g., flying squirrels). All voucher photos will be submitted to the NPS in JPEG or TIFF format on CD-ROM with accompanying documentation in MS Word. In the event a voucher specimen needs to be collected, study skins will be prepared and skeletal remains archived. These samples will be documented and deposited in the natural history collection at Acadia NP in Maine.

All data associated with voucher specimens will be provided to the Service in ANCS+ and NPSpecies database format.

Reports

A Progress report will be submitted on October 1 of each year to be included in the Annual Administrative Report and additional progress reports will be submitted quarterly in MS-Word format both electronically and on CD-ROM.

Final reports will be written and reviewed by the NPS and peer reviewed by experts selected by the NPS to insure compliance. Drafts of these reports will be submitted digitally, in MS-Word format, on CD-ROM to the Northeast Region I&M Program Coordinator.

The graduate student thesis emanating from this project will be submitted in hard copy (2 copies).

Investigator's Annual Reports will be completed on or before December 31 of each calendar year that this Agreement is in effect, including the year of completion.

Project Budget

	FY2003	FY2004
Funds transferred from NPS to PWRC		
<i>Personnel*</i>		
- Biologist (GS-401-7/9)	\$46,548	\$56,745
- Biol. Tech, (GS-404-5)	\$12,384 (3 months)	\$36,856
- GIS Specialist (3 months)		\$10,369
<i>Travel</i>		
- Per-diem	\$4,072	\$6,110
<i>Equipment and Supplies</i>		
- Pit Tags	\$2,500	
- Trailmaster cameras and infrared sensors (8 active units, 4 passive units)	\$3,500	
- Photographic film	in-kind by PWRC	\$750
- Data loggers	in-kind by PWRC	
- Handheld GPS	in-kind by PWRC	
- Digital camera	in-kind by PWRC	
- Misc. trapping and field supplies: animal holding cage, noose pole, scales, bait, lures, bedding, binoculars, compasses, trap replacement parts, aluminum and wood supplies for track plates, hair catchers, and cubby boxes, sample bags, pit tags and applicator, flagging, stakes, USGS maps, measuring tapes and rulers, permanent markers, dyes, pitfall fencing	\$5,000	
Computer	\$2,500	
Rabies vaccinations	\$1,200	
Gasoline for PWRC Pick-Up	\$3,000	
GSA vehicle rental (one pick up)	\$3,091	\$9,275
DOI overhead - 15% (charges on funds transferred in FY03 & FY04)	\$1,319	\$18,015
Total funds to be transferred from NPS to PWRC (\$148,234)	\$10,114 \$85,114 -\$75,000 (transferred in FY02)	\$138,120

	FY2003	FY2004
USGS/PWRC in-kind funds		
O'Connell USGS)	\$26,598	\$26,598
Sauer (USGS)	\$5,550	\$5,550
Nichols (USGS)	\$7,820	\$7,820
Office rent for Biologist in Augusta, ME	\$6,000	\$6,000
Total USGS/PWRC in-kind funds (\$91,936)	\$45,968	\$45,968
Funds to remain in the NPS		
Housing for field employees (\$14,000)	\$3,000	\$11,000
Funds transfer to URI under CESU Cooperative Agreement		
Funding for URI CESU - graduate student position:		
- MS Student stipend (2003/04)	\$20,748	
(2004/05)		\$22,248
- Tuition (2003-2004)	\$12,031	
- Tuition (2004-2005)		\$12,672
- 15%OVERHEAD on CESU agreement	\$5,028	\$5,238
Total CESU agreement (\$77,965)	\$37,807	\$40,158

*Personnel costs for the GS hire and GIS specialist include benefits under the FERS system. Budget figures for personnel represent a 4% increase across FY04 and FY 05. Because it is impossible to know what the exact increases will be, the final amounts may vary. Therefore, additional funds will be requested if the increases exceed 4%. Funds are expected to be transferred in FY03 & 04.

Sub-totals:

- \$75,000 transferred to PWRC in FY02 through Inter-agency Agreement
- \$77,965 transferred to URI CESU for graduate student support

Total requested for transfer to Patuxent:

- FY03: \$10,114
- FY04: \$138,120

TOTAL COST TO NPS : \$315,199

Total Project Costs: \$407,135 (includes USGS salaries, office rent, CESU funds, and NPS contributions [housing].

