1976

Lithologic, edaphic, and biotic factors of small mammal habitats in the slate belt of Western Rutland County, Vermont, and Eastern Washington County, New York

Albert Stanley Berkowitz
Binghamton University--SUNY

A. BERKOWITZ

LITHOLOGIC, EDAPHIC, AND BIOTIC FACTORS OF SMALL MAMMAL HABITATS IN THE SLATE BELT OF WESTERN RUTLAND COUNTY, VERMONT, AND EASTERN WASHINGTON COUNTY, NEW YORK

A. BERKOWITZ — Ph.D. THESIS — 1977

LITHOLOGIC, EDAPHIC, AND BIOTIC FACTORS OF SMALL MAMMAL HABITATS IN THE SLATE BELT OF WESTERN RUTLAND COUNTY, VERMONT, AND EASTERN WASHINGTON COUNTY, NEW YORK

BY

ALBERT STANLEY BERKOWITZ

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in State University of New York
at Binghamton
1976

Accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in State University of New York at Binghamton.

Dr. John J. Christian	Biology	John J. Christian	9/21/1976
Dr. Stuart O. Landry	Biology	Stuart O. Landry	9/21/1976
Dr. Donald R. Coates	Geology	Donald R. Coates	9/21/1976

Acknowledgements

The assistance necessary to undertake a project of this type was helpfully provided by a number of people. Simply mentioning their names does not provide adequate thanks for their aid, but I hope the completion of this work affords them some small satisfaction and a feeling that their time was well spent.

Mr. George Fischler and Mr. Alvin Deming helped in the collection of the floristic data, and the week we spent in Vermont was both enjoyable and productive.

Mr. Andrew Raiford, Department of Geology, Castleton State College, Castleton, Vermont, and Dr. Brewster Baldwin, Department of Geology, Middlebury College, Middlebury, Vermont, provided valuable background information and suggestions that were incorporated into the field work.

Dr. D. Gemmell kindly allowed me to inspect the small mammal collection of the Department of Biology, Castleton State College, Castleton, Vermont, and I am grateful for his assistance and interest in my work. I was also able to inspect the small mammal collection at the University of Vermont, Burlington, Vermont, and express my appreciation to the Department of Biology for their time and help.

Mr. and Mrs. Frederick Allen, Fair Haven, Vermont, assisted in the identification of many of the wildflowers and weeds from my trap-sites; Mr. Allen allowed me to borrow his manuscript concerned with the slates of the region, and from this I was able

to obtain valuable insights into the history of the slate belt. I shall also long remember the hours spent looking for beaver from the banks of the Poultney River.

Special thanks go to Mr. and Mrs. Edward Rafter, and family, who provided a home for me while I was carrying out my research in Vermont. It is never easy being away from home for an extended period of time, but the friendship provided by Peggy, Ed, John, Susan, Meg, Ray, and Lisa is something I will carry with me for many years. Their interest in my work was a sustaining influence throughout my two summers in Fair Haven.

To the residents of Rutland County, Vermont, and Washington County, New York who gave me permission to trap in their fields and forests, I express my gratitude.

To Steven Freeh, David Feldman, and Norie Freedman I owe more than a simple "thank you". They are responsible in no small way for helping me maintain my sanity during the three years of field work and writing. More than colleagues, they have been true and interesting friends.

I am grateful to Mrs. John J. Christian for helping me set up arrangements for my first summer in Vermont, and for the generous use of a field vehicle. Without this assistance, my work would have much less enjoyable.

My committee has been patient throughout the many drafts of this dissertation, and I appreciate their constructive comments and the availability of their help. Dr. Donald Coates enabled me to gain a working knowledge of geomorphology and the interaction

of mammals and their environment. Dr. Stuart Landry was especially helpful with respect to the style and cohesiveness of the thesis. Dr. Richard Burright helped me revise the statistical methods employed throughout my work.

I cannot properly express my gratitude to Dr. John J.Christian for his help and friendship during my four years at SUNY-Binghamton. His high standards and devotion to detail are in large part responsible for any success I have, or will attain in the field of mammalogy. The chance to study with Dr. Christian has been one of the outstanding events in my career.

For Gail, whose help, understanding, and devotion has enabled me to successfully complete this work.

Table of Contents

List of Tables

List of Figures

List of Appendices

Introduction

I. Statement of the Problem

A comprehensive examination of habitat requirements is a necessary component of most studies of small mammals, such as mice, voles, shrews, and moles. An accurate and complete survey of an animal's habitat should consider bedrock and surficial geology, edaphic characteristics, pertinent geomorphic features, successional (seral) stages, and other biological characteristics. These are the factors that influence an animal's evolutionary development, its adaptation to the environment, and affect the features and changes in the ecosystem.

Previous trapping in the slate belt, including both Rutland County, Vermont, and Washington County, New York, has indicated a relative paucity of small mammalian species. There are also rather low population levels of those mammals present when compared to other regions in Vermont and nearby states. The bedrock and soils of the area present unique problems to burrowing species since most of the soils are very heavy and filled with small slate chips. The mice, voles, shrews, and moles of the region are clearly confronted with the lack of a well developed soil humus layer. The evolution of the soils from the slate bedrock seems to be the key to understanding the problem of species exclusion from the region.

The small mammals of the slate belt must adapt to unique combinations of soil and bedrock conditions, as well as to

large scale vegetational shifts caused by intensive sheep raising during the 19th century. I have attempted to identify the precise reasons for, and processes involved in, the exclusion of small mammals from the slate belt region through statistical correlations of trapping and habitat data.

II. Physical Setting

The slate belt region of western Rutland County, Vermont, and eastern Washington County, New York, covers approximately 320 square miles between the Taconic Mountains on the east and the Hudson River, Lake Champlain, and the connecting Hudson-Champlain Valley on the west (Dale, 1899). The southern boundary of the study area is the Town of Middletown Springs, Vermont, while the Towns of Benson and Hubbardton, Vermont, delimit the northern boundary.

Physiographically, Vermont may be divided into five major and one minor topographic section: the Champlain Lowland, Taconic Mounatins, Vermont Valley, Green Mountains, Vermont Piedmont, and Northeastern Highlands (Stewart and MacClintock, 1969). Trapping sites occurred in the Champlain Lowland, Taconic Mountains, Vermont Valley, and their New York State extensions. The Champlain Lowland has generally smooth relief, broken by low hills and ridges with gentle sloping sides. The Taconic Mountains are characterized by irregular relief, with steep sides and multidirectional spurs. Drumlins and drumlinoid hills are common in the Vermont Valley, as are low, smoothly rounded and rolling ridges. Drainage is via the Poultney and Mettawee Rivers,

and smaller streams into Lake Champlain, and via Otter Creek, which drains the southern part of the Champlain Lowland (Dale, 1899).

Trap-sites were located within an 11 mile radius around the Village of Fair Haven, Town of Fair Haven, Rutland County, Vermont, near the southern tip of Lake Champlain (Table 2; Figure 3). Specifically, sites were located in the Towns of West Haven, Fair Haven, Hubbardton, Castleton, Poultney, Middletown Springs, Sudbury, and Ira, Rutland County, Vermont, and the Towns of Hampton and Whitehall, Washington County, New York. Specific trap-sites were located with the aid of U.S. Geological Survey 1:24000 topographic maps.

III. Historical Background

An early account of the natural history of Vermont was published by Thompson (1853), in which he wrote that "the soil of Vermont is generally a rich loam, but varies considerably according to the nature and compositions of the rocks in the different parts of the state". The *intervale*, or alluvial deposits, were deep and fertile, and supported a heavy growth of oak and buttonwood (in the east), plus butternut, elm, walnut, ash, and other species throughout the state. Back from these alluvial flats were slight elevations covered with white pine. The land continued to rise gently, and although the soils became more gravelly, the fertility was little diminished. Vegetation was principally sugar maple, beech, birch, ash, elm, butternut, cherry, hornbeam, spruce, and hemlock. Where the

land rose into mountains, the timber was spruce, hemlock, and fir. The land was stated to be free from stone and easy to cultivate.

In the early 1800's Merino sheep were introduced into New England from Spain, and by 1830 the total wool clipping in Vermont was worth $1.2 million (Wilson, 1963). The price of wool had increased to $.57 per pound by 1835, and concurrently, the numbers of other livestock decreased. From 1832 through 1837, cows decreased by 28,000, and yokes of oxen by 13,000. The center of sheep raising was Addison County, where in 1840 there were 370 sheep per square mile; just to the south, Rutland County was the third largest sheep raising county, with 283 sheep per square mile (Wentworth, 1948). The industry reached its climax in 1840, when there were 1,681,000 sheep in Vermont; 271,727 of these were in Rutland County alone (Thompson, 1853; Wilson, 1963). By 1870, the sheep population was reduced by 50 % because of the inability to meet competition from the western United States, Australia, and South America (Wilson, 1963).

The collapse of the sheep industry led to farm abandonment and reforestation of areas which had been denuded to facilitate grazing (Wilson, 1963). In 1850, Rutland County had 444,916 acres of improved and unimproved farms; by 1964, the figure was 260,115 acres, and in 1969 only 196,857 acres were farmed. This represents a 42 % reduction in farmed acres in 119 years (U.S. Agric. Ext. Serv. and U.S. Dept. of Commerce, Bureau of the Census). By no means has the majority of abandoned farm

acreage returned to a mature forested state. Much of it is in the initial stages of old-field succession. Howver, large areas of second-growth hardwoods are again beginning to interconnect the older stands of trees.

Both Rutland County, Vermont, and Washington County, New York, are in the hemlock-white pine-northern hardwoods region of Braun (1950). Rutland and Washington Counties are in the New England Section, and second-growth stands of hardwoods occupy abandoned fields, cut-over, and cleared forest lands. White pine is especially common in areas of old-field succession, with hemlock preferring northerly and moist slopes (Braun, 1950).

Vermont was glaciated during the Pleistocene Epoch, and glacial erosion removed the preglacial rock mantle and planed off the outer few feet of the bedrock (Stewart, 1961). Glacial drift varies in thickness from place to place, and is very thin in most areas of the slate belt. One of the few till exposures is a 21.3 m road cut on the north side of U.S. Route 4, 0.8 km east of West Rutland (Stewart and MacClintock, 1969).

IV. Bedrock-A Historical Review

Dale (1899) compiled one of the first comprehensive treatises concerned with the Vermont-New York slate belt. His nomenclature and chronology have been revised, as have some of his estimates of the thickness of the various formations of the Taconic stratigraphic series. Zen provides a framework and review for a modern interpretation of the emplacement and structure of the Taconic allochthon, and this discussion will follow closely

his interpretations (Zen, 1961; 1964a; 1964b; 1967; 1968; 1972).

The term *Taconic allochthon* is applied to rocks between the two limbs of the Middlebury synclinorium of western Vermont and eastern New York. The rocks range in age from Cambrian to Early and Middle Ordovician. Several independent thrust slices are represented in the allochthon, including the Sunset Lake slice, Giddings Brook slice, and Bird Mountain slice (from lowest to highest). Complex internal deformities which evolved in two stages occur in each slice. The emplacement of the slices resulted in large scale recumbent folds and thrusts, while a second deformation of the allochthon occurred synchronously with the deformation of the Middlebury synclinorium.

Diastrophic events that began in early Middle Ordovician were responsible for the emplacement of the Taconic allochthon. Longitudinal folds occurred in what would develop into the east limb of the Middlebury synclinorium. The Berkshire-Green Mountain site of the Taconic deposition was uplifted, and unconformities resulted from simultaneous deposition and erosion. Continued and increased uplift resulted in large scale westward submarine sliding of the Taconic rocks, probably as surficial layer gravity slides. A conservative estimate of 40 km is suggested as the traversed distance of the emplaced slices. Rocks of the Taconic sequence are now nested within the Middlebury synclinorium and the different nature of the rocks is outstanding. The Synclinorium rocks are Early Cambrian to Middle Ordovician orthoquartzite and

carbonate. By contrast, the Taconic rocks are largely slate and phyllite of the same age, but rest everywhere with pseudoconformity on the Middle Ordovician Ira Formation of the Synclinorium sequence. Since the Taconic sequence, or klippe, was emplaced as a series of thrust slices, the sequence is now probably inverted.

V. Bedrock-Stratigraphy

The following discussion of the Taconic and Synclinorium stratigraphy follows Zen (1961; 1964a), and will describe each formation within the Taconic sequence, and appropriate formations in the Synclinorium sequence. Only bedrock formations containing trap-sites are described.

A. *Biddie Knob Formation*

This is the Berkshire Schist and Cambrian Roofing Slate of Dale (1899), and is the oldest formation of the Taconic sequence. The formation is a purple or green chloritoid-bearing phyllite and slate, with minor quartzite beds. The approximate thickness of the formation is 152 m, and is dated as Early Cambrian due to its conformity with the overlying Bull Formation. No fossils have been found in the Biddie Knob Formation.

B. *Bull Formation*

This formation includes the units above the Biddie Knob Formation and below the overlying West Castleton Formation. The dominant unit, the Mettawee Slate Facies, serves as a matrix for the other members, which include the Bomoseen Graywacke, the Zion Hill Quartzite and Graywacke, the Mudd Pond Quartzite, and the North Brittain Conglomerate.

The Mettawee Facies is a purple or green fine-grained slate west of the Taconic Mountains, but is metamorphosed to a phyllite in the eastern slate belt. Choritoid is absent, but discontinuous quartzite layers are often randomly present.

The Bomoseen Graywacke is the Cambrian Olive Grit of Dale (1899). It is a massive olive-gray, fine-grained graywacke, with flakes of mica apparent on fresh surfaces. The more typical weathered appearance is white or brick-red. Bedding is rare, and cleavage poor. West of Glen Lake, the Bomoseen member is stratigraphically below the Zion Hill member; east of this location, the opposite is true (Figure 3). The two lithofacies probably cross each other.

The Zion Hill Quartzite and Graywacke is the Ferruginous Quartzite of Dale (1899), and is a medium to coarse-grained quartzite or graywacke. It is a discontinuous unit generally found near the base of the Mettawee Slate. Slate, quartz, feldspar, and mica fragments are often present, and are commonly less than one-half centimeter across. The base of the rock is often a conglomerate. Since the Zion Hill may represent channel fills, the different areas of this unit may not represent precise time equivalents.

The Mudd Pond Quartzite is near the top of the Bull Formation, and is medium-grained, vitreous, and white to pale green. This member is rare west of the Bird Mountain thrust fault.

The North Brittain Conglomerate is a poorly sorted limestone-pebble, slate matrix conglomerate at or near the top of the

Bull Formation. The pebbles are usually deformed, and weather to a buff or pale to deep gray color.

The constituent units of the Bull Formation vary greatly in thickness from location to location, as well as when compared to each other. The total thickness of this Early Cambrian formation is between 300 and 600 m.

C. *West Castleton Formation*

This Early Cambrian black and gray slate unit overlies the Bull Formation, and is approximately 150 m thick. Observable bedding is rare. The slate weathers into low, rounded hills, and weathered surfaces are dull gray or rusty to reddish-colored. The West Castleton Formation is not common east of the Bird Mountain thrust fault.

D. *Mount Hamilton Group*

This Late Cambrian to Early and Middle Ordovician group of rocks contains the Hatch Hill Formation, Poultney Slate, and Indian River Slate. The Hatch Hill Formation is approximately 30 m thick and consists of rusty-weathering slates interbedded with rotten-weathering bluish dolomitic sandstones. The Poultney Slate is a fine-grained gray, green, or motley-colored argillite about 183 m thick that weathers dull white. Thin (1.2 to 15.2 cm) quartzite beds are common and interlaminate with the slate. The Indian River Slate is red, merging into maroon, and is often associated with thin green quartzite seams.

E. *Pawlet Formation*

This formation is a gray to black slate and graywacke

of Middle Ordovician age. It is approximately 152 m thick, and of two intergrading types: silty and gray, or black, soft, fissile, and locally graphitic. The graywacke is gray when fresh and weathers to dull gray or light grayish-brown. Included in the formation are chips and fragments of angular slate and quartz. The graywacke is often bedded, and ranges from a few centimeters to 1.8 m in thickness.

F. *The Synclinorium Sequence*

The Chipman and Hortonville Formations were the only stratigraphic units trapped on the Synclinorium sequence. Four formerly independent units are now included in the Chipman Formation: the Bridport Dolostone; the Beldens Formation; The Weybridge Member of the Beldens; and the Burchards Formation.

Two trap-sites were on the Beldens Member. It is a snow white to pink marble, and aggregates of chlorite and actinolite impart green streaks. Dolostone beds are common, and weather to a buff color. The Chipman Formation is, in all, about 90 m thick, and of Early Ordovician age.

The Hortonville Slate, which occurs west of the Taconic Mountains, is correlated with the Ira Formation, which is found east of the same mountains. It is a black slate and phyllite unit, approximately 152 m thick, and of Mid-Ordovician age.

VI. Soils

The lithology of the Taconic bedrock is largely responsible for the type of soil development in the slate belt. Shallow soils filled with both large and small slate fragments have been derived from the glaciated slates and shales of the bedrock.

The dominant soil associations include the *Dutchess, Nassau,* and to a lesser extent, *Cossayuna*. Various alluvial soil associations, though common, do not cover extensive areas. The following discussion follows Latimer, et al., (1930), and data published by the U. S. D. A. Soil Conservation Service (1973), and illustrates that each individual soil unit has unique characteristics. However, most of the non-alluvial soil profiles are unified by the presence of the previously mentioned slate fragments, and a greater or lesser degree of podzolization.

Typically, the soils of the slate belt have developed to a depth of less than 0.6 m. The members of the Gray-Brown Podzolic soil province typically lack a well developed humus layer, and instead, raw organic material is found in the surface layer.

A. *Dutchess Soils*

Dutchess loam is common around mountain bases in the slate belt. Site 17 illustrates this type of placement (Tables 1,2; Figure 3). The surface soil is brown, changing to yellowish-brown at a depth of approximately 25.4 cm, while at 50.0 to 60.0 cm, greenish-yellow or greenish-gray compact till is found. Small amounts of quartz are found mixed with the slate fragments in the till; the till itself can exceed 3.0 m in depth. Permeability is moderate, available moisture capacity is medium, and the soil is acid throughout. Dutchess stony loam occupies steeper land than Dutchess loam, and cultivation is hindered by the quartz and sandstone cobbles and pebbles present throughout the profile.

The soil at site 20, Mount Hamilton, is illustrative of the stony loam (Tables 2, 3).

B. *Nassau Soils*

Soils of the Nassau association occupy the largest area in and adjacent to the Taconic Mountains. Nassau slate loam contains a large quantity of small slate chips, and merges with slate bedrock at a depth of 60.0 to 80.5 cm. Drainage is somewhat excessive. A typical Nassau profile has a 12.0 to 18.0 cm brown surface layer which rests on a yellowish-brown loam layer, and eventually grades into partially disintegrated parent material. Due to the steep slopes exposed by erosion, site 29 illustrates these characteristics well (Tables 2, 3; Figure 3). Nassau stony loam contains larger fragments of slate than the slate loam, and also has a significant amount of quartz. Bedrock outcrops are especially common in the stony loam, as illustrated at site 13 (Tables 2, 3; Figure 3). The Nassau rock outcrop soil is extremely rocky, and somewhat excessively drained. Bedrock outcrops are closely spaced. Most of the Nassau soils are in pasture and forest.

C. *Cossayuna Soils*

The coloring of Cossayuna loam is similar to that of the Dutchess soils, but it differs in its mineral constituency. Limestone boulders provide lime material to the surface soil; bedrock may be sandstone (graywacke). Cossayuna loam generally presents smooth relief and excellent drainage. Site 52, near Glen Lake, was notable for its gentle relief (Tables 2, 3; Figure 3).

D. *Suffield Soils*

Suffield silt loam is an alluvial noncalcareous soil developed from clays. A 20.0 to 25.0 cm surface layer rich in silt grades through a silt loam to a greenish-yellow or greenish-gray clay at a depth of 50.0 to 76.0 cm. The main accumulations of this soil have been developed on the outer edge of the ancient Champlain Sea. Site 35, a slope in the Village of Fair Haven, Vermont, was on the Suffield silt loam, and adjacent gardens testified to the ease of cultivation of the marine soil (Tables 2, 3; Figure 3).

E. *Adams Soils*

Adams loamy fine sand is a uniform loamy fine sand to a depth of about 2.4 m, where it rests on a clay bed. The surface soil is dark brown, and surface relief is level. The moisture holding capacity is good due to the clay base.

F. *Stockbridge Soils*

Stockbridge loam has a dark brown surface soil underlain by a yellowish-brown friable loam, and a substratum of compact greenish-gray calcareous till. Slate gravel is found throughout the profile. Near Castleton, calcareous slate is the dominant parent material. The soil occupies drumlins or drumlinoid-shaped low hills, and is closely associated with the Dutchess soils. Slate gravel was present in places at site 47, but little indication of calcareous conditions, e.g. plant indicator species, could be discerned (Tables 2, 3; Figure 3).

G. *Copake Soils*

Copake gravelly fine sandy loam has developed from material washed from slate. The surface soil is brown, and eventually grades into mixed yellow and gray gravel and sand. Gravel is often present above 38.0 to 46.0 cm, but is more common below this depth. Quartz is the major constituent of the surface gravel. Surface gravel was not present at site 50, but did appear deeper in the profile (Tables 2, 3; Figure 3). Permeability is veryrapid in this soil's gravelly sandy underlying material, resulting in somewhat excessive drainage.

H. *Schodack Soils*

Schodack gravelly fine sandy loam is developed from outwash; slate is the dominant material. Surface soil is brown, and due to kame-like surface relief, the drainage is good. Surface and subsurface layers have large amounts of gravel, which increases with depth. There is calcareous shale and limestone below a depth of about 1.8 to 2.4 m.

I. *Hadley Soils*

Hadley silt loam is an alluvial soil with a dark yellowish-brown surface soil and greenish-yellow or olive-colored subsurface layer. The moisture holding capacity is large, and the soil is well drained. The Hadley soils are among the most productive in Vermont. Extensive hay crops were raised on this productive soil at site 45 (Tables 2, 3; Figure 3).

J. *Bernardston Soils*

Bernardston loams are common on gently sloping hills and benches along the base of mountains. The substratum is till, and slate fragments and quartz gravel occur throughout the profile. Permeability is moderate above the till, and low within the compact layer.

K. *Windsor Soils*

Windsor soils formed on terraces along rivers and streams, and are somewhat excessively drained. These sandy and gravelly soils are generally low in lime. Part of site 1 was on this soil, and illustrates the formation of the soil on the floodplain of the Castleton River (Tables 2, 3; Figure 3).

L. *Pittstown Soils*

Pittstown soils are well to moderately well drained, loamy to silty, medium in lime, and usually have a hardpan. They are found on slate uplands. Site 38 was typical of a slate upland, with its extensive outcrops (Tables 2, 3; Figure 3).

M. *Nellis Soils*

Nellis soils are similar to those of the Pittstown association, but higher in lime due to their position om limestone uplands. Site 41 was not in the slate belt proper, but part of the Synclinorium sequence. The site revealed areas of marble outcrop, and a large stand of arborvitae testified to the amount of lime present in the soil (Tables 2, 3; Figure 3).

N. *Rough stony land*

Large areas classified as rough stony land still remain.

About 95 % is still forest covered, and most has a thin layer of glacial till. The character of the soil reflects the parent bedrock. A separate mountain phase includes land with no probable commercial forest or crop potential.

O. *Muck and Peat*

Local areas of muck and peat also occur. Muck is shallow, usually less than 0.9 m in depth, and is a mixture of brown organic material and mineral soil material. Peat is deeper, and consists of brown fibrous partly digested organic matter. Alder and red maple usually dominate muck associations, and spruce cover peat associations, as may be seen at site 4, the Fair Haven Cedar Bog (Tables 2, 3; Figure 3).

Methods and Materials

Trap-sites were chosen on the basis of three key characteristics:

1. type of bedrock
2. type of soil
3. Type of forest and/or grassland association, including slope.

An effort was made to maximize the different types of habitats containing different combinations of the three characteristics. This was not always possible, since all types of bedrock, soil, and habitat type combinations do not occur. Prior to trapping, U. S. Geological Survey 1:24000 topographic maps, of the 7 1/2 minute series, were consulted in order to plan the specific trap-sites.

Habitats were subdivided into five main categories:

1. streamside
2. steep forested slopes
3. gentle to moderate forested slopes
4. pasture and old-field associations
5. bog.

These habitat types were further categorized by the type of cover present at each trap:

1. rocky cover or outcrops
2. holes
3. logs or roots
4. litter
5. tree bases

The exact type of cover present was recorded at the time each trap was set.

Victor snap traps (9.8x4.7x0.5 cm) were set approximately 3.0 to 4.0 m apart, and baited with peanut butter. Rarely, oats were used as bait to discourage raccoon damage to the traps. One trap-site (35; Tables 1, 2, 3; Figure 3) utilized *Sherman* live traps (23.0x7.6x7.6 cm) set at the same distance intervals as the snap traps. Site 35 was utilized to live trap *Peromyscus leucopus noveboracensis*. Traps were set at the apparent optimal location within the 3.0 to 4.0 m interval. This was often a tree base, root, along an outcrop, or in a run beneath the litter. Runs were always sought in pasture and old-field associations. Traps were set between 1400 and 1600 hours, and checked the

following two mornings between 0800 and 1000 hours. Traps were rebaited if necessary. Trapping took place 11 June through 20 August, and 12 and 13 October, 1974, and 17 June through 22 July, 1975.

Trapped animals were weighed and measured; they were then autopsied for gross pathology. Skulls were removed and tagged, while carcasses were stored in 10 % buffered formalin. One hundred and fifteen voucher specimens were prepared, and along with 165 skulls, are in the collection of Dr. John J. Christian, State University of New York, Binghamton, New York 13901.

A survey of flora was undertaken to determine the types of plants providing canopy and ground cover at each site (Appendix 2). Circular plots encompassing 0.2 acre were located at intervals of 1.0 or 2.5 chains (1 chain=20.2 m) along each trap-line (Avery, 1967). Each species of tree present was catalogued, and dominance was determined by numerical superiority. Within each 0.2 acre circular plot was randomly located a 1.0 m^2 plot; each species of plant present was also catalogued, and the percentage of cover it provided was estimated. The number of plots per trap-line depended on the length of the line, and on the homogeneity of plant species present.

The angle of inclination of slopes was determined with an Abney level. A Biltmore stick was used to estimate tree height, and tree calipers and a Biltmore stick were used to determine the diameter breast height (d. b. h.) of the trees in the trap-line.

Samples of bedrock were collected from the various trapsites, and were examined to verify the published accounts of bedrock distribution. These specimens are now in the possession of Dr. John J. Christian.

Site Descriptions

The present forest composition of the slate belt is a mixture of second growth hardwoods and white pine, with stands of hemlock in appropriate damp sloping habitats. Sugar maple is the dominant hardwood. However, the forest composition has been dramatically altered since the pre-settlement era. Data from northern Vermont (Siccama, 1971), and similar ecological settings in the Catskill region of New York State (McIntosh, 1972) indicates a significant shift in forest species dominance since 1800. The dominance of beech and hemlock have decreased , while younger sugar maple is now most abundant. In northern Vermont (Chittenden County, approximately 131 km north of the slate belt research area), beech and maple originally (pre-settlement era) constituted 50 % of the forest species present, and beech outnumbered maple by a 4:1 ratio. In 1962, only 15 % to 20 % of sample stands contained enough beech to justify including that species in a named association (Siccama, 1971). The dominance of hemlock is also not as great as in 1800. In the Catskills this is largely due to a once thriving tanning industry. In Vermont the answer is not as simple. It has been proposed that hemlock is not a climax species, and only

persists where favored by local conditions, such as cool moist slopes and ravines (McIntosh, 1972). The latter appears to be the case in the slate belt.

It will be shown that the soil type and development is intimately associated with the small mammals' habitat at each trap-site. Most of the soils in the slate belt are rocky, and rarely is there any extensive development of the soil profile. These factors, combined with (and due to) the devastating effect of sheep grazing, have resulted in a unique series of habitats. By the late 19th century, the ecosystem had been forced into a relatively immature stage, and nowhere have stream and slope habitats evolved into complex environments sufficiently diverse to support a large and varied population of small mammals.

Each site trapped has been described in detail in Appendix 1. The following overview of the trap-sites provides a synopsis of the five habitat categories, and a point of reference for discussing the results. The detailed ground cover analysis for three of the habitats is presented in tables 12a, 12b, and 12c. An effort will be made to present the special features of each composite habitat, as well as a graphic description of the habitat.

I. Composite Streamside Habitat

A streamside habitat in Vermont is refreshing in its solitude, and simple in its composition. A typical streamside habitat has low, but sometimes broad, banks of alluvium. Litter cover is reduced adjacent to the stream, with outcrops, loose rocks, and tree bases providing the bulk of the cover for small mammals.

canopy trees are primarily of second or even third growth, the majority of which are less than 15.2 cm d. b. h. Dominant trees included yellow birch (*Betula alleghaniensis*), hemlock (*Tsuga canadensis*), white ash (*Fraxinus americana*), and eastern hophornbeam *Ostrya virginiana*). Of these, hemlock are the largest, but they are usually dispersed throughout the other species. The alluvium grades into typical slate-derived soil with abundant surface slate chips. Understory species were not abundant immediatley adjacent to the stream, but increased in density at a distance of usually 3.0 m or less. A typical assemblage includes white ash seedlings, large-flowered trillium (*Trillium grandiflorum*), false Solomon's seal (*Smilacena racemosa*), leafy liverwort (*Ptilidium pulchrinum*), scaly liverwort (*Porella platyphylloides*), running evergreen (*Lycopodium complanatum*), false lily-of-the-valley (*Maianthemum canadense*), and spring spikemoss (*Selaginella rupestris*).

The rate of streamflow is almost always rapid enough to preclude the formation of stagnant algae-choked pools. The stream width varies from 1.0 to 3.0 m, usually with a shallow depth of no more than 10.0 cm. The narrow width, rapid flow, and shallow depth gives the impression that little animal life might be supported in the stream, and closer examination reveals this to be probably true. no crayfish, salamanders, or frogs were observed, and only a few species of fish (Cyprinidae) were seen. Sterile is too harsh a term to use to describe the streamside habitat, but it is impoverished with respect to the amount of vegetation and diversity of species, both plant and animal (Figure 2).

Exceptions to this composite model occur at various localities. The stream at site 27 (Tables 2, 3; Figure 3) was one of the least consistent, in that its speed varied from a fast flow over an exposed bed of Mettawee Slate to seepage through a mud and litter-choked bed. The stream at site 40 is more than 8.0 m wide, while the width of the stream at site 2 averages only 0.5 m wide (Tables 2, 3; Figure 3).

