Landscape Classification for the Hudson Valley Section of New Jersey

New Jersey Forest Service, NJ Division of Parks and Forestry

LANDSCAPE CLASSIFICATION FOR THE HUDSON VALLEY SECTION OF NEW JERSEY NJ ECOMAP

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This publication is dedicated to retired N.J. State Forester G. Lester Alpaugh, without whose support this project may never have been completed.

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1 INTRODUCTION

Landscape Classification for the Hudson Valley section of New Jersey is part of the New Jersey Forest Service Ecomap Project (NJ ECOMAP), an ongoing effort to map the land types of New Jersey with special reference to the plant communities associated with them. NJ ECOMAP is modeled after the National Hierarchy of Ecological Units (ECOMAP) developed by the U.S. Forest Service, which was designed to capture a large amount of geographic information, relevant to the distribution of plant communities, into mappable units defined at specific scales. This publication is the first in a series of publications which will extend the national ECOMAP to finer scales within New Jersey. Ecological landform classification at broader regional scales are already available for the entire U.S. (see McNab and Avers 1994).

The NJ ECOMAP project began by providing Section (SEC) boundaries for the National Hierarchy of Ecological Units (ECOMAP), which are defined by large-scale regional physiography and geomorphology (McNab and Avers 1994). Boundaries for these sections dissect New Jersey into four units, the Hudson Valley, the Lower New England, the Northern Appalachian Piedmont, and the Middle Atlantic Coastal Plain, all of which are contiguous with physiographic provinces in other states (Figure 1). Subsections (SUB) subdivide ECOMAP sections into landscape units based upon local bedrock formations and surface geology. Subsections are divided into Land Type Associations (LTA), based upon broad scale soil-taxonomy, which are further divided in Ecological Land Types (ELT), defined by unique combinations of different soil characteristics (i.e., soil texture, minerology, and chemical reaction) and topographic data.

This publication describes subsections, land type associations, and ecological land types within the Hudson Valley section of New Jersey according to the National Hierarchy of Ecological Units.

This area is bounded by the Delaware River on one side and the Lower New England section on the other, and includes most of Sussex and Warren Counties, N.J.

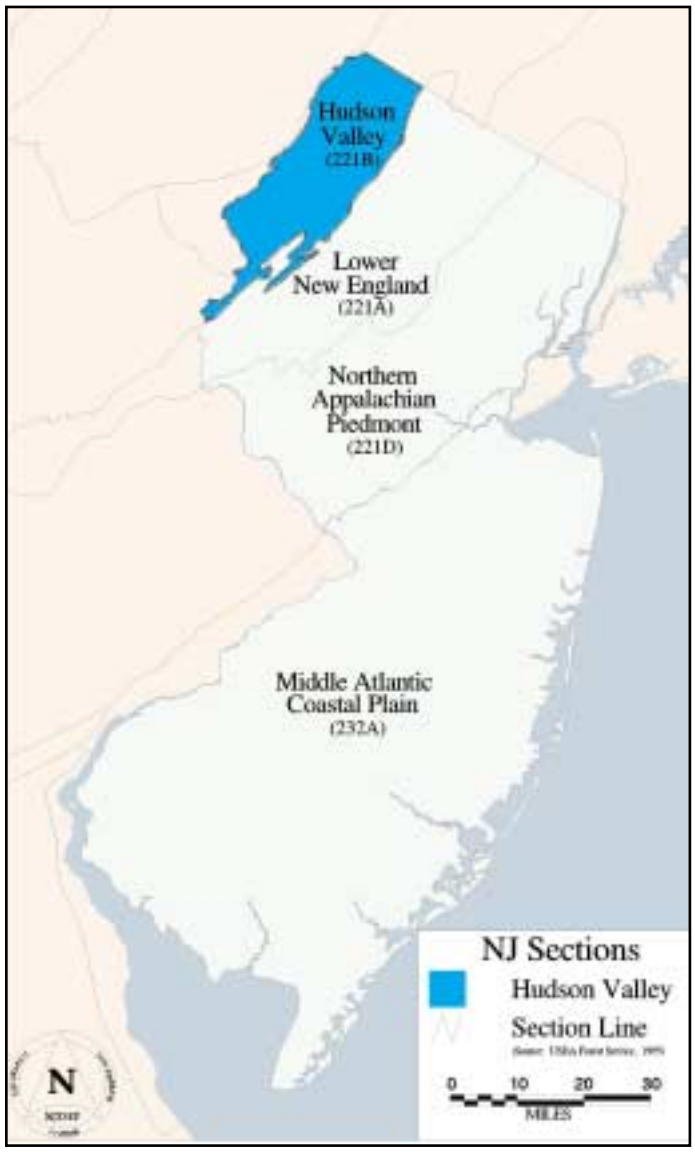


Figure 1. ECOMAP sections of New Jersey.

2 HOW TO USE THIS PUBLICATION

This publication is designed as a companion to a mapping system. The map-units described in this text delineate actual landforms within the limits of the applied technology. This publication describes general characteristics of each map-unit, including the description of the landform, associated plant communities and other related information. Full written descriptions are provided for map-units, down to the ELT scale, along with general background information. Only selected maps, pictures, and figures are presented in this publication, however, due to limitations in space, but the full complement of maps and data for the Hudson Valley section are provided in their entirety on the CD-ROM enclosed with this publication.

This is not a publication which maps plant communities, per se, rather the characteristics of each map unit reflect aspects of geography which influence the distribution of forested plant communities. At the upper levels of the hierarchy, such as the SUB scale, plant communities are based upon the the geographic ranges of tree species. At the ELT scale (the smallest mapped units) plant communities are described with reference to specific points in the landscape, such as a rocky ledge, for which plants may have a preference (although they are not necessarily limited to these locations). While this publication contains extensive information regarding the distribution of specific species, it is important to recognize that these plant communities represent "idealized" communities constructed from actual field data, historical records, and other published information. In other words, the composition of plant communities is influenced by many factors and cannot be described by landscape features alone. Hence, the plant communities presented in this publication might best be viewed as our current knowledge related to the preference of certain plants for certain places in the landscape.

Other information including climate data, historical influences on the landscape, wildlife populations, etc., is also included in the text to provide a more detailed picture of the landscape, although this information is necessarily incomplete.

Following the NJ ECOMAP Hierarchy

The NJ ECOMAP hierarchy has a nested structure in which smaller map units are aggregated into groups which form the next highest scale, and the top level of the hierarchy contains all of the map units below it (see Figure 2). In this publication, the Hudson Valley Section is the top level of the hierarchy, which is composed of 2 subsections, the Kittatinny-Shawangunk Ridge and Valley and the Hudson-Kittatinny Valley, which are composed of three and two Land Type Associations, respectively. Each Land Type Association contains a number of Ecological Land Types. Throughout this publication "hierarchy codes" are used, in addition to verbal descriptions of the map units, which reflect the nested structure of the hierarchy. The code is designed so that each "hierarchy code" is unique, but also contains letters or numbers describing all of the units above it in the hierarchy. Thus ELTs, at the bottom of the hierarchy, will have the longest code. The SEC code, at the top of the hierarchy, is the first part of all of the map units beneath it.

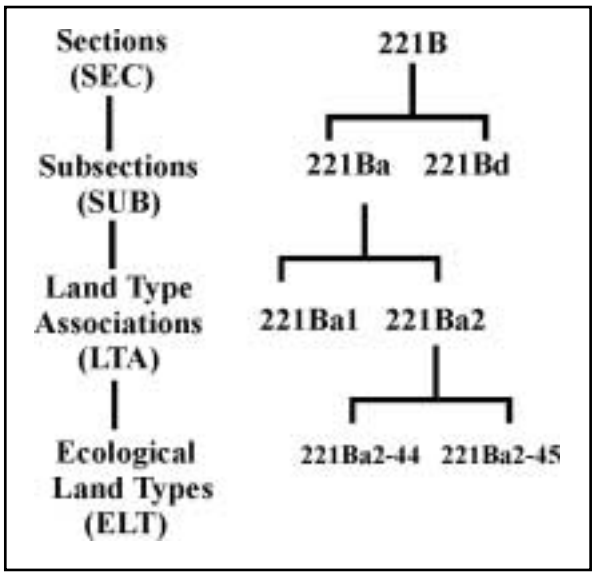


Figure 2. Graphic representation of the NJ ECOMAP hierarchy, (a) and an example of the hierarchy code (b).

3 DEVELOPING ECOMAP FOR NEW JERSEY

NJ ECOMAP is at its basic level a set of maps. Map-units were delineated using a variety of digital technologies associated with Geographic Information Systems (GIS). These map-units are unique in their final form, representing a new synthesis of a large amount of spatially defined information. Digital information was developed by NJ Forest Service or derived from a wide range of sources which are mentioned below and credited in the references at the end of this publication. Methodology is described below for each of the four defined scales: sections, subsections, land type associations and ecological land types.

1. Sections

The Hudson Valley Section (SEC) was delineated from digital maps of bedrock geology developed by New Jersey Geological Survey (NJGS) and state boundary lines developed by NJ Forest Service (NJFS). The western and southern boundaries were defined as the border between the Appalachian Ridge and Valley and the Reading Prong physiographic provinces. In NJ ECOMAP the state forms the boundary to the north, and the upper Delaware River forms the boundary to the west, although these political boundaries have no meaning in the larger context of the national hierarchy (ECOMAP).

2. Subsections

The Hudson Valley Section was divided into two subsections (SUB), which are related in their geomorphology (e.g., the bending and folding of the earth's crust to form the Appalachian Ridge and Valley) but are different in terms of the age and composition local geologic features and the overall characteristics of the landscape. The Kittatinny - Shawangunk Ridge and Valley (SUB) is dominated by Devonian and Silurian-age sandstone and conglomerate, mantled with locally derived till. The area has steep topography, with high ridges and deep narrow valleys. The Hudson-Kittatinny Valley (SUB) is dominated by till of the Ordovician-age Kittatinny Limestone and Martinsburg Shale. It has rolling topography with wide shallow river valleys. Both of these subsections contain lesser elements of the other surface rock types, which is typical of the diverse regional geomorphology of the Appalachian Ridge and Valley. This natural heterogeneity in rock formations was also enhanced by the action of glaciers (Wisconsin, Illinoian, Kansan), which redistributed material across the landscape of northern New Jersey.

Text describes only the New Jersey portion of these subsections. Descriptions include a large amount of information related to climate, geology, soils, hydrology, and land use demographics, provided to give a more detailed description of the landscape. This information was derived from a wide variety of sources listed in the reference section of this publication.

3. Land Type Associations

Each subsection contains a mosaic of Land Type Associations (LTA) which were delineated on the basis of similar parent material and topography. LTAs were derived from digital soil series maps provided by the Natural Resource Conservation Service (NRCS). Soil series map-units were aggregated into broad-scale groupings which reflect the similar parent material from which they were derived. For example, all soil series derived from limestone-bearing till were aggregated into the same parent material group. Parent material groups were aggregated to form LTAs, which reflect both parent material and landscape topography. The Lower Kittatinny Valley (LTA:221Ba2), for example, is comprised of soil series derived from alluvial, glacio-fluvial and limestone till which dominate the lower portions of the Hudson-Kittatinny Valley (SEC:221Ba). LTAs were assigned a minimum size of 100 acres (see Figure 3).

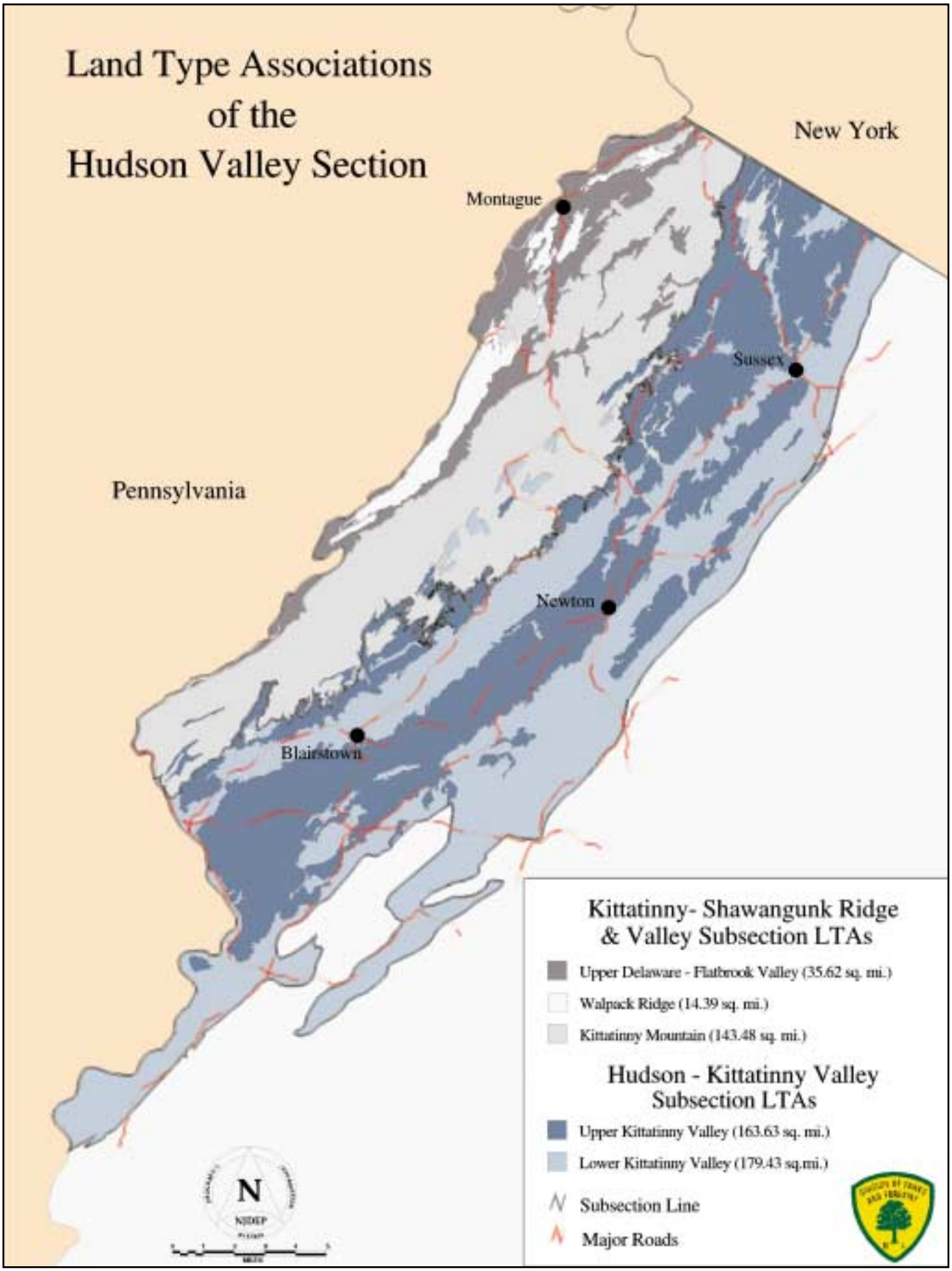


Figure 3. LTAs of the Hudson Valley Section

LTA descriptions contain information regarding the parent material and topography of the LTA, plant community information and estimates of 1991 land use / land cover. Plant Community descriptions consist of the most common trees found found within each LTA, compiled from botanical surveys conducted by the NJFS and information contained in botanical literature. Land use/land cover within each LTA was determined using Integrated Terrain Units (ITUs) obtained from the New Jersey Bureau of Geographic Information Systems Analysis (NJBGIA).

Each LTA contains a listing of all ELTs mapped within them. Many of these ELTs reflect some aspect of the general characteristics of the LTA, such as topography or parent material (for example, the Kittatinny Mountain contains ELTs which represent the dry, rocky ridgetops and escarpments of the mountain), but ELTs with atypical characteristics were also included because it was impractical to map them separately. These "inclusions" are not simply an artifact of mapping techniques, rather they represent real variability in the landscape.

4. Ecological Land Types

Ecological Land Types (ELT) are specific portions of the landscape, whose physical characteristics should have a strong influence on the ecological communities found there. Ecological land types, in this case, were defined as unique combinations of soil characteristics and topographic information, with the goal of mapping water and nutrient availability for forested plant communities at specific points in the landscape. Digital soil series coverages (made available by NRCS) were combined with digital elevation models (USGS) and topographic line work developed by NJFS to create a three-dimensional model of the landscape. The model landscape was composed of 50′ x 50′ pixels rectified to the State Plane Coordinate System. Thus, each pixel in the model landscape had specific soil characteristics (i.e., minerology, texture, and chemical reaction), a slope value and an elevation. Unique combinations of soil characteristics, slope and elevation were used to define each ELT (Hence, the smallest possible size for an ELT is 50′ by 50′ plot or 1/16 acre).

Each ELT was assigned a double digit code number which is an index of site conditions for forest plants at a particular location in the landscape. The first number represents a hydrological index and the second number is an index of the fertility of the site for forest plants. For example, an ELT code of 42 would refer to a moderately well drained location (4) with high fertility (2) for forest plants (see Table 1). A complete listing of ELT codes and their meanings is presented in Table 1.

Table 1. ELT codes developed for New Jersey

1st Digit	**Hydrologic Index**	2nd Digit	**Forest Fertility Index**
0	Water	0	Water[1]
1	Very Poorly Drained	1	Very High
2	Poorly Drained	2	High
3	Somewhat Poorly Drained	3	Moderate
4	Moderately Well Drained	4	Low
5	Well-Drained	5	Very Low
6	Excessively Drained	6	Organic
7	Tidal Flooded	7	Saline
8	Riparian Flooded	8	Variable[2]
9	Altered[3]	9	Altered[3]

[1] not applicable;
[2] too variable to be assessed;
[3] altered lands include mine pits, urban areas and other areas for which hydrology or fertility could not be estimated with our methodology.

The hydrology index was based on soil texture, slope and elevation. Typical drainage classes normally associated with soil series (NRCS) were reinterpreted using an independent digital model of slope and elevation. Essentially, each 50′ by 50′ pixel in our model landscape was assigned a soil series designation, a slope code and an elevation, and then units with the same value for all three were aggregated to form hydrologic indices. In some cases ELT map-units were simply assigned a hydrology index, such as "tidal flooded", because some special characteristic of the hydrology could not be represented accurately in our model landscape.

An index of fertility for forest dwelling plants was developed for the whole state and applied locally in northern New Jersey (Table 2). Forest fertility at any point in the landscape was calculated as (equation 1):

$$\mathbf{F = (T * M * P)^{1/3}}$$

where F, is the forest fertility index, T is a texture index, M is a soil minerology index, and P is the average soil reaction (pH) across the soil profile. Values for T, M, and P were obtained from county soil surveys compiled by the Warren and Sussex County Soils Conservation Districts (USDA 1975, 1979) and ranked on a general scale (see Table 2). Note that the use of equation 1 leads to fractional values in some cases, and the fertility classification in Table 2 is a whole number value. Fractions were truncated to leave whole number values for F.

For example:

Wassaic rock outcrop soils series (see USDA 1975), T = 5, M = 1, and P = 1.

Using equation 1:

$$F = (5*1*1)^{1/3} \qquad F = 1.71$$

which is truncated to obtain F = 1, very high fertility. Truncating fractions, rather than typical rounding, was employed to define a narrow upper limit for very low fertility, where we expect an unusually close relationship between the forest fertility index and the species composition of the forest community.

Table 2. Components of Forest Fertility Indices

#	Fertility Index (F)	Texture (T)	Mineralogy (M)[1]	pH (P)[2]
1	very high	silt, clay	limestone	≥ 6.6
2	high	fine loam	basalt-diabase, carbonate-bearing or mod-fine alluvium	6.1-6.5
3	moderate	loam, coarse loam	granitic, slate, shale, coarse alluvium	5.6-6.0
4	low	loamy-coarse	sandstone, quartz conglomerate	5.1-5.5
5	very low	rock outcrop, sand	quartzitic sand, gravel	≤ 5.0

[1]refers to the dominant material in soil map-units;
[2]refers to average value for profile.

While this technique allowed for a general determination of fertility for most sites, it was not employed as a fixed rule, and in a few cases fertility indices were modified to reflect differences, such as soil depth, which were not captured in this measure. Note that a number of the ELTs were assigned a fertility code which was not determined by this method (see Tables 1 & 2 for comparison). For example, "organic" fertility (code 6, in Table 1) was used to describe sites generally dominated by the influence of thick layers of peat, which were assumed to obscure the effects of soil texture or mineralogy on forest plants.

ELT codes are interpreted in terms of the LTA they were mapped within (and higher levels of the hierarchy). Thus a "53" in one LTA can be differentiated from a "53" in another LTA, but both would be well-drained sites with moderate fertility. For example, Well Drained Shale Till Flats and Well Drained Sandstone-Slate Outwash Terraces Till flats both have the same ELT code (53) but a different hierarchy code (ELT:221Ba1-53 and ELT:221Bd3-53, respectively), and different text descriptions. Hence there is more than one combination of soils and topography which could produce ecologically similar, but not the same site conditions.

ELT text descriptions contain information regarding physical characteristics, potential landscape influence on plants, and a listing of the common plant species, within each ELT. Full text descriptions for all ELTs are provided in this publication, but are not duplicated, if they occur in more than one LTA. ELT descriptions also contain information regarding land use / land cover classification (based on 1991 data), derived from Integrated Terrain Units (ITUs) obtained from the New Jersey Bureau of Geographic Information Systems Analysis (NJBGIA).

Most ELT map-units include microsites and altered "land-type-phases", which may differ in character from general ELT descriptions. An attempt was made to describe some of these inclusions within each ELT, based upon field observations, although no formal effort was made to map them. These altered land types may offer an interesting opportunity for users of NJ ECOMAP to interpret landscape disturbance.

Forested Plant Communities

Botanical surveys were conducted within forested portions of each ELT as a basis for describing forested plant communities. Community descriptions are essentially a listing of common plants observed within each ELT, with special notations regarding the relative abundance or localized site preferences for common species. These surveys were not exhaustive, however, so that some species might be over-represented and others may be under-represented, or absent. Annual plants and other plants which may only be identifiable during certain seasons, including orchids and spring ephemerals, are most likely to be omitted, because the surveys were not all conducted at the same time of year with in each map-unit. Surveys of some ELTs, particularly the very small ones or one's which had little forest cover, were limited to a few sample plots. Botanical survey data was enhanced, in such cases, through extensive research into the botanical literature, to account for presence of plants which are commonly known to associate with the communities and landforms we were describing, but were not present at our study sites. Thus plants were listed as members of these communities if fieldwork and historical accounts suggested that they have a high probability of occurring within these map-units (MacFarlane et. al. unpubl., Chrysler and Edwards 1947, Hough 1983, Reed 1988, Robichaud and Anderson 1994).

Hudson Valley
Section:221B

The Hudson Valley Section is divided here into two subsections, SUB:221Ba, the Hudson-Kittatinny Valley, and SUB:221Bd, the Kittatinny-Shawangunk Ridge and Valley (see Figure 4). A full description of the Hudson Valley Section can be found in "Ecological Subregions of the United States: Section Descriptions."(McNab and Avers 1994.).

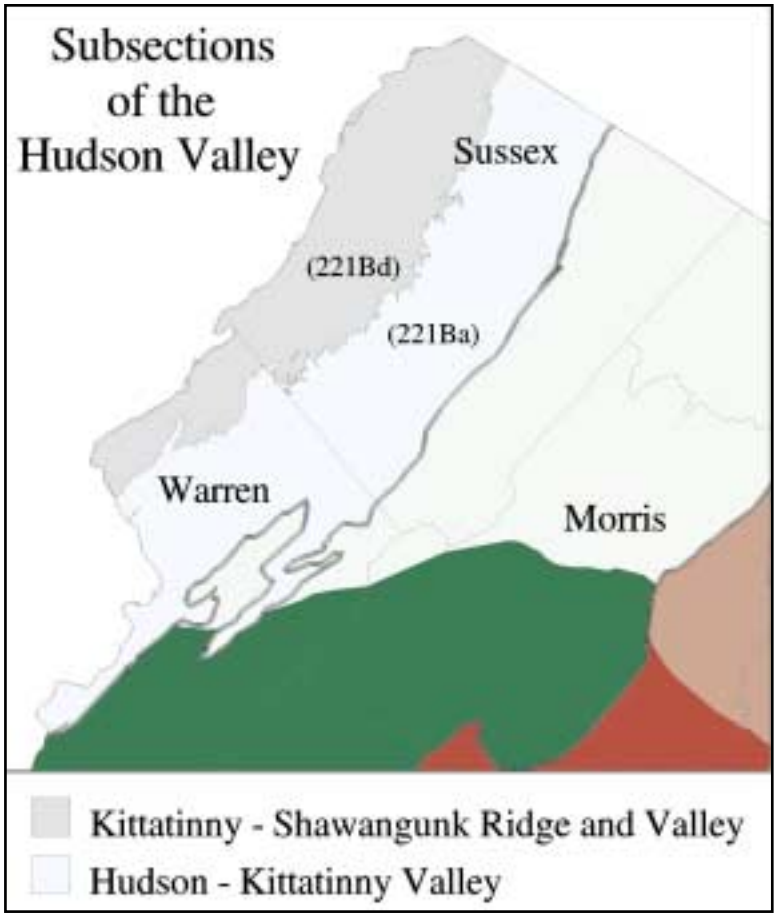


Figure 4. Subsections of the Hudson Valley.

Table 3 . Area of the Hudson Valley by subsection for New Jersey.

Table 3. Subsections of the Hudson Valley

	Name	Area (sq.miles)
SUB:221Ba	Hudson-Kittatinny Valley	343.06
SUB:221Bd	Kittatinny-Shawangunk Ridge and Valley	193.49
SEC:221B	Hudson Valley Section	536.55

Hudson-Kittatinny Valley

Subsection:221Ba

The Hudson-Kittatinny Valley Subsection extends southeast from the Hudson Valley in New York into the Kittatinny Valley of New Jersey. The N.J. portion covers large areas of Warren and Sussex Counties, bounded by the Kittatinny Mountain to the northwest and the New Jersey Highlands which border it to the southeast. The landscape is characterized by rolling hills downcut by a few large rivers. The valley is divided into a number of sub-valleys separated by broad ridges of more weather resistant rocks. These sub-valleys run generally parallel to each other, running northeast to southwest, and the rivers follow the natural contour of them. The rolling terrain is peppered with numerous lakes and farm ponds, creating a "hill and hollow" topography. The hills and dales are covered with farm fields and pastures in most locations, and most of the forested areas consist of large woodlots which separate homes and fields. Large forested tracts are uncommon and are generally in public ownership.