Cost comparison: mammal inventories conducted at four parks in the northeast region by Yahner et al. (1997) cost about \$224,000. This effort sampled four or five major habitat associations during one season at four different parks. Multiple techniques were used (e.g., small mammal live-traps and pit falls, scent posts, vehicular road surveys) and as such are comparable to this work, only on a much smaller geographic and operational scale. In addition, the full cost of Investigator salaries are not included in the above amount.

The following equipment will be used on this project; the investigator and NPS-staff purchased it for projects at Acadia:

- 100 Havahart cage traps (squirrel size)
- 15 Trailmaster remote cameras, active and passive systems with infrared sensors
- 300 Sherman traps (mice, vole size)
- 6 Tomahawk cage traps (fox size)
- 3 Pesola scales
- 1 Anabat Recorder

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Appendix 1. Brief synopsis of network parks and the significant resources.

Acadia National Park (Bar Harbor, ME). One of the first national parks to be legislated, this unit consists of nearly 40,000 acres along the central Maine coast. Located at the interface between the deciduous and boreal forest biomes.

Marsh-Billings-Rockefeller NHP (Woodstock, VT). This unit is a recent addition to the NPS. Donated by the Rockefeller family, this historical park has little more than 500 acres of actively managed forestland and includes northern hardwoods, conifer plantations, cliff/rocky outcrop communities, open fields, streams, a 7 ha pond, vernal pools, and seeps.

Minute Man NHP (Concord, MA). This park, has a total of 967 acres divided among three units, and was established to preserve the historic landscapes, structures and sites. Habitats include approximately 1/3 wetlands (forested wetland, shrub swamp, emergent wetlands, river/stream, ponds, vernal pools), 1/3 upland forests, and 150-200 agricultural lands and other managed types.

Morristown NHP (Morristown, NJ). This historic park is located within north central New Jersey. Of the 1,685 acres within park boundaries, 80% is forest, 10% wetlands, and 5% fields.

Roosevelt-Vanderbilt NHP (Hyde Park NY). This park is comprised of three separate sites: Vanderbilt Mansion NHS (211 acres), Home of Franklin D. Roosevelt NHS (290 acres), Eleanor Roosevelt NHS (180 acres). In total, these parks are comprised of 55% forests and 30% wetlands (open water, Hudson River, and freshwater tidal marshes).

Saratoga NHP (Stillwater, NY). This historic park is 3,406 acres in area. Forest covers nearly two-thirds of the area and managed grasslands nearly one-third. Grasslands are maintained by prescribed fire and mowing. Brush/shrub areas (416 acres) and wetlands (45 acres) make up the rest of the park landscape. The park occurs in a transition zone of two biome types (Oak-Chestnut region, Hemlock-White Pine-Northern Hardwoods region), which increases habitat complexity. Also, unique habitats occur on the Hudson River floodplain.

Saint-Gaudens NHS (Cornish, NH). This historic site is 150 acres of forest, wetlands, riparian areas and fields. The region in which this park occurs is dominated by hemlock and hemlock-beech transitional forest. Much of the forest is adjacent to the Connecticut River. The site contains terraced slopes with rich mesic forests. Vernal pools are present.

Saugus Iron Works NHS (Saugus, MA). This is a small (9 acres) historic site located in east-central Massachusetts (due north of Boston) and includes wetlands, riparian woodlands, and riverine habitat.

Weir Farm NHP (Wilton, CT). This is a small park (60 acres). It is located in the Southwest Hills Ecoregion in southern Connecticut. It has a number of wetland complexes (palustrine scrub shrub and forested), intermittent and ephemeral surface streams, and a 3.7 acre pond.

Martin Van Buren NHP (Kinderhook, NY). This park's acreage recently increased with the addition of a 126-acre farm that was part of Van Buren's original estate.

Sagamore Hill NHS (Oyster Bay [Long Island], NY). This 60 acre park is the former home of Teddy Roosevelt and includes fields, forest, and both fresh and salt water wetlands. Established in the early 1960's, the site is located on Long Island Sound.

Appendix 2. List of mammalian species whose known geographic range overlaps park units of the Northeast Temperate Network of the NPS.

