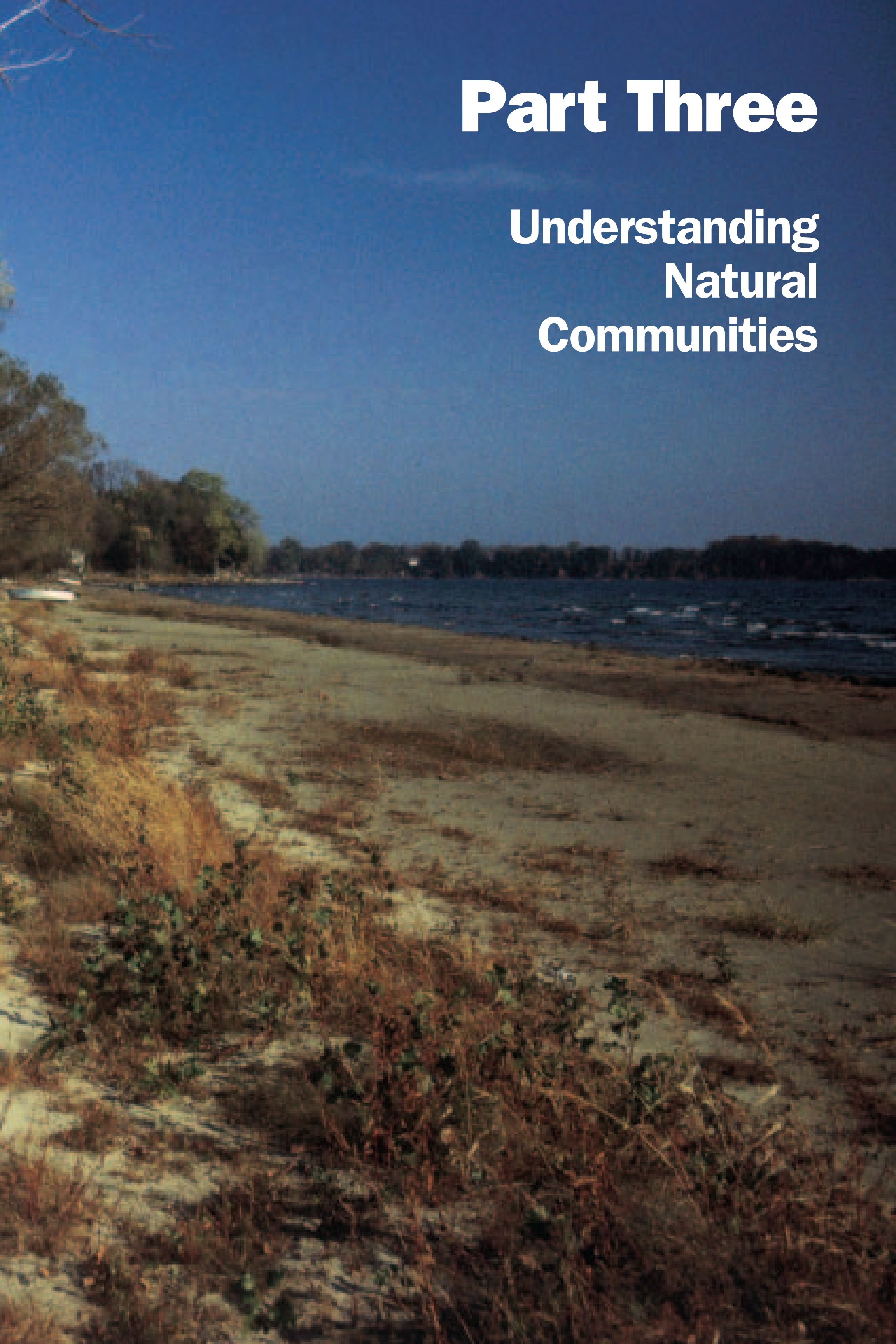
Part Three

Understanding Natural Communities



The Natural Community Concept

Those of us interested in the natural world tend to look for patterns in nature that help us explain some of its complexity. Such patterns include the behavior traits of familiar wildlife species, the flowering times and specific habitats of favorite spring wildflowers, and the associations of plants and animals that often occur together. This last pattern is part of the natural community concept, which provides us with a tool for understanding the complexity and diversity of the landscape around us.

A natural community is an interacting assemblage of organisms, their physical environment, and the natural processes that affect them.

What makes natural communities such a useful ecological concept is that there is a pattern to their distribution. The assemblages of plants, animals, and other organisms found in natural communities repeat wherever certain environmental conditions (soil, water, and climate) are found. Whereas a natural community refers to an actual occurrence on the ground, a ***natural community type*** is a composite description summarizing the characteristics of all known examples of that type. These two terms are often used interchangeably, although there are situations when the distinctions are helpful. Although no two natural communities are identical, the species composition, vegetation structure, and environmental conditions in which they exist repeat with enough similarity across the landscape so that we can recognize and classify natural community types. In this book, we describe natural community types based on years of study of Vermont's natural communities.

It is important to remember that there is a continuum of variation in nature and that natural communities grade into one another. The gradation may be abrupt, as with a cliff rising out of a wetland, or the gradation may be gradual, as occurs between many closely related forest communities.

In addition, there is considerable variability in community structure and species composition within the concept of some natural community types. In order to acknowledge this variability, some of the natural community types described below also include descriptions of "variants" of the community type. As an example, Northern Hardwood Forests are widespread and extremely variable. We recognize and describe four variants of this natural community type.

Plants play a dominant role in the classification because they are good indicators of the specific environmental conditions where they are found growing. These environmental conditions include soil type, bedrock type, moisture regime, slope, slope aspect, climate, and natural disturbance regime. The role of animals may be very important in defining a natural community, but this role is often much more difficult to document or has been studied very little. In addition, most animals are highly mobile and their habitat may include many natural communities. We include animals in the classification when we can, but they are not prominent.

Another attribute of natural communities is that they are defined to be those areas of the landscape that have experienced minimal human alteration or have had sufficient time to redevelop under primarily natural processes, including succession and natural disturbance. Our focus, then, is on mid- to late-successional vegetation, and this excludes many areas of the landscape from being considered natural communities and from consideration in this book. Although many early-successional forests and fields are not considered natural communities by this strict definition, they may still be very important habitat for some plants and animals or provide other benefits for people. Also, these early-successional areas, left to natural processes, will become natural communities. We provide information on successional trends and environmental conditions for each natural community type so that it will be possible to make educated guesses as to which natural community is likely to develop in an area that is currently disturbed or dominated by early-successional vegetation.

