The Harwood Union School Forest Stewardship Plan

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in collaboration with the Harwood Forest Project

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Introduction

The Harwood Forest Project (HFP) was developed through a collaborative partnership between the University of Vermont and Harwood Union High School with the goal of implementing community-based forest management strategies on the Harwood Union School Forest. Community-based forest management is a broad discipline with diverse objectives based on geographic location, community capacity and interest in undertaking forest management. The goal of this forest management plan will be to guide active management of the Harwood Union School Forest using adaptive management strategies. Adaptive management requires community participation in developing goals and objectives, collecting forest data, and implementing forest monitoring programs that will sustain and improve the ecological functioning of the forest and provide the social benefits desired by communities affected by management activities. Stewardship is at the core of community-based forestry efforts. This is the concept that draws many people into such efforts, guides their actions, and provides a focus for the groups' activities. Stewardship also represents a shift away from forest management planning based on market outputs and toward a more holistic approach that recognizes the connection between healthy and functioning ecosystems and communities. The Harwood Forest Project has developed with an eye toward stewardship and will attempt to capture the diverse interests of all forest users and those involved in the planning process. The forest management plan will consider both human and non-human uses and provide a roadmap to sustain the ecological functionality of the Harwood Union School Forest.

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1.0 - Preface

1.1 - What is forest management planning in the context of community-based forestry?

Forest management planning takes place when goals and objectives for forest stewardship are developed and a formal strategy is implemented to achieve those goals and objectives. Community-based forestry offers a holistic approach to forest management must include input from community members who may be affected by any management prescriptions set out in a corresponding forest management plan. In contrast, a forest management plan for a private woodlot, or individual owner, must only take into consideration the goals and objectives of that one property owner. At Harwood Union, our goal is to develop forest management strategies that can be out as adaptive management. This means that the forest management plan should be flexible and allow community input and changes over time as lessons from management activities are realized. It also means that community members should have meaningful participation in: 1.) developing planning goals, which is termed "empowering participation", and 2.) collecting and analyzing forest data, termed "functional participation".

1.2 - Why plan for forest management and use?

It is important to plan for forest management and use because we value our forests as places for recreation, as part of Vermont's rural landscape, as providing economic resources, and as providing critical habitat and ecosystem services (Turner, 2008). By prioritizing forest values and management goals, the first step in the process, communities and landowners will develop an intimate relationship with their forest. This relationship fosters greater understanding of the natural processes at work in the landscape and can unite the community around common forest objectives. Community-based forest management planning on the Harwood Forest will ensure that forest management objectives are met and forest health is maintained for future generations.

1.3 - What's in a Forest Management Plan?

Forest management plans come in all different forms. At a minimum a forest management plan includes the following: management goals and objectives, forest conditions, including maps, a management prescriptions and a schedule for carrying them out, and a statement about how the prescriptions will achieve the goals and objectives (Turner, 2008). A forest stewardship plan, like this plan, attempts to encapsulate a much wider scope of goals and objectives. While traditional forest management plans used to focus on maximizing harvestable timber from forestland (Donovan, 2002), stewardship plans are much more of an attempt to maximize ecosystem functioning, which in turn will provide multiple ecological and social benefits. Examples of background information that might be included in a forest stewardship plan include natural and cultural history, geologic and soil information, and information on water quality, wildlife habitat, and forest inventory data. Prescriptions on active management are also included. These can range from managing for recreational activities, wildlife and nature, timber production, ecosystem
services, like clean air and water, or social benefits, like employment and education. The goals and objectives for the property are established by the landowner, or the community users, and the forest management plan is a vehicle for achieving those objectives.

1.4 - Who Benefits from a Forest Management Plan?

In the traditional sense, the landowner benefits from a management plan because the management plan is written to achieve his or her objectives. On the Harwood Union School Forest, and other similar community-owned forests, it is the local community who benefits from the actions directed by the forest management plan. It is most appropriate for the Harwood Union's school board to facilitate continuing opportunities for community engagement and adaptive management as described within the forest management plan. This will result in increased opportunities for participation in planning and greater benefits for a larger population of people. The Harwood Forest Management Plan is intended to be a public document and should be made available for public use. Students and teachers may use the plan for developing educational opportunities. High school sports teams will undoubtedly use the plan and its trail maps for athletics and recreation. Community members may use the plan to understand issues of forest health or borrow ideas for management of their own properties. Other institutions may also use this forest management plan as a reference of how to guide their own stewardship activities. Basically, anyone who uses the Harwood School Forest, or has an interest in what's happening in the forest, should have access to the plan and its components.

1.5 - Issues of Governance

This plan is an official document and must be adopted by the school board prior to its implementation. It should be the responsibility of the school board to direct the implementation of this management plan in a way that benefits the local community through support of the stewardship actions included in the management prescriptions. The school board may enlist the services of public and private professionals and partner organizations to assist in carrying out management activities as needed. For example, the school board should enlist a professional forester to lay out and mark any timber sale prior to conducting a commercial harvest on the property, or community partners might be engaged to help eradicate invasive species on the Harwood Forest. The Department of Forests, Parks, and Recreation (FPR) may also be able to provide Harwood Union with some management services through the Washington County Forester's office. Other management activities may not require professional assistance and can be carried out by teachers, staff, students, or community members. The school board should make sure the forest management plan remains current by having it updated every 10 years. Updates to the plan should take into consideration any changes in land use or tenure, forest health and ecosystem services, community forest initiatives, and/or student collaborations that will affect how the forest is managed over the next planning horizon. For practical considerations, it is recommended that the school board designate the Facilities Committee as the official body charged with overseeing the plan's implementation. This will allow management activities to be carried out in an efficient manner. The Facilities Committee, and its
leadership, is also an accessible resource for students, teachers, and community members to access when engaging in educational, athletic, or other recreational opportunities on the forest property. The Facilities Committee may also designate certain sub-committees to assist in management implementation, such as a trails sub-committee.

1.6 - Community Partnerships

The following community partners and organizations participated in a collaborative process which led to the creation of this forest management plan:

- The University of Vermont
  - Graduate students: Grahm Leitner and Kimberly Coleman
  - Undergraduate/graduate classes NR206, FOR235
  - Associate Professor Cecilia Danks, Ph.D
- Harwood Union faculty, staff and students
- Vermont Department of Forests, Parks, and Recreation – Washington County Forester
- Friends of the Mad River
- The Biomass Energy Research Center
- Audubon Vermont
- The Vermont Land Trust

1.7 - Beginning the Planning Process

The Harwood Forest Project, which culminated in this forest management plan began in the fall of 2010 as a collaborative partnership between Harwood Union High School and the University of Vermont. It developed as a spin-off of a biomass energy project that UVM had participated in: Community-Based Wood Biomass Energy in Vermont: Promoting Social and Environmental Sustainability. This project was led by Dr. Cecilia Danks, along with partners at Vermont Family Forests, The Forest Guild, The Biomass Energy Research Center, and the Northern Forest Alliance. School officials at Harwood Union were alerted of this project because one of its study locales was the Mad River Valley and they became interested in developing policies to sustainably source woodchips for their biomass burner. This included sourcing fuel wood from the school forest. Due to the volume of fuel wood consumed by the biomass heating system at Harwood Union, it was immediately evident that biomass harvesting in the Harwood School Forest would only produce a fraction of the chip supply that Harwood Union consumes on an annual basis, and even that would only be a practical or sustainable endeavor as part of a larger forest management strategy. Therefore, the Harwood Forest Project took a broader focus. Active forest management and the development of a forest management plan for the Harwood School Forest is one expected outcome, but equally important is the collaborative partnership between Harwood Union High School and the Rubenstein School of Environment and Natural Resources (RSENR) at the University of Vermont. The Harwood Union faculty and staff who participated in the initial scoping meetings also expressed interest in developing forest educational opportunities using the forest as an outdoor laboratory.
2.0 - Planning Objectives

The objective of this forest management plan is to incorporate past, present, and future uses as suggested by the Harwood Union HS community. It provides detailed forest inventory data, management prescriptions, and forest maps. These items will be guide current forest management activities on the property. The plan is structured in a way that allows future revisions or additions and updates to be made by the Harwood community with the assistance of community partners and a consulting forester or the Washington county forester. It is in the spirit of adaptive management that this plan is set forth.

2.1 - Management Goals and Objectives

The following is a list of management objectives that was developed by the Harwood Forest Project committee with input from those who attended the forest project meetings. Secondly, survey responses from a 2010 community survey on forest use at Harwood Union yielded results that support the following management goals. This survey was conducted as part of a graduate class in participatory, and it attempted to quantify desired present and future forest uses and conditions. Survey methodology and data are contained in appendix 1.

- **Characterize the physical, biological, and cultural resources of the Harwood School Forest** – the Harwood community members who have attended the Harwood Forest Project stakeholder meetings have expressed interest in learning about the physical, biological, and cultural nature of the Harwood Forest through this management plan.

