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Appalachian Trail Mammal Inventory for Pennsylvania, New Jersey, New York, and Connecticut

Technical Report NPS/NER/NRTR—2007/097

ON THE COVER
Black Bear (*Ursus americanus*). Photograph by S.A. Sedivec
Southern flying squirrel (*Glaucomys volans*) captured in a nest box along the Appalachian Trail. Photograph by S.A. Sedivec.

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U.S. Department of the Interior
National Park Service
Northeast Region
Boston, MA

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Abstract

We conducted a targeted inventory for mammals along 742 km (460 miles) of the Appalachian National Scenic Trail (AT) from Connecticut through Pennsylvania. Our primary goal was to document all non-volant mammalian taxa listed as Critically Imperiled (S1), Imperiled (S2), or Vulnerable (S3) in Connecticut, New York, New Jersey, and Pennsylvania, as well as several taxa whose status is currently unclear (e.g., S3S4 or SU). Other mammals that were captured or observed during the course of the inventory were also recorded. Fieldwork was conducted from May 2005 through April 2007 in a corridor extending 152 m (500 feet) on either side of the AT centerline. We used a variety of inventory techniques to maximize the number of species detected, including live traps, snap traps, pitfall traps, nest boxes, motion-sensor cameras, and direct observation of mammals and their sign. We documented seven of our target taxa: Maryland shrew (*Sorex fontinalis*), American water shrew (*Sorex palustris*), Kittatinny red-backed vole (*Clethrionomys gapperi rupicola*), southern bog lemming (*Synaptomys cooperi*), bobcat (*Lynx rufus*), fisher (*Martes pennanti*), and American black bear (*Ursus americanus*). We also documented 23 non-target species: Virginia opossum (*Didelphis virginiana*), northern short-tailed shrew (*Blarina brevicauda*), masked shrew (*Sorex cinereus*), smoky shrew (*Sorex fumeus*), American beaver (*Castor canadensis*), eastern chipmunk (*Tamias striatus*), eastern gray squirrel (*Sciurus carolinensis*), red squirrel (*Tamiasciurus hudsonicus*), southern flying squirrel (*Glaucomys volans*), woodchuck (*Marmota monax*), meadow vole (*Microtus pennsylvanicus*), muskrat (*Ondatra zibethicus*), southern red-backed vole (*Clethrionomys gapperi*), white-footed mouse (*Peromyscus leucopus*), meadow jumping mouse (*Zapus hudsonius*), woodland jumping mouse (*Napaeozapus insignis*), North American porcupine (*Erethizon dorsatum*), eastern cottontail (*Sylvilagus floridanus*), northern raccoon (*Procyon lotor*), coyote (*Canis latrans*), long-tailed weasel (*Mustela frenata*), striped skunk (*Mephitis mephitis*), and white-tailed deer (*Odocoileus virginianus*). We did not record 13 of our target species: least shrew (*Cryptotis parva*), long-tailed shrew (*Sorex dispar*), eastern fox squirrel (*Sciurus niger*), northern flying squirrel (*Glaucomys sabrinus*), rock vole (*Microtus chrotorrhinus*), deer mouse (*Peromyscus maniculatus*), Allegheny woodrat (*Neotoma magister*), New England cottontail (*Sylvilagus transitionalis*), snowshoe hare (*Lepus americanus*), American marten (*Martes americana*), least weasel (*Mustela nivalis*), northern river otter (*Lontra canadensis*), and moose (*Alces alces*). The failure to document these species may be because most of these species are habitat specialists and their preferred habitats are limited or absent within the Appalachian Trail corridor. It may also be because they are naturally rare, secretive, or trap-shy, are present but not likely to be encountered in the field, or some combination of these factors. We conclude that the Appalachian National Scenic Trail corridor provides important habitat for the conservation of many mammalian species, including those at risk of extinction.

Introduction

Small mammals comprise a majority of the at-risk mammals in Appalachian National Scenic Trail (AT) states (NatureServe 2004). Natural Heritage inventories for each of the fourteen AT states, conducted from 1990 – 2000 (e.g., Pennsylvania Science Office 1990, McKay et al. 1992, Elliman 2000a,b), identified some Element Occurrences (EO) for mammals, but these inventories did not assess the range of mammalian diversity or distributional extent of most small mammals. Since the monitoring of at-risk populations may become an important component of an AT Ecological Monitoring program, it is imperative to acquire baseline data on mammals using habitat along the AT. Therefore, a targeted inventory of mammals occurring along the AT was deemed appropriate and was supported by National Park Service (NPS) Inventory & Monitoring (I&M) Program inventory funds.

Our objectives were to:

1) Conduct a targeted inventory along the Appalachian Trail corridor from Pennsylvania through Connecticut for non-volant mammalian taxa (mammals other than bats) that are listed as Critically Imperiled (S1), Imperiled (S2), or Vulnerable (S3), or whose status is currently unclear (e.g., S3S4 or SU).
2) Document all non-volant mammals associated with sites that were surveyed for target species.
3) Provide a sound basis for the future development of a management plan to preserve rare mammalian species along the Appalachian Trail.

Standards and Compliance

All activities conducted during this study were approved by the East Stroudsburg University Institutional Animal Care and Use Committee (IACUC). Fieldwork performed within the Appalachian Trail corridor was conducted under Scientific Research and Collecting Permit Numbers APPA-2005-SCI-0002 and DEWA-2005-SCI-0002 from the National Park Service. Fieldwork in New Jersey was conducted under Scientific Collecting Permit SC25039 from the New Jersey Division of Fish and Wildlife. Fieldwork in Connecticut was conducted under Permit to Collect Wildlife for Scientific and Educational Purposes # 0406101. Fieldwork in New York was conducted under License to Collect or Possess # LCP04-768 from the New York State Department of Environmental Conservation. Fieldwork in Pennsylvania was conducted under Wildlife Collecting Permit # COL00182 from the Pennsylvania Game Commission.

Project Area

The Appalachian National Scenic Trail traverses approximately 3,500 km (2,170 miles) from Mount Katahdin, in central Maine, to Springer Mountain, in northern Georgia (Chazin 2002). This inventory covered approximately 742 km (460 trail miles) from the northern Connecticut border to the southern Pennsylvania border (Figure 1). Ownership of this section of the AT is a mosaic of federal, state, and private lands. We sampled in a corridor that extended 152 m (500 feet) on either side of the trail centerline. In a few cases, we sampled in sites that were slightly beyond 152 m (500 feet) to inventory unusual habitats (e.g., Tocks Swamp and River of Rocks).

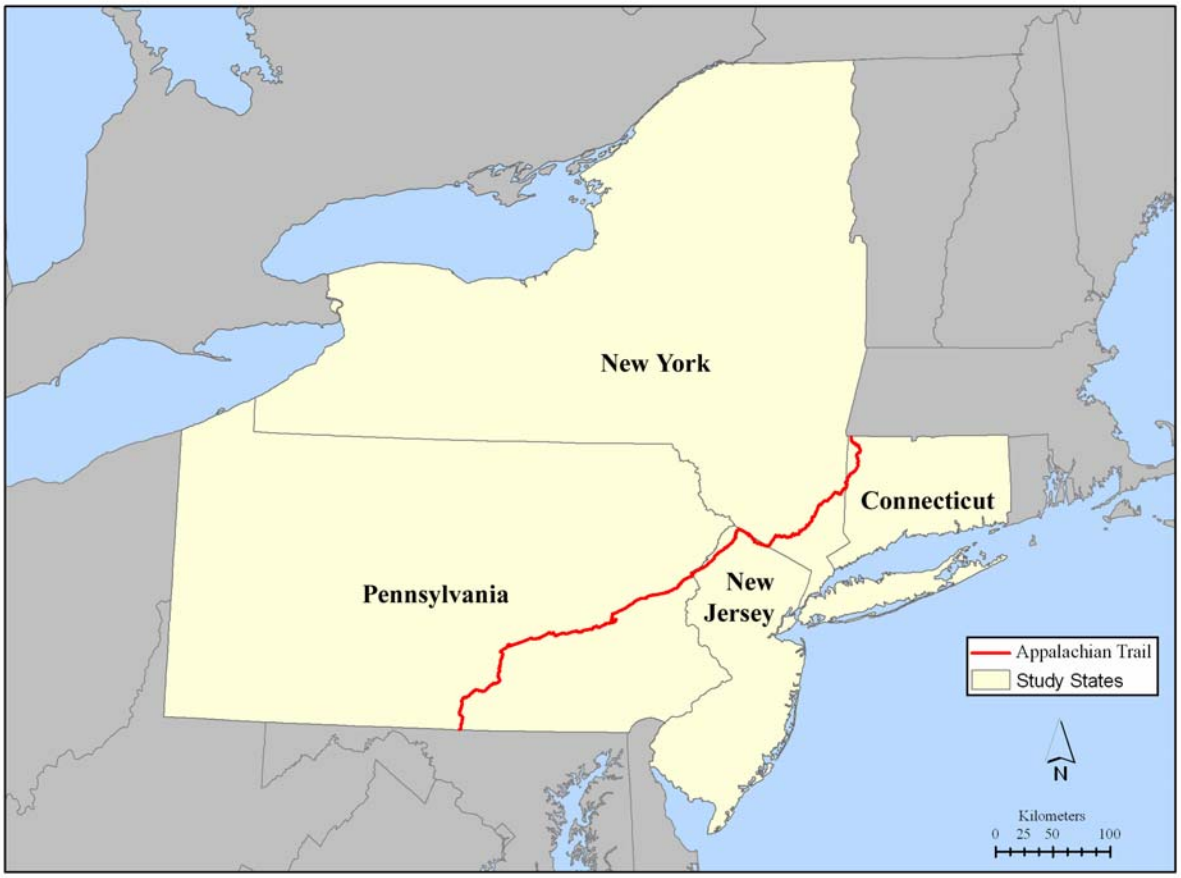

Figure 1. Map of project area showing the four Appalachian National Scenic Trail segments that were inventoried.

Methods

Target Species

We targeted 20 non-volant mammalian taxa for inventory (Table 1) based on their current conservation status as reported by NatureServe (2004). Our goal was to document all mammalian taxa listed as Critically Imperiled (S1), Imperiled (S2), or Vulnerable (S3) in Connecticut, New York, New Jersey, and Pennsylvania, as well as several taxa whose status is currently unclear (e.g., S3S4 or SU).

Identifying Known Localities and Habitat Preferences

During the initial phase of this project, we conducted an intensive literature review to identify known geographic distributions and preferred habitats for each of the target species within the project area. The life history requirements for all target species, many of which are habitat specialists, were determined and their habitat preferences identified and targeted for inventory (Table 2). Geographic distributions were obtained largely from Mammals of the Eastern United States by Whitaker and Hamilton (1998) and Mammalian Species accounts published by the American Society of Mammalogists, with additional state-specific distributional data from Godin (1977), Van Gelder (1984), DeGraff and Rudis (1986), Merritt (1987), and Kirkland and Hart (1999). Locality records were also obtained through personal communications with F. Dirrigl (Post University), J. Hart (Pennsylvania Natural Heritage Program), J. Shreiner (National Park Service), and the staff at the New York State Museum.

Table 1. Mammalian species targeted for inventory along the Appalachian National Scenic Trail corridor in Pennsylvania, New Jersey, New York, and Connecticut.*

Scientific Name	**Common Name**	**PA Rank**	**NJ Rank**	**NY Rank**	**CT Rank**	**Global Rank**
Sorex dispar	long-tailed shrew	S3	S1	S4	-	G4
Sorex fontinalis	Maryland shrew	S3S4	-	-	-	G4
Sorex palustris	American water shrew	S3	-	-	-	G5
Cryptotis parva	least shrew	S1	SU	SH	S1	G5
Clethrionomys gapperi rupicola	Kittatinny red-backed vole	S3	-	-	-	G5
Synaptomys cooperi	southern bog lemming	S4	S2	S4	S3	G5
Glaucomys sabrinus	northern flying squirrel	SU	SU	S5	-	G5
Sciurus niger (vulpinus)	eastern fox squirrel	S5	SX	S3	SX	G5
Microtus chrotorrhinus	rock vole	S2	-	S4	-	G4
Peromyscus maniculatus	deer mouse	S5	SU	S5	S3	G5
Neotoma magister	Allegheny woodrat	S3	S1	SH	SNR	G3G4
Sylvilagus transitionalis	New England cottontail	-	SU	SH	S4	G4
Lepus americanus	snowshoe hare	S3S4	SX	S5	S4	G5
Lontra canadensis	northern river otter	S3	S4	S5	S5	G5
Mustela nivalis	least weasel	S3	-	SH	-	G5
Martes pennanti	fisher	SNR	SX	S4	S2	G5
Martes americana	American marten	SX	-	S3	-	G5
Lynx rufus	bobcat	S4	S3	S3S4	S2	G5
Ursus americanus	American black bear	S5	S3	S5	S3	G5
Alces alces	moose	SX	-	SU	SX	G5

* State rarity rank codes: SX: Presumed Extirpated; SH: Possibly Extirpated; S1: Critically Imperiled; S2: Imperiled; S3: Vulnerable; S4: Apparently Secure; S5: Secure; SU: Unrankable; SNR: Not Yet Ranked. Global rarity rank codes: G3: Vulnerable; G4: Apparently Secure; G5: Secure. Data from NatureServe (2004). Common names follow Baker et al. 2003.

Table 2. Summary of identified habitats for each target species.*

Scientific Name	Common Name	Habitat Type
Sorex dispar	long-tailed shrew	Moist wooded talus and along streams
Sorex fontinalis	Maryland shrew	Moist sedge-grass meadows and woodlands
Sorex palustris	American water shrew	Fast-moving streams, sphagnum swamps, sedge-grass marshes
Cryptotis parva	least shrew	Old fields, grasslands, & woodland edges
Clethrionomys gapperi rupicola	Kittatinny red-backed vole	Mesic forests along crest of Kittatinny Ridge
Synaptomys cooperi	southern bog lemming	Old fields and wet meadows with succulent grasses & sedges, sphagnum bogs
Glaucomys sabrinus	northern flying squirrel	Old-growth coniferous and mixed forest
Sciurus niger (vulpinus)	eastern fox squirrel	Deciduous forest with open understory
Microtus chrotorrhinus	rock vole	Among rocks in moist forest, wooded talus near streams
Peromyscus maniculatus	deer mouse	Diverse habitats, including mixed woods, woodland edges, and open fields
Neotoma magister	Allegheny woodrat	Rocky cliffs, caves, and talus slopes
Sylvilagus transitionalis	New England cottontail	Dense forests, brushy swamps, thickets
Lepus americanus	snowshoe hare	Forests and swamps with dense understory, dense thickets
Lontra canadensis	northern river otter	Along rivers and streams, also the shores of lakes and ponds
Mustela nivalis	least weasel	Open woodlands, cultivated fields, meadow & pond edges
Martes pennanti	fisher	Coniferous and mixed forests with a closed canopy
Martes americana	American marten	Cool, moist coniferous and mixed forest with established and complex understory
Lynx rufus	bobcat	Woodlands with brushy thickets and rocky outcrops
Ursus americanus	American black bear	Mixed woodlands with thick understory
Alces alces	moose	Coniferous forests and thickets near water

* Information on preferred habitats from Merritt (1987) and Whitaker and Hamilton (1998).

Selection of Study Sites

Historic and recent species records were reviewed prior to the selection of survey sites. Information from state and federal agencies and input from knowledgeable experts and park professionals also played a role in site selection. We then used a number of other resources to identify particular microhabitat features associated with the target small mammal species. Natural Heritage Inventory data reports for Pennsylvania (Pennsylvania Science Office 1990), New Jersey (Elliman 2000a), New York (Elliman 2000b), and Connecticut (McKay et al. 1992) were reviewed carefully; these reports provided detailed descriptions of vegetation along the trail corridor, and allowed us to identify sampling sites for several target species that are habitat specialists. Information provided in Natural Heritage Element Occurrences (EO) reports were also useful in the selection of potential sampling points.

We used ArcGIS (ESRI Version 9.1) to identify target habitats and potential sampling sites for each target species. We used several spatial data sources to develop a preliminary list of sites. National Land Cover Dataset 1992 layers (Vogelmann et al. 2001) were used to locate suitable tracts of target habitat within the AT corridor that were not mentioned in inventory reports. National Wetland Inventory data layers (http://www.fws.gov/nwi/) helped us identify wetland habitats, a critical step for locating potential survey sites for the American water shrew (*Sorex palustris*), southern bog lemming (*Synaptomys cooperi*), Maryland shrew (*Sorex fontinalis*), and northern flying squirrel (*Glaucomys sabrinus*). Topographic maps were examined for species where elevation may affect distribution, such as the northern flying squirrel. Finally, orthophotographs were examined to locate additional sites of potential interest.

After all data layers were added to the GIS, we used habitat characteristics to identify 100 potential sampling points for target species. These points were downloaded to a Garmin® 60CS GPS unit for use in the field. All sites were field-checked prior to sampling. Additional sites that we identified while in the field were added as necessary. A few potential sites were eliminated because we could not obtain the landowner's permission to conduct inventory work or because access to the site was limited. We used our professional judgment to narrow this list to 40 sites for final sampling, ensuring that we sampled a variety of habitats in each study state.

We sampled at 9 sites in Connecticut, 7 in New York, 11 in New Jersey, and 13 in Pennsylvania (Table 3, Figure 2). Two of our sites (Tocks Swamp and River of Rocks) were slightly outside of the 152 m (500 foot) buffer. However, these two sites contained unusual habitats that are preferred by two of our target species (southern bog lemming and long-tailed shrew, respectively). We felt that these sites were close enough to the AT that they could serve as source populations for target species using the AT corridor. Sites were named using Natural Heritage site names where appropriate. Other sites were named based on the local topographic features and prominent features of the landscape. We noted many of the plants that were common at each site, including unusual or invasive plant species, but we did not attempt any formal sampling of vegetation.

Several of our sites were Natural Heritage sites that contained threatened and endangered (T&E) plant species that had been identified in Natural Heritage Inventory Reports. We minimized impact on these T&E plants in one or more of the following ways: (1) by avoiding a Natural

Heritage site with T&E plants altogether; (2) by maintaining a safe distance between our sampling locations and known T&E plant localities at Natural Heritage sites; (3) by sampling for mammals during months when the T&E plants were dormant; and (4) by choosing a sampling technique that would not impact the T&E plants.

Table 3. Study sites sampled during the AT mammal inventory. Sites are listed north to south along the AT. *

State	Site #	Site Name	UTM-X	UTM-Y
Connecticut				
	1	Bear Mountain	628027	4656128
	2	Lions Head	628538	4651597
	3	Moore Brook	630971	4649920
	4	Pine Marsh	632632	4639104
	5	Pine Knob	633539	4633337
	6	Hatch Brook	633441	4633067
	7	St. Johns Ledges	627445	4623244
	8	Glacier Rock	625869	4621274
	9	Grand Staircase	625423	4620970
New York				
	10	Deuel Hollow Brook	622750	4610671
	11	West Pawling Wetland	611987	4605247
	12	West Pawling Swamp	611951	4605496
	13	Shenandoah Mountain	600005	4596400
	14	Cooper Mine Brook	587695	4575837
	15	Little Dam Lake	567675	4568462
	16	Trout Brook & Fitzgerald Falls	562723	4569130
New Jersey				
	17	Maple Hill	551797	4561245
	18	Pochuck Creek Crossing	544613	4564246
	19	High Point	528742	4573878
	20	Stony Brook Trail	520700	4560724
	21	Stony Brook Trail Wetland	520709	4560582
	22	Sunrise Mountain Road	518086	4558880
	23	Culvers Gap	517382	4558710
	24	Crater Lake	508836	4551111
	25	Rattlesnake Swamp	502935	4545080
	26	Camp Mohican	499565	4542302
	27	Tocks Swamp	494597	4538931
Pennsylvania				
	28	Lake Latini	488214	4535379
	29	Eureka Creek/Mt. Minsi	488444	4535070
	30	Totts Gap	486366	4532955
	31	Little Gap Swamp	454979	4517615
	32	Hawk Mountain & Kettle Creek	418863	4499038
	33	River of Rocks	417974	4499042
	34	Hamburg Reservoir	419968	4493568
	35	Blue Mountain Bog	403046	4489365
	36	Rausch Gap	365348	4484021
	37	Camp Michaux & Tom's Run	300434	4434344
	38	Birch Run Swamp	293504	4428886
	39	Quarry Gap	287840	4422726
	40	Pen Mar & Falls Creek	285622	4400031

* UTM coordinates are in NAD 83, zone 18T for sites 1-37 and zone 18S for sites 38-40.

Figure 2. Distribution of sites sampled along the Appalachian National Scenic Trail. Symbols may represent multiple adjacent sites; see Figures 3 – 31 for more detailed site maps.

Sampling Techniques

Due to their diverse life histories, sometimes narrow habitat requirements, and cryptic nature, it is often necessary to use multiple techniques for a comprehensive inventory of small mammals (Cockrum 1947, Sealander and James 1958, Wiener and Smith 1972, Jones et al. 1996). We used five basic sampling techniques in addition to direct observation in an attempt to maximize the probability of detecting the mammals which make use of the AT corridor. Table 4 summarizes the sampling techniques and sampling intensity used at each study site.

Traplines

Traplines of Museum Special snap traps and Sherman live traps were the main inventory technique used to document small mammals. At each site, we deployed pairs of traps at 40 stations, each station containing one Museum Special and one Sherman live trap. These traps were generally set for four consecutive nights (see Table 4 for the duration at each site). Trap stations were generally placed 5 – 10 m apart and in lines to suit the local topography; we tried to keep stations within 100 m of the site GPS point. Traps were baited with a pea-sized mixture of peanut butter, bacon grease, and rolled oats and were checked daily. If a target species was caught at a study site, sampling ceased immediately to limit the impact on the remaining population. Each specimen caught in a Museum Special trap or found dead in a Sherman trap was labeled and frozen; animals in good condition were made into voucher specimens. Most small mammals found alive in Sherman live traps were identified and released at the site of capture. Animals captured alive in Sherman live traps that could not be properly identified in the field were collected following the guidelines of the American Society of Mammalogists (Animal Care and Use Committee 1998). At the River of Rocks, an extensive boulder field in Pennsylvania, we used Victor snap traps instead of the Museum Special and Sherman traps because the smaller Victor traps were more easily placed in the deep rock crevices of the boulder field. Species targeted using traplines include the long-tailed shrew (*Sorex dispar*), Maryland shrew (*Sorex fontinalis*), American water shrew (*Sorex palustris*), deer mouse (*Peromyscus maniculatus*), rock vole (*Microtus chrotorrhinus*), southern bog lemming (*Synaptomys cooperi*), and Kittatinny red-backed vole (*Clethrionomys gapperi rupicola*).

Pitfall Traps

Pitfalls are particularly effective for capturing shrews of the genus *Sorex*, many of which are thought to avoid both live traps and snap traps (Pucek 1969, Williams and Braun 1983, Handley and Kalko 1993). Our pitfalls were plastic containers approximately 20 cm deep and 15 cm in diameter that were set slightly below or flush to the soil surface. Drift fencing was used with the pitfalls to increase their effectiveness. The fencing was a 1.5 m length of 6 mil polyethylene plastic sheeting supported by plastic garden stakes and held snug to the soil surface with sticks and 16d nails. Pitfalls were checked daily, and animals found dead in pitfalls were collected, labeled, and frozen to be made into voucher specimens. We set pitfalls in two configurations: aquatic pitfall transects and terrestrial pitfall arrays.

Table 4. Sampling techniques and sampling effort for each study site.

		Sampling Technique										
		Museum Special traps		Sherman Traps		Terrestrial Pitfalls		Aquatic Pitfalls		# Nest Boxes	Trail Cameras	
Site #	Site Name	# traps	# nights	# traps	# nights	# traps	# nights	# traps	# nights		# cameras	# nights
1	Bear Mountain	40	4	45	4					10		
2	Lions Head									10		
3	Moore Brook	40	4	40	4	4	4					
4	Pine Marsh	40	5	40	5							
5	Pine Knob									10		
6	Hatch Brook	40	4	40	4	4	4					
7	St. Johns Ledges	40	2	40	2	8	2					
8	Glacier Rock	40	3	40	3	4	3					
9	Grand Staircase	40	4	40	4	4	4					
10	Deuel Hollow Brook									10		
11	West Pawling Wetland	40	4	40	4							
12	West Pawling Swamp	40	4	40	4							
13	Shenandoah Mountain									10		
14	Cooper Mine Brook	50	1	50	1					10		
15	Little Dam Lake									10		
16	Trout Brook & Fitzgerald Falls	80	4	80	4			20	4	10		
17	Maple Hill					12	7	10	7	10		
18	Pochuck Creek Crossing										2	14
19	High Point	40 / 10	4 / 3	40 / 10	4 / 3					10		
20	Stony Brook Trail							40				
21	Stony Brook Trail Wetland	40	4	40	4							
22	Sunrise Mountain Road	40	4	40	4						2	21
23	Culvers Gap	40 / 50	4 / 3	40 / 50	4 / 3					10	3	7
24	Crater Lake	40	4	40	4						2	42
25	Rattlesnake Swamp	40	4	40	4			10	4	10		
26	Camp Mohican	80	4	80	4			10	4			
27	Tocks Swamp	40	4	40	4							
28	Lake Latini	40	4	40	4						3	7
29	Eureka Creek/Mt. Minsi	40	4	40	4			10	10	10	2	7
30	Totts Gap	10	1	10	1							
31	Little Gap Swamp	40	4	40	4							
32	Hawk Mountain & Kettle Creek	80	4	80	4			10	4			
33	River of Rocks	40[1]	2									
34	Hamburg Reservoir	40	4	40	4	8	4					
35	Blue Mountain Bog	40	4	40	4							
36	Rausch Gap	40	4	40	4							
37	Camp Michaux & Tom's Run	40	4	40	4							
38	Birch Run Swamp	40	4	40	4	16	4	2	4			
39	Quarry Gap	40	4	40	4							
40	Pen Mar & Falls Creek	40	4	40	4			10	4			

[1] = Victor snap traps used instead of Museum Special traps.

Aquatic Pitfall Transects: This technique for inventorying water shrews followed recommendations outlined by the Resource Inventory Committee (1998). Pitfalls were set along the water's edge (normally within 5-10 cm but always within 30 cm of the water's edge), and drift fence was placed perpendicular to the stream beginning in the water and running over the mouth of the pitfall and onto the bank. Species targeted using this technique include the American water shrew (*Sorex palustris*).

Terrestrial Pitfall Arrays: Where terrain permitted, we constructed pitfall arrays following Handley and Varn (1994). In this configuration, three buckets were placed 120° apart around a central bucket; drift fencing extended between the central bucket and each surrounding bucket. Species targeted using this technique include the Maryland shrew (*Sorex fontinalis*) and the American water shrew (*Sorex palustris*).

Nest Boxes

We used tree-mounted wooden nest boxes to inventory northern flying squirrels based on the recommendations of G. Turner (Pennsylvania Game Commission). In appropriate forested areas, 10 nest boxes were set 3 – 4 m from the ground and approximately 25 m apart. Leaf litter was placed in the bottom of each box to encourage use. To maximize the probability of use, nest boxes were left in situ for a minimum of 6 months before they were checked. Each nest box was checked once during the inventory. Species targeted using this technique include the northern flying squirrel (*Glaucomys sabrinus*).