Finally, it is important to reiterate that the natural community types we describe in the following sections are not static. They have changed in species composition and structure over the millennia as species themselves have shifted their ranges across the landscape in response to climatic change and disturbance regimes. This constant change reinforces the commonly held idea that natural communities are assemblages of plant and animal species responding independently to environmental conditions but also interacting in complex ways. This viewpoint is intermediate between two, long debated concepts in community ecology: the "continuum concept" states that all species have distinct, independent responses to the environment, whereas the "community unit concept" states that communities are integrated wholes with repeatable assemblages consistently occurring together, interacting almost at an organismal level, and directed to stable successional endpoints.

Classifications, Regional and Local

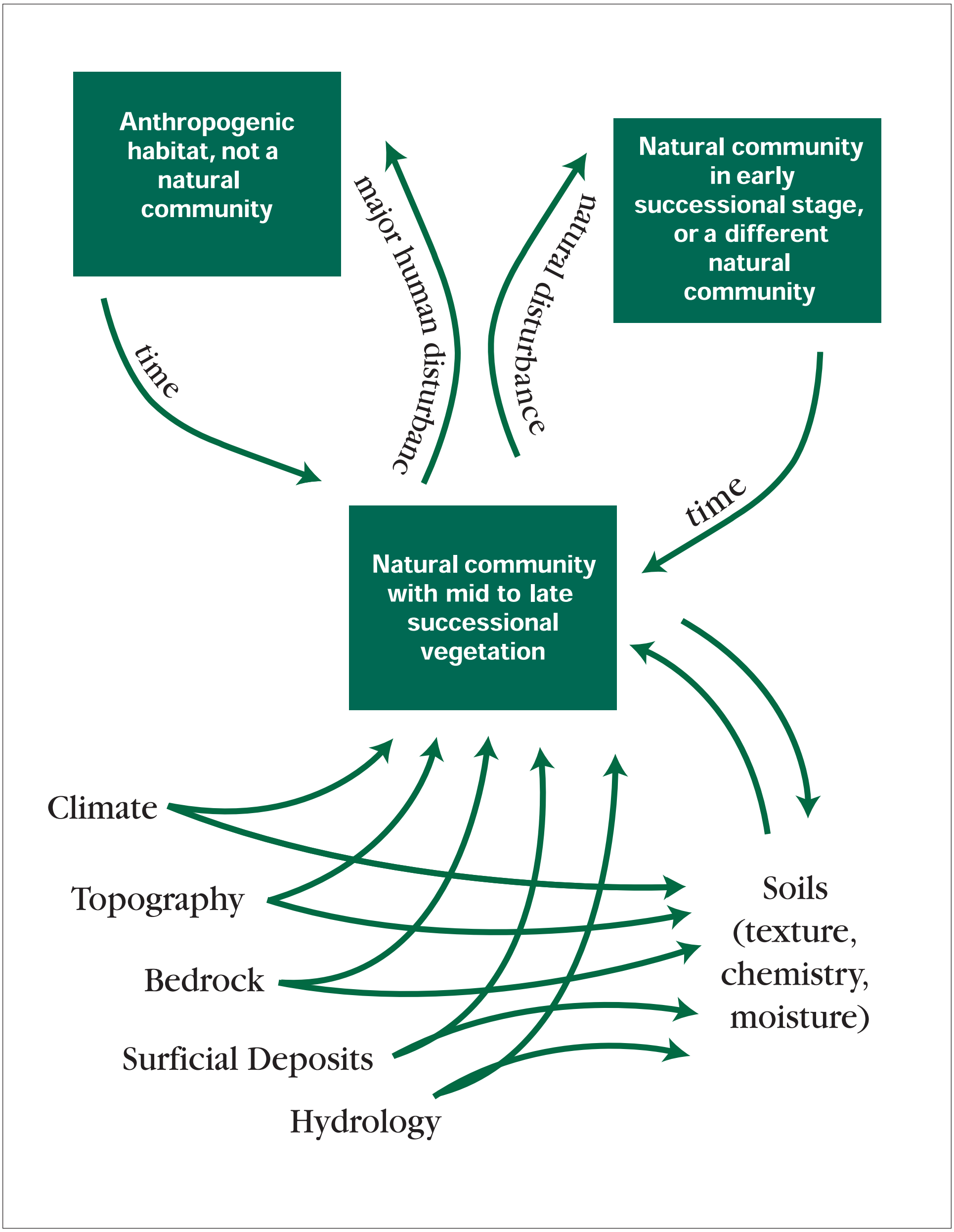
The community classification presented in this book is closely linked to a regional and a national classification system developed by The Nature Conservancy and the network of state Natural Heritage Programs (Sneddon et al. 1998). This link to a regional classification system is critical for efficient conservation planning across the region. Synonyms for the natural community types presented in this book, an earlier version of the Vermont Classification (Thompson 1996), and The Nature Conservancy's regional classification are provided in Appendix C. Where appropriate, synonyms are also provided in Appendix C for forest types as described by the Society of American Foresters (Eyre 1980) and for wetland types as described by the U.S. Fish and Wildlife Service (Cowardin et al. 1979).

Ecological Influences on Natural Communities

The ecological influences on natural communities are extremely complex, but they can be divided into three categories based on the relative scale at which these ecological influences operate. At the largest scale is climate, which affects all natural communities and is determined mainly by regional patterns. At the smallest scale are the individual factors that make up the physical setting and environment in which the natural community occurs, including soils, slope, and hydrology. At an intermediate scale are a number of ecological processes that may operate entirely within a natural community or may operate over larger areas of the landscape. Processes of particular importance are natural disturbance and succession. Other ecological processes that are not discussed here but may be very significant factors in some communities include energy flow, nutrient cycling, predation, herbivory, and competition.

Although the ecological influences on natural communities are discussed separately below, many are interrelated. For example, climate varies with latitude, elevation, slope aspect, and landscape position. Soil development is strongly influenced by climate, bedrock type, and hydrology. And most of the forms of natural disturbance are closely linked to specific weather conditions resulting from larger scale climatic patterns. A schematic representation of these interrelationships is shown in Figure 3.