ORDER - MARSUPIALIA

FAMILY DIDELPHIDAE

Virginia Opossum *Didelphis virginianus*

ORDER - INSECTIVORA

FAMILY SORICIDAE

Masked Shrew *Sorex cinereus cinereus*

Water Shrew *Sorex palustris albibarbis*

Smoky Shrew *Sorex fumeus*

Long-tailed Shrew *Sorex dispar dispar*

Thompson's Pygmy Shrew *Microsorex thompsoni thompsoni*

Short-tailed Shrew *Blarina brevicauda*

Least Shrew *Cryptotis parva*

FAMILY TALPIDAE

Hairy-tailed Mole *Parascalops breweri*

Eastern Mole *Scalopus aquaticus aquaticus*

Star-nosed Mole *Condylura cristata*

ORDER - CHIROPTERA

FAMILY VESPERTILIONIDAE

Little Brown *Myotis myotis lucifugus*

Keen's Myotis *Myotis keenii septentrionalis*

Indiana Myotis *Myotis sodalis*

Eastern Small-Footed *Myotis Myotis leibii*

Silver-haired Bat *Lasionycteris noctivagans*

Eastern Pipistrelle *Pipistrellus subflavus obscurus*

Big Brown Bat *Eptesicus fuscus*

Red Bat *Lasiurus borealis*

Hoary Bat *Lasiurus cinereus*

ORDER - LAGOMORPHA

FAMILY LEPORIDAE

Eastern Cottontail *Sylvilagus floridanus*

New England Cottontail *Sylvilagus transitionalis*

Snowshoe Hare *Lepus americanus*

Black-tailed Jackrabbit *Lepus californicus melonotis*

European Hare *Lepus europaeus*

ORDER RODENTIA

SUBORDER SCIUROMORPHA

FAMILY SCIURIDAE

Eastern Chipmunk *Tamias striatus*

Woodchuck *Arctomys monax*

Gray Squirrel *Sciurus carolinensis pennsylvanicus*

Red Squirrel *Tamiasciurus hudsonicus*

Southern Flying Squirrel *Glaucomys volans*

Northern Flying Squirrel *Glaucomys sabrinus*

FAMILY CASTORIDAE

Beaver *Castor Canadensis*

SUBORDER MYOMORPHA

FAMILY CRICETIDAE

Deer Mouse *Peromyscus maniculatus*

White-footed Mouse *Peromyscus leucopus*

Eastern Woodrat *Neotoma floridana magister*

Gapper's Red-backed Mouse *Clethrionomys gapperi*

Meadow Vole *Microtus pennsylvanicus*

Beach Vole *Microtus breweri*

Rock Vole *Microtus chrotorrhinus*

Pine Vole *Microtus pinetorum scalopsoides*

Muskrat *Ondatra zibethicus*

Southern Bog Lemming *Synaptomys cooperi*

Northern Bog Lemming *Synaptomys borealis sphagnicola*

FAMILY MURIDAE

Black Rat *Rattus rattus*

Norway Rat *Rattus norvegicus*

House Mouse *Mus musculus*

FAMILY ZAPODIDAE

Meadow jumping Mouse *Zapus hudsonius*

Woodland Jumping Mouse *Napaeozapus insignis*

SUBORDER HYSTRICOMORPHA

FAMILY ERETHIZONIDAE

Porcupine *Erethizon dorsatum dorsatum*

ORDER CARNIVORA

FAMILY CANIDAE

Coyote *Canis latrans*

Red Fox *Vulpes vulpes*
 Gray Fox *Urocyon cinereoargenteus*

FAMILY URSIDAE

Black Bear *Ursus americanus*

FAMILY PROCYONIDAE

Raccoon *Procyon lotor*

FAMILY MUSTELIDAE

Marten *Martes americana americana*
 Fisher *Martes pennanti pennanti*
 Ermine *Mustela erminea cicognanii*
 Long-tailed Weasel *Mustela frenata*
 Mink *Mustela vison*
 Striped Skunk *Mephitis mephitis nigra*
 River Otter *Lutra canadensis*

FAMILY FELIDAE

Lynx *Lynx canadensis*
 Bobcat *Lynx rufus*

FAMILY CERVIDAE

White-tailed Deer *Odocoileus virginianus borealis*
 Moose *Alces alces americana*

Species extinct or not known to have viable breeding populations in the northeast

Eastern Timber Wolf *Canis lupus*
 Wolverine *Gulo luscus luscus*
 Sea Mink *Mustela vison macrodon*
 Mountain Lion *Felis concolor*
 Wapiti or American Elk *Cervus elaphus*
 Eastern Woodland Caribou *Rangifer tarandus*

Appendix 3. Life-history strategies and major groupings of mammals that reside in the Northeast Temperate Network parks.