Motion-sensor Cameras

We used TrailMaster® (Lenexa, KS) passive and active infrared motion-sensor cameras to inventory several target taxa that were unlikely to be trapped or directly observed (e.g., snowshoe hare and carnivorans). Motion-sensor cameras were baited with appropriate bait for the target species and set at the shoulder height of the animal targeted. At Pochuck Creek Crossing in New Jersey, we used pieces of apple as bait in an attempt to confirm a possible observation of snowshoe hare. At Lake Latini and Eureka Creek in Pennsylvania and at Sunrise Mountain Road and Culvers Gap in New Jersey, we used scent lures and chicken as an attractant for carnivorans. Cameras were checked weekly and rebaited on each visit. Species targeted using this technique include snowshoe hare (*Lepus americanus*), bobcat (*Lynx rufus*), fisher (*Martes pennanti*), American marten (*Martes americana*), and American black bear (*Ursus americanus*).

Direct Observation and Sign

The simplest inventory method for many species is direct observation or observation of characteristic physical sign such as scat, tracks, and cuttings. Species targeted using this technique include: fisher (*Martes pennanti*), American marten (*Martes americana*), least weasel (*Mustela nivalis*), northern river otter (*Lontra canadensis*), bobcat (*Lynx rufus*), American black bear (*Ursus americanus*), and moose (*Alces alces*).

Species Identification

We recorded mammalian species as *present* at a site only if they could be identified with confidence. We considered voucher specimens to be the most reliable form of documentation. Voucher specimens are especially important for species that are not easily identified in the field, including shrews of the genus *Sorex*, mice of the genus *Peromyscus*, and cottontails of the genus *Sylvilagus*. For many other species, a photograph can serve as a voucher. Direct observation of more conspicuous species that are distinctive (e.g., American black bear) also served as a means of valid documentation. Finally, some mammals produce characteristic sign that documented their presence, including white-tailed deer (scat), American beaver (cuttings), and northern raccoon (tracks).

White-footed mice (*Peromyscus leucopus*) and deer mice (*P. maniculatus*) can be difficult to distinguish due to similarities in morphology, size, and pelage. This is especially true for juveniles and subadults. However, these species can be easily identified through allozyme electrophoresis of salivary amylase enzymes (Rich et al. 1996). We used this technique to identify all specimens of *Peromyscus* that we collected along the Appalachian Trail. Additionally, we tested a new multiplex PCR technique that distinguishes these two species using species-specific DNA primers (Tessier et al. 2004).

Voucher Specimens

We prepared voucher specimens of the majority of small mammals found dead in traps. Most specimens were prepared as scientific study skins and associated skeletons, but other specimens were prepared as complete skeletons. Tissues were collected from some specimens and stored in cryotubes in 95% ethanol at -80° C. Specimens are catalogued into the National Park Service's NPSpecies database, and specimen information is also available in an Access database that accompanies this final report. Vouchers and tissue samples are being held in the Museum of Natural History at East Stroudsburg University, East Stroudsburg, PA.

Assessment of Trap Effectiveness

Upon completion of the small mammal trapping, we compared the effectiveness of Museum Special, Sherman, and pitfall traps for documenting small mammals. Because Museum Special snap traps and Sherman live traps were paired at stations along transects, we compared the effectiveness of these two traps using a Wilcoxon test for paired samples (Sokal and Rohlf 1981). We also examined the effectiveness of pitfall traps for documenting shrews of the genus *Sorex* by calculating an index of captures per trap night for each type of trap.

Results

We documented the presence of 29 mammalian species along the Appalachian National Scenic Trail (Tables 5 and 6). This total includes seven of our target taxa: Maryland shrew (*Sorex fontinalis*), American water shrew (*Sorex palustris*), Kittatinny red-backed vole (*Clethrionomys gapperi rupicola*), southern bog lemming (*Synaptomys cooperi*), bobcat (*Lynx rufus*), fisher (*Martes pennanti*), and American black bear (*Ursus americanus*). The species we documented are described on a site-by-site basis in the following pages. These pages contain descriptive information for each site: state name, site number and name, location, GPS coordinates in UTM NAD 83, approximate elevation, USGS 7½" topographic quadrangle names, county name, town, township, or municipality name, ownership, and the sampling techniques and sampling dates for the site. This information is immediately followed by a summary table of species documented at that site, a brief site description, and a list of target species. There is also a map showing the location of each study site.

Table 5. Mammalian species documented at study sites along the AT corridor.

Scientific Name	Common Name	Connecticut									New York							New Jersey											Pennsylvania												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Didelphimorphia																																									
Didelphis virginiana	Virginia opossum																								•																
Insectivora																																									
Blarina brevicauda	northern short-tailed shrew	•		•			•	•	•	•							•			•				•			•					•					•		•	
Sorex cinereus	masked shrew			•			•										•	•						•	•		•	•		•			•		•					•	
Sorex fontinalis	Maryland shrew																																						•		
Sorex fumeus	smoky shrew	•							•	•							•							•	•		•			•											
Sorex palustris	American water shrew				•																																				
Lagomorpha																																									
Sylvilagus sp.	unidentified cottontail			•																																					
Sylvilagus floridanus	eastern cottontail								•									•						•													•				
Rodentia																																									
Castor canadensis	American beaver											•				•			•					•																	
Clethrionomys gapperi	southern red-backed vole	•			•		•										•			•					•		•	•		•									•	•	
C. gapperi rupicola	Kittatinny red-backed vole																																•			•					
Erethizon dorsatum	North American porcupine																								•					•											
Glaucomys volans	southern flying squirrel												•			•								•		•															
Marmota monax	woodchuck																		•						•																
Microtus pennsylvanicus	meadow vole			•	•							•	•					•				•		•		•		•				•				•					
Napaeozapus insignis	woodland jumping mouse																													•			•				•				
Peromyscus leucopus	white-footed mouse	•		•	•		•	•	•	•		•	•				•			•			•	•	•	•				•	•	•	•	•	•	•	•		•	•	•
Sciurus carolinensis	eastern gray squirrel												•					•			•		•	•	•		•												•		
Synaptomys cooperi	southern bog lemming																									•															
Tamiasciurus hudsonicus	red squirrel									•																															
Tamias striatus	eastern chipmunk													•			•	•		•	•		•		•		•												•		•
Zapus hudsonius	meadow jumping mouse																							•					•				•								
Carnivora																																									
Canis latrans	coyote			•						•					•																										
Lynx rufus	bobcat									•															•																
Martes pennanti	fisher									•																															
Mephitis mephitis	striped skunk																	•																							
Mustela frenata	long-tailed weasel																																			•					
Procyon lotor	northern raccoon								•						•	•		•							•																
Ursus americanus	American black bear															•		•		•	•	•	•		•	•						•									
Artiodactyla																																									
Odocoileus virginianus	white-tailed deer			•					•	•			•	•	•	•		•	•	•	•	•		•			•			•			•				•	•		

Table 6. Incidental observations of mammals at areas other than study sites within the project area.*

Order	Scientific Name (Common Name)	State: County, Site Name	UTM-X	UTM-Y	Observation Type
Rodentia					
	Ondatra zibethicus (muskrat)	PA: Franklin Co., Caledonia S.P. & Conococheague Creek	287505	4420383	Carcass
	Sciurus carolinensis (eastern gray squirrel)	NJ: Sussex Co., Courtright Road	530728	4574755	Direct Observation
		NJ: Warren Co., Tocks Swamp	495194	4539496	Direct Observation
		NJ: Warren Co., Sunfish Pond	494107	4539134	Direct Observation
		PA: Franklin Co., Caledonia S.P. & Conococheague Creek	287505	4420383	Direct Observation
	Tamias striatus (eastern chipmunk)	NJ: Sussex Co., Courtright Road	530728	4574755	Direct Observation
		NJ: Sussex Co., High Point & Deckertown Turnpike	527138	4568546	Direct Observation
		NJ: Warren Co., Tocks Swamp	495194	4539496	Direct Observation
		NJ: Warren Co., Sunfish Pond	494107	4539134	Direct Observation
Carnivora					
	Procyon lotor (northern raccoon)	PA: Franklin Co., Beartown Woods & Mackey Run	286720	4402334	Sign (tracks)
		PA: Franklin Co., Caledonia S.P. & Conococheague Creek	287505	4420383	Sign (tracks)
	Ursus americanus (American black bear)	NJ: Sussex Co., High Point & Deckertown Turnpike	527138	4568546	Sign (scat)
		NJ: Warren Co., Tocks Swamp	495194	4539496	Sign (scat)
Artiodactyla					
	Odocoileus virginianus (white-tailed deer)	NJ: Sussex Co., High Point & Deckertown Turnpike	527138	4568546	Direct Observation
		NJ: Sussex Co., Courtright Road	530728	4574755	Sign (tracks)
		NJ: Sussex Co., Goodrich Road	533472	4573249	Carcass
		NJ: Warren Co., Tocks Swamp	495194	4539496	Direct Observation
		PA: Franklin Co., Beartown Woods & Mackey Run	286720	4402334	Carcass
		PA: Franklin Co., Methodist Hill & Ridge Road	288405	4426600	Carcass
		PA: Franklin Co., Caledonia S.P. & Conococheague Creek	287505	4420383	Carcass

* UTM coordinates are in NAD 83, zone 18T (Sussex and Warren counties, NJ) and zone 18S (Franklin County, PA).

Connecticut

Site #1: Bear Mountain

Location: This site is near the summit of Bear Mountain in northern Connecticut (Figure 3). It is accessed via Mount Washington Road near the Connecticut/Massachusetts border. Park at the end of Mount Washington Road and hike past the AMC Shelter to the north side of Bear Mountain.

UTM (NAD 83) 18T 628027 4656128
Elevation(s): 503 m (1,650 feet)
Topographic Quadrangle(s): Bashbish Falls
County: Litchfield
Township/Town/Municipality: Salisbury
Ownership: AT

Sampling Techniques: Trapline (27 – 31 December 2005), nest boxes (installed 18 August 2005, checked 2 September 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Trapped & Released
Sorex fumeus	smoky shrew	S5	Voucher
Clethrionomys gapperi	southern red-backed vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher

Site Description: The site is a forested slope with diverse hardwood trees and mountain laurel (*Kalmia latifolia*) in the understory. It includes moist wooded talus.

Target Species: Long-tailed shrew, American water shrew, and northern flying squirrel.

Site #2: Lions Head

Location: This site is in the Wachocastinook Ravine below Lions Head (Figure 3). It is accessed via Mount Riga Road near the New York State border.

UTM (NAD 83) 18T 628538 4651597
Elevation(s): 503 m (1,650 feet)
Topographic Quadrangle(s): Bashbish Falls
County: Litchfield
Township/Town/Municipality: Salisbury
Ownership: AT

Sampling Techniques: Nest boxes (installed 9 July 2005, checked 3 September 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
No species recorded			

Site Description: The site is an eastern hemlock (*Tsuga canadensis*) ravine with steep slopes and mature trees.

Target Species: Northern flying squirrel.

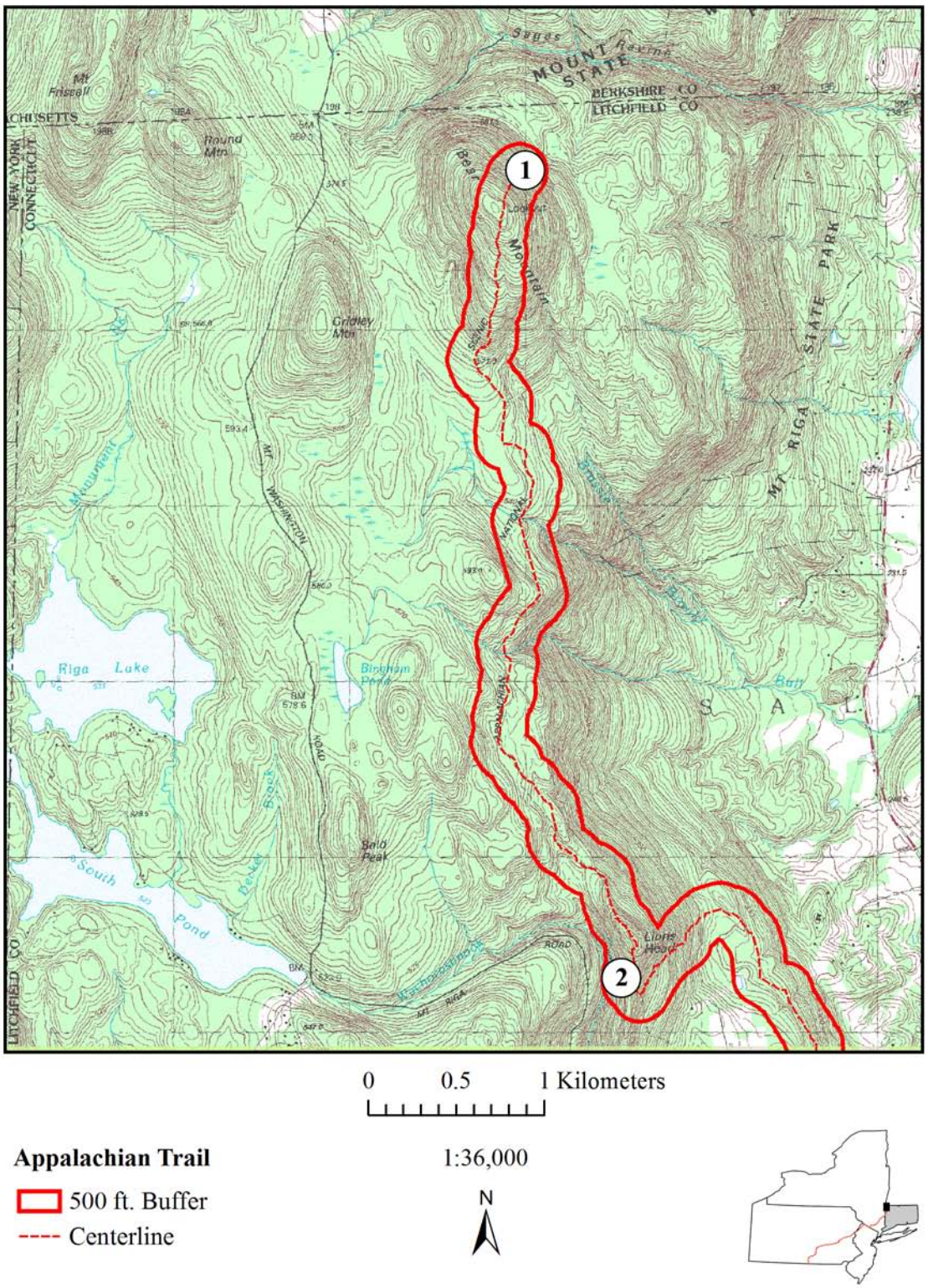

Figure 3. Map of study sites at Bear Mountain (1) and Lions Head (2) in Litchfield County, CT.

Site #3: Moore Brook

Location: This site is along Moore Brook just north of the town of Salisbury (Figure 4). It is accessed via State Route 44. Park on Cobble Road and hike to the intersection of the Appalachian Trail and Moore Brook. Site access requires landowner's permission.

UTM (NAD 83) 18T 630971 4649920
Elevation(s): 192 m (630 feet)
Topographic Quadrangle(s): Sharon
County: Litchfield
Township/Town/Municipality: Salisbury
Ownership: Private

Sampling Techniques: Trapline (19 – 23 December 2005), aquatic pitfalls (19 – 23 December 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Sorex cinereus	masked shrew	S5	Voucher
Microtus pennsylvanicus	meadow vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher
Sylvilagus sp.			Sign (tracks)
Odocoileus virginianus	white-tailed deer	S5	Sign (tracks)
Canis latrans	coyote	S5	Sign (tracks)

Site Description: The site is a riparian area along Moore Brook with white pine (*Pinus strobus*) and mixed hardwoods, and diverse shrubs, forbs, and ferns in the understory.

Target Species: American water shrew and southern bog lemming.

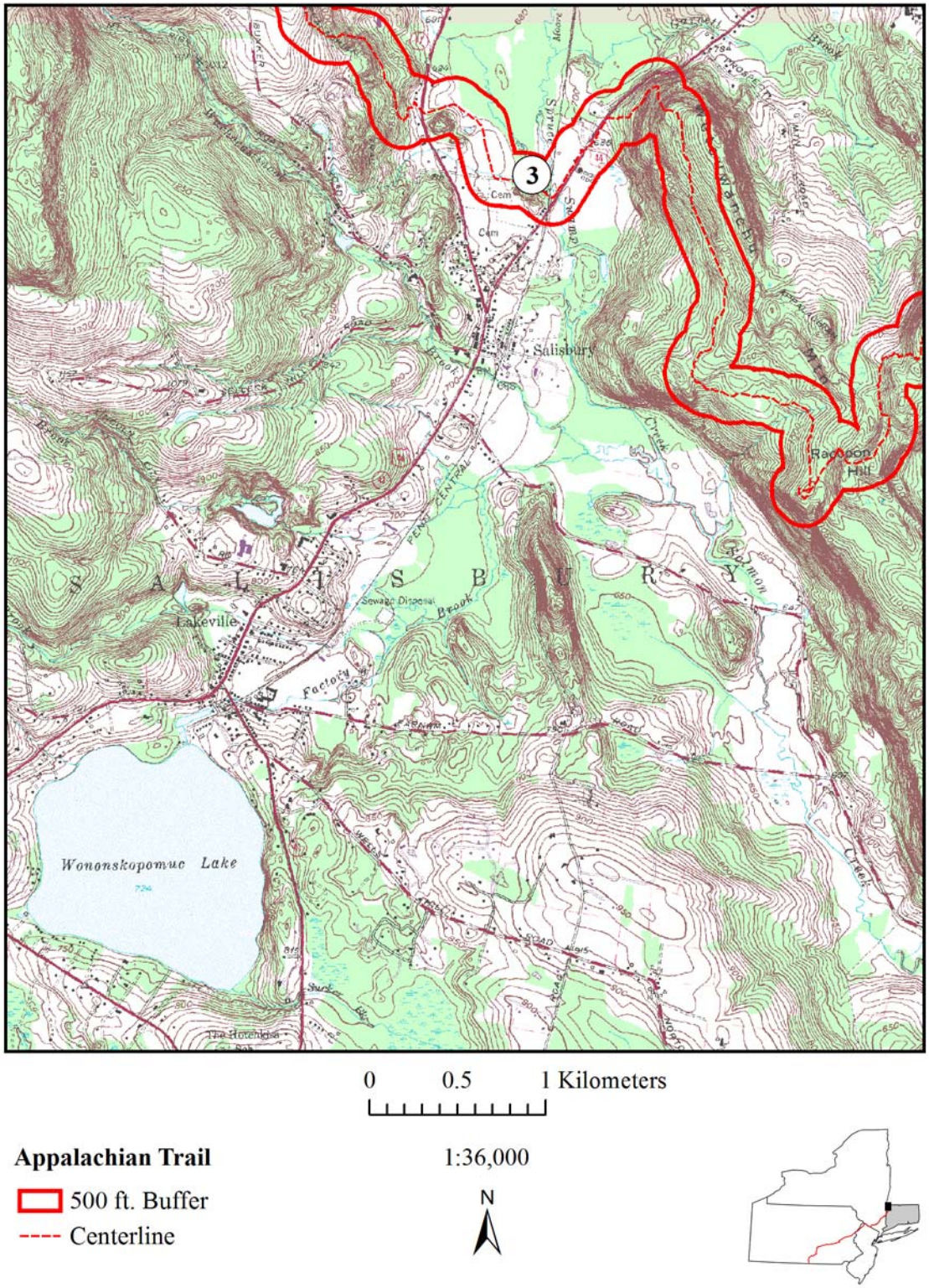

Figure 4. Map of study site at Moore Brook (3) in Litchfield County, CT.

Site #4: Pine Marsh

Location: This site is located adjacent to Pine Marsh, a wetland with open water (Figure 5). It is accessed via Sharon Mountain Road. Park at the gate on Sharon Mountain Road and hike up the dirt road to the site.

UTM (NAD 83) 18T 632632 4639104
Elevation(s): 335 m (1,100 feet)
Topographic Quadrangle(s): Sharon
County: Litchfield
Township/Town/Municipality: Salisbury
Ownership: State of Connecticut

Sampling Techniques: Trapline (17 – 18 August 2005 and 15 – 19 November 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Sorex palustris	American water shrew	S3S4	Voucher
Clethrionomys gapperi	southern red-backed vole	S5	Voucher
Microtus pennsylvanicus	meadow vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher

Site Description: The wetland contains a fringing marsh dominated by sphagnum (*Sphagnum* sp.), sedges (*Carex* spp.), and diverse forbs. A mixed hardwood forest surrounds the site.

Target Species: American water shrew and southern bog lemming.

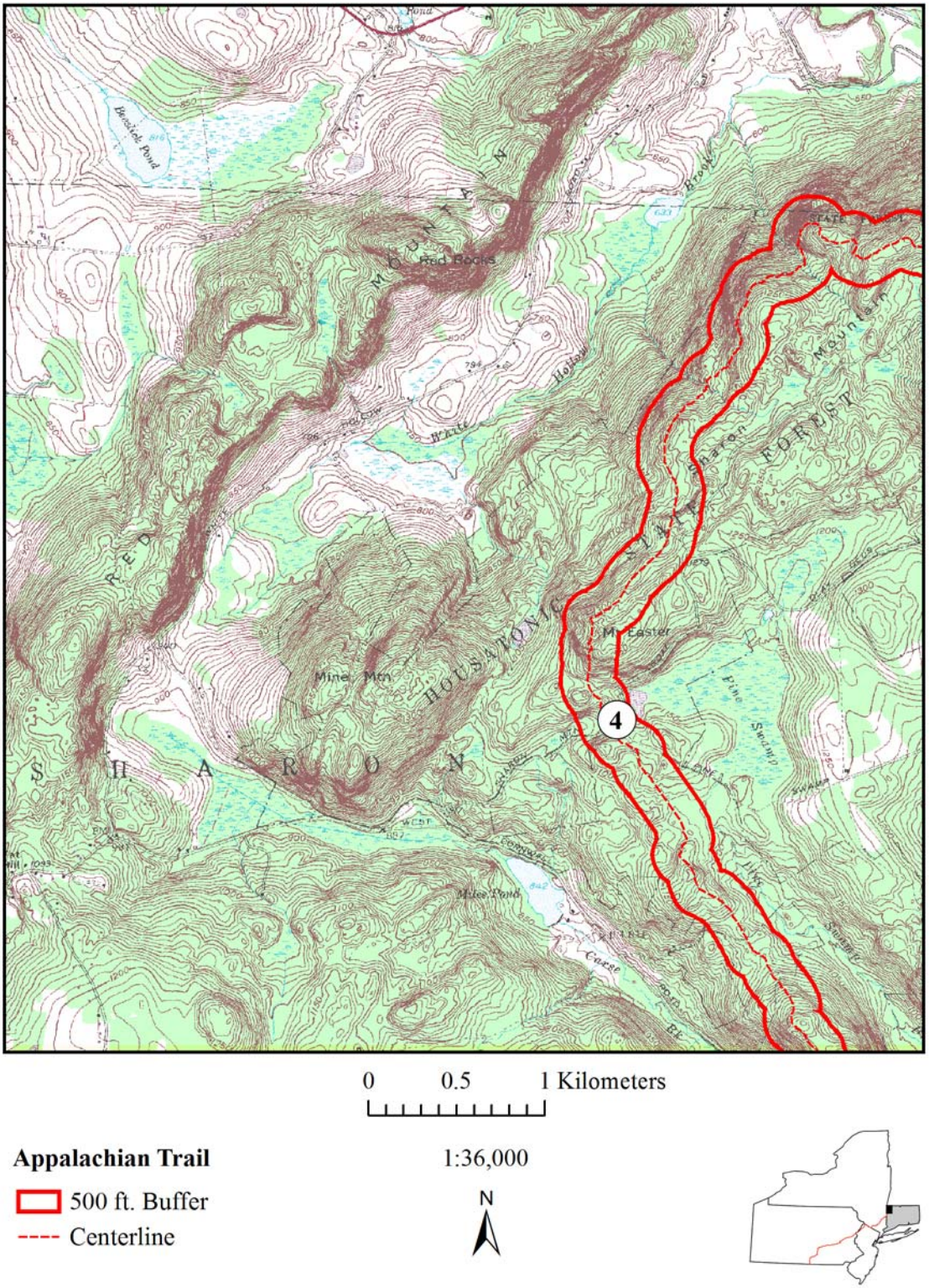

Figure 5. Map of study site at Pine Marsh (4) in Litchfield County, CT.

Site #5: Pine Knob

Location: This site is located in a ravine near the Pine Knob Trail, a side trail to the AT (Figure 6). It is accessed by taking State Route 7 to the Pine Knob Trail parking lot, and then hiking up this trail to the AT.

UTM (NAD 83) 18T 633539 4633337
Topographic Quadrangle(s): Ellsworth
Township/Town/Municipality: Sharon

Elevation(s): 320 m (1,050 feet)
County: Litchfield
Ownership: AT

Sampling Techniques: Nest boxes (installed 19 August 2005, checked 2 September 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
No species recorded			

Site Description: This site is an eastern hemlock (*Tsuga canadensis*) ravine with mature trees.

Target Species: Northern flying squirrel.

Site #6: Hatch Brook

Location: This site is located along Hatch Brook near the Pine Knob site (Figure 6). It is accessed by taking State Route 7 to the Pine Knob Trail parking lot, and then hiking up this trail to the AT. Hike south along the AT to the junction of the main brook.

UTM (NAD 83) 18T 633441 4633067
Topographic Quadrangle(s): Ellsworth
Township/Town/Municipality: Sharon

Elevation(s): 335 m (1,100 feet)
County: Litchfield
Ownership: AT

Sampling Techniques: Trapline (23 – 27 November 2005), terrestrial pitfalls (23 – 27 November 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Sorex cinereus	masked shrew	S5	Voucher
Clethrionomys gapperi	southern red-backed vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher

Site Description: Hatch Brook is a cold stream with a rocky bottom. The site is dominated by eastern hemlock (*Tsuga canadensis*) and mixed hardwoods, and there is mountain laurel (*Kalmia latifolia*) in the understory.

Target Species: American water shrew, long-tailed shrew, and deer mouse.