Figure 3: A Representation of Important Ecological Influences on Natural Communities



Climate

Climate is a major factor affecting the distribution of plant and animal species and therefore affects natural community distribution in Vermont. There are strong gradients in temperature and growing season based on latitude and elevation. Gradients in precipitation are also important, with the greatest precipitation occurring at the higher elevations in the Green Mountains. The upland forest communities in this book are, in fact, separated into three formations based mainly on climate — forests of cooler climate areas, forests of moderate climate areas, and forests of warmer climate areas. Examples of wetland communities with distributions strongly influenced by climate include Northern White Cedar Swamps, which occur primarily in the northern portion of the state and are largely replaced by Hemlock Swamps in similar physical settings in the southern portion of Vermont. Several wetland communities are associated with the warmer climates of the Champlain Valley and Connecticut River valley, including Buttonbush Swamps, Red or Silver Maple-Green Ash Swamps, and Red Maple-Black Gum Swamps.

Although climatic patterns are generally thought of on regional scales, microclimates are local and restricted climates that result from physical geography and also have a strong influence on community distribution. Cold air is heavier than warm air and when unmixed will flow like a fluid downward and accumulate in depressions. Cold air drainage is a major factor at the bases of cliffs where Cold-Air Talus Woodlands occur and also in large and small landscape depressions where Dwarf Shrub Bogs and Lowland Spruce-Fir Forests are found. Microclimates are also very important in the distribution of natural disturbance events. For example, a forested valley sheltered from the prevailing southeasterly winds of a hurricane may largely escape damage.

Although elevation is a feature of the physical landscape, its strongest effect on natural community distribution is related to climate. The higher elevations of the Green Mountains have cool summers, short growing seasons, and abundant fog and precipitation. Alpine Meadow, Alpine Peatland, and Subalpine Krummholz are all examples of communities found only at elevations above 3,500 feet in Vermont, but they are more widespread to the north in Canada and in adjacent states with more high peaks. It is typically warmer and drier at lower elevations, although local topography can create areas of cold air drainage. Hemlock Forests are mainly found below an elevation of 1,800 feet because hemlock does not survive at the colder, higher elevations. The effect of elevation on community distribution varies from north to south, with communities generally occurring at slightly higher elevations in the south than in the north.

The Physical Setting and Environment

Some natural communities are closely linked to specific sets of environmental conditions, whereas others have a broader amplitude of conditions under which they occur. Unlike climate, natural disturbance, and succession, most of the following environmental conditions are relatively easily observed when walking through and investigating a community and its surroundings.

Bedrock types in Vermont are diverse. They include granite, limestone, schists, phyllites, shales, slates, and many others. Each bedrock type has its own characteristics of chemistry, resistance to abrasion and weathering, and texture. These factors, in turn, affect plant and natural community distribution. Granite, for instance, is hard, resists erosion, and has few soluble minerals available to plants. Acidic cliff and outcrop communities are both associated with granite, but occur on other hard, acid bedrock types as well. Limestone, in contrast, is soft, easily weathered, and high in soluble calcium. Several natural communities are closely associated with limestone and other carbonate-rich rocks, including Temperate Calcareous Cliffs, Limestone Bluff Cedar-Pine Forest, Rich Fens, and Calcareous Red Maple-Tamarack Swamps.

Surficial deposits are also diverse in Vermont because of the activity of glaciers. Glacial till covers most of Vermont. Although this till has buried the bedrock in many areas, it retains the characteristics of the bedrock from which it was derived and is therefore still a very important influence on the formation of soils and the distribution of natural communities. Fine-textured sediments (silts and clays) resulting from glacial lake and sea deposition are widespread in the Champlain Valley. Deposits of coarser texture, primarily sand, occur along many river valleys and in the former deltas of glacial lakes, especially the ancient shores of Lake Vermont and the Champlain Sea.

Topography can be separated into three important components: slope, slope aspect, and landscape position. *Slope* refers to the amount of incline at a particular location and is usually measured in degrees. The steepness of slope is closely related to soil development and drainage. We define cliffs as exposed bedrock with slopes greater than 60 degrees. There is practically no soil development on cliffs, and unless there is a source of groundwater seepage, cliffs are very well drained and dry. On steep slopes less than 60 degrees, soils and forests may develop, but these areas remain well drained and may experience periodic landslides. Very few wetland communities are found on slopes because water does not accumulate. Two exceptions are Rich Fens and Alpine Peatlands, which may have gentle slopes. Rich Fens are fed by groundwater discharge and Alpine Peatlands receive abundant precipitation and fog to keep them wet.

Slope aspect refers to the orientation of a slope relative to the cardinal directions. Slope aspect has a strong influence on microclimate and consequently on natural community distribution. South and west facing slopes are typically warmer and drier, whereas slopes facing north and east are cooler and moister. Many of our natural communities with southern affinities are found on west and south aspect slopes, including Dry Oak Woodland and Pitch Pine-Oak-Heath Rocky Summit. Hemlock Forests are more common on shady, north aspect slopes.

Landscape position is the setting at a particular location relative to other topographic features. Examples of landscape positions include summit, ridge, plateau, high slope, toe slope, valley bottom, and basin floor. Landscape position affects microclimate, nutrient availability, and the abundance of moisture. Many of our dry, oak-dominated communities occur on the summits of hills in the warmer areas of the state. Rich Northern Hardwood Forests, on the other hand, typically occur at the toe of slopes and in coves where organic materials and nutrients accumulate over time by slow movement downslope. Floodplain Forests are found in valley bottoms in the active floodplains of rivers where they receive annual flooding and deposition of mineral soil.

Hydrology is the study of water and its properties, distribution, and effects. Water is critical for the survival of plants and animals and its relative availability and abundance is a key factor in determining the natural community that occurs in a given location. The first level in the hierarchy of natural communities presented in this book is a separation of upland and wetland communities, a distinction determined completely by hydrology and its effects on soils and vegetation. At any one location there are many factors affecting hydrology. These include the amount of precipitation, the characteristics of the surrounding watershed, and the rate of water use and evapotranspiration by plants. Specific watershed characteristics of importance include topographic position, drainage characteristics of the dominant soil type, and depth to bedrock.

Lakes, ponds, rivers, and streams are aquatic communities and will not be discussed in this book. They occur in locations where water accumulates either as standing water in basins or flowing water in river valleys, but they are all dominated by open water. Wetlands are saturated or inundated with water for long enough periods of the growing season to develop specific soil conditions and provide habitat for plants that are adapted to survival in abundant moisture. Upland communities generally lack soil saturation or inundation, except following a heavy rain.