Some of the streams are contained in steep-walled gorges (sites 7, 17; Figure 1) with only minimal floodplains. In contrast, the area around site 16 had recently been storm-damaged, as evidenced by the blow-down of many medium and large trees. Extensive areas of mud existed at some distance from the stream (Tables 2, 3; Figure 3).

The sandy floodplain of the Poultney River (site 8; Tables 2, 3; Figure 3) contains vegetative associations which differ from the other streamside habitats. The dominant streamside canopy species include American sycamore (*Plantanus occidentalis*), quaking aspen (*Populus tremuloides*), sandbar willow (*Salix interior*), and staghorn sumac (*Rhus typhina*). The patchy ground cover consists of purple-flowering raspberry (*Rubus odoratus*), barren strawberry (*Waldsteinia fragaroides*), common milkweed (*Asclepsias syriaca*), common horsetail (*Equisetum arvense*), common plantain (*Plantago major*), black medick (*Medicago lupulina*), orchard grass (*Dactylis glomerata*), and quack grass (*Agropyron repens*). The floodplain is bordered by massive outcrops of West Castleton Slate.

II. Composite Steep Forested Slope Habitat

Forest slopes are subdivided on the basis of degree of inclination. Slopes 35^{0} or more from horizontal are designated *steep*. On the steep slopes, exposed slate chips often give way underfoot.

Tree bases provide the largest single source of trap locations, with the next most heavily trapped small mammal cover being outcrops. Common tree associations (each listed in order of dominance) include: sugar maple (*Acer saccharum*) and hemlock; sugar maple, paper birch (*Betula papyrifera*), and American elm (*Ulmus americana*); American hornbeam (*Carpinus caroliniana*), American beech (*Fagus grandifolia*), eastern hophornbeam, and shagbark hickory (*Carya ovata*); and paper birch, hemlock, sugar maple, yellow birch, and shagbark hickory. White pine (*Pinus strobus*) and hemlock often occur in evenly-spaced homogeneous stands, or jointly as co-dominants, but as such, are on different parts of the same trap-site.

Rarely on a steep slope does one get the impression of being surrounded by a closed canopy. Second growth trees are the rule, and most of these are very young, but any species may be represented by a large, older individual (e.g., d. b. h. $\geq$ 30.5 cm, and 15.2 to 18.3 m in height). Hemlock was often represented by saplings as well as mature (100+ years old) specimens.

Amount of litter cover varies from site to site, and is affected by the degree of slope and species in the canopy. On slopes dominated by white pine and hemlock, the litter of needles is compact, and reaches a maximum thickness of approximately 10.0 cm. Earthworms are rarely seen on the surfaces of the slate-

derived soils, and never on the more acid soils such as those with a predominantly needle litter. Hardwood litter is less compact due to curling and bending of leaves, and does not reach the depth of the deposits of needles. Steep slopes with a predominantly deciduous canopy are often partially denuded of litter by rain runoff, wind action, and gravity.

Since type of ground cover does not vary significantly with the angle of slope except in quantity (greater coverage on the gentler slopes), its species composition will be listed in the following section.

III. Composite Gentle to Moderate Forested Slope Habitat

Slopes less than 35^{o} from horizontal are judged *gentle to moderate*. Canopy associations are similar to those found on steep slopes, and again, tree bases and outcrops provide the best trap locations. In addition to the previously mentioned assemblages, there are associations of hemlock, white pine, and arborvitae (*Thuja occidentalis*); white pine and red maple (*Acer rubrum*); white pine and sugar maple; sugar maple and hophornbeam; and American elm and American beech.

Owing to the gentler slope, there is less water action, and subsequently a deeper deciduous litter layer than on steep slopes. Outcrops were often blocky and bench-like, and could provide protected runs for small mammals. The canopy often is closed, even though the trees were dominantly small to medium in size. Sugar maple especially grows in dense stands, often associated

with one or two large (d. b. h. $\geq$ 25.0 cm) paper birch. The very gentle slopes are a monotonous collection of young trees (d. b. h. $\leq$ 5.0 cm), loose litter, and widely spaced low outcrops. There is so little soil profile development, that few opportunities exist for small mammal harborage. In contrast to the steep slopes, there are fewer trap locations to be found adjacent to roots and logs. This is probably due to the ease with which logs can be removed from the gentler slopes during clearcutting. Some of the larger trees not removed from the steeper slopes eventually fell and now provide good cover.

Species providing ground cover are numerous, but encompass only a small percentage of actual cover when compared to the litter layer. Seedlings of the various canopy species are numerous, as are ferns, which included (in a general descending order of prevalence) woodfern (*Dryopteris* sp.), Christmas fern (*Polystichum acrostichoides*), oakfern (*Dryopteris disjuncta*), sensitive fern (*Onoclea sensibilis*), and royal fern (*Osmunda regalis*). Less common ferns include New York fern (*Thelypteris noveboracensis*), marsh fern (*T. pubescens*), bracken fern (*Pteridium aquilinum*), and resurrection fern (*Polypodium polypodioides*).

Other species in the understory occur in discontinuous patches, and include fern moss (*Thuidium delicatulum*), stiff club-moss (*Lycopodium annotinum*), running evergreen, common juniper (*Juniperus communis*), Indian cucumber-root (*Medeola virginiana*), lily (*Lillium* sp.), field garlic (*Allium vineale*), Solomon's seal (*Polygonatum biflorum*), wild ginger (*Asarum canadense*),

red baneberry (*Actaea rubra*), goldthread (*Coptis groelandica*), may apple (*Podophyllum peltatum*), herb-Robert (*Geranium robertianum*), plae touch-me-not (*Impatiens pallida*), Virginia creeper (*Parthenocissus* sp.), violet (*Viola* sp.), blueberry (*Vaccinium* sp.), wintergreen (*Gaultheria procumbens*), partridgeberry (*Mitchella repens*), common elderberry (*Sambucus canadensis*), and aster (*Aster* sp.).

IV. Composite Pasture/Old-field Association

Pasture and old-field associations are grouped together since they provide grassy or grass-like cover. Old-field associations are more diverse with respect to the number and height of the species present, as compared to areas being more or less actively grazed. Trapping in actively grazed pastures was limited to the taller vegetation at the pasture edge, since little was to be gained from trapping in very short ($\leq$ 3.0 cm) grass. Trap-sites in this habitat also include the pasture-like areas surrounding the trees in two apple orchards.

Pastures and old-field associations are by no means rock and outcrop-free. The areas with the least rocky profiles are under crop or hay cultivation. An area supporting a lush growth of vegetation at eye level would be revealed to provide sparse coverage at the base of the stems. The lack of a well developed humus layer and the shallowness of the soil profile also generally results in a paucity of earthworms and arthropods.

The pasture habitats are generally dry, and contain white clover (*Trfolium repens*), red clover (*T. pratense*), common dandelion (*Taraxacum officinale*), wild oats (*Uvularia sessilifolia*),

orchard grass, quack grass, reed canary grass (*Phalaris arundinacea*), and cheat (*Bromus secalinus*). Site 49 (Tables 2, 3; Figure 3) is a damp, partially grazed willow-witch hazel pasture and includes more old-field elements, including daisy fleabane (*Erigeron annus*), fringed loosestrife (*Lysimachia ciliata*), tall meadow rue (*Thalictrum polygamum*), goldenrod (*Solidago* sp.), and sensitive fern. Site 50 (Tables 2, 3; Figure 3) is a wet field dominated by cattails (*Typha latifolia*), most of which exceed 1.5 m in height.

Other common pasture and old-field species, in various combinations include iris (*Iris versicolor*) in marshy areas, thistle (*Cirsium* sp.), cowslip (*Caltha palustris*), common buttercup (*Ranunculus bulbosa*), field mustard (*brassica rappa*), bramble (*Rubus* sp.), black medick, cow vetch (*Vicia cracca*), wild grape vine (*Vitis* sp.), hedge-bindweed (*Convolvulus sepium*), maple-leaved viburnum (*Viburnum acerifolium*), common chickweed (*Stellaria media*), orange hawkweed (*Hieracium auranticum*), common ragweed (*Ambrosia artemisiifolia*), ox-eye daisy (*Chrysanthemum leucanthemum*), and common yarrow (*Achillea millefolium*).

V. Bog Habitat

The only true bog that was trapped contains the following tree species in about equal amounts: American yew (*Taxus canadensis*), arborvitae, hemlock, white pine, and balsam fir. Lesser amounts of paper birch and tamarack are also present. The litter is dominantly of needles, and often exceeds 7.5 cm in depth. Typical bog understory species are present, including bunchberry (*Cornus*

canadens), mint (*Mentha* sp.), pink ladyslipper (*Cypridium acaule*), cinammon fern (*Osmundus cinnamonea*), bracken fern, false lily-of-the-valley, goldthread, and Indian cucumber -root.

The canopy species are of medium size, (average d. b. h.= 15.0 cm), but many are dead. The litter is dominantly of needles, and very moist. The combination of an open canopy and few outcrops provides little cover for small mammals. Only numerous rotting logs provide adequate cover in the bog.

Results

Results of trapping and habitat comparisons are presented in Tables 1 through 5 and 7 through 11, and Figures 4 through 7. Ten species of small mammals were trapped in the slate belt and adjoining areas in 8880 trap-nights (one trap set for one night = one trap-night). This total includes 4630 first trap-nights (Table 1). The ten species trapped include *Peromyscus leucopus noveboracensis* (white-footed mouse), *Peromyscus maniculatus gracilis* (forest deermouse), *Sorex fumeus* (smoky shrew), *Blarina brevicauda* (short-tailed shrew), *Clethrionomys gapperi* (boreal or red-backed vole), *Microtus pennsylvanicus* (meadow vole), *Napaeozapus insignis* (woodland jumping mouse), *Zapus hudsonius* (meadow jumping mouse, *Condylura cristata* (star-nosed mole), and *Tamias striatus* (chipmunk).

Trapping was carried out during two consecutive summers, with nine areas retrapped the second summer. Only site 30, the outlet stream of High Pond, showed any appreciable difference the second summer. Whether due to increased logging near the pond,

or normal fluctuations, the normally southwest flowing stream was barely flowing the second summer. The streambed, however, was not dry, as there were many pools of standing water.

I. General Trends

The "expected" number of captures for any category is computed on a proportion basis, and is based on the assumption that a species is randomly distributed throughout the environment. The relationship of the number of captures to the number of trap-nights is then theoretically direct, e.g.

$$\text{Expected number of captures} = \frac{\text{Number of trap-nights associated with a specific soil type, bedrock, habitat, etc.}}{\text{Total number of trap-nights (always 8880)}} \times \text{Total capture of an individual species in this study}$$

The null hypothesis is that the number of captures expected is proportional to the number of traps set. Chi-square was used to test for significant departure from the null hypothesis.

For certain species (e.g. *Condylura cristata, Peromyscus maniculatus gracilis, Zapus hudsonius, and Napaeozapus insignis*), the total captures were so small that even though a chi-square test might indicate a statistically significant deviation from a random distribution, there was no biological significance in the results. Expected and actual captures of these species were so small that other factors, such as weather and visitation of the trap-site by raccoons, could have a large influence on the success of trapping the species.

Table 15 compares the yearly catches in terms of total captures per 1000 trap-nights, and Tables 7 through 11 present comparisons based on observed and expected captures of the small mammals. Chi-square analysis indicates there was a small,non-significant overall decrease in captures per 1000 trap-nights the second summer. Table 4 indicates the actual number of captures and captures per 1000 trap-nights for the various species trapped. Significantly fewer than expected captures of *P. l. noveboracensis* took place the second summer (X^2 = 5.48; 1 d.f.; p<.01). The second summer actual captures of *N. insignis* were greater than expected (X^2 = 5.94; 1 d.f.; p<.01), but the low numbers caught (Tables 1, 4) fail to make this biologically significant.

Captures were not uniform with regard to numbers or distribution (Table 1; Figures 4 through 7). *P. l. noveboracensis* was nearly ubiquitous, occurring in 32 of the 52 trap-sites. Both *C. gapperi N.insignis* exhibited a preference for the eastern half of the research area (east of Route 30; Figures 5, 7). This preference cannot be explained simply by the lack of individual habitats. An investigation of past and present land use and reforestation in the area will be explored as contributing to the non-random distribution of these species.

II. Individual Correlations

A. *Peromyscus leucopus noveboracensis*

The white-footed mouse was the most common species trapped, with 54 *P. l. noveboracensis* trapped in the eastern half of the research area (east of Route 30) in 4467 trap-nights (12.09

captures per 1000 trap-nights), and 40 trapped west of Route 30 in 4413 trap-nights (9.06 per 1000 trap-nights; Figure 7). Significantly more were caught east of Route 30 than west of it (X^2 = 3.92; 1 d.f.; $p<.05$).

P. l. noveboracensis occurred in all types of habitat except the bog habitat (Table 9). The bog was trapped, though not extensively, in two consecutive years. The white-footed mouse had, however, been taken in this bog in 1951 and 1952 (Christian, et al., unpublished). *P. l. noveboracensis* was not randomly distributed with respect to soil or bedrock (Tables 7, 8), but when habitat is analyzed concurrently with soil and bedrock features, some of the nonrandom distributions seem explainable.

B. *Peromyscus maniculatus gracilis*

Only 7 *P. m. gracilis* were trapped, and these captures encompassed only two types of bedrock: the Mettawee Slate, and the West Castleton Formation. However, the distribution of the forest deermouse with respect to bedrock is not as straightforward as it would seem. Previous trapping in the region (Christian, et al., unpublished) failed to capture *P. m. gracilis* west of Route 30, while 24 forest deermice were taken east of Route 30. *P. m. gracilis* was rarely taken in the same part of the trap-line as *P. l. noveboracensis* in the previous study. In the present study, the same trap at the forest-stream interface near Lewis Brook (site 37) took the white-footed mouse and forest deermouse on consecutive trap-nights.

C. *Sorex fumeus*

Bedrock apparently did not influence the distribution of the smoky shrew, but this species did occur with a significantly increased frequency on steep forested slopes (eight of the ten captures), particularly in conjunction with outcrops, logs, and roots (Tables 7, 9). Dutchess loam was associated with the steep forested slopes in three of the captures, while stony and rocky loams of the Nassau and Pittstown series were associated with four captures on steep slopes (Table 8).

D. *Blarina brevicauda*

The short-tailed shrew was the second most frequent species caught (29.3 % of the total). Sites with bedrock of Poultney Slate had significantly more captures than expected, but site 25, Bartholomew Hill, accounted for nearly all the success (Tables], 7; Figure 4). Muck and peat soil was preferred by *B. brevicauda,* while rough stony land was not (Table 8). Logs and roots provided significant cover for the short-tailed shrew, as did forest litter, especially on the steeper slopes (Tables 8, 10).

E. *Clethrionomys gapperi*

Only the Poultney Slate bedrock was deficient in catches of the red-backed vole, but most of the habitats found on this bedrock (e.g. sites 3, 25; Tables 2, 7) were lacking in the damp rocky substrate and rotting logs preferred by this vole (Gunderson, 1959). A significantly increased frequency of capture occurred on Dutchess, Cossayuna, and Schodack soils (Table 8).

Rocky substrate provided a large number of captures, especially on forested slopes; 53 % of the captures took place under these conditions. *C. gapperi* was caught less frequently than expected at traps set at tree bases in any habitat (Table 9).

F. *Napaeozapus insignis*

N, insignis occurred only in forested areas near running or standing water, even though the presence of water is not a requisite for the presence of this species (Wrigley, 1972). This species was essentially random in its distribution on the different soil and bedrock types in its preferred habitat (Peterson, 1966). Four capture sites (2, 7, 17, 39) were "gorges" to a greater or lesser degree, three of which (7, 17, 39) were steep-walled with rapidly flowing streams (Tables 1, 2; Figure 5).

G. Other species

Neither *Condylura cristata, Zapus hudsonius,* nor *Microtus pennsylvanicus* was caught in numbers large enough to permit statistical analysis. Each species is restricted to a specific habitat, and was captured in that preferred setting. The only star-nosed mole was taken on a sloping alluvial floodplain bordering a small brook. The single *Z. hudsonius* was trapped at a pasture-forest edge. Meadow vole numbers were much reduced from what might be expected, even though many old signs, e.g. runs and clippins, were prevalent. Captures occurred in a moist cattail field (site 30), and in unmowed grasses including alfalfa (*Medicago sativa*), sorrel (*Rumex acetosella*),

and orchard grass at Griffen's Apple Orchard (site 12).

The captures of *Tamias striatus* must be considered random and fortuitous, since the traps are generally too small to take this species unless it is hit directly on the head. It would be impossible to extrapolate presence or absence of this species based on this type of data.

Overall, steep forested slope habitats exhibited a statistically greater than expected number of captures (all species pooled), while pasture and old-field association captures on the same basis were significantly fewer than expected (Table 10). Distribution is nonrandom because many of the captured species, e.g. *P. l. noveboracensis*, *P. m. gracilis*, *S. fumeus*, *C. gapperi*, and *N. insignis* are not normal components of the grassland fauna.

Discussion

The findings will be analyzed in the following way:

1. The literature will be used to construct a synopsis of the distribution and habits of each species of small mammal caught in the slate belt.

2. The characteristics of the trap-sites on which the various species were caught in the slate belt will be compared to the published accounts and descriptions of habitats from other localities outside the slate belt.

3. Data from this, and the only other comprehensive survey of the region, beginning two decades earlier (Christian, et al., unpublished), will be compared and combined.

4. Animals adapted to the general climate, altitude, and flora of the slate belt, but not captured, will be described, and possible reasons for their exclusion will be presented.

General habitat descriptions follow Hall and Kelson (1959), Hamilton (1963), Burt and Grossenheider (1964), and Peterson (1966).

I. Soil Influence

The heavy slate-filled soils of the Nassau and Dutchess series dominate the areas trapped in Rutland County, Vermont, and Washington County, New York. Various Nassau soils occupy the steeper slopes and exhibit a poor topsoil, with excess shale and slate fragments present. Sand content is low. Most of the Nassau soils are excessivly drained and often only a small amount of soil moisture is available to plants. The shallow bedrock inhibits deepening of natural waterways as well as construction of artificial drainage systems. Dutchess soils occupy somewhat gentler slopes than the Nassau soils, and are the dominant soils of the region. The topsoil is stony, and the soil profile as a whole is well drained. This restricts the availability of moisture, and may be responsible to some degree for the reduction in the number of species present, and the relatively low absolute number of animals present in the area.

II. Vegetative Influence

While different plant species occur in different habitats, there is no indication that type of bedrock significantly affects the plant associations within a habitat type (Tables 12a, 12b, 12c). Litter covers the bulk of the plots sampled, and consistent

assemblages of ferns, herbs, wildflowers, and grasses recur over the entire area. While a few species of plants can be regarded as indicators of specific lithologies (e.g. ebony spleenwort and arborvitae indicate limestone), they occur in no clear pattern that would explain the absence of certain mammalian species, or the low numbers of animals (25.00 per 1000 trap-nights) trapped in the slate belt (Tables 6, 13).

III. Species of Small Mammals Trapped in the Slate Belt

A. *Peromyscus leucopus noveboracensis*

Peromyscus leucopus noveboracensis occurs in southern Ontario and Quebec, and ranges in a broad band into northern Kentucky. Controversy exists as to the type of forest and altitude the white-footed mouse prefers and inhabits. Klein (1970) found the climatic climax of the oak-chestnut forest in central New York State to be optimal for the white-footed mouse, while the plants of the hemlock-white pine-northern hardwoods region were avoided. The situation was different in southeastern Ontario, where upland forest (sugar maple, beech, hemlock, red maple, yellow birch, paper birch, American elm, and basswood) was preferred, while mixed and cedar-forest associations were avoided (Smith and Speller, 1970).

Mearns (1898) captured *P. l. noveboracensis* only below 609.6 m in the Catskill Mountains of New York State, and Osgood (1938a) reported that in Vermont this species was confined to altitudes under 365.0 m. However, Starrett and Starrett (1952) trapped adult white-footed mice at 1524.0 and 1890.0 m

on Mount Washington, in Coos County, New Hampshire. In the present study, white-footed mice were taken at the highest altitude trapped (site 27, 506.0 m ; Table 1; Figure 7), as well as at very low altitudes (site 24, 42.7 m; Table 1; Figure 7). A previous capture of *P. l. noveboracensis* was made in 1951 at 426.7 m in the nearby Green Mounatins (Christian, et al., unpublished).

P. l. noveboracensis was the most commonly trapped species in the slate belt, and overall was effectively randomly distributed with respect to soil, bedrock, and appropriate cover (Tables 7, 8, 9). The white-footed mouse did not avoid the vegetation of the hemlock-white pine-northern hardwoods association. However, fewer *P. l. noveboracensis* than expected by chance were trapped in pasture and old-field associations, but this is probably a sub-optimal habitat for this species (King, 1968). Since rocky, open streamsides also offer little protection for this species, it was not surprising that fewer captures (Chi-square analysis) were associated with this type of cover. Concommitant with the reduced number of streamside trees is the reduced probability of finding a thick litter layer within 2.0 m of the stream (Bell and Sipps, 1975). Chi-square analysis indicated no departure from a random distribution of *P. l. noveboracensis* on alluvial soil if all types of cover were pooled (Table 11), and this is probably due to the fact that the floodplain extends some distance from the stream, into the more densely forested areas adjacent to the stream.

White-footed mice were trapped with greater than expected frequency on rough stony land, and Dutchess loam and stony loam (Table 8). Trapping sites associated with rough stony land are mountain slopes (Bird and Herrick Mountains; Tables 1, 2, 8; Figures 3, 7),both having a reduced litter cover. The Herrick Mountain site is dominated by balsam fir, and the needle litter is largely devoid of any concentration of ground cover vegetation. On Bird Mountain, juvenile and adult mice were taken in the same traps on consecutive nights; the trapping, therefore, may have been of a family group from a circumscribed area. This may have resulted in an overestimation of the number of white-footed mice on rough stony land (Nicholson, 1941).

The greater than expected number of captures of *P. l. noveboracensis* on Dutchess soils can be explained by captures at site 17 (Tables 1, 2, 8; Figure 7): 12 of the 28 captures on the six sites with Dutchess soils were at this site. This site south of Belgo Road combines streamside, steep, and gentle to moderate forested slopes. Here, the overall capture of small mammals was relatively high for the slate belt region (27 captures in 370 trap-nights=73 captures per 1000 trap-nights; Tables 6, 13). Cover of outcrops and fallen logs is extensive, providing a diverse habitat and good harborage for small mammals. Yellow birch is a large component of the cover, in the form of fallen, rotting logs. Yellow birch is not a long-lived component of the hemlock-white pine-northern hardwoods climax vegetation, and the number of decaying logs may have provided extra protection

for the mice, voles, and shrews present.

Assuming a random distribution, fewer than the expected number of *P. l. noveboracensis* captures were on muck and peat associations, Cossayuna loam, or Bernardston stony loam (Table 8). Site 4, the Fair Haven Cedar Bog, is the only representative of muck and peat soil in the study, and the reduced ground cover and acid soil conditions may account for the poor results. In this bog, plant decay is severely retarded due to the high water table. Acids produced when decay does occur are not readily neutralized (Andrews, 1973). All the sites on Cossayuna loam (7, 30, 52; Tables 1, 2, 8; Figure 7) are near running or standing water, and earlier experience has indicated that *P. m. gracilis* rather than *P. l. noveboracensis* is more likely to be trapped under these conditions (Christian, et al., unpublished).

More captures of the white-footed mouse than expected took place on the two sites underlain with Hortonville Slate (Table 7). One site (41) provided 12 of the 13 captures (Table 1). This site is approximately 150 m from Roach Pond, and its gentle slopes are isolated from the pond by bordering steep slopes of grass and secondary growths of hardwoods. Fallen logs and deep litter provide excellent small mammal harborage, but the microclimate may not be moist enough for *P. m. gracilis* (Klein, 1960). The Biddie Knob bedrock formation is also associated with a greater than expected capture of the white-footed mouse, but again, captures on site 19, Bird Mountain, are primarily responsible for this correlation.

B. *Peromyscus maniculatus gracilis*

Peromyscus maniculatus gracilis occurs throughout most of eastern Canada and south into the mountains of New Hampshire, Vermont, and Massachusetts. It occurs as far south as the Catskill Mountains of New York State and adjacent Pennsylvania, and west through the northern portion of the southern peninsula of Michigan and northern Wisconsin. In contrast to *P. l. noveboracensis*, Klein (1960) felt that *P. m. gracilis* was positively associated with plants of the hemlock-white pine-northern hardwoods region, and also preferred a cooler microclimate. In central New York, the forest deermouse seemed to be restricted to mature woodland, and avoided plants of the drier oak-chesnut forest region. Smith and Speller (1970) demonstrated that *P. m. gracilis* in southeastern Ontario was ubiquitous in various types of forest, including upland, mixed, and cedar. The same study indicated that *P. m. gracilis* often utilize existing holes for shelter, and may be able to outcompete the white-footed mouse for these holes, excluding the latter species from a forest region. In 1973, a forest deermouse was captured as it emerged from a large hole near the exposed roots of a streamside hardwood tree (Christian, et al., unpublished). In other regions, *P. m. gracilis* have been taken at altitudes from 640.0 to 1622.0m (Mearns, 1898; Harper and Harper, 1929). Osgood (1938a) considered the forest deermouse common only above 366.0m in the cool moist woodlands of Vermont, and Smith (unpublished thesis, 1972) trapped this species between 553.0 and 732.0m in the Green Mountains of Vermont.

The forest deermouse was captured only below 305.0 m in the slate belt, and was taken at altitudes as low as 153.0 m. *P. m. gracilis* was randomly distributed with respect to general type of habitat and soils (Tables 8, 9), but not with respect to bedrock (Table 7). Although three captures of *P. m. gracilis* were associated with West Castleton bedrock, all took place on one of eight sites with type of bedrock (site 2; Tables 1, 2; Figure 7). This site borders a small forest brook, and a massive talus litters the steep slope. The forest deermouse was trapped nearer the base of the slope and closer to the stream than the white-footed mouse. This pattern of occurrence of the two species is found in most places where the two species of *Peromyscus* were trapped.

During this study, *P. m. gracilis* was caught in very low numbers (table 1), and often in habitats not classically associated with this species (Klein, 1960; Smith and Speller, 1970). Site 2 is immediately east of Vermont Route 30, and from 1951 until the summer of 1975, no captures of *P. m. gracilis* had occurred west of this route. A total of 26 *P. m. gracilis* were captured at eight sites east of Route 30 (Christian, et al., unpublished, and the present study). At *P. m. gracilis* capture sites there is running or standing water in the trapping area or immediately nearby. During the present study, two *P.m. gracilis* were trapped in two areas west of Route 30 (sites 7, 52; Table 1; Figure 7). These two areas are not remarkably different from the areas where the forest deermouse occurs east of Route 30. There are

exposures of bedrock, running or standing water, typical heavy slate-filled soil, and characteristic forest and ground cover associations. The Glen Lake site (52) has a stand of probable virgin hemlock, white pine, and a few red oak, all with a d. b. h. of 107 cm or more. A combination of data from this and the previous study by Christian, et al., (unpublished) indicates that captures of *P. m. gracilis* east of Route 30 were 13 times more frequent than captures in the western half of the trapping area, even though more traps (10,403 vs. 7,943) were set on the west than on the east of Route 30.

The areas west of Route 30 where *P. m. gracilis* were trapped are possibly part of an east-west natural expansion route for small mammals (Figure 7). This route is composed of a chain of lakes, waterways, and surrounding forests. The trapping area north of the Hortonville Road (site 2) is an extension of the migratory path across Route 30, which itself may be a barrier. Presently, this sequence of forested habitats is the only way small mammals can overcome the topographic barrier created by Lake Bomoseen in northern Rutland County. This association extends west from Route 30, and then turns southwest and may eventually include areas along the western edge of Lake Bomoseen.

The floristic composition of such a migratory route is of importance, since the flora and harborage can determine the ability to support populations of the various species of mice, voles, and shrews as they move through the area. Smith

and Speller (1970) found *P. m. gracilis* to be ubiquitous in a southern Ontario woodlot which included an upland forest (sugar maple, beech, hemlock, red maple, yellow birch, white elm, and basswood), mixed forest (balsam fir, large toothed aspen, white elm, white cedar, blue beech, paper birch, basswood, red maple, and bitternut hickory), and cedar forest (white cedar, tamarack, balsam fir, and quaking aspen). *P. l. noveboracensis* avoided the mixed and cedar forest in southern Ontario. The occurrence of the two species of *Peromyscus* in the slate belt is opposite in many respects. *P. l. noveboracensis* was ubiquitous in the region, and occurred in greatest numbers associated with hardwoods such as yellow birch, American beech, paper birch, and sugar maple. *P. l. noveboracensis* also occurred in brushy and edge habitats (e.g. site 35; Tables 1, 2, 3; Figure 7) dominated by white pine, tamarack, witch hazel, and sugar maple. Homogeneous stands of balsam fir (site 26; Tables 1, 2, 3; Figure 7) also were associated with captures of the white-footed mouse. Conversely, *P. m. gracilis* were particularly associated with hemlock and yellow birch, and to a lesser extent, with sugar maple, white pine, and hophornbeam. When both species of *Peromyscus* were trapped in the same ravine, as in Finel or Morris Hollows (Christian, et al., unpublished), or the outlet stream of Black Pond (site 2; Tables 1, 2; Figure 7), *P. l. noveboracensis* was always taken on the higher parts of the slope, and *P. m. gracilis* were taken along the bottoms of the ravines.

C. *Sorex fumeus*

Sorex fumeus occurs in Maine, New Hampshire, Vermont, much of Massachusetts and Connecticut, west to central Ohio, and south in the mountains to Kentucky, Tennessee, and northern Georgia. In Canada, it is found throughout the Maritime provinces and southern Quebec and Ontario. Reportedly, this is an animal of cool mossy woods and sphagnum bogs (Osgood, 1938a), and has been taken in mixed spruce-hardwood forests (Harper and Harper, 1929) up to elevations of at least 914.0 m (Harper, 1929).

This shrew occurred more often than expected on steep forested slopes, especially those which have outcrops, logs, and roots to provide cover (Table 9). The ability of the traps to capture very small (4.92 g) individuals of this species indicates that the species was probably captured less often in other habitats because of low numbers and not because of a lack of trap sensitivity. Steep forest slopes often contain extensive outcrops, and outcrops provide an overhang as protection for runs, as well as local areas of humus development. These factors may have contributed to this nonrandom distribution of *S. fumeus* on steep slopes.