- **Support Recreation Management Activities on the Harwood Forest** – map and maintain the recreational trail system on the Harwood Union property. These include trails used by high school athletic teams, community hiking and cross-country skiing trails, as well as the VAST snowmobile trail.

- **Develop Place-based and Experiential Educational Opportunities in the Forest** – the Harwood School Forest provides teachers and students with valuable opportunities for experiential learning in the natural resource fields. These opportunities can be expanded and sustained with the help of community partners.

- **Increase Quantity and Quality of Suitable Wildlife Habitat** – the Harwood School Forest contains a variety of diverse and interesting habitats. 73% of the property is classified as a deer wintering yard by the Vermont Department of Fish and Wildlife and should be maintained as such. Many other opportunities also exist within the forest to sustain and enhance habitat and food sources for a variety of game and non-game wildlife species.

- **Generate Sustainable Forest Products** – The Harwood School Forest contains a wide variety of timber and non-timber forest product that can be sustainably harvested as part of educational opportunities, to generate income, or to provide economic or other benefits to the local community. A suggested goal has been to engage in a demonstration timber harvest that could provide woodchips for Harwood’s biomass boiler. Any revenues generated from the sale of
forest products may be used to further the objectives of this management plan or may be placed in the school’s general fund, as determined by the school board and facilities committee.

- **Establish Long-term Forest Health Monitoring Efforts at Harwood Union** – Our forests face an increasing number of threats from invasive species and ensuing climate change. The Harwood School Forest provides excellent opportunities to enlist community members and students to learn about and carry out forest monitoring activities. The science department at Harwood Union has expressed interest in conducting yearly student studies to see how the forest and its biological factors change over time.

- **Protect the Harwood School Forest through a Conservation Easement** – Two other Valley schools have been working toward permanently protecting their school forests through conservation easements with the Vermont Land Trust (VLT). Working with the Vermont Land Trust to permanently protect the Harwood School Forest and/or surrounding forest and agricultural properties would demonstrate Harwood’s long-term commitment to conservation of publicly owned lands and would likely generate income for the school through the sale of a conservation easement. The VLT works with outside organizations and individuals to secure funding to purchase the development rights for properties that exhibit significant conservation value.
3.0 - Physical Features and their Management Objectives in the Harwood Forest

3.1 - Soil Resources

Soil supports plant, animal, and microbial growth. Trees and other forest plants obtain the necessary nutrients and minerals from the soil on the forest floor. When they die, they return nutrients and minerals to the soil through the process of decomposition. The chemical properties of forest soils depend on the microbial and invertebrate interactions with decaying organic material. The structural, chemical, and biological characteristics of soil on a particular site determine its productivity, and the process of soil building is part of nutrient cycling, an important component of ecosystem health and functioning.

Different types of trees and forest plants are adapted to different types of soils. For example, sugar maple, a dominant hardwood species in parts of the Harwood School Forest, favors rich organic soils that are high in calcium. Combinations of certain species dominating certain sites, such as sugar maple, white ash, and basswood, indicate rich calcareous soils. Having knowledge of the different soils present on a given site can help predict the natural communities of plants that will compete well there.

There are three dominant soil types and several minor soil types present on the Harwood School Forest. The most abundant soil type is Colton gravelly loamy sand on 0-3% and 8-15% slopes and covering roughly 35% of the land area. This soil type is found under the high school itself and extends south past the adjacent recreation fields into the forest, almost to the VAST trail bridge over Dowsville Brook. A series of glacial lake terraces is found in this area, which characteristically have unsorted finer materials like sand and gravel. The Tunbridge-Lyman complex, covering about 30% of the forest floor, is the second most abundant. These areas are characterized by 15-35% slopes and very rocky soils. Next is the Grange silt loam on 0-3%, which is found at the southern end of the property. This area is historically a floodplain for Dowsville Brook, where frequent flooding and relatively gentle slopes caused fine silt and loam to be deposited.

See Figure 2 for a NRCS map and legend that lists all of the soil types, their locations, and their acreages on the Harwood Union property.

Soil Management Objective

It is recommended that soil productivity is maintained by preventing erosion, and by promoting nutrient cycling and retention in the forest. The following guidelines will help achieve this objective:

- Best Management Practices (BMP’s) shall be used during construction activities, logging, or trail building/maintenance activities
- Timber harvesting on steep slopes should only take place during frozen conditions to limit the amount of soil disturbance and compaction in those areas
- Perform regular trail maintenance to identify problems with erosion from recreational use, especially from steep slopes
- Maintain bridges and culverts so they are functioning properly, especially during storm events
• The Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont (AMP's) should be used as a guide during trail building/maintenance and whenever timber harvesting is taking place on the property.

3.2 - Water Resources

Streams

The Harwood School Forest is part of the Mad River and Winooski watersheds, and the Lake Champlain Basin. The Dowsville and Lezelle Brooks, which flow through the Harwood property, are considered part of the headwaters of these larger watersheds. Therefore, anything compromising the water quality of these two brooks as they flow through the Harwood School Forest, also affects a much larger regional ecosystem. As part of Harwood Union's stewardship activities, it is absolutely critical that the water quality of Dowsville and Lezelle Brooks be maintained. These brooks support habitat for native Brook trout as well as countless amphibian, reptile, and invertebrate species. Currently, both of the brooks have almost 100% tree canopy cover over them as they flow through the Harwood property; the exception being a small section of Lezelle Brook flowing directly behind the school. Some of the tree cover on Dowsville Brook was also lost during Tropical Storm Irene. The flooding uprooted a large number of trees along the stream banks and contributed to the significant woody debris and log jams in Dowsville Brook. This woody debris performs important ecosystem functions, such as slowing the movement of water and material, thereby lessening future erosion of the stream channel. It also provides excellent habitat for native fish in the stream. Downed trees in the water provide great places for Brook trout to spawn and to hide and provide some shading to keep water temperatures low. Cool water temperatures are essential to many species help to mitigate the warming of water downstream in the Mad River.

Wetlands, Seeps, Vernal Pools

There are at least three significant non-forested wetlands either on or bordering the Harwood School Forest. There is a small wetland marsh just behind the school near the apple orchard. This wetland represents one non-forested habitat type in the Harwood Forest and is an important habitat resource. The second wetland on Harwood property is the pond at the end of Delong Rd. Although this pond was man-made, it has become a permanent part of the landscape over the past five decades. It now provides excellent breeding habitat for amphibians, reptiles, and migratory species, such as wood ducks. There is also a small conifer inclusion that has been naturally established on the burn of the pond, which extends out into an open grassland/shrub habitat around the pond. This conifer inclusion provides excellent cover for mammalian species foraging in the forest opening. The largest and most significant wetland within the Harwood Forest borders Harwood property on the southwest corner. It is a mostly open conifer and cattail swamp, and provides breeding habitat for red-winged black birds and other bird and waterfowl species. It is also an essential winter foraging area for deer and other wildlife overwintering in the Harwood Forest. In this same general location, there is three-quarters of an acre that is characterized by mucky, hydric soils, where ground cover species include sedges, sphagnum, and plant species typically associated with wetland ecosystems. However, this area still supports tree species such as spruce, fir, and hemlock and is only seasonally wet. Wildlife, including reptiles and amphibians, use this type of ground
cover habitat throughout the year. The open and forested wetlands in the Harwood Forest are valuable places for wildlife habitat, recreation, and student learning.

Small seeps are abundant throughout the Harwood School forest, as in many places characterized by steep slopes and shallow soils. There is also one very large seep, a half acre or more, located just south of the Delong Pond. This seep is likely wet throughout the year and provides foraging opportunities for bear and other wildlife in early spring, before most woodland plants leaf out. Seeps are fragile ecosystems that often support an abundance of plant and woodland species, especially amphibians. There have been anecdotal findings of many woodland salamanders in this area, including the spotted salamander. Care should be taken to avoid disturbance to these areas when constructing trails and completing forest management activities, as erosion can be a problem in areas where water carries soil particles downslope. Tracking machinery through these areas should be avoided at all costs.

To date, no vernal pools have been mapped on the Harwood property. Vernal pools are another important seasonally wet habitat used frequently as breeding sites for amphibians. Vernal pools occur in early spring where soil drainage conditions or litter accumulations prevent water infiltration. They support egg-laying habitat for salamanders, frogs, and toads if they are large enough to remain wet until the eggs hatch. A small pool found along the Mount Harwood Trail (see map 2) may remain long enough to be considered a vernal pool, but further observation, possibly by high school science classes is needed to make a proper determination.

