Hinesburg Town Forest:

Inventory, Assessment, and Management Considerations

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FOREWORD

May 12, 2006

Imagine walking along an old road in the woods. Bordering the path are a moss-laden stonewall and a line of towering white birch trees. Cresting a hill, you become aware of a clearing, and, stopping to investigate, spot a large brick chimney base jutting out of the earth. You can almost see in your mind the one-room house that once stood where you now stand, can almost picture the lives of the people who plowed these fields. You start to notice how young the forest seems, with sugar maple and American beech trees coming up in gaps in the canopy. Standing, listening, you hear the call of a brown creeper and the insistent knock of a hairy woodpecker working at a nearby snag. And you realize that these woods are filled with stories.

For our team, getting to know the 800+ acres of the Hinesburg Town Forest seemed at first like a daunting task. From tracking bobcat and coyotes in the cold snows of winter to identifying the first blooming flowers of spring, the process was always intensive, and sometimes arduous. And yet, despite archives and maps and past management plans giving us baseline information about what we'd see, each time we went out we discovered the unexpected – rich soils where they were not supposed to be, calling frogs in vernal pools hidden between ridgelines, fire-associated red pine trees amongst a dry-oak woodland, and fresh moose scrapings in an unmapped alder swamp. With each discovery, the stories of the Forest became more intricate and captivating, and our affection for the landscape grew.

These months were also about putting to work our field naturalist and ecological planning skills, central components of our educational experience. Being able to use these newly-acquired skills to provide assistance to the Hinesburg community fueled us with a sense of purpose. Our research brought us out into the natural world, and field days in the Forest reinvigorated us academically and emotionally. The experience also required drawing on our collective skills and pooling our knowledge, a process that brought us together as a team during a busy time.

It's spring now, and the forest that we saw sleeping for many months is awakening. The blue cohosh and spring beauties, wood frogs, and goshawks enrich our understanding. As we watch and feel the change of seasons, our work comes to a close.

After months of exploration, we find ourselves immensely excited to share everything we have come to know on this landscape with the Town of Hinesburg. We have compiled our findings into a comprehensive integrated document that we hope will not only impart knowledge, but also convey our appreciation of the unique diversity of the Hinesburg Town Forest. With a landscape of such complex assemblages of patterns and processes, we know we cannot have captured it all. But we hope that what we have compiled will help to inform future activities on, and future explorations of, the land.

The consultant team,

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ACKNOWLEDGEMENTS

In the process of researching and compiling this document, we, the 2006 LIA consulting team, were extremely fortunate to have the help and support of an extensive number of people. In addition to contributing time, knowledge, valuable resources and information, many of these people became an essential part of our process and even our team. We would like to express our sincere appreciation.

We first thank our sponsor, the Town of Hinesburg, for providing the funding necessary to complete the project. The PLACE program provided further resources essential to the completion of this project. Michael Snyder, Chittenden County Forester, offered a wealth of background information about the Hinesburg Town Forest in addition to spending a number of days with us in the field. Our project would not have been possible without additional support from Andrea Morgante and Suzanne Richard, who acted as representatives of the Town of Hinesburg and the PLACE program.

Our deepest gratitude goes to Walter Poleman, who not only acted as professor and mentor, but also facilitated the entire LIA experience. His constant support and enthusiasm contributed to the team's enjoyment of this unique educational opportunity.

The list of contributors is extensive. Jane Dorney, Brett Engstrom, Matt Kolan, Liz Thompson, and Ian Worley provided hands-on field days for the entire team. Our support system and mentors from the University of Vermont include Deane Wang, Jeffrey Hughes, Leslie-Ann Dupigny-Giroux, Porky Reade, and Bill Gill. The entire V6 team of Field Naturalists and Ecological Planners were also extremely helpful in sharing their experience and expertise gained as past LIA Consultants.

Essential also were those who added additional support and information: Caroline Alves, Jeanette Armell, Noelia Báez Rodríguez, Bissonette Family, Chris Burns & UVM Special Collections, the Canaday Family Charitable Trust, the Carpenter-Carse Public Library, John Crock, Scott Darling, the Donegan Family, Paul Eddy, Charlie Fortin, Caroline Harvey, Britt Haselton, Craig Heindel, the Hinesburg Community School, David Hirth, Audrey Horton, Cheryl Hubbard, John Hunter, the Lintilhac Foundation David Lyman, Rocky Martin, Johnny and Emma Mead, Jean Miner, Lexi Reiss, Becca Rimmel, Missy Ross, Steve Russell & the Hinesburg Town Forest Committee, the Russell Family, Brooke Scatchard & The Fellowship of the Wheel, Martha Stuart, Ann Thomas & the Hinesburg Historical Society, Kristen Watrous, and Terry Wilson.

Thank you!

EXECUTIVE SUMMARY

In January of 2006, Andrea Morgante and Suzanne Richard from the town of Hinesburg and Michael Snyder, Chittenden County Forester, approached our Landscape Inventory and Assessment (LIA) class with a problem. As Snyder summarized, the Hinesburg Town Forest is being "loved to death." The forest is used by a multitude of interest groups but currently has no comprehensive management plan with which to regulate the activities or assess their impact on the forest itself. In order to create an informed management plan, the Hinesburg Town Forest Committee must first have a better understanding of the natural and cultural history of the forest.

Enter our LIA consulting team. Our charge was to investigate the story of the Town Forest, including its physical landscape, vegetation, wildlife, cultural history and land use. Each layer of the story was identified individually, but the full story unfolded only by integrating the layers into a single yarn. We then used this integrated tale to assess the impact associated with various forest uses to inform a management plan.

The Hinesburg Town Forest is 837 acres of mixed broadleaf and coniferous woodland that is located on the eastern edge of Hinesburg, sharing a border with the town of Huntington (Map 1). Situated at the foothills of the Green Mountains, most of the forest is part of the Winooski River watershed, with the far western portion of the property draining into Lake Champlain via the LaPlatte River watershed (Map 2). The Town Forest includes two parcels. The small Hollis parcel shares only a corner boundary to the northwest of the larger main parcel (Map 1). A ridge of exposed bedrock runs from the center of the main parcel to the south, with another patch along the northern edge of the Hollis parcel. Glacial till mantles most of the remaining landscape, and several small wetlands provide diversity in cover and habitat.

Historically, most of the forest was cleared for farmland. As was true for all Vermont hill farms, small-scale farming became economically difficult as technology changed the industry, and many farms were abandoned. Although some parcels that now make up the town forest were donated by their former owners, others were taken by the town as compensation for tax default. The current boundary of the Town Forest was established in 1958 when the final parcel (125 acres of the J. Fraser Farm) was acquired by the town. The remnants of several farmsteads and many stone walls are still present on the landscape, along with rows of red pine, white pine, and Norway spruce planted on abandoned fields.

Residents of Hinesburg and the surrounding communities now use the Town Forest for many forms of recreation. Hiking and mountain biking are popular summer activities, while winter attracts cross country skiers and snowshoers. Some ride all terrain vehicles, and yet others picnic by the stream. Hunting is a common activity enjoyed by forest visitors, as are birding and other wildlife searches. Teachers bring school students to explore their environment, and other workshops are held by community groups and the county forester to interpret their surroundings. Timber harvested from the forest has provided a small source of income for the town, much of which has paid for habitat improvement, access and signage, gates, and erosion control.

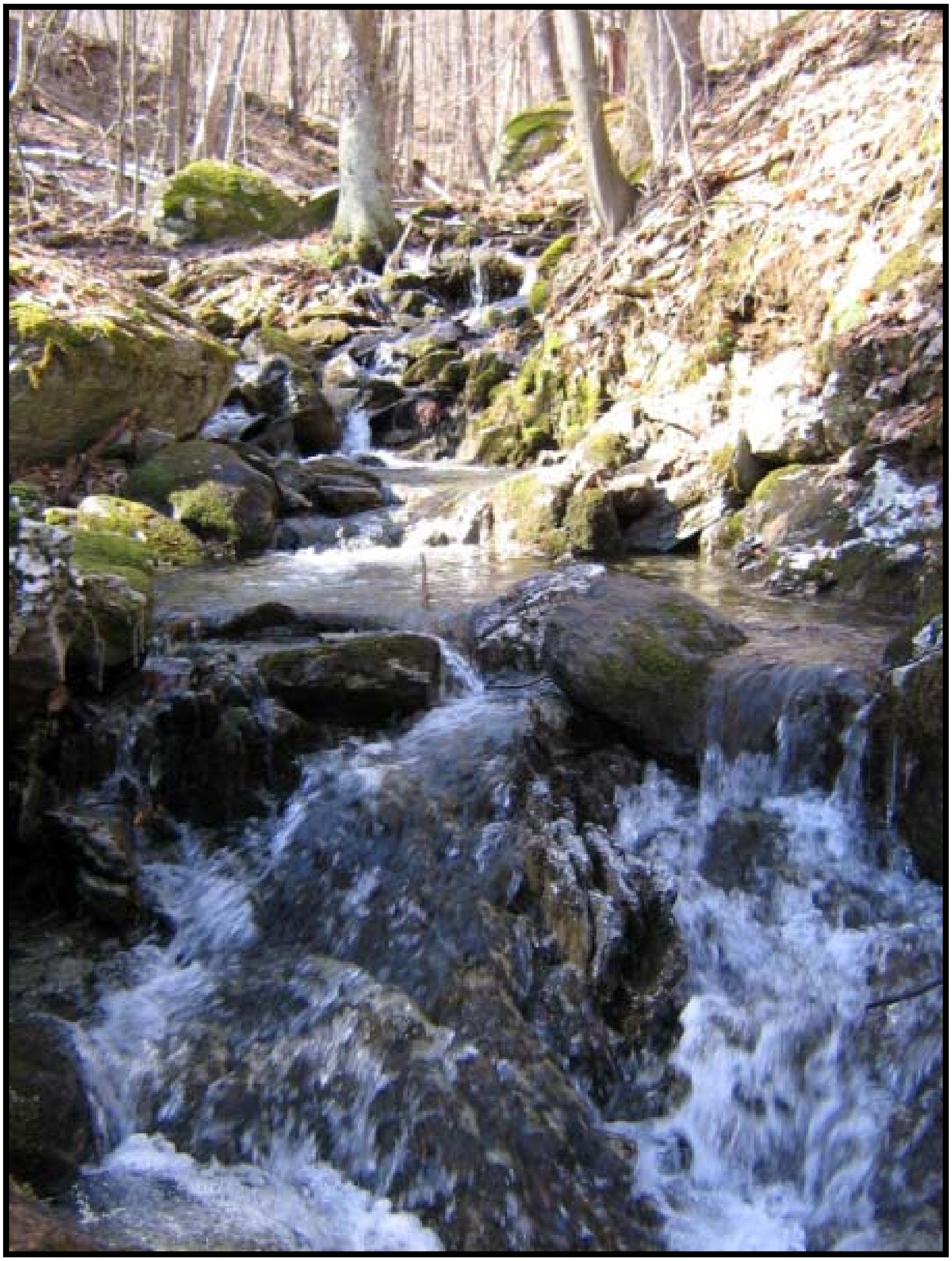
In compiling this document, our team hopes to accomplish three tasks. The first is to provide an inventory of the various components of the Hinesburg Town Forest. Next, we assess the current factors that may influence the Town Forest and change it in the future. Finally, we provide several suggestions to consider in the creation of an informed management plan.

Who are we?

The LIA consulting team is a group of ten graduate students from the Field Naturalist (FN), Ecological Planning (EP), and Vermont Law School Dual Degree programs at the University of Vermont. These programs are designed to give students hands-on skills in integrated field science and natural resource planning. During the first spring semester of these programs, Walter Poleman teaches a Landscape Inventory and Assessment (LIA) course devoted entirely to completing a field-based inventory and assessment for an organization or town.

For more information about the FN and EP Programs, call (802) 656-2930.

SECTION I: LANDSCAPE INVENTORY



SECTION I: LANDSCAPE INVENTORY

Going into the woods, it is easy to be overwhelmed by the many things to observe and understand. You could spend a lifetime learning the details of the suite of flowering plants or cataloguing the unique types of insects and their biologic associations. Months of fieldwork could be exhausted just in examining the minutiae of bedrock and overlying soil of one small patch of forest. Clearly, if the goal is to understand the story of a landscape as a whole, it is necessary to have an organizational approach to looking at the natural world and all of its complexity.

In exploring the landscape of the Hinesburg Town Forest (HTF), we used just such an approach to gather the diversity of data for this project. Although in reality no single part of any landscape can be isolated from the rest, we divided the large and multifaceted HTF terrain into four thematic categories: Physical Landscape, Vegetation, Wildlife, and a Land Use category that included both Cultural History and Current Use. Small teams covered each of these topics separately.

Each team honed in on individual facets of the land, to identify distinct plant species and wildlife sign, field test soil samples and map different types of rock outcrops, and catalog stone walls and cellar holes. This served to inventory the myriad of PIECES that comprise the landscape. But in trying to understand the big picture, the pieces alone don't tell about interactions with one another or fit into the larger scheme. The next step was to look for distinct PATTERNS that clued us in as to how the pieces are arrayed and grouped, and where they are distributed on the land. We also took note of how these patterns have changed through time. With a large landscape and a limited amount of time we realized that it was not essential to know all of the pieces; picking out the spatial and temporal arrangements of salient features revealed the essence of dominant landscape themes. Finally we asked about why the observed patterns exist, and investigated the PROCESSES that drive them. This exposed the causal mechanisms that explain the distribution of pieces and patterns through time.

This first section of this document focuses on the findings of our team as a whole, presented by theme. Though not intended to be comprehensive, we weave together the diversity of landscape layers to provide a basis for the integration in Section II that will later inform management considerations.

PHYSICAL FEATURES

Physical Features

Introduction

In assessing a landscape, the physical geography and the geologic strata provide the base layers above which everything else is built. The bedrock not only creates the topography of the land but also provides much of the mineral component of the soils in which plants will grow. The surficial geology also influences soil composition, as well as providing a context for use of the land by humans and wildlife based on what materials appear close to the surface. Soils directly affect the plants growing above, while the force behind the processes that we see at the surface is the landscape's hydrology. Climate interacts with the vegetation to influence the specific composition of the forests, as well as influencing both wildlife and land use. In terms of land use considerations for the present day Hinesburg Town Forest, the physical landscape determines the best places for trails and roads to be restored and maintained and is important when addressing hydrologic concerns. In this section, we divide the features of the physical landscape into the following categories:

- Climate
- Topography and Landforms
- Bedrock Geology
- Surficial Geology
- Soils
- Hydrology

Methods

We conducted an inventory of the bedrock geology, surficial geology, and soils of the Hinesburg Town Forest by comparing existing maps with our findings in the field. We inspected bedrock outcroppings to visually compare rock types, noted rockiness and sandiness to assess the surficial geology of an area, and examined soil layers, slope, stoniness, and drainage capacity to determine soil type. In addition to the existing surface hydrology data, we used a digital elevation model (DEM) and spatial analysis resources to map smaller streams and microwatershed boundaries on the Town Forest landscape. The DEM we used was projected using a technique in which pulses of laser light capture elevational gradients. This LiDAR technology converts these gradients into elevational values, which are then used to predict the direction water will flow on the landscape (Kavaya, 1999). This allowed us to delineate the edges of small basins acting as microwatersheds at the Town Forest level. Since the use of any computer-generated model gives only a *prediction* of the features that actually occur on a landscape, we supplemented these digital findings with our own GPS-marked observations of actual surface water. We also marked 'drainage concerns' in areas with braided streams or heavy trail erosion.

Climate

In Vermont, climate is closely related to the state's biophysical regions (Figure A1).

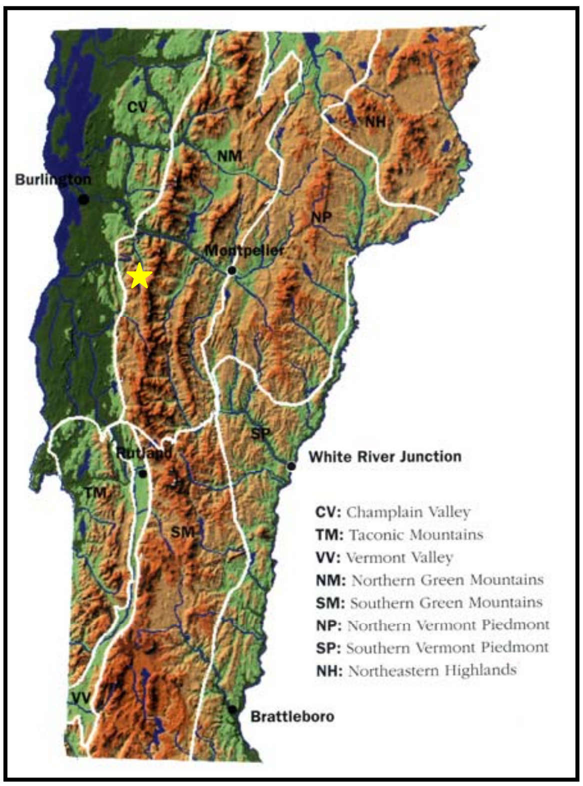


Figure A1: *The biophysical regions of Vermont (Source: Thompson & Sorenson, 2000)*

A biophysical region is a large area that shares similar features of climate, geology, topography, soils, natural plant communities, and human history (Thompson & Sorenson, 2005). The Hinesburg Town Forest is located within the Northern Green Mountain region of Vermont, a region extending from the western foothills across the peaks of the Greens and into central Vermont. The climate of this region is primarily affected by the Green Mountains themselves. Elevation is a key component of climate at a local level, especially with respect to summer temperatures. Between the highest Green Mountain elevations and the base of the Champlain valley, temperatures commonly vary by 20ºF or more (Thompson & Sorenson, 2005). Aspect also contributes to localized climate patterns, with north-facing slopes experiencing the coldest temperatures and the shortest growing seasons.

Patterns of precipitation are also heavily regulated by the Green Mountains as western prevailing winds push warmer air up over the foothills, where it cools. Since cooler air holds less moisture, water vapor condenses into clouds or fog and may precipitate into rain or snow as it rises to higher elevations. This causes a sharp increase in precipitation in this region, rising as high as 72 inches annually at the peaks while remaining at 28-38 inches in the Champlain Valley.

Topography and Landforms

In the foothills of the Green Mountains, the varied topography of the Hinesburg Town Forest has a huge influence on the patterns and diversity of vegetation and land-use on the past and current landscape. Elevations on the property range from approximately 900 feet to 1600 feet above sea level (Figure A2). The most prominent topographical features are a fairly concentric knoll in the middle of the Hollis parcel and a large U-shaped ridge that runs northeast to southwest and then follows the southwestern edge of the property boundary in the main parcel. These ridges are responsible for directing hydrologic patterns on the landscape, and their slope and aspect has a large influence on the vegetation and land-use in those areas. These high ridge tops also provide spectacular views of the Green Mountains and the Champlain Valley.

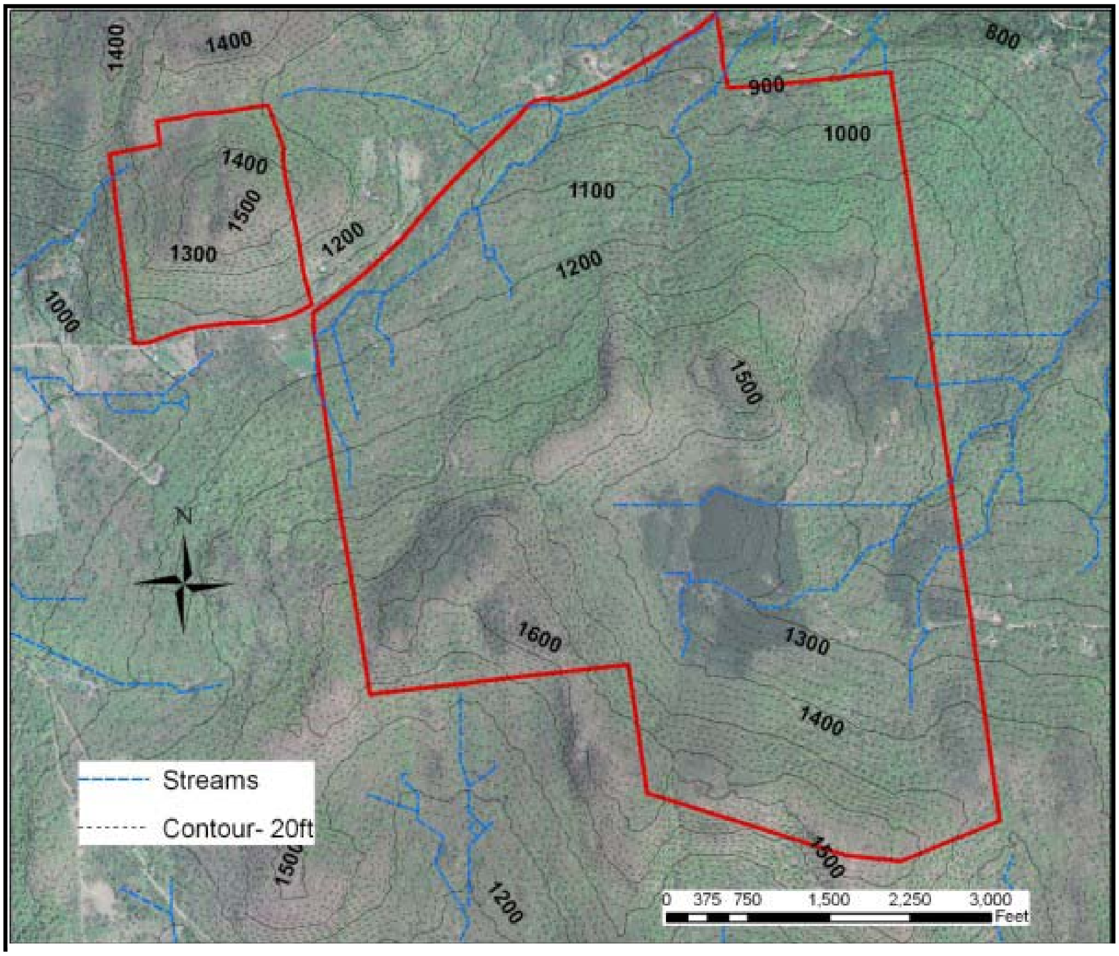


Figure A2: *Topographical map of the Hinesburg Town Forest. (Modified from Vermont Center for Geographic Information and the Chittenden County Metropolitan Planning Organization)*

Mapping landforms provides a method of classification for the different physical shapes that appear on the surface of a landscape. Many ecologists believe that the diversity of the physical landscape is related to the biological diversity it can support (Burnett et al., 1998 as cited in Brook et al., 2003). Below is a map of the landforms found in the Hinesburg Town Forest (Figure A3).

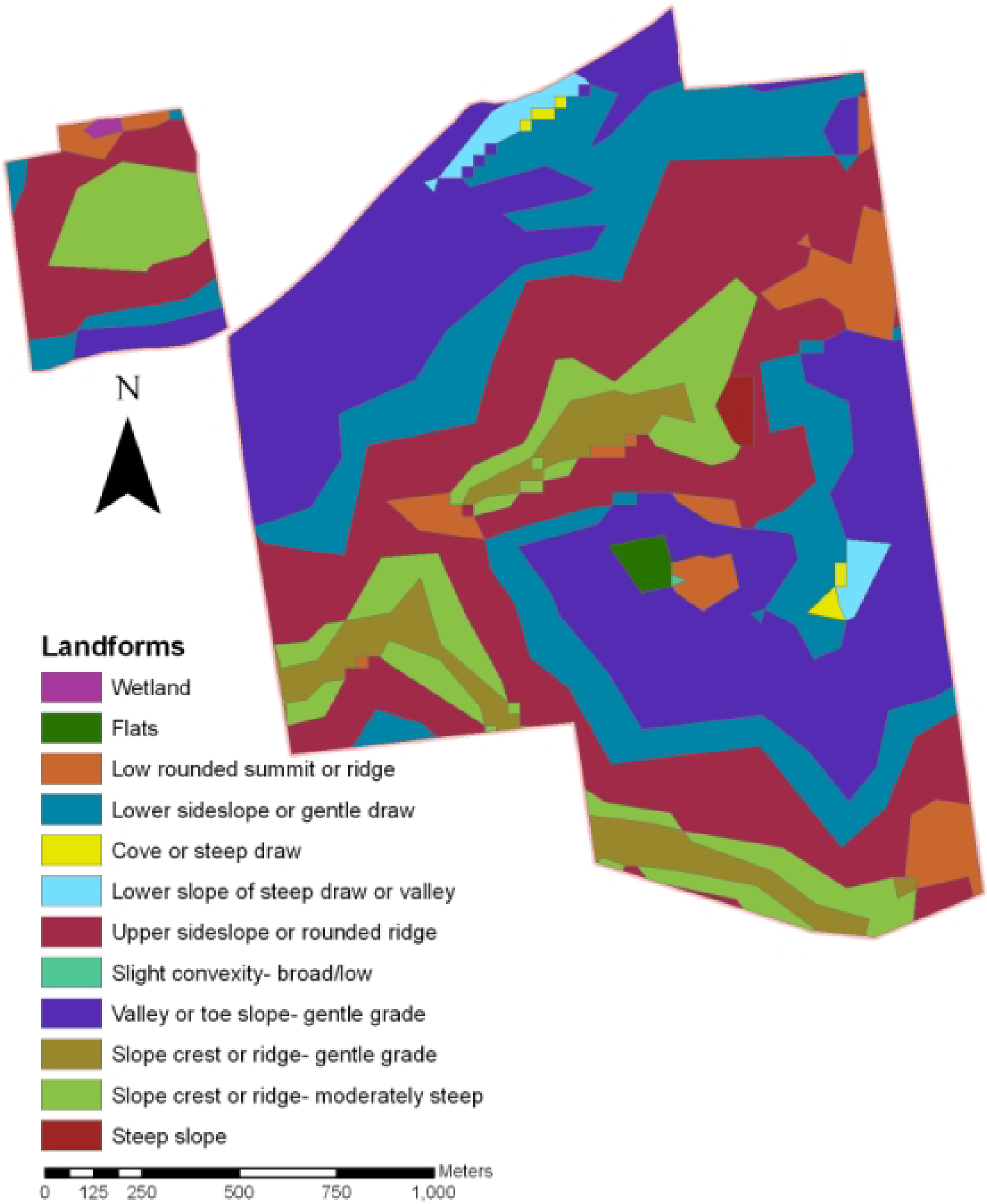


Figure A3: *Landforms of the Hinesburg Town Forest. (Modified from Vermont Center for Geographic Information)*

Of the 18 landform classes that have been defined for the state of Vermont, 12 are found in the Hinesburg Town Forest. Most of these are the steep slopes and gentle coves associated with the various ridges on the property, but the forest also includes several plots of the 'wetland' landform class.