D. *Blarina brevicauda*

Blarina brevicauda is common from Maine to Florida, and west to Manitoba and Texas. In Canada it is common south of a line joining the Gaspé Peninsula, Lake St. John, Lake Nipigon, and Lake of the Woods. In Vermont, the short-tailed shrew is common at various altitudes throughout the state (Osgood, 1938a).

In this study, *B. brevicauda* was the second most commonly trapped small mammal. Fewer than expected were captured at logs and roots in streamside habitats, on rough stony land, alluvial soils, and bedrock of the West Castleton and Hortonville Formations. More captures than expected were on muck and peat soils, on steep forested slopes with log, root, and litter cover, and on the Poultney Slate bedrock. While *B. brevicauda* does make use of many types of cover, the floodplain areas of forest streams (with their attendant alluvial soils) tend to be devoid of enough cover to encourage the presence of most small mammals, including this shrew (Bell and Sipps, 1975). The lack of captures of the short-tailed shrew on the mountain slopes (rough stony land) was no doubt due to the uniformly thin, poor litter cover and the inability of the soil to adequately support this species' invertebrate prey (Cruickshank, 1972). Of the two trap-sites on the Hortonville bedrock, one (site 24; Tables 1, 2; Figure 4) is particularly devoid of cover required by *B. brevicauda* and other small mammals.

Bartholomew Hill (site 25; Tables 1, 2; Figure 4) is unusual due to the large number (9) of *B. brevicauda* caught in two consecutive trap-nights. Four traps were responsible for all the captures. This site accounted for many of the greater than expected number of captures of short-tailed shrews on the Poultney Slate bedrock. The Nassau rock outcrop soil is unusually dry in the area of the captures, and the litter is deposited in small hollows in the forest

floor. Hamilton (1941) felt that earthworms were an important food source when present, but beechnuts were eaten if other invertebrate food was lacking. Bartholomew Hill is dominated by hophornbeam, paper birch, and American beech. The combination of dry soil, deep loose litter, and abundant food apparently attracted an unusually large migration, local population, or family of this shrew.

E. *Clethrionomys gapperi*

Clethrionomys gapperi is common in all but the southernmost part of eastern Canada and it ranges fron northern New York State into northern New Jersey and the Pennsylvania mountains. The red-backed vole can be found as far west as the lower peninsula of Michigan and much of northern Wisconsin. The subspecies *C. g. gapperi* is the subspecies thought to occur in Vermont (Hall and Kelson, 1959), and Osgood (1938a) felt this species was more prevalent above 366 m in Vermont.

In the present study, *C. gapperi* occurred from 103.0 m to 488.0 m, with the greatest number of captures occurring at the lower (< 300.0 m) altitudes (Table 1). Gunderson (1959) studied the habitat preferences of this vole in a Minnesota tamarack-white cedar bog, and found sparse undercover suitable if it included a high frequency of rotting logs, roots, and stumps; the presence of free water was also thought to be of importance. Table 9 indicates the red-backed voles of the slate belt were associated more often than expected with rocky cover, both streamside and on steep forested slopes.

C. gapperi did not occur as frequently as expected on the Poultney Slate bedrock, but one of the sites on this bedrock (site 16; Tables 1, 2, 9; Figure 5) has recently sustained a local flood. The stream had enlarged its floodplain so that areas 10.0 m from the stream were still inundated with mud. Litter and vegetative cover were greatly reduced, and most small mammals, except perhaps for some species of mole, would have had poor protection from predators and weather in this locality.

The significant increase over expected captures of red-backed voles on Cossayuna loam results primarily from the captures at site 7, the outlet of Black Pond. This apparently was good habitat for *C. gapperi*, e.g. streamside (moist) outcrops, logs, and roots (Gunderson, 1959). Site 21 contains a massive talus which provides good cover and local dampness, and this in turn probably resulted in the significantly large numbers of captures on Stockbridge loam. The same explanation helps clarify the captures of *C. gapperi* on site 17 (Tables 1, 2; Figure 5), and its effect on the captures on Dutchess loam and stony loam (Table 8).

F. *Microtus pennsylvanicus*

Microtus pennsylvanicus is predominantly a grassland species and occurs from Maine to South Carolina, and west through Minnesota. In eastern Canada, the meadow vole is found as far north as the north shore of Georgian Bay. Harper and Harper (1929) trapped the meadow vole at 1295.0 m in the Adirondacks, while in Vermont, the meadow vole has been taken at 1219.0 m on Killington Mountain (Osgood, 1938a).

M. pennsylvanicus was trapped in very low numbers in the slate belt, but its ecology and population dynamics in Pennsylvania and New York are well documented and will not be reviewed here (Barbehenn, 1955; Christian, 1971a, 1971b). Besides the grassland habitat, it may be found in marshy areas. In this study, it was trapped only in an apple orchard, and a wet cattail field. Sites 12 and 44 (Tables 1, 2; Figure 3) contain extensive old *M. pennsylvanicus* runs, but few were active judging from the lack of recent droppings and fresh cuttings of vegetation. This species is notoriously cyclic (Christian, 1971a), and this fact may help account for the low numbers trapped in the slate belt. While this vole is not truly fossorial, it burrows nevertheless, and the slate fragments in the soil may prevent the meadow vole from constructing deep protected runs.

G. *Napaeozapus insignis*

Napaeozapus insignis occurs throughout eastern Canada, and south through Maine and the northern part of Connecticut, and has been taken in the mountainous parts of Maryland and Virginia. It ranges as far west as northeast Ohio. Jameson (1941) felt *N. insignis* in central New York State favored the cover of yew; Osgood (1938a) reported them from cool mountain streams and other moist areas in Vermont. The presence of running or standing water is not, however, a requisite for the presence of this species (Wrigley, 1972). Smith (unpublished thesis, 1972) felt the woodland jumping mouse was associated with the denser vegetation caused by moist conditions.

In the eastern United States, the distribution of *N. insignis* follows the distribution of the hemlock-northern hardwoods forest, and is usually not found in mixed mesophytic forests where hemlock is lacking. Logs, mossy rocks and outcrops, as well as dense herbaceous foliage can provide adequate cover for this species (Wrigley, 1972).

N. insignis did not exhibit any trends with respect to bedrock, habitat, and ground cover for its known types of preferred habitats (Whitaker, 1963; Wrigley, 1972). It did not occur as often as expected on soils of the Nassau association, but most of the habitats on that soil are not proper for the presence of this species. Equal numbers of captures took place at tree bases and in rocky cover (Table 9). *N. insignis* was caught near running or standing water at sites 39 and 52 (Tables 1, 2; Figure 5), but these areas are without the lush vegetation alluded to in descriptions of this species habitat (Wrigley, 1972). The woodland jumping mouse was typically taken at tree bases surrounded in many cases by only scant litter cover and a few mossy outcrops.

H. *Zapus hudsonius*

Zapus hudsonius is the grassland equivalent of *N. insignis*, in that the two species are similar in most morphological features, but are ecologically separated. The areas that yield the best catches of the meadow jumping mouse are marshes, pond edges, brushy areas, and open fields with lush vegetation (Whitaker, 1963). The meadow jumping mouse occurs in the majority of eastern

Canada, and ranges southward into the mountains of North Carolina. It has been taken occasionally on the highest peaks of Vermont's Green Mountains (Osgood, 1938a). There seems to be no correlation between the number of *Z. hudsonius* caught and the distance from bodies of water, nor is there a correlation of captures with specific plant species (Whitaker, 1963).

Only one *Z. hudsonius* was trapped; the site was along a small outcrop at the edge of a pasture actively grazed by dairy cattle. Traps near a collapsed slate wall on the same site had no success (Tables 1, 2; Figure 5). In two other areas (sites 45, 48; Tables 1, 2; Figure 3) traps were set bordering hay fields that were being harvested. It was hoped the harvesting process would drive grassland species, including *Z. hudsonius* and *M. pennsylvanicus*, into the traps. This did not occur in either area. The lack of captures may be directly related to the soils, since the meadow jumping mouse needs fairly loose soil in a mound to build nests for hibernation (Whitaker, 1963). This type of soil is generally lacking in most areas of the slate belt. The winter burrows are often below the frost line, and digging to that depth in slate-derived soils would be very difficult. Since *Z. hudsonius* is often found in the burrow systems of other species, such as moles (Whitaker, 1963), a lack of other burrowing species in the pasture habitat may limit the range and population size of the meadow jumping mouse. This may be the case in the slate belt. Even though Sheldon (1938) felt this species might seek the shelter of stone walls, no captures were

made at this type of cover.

I. *Condylura cristata*

Condylura cristata is found on both sides of James Bay in eastern Canada, and ranges south through New England to Virginia. The habitat of this species is discontinous, and it is often found in areas of muck and marsh, both adjacent to and on the floodplains of streams (Jackson, 1915; Jameson, 1949). Moist meadows and borders of marshes are common habitats for this mole in Vermont (Osgood, 1938a).

The star-nosed mole may be too large for routine captures with small snap traps, but has been taken in these traps on many occasions (Christian, et al., unpublished). The runs of this mole were observed in many areas in which it was not trapped, and its fossorial habits may render it less susceptible to the type of trapping employed. Alluvial soils may be the only type habitable by moles in the slate belt, since their tunnels are often 25.0 to 45.0 cm below the surface (Jackson, 1915). The slate-derived soils offer a much reduced topsoil in which to burrow.

IV. Comparisons and Correlations Based on Combined Data From This Study and Christian et al., (unpublished)

If data from the present study are combined with data from the only previous adequate study of the area (1951-1974; Christian, et al., unpublished), trends additional to those discussed in section III of the discussion appear, and some conclusions concerning habitat preferences are confirmed (Tables 14, 15, 16). Only the results from the first 24 hours of trapping in each

study are considered in the combined study, since the earlier study did not consistently include second trap-night data.

A. *Peromyscus leucopus noveboracensis*

Evergreen bogs and streamside habitats yielded fewer *P. l. noveboracensis* than expected, but these areas are not the preferred habitats for this species (King, 1968). More than the expected number of captures took place on steep forested slopes, and this is surprising in view of the reduced litter layer found on steep slopes during the present study. There were fewer than expected captures of the white-footed mouse on West Castleton bedrock, and more than expected on sites with Hortonville bedrock; this is probably not a function of the bedrock *per se*, but the habitat found on these sites (Table 14). Sites with deep litter, abundant logs and roots for cover, and high moisture, no matter what the type of bedrock, yielded a high number of captures of both species of *Peromyscus* (Tables 14, 16). There were more captures than expected of the white-footed mouse on Addison soils, but the reasons for this association are unclear. One site provided nine of the thirteen captures; it is a wooded ridge and falls off to the bed of a small stream (Christian, et al., unpublished). The site is rich in ferns and boreal angiosperms, and contains an extensive talus.

B. *Peromyscus maniculatus gracilis*

The forest deermouse was trapped more often than expected in stream habitats (Table 16), and the same association was discussed in section III-B of the discussion. However, there were

fewer captures than expected on alluvial and lacustrine soils, indicating an immediate influence other than edaphic on *P. m. gracilis* occurring near streams. It is not possible to investigate the preferred cover from the earlier (1951-1974) study to determine what factors account for the large number of captures of *P. m. gracilis* in the streamside habitat. This type of data was not collected for each trap location. In contrast, during the present study the forest deermouse was randomly distributed with respect to the various types of habitats (Table 9).

C. *Sorex fumeus*

Sorex fumeus was persistently associated with steep forested slopes in both studies. They were also captured more often than expected on Nassau soils, which characteristically have large numbers of outcrops that provide sheltered runs (Table 15). Nassau soils are also among those found on the steepest slopes in the slate belt. The Addison soils exhibited a greater than expected number of captures, but nine of the thirteen shrews taken were from one site with an extensive moss-covered talus.

D. *Blarina brevicauda*

Blarina brevicauda was trapped more often than expected on steep forested slopes, probably for the reasons given in discussion section III-D. Gentle to moderate forested slopes provide fewer captures than expected; the lack of outcrops, which may provide good cover for runs, may have been a factor (Table 16). The large catch on the Hortonville Slate (Synclinorium sequence, on the border of the slate belt) and associated Addison soil (Tables 15, 16) is explained by the success on one site

(site 2; Christian, et al., unpublished). Short-tailed shrews were trapped more often than expected on the Belden's Member of the Chipman Formation, but this may be related to the occurrence of a mossy talus (site 1; Christian, et al., unpublished). Alluvial and lacustrine soils provided fewer than the expected number of captures, but this again is probably due to the lack of cover (Bell and Sipps, 1975).

E. *Microtus pennsylvanicus*

The occurrence of the meadow vole was limited to pasture, old-field associations, and bogs, with their accompanying alluvial, lacustrine, muck, and peat soils. The one exception was a single *M. pennsylvanicus* taken in a streamside habitat (Table 16). The other captures of the meadow vole occurred in the classically described habitats for this species (see discussion section III-F).

F. *Clethrionomys gapperi, Zapus hudsonius, and Napaeozapus insignis*

The distribution of *C. gapperi, Z. hudsonius,* and *N. insignis* based on the combined data follows the distribution of the present study for soils and habitats (Tables 15, 16). Increased and decreased number of captures (compared to a random distribution) on different bedrocks are associated with the occurrence of, or lack of, suitable habitats.

V. Small Mammals Not Trapped in the Slate Belt During the Present Study

There are eight species of small burrowing mammals whose distribution includes Vermont and New York, but have not been

trapped in the slate belt. These species include four shrews, three Microtines, and one mole.

A. *Sorex cinereus, Sorex dispar,* and *Microsorex hoyi*

Sorex cinereus, the masked shrew, occurs from Alaska through northern Quebec, and ranges south to Tennessee, and west to Kentucky, Indiana, Wisconsin, and Michigan. In New York State it has been trapped in a balsam swamp at 1128.0 m (Mearns, 1898), as well as on Long Island, New York, in both damp and dry areas with or without woody cover (Harper and Harper, 1929; Connor, 1971). *S. cinereus* has been trapped in wooded areas of Rutland County adjacent to, but not on, the slate belt (Osgood, 1938a).

Sorex dispar, the longtailed shrew, rarely has been taken in Canada, but it probably is continuous in the mountains from New Hampshire to southern West Virginia (Richmond and Grimm, 1950). It is rare in Vermont, but has been taken in non-slate bedrock areas of Rutland County, at elevations of 762.0 to 1219.0 m (Osgood, 1938a; 1952). In Pennsylvania, the big-tailed shrew has been taken at elevations lower than 762.0 m (Richmond and Grimm, 1950).

Sorex dispar has longer hind feet, a much longer tail, slightly larger ears, and longer vibrissae then *S. cinereus* or *S. fumeus*. It is well adapted for living in darkness within crevices of talus (Tate, 1935; Richmond and Grimm, 1950).

Microsorex hoyi, the pygmy shrew, is a rare capture throughout its range, but it is known to occur throughout eastern Canada in a north-south cline of size, with the smaller specimens occurring

in the south. In the United States, the pygmy shrew has been trapped in Maine, Vermont, New York, Massachusetts, and probably Pennsylvania. Vermont captures occurred in 1842 and 1936, at Burlington (north of the slate belt), and Brighton, respectively (Osgood, 1938a). Miller (1964b) reports the capture of the pygmy shrew from Lyndon Center, in northeast Vermont, and on the southwest flank of Ide Mountain, in a beech-maple subclimax forest. *S. cinereus* was also captured at the latter location.

The inability to capture *S. cinereus*, *S. dispar*, and *M.hoyi* in the slate belt is puzzling, but the ecology of these species provides some clues to their exclusion. *S. dispar* is usually taken in areas where talus can form, but the slates and phyllites that constitute the bulk of the bedrock in the slate belt do not form talus to any great extent. The bedrock weathers into thin fissile plates and fragments, which offers little harborage to the longtail shrew. The foods preferred by *S. cinereus* and *S. fumeus* seem nearly identical (Hamilton, 1941), and the possibility exists that the smoky shrew is better able to utilize the the limited food resources.

Microsorex hoyi is admittedly a rare capture, but has recently been taken in other regions of Vermont (Miller, 1964b). A possible factor in this and the other shrew species' exclusion may be the poor humus development on the slate-derived soils. Invertebrate prey and hospitable habitats may be limited by the lack of a well developed mull humus, and thus the number of insectivore species is likewise limited. The acidic and poorly developed mor humus

of the slate belt is a function of the youth of the podzolic soils, which are recovering from disastrous erosion caused by sheep grazing.

B. *Sorex palustris*

Sorex palustris, the water shrew, is found in eastern Canada except in Newfoundland and the northern part of the Ungava Peninsula. It occurs in the eastern United States from Maine to Connecticut, and westward through southeastern Pennsylvania, eastern and northern New York State, and well beyond. It prefers fast, cold mountain streams with banks of large stones, boulders, and overhanging ledges (Conaway, 1952). It has been taken at altitudes of 488.0 m and 610.0 m in northeastern Pennsylvania (Christian, unpublished data), 823.0 m in New Hampshire (Starrett, Starrett, and Youngman, 1952), and up to 2118.0 m in Montana (Conaway, 1952). This shrew has been taken in Rutland and Essex Counties in Vermont, but not from the slate belt proper.

It is my impression that in the slate belt the proper habitats are rare for this species. Streams with an adequate rate of flow to support this species have relatively clean banks, with few large boulders, roots, and overhangs. There also seems to be a lack of invertebrate prey (e.g. crayfish) and small fish in the faster, cooler streams, such as Gully Brook (site 40; Tables 1, 2; Figure 3).

C. *Parascalops breweri*

Parascalops breweri, the hairy-tailed mole, is found in the northeast United States and adjacent Canada. It ranges south

into the mountains of Virginia and North Carolina, and probably occurs as far west as eastern Indiana. This mole prefers a coarse mull-friable humus substrate (Jameson, 1949), and usually inhabits drier soils, burrows deeper, and confines itself more to subterranean runways than does *Condylura cristata*. *P. breweri* is known to be scarce or absent in heavy clay, stony, or gravelly soils (Jackson, 1915). *P. breweri* has been taken in forests of mixed hardwoods and conifers (similar to the slate belt association) in the Adirondacks, at 914 m (Harper, 1929), and at various altitudes in parts of Vermont north and south of the slate belt (Osgood, 1938a; Christian, et al., unpublished).

The published accounts of *P. breweri's* preferred habitat are not approximated well by those found in the slate belt. The soil is heavy, and filled with slate chips. Deep burrows cannot be easily constructed. Hamilton (1941) determined that earthworms constitute a major part of this species' diet, but earthworms probably do not thrive in the podzolic acid soil of the slate belt. The physical factors necessary for the presence of this mole seem lacking in the slate belt.

D. *Microtus chrotorrhinus*

Microtus chrotorrhinus, the rock, or yellow-nosed vole, has been taken in the mountains from Maine to Pennsylvania, and westward to northern Minnesota. In Canada it inhabits a narrow belt bordering the St. Lawrence River. The yellow-nosed vole has been taken in moss-covered rocks or talus in the White Mountains of New Hampshire, and New York's Adirondack

and Catskill Mountains (Kirk, in Osgood, 1938b). In Vermont, the rock vole has been trapped in talus at 427.0 m in Essex County.

M. chrotorrhinus requires much the same kind of habitat as *S. dispar*. Even small colonies need a talus-like habitat (Duott, Heppenstall, and Guilday, 1973). It has been demonstrated that bedrock of the Taconic sequence simply does not weather into the necessary type of configuration. The two sites which contained talus (sites 2, 21; Tables 1, 2; Figure 3) were widely separated, and perhaps neither was extensive enough to support a colony of this vole large enough to survive from year to year.

E. *Pitymys pinetorum*

Pitymys pinetorum, the pine vole, has a very limited distribution in eastern Canada.It is found in a narrow area north of Lake Erie in Ontario, and has a limited range along the southern border of Quebec and the United States. It occurs in northern Vermont and southern New Hampshire, and ranges south to northern Virginia. *P. pinetorum* has been trapped in Rensselaer County, New York, which is adjacent to Rutland County, Vermont (Benton and Krug, 1956), but not in the slate belt. It is found as far west as central Ohio and Illinois. The physical nature of the humus is perhaps one of the most important factors in the distribution of the pine vole. It prefers a coarse mull humus, mull with a very deep mor, or the sandy alluvial soils of floodplains (Jameson, 1949). Miller (1964a) caught *P. pinetorum* in Caledonia County, Vermont, in a subclimax beech-maple forest.

Associated captures in the same locality included 23 *N. insignis*, 18 *S. cinereus*, 15 *Peromyscus* sp., 14 *C. gapperi*, 5 *M.hoyi*, 3 *P. breweri*, and 3 *B. brevicauda*. Osgood (1938a) reports this species east of the slate belt.

P. pinetorum is a truly fossorial vole, with discontinuous occurrence throughout its range. It is often found in orchards, and may girdle roots of trees, causing severe damage. No pine voles were caught in the two orchards trapped in the slate belt, yet they have been taken 129.0 km north of the research area, as attested to by voucher specimens in the collection of the Department of Biology, University of Vermont, Burlington, Vermont. Both orchards (sites 12,44; Tables 1, 2; Figure 3) were on soils filled with slate chips, and indications of girdling of roots and trunks could probably be assigned to *M. pennsylvanicus*, with some rabbit and deer damage also occurring. The soils of the slate belt are not of the type preferred by the pine vole, but it does occur in the nearby regions.

F. *Synaptomys cooperi*

Synaptomys cooperi, or bog lemming, occurs from northern Maine to northwest Connecticut, in the Catskills of New York, and west through central Michigan and northern Wisconsin. In Canada, it is found in northern Quebec, most of Labrador, and in some regions adjacent to the St. Lawrence River. It is a woods and grassland species, but is usually found in areas that are suboptimal for the meadow vole. Osgood (1938a) reports capturing this species at nearly 1219.0 m in Rutland County.

S. cooperi is represented by a single reported capture in 1951 at site 4, the Fair Haven Cedra Bog (Tables 1, 2; Figure 3; Christian, et al., unpublished). *C. gapperi* was also taken in the same bog in 1973, but was not trapped there in 1974 and 1975. It is possible that the bog is part of a southern route used by animals to move around Lake Bomoseen. This bog is contiguous with the Poultney River and its drainage system, and animals extending or changing their ranges therefore may occasionally occur in the bog.

Conclusions

The number of captures of small mammals in the slate belt as indicated by this study is low (25.00 per 1000 trap-nights), even when compared to previous studies done in the region (Table 13; Christian et al., unpublished). The paucity of captures in the slate belt has a two-fold basis:

1. eight species of small mammals apparently adapted to the general climate, elevations, and flora of the slate belt do not occur there, and

2. species present occur in reduced numbers relative to other nearby regions.

Significant differences in the number of captures cannot be assigned solely to the bedrock component of the various habitats. The major association is between the animal species and the biotic aspects of the ecosystem. The development and types of soils present in the region is of major importance, and the shallow depth to bedrock, abundance of slate fragments in the upper

soil profile horizons, and weakly developed humus layer are probably detrimental to burrowing species of small mammals. The lack of a proper substrate is of immediate importance to such species as *P. breweri, Pitymys pinetorum,* and *C.cristata.* The lack of certain bedrock-derived features, such as talus, directly excludes such species as *M. chrotorrhinus* and *S. dispar.* The relationship between *S. cinereus, M. hoyi, S. cooperi,* and the environmental influences of the region are more difficult to discern.

Intensive sheep grazing, which peaked in the mid-19th century, resulted in a vast change in land use, and conditions are only beginning revert. The region will probably never return to the pre-grazing conditions of extensive forests and small, intensely worked farms. Nearly all the mature forest was removed from the area, and only secondary or even tertiary stands remains.

The amount of topsoil lost to erosion will take tens of generations to replace. A study of the movement of *P. m. gracilis* west of Route 30 should prove particularly interesting and rewarding, since it will probably parallel the reforestation of the region. As reforestation and topsoil replacement occurs, additional species of small mammals may spread into the slate belt from the surrounding regions, while the species now present may increase in number.

Table 1. Results of trapping in the slate belt and adjacent areas. Key: Sf= *Sorex fumeus*; Bb= *Blarina brevicauda*; Cc= *Condylura cristata*; Ts= *Tamias striatus*; Cg=*Clethrionomys gapperi*; Mp= *Microtus pennsylvanicus*; Pmg= *Peromyscus maniculatus gracilis*; Pln= *Peromyscus leucopus noveboracensis*; Zh= *Zapus hudsonius*; Ni= *Napaeozapus insignis*.

No.	Locality	Elev. (m)	Year	Traps	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni	Total
1.	Wooded slope N. of Blissville Rd.	121.9	1974	50	50											0
2.	0.32 km N. of Hortonville Rd.	152.4-170.7	1974	50	100	1		1		2		3	1			8
			1975	65	130	1	2			4			2		2	11
3.	Point of Pines	146.3	1974	65	130		2		1				2			5
4.	F. H. Cedar Bog	109.7	1974	50	100		1									1
			1975	50	100		3									3

No.	Locality	Elev. (m)	Year	Traps	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni	Total
5.	Morris Hill	243.8-262.1	1974	50	100		1						2			3
6.	Near Hampton Hill	134.1-140.2	1974	53	106	1	1						1			3
7.	Outlet of Black Pond	176.8-201.2	1974	110	220		1						3		2	6
			1975	78	156		1					1				2
8.	Floodplain of Poultney River	85.3-91.4	1974	80	80				1							1
9.	0.88 km W. of Wm. Miller Chpl.	128.0-134.1	1975	78	156		2						4			6

No.	Locality	Elev. (m)	Year	Traps	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni	Total
10.	Slope 0.40 km & 210° from elev. 149.7 m, Town of Poultney	164.6	1974	85	170								1			1
11.	Lewis Farm	164.6-170.7	1974	65	130									1		1
12.	Griffin's Ochd.	219.5-237.7	1974	100	200						1		1			2
13.	Gorhamville Fm.	201.2-249.9	1974	85	170					1			3			4
14.	Slope below Carver Falls Cemetery	91.4	1974	85	170	1	1									2
15.	Sheldon Fm.	152.4-182.9	1974	100	200		1									1
16.	Trib. of the Poultney River	91.4-103.6	1974	55	110											0

No.	Locality	Elev. (m)	Year	Traps	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni	Total
17.	S. of Belgo Rd.	207.3-274.3	1974	100	200	1	5			5			8			19
			1975	85	170	2	1						4		1	8
18.	N. of Belgo Rd.	219.5	1974	75	150		3						4			7
19.	N.E. slope of Bird Mt.	304.8-347.5	1974	100	200								6			6
20.	S.E. slope of Mount Hamilton	182.9-219.5	1974	100	200		2						2			4
21.	Talus below Wallace Ledge	152.4	1974	100	200					4		1	3			8
22.	Brandon Mt. Rd.	304.8-378.0	1974	82	164					1			6			7
23.	Outcrops of Zion Hill Qzte.	304.8-335.3	1974	100	200		1			2			4			7

No.	Locality	Elev. (m)	Year	Traps	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni	Total
24.	Streamside slope 0.32 km and 345° fr. elev. 103.9 m, Town of Hampton	42.7-61.0	1974	90	180								1			1
25.	Bartholomew Hl.	140.2-176.8	1974	95	190	1	10						2			13
			1975	70	140		2						1			3
26.	Herrick Mt.	426.8-487.7	1974	100	200								3			3
27.	Slate wall, Town of Mid. Spgs.	487.7-506.0	1974	80	160	1				1			2			4
28.	Cedar Mt. Rd.	146.3-170.7	1974	100	200											0

No.	Locality	Elev. (m)	Year	Traps	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni	Total
29.	Scotch Hill Rd.	182.9-225.6	1974	75	150											0
30.	Outlet of High Pond	195.1-213.4	1974	100	200		2			5						7
			1975	60	120		1			1						2
31.	Forested slope, Half-moon Pk.	176.8	1974	50	100								1			1
32.	Mixed forest, border of Towns of Hubbardton & Sudbury	182.9-189.0	1974	70	140											0
33.	Hatch Hill	170.7-231.6	1974	90	180								1			1

No.	Locality	Elev. (m)	Year	Traps	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni	Total
34.	Forest & slate wall, 0.48 km & 160° from elev. 206.7 m, Town of Hubbardton	201.2-237.8	1974	60	120		1									1
35.	Fallow slope, Village of F.H.	128.0-146.3	1974	25	125		3						3			6
36.	Base of Stony Hill	207.3-225.6	1974	96	192		2						2			3
37.	Lewis Brook	243.8-274.3	1974	65	130		3					1	2			6

No.	Locality	Elev. (m)	Year	Traps	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni	Total
38.	Outcrops & slope, 1.13 km & 345° from elev. 229.8 m, Town of Poultney	268.2-274.3	1974	50	100	1										1
39.	Lavery Brook	298.7-365.8	1974	100	200											0
			1975	75	150					1					3	4
40.	Gully Brook	219.5-250.0	1974	75	150		2			2			1			5
41.	Near Roach Pond	182.9	1974	75	150		1						7			8
			1975	70	140		1			1			5			7
42.	Near Inman Pond	176.8-195.1	1974	100	100								2			2
43.	Outlet of Beaver meadow	152.4	1974	85	85								2			2
44.	Vt. Apple Co.	146.3-152.4	1975	80	160											0

No.	Locality	Elev. (m)	Year	Traps	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni	Total
45.	Hayfield & forest, 0.16 km & 285° from. elev. 172.2 m, Town of Castleton	164.6-176.8	1975	90	180		2						1			3
46.	Bull Hill	231.6-256.0	1975	78	156		1									1
47.	Fallow pasture, 0.64 km and 150° from elev. 255.4 m, Town of Castleton	250.0-262.1	1975	70	140		1									1
48.	"Dry swamp"	256.0	1975	65	65											0
49.	Willow-witch hazel pasture	298.7	1975	70	140											0

No.	Locality	Elev. (m)	Year	Traps	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni	Total
50.	Cattail field	219.5	1975	75	150		1				2		1			4
51.	Talus and slope 1.13 km & 15° from elev. 103.9 m, Town of Hampton	36.6-61.0	1975	75	75		1									1
52.	Near Glen Lake	152.4-164.6	1975	75	150		3					1	1		1	6

Table 2. Locations of trap-sites. References: U.S.G.S. 7½' topographic quadrangles of Poultney, Vt.-N.Y., 1972; Bomoseen, Vt., 1944; Thorn Hill, N.Y.-Vt., 1972; Benson, Vt.-N.Y., 1946; West Rutland, Vt., 1972; Sudbury, Vt., 1972. All compass bearings are true.