**Water Management Objectives**

It is important to protect and maintain water quality and the ecosystem services provided by the water resources in the Harwood School Forest. The following management guidelines will help to achieve this objective:

- Prevent soil erosion during harvesting operations or construction activities by using best management practices and established acceptable management practices.
- Perform regular trail maintenance to identify problems with erosion from recreational use, especially on steep slopes
- Maintain bridges and culverts so they are functioning properly, especially during storm events
- Maintain high canopy cover and buffer strips for both permanent and ephemeral streams on the Harwood Forest
- Identify seeps, hydric soils, and vernal pools prior to timber harvesting and exclude heavy machinery from these areas
- Engage in formal mapping of water and wetland features on the Harwood property – this may involve high school science departments and/or community partners and contracted natural resource professionals
### 3.3 - Wildlife Resources

The Northern Forest Region, which includes forested areas in New York, Vermont, New Hampshire, and Maine, contains the largest contiguous forest, at 26 million acres, east of the Mississippi (Daigle, 2012). It provides critical habitat for a large range of species, many of which are present in central Vermont and on the Harwood Union School Forest. Healthy and diverse populations of wildlife depend on an abundance of suitable habitat conditions; habitat is the single most limiting factor for wildlife in a given area. Wildlife habitat is defined as "the sum of the environmental factors – food, water, cover, and their special distribution – that a given species needs to survive and reproduce in an area" (Schemnitz, 1980). Wildlife populations are dynamic, and they change in response to changes in habitat conditions. Therefore, managing for wildlife populations essentially means managing and manipulating habitat conditions. Several well-known and charismatic mammalian species currently use the Harwood Forest. These include white-tailed deer, black bear, and moose. Also, many song birds and game birds, such as ruffed grouse and turkey, are found here. A formal bird habitat assessment is to be performed by Vermont Audubon during the summer of 2012. This assessment will provide valuable information to the community regarding habitat quality and management.

Instead of managing for single species, it is more effective to manage entire landscapes in order to provide diverse habitat features, many of which can be used by a variety of animals; mammals, birds, amphibians, and reptiles alike. Below is a discussion of the major habitat features applicable to forest management strategies at Harwood Union:

**Deer yard** – Seventy-three percent of Harwood Union's forest is formally mapped as deer wintering habitat. This area includes portions of all forest stands (see map 3) and is characterized by high densities of eastern hemlock and other softwood. Softwoods provide thermal protection to white-tailed deer in the winter months. A softwood understory also provides winter browse when snow is deep. Observations during the forest inventory data collection suggest that deer utilized the hemlock dominated stands and foraged along the periphery during the winter. There was little regeneration of seedlings in areas commonly used by deer.

**Hard and Soft Mast** – Hard and soft mast are the terms used to describe nutritional fruits produced by woody plant species. Hard mast includes beech nuts and other seeds. Soft mass includes fleshy fruits, such as cherries, apples, and other berries. Large volumes of a variety of mast types are essential to providing good wildlife habitat. Hard mast, such as beechnuts and hop hornbeam seeds, provide calorie rich foods during winter. Beechnuts are especially important to black bears and wild turkey. Bears climb beech trees and eat the nuts right off the branches, and claw marks on beech trees are evidence of past bear activity. Songbirds and game birds, depend on a variety of woodland seeds for food both during the fall and winter. Soft mast, is very important to many species in summer through fall. Migratory birds need to stock up on calories before completing their trip south, and species that over-winter in Vermont need the fleshy fruits to build up winter reserves. A good source of soft mast present in the Harwood School Forest is from wild apples. Deer, grouse, turkey, bears, and a variety of other species feed on apples in the fall.
**Ledges, cliffs, talus, and ridges** - The Harwood Forest property is a rugged parcel with exposed rock, cliffs, and ledges leading up to the ridge top east property line. These habitats provide unique, and sometimes isolated, habitat niches for some important species. Small trees, such as mountain maple and elderberry, compete well in areas with minimal soil and provide food and shelter to animals. Talus, which accumulates at the bottom of cliffs and ledges, provides shelter and denning sites for porcupines, fishers, coyotes, and bobcats. Rocky, elevated habitats such as these also provide good hunting habitats for ravens and forest hawks because they offer good vantage points. Because ridges are also defensible, many species use them as travel corridors through their ranges. Game trails are evident along the eastern ridge of the Harwood School Forest.

**Snags, Den Trees, and Coarse Woody Debris** - Den trees, both living and dead, provide essential nesting sites and foraging sites for a variety of mammals and birds. Den trees occur in all sizes and in all forest types, however, more species use den trees and snags in Northern Hardwood forest types than in Hemlock forest types (DeGraaf et.al, 2006). The cavities in live and dead trees provide denning sites for mammals like porcupine, fisher, red squirrel, raccoon, opossum, and many bat species, to name a few. Many forest birds utilize cavities as nesting sites as well. A large number of birds also depend on cavities for nesting and foraging. Cavities in small stems are used by songbirds, such as chickadees and bluebirds. Mid-size stems, 12-18” are used by screech owls, and various woodpeckers. Large stems, greater than 18”, are used by pileated woodpeckers and the small mammals listed above. Snags, standing dead trees, can provide the same benefits as den trees, but they also contribute to nutrient cycling in the forest. As trees decay, organisms that feed on dead wood; carpenter ants and termites, for example, begin to break the tree down into smaller and smaller pieces. Saprophytes also take up the carbohydrates in the decaying wood and return the nutrients to the soil. The same process takes place on the forest floor where fungi and other decay agents feed on downed logs, returning nutrients to the soil. Coarse woody debris also provides hiding places and habitat for invertebrates, amphibians, and small mammals. Turn over any large log in the forests, and you are likely to find a whole range of species living there. Downed logs also provide good mating sites in the forest. Ruffed grouse use large coarse woody debris in spring as drumming logs.

**Critical Habitat** – There are a variety of habitats that are rare and declining in the Northern Forest. For the first time since European settlement, early-successional dependent species are in decline due to habitat loss. As the remaining patches of early-successional habitat mature, species such as field sparrows, whip-poor-wills, chestnut-sided warblers, and eastern cottontails are becoming rare. Game species, deer, ruffed grouse, and moose all depend on early-successional habitat for browse or cover as well. Early-successional habitat is in decline because the natural agents of disturbance; fire, beaver, flooding, and Native American burning and agriculture have all been eliminated from the landscape. Fires are not allowed to burn. Beavers are confined to “acceptable” areas, rivers are “confined” to their banks, and lands that were once used by Native Americans for agriculture and hunting have been swallowed up by suburban sprawl. Because natural disturbance agents are no longer acting on our landscape, early-successional habitats must be created through manipulations of forest vegetation. The primary way of doing this is through silvicultural treatments.

Other critical habitats in the Northern Forest are those that are favored by species on the Rare, Threatened, or Endangered List (RTE). To date, there have been no official findings of RTE species at
Harwood Union High School. However, Harwood Union faculty have reported identifying spotted salamanders and some rare orchids on the property. The biological science department at Harwood Union HS may be able to assist in formally identifying these and other species with their students, and reporting their findings to the Vermont Department of Fish and Wildlife.

**Wildlife Management Objectives**

The following management objectives are provided as guidelines for sustainable wildlife habitat management and should be adhered to when planning timber harvesting operations or other vegetation manipulations on the forest:

- Maintain and enhance deer wintering habitat by increasing the abundance of softwood in the understory and retaining high densities of hemlock and conifer inclusions in the overstory. White-tailed deer food sources can also be improved by creating forest openings on the periphery of the deer yard to stimulate regeneration and provide winter browse for deer.

- Enhance the quality and abundance of mast within the Harwood School Forest. Retain beech trees that show resistance to beech bark disease (Nectria sp.). Retain cherry as a scattered masting component of all stands. Promote high value seed producers, such as aspen, and mast plants, such as raspberry in forest openings.

- Protect fragile steep and rocky habitats by excluding these areas from active timber harvesting and management.

- Maintain high volumes of snags, cavity trees, and den trees. Avoid culling snags except when deemed necessary as a safety precaution for recreation or timber harvesting. Minimum retention densities are as follows: at least 6 cavity, snag, or den trees per acre; (1) greater than 18 inches in diameter and (3) greater than 16 inches in diameter (Turner, 2007).

- Maintain high volumes of coarse and fine woody debris – at least (4) downed logs greater than 16 inches diameter per acre (Turner, 2007). In areas where coarse woody debris is lacking, consider leaving cull logs or creating snags through girdling during timber harvest operations. Retain all fine woody debris – tops and limbs – during timber harvest operations.

- Use silvicultural treatments to create early-successional habitat on the Harwood Forest. Areas should be identified where group selection harvesting can provide adequate regeneration benefits. Groups should be a minimum of 0.5 acres, and up to 3 acres. This will allow conditions necessary to establish early-successional habitats within the group selection area, which will support many bird species, such as winter wrens, willow flycatchers, chestnut sided warblers, common yellowthroats, cedar waxwings, eastern towhees, American redstarts, and many others.
3.4 - Forest Vegetation

The Harwood Union property is mostly forested, with approximately 117 acres having mature forest cover. For management purposes, the Harwood School Forest has been divided into four different forest stands, based on similar characteristics, such as tree species composition, slope, and soil conditions (See map 1). These management units were classified based on present vegetation conditions in the forest. Due to forest succession, natural disturbance, and human disturbance, these characteristics will change over time, and the stand boundaries may need to be adjusted during future iterations of this forest management plan. Current stand conditions and descriptions are based on forest inventory data gathered by Harwood High School students, with the help of a UVM service learning class, in the spring of 2011. See appendix 2 for inventory details and methodology. Inventory data was gathered using 10-factor prism plots on a regular grid spacing of 100 meters. Other important natural features, such as water, trails, and large den or snag trees were also noted in the inventory. The major forest types present on the forest are Hemlock and Northern Hardwoods. Hemlock occurs as a major component in all stands, but less so in the Upland Stand. The following stand descriptions provide detailed vegetative descriptions of each of the four stands based on tree composition.