Soils and natural communities are intricately related. Soils are the substrates in which plant roots grow and the type of soil is closely related to the availability of plant nutrients and water. Throughout this book, key soil conditions are discussed as part of each natural community. We find certain plant species and certain natural communities only on certain types of soils. Soils and natural communities are similar in that they both are good indicators of long term environmental conditions at a particular site. Because of their critical importance as integrators of site conditions, this section digs a little deeper into the subject of soils: what are their basic properties and why do we find them where we do?

There are five factors that affect the distribution of soils on the landscape: parent material, climate, vegetation, topography, and time. Some of these factors have been discussed above, but are reviewed here in terms of their effect on soil formation. This information, and Table 2, were provided by Thom Villars of the Natural Resources Conservation Service.

Parent materials provide the basic ingredients from which soils develop and have a strong influence on soil texture, drainage characteristics, depth, and chemistry. In Vermont, these materials include alluvium on floodplains, sandy and gravelly glacial outwash on terraces, silty and clayey lacustrine deposits, various types of glacial till and bedrock on uplands, and organic materials in wetlands and on the very tops of the highest mountains in the state. Sandy textured soils tend to be droughty and infertile, while silty and clayey soils have better water holding capacity and are more fertile. Soil depth to bedrock or basal till affects plant rooting depth, drainage conditions, and windthrow susceptibility.

Climatic factors mainly affect weathering and decomposition rates in soils. Weathering and decomposition is most rapid in warm, moist environments where biological activity by fungi and other microorganisms is enhanced. Weathering and decomposition is slowest in cold, saturated environments where biological activity is greatly decreased.

Vegetation affects soil development by the types of organic acids and the nutrients their leaves and needles contain, the amount of shade they produce, and the type of root systems that they have, to name a few examples. Soft wood needles tend to acidify soils. Hardwood leaves contain more nutrients than softwood needles and tend to enrich the soils.

Topography dictates whether water will run off a site or accumulate there. A steep hillside usually has well-drained soils, while depressions collect water and have poorly drained soils that may remain saturated for long periods.

Time determines the relative maturity of a soil. Vermont's soils are fairly young, forming in the aftermath of the last glacial period, approximately 13,500 years ago. Partly because of their youthfulness, they are relatively fertile and conducive to good plant growth.

The various combinations of these five soil-forming factors in Vermont have created many types of soils. Each type has characteristic properties that can be broadly grouped into three categories: physical, chemical, and biological. Some of these important soil properties, how they can be observed, and their effect on vegetation are shown in Table 2.

Soils are classified by their unique set of characteristics. Each soil type is called a soil series. For example, the Vermont State Soil is the Tunbridge soil series. Soil survey maps, available through the Natural Resources Conservation Service, show the distribution of soils in each Vermont county. These surveys are very useful in understanding the natural communities of an area.

Table 2: Soil Properties and Their Effects on Vegetation

Soil Properties	Observable Features	Effects on Vegetation
Physical		
Horizons or layers	From the soil surface downward: organic layer (O), topsoil (A), leached subsoil (E), subsoil (B), substratum (C), bedrock (R).	Thick O and A horizons are found in enriched sites. E horizons indicate acidic sites.
Texture	Stone, gravel, sand, silt, and clay.	Gravelly and sandy soils are droughty and infertile. Silty and clayey soils hold water and are more fertile.
Color	Black means organic rich. Grey and mottled means wet. Brown and red mean good drainage.	Color indicates high water table and drainage conditions.
Depth to bedrock or basal till	Measure depth to impeding layer. For bedrock: <20 inches is a shallow soil, 20 to 40 inches is moderate, and >40 inches is a deep soil; basal till usually occurs at 18 to 30 inches below the surface.	Affects rooting depth, drainage conditions, and windthrow susceptibility.
Depth to seasonal high water table	Ranges from greater than 6 feet in well-drained soils to the soil surface in poorly and very poorly drained soils. Related to soil color.	Affects rooting depth, drainage conditions, windthrow susceptibility, and rate of decomposition.
Slope	Most soils develop on slopes < 40 degrees. Cliffs have slopes > 60 degrees and usually minimal soil.	Affects runoff characteristics, soil erodibility, and drainage. Slope aspect affects soil temperature.
Chemical		
Nutrients	Available amounts of nitrogen, phosphorus, calcium, magnesium, and others.	Affects rate of plant growth. Some plants are restricted to soils with high calcium or magnesium concentrations.
pH (acidity)	Soils range from extremely acid to slightly alkaline.	Affects availability of nutrients, solubility of metals in soil, and decomposition rates. Enriched sites have high pH.
Organic matter	The amount and degree of decomposition of organic matter in each soil horizon.	Affects water holding capacity and fertility. Poor sites are usually low in organic matter.
Biological		
Microorganisms (fungi, bacteria, and invertebrates)	The species and densities of populations in the soil.	Important role in decomposition of organic matter, nutrient cycling, and soil aeration. Some form symbiotic relations with plants.

Natural Disturbance

All communities are subject to disturbances of natural origin. Three characteristics of natural disturbances are especially relevant to their effects on natural communities and their distribution: disturbance extent, disturbance severity, and disturbance frequency. Natural disturbances may be small in scale or widespread. They may significantly alter the landscape or they may be minor disruptions to a few plants or animals. The disturbances may recur annually or they may recur irregularly, possibly as seldom as once every 200 to 400 years.