Bedrock Geology

The Hinesburg Town Forest is located on the Eastern side of town in the foothills of the Northern Green Mountains. Like most of the bedrock in this region, the bedrock of the town forest consists of schists, phyllites, and graywackes. The name of this prominent mountain range can be attributed to the greenish hue of these rock types (Detwiller et al., 2005). These older Precambrian and Cambrian rocks were originally laid down as sediments, and were exposed and metamorphosed approximately 450 million years ago during the Taconic orogeny, the event in which the Green Mountains were formed. They are generally non-calcareous or mildly calcareous locally, meaning that they contain little calcium carbonate that would enrich the soil with calcium and magnesium, increasing its buffering capacity. (Thompson & Sorenson, 2005)

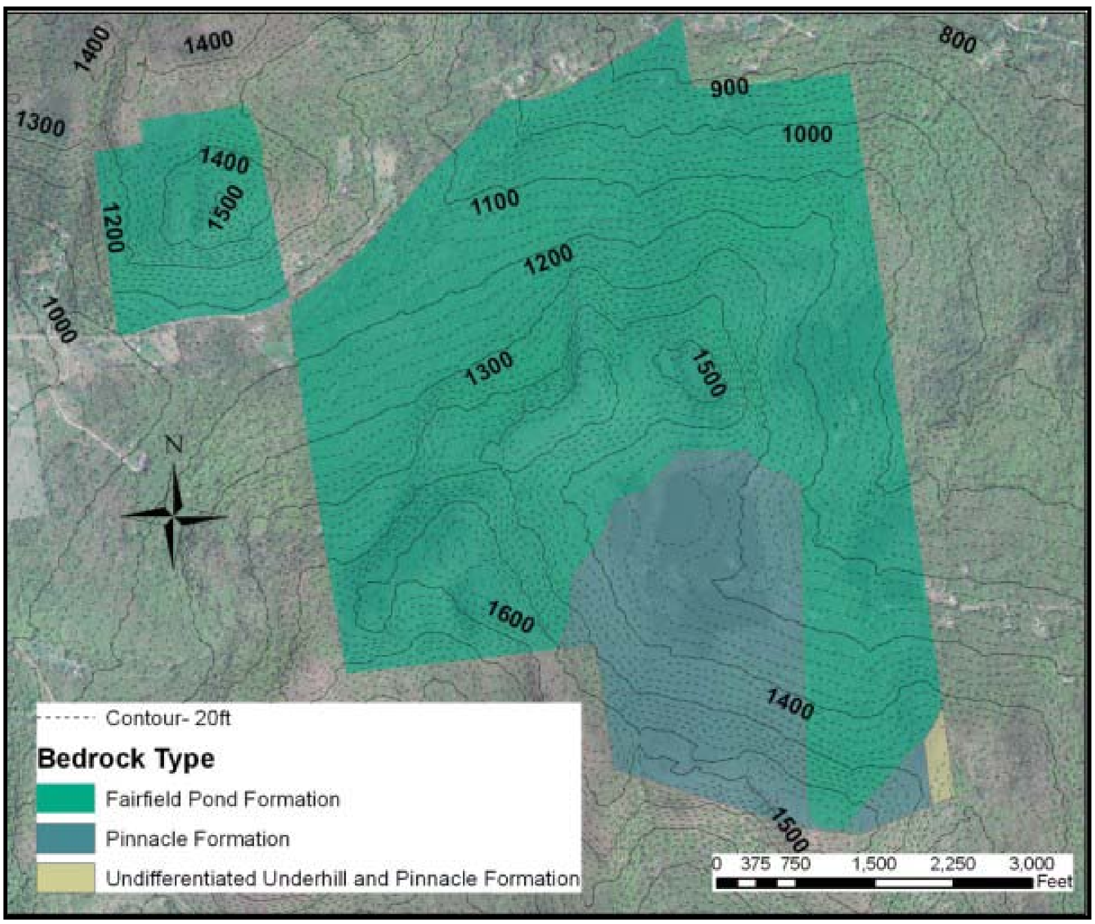


Figure A4: *Bedrock Geology of the Hinesburg Town Forest, Hinesburg, Vermont. (Modified from The Vermont Geological Survey, 1961)*

The majority of the bedrock in the Hinesburg Town Forest is classified as Fairfield Pond Formation (Figures A4, A5). This is a light grey to light green quartz-sericitechlorite phyllite. A phyllite is a fine-grained metamorphic rock derived from shale that is identified by the "lustrous, silky sheen" from light reflected off of many mica crystals. Compared to other metamorphic rocks, the grain size in phyllites is "larger than that of slates but finer than that of schists" (Spencer, 1983).

The southern part of the town forest contains undifferentiated Pinnacle Formation as well as some undifferentiated Underhill Formation and Pinnacle Formation (Figure A4). Pinnacle Formation is a schistose greywacke, which is a dark gray to green sandstone that has been subjected to moderate metamorphism and contains a mixture of quartz and feldspar grains, dark rock fragments and a fine-grained clay and mica matrix. In areas where Underhill and Pinnacle Formations are undifferentiated, the Underhill Formation contributes more coarse grained, metamorphic schist. (Chernikoff, 1995)

Figure A5: *Outcropping of Fairfield Pond Formation (phyllite) in the Hinesburg Town Forest.*

You can find examples of these bedrock types in the many small outcroppings, on larger cliff faces and in most of the stream beds in the Hinesburg Town Forest. The Fairfield Pond Formation is particularly prominent along the eastern edge of the Hollis Parcel, where an expanse of ledges exposes the bedrock at the surface. The stone walls built by 19th century subsistence farmers on this landscape also illustrate these rock types as well as those of surrounding areas that were deposited as glacial till.

> **Landscape Integration**
>
> Stonewalls built by 19th century subsistence farmers are a good place to find examples of the area's rock types. Most of these stones were deposited as glacial till on the landscape, so they include not only rocks corresponding to the bedrock directly below but also to that of up to several miles to the northwest (the path of the glacier).

Surficial Geology

Surficial geology refers to loose materials deposited above the bedrock layer by wind, water, or glaciers. Located in the foothills of the Green Mountains, the surficial geology of the Hinesburg Town Forest closely resembles that of the larger Green Mountain region. The majority of the land is covered in glacial till, with a small pocket of glacial outwash along the northern edge of the property and an area of bare, exposed bedrock in the Hollis Parcel (Figure A6).

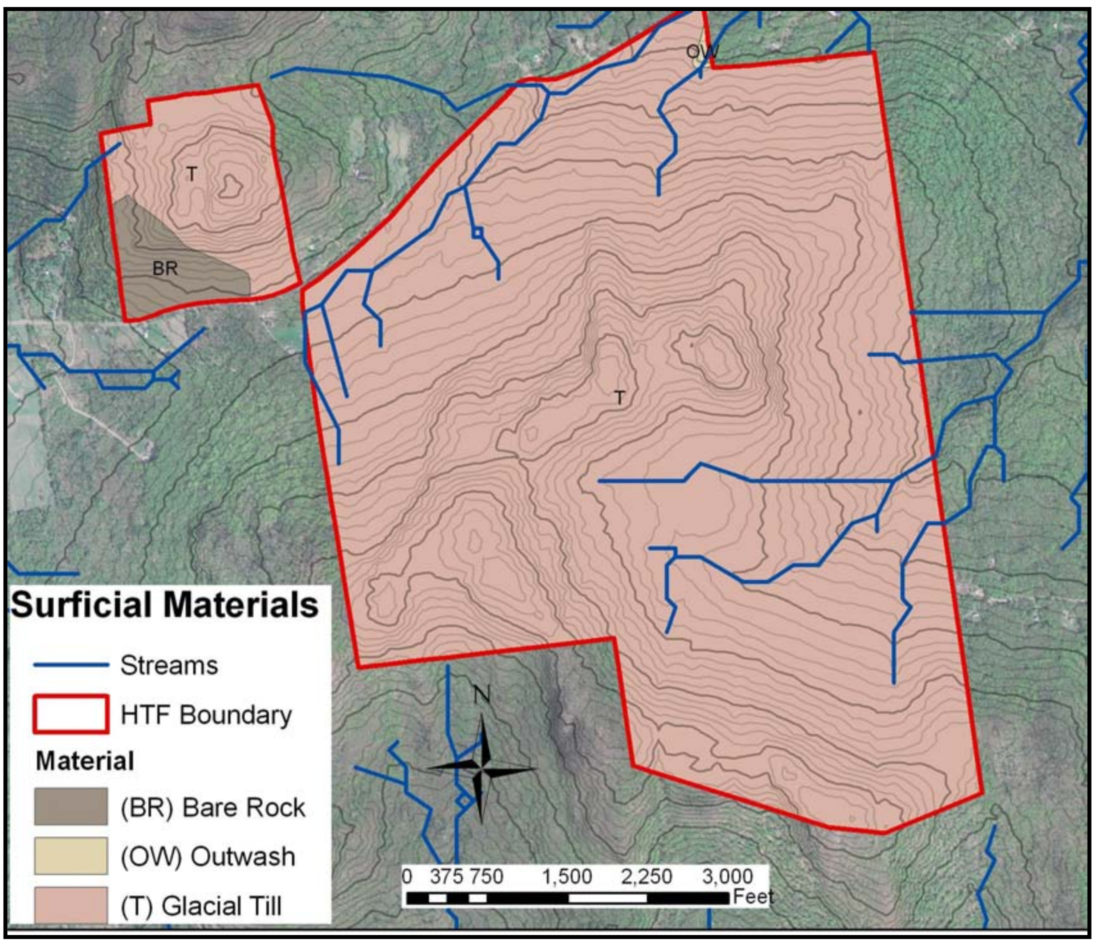


***Figure A6:** Surficial Geology map of the Hinesburg Town Forest, Hinesburg, Vermont (Modified from The Vermont Geological Survey, 1961)*

Glacial Till

About 18,000 years ago, all of Vermont was submerged beneath a layer of ice. This was the maximum extent of the last glacier to cover New England, and it reached as far south as Long Island (Johnson, 1980). As the glacier advanced to the south, rocks, boulders, and debris loose on the landscape were incorporated into the ice pack. After this point of maximum glacial coverage, the glacier began to melt and slowly recede to the north. As the glacier melted, the rocks and debris trapped in the ice were left on the landscape. We call this debris till. It is characterized by its mix of particle sizes that are poorly sorted. Particles range from large boulders to fine silts and clays (Figure A7).

Figure A7: *A variety of particle sizes are associated with glacial till.*

Landscape Integration

The surficial geology of an area directly influences human land use. Although the rocky till soils of the Hinesburg Town Forest and across Vermont were once used for agriculture, these were the first farms abandoned, leaving the majority of current agriculture on the flatter and easier-to-work clay lake deposits of the Champlain Valley.

Because materials were moved from their original locations in the deposition of the till, the surficial material does not necessarily correspond to the bedrock directly below. Till deposits in the Hinesburg Town Forest are especially diverse in composition due to their proximity to the Hinesburg Thrust Fault, a geologic boundary located just to the east of Route 116 along a north-south axis. Where this geologic feature is exposed, several bedrock layers are visible at the surface. This fault line is a junction between two main bedrock types: to the east lies the phyllite and schist that comprises the base layer of the Hinesburg Town Forest and most of the Green Mountains, and to the west lies an array of limestone and dolostone that are characteristic of the Champlain Valley. These rocks exposed to the west, composed predominately of calcium carbonate, break down into soils rich in calcium and magnesium. Since these nutrients are often limiting for plant growth, the soils made from these minerals are considered “rich” and foster plant communities quite different from those made from the phyllites and schists of the rest of the Green Mountain foothills.

In the Hinesburg Town Forest, the till that coats the land is comprised mostly of the phyllites corresponding to the bedrock below. However, pockets of glacially-carried dolostone and limestone are partially responsible for the calcium and magnesium enrichment found in isolated pockets of Hinesburg Town Forest soil (Figure A8). Groundwater seeping through deeper layers of calcareous bedrock enriches the soil further.

The term “till” includes not only the materials deposited in the last glacial retreat but also deposits from all past glacial activity. In New England, it was a series of glaciers that advanced and retreated to carve the landscape that we now see. When till was deposited by an earlier glacial retreat, it was often crushed by the next glacial advance. From the weight of the ice, this till was compacted into a dense layer of “hardpan” or basal till in which particles of all sizes are glued into a mass nearly impermeable to water. A similar layer can be found in areas densely compacted by agricultural equipment or other heavy land use, but in the Hinesburg Town Forest the hardpan layer can most often be associated with the area’s glacial history.

Landscape Integration

Since water often collects above layers of impermeable basal till, vernal pools often correspond to this surficial feature.

Outwash

The northern edge of the property includes a small portion of an expanse of outwash sediments (Figure A6). Outwash refers to the sand and gravel particles deposited by a flow of glacial meltwater, and particles are much better sorted than glacial till, lacking fine sediments as well as large rocks and boulders. Outwash deposits are associated with high permeability and are very well-drained.

Bare Rock

The remaining areas appearing on a surficial geology map are those where bedrock appears directly at the surface (Figure A6). The one large bedrock ledge extending into the Hollis parcel is the only such feature to appear on the map, since expanses less than one acre in size were not plotted. The steep slopes associated with the ridges of the main parcel contain several other rocky ledges, but their small breadth prevents them from appearing on the map.

Soils

The majority of the soils on the HTF are derived from till. With a single family of soil types, the mosaic of varying soils seen on Map 3 can be explained by differences in topography, depth to bedrock, and drainage capacity rather than differences in parent material. They are identified as loams, sandy loams, and silt loams, meaning that they contain relatively comparable mixtures of sand, silt, and clay particles but some areas may have higher relative sand or silt concentrations. The drainage of a soil relies on the depth of the soil developed above the bedrock and the grade of slope. The wetness associated with this drainage capacity is often the distinguishing factor in the visual appearance of these closely-related soils. All five soil types found in the HTF are considered spodosols, but they are not yet fully developed into the layers typically associated with these soils (Figure A8). These five soils include three upland soils (Lyman-Marlow, Marlow, and Peru) and two wetland soils (Cabot and Peacham). The topography associated with each soil is shown in Figure A9.

Figure A8: *The reddish color and layering of the soil appearing in this punch auger suggest the horizons of a spodosol.*

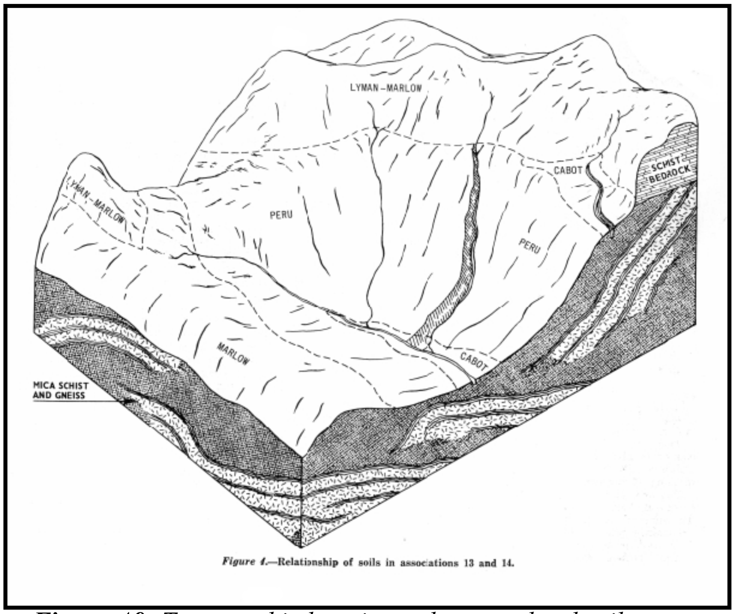


Figure A9: *Topographic locations where spodosol soils occur on the landscape (Source: Chittenden County Soil Survey)*

Lyman-Marlow

Lyman-Marlow soils are till-derived soils occurring on steep slopes where the bedrock is within 10 to 20 inches of the surface. Frequent bedrock outcroppings and very rocky terrain are typical of these soils. They contain coarser particles than other HTF soils and are range from "loam" to "fine sandy loam." Due to a combination of this coarse particle size and the steep slopes on which they are found, Lyman-Marlows are well-drained and appear drier than related soils. They are considered highly erodible and correspond to severe windthrow hazard, particularly on the steepest slopes.

Marlow

Marlow soils (Figure A10) are very similar to Lyman soils but are found on slopes of a lower gradient where they are thicker and better developed. Because of the difference in topography, Marlow soils are typically a deeper 20 to 40 inches thick and are found atop a layer of dense glacial till. Finer particles also occur on this gentler slope, and sand content is lower. Marlow soils generally hit bedrock at least 60 inches below the surface. Marlow soils are well drained and are considered to be "rocky" soils. They can also be highly erodible, but

Figure A10: *An example of a Marlow soil in the Hinesburg Town Forest.*

less so than Lyman soils. However, the higher moisture content corresponds to a more severe rutting hazard.

Peru

Also till-derived and very similar in composition to Lyman and Marlow soils, Peru soils differ mainly in their drainage capacity. Because they are often associated with a layer of dense basal till that inhibits water penetration, Peru soils are wetter than Lyman and Marlow soils and are considered "moderately well drained." When this till hardpan layer is especially dense or close to the surface, it can be impenetrable by tree roots, creating patches of high windthrow hazard (C. Alves, personal comm., 2006). Since dense basal till is also impenetrable to water, it often corresponds to a landscape scattered with vernal pools, as is seen in the HTF. Peru soils are found in areas containing few bedrock outcroppings on sideslopes, and they may contain many loose stones of varying size. They can range from 12 to 36 inches deep to a layer of glacial till or basal till, and bedrock is over 60 inches below the soil surface. These soils are very sensitive to rutting and erosion.

Cabot

Cabot soils are found only in a small wetland area of the Hinesburg Town Forest but are typically located at the base of slopes. They are similar to the soils previously described, but are considered to be silt loams with a smaller overall particle size. Due to their location on the landscape, water collects in these soils and drainage tends to be slow. As a result, these soils often remain saturated for much of the year. They are typically less than 20 inches to glacial till and more than 60 inches to bedrock. Because of their frequent saturation, these soils are particularly vulnerable to compaction and disturbance.

Peacham

These soils occupy the lowest depressions in the landscape and are very poorly drained. Peacham soils rarely dry out, causing decomposition to happen very slowly.

This in turn causes a buildup of organic material into a layer of peat or muck that can be 6 to 16 inches thick. Like Cabot soils, glacial till is less than 20 inches from the surface and bedrock is more than 60 inches deep. They are also very vulnerable to compaction and windthrow.

Soil Characteristics Definitions

Windthrow Hazard

Windthrow hazard is based on the ability of a soil to anchor trees. Rooting depth is the primary factor involved, which may be limited in areas shallow to bedrock, places where a hardpan layer is present, or where there is a water table close to the soil surface. The soil's ability to maintain structure when wet is an additional feature that influences windthrow hazard.

Slight – (greater than 30 inches of rooting depth) Normally there are no trees blown down by the wind. Strong winds may break trees, but the trees are not uprooted.

Moderate- (20-30 inches of rooting depth) An occasional tree may blow down during periods of soil wetness with moderate or strong winds.

Severe- (less than 20 inches of rooting depth) Many trees may be expected to be blown down during periods of soil wetness with moderate or strong winds.

Potential Erosion Hazard (Road/Trail)

Factors considered in determining erosion hazard are slope, the soil erodibility factor (K factor), and the percent of stones greater than 3 inches in diameter in the soil.

Slight – Little or no erosion is likely.

Moderate- Some erosion is likely; occasional maintenance may be needed; simple erosion control measures needed.

Severe- Significant erosion can be expected; roads require frequent maintenance; costly erosion control measures are needed.

Soil Rutting Hazard

Rutting hazard examines only the uppermost soil surface layer. The seasonality of a water table, the percent of stones greater than 3 inches in diameter in or on the soil, and the unified classification of the upper soil layers influence rutting hazard.

Slight – Little or no rutting.

Moderate- Ruts are likely.

Severe- Ruts readily.

Table of Soil Characteristics

Soil Type	Depth to Water Table (ft)	pH	Dominant Texture	Stoniness	Depth to Bedrock (in)	Erosion Hazard	Rutting Hazard	Windthrow Hazard
Cabot	0-2.0	5.6-7.3	Silt Loam	Extremely Stony	> 60	Slight	Severe	Severe
Lyman-Marlow	2.0-3.5	4.5-7.3	Loam to Fine Sandy Loam	Very Rocky	10-20	Severe	Slight	Severe
Marlow	2.0-3.5	4.5-7.3	Loam	Stony to Extremely Stony	> 60	Moderate to Severe	Severe	Moderate
Peacham	0-0.5	5.6-7.3	Silt Loam	Stony	> 60	Slight	Severe	Severe
Peru	1.5-2.5	4.5-6.5	Loam	Stony-Extremely Stony	> 60	Moderate to Severe	Severe	Moderate

Figure A11: *The soils found in the Hinesburg Town Forest and their associated characteristics. (Modified from NRCS Soil Fact Sheets and Chittenden County Soil Survey)*

Enrichment

The enrichment of a soil directly influences the plant community that will grow above. An enriched soil is often rich in calcium and magnesium, raising the pH and making available other nutrients essential for plant growth. Although a calcareous parent material contributes to soil enrichment, particle size and location on the landscape may also influence the nutrient availability of a site. Soils containing a higher concentration of smaller silt and clay particles retain enrichment as on Cabot soils, and areas located at the bases of slopes generally collect nutrients from surrounding higher areas, such as in the Marlow soils. Groundwater can also bring enrichment to the surface from deeper layers of calcareous bedrock, which appears to be happening in several areas of the Hinesburg Town Forest. In comparison to other areas, none of the HTF soils would be considered to be extremely enriched, but pH

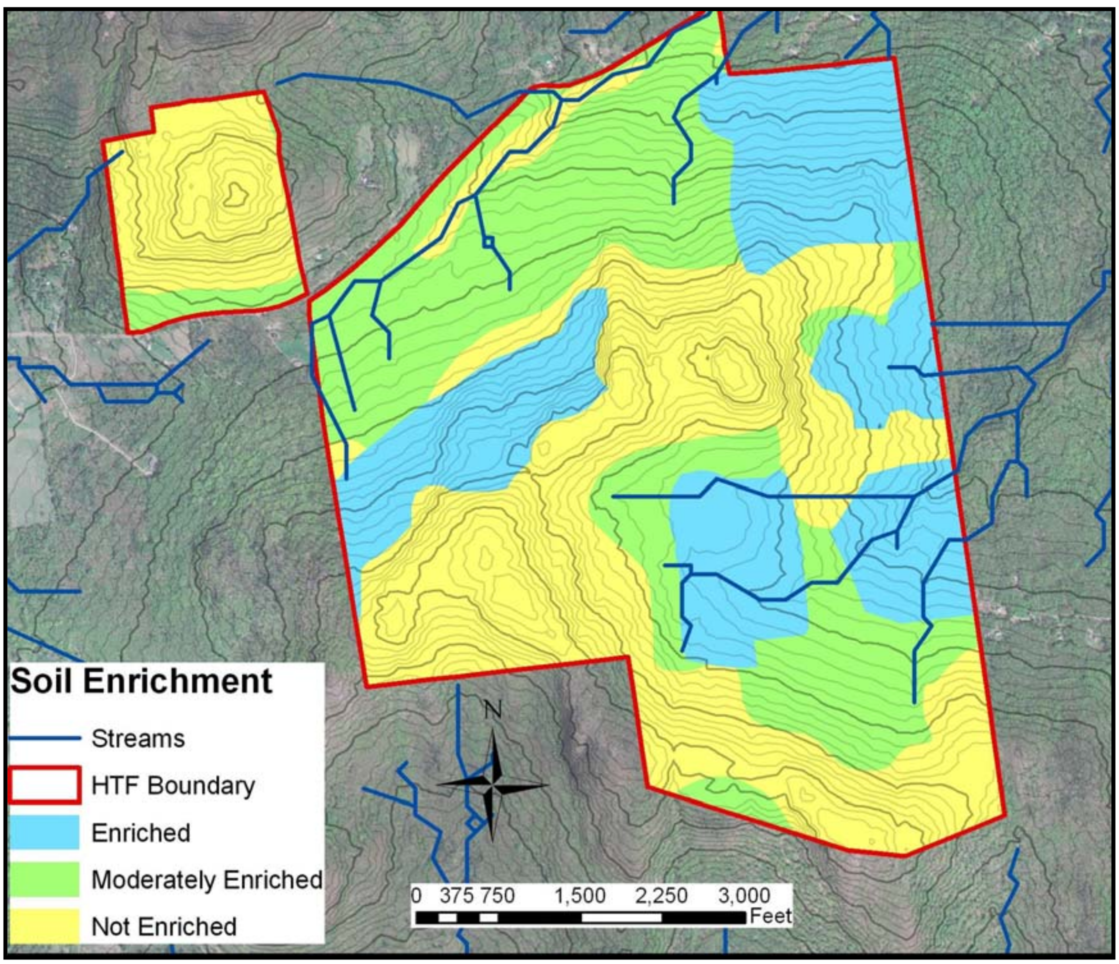


Figure A12: *Estimated Soil Enrichment in the Hinesburg Town Forest, Hinesburg, Vermont (Based on soil characteristics, pH, and presence of plant indicator species)* and various rich-site plant indicators indicate pockets that are richer than soil types alone can explain (Figure A12).

Landscape Integration

Soil composition heavily influences the natural communities able to grow on the land. The table below correlates natural communities that are often associated with specific soil types.

Soil Type	Associated Natural Communities
Cabot	Red Maple-Black Ash Swamp, Spruce-Fir-Tamarack Swamp, Lowland Spruce-Fir Forest, Northern White Cedar Swamp, Alder Swamp, Calcareous Red Maple-Tamarack Swamp
Lyman-Marlow	Hemlock-Northern Hardwood Forest, Northern Hardwood Forest, Mesic Red Oak-Northern Hardwood Forest, Hemlock Forest, Red Pine Forest or Woodland
Marlow	Northern Hardwood Forest, Beech-Red Maple-Hemlock Northern Hardwood Forest Variant, Hemlock Forest
Peacham	Red Maple-Black Ash Swamp, Alder Swamp, Spruce-Fir-Tamarack Swamp, Northern White Cedar Swamp
Peru	Northern Hardwood Forest, Red Spruce-Northern Hardwood Forest, Hemlock Forest

Figure A13: *The soils found in the Hinesburg Town Forest and plant communities often associated with those soils. These are general natural community types; not all communities listed are found in the Hinesburg Town Forest. (Source: NRCS Soil Fact Sheets,2005)*

Hydrology

The majority of the Hinesburg Town Forest is part of the Huntington River and larger Winooski River watershed (Map 2), while the southwestern edge of the main parcel and the western side of the Hollis Parcel are part of the LaPlatte River watershed, which feeds into northern Lake Champlain.

Land-use practices have direct impact on the water quality both within the watershed and on any land downstream from that watershed (Brooks et al., 2003). At a more local level, delineating small-scale watersheds within a property can be useful for assigning forest management compartments and informing land-use decisions. Map 4 shows the surface water and microwatershed boundaries in the Hinesburg Town Forest as calculated using a computerized digital elevation model.

As this image demonstrates, the direction of water flow in the Hinesburg Town Forest divides the property into two more or less even sections by the U-shaped ridge that runs roughly from the northeast to the southwest. While personal observation and inventory of actual topographic and surface water patterns appear to correlate with those predicted by the model, we recommend additional comparisons of this map to the actual landscape to test the accuracy of the computer-generated data.

Landscape Integration

Since a localized impact can influence the entire watershed around it, micro-watershed boundaries can be used to inform forest management and land-use decisions that are sensitive to water-quality.

According to well-known naturalist and consultant Brett Engstrom, soil moisture and surface water patterns have a strong influence on the local vegetation. Thus, hydrology can be as important in determining natural community types as substrate.

Several streams on the property originate from large groundwater seeps. A seep is a small area of saturated soils fed by a constant supply of groundwater (Thompson & Sorenson, 2005). These larger seeps are responsible for two wetland communities on the property that are located on the northwest corner of the Hollis parcel and in the middle of the northern edge of the largest plantation of the main parcel. The forest in the springtime is patterned with many small streams, but since we collected data during the wettest time of the year, we had difficulty determining which streams are ephemeral and which will dry up in other seasons.

There are some areas on the property where human-made trails and the natural hydrology appear to be at odds. In some cases, trails that were built have disrupted the flow of surface water, creating braided streams and large puddles. In others, logging roads and trails have gradually reverted to small streambeds. Several of these "drainage concerns" are noted on Map 4, although these points are not intended to represent a comprehensive list of *all* such locations.

Landscape Integration

In the 19th century, an area's hydrology was an important factor in determining land use. Springs were used to keep dairy products cold, wells were dug for domestic water use, and dams were built across many small streams to control hydrology for other personal needs.

Because groundwater in Vermont is usually well above freezing (averages 47°F), seeps remain thawed year round. This constant supply of warmer water often results in early spring growth of grasses and sedges. This early vegetation can be an important source of food for black bears emerging in the spring (Thompson & Sorenson, 2005).