**Stand 1 – Uplands Stand**

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The Uplands Stand is a Northern Hardwoods mixed forest type. There is no evidence of recent forest management in this stand, and the lower elevation portions appear to have regenerated from an old pasture. The presence of an old stone wall, old fencelines, many scattered apple trees, and a remnant apple orchard support the assumption that this stand was previously used for agricultural purposes, most likely pasture. The hardwood timber throughout most of this stand is in poor condition, low-value wood, or immature hardwood types. The dominant hardwood types are sugar maple (Acer saccharum) and yellow birch (Betula alleghaniensis), with red maple (Acer rubrum), white ash (Fraxinus americana), big tooth aspen (Populus grandidentata), and black cherry (Prunus serotina) occurring as intermediates. The softwood component includes several inclusions of eastern hemlock (Tsuga Canadensis), red spruce (Picea rubens), and white pine (Pinus strobus), which accounts for approximately 30% of the total tree density. However, because the conifers tend to be in the larger size classes, they account for almost 50% of the basal area of the stand. The white pine occurring in stand 1 is of mixed quality. Some trees that regenerated in the open when grazing ceased on the property exhibit signs of white pine weevil, however, there are a few stands that are mature, very well formed, and could provide good quality sawtimber. It
was also noted that this stand contains a higher proportion of exotic invasive species than any other stand; primarily multi-flora rose, Japanese barberry and Japanese honeysuckle.

**Stand 2 – Cliff Stand**

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</tr>
<tr>
<td>Conifers (% BA)</td>
<td>52</td>
</tr>
<tr>
<td>Hardwoods (% BA)</td>
<td>48</td>
</tr>
</tbody>
</table>

The Cliff Stand is a Hemlock-Northern Hardwoods forest type. Eastern hemlock occurs most frequently, with other dominant tree species being yellow birch, sugar maple, red maple, and red spruce; making this stand a mixed-wood stand. The trees in this stand tend to be very well formed and in intermediate or mature age classes. Due to the physical characteristics of this stand, it is unlikely that it was used extensively for pasture, although some existing barbed wire is present; nor is there evidence of past timber harvesting. As the stand name implies, this area is characterized by steep terrain, very rocky soils, and fragile ground habitats. This area is where the cliff, ledge, ridge, and talus habitats occur in the Harwood School Forest. A significant talus natural community also exists along the base of the cliffs, east of the Mount Harwood Trail (see map 2).

**Stand 3 – DeLong Rd Access**

<table>
<thead>
<tr>
<th>Stand Area (acres)</th>
<th>26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Index</td>
<td>61</td>
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<tr>
<td>Basal area (ft²/acre)</td>
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<tr>
<td>Quadratic Mean dbh (in.)</td>
<td>13</td>
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<tr>
<td>Size class</td>
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<tr>
<td>Gross volume (tons/acre)</td>
<td></td>
</tr>
<tr>
<td>Conifers (% BA)</td>
<td>65</td>
</tr>
<tr>
<td>Hardwoods (% BA)</td>
<td>35</td>
</tr>
</tbody>
</table>

The DeLong Rd Access stand is a Hemlock-Northern Hardwoods forest type dominated by hemlock and red maple. Red spruce and yellow birch are intermediate components, and white pine, sugar maple, and black cherry make up minor components. This area is located just south of the current baseball diamond. There is no evidence of recent forest management in this area of the forest, and tree cores indicate the
dominant trees to be approximately 80-100 years old, meaning that this area reverted back to forest around 1900.

**Stand 4 – South End**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand Area (acres)</td>
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<tr>
<td>Site Index (red spruce)</td>
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<tr>
<td>Quadratic Mean dbh (in.)</td>
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<tr>
<td>Size class</td>
<td>Large sawtimber</td>
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<tr>
<td>Gross volume (tons/acre)</td>
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</tr>
<tr>
<td>Conifers (% BA)</td>
<td>78</td>
</tr>
<tr>
<td>hardwoods (% BA)</td>
<td>22</td>
</tr>
</tbody>
</table>

The South End Stand is located at the very southern end of the property. This is an Eastern Hemlock forest type, with total conifer composition approaching 80% of basal area. The Northern Hardwood component of this stand includes mostly yellow birch and red maple, plus sugar maple occurring in a few locations along the northeast stand boundary.

The shrub and mid-story layers of the entire Harwood School Forest are primarily deciduous, containing both small and large tree species and true shrubs, such as hobblebush. Detailed inventories of the shrub and ground layers have yet to be completed, and an inventory of these features would make for an excellent high school or middle school science project. A wide variety of ground-based sampling methods are available, and include both transect and fixed-area plots. The ground cover layers within stands tend to vary based on soil types, slope, aspect, and canopy closure.

**Vegetation Management Objectives**

Maintaining a healthy and functioning forest ecosystem on the Harwood property may include the use of silvicultural treatments to improve timber quality and manipulate vegetation structure to benefit wildlife habitat or other human uses. The following general guidelines, developed by Vermont Family Forests, have been included to support ecologically based forest management on the Harwood School Forest. They have been modified by the principal investigator to correspond with the objectives for the Harwood forest and adopted as part of these management recommendations because they are consistent with Forest Stewardship Council (FSC) principals in the Northeast. Further, they have been applied to harvesting guidelines in other regional community-based forestry examples (Turner, 2007):
Vegetation Management Guidelines

- The single tree and small group selection methods should be used for natural communities that would typically experience small scale natural disturbances producing canopy gaps (e.g. northern hardwoods), and the irregular shelterwood method can be used for communities with stand-replacing disturbance regimes (e.g. spruce-fir). Where the group-selection method is employed, canopy openings of at least 0.5 acres are preferred, to allow for the establishment of early-successional species. Where the irregular shelterwood method is employed, the size of the regenerated areas can be increased. Whole-tree harvesting should be avoided.

- Gradual or soft edges between habitats are preferred. Allow native shrubs, saplings, and some overstory trees to remain along the harvest boundary. Edges may also be “feathered” by retaining more trees closer to the uncut forest and gradually fewer trees closer to the harvested area.

- Manage for at least four large and secure cavity, snag, and/or decadent, living trees per acre on average, with one exceeding 18 inches diameter breast height (DBH) and three exceeding 16 inches DBH. Leave trees that have cavities of varying sizes and are located in the upper trunk of the tree. Also, give priority to hardwood trees with cavities, rather than softwood, as they remain intact longer.

- Manage for at least four downed trees or 16+ foot long logs greater than 16” DBH per acre on average.

- Retain a minimum of three vigorous and wind-firm legacy trees per acre measuring over 19 inches DBH.

- Intermediate treatments should raise the average (mean) diameter of the residual dominant and co-dominant trees of the forest.

- Any forest management in natural communities that are ranked as “very rare” (S1) and “rare” (S2) or in natural communities ranked as “uncommon” (S3), “common” (S4), and “very common” (S5) but with little or no evidence of past human disturbance should be reviewed and approved by the VT F&W Natural Heritage Biologists.

- When planting, use only local sources of native species, plant three or more species, and include deciduous species.

- When thinning or regenerating stands, favor native species over non-native species and trees and shrubs that produce seeds and fruits.

- Use natural regeneration to the maximum practical extent.

- Biological legacies of the forest community -- including coarse dead wood, logs, and snags; trees that are large, living, and old; buried seeds; soil organic matter; invertebrates; sprouting plants; and mycorrhizal fungi -- should be protected to aid in post-harvest recovery and to keep the forest from becoming "oversimplified".

- Promote the seed bearing capacities of poorly represented members of the forest.
• Tree felling should be avoided on slopes exceeding 60%.

• In general, leave as much biomass on site as possible including all materials that are less than 3 inches in diameter.

• Promote a vertical stand structure that includes over-story, mid-story, shrub, and herbaceous vegetation layers.

• Most woody, invasive exotics should be removed from the harvest area before harvesting forest products. Direct cut stump applications and foliar application of herbicides may be used in conjunction with mechanical removal of invasive plants. Herbicides shall be applied by a licensed pesticide applicator.

• Residual stand damage -- including basal wounds, broken and/or scraped tops, and exposed roots -- should be confined to 10% or fewer of the dominant or co-dominant trees.