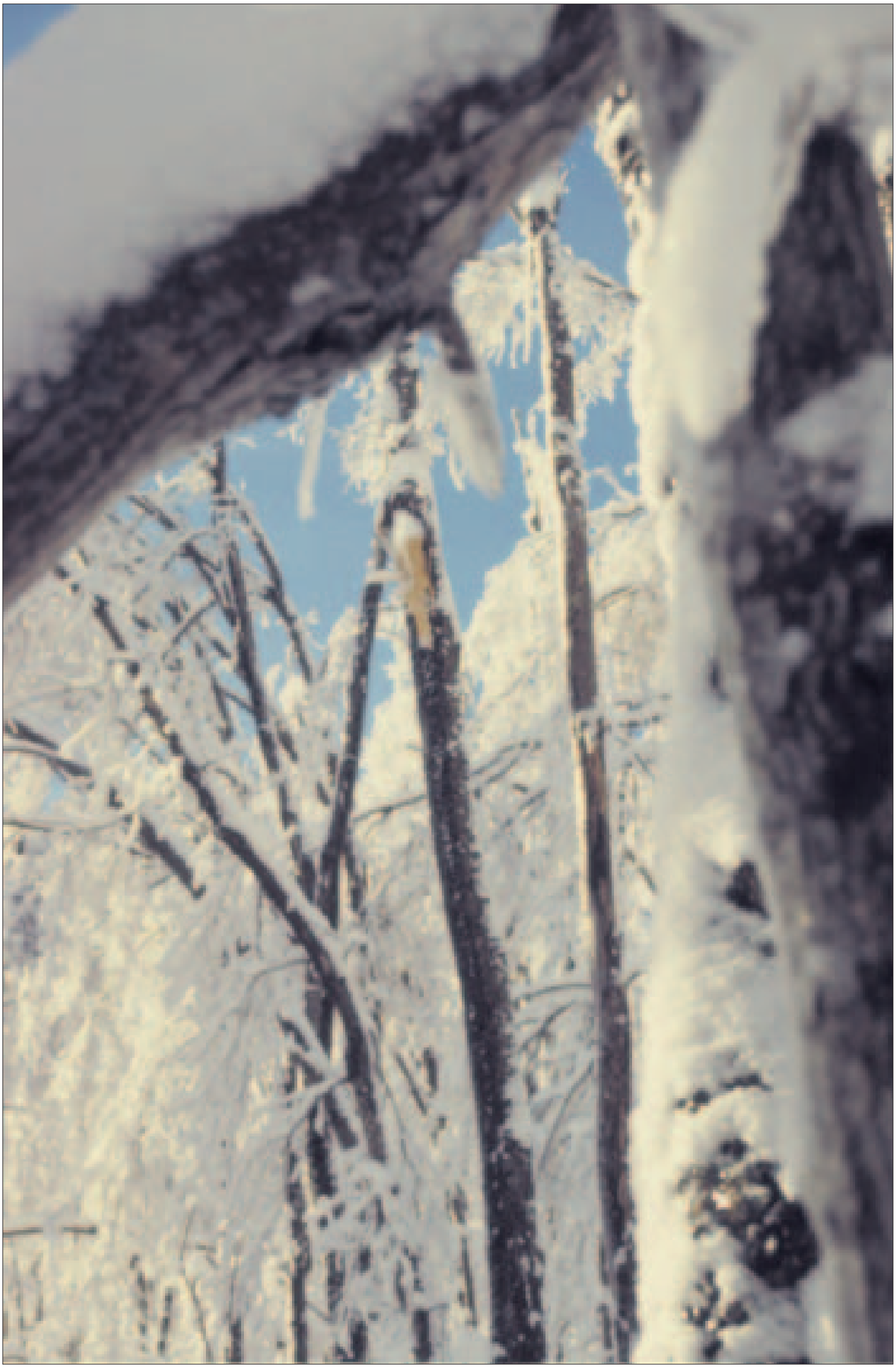
Forest is the natural condition for most of Vermont and the rest of the northeastern United States. Severe natural disturbances can drastically alter the condition of forests and cause serious problems for people. However, these severe disturbances can also create or enhance habitats for herbaceous plants, animals, fungi, and other organisms. Careful observation of areas that have undergone natural disturbance can heighten one's appreciation for the complex ecological changes that will occur in subsequent years.

A few of the most important forms of natural disturbance are significant enough regionally to warrant discussion. Insects and disease can be important in some communities but are not discussed here.

Wind is one of the major natural forces that affects upland and wetland forests of the Northeast. The 1938 hurricane had a major effect on Vermont's forests, leveling trees in many parts of the state and throughout New England. In 1995, a major windstorm in the Adirondacks toppled more than half the trees in a 100,000 acre area. These events are dramatic and seem devastating when and where they happen, but in any given place, the average interval between such events may be hundreds of years. Of course, the time between events varies with local weather patterns and topography, and the odds can always be beaten, but major windstorms are not common occurrences in Vermont.

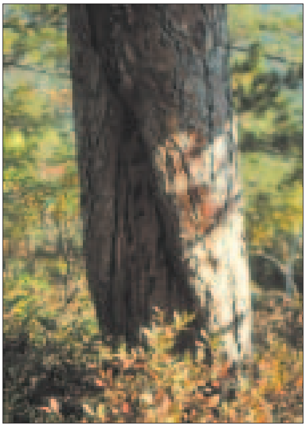
Single tree fall is probably the most important natural disturbance process in many of Vermont's forests. Although the effect of one downed tree is limited, the cumulative effect of single tree falls covers extensive areas and occurs nearly constantly. Minor windstorms can cause individual trees to fall, especially those that are dead or diseased and those with shallow root systems, which occur in many forested wetlands. Species like yellow birch and paper birch are especially well adapted to colonize the bare soil exposed by the upturned roots of a downed tree. For shade tolerant species like sugar maple, hemlock, and northern white cedar, growing slowly in the shade of the canopy, the newly abundant light on the forest floor gives them a sudden growth spurt. In this way, the forest remains ever-changing and diverse, with patches of old and young forest intermixed, and a concomitant diversity of plants, animals, fungi, and soil microorganisms.

Ice and snow loading are important disturbance processes in our forests, sometimes causing significant changes in the forest canopy. The ice storm of January 1998 affected several million acres in New York, New England, and southern Québec, in many areas removing up to 75 percent of the tree canopy. In the short term, this limb removal allows significantly more light to reach the forest floor, resulting in dramatic increases in the biomass of herbs and shrubs. We do not yet know the long-term effects of such a major event. In general, evergreen trees are well adapted to snow and ice loading, as will be described in the introduction to the Spruce-Fir-Northern Hardwood Forest Formation.



The ice storm of January 1998 affected trees throughout Vermont, New England, and southern Québec.

Fire is, overall, a minor player in the ecology of Vermont's forests. In this moist climate, fires do not usually spread far. But on dry ridgetops or knolls, and in dry, flat, sandy soils lightning-caused fires can spread locally and affect the structure and composition of the forest. Red Pine Forests and Woodlands are maintained by such occasional localized fires. Starting as they do on remote ridgetops, these fires often go unnoticed by humans or they burn themselves out before people can get there to control them. Pine-Oak-Heath Sandplain Forests are also believed to have been maintained naturally by fires, but since they occur in heavily developed areas where fires have been suppressed, the evidence is difficult to find now. Although it may be hard to picture wetlands burning, the Pitch Pine Woodland Bog at the mouth of the Missisquoi River has had repeated fires burn across its surface, which has encouraged the reproduction of pitch pine.