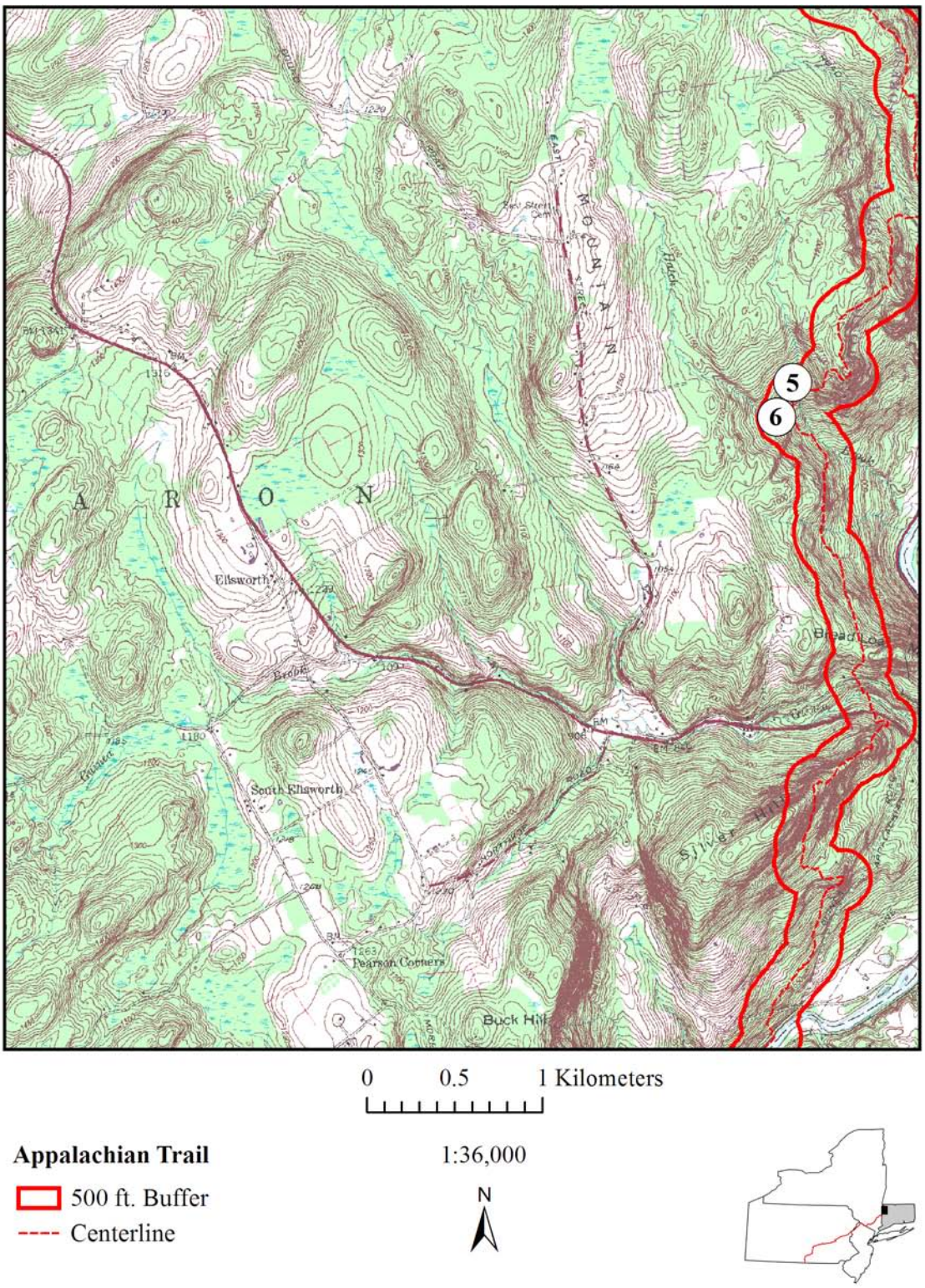

Figure 6. Map of study sites at Pine Knob (5) and Hatch Brook (6) in Litchfield County, CT.

Site #7: St. Johns Ledges

Location: This site is located near Choggam Brook and Caleb's Peak (Figure 7). It is accessed via State Route 341 to Skiff Mountain Road.

UTM (NAD 83) 18T 627445 4623244
Topographic Quadrangle(s): Ellsworth/Kent
Township/Town/Municipality: Kent

Elevation(s): 305 m (1,000 feet)
County: Litchfield
Ownership: AT

Sampling Techniques: Trapline (28 – 30 November 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher

Site Description: The site is a small spring or seep-fed swamp, with grasses and mosses covering the ground. The surrounding forest is dominated by deciduous hardwood trees.

Target Species: Southern bog lemming.

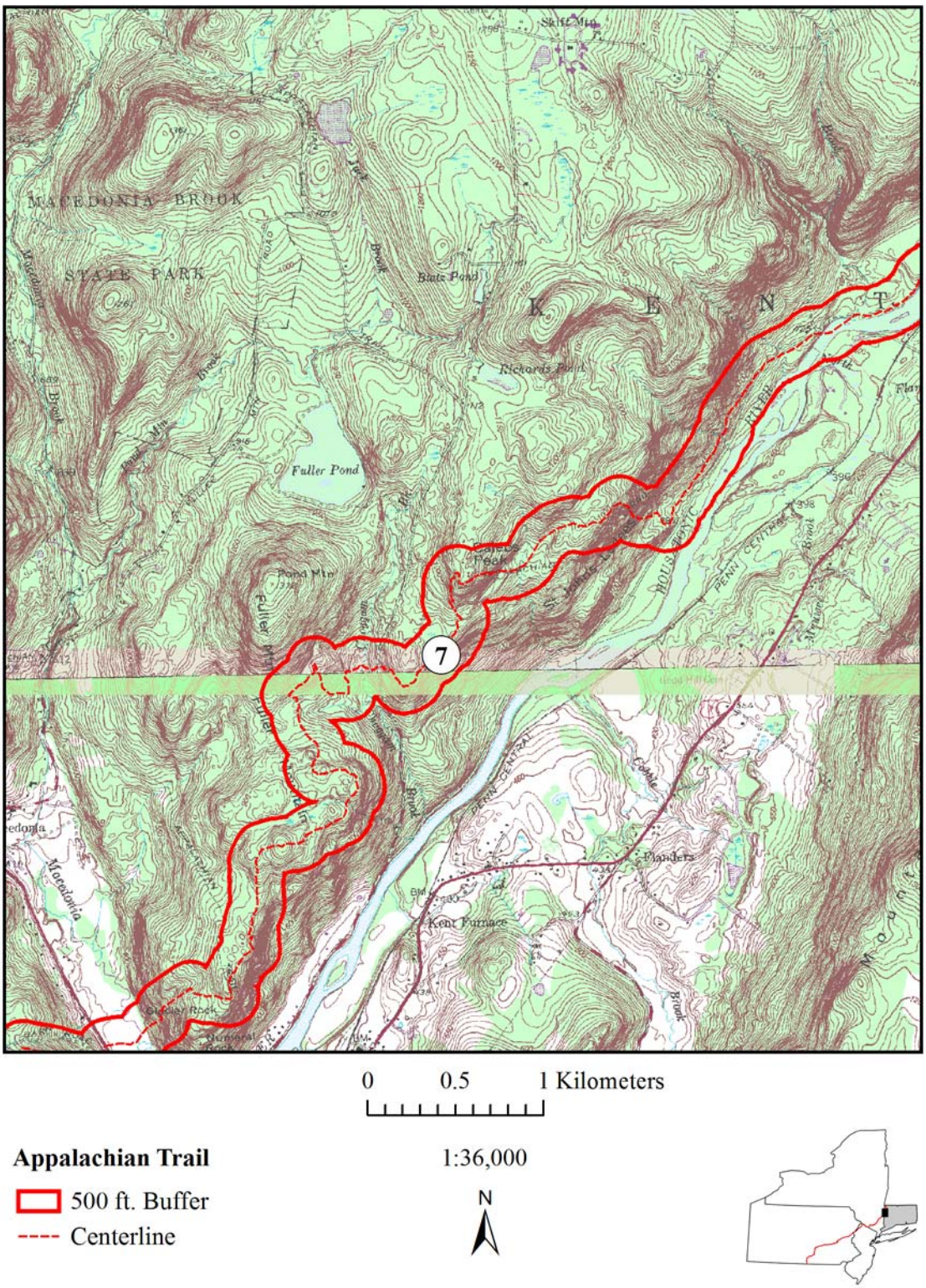

Figure 7. Map of study site at St Johns Ledges (7) in Litchfield County, CT.

Site #8: Glacier Rock

Location: This site is near the steep slopes northeast of Macedonia Brook (Figure 8). It is accessed via State Route 341: hike north from SR 341 on the AT across the brook to the site.

UTM (NAD 83) 18T 625869 4621274 Elevation(s): 195 m (640 feet)
Topographic Quadrangle(s): Kent County: Litchfield
Township/Town/Municipality: Kent Ownership: AT

Sampling Techniques: Trapline and terrestrial pitfalls (both 6 – 9 December 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Sorex fumeus	smoky shrew	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher
Sylvilagus floridanus	eastern cottontail	S5	Direct Observation
Procyon lotor	northern raccoon	S5	Sign (tracks)
Odocoileus virginianus	white-tailed deer	S5	Sign (tracks)

Site Description: A forested talus slope dominated by deciduous hardwood trees; Japanese barberry (*Berberis Thunbergii*) is present in the understory.

Target Species: Deer mouse and long-tailed shrew.

Site #9: Grand Staircase

Location: This site is in the upland southwest of Macedonia Brook (Figure 8). It is accessed via State Route 341. Hike south along the AT and the site is near an old service road (Barn Road).

UTM (NAD 83) 18T 625423 4620970 Elevation(s): 186 m (610 feet)
Topographic Quadrangle(s): Kent County: Litchfield
Township/Town/Municipality: Kent Ownership: AT

Sampling Techniques: Trapline and terrestrial pitfalls (both 5 – 9 December 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Sorex fumeus	smoky shrew	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher
Tamiasciurus hudsonicus	red squirrel	S5	Sign (tracks)
Canis latrans	coyote	S5	Sign (tracks)
Lynx rufus	bobcat	S2	Sign (tracks)
Martes pennanti	fisher	S2	Sign (tracks)
Odocoileus virginianus	white-tailed deer	S5	Sign (tracks)

Site Description: A talus slope dominated by eastern hemlock (*Tsuga canadensis*) and various hardwoods; there is mountain laurel (*Kalmia latifolia*) in the understory, and mossy rocks.

Target Species: Deer mouse, long-tailed shrew, and northern flying squirrel.

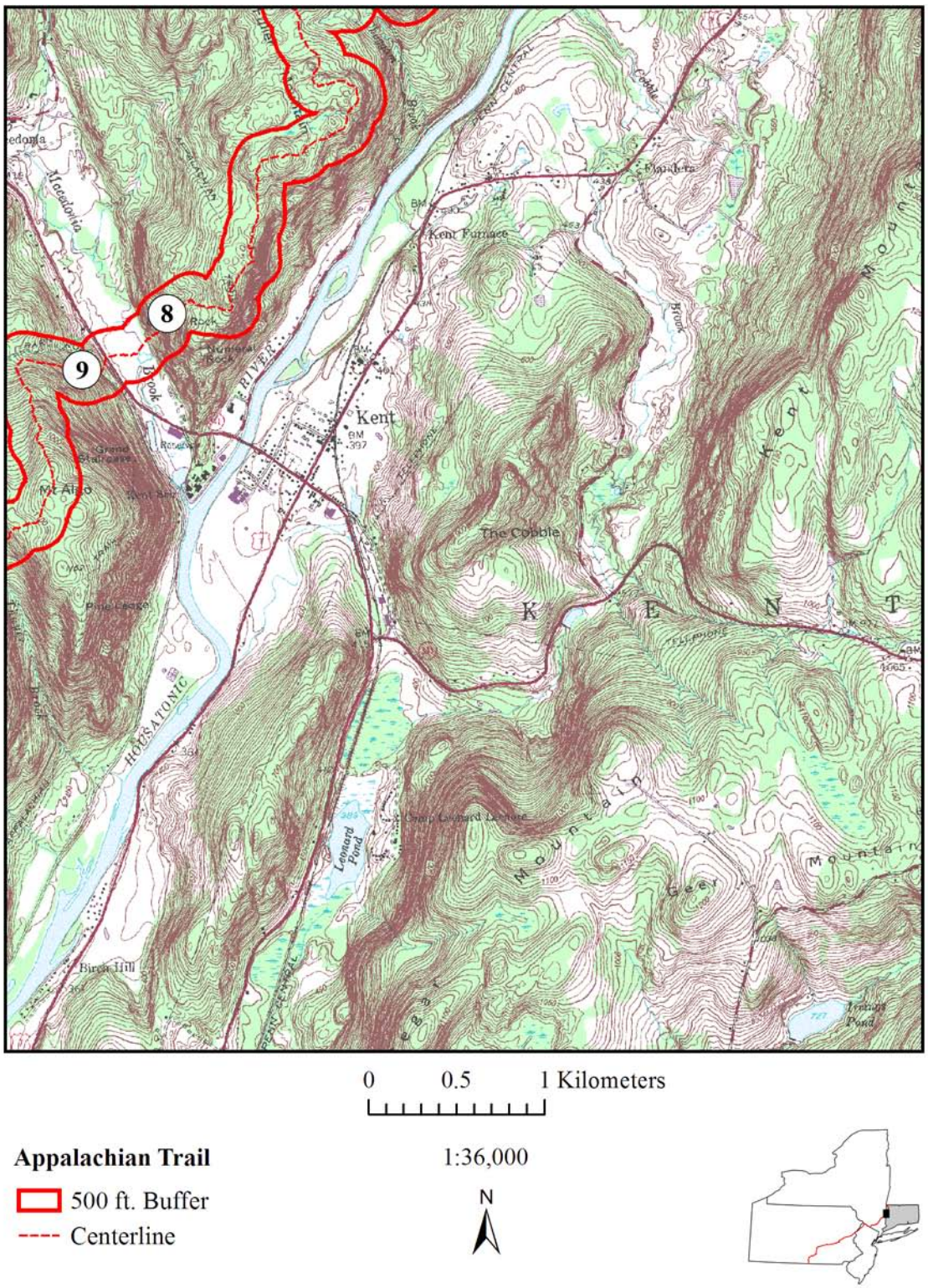

Figure 8. Map of study sites at Glacier Rock (8) and Grand Staircase (9) in Litchfield County, CT.

New York

Site #10: Deuel Hollow Brook

Location: This site is located along Deuel Hollow Brook near the New York – Connecticut border (Figure 9). It is accessed by taking State Route 55 to Deuel Hollow Road. Hike southeast from Deuel Hollow Road on the Appalachian Trail. The site is located near Camp Siwanoy.

UTM (NAD 83) 18T 622750 4610671
Topographic Quadrangle(s): Dover Plains
Township/Town/Municipality: Dover

Elevation(s): 113 m (370 feet)
County: Dutchess
Ownership: AT

Sampling Techniques: Nest boxes (installed 28 July 2005, checked 15 April 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Glaucomys volans	southern flying squirrel	S5	Observed in Nest Box

Site Description: Deuel Hollow Brook is a fast-flowing brook that has a cobble bottom. The surrounding forest contains eastern hemlocks (*Tsuga canadensis*) and mixed hardwoods.

Target Species: Northern flying squirrel.

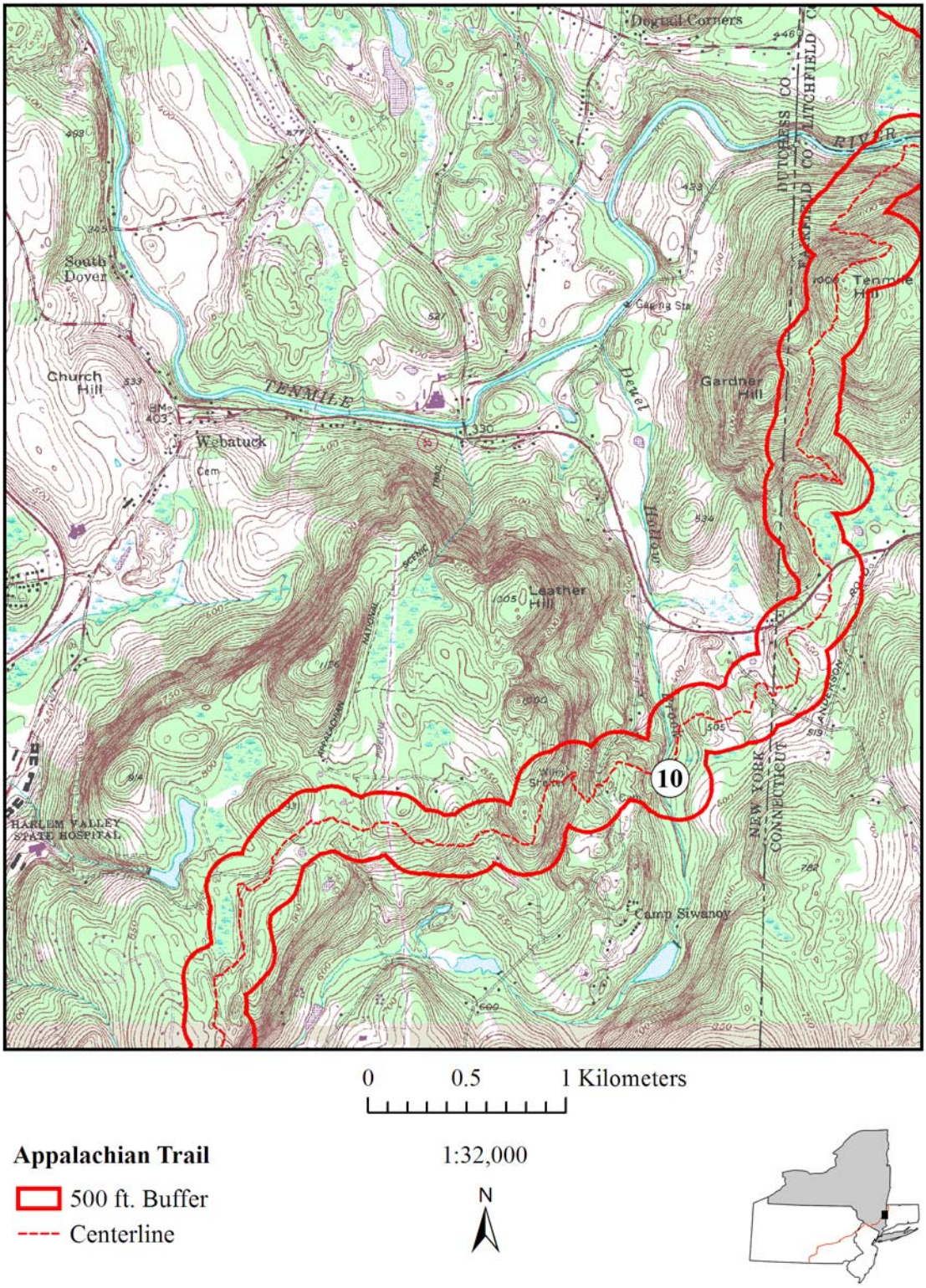

Figure 9. Map of study site at Deuel Hollow Brook (10) in Dutchess County, NY.

Site #11: West Pawling Wetland

Location: This site is located slightly west of Nuclear Lake and is part of a larger wetland complex (Figure 10). It is accessed via State Route 55 in West Pawling. Hike the AT approximately 0.5 km northeast to the site.

UTM (NAD 83) 18T 611987 4605247
Elevation(s): 247 m (810 feet)
Topographic Quadrangle(s): Poughquag
County: Dutchess
Township/Town/Municipality: Beekman/Pawling
Ownership: AT

Sampling Techniques: Trapline (30 November – 4 December 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Castor canadensis	American beaver	S5	Sign (lodge)
Microtus pennsylvanicus	meadow vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher

Site Description: The site borders a large wetland complex with abundant sedges (*Carex* spp.) and grasses and some sphagnum (*Sphagnum* sp.).

Target Species: American water shrew and southern bog lemming.

Site #12: West Pawling Swamp

Location: This site is located near the West Pawling Wetland site and is part of the same wetland complex (Figure 10). It is accessed via State Route 55 in West Pawling. Hike the AT approximately 0.5 km northeast to the site.

UTM (NAD 83) 18T 611951 4605496
Elevation(s): 226 m (740 feet)
Topographic Quadrangle(s): Poughquag
County: Dutchess
Township/Town/Municipality: Beekman/Pawling
Ownership: AT

Sampling Techniques: Trapline (30 November – 4 December 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Microtus pennsylvanicus	meadow vole	S5	Voucher
Sciurus carolinensis	eastern gray squirrel	S5	Sign (tracks)
Peromyscus leucopus	white-footed mouse	S5	Voucher
Odocoileus virginianus	white-tailed deer	S5	Sign (scat)

Site Description: The site borders a large wetland complex with abundant sedges (*Carex* spp.) and grasses and some sphagnum (*Sphagnum* sp.).

Target Species: Northern water shrew and southern bog lemming.

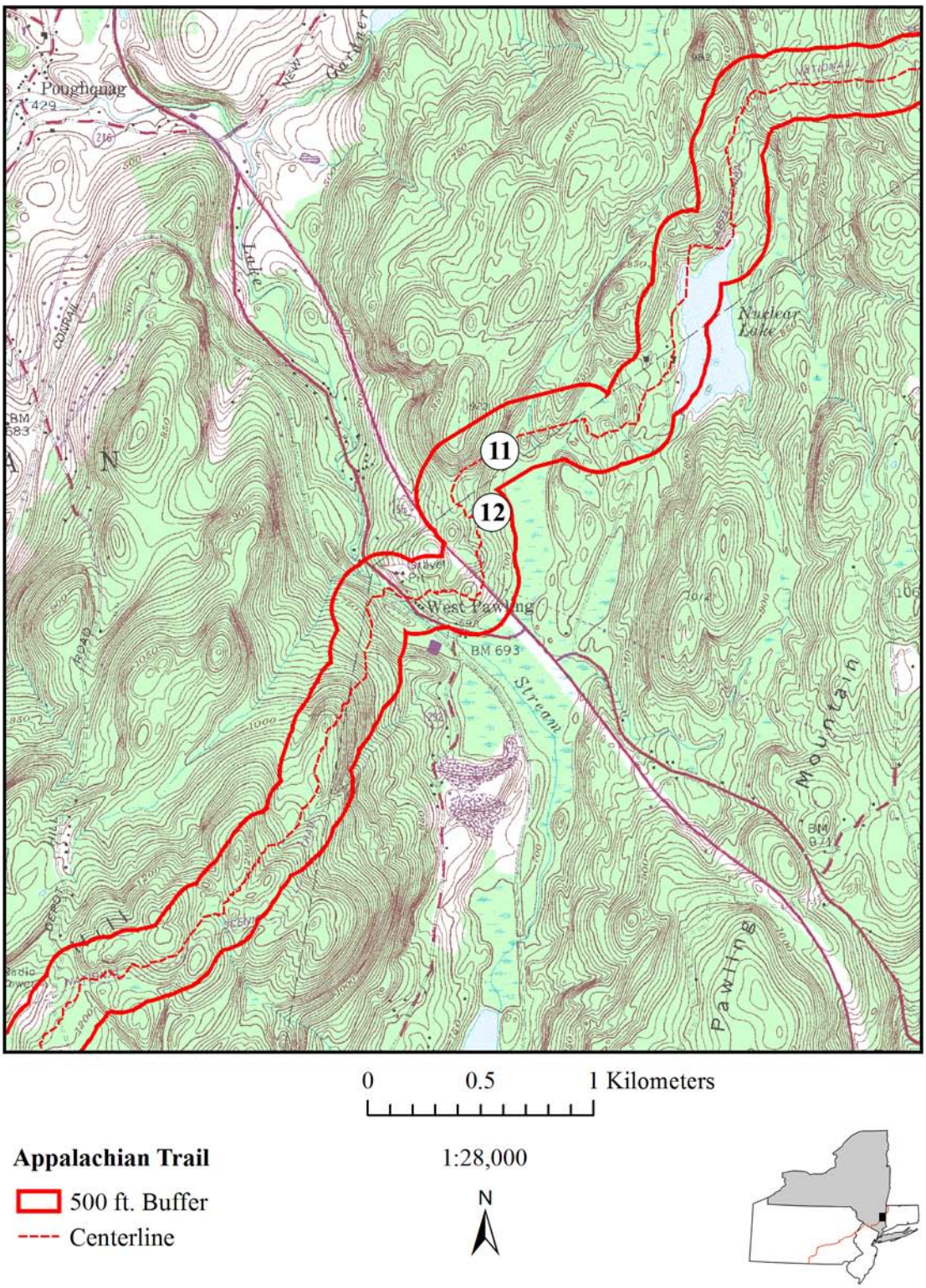

Figure 10. Map of study sites at West Pawling Wetland (11) and West Pawling Swamp (12) in Dutchess County, NY.

Site #13: Shenandoah Mountain

Location: This site is near the ridgeline of Shenandoah Mountain (Figure 11). It is accessed via Miller Hill Road to Hortontown Road. Park near the RPH Shelter where the AT crosses Hortontown Road, then hike the AT north to the site.

UTM (NAD 83) 18T 600005 4596400
Elevation(s): 206 m (675 feet)
Topographic Quadrangle(s): Hopewell Junction
County: Dutchess
Township/Town/Municipality: East Fishkill
Ownership: AT

Sampling Techniques: Nest boxes (installed 28 July 2005, checked 15 April 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Tamias striatus	eastern chipmunk	S5	Direct Observation
Odocoileus virginianus	white-tailed deer	S5	Sign (scat)

Site Description: The site is a mature eastern hemlock (*Tsuga canadensis*) and mixed hardwood forest with abundant mast/acorn production. A ravine with outcrops and ledges is present near the site.

Target Species: Northern flying squirrel.

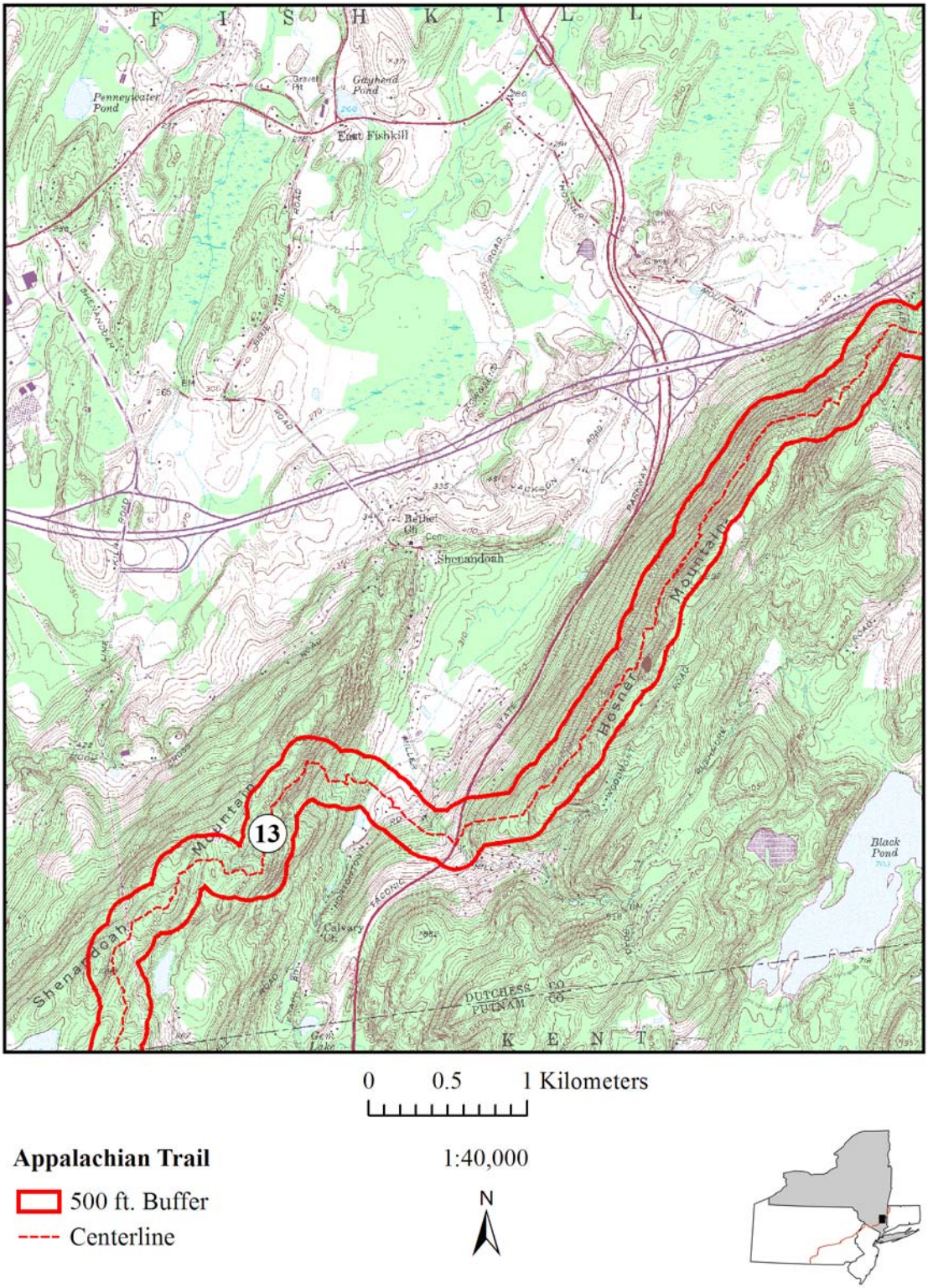

Figure 11. Map of study site at Shenandoah Mountain (13) in Dutchess County, NY.