• It is recommended that all trees to be removed be marked prior to the inception of harvest.

**Skid Trails, Truck Roads, and Log Landings**

• Truck roads, skid trails, and log landings should be built and maintained in full compliance with the standards contained in the *Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont* (VT FP&R 1987). The drainage structures should remain fully functional with post-harvest use.

• Avoid spring harvests and deep rutting of skid trails.

• To maximize the soil’s ability to store carbon, harvesting should only be done when the soil is completely frozen.

• It is strongly recommended that all skid trails, truck roads, and log landings be designed and constructed prior to the inception of harvesting. Whenever possible, existing recreational trails will be used as skid trails.

• Properly buffer and protect special habitats such as cliffs, caves, talus slopes, beaver meadows, vernal pools, spring seeps, and remnant patches of old growth forest.

• Take special care to protect wetlands, particularly those with muck and peat soils and a thick organic layer as these wetland soils are capable of storing ten times as much carbon as other soils in the region.

• Winter harvesting is preferred to protect breeding birds. Delay summer harvests until after August 1st.
• Skid trails, truck roads, and log landings -- should only be used when adequately dry or frozen.

• Log landings should: be located on nearly-level, stable ground; be kept away from protective strips; have water diversions installed; and be graded to prevent erosion and sedimentation.

Protective Strips and Buffer Strips

• Protective strips -- characterized by minimal soil disturbance, nearly-complete canopy closure, and many large, mature trees - should be maintained between the access network and surface waters according to Table 4 in the Vermont AMPs at a minimum.

• Areas of exposed soil that occur within the protective strip should be seeded using native species and sources to the maximum extent possible and mulched with material free of invasive exotics and applied according to Table 3 in the Vermont AMPs.

• Stream buffer strips should: be kept free of logging vehicles; have only little or no tree cutting; and be at least 25 feet in width.

• Particular care should be taken to prevent stream bank erosion in order to avoid the release of sediment and stored carbon.

Stream Crossings

• Stream crossings should be restored and non-permanent structures should be removed as soon as possible.

• Streams should be crossed with bridges or culverts which are properly sized according to Table 2 in the Vermont AMPs and installed at right angles.

• Sediment should be prevented from reaching streams by using turn-ups or broad-based dips on truck roads and skid trails prior to all stream crossings. Drainage ditches should not feed directly into streams or other surface waters.
4.0 - Forest Management Prescriptions

4.1 General Requirements
1. Harwood Union shall utilize the resources of a professional forester or the Washington County Forester in planning and implementing any commercial timber sale.
2. All property boundaries in harvesting units shall be marked prior to the commencement of harvesting activities.
3. A signed contract with the operators shall be received by Harwood Union or its agent prior to the commencement of harvesting.
4. The said signed contract shall include the Vegetation Management Guidelines provided above.
5. Because of the community-based nature of forest stewardship at Harwood Union, attempts shall be made to incorporate demonstration days into the planning and implementation of timber harvests and wildlife improvements.
6. If economically feasible, hardwood pulp from harvest activities should be retained by Harwood Union for use in their biomass burner – a biomass demonstration day is one possibility for community involvement.
7. Due to the recreational nature of the property, signs warning of a timber harvest and associated dangers shall be posted at all trail entrances to the forest.
8. The following prescriptions were formulated to facilitate the harvesting of two stands at a time, with return entries into each stand every 15-20 years and one entry every seven (+) years.

4.2 - Stand 1 – Uplands Stand

Timber management strategies - Uneven-age management is to be used as the silvicultural treatment in the Uplands Stand. Single tree and group selection methods are recommended here to regenerate shade and intermediate tolerant, high value hardwoods. Sugar maple can be regenerated and released from the understory using single tree selection methods. Where other species, such as white ash and yellow birch, dominate, small group selection methods can be employed.

Non-timber Forest Products – Maple sugaring is an important part of Vermont's heritage and has been conducted on the Harwood Forest for several years. This provides important learning opportunities for the students involved and helps preserve Vermont's cultural heritage. The timber management strategies proposed for Stand 1 will also help improve and sustain Harwood's sugarbush. It is recommended that the school board use a portion of the proceeds from a timber sale in stand 1 to upgrade and improve the school's sugaring infrastructure.

Wildlife resources
1. Early-successional habitat - where aspen are likely to provide good seed and sprout source for regeneration, at least one forest opening of at least 0.5 acres, and up to 3 acres is to be created using a large group selection method.
2. Apple tree release – apple trees existing in the understory need to be released and properly pruned. This will provide additional soft mast resources for wildlife.
3. Snag and legacy retention – all snags within the harvest area shall be retained unless they pose a safety threat to forest workers or recreational users. Snags may be created through girdling if the required number of snags is not present in the harvest area. All legacy trees shall be retained during harvest operations.
4. Conifer inclusions shall be maintained as part of the deer wintering habitat. Group selection harvesting around the periphery of inclusions shall be prescribed to increase the abundance of conifers and browse in the understory.

**Cultural Resources** – the Uplands Stand contains an old ski slope. This is a cultural legacy of past land use and should be preserved. Operation in this stand shall not disturb this or other cultural resources. Trees may be marked and removed along the edge of the old ski slope as a means of preserving it on the landscape. The cutting prescription shall also include severing all small stems on the slope to keep it open.

**Invasive Species** – the Uplands Stand contains higher densities of Japanese barberry and honeysuckle than any other stand and should be targeted for invasive species control and eradication. These, and other, invasives shall be removed prior to initiating a commercial timber harvest. It is recommended that high school science teachers lead the invasive eradication effort at Harwood Union. The first line of defense can be mechanical removal. If mechanical removal of stems and roots is completed on a yearly basis by students and teachers, it may not be necessary to employ the use of herbicides. Should the mechanical removals not be successful, it may be necessary to use a foliar application or cut-stump application to eradicate invasives prior to harvesting forest products or engaging in large-scale vegetation manipulation. Community members can also participate in invasive species removals through community work days organized by Harwood staff or other community partners.

**Access** – timber harvesting access to stand(s) 1 and 2 shall be provided via the VAST snowmobile bridge near the baseball diamond. The bridge may need to be reinforced prior to utilization by harvesting equipment.

**Prescription Timeline** – It is recommended that the above management prescriptions be carried out by the year 2022, or seven years after active management of stands 3 and 4. It is recommended that apple tree release and invasive species management be carried out by 2014. The Harwood community; teachers, students, and staff should carry out these management prescriptions with the help of Vermont Department of Forests, Parks, and Recreation, or other community partners facilitating technical training for the projects.

### 4.3 - Stand 2 – Cliff Stand

In general, the Cliff Stand is a steep, rocky stand with very few active management opportunities. There is no evidence of past management on in this stand, due to its inoperability, and it is recommended that this area be set aside as a forest reserve to mature and age on its own. Because this is a rare and fragile habitat, it provides good opportunities for passive recreation, such as wildlife viewing. It is recommended that an interpretive sign be placed along the trail that runs along the bottom of the cliff to denote these special features.

The one exception to this "no management" strategy is in an area located near plot 38 (see map 1). Here there is a small group of apple trees that border stand 1, which should be released. Also, there is a high density of big tooth aspen in this area, which could provide seed and sprouting stock for aspen regeneration.
Active management

1. Release all apple trees in the vicinity of plot # 38.
2. Create one forest opening in the vicinity of plot #38 where aspen regeneration would be favored. This area may include the apple trees listed in #1. The forest opening should be at least 0.5 acres, and could be as large as 1.5 acres.
3. Initiate exotic invasive control procedures where necessary to control the spread of Japanese barberry, Japanese honeysuckle, and multi-flora rose, especially in and around forest openings

Prescription Timeline – Active management of stand 2 shall occur by 2022, in conjunction with management activities in stand 1

4.4 - Stand 3 – DeLong Rd Access

Land Use – the portion of stand 3 that is adjacent to the Harwood Union baseball diamond may be reserved for future development if the school board elects to expand the athletic campus. This area may include up to 5 acres located at the end of Delong Rd. The clearing at the end of Delong Rd. also provides the best location for a log landing to be used in subsequent harvesting operations. Timber in this harvest unit has previously been inventoried and marked with blue marking paint. Volume estimates for the reserved portion only of stand 3 are available in Appendix 2 Although developable land on the Harwood property is scarce, multiple options for athletic improvements should be considered. The forested area under consideration for development is currently used by the Harwood athletic teams and provides easy access for public recreation.

Timber/wildlife management strategies - Stand 3 is a Hemlock-Hardwood stand in even-aged condition, and is part of the deer wintering habitat on the Harwood Forest. It also has the highest volume of sawtimber per acre on the Harwood School Forest. However, due to the current low economic value of the dominant species (hemlock/red maple), silviculture should be focused on enhancing wildlife habitat, while simultaneously returning the stand to an uneven-aged condition. Single tree, small, and large group selection shall be used as appropriate in stand 3 to enhance wildlife food sources and perpetuate regeneration of softwood in the understory. Groups should be at least 0.25 acres and up to 1.5 acres, in order to establish early successional characteristics. Groups should vary in size, shape, and location, to create a patchy mosaic of forest types and age classes. Wetland features in stand 3 shall be protected and are off limits to harvesting equipment.