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CULTURAL HISTORY

Cultural History

Introduction

Today, when walking through the HTF, you could chance upon the relics of ten homestead sites – if you know where to look. If you don't know where to look, you could trace stonewalls running down the slopes and along roadsides, or you could search among patches of apple trees interspersed throughout native hardwoods. When such clues lead you to relics of a homestead site you might discover more remnants of past lifestyles, such as milk cans and agricultural equipment, left behind to rust. You might also notice less tangible relics, like a line of old wolf maple trees bordering an early-successional forest, rock piles amid conifer plantations, or paper birch trees distributed in a checkerboard pattern.

Past human land use can be pieced together through the compilation of historical records like warranty deeds, photographs, and census information, but often remains somewhat enigmatic. Further clues about past land uses persist on the landscape today and exist in people's memories. To really understand the lives of people who lived and worked on the land that is now the HTF and the forces driving their different land uses, it is valuable to place these clues into the larger context of historical influences and the resulting landscape trends. Our primary objectives were to inventory the remnant cultural features and investigate how past human land uses influenced the landscape that we see today. Specifically, we were interested in locating the internal parcel boundaries of farms that were active around the year 1869 and tracing their ownership through the present day.

This section outlines past human land use of the HTF area from pre-settlement times through its transition to a town forest. We also outline our methods for investigating human land use and feature analysis of vegetative patterns and remnant cultural features as important components of this process.

Methods

To piece together the stories of past human land use in the HTF we utilized a variety of sources including: historical records, historical photographs, the expertise of town residents and consultants, and on-the-ground landscape analysis. Historical documents that we relied on include: the 1869 *Atlas of Chittenden County*, by F. W. Beers (referred to as 'the Beers *Atlas'*), the 1882-83 *Gazetteer and Business Directory of Chittenden County*, compiled by H. Child (referred to as 'the Child *Gazetteer'*), and the *U.S. Agricultural Censuses of Vermont* available through the University of Vermont's Media Services. We determined ownership and boundary information of the internal parcels from warranty deeds archived at the Hinesburg Town Clerk's Office and with the assistance of Jane Dorney, a historical geographer. We also consulted collections of historical photographs from the Special Collections Department at the University of Vermont and the Hinesburg Historical Society. To inform our field investigation we used the book *Stonewalls & Cellarholes,* by Robert Sanford, Don Huffer, and Nina Huffer (1995). We also conducted a fly-over of Hinesburg and the HTF on April 6, 2006. Cultural features were recorded using *Global Positioning System* (GPS) units and maps were produced with *Geographic Information System* (GIS) ArcMapping software. All research sources are listed in the reference section.

Figure B1: *Investigating a stonework feature in the HTF*

It is important to note that, throughout history, the nature of available records for Hinesburg has changed. For example, there are significant data on individual farms available for the nineteenth century in the form of agricultural censuses, while the information available for the twentieth century is more qualitative, in the form of oral histories and photographs. The change in available information affects the tone of the sections in this report covering these different time periods.

Pre-European Settlement History B.C. – 1600 A.D.

The archaeological record in Vermont is rich, but incomplete. We did not discover any archaeological remains of Native American human use in the HTF. However, if we broaden our scope to the town of Hinesburg, archaeological surveys have turned up small items such as clay shards of pottery, stone arrowhead tips and woven fibers (Vermont Division for Historic Preservation, 1992). The Division for Historic Preservation's model, *Guidelines for Conducting Archaeology in Vermont* (Peebles, 2002), provides a way to estimate the probability of locating Native American cultural relics on a particular site. The model considers a variety of criteria when assessing a site such as: ridgeline vantage points, proximity to lakes, ponds or other annually wet physical features, and availability of stone resources likely utilized for production of tools for hunting and other purposes. Since Native American artifacts have been found on sites throughout Hinesburg, it is likely that Native Americans at least passed through the area that is now the HTF for the purposes of hunting and gathering. However, it is unlikely that these people set up permanent settlements on the HTF; the immediate area lacks a major body of water. There are opportunities to explore the possibility of Native American land use on the HTF more in depth by collaborating with the University of Vermont's Consulting Archaeology Department.

Landscape Integration

Native Americans in Hinesburg would have been most likely to establish seasonal settlements and hunting camps on sites that had good vantage points along ridgelines, permanent bodies of water such ponds or lakes, or rock outcrops suitable for making tools or weapons for hunting and other purposes.

European Settlement to Municipal Forest: 1600 A.D. – present

Claiming the Frontier

During the early 1700s, the land that is now Vermont was an unclaimed frontier between the English colonies of New York and New Hampshire. Between 1749 and 1764, the governor of New Hampshire, Benning Wentworth, divided more than half the land that would make up Vermont into a grid of towns, with smaller lot divisions comprising each town. Wentworth primarily granted the lots to wealthy, out-of-state land speculators, or proprietors, who profited by dividing and selling the lots to homesteaders (Albers, 2000). Governor Wentworth signed the charter for the town of Hinesburg (originally spelled "Hinesburgh") on June 24, 1762. The town is named for Abel Hine, an original grantee who clerked the meetings held by the proprietors in New Milford, Connecticut. They held these meetings between 1762 and 1783 for the purpose of selling acreage to homesteaders (Hemenway, 1868).

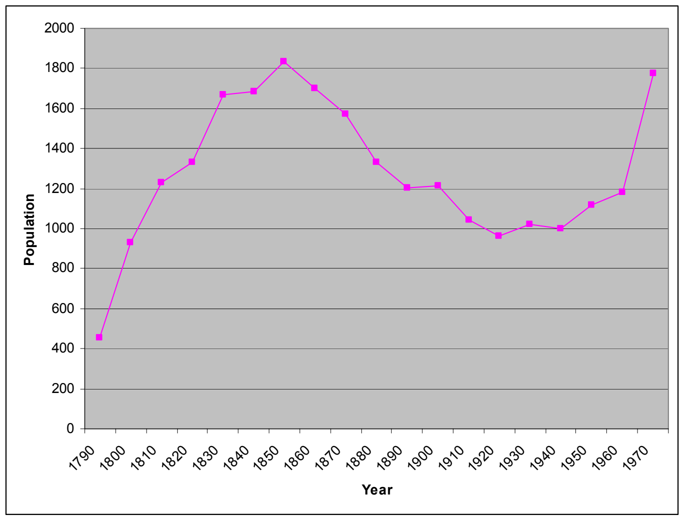


Figure B2: *Hinesburg's population from 1790 – 1970 (Source: Donath, 1975) Hinesburg's population grew to 4,427 by 2004 (Source: Center for Rural Studies, UVM)*

Figure B3: *Second division lots in western Hinesburg; the boundary of the HTF has been added in red. (Beers* Atlas*, 1869)*

Early European settlers moved into the area that is currently Vermont from south to north through two major transportation routes: the Taconic/Champlain Valley in the west and the Connecticut Valley in the east (Albers, 2000). The first two settlers known to have arrived in Hinesburg before the end of the Revolutionary War in 1783 were Issac Lawrence and Abner Chaffee, who were both from Connecticut (Hemenway, 1868). After the end of the War, Hinesburg's population began to grow; by 1791, 454 people resided within the boundaries of the town (Figure B2). Remarkably, more people lived in Hinesburg than in Burlington at this time.

The original Hinesburg lot lines from the New Hampshire Grants can be seen on the 1869 Beers *Atlas*. Smaller fifty-acre lots were created in the valley and village, and larger 100-acre lots, referred to as the "second division", were carved out in the hills (Figure B3). The current HTF includes all of lots 138, 139, 140, 120 and 119, as well as parts of lots 101, 102, 121 and 141. These properties were obtained individually by the Town of Hinesburg during the mid-twentieth century until they formed the contiguous forest we see today. Despite the varied topography found in the HTF, these lot lines were followed quite closely by the people who first settled the area and can still be seen in vegetations patterns on aerial and orthophotographs as well on the ground in the form of stonewalls and barbed wire (Figure B4).

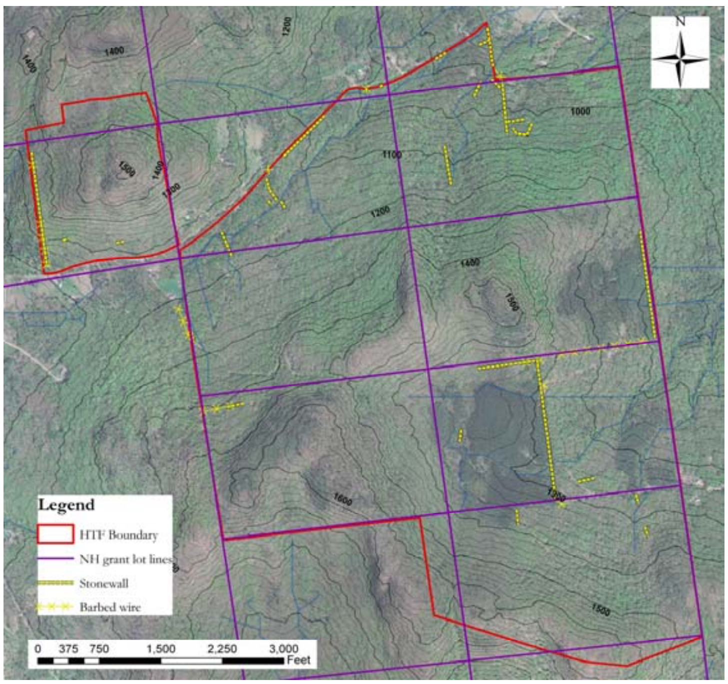


Figure B4: *New Hampshire Grant lot lines with current vegetation patterns and relic cultural features on the HTF*

Landscape Integration

Many of the lines that can be seen on the HTF today, such as abrupt changes in vegetation or stonewalls, mark the original boundaries between the lots that were created over 200 years ago by the New Hampshire Grants.

Legacies of Early Settlement: 1785 - 1850

In order to learn who the very first settlers were to homestead within the landscape of the present-day HTF, it would be necessary to trace the ownership of the properties located within its boundaries back more than 200 years. Although this project did not go into such detail, a general understanding can be pieced together of when and under what circumstances settlers first began hill farming in this area using a sampling of deed records and other historical documents. Based on the available information from the Beers *Atlas*, the Child *Gazetteer* and agricultural censuses, our reconstruction efforts focused on the years 1860 – 1880. Farms are referred to by the last name of the owner at the time of the making of the Beers *Atlas* in 1869, the location and boundaries of which can be referenced on Map 6.

Hinesburg's dramatic population growth during the beginning of the nineteenth century (Figure B2) would have resulted in increased settlement and clearing of areas such as the hills of the HTF for agriculture. The results of our limited deed searches show some properties on the HTF being bought and sold as early as 1820 (Appendix 1). Hinesburg's expansion during this period coincided with the beginning of Vermont's booming sheep industry, which reached its statewide peak in 1840 (Wilgus, 1945). It is likely that farmers were grazing sheep on the hills of the HTF by the turn of the nineteenth century. At this time, they probably would have run small, self-sufficient farms on which woolen cloth and other products, like butter, were produced and kept for consumption or sold locally (J. Dorney, personal communication, 2006).

Mechanicsville and the Sheep Industry

In Hinesburg, the industrial mills of Mechanicsville were powered by the waterfalls and man-made mill ponds of Pond Brook (Figure B5). These mills played a large role in supporting the local agricultural economy from the late 1700s to the early 1900s. The opening of Hinesburg's first carding mill in Mechanicsville in 1836 (Donath, 1975), would have supported a movement toward specialized sheep farming across Hinesburg, since a large part of the processing involved in producing home-spun cloth could be done at the mill (J. Dorney, personal communication, 2006). The transition to large-scale commercial production of woolen cloth in Hinesburg did not occur until later when the carding mill was converted to a woolen mill opened by Isaiah Dows in 1856 (J. Dorney, personal communication, 2006; Donath, 1975).

Figure B5: *Mechanicsville mill, circa 1900*

It is likely that the hill farms in the HTF produced wool to be processed at Dows' woolen mill. Early settlers across Vermont built stonewalls surrounding their cultivated fields to keep grazing sheep out of their crops (J. Dorney, personal communication, 2006). Some of the stonewalls on the HTF may have been constructed during the early 1800s for this purpose. For example, J. Stevens (outlined on Map 6) ran a 90-acre farm on land at least partially within the current HTF prior to 1850. The stonewalls on his property still lace though the woods behind the Hayden Hill East Road parking lot. In 1849, J. Stevens kept 40 sheep and produced 120 pounds of wool. In the same year, Stevens' neighbor, A. Owens, kept 10 sheep and produced 30 pounds of wool. All the other farmers living and working on hill farms near Stevens and Owens also kept sheep and produced wool in 1849 (*Seventh U.S. Agricultural Census*). Although these were not large farms relative to other operations in Vermont at this time, the cleared, steep, rocky slopes of the HTF would have made ideal pasture for the popular merino sheep.

Although homesteaders were active on the HTF prior to 1850, many of the stonewalls found running through the forests of the HTF were probably not built until properties were further subdivided and cleared later in the 1800s. For example, it is possible that A. Place's farm (labeled on our Map 6 on the eastern half of Lot 138 was originally part of J. Steven's farm. Therefore, the cellar hole and barn footing on the A. Place farm were probably not built until after Andrew Place bought the property in 1865 (J. Dorney, personal communication, 2006).

From Sheep to Dairy Farming: 1850-1900

Many farms across Vermont were being abandoned during this period, as people gave up on the rocky, depleted soils of the Vermont hills and moved west or to urban areas (Wilson, 1936). However, many parts of Chittenden County, probably including the HTF, did not reach a height of land clearing until the late 1800's (J. Dorney, personal communication, 2006). Therefore, we can assume that, except for some scattered patches of woodlot and rocky areas or ledges where cows could not graze, most of the HTF had been cleared and was actively being grazed or cultivated by hill farmers in the late 1800s. All of the remnant stonewalls, cellar holes and barn footings that we can see in the Forest today had been built by the time Beers created his atlas in 1869 (Map 5; J. Dorney, personal communication, 2006). It was not until later, as agriculture became increasingly mechanized, that the hill farms in the HTF truly began to lose their struggle with the scoured physical landscape, resulting in an inevitable return to forest on the HTF.

During the period from 1850 to 1870, many properties on the HTF changed ownership (Appendix 1). Farmers such as Andrew Place, Nelson Alger, John Mahan (spelled 'J. Mann' on the Beers *Atlas*), Thomas Drinkwater, Wyman Taft, James

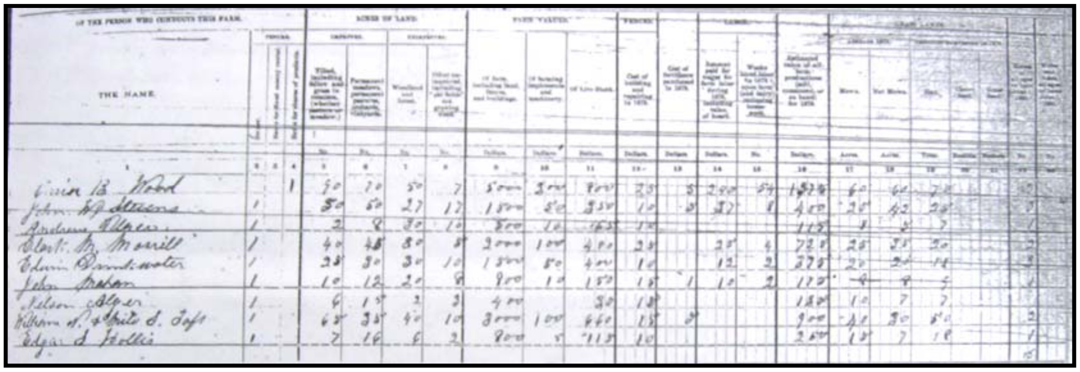


Figure B6: *Tenth U.S. Agricultural Census for farms on the HTF in 1879*

Fraser and Henry Hollis, who can be located on Map 6 and the Beers *Atlas*, all started farming on the HTF during this time. Many of these farmers, such as Andrew Place, came from families who had lived in Vermont and Hinesburg for many years. The Places originally settled the Rhode Island Corners area of Hinesburg (J. Dorney, personal communication, 2006), and Thomas Place is recorded as having arrived in Hinesburg in 1785 with some of the earliest settlers (Hemenway, 1868). However, Thomas Drinkwater and his wife, Ann, had emigrated from England and John Mahan and his wife, Jane, were born in Ireland (*U.S. Census*, 1860 and 1870). The immigrant population in the HTF during this time reflected a town-wide trend since, in 1868, a third of Hinesburg's population were recent immigrants, primarily French Canadians and Irish (Hemenway, 1868).

Even in 1870, when Mechanicsville had been operating as an area of local industry for nearly a century, the hill farms in the HTF were still impressively diversified. Since transportation on unimproved roads by horse and wagon or cart was still slow and unreliable, most families continued to produce much of what they needed on their farms. In 1870, Wyman and Milo Taft owned one of the larger farms on the HTF, totaling 120 acres (outlined on Map 6). The brothers lived there with Wyman's wife, Roselle, and their three young children, including twin infant sons (*U.S. Census*, 1870). In 1879, Wyman and Milo kept two horses, 15 milk cows, four sheep and three pigs, grew wheat, Indian corn, hay, potatoes and apples, and produced wool, butter, maple syrup and molasses (*Tenth U.S. Agricultural Census*)(Figure B6).

However, not all hill farmers in the HTF relied solely on farming to make a living. Andrew Place only owned 50 acres of land, which would have been too small of a farm to support him without another source of income (J. Dorney, personal communication, 2006). The Child *Gazeteer* shows that Andrew was a carpenter, as well as a farmer. Andrew's land use also reflected his second profession. He maintained 30 of his 50 acres as a woodlot from which he removed 89 cords of wood 1879 (*Tenth U.S. Agricultural Census*), possibly to be milled into boards for use in construction.

What is most unique about the hill farms in the HTF during the 1860s and 1870s is the fact that farmers still kept sheep (*Eighth and Ninth U.S. Agricultural Censuses)*. Even though most farmers only had a few, the fact that they had any at all during this time period was very unusual in Vermont (J. Dorney, personal communication, 2006). In the rest of the state, sheep farming was in sharp decline by 1850 due to the removal of a protective tariff on imported wool in 1846 and the increased production of wool in the west, which could easy be transported to mills and factories in the east as the railroad network was expanded and improved (Wilson, 1936). Hinesburg farmers were temporarily insulated from the statewide collapse of the woolen market by the continued operation of Dows' woolen mill in Mechanicsville until the late 1880s (J. Dorney, personal communication, 2006).

Landscape Integration

The unique geology of the Hinesburg Thrust Fault probably contributed the formation of Pond Brook, which flows over the thrust fault and drops 300 feet in one mile. Pond Brook provided waterpower for 34 mills during the 215-year industrial history of Mechanicsville.

Even though the sheep industry was still active in Hinesburg after 1850, most farmers on the HTF, like farmers across the state, were transitioning to dairy farming. In Hinesburg, this transition corresponded with a drop in the town's population (Figure B2) when the railroad from southern Vermont to Burlington was constructed and bypassed Hinesburg. By 1870, all farmers on the HTF kept dairy cows; Wyman and Milo Taft, James Fraser, Henry Hollis and H. Owens had the largest operations with 17 - 22 cows (*Ninth U.S. Agricultural Census*). When the dairy industry first began in Vermont, the farmers closest to the town centers furnished the larger urban areas with liquid milk, the farmers farther away furnished butter, and those around the periphery sent cheese (Albers, 2000). A cheese box factory opened in Mechanicsville in 1855 (Donath, 1975), which provided home-producers, such as James Fraser who made 5500 pounds of cheese on his farm in 1869 (*Ninth U.S. Agricultural Census*), with packaging for their products. For many hill farms, selling liquid milk was not an option until more efficient means of transportation became widespread in the 1930s (J. Dorney, personal communication, 2006). Andrew Place, who married Ellen and had a daughter, Daisy, after 1880, (*U.S. Census,* 1880; C. Harvey, personal communication, 2006) sold butter that he made at home (*Ninth U.S. Agricultural Census*) but probably never produced liquid milk for commercial purposes before he sold his farm in 1925.

From Dairy to Decline: 1900-1936

Because home production of butter and cheese was labor-intensive and subject to inconsistencies in quality, farmers banded together to open creameries (Albers, 2000). Local farmers brought liquid milk to the creameries where it was processed into cheese and butter in a factory setting. The first creamery in Hinesburg opened along the canal in the village in the early 1800s (J. Dorney, personal communication, 2006). At first, it primarily served valley dairy farmers whose trips to the creamery were relatively short. But, as transportation improved, farmers from farther distances were able to transition from home-production to factory-production of dairy products.

Andrew and Ellen Place sold their 50-acre farm in 1925 to Marien Verboom, a herdsman originally from Holland who would marry their daughter, Daisy (C. Harvey, personal communication, 2006). When Marien and Daisy Verboom operated their farm (Figure B7) in the 1930s and 40s, they were probably able to drive liquid milk to town daily to be made into butter or cheese at the creamery.

Figure B7: *Verboom (A. Place) house, circa 1930*

Despite the lack of agricultural census data for the early twentieth century, the Verbooms were said to have kept between 10 – 12 dairy cows (S. Russell, personal communication, 2006). The relic milk cans (Figure B8) and remnants of a spring house on the property suggest that the Verbooms milked in the evening, stored the milk in cans overnight in the cold spring house water to avoid spoilage, milked again in the morning and then drove the cans to town (J. Dorney, personal communication, 2006).

Figure B8: *Remnants of the Verboom (A. Place) house with chimney (foreground) and milk cans (background.) 2006*

Other dairy farmers on the HTF followed a similar pattern of production during that time (C. Harvey, personal communication, 2006).

However, the forces of increased mechanization and regulations in the dairy industry, combined with depleted soils and difficult terrain, began to have a significant impact on hill farms all over Vermont. It became increasingly difficult for small, non-mechanized hill farms to compete with growing valley farms (J. Dorney, personal communication, 2006). In addition, health concerns over sanitation practices necessitated more regulations in the milk production industry. For example, farmers were encouraged, and later required, to replace their wooden barn floors with cement ones (Albers, 2000). But the most significant change in the industry for small hill farm producers was the switch from milk cans to bulk tanks. The bulk tanks were large, stainless steel cooling tanks that held the farm's milk for several days until a tanker truck visited the farm and drained the milk into its tank. Milk cans had been fairly inexpensive and easy for farmers to transport. The bulk tank, on the other hand, was quite expensive, required electricity, and relied on visitation from a milk tanker truck. Although bulk tanks were not required by law until the mid-1950s, movements by local creameries to only accept milk delivered by bulk truck happened earlier (Albers, 2000). For the Verbooms and the other hill farmers on the HTF, making enough money to support themselves and pay taxes in the face of these changes became impossible.

Figure B9: *Old milk can near the cellar hole on the T. Drinkwater farm. 2006.*

The Making of a Town Forest: 1936 – present

As a result of these difficult conditions, the hill farms of the HTF were abandoned over a period of about 20 years beginning in 1936. The HTF was formed as a municipal forest as a result of these farmers' hardships. Although we do not know the exact circumstances under which it was acquired, the first farm that became town property, and eventually part of the HTF, was the 100-acre T. Drinkwater farm (outlined on Map 6) owned by Felix Martin in 1936. As the hill farms in the HTF continued to decline, the 100-acre J. Mahan farm owned by Fred Judas was taken by the town for taxes in the following year and the adjacent 120-acre W. and M. Taft farm was deeded to the town by Blodgett in 1941. Thomas Drinkwater, John Mahan and Milo and Wyman Taft had been farming on these properties only 50 – 60 years earlier.

The rest of the properties that make up the HTF were taken by the town for taxes or deeded by the owner over the next 17 years until the last 125 acres was acquired in 1958 from the Plant and Griffith Lumber Company (Appendix 1). Since the early years of its existence, the HTF has been managed by the State's county foresters (George Turner, William Hall (with assistant county forester David Brynn), and Michael Snyder) and Hinesburg's Town Forest Committee primarily for timber, firewood, and wildlife habitat, especially for game species such as white-tailed deer.

UNDERSTANDING LAND USE FROM VEGETATIVE PATTERNS

Figure B10: *A stonewall marks the boundary of an old field that is now a plantation (right) on the T. Drinkwater farm. 2006.*

Past land use has played a major role in defining the current vegetation patterns that we see on the HTF today. As we have discussed, until fairly recently, farmers on the properties that make up the HTF used sections of their land for different purposes: cultivating crops, mowing hay, grazing cows and sheep, sugaring, growing apples and cutting firewood. As this patchwork of fields, pastures, orchards and woodlots were abandoned over time, different plant communities established, contributing to the patchwork of forest cover types of different ages and species compositions in various stages of development that makes up the forest today. Using historical records, such as agricultural censuses and deeds, and many clues on the current landscape, it would be possible to reconstruct the historical use of each acre of the HTF. Although we did not go into such detail for this project, we did find some interesting vegetation patterns that help us piece together the details of past land use on the HTF.

Plantations

Looking at the HTF from above, the dark, geometric shapes of the patches of softwoods in the eastern part of the HTF immediately catch the eye (Figure B11). These plantations of Norway spruce, eastern white pine, and red pine, were planted in the 1940s by the town as part of a state-wide soil conservation effort. In an aerial photograph, it is possible to see that the land where the plantations are today was still open in 1942 (Figure B12). We can assume that these areas were cultivated fields rather than pastures because the floors of the plantations are still smooth, indicating that the soil was tilled by a plow, and piles of stones that farmers would not have bothered to clear from pastures can be found throughout the

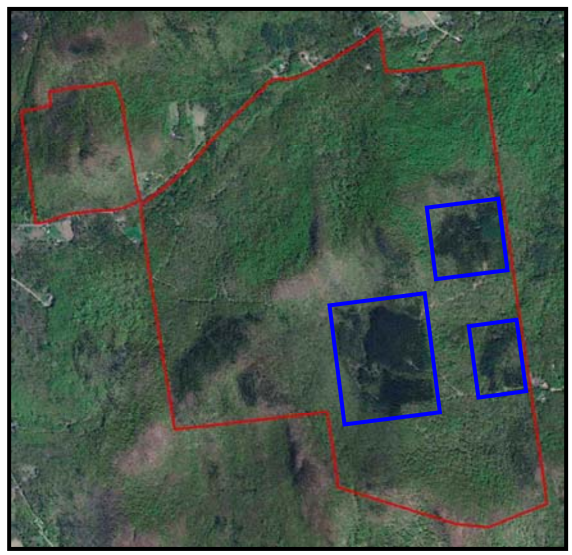


Figure B11: *Current orthophoto of the HTF (plantations outlined in blue)*

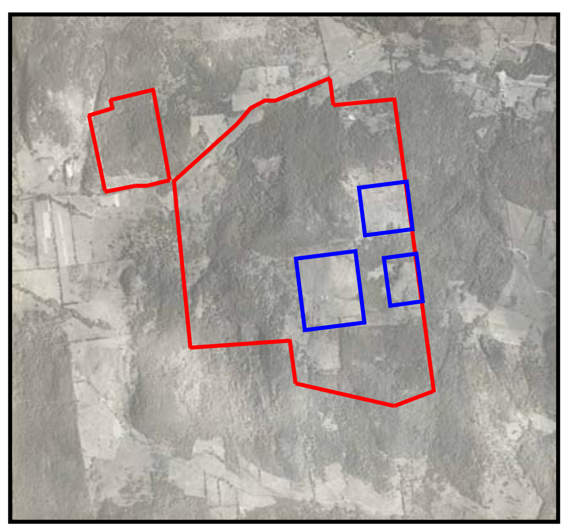


Figure B12: *1942 aerial photograph of the HTF (open fields outlined in blue)* plantations. In addition, it would have been easier to plant seedlings in an abandoned field, rather than a stony pasture. Many of the plantations are also surrounded by old stonewalls and barbed wire, which originally marked boundaries between properties or fields, pastures, and woodlots, and today, mark boundaries between forest stands (Figure B10).