➤ ***Area: 343 square miles (N.J. only)***

Geomorphology

The rock formations of the Hudson Kittatinny Valley Subsection are the result of events associated with continental plate-tectonic processes which formed the Appalachian Mountains and Great Valley of North America, during the Paleozoic Era (570 to 225 million years ago). The valley began as layers of sediment eroded from Pre-Cambrian rocks and deposited on the continental slope of the Proto-Atlantic Ocean. Mud, silts, clays, and biogenic lime-sediments accumulated throughout the Cambrian and Ordovician periods forming beds of shale and limestone. The Proto-Atlantic Ocean began to slowly close late in the Ordovician period drawing the Eurasian and North African continents closer to North America, until the end of the Permian period when the continents were forced together forming part of Pangea, the Supercontinent. The intense pressure of continental collisions folded and faulted these sedimentary rock beds and lifted them high above the sea. Subsequent erosion and glacial scouring carved the rocks into a

Figure 5. View across the broad expanse of the Kittatinny Valley from atop Sunrise Mountain.

broad valley, with softer limestones in the deep river valleys and slightly more resistant shales forming higher ground. Glacial drift covers most of the surface creating distinct landscape features.

➤ ***Elevation: 400′ to 1000′ (120 to 300m)***

Lithology/Stratigraphy

Bedrock Geology: The valley is underlain by a series of sedimentary rocks which range in age from the early-Cambrian through the Ordovician period (570 to 440 million years ago). These rock beds are folded and faulted, dipping down to the northwest. The oldest and deepest formation is the Hardystone Quartzite (Cambrian) that unconformably overlies the Precambrian basement rock of the continental shield. The Hardystone is overlain by the Leithsville Formation, which is composed mainly of coarse-grained and calcitic dolomite, and then by the Allentown Dolomite. During the Ordovician period, layers of the Kittatinny Limestone and Jacksonburg Limestone were layered over these formations, followed by thick slaty, shale beds of the Martinsburg Shale.

Surficial Geology

The valley is covered by a discontinuous mantle of glacial sediments which were scoured from local bedrock by the expanding Wisconsin ice sheet and deposited by its meltwater as it retreated. Glacial drift deposits are generally thin (less than 10′) and patchy with frequent outcrops of bedrock, although in a few locations, mostly on broad uplands and on the bases of shallow slopes, it is quite deep (150-200′). The advancing ice sheet carved intricate ridge, cliff, and swale topography out of the soft carbonate rocks, and smooth streamlined landforms on the shale bedrock. Meltwater streams flowing out from the retreating glacier filled the valleys with stratified drifts consisting of sand, gravel, silt, and clay forming flat outwash plains, eskers, kames, terraces and deltas. Numerous lakes, ponds, and wetlands formed where meltwater and ice were trapped in basins scoured out from the bedrock or in areas where glacial sediments dammed or distorted drainage pathways. Glacial deposits created a rolling "hill and hollow" topography. A limited "karst topography", consisting of sinks, underground streams and caverns, has developed in some of the limestone formations. Fluvial erosion and deposition are the dominant processes modifying the surface formations today.

Soils

➤ **General Characteristics:** The soils in this area of the state are generally silty, slaty or shaly loams mixed frequently with stones and gravel. These soils developed in glacial drift scoured mostly from local bedrock and deposited by glacial outwash streams.

➤ **Classification:** The upper portions of the valley are dominated by shaly loams including shallow Nassau series and Deeper Bath, Valois, Albia and Chippewa series. The lower valley is dominated by soils derived from limestone glacial drift including Washington and Wassaic Series. Hazen and Palmyra series formed in stratified limestone-bearing drift in the deeper river valleys. Considerable deposits of alluvial soil are found in the lower valley as well as extensive peatlands. Carlisle and Adrian muck cover large areas of poorly drained bogs and swampy ravines, many of which occupy old glacial lake and pond sites.

Climate and Weather

I. Temperature

a. Mean Annual: 48-52° F (8.8°C) (evenly distributed)

b. Mean Jan. low: 12.5° F (-10.8° C)

c. Mean July high: 83.1° F (28.4° C)

II. Precipitation

a. Mean annual total: 44-46 in. (115.1 cm); (greatest during Summer, least in Winter and Fall)

b. Snowfall: 39-41" annually

Occurance of moisture deficits: Generally near normal with some occurances of extreme wet and dry years (based on Palmer Drought Severity Indexes for 1895 - 1990).

III. Growing season

a. Average number of frost free days: 130-150 days

b. Average last Spring frost date: May 10

c. Average first Fall frost date: Oct. 2

d. Cloud free days 94 annually: 7.8/mo. (clearest during October)

e. *Air Quality:* Air quality in the valley is generally better than other areas of the state, mainly due to its low population density and few industrial areas. Automotive pollution is generally not a problem, but somewhat elevated levels of carbon monoxide and ground level ozone can exist on a short-term basis in local areas characterized by heavy traffic and wood burning stoves. The nearest ozone monitors in New Jersey, however, have not recorded elevated levels in recent years. Acid deposition, carried on westerly winds from the mid-western states, is significant in this area and sometimes seriously damages crops and forests. Visibility can be locally poor due to dense fog.

Hydrology

Three major rivers, the Paulinskill, Pequest and Big Flatbrook, and their tributaries drain most of the area flowing southwest into the Delaware River. The remainder of the area, located in the northeastern part of the valley is drained by the Wallkill River which flows northward through New York state before its confluence with the Hudson River. Water quality is strongly affected by agricultural runoff, as many of the streams in the valley pass through farm field and pasture along their courses. Natural "kettle lakes" and ponds are somewhat common, formed by glacial action when blocks of ice where buried beneath mounds of till, or watery hollows were created in troughs between the belts of hills formed by recessional moraines. Many streams and water bodies in the valley have been altered to divert existing hydrologic patterns or create new ones. Beavers have also become an important agent of disturbance and their populations in this region have increased substantially in recent years due to legal protection. The beavers can severely effect local drainage, flooding some areas with water and depriving others.

Land Use and Landscape Ecology

Pre-historic hunter/gatherer tribes roamed this region of New Jersey as early as the first retreat of the glaciers, using forest resources for tool-making, food, fuel and shelter. Small scale fuel burning later expanded to slash and burn agriculture and semi-permanent villages in the fertile valleys. Numerous, small quarries have also been located where pre-historic peoples mined chert and quartzite for tool and weapon-making. Major changes to the landscape began early in the seventeenth century, when successive waves of Dutch settlers began to colonize the Delaware and Hudson-Kittatinny Valleys. Over the centuries that followed, widespread changes

in land use altered the surrounding landscape severely. Forests were cleared and converted to pastures and cultivated fields. Wood from the forests was used to build homes and burned as fuel. Lime rock was quarried and minerals such as iron and copper were mined.

Patterns of land use continue to transform the character of the landscape today. Mining, plowing, home and road building and the diversion of natural water systems have caused considerable changes. Agricultural runoff, including soil, pesticides and fertilizers have affected water quality and aquatic communities in some areas. The introduction of many foreign species from farm and garden has had considerable impact as well. Landcover assessments (based on 1991 data) indicate that 52% of the Upper Valley is covered with natural plant communities (i.e., forests, shrubland, marshes, etc..); 33.5% is in agricultural use and 11.1% is urbanized. The general land use trends in this region can best be described a slow urbanization of mostly forested and agricultural land.

Demographics

- Population: approx. ~100,725 people (~294 per square mile)
- Population Centers: Sussex & Newton

Plant Communities

The Hudson-Kittatinny Valley is a mixture of forested and agricultural communities, with patches of urbanization in some areas. Agricultural land use and more recently urbanization have had a strong influence on the plant communities in the area. Many plants associated with farm, pasture and home landscapes are common in woodlands and on woodland edges. Many mature forested areas are found on rocky ridges or wetlands where farming was more difficult. Another major influence is the cool continental climate (USDA Zone 5) which is uncharacteristic for most of New Jersey. Forests include a diverse mixture of north-central hardwood trees, including sugar maple, red, white and black oaks, pignut, bitternut and shagbark hickories, sweet, yellow and gray birches, and basswood. Red maple and hemlock are sometimes common, primarily in poorly drained and depressional areas. Other distinctive plant communities of the region include those that form on limestone rock outcrops or calcareous wetlands seeps.

Threatened, Endangered & Rare Plants

Federal (threatened or endangered):
1 spp., Small Whorled Pogonia

State (threatened, endangered or rare):
155 spp. including, Lake Cress, Two-Leaved Toothwort, Small White Lady's Slipper, Linear-leaved Willow-Herb, Shrubby St. John's Wort, Yellow Water Crowfoot, American Yew and others (compiled from the New Jersey Natural Heritage data base)

Natural Areas

Johnsonburg Natural Area
(Johnsonburg, Warren County)

Whittingham Natural Area,
(Whittingham Wildlife Management Area)

Bursh Sugar Maple Natural Area
Osmun Forest Natural Area
(Ramseyburg near Jenny Jump State Forest)

Wildlife Populations

Prehistoric evidence of large mammals includes, mastodons, mammoths, elk, moose and caribou, which are characteristic of boreal or tundra-like environments and indicators of the past glacial influence on climate. A number of species of large mammals and birds were present in relative abundance when the first Europeans arrived and are now scarce or extirpated from the valley including, bobcats, cougars, timber wolves, and otter. Black bears are still locally abundant in isolated locations, and populations of turkeys and beaver are recovering rapidly and expanding their ranges as a result of reintroduction and legal protection.

The landscape of the valley is largely farmland and open pasture with a maze of forest edge following property boundaries, streams and public woodlands. Typical wildlife populations include:

Farmland/Forest Edge Wildlife

Include domestic cattle and horses, raccoon, rabbit, woodchuck, skunk, opossum, snakes, frogs, deer, pheasant, fox, songbirds, hawks and owls. (Coyotes have recently expanded their range into this part of New Jersey.)

Woodland Wildlife

Includes black bear, gray squirrel, chipmunk, white-tailed deer, grouse, numerous reptiles and amphibians, hawks, owls, wild turkey. Streams contain trout and many aquatic insects and macroinvertebrates.

Threatened, Endangered, and Rare Animals

Federal (endangered)

3 spp., Dwarf Wedge Mussel, Mitchell's Marsh Satyr and Bald Eagle.

State (threatened, endangered or rare)

44 spp. including Fen Buck Moth, Longtail Salamander, Pitcher Plant Borer, Culver's Root Borer, and others (compiled from the New Jersey Natural Heritage data base).

The Hudson-Kittatinny Valley is divided into two LTAs: LTA :221Ba1, the Upper Kittatinny Valley and LTA:221Ba2, the Lower Kittatinny Valley (Table 4. lists the area of the Hudson-Kittatinny Valley by Land Type Associations).

Table 4. LTAs of the Hudson-Kittatinny Valley

	Name	Area (sq.miles)
LTA:221Ba1	Upper Kittatinny Valley	163.63
LTA:221Ba2	Lower Kittatinny Valley	179.43
SUB:221Ba	Hudson-Kittatinny Valley Subsection	343.06

Figure 6. View of the Lower Kittatinny Valley with the Kittatinny Mountain in the distance.

Upper Kittatinny Valley

LTA:221Ba1

The Upper Kittatinny Valley LTA includes the portions of the Kittatinny Valley where soils formed from shale-dominated parent materials or slaty, shale bedrock (from the Martinsburg Shale formation). This LTA generally occupies the higher elevations of the Kittatinny Valley, above the major river valleys which drain it. Local elevations range from about 500 to 850 feet above sea level. The substantial movement of materials by glacial ice has helped to create a somewhat rolling topography, although steep rocky ledges and exposed bedrock are still somewhat common. The area is dissected by a number of small and intermittent streams which eventually drain into the larger rivers of the Lower Kittatinny Valley (221Ba2).

Soils associated with this LTA formed from two major processes. Most soils were derived from the mantle of shaly till present at the surface in many locations, which give rise to rocky and shaly loam soils. Lesser amounts of non-shale materials are present, transported through glacial action, including sandstones and conglomerates from the Kittatinny Mountain (221Bd1), and small inclusions of carbonate rock from adjacent limestone formations. Major soil series include, Albia, Bath, Chippewa, Nassau, Valois, and Venanago, which are dominated by shale materials.

More than half (54% of total landcover) of the Upper Kittatinny Valley is covered by natural plant communities (tree, shrub or herb-dominated uplands and wetlands). The major influence on plant communities in this LTA is the agricultural history of the region, and many, if not all, of the forested areas are the result of "old-field succession". Much of the land (33.8%) is still used for agricultural production, and urban land use is substantial (10.7%, which has likely increased over the last 10 years).

Upland forests are composed of a wide variety of trees including northern red oak, black oak, white oak, chestnut oak, pignut hickory, shagbark hickory, sugar maple, red maple, white ash, and sweet birch. Wetland forests are composed primarily of red maple, white ash, and swamp white oak. Many species associated with abandoned farmland and forest succession in northern New Jersey are abundant in these forests and woodlands, including white ash, eastern red cedar, bigtooth aspen, quaking aspen, black locust, tree-of-heaven, oriental bittersweet, Amur honeysuckle, Tatarian honeysuckle, multiflora rose, Japanese wire-grass, Japanese barberry, Japanese honeysuckle, and many species of goldenrod. Hawthorns were found to be quite common in woodlands throughout this LTA, perhaps because their thorns protected them from animals grazing in pastures.

Figure 7. Cow pasture on a shale slope in the Upper Kittatinny Valley.

Table 5.

ELT#	Name	Area(acres)
221Ba1-00	Water Bodies	1,392.55
221Ba1-11	Very Poorly Drained Limestone[1] Till Flats	106.97
221Ba1-12	Very Poorly Drained Carbonate-bearing Shale[2] Till Flats	2,056.55
221Ba1-13	Very Poorly Drained Sandstone-Conglomerate[3] Till Flats	3,428.16
221Ba1-16	Very Poorly Drained Flat Peatlands	574.50
221Ba1-21	Poorly Drained Limestone[1] Till Slopes	160.12
221Ba1-22	Poorly Drained Carbonate-bearing Shale[2] Till Slopes	5,728.93
221Ba1-23	Poorly Drained Shale[4] Till Slopes	3,065.82
221Ba1-32	Somewhat Poorly Drained Silty[5] Terraces	154.43
221Ba1-33	Somewhat Poorly Drained Shale[4] Till Flats	2,182.64
221Ba1-41	Moderately Well Drained Limestone[1] Till Flats	299.82
221Ba1-42	Moderately Well Drained Carbonate-bearing Sandstone[6] Terraces	130.42
221Ba1-43	Moderately Well Drained Shale[4] Till Slopes	13,161.27
221Ba1-51	Well Drained Limestone[1] Till Slopes	1,325.85
221Ba1-52	Well Drained Carbonate-bearing Sandstone[6] Terraces	984.75
221Ba1-53	Well Drained Deep Shale[4] Till Slopes	58,129.34
221Ba1-54	Well Drained Shallow Rocky Shale[4] Till Slopes	1,356.13
221Ba1-61	Excessively Drained Steep Rocky Limestone[1] Till Slopes	412.34
221Ba1-63	Excessively Drained Steep Rocky Shale[4] Till Slopes	8,850.07
221Ba1-64	Excessively Drained Sandstone-Conglomerate[3] Rock Outcrops	424.78
221Ba1-82	Seasonally Flooded Loamy Alluvial Plains	635.20
221Ba1-99	Altered Lands	121.86
221Ba1	Upper Kittatinny Valley Land Type Association	104,682.50

[1]Till and bedrock predominantly composed of limestone till fragments but includes lesser amounts of sandstone, shale and granite.
[2]Till dominated by fragments of shale, slate, and sandstone, but enriched with lesser amounts of carbonate-bearing rock.
[3]Till and bedrock predominantly composed of sandstone and conglomerate till with small amounts of other materials.
[4]Till and bedrock materials dominated by shale and slate rock fragments, but also contain fragments of sandstone.
[5]Glacial outwash and drift materials predominantly composed of silt-sized particles.
[6]Glacial outwash and drift materials dominated by sandstone and shale rock fragments, but are enriched with lesser amounts of carbonate-bearing rock.

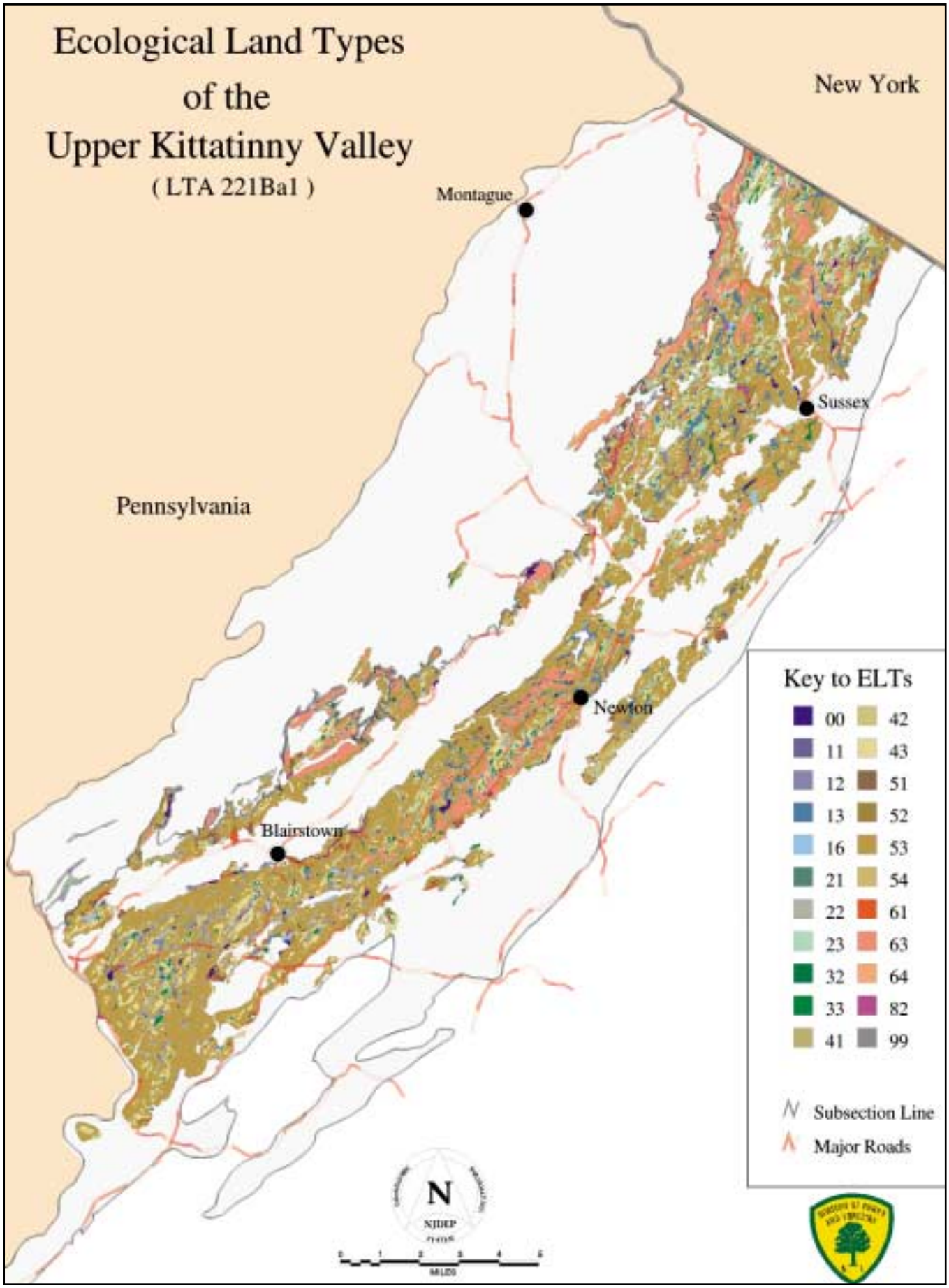


Figure 8. ELTs of the Upper Kittatinny Valley.

Table 6. Land Use[1] for ELTs of the Upper Kittatinny Valley LTA

ELT#	Area(acres)	%Forested	%Agriculture	%Urban[2]	%Other[3]
221Ba1-11	106.97	39.1	23.1	9.8	28.0
221Ba1-12	2,056.55	52.7	14.9	6.4	26.0
221Ba1-13	3,428.16	55.8	19.4	7.0	17.8
221Ba1-16	574.50	46.1	8.2	4.0	41.7
221Ba1-21	160.12	51.4	16.6	6.4	25.6
221Ba1-22	5,728.93	48.3	23.3	8.5	19.9
221Ba1-23	3,065.82	49.5	17.9	7.2	25.4
221Ba1-32	154.43	36.0	23.5	5.4	35.1
221Ba1-33	2,182.64	32.5	36.0	14.0	17.5
221Ba1-41	299.82	42.0	22.0	23.8	12.2
221Ba1-42	130.42	24.7	56.8	7.3	11.2
221Ba1-43	13,161.27	27.3	45.5	13.0	14.2
221Ba1-51	1,325.85	61.7	15.7	12.8	9.8
221Ba1-52	984.75	24.0	45.7	17.0	13.3
221Ba1-53	58,129.34	35.7	38.2	11.3	14.8
221Ba1-54	1,356.13	72.8	10.4	4.3	12.5
221Ba1-61	412.34	74.0	9.0	6.8	10.2
221Ba1-63	8,850.07	53.7	25.3	9.6	11.4
221Ba1-64	424.78	97.6	0.0	1.0	1.4
221Ba1-82	635.20	29.6	22.0	6.1	42.3

[1]based on 1991 reports;
[2]includes residential,commercial, industrial, athletic fields, etc.;
[3]includes water bodies, herbaceous wetlands and non-forested, and undeveloped uplands, not devoted to agriculture (i.e., shrubland, brushland, barren land).

VERY POORLY DRAINED LIMESTONE TILL FLATS
ELT:221Ba1-11

This ELT comprise a tiny portion of the Upper Kittatinny Valley LTA, occurring in depressions where small areas of limestone till are present (for a description of this map-unit refer to ELT:221Bd2-11).

VERY POORLY DRAINED CARBONATE-BEARING SHALE TILL FLATS
ELT:221Ba1-12

This ELT occurs in the landscape as broad upland swales and at the bottom of narrow ravines. Soil texture is fine loamy and extremely stony in many places. Till materials are dominated by fragments of slate, silt and carbonate-bearing sandstone. Compacted materials in the subsoil contributes to the high water table along with a generally low position in the landscape. The water table in this ELT is generally within a few feet of the surface during the winter and spring. Standing water is present in some places throughout the year.

Phytotrophic characteristics of this ELT are a compacted subsoil layer and saturated soils with high fertility. Rooting conditions are poor in many portions of this land type because of the very poor drainage and associated anoxic conditions, and rooting depth may also may be limited by the compacted sub-surface. Site fertility is considered to be high for forest plants due to fine loamy soil conditions and mineral enrichment due to a presence of carbonate-bearing rock fragments, although nutrient uptake may be limited for many terrestrial plants because of saturated soil conditions. These rich, wet site conditions tend to favor hydrophilic plants and the formation of hardwood swamp communities. In areas where the surface is stony, however, many vines, mosses, bulbs, and small herbs, not typical of wetlands, seem to be able to exploit these somewhat drier microsites.

Forested Plant Communities

Common trees include red maple, white ash, swamp white oak and yellow birch, although red maple and white ash dominate the wettest areas. Basswood, white oak, black gum, elm, black birch and sycamore are sometimes common. Beneath the forest canopy hornbeam, hawthorn and juneberry are often present. Common shrubs include a mixture of spicebush, winterberry, witch hazel and arrowwood. Highbush blueberry is present in some places, particularly where more acidic shale rock fragments are thick at the surface. The forest floor is generally thick with a diversity of woody and herbaceous plants including skunk cabbage, jewelweed, jack-in-the pulpit, tussock sedge, rough bedstraw, partridgeberry, Japanese wire-grass, cinnamon fern, royal fern, Massachusetts fern, Boot's wood fern and spinulose wood fern. Poison ivy, Virginia creeper, Christmas fern, common violets, dwarf cinquefoil, Canada mayflower, Solomon's seal, and a number of mosses, including fern moss, star moss, hair-cap moss, white cushion moss, and sphagnum moss, are common in rocky areas.

In open wet areas and along streambanks a number of hydrophilic shrubs and small trees including silky dogwood, smooth alder, steeple bush, elderberry, and a number of willows (Salix spp.) may be present. Silver maple, river birch, and sycamore are common along stream banks. Blue flag, water horehound, purple loosestrife, swamp loosestrife, swamp milkweed, tussock sedge, Joe-pye-weed, turtlehead, marsh fern, royal fern, sensitive fern and many other freshwater marsh plants are also common in these open wet areas. Many of these communities form in areas flooded by beavers or people.

VERY POORLY DRAINED SANDSTONE-CONGLOMERATE TILL FLATS
ELT:221Ba1-13

This ELT occurs on upland flats, in ravines and along stream courses, where sandstone and conglomerate till are abundant. These areas are mainly found in the western portions of this LTA where it abuts the eastern slopes of the Kittatinny Mountain (for a description of this map-unit refer to ELT:221Bd1-13).

VERY POORLY DRAINED FLAT PEATLANDS
ELT:221Ba1-16

This ELT comprises a tiny portion of Upper Kittatinny Valley LTA, occupies former ponds and lake beds and upland depressions which are permanently flooded and have accumulated extensive peat deposits (for a description of this map-unit refer to ELT:221Ba2-16).

POORLY DRAINED LIMESTONE TILL SLOPES
ELT:221Ba1-21

This ELT comprises a tiny portion of the Upper Kittatinny Valley LTA, occurring along shallow slopes where small areas of limestone till are present (for a description of this map-unit refer to ELT:221Bd2-21).

POORLY DRAINED CARBONATE-BEARING SHALE TILL SLOPES
ELT:221Ba1-22

This ELT occurs in the landscape on gently sloping lowlands, in ravines, and concave uplands which serve as uplands for small and intermittent streams. Soil texture is fine loamy and extremely stony in many places, which are composed of glacial drift materials dominated by fragments of shale, slate and carbonate-bearing sandstone. Compacted materials in the subsoil contributes to the high water table along with a generally low position in the landscape. The water table in this ELT is generally within a few feet of the water table during the winter and early spring, perched above the fragipan, and moves slowly along the shallow slopes forming "seepage swamps".