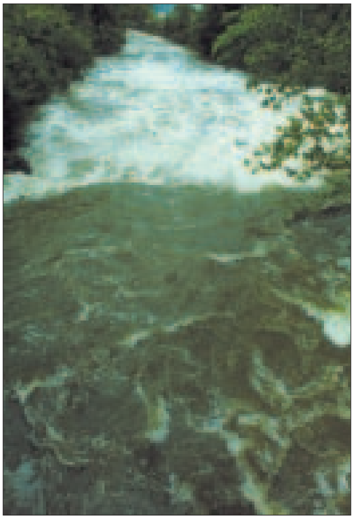


The deep fire scar on this red pine indicates a relatively recent fire. The short shrub layer of black huckleberry reflects a long history of fire.

Downslope movement is a key disturbance process in mountainous regions throughout Vermont. It ranges from the gentle washing of nutrients and organic matter downslope, as happens in Rich Northern Hardwood Forests, to severe and major landslides that completely remove all vegetation and soil. Such slides are commonplace in Smugglers Notch (a steep-walled valley in the northern Green Mountains) where a heavy rain can easily saturate the soil down to the bedrock and send it sliding downslope. Between these extremes are the minor slope slippages that may not even uproot trees, but just send them downslope a ways and disturb the soil a bit in the process. Such slippages are common in steep places where the soil is constantly saturated by springs or seeps.

Flooding is a significant form of natural disturbance in many wetland communities, especially those occurring at the margins of lakes and rivers that have seasonally fluctuating water levels. Most woody plants are absent from wetlands that experience long periods of flooding, and these communities are typically dominated by specially adapted herbaceous plants. Riverine and Lakeside Floodplain Forests and Silver Maple-Green Ash Swamps are dominated by silver maple, green ash, and other trees that can withstand the annual flooding that occurs in the early part of the growing season. However, it is common to see dead trees at the lowest elevations of these communities as a result of unusually long periods of flooding in some years.

Water and ice movement are important disturbance processes for those communities occurring along river and lake shores. On rivers, the enormous energy in the force of moving water erodes and redeposits tons of boulders, cobbles, gravel, sand, and silt. The communities that occur in these seasonally exposed shorelines, such as River Cobble Shores, are composed of species adapted to life on a shifting and dynamic substrate. The velocity of moving water combined with flooding carries fine textured sands, silts, and clays onto the level floodplain where they are deposited annually. This annual accumulation of mineral soil is another form of disturbance that floodplain species must tolerate. Flowing water is a strong eroding force, cutting through floodplains and eroding riverbanks. Erosional River Bluffs are the result of this erosive force. Large blocks of ice carried by spring river flows and high water along lakeshores can scour the exposed shorelines of all but the most tenacious plants. Ice scour is an important form of distur bance in many shoreline communities, including Riverside Outcrops and Lakeshore Grasslands. On shores of larger lakes, waves are also a substantial force, creating shifting beaches of sand and cobble and determining the species composition of some deepwater wetlands.



There is enormous energy in moving water.

Succession

One of the keys to understanding what might grow in a given place is the concept of succession, or the natural changes in species composition over time. Although succession is happening all the time in natural communities, we often speak of succession in connection with extensive or severe disturbances, because changes following these types of disturbance are dramatic and easy to observe. The flush of new growth after a fire, the “release” of saplings when a forest canopy is opened up by logging or natural disturbance, and the fast growth of alders in a wet field that has been abandoned are all examples of succession. However, succession is also occurring when a single tree falls in the forest and is replaced by another species. This slow and ongoing change in species composition and community structure is just as important as the dramatic changes caused by a severe disturbance.

We have all observed succession and to a certain extent we can predict how it will progress, but there are many things that we still do not know about it. The factors that affect succession after a major disturbance include climate, soil texture, soil moisture, whether the disturbance stripped organic matter from the soil, how severe the disturbance was, what seeds are available for recolonization in the soil and in surrounding communities, the movement of seed-carrying animals through the area, and so forth. All these things interact to determine what will grow after a disturbance.

Certain plants are better colonizers of disturbed lands than others and therefore we see certain predictable patterns of succession over and over again. Prickly sarsaparilla, for example, is almost always found in clearings created by logging or fires. It does well in these openings but disappears as the forest canopy closes. Raspberries behave similarly. Pin cherry, also known as fire cherry, is a short-lived tree that colonizes cut or burned areas, especially in cooler climates.

Ecologists and foresters use the concept of shade tolerance to help explain forest succession. Pin cherry is considered ***intolerant,*** meaning it does not tolerate the shade of a closed forest canopy, so it dies out as other species grow and mature. In general, ***tolerant*** species, those that can survive under a forest canopy, are also long lived. Hemlock may be the most tolerant and long-lived species in our forest. Its life strategy is typical for a tolerant species: if a seed source is available and soils are suitable, it will come in under a hardwood canopy and persist there for decades, eventually growing to maturity and replacing less tolerant species. However, heavy browse by white-tailed deer can eliminate young hemlock and other saplings from the understory.

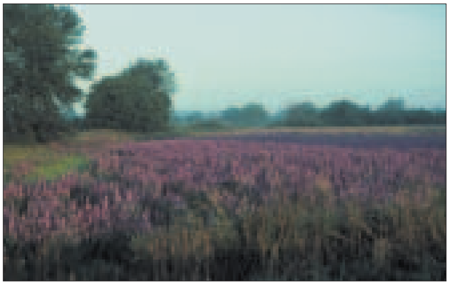
The interaction of natural disturbance and succession is what determines the long-term stability of a natural community. Some communities that are described in the following sections are the result of frequent, severe disturbances that maintain species composition and community structure at an early stage of succession for relatively long periods. These communities are generally small and include the open shoreline communities. The species compositions and community structures that have evolved in upland forest communities with regular disturbance by fire will not persist if fires do not continue to occur. Although fires continue to ignite and burn in the remote ridgeline settings of Red Pine Woodlands, fires are largely suppressed in the urban settings of our Pine-Oak-Heath Sandplain Forests of Chittenden County. The suppression of a critical natural disturbance regime has clear implications for the conservation of this rare community and does not bode well for its long term protection.

Many of our natural communities are thought to be relatively stable over the long periods that may occur between major disturbance events. In many upland and wetland forests single tree fall is the dominant form of disturbance, and canopy gaps are typically filled by individuals that maintain the same species composition of the forest. Examples of relatively stable forest communities include Northern White Cedar Swamps and Northern Hardwood Forests. Changes in species composition and community structure may also be very slow in some open wetlands, especially those with relatively stable hydrologic regimes, such as many fens and Dwarf Shrub Bogs. Community stability is clearly relative to a chosen time frame, however, and we can expect all of our communities to change over the long term as global climate changes — whether in response to natural forces or human activities.