Sugarbushes and Orchards

We know from agricultural censuses and deed records that many farmers on the HTF maintained sugar bushes. It is likely that most of these original stands of sugar maple were logged off since there are very few trees over 200 years old on the HTF today, and we know that logging has occurred regularly on the HTF for a long time. However, based on the information from historical records, topography and current cover types, we can make guesses about where sugarbushes may have been located on some of the properties. For example, Thomas Drinkwater made 150 pounds of maple sugar in 1869 and 500 pounds in 1879 (*Ninth and Tenth U.S. Agricultural Census*). When Drinkwater's farm was sold by its next owner in 1893, the deed shows that all sugaring tools were also transferred to the grantee.

The northern portion of the 100-acre T. Drinkwater farm is comprised of several steep-sloped gullies, where sugar maple is currently dominant in the canopy. Since this site would have been impossible to plow and sugar maple clearly does well here, it is possible that this was Drinkwater's sugarbush. In a similar site nearby on the A. Place farm we found the stonework remains of a structure that could have been an old sugarhouse (Map 5).

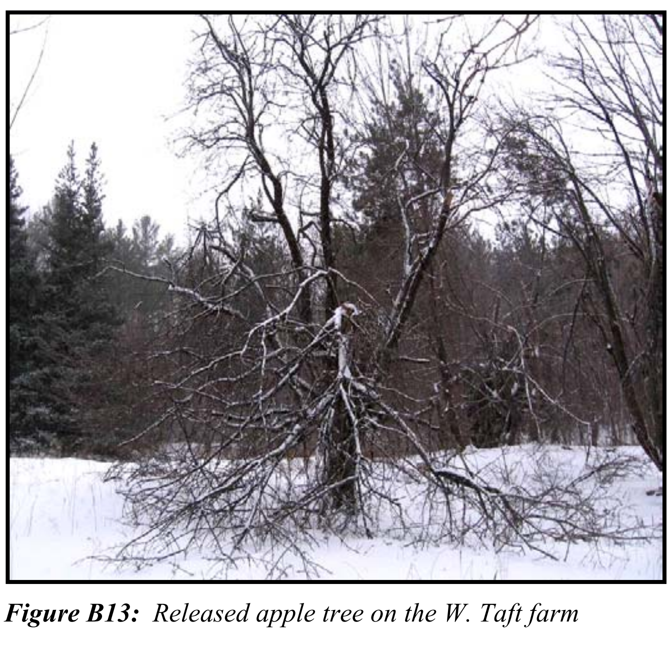


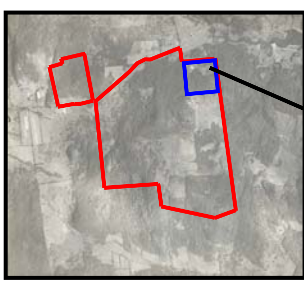
Figure B13: *Released apple tree on the W. Taft farm*

Although we did not find any record that Andrew Place sugared, it is possible that Marien and Daisy Verboom produced maple syrup or sugar. If this is the case, such selective management for sugar maples would certainly have affected the development of the forest that we see on the site today.

The remnants and descendants of old apple orchards (Figure B13) on the HTF are found primarily near old cellar holes and barn footings. Farmers on the HTF had up to 100 trees in their orchards (*Tenth U.S. Agricultural Census*). Most of these original orchards were probably taken over by other trees as the forest returned to the HTF after abandonment of the farms. The apple trees that remain have been released to provide food for a wide variety of animal species (M. Snyder, personal communication, 2006).

Woodlots vs. Pasture

All of the farmers on the HTF would have kept at least a small woodlot in order to supply firewood to their households for cooking and heating, and perhaps lumber for use or sale. These historic woodlots are unique because it is unlikely that they were ever fully cleared for grazing or cultivation. The successional patterns of a logged, or



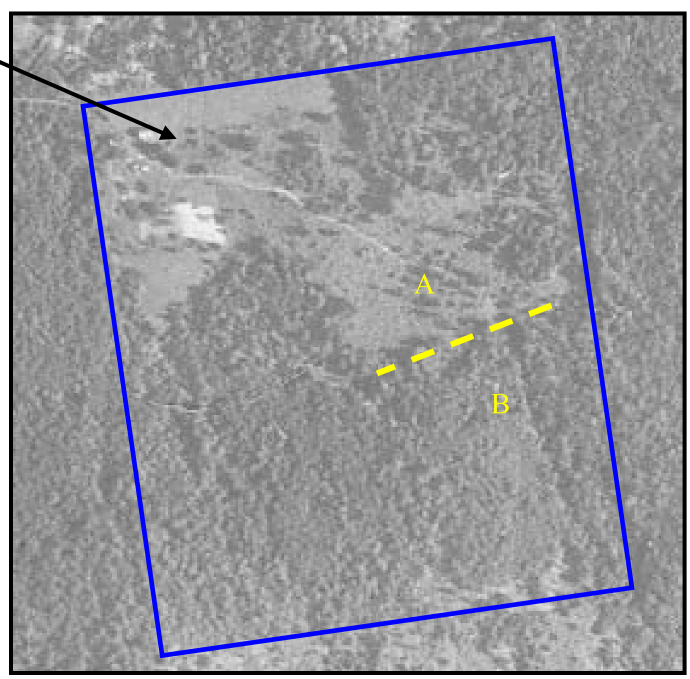


Figure B14: *Verboom (A. Place) farm in 1942 showing the old pasture (A), the old woodlot (B), a line of old stumps between the two (yellow dashed line), and the 50-acre property boundary (blue line)* even clearcut, woodlot are likely to be different than those of an abandoned pasture or field and can be recognized even years later (J. Dorney, personal communication, 2006).

On the A. Place farm, we know that Andrew maintained 30 acres of his property as a woodlot (*Tenth U. S. Agricultural Census*). By 1942, when Marien and Daisy Verboom were running the farm, some of the old pastures had probably already been abandoned, but others were still being actively grazed (Figure B14). Today, all of the A. Place farm, except for the area immediately around the cellar hole and barn footing, has returned to forest. However, there are subtle differences in species composition and forest structure between the old pastures that were most recently abandoned and what we believe to be the old woodlot. A line of old sugar maple stumps can still be followed along the old boundary between forest and pasture (Figure B14). The most noticeable difference between the current forest on either side of this line is that paper birch is abundant in the old pasture and absent from the old woodlot. The old woodlot also has a greater number of larger trees, which are more spread out, indicating that the stand, despite active cutting within the past thirty years, has had a longer time to develop as a forest than the old pasture. As these two forest stands continue to age, it is possible that, eventually, their development will converge and it will no longer be possible to recognize the effects of past land use. However, there are also differences in slope and soil moisture between the two sites that will continue to have an impact on the development of the stands. It is likely that these physical site differences affected the initial choices made by Andrew Place and previous landowners about how to use the land.

REMNANT CULTURAL FEATURES

The cultural features we see today within the HTF are varied and dispersed across the landscape. They are clues to the mysteries of past human land use because they provide a visual reference that informs reconstruction of a particular site's history. The sensitivity of these features and their associated site can inform management decisions regarding future use. Remnant cultural features include: building foundations, boundary and field markers, and relics of the agricultural past.

Cellar Holes and Barn Footings

Figure B15: *Barn footing on T. Drinkwater farm. 2006.*

The clearsest indicator that a home once stood on a site is a cellar hole, which is a sunken earthen hole between two to six feet deep and lined on all sides by stonewalls. There are ten known cellar holes in the HTF; many of them are relatively near an accompanying barn footing. Barn footings usually involved less excavation than cellar holes and often were built into the side of a hill. In order to easily transport agricultural products, houses and barns were typically built along roadways (Sanford et al., 1995). The cellar hole and barn footing on the T. Drinkwater farm are largely intact and aid in the visualization of the past cultural landscape (Figure B15).

Stonewalls and Barbed Wire

Farmers used fencing both to manage farm animals and to mark property boundaries. In order to keep farm animals out off crop fields, early fencing enclosed the crops whereas later fencing enclosed the animals. While wood fences were the original form of boundary marking, all that remains of them are the stones that farmers piled at the base when clearing fields (Sanford et al., 1995). Stonewalls that traverse the Forest are either the result of the collection of stones under wooden fences or of careful construction near farmhouses (Figure B16). The walls in the HTF generally run from north to south or east to west, often along original lot lines (Map 6).

With the invention of barbed wire in the late nineteenth century, farmers replaced wooden fences with the metal wire attached to trees growing along the existing stonewalls (Sanford et al., 1995). A network of barbed wire can be found in the HTF, often embedded within a tree or attached to an old fence post (Figure B17). Typically, animals were kept on the side of the barbed wire fence that was attached to the tree because the animals could not push the barbed wire out and escape (Sanford et al., 1995). Judging from the ages of the trees used as fence posts and the extent to which the trees have grown around the wire, the barbed wire fencing at the HTF probably dates from many different time periods.

Figure B16: *Stonewall marking the western boundary of the A. Place farm. 2006.*

Figure B17: *Barbed wire wrapped around an old fence post. 2006.*

Other Relics of an Agricultural Past

As mentioned earlier, rock piles are found in areas of the HTF that were once cultivated fields. As most gardeners know, each year winter frosts heave rocks from beneath the ground. Because farmers did not want to damage their farming equipment, they piled these endlessly-surfacing rocks, not only under wooden fences, but also in central locations (Figure B18).

The line between trash and relic blurs at the HTF; milk cans, glass bottles, farm equipment, motors, sap buckets, and household items are strewn around old homesteads (Figure B19).

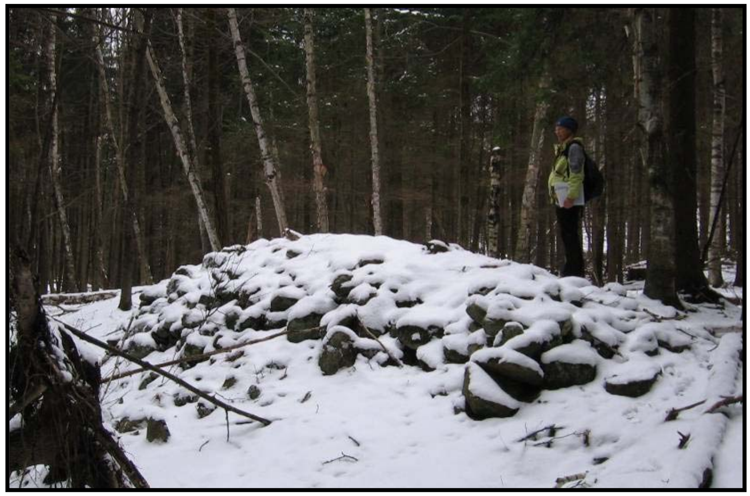


Figure B18: *Rock pile in a plantation on the T. Drinkwater farm. 2006.*

Figure B19: *Collection of relics at the cellar hole on the A. Place farm. 2006.*

It seems that yesterday's refuse is today's treasure and give us an insight into the lives of people who once made their living in these hills.

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VEGETATION

Aerial photo, Hinesburg Town Forest flyover, April 7, 2006.

Vegetation

Introduction

Understanding the vegetative pattern on a landscape is important in developing an effective management plan; there are several methods that can be used to classify these patterns. We utilized two classification systems in our assessment of the Hinesburg Town Forest: cover types and natural communities. The cover type approach classifies landscape elements predominately based on canopy tree species present, and traditionally has been used to assess timber resources. The natural community approach classifies landscape elements based on an integrated assessment of current vegetation, soils, hydrology, and other site characteristics and is used to predict the potential future vegetation of a site. Natural community mapping is often used for the purposes of conservation planning and biodiversity protection, as well as for timber, wildlife, and recreation management. In the following pages, we describe the cover types and natural communities of the Town Forest.

Current Cover Types

The classification of current cover types can be used as a tool to assess timber resources and to inform management decisions. Traditionally, current cover classifications are created to identify the vegetative composition of a forest stand. Relevant resources, such as the Society of American Forester Cover Types (Eyre, 1980), were consulted. Though the SAF cover type approach is based on tree species whenever possible, we found it useful to include information in our descriptions about all vegetation in a stand, from the herbaceous layer to the canopy cover. We mapped the current vegetation of the Hinesburg Town Forest, and assigned cover type names based on dominant tree species composition.

Cover Type Methods

Current cover assessment is multi-step process. First, we sorted data that had been amassed by Michael Snyder. Michael Snyder is the Chittenden County Forester, and has been managing the Hinesburg Town Forest since 1997. We recorded pertinent information on forest cover was recorded, including historic land use, timber management, and stand information. Special attention was paid to David Brynn's stand notes and 1986 management plan (Brynn was assistant Chittenden County Forester at that time). The team consulted aerial and orthophotographs were consulted to delineate Brynn's 1986 stands, and to develop an understanding of vegetative cover. We found historical aerial photos were especially helpful in determining historic land-use patterns and field abandonment. We could actually see fields recolonized by trees in the successive aerial photos, and begin to pinpoint the time of field abandonment. This was very helpful when considering patterns of succession in the Town Forest. Field time was spent to determine the accuracy of the historical vegetation data. The team focused field time on areas where little information had previously been recorded, on areas of special interest to Mr. Snyder, and on areas where vegetation type could not be readily determined using the orthophotos or historical vegetation data. A current cover map (Map 7) was created based on vegetation data collected. The stands have been renumbered (Map 11 in Appendix 3) but 1986 Brynn stand numbers can be found in the stand information chart (Appendix 3) that follows the current cover descriptions.

Cover Types

Northern Hardwood Cover Types

The Northern Hardwood Forest cover type dominates the forested Vermont landscape (Thompson & Sorenson, 2000). Not surprisingly, this cover type is a major component of the Hinesburg Town Forest, making up the majority of the Forest's current cover. Variations in soils, past land-use, climate, topography and hydrology affect which species thrive in certain forest areas; therefore, we have separated the Northern Hardwood Forest cover type into several variations based on species composition, age class, and site characteristics.

Intermediate Northern Hardwood

(Stands 4, 10A, 18B, 19A, 19B, 20A, 20B, 20D, 25, 27 – Map 11 in Appendix 3)

The Intermediate Northern Hardwood stands are diverse in species composition, and are dominated by more shade tolerant species, therefore containing fewer early successional species. Sugar maple and red maple are dominant. Some stands include large white ash, and paper birch, if present, is often senescing. Christmas fern, Lycopodium species, and wintergreen can be found in the understory. Since these stands have not been disturbed recently, trees are more mature, and soils are often better developed.

Figure C1: *Stand 4**.** Spring 2006**.***

Landscape Integration

The Northern Hardwood Forest stands are great places to see succession influenced by human land use. The Intermediate Northern Hardwood stands have been abandoned longer than the Early Northern Hardwood stands. When farmsteads were abandoned in the Town Forest, paper birch typically was one of the first species to colonize these fields. As the paper birch decline they senesce, thus more intermediately shade tolerant species, such as red maple and white ash, are able to take the place of birch in the canopy.

Early Northern Hardwood

(Stands 2, 13B, 16, 17, 21 – Map 11 in Appendix 3)

Figure C2: *Stand 16. Spring 2006.*

Although similar to the Intermediate Northern Hardwoods, these stands are at an earlier stage of succession due to more recent human or natural disturbances. Paper birch, often an early colonizer of the abandoned fields of the Town Forest, is a major component of the canopy in these Early Hardwood stands. Several of these stands were open in the 1942 aerial photo, and are thus less than 65 years old. They are in a transitional stage from early successional species to more of a mid-successional forest, as indicated by the senescing of the paper birch and aspen (early successional species) which are sparse in the understory. Another indication of the inexorable change in forest composition is evidenced by the abundance of sugar maple and beech in the subcanopy and understory. Red maple, black cherry, and striped maple may also be found in the subcanopy and seedling levels of the Early Northern Hardwood Forest stands.

Red Maple - Northern Hardwood

(Stands 10C, 13A – Map 11 in Appendix 3)

The Red Maple-Northern Hardwood stands are classified as variants of the Northern Hardwood cover type due to the canopy dominance by red maple, which comprises a majority of the growing stock. These stands also include other species typical of the Northern Hardwood Forest. Paper birch is a component of the canopy, while striped maple and American beech are abundant in the understory. The two stands associated with this cover type are characterized by relatively large, vigorous trees, and dense canopies. Both stands occur mid-slope on thin soils, and have a northwest aspect. In the 1942 aerial photos these stands were heavily forested, indicating abandonment long before 1942. Stand 13A has skid trails and stumps on the eastern side, indicating past logging activity.

Figure C3: Stand 26. Spring 2006.

Sugar Maple - Northern Hardwood

(Stands 19C, 20C, 20E, 26 – Map 11 in Appendix 3)

These stands are dominated by sugar maple and occurs in several areas in the forest. All four stands associated with this cover type contain large, well developed trees. These stands tend to be located on northern-facing aspects, and have site conditions favorable to sugar maple growth. There are some sites, those which are located at the base of a slope or in local depressions, which accumulate organic matter and nutrients, thus becoming richer sites. Localized enrichment from bedrock, surficial deposits, or colluvium, the downhill movement of nutrients, is common in many of the Sugar Maple - Northern Hardwood cover types. Stands 19C and 26 are both located on benches in the slope, which allow for the collection of organic matter and nutrients. In the past, forest management activities in some of these areas have focused on releasing sugar maples, and have helped to improve sugar maple productivity. There is vertical structure in these stands, and sugar maple can be found in all stages of growth from seedling to saw timber size. Stand 29 has the feel of a sugar bush, but is not known to have been utilized for that purpose.

Dry Oak - Northern Hardwood

(Stands 23, 24 – Map 11 in Appendix 3)

This cover type is rare in the Hinesburg Town Forest and all three stands occur on the Hollis parcel. Shallow, well-drained soils with a southern aspect, features that do not exist together on many other parts of the property, influence the unique vegetation patterns in these stands. Red oak is a significant component of these stands, but its dominance in the canopy varies with microsite characteristics. Hophornbeam, a tree species typically associated with dry sites, is also abundant in these stands. Sugar maple is a prominent canopy tree species in stands 23 and 24. These stands have little understory vegetation; however, there are places where the woodland sedge *Caryx pensylvanica* is abundant.

Alder Swamp

(Stand 12 – Map 11 in Appendix 3)

The Alder Swamp is a unique wetland area on the Forest property. Though dominated by alder, willows abound in this community. Swamp saxifrage and glyceria species are major components of the groundcover. A dynamic ecosystem, wind throws are widespread, as shallowly rooted trees are blown down from the hummocks. Groundwater, precipitation, and surface flow are all likely contributing water to this swamp. This wetland's groundwater inputs also keep the swamp from completely freezing in the winter.

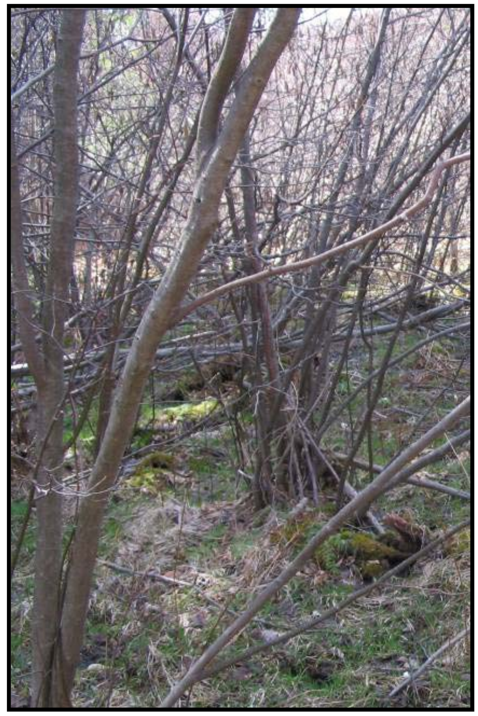

Figure C4: *Stand 12. Spring 2006***.**

Landscape Integration

The Alder Swamp is a unique stand type that we couldn't help but explore further. A soil auger provided a look at a soil core with mucky peat at the surface and glacial till in the mineral soil below. The organic horizon had a pH of 5.5, while the B soil horizon had a less acidic pH of 6.5. Wildlife sign was abundant in the Alder Swamp this spring, including moose scrapings and wood frog eggs. This area will likely need a buffer to protect the unique stand, and the wildlife which utilize it.

Wet Northern Hardwood

(Stand 10B – Map 11 in Appendix 3)

This stand is unique in the forest and occurs in the transitional zone between the alder swamp and the upland forest. This stand is characterized by shallow, wet soils creating abundant pit and mound topography. The previous agricultural field was abandoned in 1930, and the 1942 aerial photo shows that trees had begun to colonize the field by then. Because the wet conditions prevent the trees from rooting deeply, the stand has many tip-ups. Although red maple is the most prominent species, the species composition in this stand is diverse, with many early successional species (especially paper birch and aspen) maintaining a presence due to the frequency of disturbances. Serviceberry and musclewood, species that thrive in wet soils, are also present in this stand.

Landscape Integration

The soil in the Wet Northern Hardwood Stand had a more acidic pH than other areas in the Town Forest. The O soil layer had a pH of 5.5, while the B soil horizon had a less acidic pH of 6.0. The wet conditions and more acidic soil likely allowed for the dominance by red maple, a tree species that competes well in conditions that would be less desirable to other hardwoods such as sugar maple or white ash.

Red Maple Swamp

(Stand 28 – Map 11 in Appendix 3)

This stand is a woodland swamp with a red maple canopy cover. The Red Maple Swamp is located on the Hollis parcel in a broad low point between a ridge and a knoll. The topography is such that significant amounts of water collect in the area, keeping the water table quite high for much of the year. In addition to runoff from the surrounding land, it seems likely that this area also has

Figure C5: *Stand 28. Spring 2006.*

groundwater input. The stand is dominated by red maple, some of which are quite mature and vigorous. The largest trees are located on the drier edges and hummocks of the swamp. The high water table that characterizes the area doesn't allow for trees to root deeply, and tip-ups commonly create gaps in the forest canopy and exposed mineral soil. Yellow birch competes well in such conditions, and comprises a significant component of the stand. Woodfern species comprise the herbaceous layer, along with water avens and golden ragwort.

Landscape Integration

The Red Maple Swamp was also a stand with abundant wildlife sightings this spring. Wood frogs were calling in the early springtime breeding season, and their eggs were found in the Swamp alongside salamander eggs.

Red Spruce - Northern Hardwood Ridge

(Stands 10D, 11, 13C, 18A, 19D – Map 11 in Appendix 3)

Figure C6: *Stand 18A. Spring 2006.*

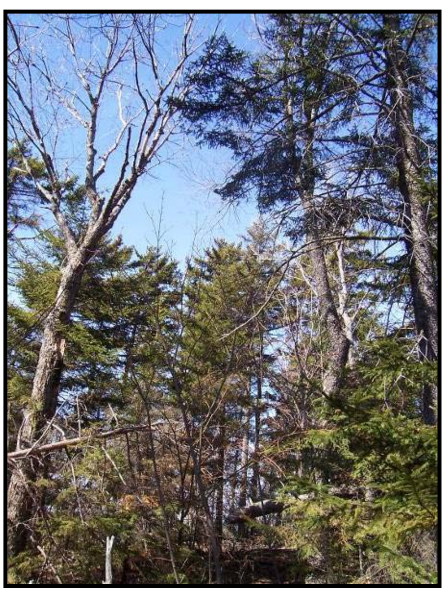

Figure C7: *Stand 11. Spring 2006.*

The Red Spruce - Northern Hardwood stands are situated on the major ridge that runs through the Forest. Red spruce is the dominant species in these stands. Many of the spruce, especially those in Stand 18A, are quite large, mature trees. Although red spruce dominants, yellow birch, paper birch and red maple are also present in these stands. With their location on higher ridges, these stands are typically characterized by thin, well-drained soils above ledges of bedrock outcrops. Most of these stands have a north-facing aspect, and are exposed to high winds, which create wind throw on the shallow soils. A history of these high-frequency natural disturbances is visible in the pit and mound topography of the stands. According to 1942 aerial photos, these stands were mostly forested and thus likely to have been some of the first Town Forest lands to be abandoned. Today, there is little evidence of recent logging activity. Because of the longer period without human disturbance, these stands also tend to have more vertical and horizontal structure than other areas of the forest.

Mixed Northern Hardwood Ridge

(Stands 10E, 14, 22, 29 – Map 11 in Appendix 3)

This stand type is similar to the Red Spruce - Northern Hardwood type in location and the associated site conditions. These stands have thin, droughty soils and are subject to high winds. Unlike the Red Spruce-Northern Hardwood Forest type, red spruce is not a major component in the Mixed Northern Hardwood Ridge canopy. The species composition of these stands is diverse, with red oak, white ash, sugar maple, paper and yellow birch, red maple and beech all sharing space in the canopy. The relative distribution of these canopy species depends on differing microsite characteristics. Red pine, mature American beech, and large black cherry can also be found in these Northern Hardwood Ridge stands. Hophornbeam, American beech, and striped maple are common in the subcanopy, with American beech, striped maple, sugar maple and birch seedlings in

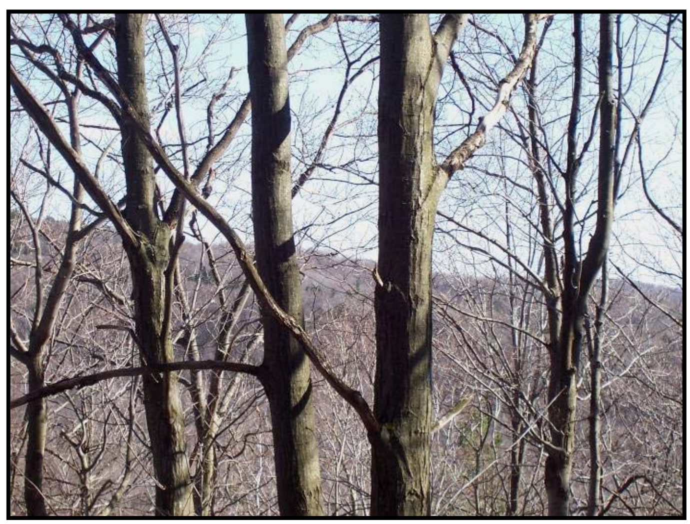

Figure C8: *Stand 22. Spring 2006.*

the understory. Hobblebush, lycopodium species, and woodfern species are also abundant in the understory. Although many of the trees in these stands have sizeable diameters, they are relatively short in stature, which likely reflects the stresses associated with growing on a ridgetop. We noticed areas that had sustained damage likely due to winter ice. According to 1942 aerial photos, these ridgetops were mostly forested, and there is little evidence of recent logging activity.

Conifer Plantation

(Stands 1, 3, 5, 6, 7A, 7B, 7D, 9, 15 – Map 11 in Appendix 3)

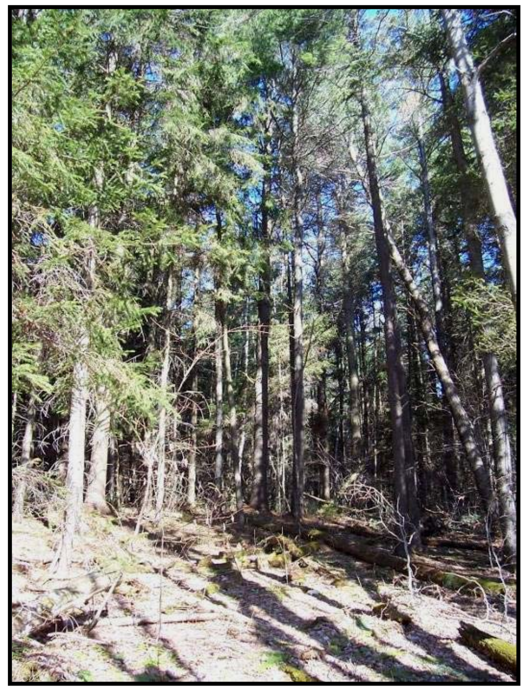

Figure C9: *Stand 7A. Spring 2006.*

Conifer plantations make up a significant portion of vegetation in the Hinesburg Town Forest. The plantations primarily consist of Norway spruce, white pine and red pine. These fast growing conifer species are growing productively on the abandoned agricultural soils of the Forest's hill farms. According to the aerial photos, most of the plantations remained open fields in 1942. Herbaceous site indicators such as blue cohosh and toothwort indicate that many of the soils of these plantations are enriched. Likely due to the shading by the conifers, however, plantations have sparse abundant understories. In addition to reduced light availability, some of the uppermost soil horizons, the rooting zones for the herbaceous plants, have more acidic pHs, possibly also contributing to the reduced number of understory plants. Hardwood tree species, if present, are in the subcanopy, and few hardwood seedlings can be found.