Phytotrophic characteristics of this ELT are a compacted subsoil layer and somewhat saturated soils with high fertility. Rooting conditions are somewhat poor in many portions of this land type because of the poor drainage and associated anoxic conditions, although this seems to be mitigated in many places by the presence of large stones in the soil profile, which apparently create sufficient air pockets to a number of sustain non-hydrophilic plants (see below). Rooting depth, however, may be limited by the compacted sub-surface. Site fertility is considered to be high for forest plants due to fine loamy soil conditions and mineral enrichment due to a presence of carbonate-bearing rock fragments, although nutrient uptake may be limited for many terrestrial plants because of saturated soil conditions. Hydrophilic plants tend to dominate on these "swampy" slopes, although in areas where the surface is stony, a number of species of vines, mosses, bulbs, and small herbs seem to be able to exploit these somewhat drier microsites.

Forested Plant Communities

Common trees include, red maple, white ash, swamp white oak, shagbark hickory, elm, and white oak. Other trees including basswood, sweet birch, sugar maple, bitternut hickory and northern red oak are common in some places, particularly on better-

drained microsites. Aspens are common in young woodlands. Beneath the forest canopy hawthorn, hornbeam, hophornbeam and juneberry are often present. Common shrubs include amixture of spicebush, winterberry, greenbrier, arrowwood, witch hazel and occasionally highbush blueberry, in areas where acidic shale bedrock fragments are common at the surface. Northern prickly ash is occasionally present along streambanks and where mineral-rich seeps occur. Japanese barberry is locally abundant in some areas, particularly old pastures. The forest floor is variably covered with a number of woody and herbaceous plants including jack-in-the pulpit, skunk cabbage, garlic mustard, poison ivy, jewelweed, Virginia creeper, Solomon's seal, partridgeberry, rough bedstraw, dwarf cinquefoil, common violet, tussock sedge, wild yamroot, cinnamon fern, Christmas fern, Massachusetts fern, New York fern, hay-scented fern, and a number of species of club mosses (Lycopodium spp.). A number of mosses including fern moss, star moss, and hair-cap moss are common on exposed rocky surfaces.

Figure 9. Somewhat poorly drained, shale till flat.

In open wet areas and along streambanks a number of hydrophilic shrubs and small trees including silky dogwood, smooth alder, steeple bush, elderberry, and a number of willows (Salix spp.) may be present. Silver maple, river birch, and sycamore are common along stream banks. Blue flag, water horehound, purple loosestrife, swamp loosestrife, swamp milkweed, tussock sedge, Joe-pye-weed, turtlehead, marsh fern, royal fern, sensitive fern and many other freshwater marsh plants are also common in these open wet areas. Many of these communities form in areas flooded by beavers or people.

POORLY DRAINED SHALE TILL SLOPES

ELT:221Ba1-23

This ELT occurs in the landscape on gently sloping lowlands, in ravines, and concave uplands which serve as uplands for small and intermittent streams. Soil texture is coarse loamy and extremely stony, composed of mostly shale, slate, and sandstone till scoured from local bedrock. Poor drainage in this land type is attributable to a compacted layer in the subsoil and slow surface runoff across the gently sloping terrain. The water table is generally very high and near the surface throughout most of the year. Standing water is common is some places.

Phytotrophic characteristics of this ELT are saturated soil conditions, an abundance of large stones at the surface, and a subsurface layer of compacted material. Rooting conditions are limited by anoxic soil conditions caused by water saturation and the compact sub-soils. Site fertility is considered to be moderate for most forest plants because of the deep, coarse-loamy textured

soil. Site conditions favor mainly hydrophilic plants, although the proliferation of large stones throughout the soil profile tends to create many, more tolerable microsites, which support plants that prefer more aeration in the rhizosphere. Rocky till at the surface also creates drier microsites which support a number of more typically hydrophobic herbs and shrubs.

Forested Plant Communities

Common trees include red maple, white ash, shagbark hickory, swamp white oak, and white oak. Sugar maple, yellow birch, black birch, northern red oak, hemlock, beech, basswood and elm, are sometimes common. Beneath the forest canopy hornbeam, juneberry and hawthorn are often present. Common shrubs include winterberry, arrowwood, highbush blueberry, spicebush, Japanese barberry and witch hazel. The forest floor is variably covered with a number of woody and herbaceous plants, including jewelweed, jack-in-the-pulpit, poison ivy, Virginia creeper, swamp blackberry, golden ragwort, skunk cabbage, false hellebore, tussock sedge, Japanese wire grass, cinnamon fern, New York fern and spinulose wood fern. Wild geranium, white wood aster, common violets, dwarf cinquefoil, white avens, Solomon's seal, male fern, rattlesnake fern, and Christmas fern are common on the drier, rocky microsites. A number of mosses, including fern moss, star moss, hair-cap moss, white cushion moss, and sphagnum moss, are also common.

In open wet areas and along streambanks a number of hydrophilic shrubs and small trees including silky dogwood, smooth alder, steeple bush, elderberry, and a number of willows (Salix spp.) may be present. Silver maple, river birch, and sycamore are common along stream banks. Blue flag, water horehound, purple loosetrife, swamp loosestrife, swamp milkweed, tussock sedge, Joe-pye-weed, turtlehead, marsh fern, royal fern, sensitive fern and many other freshwater marsh plants are also common in these open wet areas. Many of these communities form in areas flooded by beavers or people.

SOMEWHAT POORLY DRAINED SILTY TERRACES

ELT:221Ba1-32

This ELT comprises a tiny portion of the Upper Kittatinny Valley, where silty glacial outwash is present. These inclusions are mainly found where this LTA abuts the stream courses of the Lower Kittatinny Valley (for a description of this map-unit refer to ELT:221Ba2-32).

SOMEWHAT POORLY DRAINED SHALE TILL FLATS

ELT:221Ba1-33

This ELT occurs in the landscape as upland flats and in depressions. Soil texture is coarse loamy and extremely stony composed of mostly shale, slate, and sandstone till scoured from local bedrock. The somewhat poor drainage of these land types is attributable to a compacted layer of till in the subsoil and flat topography. The impeded percolation contributes to a seasonally high water table which rises to within a few feet below the surface in late winter and early spring. Vernal pools are common.

Phytotrophic characteristics of this ELT are saturated soil conditions in late winter and early spring, an abundance of large stones at the surface, and a subsurface layer of compacted material. Rooting conditions are somewhat limited in the subsurface portions of this land type because of seasonal anoxic conditions caused by a high water table and compact sub-soils. Site fertility is considered to be moderate for most forest plants because of the deep, coarse-loamy textured soil. Site characteristics create conditions which favor a mixture of hydrophilic

and non-hydrophilic plants, and tends to support plant communities somewhere in between a hardwood swamp and a deciduous forest.

Forested Plant Communities

Common trees include white ash, red maple, shagbark hickory, white oak, and sugar maple. Black oak, northern red oak, pignut hickory, white pine and elm are sometimes common. Beneath the forest canopy, hornbeam, juneberry and hawthorn are often present. Common shrubs include spicebush, winterberry, arrowwood, highbush blueberry, and witch hazel. Japanese barberry is abundant in old pastures. The forest floor is variably covered with a number of woody and herbaceous plants, including jack-in-the-pulpit, Solomon's seal, partridgeberry, Canada mayflower, swamp blackberry, white wood aster, Japanese wiregrass, white baneberry, jewelweed, Christmas fern, New York fern, garlic mustard, and Virginia creeper. Rattlesnake fern, ebony spleenwort, false Solomon's seal, intermediate wood fern, common violets, white avens, wood anemone, and a number of bedstraws (Galium spp.) are common on the drier microsites. Rough bedstraw, maddog scullcap, tussock sedge, halberd-leaved tearthumb, arrow-leaved tear-thumb, golden ragwort, skunk cabbage and cinnamon fern are somewhat common, and often abundant in shallow depressions where vernal pools form. A number of mosses including fern moss, star moss, hair-cap moss and sphagnum moss are common in this ELT.

MODERATELY WELL DRAINED LIMESTONE TILL FLATS

ELT:221Ba1-41

This ELT comprises only a small portion of the Upper Kittatinny Valley LTA, occurring on upland flats and in depressions where small areas of limestone till are present (for a description of this map-unit refer to ELT:221Bd2-41).

MODERATELY WELL DRAINED CARBONATE-BEARING SANDSTONE TERRACES

ELT:221Ba1-42

This ELT comprises a small portion of the Upper Kittatinny Valley LTA, occurring where glacial outwash, dominated by sandstone and shale fragments, is enriched with carbonate rock, is present (for a description of this map-unit refer to ELT:221Ba2-42).

MODERATELY WELL DRAINED SHALE TILL SLOPES

ELT:221Ba1-43

This ELT occurs on gently to moderately sloping uplands, on hillsides and slopes. Soil textures range from fine loamy to coarse loamy, and are very stony in some locations. Soils are generally derived from shale, slate and sandstone till scoured from local bedrock. Soils are generally deep and an abundance of large stones are usually present on the surface. These moderately well drained sites have slightly impeded drainage attributable to a compacted layer of material in the subsoil, which is moderated somewhat by the sloping topography. The impeded drainage contributes to a seasonally high water table which rises to within a few feet of the surface in late winter and early spring, but recedes considerably later in the growing season.

Phytotrophic characteristics of this ELT are somewhat saturated soil conditions in late winter and early spring, an abundance of large stones at the surface and a subsurface layer of compacted material. Rooting conditions may be slightly limited in the subsurface portions of this land type because of somewhat anoxic conditions caused by a seasonally high water table, and

compact sub-soils may limit rooting depths. Site fertility is considered to be moderate for most forest plants because of the deep, loamy textured soil. Fluctuating hydrologic conditions account for the presence of a number of somewhat hydrophilic plants, in what otherwise appear to be upland forest communities.

Forested Plant Communities

Common trees include, red maple, white ash, shagbark hickory, northern red oak, sugar maple and white oak. Sweet birch, beech, black gum, black cherry, and pignut hickory are also somewhat common. Black cherry, sassafras, and aspens are abundant in young woodlands. Beneath the forest canopy, hornbeam, juneberry, dogwood, and hawthorn are often present. Common shrubs include maple-leaf viburnum, arrowwood, highbush blueberry, black huckleberry, pinxter azalea, Japanese barberry, and witch hazel. The forest floor is variably covered with a number of woody and herbaceous plants including lowbush blueberry, jack-in-the pulpit, mayapple, wild geranium, Virginia creeper, partridgeberry, jewelweed, Solomon's seal, false Solomon's seal, wood anemone, wild sarsparilla, white wood aster, Canada mayflower, white baneberry, striped wintergreen, Christmas fern, New York fern, garlic mustard, and common violets. Skunk cabbage, cinnamon fern, jewelweed and jack-in-the-pulpit are sometimes abundant on the forest floor on shallow slopes and in depressions. A number of mosses including fern moss, star moss and white cushion moss are common in this ELT.

WELL DRAINED LIMESTONE TILL SLOPES

ELT:221Ba1-51

This ELT occurs on hills and slopes of the Upper Kittatinny Valley where limestone till and bedrock are dominant (for a description of this map-unit refer to ELT:221Bd2-51).

Figure 10. Large northern red oak on a well-drained, shale till slope.

WELL DRAINED CARBONATE-BEARING SANDSTONE TERRACES

ELT:221Ba1-52

This ELT occurs in portions of the Upper Kittatinny Valley LTA, on old glacial outwash terraces. Sandstone and shale rock fragments dominate, but are enriched with carbonate rock fragments (for a description of this map-unit refer to ELT:221Bd2-52).

WELL DRAINED DEEP SHALE TILL SLOPES

ELT:221Ba1-53

This ELT occurs in the landscape on moderately to steeply sloping uplands where shale-dominated till is deep. Soils are generally deep and loamy or coarse-loamy. Soils are extremely stony in some areas, composed mainly of shale and slate fragments.

Phytotrophic characteristics of this ELT are deep well-drained soils, moderate to steep slopes, and an abundance of large stones throughout the soil profile. These well-drained sites have good surface water drainage and coarse loamy textures which denote somewhat of an optimum condition of drainage and aeration for plant roots. Rooting conditions may be somewhat limited on the steeper slopes, however. Site fertility is considered to be moderate for most forest plants because of the deep, coarse-loamy textured soil.

Forested Plant Communities

Common trees include sugar maple, red maple, northern red oak, black oak, white oak, beech, sweet birch, pignut hickory, shagbark hickory, and white ash. Scarlet oak, chestnut oak, sassafras, black cherry, hemlock and bitternut hickory are sometimes common. Beneath the forest canopy hornbeam, hophornbeam, flowering dogwood, hawthorn, and juneberry are often present. Common shrubs include maple-leaf viburnum, spicebush, black huckleberry, pinxter azalea, witch hazel and Japanese barberry. Allegheny blackberry and multiflora rose are sometimes common in young forests, and abundant in clearings. The forest floor is variably covered with woody and herbaceous plants including lowbush blueberry, white wood aster, Canada mayflower, partridgeberry, Pennsylvania sedge, striped wintergreen, Virginia creeper, poison ivy, garlic mustard, Solomon's seal, false Solomon's seal, fox grape, white baneberry, wild sarsaparilla, white snakeroot, wood anemone, naked tick trefoil, Christmas fern, intermediate wood fern, marginal wood fern, and hay-scented fern. Hair-cap moss and white cushion moss are common on rocky and exposed areas where leaf litter is absent.

WELL DRAINED SHALLOW ROCKY SHALE TILL SLOPES

ELT:221Ba1-54

This ELT occurs on moderate to steeply sloping uplands, where till is thin and rock outcroppings are somewhat common. Soils are generally thin and soil texture is coarse loamy and extremely stony composed of mostly of shale and slate fragments.

Phytotrophic characteristics of this ELT are thin well-drained soils, moderate to steep slopes, and a considerable amount of exposed rocky surfaces. These well-drained sites have good surface water drainage, but available water capacity for plant communities is moderately low because the stony texture of the soil and short distance to the underlying bedrock. Rooting conditions may be somewhat limited because of thin soil, particularly on the steeper slopes. Site fertility is considered to be low for most for-

est plants because of the somewhat, shallow, coarse textured shaly soils and the very strongly acidic conditions.

Forested Plant Communities

Common trees include chestnut oak, white oak, red oak, black oak, red maple, sweet birch, and pignut hickory. Scarlet oak, mockernut hickory, black cherry, sassafras, white pine, hemlock and beech are sometimes common. Beech is generally uncommon as a canopy tree in most areas because of the somewhat low soil fertility, but are a significant portion of the subcanopy layer in some places. Beneath the forest canopy juneberry, and American chestnut (sprouts) are often present. Common shrubs include a mixture of lowbush blueberry, black huckleberry, witch hazel. Maple-leaf viburnum, Allegheny blackberry, mountain laurel, and pinxter azalea are locally common. The forest floor is variably covered with a number of herbaceous plants including Pennsylvania sedge, bracken fern, dwarf cinquefoil, Canada mayflower, Virginia creeper, naked tick trefoil, teaberry, false Solomon's seal, Solomon's seal, wild sarsaparilla, striped wintergreen, rattlesnake weed, ebony spleenwort, marginal wood fern, and hay-scented fern. Hair-cap moss and white cushion moss and other mosses are common on the forest floor.

EXCESSIVELY DRAINED STEEP ROCKY LIMESTONE TILL SLOPES

ELT:221Ba1-61

This ELT comprises only a small portion of the Upper Kittatinny Valley LTA, where small escarpments of limestone bedrock are present (for a description of this map-unit refer to ELT:221Bd2-61).

EXCESSIVELY DRAINED STEEP ROCKY SHALE TILL SLOPES

ELT:221Ba1-63

This ELT occurs on steeply sloping uplands and on ridges. Soils are generally somewhat shallow in depth, with patches of exposed shale bedrock in many places. Excessive drainage is attributable to rapid surface runoff down the steep slopes and exposure to drying winds.

Figure 11. Pinxter azalea flowering in the understory of a chestnut oak forest on a steep, shale till slope.

Phytotrophic characteristics of this ELT are characterized by dry, somewhat thin, stony soils, and a moderate soil fertility. These excessively drained sites provide scarce water for plants, because of fast runoff, low water holding capacity in the soil, and a topographic position which contributes to high levels of evaporation for wind. Site fertility is considered to be moderate for most forest plants because of the loamy, albeit somewhat thin, soils. Rooting conditions are somewhat limited because of the shallow soils although many plants are able to work there roots into the rocky embankments. Site conditions support a somewhat open canopy forest community, and the steep rocky surface conditions create microsites which favor a number of herbs and grasses on the forest floor.

Forested Plant Communities

Common trees include northern red oak, black oak, white oak, chestnut oak, pignut hickory, sweet birch and red maple. Scarlet oak, mockernut hickory, shagbark hickory, black cherry, beech, hemlock, and sugar maple are sometimes common. Beneath the forest canopy juneberry, hophornbeam, hawthorn, and sassafras are often present. Common shrubs include maple-leaf viburnum, witch hazel, lowbush blueberry, black huckleberry, and pinxter azalea.

The forest floor is variably covered with a number of woody and herbaceous plants including Virginia creeper, striped wintergreen, Canada mayflower, naked tick trefoil, false Solomon's seal, white wood aster, white snakeroot, wood anemone, wild sarsaparilla, hay-scented fern, intermediate wood fern and marginal wood fern. Haircap moss, white cushion moss and a number of other mosses are common on the forest floor. On steep rocky embankments, where the canopy is somewhat open, a number of species including dwarf cinquefoil, prostrate tick trefoil, Pennsylvania sedge, hairy rock cress, little blue stem, white lettuce, polypody fern, and a number of species of panicgrass (Panicum spp.) are common.

EXCESSIVELY DRAINED SANDSTONE-CONGLOMERATE ROCK OUTCROPS

ELT:221Ba1-64

This ELT comprises only a small portion of the Upper Kittatinny Valley where sandstone and conglomerate rock outcrops are present. These inclusions occur along the western edge of the Upper Kittatinny Valley where it abuts the eastern slope of the Kittatinny Mountain (for a text description of this map-unit refer to ELT:221Bd1-64).

SEASONALLY FLOODED LOAMY ALLUVIAL PLAINS

ELT:221Ba1-82

Seasonally Flooded Loamy Alluvial Plains comprise a small portion of the Upper Kittatinny Valley, along the narrow floodplains of streams which flow into the Lower Kittatinny Valley (for a description of this map-unit refer to ELT:221Ba2-82).

Lower Kittatinny Valley

LTA:221Ba2

The Lower Kittatinny Valley Land Type Association includes lower portions of the Kittatinny Valley where limestone-bearing drift and glacio-fluvial materials dominate. The lower valleys formed because both rivers and glacial ice preferentially downcut through veins of limestone, because it is softer and more erodible than the surrounding shale bedrock (LTA 221Ba1). Two large rivers, the Paulins Kill and the Peaquest, run through the two main valleys which comprise this LTA. Local topography is generally flat to gently rolling, and pitted with many small ponds and lakes. Elevations generally range from 300 to 500 feet above sea level, although low limestone ridges reach elevations of 900 feet in a few locations. Limestone outcroppings are fairly common at the higher elevations. The surface is covered by a discontinuous mantle of sediments which were scoured by glaciers from local limestone bedrock and deposited by glacial meltwater. Underground steams, sinkholes and seeps are somewhat common in areas of limestone bedrock geology. Glacial drift deposits are generally thin and patchy on hillsides and slopes, but are deeper in a number of low-lying and flat areas. Glacio-fluvial drift materials form old river terraces, knolls and outwash plains in the lower portions of the valleys. Alluvial materials dominate the bottoms of the river valleys.

Soils associated with this LTA are generally deep or moderately deep, stony loams derived from glacial deposits and weathering of local bedrock. Soils are thin on steep slopes and hilltops where limestone outcrops are common, and deepest at the base of shallow slopes. The predominant rock fragments in the soil are Devonian-age limestone, sandstone and shale. Local limestone is of the dolomitic type, characteristically enriched in magnesium (with lower calcium levels) compared to other limestone types. Major soils include Washington, Wassaic, Hazen, Fredon and Palmyra series. Wassaic soils are characteristically thin, with frequent limestone rock outcrops. Hazen, Fredon and Palmyra soils are present on river terraces and outwash plains where stratified drift is somewhat enriched with carbonate rock. Middlebury, Sloan, Wayland, and Walkill soils are found along the floodplains of larger streams.

About half (50.4%) of the Lower Kittatinny Valley is covered by natural plant communities (upland and wetland forests, brush and shrublands), with substantial areas of wetlands (33% of total natural plant communities). Most areas were used as pasture or farmland in the past and many areas are still used for agricultural production (33.9%). Urban land accounts for 11.6% of land cover. A major influence on plant communities in this LTA is the long history of farming due to the rich valley soils. Most, if not all, of the forested communities have developed on fallow farmland. Forests are typically diverse in species composition with a number of tree species including sugar maple, red maple, sweet birch, white ash, northern red oak, black cherry, white oak, black oak, black walnut, shagbark hickory, pignut hickory and eastern hemlock. Eastern red cedar is abundant on exposed ridges, rock outcroppings and in young successional woodlands. Hornbeam, dogwood and hophornbeam are all common in the subcanopy layers. Red maple and white ash are particularly abundant in the wet areas.

Many introduced species common to old fields and pastures are abundant in this LTA including Autumn olive, Russian olive, Amur honeysuckle, multiflora rose, wineberry, and number of farmland herbs and grasses.

Table 7. ELTs of the Lower Kittatinny Valley LTA

ELT#	Name	Area(acres)
221Ba2-00	Water Bodies	3,689.95
221Ba2-11	Very Poorly Drained Limestone[1] Till Flats	1,220.50
221Ba2-12	Very Poorly Drained Carbonate-bearing Sandstone[2] Terraces	3,288.67
221Ba2-13	Very Poorly Drained Sandstone-Slate[3] Terraces	734.19
221Ba2-16	Very Poorly Drained Flat Peatlands	9,200.12
221Ba2-21	Poorly Drained Limestone[1] Till Slopes	681.89
221Ba2-22	Poorly Drained Carbonate-bearing Sandstone[2] Terraces	3,909.62
221Ba2-23	Poorly Drained Sandstone-Slate[3] Terraces	152.05
221Ba2-32	Somewhat Poorly Drained Silty[4] Terraces	1,048.62
221Ba2-33	Somewhat Poorly Drained Shale[5] Till Flats	306.68
221Ba2-41	Moderately Well Drained Limestone[1] Till Flats	5,564.57
221Ba2-42	Moderately Well Drained Carbonate-bearing Sandstone[2] Terraces	4,243.59
221Ba2-43	Moderately Well Drained Sandstone-Slate[3] Terraces	496.59
221Ba2-51	Well Drained Limestone[1] Till Slopes	28,060.40
221Ba2-52	Well Drained Carbonate-bearing Sandstone[2] Terraces	23,196.03
221Ba2-53	Well Drained Sandstone-Slate[3] Terraces	3,299.07
221Ba2-54	Well Drained Shallow Rocky Shale[5] Till Slopes	71.73
221Ba2-61	Excessively Drained Steep Rocky Limestone[1] Till Slopes	7,012.57
221Ba2-63	Excessively Drained Steep Rocky Shale[5] Till Slopes	20.54
221Ba2-82	Seasonally Flooded Loamy Alluvial Plains	17,514.46
221Ba2-99	Altered Lands	675.59
221Ba2	Lower Kittatinny Valley Land Type Association	114,463.43

[1]Till predominantly composed of limestone fragments but includes lesser amounts of sandstone, shale and granite.;
[2]Glacial outwash and drift materials dominated by sandstone and shale rock fragments, but are enriched with lesser amounts of carbonate-bearing rock;
[3]Glacial outwash and drift materials predominantly composed of sandstone, slate and siltstone;
[4]Glacial outwash primarily composed of silt-sized particles;
[5]Till and bedrock materials dominated by shale, slate and sandstone.

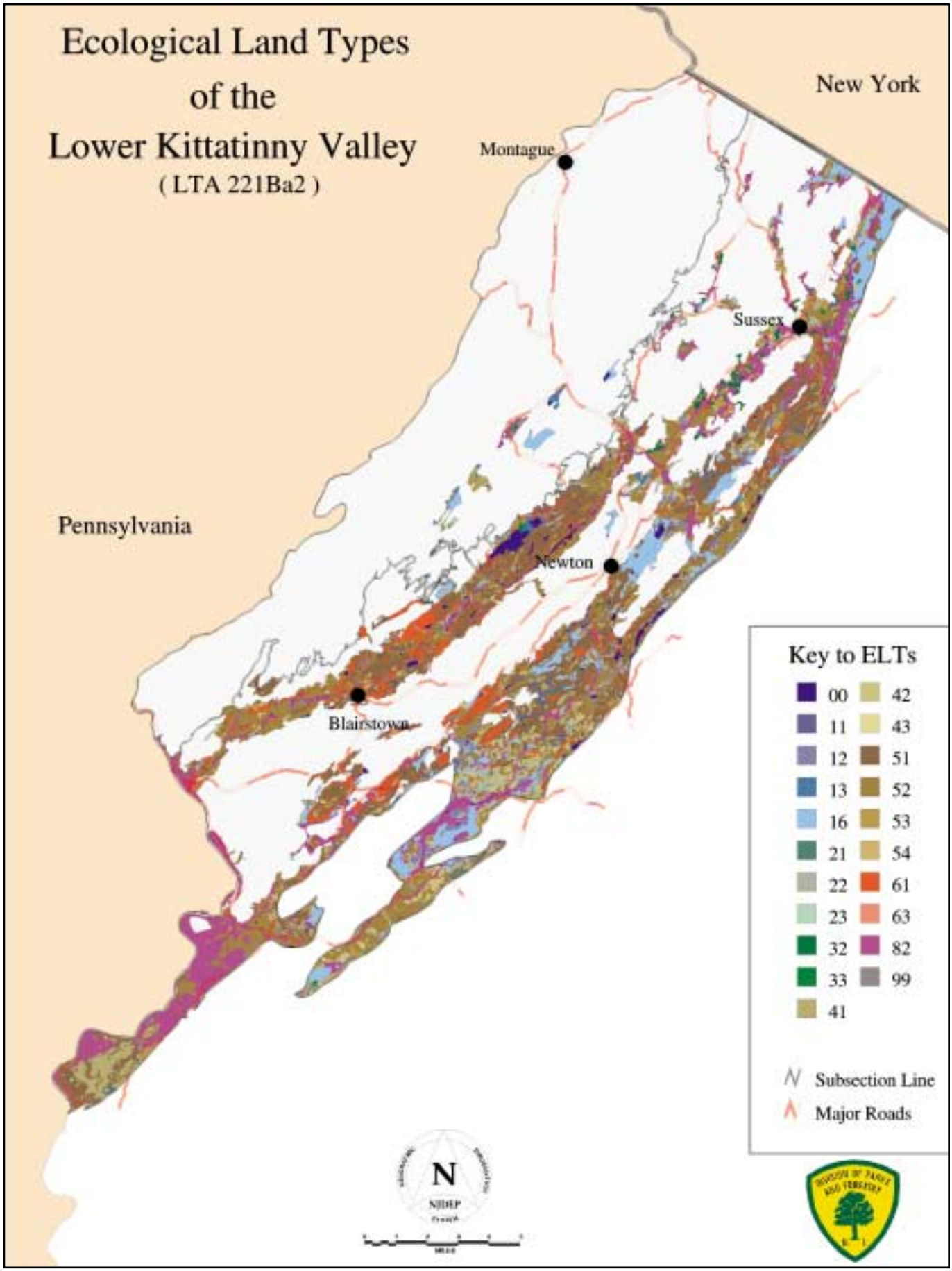


Figure 12. ELTs of the Lower Kittatinny Valley.