Human Influences on Natural Communities

Humans have been present in Vermont and the surrounding region since the retreat of the glaciers and have had a dramatic effect on the environment. Major philosophical discussions may arise from questions like, “Are humans and our activities part of natural ecological processes?” Answering such a question is clearly a deeply personal matter, but there are probably some bounds to the answer with which most people will agree. Populations of Native Americans in the region prior to European settlement were small and their use of the land was dispersed, resulting in few permanent changes in the landscape or in ecological processes. In contrast, by the 1850s European settlers had cleared about 75 percent of Vermont’s forests, with related loss of many species and severe degradation of air and water quality. Although Vermont’s forests have regrown, the human population has grown as well, and some of our current activities are clearly resulting in the degradation of ecological processes. Examples of such activities include landscape and habitat fragmentation, irreversible land development, global climate change, and introduction of non-native species. Even with this history of significant environmental alteration, we are fortunate to have large areas of Vermont that are now mostly under the influence of natural ecological processes.

Some human influences on Vermont's current natural communities are readily observed, while others are obscure and are only partly understood through detailed research. It is easy to notice an old stone wall or a plowed surface soil horizon in a forest, both of which indicate past clearing and use of the land for agriculture, which in turn is likely to be reflected in the species composition of the forest. Clues about the logging history of a forest are revealed by the presence of cut tree stumps, the species of the stumps, and the degree of stump decomposition that indicates the timing of the last logging operation. The presence of non-native plant species may indicate past clearing, agriculture, or soil disturbance in both upland and wetland communities. Learning about other aspects of Vermont's ecological history takes more detailed research, however. A recent study of land surveyors' records has revealed that Vermont's presettlement forests had higher proportions of beech, hemlock, and red spruce than current forests do. Detailed examination of organic soil profiles in some riverine floodplain wetlands has revealed buried layers of mineral soil, reflecting the significant changes in runoff that occurred when the landscape was cleared in the 1800s. These and other subtle clues are providing new insights into the current condition and species composition of Vermont's historic and current natural communities.



Purple loosestife can dramatically alter the character of natural wetlands.

How Natural Communities Are Arrayed on the Landscape: A Question of Scale

The 80 natural community types described in the following sections occur at very different scales across the landscape. The communities form a rich mosaic. Some of them are large and occupy vast areas, while others are much smaller and are embedded within the dominant communities. In order to better understand individual community types and to plan for effective conservation of species and communities, it is useful to separate the communities into three broad categories (Poiani et al. in press). These categories are based on the relative abundance of a community type in the landscape, the average size of individual contiguous occurrences of the community, and the specificity with which the community is associated with particular environmental conditions and ecological processes. The three community categories are ***matrix, large patch,*** and ***small patch.***

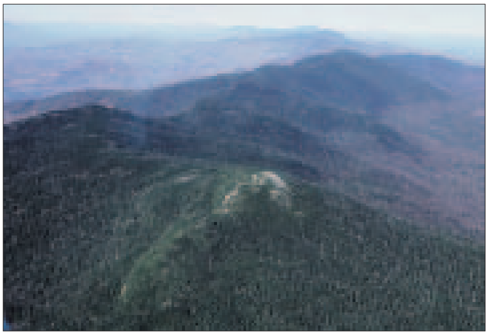
A few communities dominate the landscape and form the background in which other smaller scale communities occur. We call these *matrix* communities. Matrix communities collectively occupy approximately 75 percent of the land area. These communities generally occur in contiguous units of 1,000 to 100,000 acres. Matrix communities have broad ecological amplitude, occurring across a wide range of soil and bedrock types, slopes, slope aspects, and landscape positions. Regional scale processes such as climate typically determine their range and distribution. There are six matrix-forming natural communities in Vermont: Montane Spruce-Fir Forest, Lowland Spruce Fir Forest, Montane Yellow Birch-Red Spruce Forest, Spruce-Fir-

Northern Hardwood Forest, and Northern Hardwood Forest. Valley Clayplain Forest was the matrix forest of the Champlain Valley prior to European settlement but is now reduced to small, scattered forest fragments. Matrix communities can be conserved through a variety of techniques, from inclusion in nature reserves to careful forestry practices that consider biodiversity and ecological integrity. The scale of conserved land should mirror the scale at which matrix communities occur on the landscape.

Northern Hardwood Forests, appearing gray in this winter photograph of the Southern Green Mountains, are one of the matrix-forming communities here. Lowland Spruce-Fir Forest and open wetlands are visible as patch communities.

Large patch communities are nested within matrix communities and collectively occupy approximately 20 percent of the land area. They occur as discrete units of about 50 to 1,000 acres. The boundaries of large patch communities are usually associated with a single dominant ecological process or environmental condition such as fire or hydrology. There are 17 natural community types that fall within this category, including Mesic Pine-Oak Forest, Red Maple-Black Ash Swamp, and Silver Maple-Ostrich Fern Riverine Floodplain Forest. Protection of large patch communities requires knowledge of where they occur, and can be accomplished either through inclusion in nature reserves or through careful management.

Small patch communities are also nested within matrix communities. Together they occupy roughly five percent of the land area. These small, discrete communities are typically less than 50 acres, and some types are consistently under an acre in size. Small patch communities occur where several ecological processes and environmental conditions come together in a very precise way. These communities contain a large percentage of the region's biological diversity. There are 57 small patch community types, including Serpentine Outcrops, Cold Air Talus Woodlands, Calcareous Riverside Seeps, and all the fen types. Because of their small size and specificity of conditions, small patch communities may not be viable without protection of the surrounding area. If a small patch community is not surrounded by natural communities with intact ecological processes, protection of these patch communities may require specific management techniques that consider the ecological processes particular to that community.



The Alpine Meadow of Mount Abraham is a small patch community surrounded by a matrix of Montane Spruce-Fir Forest which extends for miles along the ridgeline of the Northern Green Mountains.

These categories are not clearcut, and some communities could easily be placed in two categories. There is also considerable variation among biophysical regions of the state, and communities that may be considered large patch in one region may be better categorized as small patch in other regions. For example, Rich Northern Hardwood Forests cover hundreds of contiguous acres in the eastern Taconic Mountains but are typically under 50 acres in other regions. Similarly, Cattail Marshes and Dry Oak-Hickory-Hophornbeam Forests are large patch communities in the Champlain Valley but are typically small patch communities in other regions where they occur. (Appendix C lists natural communities and how they most commonly occur by category, matrix, large patch, or small patch.)