Landscape Integration

According to the soil survey map, these plantation stands are typically found on Marlow soils - the Town Forest's most productive soil type. These soil types, because of their productivity, were the last of the hill farms to be taken out of agriculture. During the 1930s and 1940s, landowners were encouraged to plant conifer species on agricultural fields, in order to reduce soil erosion. Fast growing species such as Norway spruce, white pine, and red pine were often planted for this purpose. The plantation stands in the Hinesburg Town Forest are examples of the legacies of the soil erosion plantings. Since large patches of dense conifers are not commonly found naturally in the Town Forest, it will be interesting to follow the future of the plantations, and to track their effects on soil chemistry, succession and wildlife.

Gap Cut

(Stand 7C – Map 11 in Appendix 3)

This gap is a unique stand, as it is one of the few open areas in the Hinesburg Town Forest. The cut, an effort to increase horizontal and vertical Forest structure, took place in August 2005 in a plantation that was planted in 1942.

Figure C10: *Stand 7C. Sping 2006.*

Landscape Integration

While many species of birds prefer to live in the dense cover of the forest, others thrive in the open edge areas such as those provided by the cut. This gap cut is one of several silvicultural treatments in the Town Forest designed to improve wildlife habitat, and increase the diversity of forest structure. Several species of birds were observed foraging in this area.

Homestead

(Stand 8 – Map 11 in Appendix 3)

The Gillett Farmstead is the largest of the homesteads that have been mown in recent years to release apple trees, and preserve the cultural history of the site. In the 1942 aerial photos, this homestead was in the middle of a large agricultural area, most of which has returned to forest. The stand has been managed for early successional species by repeated brush hogging. Apple trees in this stand have been released to encourage maximum fruit production for wildlife. Introduced species such as Norway spruce and sedum are present.

Landscape Integration

Few sizable open areas remain in the Town Forest, as it has been allowed to return to the historical forested landscape. As mentioned above, these open areas are necessary for certain species of wildlife to thrive. Evidence of deer, likely feeding from the released apple trees in the area, is abundant in this open homestead stand. The apples trees, early successional vegetation, and open field attract deer, birds, and other wildlife, while also adding important horizontal diversity to a section of forest that is otherwise dominated by plantations.

Plant Inventory

The vegetation team compiled a list of all plant species our LIA team encountered in the Hinesburg Town Forest. This list of common and scientific names can be found in Appendix 2. Due to late leaf-out caused by cold weather and relatively high elevation, this plant list is not exhaustive.

There were no non-native invasive plant species recorded in the Forest, either by this LIA team or Mike Snyder, Chittenden County Forester.

Additionally, no threatened or endangered plants were noted on the Forest property. *Milium effusum,* a woodland grass that is uncommon in Vermont, was located in Stand 20C. This grass is an indicator of rich sites, competes better in hardwood forest over coniferous forest, is rare in valleys and is usually found at an elevation above 1300 feet (Brett Engstrom, personal communication, May 1, 2006).

Figure C11: *Milium effusum, uncommon woodland grass. Spring 2006.*

Invasive Plant Species

Invasive species, defined as non-native species that have deleterious effects on native ecosystems, are considered one of the greatest current threats to biodiversity. These species have the tendency to change forest nutrient cycling regimes, and out-compete native species. Early detection, and subsequent management, of invasive species is key to limiting their impact. No invasive species were noted thus far in the Hinesburg Town Forest by assessment teams, or managing parties; however, there are many species that are current problems in other parts of Vermont, and some species that are moving northwards from southern states. Buckthorn, a common invader in Vermont, does not tend to occur in the foothills; however, its presence should be watched for nonetheless. Other species that could become a problem include two species of honeysuckle, barberry, burning bush, and garlic mustard (which does well in enriched soils).

Natural Community Mapping

In addition to assessing current vegetation on a landscape, it is also important to consider how a landscape will change over time. Natural community mapping is a tool that provides a common classification system for ecological patterns and for the successional trajectory of a landscape.

A natural community is "an interacting assemblage of organisms, their physical environment, and the natural processes that affect them" (Thompson & Sorenson, 2005). Natural communities are identified through an integrated assessment of soils, geology, micro-climate, topography, hydrology, and current vegetation. In addition, it is important to consider past land-use since activities, such as farming and logging, which can significantly change vegetation patterns.

Natural communities can range in size from tiny vernal pools, to hundreds of thousands of acres of forest land. Within large communities, there are numerous variant communities, in which micro-site characteristics alter the natural processes and dominant vegetation. Due to these variations, natural communities often transition into one another and, although natural community boundaries are visually represented by lines on a map, clear boundaries often do not exist in nature.

Although natural community mapping is a valuable tool, it is not without limitations. There is inherent room for error in the mapping process, which relies upon evaluating ecosystem processes and conditions, and formulating hypotheses about future vegetation patterns. In addition, natural communities are defined as the likely future vegetation in the absence of human disturbance, which may also limit its applicability.

We mapped natural communities at the Hinesburg Town Forest and, for each natural community type identified, listed associated plant species (Map 8). A brief description of natural processes occurring on the site is also included.

Natural Community Mapping Methods

Natural community mapping is a four-step process. First, we collected data about current vegetation by walking the site and noting dominant species and vegetation patterns (see current cover methods above). We then analyzed current vegetation in conjunction with information about past land use, soils, geology, hydrology, topography and other micro-site characteristics to predict future vegetative patterns. A natural community map was then drafted. Fourth, after developing preliminary maps, extensive time was spent at the Forest field-checking information and modifying natural community boundaries. Although community types are based on descriptions from *Wetland, Woodland, Wildland* (Thompson & Sorenson 2005), unique community characteristics at the Hinesburg Town Forest required some variations.

Natural Community Types

Northern Hardwood Forest

The Northern Hardwood Forest is the most prevalent natural community type in Vermont, as well as in the Hinesburg Town Forest. This community occurs in cool-temperate climates, on soils developed from glacial till that are neither too wet nor too dry, and on gentle to steep slopes below 2,700 feet elevation. Disturbance by wind and ice are common in this community, which creates gaps in the forest canopy. There are three classic northern hardwood species that are often dominant in mid to late successional forests: sugar maple, beech and yellow birch. However, many other species are associated with this community type, such as red maple, paper birch, red oak, white ash, white pine, black cherry, hophornbeam, red spruce and poplar.

***Figure C12**: Spring beauties in the Sugar Maple-White Ash-Northern Hardwood Forest. Spring 2006.*

The Northern Hardwood Forest is the matrix community of the Hinesburg Town Forest, meaning that it the dominant community and occurs throughout the forest. Currently, boundaries between former agricultural lands and more mature woodlands are apparent, creating patches in different stages of succession which therefore have different species compositions. In nearly all areas of this community, however, sugar maple and beech are the most dominant species in the understory, indicating a common successional trend. In addition, there are a few variants of the community that result from differences in micro-site characteristics, such as locally enriched soils, or poor drainage.

Variant: Sugar Maple-White Ash-Northern Hardwood Forest

This variant of the Northern Hardwood Forest community occurs where soils are more enriched. Sugar maple and white ash dominate this community, but other northern hardwood species are also found. Jack-in-the-pulpit, red trillium, Christmas fern, blue cohosh and lady fern, occur here; these are some of the herbaceous plants that need high levels of nutrients to survive and are therefore ‘indicators’ for this community type. This variant is common in the Hinesburg Town Forest, mostly in the lower parts of the forest where nutrients from the ridges can collect; it will also likely develop from the plantations, where soils are notably richer.

Landscape Integration

The nutrient enriched soils that support rich northern hardwood forest communities can be due to a number of factors. At the base of slopes, or on benches in the forest, organic matter and nutrients can accumulate, a process known as colluvium. Enrichment can also be a result of pockets where calcareous rock deposits are close to the surface, a situation common in Vermont where surficial geology is primarily glacial till. Similarly, groundwater flowing from calcareous rocks can also enrich local soils. Sometimes, tree plantations can also indicate soil enrichment because they were often planted on the productive soils last abandoned by farmers.

Variant: Red Spruce - Northern Hardwood Forest

This variant of the Northern Hardwood Forest community frequently appears throughout Vermont in the transition zone between the Northern Hardwood Forest and the Spruce-Fir forests of the higher elevations of the Green Mountains. It is comprised of a mix of conifers and hardwoods that compete well on shallower soils, which are often close to bedrock, and sometimes nutrient poor. Red spruce and yellow birch are often dominant in these areas, with red maple common in younger stands. Common herbs include shining clubmoss and bluebead lily. This variant community can be found on the main ridgeline of the Hinesburg Town Forest, as well as along localized bedrock outcroppings.

Variant: Red Maple Wet Northern Hardwood Forest

This variant of the Northern Hardwood Forest community describes the transition zone between the upland forests of the Hinesburg Town Forest and the alder swamp. Due to a high water table and shallow soils, the area is characterized by a large number of trees that have been blown down, likely due to their inability to root deeply. This has created significant pit-and-mound micro-topography. Red maple is the dominant tree species, competing well in shallow soils, and paper birch and poplar are also prominent in this area. In addition, musclewood, often considered an indicator for wet soils, and service berry, can be found in this area.

Variant: Beech - Red Maple Northern Hardwood Forest

This variant of the Northern Hardwood Forest community occurs on drier, more nutrient poor sites. In the Hinesburg Town Forest, it occurs on a south-facing slope below the main ridge of the forest, and north of the alder swamp, and is characterized by coarse, shallow soil. Although this area seems relatively nutrient poor, sizeable beech and red maple trees were found. This is more likely an indicator of minimal human disturbance than of high site productivity, in that the site is difficult to reach. Wintergreen and clubmosses are among the herbaceous vegetation in this area.

Mesic Red Oak - Northern Hardwood Forest

***Figure C13**: Dry Oak- Hophornbeam Forest. Spring 2006*

This community type is similar to the Northern Hardwood Forest but differs in that red oak is a significant part of the canopy. These forests can be found in all biophysical regions of Vermont below 2,500 feet on warm, dry microsites and soils that are well to moderately-well drained. At the Hinesburg Town Forest, this community can be found in the Hollis parcel, on and below the south-facing ridge. Tree species in this community include red oak, sugar maple, beech, hop hornbeam and occasional butternut. Due to a fairly closed canopy, the shrub layer in this community is generally sparse, but may include maple-leaf viburnum, beaked hazelnut, witch hazel, and shadbush. Herbs may include Indian cucumber root, blue-stemmed goldenrod and marginal and intermediate wood ferns.

Dry Oak-Hophornbeam Forest

This community type is a variant of the Dry-Oak-Hickory-Hophornbeam community, but is different in that the climatic conditions are not favorable to hickories, which compete better in warmer, southern areas. This community type is uncommon in Vermont, and their open dry expanses give the unique sites a distinctly different feel. They are found on low ridges where bedrock is close to the surface, often on south-facing slopes, and are characterized by dry rocky soils. Red oak and hop hornbeam are the dominant species, but sugar maple can also be abundant. Although the canopy can be fairly open, shrubs tend to be sparse due to the dry conditions, and woodland sedge often carpets the forest floor. This community exists in the Hollis parcel in the Hinesburg Town Forest, where a moderate south-facing slope creates the extremely dry conditions favorable to this community.

Alder Swamp

Figure C14: *Alder Swamp. Spring 2006.*

The Alder Swamp community is the most common shrub-dominated wetland in Vermont. These swamps appear in a variety of physical settings, including the outskirts of lakes and ponds, or in floodplains of rivers and streams, and can be surrounded by other wetland types or by forests. Soils in these swamps are saturated for at least a portion of the year and can span the range from muck to mineral composition. Speckled alder grows in dense thickets in these swamps, but shrub willows and sapling red maples can also be common. Larger red maple and paper birch persist along the edges and on drier hummocks. Herbaceous plants include tussock sedge, bluejoint grass, longhaired sedge, purple-stemmed aster, cinnamon fern, and Joe-pye weed. Mosses are also abundant.

The alder swamp at the Hinesburg Town Forest is located in a depression at the base of a large slope, and collects water from the surrounding ridge. The swamp is flooded year-round, and it is likely that this area receives groundwater inputs as well as surface flow, as evidenced by a resistance to freezing in the winter and relatively rich soils.

Red Maple-Yellow Birch Swamp

Figure C15: *Maple flowers. Spring 2006.*

The Red Maple-Yellow Birch Swamp community type is one of the most common hardwood swamps in Vermont. These forested wetlands are characterized by a perched water table, often formed by depressions in the bedrock that fill with groundwater and surface water. The organic soils of these swamps are primarily well-decomposed mucks. The relative extent of seasonal flooding and the degree to which enriched groundwater is part of the water table will affect the mix of species present. At the Hinesburg Town Forest, this swamp can be found in the Hollis parcel, nestled between ridges, capturing both groundwater and surface water. As is characteristic, red maple is dominant in this community at the Hinesburg Town Forest, with yellow birch and red spruce also common. Due to the high water table, trees are not able to root deeply and tip-ups are common, creating pit-and-mound micro-topography. In addition, fallen trees allow sunlight to penetrate the forest canopy, which supports a variety of shrubs, including winterberry holly and high-bush blueberry. Ferns and sedges are abundant in the herbaceous layer, especially cinnamon fern, royal fern, sensitive fern, tussock sedge, and bluejoint grass.

Vernal Pools

Vernal pools are small, temporary pools of water, caused by localized depressions in the soil or bedrock, which often occur at the base of slopes or in upland forests. These small depressions fill with water during the spring, and are important habitat for amphibians and invertebrates. These animals use the pools to lay their eggs because they are safe from fish predation. Soils in vernal pools have a rich, organic surface layer due to standing water. Vegetation is usually absent in the pool, though some wetland species, such as sensitive fern and rice cutgrass, may occur on the margins. Surrounding forests are important to the persistence of vernal pools because they shade the water, keeping climates cool, and prevent evaporation. At the Hinesburg Town Forest, these pools occur in various places and range in size. They are noted on the included maps.

Seeps

Seeps are wet areas in a forest usually found at the base of slopes or on mid-slope benches where the arrangement of bedrock causes a discharge of groundwater at the surface. The resulting wet areas are important for diversity of plants because they support a wide range of species that would otherwise not exist in the forest. Soils associated with seeps are often rich due to the nutrient inputs from the bedrock. Seeps often show early spring ephemerals, making them an important habitat for foraging species such as bears.

Figure C16: *Groundwater Seep. Spring 2006.*

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WILDLIFE

Wildlife

Introduction

From the spruce ridges where barred owls call at dusk to the wet seeps where moose browse red maple, the landscape of the Hinesburg Town Forest varies accommodating a diversity of animals and their habitat needs. Special habitat features abound throughout the property, such as vernal pools, cavity and mast trees, ledge outcroppings, and wetland swamps. Bobcat tracks can be found in midwinter below the ledges, and fresh pileated woodpecker feeding cavities can be seen in snags at any time of year. Deer scat is plentiful beneath apple and oak trees and in the early spring wood frogs broadcast their chorus from several vernal pools.

The wildlife habitat of the Town Forest is not bound by the property; animals ignore geopolitical borders, and many of the same individuals that dwell in the forest might be found in the backyards of residents of Hinesburg and nearby Huntington. The success of a management plan for the wildlife of Hinesburg Town Forest may depend on the preservation of some of the forested lands surrounding it.

Being the largest piece of publicly owned land in town, the 837 acres that make up the forest provide core habitat for animals with large ranges such as fisher, and possibly black bear as well. The extensive forested landscape supports breeding bird species that only nest in mature interior forest spaces, such as goshawk and blackburnian warbler. Yet the forest and its habitats also sit within the context of a larger, multifaceted landscape. The management of wildlife on this property must be accomplished by viewing the interests of the wild residents of the land in concert with the public interest groups of the town.

This section on wildlife will explain our methodology, describe our encounters with seven focal species, discuss the presence and distribution of important habitat features on the landscape, and list of the potential and observed vertebrate species in the forest. Finally, we provide a map that illustrates our findings.

Methods

The landscape inventory and assessment team conducted a study of the Hinesburg Town Forest in the months of February through April. An analysis of the wildlife use of 837 acres in three months cannot be a comprehensive survey. Limitations include the time it takes to gather comprehensive data across a broad landscape, the elusiveness of many vertebrate species, and the absence of many breeding species between the months of February and April.

Our approach was to conduct a qualitative assessment. We created “intuitive transects” by looking at an aerial photograph and identifying landscape features such as waterways and ridgelines where we would expect to find wildlife. We designed the intuitive transects to cross through various forest types, such as conifer plantations, northern hardwood forest, apple orchards near abandoned homesteads, and wetland forests. The intent was to walk through as many habitats as possible. We mapped important sightings, sign, and habitat features by GPS and documented these findings through detailed notes and photography.

We listed potential species by habitat type using Yamasaki and DeGraaf’s (2001) matrices. We compared the species we found against the potential species list (Appendix 4). This is not to suggest that the species we did not see sign of are not in the forest; they may be difficult to detect, uncommon, or out of season.

We chose seven focal species, including the white-tailed deer, fisher, bobcat, northern goshawk, pileated woodpecker, ruffed grouse, and wood frog to highlight several of the wildlife stories we uncovered in the forest. We selected these species based on one or more of the following criteria: (1) game status, (2) vulnerability to disturbance, or (3) high impact on the ecology of the forest. These animals are not necessarily the most abundant throughout the forest, but are among the most critical for management purposes.

Habitat Features

Snags and cavity trees

Snags and cavity trees are critical habitat for many animals due to their three-dimensional structure and slow decomposition. Snags are used by wildlife primarily for winter shelter, cavity nest sites and dens, but other uses include nesting platforms, feeding substrate, plucking posts, singing perches, food caches, courtship areas, lookout posts, and hunting perches. The shelter standing snags provide is weatherproof and offers protection from predators. Cavities well above ground level are less accessible by predators and provide potential lookout posts. In New England there are at least 21 bird species that nest in cavities including owls, woodpeckers, swallows, and the common black-capped chickadee (DeGraaf & Yamasaki, 2001). These same forests provide den cavities and roosts for at least 11 mammal species, including bats, mice, and mustelids. Hinesburg is the northern-most confirmed town within the endangered Indiana bat range; the dead and dying trees with loose bark in the maturing Town Forest may be suitable habitat for this species.

Cavities can form through rot alone or can be excavated by woodpeckers. Woodpeckers are the only vertebrates that play an active role in creating cavities; much of the forest wildlife depends on their craftsmanship. They prefer hardwoods with fungal heart rot. The early stages of this fungal infection can by identified by fungal conks or the bark of the tree, broken branches, scars, dead areas on living trees, and woodpecker cavities, so these trees can be preserved for pileated woodpeckers and other cavity using wildlife. Forest managers generally agree it is desirable

Porcupine den. Spring 2006.

to leave 5 to 10 large snags per hectare, favoring a larger number of hard snags. Deciduous trees are more likely than conifers to develop cavities because their branches break more easily. Larger snags should always be favored over smaller snags because certain species, such as barred owl, pileated woodpecker, and fisher, will only use large snags (Hunter, 1990). Also, the larger the snag, the more likely it is to remain standing for a longer period of time (Paine & Bryant, 1994). For long-lasting snags, wind-firm trees should be chosen. Hunter (1990) also suggests that due to the territorial nature of most animals, snags should be left throughout a forested parcel, not only in a few concentrated areas.

Snags with cavities are abundant in the Hinesburg Town Forest, but are not distributed evenly. A rapid assessment of select parcels showed that snags were four times more abundant in hardwood stands that in softwoods. This is probably due to both the higher snag potential of hardwoods and due to the management regime of the two respective areas. Areas of potential high cavity tree concentration could be considered for long-term snag management, while areas of low snag concentration could be considered for tree girdling.

Mast trees

Mast trees have seeds and fruit that are consumed by various kinds of wildlife. Trees with hard mast produce nuts, like acorns, while trees with soft mast bear fleshy fruits (Austin et al., 2004). In the Town Forest the hard mast trees are primarily beech and oak, while the dominant soft mast trees are cherry, serviceberry, and apple. Large diameter beech and oak trees are not abundant throughout the town forest, but there are a few areas of high concentration of trees with diameters larger than 16 inches (Map 9).

Although beech regeneration is prolific in some parts of the forest, many of the large beech trees are infected with beech bark disease. The future of beech mast in the town forest may be impacted. Beechnuts are consumed by bear, red squirrel, wild turkeys, and a variety of other wildlife species.

McShea & Healy (2002) report that red oak acorns account for about 50% of the diet of white-tailed deer and wild turkey. The large oaks in the Town Forest, especially in the Hollis parcel (Map 9), are thriving, but show poor recruitment in the understory. We have seen first hand sign of the importance of these trees as food sources for red squirrel, deer, and raccoon. Piles of raccoon and deer scat were found in abundance at the base of these trees. Forestry practices should continue to take into account the importance of hard mast for wildlife.

The apple tree stands within old homestead sites are also a source of nourishment to many mammal and bird species (Figure D2). The focal game species white-tailed deer especially benefits from the existence of these patches. Bear, raccoon, cedar waxwings, and a range of other species also eat apples. The current management scheme of orchard release should be continued to preserve this resource.

Figure D2: *This apple tree once provided fruit for an old homestead. Today its apples are enjoyed by a variety of wildlife. Spring 2006.*

Landscape Integration

Many of the grand mast trees present in the Hollis parcel are witness trees that mark old boundary lines of the homesteads that once abounded on the property. Some of the trees still retain twisted stands of barbed wire embedded in their bark.

Ledges

Exposed rock and ledges are critical habitat features for many animals (Figure D3). The three dimensional structure of rocky ledges provides cracks, crevices, and caves. Many mammals find use these spaces as hibernacula, dens, or temporary shelter from weather. Bears and bats use caves as hibernacula. Porcupines, foxes, and bobcats often use spaces between rocks as dens.

Exposed rocks and ledges were determined in the town forest by examining high-resolution ortho photos (Map 9) and field checking. The mapped areas may provide shelter for wildlife.

Figure D3: *Rocky ledges provide excellent shelter for many animals in the Town Forest. Spring 2006.*

Vernal pools

Vernal pools are created by spring snowmelt gathering in low bowls upon the landscape (Figure D4). They are shallow, ephemeral water sources characterized by a lack of vegetation and lack of predatory fish, and diving beetles used by breeding amphibians (Austin et al., 2004). To qualify as a proper breeding area a vernal pool must retain water for at least two months during the spring and summer (Austin et al., 2004).

In the Hinesburg Town Forest vernal pools were exposed in early April as the snow melted away (Map 9). Wood frog eggs were used as an indicator of pool use by amphibians. At least two pools also contained spotted salamander eggs. All of the vernal pools in the Hinesburg town forest are small, but some are part of two separate large wetland complexes.

Figure D4: *This vernal pool is located at the edge of the unmaintained portion of Hayden Hill Rd. in an old homestead site. Wood frog eggs can be seen at the surface of the water. Spring 2006.*

The spring and summer is a period of sensitivity for amphibians. It is also the time of year when humans begin a vast array of outdoor activities, such as hiking, biking, horse-back riding, and four-wheeling. Interestingly, the presence of motorized vehicles in the forest provided the ruts and pits where some vernal pools now exist. However, the amphibians relying on the current vernal pools will not benefit from further human disturbance. A technique currently used to manage for the persistence of these pools is to fell trees upon them, which protects them from recreational activities. If continued, this type of management may be sufficient. Austin et al. (2004) suggest that any land alteration within 100 feet of the pool can have a negative impact on amphibian populations due to amphibian movement to and from the pool. They also recommend a 600 foot buffer where at least 60% canopy is maintained and no new roads are established. In the Hinesburg Town Forest this information is most applicable to the two pools near the end of Hayden Hill West Rd, and the pools within the Hollis parcel (Map 9).

The reopening of the un-maintained portion of Hayden Hill Rd is a potential threat to the viability as suitable amphibian breeding habitat of the two largest pools on the property.

Landscape Integration

The largest vernal pool on the property lies along the unmaintained portion of Hayden Hill Rd. The basin where water collects is the foundation of an old homestead. While amphibian breeding areas are sensitive to human interference, sometimes structures built by humans can help create these ephemeral pools.

Wetlands

There are two major wetland areas within the Hinesburg Town Forest (Map 9). One is an alder swamp in the central portion of the main parcel and the other is a red maple swamp in the Hollis parcel. Each has a distinct character defined by the vegetation, but both are important habitat features for a high diversity of wildlife. We have seen moose scat, tracks, and browse in both wetlands. Although we did not confirm the presence of these species, star-nosed moles, alder flycatchers, and pickerel frogs probably rely on the wetland areas in the HTF for breeding and feeding territory. The up-ended root masses of the wind-thrown trees in these areas provide nesting habitat for winter wrens and Canada warblers and the pits where the roots once had been offer deeper pools where wood frogs lay their eggs. We have seen moose scat, tracks, and browse in both wetlands. Both wetlands contain small pools of standing water which serve as watering holes for many animals.

The alder swamps supply ruffed grouse, moose, and black bear with alder twigs and catkins, which are primary food sources for these animals. Moose also browse on young red maple in the Hollis parcel wetland. The low, shrubby thickets of the swamps provide good cover for bird nests and stalking predators.

Corridors and Connectivity

A quick look at any Vermont map or aerial photo will readily reveal that one species, *Homo sapiens*, is highly dependent on a vast arrangement of pathways to get from one area of concentrated dwellings to the next. In the same way, the animals of Hinesburg use an extensive system of wildlife corridors to travel from one habitat area to another. Different animals use a variety of transport conduits in discrete ways. The corridors range in size and shape and topography and biotic assemblage, connecting a series of isolated habitat fragments into a cohesive network that supplies the faunal assemblage with sufficient settings for feeding, mating, migrating, and resting.

As Figure D5 illustrates, the majority of forested land in Hinesburg lies toward the eastern side of town, with fragments of woodland patches peppering the valley lands to the west. In fact, the Hinesburg Town Forest lies within a band of fairly continuous north-south forest habitat at the foothills of the Green Mountains. This area is considered to have regional high biodiversity potential based on data from the Vermont Center for Geographic Information (www.vcgi.org).

The existing corridors between the Town Forest and the designated deer wintering areas may also be important targets for future conservation. It is likely that to pass from one woodland patch to another across the fragmented landscape the deer are using contiguous forest pathways, whether along riparian borders or between woodland properties.