Table 8. Land Use[1] of the Lower Kittatinny Valley LTA

ELT#	Area(acres)	%Forested	%Agriculture	%Urban[2]	%Other[3]
221Ba2-11	1,220.50	29.9	32.6	6.2	31.3
221Ba2-12	3,288.67	41.0	23.5	4.0	31.5
221Ba2-13	734.19	53.8	13.4	4.5	28.3
221Ba2-16	9,200.12	49.7	18.1	1.1	31.1
221Ba2-21	681.89	40.8	28.4	9.7	21.1
221Ba2-22	3,909.62	19.5	46.4	9.1	25.0
221Ba2-23	152.05	69.6	10.8	11.4	8.2
221Ba2-32	1,048.62	14.7	52.0	10.3	23.0
221Ba2-33	306.68	34.9	24.1	22.4	18.6
221Ba2-41	5,564.57	18.5	56.9	13.5	11.1
221Ba2-42	4,243.59	10.9	62.8	13.6	12.7
221Ba2-43	496.59	26.5	37.4	20.5	15.6
221Ba2-51	28,060.40	49.9	22.8	13.1	14.2
221Ba2-52	23,196.03	15.4	52.7	17.6	14.3
221Ba2-53	3,299.07	38.8	32.0	15.9	13.3
221Ba2-54	71.73	47.6	21.1	5.9	25.4
221Ba2-61	7,012.57	83.5	4.8	5.3	6.4
221Ba2-63	20.54	89.2	0.0	0.0	11.8
221Ba2-82	17,514.46	26.2	36.7	11.5	25.6

[1]based on 1991 reports;
[2]includes residential,commercial, industrial, athletic fields, etc.;
[3]includes water bodies, herbaceous wetlands and non-forested, and undeveloped uplands, not devoted to agriculture (i.e., shrubland, brushland, barren land).

VERY POORLY DRAINED LIMESTONE TILL FLATS
ELT:221Ba2-11

This ELT occurs in portions of the Lower Kittatinny Valley depressions where small areas of limestone till are present (for a description of this map-unit refer to ELT:221Bd2-11).

VERY POORLY DRAINED CARBONATE-BEARING SANDSTONE TERRACES
ELT:221Ba2-12

This ELT occurs in the landscape as broad flat areas just above the floodplains of streams and in depressional areas, where glacial outwash and drift materials are dominated by fragments of sandstone and shale, but also contain fragments of carbonate-bearing rock. Soil texture is generally loamy to silt loamy, with smaller areas of sandy loams. The water table in this ELT is generally at or near the surface except in the case of extreme drought. Soils are saturated throughout most of the year. Standing water is sometimes present in the wettest areas.

Phytotrophic characteristics of this ELT are saturated soils with naturally high fertility. Rooting conditions are characteristically poor in many portions of this land type because of the poor drainage and associated anoxic conditions. Rooting depth is limited by the high water table. Site fertility is considered to be high for forest plants due to fine loamy soil conditions and mineral enrichment due to a presence of carbonate-bearing rock fragments, although nutrient uptake may be limited for many plants because of saturated soil conditions. Canopy closure in forested communities is unlikely to be limited by nutrient availability but is limited by standing water in some places. Windthrow is common in the soft, muddy soil and fallen trees are common along the cut banks of streams.

Forested Plant Communities

Common trees include red maple, white ash, hemlock, yellow birch and elm. Tuliptree, black walnut, northern red oak, sweet birch, beech, basswood, and sugar maple are sometimes common. Beneath the forest canopy, hornbeam and witch hazel are often present. Common shrubs include a mixture of spicebush, multiflora rose, arrowwood, nannyberry, Japanese barberry, and fox grape. The forest floor is generally thick with a diversity of herbaceous plants including skunk cabbage, jewelweed, Virginia creeper, jack-in-the pulpit, tussock sedge, cinnamon fern, Christmas fern, Massachusetts fern, New York fern, rattlesnake fern, garlic mustard, marsh blue violet, partridgeberry, halberd-leaved tearthumb, Japanese wiregrass, Japanese honeysuckle, poison ivy, and common violets.

In open wet areas and along streambanks a number of hydrophilic shrubs and small trees including silky dogwood, smooth alder, steeple bush, elderberry, and a number of willows (Salix spp.) may be present. Silver maple, river birch, and sycamore are common along stream banks. Blue flag, water horehound, purple loosestrife, swamp loosestrife, swamp milkweed, tussock sedge, Joe-pye-weed, turtlehead, marsh fern, royal fern, sensitive fern and many other freshwater marsh plants are also common in these open wet areas. Many of these communities form in areas flooded by beavers or people.

VERY POORLY DRAINED SANDSTONE-SLATE TERRACES
ELT:221Ba2-13

This ELT occurs in portions of the Lower Kittatinny Valley where glacial outwash, dominated by sandstone and slate rock frag-

ments, has accumulated (for a description of this map-unit refer to ELT:221Bd3-13).

VERY POORLY DRAINED FLAT PEATLANDS
ELT:221Ba2-16

This ELT occupies former ponds and lake beds and upland depressions which are permanently flooded and have accumulated extensive peat deposits. Peat is variable in thickness, usually ranging down 5 to 6 feet in depth, with highly decomposed sedge peats in the upper horizons and a more fibric woody peat mixed in at lower depths. Subsoils have variable textures ranging from sandy glacial outwash to lacustrine clays. The water table is always at or near the surface.

Phytotrophic characteristics of this ELT are an abundance of water and a thick layer of organic matter. Cold temperatures are also important as many of these areas in the valley bottoms where cool air condenses and collects over night. Rooting conditions are poor in many portions of this land type because of standing water and associated anoxic conditions. Site fertility is somewhat high in these areas with a high availability of mineral nutrients, abundant organic matter and a soil reaction ranging from slightly acid to neutral. Site conditions tend to support hardwood swamp communities, although herbaceous wetlands account for about one-sixth of all mapped units (see Table 8). Forested areas usually have a characteristic "hummock and hollow" topography, which creates a somewhat open canopy (with trees on the hummocks separated by watery hollows in between). The open canopy and thick spongy surface of this land type seems to increase the germinating potential for many seedlings, but provides poor anchorage for large woody plants as they increase in size and weight.

Forested Plant Communities

Common trees include a mixture of red maple, hemlock, yellow birch, gray birch, black gum, and white ash. An interesting combination of coniferous species are often found intermixed in these forests, including Atlantic white cedar, black spruce, and pitch pine, although only a tiny percentage of forested areas (0.2%) were estimated to be dominated by conifers. This interesting combination of conifers occurs in the peatlands of northwestern N.J. because the geo-

Figure 13. Wild calla growing on a mat of sphagnum moss in a watery hollow in a peatland swamp.

graphic ranges of a few swamp-dwelling conifers overlap; Atlantic white cedar is at the northwestern limit of its range here and black spruce is in the southwest corner of its range. A few other trees, including tamarack, gray birch and aspen, may also be present. The latter two are abundant in young woodlands where peat mining had occurred in the past. The understory is usually dense with thickets of great rhododendron, and other hydrophilic shrubs, including highbush blueberry, swamp azalea, winterberry, mountain holly, witherod, juneberry, and spicebush. The forest floor is usually carpeted with thick mats of sphagnum moss and a number of other mosses including fern moss and star moss. Many woody and herbaceous plants are also common, including skunk cabbage, sheep laurel, partridgeberry, cinnamon fern, royal fern, sensitive fern, marsh blue violet, starflower, and goldthread. Note that meadowsweet and goldthread are typical of boreal and transitional forests north of New Jersey.

In open wet areas trees are sparse, and there is generally an open canopy of "flood-stunted" red maple and white ash trees. Intermixed with these stunted trees are a number of hydrophilic shrubs, including meadowsweet, steeplebush, highbush blueberry, leatherleaf, and a few species of alder (Alnus spp.), which form an open thicket. Aquatic and semi-aquatic herbaceous plants are also common in these open areas including wild calla, arrow arum, swamp loosestrife, bluejoint, sensitive fern, tussock sedge and many others common to open peat meadows. In some disturbed areas, particularly where drainage has been altered, reed grass (Phramites australis) is a major component of these shrub-meadows.

Fringed gentian, grass-of-parnassus, shrubby cinquefoil, tufted loosestrife, and yellow water crowfoot, and other plants characteristic of mineral-rich peatlands may also be present in some locations (Collins and Anderson 1994).

POORLY DRAINED LIMESTONE TILL SLOPES
ELT:221Ba2-21

This ELT occurs in gently to moderately sloping low-lying areas in and around the Lower Kittatinny Valley LTA. It occurs in the landscape as broad upland swales, at the base of slopes, along the courses of streams, and around water bodies (for a description of this map-unit refer to ELT:221Bd2-21).

POORLY DRAINED CARBONATE-BEARING SANDSTONE TERRACES
ELT:221Ba2-22

This ELT occurs in the landscape as gently sloping lowland terraces where outwash and drift materials are dominated by fragments of sandstone and shale, but also contain fragments of carbonate rock. Soil texture is generally loamy to silt loamy, with lesser areas of coarse-loamy materials. Poor drainage is generally due to a low position in the landscape. The water table in this ELT is generally very high and within a few feet of the surface throughout most of the year. Vernal pools are common.

Phytotrophic characteristics of this ELT are saturated soils throughout most of the growing season and high fertility. Rooting conditions are somewhat poor in many portions of this land type because of the poor drainage and associated anoxic conditions. Site fertility is considered to be high for forest plants due to fine loamy soil conditions and mineral nutrient enrichment from carbonate rock fragments, although nutrient uptake may be somewhat limited for many terrestrial plants because of anoxic soil conditions. Windthrow is common in the soft muddy soil.

Forested Plant Communities

Common trees include tuliptree, white ash, red maple, sugar maple, yellow birch,

northern red oak, elm, bitternut hickory, beech, and black walnut. Basswood, sweet birch, and hemlock are sometimes common. Yellow buckeye, which is generally uncommon in New Jersey forests, is present in a few locations. Beneath the forest canopy, hornbeam, flowering dogwood, witch hazel and black haw viburnum are often present. Common shrubs include a mixture of spicebush, multiflora rose, arrowwood, nannyberry and Japanese barberry. The forest floor is variably covered with a number of woody and herbaceous plants including jack-in-the pulpit, skunk cabbage, garlic mustard, poison ivy, white wood aster, jewelweed, Virginia creeper, enchanter's nightshade, Solomon's seal, false Solomon's seal, New York fern, Massachusetts fern, Christmas fern, blue-stemmed goldenrod, rattlesnake fern, Japanese honeysuckle and common violets. Japanese wire-grass (Microstegium vimineum) is locally abundant in some areas.

In open wet areas and along streambanks a number of hydrophilic shrubs and small trees including silky dogwood, smooth alder, steeple bush, elderberry, and a number of willows (Salix spp.) may be present. Silver maple, river birch, and sycamore are common along stream banks. Blue flag, water horehound, purple loosestrife, swamp loosestrife, swamp milkweed, tussock sedge, Joe-pye-weed, turtlehead, marsh fern, royal fern, sensitive fern and many other freshwater marsh plants are also common in these open wet areas. Many of these communities form in areas flooded by beavers or people.

POORLY DRAINED SANDSTONE-SLATE TERRACES
ELT:221Ba2-23

This ELT comprises only a small portion of the Lower Kittatinny Valley where glacial outwash, dominated by sandstone and slate rock fragments, has accumulated (for a description of this map-unit refer to ELT:221Bd3-23).

SOMEWHAT POORLY DRAINED SILTY TERRACES
ELT:221Ba2-32

This ELT occurs in the landscape, where old glacial terraces are composed of silt and fine sand-sized particles, generally just above the floodplains of streams. Topography is generally flat to gently sloping. Soils are loamy and high in fertility. The somewhat poor drainage of these land types is attributable to fine soil texture and a low topographic position. The impeded drainage contributes to a seasonally high water table which rises near the surface in late winter and early spring. Vernal pools are common.

Phytotrophic characteristics of this ELT are saturated soil conditions in late winter and early spring and rich soils. Rooting conditions are somewhat limited in the subsurface portions of this land type because of anoxic conditions associated with a seasonally high water table. Site fertility is considered to be high for most forest plants because of the deep, rich silty loam soils and mildy acidic conditions. Vernal pools are common in depressions and support a number of typically hydrophilic plants.

Forested Plant Communities

Common trees include northern red oak, red maple, yellow birch, tuliptree, beech, elm, shagbark hickory, white ash, and sugar maple. Black walnut, white oak, black gum, pin oak, and swamp white oak are sometimes common. Red cedar and big-tooth aspen are common in young woodlands. Beneath the forest canopy dogwood, hornbeam, and witch hazel are often present, with a mixture of tree saplings. Common shrubs include spicebush, Japanese barberry, greenbrier, maple leaf viburnum, blackhaw viburnum, and occasionally highbush blueberry. Amur honeysuckle is common on forest edges and clearings. The forest floor is generally dense with low growing woody

and herbaceous plants including Virginia creeper, poison ivy, partridgeberry, jack-in-the-pulpit, white wood aster, enchanter's nightshade, mayapple, male fern, New York fern, broad beech fern, whorled pogonia and indian cucumber root. Skunk cabbage, jewelweed, are also common, and abundant in the vernal pools. Japanese wiregrass, Japanese honeysuckle, wild yamroot, marsh bedstraw, rough bedstraw, halbard-leaved tearthumb, arrow-leaved tearthumb, hog peanut, and oriental bittersweet are abundant in young woodlands and thickets, sometimes covering the forest floor completely.

SOMEWHAT POORLY DRAINED SHALE TILL FLATS
ELT:221Ba2-33

This ELT comprises only a small portion of the Lower Kittatinny Valley, occurring on upland flats and depressions, where shale till is dominant (for a description of this map-unit refer to ELT:221Ba1-33).

MODERATELY WELL DRAINED LIMESTONE TILL FLATS
ELT:221Ba2-41

This ELT occurs in the landscape as broad upland flats and gently slopes in the Lower Kittatinny Valley, where limestone fragments dominates glacial drift materials (For a text description of this map-unit refer to ELT:221Bd2-41).

MODERATELY WELL DRAINED CARBONATE-BEARING SANDSTONE TERRACES
ELT:221Ba2-42

This ELT occurs in the landscape as broad flats and gently sloping glacial outwash terraces, where sandstone and shale rock fragments are mixed with carbonate bearing materials. Soil texture is loamy and slightly impeded drainage is caused by fine materials in the subsoil and a generally low position in the landscape. The water table is seasonally high rising to within a few feet of the surface in winter and early spring, but subsides later in the growing season. Vernal pools are present in some locations.

Phytotrophic characteristics of this ELT are seasonally high water table, slightly impeded drainage and high fertility. Rooting conditions may be slightly limited in some areas due to subsurface drainage problems, and may contribute to shallow rooting depths for some forest trees. Site fertility is considered to be high for forest plants due to fine loamy soil conditions and mineral nutrient enrichment from carbonate rock fragments. A number of hydrophilic shrubs are common in the understory which are indicators of excess water in the subsoil. These plants are commonly concentrated in concave depressions which support vernal pools.

Forested Plant Communities

Common trees include tuliptree, white ash, elm, sugar maple, northern red oak, shagbark hickory, and red maple. Hemlock, pignut hickory, black walnut, basswood, yellow birch and bitternut hickory are sometimes common. Yellow buckeye is occasionally present, but is generally rare in most New Jersey forests. Black cherry and quaking aspen are common in young woodlands. Beneath the forest canopy, hornbeam, dogwood and black haw viburnum are often present. Common shrubs include a mixture of spicebush, arrowwood, multiflora rose, Japanese barberry. American bladdernut is sometimes present. The forest floor is densely covered with a diversity of woody and herbaceous plants including poison ivy, Virginia creeper, blue-stemmed goldenrod, Japanese honeysuckle, garlic mustard, jack-in-the pulpit, black cohosh, wild geranium, rue anemone, oriental bittersweet, sweet-scented bedstraw, skunk cabbage, white wood aster, enchanter's nightshade, mayapple, Solomon's seal, false Solomon's seal, Christmas fern, intermediate wood fern, New York fern, fox grape, aniseroot, sweet cicely,

bloodroot, wild ginger, honewort and Japanese wire-grass. Jewelweed, skunk cabbage, jack-in-the-pulpit, swamp blackberry, elderberry, spicebush and arrowwood are common in depressions which support vernal pools.

MODERATELY WELL DRAINED SANDSTONE-SLATE TERRACES
ELT:221Ba2-43

This ELT occurs in the landscape as narrow drainways and on lower slopes where glacial outwash is dominated by sandstone and slate rock (for a description of this map-unit refer to ELT:221Bd3-43).

WELL DRAINED LIMESTONE TILL SLOPES
ELT:221Ba2-51

This ELT occurs on the uplands of the Lower Kittatinny Valley. In some places soils are very stony containing mostly fragments of limestone, with lesser amounts of sandstone and shale. Rock-outcroppings are common throughout on steep slopes, ledges and on the tops of limestone ridges (for a description of this map-unit refer to ELT:221Bd2-51).

WELL DRAINED CARBONATE-BEARING SANDSTONE TERRACES
ELT:221Ba2-52

This ELT occurs in the landscape as hills and slopes of glacial outwash terraces, where sandstone and shale rock fragments are mixed with carbonate bearing materials. Topography is rolling ranging from gently sloping to steep. Soil texture is coarse loamy derived from stratified sands and gravel of glacial-fluvial origin. Rock fragments are composed of sandstone, slate and shale, with considerable amounts of limestone.

Phytotrophic characteristics of this ELT are deep, well drained soils and a moderately high natural fertility. Rooting conditions are excellent due to the well drained nature of the soils, although bank erosion may cause uprooting on steep embankments. Site fertility is considered to be moderately high for forest plants due to fine loamy soil conditions and mineral nutrient enrichment from carbonate rock fragments.

Figure 14. Jack-in-the-pulpit fruiting on the forest floor on a well drained, carbonate-bearing, sandstone terrace.

Forested Plant Communities

Common trees include sugar maple, white ash, black cherry, elm, tuliptree, white oak, northern red oak, black oak, shagbark hickory, pignut hickory, and red maple. Black birch, black walnut, white pine, and bitternut hickory are sometimes common. Eastern red cedar, black cherry, gray birch, white pine, sassafras and hackberry are common in young woodlands. Beneath the forest canopy hornbeam, dogwood, sassafras and hawthorn are often present. Common shrubs include spicebush, multiflora rose, Japanese barberry, gray dogwood, Amur honeysuckle, black raspberry, and Allegheny blackberry, the latter three are most abundant in young successional woodlands. The forest floor is variably covered with a diversity of low woody and herbaceous plants including poison ivy, Virginia creeper, garlic mustard, jack-in-the pulpit, enchanter's nightshade, black cohosh, Japanese wire-grass, wild geranium, rue anemone, oriental bittersweet, may apple, bloodroot, wild licorice, sweet-scented bedstraw, white wood aster, honewort, sweet cicely, aniseroot, Solomon's seal, false Solomon's seal, round-lobed hepatica, wild ginger, fox grape, Christmas fern, New York fern, maiden hair fern and lady fern.

WELL DRAINED SANDSTONE-SLATE TERRACES
ELT:221Ba2-53

This ELT occupies portions of the Lower Kittatinny Valley where glacial outwash terraces, dominated by sandstone and slate rock fragments, are present (for a description of this map-unit refer to ELT:221Bd3-53).

WELL DRAINED SHALLOW ROCKY SHALE TILL SLOPES
ELT:221Ba2-54

This ELT occurs on portions of the Lower Kittatinny Valley, where shallow shale till or outcroppings of shale bedrock are present (for a description of this map-unit refer to ELT:221Ba1-54).

EXCESSIVELY DRAINED STEEP ROCKY LIMESTONE TILL SLOPES
ELT:221Ba2-61

This ELT occurs on portions of the Lower Kittatinny Valley where outcrops of limestone bedrock are present (for a description of this map-unit refer to ELT:221Bd2-61).

EXCESSIVELY DRAINED STEEP ROCKY SHALE TILL SLOPES
ELT:221Ba2-63

This ELT comprises only a tiny portion of the Lower Kittatinny Valley, occurring on steep slopes and small escarpments where shale till and bedrock dominate (for a description of this map-unit refer to ELT:221Ba1-63).

SEASONALLY FLOODED LOAMY ALLUVIAL PLAINS
ELT:221Ba2-82

This ELT occurs in the landscape as the floodplains of streams and rivers. Soil textures are variably sandy and silty loams. Surface drainage, ranges from well drained to very poorly drained, depending on differences in local topography and stream characteristics between locations. Within a given site drainage is also somewhat variable, with fairly large differences over short distances. Along the larger streams floodplains are well developed, with ponded backwater areas and better drained rises along the stream banks. Many of the smaller streams have narrower, less developed floodplains. Flooding ranges from seasonal annual flooding to occasional flooding every few years or during extreme weather conditions. In a few

areas floodplains are fairly high above the level of the river and flooding is rare (50 to 100 yrs. between floods).

Phytotrophic characteristics of this ELT are variable drainage, periodic flooding, large areas of standing water and saturated soil, and a generally high fertility. Rooting conditions are somewhat inhibited in many portions of this land type because of the poor drainage and associated anoxic conditions in "backwater swamps". Site fertility is considered to be moderately high for forest plants due to the loamy alluvial soil conditions, although nutrient uptake may be limited for many terrestrial plants during flooded conditions. Site conditions support a wide diversity of tree species due to variability in the floodplain. Both well drained and flooded microsites can appear within a short distance from each other. The canopy is often open in many areas, particularly the flooded backwaters, due to frequent disturbance on the floodplain. Windthrow is common in the soft muddy soil and fallen trees are common along the cut banks of streams.

Forested Plant Communities

Common trees include sugar maple, bitternut hickory, shagbark hickory, white ash, black walnut, elm, red maple and basswood. Silver maple, river birch, black willow and sycamore are common along stream banks and in flooded backwater areas. Butternut, northern red oak, beech, tuliptree, black gum, red mulberry, hemlock, yellow birch, and yellow buckeye are sometimes common, especially on the upper floodplains where flooding is less common. Beneath the forest canopy hornbeam, blackhaw, silky dogwood, witherod, and multiflora rose are often present. Fox grape, riverbank grape, poison ivy and other vines commonly entangle these shrubs and small trees. The forest floor is generally thick with a diversity of woody and herbaceous plants including swamp blackberry, jewelweed, blue-stemmed goldenrod, garlic mustard, giant ragweed, tussock sedge, jack-in-the pulpit, white wood aster, false nettle, naked tick trefoil, wild yamroot, Joe-Pye weed, jewelweed, skunk cabbage, jumpseed, wood nettle, Virginia creeper, partridgeberry, arrow-leaved tearthumb, halberd-leaved tearthumb, climbing false-buckwheat, Japanese honeysuckle and Japanese wiregrass.

In long-flooded areas and along the edges of streambanks a number of hydrophilic shrubs and small trees including silky dogwood, swamp rose, smooth alder, steeple bush, elderberry, and a number of willows (Salix spp.) may be present. Blue flag, water horehound, purple loosestrife, swamp loosestrife, swamp milkweed, tussock sedge, Joe-pye-weed, turtlehead, marsh fern, royal fern, sensitive fern and many other freshwater marsh plants are also common in these open wet areas.

Figure 15. A seasonally flooded alluvial plain in early spring.

Kittatinny-Shawangunk Ridge and Valley

Subsection:221Bd

The Kittatinny-Shawangunk Ridge and Valley extends from northwestern New Jersey into the Shawangunk Mountains of New York. In N.J. this subsection includes all of Kittatinny Mountain, the Walpack Ridge, the Flatbrook Valley and a section of the upper Delaware River Valley. Kittatinny Mountain towers over the surrounding countryside forming one of the most outstanding features of the state. It borders the adjacent Kittatinny Valley (SUB: 221Ba) to the southeast. The Walpack Ridge is separated from the Kittatinny Mountain by the narrow valley of the Big Flatbrook river. The Delaware river forms the northwest boundary of this SUB, as well as the NJ state boundary with Pennsylvania. The terrain in this is generally rough, rocky and steep. The surface is strewn with many boulders, especially along the lower slopes and flat ridge-tops.

- *Area: 193.5 square miles (N.J. only)*

Geomorphology

The rock formations of these mountains and ridges formed as a result of a series of orogenic (mountain-building) events associated with continental plate-tectonic processes which created the Appalachian mountains and Great Valley of North America during the Paleozoic Era (570 to 225 million years ago). These ridges began as sediment eroded from Pre-Cambrian rocks and deposited on the continental slope of the Proto-Atlantic Ocean. Sands, gravels, silts, clays, and biogenic lime-sediments accumulated throughout the Cambrian, Ordovician, Silurian and Devonian periods and lithified into beds of sandstone, shale, limestone and conglomerate. The Proto-Atlantic Ocean began to slowly close late in the Ordovician period drawing the Eurasian and North African continents closer to North America, until the end of the Permian period when the continents were forced together forming part of Pangea, the Supercontinent. The intense pressure of continental collisions folded and faulted these sedimentary rock beds and lifted them high above the sea. Subsequent erosion and glacial scouring carved the softer rocks into deep valleys leaving the more resistant rocks as the higher ridges seen in the topography of the landscape today.