Site #14: Copper Mine Brook

Location: This site is located in a small wetland just southeast of the AT (Figure 12). It is accessed via the Bear Mountain Beacon Highway to Manitou Road (= South Mountain Pass). Park in designated parking lot and hike the Appalachian Trail approximately 35 m) past the gate to the site.

UTM (NAD 83) 18T 587695 4575837
Elevation(s): 155 m (510 feet)
Topographic Quadrangle(s): Peekskill
County: Putnam
Township/Town/Municipality: Philipstown
Ownership: AT & New York State

Sampling Techniques: Trapline (6 – 10 July 2005), nest boxes (installed 30 July 2005, checked 15 April 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Canis latrans	coyote	S5	Sign (tracks)/hiker report
Procyon lotor	northern raccoon	S5	Sign (scat)
Odocoileus virginianus	white-tailed deer	S5	Sign (tracks, scat)

Site Description: The site is in a small wetland near Copper Mine Brook and has abundant ferns and sphagnum (*Sphagnum* sp.). A mature eastern hemlock (*Tsuga canadensis*) and mixed hardwood forest surrounds the site.

Target Species: Southern bog lemming and northern flying squirrel.

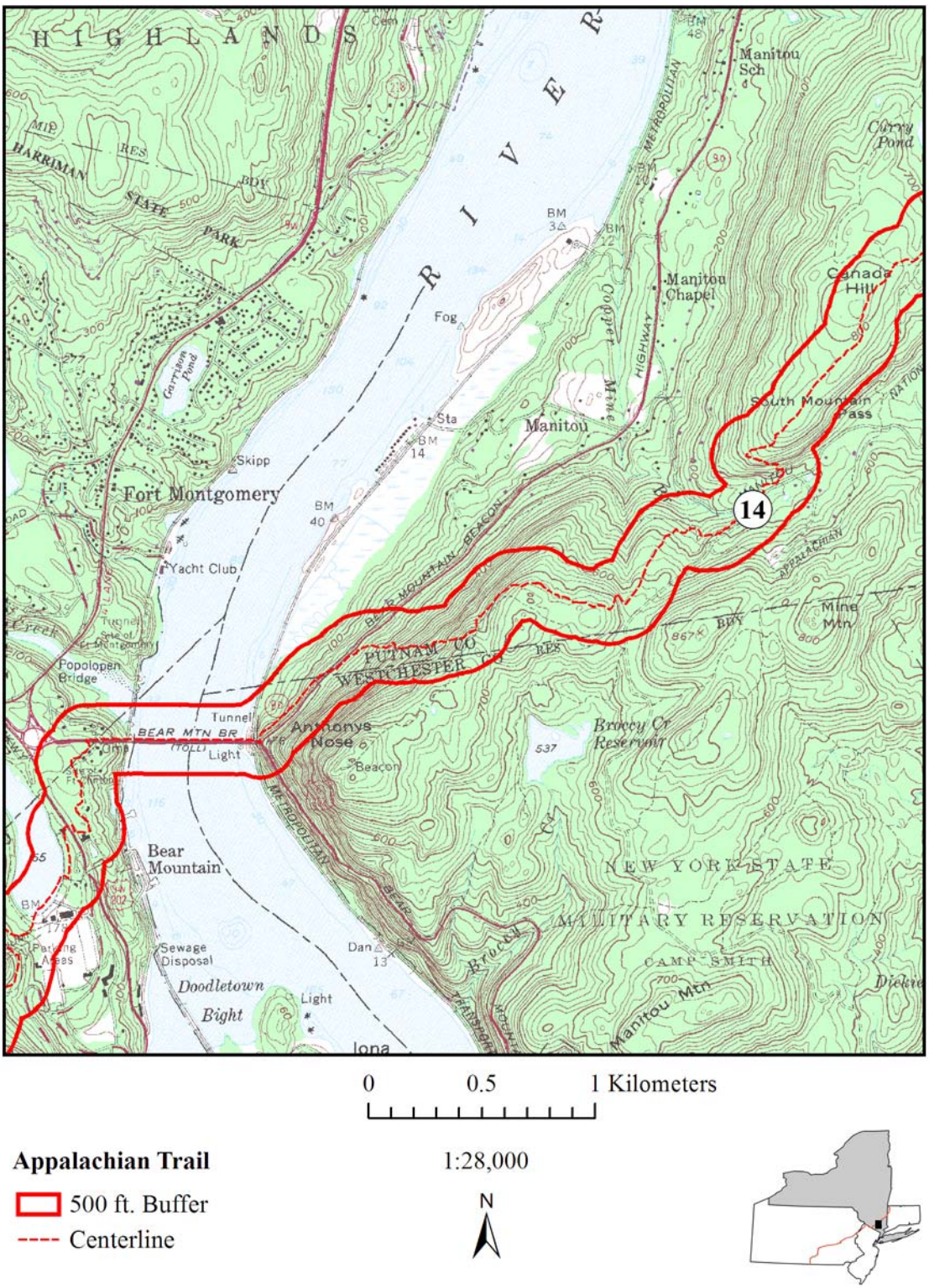

Figure 12. Map of study site at Copper Mine Brook (14) in Putnam County, NY.

Site #15: Little Dam Lake

Location: This site is located in a wetland near Little Dam Lake (Figure 13). It is accessed via East Mombasha Road, although the AT is somewhat difficult to spot from the road. The site located at intersection of a wooden bridge and a slow moving stream/wetland complex.

UTM (NAD 83) 18T 567675 4568462
Elevation(s): 192 m (630 feet)
Topographic Quadrangle(s): Monroe
County: Orange
Township/Town/Municipality: Tuxedo
Ownership: AT

Sampling Techniques: Nest boxes (installed 9 June 2005, checked 25 February 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Castor canadensis	American beaver	S5	Sign (active lodge)
Glaucomys volans	southern flying squirrel	S5	Observed in Nest Box
Procyon lotor	northern raccoon	S5	Carcass
Ursus americanus	American black bear	S5	Direct observation
Odocoileus virginianus	white-tailed deer	S5	Sign (scat)

Site Description: The site is in a wetland complex with emergent vegetation. An eastern hemlock (*Tsuga canadensis*) and mixed hardwood forest surrounds the site.

Target Species: Northern flying squirrel.

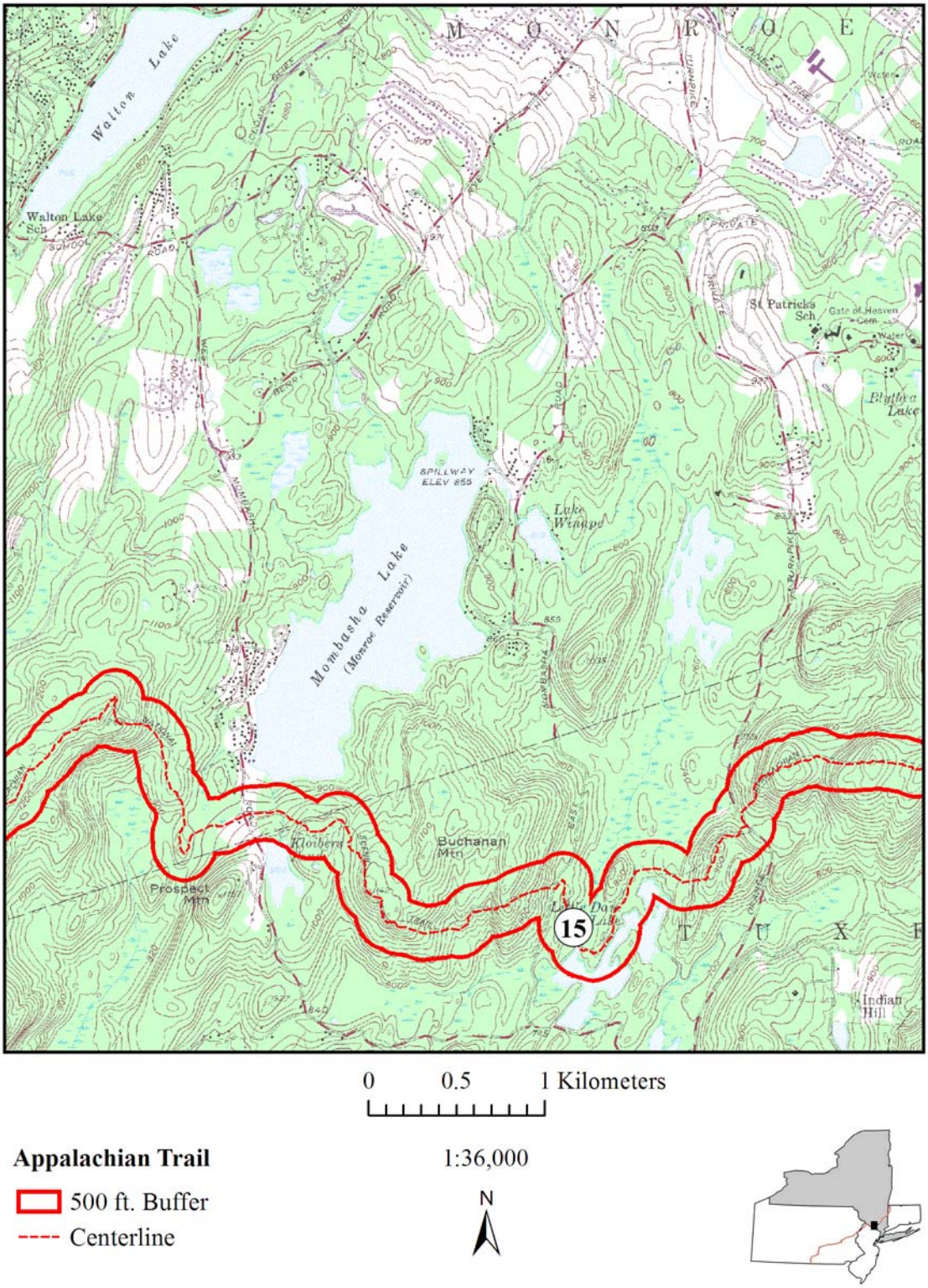

Figure 13. Map of study site at Little Dam Lake (15) in Orange County, NY.

Site #16: Trout Brook & Fitzgerald Falls

Location: This site is along Trout Brook and near Fitzgerald Falls (Figure 14). It is accessed via State Route 5 (Lakes Road). Park in the designated gravel pull-off and hike 100 m southeast to the site.

UTM (NAD 83) 18T 562723 4569130
Topographic Quadrangle(s): Warwick
Township/Town/Municipality: Warwick/Monroe

Elevation(s): 232 m (760 feet)
County: Orange
Ownership: AT

Sampling Techniques: Trapline (6 – 10 July 2005), nest boxes (installed 5 June 2005, checked 25 February 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Sorex cinereus	masked shrew	S5	Voucher
Sorex fumeus	smoky shrew	S5	Voucher
Clethrionomys gapperi	southern red-backed vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher
Tamias striatus	eastern chipmunk	S5	Voucher

Site Description: This site is along a fast-flowing brook with a rocky or cobble bottom. Eastern hemlocks (*Tsuga canadensis*) are abundant in the mixed deciduous/coniferous forest surrounding the site. Immediately left of Fitzgerald Falls there is moist wooded talus.

Target Species: American water shrew, long-tailed shrew, rock vole, and northern flying squirrel.

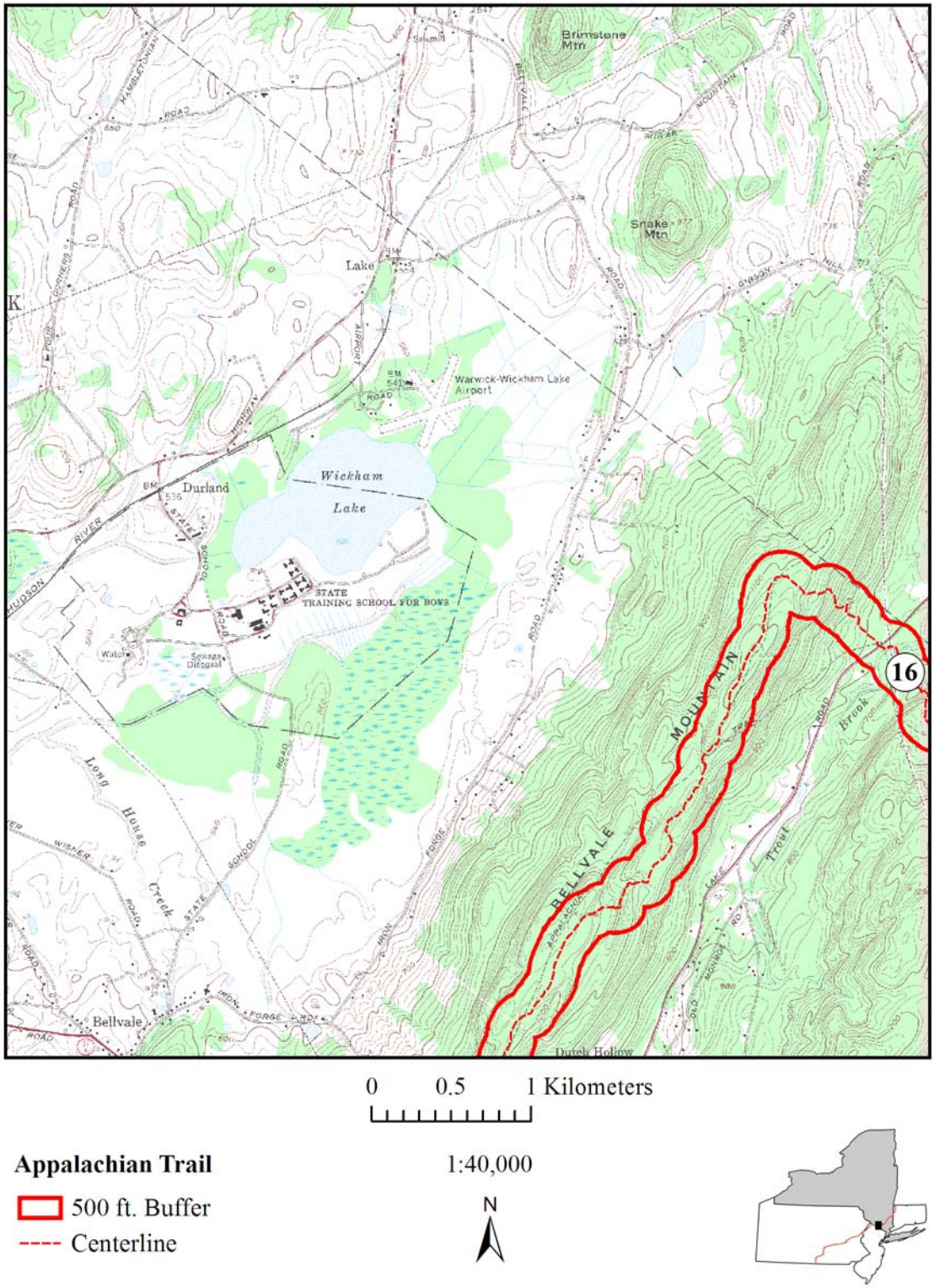

Figure 14. Map of study site at Trout Brook and Fitzgerald Falls (16) in Orange County, NY.

New Jersey

Site #17: Maple Hill

Location: This site is along Waywayanda Creek just south of Maple Hill (Figure 15). It is accessed by taking State Route 94 to the Warwick Turnpike (Orange 21). Park in the designated AT pull off and go east over wooden puncheons approximately 1 km to the site.

UTM (NAD 83) 18T 551797 4561245
Topographic Quadrangle(s): Waywayanda NJ-NY
Township/Town/Municipality: Vernon

Elevation(s): 434 m (1,425 feet)
County: Sussex
Ownership: AT & New Jersey State

Sampling Techniques: Terrestrial pitfalls (22 – 29 May 2005), aquatic pitfalls (22 – 29 May 2005), nest boxes (installed 20 May 2005, checked 25 February 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Sorex cinereus	masked shrew	S4	Voucher
Microtus pennsylvanicus	meadow vole	S5	Voucher
Sciurus carolinensis	eastern gray squirrel	S5	Direct Observation
Tamias striatus	eastern chipmunk	S5	Direct Observation
Sylvilagus floridanus	eastern cottontail	S5	Carcass
Mephitis mephitis	striped skunk	S5	Carcass
Procyon lotor	northern raccoon	S5	Sign (tracks, scat)
Ursus americanus	American black bear	S3	Direct Observation
Odocoileus virginianus	white-tailed deer	S5	Direct Observation

Site Description: Waywayanda Creek is a slow-flowing creek with a sandy/pebbly bottom. An eastern hemlock (*Tsuga canadensis*) and mixed hardwood forest surrounds the site.

Target Species: American water shrew and northern flying squirrel.

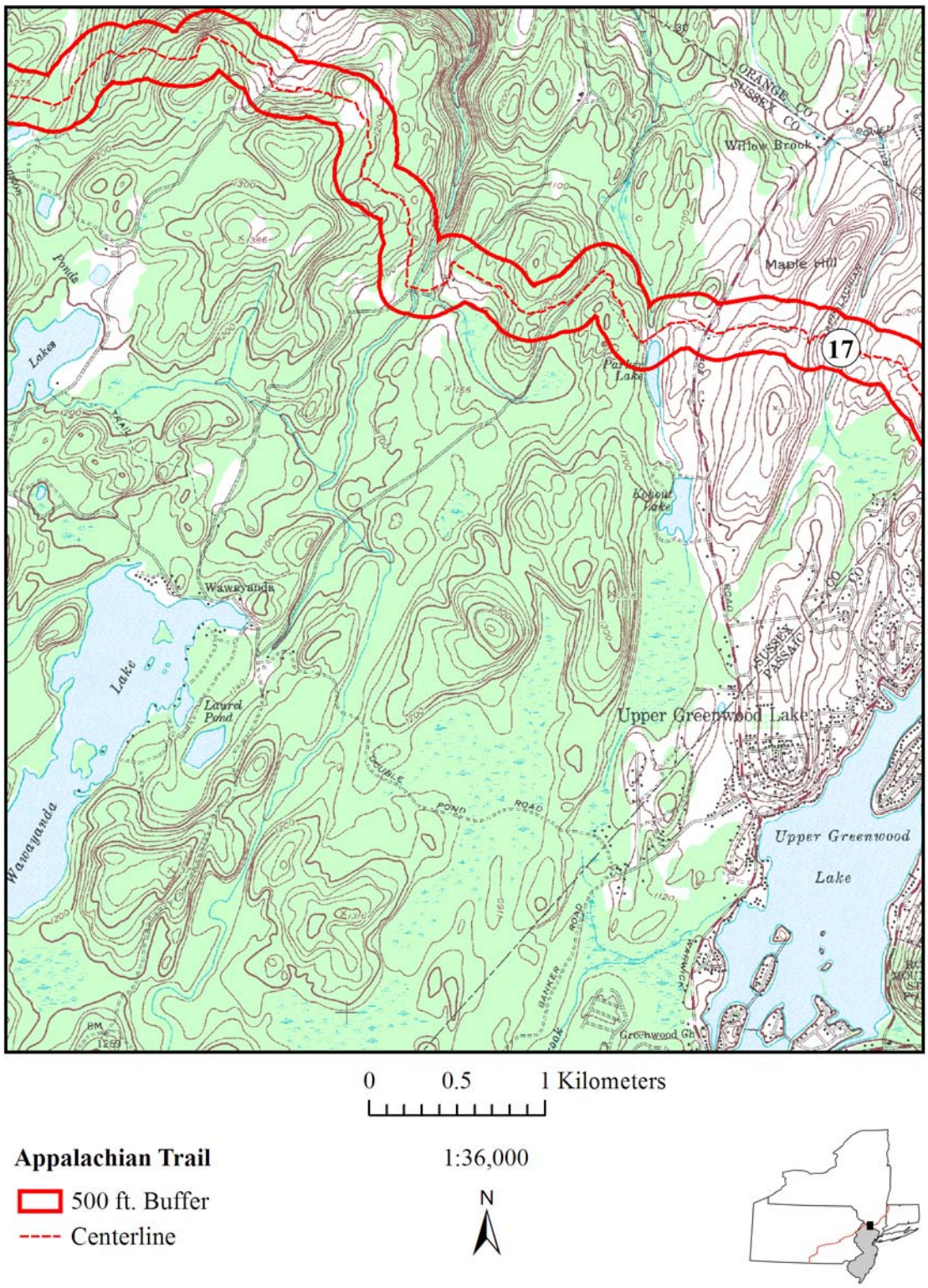

Figure 15. Map of study site at Maple Hill (17) in Sussex County, NJ.

Site #18: Pochuck Creek Crossing

Location: This site is near the junction of Pochuck and Waywayanda creeks (Figure 16). It is accessed by taking Maple Grange Road to Canal Road or via County Route 517.

UTM (NAD 83) 18T 544613 4564246
Elevation(s): 122 m (400 feet)
Topographic Quadrangle(s): Waywayanda NJ-NY
County: Sussex
Township/Town/Municipality: Vernon
Ownership: AT & New Jersey State

Sampling Techniques: Motion-sensor cameras (15 – 29 June 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Castor canadensis	American beaver	S5	Sign (lodge)
Marmota monax	woodchuck	S5	Sign (burrow)
Odocoileus virginianus	white-tailed deer	S5	Motion-sensor camera

Site Description: This diverse site includes several different wetland types, low forest ridges, and successional old fields.

Target Species: Snowshoe hare (*Lepus americanus*), based on an unconfirmed sighting on a previous visit to the site.

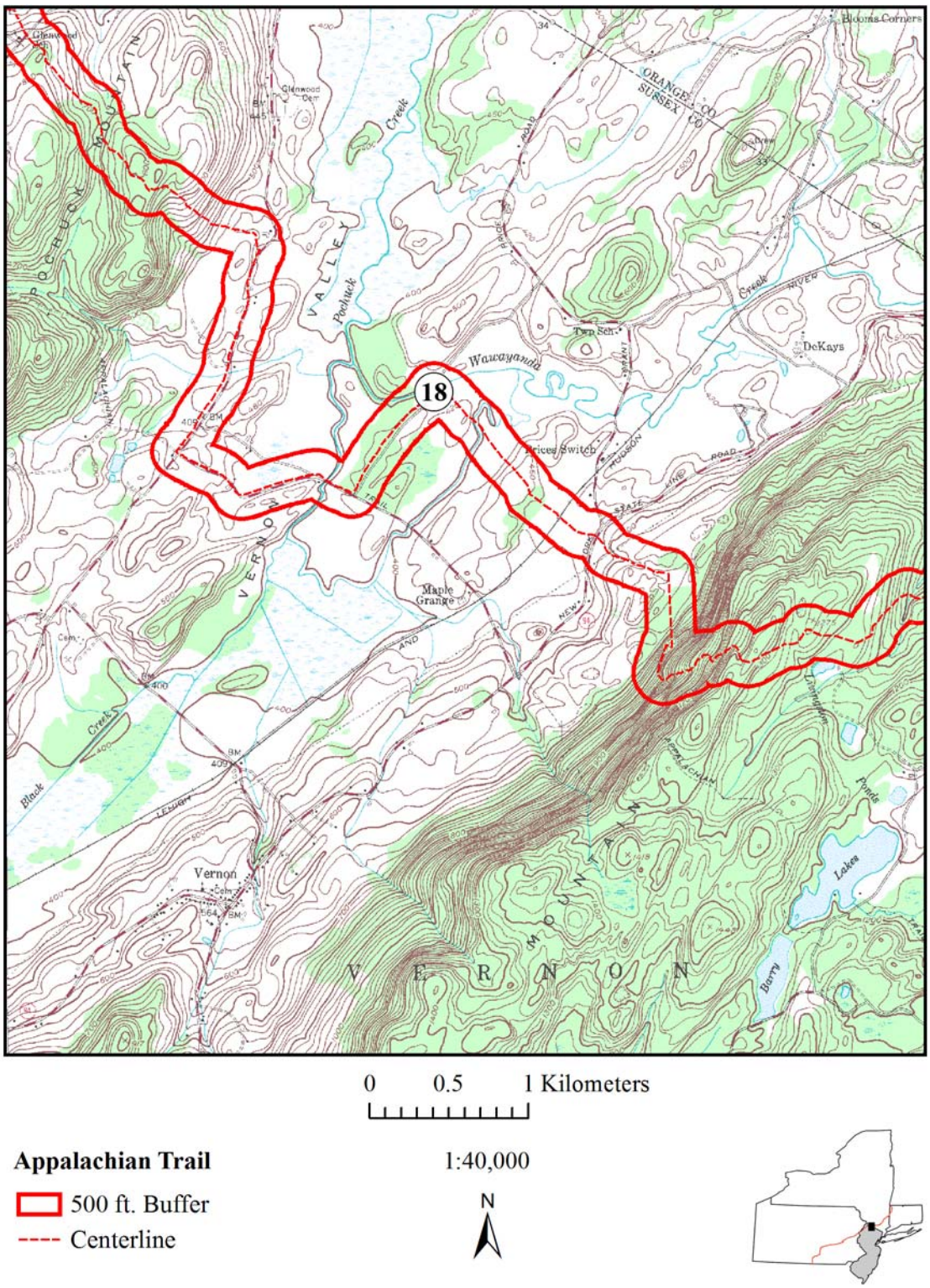

Figure 16. Map of study site at Pochuck Creek Crossing (18) in Sussex County, NJ.

Site #19: High Point

Location: This site is located in High Point State Park (Figure 17). It is accessed via State Route 23; ask for permission to use the gated service road that leads to High Point Monument Shelter.

UTM (NAD 83) 18T 528742 4573878
Elevation(s): 404 m (1,325 feet)
Topographic Quadrangle(s): Port Jervis South
County: Sussex
Township/Town/Municipality: Wantage/Montague
Ownership: State of New Jersey

Sampling Techniques: Trapline (26 – 30 June 2005), nest boxes (installed 29 May 2005, checked 20 February 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Clethrionomys gapperi	southern red-backed vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher
Tamias striatus	eastern chipmunk	S5	Direct Observation
Ursus americanus	American black bear	S3	Sign (scat)
Odocoileus virginianus	white-tailed deer	S5	Direct Observation

Site Description: This site is in mixed hardwood forest along a fast-flowing stream with cobble/rocky bottom. The flying squirrel nest boxes were erected approximately 0.5 km east of Monument Shelter in a narrow ravine in a mixed eastern hemlock (*Tsuga canadensis*) and hardwood forest.

Target Species: American water shrew, deer mouse, and northern flying squirrel.