Rarity of Natural Communities

Natural communities are not equally distributed across the landscape — some are abundant, some are common, and some are rare. Rare communities are typically a high priority for conservation action, as are high quality examples of more common communities. Understanding the reasons for a particular community's rarity can be helpful in developing protection strategies. Community rarity may be a natural condition or it may be the result of human activities. Rarity may also be a function of the area in which one chooses to look for the community. There are several reasons for rarity.

In some cases, the dominant species of the rare community are at the edge of their climatic range. An example is Red Maple-Black Gum Swamps in Vermont. Black gum is a prominent component of this swamp type, and in Vermont this tree reaches the northern limit of its extensive southeastern United States distribution. Red Maple-Black Gum Swamps are considered rare here, even though this community is more common to our south.

Some communities are rare because the specific physical environments in which they occur are rare. Serpentine Outcrops are found only on serpentine rock, which is limited primarily to the eastern side of the Green Mountains, where it is only exposed in several relatively small areas. Lake Sand Beaches and Sand Dunes are rare in Vermont because limited supplies of sand reach the windward shores of our larger lakes where wind and waves can move it to create the beaches and dunes on which these two communities develop.

Unfortunately, human activity is another cause of community rarity. There are several community types for which human disturbance has resulted in the destruction or alteration of most of the physical environment in which the community occurred. Examples include Valley Clayplain Forest, Pine-Oak-Heath Sandplain Forest, and all three types of Riverine Floodplain Forests. All these communities occur on soils or in landscape settings that are highly productive for agriculture or desirable for development. Community restoration will be necessary to re-establish and protect them.

Another reason for community rarity is the alteration of critical ecological processes that support or maintain a particular community. In these cases, innate rarity and human-caused alterations of natural processes conspire to make them especially rare and threatened. Lake Sand Dunes are rare in Vermont not only because there are few locations with abundant sand on the windward exposure of our larger lakes but also because development in the vicinity of existing dunes has altered wind patterns and the accumulation of sand into dunes. Our most dramatic example of rarity caused by human alteration of ecological processes is the Pine-Oak-Heath Sandplain Forest.

This community is rare both because of habitat fragmentation and development and because natural fires have been suppressed.

All of Vermont's natural community types have been assigned ranks that reflect their relative rarity. These ranks range from "extremely rare" (fewer than five high quality occurrences) to "common and widespread" (good examples are easily found). Pitch Pine-Oak-Heath Rocky Summit is an example of an extremely rare community type. Alder Swamp is a common and widespread community type. The rarity ranks for all natural community types are provided in an appendix.

Mapping Natural Communities

A map describing the natural features of the landscape is a very important tool for making land use decisions of all kinds. A map identifying natural communities of an area can be extremely useful, especially when it is combined with maps of aquatic communities, locations of rare and sensitive plant and animal populations, and important wildlife corridors.

Natural communities are a logical unit for classifying and mapping land. They integrate many environmental site conditions (climate, soils, bedrock, slope, and hydrology) into a discrete number of community types. Each natural community type has its own set of qualities and constraints that can be used for developing sound management or conservation plans. In addition, since Vermont's natural communities are cross-referenced to regional and national classifications, they can be used as a common land classification system across many political boundaries.

So, whether the task is to develop a management plan for a 100-acre woodlot, a town forest, thousands of acres of commercial forest, or a large tract of public land, producing a natural community map will be a helpful step in developing that plan. As was discussed in the introduction, natural communities can be used as a coarse filter for conserving biological diversity, and mapping the location of individual natural communities is the first step in this conservation process.

Producing a natural community map is not an easy proposition, but can be accomplished with some planning and forethought. In general, there are four steps in the mapping process: information gathering, mapping by photo-interpretation, accuracy assessment, and final map production. Although there are many approaches that can be used successfully, here are some general guidelines to consider.

1. Whether the focus area is tens or thousands of acres, those people who will be producing a map should become as familiar with the land as possible. Talk to people who know the land well, walk through it, or fly over it. Take notes and photographs.

2. Gather as much existing information about the focus area as possible, for this will add to the resolution and accuracy of the map produced. Sources to consider include the following:

    ~ USGS topographic maps

    ~ all aerial photographs available for the area

    ~ county soil surveys (Natural Resources Conservation Service)

    ~ National Wetlands Inventory maps (U.S. Fish and Wildlife Service)

- ~ bedrock and surficial geology maps
- ~ Nongame and Natural Heritage Program information on rare species and significant natural communities
- ~ forest inventory data
- ~ land use history information

3. Select the best available aerial photographs to be used for mapping. In general, low elevation color-infrared photographs taken in the spring before leaf-out or in the fall after leaf-off are a good choice for identifying wetlands and distinguishing between deciduous and needle-leaved evergreen forest types. Photo-interpretation using a high quality stereoscope and stereo pairs of photographs provides a magnified three-dimensional view of the land that greatly enhances the accuracy of the map product. In some cases, aerial photographs may be replaced by satellite imagery or aerial videography.
4. Map communities in the focus area to the finest scale that is possible given the quality of photographs and the time and budget for the project. Use knowledge of the site and the classification of community types in this book as the basis for mapping, but add additional community types or variants if that is appropriate for the project area. Label each mapped polygon with the interpreted natural community type; early-successional areas and undetermined areas should be labeled as such. Remember that it will be very difficult to identify some small patch communities on aerial photographs, especially those that will be hidden by forest cover, such as Seeps.
5. Develop a procedure for field work to confirm the accuracy of the initial map. This should include visiting each mapped natural community type in several polygons to check the mapping accuracy for the type. Successional and undetermined polygons should also be visited. Typically, all polygons can be visited for small project areas, while only a subset of each mapped type can be visited for large project areas. Collect community data for each polygon visited and revise the boundaries of the visited polygons, as necessary.
6. Compile and analyze information from the field work to revise the initial map.
7. Decide early in the mapping project what the final map product will be and plan accordingly. It may be a rough sketch on a topographic map, or it may be a digitized map for which each polygon has its own set of attributes. There are many possible methods for transferring mapped polygons on aerial photos to a digital format. Consult with an appropriate expert if the final product is to be in digital format as this may affect many steps along the way.