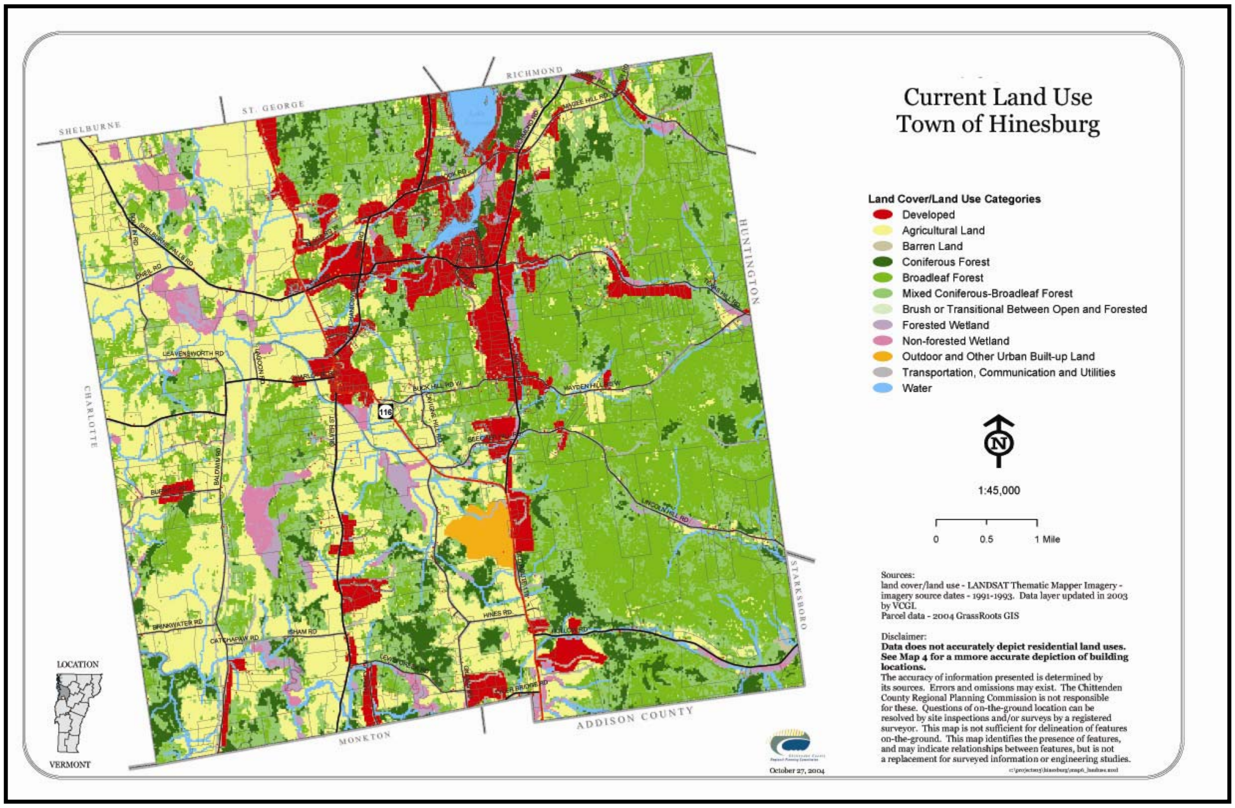

Figure D5: *The town of Hinesburg has many woodland and riparian corridors which connect the Hinesburg Town Forest to the broader landscape. (Modified from the Hinesburg Planning and Zoning Office webpage).*

As with the deer, woodland corridors probably are key pathways along which other large mammals move from one habitat area to another, linking isolated gene pools that are interspersed throughout a landscape that is fragmented by human land use. These connective channels might be narrow bands of woodland found along the edges of properties, or riparian buffer zones like the tributaries of rivers and creeks. If the Hinesburg Town Forest is to continue as habitat suitable for fisher, bobcat, and bear, it will likely have to remain as an intact parcel within a larger matrix of woodland cover. While we suggest that continuous forest and corridors may be the only way to preserve the habitat of some animals with large ranges, the development pressures around the forest are imminent. The actualization of these changes will be the only way to know for sure what consequences they may bring.

Focal Species

White-tailed deer *(Odocoileus virginianus)*

The white-tailed deer is the most conspicuous large mammal using the Hinesburg Town Forest. It was chosen as a focal species due to its game status and its potential effect on the regeneration of trees in the forest. We found sign of this skittish herbivore every time we visited the forest regardless of location. Deer were so ubiquitous that we did not mark their sign on our wildlife map. Tracks trailed through the snow from creek beds to ridgelines, through conifer plantations and open homestead sites. When the snow melted, deer scat was plentiful throughout the property and we consistently found browse on low hanging twigs and evergreen herbs (Figure D6). We discovered three deer stands tucked away throughout the forest as shown on the wildlife map. The extirpation of wolves from the Vermont landscape by the mid-1800s allowed humans to step in as the top predator of deer. The abundance of deer indicates that hunting will likely continue to be a prolific activity in the Town Forest in years to come.

Figure D6: *Deer browse on Christmas fern. Spring 2006.*

Deer wintering areas are defined by the Vermont Fish and Wildlife Department and Agency of Natural Resources as areas with generally southern aspects and medium-aged to mature coniferous trees, which provides shelter from heavy snow drifts (Austin et al., 2004). While the Hinesburg Town Forest is not recognized by the Agency of Natural Resources as an official deer wintering area (Figure D7), we can say with a good degree of certainty that deer spend the winter there, feeding on red and striped maple buds and bark, and herbaceous plants such as Christmas fern, among other things. The forest provides habitat that fits the definition of deer wintering areas, and we saw deer beds throughout the winter months in many, though not exclusively, softwood stands. Some of the conifer plantations within the Hinesburg Town Forest have potential to be managed as deer yards according to the guidelines set out in the Fish and Wildlife Department's *Management Guide for Deer Wintering Areas in Vermont (2005).* The maintenance of the open orchards on the old homesteads and red oak stands on the Hollis parcel will provide feeding areas.

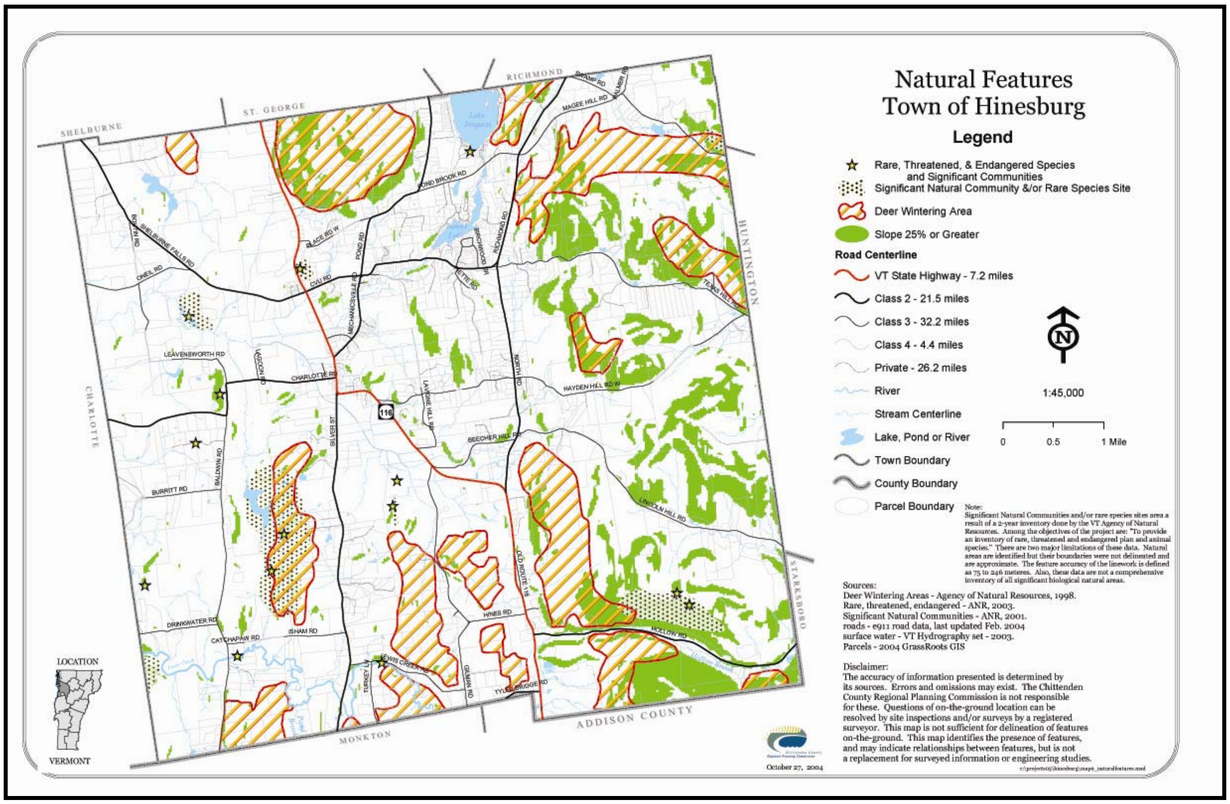

Figure D7: *Deer wintering areas in the town of Hinesburg are designated by the VT Fish and Wildlife Dept. Map modified from the Hinesburg Planning and Zoning Office webpage.*

Landscape Integration

During winters of low snowfall, white-tailed deer benefit from evergreen vegetation at the ground level. The Hinesburg Town Forest has an abundance of Christmas fern and intermediate wood fern, which both stay green all winter. We often found sign of deer browse on these ferns sticking up out of a sparse layer of snow (see Figure D6).

Fisher *(Martes pennanti)*

The fisher was chosen as a focal species because it is particularly sensitive to forest fragmentation and because as a large carnivore, the fisher is at the top of the trophic dynamics involving many animals and plants in the forest. We first discovered fisher tracks in the Hinesburg Town Forest near the Economou Road entrance in February (Map 9). Following the largest bounding tracks we had yet to encounter, we toured around the base of many trees, circled and climbed over brush piles, and slipped under downed logs less that a half meter off the ground. The tracks led us through a pine stand and stopped at an exposed rock that was decorated with a pile of twisted scat. They continued on to cross coyote tracks and follow a mink along an icy creek bed. From there the fisher made a beeline, moving quickly with long strides across an open stand of secondary hardwoods, across the property line and on into Huntington.

Fishers are known as creatures of large, mature coniferous or mixed forest tracts with continuous canopy cover. As Powell (1982) blatantly put it, "fishers have an unexplained aversion to open areas" (p. 86). Yet our own observations did not concur as solidly with what the literature offers.

Figure D8: *Fisher tracks zig-zagged throughout the Town Forest. Spring 2006.*

We saw fisher tracks frequently throughout the Hinesburg Town Forest, crisscrossing open assemblages of northern hardwoods (Figure D8). This versatile and agile weasel inhabits cavities in trees and logs, ground holes below boulders, or burrows dug by other animals for its den. Common prey include the porcupine, snowshoe hare, passerine birds, and vegetation such as apples, nuts, and berries (Martin, 1994). Although we saw no sign of snowshoe hare in the forest, there are porcupines, and on one occasion we encountered fisher tracks with dab of blood, likely from a fresh rodent kill dangling in its mouth. Because of their large home range, which can vary from 3 to 20 miles (Powell, 1982), the fishers present in the Town Forest are likely traveling extensively to the north, south, and east, where continuous forest lies. Whether they are denning in the forest or just using it for hunting is unknown.

Bobcat *(Lynx rufus)*

Figure D9: *Bobcat track found at the base of a steep, rugged slope. 2006.*

Bobcats exist in Vermont at the northernmost part of their range. Bobcats were chosen as a focal species because, as one of the largest carnivores in the state, they indicate the presence of at least a handful of their prey species within their territory. Some of their favorite prey species are snowshoe hare, cottontail, squirrels, muskrat, deer, and birds (DeGraaf & Yamasaki, 2001). We never detected any hare in the town forest, likely due to the lack of extensive spruce-fir forests. Nor did we see any cottontail rabbit, but suspect they may inhabit some of the abandoned homesteads. Red squirrels left abundant sign from tracks in the snow to piles of acorns in trees. Bobcat tracks were observed only once throughout the course of the winter. The tracks were discovered at the base of a steep, rugged slope on the north side of the eastern ridgeline of the forest (Figure D9). In April we found the remains of a turkey kill near the Hayden Hill West entrance (Map 9) that was clearly the work of a bobcat. The kill site consisted of a pile of sheared feathers, broken bones, and two large, dried scat pellets.

A second reason the bobcat was chosen as a focal species was because it relies on large parcels of continuous forest for habitat. As the Champlain Valley continues to be developed and fragmented, large pieces of nearby contiguous forest will become increasingly important to the persistence of bobcats and other mammals which require large territories to survive. The maintenance of the town forest *as a forest* is crucial to the continued presence of bobcats in the town of Hinesburg.

Northern goshawk *(Accipiter gentilis)*

Northern goshawks are the largest woodland hawk found in New England. The reason the goshawk was chosen as a focal species is because the presence of this top predator indicates extensive mature woodlands. Before 1933 there were only 3 breeding records of this bird in the state, but between the years of 1977 and 1981 eight breeding pairs were confirmed, and this number is still on the rise (Laughlin & Kibbe, 1985). Goshawks generally move south for winter, although they are occasionally found in Vermont year round. In Vermont, their nests are likely to be active between early April and mid August (Renfrew, 2003).

Figure D10: *A goshawk pair made several nests in the town forest over the past five years.*

For five consecutive years, a pair nested in or near to the Town Forest (Snyder, personal communication). This pair had gone undetected this year until a pair was discovered for the first time on the nearby Birds of Vermont Museum property in Huntington. These birds may or may not be the same pair that nested in the town forest and we cannot say with certainty that the town forest pair has deserted their territory. In fact, in the beginning of May, Mike Snyder heard goshawks near their old nesting area. Continued observation throughout the summer may provide further information. Even if the goshawks do not return this season, they may be back in years to come. The fact that goshawks chose this territory indicates that it is a distinct habitat, providing tall, dense trees for nests and an open understory for hunting. The goshawk breeding area (Map 9) is an area to consider as a logging-free and low-impact recreation zone**. Editor's Note: After the completion of the authors' fieldwork, a pair of goshawks was once again found nesting in the same general location during June 2006.**

Landscape Integration

Goshawks may have been enticed to the forest by the large conifer stands, which were planted in the 1940s after the land became part of the Town Forest. Although goshawks often inhabit mature conifer forests, they tend to choose hardwoods as nest trees. (Laughlin and Kibbe, 1985) The goshawks that have nested in the Town Forest have placed nests both in conifers and hardwoods.

Pileated woodpecker *(Dryocopus pileatus)*

The pileated woodpecker was chosen as a focal species because it is the largest primary excavator of cavities in northern forests. Pileated woodpeckers require large diameter trees for nest holes and often excavate multiple nest cavities in one year. They excavate new nest cavities every year. The feeding cavities and abandoned nest cavities of pileated woodpeckers are used as shelter by numerous vertebrates including fisher, northern flying squirrel, several owl species, and other woodpeckers. Monitoring pileated woodpecker use of the forest could potentially estimate cavity tree use by many other species.

The work of pileated woodpeckers is on display in many places throughout the HTF (Figure D11). Some areas are highly concentrated in the snags these birds require for feeding and nesting (see Habitat Features: Snags and Cavity Trees). The forestry practices in many places throughout the forest have maintained a large number of large snags, and we recommend that this practice is continued as timber is extracted. The greatest abundance of fresh pileated cavities was in the Hollis parcel, along the north-facing hardwood slopes on the north side of the major ridge, and along the north-facing slope of the southeastern portion the forest (Map 9). We heard

Figure D11: *Pileated woodpecker feeding cavities are abundant throughout the town forest. Spring 2006.*

pileated woodpeckers calling along both sides of Hayden Hill Road West early in April.

Ruffed grouse *(Bonasa umbellus)*

Ruffed grouse was chosen as a focal species due to its game status. Forests with grouse populations must include four special habitat requirements: drumming sites, nest sites, brood cover, and winter cover (DeGraaf & Yamasaki, 2001). Drumming sites are logs or stone walls near dense undergrowth. Nest sites and feeding sites are in aspen and hardwood stands and winter cover is within dense conifers. Brood cover consists of any forested area with dense understory.

We encountered grouse scat beneath logs and under ledges on hardwood slopes throughout the forest and at the entrance to the Hollis parcel. We discovered several snow roosts along the trail near the Hayden Hill West entrance. By the second week of April ruffed grouse drumming echoed throughout the forest in the hardwoods near Economou Road and along the streambed that parallels the un-maintained portion of Hayden Hill Road. One spring morning we scared up a grouse from under spruce saplings near the farthest eastern ridge top. Grouse appear to be plentiful throughout the forest feeding on catkins of aspen and birch and alder. As with the deer, the maintenance of the open orchards on the old homesteads (Map 9) will encourage the shrubby undergrowth these birds need for escape cover.

Wood frog *(Rana sylvatica)*

Wood frogs spend the cold northern winter in pockets in the leaf litter of the forest. This insulation is not enough to keep the frogs from freezing, but as the temperature drops, they accumulate enough glucose in their bodies that it acts like antifreeze. While their extra-cellular fluids freeze, the fragile cellular interior

Figure D12: *Wood frog egg masses were found in pools throughout the property by early April 2006.*

remains liquid (Benyus, 1989). In the spring wood frogs thaw out and are the first amphibians to sing.

We selected wood frogs as a focal species because they were the earliest amphibian found breeding in the Town Forest's vernal pools. Their breeding period extends from March to July, when they emerge from the leaf litter to find small pools of water in which to lay their eggs (Degraaf & Yamasaki, 2001). We used wood frogs as an indicator of vernal pools, and our map reflects the distribution of their breeding habitat throughout the forest. Wood frogs were first observed in the first week of April and egg masses continued to pop up throughout the property, from deep, old tire ruts to the lower lying wetland features. The egg masses each contain up to 3,000 individual eggs around the base of any submerged vegetation (Benyus, 1989). The areas where wood frog eggs were found are sensitive to disturbance and we noted that trees felled on or around these pools may discourage vehicles and recreationists from passing through these locations.

Wildlife summary

A three month long exploration of the Hinesburg Town Forest revealed the wildlife stories told above, as well as the sightings and sign of many other animals. Porcupine browse was abundant on conifer trees, both fresh and old enough to show only the twisted nature of trees affected by these creatures. A porcupine den in the trnk of a large tree was discovered with the occupant inside. A barred owl was seen upon a spruce ridgetop in midday. A flock of evening grosbeaks graced the gap cut area with their presence on several consecutive days in late winter. We followed mink tracks along streambeds and red fox tracks along trails. Black bear claw marks exist on a few of the large beech trees in the Town Forest (Map 9), yet the sign is sparse and not indicative of primary feeding area. The sign does not appear to be fresh, many markings being well scarred over. We noted increasing moose activity in the wetland areas as spring wore on. Some of the earliest spring migrant birds to arrive were the American robin, yellow-bellied sapsucker, eastern phoebe, hermit thrush, and winter wren. Our further musings are summarized in Appendix D-1, which shows the comprehensive list of animals and animal sign we noted in the HTF from a list of potential species in the area.

The wildlife of Hinesburg Town Forest is a rich assemblage of forest dwellers. The information provided in this document may serve as a baseline against which the results of future management can be compared. As land-use patterns change, and as the vegetation of the forest matures, the wildlife populations will probably change as well. The documentation of these changes will be a preservation of history and potentially provide lessons for management adjustments in the future.

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CURRENT LAND USE

Current Land Use

Introduction

Figure E1: *Bridge on the Eagle's Trail.*

Traditionally, the HTF has been managed for timber extraction and habitat enhancement. These management decisions are made by the Hinesburg Town Forest Committee and the County Forester. Currently, the HTF is also utilized by a variety of groups and individuals for recreation and scenic and natural appreciation (Figure E1). The forest is a prime site for involving the public at a host of different levels, whether it is opportunities for recreation, education, community events, or outdoor learning. This section briefly outlines some of these current uses at the HTF.

METHODS

The exciting part of examining current land use is the opportunity to engage the people who use and manage the forest. Personal interviews, personal observations, and a fly-over of the forest on April 6, 2006 were the primary sources used to determine the current uses at the HTF. Online research was also utilized for additional information.

RECREATION

Many different recreational activities take place on the HTF. However, in speaking with some Hinesburg residents, it appears that many people in the town are unaware that a trail map of the HTF even exists. There are thirteen named trails, as identified by a local mountain biking group known as Fellowship of the Wheel (FOTW). The

Eagle's Trail, built by a group of Eagle Scouts in the 1980s, goes past several of the old cellar holes and natural communities, is the most clearly marked trail, and is easily accessed from both the Hayden Hill East and Economou Road parking areas. Most users of the forest are hiking, mountain biking, hunting (Figure E2), horseback riding, cross-country skiing, snowshoeing, riding ATV's or snowmobling (S. Russell, personal communication, 2006). Great views of the Adirondacks and Lake Champlain at higher elevations make the HTF an ideal area for appreciating the natural landscape and wildlife viewing.

Figure E2: *Deer stand in the HTF. Spring 2006.*

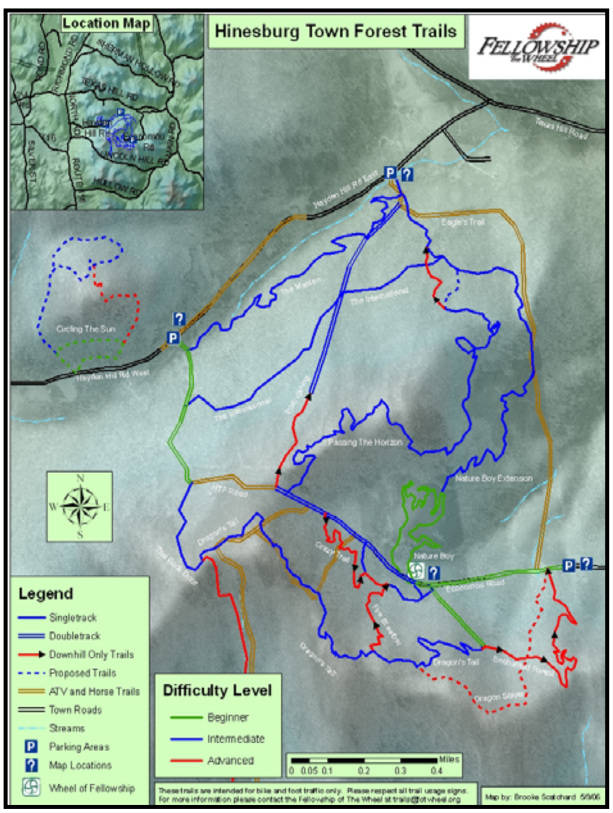

Figure E3: *Fellowship of the Wheel Trail Map (Source: Brooke Scatchard)*

The FOTW has built and utilized trails on the HTF for over two years and has mapped the entire trail system (H. Jenny, personal communication, 2006)(Figure E3). The trail-building project at HTF is the most extensive trail system operated by the FOTW (Fellowship of the Wheel, 2006). The FOTW educates outside trail-builders about proper trail-building techniques, leads group rides, and encourages participation in trail-maintenance volunteer days. Due to their active trail-building, the use of the Hinesburg Town Forest by the FOTW is more visible than use by other groups. Despite the active use of the HTF by many different user groups, there is currently no governing body or guiding document that regulates or coordinates actives such as trail-building.

EDUCATION

The rich natural and cultural history of the HTF makes it an excellent learning environment. Some teachers from the Hinesburg Community School have taken their classes to the forest for short field trips (B. Haselton, personal communication, 2006). College students, such as ourselves, and other environmental studies or forestry students have also used the HTF as an outdoor classroom. In addition, the Chittenden County Forester has led numerous forest management demonstrations and workshops for landowners, university students, and fellow foresters.

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SECTION II: IMPACT AND CONSIDERATIONS FOR FUTURE LAND USE

SECTION II: IMPACT AND CONSIDERATIONS FOR FUTURE LAND USE

Introduction

The first section of this document looks in depth at particular pieces of the HTF and their roles in creating the landscape we now see. We explored several components of the natural and cultural histories of the property, weaving them together in a broad narrative that characterizes the geology, biology, and human geography of this landscape. This section shifts the focus to examine more closely the current human presence on the land. We ask how that presence is influencing the forest today, and examine possible management considerations that might be useful to alleviate future negative impacts and enhance the quality of the forest as a whole.

When we look at the forest from a management perspective, the individual details of bedrock, flora, and fauna merge into a series of broader integrative questions:

What is the value of this land as a town forest? How does recreation affect the diversity of habitats? What conflicts are there between users and what opportunities are there for citizen education and community forestry? How should the plantations and homesteads sites be managed? What is the impact of encroaching development on the outskirts of the property? What potential is there for increased signage and public exposure?

Accordingly, we designed our impact and management inquiry to cross distinct physical regions of the property and address the physical, ecological and cultural aspects in concert. We grouped this discussion around several dominant themes:

- Recreation;
- Education, interpretation & citizen science;
- Conservation biology and restoration;
- Forest management/community forestry; and
- Ecosystem services

Landscape management is an interdisciplinary issue, and we acknowledge that some of the strategies suggested under one heading may help achieve the objectives of other themes as well. The following pages present a list of impacts and our suggestions for each of these topics. While this might serve as an informative compilation of ideas, we would like to encourage residents and planners alike to expand upon these suggestions in developing a comprehensive management plan that suits the needs of people living in Hinesburg.

Recreation

The Hinesburg Town Forest is used for recreation by many people. Hiking, mountain biking, cross-country skiing, and hunting are especially popular, and the property has also been used by those looking for picnic spots and riding horses and ATVs. Although the Hinesburg Town Forest promotes many of these recreational activities, each has an impact on the forest that is important to consider before planning future activities.

Trails

A major function of a town forest is to provide an environment conducive to recreational opportunities for a diversity of uses. Hiking, biking, horseback riding, ATV use, and skiing all require trail creation and maintenance. Old and new logging roads make up a backbone of the trail system currently in place in the HTF (Map 10). The Fellowship of the Wheel, a mountain biking club, has designed and put in place a network of trails crossing nearly all of the HTF, and additional trails have been mapped for future clearing (Figure E3). While many of the wooden and stone bridges built by the Fellowship of the Wheel are examples of ecologically conscious trail design, there still are many places throughout the forest in which road and trail placement have created erosion and drainage problems. The specific impacts of trails in the HTF are discussed below.

Aside from ecological impact, a second consideration in the trail system and trail use in the HTF is compatibility of use of the current trails. The logging roads were originally designed for the use of heavy and wide wheeled vehicles. If these roads are maintained for this purpose, they could serve as multiple-use trails where all recreational uses could co-exist. Most of the other trails in the forest have been designed by the Fellowship of the Wheel mountain bike club. This club uses a large volunteer pool from the entire county to clear and maintain trails. While this activity is unauthorized, it is arguably a benefit to the town and the town forest. Many of the trails have been designed with consideration for erosion and drainage control. The club has posted signs to discourage horse travel on these trails. This is a conflict that must be addressed by a management plan of the forest. Whether these trails are suitable for horseback riding *or* biking could be argued and a consensus must be reached so recreational groups are not in constant conflict. The inclusion of multiple recreational groups in trail building may alleviate the tension between groups. Still, some trails may need to be restricted to low-impact use.

Impact

Although the extent of trail impact is not equal for all activities, trail placement has consequences on erosion, rutting, hydrology, and wildlife habitat to be considered regardless of activity. Erosion hazard is greatest on steep slopes on Lyman and Marlow soils, while severe rutting occurs at the base of slopes where water collects. Erosion and rutting hazard are shown on Map 10 along with current trail locations. Due to the particular soils present in the HTF, *all* locations pose threat of either serious erosion or severe rutting, and many of the current HTF trails and old roads are already well eroded and contain many ruts. In areas where trails cross streams without bridges erosion and rutting are particularly heavy, and many of the eroded sediments can cloud waterways, impacting stream wildlife. In other wet areas water pools in trails and occasionally divides into braided stream channels to change the area's natural hydrology. A few of these drainage concerns are plotted on Map 4.

In addition to erosion and rutting hazard, wildlife habitat can be significantly altered with the addition of poorly planned trails or off-trail use. Vernal pools and wetlands and the animals that use these areas are particularly sensitive to disturbance by logging and drainage modification, and heavy sediment loads due to erosion are an additional concern. Austin et al. (2004) suggest that any land alteration within 100 feet of a vernal pool can have a negative impact on amphibian populations due to amphibian movement to and from the pool. They also recommend a 600 foot buffer where at least 60% canopy is maintained and where no new roads are established. Vernal pools are especially sensitive between the months of April and July. These concerns may be particularly pertinent to the vernal pools near the end of Hayden Hill West Rd (Map 9). Although these pools may have been partially created by the road building process in combination with an old cellar hole located directly beside the unmaintained portion of the road, any new work in this area would fall within the 100 foot impact zone of these pools. Trail use can also facilitate the introduction of non-native species, as seeds can be carried in vehicle tires, shoes and clothing, and in horse or dog hair.

When planning trails, the specific use of a trail is relevant to the extent of concern. Hiking and skiing trails have less potential for erosion and rutting than biking, horseback riding, and ATV use, making them more advisable on areas of greater hazard.