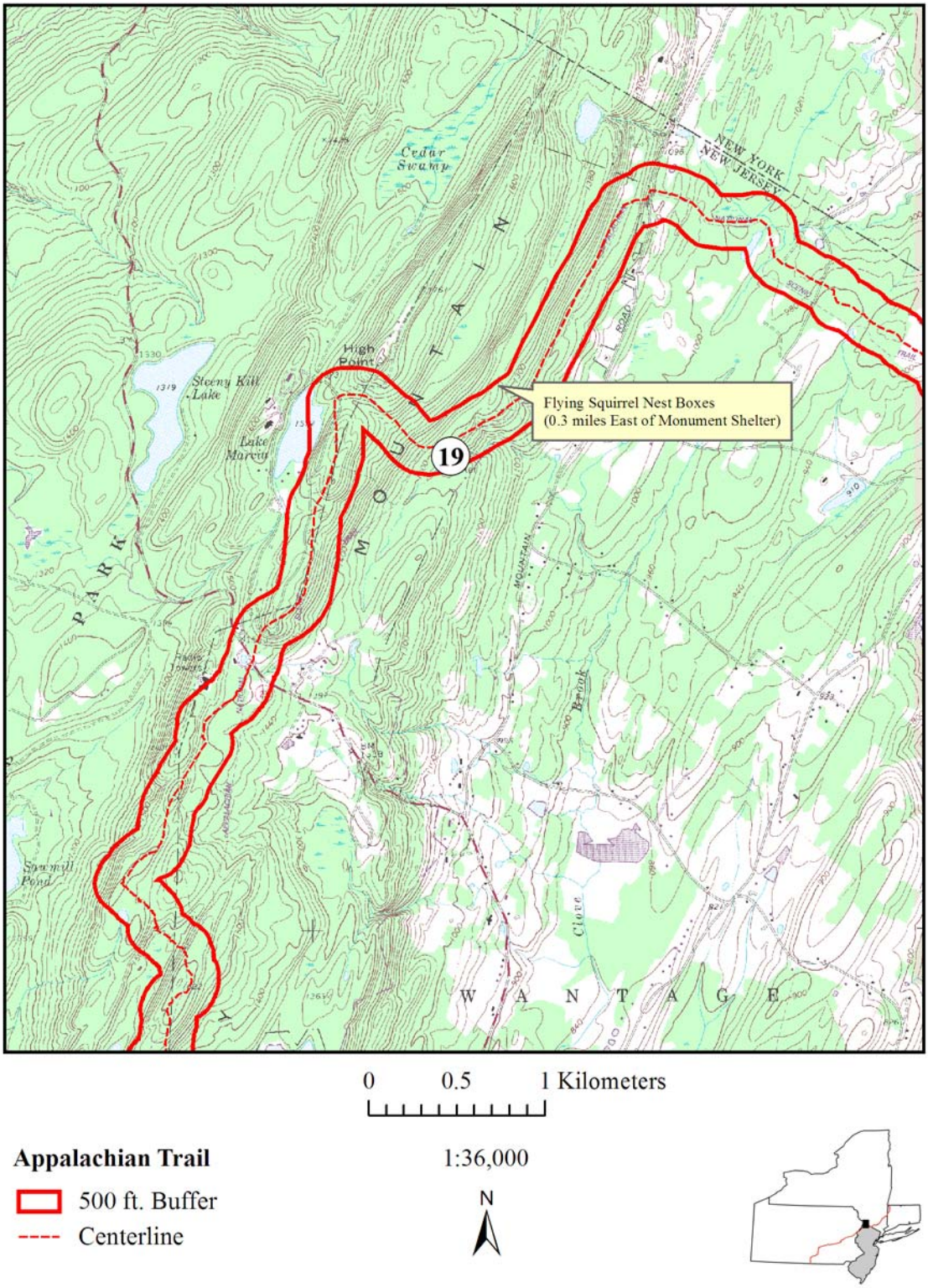

Figure 17. Map of study site at High Point (19) in Sussex County, NJ.

Site #20: Stony Brook Trail

Location: This site is located along Stony Brook Trail in Stokes State Forest (Figure 18). It is accessed via Sunrise Mountain Road and hike Stony Brook Trail to its intersection with the AT, then follow the AT to Stony Brook.

UTM (NAD 83) 18T 520700 4560724 Elevation(s): 344 m (1,130 feet)
Topographic Quadrangle(s): Culvers Gap County: Sussex
Township/Town/Municipality: Sandyston/Frankford Ownership: State of New Jersey

Sampling Techniques: Aquatic pitfalls (13 – 17 June 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Sciurus carolinensis	eastern gray squirrel	S5	Direct Observation
Tamias striatus	eastern chipmunk	S5	Direct Observation
Ursus americanus	American black bear	S3	Sign (scat, damaged traps)
Odocoileus virginianus	white-tailed deer	S5	Direct Observation

Site Description: A moderate-flowing brook with a gravel/rocky bottom. A mixed hardwood forest surrounds the site.

Target Species: American water shrew.

Site #21: Stony Brook Trail Wetland

Location: This site is located in a wetland complex adjacent to the Stony Brook Trail site (Figure 18). It is accessed via Sunrise Mountain Road and hike Stony Brook Trail to its intersection with the AT, follow the AT to Stony Brook, then go southeast approximately 150 m to the large wetland complex.

UTM (NAD 83) 18T 520709 4560582 Elevation(s): 335 m (1,100 feet)
Topographic Quadrangle(s): Culvers Gap County: Sussex
Township/Town/Municipality: Sandyston/Frankford Ownership: State of New Jersey

Sampling Techniques: Trapline (20 – 24 July 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Microtus pennsylvanicus	meadow vole	S5	Voucher
Ursus americanus	American black bear	S3	Sign (damaged traps)
Odocoileus virginianus	white-tailed deer	S5	Sign (scat)

Site Description: A wetland complex with abundant grasses, sedges (*Carex* spp.), and sphagnum (*Sphagnum* sp.).

Target Species: American water shrew and southern bog lemming.

Site #22: Sunrise Mountain Road

Location: This site is located just past the Culvers Gap parking lot off State Route 206 in Stokes State Forest (Figure 18). Hike approximately 400 m east on Sunrise Mountain Road to the Appalachian Trail; the site is located just west of the trail.

UTM (NAD 83) 18T 518086 4558880
Elevation(s): 274 m (900 feet)
Topographic Quadrangle(s): Culvers Gap
County: Sussex
Township/Town/Municipality: Sandyston/Frankford
Ownership: State of New Jersey

Sampling Techniques: Trapline (13 – 17 July 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Peromyscus leucopus	white-footed mouse	S5	Voucher
Sciurus carolinensis	eastern gray squirrel	S5	Direct Observation
Tamias striatus	eastern chipmunk	S5	Direct Observation
Ursus americanus	American black bear	S3	Direct Observation

Site Description: This site is a wooded talus slope near an ephemeral stream.

Target Species: Long-tailed shrew and rock vole.

Site #23: Culvers Gap

Location: This site is located just north of Culvers Gap and is adjacent to a wetland complex (Figure 18). It is accessed from Sunrise Mountain Road off State Route 206. Park in the Culvers Gap parking lot and then hike the AT northwest to the site.

UTM (NAD 83) 18T 517382 4558710
Elevation(s): 259 m (850 feet)
Topographic Quadrangle(s): Culvers Gap
County: Sussex
Township/Town/Municipality: Sandyston/Frankford
Ownership: State of New Jersey

Sampling Techniques: Trapline (14 – 18 July 2005 and 19 – 22 September 2005), nest boxes (installed 5 December 2004, checked 18 February 2006), motion-sensor cameras (11 – 18 February 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Sorex cinereus	masked shrew	S4	Voucher
Sorex fumeus	smoky shrew	SU	Voucher
Castor canadensis	American beaver	S5	Sign (lodge)
Glaucomys volans	southern flying squirrel	S4	Observed in Nest Box
Microtus pennsylvanicus	meadow vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher
Sciurus carolinensis	eastern gray squirrel	S5	Carcass
Zapus hudsonius	meadow jumping mouse	S4	Voucher
Sylvilagus floridanus	eastern cottontail	S5	Direct Observation
Odocoileus virginianus	white-tailed deer	S5	Direct Observation

Site Description: This site is in mixed forest containing eastern hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), balsam fir (*Abies balsamea*), and red maple (*Acer rubrum*). Adjacent to the site is a wetland with abundant sphagnum (*Sphagnum* sp.) and sedges (*Carex* spp.).

Target Species: American water shrew, southern bog lemming, and northern flying squirrel.

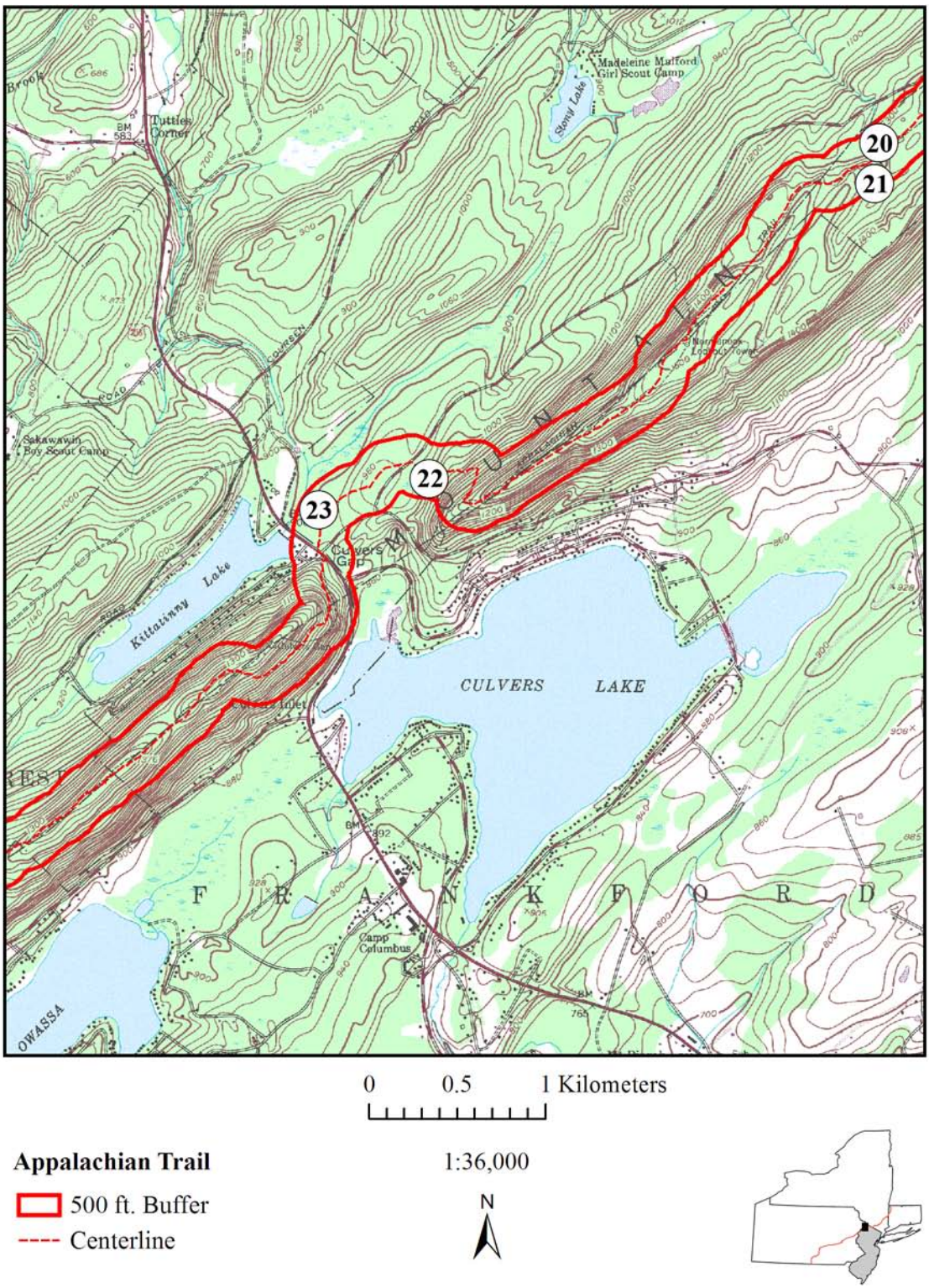

Figure 18. Map of study sites at Stony Brook Trail (20), Stony Brook Wetland (21), Sunrise Mountain Road (22), and Culvers Gap (23) in Sussex County, NJ.

Site #24: Crater Lake

Location: This site is located in Delaware Water Gap National Recreation Area (DEWA) near Crater Lake, a popular recreation spot for swimming and picnics (Figure 19). Park in the Crater Lake parking lot and hike an old gated service road (orange blazes) to the site.

UTM (NAD 83) 18T 508836 4551111
Elevation(s): 408 m (1,340 feet)
Topographic Quadrangle(s): Flatbrookville
County: Sussex
Township/Town/Municipality: Walpack
Ownership: DEWA

Sampling Techniques: Trapline (20 – 24 June 2005), motion-sensor cameras (28 January – 11 March 2007)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Sorex cinereus	masked shrew	S4	Voucher
Sorex fumeus	smoky shrew	SU	Voucher
Clethrionomys gapperi	southern red-backed vole	S5	Voucher
Erethizon dorsatum	North American porcupine	S4	Sign (scat, quills)
Marmota monax	woodchuck	S5	Direct Observation
Peromyscus leucopus	white-footed mouse	S5	Voucher
Sciurus carolinensis	eastern gray squirrel	S5	Direct Observation
Tamias striatus	eastern chipmunk	S5	Direct Observation
Lynx rufus	bobcat	S3	Motion-sensor camera
Procyon lotor	northern raccoon	S5	Motion-sensor camera
Ursus americanus	American black bear	S3	Motion-sensor camera

Site Description: This site is in dry wooded talus.

Target Species: Long-tailed shrew and rock vole.

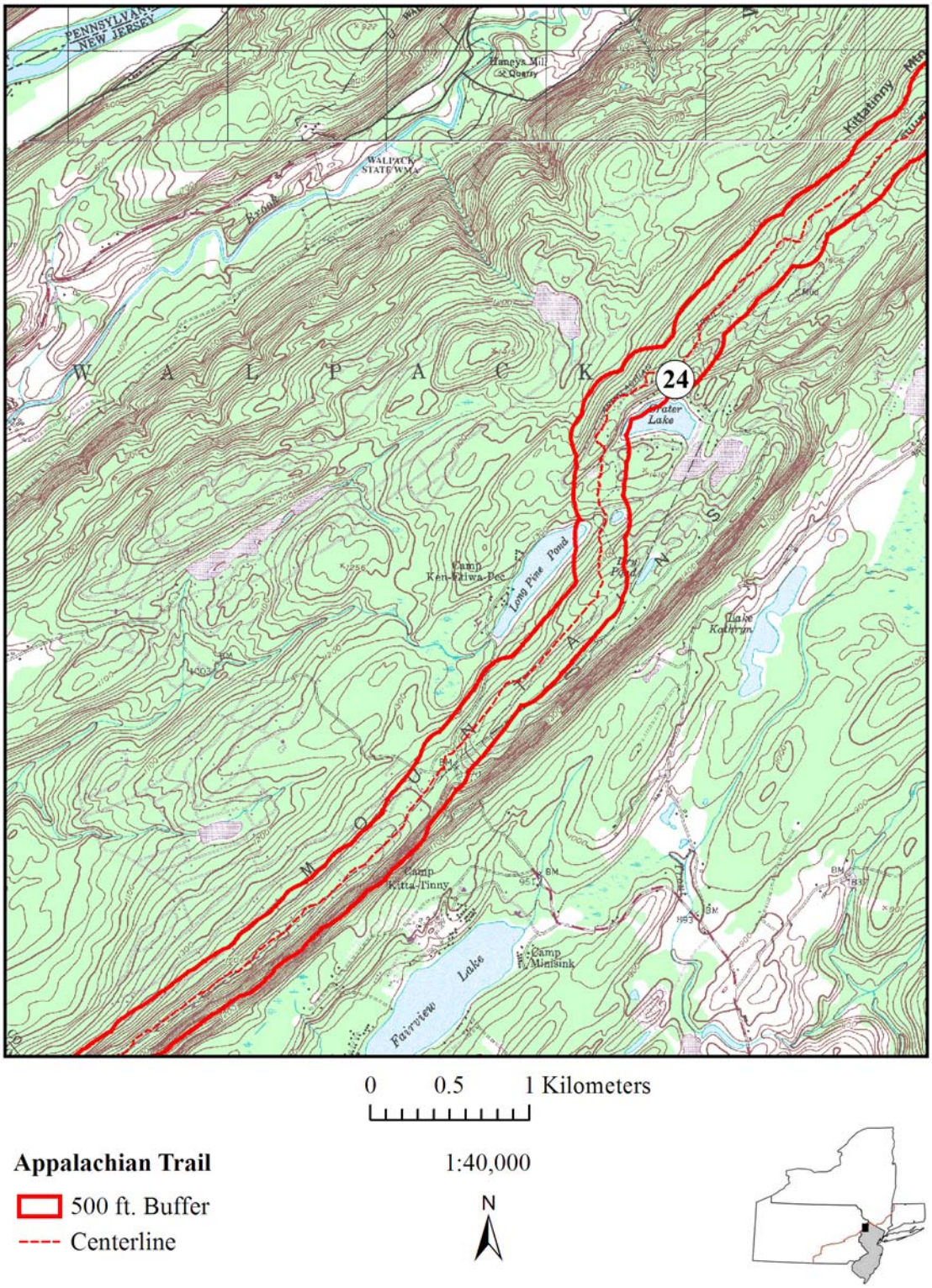

Figure 19. Map of study site at Crater Lake (24) in Sussex County, NJ.

Site #25: Rattlesnake Swamp

Location: This site is in DEWA (Figure 20), accessed via Millbrook/Blairstown Road. Park in the small AT parking area and hike about 300 m past the iron gate. The site is west of the AT.

UTM (NAD 83) 18T 502935 4545080
Elevation(s): 433 m (1,420 feet)
Topographic Quadrangle(s): Flatbrookville
County: Warren
Township/Town/Municipality: Blairstown
Ownership: DEWA

Sampling Techniques: Trapline (20 – 24 June 2005 and 8 – 12 August 2005), aquatic pitfalls (8 – 12 August 2005), nest boxes (installed 28 May 2005, checked 19 February 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Glaucomys volans	southern flying squirrel	S4	Observed in Nest Box
Microtus pennsylvanicus	meadow vole	S5	Voucher
Synaptomys cooperi	southern bog lemming	S2	Voucher
Ursus americanus	American black bear	S3	Direct Observation

Site Description: A wetland with standing dead trees and abundant sphagnum (*Sphagnum* sp.) hummocks. Eastern hemlocks (*Tsuga canadensis*) and rosebay rhododendron (*Rhododendron maximum*) are common in the surrounding forest.

Target Species: Southern bog lemming and northern flying squirrel.

Site #26: Camp Mohican

Location: This site is near the Camp Mohican Outdoor Center (Figure 20). Take Gaisler Road to Camp Road: park in a gravel pull-off before the outdoor center lot area and hike to the stream.

UTM (NAD 83) 18T 499565 4542302
Elevation(s): 341 m (1,120 feet)
Topographic Quadrangle(s): Bushkill
County: Warren
Township/Town/Municipality: Blairstown
Ownership: DEWA

Sampling Techniques: Trapline (13 – 23 June 2005), aquatic pitfalls (19 – 23 June 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Sorex cinereus	masked shrew	S4	Voucher
Sorex fumeus	smoky shrew	SU	Voucher
Sciurus carolinensis	eastern gray squirrel	S5	Direct Observation
Clethrionomys gapperi	southern red-backed vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher
Tamias striatus	eastern chipmunk	S5	Direct Observation
Odocoileus virginianus	white-tailed deer	S5	Direct Observation

Site Description: This site is along a fast-flowing, rocky-bottomed stream surrounded by mixed hardwood forest.

Target Species: American water shrew, long-tailed shrew, and rock vole.

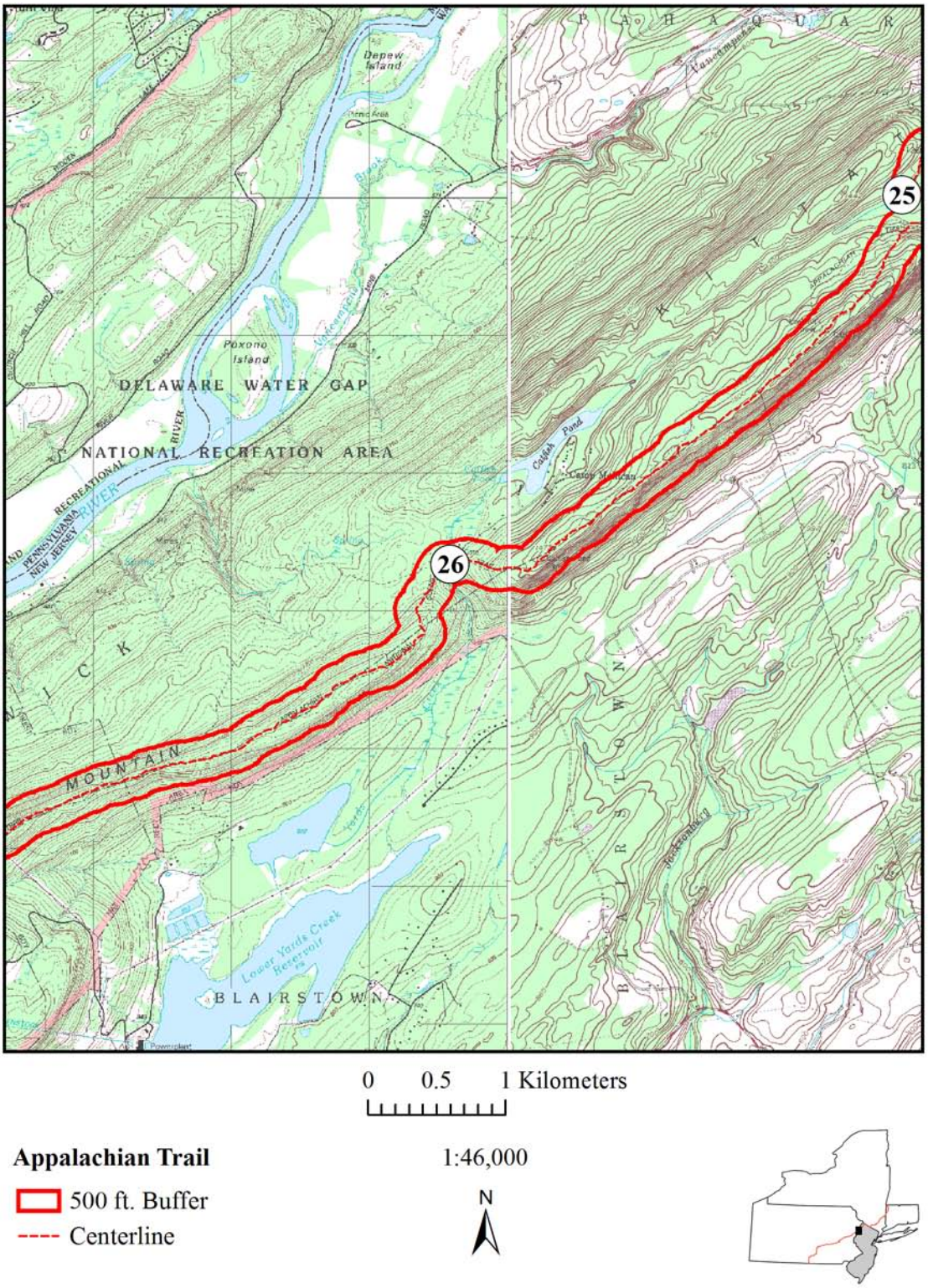

Figure 20. Map of study sites at Rattlesnake Swamp (25) and Camp Mohican (26) in Warren County, NJ.

Site #27: Tocks Swamp

Location: This site is located near the Upper Yards Creek Reservoir and is approximately 200 m outside of the AT corridor (Figure 21). The site is accessible only by permission.

UTM (NAD 83) 18T 494597 4538931
Topographic Quadrangle(s): Bushkill
Township/Town/Municipality: Hardwick

Elevation(s): 445 m (1,460 feet)
County: Warren
Ownership: Private

Sampling Techniques: Trapline (9 – 13 August 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Sorex cinereus	masked shrew	S4	Voucher
Clethrionomys gapperi	southern red-backed vole	S5	Voucher
Microtus pennsylvanicus	meadow vole	S5	Trapped & Released

Site Description: This site is a large wetland with thick shrub cover and abundant sphagnum (*Sphagnum* sp.).

Target Species: Southern bog lemming.

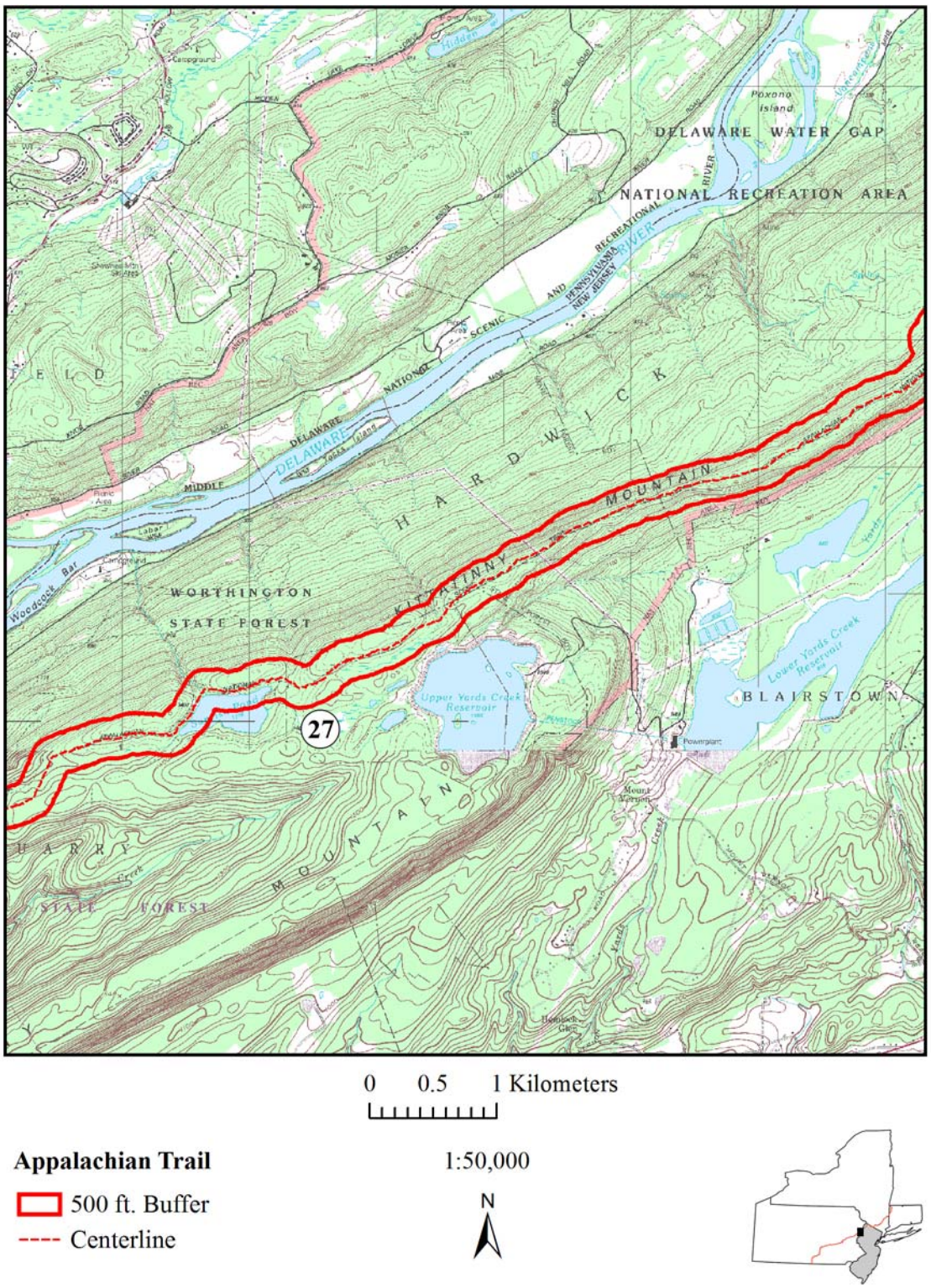

Figure 21. Map of study site at Tocks Swamp (27) in Warren County, NJ.