Local relief is steep from the ridgetops to the valleys from 400 to 800 feet, especially on the southeastern face of Kittatinny mountain which is characterized by steep escarpments.

Elevation

- Kittatinny Mountain: 1400′ to 1600′ (420 to 480m.), to 1800′ (540m.) at High Point
- Walpack Ridge: 400′ to 900′ (120 to 270m.)

Lithology/Stratigraphy

Bedrock Geology: The ridge and valley is underlain by a series of sedimentary rocks which range in age from the early-Cambrian to the mid-Devonian periods (570 to 375 million years ago). These rock beds are folded and faulted, dipping down to the northwest with the older rocks underlying the valley and successively younger layers comprising the ridges to the northwest. The oldest and deepest formation is the Hardystone Quartzite (Cambrian) that unconformably overlies the Precambrian basement rock of the continental shield. The Hardystone is overlain by thick layers of dolomite and limestone of Kittatinny and Jacksonburg formations, which are mostly covered by thick shale beds of the Martinsburg formation. These three formations (Ordovician) comprise the bedrock of the Kittatinny Valley. The Martinsburg Shale is overlain by the Shawangunk and Bloomsburg formation (Silurian), which

form the backbone of the Kittatinny Mountain. These are overlain by a complex (late-Silurian through mid-Devonian) series of thin, sandstone, shale, and limestone formations which comprise the Walpack Ridge, Flatbrook Valley and the Upper Delaware river-terraces.

Surficial Geology

The surface is covered by a discontinuous mantle of glacial sediments which were scoured from local bedrock by the expanding glacial ice sheets and deposited by meltwater as they retreated. Glacial drift deposits are generally thin (less than 10′) and patchy, with frequent outcrops of bedrock. In a few locations, mostly on broad uplands and on the bases of shallow slopes, it is quite deep (150-200′). The ice sheet scraped the rocks and cliffs bare and flattened many ridgetops. Lakes and ponds formed where meltwater and ice were impounded in basins scoured into the bedrock or areas where glacial sediments distorted or dammed drainage pathways. Fluvial erosion and deposition, frost wedging, and mass wasting are the dominant processes modifying the surface geology today.

Soils

➤ **General Characteristics:** The soils in this area of the state are generally sandy or shaly loams mixed frequently with stones and gravel. These soils developed in glacial drift scoured mostly from local bedrock and deposited by glacial outwash streams. The soils, much like the mantle of sediments they developed on, are unequally thick, with deep soils forming on the broad uplands and valley bottoms and shallow soils forming on ledges and steep slopes.

➤ **Classification:** Kittatinny Mountain is dominated by deep, stony loam soils of the Swartswood series and shallow stony loam soils of the Oquaga series, both of which formed on till comprised mostly of red and gray sandstone. The Walpack Ridge is dominated by soils which formed on unstratified limestone drift or fractured limestone bedrock, classified as Wassaic, Washington and Wooster series. The Chenango series, a sandy loam soil mixed with gravel and silt, is common in the upper Delaware Valley, developing on glacio-fluvial terraces. Hazen and Palmyra series, which formed in stratified drifts containing limestone gravel, are common in the Flatbrook Valley.

Hydrology

Mountain streams drain plateaus and lakes where water accumulates which flow into the narrow stream valleys. Three major streams drain the landscape, conforming to the natural topography of the ridge-and-valley land formation; VanCampens Brook and Big Flatbrook, which drain south and west into the Delaware River, and Wallkill River which drains north into the Hudson River Valley. Many of these streams are swift, with rocky bottoms, and large populations of aquatic insects and macroinvertebrates. These aquatic organisms are strong indicators of good stream quality and highly oxygenated waters. Natural lakes and ponds are common, having formed in impoundments and depressions created by past glacial action.

Man-made lakes are also common in many locations. Beavers have become an important agent of disturbance in some areas and their populations in this region have increased substantially in recent years due to legal protection. The beavers can severely affect local drainage, flooding some areas with water and depriving others.

Climate and Weather

I. Temperature

a. Mean Annual: 47-51° F (8.8° C)

b. Mean Jan. low: 12.5° F (-10.8° C)

c. Mean July high: 83.1° F (28.4° C)

II. Precipitation

a. *Mean annual total:* 44-46 in. (115.1 cm) (greatest during Summer, in Winter and Fall)

b. *Snowfall:* 39-41" annually

Occurrence of moisture deficits: generally near normal with some occurrences of extreme wet and dry years (based on Palmer Drought Severity Indexes for 1895 - 1990)

III. Growing season

a. Average number of frost free days: 135-155 days

b. Average last Spring frost date: May 10

c. Average first Fall frost date: Oct. 2

d. Cloud free days: 94 annually (7.8/mo.) (clearest during October)

IV. Air quality: Air quality is generally better than other areas of the state, mainly due to its low population density and few industrial areas. Automotive pollution is generally not a problem, but somewhat elevated levels of carbon monoxide and ground level ozone can exist on a short-term basis in local areas characterized by heavy traffic. The nearest ozone monitors in New Jersey, however, have not recorded elevated levels in recent years. Acid deposition, carried by wind from the mid-western states, can also be significant in this

Land Use and Landscape Ecology

Pre-historic hunter/gatherer tribes roamed this portion of New Jersey as early as the first retreat of the glaciers. Land use was likely limited to forest-nut gathering, fishing and hunting along with selective tree-cutting, and minor mining of chert and quartzite for tool and weapon-making. Major changes to the landscape began early in the seventeenth century, when successive waves of settlers began to colonize the Delaware and Kittatinny valleys. Large areas of the mountain forests were harvested to provided timber and fuel for the settlements in the valley below and many attempts to establish farms and pastures were made. Minerals such as iron and copper were mined.

The impact of man upon the forests of this subsection has been somewhat limited by the rough, rocky nature of the terrain. Agriculture was largely abandoned in many areas, in the mid to late 19th century, except in the valleys. Large scale clear-cutting, burning and mining over the last few centuries have had a lasting impact on the forests, however, and have influenced the composition of the regenerating forests. The introduction of numerous exotic plant species including Japanese barberry, Norway spruce, white mulberry, Tree-of-Heaven, Japanese wire-grass, Autumn-olive, and Norway maple, is a notable result of large-scale disturbances. Fire has also had a significant influence on the composition of the forests in the past, favoring oaks and pitch pine, although fire suppression may be contributing to the abundance of maple, beech and birch in the forest understory. One of the most significant impacts upon these forests might have been the decline of the American Chestnut tree, early in this century, due to the Chestnut Blight pathogen. The complete elimination of this canopy species has permanently altered the nature of the forests and the associated food web, of which the Chestnut's mast was a

prominent component. Within the past few decades white-tailed deer, gypsy moth caterpillars and the hemlock wooly adelgid have had notable effects on the forests.

This area is one of the least affected by the full scale urbanization which has occurred in other areas of the state (urban areas account for only 4.8% of total land use). In general most (85.5%) of this Subsection is covered by natural plant communities (i.e., forests, shrubland, marshes, etc..), although small areas (5.8% of land use) are still used for agriculture. Large areas of mature forest are present, with large tracts in public ownership, and outdoor recreation, including hunting, fishing, camping and hiking, are a major land use.

The population of this area is largely rural, with the lowest population density in the state, although a recent trend of urbanization is bringing office parks, shopping malls and residential communities into the area. Small towns, private woodlots, farms and state-owned parks and forests make up most of the area.

Demographics

- Population: ~35,190 people (~182 per square mile)
- Population Centers: no cities or large towns

Plant Communities

Major influences of plant communities in this Subsection include wildfire, a long agricultural history, and a cool continental climate (USDA Zone 5) which is uncharacteristic for most of New Jersey. Ridgetop vegetation on Kittatinny Mountain can best be described as a chestnut oak-dominated forest, with black oak, white oak, northern red oak, sweet birch, and pignut hickory as common associates. Exposed rock outcrops are covered with a pitch pine-scrub oak community. The lower slopes and hills of the Kittatinny Mountain and most of the Walpack Ridge are dominated by a mixture of oaks, hickory, maples and birches, with an abundance of hemlock in rocky ravines and on shady slopes. Valley forests include a diverse mixture of north-american hardwoods including many of the above-mentioned trees as well as tuliptree, beech, and ash.

Threatened, Endangered, and Rare Plants

Federal (threatened or endangered): 1 spp., Small Whorled Pogonia.

State (threatened, endangered or rare): 120 spp. including, Canada Pussytoes, Paper Birch, Hammond's Yellow Spring Beauty, Wild Bleeding Hearts, Beaverpond Clubtail, Heart-leaved Twayblade, Slender Mountain Ricegrass, Red Spruce, Three-Toothed Cinquefoil, Snowy Campion, White Twisted-Stalk and others (compiled from the New Jersey Natural Heritage data base).

Natural Areas

Dunnfield Creek Natural Area
Sunfish Pond Natural Area
(Worthington State Forest)

Tillman Ravine Natural Area
(Stokes State Forest)

Dryden Kuser Natural Area
(High Point State Park)

Wildlife Populations

Wildlife populations are diverse and generally thriving in this area due to the large areas of continuous forest cover. Areas like Stokes State Forest and High Point State Park are important habitats for large mam-

mals, like the Black Bear, and neo-tropical migrant birds, like Scarlet Tanagers and Ovenbirds, which prefer large, continuous forest tracts. Prehistoric evidence of large mammals in this region includes, mastodons, mammoths, elk, moose and caribou, which are characteristic of boreal or tundra-like environments and indicators of the past glacial influence on climate. A number of species of large mammals and birds were present in relative abundance when the first Europeans arrived and are now scarce or extirpated including, bobcats, cougars, timber wolves, and the now extinct Passenger pigeon. Black bears are still locally abundant, and along with turkey and beaver, are recovering and expanding their ranges as a result of reintroduction and legal protection. Coyotes have recently expanded their range into this part of New Jersey. Common species include:

Farm/Forest Edge Wildlife

Includes raccoon, rabbit, woodchuck, opossum, skunk, snakes, deer, pheasant, fox, songbirds, hawks and owls.

Woodland Wildlife

Includes black bear, gray squirrel, chipmunk, white-tailed deer, grouse, numerous reptiles and amphibians, hawks, owls, many songbirds and wild turkey.

Streams/Lakes & Ponds

Contain beaver, brook trout, bass, pike, perch and sunfish many aquatic insects and macroinvertebrates. Shad are common in the Delaware River.

Threatened, Endangered, and Rare Animals

Federal (endangered):
no species recorded in this subsection;

State (threatened, endangered, or rare):
30 spp. including Superb Jewel wing, Arctic Skipper, Rock Shrew, Golden-Winged Warbler, Solitary Vireo, Northern Goshawk and others (compiled from the New Jersey Natural Heritage data base)

Table 9. LTAs of the Kittatinny-Shawangunk Ridge and Valley

	Name	Area (sq.miles)
LTA:221Bd1	Kittatinny Mountain	143.48
LTA:221Bd2	Walpack Ridge	14.39
LTA:221Bd3	Upper Delaware-Flatbrook Valley	35.62
SUB:221Bd	Kittatinny-Shawangunk Ridge and Valley Subsection	193.49

Figure 16. View of the Kittatinny Mountain from the Flatbrook Valley.

Kittatinny Mountain

LTA:221Bd1

This LTA includes the Kittatinny Mountain and surrounding areas where soils are derived mainly from sandstone and conglomerate till. The Kittatinny Mountain is one of the most prominent features of the New Jersey landscape, rising high above the adjacent valleys. Slopes are in general steep and the landscape is dissected by many narrow ravines. Elevations range from about 800 to 1800 feet (the highest point in the state, located at High Point State Park). The surface is rocky and is covered by a discontinuous mantle of glacial sediments which were scoured from local bedrock. Glacial drift deposits are generally thin (less than 10') and patchy, with frequent outcrops of bedrock. Natural lakes and ponds are common (accounting for 3% of total surface area) formed where meltwater and ice were impounded by till, and in basins scoured into the bedrock by glacial ice.

Figure 17. Aerial view of High Point Monument.

Soils associated with this LTA are generally deep or moderately deep, stony loams derived from till deposits or weathering of local bedrock. The predominant rock-types are Silurian-age Kittatinny gray sandstone, Tuscarora red sandstone and Shawangunk conglomerate (see Table 10). Soils are thin on steep slopes and ridgetops and deepest at the base of shallow slopes. Rock outcroppings are common. Major soil series include Swartswood, Oquaga, Wurtsboro and Norwich.

The Kittatinny Mountain LTA is mostly (84.3% of total area) covered by natural plant communities (i.e., forests, shrublands, marshes, etc..). Forested communities in this LTA have, for the most part, regenerated on fallow pastureland or from old timber harvests. Only a small portion of the land remains in agriculture (2.9%), although the area is still largely rural (urban land accounts for 4.7% of land use). Large portions of the ridge are publicly owned and used primarily for outdoor recreation. The ridgetops and upper slopes are dominated by a mixture of chestnut oak, scarlet oak, white oak, black oak, northern red oak and pignut hickory. Pitch pine is common on exposed ridges, or areas frequently burned by wildfire. Sweet birch, red maple and juneberry are also common, especially in the subcanopy layers of the forest canopy. Occasionally black gum, white pine, paper birch, striped maple and black cherry are present. Paper birch and striped maple, which are normally common north and west of New Jersey, are generally limited to this LTA. Ridge forests grade into forests dominated by a mixture of sugar maple, red maple, sweet birch, white ash, shagbark hickory, bitternut hickory, which are found primarily on the lower mountain slopes and areas where till deposits are deep. Red maple, beech, hornbeam

and hemlock are among the most common trees in the subcanopy of these forests. American Elm, basswood and tuliptree are sometimes common on lower slopes and flats where soil moisture is abundant. Narrow ravines and shady slopes are often dominated by stands of hemlock, with yellow birch and beech as its only common associates. Red Maple dominates most wetlands. High Point State Park contains a unique upland, inland Atlantic White-cedar bog.

Table 10. ELTs of the Kittatinny Mountain LTA

ELT#	Name	Area(acres)
221Bd1-00	Water Bodies	2,738.49
221Bd1-12	Very Poorly Drained Carbonate-bearing Sandstone[2] Terraces	210.88
221Bd1-13	Very Poorly Drained Sandstone-Conglomerate[3] Till Flats	13,456.24
221Bd1-16	Very Poorly Drained Flat Peatlands	327.35
221Bd1-21	Poorly Drained Limestone[1] Till Slopes	9.13
221Bd1-22	Poorly Drained Carbonate-bearing Sandstone[2] Terraces	408.43
221Bd1-23	Poorly Drained Sandstone-Slate[4] Terraces	89.16
221Bd1-33	Somewhat Poorly Drained Sandstone-Conglomerate[3] Till Slopes	3,210.47
221Bd1-41	Moderately Well Drained Limestone[1] Till Flats	32.13
221Bd1-43	Moderately Well Drained Sandstone-Conglomerate[3] Till Flats	13,456.24
221Bd1-51	Well Drained Limestone[1] Till Slopes	106.93
221Bd1-52	Well Drained Carbonate-bearing Sandstone[2] Terraces	158.94
221Bd1-53	Well Drained Deep Sandstone-Conglomerate[3] Till Slopes	22,010.92
221Bd1-54	Well Drained Shallow Rocky Sandstone-Conglomerate[3] Till Slopes	25,942.05
221Bd1-61	Excessively Drained Steep Rocky Limestone[1] Till Slopes	21.57
221Bd1-63	Excessively Drained Steep Rocky Shale[5] Till Slopes	62.95
221Bd1-64	Excessively Drained Sandstone-Conglomerate[3] Rock Outcrops	9,740.07
221Bd1-82	Seasonally Flooded Loamy Alluvial Plains	168.76
221Bd1-99	Altered Lands	51.23
221Bd1	Kittatinny Mountain Land Type Association	92,277.94

[1]Till and bedrock predominantly composed of limestone but includes lesser amounts of sandstone, shale and granite;
[2]Glacial outwash and drift materials dominated by sandstone and shale rock fragments, but are enriched with lesser amounts of carbonate-bearing rock-fragments;
[3]Till and bedrock predominantly composed of sandstone and conglomerate till with small amounts of other materials;
[4]Glacial outwash and drift materials predominantly composed of sandstone, slate and silt stone;
[5]Till and bedrock materials dominated by shale and slate fragments, but also contain fragments of sandstone.

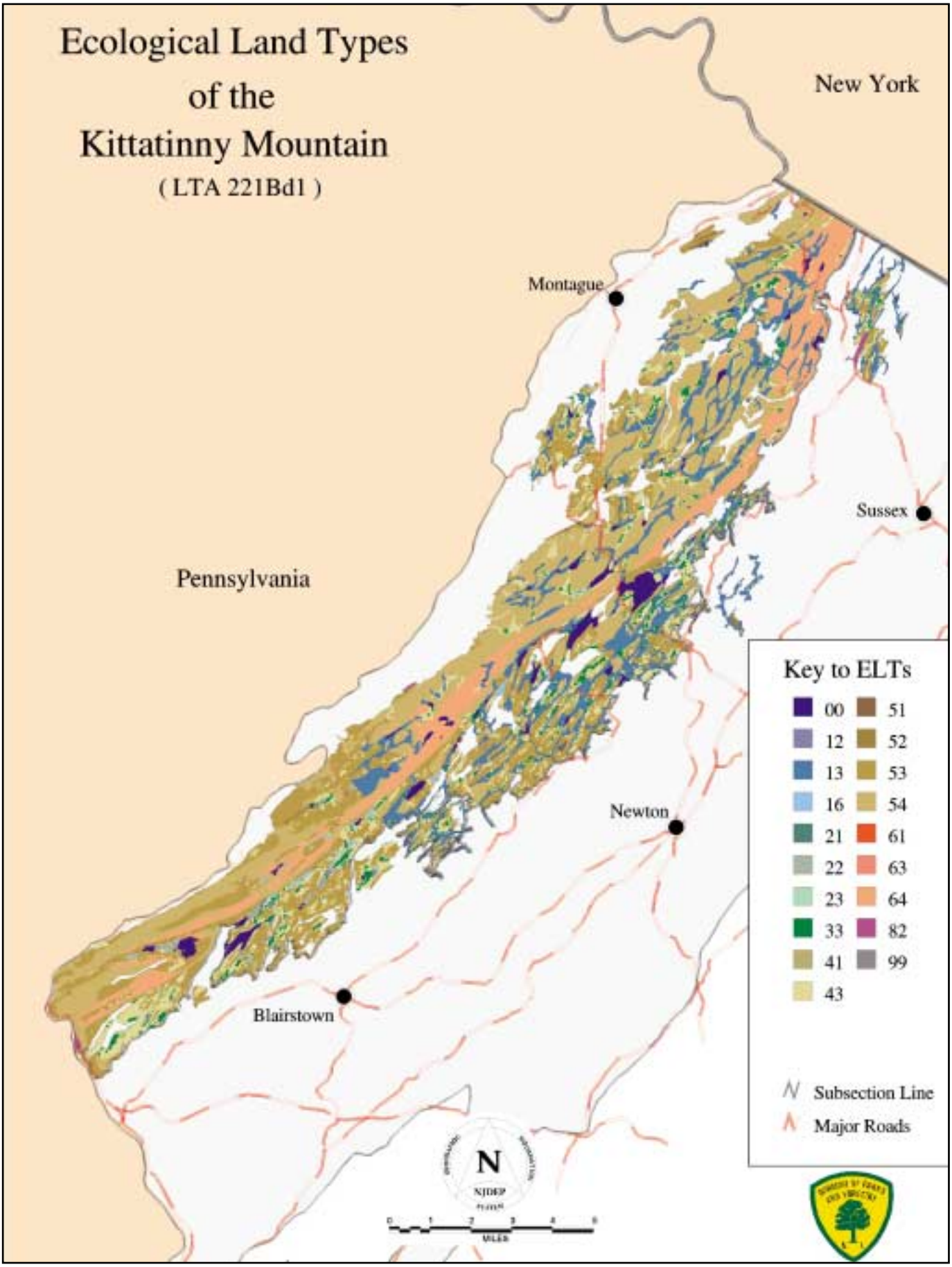


Figure 18. ELTs of the Kittatinny Mountain

Table 11. Land Use[1] for ELTs of the Kittatinny Mountain LTA

ELT#	Area(acres)	%Forested	%Agriculture	%Urban[2]	%Other[3]
221Bd1-12	210.88	75.6	0.0	5.5	18.9
221Bd1-13	13,456.24	80.3	2.9	3.2	13.6
221Bd1-16	327.35	51.9	8.9	1.9	37.3
221Bd1-21	9.13	96.2	0.0	2.7	1.1
221Bd1-22	408.43	82.5	0.9	8.2	8.4
221Bd1-23	89.16	66.0	9.5	5.2	19.3
221Bd1-33	3,210.47	77.8	5.6	10.9	5.7
221Bd1-41	32.13	45.0	28.8	21.4	4.8
221Bd1-43	13,456.24	78.7	5.8	9.4	6.1
221Bd1-51	106.93	80.1	6.3	9.5	4.1
221Bd1-52	158.94	55.5	26.5	3.7	14.3
221Bd1-53	22,010.92	80.1	5.3	8.1	6.5
221Bd1-54	25,942.05	97.6	0.2	1.3	0.9
221Bd1-61	21.57	98.5	0.0	0.3	1.2
221Bd1-63	62.95	81.2	2.3	16.5	0.0
221Bd1-64	9,740.07	97.4	0.0	0.2	2.4
221Bd1-82	168.76	55.7	0.3	14.1	29.9

[1]based on 1991 reports;
[2]includes residential,commercial, industrial, athletic fields, etc.;
[3]includes water bodies, herbaceous wetlands and non-forested, and undeveloped uplands, not devoted to agriculture (i.e., shrubland, brushland, barren land).

VERY POORLY DRAINED CARBONATE-BEARING SANDSTONE TERRACES
ELT:221Bd1-12

This ELT comprises only a small portion of the Kittatinny Mountain LTA, occurring at the bottoms of narrow ravines and on flat portions of glacial outwash terraces, where sandstone and shale glacial outwash materials are enriched with carbonate-bearing materials (for a description of this map-unit refer to ELT:221Ba2-12).

VERY POORLY DRAINED SANDSTONE-CONGLOMERATE TILL FLATS
ELT:221Bd1-13

This ELT occurs in the landscape as broad upland swales, in wide, sluggish drainways, and at the bottom of narrow ravines. Soil texture is coarse loamy and extremely stony composed of mostly sandstone, quartzite conglomerate and shale till scoured from local bedrock by glacial ice. Compacted materials in the subsoil contributes to a high water table in many areas along with a low position in the landscape. In some areas rocky and stony till are not exposed at the surface and are instead covered by a heterogenous mixture of sandy and gravelly material deposited by stream waters. The water table is usually at or near the surface except in the case of extreme drought. Standing water is often present throughout the year.

Phytotrophic characteristics of this ELT are an abundance of water, large stones, and

moderate site fertility. Rooting conditions are somewhat poor in many portions of this land type because of the very poor drainage and associated anoxic conditions, although this seems to be mitigated somewhat by the large stones which apparently create sufficient air pockets to sustain a number of non-hydrophilic plants. Site fertility is considered to be moderate for most forest plants because of the deep, coarse, loamy textured soil. The stony surface of this land type reduces the germination surface for seedlings, but seems to benefit mosses and similar mat-forming plants. It also provides drier microsites for plants not typically found growing under these swampy conditions. Canopy closure in forested communities is unlikely to be limited by water or nutrient availability, but is limited by water depth in some areas.

Forested Plant Communities

Common trees include red maple, hemlock, sugar maple, yellow birch and white ash. Red maple and ash are the most abundant and generally dominate the wettest portions of the ELT. Hemlock, sugar maple and yellow birch are more common at the bottoms of narrow coves. Shagbark hickory, black birch, black gum, basswood, swamp white oak, elm and tuliptree are sometimes common. Beneath the forest canopy hornbeam and juneberry are often present. Common shrubs include a mixture of spicebush, witch hazel, swamp azalea and highbush blueberry. The forest floor is variably covered with a number of woody and herbaceous plants including jack-in-the pulpit, skunk cabbage, false hellebore, partridgeberry, jewelweed, starflower, swamp blackberry, cinnamon fern, Massachusetts fern, New York fern, Boot's wood fern, and spinulose wood fern. A number of mosses including fern moss, star moss and sphagnum moss are common in this ELT, forming thick carpets over the wet rocky till. Japanese wire-grass (Microstegium vimineum) is locally abundant in some areas.

In the wettest areas trees are sparse, and there is generally an open canopy of "flood-stunted" red maple and white ash trees. Some of these areas were flooded by beavers and contain standing, dead trees of many of the above-mentioned species. Hydrophilic shrubs and small trees are generally abun-

Figure 19. Standing dead trees on a very poorly drained, sandstone-conglomerate till flat previously flooded by beaver.

dant in these areas silky dogwood, arrowwood, smooth alder, steeple bush, elderberry, and a number of willows (Salix spp.) may be present. Blue flag, water horehound, purple loosestrife, swamp loosestrife, swamp milkweed, tussock sedge, Joe-pye-weed, turtlehead, marsh fern, royal fern, sensitive fern and many other freshwater marsh plants are also common in these open wet areas. In some disturbed areas, particularly where drainage has been altered, reed grass (Phragmites australis) is a major component of these shrub-meadows.

VERY POORLY DRAINED FLAT PEATLANDS
ELT:221Bd1-16

This ELT comprises only a small portion of the Kittatinny Mountain LTA, occurring on former lake beds or upland depressions which are permanently flooded and have accumulated extensive peat deposits (for a description of this map-unit refer to ELT:221Ba2-16).

POORLY DRAINED LIMESTONE TILL SLOPES
ELT:221Bd1-21

This ELT comprises only a tiny portion of the Kittatinny Mountain LTA, occurring in depressions where small areas of limestone till are present. These inclusions are mainly found where the Kittatinny Mountain abuts portions of the Walpack Ridge LTA (for a description of this map-unit refer to ELT:221Bd2-21).