Considerations for future use

The lack of regulation and communication of trail use and construction is an immediate problem that must be addressed. In addition to creating a potentially excessive number of trails, unregulated trail clearing causes conflict between users, and lack of communication may preclude the ability to manage the forest for multiple objectives. The town may benefit from designating a clear leader to regulate trail management.

Due to the severe erodibility and rutting hazard of *all* HTF soils, limiting the extent of trail networking is advisable. We suggest that recreational trail use be condensed to the existing trails in order to allow restoration of some of the less-used, higher-impact areas. Since the impact of a trail is related to its use, it may be advisable to designate trails for particular uses as well, restricting ATVs to the least sensitive areas and biking and horseback riding to the moderately sensitive areas. Due to a conflict between bikers and horseback riders, areas for each distinct use may need to be developed. We advise that certain uses be restricted to specific times of year, limiting biking, horseback riding, and ATV use during mud season. If ATVs are to be used at all, we suggest improving roads to limit rutting and erosion impact. Alternatively, ATV users could be encouraged to use this form of recreation elsewhere.

To protect the hydrology of the HTF, more small bridges could be constructed for heavily-used trails and rock linings for trails of lower use. Bridges will prevent sedimentation in streams as well as make trails attractive to a wider variety of interest groups, and rocks will limit rutting and erosion hazard (Figure F1).

Figure F1: *Example of a trail crossing lined with rocks to prevent erosion and rutting. Spring 2006.*

Specific management options might also relate to community type and wildlife habitat. The dry oak community, vernal pools, and wetlands are uncommon on the local landscape, so trails through these places may have greater impact due to the rarity of landscape affected. Diverting trails away from these sites may foster successful wildlife populations. At present, one proposed trail runs directly through the wetland area of the Hollis parcel. We suggest that construction of this trail be rerouted to avoid wetland areas.

Several trail users of the HTF have expressed an enthusiastic interest in active participation in trail management. With some guidance, this energy can be harnessed in a way in which users themselves provide informed trail construction and maintenance. In order for this to be feasible, user groups must be coordinated so as to ensure representation and agreement among the diverse users. One possibility would be to coordinate "Community Work Days," in which those interested in the planning process and proper maintenance of trails could use the HTF as a recreational resource and agree on the location of trails. Perhaps the Hinesburg Conservation Commission can be involved in bringing these recreational interest groups together and providing workshops in responsible land management. For this to be practical, we suggest designating a contact person for user groups interested in trail upkeep, then designing a system for groups to apply to do work if they wish to request a trail. An approval process must then be followed before construction begins. The key in this entire process is to involve HTF users in the planning process. If user groups are invited to be involved, awareness of other uses of the forest and of ecological concerns may be spread. Meetings in which user group leaders coordinate ideas could also be a time to prioritize trails, maintenance, and awareness. We also suggest researching the state's Trails Grant Program in order to get money for this ecologically-sustainable trailwork and follow their protocols.

If use of the HTF trails continues to increase, improving signage and access of trail heads and parking areas may also help to direct recreation traffic and therefore limit impacts. Kiosks at trailheads could provide information about land-use ethics, hunting season information, and background on forest management. By providing awareness about the many uses of the town forest, these kiosks may also facilitate interactions between various user groups by simply alleviating lack of knowledge of other forest uses. These improved trailheads could be further developed as picnic areas in which heavy use is kept at the property borders and inner plots are kept more intact.

Hunting

Impact

Hunting within the HTF is a popular activity. Since Vermont Fish & Wildlife already regulates game removed from forests statewide, the major impact to consider in creating a management plan is its potential conflict with other user groups. Some are concerned with safety and others would prefer that hunting not be allowed along trails used for other forms of recreation. This concern is especially valid with an increasing number of people moving into region and using the forest, some of whom are conscious of hunting practices and some who are not.

Considerations for future use

Crucial to the continuation of hunting in the HTF as use intensifies is increased awareness and education of all HTF users. Signage at trailheads alerting hikers and bikers to the possible presence of hunters during deer, turkey, and grouse seasons will be important, as is involvement of *all* forest user groups in the planning process. Conversations need to be instigated in which "rules of proper hunting" are clarified and an safety concerns communicated. Perhaps hunting should be limited to particular areas of the forest to alleviate some public concern.

Some of the conifer plantations within the Hinesburg town forest have potential to be managed as deer yards according to the guidelines set out in the Fish and Wildlife Department's *Management Guide for Deer Wintering Areas in Vermont* (1998). The maintenance of the open orchards on the old homesteads and red oak stands on the Hollis parcel provide feeding areas for game species. These areas may be good places to hunt, as indicated by the presence of deer stands (Map 9).

Education and Interpretation

Impacts

Many people have expressed interest in using the HTF not only for recreation but also for educational purposes, and a management plan can reflect and encourage this opportunity. If there are negative impacts of educational use, they arise in the form of increased use of the property. Having large groups of people in an area could potentially have a sizeable impact on soils and vegetation.

Considerations for future use

The Hayden Hill East entrance to the HTF already contains a small picnic area, though improvement of the site may be necessary before encouraging use by large groups. An outdoor classroom area using logs from the forest would concentrate educational use on a single spot and could also be used by other forest users. If school groups or other large crowds come to the forest, creating larger gathering spots positioned along major trails would concentrate and reduce overall impact on vegetation and soil erosion.

In addition to renovating the Hayden Hill East picnic area, we suggest establishing an interpretive trail that extends from this entrance to (1) the stream, (2) the logging landing and managed forest, and (3) the Place homestead. This interpretive venture could either include signage or a brochure and would contain information and stories about the site's natural history, current forest management, and cultural history. Some recreation user groups have also suggested renaming trails to reflect the rich cultural history of the forest.

Several of the homesteads on the property could be valuable educational sites. We suggest managing two or three to remain open for wildlife habitat and possibly hunting as well as for educational and interpretive purposes. The Place and Taft homesteads are located in ideal places for this kind of management goal (Maps 5 &

6). We suggest that other less accessible and less recently maintained cultural sites be left as legacies of past human use.

In addition to simply crafting places for education to occur with minimal impact, educational opportunities also include actively involving community members in learning from and managing the forest. Including high school and community groups in trail management not only creates a work force for the Town Forest but also models ecological consideration and sensitivity in forest use, builds community, and carries on a longstanding Town Forest tradition. Additionally, the Vermont Youth Conservation Corps could also be involved in designing and developing trails. Active management may also benefit students' sense of place if they cut and haul the wood to be used at CVU in their new wood-burning heating system. One already-proposed use of the Forest is for students to cut firewood in order to raise funds for a school trip, as suggested by Andrea Morgante (and others). We suggest that this type of interactive, community-engaging project be encouraged, not only for its utility, but also for the inherent educational opportunities.

Conservation Biology and Restoration

Impacts

If an area is to be conserved, it makes sense to first restore it to an ecologically sustainable condition. Currently, there are areas throughout the forest in which trails cross streams or seeps to cause hydrological concerns (Map 10). Trails and logging roads may exacerbate these problems by increasing erosion and rutting. In general, recreation and forest management practices could be having a significant impact on the conservation of the forest's natural processes by degrading certain areas. Some silvicultural treatments can also be used to *improve* diversity of habitat, tree species compositions, forest structure, and age class distribution in the absence of natural disturbances that would change the forest in similar ways. Although current forest management has attempted to increase forest structure and diversity, some of the old logging roads running through the forest need attention.

Considerations for future use

A first step in restoring the property into an ecologically sustainable state is to manage trails as mentioned earlier, with particular concern for erosion, rutting, hydrology, and wildlife. Continuing to manage forests for structure and diversity is also advisable, with special consideration for wildlife habitat. Although past wildlife management focused on game species, we recognize that current management includes the creation and protection of mature habitat for non-game species, and we recommend the continuation of this practice. Plenty of deer use the HTF, but this is also habitat that is abundant in neighboring areas. Setting aside regions such as the ledge areas where bobcats have been found, vernal pools for amphibians, known nesting and breeding areas of birds and mammals, and larger mast stands for a variety of wildlife may encourage a higher diversity of animal species (Map 9).

We suggest several alternative approaches for managing in this way. The first is to use passive restoration techniques, such as establishing stream buffers and prohibiting travel and management in sensitive areas. This method, already being implemented in some sections of the forest, is a low-cost yet highly effective way to isolate areas of greatest concern.

Many of the old logging roads and skid trails passing through the HTF are degraded and are the source of erosion and rutting. Where future timber management is likely to continue to use roads, we suggest maintaining roads and inserting bridges and culverts to restore the area's hydrology. The upkeep of these roads would also provide low-impact sites ideal for activities with which heavy erosion and rutting hazard are associated, such as horseback riding, mountain biking, and four-wheeling. If there are road and skid trails unlikely to be used in the future, however, we suggest decommissioning roads and restoring natural vegetation (a process already being done under the direction of Michael Snyder).

We also suggest that if a piece of forest be considered for preservation, the Hollis parcel would be an ideal location for an ecological preserve. This area is unique in its diversity, including several natural community types as well as a red maple swamp and vernal pool ideal for many wildlife species (Maps 8 & 9). There are currently no completed recreational trails through the parcel, although several have been proposed and cutting has unofficially begun. The isolation from the rest of the HTF would make such a preserve easier to maintain.

The recent forestry practices within the Town Forest have also been conscious of snag management. We recommend that this practice be continued, since snags are important habitat features for many mammals and birds as well as the insects upon which they feed.

None of these alternatives are mutually exclusive, and if restoration and conservation is a priority, we suggest all of the above. Further study of the property and its location as a part of larger habitat corridors is also recommended. This study could shed light on management concerns present for the entire town of Hinesburg as development continues as well. Additional research into prevention of invasive, non-native species could further inform a management plan that focuses on conservation. A list of invasive species affecting New England can be found at http://invasives.uconn.edu/ipane/, while additional information including management recommendations for individual species, as well as general management guidelines, is available through the Nature Conservancy at http://www.nature.org/initiatives/invasivespecies.

Forest Management and Community Forestry

Forest Management

Impacts

The HTF has been managed for timber for over twenty years with concern for biodiversity and ecosystem health. However, any timber management of a forest has numerous impacts. In addition to changing forest structure, diversity, and age-class, timber harvesting operations can potentially erode soils, change nutrient cycling regimes, alter hydrology of the landscape, and add or detract from wildlife habitat. There is also the possibility that timber management can conflict with other activities at the town forest, such as recreation, aesthetics, ecosystem services, and wildlife habitat.

Considerations for future use

Most of the HTF has, at some point, already been harvested for timber, or cleared for agriculture. Current management by Chittenden County Forester Mike Snyder has been done with care to regenerate naturally occurring species in the plantations, to increase forest structure and diversity in hardwood forests, and to maintain wildlife habitat, in addition to sustainably harvesting timber and protecting water resources. Responsible logging supports forest maintenance financially and, in some cases, is crucial to maintaining biodiversity. We suggest continuing forest management activities along these lines, incorporating new information from this analysis to support a more comprehensive management plan.

Historically, the ridgetops throughout the forest have been less managed because they are difficult to reach in the interior of the forest. Since the soils in these areas are more erodible and the communities have high aesthetic and wildlife value, we recommend continuing to leave these ridges untouched (Maps 3 & 9). Similarly, we recommend preserving the dry-oak natural community; this plant community is rare on the Vermont landscape, provides essential game habitat, and has a unique aesthetic feel.

We again suggest that the Hollis parcel be maintained as an ecological preserve in which timber management is prohibited and recreation is contained to certain areas. Wet soils, and unique swamp and vernal pool areas make this area susceptible to disturbance, and highly significant to wildlife.

Community forestry

"Community Forestry" refers to the activities encouraged by a community that take advantage of economic, social, and environmental opportunities provided by a forest.

For the Hinesburg Town Forest, several such programs could be applied to engage and educate townspeople. These programs could include a sugaring program, a fuelwood program, and the use of town forest timber for community projects. With the recent implementation of a fuel for school project at CVU, students can also be directly involved in extracting wood from the forest. Making management choices in an inclusive way can serve as an example of local forest stewardship to the community, while also illuminating how essential healthy forests are to the Vermont way of life.

We also suggest continued networking with the Northern Forest Alliance to gain additional guidance in the management process. The Northern Forest Alliance has initiated a Vermont Town Forest Project, which is open to any Vermont municipality. The program's goal is to officially recognize the importance of Town Forests by developing cultural and educational programming through financial and technical support at the town scale. Additionally, Northern Forest Alliance is committed to guiding towns through the stewardship process, even assisting to acquire additional lands (Northern Forest Alliance, 2004/2006).

Ecosystem Services

When assessing the value of a piece of land, it is easy to look at the real estate value of the land, as well as the tangible products such as timber that can be harvested for current or future income. It is often more difficult to place a value on, or even be aware of, the services given by simply maintaining a healthy, intact piece of land. Ecosystem services are the benefits humans receive, directly or indirectly, from ecosystems. In addition to the forest product extraction and recreational/educational values already mentioned, a healthy, intact forest cycles nutrients, regulates climate and organic waste, retains soil necessary for vegetation growth, maintains high air and water quality, and provides many other essential services on which it is difficult to place a price tag. Though we don't often recognize these benefits until they are gone, we may later experience their absence in the form of poor air quality, increased air temperatures, polluted waterways and drinking water, expensive large- and small-scale natural disasters and changes in the composition of vegetation and wildlife.

Hinesburg's Town Forest is currently zoned as "Rural Residential Use II," meaning that the forest is conserved but not protected from potential development. Under the intense pressures for development that threaten the rural character of many Vermont towns, it may be especially crucial to consider these ecosystem benefits as a community resource. A more extensive overview of the ecosystem services provided by the Hinesburg Town Forest and their economic value to the town is provided in Appendix 5. In determining the future of the HTF, we hope that these services are considered along with those previously mentioned.

Conclusion

In essence, these considerations are aimed to consider the value of a large parcel of forest within the greater context of the town as a whole. While many of these suggestions can overlap, such as recreational and educational uses, other management activities may conflict with each other.

It is important to note that all of the ideas presented in this section are simply our team's suggestions based on a four-month exploration of the Town Forest. Long-term, sustainable development specifically appropriate for the HTF is much bigger than the pieces we have considered here. Ultimately, any management strategies that seek to serve the needs of the community as a whole must first engage a broad spectrum of citizen participation to determine what values are mutually important. From there, the town can establish clear goals and objectives and design an effective management plan for using public land.

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APPENDICES

APPENDIX 1 - HTF PROPERTY OWNERSHIP

Timeline of Property Ownership on the Hinesburg Town Forest

The properties that make up the HTF are identified here by the owner in 1869, as shown on the Beers *Atlas*. These properties can also be seen on the Historical Boundaries Map #6.

J. Mahan (Mann) Farm (100 acres: half of Lot 140 and half of Lot 141)

1936 *Fred Judas* (administrator of *Charles Griffith's* estate**)** granted the farm to the *Town of Hinesburg*.

1913 *J.E. and T.J. Mahan* granted the farm to *Charles J. Griffith* including: 12 cows, 1 2-year-old bull, 1 pair of horses and all farming equipment and machinery.

1895 *Sidney E. Griffin* (administrator of *Benjamin Barnes'* estate) granted the farm to *J.E. and T.J. Mahan*. By 1870, John Mahan and his wife, Jane, who were both born in Ireland, were living and working on the farm with their children.

A. Place Farm (50 acres: eastern half of Lot 138)

1948 *Daisy and Marien Verboom* deeded the farm to the *Town of Hinesburg* for support.

1925 *Andrew and Ellen Place* sold the farm to *Marien Verboom* for $1.00. Marien married Daisy, Andrew and Ellen Place's daughter. Marien was an immigrant from Holland and had worked in the area as a herdsman.

1865 *Jacob S. and Almon D. Rood* sold the farm to *Andrew Place*.

1848 *Giles Rood* granted the farm to *Jacob S. and Almon D. Rood*.

1820 *Jacob Snyder* granted the farm to *Giles Rood*.

T. Drinkwater Farm (100 acres: Lot 139)

***Note**: This is the only original lot on the HTF that was never subdivided.

1937 *Felix Martin* granted the farm to the *Town of Hinesburg*.

1923 *James Kennedy* granted the farm to *Felix Martin* (estate).

-Missing Ownership Information-

1893 *Murray and Alice Taft* granted the farm to *James and Alice Mobbs* including: hay, grain and coarse fodder now on the premises, one sorrel horse, two yearlings, four calves, five cows, all the sugar tools complete, one sleigh, one lap robe, two horse blankets, three forks, two shovels, three saws, one steel bar, 25 chords of stove wood more or less, one drag rake, one scythe, three hoes, one potato rake, one wrench, one fanning mill, one churn and one plow.

- Missing Ownership Information-

1885 *James Miner* granted the farm to *W. and M. Taft.*

1860s – 70s *Thomas Drinkwater* lived on the farm with his family. Thomas and his wife, Ann, were both born in England. By 1870, Thomas and Ann were living and working on the farm with their grown daughter, Betsy, and their son, Edwin, and his wife, Rosannah. By 1880, Edwin and Rosannah were running the farm and had two young sons. Thomas was still living on the farm at the time at the age of 78.

- Missing Ownership Information-

1835 *Austin Place* granted the farm to *Giles Rood*.

J. Stevens Farm (Parts of Lots 137 and 138)

1954 *Herbert H. Germain* sold the 80-acre "Smith Lot" and a 7-acre a joining wood lot to the *Town of Hinesburg*.

1928 *George W. Smith* granted the 87 acres to *Herbert H. Germain*.

1910 *C.J. Russell* granted the 87 acres to *George W. Smith*.

1907 *Ira D. Rogers* granted the 87 acres to *C.J. Russell*.

1899 *Martha Williams* granted 80 acres (parts of Lots 137 and 138) to *Ira and Isaac Rogers*.

1899 *Murray Taft* (deceased)*, and Alice, Ruby and Lena Taft* granted 75 acres "more or less" to *Martha and George* (deceased) *Williams*.

1894 *John and Mary Stevens* granted their 75-acre farm (plus a separate 50-acre property) to *Murray Taft* as well as all their personal property, including: all cows, stock horses, hay, grain, coarse fodder, farming dairy and sugar utensils, wagons, harnesses. Did not include: beds and bedding, one 3-year-old colt, one pair of sap pails and several other items. John had grown up on the farm, which, by 1850, was being run by his parents (or grandparents?) James and Martha.

J. Fraser Farm (125-165 acres: parts of Lots 120 and 121)

1958 *Plant and Griffith Lumber Co.* sold 125 acres to the *Town of Hinesburg*.

1946 *Edward and Elizabeth Murray* granted 125 acres to the *Plant and Griffith Lumber Co*.

1930. *A. Wortheim* granted 125 acres to *Edward and Elizabeth Murray*.

1926 *Nettie Fargo* granted land to *A. Wortheim*.

1921 *Smith O'Brien* (estate) granted part of the farm to *Nettie Fargo*.

1912 *William and Minnie Casey* granted 165 acres to *Smith O'Brien*.

1905 *Michael Casey (estate)* granted 165 acres to *William and Minnie Casey*.

1884 *James Fraser* granted 165 acres to *Michael Casey*.

W. Taft Farm (128 acres: parts of Lots 119, 140, 141 and 118)

1941 *Clarence Blodgett* deeded the farm to the *Town of Hinesburg* for $500 plus back taxes. As part of the deal, Blodgett was required to remove all the buildings on the property within two years.

1928 *Ted and Annabel Pechie* granted the farm to *Clarence Blodgett*.

1927 *Ovett and Hattie Morrill* granted the farm to *Ted and Annabel Pechie*.

1926 *Hattie and Horace* (deceased) *Tomlinson* granted the farm to *Ovett Morrill*.

1898 *Wyman and Roselle Taft* granted the farm to *Horace and Hattie Tomlinson***.**

1884 *Frank Smith* granted a 3-acre piece of the northeast corner of Lot 118 to *Wyman Taft* that was added onto Taft's 125-acre farm. By the 1860s, Wyman and his wife, Roselle, were farming the property with Wyman's brother, Milo.

N. Alger Farm (25 acres: part of Lot 141)

? *A.C. May* lost the farm to the *Town of Hinesburg* for taxes.

1909 *Perry Read* granted the farm to *Alfred C. May*. Perry Read may have quit his claim to the property.

1902 *Nelson Alger and Alfred May* granted the farm to *Perry Read* as part of a warranty. By 1870, Nelson Alger and his wife, Ellen, were living and working on the farm.

APPENDIX 2 - HTF PLANT INVENTORY

Hinesburg Town Forest Herbaceous Plant List

Common Name	*Scientific Name*
Beech drops	*Epifagus virginiana*
Blue cohosh	*Caulophyllum thalictroides*
Brachyelytrum Species	*Brachyelytrum erectum*
Bracken fern	*Pteridium aquilinum*
Canada mayflower	*Maianthemum canadense*
Canada violet	*Viola Canadensis*
Christmas fern	*Polystichum acrostichoides*
Cinnamon fern	*Osmunda cinnamomea*
Coltsfoot*	*Tussilago farfara*
Day lily*	*Hemerocallus fulva*
Dutchman's breeches	*Dicentra cucullaria*
Dwarf ginsing	*Panax trifolius*
Fescue species	*Festuca obtuse*
Glyceria	*Glyceria* sp.
Golden alexander	*Zizia aurea*
Golden ragwort	*Senecio aureus*
Goldthread	*Coptis trifolia*
Ground cedar	*Lycopodium digitatum*
Ground pine	*Lycopodium obscurum*
Hepatica	*Hepatica* sp.
Intermediate wood fern	*Dryopteris intermedia*
Maidenhair fern	*Adiantum pedatum*
Meadow rue	*Thalictrum* sp.
Millet grass	*Milium effusum*
Partridgeberry	*Michella ripens*
Pedunculate sedge	*Caryx pedunculata*
Pennsylvania sedge	*Caryx pennsylvanica*
Plantain-leaved sedge	*Carex plantaginea*
Raspberry	*Rubus* sp.
Red trillium	*Trillium erectum*
Roundleaf yellow violet	*Viola rotundifolia*
Sedge Species	*Caryx communis*
Sedum*	*Sedum* sp.

Hinesburg Town Forest Herbaceous Plant List Continued	
Sharp-lobed hepatica	*Anemone americana*
Spring beauty	*Claytonia virginica*
Squirrel corn	*Dicentra canadensis*
Stiff clubmoss	*Lycopodium annotinum*
Strawberry	*Fragaria* sp.
Swamp saxifrage	*Saxifraga pensylvanica*
Toothwart	*Dentaria diphylla*
Trout lily	*Erythronium americanum*
Violet	*Viola* sp.
Virginia waterleaf	*Hydrophyllum virginianum*
Water avens	*Geum rivale*
Wild leek	*Allium tricoccum*
Wild oats	*Uvularia sessilifolia*
Wintergreen	*Gaultheria procumbens*
Wood anemone	*Anemone quinquefolia*
Wood sorrel	*Oxalis* sp.
* Non-natives	

Hinesburg Town Forest Woody Plant List	
Common Name	*Scientific Name*
American beech	*Fagus grandifolia*
Alternate-leaved dogwood	*Cornus alternifolia*
Apple*	*Malus pumila*
Big tooth aspen	*Populus grandidentata*
Bitternut hickory	*Carya cordiformis*
Black cherry	*Prunus serotina*
Butternut	*Juglans cinera*
Elderberry	*Sambucus* sp.
Hemlock	*Tsuga canadensis*
Hobblebush	*Viburnum alnifolium*
Hophornbeam	*Ostrya virginiana*
Musclewood	*Carpinus caroliniana*
Norway spruce	*Picea albies*
Paper birch	*Betula papyrifera*
Red maple	*Acer rubrum*
Red oak	*Quercus rubra*
Red pine	*Pinus resinosa*
Red spruce	*Picea rubens*
Serviceberry	*Amelanchier* sp.
Shagbark Hickory	*Carya ovata*
Speckled alder	*Alnus incana*
Striped maple	*Acer pensylvanicum*
Sugar maple	*Acer saccharum*
White ash	*Fraxinus americana*
White pine	*Pinus strobus*
Willow	*Salix* sp.
Yellow birch	*Betula alleghaniensis*
* Non-natives	

APPENDIX 3 - STAND INFORMATION CHART

Stand #	Current Cover Types	Vegetation Team Comments	Approx. Stand Area (acres)	Notes from David Brynn's 1986 management plan	Landscape interpretations of the 1942 aerial photo
1	Conifer Plantation	White pine plantation	3	Even-aged white pine planted in 1940	Open, agricultural land
2	Early Northern Hardwood	Even-aged hardwood stand along stream	4	Abandoned field in 1940; aspen, paper birch	Open, agricultural land
3	Conifer Plantation	White pine, Norway spruce plantation	8	Even-aged white pine, some Norway spruce; planted in 1942	Looks open prior to plantation; possibly agricultural land
4	Intermediate Northern Hardwood	Northern hardwood - red maple, white ash, paper birch	57	Stand over 60 years; probably field at some point	Forested; except for stand 6 in middle
5	Conifer Plantation	Norway spruce, red pine plantation	7	Norway spruce; red pine; planted in 1941; red pine refill in 1960; crop trees pruned; some hardwoods mixed in	Open, agricultural land
6	Conifer Plantation	Red pine, white pine plantation; some American beech, sugar maple, and a little white ash, late-early successional	3	White pine; red pine planted 1939; also aspen, red maple, paper birch	Open, agricultural land, among forested land
7A	Conifer Plantation	White pine, red pine, Norway spruce plantation, some blister rust	18	White pine, red pine; planted in 1942; crop trees pruned, some red maple, Norway spruce, paper birch, aspen	Open, agricultural land
7B	Conifer Plantation	Red pine planted; northern hardwood - paper birch, red maple, black cherry, American beech. Thick organic mat	6	None	Partially forested, possibly pasture
7C	Gap Cut	Open; recently cut conifer plantation	1	None	Mostly open
7D	Conifer Plantation	Red pine, white pine plantation	2	White pine, red pine; planted in 1942; crop trees pruned; some red maple, Norway spruce, paper birch, aspen	Open
8	Homestead	Open, homestead site; some Norway spruce, apple trees	2	None	Homestead
9	Conifer Plantation	Norway spruce, red pine, white pine plantation; red maple, white ash in understory	24	Planted in 1943	Open

Stand #	Current Cover Types	Vegetation Team Comments	Approx. Stand Area (acres)	Notes from David Brynn's 1986 management plan	Landscape interpretations of the 1942 aerial photo
10A	Intermediate Northern Hardwood	Red maple, paper birch, American beech	12	Paper birch, red maple, sugar maple, aspen, white ash, red oak. Abandoned field in 1930	Partially open
10B	Wet Northern Hardwood	Red maple dominant, paper birch, some musclewood - area is wetter and transitions into swamp below	4	Paper birch, red maple, sugar maple, aspen, white ash, red oak. Abandoned field in 1930	Partially open
10C	Red Maple - Northern Hardwood	Red maple dominant northern hardwood	11	Red maple, paper birch, sugar maple, aspen, white ash, red oak. Abandoned field in 1930	Mostly open
10D	Red Spruce - Northern Hardwood Ridge	Red spruce northern hardwood, with abundant spruce and some birch	19	Paper birch, red maple, sugar maple, aspen, white ash, red oak. Abandoned field in 1930	Partially open, possibly abandoned pastured
10E	Mixed Northern Hardwood Ridge	Hardwood ridge - red oak, white ash, black cherry, American beech, sugar maple	19	Paper birch, red maple, sugar maple, aspen, white ash, red oak. Abandoned field in 1930	Forested
11	Red Spruce - Northern Hardwood Ridge	Red spruce ridge, yellow birch, mixed	14	Red spruce, sugar maple, American beech, red maple, yellow birch, white pine	Mostly forested
12	Alder Swamp	Alder, willow, some red maple, grey birch	3	Red maple, alder stand good for woodcock, abandoned pasture	Partially open
13A	Red maple - Northern Hardwood	Northern hardwood, red maple dominant	59	Red maple, sugar maple, red spruce, aspen, balsam fir, abandoned pasture	Forested
13B	Early Northern Hardwood	Northern hardwood, paper birch, red maple	12	Red maple, sugar maple, red spruce, aspen, balsam fir, abandoned pasture	Open
13C	Red Spruce - Northern Hardwood Ridge	Red spruce northern hardwood, paper birch	11	Red maple, sugar maple, red spruce, aspen, balsam fir, abandoned pasture	Forested
14	Mixed Northern Hardwood Ridge	Hardwood ridge - red oak, white ash, American beech, sugar maple	20	Northern hardwood	Forested
15	Conifer Plantation	Norway spruce plantation - red maple	3	Norway spruce, red maple plantation, planted in 1942/1943, also white ash, white pine	Partially open
16	Early Northern Hardwood	Northern hardwood, was more open lower on the slope, big trees on ridges, birch senescing	72	Paper birch, red maple	Pasture, partially open