No.	Habitat	Location
1.	Moderately sloping wooded embankment	1.13 km and 85° from Blissville Corners, Town of Castleton, Rutland County, Vermont
2.	Forested gorge and woods	0.32 km north of Hortonville Road, Town of Hubbardton, Rutland County, Vermont
3.	Forest floor and slate wall	1.77 km and 356° from the 411 ft BM, Hydesville, Rutland County, Vermont
4.	Cedar bog	1.61 km and 245° from the 377 ft BM, Town of Fair Haven, Rutland County, Vermont
5.	Steep forested slope	3.22 km and 135° from the 436 ft BM, Town of Hampton, Washington County, New York
6.	Gentle forested slope	1.61 km NNE of elevation 141.1 m, near Hampton Hill, Town of Hampton, Washington County, New York

No.	Habitat	Location
7.	Streamside steep forested slope	0.48 km and 195° from the 644 ft BM, Moscow Road, Town of Hubbardton, Rutland County, Vermont
8.	Sandy floodplain	2.25 km and 281° from Main Street and W. Park Place, Village of Fair Haven, Town of Fair Haven, Vermont.
9.	Gentle forested slope	0.88 km west of the William Miller Chapel, Town of Whitehall, Washington County, New York
10.	Gentle slope and outcrops	0.40 km and 210° from elevation 149.7 m, Town of Poultney, Vermont
11.	Forested hillside and pasture	0.32 km and 85° from elevation 161.2 m, Town of Poultney, Rutland County, Vermont
12.	Apple orchard	1.61 km and 200° from the 462 ft BM, Town of Poultney, Rutland County, Vermont
13.	Pasture, hillside, and steep forested streamside slope	0.97 km and 80° from elevation 193.5 m, Town of Poultney, Rutland County, Vermont

No.	Habitat	Location
14.	Steep wooded slope	0.97 km and 230^{o} from the 377 ft BM, Town of West Haven, Rutland County, Vermont
15.	Forested slope and outcrops	1.45 km and 65^{o} from elevation 112.2 m, Town of Fair Haven, Rutland County, Vermont
16.	Small stream and adjacent forest	0.48 km and 185^{o} from elevation 107.3 m, Town of Hampton, Washington County, New York
17.	Forested slope and streamside	0.64 km and 275^{o} from elevation 234.1 m, Town of Castleton, Rutland County, Vermont
18.	Gentle streamside slope	0.16 km and 305^{o} from elevation 234.1 m, Town of Castleton, Rutland County, Vermont
19.	Northeast slope of Bird Mountain	0.80 km and 230^{o} from elevation 244.8 m, Town of Ira, Rutland County, Vermont
20.	Forested southeast slope of Mount Hamilton	0.80 km and 50^{o} from elevation 158.2 m, Town of Fair Haven, Rutland County, Vermont

No.	Habitat	Location
21.	Forested talus	1.13 km and 205^{o} from elevation 171.3 m, Town of Castleton, Rutland County, Vermont
22.	Steep forested slope	0.08 km and 35^{o} from the 973 ft BM, Town of Hubbardton, Rutland County, Vermont
23.	Outcrops of Zion Hill Quartzite	1.13 km and 310^{o} from the 973 ft BM, Town of Hubbardton, Rutland County, Vermont
24.	Forested streamside slope	0.32 km and 345^{o} from elevation 103.9 m, Town of Hampton, Washington County, New York
25.	Steep forested slope	0.48 km and 215^{o} from the 436 ft BM, Town of Whitehall, Washington County, New York
26.	Steep forested slope	0.64 km and 320^{o} from the 1137 ft BM, Town of Ira, Rutland County, Vermont
27.	Slate wall and forested streamside	0.80 km and 45^{o} from elevation 440.4 km, Town of Middletown Springs, Rutland County, Vermont
28.	Forested hillside	0.97 km and 105^{o} from the 475 ft BM, Town of Castleton, Rutland County, Vermont

No.	Habitat	Location
29.	Steep slope and old-field association	0.16 km and 115° from elevation 182.6 m, Town of Fair Haven, Rutland County, Vermont
30.	Forested streamside and outcrops	0.48 km and 130° from elevation 214.0 m, Town of Hubbardton, Rutland County, Vermont
31.	Forest floor	0.64 km and 100° from the 631 ft BM, Town of Hubbardton, Rutland County, Vermont
32.	Mixed forest association bordering a hayfield	0.08 km and 45° from elevation 206.7 m, Towns of Hubbardton and Sudbury, Rutland County, Vermont
33.	Forested steep northerly slope	0.97 km and 325° from elevation 182.6 m, Town of Whitehall, Washington County, New York
34.	Gentle forested slope and adjacent slate wall	0.48 km and 160° from elevation 206.7 m, Town of Hubbardton, Rutland County, Vermont
35.	Fallow steep slope	0.16 km and 255° from the intersection of West Street and W. Park Place, Village of Fair Haven, Town of Fair Haven, Rutland County, Vermont

No.	Habitat	Location
36.	Forested gentle slope	0.32 km and 195° from elevation 156.4 m, Town of Sudbury, Rutland County, Vermont
37.	Forested brookside slope	1.61 km and and 340° from elevation 229.8 m, Town of Poultney, Rutland County, Vermont
38.	Outcrops and steep forested slope	1.13 km and 345° from elevation 229.8 m, Town of Poultney, Rutland County, Vermont
39.	Brookside steep forested slopes	1.93 km and 95° from elevation 193.5 m, Town of Poultney, Rutland County, Vermont
40.	Steep slopes and brookside floodplain	1.29 km and 210° from the 638 fy BM, Town of Castleton, Rutland County, Vermont
41.	Rolling forested hillside	0.40 km and 145° from elevation 171.3 m, Town of Hubbardton, Rutland County, Vermont
42.	Gentle forested slopes adjacent to Inman Pond	0.80 km and 230° from elevation 155.4 m, Town of Fair Haven, Rutland County, Vermont

No.	Habitat	Location
43.	Flat forested streamside floodplain	0.16 km and 35^{o} from elevation 155.4 m, Town of Fair Haven, Rutland County, Vermont
44.	Apple orchard	0.80 km and 190^{o} from elevation 185.9 m, Town of Hampton, Washington County, New York
45.	Hayfield and moderate forested slope	0.16 km and 285^{o} from elevation 172.2 m, Town of Castleton, Rutland County, Vermont
46.	Gentle forested slope	0.16 km and 100^{o} from elevation 275.8 m, Town of Castleton, Rutland County, Vermont
47.	Fallow pasture	0.64 km and 150^{o} from elevation 255.4 m, Town of Castleton, Rutland County, Vermont
48.	Fallow pasture	0.16 km and 195^{o} from elevation 255.4 m, Town of Castleton, Rutland County, Vermont
49.	Willow-witch hazel pasture	0.24 km and 115^{o} from elevation 296.0 m, Town of Hubbardton, Rutland County, Vermont
50.	Cattail field	1.13 km and 240^{o} from the 686 ft BM, Town of Hubbardton, Rutland County, Vermont

No.	Habitat	Location
51.	Outcrops, talus, and steep forested slope	1.13 km and 15^{o} from elevation 103.9 m, Town of Hampton, Washington County, New York
52.	Flat forest floor adjacent to Glen Lake	0.80 km and 260^{o} from elevation 172.5 m, Town of Castleton, Rutland County, Vermont

Table 3. Edaphic, lithologic, and vegetative features of the trap-sites.

Soil Key: A+W = Adams and Windsor loamy fine sand; Sch = Schodack gravelly fine sandy loam; N ro = Nassau rock outcrop; Cop = Copake gravelly fine sandy loam; B stl = Bernardston stony loam; D l = Dutchess loam; St l = Stockbridge loam; R = rough stony land; D stl = Dutchess stony loam; N sl = Nassau silt loam; N vstl = Nassau very stony loam; B vstl = Bernardston very stony loam; P vstl = Pittstown very stony loam; P stl = Pittstown stony loam; H sl = Hadley silt loam; N stl = Nassau stony loam; B sl = Bernardston silt loam; U = undifferentiated alluvial; Cop g = Copake gravelly loam; M+P = muck and peat; N sh = Nassau shale loam; Cos l = Cossayuna loam; Suf sl = Suffield silt loam; O = Oakville loamy fine sand.

Bedrock Key: MS = Mettawee Slate; WCF = West Castleton Formation; PF = Pawlet Formation; BKF = Biddie Knob Formation; BG = Bomoseen Graywacke; ZHQ = Zion Hill Quartzite; CF = Chipman Formation; NBC = North Brittain Conglomerate; MPQ = Mudd Pond Quartzite; PS = Poultney Slate; H = Hortonville Formation; HH = Hatch Hill

Tree Key: H= hemlock; Wp = white pine; Av = arborvitae; Qa = quaking aspen; Yb = yellow birch; Hhb = hophornbeam; Bf = balsam fir; Rm = red maple; Sm = sugar maple;

Pb = paper birch; Ae = American elm; Hw = hawthorne; Bm = black maple; A = apple; Sw = sandbar willow; Ss = staghorn sumac; S = sycamore; Ab = American beech; Ro = red oak; Ah = American hornbeam; Sh = shagbark hickory; Bb = blackbirch; B = basswood; Se = slippery elm; Wa = white ash; T = tamarack; Wh = witch hazel; W = willow.

East of Route 30

No.	Soil	Bedrock	Dominant Canopy Species
1.	A+W	MS	H, Wp, Av
2.	Sch	WCF	Yb, H, Hhb
10.	N ro	PF	Wp, Rm
11.	Cop g	PF	Hw, Sm, Bm
12.	B stl	WCF	A
13.	N ro	MS	H, Yb, Pb, Qa
17.	D l	MS	Yb, H, Ab, Pb
18.	St l	MS	Wp, H, Pb
19.	R	BKF	Sm, Pb
21.	St l	MS	Sm
22.	D stl	MS, BG	Ah, Ab, Hhb, Sh
23.	D stl	ZHQ	Rm, Wp, Bb
26.	R	MS	Bf
27.	N sl	MS	Sm
34	D l	WCF	Wp, Sm
36.	N vstl	WCF	Wp, Av

No.	Soil	Bedrock	Dominant Canopy Species
37.	B vstl	MS	H, Wp, Hhb
38.	P vstl	MS	Pb, H, Sm, Yb, Sh
39.	B vstl	MS	Wa, Sm, Wp, H
40.	P stl	BKF	H
45.	H sl	MS, ZHQ	Sm, Wp, H
46.	N stl	MS	Wp
47.	St l	MS, NBC, MPQ	Sm
48.	B sl	MS	none
49.	U	MS, BG	W, Wh
50.	Cop g	MS	W
		West of Route 30	
3.	N stl	MS, BG	Wp, Qa
4.	M+P	MS	H, Av, Bf
5.	N ro	PS	Sm, Pb, Ae
6.	N sh	WCF, BG	Sm, Ae
7.	Cos l	MS, HF	H, Yb
8.	Suf sl	MS	Sw, Qa, Ss, S
9.	N sh	MS	Sm, H
14.	Suf sl	MS, HF	Sm, Ab, H
15.	N sh	WCF	Sm, Ro, Ab, H
16.	O	PS	Sm, H
20.	D stl	HH	Wp, Sh, Qa. Ab, Pb
24.	O	HF	Wp, H, B, Sm
25.	N ro	PS	Hhb, Pb, Ab

No.	Soil	Bedrock	Dominant Canopy Species
28.	N sl	MS	Sm, Hhb
29.	N stl	WCF	Sm, Ae, Se
30.	Cos l	MS	Bb, Ab, Yb, H
31.	U	MS	Wp, H
32.	N sl	WCF	Wa, Pb, Wp
33.	N ro	PS, HH	Sm, Rm, Pb, Bb
35.	Suf sl	MS	Wp, T, Wh, Sm
41.	N sl	HF	Sm, Hhb
42.	D stl	HH	Pb, Wp, Sm, Ae
43.	D stl	BG	Wp
44.	N ro	WCF	A
51.	O	CF	Ae, Ab
52.	Cos l	MS	H

Table 4. Comparison of catch/1000 trap-nights in different years of trapping, and catch/1000 trap-nights for all years of trapping. *Tamias striatus* ommitted. Key follows Table 1.

	Sf	Bb	Cc	Cg	Mp	Pmg	Pln	Zh	Ni
1974 captures (6262 trap-nights)	7	43	1	23	1	5	75	1	2
1974 captures/1000 trap-nights	1.1	6.9	0.1	3.7	0.2	0.8	12.0	0.2	0.3
1975 captures (2618 trap-nights)	3	22	0	7	2	2	19	0	7
1975 captures/1000 trap-nights	1.1	8.4	0	2.7	0.8	0.8	7.3	0	2.7
1974+1975 captures (8880 trap-nights)	10	65	1	30	3	7	94	1	9
1974+1975 captures/1000 trap-nights	1.1	7.3	0.1	3.4	0.3	0.8	10.6	0.1	1.0

Table 5. Comparison of catch/1000 trap-nights for all species for all years of trapping.

Year	Overall catch/1000 trap-nights
1974	25.55
1975	23.68
1974+1975	25.00

Table 6. Results of trapping in other regions for the same species trapped in, or known to occur adjacent to, the slate belt.

Source	Area	Catch/1000 trap-nights
Jameson (1949)	Central New York	126.1
Miller (1964a)	Northeast Vermont	54.8
Miller (1964b)	Northeast Vermont	67.3
Christian (1971b)	Southeast Pennsylvania	95.0
Van Deusen (unpublished)	Northcentral Kansas	80.0
Van Deusen (unpublished)	Northcentral Kansas	109.0
Kaufman (unpublished)	Northcentral Kansas	96.8
Van Deusen (unpublished)	West Virginia	101.6
Van Deusen (unpublished)	Northern New York	114.3
Van Deusen (unpublished)	Southeastern Vermont	120.8
Van Deusen (unpublished)	Southeastern Vermont	180.2

Table 7. Captures of each species on each type of bedrock. The proportion of trap-nights set on each type of bedrock was utilized for the χ^2 analysis. Species key follows Table 1. Δ = p<.05; ∇ =p<.025; * =p<.01; † =p<.005; ↑ = number greater than expected; ↓ = number less than expected; () = approaches significance at the level indicated.

Bedrock		Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni
Biddie Knob Formation		350		2			2			7∇↑		
Bull Formation	Mettawee Slate	4882	6	37		2	19	2	4	51		7
	Zion Hill Quartzite	200		1			2			4		
	Bomoseen Graywacke	85								2		
West Castleton Formation		1306	3	5Δ↓	1		6	1	3†↑	5†↓		2
Pawlet Formation		300		Δ↓						1	1	
Mount Hamilton Formation	Poultney Slate	720	1	13†↑			Δ↓			6		
	Hatch Hill	300		2						4		
Hortonville Formation		470		2			1			13†↑		
Chipman Formation		267		3						1		
Total		8880	10	65	1	2	30	3	7	94	1	9

Table 8. Captures of each species on each type of soil. The proportion of trap-nights set on each type of soil was utilized for the χ^2 analysis. Species key follows Table 1. Symbol key follows Table 7.

Soil and Site	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni
Rough stony land 19, 26	400		∇↓						9†↑		
Muck and peat 4	200		4 †↑						Δ↓		
Cossayuna loam 7, 30, 52	846		8			6*↑		2	4∇↓		3
Dutchess loam and stony loam 23, 17, 20, 22, 42, 43	1239	(3)Δ↑	10			8*↑			28†↑		1
Bernardston stony loam 12, 37, 39	680		3			1	1	1	3Δ↓		3
Stockbridge loam 18, 21, 47	490		4			4∇↑		1	7		
Nellis very stony loam 36	192		2						1		
Pittstown stony loam 38, 40	250	1	2			2			1		

Soil and Site	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni
Nassau stony loam and Nassau rock outcrop 29, 3, 13, 46, 15, 9, 6, 25, 10, 5, 33, 44	2008	2	(20)Δ↑		1	1†↓			17		Δ↓
Silt and sandy loams (Adams and Windsor; Oakville; Schodack; Hadley; Bernardston; Nassau; Copake; undifferentiated) 1, 16, 24, 51, 2, 11, 50, 8, 14, 31, 35, 49, 45, 48, 27, 28, 32, 34, 41	2575	4	12Δ↓	1	1	8	2	3	24	1	2
Total	8880	10	65	1	2	30	3	7	94	1	9

Table 9. Captures of each species in different types of habitats. The proportion of trap-nights on each type of habitat was utilized for the X^2 analysis. Species key follows Table 1. Symbol key follows Table 7.

Habitat and Site	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni
Streamside	(1351)										
Rocky cover 2, 7, 8, 16, 17, 24, 26, 30, 37, 39, 43	562	1	3			4$\Delta\uparrow$			2$\nabla\downarrow$		
Logs and roots 7, 8, 14, 24, 27, 30 37,39, 43	291		$\nabla\downarrow$		1	2			1		
Litter 24, 39	41										
Tree bases 7, 8, 14, 16, 17, 24,27, 30, 37, 39, 43	457		4			2		1	4		2

Habitat and Site	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni
Steep forested slopes	(3097)										
Outcrops 2, 7, 11, 13, 15, 17, 19, 20, 22, 23, 24, 25, 26, 29, 33, 38, 39, 40, 51	842	3†↑	6	1		10†↑		1	10	—	3
Holes 2, 5, 13, 15, 7, 25	35					1		2			
Logs and roots 2, 5, 7, 11, 13, 14, 15, 17, 19, 20, 22, 23, 25, 26, 29, 33, 35, 38, 39, 40, 51	761	3†↑	11†↑			1			11		
Litter 2, 5, 11, 13, 14, 15, 17, 19, 20, 22, 24, 25, 26, 29, 31, 40, 7	151		5†↑						2		
Tree bases 2, 5, 7, 11, 13, 14, 15, 17, 19, 20, 22, 23, 24, 25, 26, 29, 33, 38, 39, 40, 51	1308	2	7			1▽↓		1	17		2

Habitat and Site	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni
Gentle to moderate forested slopes	(3310)										
Outcrops 3, 6, 10, 11, 13, 17, 18, 21, 23, 26, 28, 29, 31, 32, 33, 34, 36, 39, 41, 42, 43, 45, 46, 51, 52,9	1093		6		1	6		1	16Δ↑		1
Holes 10, 17, 41, 46, 52	34										
Logs and roots 1, 6, 10, 13, 17, 18, 23, 26, 28, 42, 43, 46, 51, 52	543		8†↑			2			8		1
Litter 1, 6, 10, 13, 17, 18, 23, 26, 28, 32, 34, 36, 41, 42, 43, 46, 51	131		2						1		
Tree bases 1, 6, 9, 10, 11, 13, 17, 18, 20, 23, 26, 28, 29, 31, 32, 33, 34, 36, 39, 41, 42, 43, 45, 46, 51, 52	1509	1	5*↓			1▽↓		1	19		

Habitat and Site	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni
Pasture	(922)										
Outcrops 11, 13, 45, 47	76		1							1	
Tree bases 11, 12, 13, 44, 45 47	392		2				1		2		
Grass 13, 44, 47, 48, 49, 50	454		1				2		1*↓		
Bog	(200)										
Tree bases 4	114		3								
Logs and roots 4	68		1								
Holes and litter 4	8										
Water pools 4	4										
Outcrops 4	6										
Total	8880	10	65	1	2	30	3	7	94	1	9

Table 10. Total captures in different habitats. The proportion of trap-nights on each type of habitat was utilized in the X^2 analysis. Symbol key follows Table 7.

Habitat	Trap-nights	Total Captures
Streamside	1351	27
Steep forest slopes	3097	100†↑
Gentle to moderate forested slopes	3310	80
Pasture	922	11†↓
Bog	200	4
Total	8880	222

Table 11. Captures of each species in different types of cover across all types of habitat. The proportion of trap-nights in each type of cover was utilized for the X^2 analysis. Species key follows Table 1. Symbol key follows Table 7.

Type of Cover	Trap-nights	Sf	Bb	Cc	Ts	Cg	Mp	Pmg	Pln	Zh	Ni
Outcrops and rocks	2579	4	16	1	1	20†↑		2	28	1	4
Logs and roots	1663	3	20†↑		1	5			20		1
Litter	331		7*↑						3		
Tree bases	3780	3	21			4†↓	1	3	42		4
Holes	69					1		2†↑			
Grass	454		1				2		1∇↓		
Water pools	4										
Total	8880	10	65	1	2	30	3	7	94	1	9

Table 12a. Ground cover by species on steep forest slopes, for the various types of bedrock. A single number indicates the species occurred once, and is the actual percentage of coverage on a square meter plot. Two numbers indicate the range of coverage supplied when the species occurred more than once. Bedrock key follows Table 3. Species key: s = seedling. The number above the bedrock column indicates the number of plots surveyed on each type of bedrock.

	3	17	3	1	6	2	7	2	1	1
Species	BK	MS	ZHQ	BG	WCF	PF	PS	HH	HF	CF
Fraxinus americana s		1 3			5		1		5	
Populus tremuloides s										
Tsuga canadensis s					2			5		
Acer saccharum s		1 5			2		1 5	20	5	
Acer spicatum s										
Acer pennsylvanicum s										
Pinus strobus s		4					5			
Prunus virginiana s										
Ulmus sp. s										
Fagus grandifolia s		10			4					

Species	BK	MS	ZHQ	BG	WCF	PF	PS	HH	HF	CF
Tilia americana s										
Acer rubrum s		2								
Carpus caroliniana s		5 30								
Ostrya virginiana s										
Hamamelis virginiana s	5							1		
Quercus rubra s		1 5					1			
Quercus alba s										
Betula s										
Rhus typhina s										
Juniperus communis										
Graminae	20 60	1 50	1 40	10	10	80	1	20		
Parmelia sp.										
Thuidium sp.		1								
Ptilidium pulchrinum		1		1	1					
Porella platyphylloides		1 5			1					
Selaginella rupestris		1	5							
Lycopodium complanatum			3 10				5			
Lycopodium annotinum										
Cirsium sp.		5				5				
Asclepsias syriaca										
Ambrosia artemisifolia	10									
Equisetum arvense										
Onoclea sensibilis	3	1								
Poltstichum acrostichiodes	5 10	1 5		2			1	2		5

Species	BK	MS	ZHQ	BG	WCF	PF	PS	HH	HF	CF
Pteridium aquilinum										
Dryopteris sp.	2	1 5	3 5		1 5		5	5 10		
Dryopteris disjuncta	1									
Asplenium platyneuron										5
Thelypteris noveboracensis							5			
Polypodium polypodioides										
Thelypteris pubescens		2								
Athyrium filix-femina		3								
Osmunda regalis										
Uvularia sessilifolia										
Brassica rapa										
Convolvulus sepium		5								
Stellaria media										
Achillea millefolium								5		
Plantago major										
Pteridium aquilinum	2									
Medicago lupulina										
Ranunculus bulbosus	2									
Vitis sp.						2				
Viburnum acerifolium										
Impatiens pallida	2									
Iris versicolor	2 2									
Asarum canadense										
Maianthemum canadense		1	3		1 2				3	
Trillium grandiflorum									2	

Species	BK	MS	ZHQ	BG	WCF	PF	PS	HH	HF	CF
Coptis groenlandica										
Podophyllum peltatum									5	
Parthenocissus sp.						8				
Gaultheria procumbens										
Rubus odoratus				1						
Thalictrum polygamum										
Solidago sp.		1				15	5	10		
Trifolium repens										
Trifolium pratense										
Rubus sp.						1				
Waldsteinia fragaroides				2				2		
Lilium sp.										
Medeola virginiana			15							
Vaccinium sp.			50							
Smilacena racemosa		12					1			
Polygonatum biflorum		25			12		1			
Rhus radicans				2			1			
Aralia nudicaulis										
Actaea rubra		1								
Compositae sp.		1								
Mitchella repens										
Viola sp.										
Geranium robertianum										
Chrysanthemum leucanthemum										

Species	BK	MS	ZHQ	BG	WCF	PF	PS	HH	HF	CF
Taraxacum officinale										
Caltha palustris										
Uvularia sessilifolia										
Arisaema triphyllum										
litter of needles	34	15 99	5 60	40	3 48		1 23	20 60	8	5
deciduous litter	50	57 95	5 40	40	18 76	70	53	26	68	35
bare					40 80	10	100 40		10	50

Table 12b. Ground cover by species on moderate to gentle forest slopes, for the various types of bedrock. Data presented as in Table 12a.

Species	BK (1)	MS (21)	ZHQ (1)	WCF (9)	PF (3)	PS (2)	HH (4)	HF (3)	CF (3)
Fraxinus americana s				1 39		2		1 10	
Populus tremuloides s		1							
Tsuga canadensis s		2							2
Acer saccharum s		1 3		1 3		1 10	1	20 25	1
Acer spicatum s									
Acer pennsylvanicum s		1 2							
Pinus strobus s		20		5					
Prunus virginiana s		3							
Ulmus sp. s		15							
Fagus grandifolia s		1		1					
Tilia americana s							1		1
Acer rubrum s						10			1
Carpus caroliniana s									
Ostrya virginiana s		3							
Hamamelis virginiana s		1 10					1	5	
Quercus rubra s		2						4	
Quercus alba s		10							
Betula sp. s		1							
Rhus typhina s									

Species	BK	MS	ZHQ	WCF	PF	PS	HH	HF	CF
Juniperus communis									
Graminae		1 50		1 50	20 80	10	2	15 28	
Parmelia sp.					2				
Thuidium sp.									
Ptilidium pulchrinum		1 2			1 5				
Porella platyphylloides		1							
Selaginella rupestris		1 4						4	
Lycopodium complanatum		1 2			1		1		
Lycopodium annotinum		5 15							
Cirsium sp.					10				
Asclepsias syriaca									
Ambrosia artemisifolia									
Equisetum arvense									
Onoclea sensibilis		1 5			2				
Polystichum acrostichoides		1 5		8		1	1 2		
Pteridium aquilinum		5							
Dryopteris sp.		1 5	10	2 30	1	3	1	1 4	
Dryopteris disjuncta		3							
Asplenium platyneuron									
Thelypteris noveboracensis									
Polypodium polypodioides					1				
Thelypteris pubescens									
Athyrium filix-femina									
Osmunda regalis		1							
Uvularia sessilifolia					10				
Brassica rapa					5				

Species	BK	MS	ZHQ	WCF	PF	PS	HH	HF	CF
Convolvulus sepium									
Stellaria media		1							
Achillea millefolium		1			1				
Plantago major									
Pteridium aquilinum									
Medicago lupulina									
Ranunculus bulbosus		2 5			1				
Vitis sp.		1		1 15	1 10				1 5
Viburnum acerifolium							1		1
Impatiens pallida									
Iris versicolor									
Asarum canadense		2							
Maianthemum canadense		2	1				1		
Trillium grandiflorum	1								
Coptis groenlandica							1		
Podophyllum peltatum									
Parthenocissus sp.					5				1
Gaultheria procumbens		2							
Rubus odoratus									
Thalictrum polygamum									
Solidago sp.		1		25 70	1 20	20	1	5	2
Trifolium repens									
Trifolium pratense		1							
Rubus sp.		2 5			2	5			

Species	BK	MS	ZHQ	WCF	PF	PS	HH	HF	CF
Waldsteinia fragaroides		3			2				
Lilium sp.			10		1		2		
Medeola virginiana									
Vaccinium sp.									
Smilacena racemosa		1 10		1			2		
Polygonatum biflorum		1 5		1 2					1
Rhus radicans									1
Aralia nudicaulis		1							
Actaea rubra		10							
Compositae sp.				1			1		
Mitchella repens		1							
Viola sp.		2							
Geranium robertianum		1 10							1
Chrysanthemum leucanthemum		2 5			1				
Taraxacum officinale		13							
Caltha palustris				1	10				1
Uvularia sessilifolia					10				
Arisaema triphyllum			1		1			1	
litter of needles	5 94	1 100				6 95	89	7 95	
deciduous litter		1 97	78	14 95	1 5	40 99	5 95	65 75	63
bare		1 50		1 50	20 80	10	2		15 28

Table 12c. Ground cover by species in streamside habitats for the various types of bedrock. Data presented as in Table 12a.

Species	MS	BG	WCF	PS	HF
Fraxinus americana s	15				
Populus tremuloides s					
Tsuga canadensis s	12				2
Acer saccharum s	1				
Acer spicatum s	2				
Acer pennsylvanicum s					
Pinus strobus s	1				
Prunus virginiana s					
Ulmus sp. s					
Fagus grandifolia s					
Tilia americana s	2				
Acer rubrum s					
Carpus caroliniana s					
Ostrya virginiana s	1				
Hamamelis virginiana s	1				
Quercus rubra s	1				
Quercus alba s					
Betula sp.s					
Rhus typhina s			90		

Species	MS	BG	WCF	PS	HF
Juniperus communis	1				
Graminae	1 98		1 10		3
Parmelia sp.					
Thuidium sp.	1				
Ptilidium pulchrinum	1 3	1		10	2
Porella platyphylloides	1 30				
Selaginella rupestris	2 5				
Lycopodium complanatum	2 5				
Lycopodium annotinum	5				
Cirsium sp.					
Asclepsias syriaca	3 14				
Ambrosia artemisifolia	3 5				
Equisetum arvense	1 5				
Onoclea sensibilis	3 5				
Polystichum acrostichoides	1 75	2			
Pteridium aquilinum					
Dryopteris sp.	1 10		4	5	1
Dryopteris disjuncta					
Asplenium platyneuron					
Thelypteris noveboracensis	1 2				
Polypodium polypodioides					
Thelypteris pubescens					
Athyrium filix-femina					
Osmunda regalis					
Uvularia sessilifolia					
Brassica rapa					

Species	MS	BG	WCF	PS	HF
Convolvulus sepium					
Stellaria media					
Achillea millefolium	1 4				
Plantago major	5				
Pteridium aquilinum					
Medicago lupulina	1				
Ranunculus bulbosus	1				
Vitis sp.	1 50				
Viburnum acerifolium					
Impatiens pallida					
Iris versicolor					
Asarum canadense					
Maianthemum canadense	1 2	1			
Trillium grandiflorum	1				
Coptis groelandica	1				
Podophyllum peltatum					
Parthenocissus sp.					
Gaultheria procumbens					
Rubus odoratus	1 5				
Thalictrum polygamum	20				
Solidago sp.	5				
Trifolium repens					
Trifolium pratense	14				
Rubus sp.					