Access – Stand 3 has the best and most developed access of any forest stand on the Harwood Forest. A main recreation trail running north-south can be used as the main skid trail to a landing at the end of Delong Rd.

Prescription Timeline – the timing of a timber harvest in stand 3 will largely depend on whether the school board votes to expand the athletic campus into what is now the northern section of stand 3. Should the board elect to do so, clearing of the land for development shall be incorporated into the silvicultural treatments for the remainder of the stand. Harvesting operations may begin as early as 2012, or may be completed by 2015.
4.5 - Stand 4 – South End

The area south of Dowsville Brook, which is the southern-most portion of Stand 4, saw dramatic changes following Tropical Storm Irene. The shifting hydrology of this area can provide an important component of high school science education. Therefore, the area south of Dowsville Brook and the snowmobile bridge, will be set aside as a long-term monitoring site to track ecosystem changes in and around Dowsville Brook. No active timber or wildlife management will take place here. The area will continue to be used for recreation and for student research projects.

Timber management – Stand 4 is predominantly a coniferous even-aged stand with components of yellow birch, red maple, and sugar maple. Uneven-aged management should be instituted in the north and east portions of stand 4, on the north side of Dowsville Brook. This will provide greater opportunities for regeneration of multiple vegetation components. Management should be focused on promoting the yellow birch component of the forest in appropriate areas. Group selection methods located near seed trees should be used to accomplish this. Single tree selection should be used to perpetuate sugar maple in areas where it exists.

Wildlife Habitat – Using group selection methods, irregular openings of up to 0.5 acres in size shall be created to increase the softwood component in the understory and provide winter browse for deer. Openings, if large enough, will also provide pockets of early-successional habitat within a closed canopy coniferous forest.

Access – Harvesting access to the eastern portion of stand 4 (east of Lazelle Brook) is provided via an old town road that is currently the Mt. Harwood trail. It is recommended that a new bridge be constructed over Lazelle Brook that would provide access to stands 1, 2, and 4. The new bridge would be constructed at a predetermined location (see Map 1). Much of the land in Stand 4 is steep and care shall be taken to provide adequate buffer strips near streams.

Prescription Timeline – active management of stand 4 shall coincide with management of stand 3. Harvesting operations should be complete by 2015.
5.0 - Forest Recreation

In a time of changing forest ownership and forest fragmentation throughout the Northern Forest, community-owned forests offer exceptionally important opportunities for forest recreation. Forest recreation is currently the single most common use of the Harwood Union School Forest, and the Harwood community has consistently ranked recreational opportunities as one of the top management priorities for the Harwood Forest. High school athletic teams – cross-country and Nordic skiing - use the forest trails for training and athletic meets. In the past few years, the school has also developed a disc golf course throughout portions of the school forest. The VAST snowmobile club maintains a major thoroughway on the Harwood Forest that includes bridge and stream crossing infrastructure. Community members also use the recreational trails for Nordic skiing, walking, running, mountain biking, horseback riding, and other passive recreational activities. The property is also open to community members for hunting.

5.1 - Recreation Management

In order to facilitate recreation of all types on the property, manage competing interests, and protect wildlife and ecological diversity within the forest, it is important to establish a set of guidelines to provide for effective recreation management on the property.

Forest Trails – an extensive array of forest trails can be found throughout Harwood’s forest. These are a major asset to the school and the community. The University of Vermont, through the Harwood Forest Project, has facilitated the mapping of two trail systems in the Harwood Forest. The two mapped trails are the Highlander and the Mount Harwood trails. This has been completed as a service-learning project with Harwood students in the Barre Pre-Tech Outreach program. Students were involved in collecting GPS data for trail locations; analysis was completed by University of Vermont Graduate students. A trail map of the Harwood School Forest can be found in the maps section of this plan.

The following is a list of management objectives for the Harwood trail system:

- Formally establish a trails sub-committee of the facilities committee to help initiate and implement trail projects including maintenance and construction – members should include athletic staff who frequently utilize Harwood trails, at least one member of the facilities committee, and community members or parents of students who frequently use Harwood trails.
- Create one new spur trail that connects from the top of Mount Harwood to the Highlander trail at the north end of the property (see map 2).
- Maintain forest trails free of brush, woody debris, and overhead hazards.
- Engage Harwood students in a trail marking project – use color coded blazes for each trail.
- Provide a trail map and kiosk at the Highlander trailhead.
- Install trail signs and interpretive signs throughout the Harwood Forest to guide community members and provide learning opportunities to recreational users.
- Utilize the USDA Trail Construction and Maintenance Notebook, which can be found online at http://www.fs.fed.us/t-d/pubs/pdfpubs/pdf07232806/pdf07232806dpi72.pdf, as a guide to soil and stormwater management on trail system – periodically inspect trails for evidence of erosion; use corrective action where necessary.
• Where soil erosion is a persistent problem, seeding and mulching with native grasses should be used.

• Maintain proper stream crossings and/or culverts and foot bridges where necessary to prevent stream bank erosion.

• Avoid trail-side cutting of trees unless they pose a significant hazard to recreational users – hazard determination should be made by members of the facilities sub-committee.

• Consider establishing a “Nordic only” trail during the winter season to provide good skiing conditions for athletic teams and community members and reduce the frequency of trail grooming.

• Consider limiting mountain biking and horseback riding on certain trails during mud season to limit erosion on forest trails

**VAST Trail** – a major travel corridor for the VAST snowmobile club runs through the Harwood Forest. Although snowmobile access received a low ranking on a survey of community forest use, the VAST club does provide important benefits for community use and enjoyment of the forest. Grooming activities by the club benefit cross-country skiers, and the bridge and trail infrastructure provided by the VAST club benefits all forest users. Maintaining a good working partnership with the VAST club members should be an important goal of Harwood Union staff. The VAST club can be engaged as a conservation partner, providing funds, community organizing, and labor necessary to carry out specific recreational maintenance tasks.

The following are management objectives for the VAST trail:

• Consider partnering with the VAST club to develop a long-term plan and alternative route for the trail running through Stand 4. The section of trail from Dowsville Brook to the southern property boundary crosses through fragile habitat that should be reserved for education and passive recreation.

• Enlist the VAST club in trail maintenance and monitoring activities – including the replacement of bridge and other trail infrastructure.

**Hunting** – Recreational hunting has a cultural history in Vermont. Hunters also contribute significant conservation dollars to state and local governments through license fees. However, due to the nature of the Harwood Forest and its proximity to the school buildings and grounds, and due to the high level of recreational use by the community and school groups, hunting is not allowed on the Harwood property.

**Wildlife Viewing** – Harwood Union provides great opportunities for students and community members to learn about wildlife. The community should be encouraged to use the Harwood property this purpose.

The following objectives will help engage the community in wildlife viewing opportunities in the Harwood Forest:

• Actively work to establish and sustain diverse habitats to attract wildlife to the Harwood Forest

• Work with community partners, such as Vermont Audubon, to host community informational meetings and presentations on wildlife viewing opportunities.

• Work with the Vermont Department of Forests, Parks, and Recreation and the Vermont Department of Fish and Wildlife to identify opportunities for community involvement in wildlife monitoring in the Harwood Forest.
6.0 - Outdoor Educational Opportunities

The Harwood School Forest provides Harwood students with the unique opportunity to engage in outdoor learning activities right on school property. Using the forest as a classroom provides fun and interesting alternatives to standard classroom instruction. It also will help foster the development of a conservation ethic in Harwood students and may help recruit students into natural resource fields. As students begin learning about the ecology of their school forest, this knowledge will be spread informally around the community. The school may also choose to provide educational opportunities for community members through some of the participating community partners, such as Vermont Audubon. This might include a workshop and/or work days sponsored by Vermont Audubon to learn about or improve bird habitat in the forest. The same activities could be facilitated through organizations or agencies that focus on invasive species control or eradication.

6.1 - Outdoor Education Management Objectives:

• Maintain a database/collection of example curriculum or outdoor education projects for use by teachers at Harwood Union.
• Continue teacher involvement in Project Learning Tree workshops – sponsored by VT FPR.
• Encourage teachers to enroll in and use online data collection and storage forums for student projects so information gathered by Harwood classes is easily accessible to the community.
  o The website, Citizen Science, may be helpful to teachers who would like to engage their students in this type of activity. Their web address is: http://citsci.org/cwis438/websites/citsci/home.php?WebSiteID=7
• Work with community partners to create workshops and forest educational opportunities that would be available to the community as a whole.