Stand #	Current Cover Types	Vegetation Team Comments	Approx. Stand Area (acres)	Notes from David Brynn's 1986 management plan	Landscape interpretations of the 1942 aerial photo
17	Early Northern Hardwood	Northern Hardwood matrix, younger - earlier in succession	15	Northern hardwood	Partially open
18A	Red spruce - Northern Hardwood Ridge	Red spruce northern hardwood, paper birch	49	Paper birch, red spruce, balsam fir, deer yard - retain high basal area for wintering	Forested
18B	Intermediate Northern Hardwood	Northern hardwood, paper birch, sugar maple	10	Paper birch, red spruce, balsam fir, deer yard - retain high basal area for wintering	Forested with open patches
19A	Intermediate Northern Hardwood	Red maple dominant, northern hardwood matrix, poorly drained soils	107	None	Open along Hayden Hill Rd., some forested
19B	Intermediate Northern Hardwood	Mixed northern hardwood - red maple, sugar maple, American beech, white ash	41	None	Forested, with open area in center - possible agricultural land or homestead
19C	Sugar Maple - Northern Hardwood	Sugar maple dominant, also white ash	25	None	Forested
19D	Red Spruce - Northern Hardwood Ridge	Red spruce dominant - very steep slope with bedrock outcroppings	2	None	Forested
20A	Intermediate Northern Hardwood	Mixed northern hardwood - red maple, sugar maple, American beech, white ash	23	None	Mostly open
20B	Intermediate Northern Hardwood	Mixed northern hardwood - red maple, sugar maple, American beech, white ash. Recent cuttings apparent	48	None	Forested
20C	Sugar Maple - Northern Hardwood	Sugar maple dominant, also white ash. Rich site indicators abundant	37	None	Forested
20D	Intermediate Northern Hardwood	Mixed northern hardwood - red maple, sugar maple, American beech, white ash	15	None	Open agricultural land
20E	Sugar Maple - Northern Hardwood	Sugar maple dominant, also white ash	6	None	Open agricultural land
21	Early Northern Hardwood	Northern hardwood, paper birch abundant, drier south-facing slope	27	None	Open along Hayden Hill Rd., some forested
22	Mixed Northern Hardwood Ridge	Hardwood ridge - red oak, white ash, American beech, sugar maple, bigtooth aspen. Steep slopes	9	None	Forested

Stand #	Current Cover Types	Vegetation Team Comments	Approx. Stand Area (acres)	Notes from David Brynn's 1986 management plan	Landscape interpretations of the 1942 aerial photo
23	Dry Oak - Northern Hardwood	Red oak, hophornbeam, sugar maple, sparse understory and herbaceous layer, some *Carex pennsylvanica*. Two red pine found in stand	1	None	Forested
24	Dry Oak - Northern Hardwood	Red oak, hophornbeam, sugar maple, sparse understory and herbaceous layer, some *Carex pennsylvanica*	1	None	Forested
25	Intermediate Northern Hardwood	Mixed northern hardwood - red maple, sugar maple, American beech, white ash	10	None	Forested
26	Sugar Maple - Northern Hardwood	Sugar maple dominant, high quality trees, many age classes	4	None	Forested
27	Intermediate Northern Hardwood	Mixed northern hardwood - red maple, sugar maple, American beech, white ash	6	None	Forested
28	Red Maple Swamp	Red maple dominant, some yellow birch, High water table	4	None	Forested
29	Mixed Northern Hardwood Ridge	Hardwood ridge - red spruce, sugar maple, American beech, red maple	8	None	Forested

APPENDIX 4 – HTF VERTEBRATE SPECIES (POTENTIAL AND CONFIRMED)

Hinesburg Town Forest Vertebrate Species (Potential and Confirmed)		
	* *focal species* X *presence confirmed via sighting, sign, or call*	
Potential resident mammals:		
	Virginia opossum *Didelphis virginiana*	
	Masked shrew *Sorex cinereus*	X
	Water shrew *Sorex palustris*	
	Smoky shrew *Sorex fumeus*	
	Long-tailed shrew *Sorex dispar*	
	Pygmy shrew *Sorex hoyi*	
	Northern short-tailed shrew *Blarina brevicauda*	X
	Hairy-tailed mole *Parascalops breweri*	
	Star-nosed mole *Condylura cristata*	
	Little brown bat *Myotis lucifugus*	
	Northern long-eared bat *Myotis septentrionalis*	
	Eastern small-footed bat *Myotis leibii*	
	Eastern pipistrelle *Pipistrellus subflavus*	
	Big brown bat *Eptesicus fuscus*	
	Eastern cottontail *Sylvilagus floridanus*	
	Snowshoe hare *Lepus americanus*	
	Eastern Chipmunk *Tamias striatus*	X
	Woodchuck *Marmota monax*	
	Gray Squirrel *Sciurus carolinensis*	X
	Red Squirrel *Tamiasciurus hudsonicus*	X
	Southern flying squirrel *Glaucomys volans*	
	Northern flying squirrel *Glaucomys sabrinas*	
	Beaver *Castor canadensis*	
	Deer mouse *Peromyscus maniculatus*	X
	White-footed mouse *Peromyscus leucopus*	X
	Southern red-backed vole *Clethrionomys gapperi*	X
	Meadow vole *Microtus pennsylvanicus*	
	Woodland vole *Microtus pinetorum*	
	Muskrat *Ondatra zibethicus*	
	Southern bog lemming *Synaptomys cooperi*	
	Meadow jumping mouse *Zapus hudsonius*	
	Woodland jumping mouse *Napaeozapus insignis*	
	Porcupine *Erethizon dorsatum*	X
	Coyote *Canis latrans*	X
	Red fox *Vulpes vulpes*	X
	Gray fox *Urocyon cinereoargenteus*	
	Black bear *Ursus americanus*	X

	Raccoon *Procyon lotor*	X
	Fisher *Martes pennanti**	X *
	Ermine *Mustela erminea*	X
	Long-tailed weasel *Mustela frenata*	X
	Mink *Mustela vison*	X
	Striped skunk *Mephitis mephitis*	
	River otter *Lontra canadensis*	
	Bobcat *Lynx rufus**	X *
	White-tailed deer *Odocoileus virginianus**	X *
	Moose *Alces alces*	X
Potential resident birds and winter birds:		
	Sharp-shinned hawk *Accipiter striatus*	
	Rough-legged hawk *Buteo lagopus*	
	Ruffed grouse *Bonasa umbellus**	X *
	Wild turkey *Meleagris gallopavo*	X
	Eastern screech owl *Otus asio*	
	Great horned owl *Bubo virginianus*	
	Barred owl *Strix varia*	X
	Boreal owl *Aegolius funereus*	
	Northern saw-whet owl *Aegolius acadicus*	
	Downy woodpecker *Picoides pubescens*	X
	Hairy woodpecker *Picoides villosus*	X
	Pileated woodpecker *Dryocopus pileatus**	X *
	Blue jay *Cyanocitta cristata*	X
	American crow *Corvus brachyrhynchos*	X
	Common raven *Corvus corax*	X
	Tree swallow *Tachycineta bicolor*	
	Black-capped chickadee *Poecile hudsonicus*	X
	Tufted titmouse *Baeolophus bicolor*	X
	Red-breasted nuthatch *Sitta canadensis*	X
	White-breasted nuthatch *Sitta carolinensis*	X
	Brown creeper *Certhia americana*	X
	Golden-crowned kinglet *Regulus satrapa*	X
	Northern mockingbird *Mimus polyglottos*	
	Bohemian waxwing *Bombycilla garrulus*	
	Cedar waxwing *Bombycilla cedrorum*	X
	Pine grosbeak *Pinicola enucleator*	
	Purple finch *Carpodacus purpureus*	
	House finch *Carpodacus mexicanus*	
	Common redpoll *Carduelis flammea*	
	Pine siskin *Carduelis pinus*	
	American goldfinch *Carduelis tristis*	X

	Potential breeding birds and passers through:	
	American bittern *Botaurus lentiginosus*	
	Least bittern *Ixobrychus exilis*	
	Great blue heron *Ardea herodias*	
	Green heron *Butorides virescens*	
	Turkey vulture *Cathartes aura*	
	Canada goose *Branta canadensis*	
	Wood duck *Aix sponsa*	
	American black duck *Anas rubripes*	
	Mallard *Anas platyphnchos*	
	Common goldeneye *Bucephala clangula*	
	Hooded merganser *Lophodytes cucullatus*	
	Cooper's hawk *Accipiter cooperii*	
	Northern goshawk *Accipiter gentilis**	*
	Red-shouldered hawk *Buteo lineatus*	
	Broad-winged hawk *Buteo platypterus*	
	Red-tailed hawk *Buteo jamaicensis*	
	American kestrel *Falco sparverius*	
	Mourning dove *Zenaida macroura*	
	Black-billed cuckoo *Coccyzus erythropthalmus*	
	Yellow-billed cuckoo *Coccyzus americanus*	
	Long-eared owl *Asio otus*	
	Whip-poor-will *Caprimulgus vociferous*	
	Ruby-throated hummingbird *Archilochus colubris*	
	Yellow-bellied sapsucker *Sphyrapicus varius*	X
	Northern Flicker *Colaptes auratus*	X
	Eastern wood-pewee *Contopus virens*	
	Alder flycatcher *Empidonax alnorum*	
	Willow flycatcher *Empidonaz traillii*	
	Least flycatcher *Empidonax minimus*	
	Eastern phoebe *Sayornis phoebe*	X
	Great crested flycatcher *Myiarchus crinitus*	
	Eastern kingbird *Tyrannus tyrannus*	
	Blue-headed vireo *Vireo solitarius*	X
	Warbling vireo *Vireo gilvus*	
	Philadelphia vireo *Vireo philadelphicus*	
	Red-eyed vireo *Vireo olivaceus*	X
	House wren *Troglodytes aedon*	
	Winter wren *Troglodytes troglodytes*	X
	Ruby-crowned kinglet *Regulus calendula*	X
	Blue-gray gnatcatcher *Polioptila caerulea*	
	Eastern bluebird *Sialia sialis*	
	Veery *Catharus fuscescens*	
	Swainson's thrush *Catharus ustulatus*	
	Hermit thrush *Catharus guttatus*	X
	Wood thrush *Hylocichla mustelina*	
	American robin *Turdus migratorius*	X
	Gray catbird *Dumetella carolinensis*	

	Brown thrasher *Toxostoma rufum*	
	Golden-winged warbler *Vermivora chrysoptera*	
	Nashville warbler *Vermivora ruficapilla*	
	Northern parula *Parula americana*	
	Yellow warbler *Dendroica petechia*	
	Chestnut-sided warbler *Dendroica pensylvanica*	
	Magnolia warbler *Dendroica magnolia*	
	Black-throated blue warbler *Dendroica caerulescens*	
	Yellow-rumped warbler *Dendroica coronata*	X
	Black-throated green warbler *Dendroica virens*	
	Balckburnian warbler *Dendroica fusca*	
	Pine warbler *Dendroica pinus*	
	Black-and-white warbler *Mniotilta varia*	
	American redstart *Setophaga ruticilla*	
	Ovenbird *Seiurus aurocapillus*	
	Mourning warbler *Oporornis philadelphia*	
	Common yellowthroat *Geothylypis trichas*	
	Canada warbler *Wilsonia canadensis*	
	Scarlet tananger *Piranga olivacea*	
	Eastern towhee *Pipilo erythrophthalmus*	
	Chipping sparrow *Spizella passerina*	X
	Field sparrow *Spizella pusilla*	
	Song sparrow *Melospiza melodia*	X
	Swamp sparrow *Melospiza georgiana*	
	White-throated sparrow *Zonotrichia albicollis*	X
	Dark-eyed junco *Junco hyemalis*	X
	Northern cardinal *Cardinalis cardinalis*	
	Rose-breasted grosbeak *Pheucticus ludovicianus*	
	Indigo bunting *Passerina cyanea*	
	Red-winged blackbird *Agelaius phoeniceus*	X
	Common grackle *Quiscalus quiscala*	
	Brown-headed cowbird *Molostrus ater*	X
	Baltimore oriole *Icterus galbula*	
	Evening grosbeak *Coccocthraustes vespertinus*	X
	Potential resident amphibians/ reptiles:	
	Mudpuppy *Necturus maculosus*	
	Jefferson salamander *Ambystoma jeffersonianum*	
	Blue-spotted salamander *Ambystoma laterale*	
	Spotted salamander *Ambystoma maculatum*	X
	Red-spotted newt *Notophthalmus v. viridescens*	
	Northern dusky salamander *Desmognathus fuscus*	X
	Northern red-backed salamander *Plethodon cinereus*	
	Northern spring salamander *Gyrinophilus p. porphyriticus*	
	Northern two-lined salamander *Eurycea bislineata*	X
	Eastern american toad *Bufo a. americanus*	
	Northern spring peeper *Pseudacris c. crucifer*	X

	Gray treefrog *Hyla versicolor*	
	Bullfrog *Rana catesbeiana*	
	Green frog *Rana clamitans*	X
	Wood frog *Rana sylvatica**	X *
	Northern leopard frog *Rana pipiens*	
	Pickerel frog *Rana palustris*	
	Common snapping turtle *Chelydra s. serpentine*	
	Wood turtle *Clemmys insculpta*	
	Painted turtle *Chrysemys picta*	
	Northern brown snake *Storeria d. dekayi*	
	Northern redbelly snake *Storeria o. occipitomaculata*	
	Common garter snake *Thamnophis sirtalis*	X
	Ribbon snake *Thamnophis sauritus*	
	Northern ringneck snake *Diadophis punctatus edwardsii*	
	Eastern smooth green snake *Liochlorophis vernalis*	
	Eastern milk snake *Lampropeltis t. triangulum*	

APPENDIX 5 - VALUE OF THE HTF

The Value of the Hinesburg Town Forest:
An Argument for Forest rather than Real Estate

KATE WESTDIJK

In our first day at the Hinesburg, Vermont town forest, Chittenden County Forester, Mike Snyder, didn't waste any time laying out the challenges in balancing the range of possible fates for this town land. He told us that five years ago there was a motion among some town residents to sell the forest. They wanted to subdivide the land and sell it to new residents in order to widen the tax base. In my subsequent research about the Town Forest, I came across a letter written in 1990 by David Brynn, Mike's predecessor, to selectmen and planning commission members. He also addressed a consideration to sell the Hinesburg Town Forest. Both Mike Snyder and David Brynn have managed, for the time being, to justify the retention of the forest by highlighting its economic benefits (timber production benefits and lack of maintenance costs to the community) and social benefits (recreation and education), but the risk of a new movement to sell is still there. Is the town forest really worth more to the town of Hinesburg as a forest versus as subdivided housing plots? To provide further support for keeping the Hinesburg Town Forest a forest, this paper outlines the sources of value of this forested land to the Hinesburg community as well as to surrounding areas.

A more traditional argument for holding on to a natural resource is to allow for growth in the value of those resources over time, something referred to in economics as "stock flow" (Erickson, 2006). The Hinesburg Town Forest can provide a stock of raw materials in the form of timber for building or fuel, and topsoil and fertilizer for agriculture (Farber et al., 2006). By keeping and carefully managing the town forest over time, the town of Hinesburg can secure the appreciation of its raw materials resource (stock) at little to no cost. The value of this local natural resource to the town of Hinesburg has become more important because Champlain Valley Union High School recently became "one of some two dozen schools in Vermont with a wood-chip fired heating system" (McLean, 2006). Wood chips created as waste during logging operations in the town forest could be used to heat the local high school. In a time when local fuel sources are rare, and international fuel sources are unstable, the Hinesburg Town Forest can provide the security of a local source for the fuel needed to heat this large facility. However, while "stock flow" value of a natural resource is important, in most cases this value can only be realized if the resource is harvested. It is important not to overlook the value a forest provides to the surrounding community if it remains intact.

The value an intact forest provides to society is referred to by economists as "fund service" (Erickson, 2006). Natural ecosystem functions provide important and valuable services to humanity, and these services are often overlooked because we don't pay for them. The following table summarizes and describes the range of services provided by the world's ecosystems based on categories from the Millenium Ecosystem Assessment (WRI, 2005).

Table 1. Ecosystem functions and services.

Ecosystem functions and services	Description	Examples
Supportive functions and structures	Ecological structures and functions that are essential to the delivery of ecosystem services	See below
Nutrient cycling	Storage, processing, and acquisition of nutrients within the biosphere	Nitrogen cycle; phosphorus cycle
Net primary production	Conversion of sunlight into biomass	Plant growth
Pollination and seed dispersal	Movement of plant genes	Insect pollination; seed dispersal by animals
Habitat	The physical place where organisms reside	Refugium for resident and migratory species; spawning and nursery grounds
Hydrological cycle	Movement and storage of water through the biosphere	Evapotransporation; stream runoff; groundwater retention
Regulating services	Maintenance of essential ecological processes and life support systems for human well-being	See below
Gas regulation	Regulation of the chemical composition of the atmosphere and oceans	Biotic sequestration of carbon dioxide and release of oxygen; vegetative absorption of volatile organic compounds
Climate regulation	Regulation of local to global climate processes	Direct influence of land cover on temperature, precipitation, wind, and humidity
Disturbance regulation	Dampening of environmental fluctuations and disturbance	Storm surge protection; flood protection
Biological regulation	Species interactions	Control of pests and diseases; reduction of herbivory (crop damage)
Water regulation	Flow of water across the planet surface	Modulation of the drought–flood cycle; purification of water
Soil retention	Erosion control and sediment retention	Prevention of soil loss by wind and runoff; avoiding buildup of silt in lakes and wetlands
Waste regulation	Removal or breakdown of nonnutrient compounds and materials	Pollution detoxification; abatement of noise pollution
Nutrient regulation	Maintenance of major nutrients within acceptable bounds	Prevention of premature eutrophication in lakes; maintenance of soil fertility
Provisioning services	Provisioning of natural resources and raw materials	See below
Water supply	Filtering, retention, and storage of fresh water	Provision of fresh water for drinking; medium for transportation; irrigation
Food	Provisioning of edible plants and animals for human consumption	Hunting and gathering of fish, game, fruits, and other edible animals and plants; small-scale subsistence farming and aquaculture
Raw materials	Building and manufacturing Fuel and energy Soil and fertilizer	Lumber; skins; plant fibers; oils; dyes Fuelwood; organic matter (e.g., peat) Topsoil; frill; leaves; litter; excrement
Genetic resources	Genetic resources	Genes to improve crop resistance to pathogens and pests and other commercial applications
Medicinal resources	Biological and chemical substances for use in drugs and pharmaceuticals	Quinine; Pacific yew; echinacea
Ornamental resources	Resources for fashion, handicraft, jewelry, pets, worship, decoration, and souvenirs	Feathers used in decorative costumes; shells used as jewelry
Cultural services	Enhancing emotional, psychological, and cognitive well-being	See below
Recreation	Opportunities for rest, refreshment, and recreation	Ecotourism; bird-watching; outdoor sports
Aesthetic	Sensory enjoyment of functioning ecological systems	Proximity of houses to scenery; open space
Science and education	Use of natural areas for scientific and educational enhancement	A "natural field laboratory" and reference area
Spiritual and historic	Spiritual or historic information	Use of nature as national symbols; natural landscapes with significant religious values

Table 1: Categories and descriptions of ecosystem services based on the Millennium Ecosystem Assessment. (Farber et al., 2006; WRI, 2005)

Forest Ecosystem Services

Ecosystem services are the benefits humans receive, directly or indirectly, from ecosystems (Farber et al., 2006). Some ecological structures and functions, such as habitat and hydrological cycles, provide essential support for the delivery of ecosystem services. Habitat, or the physical place where organisms reside, provides the base for healthy populations that not only provide human food sources (e.g. maple products), but forested habitat also contributes to pest control and supports the biodiversity that is a prerequisite for healthy ecosystems. "Estimates indicate that it would cost more than $7 per acre to replace the pest control services provided by birds in forests with chemical pesticides" (Barclay & Batker, 2004, p. 10). This estimate does not include the high costs of toxic loading associated with the use of chemical pesticides. In addition, forest habitats support a wide variety of wildlife species that human backyards do not. In a study regarding the impact of human settlement on forest, researchers found that "in general, wildlife species diversity declines along gradients of increasing urbanization, while the population density of some well-adapted urban species increases" (McBride, et al., 2004, p.6). Signs of the important predators bobcat, fisher and red fox were found in the Hinesburg town forest this spring. These medium-size carnivores play a key role in ecological health (Miller et al., 2001), but they require forested habitat and would not be able to survive on the property if it were converted into housing.

Another ecological function that supports important ecological services is the hydrological cycle. This cycle describes the ways in which water moves around the earth and plays an important role in regulating climate as well as retaining groundwater (Dunne & Leopold, 1983). Forests play an important role in the hydrological cycle. When forests are removed for housing development, the trees are no longer present to trap moisture in the atmosphere or to replenish that moisture through evapotranspiration. Forests also provide free water filtration to the town of Hinesburg. "To avoid the need to build a $200 million water filtration plant and pay to operate it, Portland spends $920,000 annually to protect its Bull Run watershed, thus maintaining natural filtration of its drinking water supply" (Barclay & Batker, 2004, p. 10). Furthermore, forests provide a valuable stormwater system at no cost to taxpayers. When vegetation is removed from a forested area during construction, the ability of water to percolate slowly through the soil is reduced. Poor soil drainage results in increased stormwater runoff that can cause costly flood damage (Dunne & Leopold, 1983).

In addition to supportive functions, ecosystems also regulate environmental fluctuations and disturbance. As mentioned above, by regulating the hydrological cycle, forests can prevent damage from floods and large storms as well as reducing the risk and severity of droughts. Tree roots provide this valuable service by aerating the soil, which allows it to absorb water during rains and release it during dry periods (Daly & Farley, 2004). Forests are also essential for erosion control. The canopy in a forest diminishes the impact of rain and wind while the tree roots hold the soil in place. The town of Hinesburg has many dirt roads that are sensitive to flooding and severe erosion events, particularly during spring snowmelt periods. Government soil scientist Caroline Alves, who is also a resident of neighboring Monkton, VT, attested to the importance of forested land in reducing this expensive damage in a conversation we had about the recent flooding of Hayden Hill Road (2006). Both forest regulation of water and soil erosion supports human populations by dramatically reducing the risk (and the following expense) of natural disasters.

Forests are also important for regulating the climate and cleaning the air. As mentioned earlier, trees are important for cycling water in our atmosphere. They regulate temperatures by storing heat that can be transported to other regions by the wind, as well as providing shade and insulation (Daly & Farley, 2004). In addition, forest plants remove and store the greenhouse gas, carbon dioxide. According to the market for carbon sequestration based on the growing concern for climate change, forests provide climate regulation at a value of $35 per acre (Barclay & Batker, 2004). Aside from removing carbon dioxide, forests also improve air quality by removing other air pollutants such as sulfur dioxide, another byproduct of burning fossil fuels, while replacing these pollutants with clean oxygen (Daly & Farley, 2004). "According to Washington state officials, if logged forests in the Puget Sound region had been kept intact, they would have absorbed approximately 35 million additional pounds of air pollutants per year since 1972, providing a service worth almost $95 million" (Barclay & Batker, 2004, p. 10). Vermont has signed an agreement with states in the Northeast and Mid-Atlantic to reduce its carbon dioxide emissions as part of the Regional Greenhouse

Gas Initiative (RGGI, 2006). The role of Vermont forests in carbon sequestration will become even more important as the market for trading carbon credits becomes more established.

Forested land such as the Hinesburg Town Forest contributes to environmental and human health by providing these essential services, but it also provides important "cultural services". Ecosystems have the ability to enhance our "emotional, psychological and cognitive well-being" by providing recreation and education opportunities, as well as aesthetic benefits (Farber et al., 2006, p. 123). The town forest provides the Hinesburg community and other visitors with hunting, biking, birdwatching, picnicking, cross-country skiing, and many more opportunities for recreation as well as the enjoyment of open spaces and scenery. It also provides "a 'natural field laboratory' and reference area" for educational use by parents, local schools, or even regional colleges and universities (Farber et al., 2006, p. 123). The psychological health benefits of outdoor recreation are not only qualitative. According to researchers at the University of Essex in England, "evidence indicates that nature can help us recover from pre-existing stresses or problems, have an 'immunizing' effect by protecting us from future stresses and help us concentrate and think more clearly" (Pretty et al., 2005). The Hinesburg town forest is clearly an important cultural as well as natural resource that should not be overlooked.

Additional Value of Ecosystem Services

The preceding examples of ecosystem services provided by a forest also differ from raw materials in a forest because they are "nonexcludable" and "nonrival" resources. A nonexcludable resource can be used by anyone because there is no legal or practical ability for ownership of those resources (Daly & Farley, 2004). You can't stop your neighbor from breathing the clean air filtered by the trees in your yard- the service provided by those trees is a nonexcludable resource. In addition, you probably don't care that your neighbor gets to breath clean air from your trees because you and your family still have plenty of clean air for yourselves. Clean air, like many of the resources created by ecosystem services, is a nonrival resource because its "use by one person does not affect its use by another" (Daly & Farley, 2004, p.73).

These "fund services" that ecosystems provide to humanity are not only free and available to everyone, they are self-sustaining and in many cases irreplaceable. In the rare case that a man-made replacement for an ecosystem service is possible, such as a water treatment plant, these artificial subsititutes require routine maintenance of the machines and facility because they wear out over time. When a forest provides the same valuable service, it doesn't wear out because it is constantly renewing itself with the simple input of solar energy (Daly & Farley, 2004). It is also important to recognize that human technology cannot replace most of the services provided by ecosystems, and many of the substitutes that we can create are less effective. We don't understand the mechanisms behind climate well enough to create technologies to control it, and trees are still the best candidates for erosion control. The Hinesburg Town Forest is not just a cheap source of town services; it is also a self-maintaining provider of those often irreplaceable services.

Reaping the fund service benefits of a forest is not as simple as planting a few trees in your backyard, although that helps. "The larger an ecosystem fund and the better its health, the more services it is likely to generate" (Daly & Farley, 2004, p.106). The 837-acre Hinesburg Town Forest is a sizable fund for the creation of services to the community. But what about health? This is where management comes into play. "The use of a biological stock at a non-sustainable level in general also depletes a corresponding fund and the services it provides. Hence, when we harvest trees from a forest, we are not merely changing the capacity of the forest to create more trees, but are also changing the capacity of the forest to create ecosystem services, many of which are vital to our survival" (Daly & Farley, 2004, p.107). Management of the Hinesburg Town Forest should consider the sustainability of the capacity of the forest to serve the Hinesburg community as well as the sustainability of its raw materials resource.

The value of retaining the town forest to the town of Hinesburg is complex and multi-dimensional. While the harvested value of the forest's raw materials will grow over time, the valuable and important ecosystem services it provides are being realized today and the forest's capacity to supply these services can increase with careful management. Through the shared benefits of this resource and opportunities for communal recreation, the forest also fosters positive community relationships. While broadening the tax base and acquiring immediate income is important for many towns, it's important to consider the current and potential value of the town forest in social and environmental, as well as economic terms. Forests are an important and declining resource that should not be undervalued.

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