Species	MS	BG	WCF	PS	HF
Waldsteinia fragaroides	1 4				
Lilium sp.					
Medeola virginiana	1				
Vaccinium sp.	2 5				
Smilacena racemosa	1	1			
Polygonatum biflorum	1 5				
Rhus radicans	1				2
Aralia nudicaulis					
Actaea rubra	1				
Compositae sp.					
Mitchella repens					
Viola sp.	3				
Geranium robertianum	2				
Chysanthemum leucanthemum	5				
Taraxacum officinale					
Caltha palustris					
Uvularia sessilifolia					
Arisaema triphyllum	1 2				
litter of needles	1 90	4	48	1	9 65
deciduous litter	1 98	16	48	19	55
bare	5 90	75		65	30

Table 13. Results of trapping in the slate belt for the years 1951, 1952, 1953, 1968, 1969, 1972, 1973, and 1974. Data from Christian, et al., (unpublished).

Year	Catch/1000 trap-nights
1951	42.23
1952	56.91
1953	27.10
1968	30.53
1969	21.04
1972	48.47
1973	53.08
1974	24.88
Total	44.39

Table 14. Captures of each species on different types of bedrock (excluding bedrock with lacustrine or alluvial soils). The proportion of trap-nights on each type of bedrock was utilized for the χ^2 analysis. Species key follows Table 1. Symbol key follows Table 7. Data from present study, and Christian et al., (unpublished).

Bedrock	First Trap-nights	Sf	Bb	Cg	Mp	Pmg	Pln	Zh	Ni
Biddie Knob Formation	250		6				4		
Mettawee Slate	2963	9	33	20†↑	1	17	41		3
Zion Hill Quartzite	454		5	3	1	1	4		5†↑
Bomoseen Graywacke	228		4				4		
West Castleton Formation	581	5*↑	9	Δ↓		Δ↓	3*↓		
Pawlet Formation	550	Δ↓	9	Δ↓		9†↑	8	1	3†↑
Poultney Slate	344	1	8				6		
Hatch Hill Formation	200		2				3		
Hortonville Slate	468	2	14†↑			Δ↓	17†↑		
Chipman Formation	248	6†↑	8†↑				(1)Δ↓		
Total	6286	23	98	23	2	27	91	1	11

Table 15. Captures of each species on different types of soils. The proportion of trap-nights on each type of soil was utilized for the χ^2 analysis. Species key follows Table 1. Symbol key follows Table 7. Data from present study, and Christian, et al., (unpublished).

Soil	First Trap-nights	Sf	Bb	Cg	Mp	Pmg	Pln	Zh	Ni
Muck and peat	1228	4	15	3	8†↑	*↓	13		4∇↑
Alluvial and lacustrine	2512	1†↓	18†↓	4Δ↓	14†↑	3∇↓	35	7†↑	(1)Δ↓
Nassau rock outcrop; Nassau stony and slate loam	2550	11Δ↑	45†↑	7	1†↓	18†↑	32	1	3
Dutchess loam and stony loam	1460	2	16	9†↑		4	19		3
Cossayuna loam	814		(6)Δ↓	5Δ↑	()Δ↓	3	10		1
Stockbridge loam	395	1	3	3Δ↑		1	8		
Addison soil	397	8†↑	20†↑				13†↑		

Soil	First Trap-nights	Sf	Bb	Cg	Mp	Pmg	Pln	Zh	Ni
Rough stony land	200		∇↓				5Δ↑		
Bernardston stony loam	340		3			1	1∇↓		2
Nellis very stony loam	96		1						
Pittstown stony loam	125	1		1					
Total	10117	28	127	32	23	30	136	8	14

Table 16. Captures of each species in different habitats. The proportion of trap-nights in each type of habitat was utilized for the χ^2 analysis. Species key follows Table 1. Symbol key follows Table 7. Data from present study, and Christian, et al., (unpublished).

Habitat	First Trap-nights	Sf	Bb	Cg	Mp	Pmg	Pln	Zh	Ni
Pasture	1739	†↓	15Δ↓	∇↓	12†↑	†↓	24	7†↑	Δ↓
Deciduous bogs	363	3	3		4†↑		7		1
Evergreen bogs	1020	1	12	3	6†↑	∇↓	7*↓		3
Forest brooks	2576	10	37	14†↑	1∇↓	20†↑	26Δ↓	1	7*↑
Gentle to moderate forest slopes	2215	3	20Δ↓	8	†↓	6	31		∇↓
Steep forest slopes	2204	11*↑	40†↑	7	†↓	4	41†↑		3
Total	10117	28	127	32	23	30	136	8	14

Figure 1. Site 17, south of Belgo Road.

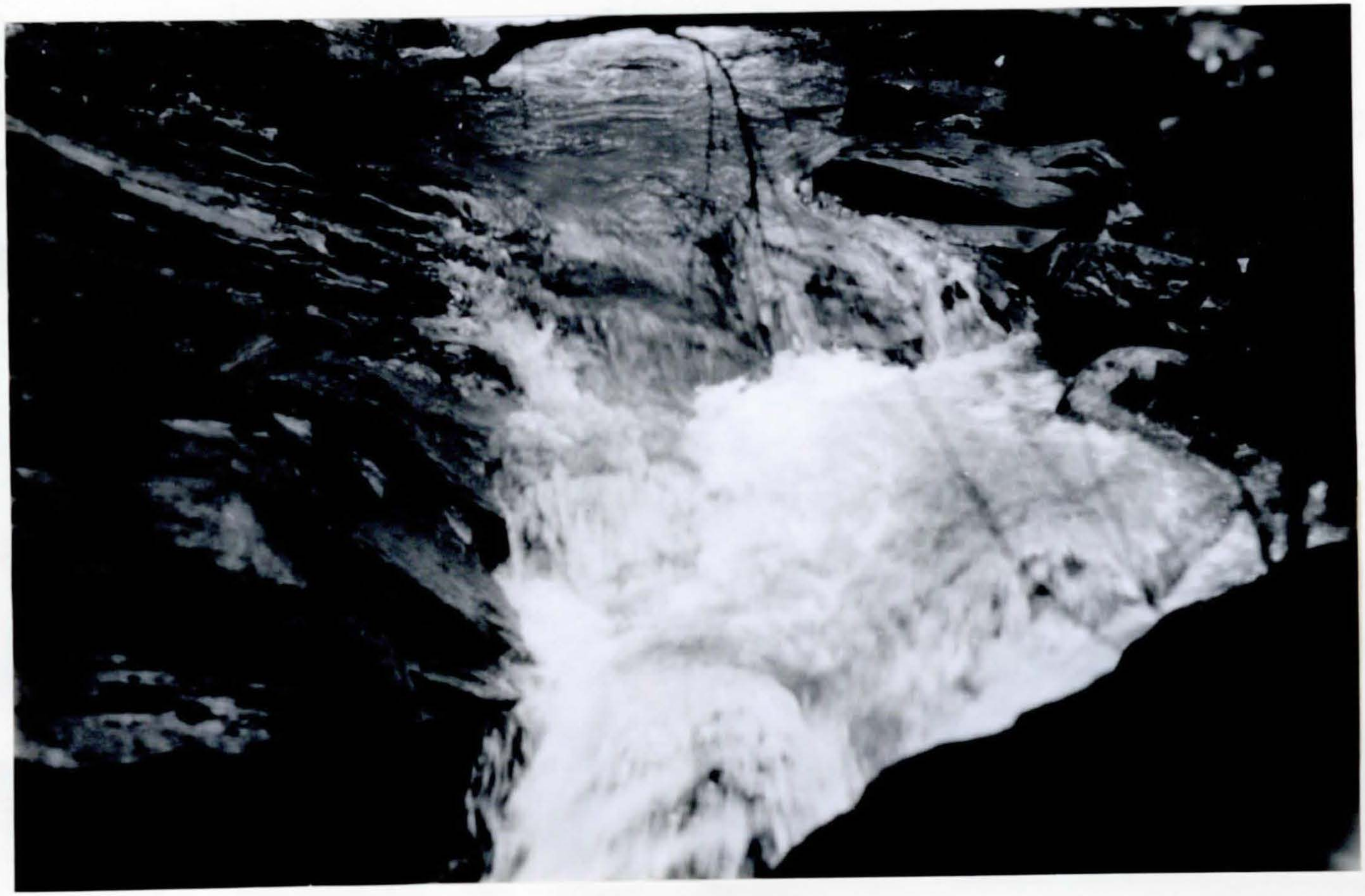
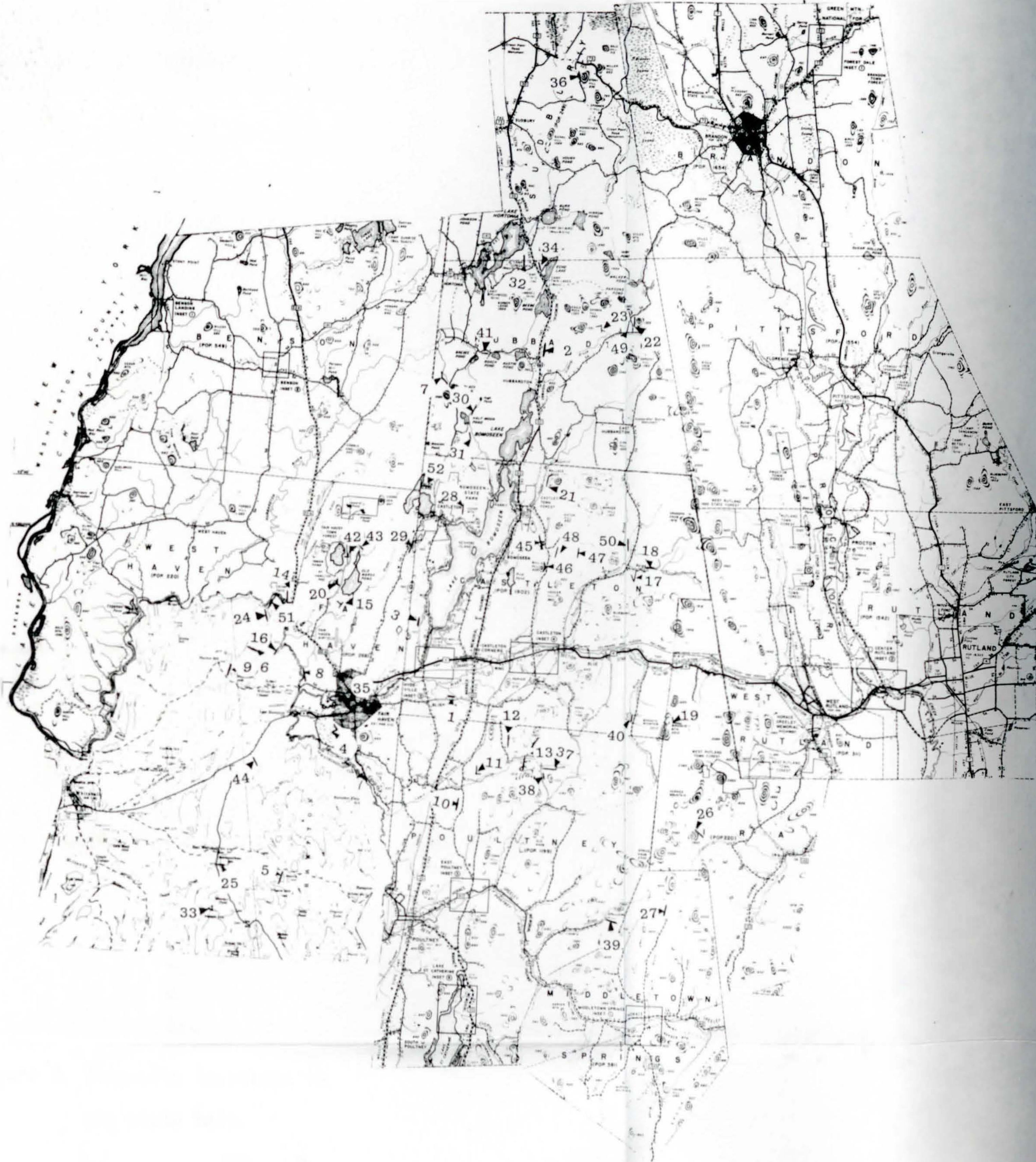


Figure 2. Site 18, north of Belgo Road.


36
34
32
41
2
23
49
22
7
30
31
52
28
21
29
42 43
45
48
50
18
47
46
17
14
20
15
24
51
3
16
9 6
8
35
1
12
40
19
4
13 37
11
38
44
10
26
5
25
33
27
39
RUTLAND
LAKE BOMOSEEN

C

Scale in km

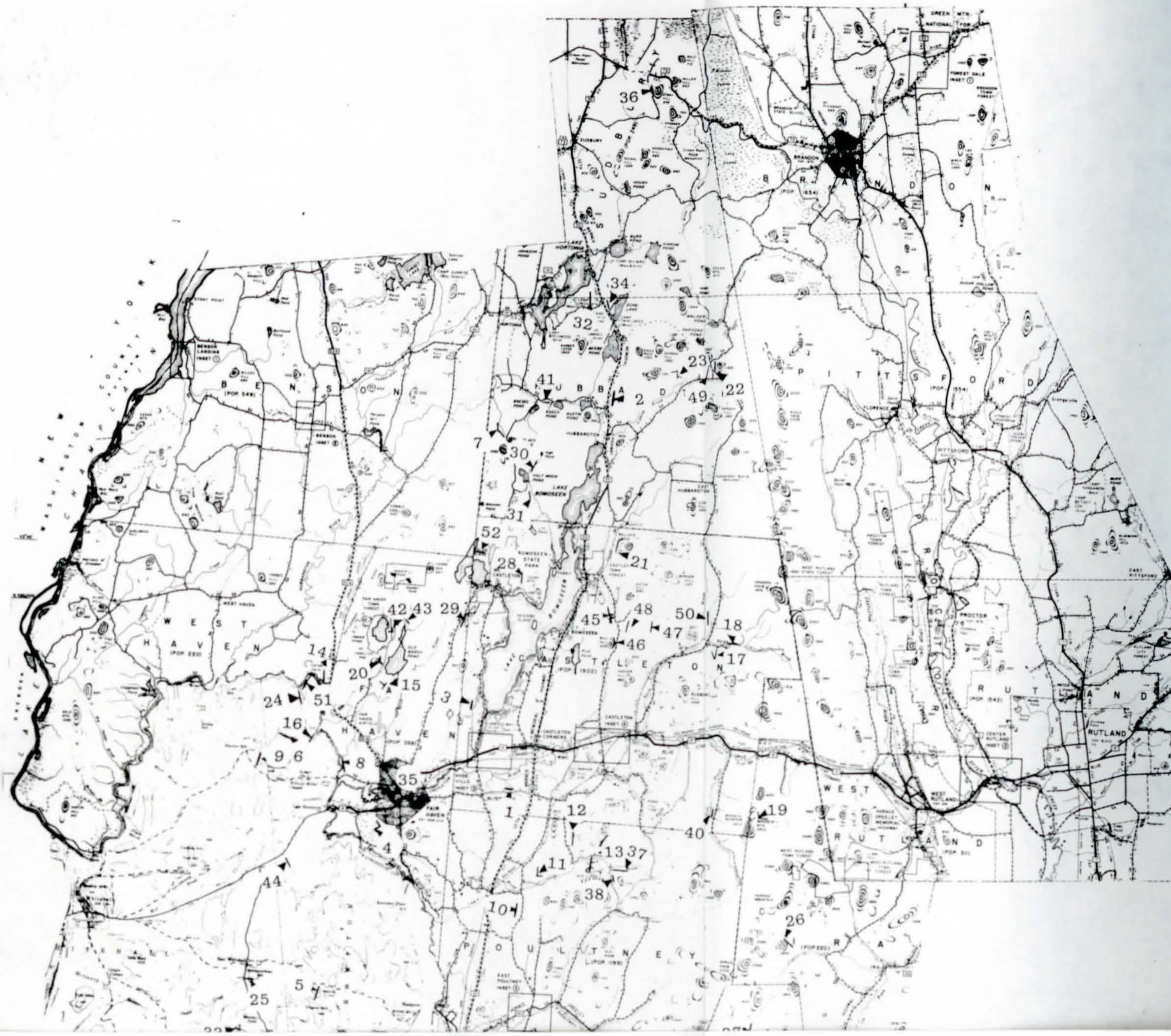


Figure 3. Trap-site locations in

the slate belt.

0 4.0 8.0 N

Scale in km

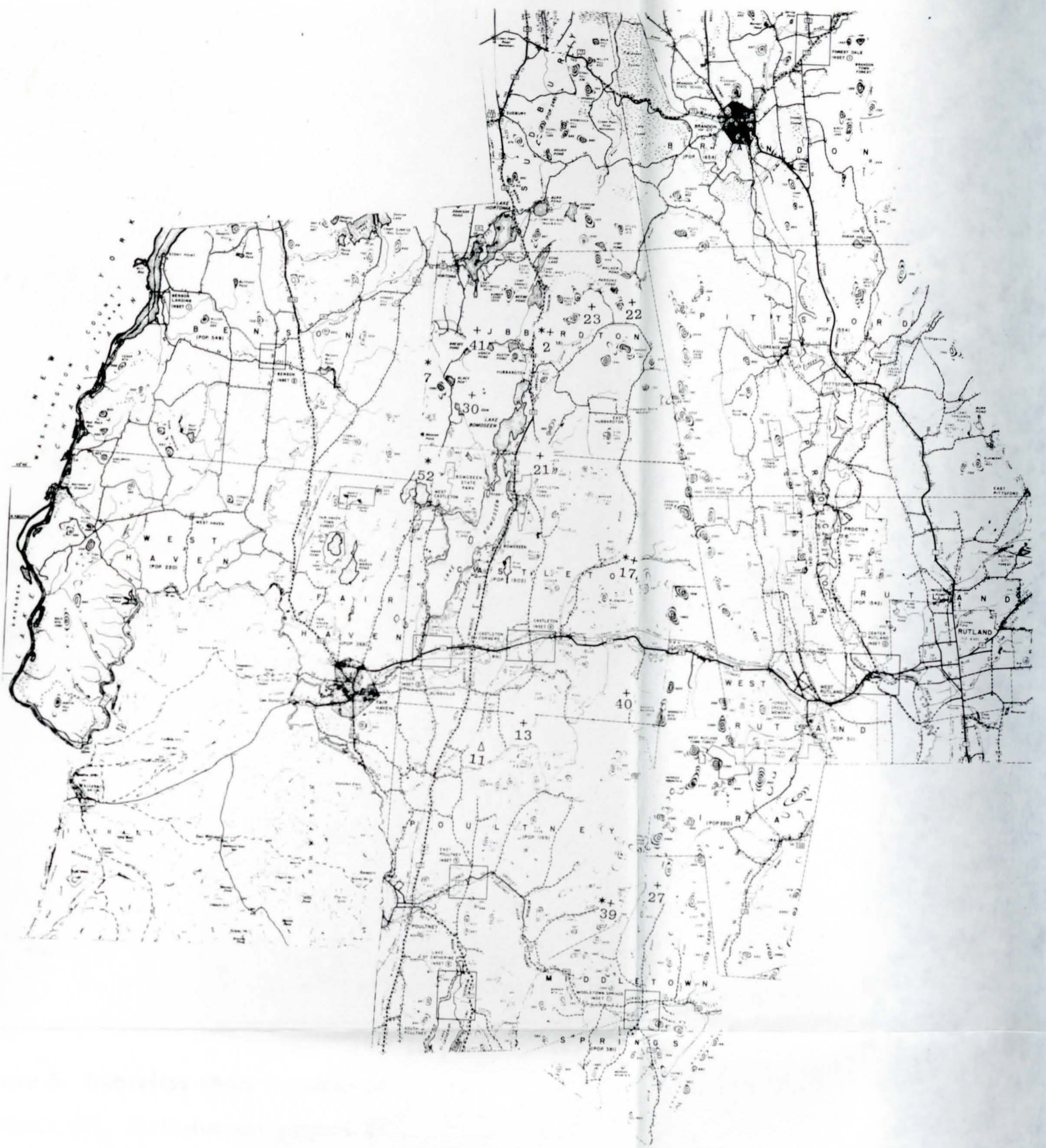

36
34
23
41
2
7
30
52
45
50
18
47
46
17
20
14
51
15
3
6
9
35
4
40
37
38
25
5
27
RUTLAND
PROCTOR
PITTSFORD
LAKE BOMOSEEN
BOMOSEEN STATE PARK
WEST HAVEN
GREEN MTN. NATIONAL FOREST

Scale in km

Figure 4. Trap-sites where *Sorex fumeus* (*) and *Blarina brevicauda* (+) were captured

0 4.0 8.0 N

Scale in km



BENSON
WEST HAVEN
FAIR HAVEN
CASTLETON
POULTNEY
MIDDLETOWN SPRINGS
IRA
WEST RUTLAND
RUTLAND
PITTSFORD
BRANDON
SUDBURY
HUBBARDTON
LAKE BOMOSEEN
23
22
41
2
7
30
52
21
17
40
13
11
27
39

Figure 5. Trap-sites where *Napaeozapus insignis* (*), *Clethrionomys gapperi* (+), and *Zapus hudsonius* (Δ) were captured

0 4.0 8.0

N ↑

Scale in km


S U D B U R Y
B R A N D O N
(POP 1654)
BRANDON
NATIONAL FOR
FOREST DALE
B E N S O N
(POP 549)
BENSON LANDING
H U B B A R D T O N
(POP 238)
P I T T S F O R D
(POP 1554)
PITTSFORD
NEW YORK
WASHINGTON COUNTY
LAKE CHAMPLAIN
LAKE BOMOSEEN
BOMOSEEN STATE PARK
W E S T
H A V E N
(POP 220)
F A I R
H A V E N
(POP 2581)
FAIR HAVEN
C A S T L E T O N
(POP 1902)
CASTLETON
PROCTOR
R U T L A N D
RUTLAND
CENTER RUTLAND
WEST
R U T L A N D
P O U L T N E Y
POULTNEY
EAST POULTNEY
LAKE ST CATHERINE
I R A
(POP 220)
M I D D L E T O W N
S P R I N G S
MIDDLETOWN SPRINGS
EAST PITTSFORD
*
50
*
12

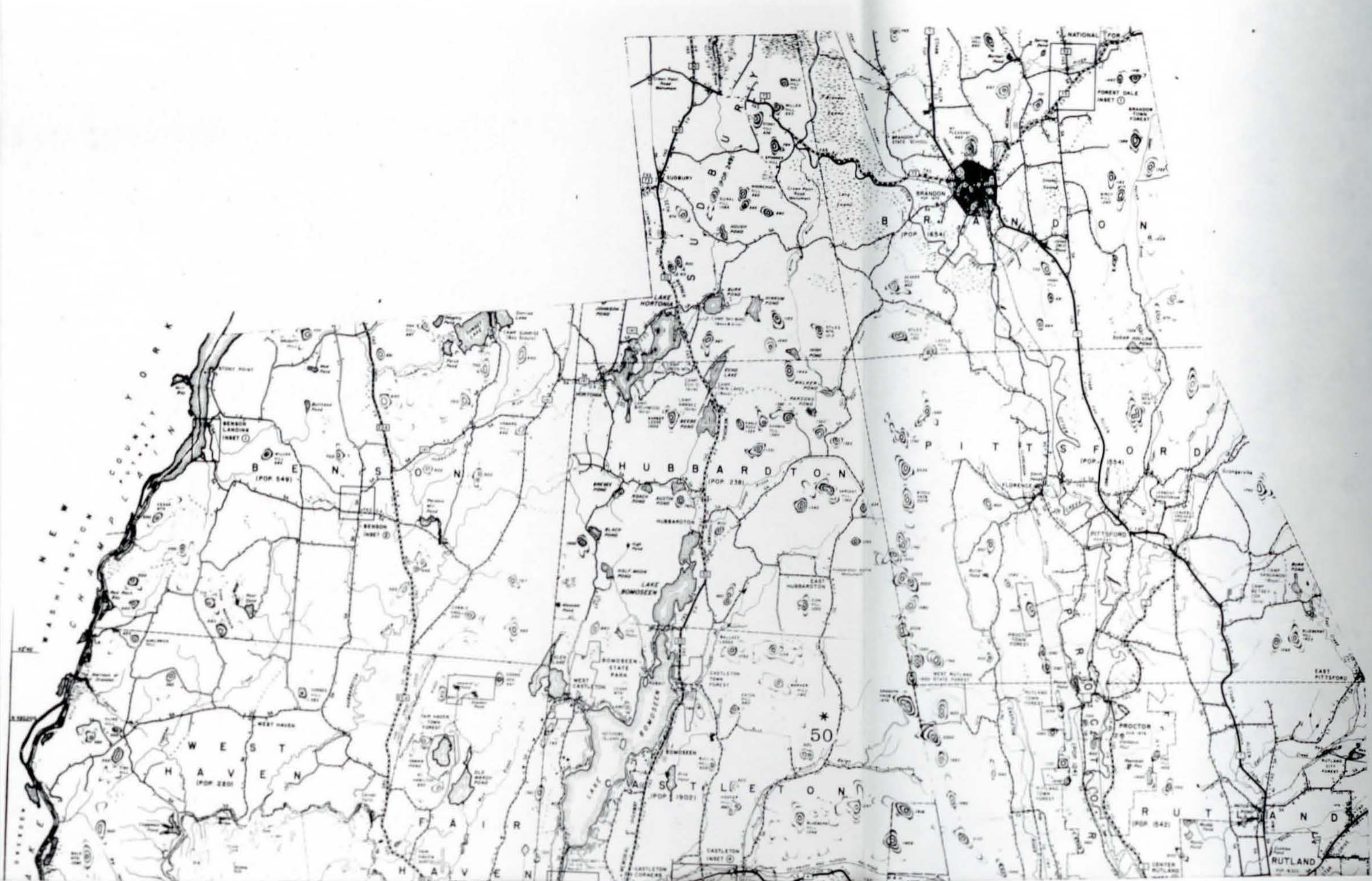


Figure 6. Trap-sites where *Microtus pennsylvanicus*(*) was captured

0 4.0 8.0 N

Scale in km


BENSON
WEST HAVEN
FAIR HAVEN
HUBBARDTON
CASTLETON
POULTNEY
MIDDLETOWN SPRINGS
PITTSFORD
RUTLAND
WEST RUTLAND
SUDBURY
BRANDON
PROCTOR
IRA
36
41
2
23
22
7
31
52
21
43
42
20
45
50
18
17
24
3
6
9
35
40
19
12
13
37
10
26
25
5
33
27

F

l

m

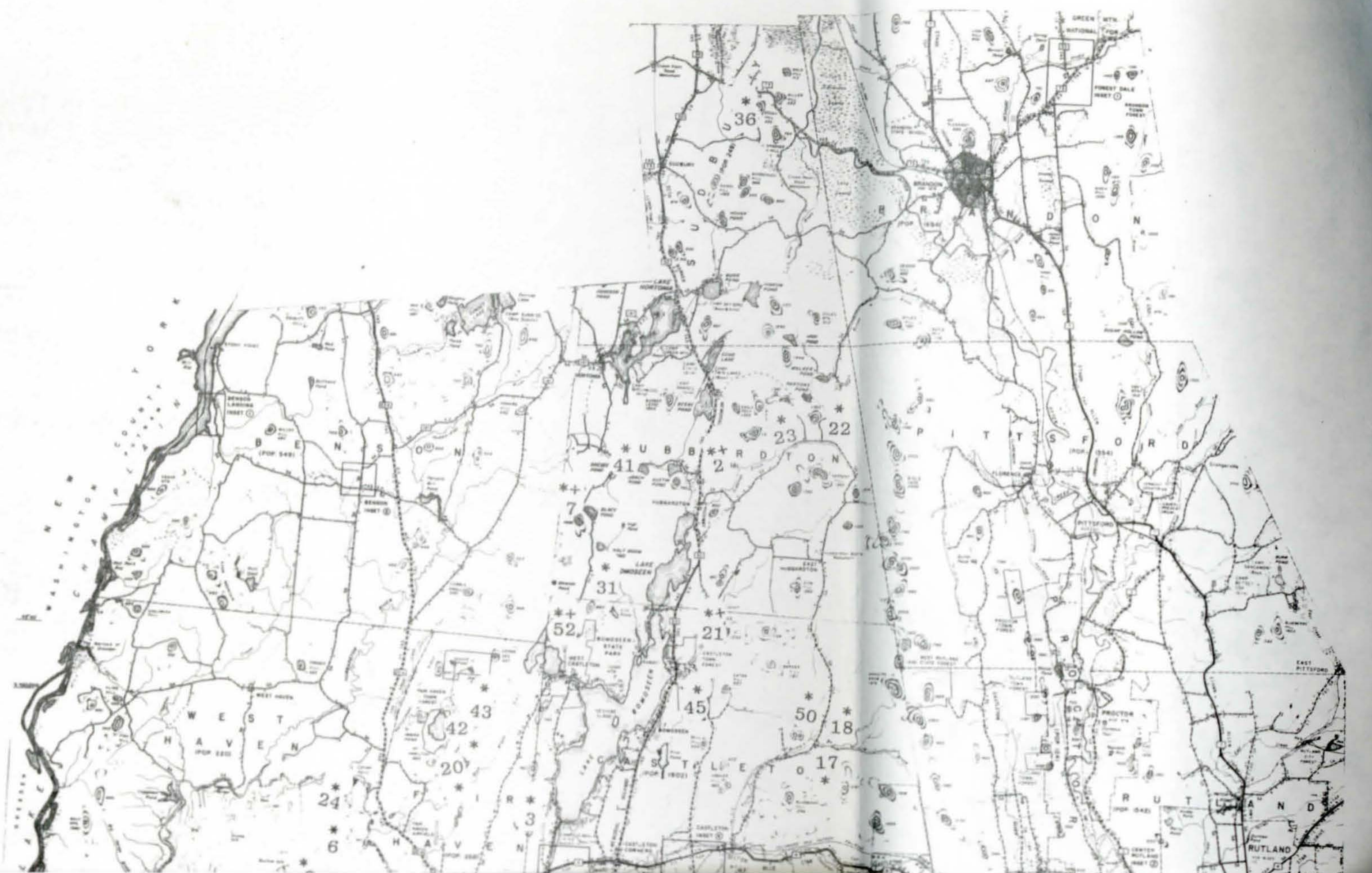


Figure 7. Trap-sites where *Peromyscus leucopus noveboracensis* (*) and *Peromyscus maniculatus gracilis* (+) were captured

0 4.0 8.0 N

Scale in km

Appendix 1. Detailed descriptions of trap-sites. Locations are referable to recent U.S.G.S. 7½' topographic maps, 1:24000 scale.

1. Flat to moderatley sloping embankment on the north side of Blissville Road, 1.13 km and 85° from Blissville Corners, Town of Castleton, Rutland County, Vermont.