Pennsylvania

Site #28: Lake Latini

Location: This site is in the Delaware Water Gap National Recreation Area south of Lake Lenape (Figure 22). It is accessed via State Highway 611 and Mountain Road from the center of the Borough of Delaware Water Gap. Park in the lot off Mountain Road and hike the fire road approximately 1 km to the site.

UTM (NAD 83) 18T 488214 4535379
Elevation(s): 223 m (730 feet)
Topographic Quadrangle(s): Stroudsburg
County: Monroe
Township/Town/Municipality: Smithfield
Ownership: DEWA

Sampling Techniques: Trapline (26 – 30 June 2005), motion-sensor cameras (1 – 8 April 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Zapus hudsonius	meadow jumping mouse	S4	Voucher

Site Description: A small open wetland with abundant grasses and sedges (*Carex* spp.), surrounded by mixed hardwood forest.

Target Species: American water shrew and southern bog lemming.

Site #29: Eureka Creek/Mt. Minsi

Location: This site is in the Delaware Water Gap National Recreation Area south of Lake Lenape and about 500 m south of the Lake Latini site (Figure 22). It is accessed via State Highway 611 and Mountain Road from the center of the Borough of Delaware Water Gap. Park in the lot off Mountain Road and hike the fire road approximately 1.5 km to Eureka Creek.

UTM (NAD 83) 18T 488444 4535070
Topographic Quadrangle(s): Stroudsburg
Township/Town/Municipality: Smithfield

Elevation(s): 314 m (1,030 feet)
County: Monroe
Ownership: DEWA

Sampling Techniques: Trapline (19 – 23 June 2005), aquatic pitfalls (18 – 23 May 2005 and 8 – 12 August 2005), nest boxes (installed 19 May 2005, checked 12 November 2006)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Sorex cinereus	masked shrew	S5	Voucher
Sorex fumeus	smoky shrew	S5	Voucher
Clethrionomys gapperi	southern red-backed vole	S5	Voucher
Erethizon dorsatum	North American porcupine	S5	Sign (chewing)
Napaeozapus insignis	woodland jumping mouse	S5	Voucher
Odocoileus virginianus	white-tailed deer	S5	Sign (scat, tracks, dentary)

Site Description: The site is along a fast-flowing creek with a rocky bottom. An eastern hemlock and mixed hardwood forest surrounds the stream, and rosebay rhododendron (*Rhododendron maximum*) is abundant in the understory.

Target Species: American water shrew and northern flying squirrel.

Site #30: Totts Gap

Location: This site is along the ridge of Blue Mountain in the Delaware Water Gap National Recreation Area (Figure 22). It is accessed by taking Totts Gap Road to a small parking area just before the park gate and then hiking up a dirt road to its intersection with the AT.

UTM (NAD 83) 18T 486366 4532955
Topographic Quadrangle(s): Stroudsburg
Township/Town/Municipality: Smithfield

Elevation(s): 372 m (1,220 feet)
County: Northampton/Monroe
Ownership: DEWA

Sampling Techniques: Trapline (6 – 7 June 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Peromyscus leucopus	white-footed mouse	S5	Voucher

Site Description: This ridge-top site contains dry wooded talus.

Target Species: Long-tailed shrew and rock vole.

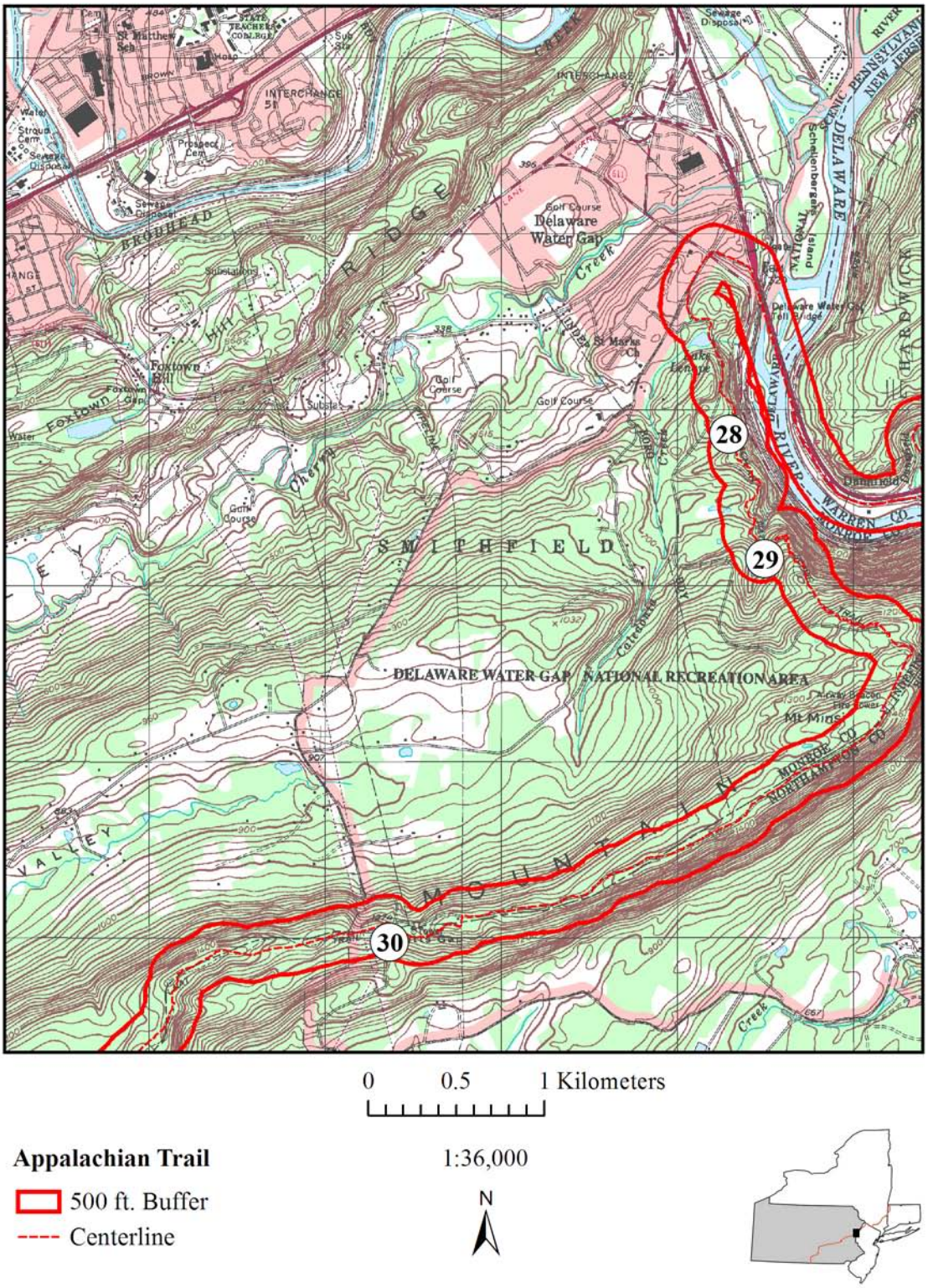

Figure 22. Map of study sites at Lake Latini (28) and Eureka Creek/Mt. Minsi (29) in Monroe County, PA, and Totts Gap (30) in Northampton and Monroe counties, PA.

Site #31: Little Gap Swamp

Location: This site is located on State Game Lands No. 168 just north of Little Gap in Blue Mountain (Figure 23). It is accessed via Little Gap Road.

UTM (NAD 83) 18T 454979 4517615
Elevation(s): 110 m (360 feet)
Topographic Quadrangle(s): Palmerton
County: Carbon
Township/Town/Municipality: Lower Towamensing
Ownership: AT

Sampling Techniques: Trapline (11 – 15 July 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Microtus pennsylvanicus	meadow vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher
Ursus americanus	American black bear	S5	Sign (damaged traps)

Site Description: An open wetland with abundant grasses, sedges (*Carex* spp.), and blueberry (*Vaccinium* sp.) bushes; some sphagnum (*Sphagnum* sp.) is present.

Target Species: Southern bog lemming.

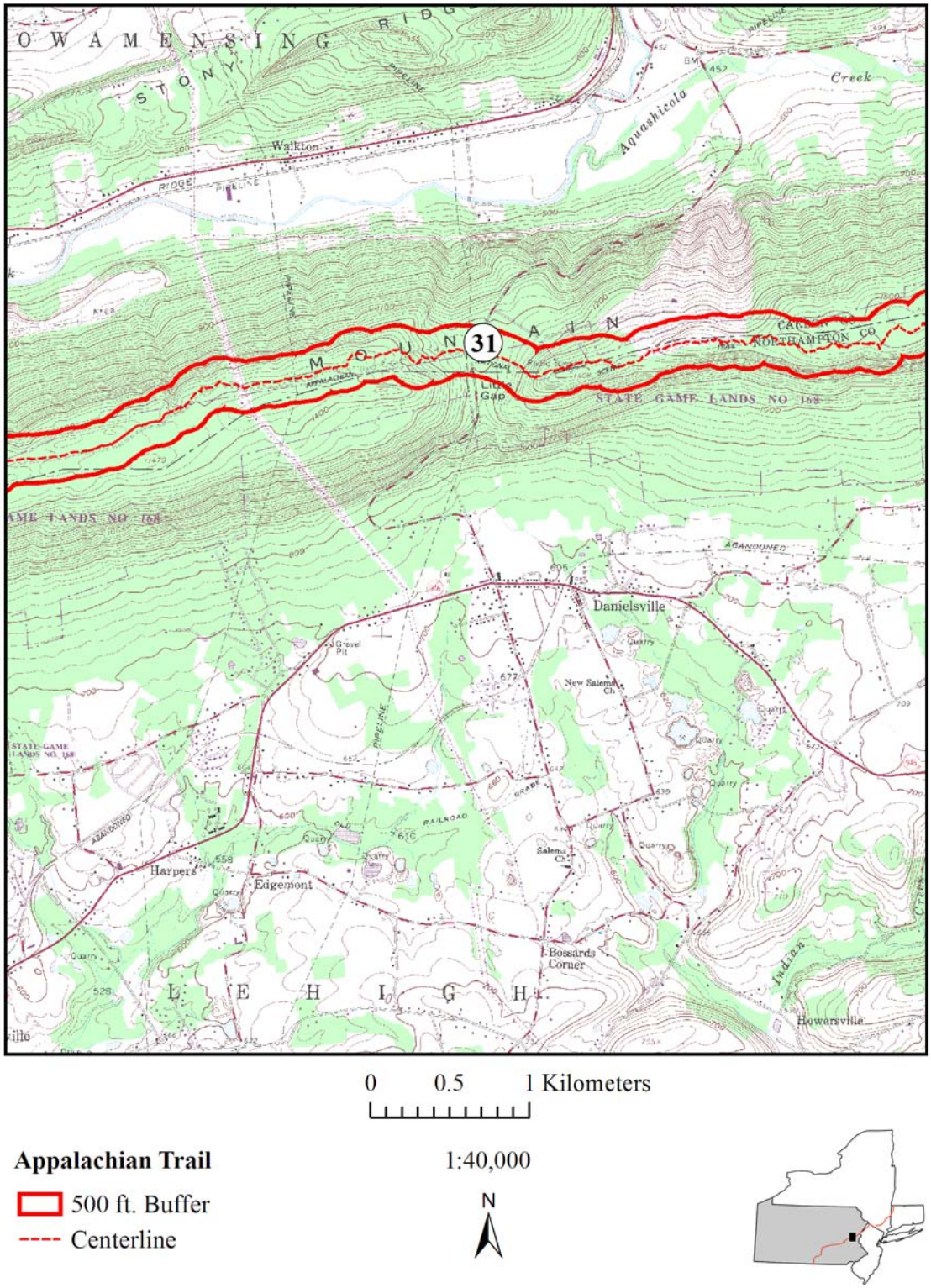

Figure 23. Map of study site at Little Gap Swamp (31) in Carbon County, PA.

Site #32: Hawk Mountain & Kettle Creek

Location: This site is located in Hawk Mountain Sanctuary (Figure 24) and accessed via Hawk Mountain Road. Park in the designated AT lot and hike 1 km to the wooden Kettle Creek bridge.

UTM (NAD 83) 18T 418863 4499038
Elevation(s): 137 m (450 feet)
Topographic Quadrangle(s): New Ringgold
County: Berks
Township/Town/Municipality: Albany
Ownership: AT

Sampling Techniques: Trapline (15 – 19 August 2005), aquatic pitfalls (15 – 19 August 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Sorex cinereus	masked shrew	S5	Voucher
Clethrionomys gapperi rupicola	Kittatinny red-backed vole	S3	Voucher
Napaeozapus insignis	woodland jumping mouse	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher
Zapus hudsonius	meadow jumping mouse	S5	Voucher
Odocoileus virginianus	white-tailed deer	S5	Sign (scat)

Site Description: This site is along a fast-flowing creek with cobble bottom. Large moss-covered rocks are abundant in the creek bed and sphagnum (*Sphagnum* sp.) and liverworts are present. The surrounding forest contains eastern hemlocks (*Tsuga canadensis*) and mixed hardwoods, and rosebay rhododendron (*Rhododendron maximum*) is common in the understory.

Target Species: Long-tailed shrew, American water shrew, and Kittatinny red-backed vole.

Site #33: River of Rocks

Location: This site is located outside of the AT corridor (1 km from the trail centerline) in Hawk Mountain Sanctuary (Figure 24). It is accessed via Hawk Mountain Road. Park in the designated AT pull-off and hike approximately 200 m west to an old service road. Hike the road approximately 1 km to the River of Rocks Trail (red blazes) and follow this trail to the site.

UTM (NAD 83) 18T 417974 4499042
Elevation(s): 213 m (700 feet)
Topographic Quadrangle(s): New Ringgold
County: Berks
Township/Town/Municipality: Albany
Ownership: Hawk Mountain

Sampling Techniques: Trapline (17 – 19 August 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Peromyscus leucopus	white-footed mouse	S5	Voucher

Site Description: This site is an extensive boulder field with numerous fissures and crevices. A hidden creek runs below the rocks.

Target Species: Long-tailed shrew and American water shrew.

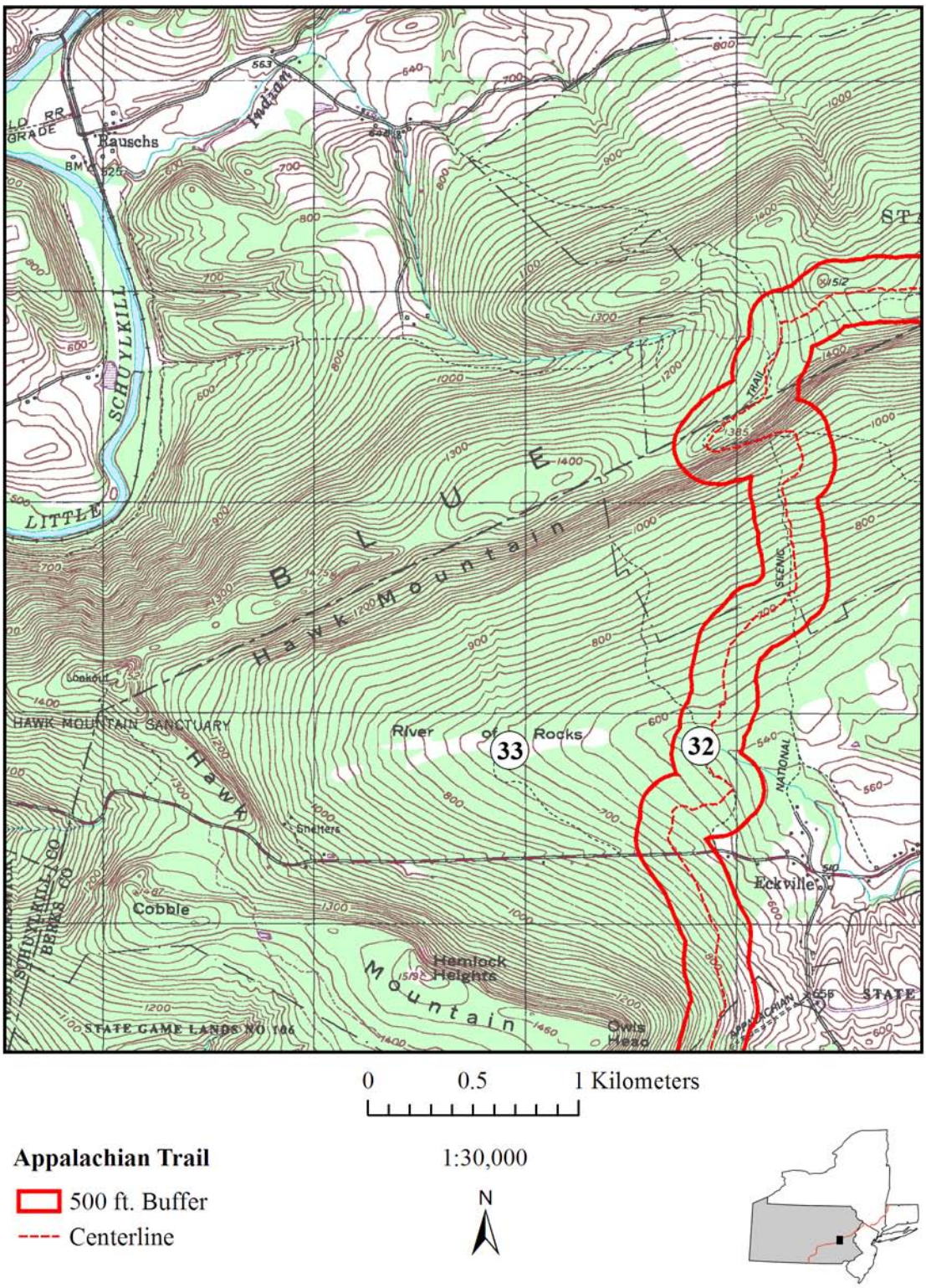

Figure 24. Map of study sites at Hawk Mountain & Kettle Creek (32) and River of Rocks (33) in Berks County, PA.

Site #34: Hamburg Reservoir

Location: This site is located along Blue Mountain just north of Hamburg Reservoir (Figure 25). It is accessed via the Hamburg Reservoir road. Park at the gate and hike approximately 1.2 km to Hamburg Creek.

UTM (NAD 83) 18T 419968 4493568
Elevation(s): 262 m (860 feet)
Topographic Quadrangle(s): Hamburg
County: Berks
Township/Town/Municipality: Windsor
Ownership: AT Easement

Sampling Techniques: Trapline (19 – 23 July 2005), terrestrial pitfalls (19 – 23 July 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Sorex cinereus	masked shrew	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher

Site Description: This site is along a small fast-flowing creek with a sandy/rocky bottom. The creek is surrounded by mixed coniferous and deciduous forest.

Target Species: American water shrew and Kittatinny red-backed vole.

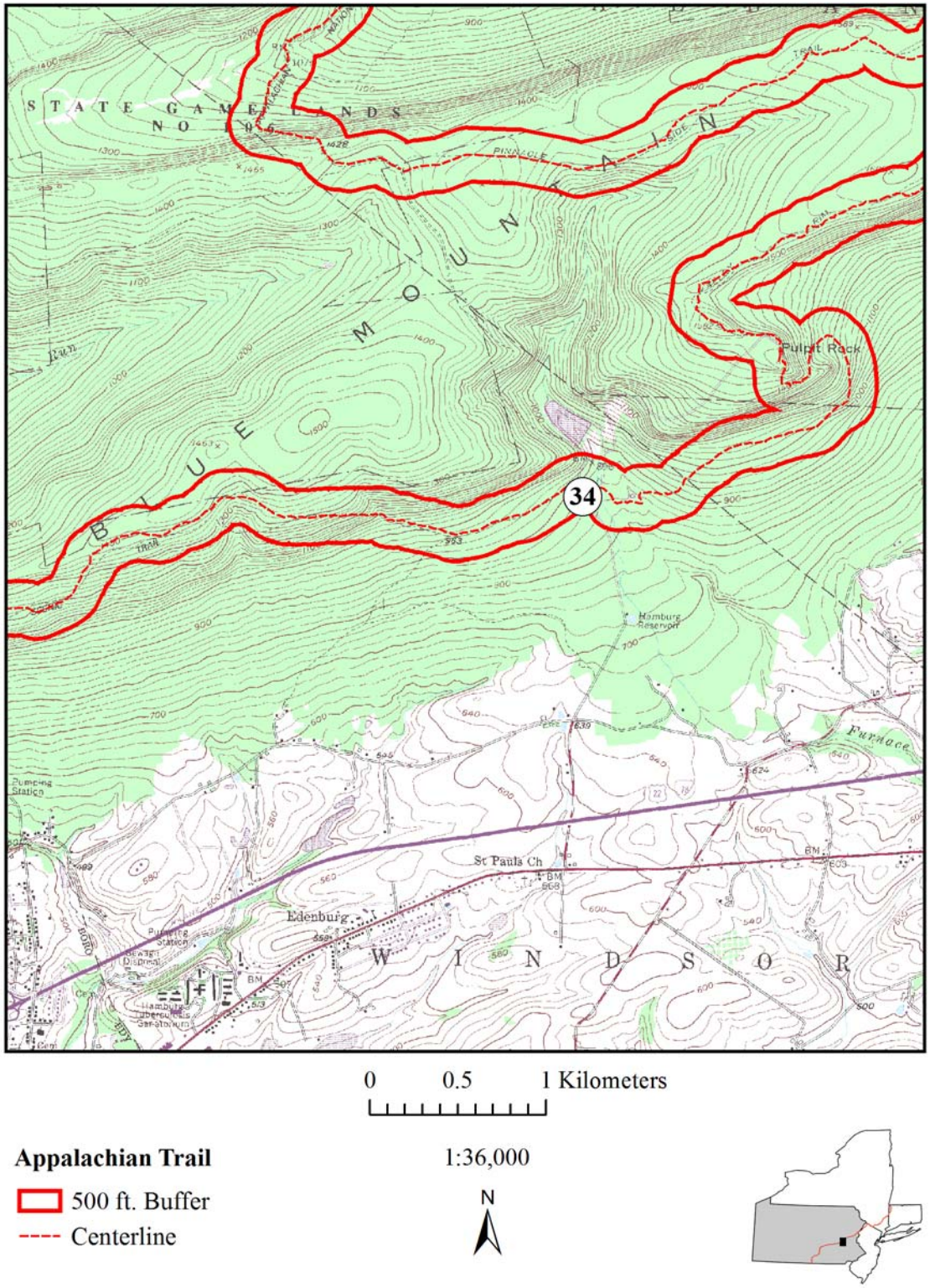

Figure 25. Map of study site at Hamburg Reservoir (34) in Berks County, PA.

Site #35: Blue Mountain Bog

Location: This site is located on State Game Lands No. 110 on the border between Schuylkill and Berks counties (Figure 26). It is accessed via the service road for State Game Lands 110. Go to the trail head, pass through the gate, and travel approximately 7 km to the site.

UTM (NAD 83) 18T 403064 4489447
Elevation(s): 497 m (1,630 feet)
Topographic Quadrangle(s): Friedensburg
County: Schuylkill/Berks
Township/Town/Municipality: Upper Tulpehocken
Ownership: State of Pennsylvania

Sampling Techniques: Trapline (1 – 5 August 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Clethrionomys gapperi rupicola	Kittatinny red-backed vole	S3	Voucher
Microtus pennsylvanicus	meadow vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher
Mustela frenata	long-tailed weasel	S5	Direct Observation

Site Description: This site is a small boggy wetland with abundant sphagnum (Sphagnum sp.), sedges (*Carex* spp.), and blueberry (*Vaccinium* sp.) bushes; red maple (*Acer rubrum*) is common in the surrounding forest.

Target Species: Southern bog lemming and Kittatinny red-backed vole.

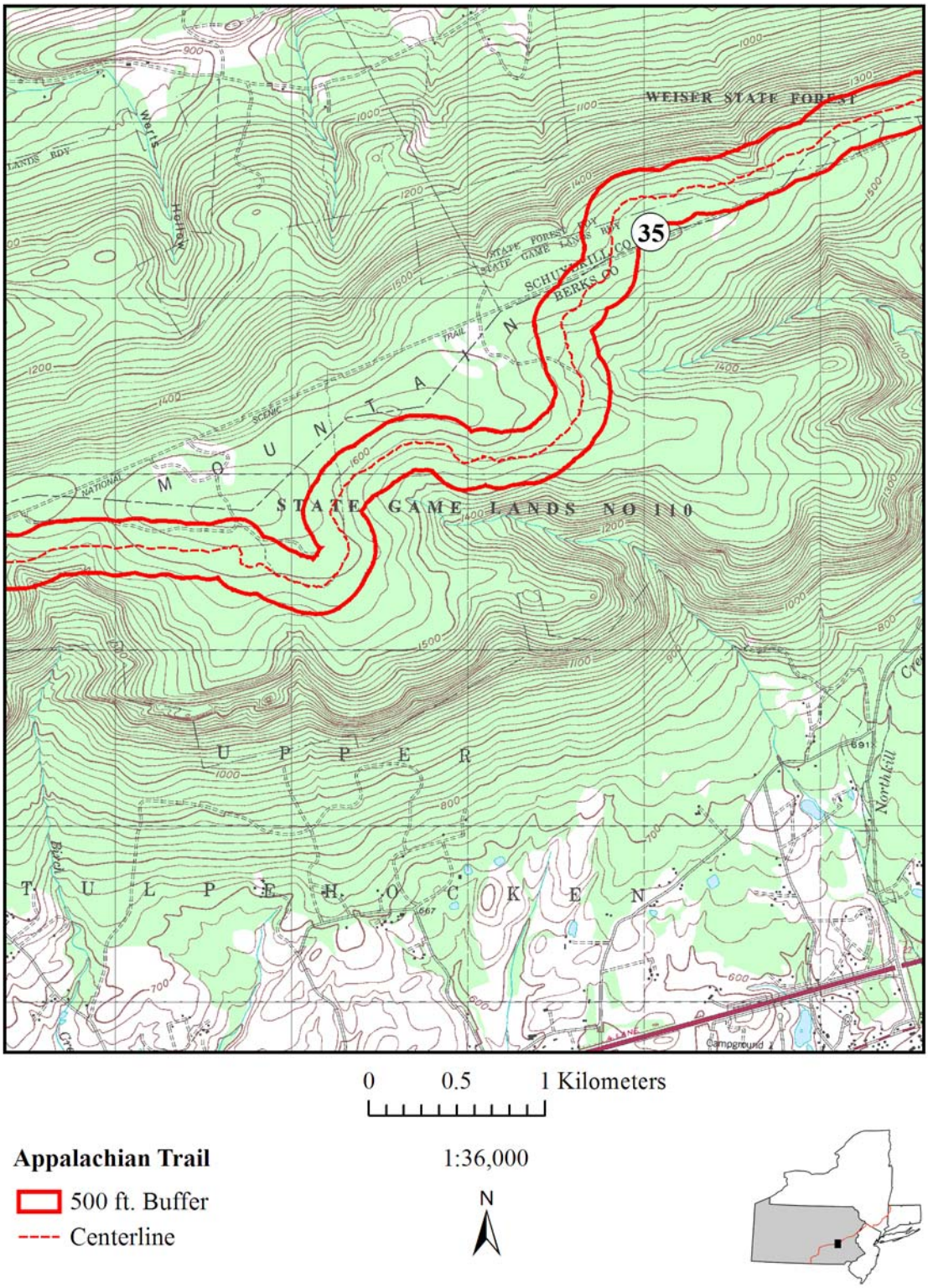

Figure 26. Map of study site at Blue Mountain Bog (35) in Berks and Schuylkill counties, PA.