6.2 – Educational Activities Completed to Date

1. Barre Pre-tech Outreach forestry skills (appendix 3)
2. Google Map/Earth place-based education workshops
3. Project Learning Tree workshop
4. Forest health monitoring (EAB/ALB) plots
5. UVM service learning classes:
   a. Environmental Problem Solving (twice)
   b. Sustainability Education
   c. Community-Forestry
   d. Rebuilding Vermont
   e. Community-based Participatory Research

6.3 Future Opportunities for Educational Outreach

1. UVM service-learning opportunities:
   a. NR206 – Senior capstone course in natural resources
   b. Environmental Interpretation – signage and pamphlets about the Harwood Forest
3. Forest Health/Forest Monitoring workshops – available through VT Forests, Parks, and Recreation
7.0 - Long-term and Community Forest Monitoring

A main tenant of CBF is to engage the local community of forest users in monitoring activities on the forest. This provides information to forest managers and land owners regarding the condition and potential threats to forest or ecosystem health. It also provides a mechanism for long-term learning and incorporating local knowledge into management activities and management plan revisions. Through the Harwood Forest Project, several monitoring activities have been suggested or established, and community groups and students will have opportunities to participate in planning activities and gathering data. Prior to any revision of this forest management plan, all monitoring data gathered by students, teachers, and/or community groups should be provided to the individual or organization revising the plan so the monitoring data may be incorporated into the revision.

7.1 - Forest Health Monitoring Objectives

- Monitor for exotic invasive insects (emerald ash borer (EAB)/asian longhorned beetle (ALB)) in the two monitoring plots established by the UVM forest health service-learning class (see map 3). Report findings to VT FPR.
- Place emerald ash borer traps in ash trees on Harwood property to help track EAB movement in the state.
- Monitor progress on invasive plant control – engage science classes and community members in invasive plant surveys, convey information on citizen science webpage or Harwood Union website

7.2 - Wildlife/Natural Community Monitoring Objectives

- Utilize the school science program to track and record information on rare, threatened, and endangered species.
  - Establish at least one amphibian plot at location of mapped seep (see map 3).
- Use information gathered from songbird habitat assessment to monitor changes in bird breeding and habitat use in the Harwood Forest – work with Audubon Vermont as a community partner for this type of project.
- Engage in post-harvest monitoring of early successional vegetation and wildlife use of harvested areas
- Establish permanent monitoring plots along Dowsville Brook to monitor hydrologic changes in the stream

7.3 - Modeling Future Forest Conditions

- State agencies and universities are increasingly interested in modeling future forest conditions. Objectives for forest ecosystems could include modeling carbon sequestration, forest cover, and forest health. While these objectives require the participation of forest specialists to lead research efforts, the studies would be open to the local community as demonstration projects. Community forests are good locations for modeling projects because the information learned can be easily disseminated directly to the users of the forest. Those organizations working on modeling projects could also involve Harwood students and teachers in their projects, thereby increasing public awareness of important implications for forest management. Possible community partners include FPR, UVM, other regional universities, the Biomass Energy Resource Center, and Vermont Family Forests.
8.0 - Permanent Conservation of the Harwood Union School Forest

Community forests in the Northeast provide ecosystem services and are highly valued by local communities for their many uses. Protecting community forests from development and parcelization should be a priority of community-based forest management because it helps to ensure they remain part of our landscape indefinitely. This management plan is meant to guide future use and enjoyment of the Harwood School Forest, and it is recommended that Harwood Union High School explore the options for placing a permanent conservation easement on the property. An easement would allow all the current uses outlined in this forest management plan to continue, and would permanently protect portions of the forest from development. Although the Harwood Forest is unlikely to be developed, this action would be representative of Harwood Union’s commitment to natural resource conservation. The Vermont Land Trust has worked with other area schools to secure such an easement and could be a valuable partner to Harwood Union.

Another possibility for permanent conservation would be to help facilitate conservation easements on adjacent properties. The adjacent Goodyear property is up for sale, which, if sold, could bring development pressure up to the edge of the Harwood Forest. This could result in subdivision of the existing parcel and decreased community access to forest recreation. Instead of a housing development around the Harwood Forest, a conservation easement could help expand community enjoyment of forest resources on surrounding properties and open the possibility of developing recreational opportunities between Moretown village and the Harwood Forest. Specifically, the Forest Legacy Program could help leverage conservation funding in order to develop trail networks that connect Harwood Union HS to Moretown village, and from Moretown Elementary School to South Hill road. This would result in a virtually contiguous block of forest that is protected and open to use by members of the community, and would include two community-owned forests (Harwood school forest and Moretown Elementary school forest) protected by conservation easements. The Vermont Department of Forests, Parks, and Recreation (FPR) may be able to provide the technical expertise needed to administer the Forest Legacy Program and other conservation activities on both properties.
9.0 - Future Management Actions

As a road map for forest management activities and community involvement in forest management on the Harwood School Forest, this plan should be used to guide forest use and enjoyment over the next 10 years. After a period of 10 years, it is recommended that the plan be formally revisited and necessary revisions made. This will include updating forest inventory data, trail maps, management objectives, and should take into consideration any information gathered by community groups or Harwood faculty, staff, and students. The Facilities Committee should direct the revision process and enlist the assistance of community partners or qualified professionals to undertake such an effort.

9.1 – Guidelines for Proposed Management Activities

Figure 1 contains a sample schedule of management activities. The management activities proposed in the schedule are activities that are recommended for the near future or have been discussed in the Facilities Committee or Forest Project Committee. It is not a complete list of activities that could take place, and members of the Harwood HS community are encouraged to develop and propose active management projects on the forest. The forest is open to all Harwood community members for use and educational opportunities, however, those using the forest for educational opportunities are encouraged to formally develop projects in the spirit of this management plan. Formally designated projects can be useful for data collection and will provide a record of management actions taken.

9.2 - Process for Initiating Forest Management Activities

1.) Each semester the Facilities Committee should request proposals for forest management activities from Harwood teachers or send out a list of proposed activities to teachers and community partners and solicit leading participants
2.) Interested participants should create a short proposal describing activities to undertake and a timeline for completion
3.) Project leaders who complete projects should submit a report of the project findings/results to the Facilities Committee.
4.) The Facilities Committee should archive all activities completed.
5.) Management activities and results should periodically be made available to the local community through the Harwood Union website, newsletter, or other appropriate sources.
6.) The goal of the project archive is to:
   a. Disseminate forest information to the Harwood community
   b. Collect forest data that will help inform the next iteration of the school’s forest management plan
Figure – 1

Schedule of Management Activities for the Harwood Union School Forest

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Activity</th>
<th>Point Person/Organization</th>
<th>Participants</th>
<th>Resource Requirements</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-2013</td>
<td>Invasive plant control – stand 1</td>
<td>Facilities Committee</td>
<td>Science teachers/bsstudents</td>
<td>Pesticide applicator</td>
<td>NRCS funding may be available</td>
</tr>
<tr>
<td>2012-2013</td>
<td>Apple tree release</td>
<td></td>
<td>Barre Pre-tech</td>
<td>Training workshop</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>Bird Habitat Assessment</td>
<td>Audubon VT</td>
<td>Community/students/teachers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Invasive Insect Monitoring</td>
<td>Facilities Committee</td>
<td>FPR/USDA/teachers/students</td>
<td>EAB traps</td>
<td></td>
</tr>
<tr>
<td>??</td>
<td>Timber Harvest Demonstration – stands 3/4</td>
<td>Facilities Committee</td>
<td>FPR/forestry consultant</td>
<td>Harvest marking and layout</td>
<td>Use hardwood pulp for biomass demonstration</td>
</tr>
</tbody>
</table>
Figure 2 – Harwood Soils Map and Legend

Soil Map—Washington County, Vermont
(Harwood Union Soils Map)
<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>33A</td>
<td>Machias fine sandy loam, 0 to 3 percent slopes</td>
<td>1.8</td>
<td>1.0%</td>
</tr>
<tr>
<td>33B</td>
<td>Machias fine sandy loam, 3 to 8 percent slopes</td>
<td>4.0</td>
<td>2.4%</td>
</tr>
<tr>
<td>39A</td>
<td>Cotton gravelly loamy sand, 0 to 3 percent slopes</td>
<td>42.2</td>
<td>25.7%</td>
</tr>
<tr>
<td>39B</td>
<td>Cotton gravelly loamy sand, 3 to 8 percent slopes</td>
<td>6.5</td>
<td>3.4%</td>
</tr>
<tr>
<td>39C</td>
<td>Cotton gravelly loamy sand, 8 to 15 percent slopes</td>
<td>15.1</td>
<td>9.2%</td>
</tr>
<tr>
<td>39D</td>
<td>Cotton gravelly loamy sand, 15 to 20 percent slopes</td>
<td>11.1</td>
<td>7.7%</td>
</tr>
<tr>
<td>39E</td>
<td>Cotton gravelly loamy sand, 25 to 30 percent slopes</td>
<td>8.9</td>
<td>5.6%</td>
</tr>
<tr>
<td>56A</td>
<td>Grange silt loam, 0 to 3 percent slopes</td>
<td>22.7</td>
<td>13.6%</td>
</tr>
<tr>
<td>70A</td>
<td>Barnsboro fine sandy loam, 15 to 35 percent slopes, very stony</td>
<td>0.7</td>
<td>0.4%</td>
</tr>
<tr>
<td>72D</td>
<td>Turbridge-Lyman complex, 15 to 35 percent slopes, very rocky</td>
<td>49.4</td>
<td>30.1%</td>
</tr>
<tr>
<td>77A</td>
<td>Peru gravelly fine sandy loam, 16 to 26 percent slopes</td>
<td>0.3</td>
<td>0.2%</td>
</tr>
<tr>
<td>72A</td>
<td>Markey and Wonsqueak mucks, 3 to 2 percent slopes, ponded</td>
<td>1.3</td>
<td>1.1%</td>
</tr>
<tr>
<td>10D</td>
<td>Pits, Sand, and Pits, gravel</td>
<td>0.5</td>
<td>0.3%</td>
</tr>
<tr>
<td>W</td>
<td>Water</td>
<td>2.9</td>
<td>1.7%</td>
</tr>
<tr>
<td><strong>Totals for Area of Interest</strong></td>
<td></td>
<td><strong>163.9</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>
GLOSSARY OF COMMON FORESTRY TERMS