Loams and loamy fine sands are the dominant soils at the beginning of the trap-line on this wooded embankment. The litter, which constitutes 70 % of the ground cover, is predominantly of hemlock, white pine, and arborvitae needles, and accurately reflected the makeup of the canopy. American elm and tamarack are interspersed, but both of these species are of minor importance. The remaining ground cover is provided by white pine seedlings, blackberry, ox-eye daisy, buttercup, and grasses. As the embankment is traversed it becomes steeper, until a wet, mucky portion of the alluvial plain of the Castleton River is encountered. Here, hemlock and tamarack become the dominant tree species, while mosses and grasses share more than 80 % of the ground cover. Loamy soils give way to muck and clay soils.

Even though the alluvial soils provide a good medium for burrowing, extensive runs and other signs of small mammals are absent. The grasses of the alluvial plain exhibit few fresh

signs (e.g. cuttings) of *Microtus pennsylvanicus*. A few *Condylura cristata* burrows are present.

2. Shallow forested gorge and woods on the east side of Route 30, 0.32 km north of the Hortonville Road, Town of Hubbardton, Rutland County, Vermont.

Yellow birch, hemlock, and hophornbeam dominate the beginning of the trap-line which is located on the small streamside floodplain and adjacent wooded slope east of the stream. Minor constituents of the canopy include white ash, mountain maple, elms, and one apple tree. The canopy is nearly closed, allowing little light penetration, and the area has a cool, damp aspect. Ground cover consists of up to 95 % deciduous and needle litter, with sumac, striped maple, and various species of woodfern also present.

The major part of the trap-line is above the stream on a moderately steep slope which is littered with a massive talus. The position and growth of certain sugar maples between blocks of rock indicates that parts of the talus are old; there is also evidence of recent rockfalls. The forest floor is deeply scored with small mammal runs, especially beneath and adjacent to the talus. Slate and quartzite outcrops are prevalent, and wherever they occur can also be found small mammal runs. The terminal portion of the trap-line parallels the stream, and is choked with fallen branches and roots over a bare, wet soil.

3. The flat forest floor and stone wall at the Point of Pines, 1.77 km and 356° from the 411 ft BM, Hydesville, Rutland County, Vermont.

White pine and quaking aspen dominate the tree species accompanying a long straight slate wall and forest west of the wall. A few dead hemlocks are near the wall, but fallen white pines are more prevalent. The trap-line ran along the base of the wall. Quaking aspen are common near one end of the trap-line, and are separated from a stand of paper birch by white pines. A few gray birch as well as red and mountain maple are mixed with the dominant white pine. The ground cover near the wall is 60 % mixed needle and deciduous litter, with wild sarsaparilla, white oak seedlings, witch hazel seedlings, and false Solomon's seal the remaining constituents.

Abundant runs are evident under the moist litter near the wall. Many rotted pine limbs are incorporated into the litter, with runs continuing over, and in some cases through these limbs. The stony loam soil is not hospitable to small mammals, but the deep rotting litter and crevices in the wall might provide suitable small mammal cover.

4. Fair Haven Cedar Bog, 1.61 km and 245° from the 377 ft BM, Town of Fair Haven, Rutland County, Vermont.

The trap-line was set in a forested bog that conatins arborvitae, hemlock, white pine, paper birch, tamarack, yew, and balsam fir. The needle litter is deep (7.5 cm) and wet, over a deep muck and peat soil. The litter often gives way under foot.

The understory consists of a typical bog association, including bunchberry, mint, leafy liverwort, pink ladyslipper, cinammon fern, bracken fern, false lily-of-the-valley, goldthread, and Indian cucumber root. A few small pools are located in the lower areas, with many logs and fallen trunks acting as natural bridges.

Small mammal runs and burrows are not plentiful, and this seems not related to soil texture characteristics. The acidity of the soil may be a factor.

5. Steep forested lower slope of Morris Hill, 3.22 km and 135^{o} from the 436 ft BM, Town of Hampton, Washington County, New York.

The tree cover of this steep (35^{o}) forested slope directly off the south shoulder of Route 273 consists of 85 % medium aged sugar maple (d.b.h.= 17.8-20.3 cm). A stand of paper birch and white pine marks the midpoint of the trap-line, but these species are surrounded by sugar maple. Black birch and hophornbeam occur sporadically on the slope, and American elm begins to replace sugar maple at a crest and resultant small plateau. Deciduous litter is the major constituent of the ground cover, while less than 5 % of the understory consists of ash, sugar maple, and red oak seedlings, Solomon's seal, and stiff club-moss.

Runs are present near the bottom of the slope, and less prevalent near the top, especially as the distance between the trees increased. Loose slate chips and larger fragments are common at the top of the slope, with little associated ground cover.

6. Gentle forested slope 1.61 km NNE of elevation 141.1 m, near Hampton Hill, Town of Hampton, Washington County, New York.

Sugar maple and American elm are the dominant trees on this gently rising slope. Interspersed are clumps of paper birch and American beech. Several quaking aspen and hophornbean are also present. The litter is totally deciduous, with a sparse understory consisting of false Solomon's seal, Solomon's seal, woodfern, and sugar maple, white ash, and American beech seedlings.

Fallen limbs and trees are abundant, and runs are found beneath and adjacent to them. The other sites of apparent small mammal activity are adjacent to the larger outcrops of West Castleton Slate.

7. Above and adjacent to the outlet of Black Pond, 0.48 km and 195^{o} from the 644 ft BM, Moscow Road, Town of Hubbardton, Rutland County, Vermont.

The west flowing outlet of Black Pond is situated in a deep gorge whose walls rise rapidly and steeply (> 35^{o}) to a more gentle forested slope. The trees occur in various combinations, including pure stands of sugar maple, American beech, hophornbeam, and hemlock. Overall, hemlock and yellow birch are dominant in the young second growth canopy. The litter is dominantly deciduous, with hemlock needles a minor but consistent component. Christmas fern is the most prevalent understory species; less than 5 % of the ground cover consists of Solomon's seal, baneberry, large-flowered trillium, aster, woodfern, striped maple, and sugar maple, basswood, and white ash seedlings.

The trap-line traversed the steep slopes, and eventually dipped down to parallel the outlet stream. The preferred areas for runs and burrows are along the large fallen and rotting hemlock trunks. These areas have abundant crisscrossing runs, and many holes. The larger roots of the hemlocks and deciduous trees also showed signs of frequent use by small mammals, but not to the extent showed by the fallen trees. As the trap-line approaches the outlet stream, the soil becomes much different from the stony phase Cossayuna loam of the rest of the line. The soil is wet and mucky, with very little litter cover. No evidence of small mammal activity was discovered, but signs of raccoon were evident.

8. The sandy floodplain of the Poultney River, 2.25 km and 281^{o} from Main Street and West Park Place, Village of Fair Haven, Town of Fair Haven, Rutland County, Vermont.

The trap-line paralled the Poultney River, whose sandy floodplain is dominated by sandbar willow, quaking aspen, staghorn sumac, and sycamore. The Suffield silt loam is bordered by massive outcrops of variegated West Castleton Slate which occur in a pasture adjacent to the floodplain. Much of the ground is bare, and the litter is not more widespread due to the distance between trees. Ground cover when present is patchy, and consists of purple-flowering raspberry, barren strawberry, clover, grapevine, milkweed, horsetail, common plantain, and black medick. There is a small area of consistent orchard grass and quackgrass cover, but it is too short (< 3.0 cm) to harbor *Microtus pennsylvanicus*. One area of river bank is steep and much dissected by tree roots;

this appears to be the only area of small mammal activity.

9. Gently rising forested slope 0.88 km west of the William Miller Chapel, Town of Whitehall, Washington County, New York.

An old wood road divides the trap-site asymmetrically, with the majority of the site and traps east of the road. Young second growth sugar maple and hemlock dominate throughout, with hophornbeam and American elm occuring as minor elements. The litter is 99 % deciduous, and deep (> 10 cm); the few understory species present include fasle Solomon's seal, leafy liverwort, running evergreen, and sugar maple seedlings.

The soil is a gravelly silt loam and shaly loam. Extensive exposures of Mettawee and West Castleton Slate occur as long, and sometimes sinuous benches. The bench areas show extensive evidence of small mammal activity, as well as piles of porcupine scats. The other area of runs and holes occurs under and adjacent to fallen and rotting trees.

10. A densely forested gentle slope with large outcrops, 0.40 km and 210^{o} from elevation 149.7 m, Town of Poultney, Rutland County, Vermont.

The forest canopy is dominantly young white pine and red maple; other constituents are apple, sugar maple, slippery elm, sweet birch, and hemlock. The quantity of ground cover species present is reduced due to the extensive needle litter. Those species present include Jack-in-the-pulpit, leafy liverwort, goldenrod, woodfern, sensitive fern, lily, resurrection fern, and running evergreen.

The dominant feature of this trap-site is a massive outcrop of slate of the Pawlet Formation. The outcrop is greater than 2.5 m tall and at least 50 m long. Quartzite is the dominant rock at one end of the outcrop. Extensive deep runs are found at the base of the outcrop, and scats of rabbits are common. Two active woodchuck holes are also present.

The soil is a moderate to steep variant of the Nassau-Dutchess rock outcrop complex. In areas distant from the large outcrop, slate chips are not prevalent in the topsoil, which is dry and loose. Near the outcrop the upper soil horizons are full of slate chips, and the horizons are wetter and more compact.

11. A forested hillside and adjacent pasture at the Lewis Farm, 0.32 km and 85° from elevation 161.2 m, Town of Poultney, Rutland County, Vermont.

A tangle of fallen hawthorne marks the beginning of the trap-line on the hillside, which also contains sugar maple, black maple, elm, black cherry, black walnut, and shagbark hickory, in decreasing order of prominence. Part of the hillside is actively used to graze dairy cattle. A typical pasture ground cover encroaches and mixes with the forest ground vegetation, and includes goldenrod, various grasses, clover, buttercup, wild mustard, wild oats, dandelion, thistle, plantain, shepard's purse, ash seedlings, wild blackberry, wild parsely, grapevine, and Virginia creeper. Leaf litter is reduced, and bare rocky areas occupy up to 10 % of the forest floor. Remnants of a slate

wall are overgrown with grapevine and afford potential cover for small mammals, but few runs were found. This may be due to the isolated position of the grove of trees on the hillside.

The pasture proper is dominated by orchard grass, and includes goldenrod, thistle, dandelion, grapevine, wild oats, wild mustard, Virginia creeper, leafy liverwort, reindeer moss, blackberry, buttercup, strawberry, and yarrow, in decreasing amount of ground coverage. Active woodchuck holes are interspersed throughout the pasture. A few American elms are on a slightly elevated portion of the pasture, and are the only trees surrounding the small outcrops found in this part of the trap-line.

12. Griffin's Apple Orchard, 1.61 km and 200° from the 462 ft BM, Town of Poultney, Rutland County, Vermont.

Traps were divided equally between two parts of the apple orchard, according to the age of the trees. The "old" part is 35 years old, while the "new" orchard is only 20 years old. The soil is Bernardston stony loam throughout. The understory is that found in a typical old-field association: grapevine, buttercup, bedstraw, hedge bindweed, alfalfa, sorrel, and various grasses. American basswood seedlings are common near the margins of the orchard.

Several trees showed indications of potential death due to girdling of the trunk or root damage. *Pitymys pinetorum* was suspected as the cause, and extensive digging below the litter revealed circular runs greater than 5.0 cm deep in the soil

surrounding these trees. Trapping, however, revealed only the presence of *Microtus pennsylvanicus*, even though few signs of *M. pennsylvanicus* activity were seen in the adjacent fields. Whether *Microtus* dug the runs is unknown.

Outcrops are absent from the orchard, as are horizons of soil with large slate chips. Smaller slate chips are apparently placed around the trees to reduce soil erosion.

13. Pasture, hillside, and steep forested streamside slope 0.97 km and 80° from elevation 193.5 m, Town of Poultney, Rutland County, Vermont.

The main features of the pasture trap-line are three large outcrops of Mettawee Slate, and the isolated green ash, red maple, hemlock, and American basswood trees. The trees are all about 13.7 m tall. Leaf litter constitutes only 1 % of the ground cover, the majority of the cover being various species of grass. A typical assemblage of pasture flowers and weeds also occurs. The trap-line crossed Lewis Brook, and continued up a steep (35°) forested slope dominated by hemlock, yellow birch, and paper birch. There is a lesser amount of American hornbeam. The litter is extensive, and nearly equally deciduous and needle. Maple and ash seedlings, as well as woodfern, constitute the sparse understory vegetation. The extensive outcrops are weathered and cracked, and mammal runs are abundant. Holes are prevalent at the base of hemlocks and yellow birches. The Nassau rock outcrop complex soil is moist, and locally poorly drained.

A second trap-line traversed a hillside slope dominated by an isolated stand of quaking aspen. A few small sand and gravel pits had been dug nearby, but are not extensively worked. The rocky loam has a surface layer of slate chips which was unbroken for some part of the trap-line. This is not a true talus. Grasses constitute the bulk of the ground vegetation, along with minor amounts of wild blackberry and strawberry, red and white clover, grapevine, buttercup, juniper, and chickweed. Some large outcrops occur above the trap=line, but fragments from these outcrops are not the source of the previously mentioned slate chips.

14. <u>The steep wooded slope below Carver Falls Cemetery, 0.97 km and 230^{o} from the 377 ft BM, Town of West Haven, Rutland County, Vermont.</u>

A shallow (< 10 cm) and intermittent stream flows at the base of a steep (35^{o}) slope dominated by young second growth sugar maple and American beech, and older hemlock. One American beech is 88.9 cm d.b.h., and at least 25.9 m tall; this is probably a virgin tree. The only other species represented are ash and black birch. The silt loam has a heavy moist litter layer, and local areas of moderate topsoil development. In these areas, usually adjacent to large roots and logs, small mammal runs are obvious. Ground cover vegetation is sparse, and concentrated around stumps and the few areas not choked with litter or shaded by the closely spaced trees. The only species present include goldenrod, oak seedlings, white ash seedlings, and woodfern. Large patches of poison ivy are common on the borders of the

slope. As the slope levels and approaches the stream, the litter cover becomes reduced, and few signs of small mammals are present near the stream.

15. Moderate to steep forested slope with extensive outcrops north of the Sheldon Farm, 1.45 km and 65^{o} from elevation 112.2 m, Town of Fair Haven, Rutland County, Vermont.

This moderately steep (30^{o}) forested slope is bordered on one side by a cornfield. Sugar maple, red oak, American beech, and hemlock are dominant among the canopy species. The beech and hemlock are older and taller than the other species, which are probably no more than 15 to 25 years old. Lesser amounts of second growth American hornbeam, quaking aspen, white ash, paper birch, and hophornbeam complete the canopy. Acorns are plentiful, and many signs of chipmunks were seen and heard, though none were trapped. The Nassau shale loam is sparsely covered by ground vegetation, which includes false lily-of-the-valley, leafy and scaly liverwort, Solomon's seal, striped maple, and woodfern. Up to 50 % of the soil is exposed without cover.

Outcrops occur in the form of massive cliffs and overhangs. This could provide good cover for small mammals in the form of protective overhangs. Runs are long and deep, yet showed few signs of active use (e.g. fresh droppings and food remnants). These runs were intensively trapped, but no captures were made. This is common in slate belt habitats. Extensive runs may only indicate use over a long period of time, not high population levels.

16. A small steam flowing into the Poultney River, 0.48 km and 185^{o} from elevation 107.3 m, Town of Hampton, Washington County, New York.

The trap-line followed a small east flowing stream as it passes over its bed of exposed Poultney Slate. In some areas the stream is contained deep within walls approaching 70^{o}; at other areas the stream has developed a small floodplain on the unwalled banks. A severe wind and rain storm had toppled many of the young sugar maple, elm, and hemlock present, and even a few of the older trees at some distance from the trap-line. None of the younger trees exceeded 7.6 cm d.b.h. Severe erosion has destroyed much of the ground cover, leaving only woodfern and leafy loverwort in isolted patches. Much of the loamy fine sand was saturated, and muds were found some distance from the stream. As outcrops were not common, traps were set mostly near logs and tree bases.

17. A forested slope and streamside south of Belgo Road, 0.64 km and 275^{o} from elevation 234.1 m, Town of Castleton, Rutland County, Vermont.

A rapidly flowing stream has cut a channel through Mettawee Slate bedrock, and in some cases the vertical walls were up to 2.0 m high. The stream is bounded by undulating to moderately steep slopes (20^{o}) which are dominated by medium aged yellow birch, hemlock, American beech, and paper birch. Seedlings present in the ground cover include mountain maple, striped maple, witch hazel, hemlock, and beech. More open areas support various

grasses, as well as Christmas fern, partridge berry, and Solomon's seal. Ground cover in the less open areas of the forests includes Jack-in-the-pulpit, leafy and scaly liverwort, wild sarsaparilla, false lily-of-the-valley, and spring spikemoss.

The beginning of the trap-line is dominated by outcrops in the form of blocks. The area is rich in small mammal cover, including fallen trees, branches, roots, and hollows filled with litter. Large numbers of stumps are present, but even where the bases seem ideal for burrowing, no mammals were caught. The litter is deep, and primarily deciduous. After the trap-line crossed the stream, it terminated on a moderately sloping forested slope where hemlock and American beech are dominant. The Dutchess loam soil exhibited local areas with horizons containing extreme amounts of slate chips.

This area yielded an unusually large number of captures and species. It is not floristically different from any of the areas trapped, yet some combination of habitat characteristics provided proper conditions to support a large and diverse population of mice, shrews, and voles.

18. <u>Flat to gently sloping streamside forest 0.16 km and 305^{o} from elevation 234.1 m, Town of Castleton, Rutland County, Vermont.</u>

The west flowing stream is bordered by flat banks and gentle ($\leq 5^{o}$) slopes, forested mainly with white pine, hemlock, and paper birch. The white pine are older than the other two dominant species of trees, and were about twice the d.b.h. Deep (10.0 cm) litter provides good cover for small mammals, especially adjacent

to large exposures of Mettawee Slate. Ground cover vegetation is sparse, consisting of Christmas fern, woodfern, Solomon's seal, false lily-of-the-valley, and leafy liverwort.

The construction of Belgo Road resulted in a steep exposure of the Stockbridge loam characteristic of the trap-site, and many roots and accompanying holes are exposed. Large slate fragments have fallen to the base of the exposure, and are beginning to be covered with needle litter. Two traps in this area were sprung and dragged under large rocks, and no amount of effort could free them. Another trap was broken in half. Chipmunks may have done the damage, but none were heard or seen.

This area is in marked contrast to site 17, which is immediately north, and contiguous to the same stream. Site 17 includes much steeper slopes, and the litter is mainly deciduous, in contrast to the dominantly needle litter of site 18.

19. The northeast slope of Bird Mountain, 0.80 km and 230^{o} from elevation 244.8 m, Town of Ira, Rutland County, Vermont.

A dry streambed biects the trap-site which bordered a pasture with old-field elements. The slope was moderately steep ($\leq 30^{o}$). The forest is young second growth throughout, probably no more than 25 to 30 years in age. Sugar maple is the overwhelming dominant canupy species, with paper birch the next most prominent. Associated with the sugar maple are a few individuals of red maple. Other canopy species include American basswood, white ash, bear and red oak, and an occasional American elm. The litter is comletely deciduous, thin (< 2.0 cm), and very dry. A few large fallen trees littered the area, especially near the dry streambed.

The soil (characterized as rough stony land) is dry and slate-filled, and this, combined with the poor litter cover, results in suboptimal cover for small mammals. Only ferns are common, and include various species of woodfern and sensitive fern. The only dense cover is found where the old-field association parallels the more exposed mountain slope. There the cover consists of grasses, iris, ragweed, pale touch-me-not, yarrow, buttercup, and tufted vetch. Few fresh signs of *Microtus pennsylvanicus* were discovered.

Runoff from heavy rains may have had serious effects on the habitats on these slopes. After rains, the dry streambed quickly fills with runoff water, and both gully and sheet erosion are locally extensive.

20. Southeast slope of Mount Hamilton, 0.80 km and 50^{o} from elevation 158.2 m, Town of Fair Haven, Rutland County, Vermont.

The trap-line traversed a steep (35^{o}) forested slope and then a nearly level terrace near the crest of Mount Hamilton. The trees are divided into two general groups. Near the base of the slope, white pine and shagbark hickory are dominant, are are obviously a marker of early successional stage due to their age. On the more level terrace, quaking aspen, American beech, and paper birch are the dominants. These trees are much larger and older than the trees at the base of the slope. Sugar maple is interspersed throughout both areas. The base of the slope has elements of a typical old-field ground cover association,

while the terrace is predominantly woodfern, dockmackie, and Christmas fern. In contrast to Bird Mountain (site 19), the litter is thicker, and the understory species more luxurious. Therefore, runoff and erosion, and subsequent soil and habitat damage, are not severe. The Dutchess stony loam is exposed in only a few places, especially near large fallen paper birches. In the areas of soil exposure, several bowl-shaped depressions have entirely filled with deciduous litter, and the soil is loose and dry beneath the litter cover. Another trapping site (25; Table 1) reveals such depressions provide good cover for *Blarina brevicauda*.

21. The talus below Wallace Ledge, 1.13 km and 205^{0} from elevation 171.3 m, Town of Castleton, Rutland County, Vermont.

The trap-site is bounded on the east by a beaver meadow, and on the west by the steep slopes leading to Wallace Ledge proper. Sugar maple is the dominant tree, no individual of which exceeded 8.9 cm d.b.h. The other tree species present included only hardwoods, and the litter, therefore, is completely deciduous. Even though the trees are young second growth and do nor exceed 10.7 m in height, the canopy is essentially closed, and little sunlight penetrates. Only two small treeless areas occurred, caused by direct damage from falling boulders; these sunlit areas are 4.0 to 5.0 m in diameter. The groundcover is provided by violet, oakfern, Christmas fern, royal fern, woodfern, wild ginger, grasses, and field garlic. The ferns are most common near the talus proper.

The talus consists of massive boulders of Mettawee Slate and

Zion Hill Quartzite. The litter is especially deep (10.0 cm) around the talus, and some humus has formed with the protection afforded by the talus. Runs and holes are most prevalent in the areas of talus and accompanying smaller chains fragments that resulted from fracture of the larger boulders. The soil closest to the beaver meadow is of alluvial origin, in contrast to the more common Stockbridge loam, but due to excess moisture and reduced cover, the alluvial soil does not seem capable of providing adequate cover for small mammals. This area provides one of the few habitats capable of supporting a population of *Microtus chrotorrhinus*.

22. Steep forested slope east of the Brandon Mountain Road, 0.08 km and 35^{o} from the 973 ft BM, Town of Hubbardton, Rutland County, Vermont.

This very steep (40^{o}) slope is capped by a flat terrace. Numerous outcrops of Mettawee Slate and Bomoseen Graywacke occur on the slope and terrace. The canopy is dominated by American hornbeam, American beech, and hophornbeam, but these species are replaced by shagbark hickory and hophornbeam on the terrace. The tallest trees are above 18.3 m in height, but most of the species are in the 4.6 to 9.2 m class. The only non-deciduous species is white pine, and most are very young, with few exceeding 1.8 m in height. The terrace ground cover is predominently grasses and hophornbeam seedlings, while the steep slopes have mostly Christmas fern, American hornbeam seedlings, and red oak seedlings as the understory species. Litter cover on the slope is thin ($\leq$ 2.0 cm), and subject to extensive movement by water

and wind. There are few runs on the slope. The terrace contains holes and runs which are concentrated around tree bases and outcrops.

23. Massive outcrops of Zion Hill Quartzite, 1.13 km and 310° from the 973 ft BM, Town of Hubbardton, Rutland County, Vermont.

Thw two outstanding features of this trap-site are the massive ($\geq$ 4.0 m in height) outcrops of Zion Hill Quartzite, and probable virgin white pines (d.b.h.= 184.5 cm). The property is in the initial stage of logging, and some of the white pine and hardwoods are being cut at some small distance from the trap-site.

Red maple and white pine, both probably greater than 30 years old, are the dominant trees around and on the outcrop, with lesser amounts of younger sugar maple, hophornbeam, paper and black birch, and American beech present. Black birch alone is dominant in areas not adjacent to the outcrops. Ground cover species present but not prevalent in other trapping areas include ebony spleenwort, Jack-in-the-pulpit, Indian cucumber root, and blueberry.

The outcrops are weathered a dirty white to green color, and crevasses are more prevalent than usually found in bedrock of the Taconic sequence. The outcrops are weathered into a "step" configuration, and the steps appear to be natural runs, especially for species of *Peromyscus*. These runs had very little litter cover, yet *Peromyscus* were trapped there. Other parts of the outcrops are deeply excavated at the base, but the Dutchess stony loam

was certainly not proper for mole existence. Another location in which trapping *Peromyscus* was successful in this and other trap-sites is in the "V" formed by the joining of roots with the trunk of a tree. Many *Peromyscus* were trapped at these locations, although ground cover is virtually nonexistent.

One of the probable virgin white pine is isolated between two large outcrops, and some of the branches have been cut. There is no evidence of runs at the base, but it is apparently a feeding station for squirrels and chipmunks judging from the number of shelled acorns and empty seed coats present.

24. Forested streamsides slope 0.32 km and 345^{o} from elevation 103.9 m, Town of Hampton, Washington County, New York.

Large white pine, hemlock, basswood, and sugar maple dominate the slopes adjacent to a shallow, meandering, intermittent stream. Many of the larger trees are widely spaced; this area is not in the early stages of succession. The slopes trapped are bordered by a pasture actively grazed by dairy cattle, and signs indicate the cows occasionally frequent the stream bank. The majority of the bedrock is Hortonville Slate, which is extensively exposed in the stream bed. Nearby outcrops are weathered into thin, rotten, black plates which shatter under low pressure. Up to 30 % of the loamy fine sands are exposed with no cover; the sparse cover consists of poison ivy, woodfern, hemlock seedlings, may apple, false lily-of-the-valley, and large-flowered trillium. The litter cover is predominantly of oak, even though that species is not a living dominant; old acorns are found in large quantities.

The only area of obvious small mammal activity is on a slope terraced by erosion.

25. East slope of Bartholomew Hill, 0.48 km and 215^{0} from the 436 ft BM, Town of Whitehall, Washington County, New York.

The moderately steep (30^{0}) forested slope is notable for its lack of ground cover vegetation. The only species present include poison ivy, false Solomon's seal, grasses, and Christmas fern. Up to 40 % of the Nassau rock outcrop soil is exposed, while the litter that is present is markedly deciduous and dry. Young second growth hophornbeam, paper birch, and American beech are the dominant species of the canopy; a few larger and older he,locks occur near the flatter summit of the hill.

Large quantities of weathered Poultney Slate are exposed, and fragments are intermixed with the litter. The slate was often the only soil cover. Few signs of small mammal activity occur in these areas.

The site contains shallow hollows filled with a mixture of dry soil and brittle litter; these hollows are generally less than 2.0 m wide. Extensive runs circle the bottoms of these hollows. No clippings were discovered in the runs; trapping revealed a large local population of *Blarina brevicauda*. This was somewhat surprising, since these shrews seem to generally prefer a moister area. These hollows may have harbored a large population of invertebrate prey.

26. Southeast slope of Herrick Mountain, 0.64 km and 320^{0} from the 1137 ft BM, Town of Ira, Rutland County, Vermont.

Balsam fir, none of which exceed 7.62 cm d.b.h., dominate

the slopes, which range from the flat area bordering a dry streambed to the steep (35^{o}), heavily forested mountainside at the 488 m level. The litter cover is only locally deep, being rather shallow ($\leq$ 3.0 cm) in most places. Old logging roads crisscross the area, and since these roads have been cleared of canopy species, many of the ground cover species are more abundant in the roadbed than on the slopes. Cover is provided by sensitive fern, stiff club-moss, woodfern, marsh fern, and lady fern.

Few signs of small mammals were discovered in the dense stands of balsam fir. Where deciduous trees such as sugar maple, red oak, and yellow birch are more common, there are small numbers of runs and holes. The dry streambed is especially active, as determined by the numbers of holes present.

Outcrops of Mettawee Slate are confined to the gentler slopes and stream bank area. They are random isolated blocks, and many are beginning to be covered by litter.

27. <u>Slate wall and stream 0.80 km and 45^{o} from elevation 440.4 m, Town of Middletown Springs, Rutland County, Vermont.</u>

A slate wall in various stages of collapse parallels the course of a south flowing stream. The speed of the stream varies from a fast flow over an exposed Mettawee Slate bed, to seepage through a mud and litter choked bed. Young sugar maple dominate the canopy species, while a few isolated older paper birch occur near a large outcrop abutting the stream. Species typical of a moist habitat dominate the ground cover; they include leafy liverwort, violet, stiff club-moss, woodfern, and spring spike-moss. The

very rocky silt loam is damp in most areas due to the meanders and seepage of the stream over its very low banks.

28. Forested hillside 0.97 km and 105^{o} from the 475 ft BM, Town of Castleton, Rutland County, Vermont.

The hillside, dominated by large second growth sugar maple and hophornbeam, is surrounded on all sides by active and fallow pasture. The active pasture is uniformly short ($\leq$ 2.0 cm). The fallow pasture is in an early successional stage, and contains quackgrass, broomsedge, reed canary grass, and cheat. These species grade into the understory of the hillside, where herb-Robert, woodfern, bracken fern, and sugar maple seedlings are common. The deciduous litter ranges from 5.0 cm thick to a layer consisting of only one leaf. Under the thick layers of litter, mold grows extensively. The very rocky silt loam is broken by numerous outcrops, and an abundance of slate chips are found at the base of trees on the steeper aspects of the hillside.

29. Steep slopes and old-field association southeast of Scotch Hill Road, 0.16 km and 115^{o} from elevation 182.6 m, Town of Fair Haven, Rutland County, Vermont.

The trap-line traversed the tops of very steep ($\geq 70^{o}$) slopes and the border of a typical old-field association. The steep slopes are dominated by large (d.b.h. $\geq$ 38.1 cm) sugar maple, American elm, and slippery elm. The Nassau stony loam is largely exposed in these areas, with only small amounts of litter, grasses and seedlings providing cover. The border of the field also contains elm and sugar maple, but typically, white pine becomes the important,

if not dominant, species. Goldenrod is very common, as are grasses. The terminus of the trap-line was in a stand of paper birch, and flocks of black-capped chickadees were often found calling from and feeding in them.

Runs of small mammals were nowhere common, including those of *Microtus pennsylvanicus*. The old-field association seems ideal for *Microtus*, but fresh signs were absent. Raccoons were a constant nemesis to the traps.

30. The outlet of High Pond, Halfmoon State Park, 0.48 km and 130^{0} from elevation 214.0 m, Town of Hubbardton, Rutland County, Vermont.