POORLY DRAINED CARBONATE-BEARING SANDSTONE TERRACES
ELT:221Bd1-22

This ELT comprises a small portion of the Kittatinny Mountain LTA, occurring on the bottoms of narrow ravines and along gently sloping portions of glacial outwash terraces, where sandstone and shale outwash materials are enriched with carbonate materials (for a description of this map-unit refer to ELT:221Ba2-22).

POORLY DRAINED SANDSTONE-SLATE TERRACES
ELT:221Bd1-23

This ELT comprises only a tiny portion of the Kittatinny Mountain LTA, occurring on the bottoms of narrow ravines and along gently sloping portions of glacial outwash terraces, where sandstone, conglomerate and slate rock fragments are dominant. These inclusions mainly occur where this LTA borders with the the Flatbrook Valley (for a description of this map-unit refer to ELT:221Bd2-23).

SOMEWHAT POORLY DRAINED SANDSTONE-CONGLOMERATE TILL SLOPES
ELT:221Bd1-33

This ELT occurs in the landscape on toe slopes, in the bottoms of coves, and on the lower slopes of broad ravines. Soil texture is coarse loamy and extremely stony composed of mostly sandstone, quartzite conglomerate and shale till scoured from local bedrock by glacial ice. The somewhat poor drainage of this land type is attributable to compacted materials in the subsoil. The impeded drainage contributes to a seasonally high water table below the surface in late winter and early spring. Vernal pools are common.

Phytotrophic characteristics of this ELT are saturated soil conditions in late winter and early spring, an abundance of large stones at the ground surface, and a subsurface layer of compacted material. Cold temperatures are also important as many of these areas are in coves where cold air con-

denses overnight. Rooting conditions are somewhat limited in the subsurface portions of this land type because of seasonal anoxic conditions caused by a high water table and compact sub-soils. Site fertility is considered to be moderate for most forest plants because of the deep, coarse-loamy textured soil. Site conditions tend to support plant communities which are somewhere in between a swamp and an upland forest. Shallow-rooted trees or trees which can draw a lot of water (white oak, for example) seem to have an advantage on these sites. There are a number of somewhat hydrophilic plants which seem to be quite common on these otherwise upland sites. Hydrophilic plants are commonly concentrated in depressions which support vernal pools.

Forested Plant Communities

Common trees include white oak, red maple, sugar maple, hemlock and shagbark hickory. Yellow birch, northern red oak, basswood and white ash are sometimes common. Beneath the forest canopy hornbeam, juneberry and hawthorn are often present. Common shrubs include highbush blueberry, shadbush, and witch hazel. Japanese barberry, pinxter azalea and elderberry are sometimes common. Japanese barberry is abundant in old pastures. The forest floor is variably covered with a number of woody and herbaceous plants, including partridgeberry, swamp blackberry, white wood aster, halberd-leaved tearthumb, Virginia creeper, common violets, dwarf cinquefoil, Canada mayflower, jack-in-the-pulpit, Solomon's seal, false Solomon's seal, aniseroot, Christmas fern, cinnamon fern, intermediate wood fern, spinulose wood fern, hay-scented fern, and a number of club mosses (Lycopodium spp.). A number of mosses including fern moss, star moss, hair-cap moss, sphagnum moss and white cushion moss are common.

MODERATELY WELL DRAINED LIMESTONE TILL FLATS
ELT:221Bd1-41

This ELT comprises only a tiny portion of the Kittatinny Mountain LTA, occurring on upland flats and in depressions where small areas of limestone till are present. These inclusions are mainly found where the Kittatinny Mountain abuts portions of the Walpack Ridge LTA (for a description of this map-unit refer to ELT:221Bd2-41).

Figure 20. Somewhat poorly drained, sandstone-conglomerate till slope in Tillman's Ravine Natural Area.

MODERATELY WELL DRAINED SANDSTONE-CONGLOMERATE TILL FLATS

ELT:221Bd1-43

This ELT occurs in the landscape on level and gently sloping uplands on plateaus and in "saddles" between mountain slopes. Soil texture is generally coarse loamy and extremely stony composed of mostly sandstone, quartzite, conglomerate and shale till scoured from local bedrock. Soils are generally deep and an abundance of large stones are usually present on the surface (see photo). These moderately well drained sites have a slightly impeded drainage attributable to a compacted layer of till in the subsoil and the generally flat topography. The impeded drainage contributes to a seasonally high water table which rises to within a few feet of the surface in late winter and early spring, but recedes considerably later in the growing season. Vernal pools are somewhat common.

Phytotrophic characteristics of this ELT are water-saturated soil conditions in late winter and early spring, slow surface runoff, an abundance of large stones at the ground surface and a subsurface layer of compacted material. Rooting conditions may be slightly limited in the subsurface portions of this landtype because of somewhat anoxic conditions caused by a seasonally high water table. Compact sub-soils limit rooting depths. Site fertility is considered to be moderate for most forest plants because of the deep, coarse-loamy textured soil. These site conditions support upland forest communities which seem to be dominate by trees which can tolerate occasional high water table and contain a number of somewhat hydrophilic plants in the forest understory.

Forested Plant Communities

Common trees include white oak, red maple, shagbark hickory, and northern red oak, are all common among the canopy dominant trees in forested portions of this ELT. Other trees, including sweet birch, hemlock, tuliptree, black gum, and basswood are also somewhat common. Hornbeam, juneberry, flowering dogwood, and hawthorn are often present beneath the forest canopy. Common shrubs include highbush blueberry, black huckleberry, pinxter azalea, witch hazel and Japanese barberry. The forest floor is variably covered with a number of woody and herbaceous plants including jack-in-the-pulpit, swamp blackberry, Virginia creeper, partridgeberry, sweet cicely, aniseroot, starflower, enchanter's nightshade, wild sarsaparilla, horse balm, white wood aster, common violet, Canada mayflower, New York fern, intermediate wood fern, Christmas fern, hay-scented fern, tree club-moss, and ground pine. A number of mosses including fern moss and white cushion moss are common.

Figure 21. White oak - red maple stand on moderately well drained, sandstone-conglomerate till flats.

WELL DRAINED LIMESTONE TILL SLOPES
ELT:221Bd1-51

This ELT comprises only a small portion of the Kittatinny Mountain LTA, occurring on lower slopes where small areas of limestone till are present. These inclusions are mainly found where the Kittatinny Mountain abuts portions of the Walpack Ridge LTA (For a text description of this map-unit refer to ELT:221Bd2-51).

WELL DRAINED CARBONATE-BEARING SANDSTONE TERRACES
ELT:221Bd1-52

This ELT comprises only a small portion of the Kittatinny Mountain LTA, occurring on old glacial outwash terraces, where sandstone and shale rock fragments dominate, but are enriched with carbonate rock fragments. These inclusions mainly occur where this LTA borders with the Flatbrook Valley (for a description of this map-unit refer to ELT:221Bd3-52).

WELL DRAINED DEEP SANDSTONE-CONGLOMERATE TILL SLOPES
ELT:221Bd1-53

This ELT occurs in the landscape on moderately to steeply sloping uplands where till is deep. Soils are generally deep and coarse-loamy in texture. Soils are extremely stony with rocks composed of mostly sandstone, quartzite, conglomerate and shale till from local bedrock.

Phytotrophic characteristics of this ELT are deep well drained soils, moderate to steep slopes, and an abundance of large stones throughout the soil profile. These well-drained sites have good surface water drainage and coarse loamy textures which denote somewhat of an optimum condition of drainage and aeration for plant roots. Rooting conditions may be somewhat limited on the steeper, upper slopes, where erosion is more severe. Site fertility is considered to be moderate for most forest plants because of the deep, coarse-loamy textured soil.

Forested Plant Communities

Common trees include white oak, red oak, black oak, beech, pignut hickory, sweet birch, and chestnut oak. Pitch pine is occasionally present on steep, upper slopes and hemlock is somewhat common on the lower, shady slopes. Sugar maple, red maple, beech, shagbark hickory, bitternut hickory, mockernut hickory, and white ash are sometimes common. Basswood and tuliptree are occasionally present, mainly on lower slopes. Hornbeam, sassafras, hawthorn and witch hazel are often present beneath the forest canopy. Common shrubs include lowbush blueberry, black huckleberry, maple-leaf viburnum, and Japanese barberry. Mountain laurel and pinxter azalea are occasionally present, particularly on steep shady slopes. The forest floor is variably covered with woody and herbaceous plants including garlic mustard, white snakeroot, Japanese wire grass, enchanter's nightshade, Virginia creeper, wild sarsaparilla, wood anemone, white wood aster, Christmas fern, hay-scented fern, lady fern and bracken fern. Oblong-leaved ragwort, white avens, white lettuce, bluets, common violets and a number of other plants are common in forest openings.

WELL DRAINED SHALLOW ROCKY SANDSTONE-CONGLOMERATE TILL SLOPES

ELT:221Bd1-54

This ELT occurs in the landscape on moderately to steeply sloping uplands where till is thin and rock-outcroppings are somewhat common. Soil texture is coarse loamy and extremely stony composed of mostly sandstone, quartzite, conglomerate and shale till derived from local bedrock. Soils are generally moderately deep to thin, depending on steepness of slope and disturbance history.

Phytotrophic characteristics of this ELT are moderately thin well-drained soils, moderate to steep slopes, and a considerable amount of exposed rocky surfaces. These well-drained sites have good surface water drainage, but available water capacity for plant communities is moderately low because the stony texture of the soil and short distance to the underlying bedrock. Rooting conditions may be somewhat limited because of thin soil, particularly on steep slopes. Site fertility is considered to be low for most forest plants because of the somewhat, shallow, coarse textured sandstone-conglomerate parent material and the very strongly acidic conditions. Canopy closure may be limited in some areas by the presence of large stones at the surface.

Forested Plant Communities

Common trees include chestnut oak, white oak, red oak, black oak, red maple, black birch, and pignut hickory. Chestnut oak is often the most abundant tree in the forest. Pitch pine, black gum, scarlet oak, sassafras, black cherry, hemlock and beech, are sometimes common. Pitch pine is most common on exposed slopes and in areas where wildfire has been common. Hemlock is common on steep, shady slopes. Beech is generally uncommon as a canopy tree in most areas because of the somewhat low soil fertility, but is sometimes a significant portion of the sub-canopy layer. Beneath the canopy of trees juneberry, American chestnut sprouts, sassafras, and saplings of red maple and black birch are often present. Red maple and black birch are very abundant in sub canopy in some portions of this ELT, almost to the exclusion of other young trees. Striped maple is sometimes present on steep, shady slopes. The shrub layer is generally low in diversity, mainly comprised of lowbush blueberry, black huckleberry, and witch hazel. Mountain laurel, pinxter azalea, and scrub oak are sometimes present. The forest floor is variably covered with a number of herbaceous plants including teaberry, Virginia creeper, false Solomon's seal, wild sarsaparilla, dwarf cinquefoil, starflower, downy rattlesnake plantain, pink moccasin-flower, bracken fern, interrupted fern, marginal wood fern, hay-scented fern, and rattlesnake weed. A number of mosses including hair-cap moss and white cushion moss are common in this ELT, particularly where leaf litter is thin. Sweet fern, winged sumac, whorled loosestrife, and hay-scented fern are among the common plants in forest clearings.

EXCESSIVELY DRAINED STEEP ROCKY LIMESTONE TILL SLOPES

ELT:221Bd1-61

This ELT comprises only a tiny portion of the Kittatinny Mountain LTA, where small escarpments of limestone bedrock are present. These inclusions are mainly found where the Kittatinny Mountain abuts portions of the Walpack Ridge LTA (for a description of this map-unit refer to ELT:221Bd2-61).

EXCESSIVELY DRAINED STEEP ROCKY SHALE TILL SLOPES
ELT:221Bd1-63

This ELT comprises only a tiny portion of the Kittatinny Mountain LTA, occurring on steep slopes and small escarpments where shale till and bedrock dominate. These inclusions are mainly found where the eastern slope of the Kittatinny Mountain abuts the Upper Kittatinny Valley LTA (for a description of this map-unit refer to ELT:221Ba1-63).

EXCESSIVELY DRAINED SANDSTONE-CONGLOMERATE ROCK OUTCROPS
ELT:221Bd1-64

This ELT occurs in the landscape on steeply sloping uplands and the ridgetops of the Kittatinny Mountain, where rock outcrops make up a large portion of landscape. Soils are thin, where present and extremely stony, derived from the local sandstone, quartzite, and conglomerate bedrock which is exposed in most areas.

Phytotrophic characteristics of this ELT are characterized by dry, thin, stony soils, and bare rock surfaces, which are at high elevations and subjected to constant exposure to the elements. These somewhat excessively drained sites provide scarce water for plants, because of fast runoff, low water holding capacity in the soil, and a topographic position which contributes to high levels of evaporation from wind. Extreme daily and seasonal temperature fluctuations are another important feature of this land type to which plants must respond. Rooting conditions are somewhat limited in the shallow soils, although many plants are able to work their roots into pockets of deeper soil which has accumulated in the fractured bedrock. Site fertility is considered to be low for most forest plants because of the somewhat, shallow, coarse textured sandstone-conglomerate parent material and the strongly acidic conditions. Site conditions tend to produce an open-canopy forest community with many standing dead trees. Height growth in many forest trees is often stunted under these harsh conditions and tree density is additionally limited by lack of microsites for seedling establishment. The rocky surface also limits the number of microsites available for the germination of the seeds of woody shrubs and trees, which seems to benefit, lichens, small ferns, grasses, vines and mat-forming plants.

Forested Plant Communities

Common trees include chestnut oak, scarlet oak, black oak, white oak, northern red oak, pitch pine, red maple, sweet birch, and pignut hickory, although chestnut oak is by far the most abundant. Pitch pine is abundant on the highest ridgetops and where wildfires are frequent. Other trees, mainly black cherry, mockernut hickory, white pine, fire cherry, sassafras, American chestnut, and gray birch are sometimes common. Paper birch, which is rare in New Jersey forests, is occasionally present. Beneath the forest canopy juneberry, American chestnut sprouts , and saplings of red maple, chestnut oak and sweet birch are often present. Striped maple is sometimes present on steep, shady slopes. Common shrubs include lowbush blueberry, deerberry, black huckleberry, mountain laurel, pinxter azalea and scrub oak. Black huckleberry often forms continuous knee-high thickets. On the ridgetops the understory and subcanopy overlap quite a bit since the height of the canopy is somewhat low, forming a tight thicket. The forest floor is variably covered with a number of herbaceous plants including bracken fern, teaberry, striped wintergreen, false Solomon's seal, wild sarsaparilla, dwarf cinquefoil, cow-wheat,

Pennsylvania sedge, haircap moss and white cushion moss.

In addition to the species mentioned above, and number of other species are common in exposed rocky areas, including winged sumac, scrub oak, sweet fern, black chokeberry, Allegheny blackberry, hairgrass, poverty oatgrass, pale corydalis, white goldenrod, sweet goldenrod, bastard toadflax, little bluestem, panicgrass, marginal woodfern, viper's bugloss, whorled loosestrife, and spotted knapweed. Exposed rocks are often colonized by smooth rock tripe, polpody fern, rock lichen, and rock mosses.

SEASONALLY FLOODED LOAMY ALLUVIAL PLAINS

ELT:221Bd1-82

This ELT comprises only a small portion of the Kittatinny Mountain LTA, mainly along the upper reaches of the Flatbrook River (for a description of this map-unit refer to ELT:221Bd3-82).

Figure 22. Sandstone-conglomerate rock outcropping atop the Kittatinny Ridge.

Walpack Ridge

LTA:221Bd2

The Walpack Ridge LTA includes the prominent limestone ridge which separates the upper Delaware and Flatbrook Valleys and surrounding areas where soils derived from limestone bedrock and till are dominant. Local topography is generally moderately to steeply sloping with considerable limestone bedrock at or near the surface. Local elevations range from 400 to 900 feet. The surface is covered by a discontinuous mantle of sediments which were scoured by glaciers from local bedrock. Glacial drift deposits are generally thin and patchy, with frequent outcrops of bedrock on steep slopes and ridges. The landscape is dissected by scattered small streams and ponds. Underground streams, sinkholes, springs and seeps are somewhat common.

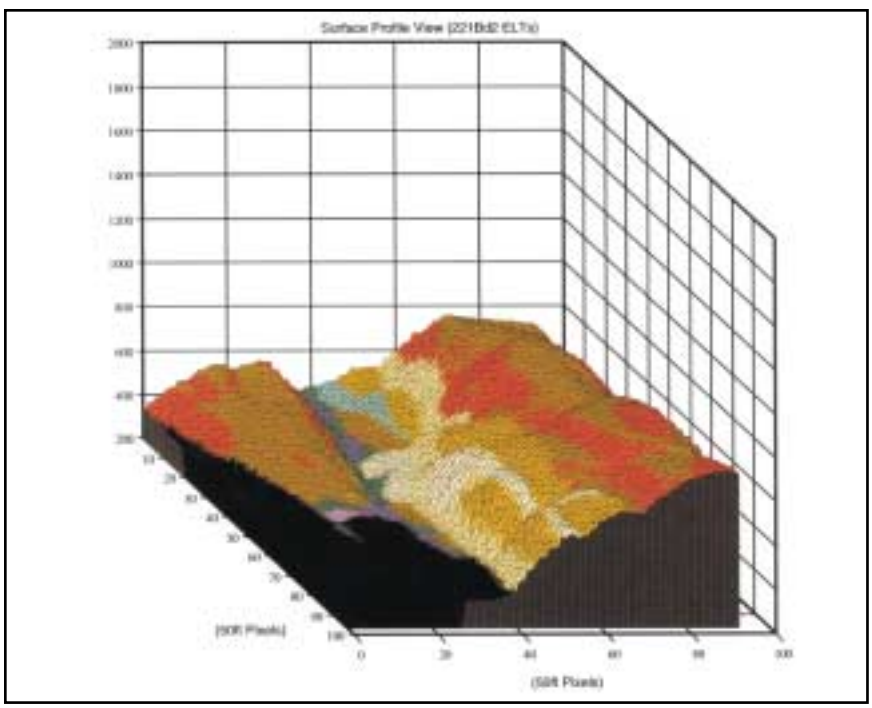
Soils associated with this LTA are generally deep or moderately deep, stony loams derived from till deposits and weathering of local bedrock. Soils are thin on steep slopes and ridgetops, where limestone outcrops are common, and deepest at the base of shallow slopes. The predominant rock-types consist of materials from the Devonian-age Kittatinny and Jacksonburg formations. Limestone along with lesser amounts of sandstone and shale. Local limestone is of the dolomitic type, characteristically enriched in magnesium, but with lower calcium levels compared to other limestone types. Major soil series include Washington, Wassaic, Wooster, and Lyons.

Most of the Walpack Ridge (86.8%) is covered by natural plant communities (i.e., forests, shrubland, etc.). Many areas were cleared for agriculture in the past and some areas remain in agricultural use (8.7% of land cover). The area remains largely rural (1.8% urban). Large portions of the ridge are in public ownership, much of this is part of the Delaware Water Gap National Recreation Area. A major influence on plant communities in this LTA is steep topography and the agricultural history of the area. Many exotic species are abundant in successional forests including black locust, catalpa, Japanese barberry, Amur honeysuckle, garlic mustard, and wineberry, reflecting the agricultural history of the region. The ridgetops and upper slopes are dominated by a mixture of sugar maple, sweet birch, white ash, northern red oak, black cherry, white oak, black oak and pignut hickory. Eastern red cedar is abundant on exposed ridges, rock-outcroppings and in young successional woodlands. Hornbeam, dogwood and hophornbeam are all common in the subcanopy layers. Occasionally eastern hemlock, red maple, beech, tuliptree, and sassafras are present. Red maple and white ash are particularly abundant in the wet areas. The limestone soils also have some characteristic species associated with them, such as walking fern.

Table 12. ELTs of the Walpack Ridge LTA

ELT#	Name	Area(acres)
221Bd2-00	Water Bodies	74.30
221Bd2-11	Very Poorly Drained Limestone[1] Till Flats	66.85
221Bd2-13	Very Poorly Drained Sandstone-Slate[2] Terraces	148.35
221Bd2-21	Poorly Drained Limestone[1] Till Slopes	215.73
221Bd2-23	Poorly Drained Sandstone-Slate[2] Terraces	66.57
221Bd2-33	Somewhat Poorly Drained Shale[3] Till Flats	9.01
221Bd2-41	Moderately Well Drained Limestone[1] Till Flats	243.56
221Bd2-43	Moderately Well Drained Sandstone-Slate[2] Terraces	162.91
221Bd2-51	Well Drained Limestone[1] Till Slopes	5,800.98
221Bd2-53	Well Drained Sandstone-Slate[2] Terraces	483.36
221Bd2-54	Well Drained Shallow Rocky Shale[3] Till Slopes	274.60
221Bd2-61	Excessively Drained Steep Rocky Limestone[1] Till Slopes	1,456.96
221Bd2-82	Seasonally Flooded Loamy Alluvial Plains	11.29
221Bd2	Walpack Ridge Land Type Association	9,014.38

[1]Till predominantly composed of limestone, but includes lesser amounts of sandstone, shale and granite;
[2]Glacial outwash and drift materials predominantly composed of sandstone, slate and siltstone; [3]Till and bedrock materials dominated by shale and slate fragments, but also contain fragments of sandstone.



Graphic 1. A 3D view of Walpack Ridge ELTs over a surface profile.

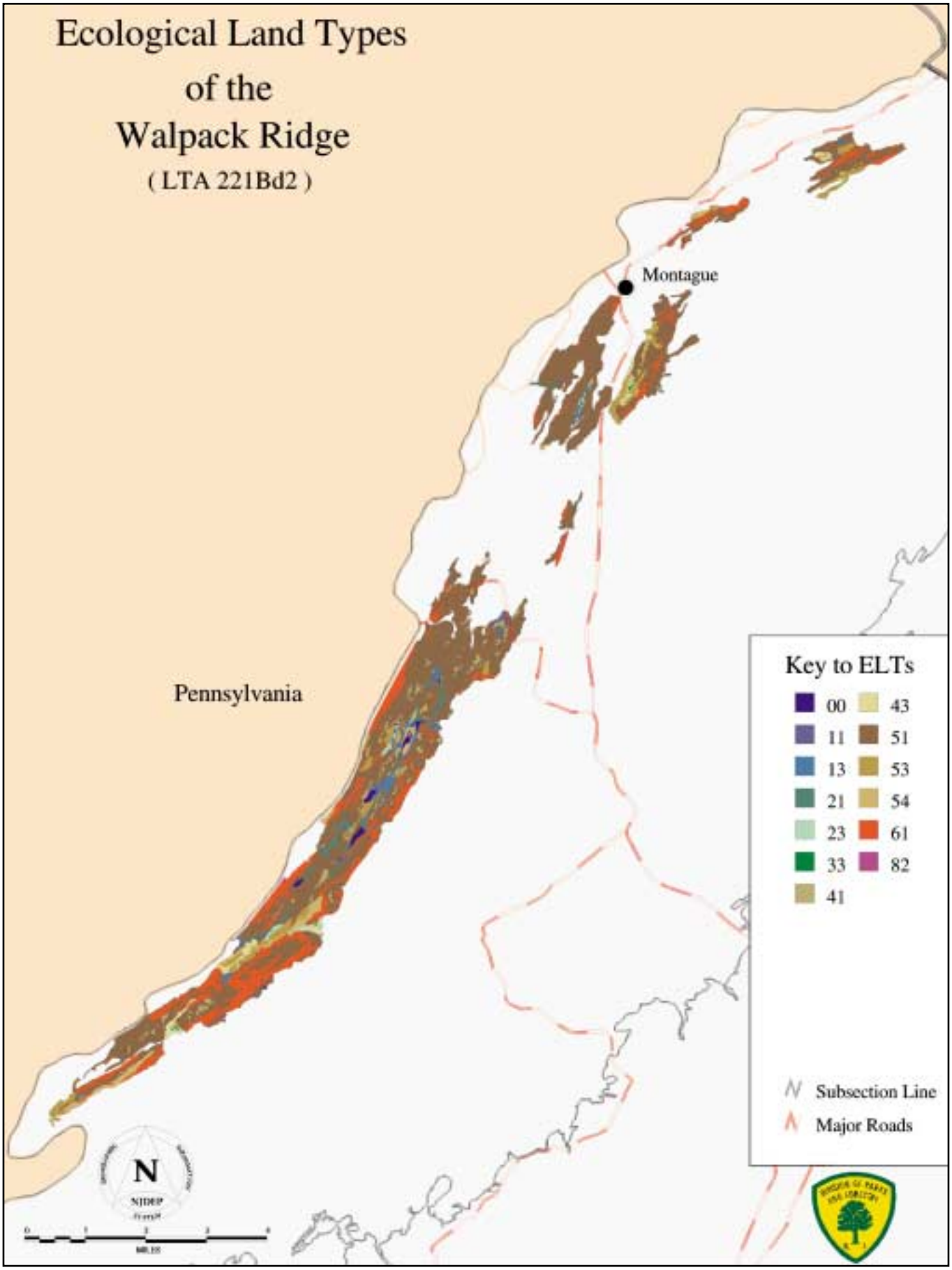


Figure 23. ELTs of the Walpack Ridge

Table 13. Land Use[1] for ELTs of the Walpack Ridge LTA

ELT#	Area(acres)	%Forested	%Agriculture	%Urban[2]	%Other[3]
221Bd2-11	66.85	20.0	8.2	11.8	60.0
221Bd2-13	148.35	74.8	5.9	0.0	19.3
221Bd2-21	215.73	48.3	4.9	2.9	43.9
221Bd2-23	66.57	52.0	2.2	0.0	45.8
221Bd2-33	9.01	79.7	9.7	5.6	5.0
221Bd2-41	243.56	55.4	16.6	2.5	25.5
221Bd2-43	162.91	71.9	5.1	3.4	19.6
221Bd2-51	5,800.98	64.7	11.5	1.7	22.1
221Bd2-53	483.36	69.5	9.0	4.4	17.1
221Bd2-54	274.60	82.6	0.3	0.8	16.3
221Bd2-61	1,456.96	93.1	1.0	0.7	5.2
221Bd2-82	11.29	97.9	0.0	0.0	2.1

[1]based on 1991 reports;
[2]includes residential,commercial, industrial, athletic fields, etc.;
[3]includes water bodies, herbaceous wetlands and non-forested, and undeveloped uplands, not devoted to agriculture (i.e., shrubland, brushland, barren land).