Site #36: Rausch Gap

Location: This site is located on State Game Lands No. 214 just southeast of Rausch Gap (Figure 27). It is accessed by taking Indiantown Road to the trailhead. Pass the army base and follow the State Game Lands Road for approximately 7 km. Hike the Appalachian Trail to the site.

UTM (NAD 83) 18T 365348 4484021
Elevation(s): 244 m (800 feet)
Topographic Quadrangle(s): Indiantown Gap
County: Lebanon
Township/Town/Municipality: Cold Springs
Ownership: State of Pennsylvania

Sampling Techniques: Trapline (25 – 29 July 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Napaeozapus insignis	woodland jumping mouse	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher

Site Description: This site is a grassy wetland with some areas of open water. Some sphagnum (*Sphagnum* sp.) is present, and the surrounding forest is dominated by conifers.

Target Species: American water shrew and southern bog lemming.

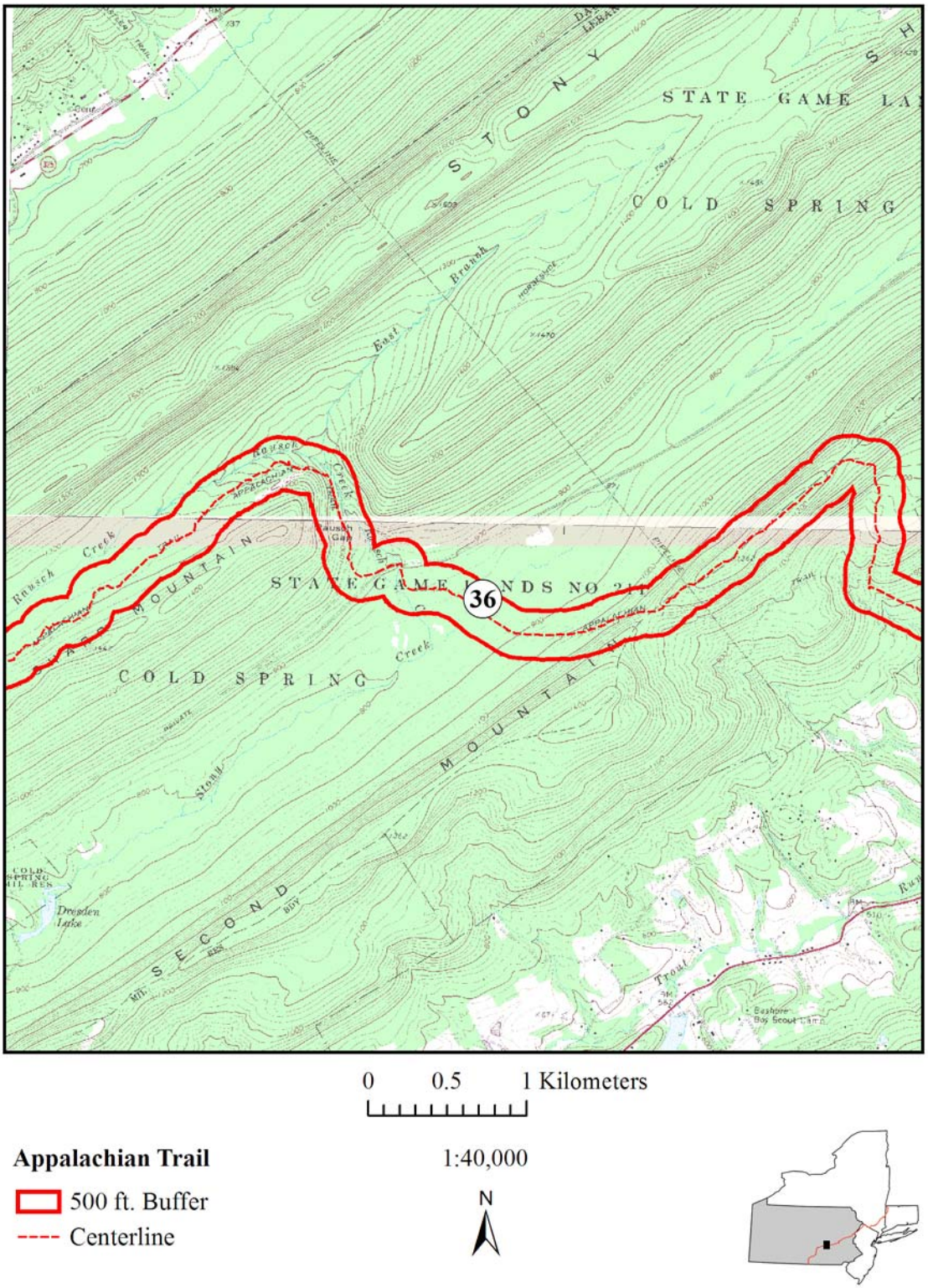

Figure 27. Map of study site at Rausch Gap (36) in Lebanon County, PA.

Site # 37: Camp Michaux & Toms Run

Location: This site is located along Toms Run just within the trail buffer (Figure 28). It is accessed by taking State Route 233 to Michaux Road, and then following Michaux Road until it crosses Toms Run.

UTM (NAD 83) 18T 300434 4434344
Topographic Quadrangle(s): Dickinson
Township/Town/Municipality: Cooke

Elevation(s): 370 m (1,215 feet)
County: Cumberland
Ownership: State of Pennsylvania

Sampling Techniques: Trapline (23 – 27 August 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Sylvilagus floridanus	eastern cottontail	S5	Carcass
Odocoileus virginianus	white-tailed deer	S5	Direct Observation

Site Description: This site is along a fast-flowing stream with a cobble/sandy bottom. Mixed coniferous-deciduous forest surrounds the stream.

Target Species: American water shrew.

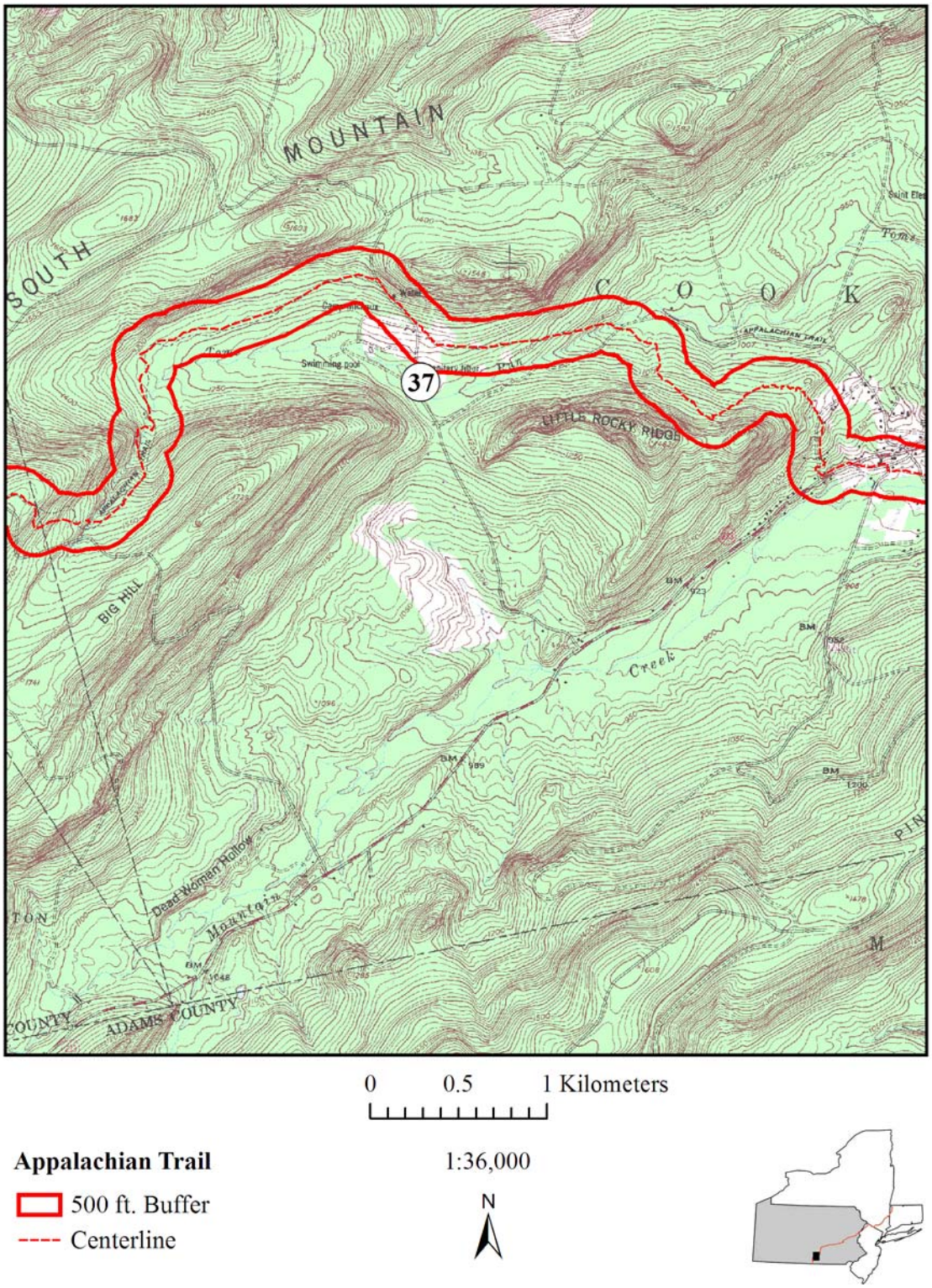

Figure 28. Map of study site at Camp Michaux & Toms Run (37) in Cumberland County, PA.

Site #38: Birch Run Swamp

Location: This site is located along Birch Run near the Birch Run Shelter (Figure 29). It is accessed by taking State Highway 233 to Shippensburg Road. Park in designated Appalachian Trail pull-off area and hike approximately 2 km to the site.

UTM (NAD 83) 18S 293504 4428886
Elevation(s): 546 m (1,790 feet)
Topographic Quadrangle(s): Caledonia Park
County: Adams
Township/Town/Municipality: Southampton
Ownership: State of Pennsylvania

Sampling Techniques: Trapline (23 – 27 August 2005), aquatic pitfalls (23 – 27 August 2005), terrestrial pitfalls (23 – 27 August 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Sorex fontinalis	Maryland shrew	S3S4	Voucher
Clethrionomys gapperi	southern red-backed vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher
Sciurus carolinensis	eastern gray squirrel	S5	Direct Observation
Tamias striatus	eastern chipmunk	S5	Direct Observation
Odocoileus virginianus	white-tailed deer	S5	Sign (tracks)

Site Description: The site is along a fast-moving stream with a cobble/rocky bottom. The riparian area contains pockets of sphagnum (*Sphagnum* sp.), ferns, and some sedges (*Carex* spp.).

Target Species: Maryland shrew, American water shrew, and southern bog lemming.

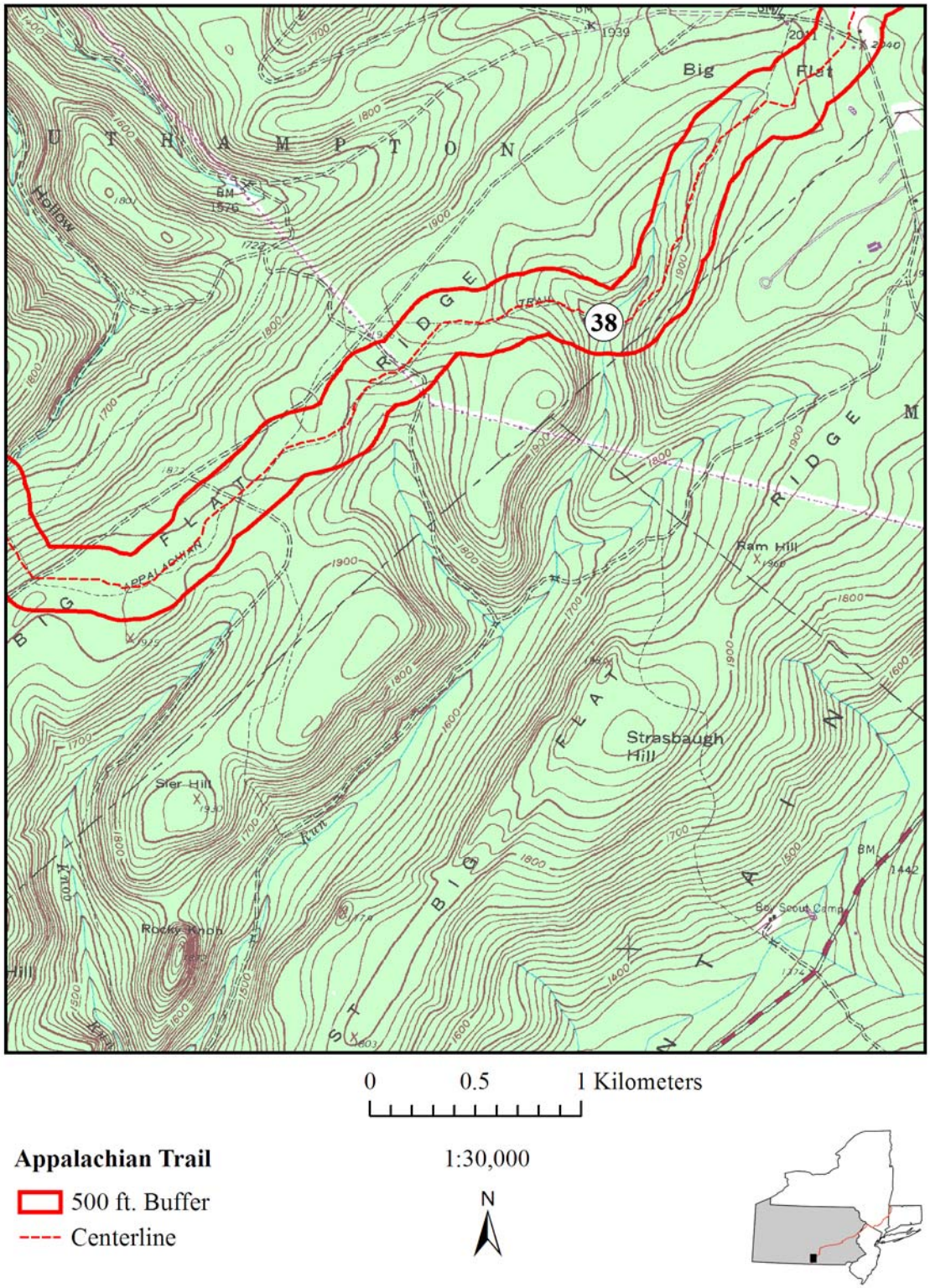

Figure 29. Map of study site at Birch Run Swamp (38) in Adams County, PA.

Site #39: Quarry Gap

Location: This site is located in Quarry Gap near Quarry Gap Shelter (Figure 30). It is accessed by taking State Highway 233 to Quarry Gap Road. Follow the gravel road to a dead end and hike slightly northwest to the AT. Hike the AT about 0.5 km to the site, located near the marked ruins.

UTM (NAD 83) 18S 287840 4422726
Elevation(s): 335 m (1,100 feet)
Topographic Quadrangle(s): Caledonia Park
County: Franklin
Township/Town/Municipality: Southampton/Greene
Ownership: AT & Pennsylvania

Sampling Techniques: Trapline (22 – 26 August 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Blarina brevicauda	northern short-tailed shrew	S5	Voucher
Sorex cinereus	masked shrew	S5	Voucher
Clethrionomys gapperi	southern red-backed vole	S5	Voucher
Peromyscus leucopus	white-footed mouse	S5	Voucher

Site Description: This site is in wooded talus and near a small, cobble-bottomed stream shaded by dense rosebay rhododendrons (*Rhododendron maximum*).

Target Species: Long-tailed shrew.

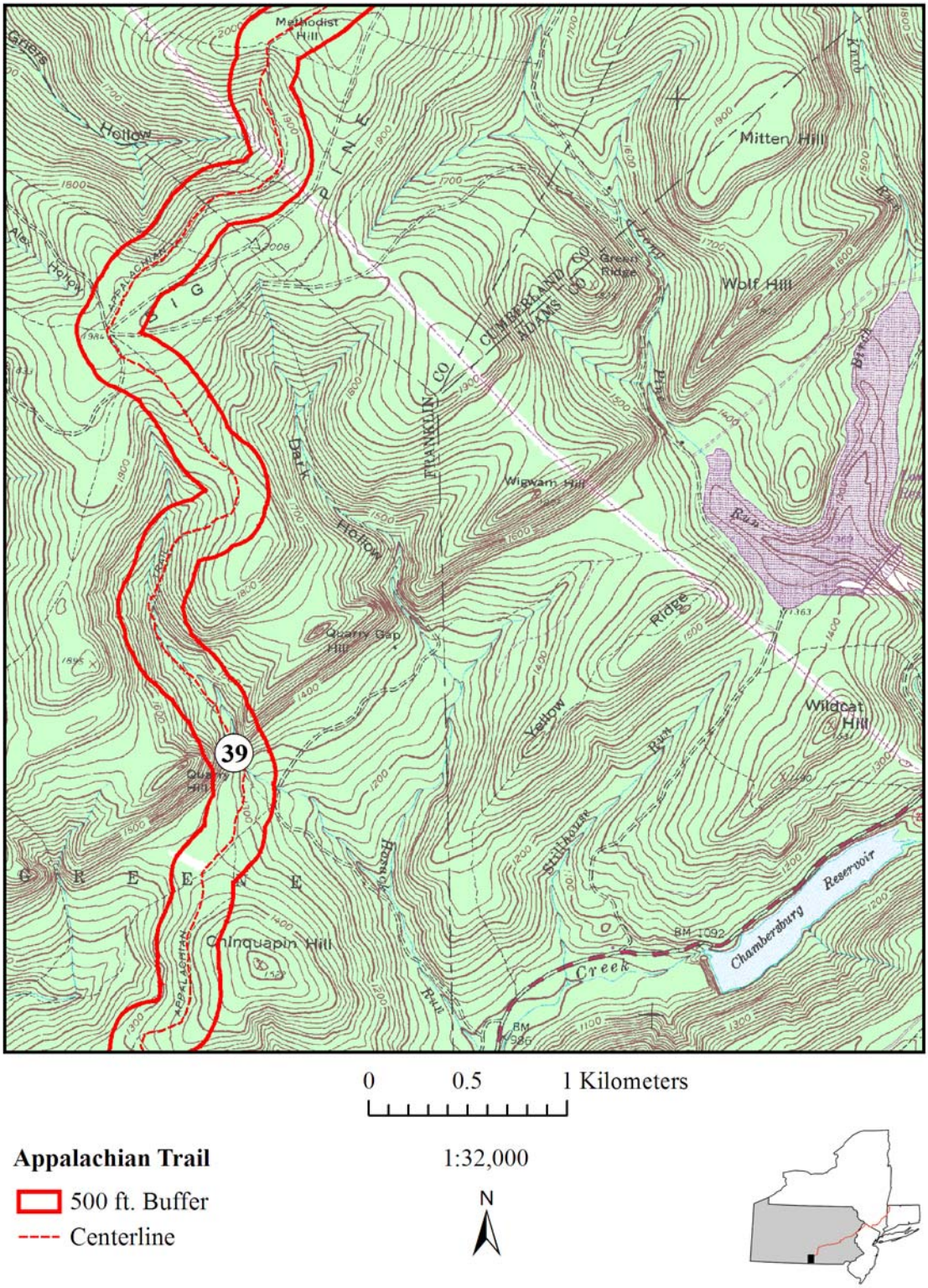

Figure 30. Map of study site at Quarry Gap (39) in Franklin County, PA.

Site #40: Pen Mar & Falls Creek

Location: This site is located outside of Pen Mar near the Pennsylvania – Maryland border (Figure 31). It is accessed by taking State Highway 16 to Buena Vista Road. Hike the Appalachian Trail approximately 0.8 km to the wooden bridge crossing Falls Creek.

UTM (NAD 83) 18S 285622 4400031
Elevation(s): 288 m (945 feet)
Topographic Quadrangle(s): Smithsburg
County: Franklin
Township/Town/Municipality: Washington
Ownership: AT

Sampling Techniques: Trapline (22 – 26 August 2005), aquatic pitfalls (22 – 26 August 2005)

Mammalian Species Summary

Scientific Name	Common Name	State Rank	Observation Type
Peromyscus leucopus	white-footed mouse	S5	Voucher
Tamias striatus	eastern chipmunk	S5	Direct Observation

Site Description: This site is along a fast-flowing, rocky-bottomed creek surrounded by eastern hemlocks (*Tsuga canadensis*) and mixed deciduous forest.

Target Species: American water shrew.

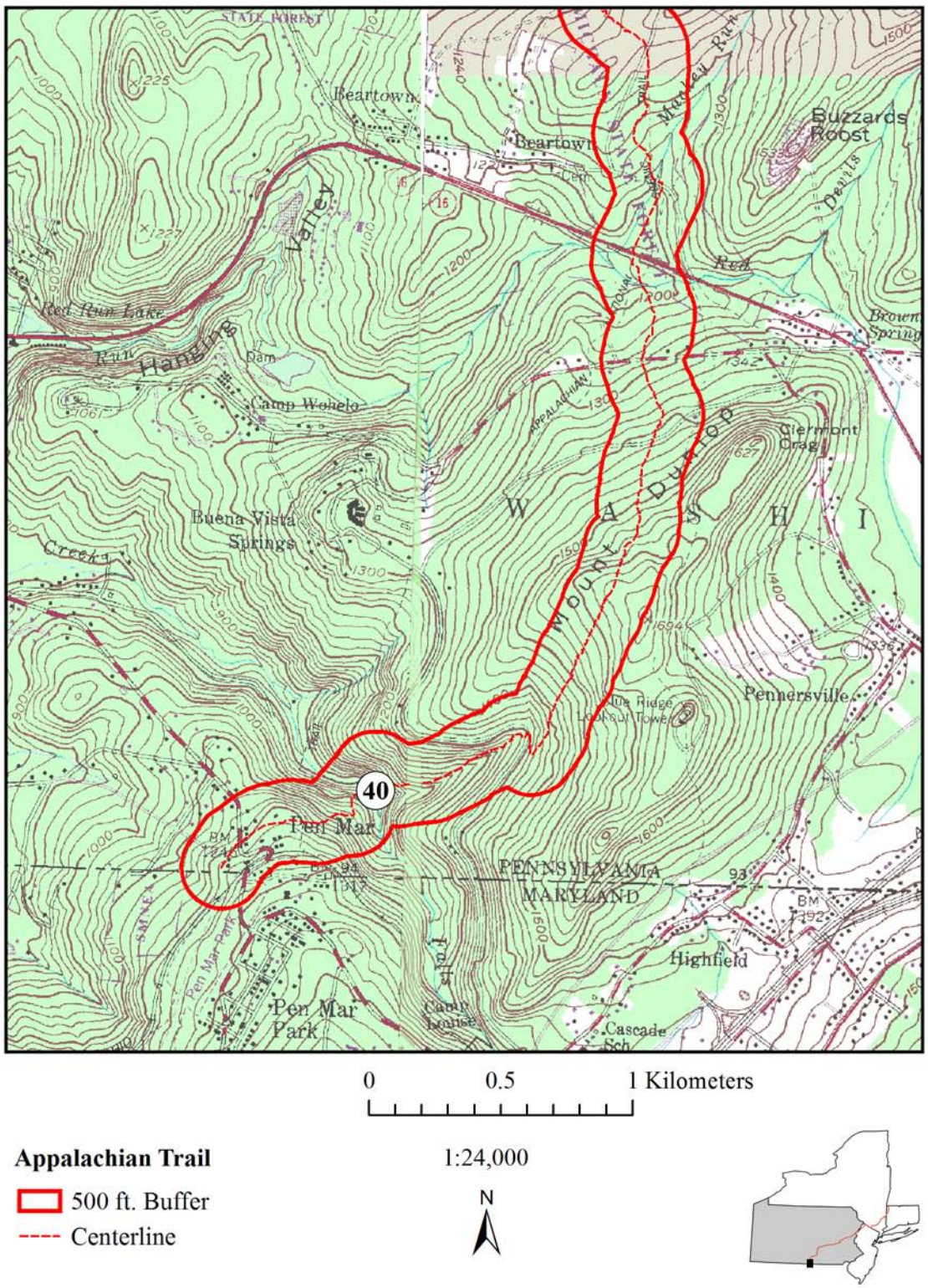

Figure 31. Map of study site at Pen Mar & Falls Creek (40) in Franklin County, PA.

Discussion

This inventory documented many of the mammalian species that make use of habitat along the Appalachian Trail from Pennsylvania through Connecticut.

Target Species Documented Along the Appalachian Trail

We detected seven of our target taxa: Maryland shrew, American water shrew, Kittatinny red-backed vole, southern bog lemming, bobcat, fisher, and American black bear. We discuss these species individually on the following pages.

Insectivora

Maryland shrew: This taxon occurs along the trail corridor in southern Pennsylvania, and may also occur in northern Maryland and the northeastern-most portions of West Virginia. We documented a single individual from Birch Run Swamp in Pennsylvania. This specimen was caught using a Museum Special snap trap and identified in the lab. There is some uncertainty whether *Sorex fontinalis* should be considered a distinct species or just a subspecies of *S. cinereus* (Whitaker and Hamilton 1998). The recognition of *S. fontinalis* as a distinct species is supported by allozyme data (George 1988) and morphological data (Kirkland 1977), which both suggest that *cinereus* and *fontinalis* occur together in southeastern Pennsylvania without interbreeding. Gaining a more complete knowledge of the taxonomic status and distribution of *S. fontinalis*, as well as a better understanding of the microhabitat characteristics that it prefers, are of prime scientific interest.

American water shrew: A considerable portion of the range of this species lies within or near the Appalachian Trail corridor. Two discontinuously distributed subspecies may be present within the corridor: *Sorex palustris punctulatus* from mid-Pennsylvania north and *S. palustris albibarbis* from southern Pennsylvania through northern Georgia and Alabama (Whitaker and Hamilton 1998). This species is frequently associated with pristine, rocky-bottomed, mountainous streams, and with forests dominated by birch (*Betula*), spruce (*Picea*), hemlock (*Tsuga*), and rhododendron (*Rhododendron*) (Beneski and Stinson 1987, Merritt 1987). Although a number of seemingly ideal sites were identified and targeted for sampling, we captured just a single *S. palustris* specimen at Pine Marsh, Connecticut, using a Museum Special trap. The presence or absence of water shrews may be an indication of habitat quality (Steele 1995), and maintaining high water quality may be essential to the long-term survival of this species.