The forested slopes surrounding the outlet stream varied from gentle ($\leq 10^{0}$) to moderate ($\leq 25^{0}$). Black birch, American beech, yellow birch, and hemlock dominate the canopy species, which make up a young uncrowded second growth forest. The beginning of the trap-line was characterized by a thick decisuous litter (10.0 cm), and many fallen trees. Large low outcrops of Mettawee Slate parallel the stream. The Cossayuna and Dutchess loams supporta thick understory of scaly and leafy liverwort, striped maple, woodfern, false lily-of-the-valley, goldthread, and Indian cucumber root. The second part of the trap-line had more extensive outcrops than the first half, and the runs found were deep (2.0 cm) and wide, especially near the outlet stream. Running evergreen is common on the outcrops and near fallen trees. The trap-line ended in a small grove of large hemlock; the soil becomes almost marshy, and an extensive stand of Goldie's fern is nearby.

31. Flat forest floor 0.64 km and 100^{0} from the 631 ft BM, Town of Hubbardton, Rutland County, Vermont.

Large white pine and smaller hemlock are the dominant tree species occurring on an undifferentiated alluvial soil. The forest floor is divided into gentle rises with lower moist areas interspersed. The litter depth is uniform throughout (5.0 cm), and is primarily dediduous except for local accumulations of white pine and hemlock needles. Ground cover includes Christmas fern, white ash, sugar maple, hophornbeam and cherry seedlings, woodfern, and leafy liverwort. There were only two or three large outcrops, and under these are the only well defined runs in the trap-site.

32. Mixed forest association bordering a hay field, 0.08 km and 45^{0} from elevation 206.7 m, Towns of Hubbardton and Sudbury, Rutland County, Vermont.

The trap-site is an area of uniformly poor ground cover and thus is probably a poor small mammal habitat. Dominant trees (none of which exceeded 16.5 cm d.b.h.) include white ash, paper birch, and white pine. Sparse ground vegetation includes white ash seedlings, dandelion, grasses, wild grapevine, and elm seedlings. Many of the trees, including the dominants, are in poor condition; the only quality stand of trees is a uniform 19.1 cm d.b.h. stand of white pine. The bulk of the rocky and stony silt loam is exposed, and many small dry channels attest to the erosion taking place. Remnants of slate walls, and piles of slate rubble are present, but no signs of activity are found at either type of structure.

33. <u>North slope of Hatch Hill, 0.97 km and 325^{o} from elevation 182.6 m, Town of Whitehall, Washington County, New York.</u>

A stone wall divides the trap-site into two dissimilar components. The first and last third of the trap-line pass through a very young second growth forest dominated by sugar and red maple, but also includes white ash, witch hazel, and shagbark hickory. No tree exceeds 6.4 cm d.b.h. Ground cover is provided by deciduous litter, goldenrod, grasses, sugar maple, red maple, and white ash seedlings, woodfern, Christmas fern, and wild blackberry.

The second third of the trap-line traversed a moderately steep (30^{o}) slope, sparsely forested and containing extensive cliff-like outcrops. The Poultney Slate was often exposed in small synclines; exposed slate is weathered and crumbly. Paper and black birch trees are dominant, and larger than the other secondary growth species. New York fern, woodfern, maple seedlings, and white pine seedlings provide ground cover in addition to the locally deep (8.0 cm) accumulations of leaf and needle litter. Signs of small mammal activity are not extensive, but do occur adjacent to the slate wall, and near some of the outcrops.

34. <u>Flat to gently sloping white pine-sugar maple forest and slate wall, 0.48 km and 160^{o} from elevation 206.7 m, Town of Hubbardton, Rutland County, Vermont.</u>

Pioneer white pine dominate the forest slope which is bordered by older sugar maples. The slope is surrounded on two sides by an old-field association. The litter is predominantly needle and 3.0 to 5.0 cm thick. Some understory species are found only

near the slate wall, e.g. woodfern, and others, such as Solomon's seal and sugar maple seedlings, are dispersed throughout the area. There are acorns of red oak in the litter, and two large, active woodchuck holes are found on the trap-site.

35. Fallow slopes 0.16 km and 255^{o} from the intersection of West Street and West Park Place, Village of Fair Haven, Town of Fair Haven, Rutland County, Vermont.

This moderately steep (30^{o}) slope is characterized by a tangle of understory species and young second growth trees. Trees include sugar maple, white pine, tamarack, witch hazel, and paper birch. Ground cover is provided by grasses, thistle, and various seedlings of the second growth trees.

36. The base of Stony Hill, 0.32 km and 195^{o} from elevation 156.4 m, Town of Sudbury, Rutland County, Vermont.

The trap-site is a forest floor with little or no slope, and succession from pasture is indicated by the presence of white pine (d.b.h= 21.6 cm). Paper birch occur randomly with the white pine. At the north end of the trap-site, arborvitae becomes co- dominant with the white pine.The needle litter is deep (5.0 to 10.0 cm) throughout, and many deep, wide runs are uncovered at the base of trees and logs. Two concentrations of needles overlying mounds of the Nellis very stony loam were excavated, and revealed intricate branching runs and tunnels. There are large numbers of holes in the litter, and these are invariably connected with a sub-litter run. Outcrops of the Chipman Formation occur as isolted blocks. The scattered understory vegetation includes grasses,

poison ivy, sugar maple, red maple, ash, and basswood seedlings, Virginia creeper, and elderberry.

37. Forested slopes bordering Lewis Brook, 1.61 km and 340° from elevation 229.8 m, Town of Poultney, Rutland County, Vermont.

A typical hemlock-white pine-northern hardwoods association borders Lewis Brook; white pine is the more mature member initially, but hemlock becomes larger as the brook is followed. Hophornbeam is interspersed throughout the area. The slope is gentle ($\leq 5^{\circ}$), and outcrops and fallen trees are common. Stumps are also found in abundance. Ground cover is primarily needle litter, but closer to the brook there are grasses, goldenrod, scaly liverwort, woodfern, sensitive fern, Christmas fern, and herb-Robert. The Bernardston stony loam is exposed in several small depressions, and pooled water has effectively turned the soil to mud in these locations.

38. Outcrops and forested slope 1.13 km and 345° from elevation 229.8 m, Town of Poultney, Rutland County, Vermont.

Steep, nearly vertical outcrops dominate this sparsely forested trap-site. Trees are generally at least 10 m apart, and initially, there are equal numbers of medium to large (13.9 to 25.4 cm d.b.h.) paper birch, hemlock, sugar maple, and yellow birch. Shagbark hickory and hemlock become numerically dominant on the steeper slopes and outcrops. Litter is deep adjacent to the outcrops; this area also contains the only deep runs discovered. Understory species include Solomon's seal, woodfern, scaly liverwort,

bindweed, and maple seedlings. The Pittstown stony loam is exposed in some shallow cuts near the trap-site.

39. Forested slopes adjacent to and above Lavery Brook, 1.93 km and 95^{o} from elevation 193.5 m, Town of Poultney, Rutland County, Vermont.

Steep (35^{o}) eroded slopes border Lavery Brook on the southeast, exposing the Bernardston stony loam and associated slate outcrops. Thin second growth white ash, sugar maple, white pine, and hemlock are the dominant species in the canopy. A few of the sugar maple reached 30.5 cm d.b.h. Ground cover is provided by a generally thin litter ($\leq$ 3.0 cm), and such species as sensitive fern, woodfern, wild strawberry, fern moss, false Solomon's seal, and goldthread.

The ground below the eroded slope is littered with an accumulation of weathered slate. The deciduous litter is locally thick (8.0 cm), and extensive runs are present. There are also intricate runs at the base of a large (2.0 m) quartzite boulder partially in the streambed.

As the slope rises above the brook, the remnants of a slate wall are encountered. It had been undoubtedly constructed during the period of extensive sheep grazing in the 19th century. The litter here is predominantly of white pine needles, and is thin. Extensive runs are absent.

40. Steep slopes and floodplain adjacent to Gully Brook, 1.29 km and 210^{o} from the 638 ft BM, Town of Castleton, Rutland County, Vermont.

Slate of the Biddie Knob Formation is exposed in the bed of Gully Brook as it flows rapidly northward. The slopes above the brook are steep (35°), and heavily forested with hemlock; the other canopy species, which include yellow birch, sugar maple, shagbark hickory, American elm, paper birch, and sycamore, are smaller than the dominant hemlock. The ground cover species are few, and include witch hazel, Christmas fern, and woodfern. Litter cover is of average thickness (4.0 cm), while outcrops are few. Small mammal runs are not common, and when present, occur under and around hemlock roots.

The small floodplain is unremarkable except for its rather thin cover of alluvial soil. A few areas of Pittstown stony soils are exposed near the brook, but there is little evidence of extensive erosion. Fallen trees and decaying logs litter even the steepest parts of the slope, but, again, extensive small mammal runs are absent.

41. <u>A rolling hillside approximately 150 m from Roach Pond, 0.40 km and 145° from elevation 171.3 m, Town of Hubbardton, Rutland County, Vermont.</u>

The trap-line ascended, traversed, and descended a small hill with deciduous woods. Sugar maple and hophornbeam are dominant, even though these trees do not reach the same size at maturity. Deep ($\geq$ 6.0 cm) litter was everywhere, except at the base of the trees. The base area is often bare, exposing the rocky silt loam present. Ground vegetation includes sugar maple seedlings, woodfern, Jack-in-the-pulpit, and ash seedlings. The crest of the

hill is littered with trees that have fallen in a connected zig-zag pattern. Runs continued from tree to tree in this area.

Most of the outcrops are of quartzite, and are clustered near the base of the hill. Remnants of a low stone wall are present, but few runs occur near this structure.

42. Gentle slopes east of Inman Pond, 0.80 km and 230° from elevation 155.4 m, Town of Fair Haven, Rutland County, Vermont.

The nearly level forested slopes are dominated by paper birch, white pine, sugar maple, and American elm. The trees are of a uniform size and age (young) near the pond, but as the distance from the shore increases, the sugar maple and American elm become larger than the surrounding trees. Ground cover species are abundant, and include Christmas fern, American basswood seedlings, goldthread, false lily-of-the-valley, woodfern, lady fern, ebony spleenwort, and large-flowered trillium. There are few outcrops, but a slate wall is present, and runs are located at its base.

43. Outlet of a beaver meadow, 0.16 km and 35° from elevation 155.4 m, Town of Fair Haven, Rutland County, Vermont.

A scrubby second growth forest of white pine, red oak, and quaking aspen is located along the meandering outlet of a beaver meadow. A few sugar maple and hemlock are also present. The trees are young, and of a uniform size and height. The Dutchess stony loam is extensively exposed, especially near the beaver meadow. Ground cover includes Christmas fern, liverworts, false Solomon's seal, poison ivy, and barren strawberry. At some distance from the beaver meadow, there is more extensive litter and

groundcover, and a few larger trees, but runs are very scarce. The only runs present occur near outcrops of Bomoseen Graywacke. One would predict little success at this site due to the exposed soil and its high moisture content, the dearth of ground cover, and the young scrubby secondary tree association.

44. The Vermont Apple Company orchard, 0.80 km and 190° from elevation 610 m, Town of Hampton, Washington County, New York.

The apple orchard is between 30 and 40 years old, with the ground cover similar to that found at site 12. Traps were set at the bases of trees or in the tall grass adjacent to the trees. A few deep runs are present where evidence of bark girdling was discovered, but fresh clippings or droppings of *Microtus pennsylvanicus* are not common. The manager stated that "meadow mice" (*M. pennsylvanicus*) and "deer mice" (*Peromyscus leucopus*) are often found dead in oxygen-free storage areas.

Both this and site 12 are sprayed with *Emedin* and *Captan* (Stoffer) insecticide, and *Plectran* (Chevron), an insecticide specifically for mites. *Alar* (Uniroyal) is applied to harden the apples.

45. Field and moderate forested slope 0.16 km and 285° from elevation 172.2 m, Town of Castleton, Rutland County, Vermont.

The trap-line began in a hayfield, paralled a small stream, and terminated in a sugar maple-white pine-hemlock forest. The forest contains both young and mature elements, with the older trees concentrated near the end of the line. The ground

cover intergrades between the different habitat types, and includes daisy, nettle, Christmas fern, grasses, woodfern, wintergreen, orange hawkweed, marsh marigold, and spring spikemoss.

The stream and hayfield are surrounded by a fence, and traps were placed at the base of the posts. Some parts of the hayfield were mowed during the trapping, but few, if any, mice, shrews, voles, or moles were driven into the traps. *M. pennsylvanicus* runs are infrequent.

Litter in the forest habitat is not deep ($\leq$ 3.0 cm), and up to 30 % of the silt loam is exposed. A large wall-like outcrop of Mettawee Slate occurs near the end of the trap-line. Many of the smaller outcrops are Zion Hill Quartzite.

46. Lower slopes of Bull Hill, 0.16 km and 100^{0} from elevation 275.8 m, Town of Castleton, Rutland County, Vermont.

White pine is dominant on these moderate ($\leq 25^{0}$) slopes, the only other canopy species present being paper birch, yellow birch, and American beech. The succession is proceeding uniformly throughout the area, as witnessed by the similar size of all the trees. Litter of needles is deep (6.0 to 7.0 cm), with only sensitive fern and leafy liverwort occurring in the understory. Runs are well developed in the litter, but few animals ever seem to be trapped in this type of habitat. These runs may be outside the area of intensive activity, and act only as connectors or passages to more preferred habitats. An area of Bull Hill is being lumbered, and heavy machinery has gouged out small exposures of the Nassau stony loam.

47. Fallow pasture 0.64 km and 150^{o} from elevation 255.4 m, Town of Castleton, Rutland County, Vermont.

The fallow pasture contains orchard grass, broomsedge, red clover, goldenrod, buttercup, ox-eye daisy, sensitive fern, and ebony spleenwort. A wooded slope impinges on the southern edge of the field, and young sugar maple are dominant over the smaller hophornbeam present. Ten per cent of the ground is bare, exposing the Stockbridge loam. Ground cover on the wooded slope is provided by a thin ($\leq$ 3.0 cm) litter cover, plus field garlic, daisy, and orchard grass.

Local areas of the pasture were waterlogged, especially in old tractor tire ruts. The vegetation on the few grassy hummocks is dry. Old *M. pennsylvanicus* runs are abundant, but again, no fresh signs of activity are in evidence. The one outcrop present occurs in the sugar maple forest.

48. "Dry swamp" 0.16 km and 195^{o} from elevation 255.4 m, Town of Castleton, Rutland County, Vermont.

The "dry swamp" is a locally wet area that has dried out over a period of years. The grasses present range in height from 1.0 to 50.0 cm, and provide 97 % of the ground cover. Orchard grass and barnyard grass constitute the bulk of the species present. Red clover, sensitive fern, and ox-eye daisy provide the other 3 % of the cover. The trap-site is surrounded by hayfields in various stages of growth and harvest, and two were harvested during the trapping period. It was hoped that animals would be driven out of the taller hayfields into the trapping area, but

again, this was not the case. Active runs are not prevalent in the trapping area, and old runs of *Microtus pennsylvanicus* are also practically nonexistent. Only one large outcrop of Mettawee Slate is present.

49. Damp willow-witch hazel pasture 0.24 km and 115^{o} from elevation 296.0 m, Town of Hubbardton, Rutland County, Vermont.

Willow and witch hazel are co-dominant on this short grass, partially grazed pasture. Species of ground cover include red clover, ox-eye daisy, daisy fleabane, aster sp., fringed loosestrife, tall meadow rue, goldenrod, spring spikemoss, sensitive fern, and buttercup. Litter cover below the trees is virtually nonexistent, or only one leaf thick. There is standing water 50 m from the pasture, to a depth of 3.0 to 4.0 cm.

Runs are present adjacent to the trees, or near outcrops of Mettawee Slate in the pasture proper. Subsequent to trapping, it was discovered that area residents actively feed and attract raccoons. The presence of raccoons was confirmed due to the number of totally destroyed traps.

50. Cattail field, 1.13 km and 240^{o} from the 686 ft BM, Town of Hubbardton, Rutland County, Vermont.

An extremely wet field dominated by cattails is fringed by small willow and quaking aspen with a few larger (15.2 to 20.3 cm) white pine interspersed. An adjacent stream drains the area. The Copake gravelly loam is saturated near the stream, but drier some 20 m distant from it. Large ramifying tunnels of *Condylura cristata* are present, as well as the smaller runs

of *M. pennsylvanicus*. The cattail marsh changes abruptly on the east to a typical hayfield-pasture association. No outcrops are present.

51. Outcrops, talus, and forested slopes 1.13 km and 15^{o} from elevation 103.9 m, Town of Hampton, Washington County, New York.

Talus and outcrops of the Chipman Formation are prevalent in this area of elm and American beech dominance. The dominant members of the canopy are between 10.2 and 22.9 cm d.b.h., and from 6.1 to 15.2 m tall. They are not early second growth, nor are they yet a mature growth. The talus is situated at the base of one steep (35^{o}) outcrop face; spring spikemoss is abundant on and around the talus. Litter is predominantly deciduous, and locally deep($\geq$ 7 cm). Ground cover is also provided by Christmas fern, goldenrod, ebony spleenwort, grapevine, herb-Robert, grasses, hemlock seedlings, and Solomon's seal.

A dry streambed was also trapped; the loamy fine sands were wet and littered with broken branches and fallen trees. The streambed is in a steep ($\geq 70^{o}$) walled ravine of erosion and stream-cut soil. A few large sugar maple, hemlock, hophornbeam, and white pine border the ravine.

52. Gentle slopes adjacent to Glen Lake, 0.80 km and 260^{o} from elevation 172.5 m, Town of Castleton, Rutland County, Vermont.

A stand of probably virgin hemlock (d.b.h. 101.6 cm) borders one side of the trap-line. Hemlock is everywhere dominant, but occurs with smaller blue beech, paper birch, sugar and red

maple, and an occasional large white pine. The dominant hemlock ranged from 10.2 to 30.5 cm d.b.h., and are about 7.6 to 16.8 m in height. The litter is of thin to medium depth (3.0 to 6.0 cm), and well dissected by runs. Understory vegetation is irregularly clustered, and consists of witch hazel, hemlock and birch seedlings, running evergreen, sugar maple seedlings, red oak seedlings, and quaking aspen seedlings. The Cossayuna loam is exposed near a few of the larger outcrops, and in shallow domed structures near several outcrops. Traps placed near these domed structures were destroyed and scattered on both trap-nights, suggesting possible bear activity. The domes may have been small ant hills. Fallen and rotting trees are prevalent, and these harbor many mouse and shrew runs.

Appendix 2. Results of the floristic survey of the various trap-sites. The first number following each tree species is the diameter breast height, in centimeters; the second number is the height, in meters. An asterisk (*) denotes the dominant tree species. The number following each species providing ground cover is the per cent coverage provided by that species in the meter square plot. A colon (:) separates various sampling areas in the same trap-site.

Site Number	Trees	Ground Cover
1.	*arborvitae 20.3, 15.2; *hemlock 20.3, 15.2; *white pine 20.3, 15.2; American elm 25.4, 16.8; tamarack 20.3, 13.7	white pine seedling 20; blackberry 5; daisy 2.5; buttercup 2.5; litter 70 {needle (n) 90, deciduous (d) 10}
2.	*yellow birch 17.8, 19.8-21.3; *hemlock 19.1, 13.7: *yellow birch 12.7-17.8, 19.8-21.3; *hemlock 12.7-17.8, 9.1; striped maple 3.8, 3.0: *yellow birch 10.2, 15.2; white ash 2.5, 1.8; *sugar maple 10.2-15.2, 13.7-15.2; mountain maple 2.5, 3.0:	ferns 2.5; grasses 2.5; litter 95 (n 50, d 50): white ash seedlings 5; litter 95 (n 50, d 50): white ash seedlings 5; wood fern 5; litter 90 (n 30, d 70): grasses 10; staghorn sumac seedlings 90

Site Number	Tree Species	Ground Cover
2. (cont'd)	*hophornbeam 15.2, 12.2; *American hornbeam 11.4, 12.2; American elm 5.1, 7.6; apple 8.9, 7.6	
3.	gray birch 14.0, 12.8; *white pine 10.2-15.2, 9.1-10.7: *white pine 26.7, 10.7-12.2; hophornbeam 3.8, 7.6; mountain maple 1.3, 12.2: red maple 5.1, 7.6-9.1; *quaking aspen 17.8-20.3, 15.2-18.3; white pine 7.6, 6.1-7.6	wild sarsaparella 10; white oak seedling 10; witch hazel seedling 10; false Solomon's seal 10; litter 60 (n 70, d 30): same : same
4.	*hemlock 15.2, 15.2-21.3; white pine 15.2, 15.2-21.3; *arbor vitae 24.1, 18.3; balsam fir 5.1, 9.1	litter 90 (n 100); bunchberry 2; Virginia cucumber root 5; mint, leafy liverwort, pink ladyslipper, cinammon fern, bracken fern, false lily-of-the-valley; goldthread (each < 1)
5.	*paper birch 17.8-20.3, 16.8; *sugar maple 17.8-20.3, 18.3; black birch 31.8, 21.3; white pine 31.1, 18.3: white	Solomon's seal, maple seedling, ash seedling (each < 1); litter 99 (n 5, d 95): ash seedling 1; sugar maple

Site Number	Tree Species	Ground Cover
5. (cont'd)	pine 17.1, 10.7-12.2; *sugar maple 8.9, 3.7-15.2: *paper birch 15.2-20.3, 16.8-18.3; white pine 10.2-15.2, 7.6-12.2; hophornbeam 7.6-10.2, 10.7; *sugar maple 22.9, 16.8	seedling 1; litter 98 (n 5, d 95): stiff club-moss 5; maple seedling 1; red oak seedling 1; litter 93 (n 20, d 80)
6.	*sugar maple 12.7, 13.7-19.8; quaking aspen 24.1, 22.9; *American elm 22.9, 18.3; American beech 20.3, 18.3; paper birch 25.4-30.5, 16.8; hophornbeam 5.1, 9.1	woodfern 4; litter 90 (d 100); unidentified compositae 5; Solomon's seal, false Solomon's seal, sugar maple seedling, white ash seedling, beech seedling (each < 1)
7.	*sugar maple 1.4, 13.7-15.2; elm 35.6, 24.4; basswood 7.6, 10.7: *sugar maple 1.3, 4.6; *American beech 6.4, 10.7; *hemlock 15.9, 12.2; witch hazel 1.3, 3.7; hophornbeam 15.9, 13.7: *yellow birch 7.6, 12.2-15.2: *yellow birch	Solomon' seal 2; baneberry 1; sugar maple seedling 1; large-flowered Trilllium 1; litter 95 (d 100): striped maple 5; Christmas fern 5; Solomon's seal 1; large-flowered Trillium 1; basswood seedling 2; aster 1; litter 85 (d 100):

Site Number	Tree Species	Ground Cover
7. (cont'd)	8.9, 18.3; American beech 11.4, 18.3; *hemlock 22.9, 12.2: *yellow birch 30.5, 16.8; *hemlock 24.1, 13.7; elm 28.0, 18.3: *hemlock 15.2, 16.8; *black birch 28.0, 18.3; paper birch 17.8, 15.2	woodfern 4; white ash seedling 1; litter 95 (d 100): woodfern 4; large-flowered Trillium 1; Christmas fern 1; litter 94 (n 40, d 60): Christmas fern 1; litter 99 (n 40, d 60): Christmas fern 75; large-flowered Trillium 1; litter 24 (n 15, d 85).
8.	*sycamore 8.9, 4.6; *quaking aspen 15.2, 7.6; *sandbar willow 10.2, 2.7; alder 0.4, 0.6; elm 5.1, 3.0; cherry 7.0, 4.6: *staghorn sumac 7.6, 6.1; *quaking aspen 7.6, 4.6; elm 5.1, 3.0; paper birch 10.2, 6.1: *sycamore 40.6, 12.2; elm 12.7, 10.7: cherry 11.4, 9.1	milkweed 3; daisy 5; yarrow 4; grasses 3; litter 35 (d 100); bare 50: wild raspberry 14; barren strawberry 14; clover 14; grapevine 14; milkweed 14; litter 30 (d 100): horsetail 5; plantain 5; grasses 50; bare 40: grasses 98; litter 1 (d 100); horsetail 0.5; black medic 0.5
9.	sugar maple 8.9, 10.7; *hophornbeam 5.1, 7.6; hemlock 11.4, 10.7; elm 15.2, 10.7	litter 98 (n 1, d 99); false Solomon's seal, sugar maple seedling, leafy liverwort (each < 1); running evergreen 1

Site Number	Tree Species	Ground Cover
10.	apple 11.4, 3.0; *white pine 14.0, 10.7; sugar maple 0.6, 1.8; *red maple 8.9, 9.1; slippery elm 7.6, 9.1; sweet birch 6.4, 9.1; hemlock 10.2, 10.7	Jack-in-the-pulpit 1; leafy liverwort 1; goldenrod 2; woodfern 1; sensitive fern 2; resurrection fern 1; lily 1; running evergreen 1; litter 90 (n 99, d 1)
11.	*hawthorne 1.9, 2.4; black walnut 27.9, 15.2; *sugar maple 22.9, 15.2: *black maple 17.8, 13.7: *elm 20.3, 13.7; *black cherry 27.9, 13.7; hickory 20.3, 13.7; hawthorne 30.5, 3.0; *hawthorne 5.1, 6.1; elm 5.1, 6.1: elm 3.8, 3.7	goldenrod 60; grasses 20; clover 2; buttercup 2; wild mustard 1; wild oats 2; dandelion 2; thistle 3; plantain 5; shepard's purse 3 : thistle 5; goldenrod 15; litter 70 (d 100); bare 10; grasses 80; ash seedling 5; wild blackberry 1; wild parsely 4; grape vine 2; Virginia creeper 8: litter 5 (d 100); grasses 20; leafy loverwort 5; Virginia creeper 5; wild mustard 5; goldenrod 20; thistle 10; dandelion 10; grape vine 10; wild oats 10: grasses 80; reindeer moss 2; grape vine 2; goldenrod 10; blackberry 2;

Site Number	Tree Species	Ground Cover
11. (cont'd)		buttercup 1; strawberry 2; yarrow 1
12.	*apple 15.2-22.9, 3.7-6.1	wild grapevine 15; buttercup 20; bedstraw 5; hedge bindweed 2; alfalfa 3; sorrel 2; American basswood seedling 18; orchard grass 35
13.	green ash 48.2, 13.7; red maple 48.2, 13.7; hemlock 5.1, 13.7; American basswood 55.9, 13.7: *hemlock 10.2, 15.2; *yellow birch 35.6, 18.3; *paper birch 40.6, 19.8; American hornbeam 1.3, 3.7: sugar maple 81.3, 13.7; *quaking aspen 12.7, 12.2; green ash 12.7, 12.2; paper birch 53.3, 10.7; white pine 12.7, 10.7	orchard grass 90; litter 1 (n 1, d 99); thistle 1; mint 1; dandelion 1; buttercup 2; yarrow 1; wormwood 1; bedstraw 1; reindeer moss 1: litter 98 (n 40, d 60); woodfern 1; maple seedling 0.5; ash seedling 0.5: bare 40; grasses 50; wild balckberry 2; wild strawberry 3; clover 1; wild grapevine 1; buttercup 1; juniper 1; giant chickweed 1
14.	*sugar maple 2.5, 7.6; cherry 12.7, 12.2: black birch 10.2, 13.0; American beech 1.2, 6.1; *hemlock 28.0, 19.1: American beech 10.2, 25.9; *hemlock	goldenrod 5; maple seedling 3; false Solomon's seal 2; litter 90 (d 100): litter 96 (n 90, d 10); oak seedling 5; white ash seedling 3; woodfern 2:

Site Number	Tree Species	Ground Cover
14. (cont'd)	5.1, 6.1; *American beech 10.2,9.1: *sugar maple 5.1, 7.6;ash 30.5, 19.8	leafy liverwort 1; woodfern 1; litter 98 (d 100): litter 90 (d 100); bare 5; Christmas fern, poison ivy, sugar maple seedling , white pine seedling, false Solomon's seal, Jack-in-the-pulpit, leafy liverwort (each < 1)
15.	American hornbeam 5.1, 7.6; *sugar maple 5.1, 9.1; *red oak 12.7, 18.3; quaking aspen 12.7, 18.3; white ash 16.5, 18.3; *American beech 17.8, 21.3: striped maple 1.9, 3.7; paper birch 34.3, 18.3; hophornbeam 5.1, 7.6; *hemlock 30.5, 13.7; red oak 78.7, 22.9	litter 50 (d 100); bare 40; hemlock seedling 2; false lily-of-the-valley 2; Solomon's seal 2; American beech seedling 4: litter 95 (n 20, d 80); woodfern 1; Solomon's seal 1; scaly liverwort 1; leafy liverwort 1; false lily-of-the-valley 1
16.	*sugar maple 5.1, 7.6; American elm 7.6, 9.1; *hemlock 6.4, 10.7	bare 65; woodfern 5; litter 20 (n 5, d 95); leafy liverwort 10

Site Number	Tree Species	Ground Cover
17.	*hemlock 19.1, 15.2; sugar maple 27.9,21.3; *yellow birch 12.7, 12.2: *paper birch 21.6, 15.2; hophornbeam 10.2, 10.7; *hemlock 22.9, 18.3: quaking aspen 24.1, 22.9; paper birch 8.9, 15.2; *American beech 11.4, 18.3; hemlock 20.3, 10.7; white pine 20.3, 18.3	litter 85 (n 10, d 90); Solomon's seal 2; mountain maple seedling 2; witch hazel seedling 1; striped maple seedling 2; Jack-in-the-pulpit 2; Christmas fern 2; leafy liverwort 1; scaly liverwort 1; wild sarsaparella 1; hemlock seedling 1: litter 98 (n 15, d 85); false lily-of-the-valley, leafy liverwort, spring spike-moss, Christmas fern (each < 1): litter 98 (n 50, d 50); striped maple seedling, grasses, Christmas fern; leafy liverwort (each < 1): litter 98 (n 20, d 80); partridge berry, Solomon's seal, scaly liverwort, American beech seedling (each < 1)
18.	American beech 1.9, 3.7; *white pine 30.4, 19.8; yellow birch 3.8, 19.8;	litter 90 (n 90, d 10); leafy liverwort 2; false lily-of-the-valley 2; woodfern 2;