VERY POORLY DRAINED LIMESTONE TILL FLATS
ELT:221Bd2-11

This ELT occurs in the landscape in flat, low-lying areas along the courses of streams and around water bodies, and in depressions. Soil texture is generally silt loam and in some places soils are very stony, containing mostly fragments of limestone with lesser amounts of sandstone and shale. The water table in this ELT is generally at or near the surface due to a low position in the landscape. Standing water is often present throughout the year in the wetter areas.

Phytotrophic characteristics of this ELT are saturated soils, standing water and very high fertility. Rooting conditions are characteristically poor in many portions of this land type because of the poor drainage and associated anoxic conditions. Site fertility is considered to be very high for most forest plants because of the natural high abundance of calcium and magnesium, although nutrient uptake may be somewhat limited for many terrestrial plants due to flooded conditions. Rich, swampy site conditions tend to support hardwood swamp plant communities although considerable area (36.6% of the total ELT) are shrubby and herbacaous wetlands. Ponded water in the wettest areas reduces the germination surface for the seedlings of terrestrial plants, although aquatic and semi-aquatic plants generally fill in these spaces. Coarse, rocky soil conditions found in some areas provide drier microsites for a number of plants not typically associated with these swampy conditions. Canopy closure in forested communities is unlikely to be limited by water or nutrient availability, but is often limited by the presence of standing water.

Forested Plant Communities

Red maple and white ash dominate most forested portions of this ELT. Yellow birch, black gum, swamp white oak, elm, shagbark hickory, beech and hemlock are sometimes common; the latter three are generally found where surface conditions are rocky. Beneath the forest canopy hornbeam, witch hazel and juneberry are often present. In wetter areas this understory layer is typically absent or composed of alder and red maple saplings only. Common shrubs include a mixture of spicebush, elderberry, nannyberry, arrowwood, multiflora rose, and Japanese barberry. The forest floor is variably covered with a number of woody and herbaceous plants including jack-in-the pulpit, tussock sedge, skunk cabbage, jewelweed, marsh blue violet, northern white violet, cinnamon fern, false hellebore, common horsetail, and Japanese wire-grass. Virginia creeper, rue anemone, mayapple, enchanter's nightshade, garlic mustard, poison ivy, black cohosh, Solomon's seal, New York fern and Christmas fern are common on the somewhat drier microsites.

In the wettest areas, trees are more sparse, and there is generally an open canopy of "flood-stunted" red maple and white ash trees. Some of these areas were flooded by beavers and contain standing dead trees of many of the above-mentioned species. Hydrophilic shrubs and small trees are generally abundant in the open areas between the trees including smooth alder, buttonbush, silky dogwood, arrowwood viburnum, elderberry, steeplebush and pussy willow. Blue flag, cattail, wild calla, purple loosestrife, swamp loosestrife, tussock sedge, sensitive fern, marsh fern and many other freshwater marsh plants are abundant in these open wet areas.

VERY POORLY DRAINED SANDSTONE-SLATE TERRACES
ELT:221Bd2-13

This ELT occurs in the landscape on the lower slopes of the Walpack Ridge or in depressions, where glacial outwash, dominated by sandstone and slate fragments, have accumulated (for a description of this map-unit refer to ELT:221Bd3-13).

POORLY DRAINED LIMESTONE TILL SLOPES
ELT:221Bd2-21

This ELT occurs in gently to moderately sloping areas in low-lying parts of the landscape, including broad upland swales, the bases of slopes, above the courses of minor streams, and around water bodies. Soil texture is silty loam which contributes to the high water table along with the low position in the landscape. In some places soils are very stony containing mostly fragments of limestone, with lesser amounts of sandstone and shale. The water table in this ELT is generally within a few feet of the surface except in the case of extreme drought. Standing water is sometimes present.

Phytotrophic characteristics of this ELT are an abundance of soil water and very high fertility. Rooting conditions are somewhat poor in many portions of this landtype because of the poor drainage and associated anoxic conditions. Site fertility is considered to be very high for most forest plants because of the natural high abundance of calcium and magnesium, although nutrient uptake may be limited for many terrestrial plants due to saturated soil conditions. While these "swampy" slopes tend to favor hydrophilic plants, a number of typically non-hydrophilic are present on better drained microsites created by coarse, rocky soil conditions or fairly rapid surface runoff.

Forested Plant Communities

Common trees include red maple, white ash, sugar maple and northern red oak; the former two dominate the wettest areas while the latter two are more common on the better-drained microsites. Black walnut, yellow birch, black gum, white oak, swamp white oak, beech, elm, hackberry, and shagbark hickory are sometimes common. Beneath the forest canopy hornbeam, witch hazel, and black haw viburnum are often present. Common shrubs include a mixture of spicebush, multiflora rose, and Japanese barberry. The forest floor is covered with a wide diversity of woody and herbaceous plants including jack-in-the pulpit, tussock sedge, skunk cabbage, garlic mustard, rue anemone, horse balm, poison ivy, jewelweed, may apple, Virginia creeper, enchanter's nightshade, garlic mustard, blue cohosh, black cohosh, Solomon's seal, false hellebore, doll's eyes, wild geranium, sweet scented bedstraw, Japanese wiregrass, showy orchis, Christmas fern, and New York fern.

In the wettest areas, trees are more sparse, and there is generally an open canopy of "flood-stunted" red maple and white ash. Some of these areas were flooded by beavers and contain standing dead trees of many of the above-mentioned species. Hydrophilic shrubs and small trees are generally abundant in the open areas between the trees including smooth alder, buttonbush, silky dogwood, arrowwood viburnum, elderberry, steeplebush and pussy willows. Blue flag, Cattails, wild calla, broad-leaved cattail, purple loosestrife, swamp loosestrife, tussock sedge, sensitive fern, marsh fern and many other freshwater marsh plants are abundant in these open wet areas.

POORLY DRAINED SANDSTONE-SLATE TERRACES
ELT:221Bd2-23

This ELT comprises only a small portion of the Walpack Ridge (LTA), occurring on the bottoms of narrow ravines and along gently sloping portions of glacial outwash terraces, where sandstone, conglomerate and slate rock fragments are dominant. These inclusions mainly occur where this LTA borders with the the Flatbrook Valley (for a description of this map-unit refer to ELT:221Bd3-23).

SOMEWHAT POORLY DRAINED SHALE TILL FLATS
ELT:221Bd2-33

This ELT comprises only a tiny portion of the Walpack Ridge LTA, occurring on upland flats and depressions, where shale till is dominant (for a description of this map-unit refer to ELT:221Ba1-33).

MODERATELY WELL DRAINED LIMESTONE TILL FLATS
ELT:221Bd2-41

This ELT occurs in the landscape as broad upland flats and gently slopes, where limestone fragments dominates glacial drift materials. Soil texture is loamy, and the slightly impeded drainage is caused by compacted materials in the subsoil and a generally flat topography. The water table is seasonally high rising to within a few feet of the surface in winter and early spring, but subsides early in the growing season. Vernal pools are common in concave depressions.

Phytotrophic characteristics of this ELT are seasonally high water table, slightly impeded drainage and very high fertility. Rooting conditions may be slightly limited in some areas due to subsurface drainage problems. Rooting depth may be somewhat limited by compacted till in the subsoil . Site fertility is considered to be very high for forest plants due to loamy soil conditions and mineral nutrient enrichment from limestone fragments. A number of hydrophilic plants are common in the understory which are indicators of excess water in the subsoil. These plants are commonly concentrated in depressions which support vernal pools.

Forested Plant Communities

White ash, sugar maple, red maple, black birch, yellow birch, white oak, shagbark hickory and black cherry are common trees in forested portions of this ELT. Pignut hickory, black walnut, basswood, tuliptree, beech, black oak, hemlock and swamp white oak are sometimes common. Swamp white oak is typically limited to depressions which support vernal pools. Black cherry, sassafras and quaking aspen are abundant in young woodlands. Beneath the forest canopy hornbeam, flowering dogwood, blackhaw, and hophornbeam are often present. The understory has a diverse mixture of shrubs including spicebush, multiflora rose, Japanese barberry, elderberry, and arrowwood viburnum. The forest floor is generally densely covered with a wide diversity of woody and herbaceous plants including poison ivy, Virginia creeper, fox grape, blue-stemmed goldenrod, Japanese honeysuckle, garlic mustard, jack-in-the pulpit, wild geranium, rue anemone, sweet-scented bedstraw, lance-leaved bedstraw, wild licorice, white wood aster, wild ginger, enchanter's nightshade, bloodroot, showy orchis, mayapple, round-lobed hepatics, Solomon's seal, false Solomon's seal, aniseroot, sweet cicely, honewort, blue cohosh, common speedwell, Christmas fern, New York fern, maidenhair fern, intermediate wood fern, and a number of violets (Viola spp.). Skunk cabbage, jewelweed, tussock sedge, false

hellebore, jack-in-the-pulpit, and smartweeds (Polygonum spp.) are common in vernal pools. Japanese wire-grass (Microstegium vimineum) is locally abundant in some areas.

MODERATELY WELL DRAINED SANDSTONE-SLATE TERRACES
ELT:221Bd2-43

This ELT occurs in the landscape as narrow drainways and on lower slopes of the Walpack Ridge, where glacial outwash is dominated by sandstone and slate rock (for a description of this map-unit refer to ELT:221Bd3-43).

WELL DRAINED LIMESTONE TILL SLOPES
ELT:221Bd2-51

This ELT occurs in the landscape on gentle to somewhat steeply sloping uplands, where till is deep. Soils are generally deep and fine-loamy in texture. In some places soils are very stony containing mostly fragments of limestone, with lesser amounts of sandstone and shale.

Phytotrophic characteristics of this ELT are deep well-drained soils and a very high fertility. These well-drained sites have good surface water drainage and fine loamy textures which denote somewhat of an optimum condition of drainage and aeration for plant roots. Rooting conditions may be somewhat limited on the steeper slopes, however. Site fertility is considered to be very high for most forest plants because of the deep, loamy textured soil and the high availability of micronutrients such as calcium and magnesium cations.

Forested Plant Communities

Common trees include sugar maple, white ash, black birch, northern red oak, white oak, black oak, and black cherry, although sugar maple is by far the most abundant. Other trees, including beech, tuliptree, red maple, shagbark hickory, black walnut, yellow birch and hemlock are common in some places. Eastern red cedar is abundant in young woodlands and on abandoned farmland. Beneath the forest canopy hornbeam, hophornbeam, dogwood, sassafras and saplings of sugar maple are often present. A variety of shrubs are

Figure 24. Young sugar maple forest growing on a well drained, deep limestone till slope.

common in the forest understory including Japanese barberry, spicebush, and maple-leaf viburnum. Allegheny blackberry, black raspberry, Amur honeysuckle, and Russian olive are common in open thickets. The forest floor is variably covered with a diverse mixture of low woody and herbaceous plants including Virginia creeper, garlic mustard, jack-in-the-pulpit, poison ivy, blue-stemmed goldenrod, enchanter's nightshade, white wood aster, bloodroot, marginal woodfern, white snakeroot, wild ginger, wild basil, showy orchis, Japanese wiregrass, Solomon's seal, blue cohosh, partridgeberry, mayapple, aniseroot, round-lobed hepatica, perfoliate bellwort, hay-scented fern, New York fern, Christmas fern, rattlesnake fern, and a number of bedstraws (Galium spp.).

WELL DRAINED SANDSTONE-SLATE TERRACES
ELT:221Bd2-53

This ELT occurs in the landscape on the lower slopes of the Walpack Ridge where glacial outwash is dominated by sandstone and slate rock fragments (for a description of this map-unit refer to ELT:221Bd3-53).

WELL DRAINED SHALLOW ROCKY SHALE TILL SLOPES
ELT:221Bd2-54

This ELT occurs in the landscape on the slopes and ridgetops of the Walpack Ridge, where shallow shale till or outcroppings of shale bedrock are present (for a description of this map-unit refer to ELT:221Ba1-54).

EXCESSIVELY DRAINED STEEP ROCKY LIMESTONE TILL SLOPES
ELT:221Bd2-61

This ELT occurs in the landscape on steeply sloping uplands where soils are generally thin and limestone outcroppings are common. Pockets of deeper soil occur in crevices and depressions. Soil texture is generally coarse loamy and stony, composed of limestone and till derived from local limestone.

Phytotrophic characteristics of this ELT are thin soils, steep slopes, and a considerable amount of exposed rocky surfaces. Surface water drainage is generally rapid although well drained areas are present in areas where the soil is somewhat deeper. Rooting depth is somewhat limited because of thin soil, but many plants are able to wind their roots into cracks and crevices to establish a foothold. Site fertility is considered to be very high for most forest plants, but nutrient uptake may be somewhat limited by dry rocky conditions. The often bare, stony surface decreases the area available for the germination of tree seedlings, but seems to benefit grasses, herbs and low-lying shrubs, which can take advantage of rocky microsites. Stand density is often limited by outcroppings of limestone bedrock.

Forested Plant Communities

Sugar maple, northern red oak, eastern hemlock, white ash, pignut hickory, white oak, black oak, beech, and black cherry are all common trees in forested portions of this ELT. Hemlock is sometimes abundant on shady lower slopes or in the forest understory. Chestnut oak is sometimes locally common on dry, upper slopes. Tuliptree and basswood are occasionally present in pockets where soils are deeper. Eastern red cedar and black cherry are abundant in young woodlands and on rock outcrops. Beneath the forest canopy, hophornbeam

and hornbeam are often present. Common shrubs include witch hazel, blackhaw, viburnum, maple-leaf viburnum, Japanese barberry, Amur honeysuckle, wineberry and other brambles (Rubus spp.). The forest floor is variably covered with a diversity of low woody and herbaceous plants including wild ginger, wild sarsaparilla, garlic mustard, early meadow rue, bottlebrush grass, Virginia creeper, wood aster, blue cohosh, white snakeroot, jack-in-the-pulpit, doll's eyes, naked tick trefoil, wild basil, false Solomon's seal, Solomon's seal, perfoliate bellwort and round-lobed hepatica. A notable diversity of ferns are also common in this ELT including, Christmas fern, maidenhair fern, rattlesnake fern, intermediate woodfern, marginal woodfern, New York fern, walking fern and a number of spleenworts (Asplenium spp.). Walking fern is only found on limestone rock outcroppings.

SEASONALLY FLOODED LOAMY ALLUVIAL PLAINS
ELT:221Bd2-82

This ELT comprises only a tiny portion of the Walpack Ridge LTA, mainly along where it abuts the Flatbrook River Valley (for a description of this map-unit refer to ELT:221Bd3-82).

Figure 25. Christmas fern growing on the forest floor on a rocky, limestone slope.

Upper Delaware - Flatbrook Valley

LTA:221Bd3

This LTA includes the glacio-fluvial terraces and stratified drift formations found on the eastern bank of the Delaware River and in the Flatbrook Valley. Local topography is generally somewhat flat to rolling, with somewhat steep embankments on the stream terraces. Local elevations range from about 300 to 550 feet above sea level. The surface is mostly covered with a deep, continuous mantle of glacial sediments carried into the valleys by water and ice. The Flatbrook Valley is located between the Walpack Ridge and the Kittatinny Mountain, running southwest, where it intersects the upper Delaware River near Flatbrookville. The Upper Delaware Valley comprises the eastern bank of the Delaware River in Warren and Sussex counties. Large portions of the LTA are within the Delaware Water Gap National Recreation Area.

Soils associated with this LTA are quite variable, having formed in a variety of different glacial drift materials and alluvial deposits. The Flatbrook Valley is narrow containing deep deposits of gravelly drift. The majority of drift materials are composed of sandstone, shale and conglomerate, giving rise to soils such as Chenango or Braceville series, but contain considerable limestone fragments in many places (Hazen, Hero series). Soils in the upper Delaware Valley mainly formed in eskers and kame terraces along it's banks (Colonie, Otisville and Unadilla Series). Fine-textured alluvial deposits are common along the banks of the Flatbrook, where Middlebury, Sloan and Wayland soils prevail. Pope series are present on moderately coarse textured alluvial soils along the banks of the Delaware River.

Large areas (68%) of this LTA are covered by natural plant communities (i.e., forests, shrublands, marshes, etc..), many of which are successional woodlands colonizing fallow farmland. Areas of mature forest are less common. The major influence on plant communities in this LTA is the long history of agriculture in the valley, and agriculture is still a substantial land use (16.6% of total land use). Much of the area remains rural (6.7% urban land use). Many species associated with abandoned farmland and forest succession in northern New Jersey are abundant in these forests and woodlands, including catalpa, eastern red cedar, bigtooth aspen, quaking aspen, black walnut, crabapple, black locust, oriental bittersweet, Amur honeysuckle, Tatarian honeysuckle, multiflora rose, Japanese wire-grass, Japanese barberry, Japanese honeysuckle, and many species of goldenrod. Valley forests are quite diverse composed of a wide variety of trees including sugar maple, white ash, black birch, tuliptree, elm, red maple, northern red oak, black cherry, white oak, black oak, black walnut, white pine, bitternut hickory, shagbark hickory and pignut hickory. Sugar maple is by far the most common tree in the mature forests. Bitternut hickory is very common on stream terraces and aspens are quite common in young woodlands. Sycamore, river birch, basswood, elm, black willow and black walnut are common on the floodplains. Silver maple is sometimes common in floodplain forests, particularly along the Delaware. Hemlock, tuliptree, and yellow birch are abundant in the narrow Flatbrook Valley, but less common along the Delaware.

Table 14. ELTs of the Upper Delaware-Flatbrook Valley LTA

ELT#	Name	Area(acres)
221Bd3-00	Water Bodies	536.79
221Bd3-12	Very Poorly Drained Carbonate-bearing Sandstone[1] Terraces	9.29
221Bd3-13	Very Poorly Drained Sandstone-Slate[2] Terraces	2,633.79
221Bd3-16	Very Poorly Drained Flat Peatlands	260.42
221Bd3-22	Poorly Drained Carbonate-bearing Sandstone[1] Terraces	39.42
221Bd3-23	Poorly Drained Sandstone-Slate[2] Terraces	614.54
221Bd3-33	Somewhat Poorly Drained Sandstone-Conglomerate[3] Till Flats	11.70
221Bd3-42	Moderately Well Drained Carbonate-bearing Sandstone[1] Terraces	134.63
221Bd3-43	Moderately Well Drained Sandstone-Slate[2] Terraces	1,468.52
221Bd3-51	Well Drained Limestone[4] Till Slopes	169.01
221Bd3-52	Well Drained Carbonate-bearing Sandstone[1] Terraces	295.09
221Bd3-53	Well Drained Sandstone-Slate[2] Terraces	11,714.24
221Bd3-54	Well Drained Sandy[5] Terraces	769.06
221Bd3-61	Excessively Drained Steep Rocky Limestone[4] Till Slopes	39.77
221Bd3-82	Seasonally Flooded Loamy Alluvial Plains	2,685.02
221Bd3-99	Altered Lands	10.39
221Bd3	Upper Delaware-Flatbrook Valley Land Type Association	21,391.68

[1]Glacial outwash and drift materials dominated by sandstone and shale rock fragments, but are enriched with lesser amounts of carbonate-bearing rock-fragments;
[2]Glacial outwash and drift materials predominantly composed of sandstone, slate and siltstone;
[3]Till and bedrock materials dominated by sandstone and conglomerate rock fragments;
[4]Till and bedrock predominantly composed of limestone till fragments but includes lesser amounts of sandstone, shale and granite;
*Glacial outwash and drift materials composed of sand-sized particles of sandstone and quartz.

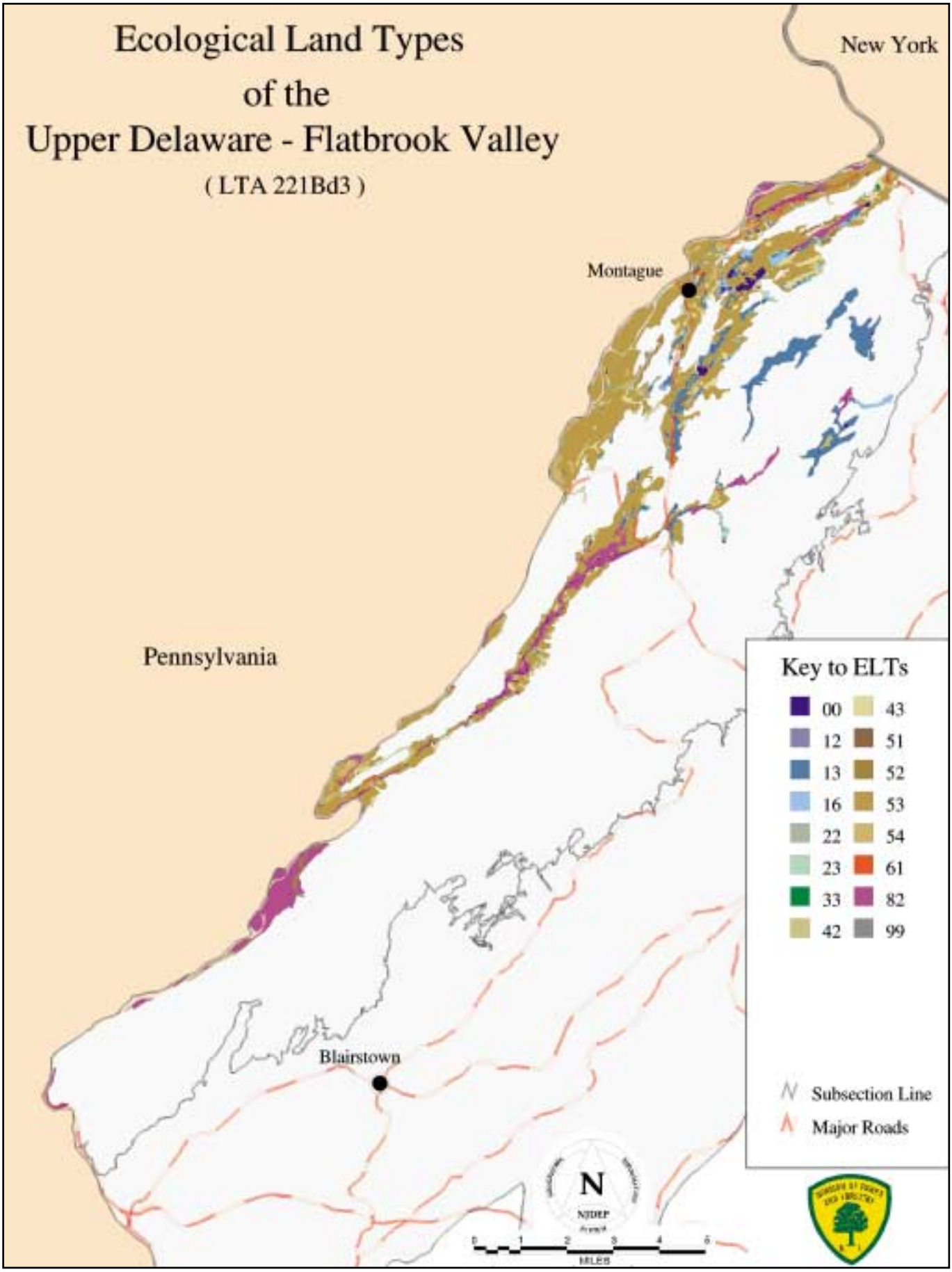


Figure 26. ELTs of the Upper Delaware - Flatbrook Valley

Table 15. Land Use[1] for ELTs of the Upper Delaware-Flatbrook Valley LTA

ELT#	Area(acres)	%Forested	%Agriculture	%Urban[2]	%Other[3]
221Bd3-12	9.29	20.7	0.0	0.0	79.3
221Bd3-13	2,633.79	60.4	3.5	1.7	34.4
221Bd3-16	260.42	49.6	1.1	0.9	48.4
221Bd3-22	39.42	41.4	34.4	17.9	6.3
221Bd3-23	614.54	64.2	8.1	5.9	21.8
221Bd3-33	11.70	47.9	0.0	0.0	52.1
221Bd3-42	134.63	26.9	32.9	5.3	34.9
221Bd3-43	1,468.52	53.3	20.2	8.4	18.1
221Bd3-51	169.01	63.5	7.7	3.5	25.3
221Bd3-52	295.09	43.4	20.5	3.3	32.8
221Bd3-53	11,714.24	49.0	22.4	9.7	18.9
221Bd3-54	769.06	51.1	20.5	8.0	20.4
221Bd3-61	39.77	84.8	2.3	0.4	12.5
221Bd3-82	2,685.02	49.6	15.3	3.0	32.1

[1]based on 1991 reports;
[2]includes residential,commercial, industrial, athletic fields, etc.;
[3]includes water bodies, herbaceous wetlands and non-forested, and undeveloped uplands, not devoted to agriculture (i.e., shrubland, brushland, barren land).

VERY POORLY DRAINED CARBONATE-BEARING SANDSTONE TERRACES
ELT:221Bd3-12

This ELT comprises a tiny portion of the Upper Delaware-Flatbrook Valley LTA, occurring at the bottoms of narrow ravines and on flat portions of glacial outwash terraces, where sandstone and shale glacial outwash materials are enriched with carbonate materials (for a description of this map-unit refer to ELT:221Ba2-12).

VERY POORLY DRAINED SANDSTONE-SLATE TERRACES
ELT:221Bd3-13

This ELT occurs in flat, low-lying portions of old glacial outwash terraces, where glacial drift materials are dominated by rock fragments of sandstone, shale and slate. Soil texture is generally loamy to silt loam, but is gravelly or sandy in some places. Poor drainage is generally due to a low position in the landscape, typically just above the floodplains along large streams. The water table is generally at or near the surface throughout the year. Pools of standing water are common in many places, particularly in the early spring or after heavy rains.

Phytotrophic characteristics of this ELT are saturated soils and moderately high fertility. Rooting conditions are poor in many portions of this land type because of the anoxic conditions associated with saturated soils. Site fertility is considered to be moderately high for forest plants due to the loamy, strongly acid soil conditions. Site conditions generally support hydrophilic plant communities although sandy or gravelly microsites provide better drained microsites for some typically non-hydrophilic plants. Windthrow hazard is high for trees and common because of soft muddy soil conditions. Large portions of this land type are wet for long periods and nearly a third (29.5%) of this land type is covered by herbaceous and shrub-dominated wetlands.