Arboreal small mammals--Several species of squirrels are thought to occur in these parks including two species of flying squirrels, northern, *Glaucomys sabrinus* and southern, *G. volans* (DeGraaf and Rudis 1986). Wire cage traps will be used to capture this group. We will modify the technique to capture flying squirrels in Maine (O'Connell et al. 2001) to determine occurrence and relative abundance. Distribution of traps and intensity of the trapping effort will be dependent on the potential habitat.

Fossorial small mammals--There are several species of fossorial and semi-fossorial small mammals occur in the northeast region that include moles, pine voles, and woodchucks/groundhogs. Woodchucks are considered semi-fossorial. Searches of potential habitat will be conducted to identify activity centers, and traps will then be placed in the appropriate areas. We will make every attempt to live-trap moles (Jensen 1982); however, because moles are not easily captured with live-traps we will utilize standard methods for capture to verify occurrence of a species in a particular area.

Small mammals--This group includes both insectivores and herbivores. These range in abundance from ubiquitous habitat generalists to rare habitat specialists (DeGraaf and Rudis 1986, Whitaker and Hamilton 1998). We propose to focus our sampling effort and strategies on the uncommon species, and expect to document the occurrence of the common species in the process. We will identify potential habitat for uncommon species from the literature and using existing habitat information for each park. Site selection will be based on a randomized design, if substantial habitat is present. Sampling will be conducted using live-traps and pit-falls on grids.

Large aquatic and terrestrial rodents--This group primarily includes the muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), and porcupine (*Erithizon dorsatum*). The presence of these species will be determined by systematic searches for evidence of activity.

Rabbits and hares (lagomorphs)--Three species may potentially occur in this network of parks including the eastern cottontail, New England cottontail, and snowshoe hare. Each species may be rare or uncommon in one or more parks. The priority for inventorying each of these species in each park will be determined by the status of each species in the region of the park, the potential habitat available, and the need for additional information. Sampling for documentation will be

conducted by live-trapping; pellet counts can be used to estimate relative abundance.

Carnivores (medium)- -This group includes species that vary in size from opossums to coyotes. This group includes some members of the families Mustelidae, Canidae, Felidae, and Ursidae. Many species in this group have home ranges larger than many of these parks. These species will be documented by multiple methods that include remote photography, physical sign, and scent stations.

Carnivores (small)- -These species include the mink and weasels. Detection is often difficult due to their small size, body shape and secretive habits. Although some techniques used to detect larger carnivores can be used on this group, modifications expressly for this group are sometimes necessary. For example, weasels are typically detected using a "cubby box" covering a smoked track plate constructed of thin sheets of aluminum. Mink spend much of their time around water and photography and live trapping will focus on station around aquatic environments.

Appendix 4. Travel routes and distance to national parks in the Northeast Temperate Network from Patuxent headquarters in Laurel, Maryland.

Start: Morristown, NJ

- 1 Oyster Bay, NY
- 2 Wilton, CT
- 3 Hyde Park, NY
- 4 Saratoga Springs, NY
- 5 Woodstock, VT
- 6 Concord, NH
- 7 Bar Harbor, ME
- 8 Saugus, MA

End: Concord, MA

Total Distance: 1068.20 miles (#1 to #8/end) + 215 miles from Laurel, MD to Morristown, NJ + 420 miles from Concord, MA to Laurel, MD



Appendix 5. Example of a mammal observation card for use by park staff.