Rodentia

Kittatinny red-backed vole: Localized in distribution, this subspecies is confined to the crest of the Kittatinny Ridge of eastern Pennsylvania, where it inhabits mesic forests of black birch, yellow birch, and hemlock in Berks and Schuylkill counties (Merritt 1981, 1987). This subspecies was first described from a specimen collected in 1932 by Earl L. Poole and Samuel

Wishnieski at The Pinnacle, a summit located on the Kittatinny Ridge along the AT in Berks County, Pennsylvania (Poole 1949, Whitaker and Hamilton 1998). Although this taxon has been generally accepted by mammalogists (e.g., Merritt 1987, Whitaker and Hamilton 1998), there have been no recent systematic analyses and NatureServe (2004) questioned its validity. Red-backed voles that are presumably this subspecies were documented from two sites along the AT: Hawk Mountain & Kettle Creek and Blue Mountain Bog in Schuylkill and Berks counties, Pennsylvania. Because of the limited distribution of this taxon along the Kittatinny Ridge, the AT corridor provides essential habitat.

Southern bog lemming: The preferred habitat of this species may vary in different parts of its geographic range, though it is known to inhabit moist areas dominated by sedges, grasses, and sphagnum (Linzey 1983). Two subspecies may be present within the project area: *Synaptomys cooperi cooperi* in Connecticut, New York, New Jersey, and most of Pennsylvania, and *S. cooperi stonei* in southern Pennsylvania near the AT (Whitaker and Hamilton 1998). We documented a single individual at Rattlesnake Swamp in Warren County, New Jersey. This specimen was caught using a Museum Special snap trap. In the future, this site can be monitored for *Synaptomys* by the identification of sign (small piles or cuttings of grasses and sedges in runways, and small pellet-shaped bright-green droppings) instead of further trapping to reduce impact to the remaining population. Currently, this site does not seem to be in any immediate danger, and the nature of the vegetation and terrain makes it an unlikely spot for hikers to venture off the trail. Although this species has been documented from a variety of habitats, the protection of areas along the AT corridor that are "bog-like" in appearance, with abundant sphagnum, sedges, and grasses, may benefit the long-term survival of this species. The fossil record indicates that southern bog lemmings are not, and have never been, a common species (Linzey 1983). Some research suggests that the meadow vole (*Microtus pennsylvanicus*) may out-compete and replace the southern bog lemming under certain circumstances; a better understanding of this interspecific competition may reveal the long-term fate of the southern bog lemming (Linzey 1983, Whitaker and Hamilton 1998).

Carnivora

Bobcat: This adaptable species makes use of a wide variety of habitats in response to prey abundance (Whitaker and Hamilton 1998). Bobcats typically prefer low elevations, south-southwest facing slopes, rock ledges, and open areas (Larivière and Walton 1997). We documented this species from Crater Lake in New Jersey based on several photographs taken by a motion-sensor camera, and also from Grand Staircase in Connecticut based on tracks visible in the snow (Rezendes 1999). Loss and alteration of habitat, as a result of agricultural practices and urban sprawl, may pose the greatest threat to this species (Beans and Niles 2003). Diseases such as feline distemper, transmitted from an ever-growing feral cat population, may also negatively affect the long-term survival of the bobcat throughout portions of its range (Beans and Niles 2003). Long-term conservation efforts should focus on the protection of large tracts of habitat which contain a variety of cover types and support a healthy prey base. Extensive corridors, such as the Appalachian Trail, allow for the connectivity of such habitat patches, and the protection of additional surrounding habitat is also warranted.

Fisher: This species favors wetlands and mixed softwood-hardwood forests characterized by an extensive continuous canopy, though it is also known from dense lowland forests and spruce/fir forests with high canopy closure (Powell 1982, DeGraaf and Rudis 1986, Whitaker and Hamilton 1998). Several successful reintroduction projects have taken place in the northeastern United States (Powell 1982, Whitaker and Hamilton 1998). We documented this species from Grand Staircase in Connecticut based on tracks in the snow (Rezendes 1999). Although the fisher was not documented from Pennsylvania during this inventory, it has become re-established in the state following successful reintroduction efforts in adjacent states.

American black bear: Known primarily from forested areas with thick understory, this species selects suitable habitat on the basis of den site and food availability (DeGraaf and Rudis 1986, Merritt 1987). Seasonally, this species seeks out patches rich in fruit and berry production, including disturbed areas such as recently logged or burned forest tracts (Larivière 2001). We documented this species at nine sites in New York, New Jersey, and Pennsylvania. Primarily documented by direct observation, observation of sign (scat), and damaged traps, we recorded American black bear most frequently at sites in New Jersey. Direct observations and sign (scat) identified along the Appalachian Trail in northern New Jersey suggest the status of this species (currently S3) may require re-evaluation as recent population estimates suggest they are secure in the Garden State (J. Huffman, East Stroudsburg University, personal comm.). The preservation and protection of large tracts of land from pressing habitat destruction and alteration is critical to the survival of large-bodied animals, such as the American black bear, that require extensive habitat patches in which to forage (Larivière 2001). If natural habitat is not protected, increasing urbanization and human encroachment will likely result in increasing human conflict (Larivière 2001). The public should be encouraged to properly store and dispose of trash and to react appropriately should they encounter a bear along the trail.

Target Species Not Documented Along the Appalachian Trail

We failed to detect 13 of our 20 target species along the AT: long-tailed shrew, least shrew, northern flying squirrel, eastern fox squirrel, rock vole, deer mouse, Allegheny woodrat, New England cottontail, snowshoe hare, northern river otter, least weasel, American marten, and moose. This may be because most of these species are habitat specialists and their preferred habitats are limited within the Appalachian Trail corridor. It may also be because they are naturally rare, secretive, or trap-shy, are present but not likely to be encountered in the field, or some combination of these factors.

<u>Insectivora</u>

Long-tailed shrew: The distribution of *Sorex dispar* lies completely south of the St. Lawrence River, covering the same mountainous terrain on which the Appalachian Trail was blazed. Failure to document this species is perhaps a reflection of its rarity and the difficulty associated with trapping it, but may result from the fact that its preferred habitat (moist wooded talus) is limited along the AT. Records from Pleistocene cave deposits in Pennsylvania, Virginia, and Tennessee suggest that *S. dispar* was probably no more abundant during the Wisconsin glacial advances than it is today (Kirkland 1981). Because this species is largely restricted to moist talus slopes, the identification of such habitat may be useful for the protection of the species.

Moist rocky talus is not as likely to experience direct human disturbances as some other habitats. Nonetheless, recreational practices may cause changes in surrounding habitats that negatively impact the microhabitat features necessary for this species. Such areas should be monitored for changes in the landscape that may affect this species.

Least Shrew: This species typically inhabits open grasslands, abandoned pastures, and early successional fields, but it has also been documented in salt marshes and woodland edges in portions of its range (Merritt 1987, Whitaker 1974). *Cryptotis parva* has apparently declined over much of its historical range, and the only extant populations known near the project area are from Gettysburg National Military Park in south-central Pennsylvania (J. Hart, Pennsylvania Natural Heritage Program, personal comm.).

Rodentia

Northern flying squirrel: While common in the northern portion of its range, this species is rare in the project area, which is near the southern end of its contiguous distribution (Whitaker and Hamilton 1998). *Glaucomys sabrinus* is commonly associated with stands of spruce/fir, hemlock, yellow birch, beech, and sugar maple, and favors cool, heavily wooded areas above 305 m (1,000 feet) in elevation (Wells-Gosling and Heaney 1984, DeGraaf and Rudis 1986, Whitaker and Hamilton 1998). Although we did not document this species, it may exist in suitable habitat within the project area. This species may be negatively impacted as a result of deforestation and fragmentation, which may reduce the number of potential nest sites and increase interspecific competition from the more abundant southern flying squirrel (*G. volans*). The periodic monitoring of nest sites may help scientists gain necessary information on the life history and habitat requirements of this species and aid in conservation efforts. The identification of this species in northwestern New Jersey would be of particular interest since there is no evidence for its occurrence now or in the past (Van Gelder 1984).

Eastern fox squirrel: *Sciurus niger* is known from small wooded lots with park-like conditions, from open woods adjacent to cultivated fields and orchards, and from mixed forest patches with a poorly developed understory (Merritt 1987, Koprowski 1994). The only place within the project area where the eastern fox squirrel may be present is south-central Pennsylvania. Population densities are highest in areas composed of tree species which produce winter-storable food such as oaks (*Quercus*), hickories (*Carya*), walnuts (*Juglans*), and pines (*Pinus*) as well as beech (*Fagus*), maple (*Acer*), and black cherry (*Prunus*) (Merritt 1987, Koprowski 1994). Logging may reduce important fox squirrel habitat, as was documented in the southeastern portion of their range (Whitaker and Hamilton 1998). Direct observation during autumn, when this scatter hoarder is most active, may be the most practical way for scientists to gain additional knowledge of this species (Merritt 1987).

Rock vole: Pleistocene cave deposits from the northeastern United States suggest that this species has never been common in comparison with other microtine rodents (Kirkland and Jannett 1982). Conservation efforts should target moist, moss-covered talus containing bunchberry (*Cornus canadensis*) and blueberries (*Vaccinium* sp.), which are major components of the rock vole's diet (Kirkland and Jannett 1982). Protection of suitable habitat is obviously

important, although there is some evidence that *M. chrotorrhinus* may benefit from clearcutting (Whitaker and Hamilton 1998).

Deer mouse: We trapped 140 mice of the genus *Peromyscus*, some of which were tentatively identified *P. maniculatus* based upon external measurements and pelage characteristics. However, genetic analyses using salivary amylase electrophoresis (Rich et al. 1996) identified all of our *Peromyscus* specimens as white-footed mice (*P. leucopus*). Although the deer mouse is widespread and abundant in much of North America, it is apparently absent from much of our study area, including trail sections in eastern Pennsylvania, New Jersey, and southern New York (Whitaker and Hamilton 1998). Given that the subspecies of deer mouse that is present in southern Pennsylvania is *P. m. bairdii*, a subspecies whose preferred habitat is grasslands and cultivated fields (Merritt 1987), we may have not detected this species in Pennsylvania because our study areas were not in grassland habitats. A woodland subspecies of deer mouse (*P. m. gracilis)* is present in northwestern Connecticut (Whitaker and Hamilton 1998), where it is listed as S3 (NatureServe 2004).

Allegheny woodrat: Most extant populations of this species are well documented. Although we did not record this species at any of our study sites, there is an extant population on Stony Mountain in Dauphin Co., Pennsylvania (C. Butchkoski, Pennsylvania Game Commission, personal comm.) and also one near Rausch Gap in Lebanon Co., Pennsylvania (Shriver et al. 2005). Historically, this species was recorded from the project area at a site west of Sand Pond and Camp No-Be-Bo-Sco in Warren Co., New Jersey (J. Shreiner, National Park Service, personal comm.), and it formerly occurred on the Schaghitocoke Indian Reservation in Litchfield Co., Connecticut (McKay et al. 1992). Hypotheses for its decline include habitat loss, increased avian and mammalian predation due to edge effects, the loss of hard mast food resources, and woodrat latrine foraging strategies which increase the probability of the successful transmission of the fatal raccoon roundworm, *Baylisascaris procyonis* (Balcom and Yahner 1996). Despite the decline of the Allegheny woodrat, a recent full scale study on a western non-endangered woodrat species by Gerber et al. (2003) offers some encouragement. This research provides guidelines for woodrat management, offering a model for the endangered Allegheny woodrat. Although habitat occupied by the Allegheny woodrat is not likely to experience direct human contact, recreational practices may cause changes in surrounding habitat that may negatively impact microhabitat features associated with this species. Areas near water gaps where cliff faces and boulder piles are naturally more abundant may be of particular interest (Hall 1985).

<u>Lagomorpha</u>

New England cottontail: This species is not easily distinguished in the field from the more common eastern cottontail (*Sylvilagus floridanus*), and we could not demonstrate that this species occurs within the trail corridor without the collection of voucher specimens. This species is thought to survive primarily in refugia of young woodlands with thick and dense cover, as well as boreal environments (Chapman 1975). Historically, specimens have been taken from brushy areas, open woodlands, swamps, mountains, beaches, salt marshes, open land, young woodlands associated with clear cuts, and in hayfields and other grasslands (DeGraaf and Rudis 1986). We observed an unidentified cottontail (*Sylvilagus* sp.) that could have been this species at Moore Brook in Connecticut, but we were unable to collect a specimen. Hunting practices that target

the eastern cottontail may inadvertently affect the long term survival of the endangered and more poorly known New England cottontail. In an effort to protect this species, state-owned lands should maintain suitable habitat, and the integrity of this species should be considered prior to the release of cottontails (*Sylvilagus* sp.) into the wild (Kirkland 1985, Merritt 1987).

Snowshoe hare: This species is never found far from cover (Whitaker and Hamilton 1998). The snowshoe hare is likely common in areas of suitable habitat in Connecticut (DeGraaf and Rudis 1986) and may occupy areas in New York where seedlings and saplings are abundant (Whitaker and Hamilton 1998). In New Jersey, the snowshoe hare is considered extirpated despite reintroduction efforts in 1963 near the Flatbrook Wildlife Management Area in Sussex County. However, at Pochuck Creek Crossing in Sussex Co., NJ, we observed an animal that may have been this species. We attempted to confirm this observation using motion-sensor cameras baited with apple pieces, but we were not successful. In Pennsylvania, the snowshoe hare may exist within the AT corridor on high ridges covered with mountain laurel and rosebay rhododendron thickets (Merritt 1987). According to Dalby (1985), regional hunting practices may need to be re-examined in Pennsylvania. Conservation efforts should strive to protect suitable habitat within and surrounding the trail corridor.

Carnivora

Northern river otter: Seldom seen, this species is most commonly noted from the presence of characteristic slides (Whitaker and Hamilton 1998). Although not documented during this inventory, this species likely occurs along the AT in permanent streams, ponds, lakes, and rivers in forested areas that provide suitable den sites and aquatic vegetation (DeGraaf and Rudis 1986, Whitaker and Hamilton 1998). Although pollution and urbanization had greatly reduced *Lontra canadensis* populations by the early 1900s, reintroduction efforts have expanded the distribution of this species, and population numbers are thought to be on the rise (Larivière and Walton 1998, Whitaker and Hamilton 1998). Today, direct harvest, habitat destruction, and habitat degradation may pose the greatest threats to the survival of this species (Whitaker and Hamilton 1998). This species is highly sensitive to pollution and oil spills, and it can serve as a bio-indicator (Larivière and Walton 1998). In Pennsylvania, the river otter is listed as S3 (NatureServe 2004). The playful temperament and social nature of the northern river otter makes it a potential flagship species to attract public attention and funding for conservation.

Least weasel: This species occurs primarily in open forest, grassy fields and meadows, cultivated fields, and pond edges with abundant microtine prey (Sheffield and King 1994, Whitaker and Hamilton 1998). Nocturnal and secretive in nature, the least weasel is the smallest member of the order Carnivora and is rarely seen (Merritt 1985). Today, *Mustela nivalis* is presumed extirpated from New York State, and it is considered vulnerable in Pennsylvania. It may occur in Franklin, Adams, Cumberland, and Perry counties in Pennsylvania (Merritt 1987). Conservation efforts should target suitable habitat in these counties and within the trail corridor south of Pennsylvania. Alteration of suitable habitat as a result of mining, intensive agriculture, and commercial and recreational development may pose the greatest threats to this species (Merritt 1987).

American Marten: This species is solitary and rarely seen, so it was not a surprise that we did not document it during our inventory. This species inhabits areas with greater than 30% canopy cover (Whitaker and Hamilton 1998). It is presumed extirpated in Pennsylvania (NatureServe 2004). It is also presumed extirpated in New Jersey, despite unsubstantiated claims of it being trapped in Passaic County (Van Gelder 1984). In New York, it is listed as an S3 species and is found in the Adirondack Mountains, but its distribution is not thought to extend to areas near the AT (Whitaker and Hamilton 1998). There are no records of this species in Connecticut. Conservation efforts should focus on protecting potential habitat along the AT that will support an abundant prey base for American marten.

Artiodactyla

Moose: The moose occurs in coniferous forests, bogs, and aspen or willow thickets, where it prefers to spend the summer near water and the winter in drier mixed-hardwoods (DeGraaf and Rudis 1986, Merritt 1987). We did not document this species within the project area, although it occurs in suitable habitat along the trail to the north (e.g., New Hampshire and Maine), and it has been seen recently in northwestern Connecticut (J. Fischer, White Memorial Conservation Center, personal comm.).

Additional Species Documented Along the Appalachian Trail

In addition to the seven target taxa, we documented 23 other mammalian species along the Appalachian National Scenic Trail.

Insectivora

Northern short-tailed shrew (*Blarina brevicauda*): This species was documented from 13 sites along the AT, and recorded as present in all four states. The majority of individuals (23 out of 31), were captured using Museum Special snap traps; eight individuals were captured using Sherman live traps.

Masked shrew (*Sorex cinereus*): This species was documented from 12 sites along the AT, and recorded as present in all four states. Most specimens were documented using Museum Special snap traps or pitfall traps.

Smoky shrew (*Sorex fumeus*): This species was documented from eight sites along the AT, and recorded as present in all four states. Most specimens were documented using Museum Special snap traps or pitfall traps.

Lagomorpha

Eastern cottontail (*Sylvilagus floridanus*): This species was documented from four sites along the AT, and recorded as present in Connecticut, New Jersey and Pennsylvania, but not New York. This species was documented by direct observation and the discovery of a scavenged or roadkill carcass. The species identifications were made based on pelage characteristics that typically distinguish the eastern cottontail from the New England cottontail (Merritt 1987,

Whitaker and Hamilton 1998). At Moore Brook in Connecticut, a cottontail species was observed (*Sylvilagus* sp.), but it was not identified to species. It is possible this individual was a New England cottontail.

Rodentia

American beaver (*Castor canadensis*): This species was documented from four sites along the AT, two sites in New York and two sites in New Jersey. Opportunistic observation of sign (dams, lodges, and cuttings) served as a means for documenting this species (Rezendes 1999).

Southern red-backed vole (*Clethrionomys gapperi gapperi*): This species was documented from 11 sites and from all four AT states in the project area. Kittatinny red-backed voles (*C. gapperi rupicola*) were identified from two additional sites: Hawk Mountain and Kettle Creek and Blue Mountain Bog in Schuylkill and Berks counties, Pennsylvania.

North American porcupine (*Erethizon dorsatum*): This species was documented from two sites along the AT. It was documented in New Jersey based on distinct sign (scat and quills) and in northern Pennsylvania by coarse incisor marks present on a few of the flying squirrel nest boxes that we erected at the site (Rezendes 1999).

Southern flying squirrel (*Glaucomys volans*): This species was documented in nest boxes erected for northern flying squirrels from three sites along the AT in New Jersey and New York. At Rattlesnake Swamp in New Jersey, two large females (92 and 94 grams) were found sharing a nest box. At Culvers Gap in New Jersey, two individuals were also found sharing a nest box; one individual got away before it could be measured and weighed, and the other individual was a 75 g male. At Little Dam Lake in New York, a smaller male (65 g), was found in a nest box. Furthermore, at Deuel Hollow Brook in New York, a female with offspring was found in one of the nest boxes.

Woodchuck (*Marmota monax*): This species was documented from two sites along the AT, both in New Jersey. At Crater Lake, a juvenile was observed running across the trail, and at Pochuck Creek Crossing a burrow was observed.

Meadow vole (*Microtus pennsylvanicus*): This species was documented from 11 sites along the AT, and was present in all four states.

Woodland jumping mouse (*Napaeozapus insignis*): This species was documented from three sites along the AT, all in Pennsylvania.

Muskrat (*Ondatra zibethicus*): This species was documented from a roadkill near the trail in southern Pennsylvania at Caledonia State Park and Conococheague Creek.

White-footed mouse (*Peromyscus leucopus*): This species is very common along the AT and was documented from 25 sites and from all four states.

Eastern gray squirrel (*Sciurus carolinensis*): This species was documented from eight sites along the AT in New York, New Jersey, and Pennsylvania. This species was commonly observed while checking traps, and it was also identified from a carcass at Culvers Gap in New Jersey.

Red squirrel (*Tamiasciurus hudsonicus*): This species was documented from tracks observed at Grand Staircase in Connecticut (Rezendes 1999).

Eastern chipmunk (*Tamias striatus*): This species was documented from nine sites in New York, New Jersey, and Pennsylvania. We regularly observed this species while traveling along the AT to and from our study sites, and four individuals were caught in traps set for target species.

Meadow jumping mouse (*Zapus hudsonius*): This species was documented at three sites along the AT: Culver's Gap in New Jersey, and Lake Latini and Hawk Mountain & Kettle Creek in Pennsylvania. It was only documented using Museum Special snap traps.

Carnivora

Coyote (*Canis latrans*): This species was documented from Moore Brook and Grand Staircase, in Connecticut, and Hemlock Springs and Copper Mine Brook, in New York. In Connecticut, we observed coyote tracks (Rezendes 1999), and in New York we observed tracks and received an unidentified hiker's report that her dog had just chased a coyote away near the site.

Striped skunk (*Mephitis mephitis*): This species was documented from a scavenged carcass from Maple Hill in Sussex County, New Jersey.

Long-tailed weasel (*Mustela frenata*): This species was documented from Blue Mountain Bog in Pennsylvania. We captured this species in a Sherman live trap. We photographed the individual then released it unharmed at the site of capture.

Northern raccoon (*Procyon lotor*): This species was documented from four sites along the AT in Connecticut, New York, and New Jersey, but not in Pennsylvania. In most instances this species was identified based on sign, scat, or tracks (Rezendes 1999).

Artiodactyla

White-tailed deer (*Odocoileus virginianus*): This species was documented from 18 sites along the AT, and was present in all four states. The majority of our records came from direct observations, but several came from diagnostic sign (tracks and scat) observed while in the field (Rezendes 1999).

Other Species Not Recorded along the Appalachian Trail

We did not record 11 other terrestrial mammalian species that likely occur within the project area. The star-nosed mole and the hairy-tailed mole almost certainly occur within the corridor, but we did not use the special sampling procedures (such as mole traps) needed to catch these species. Several mole tunnels were observed at a number of sites along the trail and were most

likely the work of star-nosed or hairy-tailed moles. Eastern moles may occur within the AT corridor, but they are less common in the upland habitats that are traversed by the trail in the project area. The pygmy shrew (*Sorex hoyi*) was recorded in recent years near West Point in New York State not far from the AT (F. Dirrigl, Post University, personal comm.). It may make use of the trail corridor, but is rare, seldom collected, and often overlooked (Whitaker and Hamilton 1998). Appalachian cottontails were also not documented along the trail. Despite their recent decline, they may make use of habitat traversed by the AT in Pennsylvania and possibly in New York west of the Hudson River. Much like the New England cottontail, this species is difficult to identify in the field, and often requires the recovery of a specimen for positive identification. The woodland vole is known from a wide range of forested habitats and almost certainly occurs within the AT corridor. However, it is rarely found on the surface, preferring to stay underground in its burrows (Whitaker and Hamilton 1998), and we did not trap specifically for this species. The house mouse and the Norway rat, both of which are introduced species, may be present in areas along the trail that are more heavily settled or near trail shelters. The short-tailed weasel may make use of the trail, but it is less common than the long-tailed weasel (Merritt 1987), which was recorded at a site in Pennsylvania during this inventory. The American mink and both red and gray foxes almost certainly make use of the trail corridor, however, we did not target these species for inventory and they are unlikely to be documented by direct observation alone.

Analysis of Trap Effectiveness for Documenting Small Mammals

An understanding of the geographic distributions of taxa is often necessary for effective conservation efforts (Groom et al. 2006). For many small mammals, distributional data are incomplete and inventories are warranted. Many previous studies have demonstrated that trap type is an important variable in the capture of small mammals (e.g., Sealander and James 1958, Wiener and Smith 1972, Kalko and Handley 1993, Kirkland and Sheppard 1994, Francl et al. 2002, Umetsu et al. 2006). After completing this inventory, we compared the effectiveness of live traps, snap traps, and pitfall traps for documenting small mammal populations. In 11,182 total trap nights, we recorded 318 individuals representing 9 genera (Table 7). All of the target small mammals identified along the AT corridor were caught in Museum Special snap traps (*Sorex fontinalis, Sorex palustris, Synaptomys cooperi,* and *Clethrionomys gapperi rupicola*), whereas only one target taxon was captured using Sherman live traps (*C. gapperi rupicola).* Museum Special snap traps were also significantly more effective than Sherman live traps for small mammals in general (T= 16, $P < 0.001$, Wilcoxon's test for matched pairs). Pitfall traps were approximately five times more effective at capturing *Sorex* shrews than any other trap type on a per trap-night basis. Pitfall traps proved effective for both *Clethrionomys gapperi* and *Napaeozapus insignis*, though they were only marginally effective for *Microtus pennsylvanicus*.

Conservationists, park managers, and policy makers are often faced with the difficult task of prioritizing areas for the protection of imperiled species. By understanding the differential success rates of traditional trap types, inventories can more effectively identify populations of target species with minimal impact. Our results suggest that Museum Special snap traps and pitfall traps are more effective for documenting small mammals than live traps, which may fail to identify at-risk populations. We hope that these data will assist in the conservation and management of at-risk small mammals.

Table 7. Numbers of small mammals captured using live traps, snap traps, and pitfall traps.

Trap Nights	**Trap Type**	***Sorex* sp.**	***Blarina brevicauda***	***Microtus pennsylvanicus***	***Clethrionomys gapperi***	***Peromyscus leucopus***	***Zapus hudsonius***	***Napaeozapus insignis***	***Tamias striatus***	***Synaptomys cooperi***	**Totals**
5280	Museum Special	33	23	22	28	103	4	10	3	1	227
5280	Sherman live	5	8	6	9	37	0	1	1	0	67
622	Pitfall	18	0	1	3	0	0	2	0	0	24
11182	All 3 Types	56	31	29	40	140	4	13	4	1	318

Conclusions

The Appalachian Trail as a Corridor for Conservation

Our results indicate that the Appalachian National Scenic Trail serves as important habitat for many species of mammals. The trail traverses critical habitat that provides food, water, and shelter for creatures both large and small. The AT corridor provides habitat for small mammal populations that may be critical to the preservation of genetic diversity. This habitat may be especially important for threatened and endangered species for which population sizes are limited, and the management of these species should be viewed as an opportunity to practice proactive conservation.

Habitat fragmentation and loss poses the single greatest threat to imperiled species in the United States (Wilcove et al. 1998). Today, natural areas are becoming increasingly fragmented and degraded, and agricultural practices, timber harvesting, water development, road construction, mining, and increasing human encroachment all contribute to the loss in connectivity among populations and may be responsible for recent and rapid declines of some mammals (e.g., the Allegheny woodrat). Proper management of Appalachian Trail fee and easement lands may therefore have a direct impact on the life history requirements of many of these species. "Preventative medicine" is the best way to keep a species from entering a downward spiral towards extinction (Hunter and Hutchinson 1994). From an economic standpoint, it is much more cost effective to monitor and protect species than to act only when they are at the brink of extinction. Protection of large corridors, such as the Appalachian National Scenic Trail, may be critical to the long-term survival of some species, especially those most at risk of extinction.

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