Forested Plant Communities

Common trees include red maple, white ash, swamp white oak, black gum, elm, and yellow birch. Other trees including tuliptree, sugar maple, white oak, northern red oak, hemlock, and basswood are sometimes common, particularly on the better-drained microsites. Hornbeam, juneberry and witch hazel are often present beneath the forest canopy. The shrub layer is generally a dense and diverse mixture of spicebush, highbush blueberry, arrowwood viburnum, multiflora rose, greenbrier, and Japanese barberry. The forest floor is variably covered with a number of woody and herbaceous plants including poison ivy, Virginia creeper, jack-in-the pulpit, Japanese wire-grass, skunk cabbage, garlic mustard, partridgeberry, jewelweed, false hellebore, tussock sedge, halbard-leaved tearthumb, arrow-leaved tearthumb, sweet-scented bedstraw, marsh blue violet, golden ragwort, wood nettle, rattlesnake fern, royal fern, New York fern, and cinnamon fern.

In open wet areas and along streambanks a number of hydrophilic shrubs and small trees including silky dogwood, smooth alder, steeple bush, elderberry, and a number of willows (Salix spp.) may be present. Silver maple, river birch, and sycamore are common along stream banks. Blue flag, water horehound, purple loosestrife, swamp loosestrife, swamp milkweed, tussock sedge, Joe-pye-weed, turtlehead, marsh fern, sensitive fern and many other freshwater marsh plants are also common in these open wet areas. Many of these communities form in areas flooded by beavers or people.

VERY POORLY DRAINED FLAT PEATLANDS
ELT:221Bd3-16

This ELT comprises only a small portion of the Upper Delaware-Flatbrook Valley, occurring on former lake beds or upland depressions which are permanently flooded and have accumulated extensive peat deposits (for a description of this map-unit refer to ELT:221Ba2-16).

POORLY DRAINED CARBONATE-BEARING SANDSTONE TERRACES
ELT:221Bd3-22

This ELT comprises only a small portion of the Upper Delaware-Flatbrook Valley, occurring on the bottoms of narrow ravines and along gently sloping portions of glacial outwash terraces, where sandstone and shale outwash materials are enriched with carbonate-bearing materials (for a description of this map-unit refer to ELT:221Ba2-22).

POORLY DRAINED SANDSTONE-SLATE TERRACES
ELT:221Bd3-23

This ELT occurs in the landscape as gently sloping lowland terraces where glacial outwash materials are dominated by sandstone, shale and slate. Soil texture is generally loamy to silt loam, but is gravelly or sandy in some places. Poor drainage is generally due to a low position in the landscape. The water table is generally very high and within a few feet of the surface throughout most of the year.

Phytotrophic characteristics of this ELT are saturated soils throughout most of the growing season and moderately high fertility. Rooting conditions are somewhat poor in many portions of this land type because of the poor drainage and associated anoxic conditions. Site fertility is considered to be moderately high for forest plants due to the loamy, strongly acid soil conditions. Wet, muddy site conditions generally support hydrophilic plants, but non-hydrophilic plants are also somewhat common, mainly in areas where sandy of gravelly microsites are present or on the upper parts of gentle slopes. Windthrow is common in the soft, muddy soil.

Forested Plant Communities

Common trees include red maple, white ash, beech, hemlock, yellow birch, black birch, shagbark hickory, and black gum. Other trees including tuliptree, white oak, northern red oak, sugar maple, basswood, bitternut hickory and elm are sometimes common. Beneath the forest canopy hornbeam, black haw viburnum, and witch hazel are often present. Common shrubs include a diverse mixture of spicebush, highbush blueberry, multiflora rose, greenbrier, and Japanese barberry. The forest floor is variably covered with a number of woody and herbaceous plants including fox grape, poison ivy, Virginia creeper, jack-in-the pulpit, Japanese wire-grass, skunk cabbage, garlic mustard, partridgeberry, jewelweed, enchanter's nightshade, wild licorice, heart-leaved aster, sweet-scented bedstraw, rough avens, common violet, rattlesnake fern, New York fern, royal fern, and cinnamon fern.

In open wet areas and along streambanks a number of hydrophilic shrubs and small trees including silky dogwood, smooth alder, steeple bush, elderberry, and a number of willows (Salix spp.) may be present. Silver maple, river birch, and sycamore are common along stream banks. Blue flag, water horehound, purple loosestrife, swamp loosestrife, swamp milkweed, tussock sedge, Joe-pye-weed, turtlehead, marsh fern, sensitive fern and many other

freshwater marsh plants are also common in these open wet areas. Many of these communities form in areas flooded by beavers or people.

SOMEWHAT POORLY DRAINED SANDSTONE-CONGLOMERATE TILL FLATS
ELT:221Bd3-33

This ELT comprises only a tiny portion of the Upper Delaware-Flatbrook Valley, occurring on upland flats and depressions, where sandstone and conglomerate till is dominant. These inclusions occur where this LTA abuts the Kittatinny Mountain LTA (for a description of this map-unit refer to ELT:221Ba1-33).

MODERATELY WELL DRAINED CARBONATE-BEARING SANDSTONE TERRACES
ELT:221Bd3-42

This ELT occurs in the landscape as broad flats and gently sloping stream terraces in the Flatbrook and Delaware valleys, where limestone bedrock is a major component of glacial drift materials (for a description of this map-unit refer to ELT:221Ba2-42).

MODERATELY WELL DRAINED SANDSTONE-SLATE TERRACES
ELT:221Bd3-43

This ELT occurs in the landscape as broad upland flats and gently sloping stream terraces in the Flatbrook and Delaware valleys. Soil texture is coarse loamy with considerable amounts of sand and gravel derived from local sandstone and slate. Slightly impeded drainage is caused by a compacted subsurface layer of till fragments. The water table is seasonally high rising to within a few feet of the surface in winter and early spring, but subsides later in the growing season. Intermittent streams are common in these narrow landscape units. Vernal pools are somewhat common.

Phytotrophic characteristics of this ELT include a seasonally high water table, slightly impeded drainage and a compacted subsoil layer. Rooting conditions may be slightly limited in some areas due to subsurface drainage problems and rooting depth is impeded by the compacted subsoil. Site fertility is considered to be moderate for forest plants due to deep, loamy soil conditions. A number of hydrophilic shrubs are common in the understory which are indicators of excess water in the subsoil. These plants are commonly concentrated in depressions which support vernal pools. Included in this land type are land type phases which have been substantially altered by the ditching for agriculture.

Forested Plant Communities

Sugar maple, white ash, northern red oak, white oak, and red maple are all common throughout forested portions of this ELT. Tuliptree, black walnut, shagbark hickory, and basswood are sometimes present or locally abundant. Hornbeam, witch hazel, dogwood and juneberry are often present beneath the forest canopy. Common shrubs include a mixture of spicebush, multiflora rose, and Japanese barberry. Amur honeysuckle is abundant in some places. The forest floor is densely covered with a number of woody and herbaceous plants including poison ivy, Virginia creeper, fox grape, garlic mustard, jack-in-the pulpit, bloodroot, wild geranium, mayapple, doll's eyes, aniseroot, Japanese honeysuckle, Japanese wiregrass, white wood aster, partridgeberry, enchanter's nightshade, cleaver, wild licorice, Solomon's seal, false Solomon's seal, Christmas fern, rough avens and New York fern. Jewelweed, swamp blackberry, skunk cabbage, and tussock sedge are scattered throughout, and common in vernal pools.

WELL DRAINED LIMESTONE TILL SLOPES
ELT:221Bd3-51

This ELT comprises only a small portion of the Upper Delaware-Flatbrook Valley, occurring on lower slopes where small areas of limestone till are present (for a description of this map-unit refer to ELT:221Bd2-51).

WELL DRAINED CARBONATE-BEARING SANDSTONE TERRACES
ELT:221Bd3-52

This ELT comprises only a small portion of the Upper Delaware-Flatbrook Valley, occurring on glacial outwash terraces, where sandstone and shale rock fragments dominate, but are enriched with carbonate-bearing rock (for a description of this map-unit refer to ELT:221Ba2-52).

WELL DRAINED SANDSTONE-SLATE TERRACES
ELT:221Bd3-53

This ELT occurs in the landscape as hills and slopes of kame terraces, eskers and glacial outwash plains in the Flatbrook and Delaware valleys. Topography is rolling ranging from gently sloping to steep. Soil texture is coarse loamy derived from glacial outwash materials dominated by sandstone, slate and shale rock fragments.

Phytotrophic characteristics of this ELT are deep, well drained soils and a moderate natural fertility. Rooting conditions are excellent, do to the well drained nature of the soils. Site fertility is considered to be moderate for forest plants due to loamy soil conditions strongly acid conditions and good soil drainage.

Forested Plant Communities

Sugar maple, black birch, black oak, white oak, northern red oak, red maple, bitternut hickory, black cherry, white ash and beech are all common in forested portions of

Figure 27. Young oak-birch stand on a well drained, sandstone-slate terrace.

this ELT. Tuliptree, elm, and white pine are sometimes common. Silver maple is sometimes common along the steep embankments of the Delaware River. Hornbeam, dogwood, sassafras and blackhaw viburnum are often present beneath the forest canopy. Common shrubs include a mixture of multiflora rose, Japanese barberry, Amur honeysuckle, maple-leaf viburnum, and gray dogwood. The forest floor is densely covered with a number of woody and herbaceous plants including lowbush blueberry, garlic mustard, poison ivy, Virginia creeper, white wood aster, white snakeroot, striped wintergreen, partridgeberry, common speedwell, marginal wood fern, Canada mayflower, wild bergamot, mayapple, doll's eyes, sweet cicely, Solomon's seal, false Solomon's seal, and Christmas fern. Haircap moss and white cushion moss are common on exposed portions of shady banks.

WELL DRAINED SANDY TERRACES
ELT:221Bd3-54

This ELT occurs in the landscape on glacial terraces, where drift and outwash are dominated by sand-size particles. The topography of these sites has a rolling character, with slopes ranging from gently sloping to steep. Soil texture is coarse loamy derived from stratified sands deposited by glacial meltwater.

Phytotrophic characteristics of this ELT are deep, well drained soils and a low natural fertility. Rooting conditions are excellent, do to the well drained nature of the soils. Site fertility is considered to be low for forest plants due to coarse textured, and strongly acid soil conditions.

Forested Plant Communities

Common trees include northern red oak, black oak, white oak, white ash, red maple, mockernut hickory, pignut hickory, and bitternut hickory. Sugar maple, white pine, black birch, black cherry, scarlet oak and hemlock are also somewhat common. Dogwood and sassafras are often present beneath the forest canopy. Common shrubs include maple-leaf viburnum, black huckleberry, gray dogwood, multiflora rose, Amur honeysuckle, and Japanese barberry. The forest floor is densely covered with a number of woody and herbaceous plants including lowbush blueberry, Virginia creeper, Japanese honeysuckle, poison ivy, partridgeberry, garlic mustard, white wood aster, striped wintergreen, common speedwell, Canada mayflower, Pennsylvania sedge, mayapple, Solomon's seal, false Solomon's seal, hay-scented fern, marginal wood fern. Haircap moss and white cushion moss are common on embankments or areas where leaf-litter is absent.

EXCESSIVELY DRAINED STEEP ROCKY LIMESTONE TILL SLOPES
ELT:221Bd3-61

This ELT comprises only a tiny portion of the Upper Delaware-Flatbrook Valley, where small escarpments of limestone bedrock are present (for a description of this map-unit refer to ELT:221Bd2-61).

SEASONALLY FLOODED LOAMY ALLUVIAL PLAINS
ELT:221Bd3-82

This ELT occurs in the landscape along the floodplains of the Upper Delaware and Flatbrook rivers (for a description of this map-unit refer to ELT:221Ba2-82).

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APPENDIX:

SCIENTIFIC NAMES OF COMMON PLANT SPECIES

TREE

Common Name	*Genus*	*Species*
American basswood	*Tilia*	*americana*
American beech	*Fagus*	*grandifolia*
American chestnut	*Castanea*	*dentata*
American elm	*Ulmus*	*americana*
American larch	*Larix*	*larcina*
Atlantic white-cedar	*Chamaecyparis*	*thyoides*
Bigtooth aspen	*Populus*	*grandidentata*
Bitternut hickory	*Carya*	*cordiformis*
Black birch	*Betula*	*lenta*
Black cherry	*Prunus*	*serotina*
Black locust	*Robinia*	*pseudoacacia*
Black oak	*Quercus*	*velutina*
Black spruce	*Picea*	*mariana*
Black walnut	*Juglans*	*nigra*
Black willow	*Salix*	*nigra*
Blackgum	*Nyssa*	*sylvatica*
Butternut	*Juglans*	*cinerea*
Chestnut oak	*Quercus*	*prinus*
Eastern hemlock	*Tsuga*	*canadensis*
Eastern hophornbeam	*Ostrya*	*virginiana*
Eastern red cedar	*Juniperus*	*virginiana*
Fire cherry	*Prunus*	*pensylvanica*
Flowering dogwood	*Cornus*	*florida*
Gray birch	*Betula*	*populifolia*
Hackberry	*Celtis*	*occidentalis*
Hawthorn	*Crataegus*	*spp.*
Ironwood	*Carpinus*	*caroliniana*
Juneberry/Shadbush	*Amelanchier*	*spp.*
Mockernut hickory	*Carya*	*tomentosa*
Mulberry	*Morus*	*spp.*
Northern catalpa	*Catalpa*	*speciosa*
Northern red oak	*Quercus*	*rubra*
Paper birch	*Betula*	*papyrifera*
Pignut hickory	*Carya*	*glabra*
Pin oak	*Quercus*	*palustris*
Pitch pine	*Pinus*	*rigida*
Quaking aspen	*Populus*	*tremuloides*

APPENDIX: *Scientific Names of Common Plant Species*, CONT.

TREE, CONT.

Common Name	Genus	Species
Red maple	*Acer*	*rubrum*
River birch	*Betula*	*nigra*
Sassafras	*Sassafras*	*albidum*
Scarlet oak	*Quercus*	*coccinea*
Scrub oak	*Quercus*	*ilicifolia*
Shagbark hickory	*Carya*	*ovata*
Silver maple	*Acer*	*saccharinum*
Striped maple	*Acer*	*pensylvanicum*
Sugar maple	*Acer*	*saccharum*
Swamp white oak	*Quercus*	*bicolor*
Sycamore	*Platanus*	*occidentalis*
Tree of Heaven	*Ailanthus*	*altissima*
Tuliptree	*Liriodendron*	*tulipifera*
White ash	*Fraxinus*	*americana*
White oak	*Quercus*	*alba*
White pine	*Pinus*	*strobus*
Willow	*Salix*	*spp.*
Yellow birch	*Betula*	*allegheniensis*
Yellow buckeye	*Aesculus*	*octandra*

SHRUB

Allegheny blackberry	*Rubus*	*allegheniensis*
American blatternut	*Staphylea*	*trifolia*
Amur honeysuckle	*Lonicera*	*maackii*
Arrowwood	*Viburnum*	*dentatum*
Autumn olive	*Elaeagnus*	*umbellata*
Black chokeberry	*Aronia*	*melanocarpa*
Black huckleberry	*Gaylusaccia*	*baccata*
Black raspberry	*Rubus*	*occidentalis*
Blackberry	*Rubus*	*spp.*
Blackhaw viburnum	*Viburnum*	*prunifolium*
Buttonbush	*Cephalanthus*	*occidentalis*
Deerberry	*Vaccinium*	*stamineum*
Dogwood	*Cornus*	*spp.*
Elderberry	*Sambucus*	*candensis*
Gray dogwood	*Cornus*	*racemosa*
Great rhododendron	*Rhododendron*	*maximum*

SHRUB, CONT.

Common Name	*Genus*	*Species*
Highbush blueberry	*Vaccinium*	*corymbosum*
Japanese barberry	*Berberis*	*thunbergii*
Japanese honeysuckle	*Lonicera*	*japonica*
Leatherleaf	*Chamaedaphne*	*calyculata*
Lowbush blueberry	*Vaccinium*	*angustifolium*
Maple-leaved viburnum	*Viburnum*	*acerifolium*
Mountain holly	*Nemopanthus*	*mucronatus*
Mountain laurel	*Kalmia*	*latifolia*
Multiflora rose	*Rosa*	*multiflora*
Nannyberry	*Viburnum*	*lentago*
Northern prickly ash	*Xanthoxylum*	*americanum*
Pinxter Azalea	*Rhododendron*	*periclymenoides*
Pussy willow	*Salix*	*discolor*
Red-osier dogwood	*Cornus*	*stolonifera*
Russian olive	*Elaeagnus*	*angustifolia*
Sheep laurel	*Kalmia*	*augustifolia*
Silky dogwood	*Cornus*	*ammomum*
Smooth alder	*Alnus*	*serrulata*
Speckled alder	*Alnus*	*incana*
Spicebush	*Lindera*	*benzoin*
Swamp azalea	*Rhododendron*	*viscosum*
Swamp blackberry	*Rubus*	*hispidus*
Swamp rose	*Rosa*	*palustris*
Sweet fern	*Comptonia*	*peregrina*
Wineberry	*Rubus*	*phoenicolasius*
Winged sumac	*Rhus*	*copallina*
Winterberry	*Ilex*	*verticillata*
Witch hazel	*Hamamelis*	*virginiana*
Witherod	*Viburnum*	*cassinoides*

VINE

Asiatic bittersweet	*Celastrus*	*orbiculatus*
Common greenbriar	*Smilax*	*rotunifolia*
Fox grape	*Vitis*	*labrusca*
Japanese honeysuckle	*Lonicera*	*japonica*
Poison ivy	*Toxicodendron*	*radicans*
Riverbank grape	*Vitis*	*riparia*
Virginia creeper	*Parthenocissus*	*quinquefolia*
Wild yamroot	*Dioscorea*	*villosa*

HERB

Common Name	*Genus*	*Species*
Aniseroot	*Osmorhiza*	*longistylis*
Arrow arum	*Peltandra*	*virginica*
Arrow-leaved tearthumb	*Polygonum*	*sagittatum*
Bastard toadflax	*Comandra*	*umbellata*
Bedstraw	*Galium*	*spp.*
Bellwort	*Uvularia*	*perfoliaty*
Black snakeroot	*Cimicifuga*	*racemosa*
Bloodroot	*Sanguinaria*	*canadensis*
Blue cohosh	*Caulophyllum*	*thalictroides*
Blue flag	*Iris*	*versicolor*
Blue-stemmed goldenrod	*Solidago*	*caesia*
Bluets	*Houstonia*	*caerulea*
Broad-leaved cattail	*Typha*	*latifolia*
Canada mayflower	*Maianthemum*	*canadense*
Cleavers	*Galium*	*aparine*
Climbing false buckwheat	*Polygonum*	*scandens*
Common blue violet	*Viola*	*sororia*
Common cinquefoil	*Potentilla*	*simplex*
Common polypody	*Polypodium*	*virginianum*
Common speedwell	*Veronica*	*officinalis*
Cow-wheat	*Melampyrum*	*lineare*
Downy rattlesnake plantain	*Goodyeara*	*pubescens*
Dwarf cinquefoil	*Potentilla*	*canadensis*
Early meadow rue	*Thalictrum*	*dioicum*
Eastern joe-pye weed	*Eupatorium*	*dubium*
Ebony spleenwort	*Asplenium*	*platyneuron*
Enchanter's nightshade	*Circaea*	*quadrisulcata*
False hellebore	*Veratrum*	*viride*
False nettle	*Boehmeria*	*cylindrica*
False solomon's-seal	*Smilacina*	*racemosa*
Fringed gentian	*Gentiana*	*crinita*
Garlic mustard	*Alliaria*	*petiolata*
Golden ragwort	*Senecio*	*aureus*
Goldthread	*Coptis*	*trifolia*
Grass of parnassus	*Parnassia*	*glauca*
Great ragweed	*Ambrosia*	*trifida*
Hairgrass	*Deschampsia*	*flexuosa*

HERB, CONT.

Common Name	Genus	Species
Hairy rock cress	*Arabis*	*hirsuta*
Halberd-leaved tearthumb	*Polygonum*	*arifolium*
Heart-leaved aster	*Aster*	*cordifolius*
Hog peanut	*Amphicarpa*	*bracteata*
Honewort	*Cryptotaenia*	*canadensis*
Horse balm	*Collinsia*	*canadensis*
Indian cucumber root	*Medeola*	*virginiana*
Jack-in-the-pulpit	*Ariseama*	*triphyllum*
Japanese wire grass	*Microstegium*	*vimineum*
Jewelweed	*Impatiens*	*capensis*
Jumpseed	*Tovara*	*virginiana*
Knotweeds/Smartweeds	*Polygonum*	*spp.*
Lance-leaved wild licorice	*Galium*	*lanceolatum*
Little bluestem	*Schizachyrium*	*scoparium*
Mad-dog skullcap	*Scutellaria*	*laterifolia*
Marsh bedstraw	*Galium*	*palustre*
Marsh blue violet	*Viola*	*cucullata*
Mayapple	*Podophyllum*	*pelatum*
Meadowsweet	*Spiraea*	*latifolia*
Moccasin flower	*Cypripedium*	*acaule*
Mountain holly	*Nemopanthus*	*mucronata*
Naked-flowered tick trefoil	*Desmodium*	*nudiflorum*
Northern white violet	*Viola*	*pallens*
Ovate leaved ragwort	*Senicio*	*obovatus*
Pale corydalis	*Corydalis*	*sempervirens*
Panicgrass	*Panicum*	*spp.*
Partridgeberry	*Mitchella*	*repens*
Pennsylvania sedge	*Carex*	*pensylvanica*
Perfoliate bellwort	*Uvularia*	*perfoliata*
Poverty oatgrass	*Danthonia*	*spicata*
Prostrate tick trefoil	*Desmodium*	*rotundifolium*
Purple loosestrife	*Lythrum*	*salicaria*
Rattlesnakeweed	*Hieracium*	*venosum*
Reed grass	*Phragmities*	*australis*
Rough avens	*Geum*	*lacinatum*
Rough bedstraw	*Galium*	*asperellum*
Round-lobed hepatica	*Hepatica*	*americana*
Rue anenome	*Anemonella*	*thallictroides*
Showy orchis	*Orchis*	*spectabilis*
Shrubby cinquefoil	*Potentilla*	*fruticosa*

HERB, CONT.

Common Name	*Genus*	*Species*
Skunk cabbage	*Symplocarpus*	*foetidus*
Solomon's-seal	*Polygonatum*	*biflorum*
Spleenwort	*Asplenium*	*spp.*
Spotted knapweed	*Centaurea*	*maculata*
Starflower	*Trientalis*	*borealis*
Steeplebush	*Spiraea*	*tomentosa*
Striped wintergreen	*Chimaphila*	*maculata*
Swamp loosestrife	*Decodon*	*verticillata*
Swamp milkweed	*Asclepias*	*incarnata*
Sweet cicely	*Osmorhiza*	*claytonii*
Sweet goldenrod	*Solidago*	*odorata*
Sweet -scented bedstraw	*Galium*	*triflorum*
Teaberry	*Gaultheria*	*procumbens*
Tufted loosestrife	*Lysimachia*	*thrysiflora*
Turtlehead	*Chelone*	*glabra*
Tussock sedge	*Carex*	*stricta*
Violets	*Viola*	*spp.*
Viper's bugloss	*Echium*	*vulgare*
Water horehound	*Lycopus*	*americanus*
White avens	*Geum*	*canadense*
White baneberry	*Actaea*	*pachypoda*
White lettuce	*Prenanthes*	*alba*
White snakeroot	*Eupatorium*	*rugosum*
White wood aster	*Aster*	*divaricatus*
Whorled loosestrife	*Lysimachia*	*quadrifolia*
Whorled pogonia	*Isotria*	*verticillata*
Wild basil	*Satureja*	*vulgaris*
Wild bergamot	*Monarda*	*fistulosa*
Wild calla	*Calla*	*palustris*
Wild geranium	*Geranuim*	*maculatum*
Wild ginger	*Asarum*	*canadense*
Wild licorice	*Galium*	*circaezans*
Wild sarsaparilla	*Aralia*	*nudicaulis*
Wood anemone	*Anemonella*	*quinquefolia*
Wood nettle	*Laportea*	*canadensis*
Yellow water crowfoot	*Ranunculus*	*flabellaris*

APPENDIX: *Scientific Names of Common Plant Species*, CONT.

FERN

Common Name	*Genus*	*Species*
Boot's wood fern	*Dryopteris*	*boottii*
Bracken fern	*Pteridium*	*aquilinum*
Broad beech fern	*Phegopteris*	*connectilis*
Christmas fern	*Polystichum*	*acrostichoides*
Cinnamon fern	*Osmunda*	*cinnamomea*
Clubmoss spp.	*Lycopodium*	*spp.*
Common polypody	*Polypodium*	*virginianum*
Hay-scented fern	*Dennsteadtia*	*punctiloba*
Intermediate woodfern	*Dryopteris*	*intermedia*
Interrupted fern	*Osmunda*	*claytoniana*
Lady fern	*Athyrium*	*filix-femina*
Male fern	*Dryopteris*	*filix-mas*
Marginal shield-fern	*Dryopteris*	*marginalis*
Marsh fern	*Thelypteris*	*palustris*
Massachussetts fern	*Thelypteris*	*simulata*
New York fern	*Thelypteris*	*noveboracensis*
Northern maiden-hair fern	*Adiantum*	*pedatum*
Rattlesnake fern	*Botrychium*	*virginianum*
Royal fern	*Osmunda*	*regalis*
Sensitive fern	*Onoclea*	*sensibilis*
Spinulose woodfern	*Dryopteris*	*spinulosa*
Tree clubmoss	*Lycopodium*	*obscurum*
Walking fern	*Asplenium*	*rhizophyllum*

MOSS/ LICHEN

Fern moss	*Thuidium*	*delicalutum*
Haircap moss	*Polytrichum*	*commune*
Juniper haircap moss	*Polytrichum*	*juniperum*
Peat moss	*Sphagnum*	*spp.*
Rock lichen	*Xanthoparmelia*	*conspera*
Rock moss	*Dicranum*	*spp.*
Smooth rock tripe	*Umbilicaria*	*mammulata*
Sphagnum moss	*Sphagnum*	*spp.*
White cushion moss	*Leucobryum*	*glaucum*