MAMMAL CHECKLIST FOR PARK STAFF AT MABI

<u>OPPOSSUM</u>			<u>SQUIRRELS & ALLIES</u>			<u>CANIDS</u>		
<i>Didelphis virginiana</i>	Virginia Opossum	☐	<i>Sciurus carolinensis</i>	Gray Squirrel	☐	<i>Canis latrans</i>	Coyote	☐
<u>SHREWS & MOLES</u>			<i>Sciurus niger</i>	Fox Squirrel	☐	<i>Canis lupus</i>	Gray Wolf ⁺	☐
			<i>Tamiasciurus hudsonicus</i>	Red Squirrel	☐	<i>Vulpes vulpes</i>	Red Fox	☐
<i>Sorex cinereus</i>	Masked Shrew	☐	<i>Glaucomys volans</i>	Southern Flying Squirrel	☐	<i>Urocyon cinereoargenteus</i>	Gray Fox	☐
<i>Sorex palustris</i>	Water Shrew	☐	<i>Glaucomys sabrinus</i>	Northern Flying Squirrel	☐	<u>BEAR & RACCOON</u>		
<i>Sorex fumeus</i>	Smoky Shrew	☐	<i>Tamias striatus</i>	Eastern Chipmunk	☐			
<i>Sorex dispar</i>	Long-tailed Shrew	☐	<i>Marmota monax</i>	Woodchuck	☐	<i>Ursus americanus</i>	Black Bear	☐
<i>Sorex hoyi</i>	Pygmy Shrew	☐	<u>MICE, VOLES, LEMMINGS, & RATS</u>			<i>Procyon lotor</i>	Raccoon	☐
<i>Blarina brevicauda</i>	Short-tailed Shrew	☐				<u>WEASELS</u>		
<i>Parascalops breweri</i>	Hairy-tailed Mole	☐	<i>Peromyscus maniculatus</i>	Deer Mouse	☐			
<i>Scalopus aquaticus</i>	Eastern Mole ^{&}	☐	<i>Peromyscus leucopus</i>	White-footed Mouse	☐	<i>Martes americana</i>	Marten	☐
<i>Condylura cristata</i>	Star-nosed Mole	☐	<i>Clethrionomys gapperi</i>	Red-backed Vole	☐	<i>Martes pennanti</i>	Fisher	☐
<u>BATS</u>			<i>Microtus pennsylvanicus</i>	Meadow Vole	☐	<i>Mustela erminea</i>	Ermine	☐
			<i>Microtus chrotorrhinus</i>	Rock Vole	☐	<i>Mustela frenata</i>	Long-tailed Weasel	☐
<i>Myotis lucifugus</i>	Little Brown Bat	☐	<i>Microtus pinetorum</i>	Woodland (Pine) Vole	☐	<i>Mustela vison</i>	Mink	☐
<i>Myotis septentrionalis</i>	Northern Myotis	☐	<i>Synaptomys cooperi</i>	Southern Bog Lemming	☐	<i>Mephitis mephitis</i>	Striped Skunk	☐
<i>Myotis sodalis</i>	Indiana Bat ⁺	☐	<i>Synaptomys borealis</i>	Northern Bog Lemming ^{&}	☐	<i>Lutra canadensis</i>	River Otter	☐
<i>Myotis leibii</i>	Small-footed Bat	☐	<i>Rattus rattus</i>	Black Rat	☐	<u>FELINES</u>		
<i>Lasionycteris noctivagans</i>	Silver-haired Bat	☐	<i>Rattus norvegicus</i>	Norway Rat	☐			
<i>Pipistrellus subflavus</i>	Eastern Pipistrelle	☐	<i>Mus musculus</i>	House Mouse	☐	<i>Lynx canadensis</i>	Lynx ^{**}	☐
<i>Eptesicus fuscus</i>	Big Brown Bat	☐	<i>Zapus hudsonius</i>	Meadow Jumping Mouse	☐	<i>Lynx rufus</i>	Bobcat	☐
<i>Lasiurus borealis</i>	Red Bat	☐	<i>Napaeozapus insignis</i>	Woodland Jumping Mouse	☐	<i>Felis concolor</i>	Mountain Lion ^{**}	☐
<i>Lasiurus cinereus</i>	Hoary Bat	☐	<u>LARGE RODENTS</u>			<u>HOOVED HERBIVORES</u>		
<u>RABBITS & HARES</u>								
			<i>Castor canadensis</i>	Beaver	☐	<i>Alces alces</i>	Moose	☐
<i>Sylvilagus floridanus</i>	Eastern Cottontail	☐	<i>Ondatra zibethicus</i>	Muskrat	☐	<i>Odocoileus virginianus</i>	White-tailed Deer	☐
<i>Sylvilagus transitionalis</i>	New England Cottontail	☐	<i>Erethizon dorsatum</i>	Porcupine	☐	<i>Sus scrofa</i>	Wild Boar	☐
<i>Lepus americanus</i>	Snowshoe Hare	☐	* = Extirpated, + = Federally endangered, # = Federally threatened, & = Presence unlikely, but known to occur in an adjacent state.					

NOTE: This checklist is intended to provide a list of mammal species to park staff that have the potential for being located within the park. It is likely that not all species listed will be found within park boundaries and should not be considered a list of mammals known to reside within the park.

Submitted by:

Principal Investigator

Date

Administrative Clearance:

Program Chief

Date

Peer Review Clearance:

Chief of Science Review

Date

Revision Clearance:

Date

Center Approval:

Center Director

Date