Site Number	Tree Species	Ground Cover
18. (cont'd)	witch hazel 2.5, 2.4; *hemlock 6.4, 7.6; *paper birch 16.5, 16.8	Solomon's seal 2; Christmas fern 2
19.	American beech, white ash, *sugar maple, bear oak, red oak, American hornbeam, red maple, hophornbeam, yellow birch, paper birch (all) 5.1-7.6, 7.6-9.1: *paper birch 8.5, 10.2; American elm 6.5, 9.1	litter 50 (d 100); woodfern 16; oak fern 1; sensitive fern 3; grasses 20; Christmas fern 10: cow vetch 2; buttercup 2; yarrow 2; pale touch-me-not 2; iris 22; ragweed 10; grasses 60
20.	*white pine 8.9, 1.8; white ash 0.6, 1.2; basswood 1.9, 1.8; sugar maple 88.9, 18.3: *shagbark hickory 2.5, 4.6; American hornbeam 3.8, 4.6; *white pine 5.1, 3.0: *quaking aspen 20.3, 19.8; sugar maple 33.0, 21.3; *American beech 7.6, 9.1; white pine 0.6, 1.2: *paper birch 21.6, 18.3; white pine 31.8, 21.3; sugar maple 19.1, 18.3	sugar maple seedling 20; goldenrod 10; litter 40 (n 50, d 50); grasses 20; hemlock seedling 5; yarrow 5: litter 85 (n 70, d 30); striped maple 15; wild strawberry 2; goldenrod 5; witch hazel seedling 1; Christmas fern 2: litter 99 (n 5, d 95); maple-leaved viburnum, Christmas fern, woodfern, goldenrod (each < 1): litter 95 (n 5, d 95); grasses 2;

Site Number	Tree Species	Ground Cover
20. (cont'd)		witch hazel seedling 1; unclassified compositae 1; maple-leaved viburnum 1
21.	red maple 7.6, 7.6; *sugar maple 8.9, 10.7; white ash 3.8, 7.6; hophornbeam 2.5, 6.1; American hornbeam 6.4, 9.1; paper birch 8.9, 10.7	unclassified violet 2; Oak fern 3; Christmas fern 3; royal fern 2; field garlic 13; grasses 20; woodfern 5; wild ginger 2; litter 50 (d 100)
22.	*American hornbeam 3.8, 4.6; paper birch 38.1, 18.3; *American beech 15.2, 18.3; sugar maple 18.4, 21.3: shagbark hickory 9.5, 15.2; white pine 1.3, 1.8; paper birch 5.7, 6.1; *American hornbeam 1.3, 4.6; *hophornbeam 3.8, 6.1: *shagbark hickory 10.2, 15.2; American beech 3.8, 9.1; quaking aspen 17.8, 15.2: red oak 58.4, 18.3; *hophornbeam 3.8, 4.6; cherry 2.5, 6.1	Christmas fern 2; unclassified compositae 1; false Solomon's seal 1; false lily-of-the-valley 1; litter 95 (d 100): litter 89 (d 100); grasses 1; red maple seedling 2; red oak seedling 3; American hornbeam seedling 5: litter 69 (d 100); red oak seedling 1; American hornbeam seedling 30: hophornbeam seedling 25; red oak seedling 5; American beech seedling 10; grasses 50; Christmas fern 5; white pine seedling 4; goldenrod 1

Site Number	Tree Species	Ground Cover
23.	hophornbeam 14.6, 21.3; sugar maple 15.2, 22.9; *red maple 25.4, 24.4: paper birch 22.9, 19.8; *white pine 39.4, 19.8; American beech 8.9, 9.1; black birch 7.6, 10.7: *white pine 12.7, 7.6; *red maple 20.5, 22.9; white pine 184.2, 27.4: white pine 91.4, 25.9; red maple 2.5, 6.1; white pine 1.9, 1.2; *black birch 8.9, 6.1	ebony spleenwort 10; woodfern 10; Jack-in-the-pulpit 1; false lily-of-the-valley 1; litter 78 (d 100): running evergreen 10; litter 80 (n 50, d 50); woodfern 5; spring spike-moss 5: Indian cucumber 15; false lily-of-the-valley 3; woodfern 3; running evergreen 3; grasses 1; litter 75 (n 80, d 20): blueberry 50; grasses 40; litter 10 (n 50, d 50)
24.	*white pine 24.1, 15.2; hemlock 3.8, 1.5: hophornbeam 8.9, 12.2; *basswood 22.9, 18.3; *hemlock 20.3, 18.3; *sugar maple 17.8, 21.3; American hornbeam 1.9, 4.6: hophornbeam 6.4, 5.5; red oak 48.3, 19.8; *hemlock 22.9, 13.7; American beech 5.1, 3.7	poison ivy 2; woodfern 1; hemlock seedling 2; bare 30; litter 65 (n 100): bare 30; litter 65 (n 15, d 85); leafy liverwort 2; grasses 3: litter 75 (n 10, d 90); bare 10; sugar maple seedling 5; may apple 5; false lily-of-the-valley 3; large-flowered Trillium 2

Site Number	Tree Species	Ground Cover
25.	*hophornbeam 3.2, 9.1; sugar maple 0.5, 1.2; mountain ash 6.4, 9.1; *American beech 15.2, 12.2: *paper birch 15.2, 16.8; hophornbeam 8.9, 15.2; American beech 3.8, 9.1: *American beech 12.7, 12.2; hophornbeam 7.0, 10.7; hemlock 34.3, 13.7; witch hazel 0.4, 1.2; black cherry 2.5, 3.0	litter 99 (n 1, d 99); poison ivy 1: litter 100 (d 100): bare 40; litter 59 (d 100); false Solomon's seal 0.5; grasses 0.5;
26.	*balsam fir 5.1, 9.1; sugar maple 3.8, 7.6; red oak 5.1, 7.6; shagbark hickory 3.8, 6.1: *balsam fir 6.4, 9.1; American beech 6.4, 7.6: *balsam fir 6.4, 9.1; paper birch 7.6, 10.7; yellow birch 3.8, 6.1; red maple 2.5, 6.1: *balsam fir 7.6, 10.7	litter 85 (n 50, d 50); sensitive fern 5;stiff club-moss 15: litter 90 (n 85, d 15); woodfern 5; stiff club-moss 5: litter 95 (n 90, d 10); marsh fern 2; lady fern 3: litter 99 (n 100); stiff club-moss 1
27.	*sugar maple 9.5, 12.2; paper birch 20.3, 18.3; white pine 10.2, 4.6; hophornbeam 0.6, 1.5: *sugar maple 10.2, 10.7; white pine 5.1, 10.7	litter 99 (n 5, d 95); spring spike-moss 5; woodfern 10; stiff club-moss 5; Solomon's seal 5; leafy liverwort 1;

Site Number	Tree Species	Ground Cover
27. (cont'd)		oak seedling 1; unclassified violet 3: litter 99 (n 2, d 98); sugar maple seedling, woodfern (each < 1)
28.	hophornbeam 11.4, 10.7; American hornbeam 11.4, 10.7; *sugar maple 8.9, 10.7; American elm 8.9, 10.7; American beech 11.4, 10.7: *sugar maple 33.0, 19.8; hophornbeam 17.8, 13.7	quackgrass 10; broomsedge 10; reed canary grass 10; cheat 20; herb-Robert 10; woodfern 5; bracken fern 5; litter 30 (d 100): litter 95 (d 100); woodfern 3; herb-Robert 1; sugar maple seedling 1
29.	*sugar maple 40.6, 16.8; slippery elm 43.2, 22.9; American elm 38.1, 22.9: *sugar maple 17.8, 13.7; white pine 15.2, 10.7: *American elm 14.0, 10.7; American beech 7.6, 7.6; *sugar maple15.2, 12.2; hemlock 17.8, 10.7; black birch 10.2, 12.2: white pine 15.2, 12.2; *paper birch 30.5, 19.8; apple 25.4, 12.2	bare 80; litter 18 (d100); maple seedling 2: goldenrod 70; litter 20 (n 30, d 70); grasses 5; white pine seedling 5: litter 65 (n 5, d 95); grasses 10; bare 25: litter 60 (n 40, d 60); goldenrod 25; grasses 10; bare 5

Site Number	Tree Species	Ground Cover
30.	scarlet oak 5.1, 9.1; red oak 7.6, 7.6; big tooth aspen 2.5, 3.0; American hornbeam 3.8, 6.1; ironwood 2.5, 6.1; *black birch 1.9, 4.6; witch hazel 1.3, 4.6; striped maple 0.6, 4.6; *American beech 5.1, 9.1; silver maple 0.6, 2.1: American hornbeam 12.7, 7.6; white pine 0.6, 0.9; *yellow birch 0.6, 2.1: yellow birch 11.4, 10.7; elm 21.6, 18.3; *hemlock 28.0, 15.2	litter 60 (d 100); large-flowered Trillium 5; false Solomon's seal 5; Christmas fern 10; ebony spleenwort 5; hophornbeam seedling 10; maple seedling 5: litter 50 (d 100); scaly liverwort 30; striped maple 3; woodfern 5; hemlock seedling 2; running evergreen 5; white ash seedling 5: litter 95 (n 5, d 95); leafy liverwort 3; false lily-of-the-valley 1; witch hazel seedling 1: litter 98 (n 70, d 30); witch hazel, goldthread, Virginia cucumber root, maple seedling (each < 1)
31.	*white pine 22.9, 16.8; sugar maple 55.9, 19.8; *hemlock 6.4, 3.7; hophornbeam 0.6, 4.6	litter 80 (n 30, d 70); Christmas fern 5; white ash seedling 2; maple seedling 3; woodfern 2; hophornbeam seedling 3; cherry seedling 3; leafy liverwort 2

Site number	Tree Species	Ground Cover
32.	elm 5.1, 6.1; *white ash 12.7, 19.8; *paper birch 16.5, 19.8; cherry 2.5, 2.4; white pine 5.1, 4.0; sugar maple 5.1, 9.1: *white ash 15.2, 16.8; *white pine 20.3, 9.1; elm 2.5, 4.6: *white pine 19.1, 15.2; white ash 15.2, 18.3	bare 60; white ash seedling 39; dandelion, grasses, wild grape vine (each < 1): bare 10; grasses 50; ash seedling 10; elm seedling 15; grape vine 15: litter 60 (n 100); woodfern 30; Christmas fern 8; grasses 1; white ash seedling 1
33.	*sugar maple 2.5, 4.6; *red maple 6.4, 10.7; white ash 3.8, 7.6; witch hazel 1.9, 4.6; shagbark hickory 5.1, 9.1: white pine 22.9, 10.7; *paper birch 11.4, 18.3; *black birch 22.9, 21.3; hophornbeam 6.4, 9.1: *paper birch 15.2, 16.8; *sugar maple 1.3, 3.7; slippery elm 1.3, 4.6	goldenrod 20; grasses 10; litter 40 (d 100); sugar maple seedling 10; red maple seedling 10; white ash seedling 2; woodfern 3; wild blackberry 5: litter 75 (n 30, d 70); white pine seedling 5; maple seedling 5; New York fern 5; woodfern 10: litter 99 (d 100); maple seedling, Christmas fern (each < 1)
34.	*white pine 5.1, 10.7: *sugar maple 28.0, 22.9; *white pine 5.1, 10.7: white ash 39.4, 25.9; *sugar maple 25.4, 21.3; cherry 27.9, 21.3; red oak 20.3, 15.2	litter 95 (n 100); Solomon's seal 2; white ash seedling 2; sugar maple seedling 1: litter 95 (n 50, d 50); Solomon's seal 2; white ash seedling 2; sugar maple

Site Number	Tree Species	Ground Cover
34. (cont'd)		seedling 1: litter 95 (d 100); sugar maple seedling 3; woodfern 2
35.	Results Not Available	Results Not Available
36.	*white pine 21.6, 16.8; paper birch 7.6, 10.7: *white pine 25.4, 9.7; arborvitae 10.2, 9.1; paper birch 22.9, 19.8; arborvitae 7.6, 7.6	grasses 28; litter 70 (n 100); poison ivy 1; sugar maple seedling, red maple seedling, ash seedling (each < 1): litter 95 (n 100); basswood seedling, poison ivy, wild grape vine,dandelion, Virginia creeper, elderberry (each < 1)
37.	*hemlock 0.6, 0.9; sugar maple 0.4,0.6; elm 15.2, 10.7; hophornbeam 3.8, 6.1; *white pine 40.6, 15.2: *hemlock 3.8, 3.0; *white pine 12.7, 15.2; black birch 10.2, 15.2: *hophornbeam 1.3, 3.0; white pine 43.2, 16.8; *hemlock 20.3, 15.2	grasses 70; goldenrod 5; litter 5 (n 50, d 50); scaly liverwort 5; woodfern 5; sensitive fern 3; Christmas fern 5; herb-Robert: litter 95 (n 95, d 5); Jack-in-the-pulpit 2; New York fern 1; false lily-of-the-valley 2: litter 90 (n 85, d 15); New York fern 2; spring spike-moss 2; running evergreen 2; false lily-of-the-valley 2; Christmas fern 2

Site Number	Tree Species	Ground Cover
38.	paper birch 19.7, 16.8; hemlock 14.0, 9.1; sugar maple 25.4, 19.8; yellow birch 20.3, 18.3: sugar maple 3.8, 4.6; *shagbark hickory 7.6; 13.7; basswood 2.5, 4.6; ash 31.8, 18.3; witch hazel 0.4, 0.6; yellow birch 7.6, 12.2; *hemlock 7.6, 10.7	litter 85 (n 20, d 80); Solomon's seal 15; maple seedling 5; woodfern 5; scaly liverwort 5; bindweed 5: litter 85 (n 20, d 80); Solomon's seal 5; maple seedling 5; woodfern 5; scaly liverwort 5; bindweed 5
39.	basswood 12.7, 19.8; hophornbeam 2.5, 4.6; *white ash 5.1, 9.1; sugar maple 15.9, 18.3: sugar maple 10.2, 18.2; *white ash 15.2, 18.3: striped maple 2.5, 2.4; *sugar maple 30.5, 18.3: *white pine 14.0, 10.7; white ash 12.7, 12.2; chokecherry 1.3,1.5	litter 75 (d 100); meadow rue 20; white ash seedling, grasses, Jack-in-the-pulpit, buttercup, unclassified sedge, sugar maple seedling, hophornbeam seedling, leafy liverwort, fern moss, Christmas fern, horsetail (each < 1): litter 95 (d 100); sensitive fern, white ash seedling, false Solomon's seal, scaly liverwort, fern moss, woodfern, Christmas fern (each < 1):litter 90 (n 5, d 95); Solomon' seal 5; white ash seedling 2; sugar maple seedling 2; spring spike-moss 1

Site Number	Tree Species	Ground Cover
40.	*hemlock 20.3, 12.2; yellow birch 2.5, 7.6; sugar maple 5.1, 9.1; shagbark hickory 2.5, 6.1; American elm 5.1, 9.1; paper birch 12.7, 9.1; sycamore 1.9, 6.1	witch hazel 5; Christmas fern 5; woodfern 5; litter 85 (n 40, d 60)
41.	*sugar maple 28.0, 19.8: paper birch 26.7, 19.8; *hophornbeam 10.2, 13.7; ash 6.4, 7.6: *sugar maple 22.9, 19.8; basswood 47.0, 25.9	litter 75 (d 100); maple seedling 20; woodfern 4; Jack-in-the-pulpit 1: witch hazel 5; sugar maple seedling 20; ash seedling 10; goldenrod 5; litter 65 (d 100): litter 70 (d 100); sugar maple seedling 25; oak seedling 4; woodfern 1
42.	yellow birch 15.2, 10.7; *paper birch 15.2, 12.2; *white pine 17.8, 12.2: *sugar maple 25.4, 16.8; striped maple 2.5, 3.0; *American elm 28.0, 22.9; hophornbeam 10.2, 10.7; red oak 28.0, 16.8; basswood 2.5, 3.0	Christmas fern 2; litter 90 (n 30, d 70); basswood seedling 1; goldthread 1; false lily-of-the-valley 1; running evergreen 1; woodfern 1; lady fern 1; ebony spleenwort 2: litter 95 (d 100); maple seedling 1; false lily-of-the-valley 1; false Solomon's seal 2; large-flowered Trillium 1

Site Number	Tree Species	Ground Cover
43.	sugar maple 10.2, 4.6; American beech 10.2, 4.6; yellow birch 15.2, 10.7; American hornbeam 5.1, 7.6; paper birch 15.2, 12.2; elm 5.1, 3.0; *white pine 5.1, 2.4; hemlock 5.1, 2.4: *red oak 45.7, 19.8; white pine 22.9, 10.7; *quaking aspen 12.7, 13.7; hemlock 33.0, 13.7	bare 75; litter 20 (n 20, d 80); Christmas fern 2; false lily-of-the-valley 1; unclassified liverwort 1; false Solomon's seal 1: grasses 10; litter 80 (n 50, d 50); wild strawberry 2; wild raspberry 1; poison ivy 2; leafy liverwort 1; Christmas fern 2; woodfern 2
44.	*apple	wild grape vine 15; buttercup 5; bedstraw 10; litter 20 (d 100); grasses 50
45.	*sugar maple 25.4, 15.2; white pine 2.5, 1.2; hemlock 2.5, 0.6: *white pine 21.6, 10.7; elm 30.5, 15.2; *hemlock 33.0, 13.7; sugar maple 22.9, 15.2	grasses 99; daisy, orange hawkweed, red clover, yellow smoothish hawkweed, nettles (each < 1): bare 25; litter 65 (n 95, d 5); Christmas fern 2; woodfern 2; wintergreen 2; spring spike-moss 4:

Site Number	Tree Species	Ground Cover
45. (cont'd)		bare 30; litter 60 (n 80, d 20); Christmas fern 2; woodfern 1; wintergreen 2; leafy liverwort 2; spring spike-moss 1; orange hawkweed 1; marsh marigold 1
46.	*white pine 8.9, 12.2; paper birch 12.7, 15.2; yellow birch 11.4, 13.7; American beech 0.6, 0.8	litter 99 (n 99, d 1); sensitive fern 0.5; leafy liverwort 0.5
47.	*sugar maple 8.9, 10.7; hophornbeam 7.6, 10.7	grasses 100: grasses 98; sensitive fern 1; red clover 1: buttercup 2; bare 15; grasses 73; ebony spleenwort 8; goldenrod 2
48.		grasses 97; red clover 1; sensitive fern 1; daisy 1

Site Number	Tree Species	Ground Cover
49.	*witch hazel 2.5, 1.5; black willow 3.8, 2.4	grasses 90; red clover 1; daisy 1; daisy fleabane 1; unclassified aster 1; fringed loosestrife 1; tall meadow rue 1; goldenrod 1; spring spike-moss 1; sensitive fern 1; buttercup 1
50.	quaking aspen 1.3, 0.9; *black willow 7.6, 6.1; white pine 17.8, 10.7	cattail 85; grasses 15
51.	sugar maple 1.3, 1.5; *American elm 22.9, 15.2; *American beech 10.2, 6.1; hemlock 2.5, 4.6; hophornbeam 7.6, 9.1; white pine 15.2, 12.2	Christmas fern 2; goldenrod 2; ebony spleenwort 2; wild grape vine 5; litter 70 (n 10, d 90); herb-Robert 1; grasses 14; hemlock seedling 2; Solomon's seal 1; spring spike-moss 1: Christmas fern 5; ebony spleenwort 5; bare 50; litter 40 (n 15, d 85)
52.	*hemlock 101.6, 19.8-21.3: blue beech 5.1, 6.1; paper birch 27.9, 15.2; *hemlock 10.2, 9.1: white pine 40.6, 16.8; *hemlock	litter 100 (n 100): litter 95 (n 70, d 30); witch hazel 1; hemlock seedling 2; birch seedling 1; stiff club-moss 1:

Site Number	Tree Species	Ground Cover
52. (cont'd)	10.2, 9.1: *hemlock 17.8, 13.7; paper birch 10.2, 12.2: *hemlock 10.2, 7.6; paper birch 15.2, 13.7; sugar maple 7.6, 7.6: red maple 3.8, 6.1; *hemlock 30.5, 16.8; white pine 7.6, 6.1; sugar maple 15.2, 16.8	litter 85 (n 98, d 2); stiff club-moss 2; spring spike-moss 2; witch hazel seedling 3; sugar maple seedling 2; striped maple seedling 2; red oak seedling 2: litter 98 (n 10, d 90); quaking aspen seedling, grasses, birch seedling, woodfern (each < 1): litter 99 (n 9,d 91); witch hazel seedling 1: litter 100 (n 15, d 85)

Abstract

Previous trapping in the slate belt, including both Rutland County, Vermont, and Washington County, New York, has indicated a relative paucity of small mammalian species. There are also rather low populations levels of those mammals present when compared to other regions in Vermont and nearby states. The evolution of the soils from the slate bedrock seems to be the key to understanding the problem of species exclusion from the region.

The bedrock of the region is part of the Taconic sequence of rocks, and is primarily slate and phyllite that ranges in age from Early Cambrian to Middle Ordovician. The lithology of the Taconic bedrock is largely responsible for the type of soil development in the slate belt. Shallow soils with both large and small slate fragments have been derived from the glaciated slates and shales of the bedrock. Typically, the soils of the slate belt have developed to a depth of less than 0.6 m. The members of the Gray-Brown Podzolic soil province typically lack a well developed humus layer, and instead, raw organic material is found in the surface layer. The effects of intensive sheep grazing during the 19th century are still to be seen in the very thin topsoil, and loss of most humus from the soils of the region.

To determine the numbers and types of small mammals present, trap-sites were chosen to maximize the different types of habitats

containing different combinations of environmental factors. Habitats were divided into five main categories, and the type of cover at each trap was recorded.

Species trapped included *Peromyscus leucopus noveboracensis*, *Peromyscus maniculatus gracilis*, *Sorex fumeus*, *Blarina brevicauda*, *Clethrionomys gapperi*, *Napaeozapus insignis*, *Condylura cristata*, *Zapus hudsonius*, *Microtus pennsylvanicus*, and *Tamias striatus*. The capture rate was 25.00 animals per 1000 trap-nights (222 animals in 8880 trap-nights). Various conclusions are drawn concerning the occurrence of different species and various factors, including type of soil, type of bedrock, and type of cover.

Eight species of small mammals known to occur in the nearby regions could not be trapped in the slate belt. They include *Sorex cinereus*, *Sorex dispar*, *Microsorex hoyi*, *Sorex palustris*, *Parascalops breweri*, *Microtus chrotorrhinus*, *Pitymys pinetorum*, and *Synaptomys cooperi*.

It is concluded that the shallow depth to bedrock, abundance of slate fragments in the upper soil profile, and weakly developed humus layer are probably detrimental to burrowing species of small mammals. The lack of a proper substrate, e.g. talus, is of immediate importance to some species of small mammals, and the lack of this formation directly excludes them from the region.

References

Avery, T.E. 1967. Forest Measurement. 9-290. McGraw-Hill, New York.

Barbehenn, K. 1955. A field study of growth in *Microtus pennsylvanicus*. J. Mammal., 36, 533-543.

Bell, D.T., and S.K. Sipps. 1975. The litter stratum in the streamside forest ecosystem. Oikos, 26, 391-397.

Braun, E.L. 1950. Deciduous forests of eastern North America. *i-xiv* + 1-596. Blakiston, Philadelphia.

Brockman, C.F. 1968. Trees of North America. 1-280. Golden Press, New York.

Burt, W.B., and R.P. Grossenheider. 1964. A field guide to the mammals. *v-xxiii* + 1-284. Houghton Mifflin Co., Boston.

Christian, J.J. 1971a. Fighting, maturity, and population density in *Microtus pennsylvanicus*. J. Mammal., 52, 556-567.

Christian, J.J. 1971b. Population density and reproductive efficiency. Biol. Reprod., 4, 1-65.

Christian, J.J., A.S. Berkowitz, F.L. Osgood, Jr., and S. Greenberg. Small mammals of the slate belt of Rutland County, Vermont, and Washington County, New York. Unpublished.

Cobb, B. 1963. A field guide to the ferns. *i-xviii* + 1-281. Houghton Mifflin Co., Boston.

Conaway, C.H. 1952. Life history of the water shrew (*Sorex palustris navigator)*. Amer. Midl. Naturalist, 48, 219-248.

Cruickshank, J.G. 1972. Soil Geography. 1-256. Halsted Press Division, John Wiley and Sons, Inc. New York.

Dale, T.N. 1898. The slate belt of eastern New York and western Vermont. 19th Ann. Rep. U.S. Geol. Surv., part 3, 159-306, Figs. 7-16.

Doutt, J.K., C.A. Heppenstall, and J.E. Guilday. 1973. Mammals of Pennsylvania. 1-283. Pennsylvania Game Commission.

Fernald, M.L. 1950. Gray's manual of Botany. *v-lxiv* + 1-1632. American Book Co., New York.

Gunderson, H.B. 1959. Red-backed vole habitat studies in central Minnesota. J. Mammal., 40, 405-412.

Hall, E.R., and K.R. Kelson. 1959. The mammals of North America. *v-xxx* + 3-1083. The Ronald Press, New York.

Hamilton, W.J., Jr. 1963. The mammals of eastern United States. 1-432. Hafner Publishing Co., New York.

Harper, F. 1929. Notes on mammals of the Adirondacks. N.Y. State Mus. Handbook, 8, 51-118.

Harper F., and J.S. Harper. 1929. Animal habitats in certain portions of the Adirondacks. N.Y. State Mus. Handbook, 8, 11-49.

Jackson, H.H.T. 1915. A review of the American moles. N.A. Fauna, 38, 1-100. U.S. Biol. Surv., Washington, D.C.

Jameson, E.W.,Jr. 1949. Some factors influencing the local distribution and abundance of woodland small mammals in central New York. J. Mammal., 30, 231-235.

King, J.A. (Ed.) 1968. Biology of *Peromyscus*. 1-593. Special Publ. No. 2, The American Soc. of Mammalogists.

Klein, E.P. 1960. Ecological relationships of *Peromyscus leucopus noveboracensis* and *P. maniculatus gracils* in central New York. Ecol. Monogr., 30, 387-407.

Latimer, W.J., S.D. Perkins, F.R. Lesh, L.R. Smith, and K.V. Goodman. 1937. Soil survey (reconnaissance) of Vermont. U.S.D.A. Bur. of Chemistry and Soils Series 1930, No. 43, Washington, D.C.

McIntosh, R.P. 1972. Forests of the Catskill Mountains, New York. Ecol. Monogr., 42, 143-161.

Mearns, E.A. 1898. Notes on the mammals of the Catskill Mountains, New York, with general remarks on the fauna and flora of the region. Proc. U.S. Nat. Museum, 21, 341-360.

Miller, D.H. 1964a. Northern records of the pine mouse in Vermont. J. Mammal., 45, 627-628.

Miller, D.H. 1964b. Pygmy shrew in Vermont. J. Mammal., 45, 651-652.

Nicholson, A.J. 1941. The homes and social habits of the wood mouse (*Peromyscus leucopus noveboracensis*) in southern Michigan. Amer. Midl. Naturalist, 25, 196-223.

Osgood, F.L. 1935. Four Vermont records of the big-tailed shrew. J. Mammal., 16, 146.

Osgood, F.L. 1938a. The mammals of Vermont. J. Mammal., 19, 435-441.

Osgood, F.L. 1938b. First Vermont record for the rock vole. J. Mammal., 19, 108.

Peterson, R.L. 1966. The mammals of eastern Canada. *vi-xxvi* + 1-465. Oxford University Press, Toronto.

Richmond, N.D., and W.C. Grimm. 1950. Ecology and distribution of the shrew *Sorex dispar* in Pennsylvania. Ecology, 31, 279-282.

Sheldon, C. 1938. Vermont jumping mice of the genus *Zapus*. J. Mammal., 38, 324-332.

Siccama, T.G. 1971. Presettlement and present forest vegetation in northern Vermont with special reference to Chittenden County. Am. Midl. Naturalist, 85, 153-172.

Smith, P.B. 1972. Seasonal distribution of several small mammal species on Camel's Hump Mountain, Vermont, with special regard to climatic, edaphic, and vegetative influences. Ph.D. dissertation, University of Vermont.

Smith, D.A., and S.W. Speller. 1970. The distribution and behavior of *Peromyscus leucopus noveboracensis* and *Peromyscus maniculatus gracilis* (Rodentia:Cricetidae) in a southeastern Ontario woodlot. Can. J. Zool., 48, 1187-1199.

Starrett, A., and P. Starrett. 1952. *Peromyscus leucopus* on the peak of Mount Washington, Coos County, New Hampshire. J. Mammal., 33, 398.

Starrett, A., P. Starrett, and P.M. Youngman. 1952. Additional records for water shrews, *Sorex palustris*, in New England. J. Mammal., 33, 398.

Stewart, D.P. 1961. The glacial geology of Vermont. 7-124. Vermont Geol. Surv., Vermont Dev. Dept. Bull. No. 19, Montpelier, Vermont.

Stewart, D.P., and P. MacClintock. 1969. The surficial geology and Pleistocene history of Vermont. Vermont Geol. Surv., Dept. of Water Resources Bull. No. 31, Montpelier, Vermont.

Thompson, Z. 1853. Natural history of Vermont +appendix. *ix* + 1-286. Reprinted by C.E. Tuttle, Rutland, Vermont, in 1972.

Wentworth, E.N. 1948. America's sheep trails. Iowa State College Press, Ames, Iowa.

Whitaker, J.O., Jr. 1963. Food, habitat, and parasites of the woodland jumping mouse in central New York. J. Mammal., 44, 316-21.

Wilson, H.F. 1963. The hill country of northern New England. 1-455. Columbia University Press, New York.

Wrigley, R.E. 1972. Systematics and biology of the woodland jumping mouse, *Napaeozapus insignis*. Illinois Biol. Monog., No. 47.

Zen, E. 1961. Stratigraphy and structure at the north end of the Taconic Range in west-central Vermont. Geol. Soc. America Bull., 72, 293-338.

Zen, E. 1964a. Stratigraphy and structure of a portion of the Castleton quadrangle, Vermont. Vermont Geol. Surv., Vermont Dev. Dept. Bull. No. 25, Montpelier Vermont.

Zen, E. 1964b. Taconic stratigraphic names:definitions and synonemies. U.S. Geol Surv. Bull No. 1174, 1-95, Washington, D.C.

Zen, E. 1967. Time and space relationships of the Taconic allochthon and autochthon. Geol. Soc. America Spec. Paper 91, 1-107.

Zen, E. (Ed.) 1968. Studies of Appalachian geology:northern and maritime. 1-290. Interscience Publishers, New York.

Zen, E. 1972. The Taconide Zone and the Taconic orogeny in the western part of the northern Appalachian orogen. Geol. Soc. America Spec. Paper No. 135, 1-72.