Acre: A standard unit of area measure. One acre equals: 43,560 square feet; 4840 square yards; 10 square chains.

Advanced regeneration: Natural regeneration that is established prior to a timber harvest.

Adventitious buds: Buds that form in an unusual spot on a tree, usually on the bole.

Age Class: One of the intervals, commonly 10-20 years, into which the age range of trees are divided for classification.

Apical meristem: The growing tip of a tree stem or root.

Aspect: The direction towards which a slope faces.

Basal Area: The cross sectional area of the stem of a tree at 4.5 feet above the ground (dbh). The basal area of a stand is the summation of all the trees or classes of trees per unit area of land. Basal area is expressed in square feet per acre. Basal area is directly related to stand volume and density.

Biomass: The total weight of all harvestable vegetation from a stand. This term can also be used to describe a harvest that results in all material being processed into chips.

Board Foot: The volume of solid wood equivalent to a piece 12 inches long, 12 inches wide and 1 inch thick. A measure of standing or felled timber usually related to sawlogs.

Bole: The stem of a tree.

Browse: Buds, leaves, and twigs of seedling and sapling regeneration that are utilized as a food resource by wildlife.

Canopy: The combined cover of individual tree crowns.

Chain: A measurement of horizontal distance, 66 feet. Areas expressed in square chains can immediately be converted to acres by dividing by 10.

Cleaning: The removal of competing vegetation to release desired regeneration for optimal growth.

Clear-cut: A silvicultural method which removes all trees from a designated area at one time for the purpose of creating a new, even-aged stand. This management system is usually used to regenerate shade-intolerant tree species. Variations include patch and strip clear-cutting.

Climax: An association of plants and animals that will prevail in the absence of disturbance.

Co-Dominate: Trees with crowns forming the general level of the forest canopy and receiving full sunlight from above but comparatively little from the sides.
**Crop Trees:** Trees to be grown to the end of the rotation.

**Crown:** The branches and twigs of the upper part of a tree.

**Cruise:** A survey of forest stands to determine the number, size and species of trees, as well as terrain, soil condition, access and any other factors relevant to forest management planning.

**Cull:** Trees that have no current or potential commercial value.

**Diameter at Breast Height (dbh):** The diameter of a standing tree measured at 4.5 feet above the ground and expressed in inches.

**Epicormic branching:** Branches that sprout from adventitious buds on the bole of a tree, usually when it is stressed or is subjected to full sunlight.

**Dominant:** Trees with well developed crowns which are above the canopy and receive direct sunlight from above and partially from the side.

**Even-aged:** An age class description of a stand in which the age of the trees is relatively close, usually within 20 years. Stands with two distinct age classes can also be referred to as even-aged.

**Even-aged Management:** Timber management that produces a stand of trees with relatively little difference in age usually 10-20 years. Even-age silvicultural systems include clear-cut, seed-tree and shelterwood.

**Forest Management Plan (FMP):** A long range plan designed to identify a landowner’s goals and objectives and the silvicultural methods that will be employed to achieve those goals.

**Forest Type:** A natural group or association of different species of trees which commonly occur together over a large area. Forest types are defined by one or more of the dominant species of trees in the type. Common commercial types in the northeast are: beech-birch-maple; beech-red maple; mixedwood; spruce-fir; white pine.

**Forestry:** The art and science of growing and managing forests and forest lands for the continuing use of their resources.

**Girdle:** To destroy the conductive tissue of a tree in a ring around the bole.

**Group Selection:** An uneven-aged harvesting method designed to favor intolerant or intermediate species. Trees are generally removed in groups in areas ranging from 1/20-2 acres in size.

**Habitat:** The place where a plant or animal can live and maintain itself.

**Hardwoods:** Broad-leaved trees which lose their leaves in the fall.

**Harvest:** A silvicultural treatment that is intended to establish regeneration. A harvest is generally a higher level of cutting intensity than a thinning.
**High-grading:** A liquidation cut in which only the best quality, highest value trees are removed. Cuts of this nature are short sighted and exploitative and result in the degradation of the forest ecosystem.

**Hydrologic Class:** A measure of a bare soil's runoff characteristics. Group A soil has a high water infiltration rate and a low runoff potential. Group D soil has a very slow rate of water infiltration and is prone to high runoff.

**Improvement Cutting:** A silvicultural treatment in which poor quality and low value trees are removed to give the best trees more room to grow.

**Individual Tree Selection:** An uneven-aged harvesting method designed to favor tolerant species. Trees are removed individually to maintain a continuous and uniform crown cover. Also referred to as single tree selection.

**Intermediate:** Trees whose crowns reach the canopy level but receive little or no direct light from above and none from the sides.

**Intermediate Treatments:** Harvesting methods employed during even-aged management. The removal of trees from a stand between the time of establishment and the final harvest with the purpose of improving stand growth and/or species composition and/or health.

**Intolerant Species:** Trees unable to grow and develop in the shade of other species.

**Landing:** Any place where logs are assembled for further transport.

**Liquidation Cutting:** Removal of all merchantable products from the forest with no regard for stand improvement or regeneration, usually preceding the sale of the land.

**Log Rule:** A table or formula showing estimated volumes, usually in board feet, for various log diameters and lengths.

**Mast:** Nuts, berries, and seeds utilized by wildlife as a food resource.

**Maturity:** Expressed in two ways: 1. Financial maturity occurs when a tree has reached the point where it has maximized value growth from the prospective market place; 2. Biological maturity occurs when a tree has reached the point where the energy costs of maintaining itself exceeds the energy input from photosynthesis. Financial maturity is reached long before biological maturity.

**MBF:** The abbreviation for one thousand board feet.

**Mean Stand Diameter (MSD):** The arithmetic mean diameter of the trees in a stand.

**Medial Diameter (MDL):** This is developed by determining the sum of each diameter class multiplied by the basal area in that class and then dividing the result by the total basal area. MDL is useful in stands with a high proportion of saplings because it is less influenced by these small trees and more accurately the size of the crop trees.

**Mixed Hardwoods:** Timber stands characterized by a mixture of hardwood species.
**Overmature**: A stand of trees that is older than normal rotation age for the type.

**Overstory**: The upper crown canopy of the forest. The overstory is usually referenced as the larger trees in the stand.

**Phloem**: Tissue of the inner bark that conducts photosynthate from the leaves down to the roots.

**Pioneer**: Shade intolerant species that are the first trees to develop in an area after or the abandonment of a field or after a disturbance that covers a fairly large area. Pioneer species include aspen and paper birch.

**Pole or Pole Timber**: A tree or trees greater than 4.0 inches dbh and less than 10.0 inches dbh.

**Pre-commercial Thinning**: An intermediate harvesting operation in a young stand that does not generate income.

**Prescription**: A course of action to effect change in a forest stand (harvest, planting, TSI).

**Q-factor**: A device used to describe the structure of an uneven aged stand. The q-factor is the ratio of the number of trees in a diameter class divided by the number of trees in the next smaller diameter class. The lower the q-factor, the higher the proportion of large diameter trees.

**Regeneration**: Renewal of a tree crop by natural or artificial means.

**Release**: The freeing of well-established seedlings or saplings from surrounding growth.

**Residual**: Trees that are left to grow in a stand after a silvicultural treatment.

**Rotation**: The length of time required to grow an even aged crop of trees to a desired age.

**Rotation Age**: The age at which an even aged stand is considered ready for harvest.

**Salvage Cut**: The removal of dead, dying and damaged trees after a natural disaster or insect or disease infestation to utilize the wood before it loses all of its commercial value.

**Sanitation Cut**: The removal of dead, dying or damaged trees to prevent or interrupt the spread of insects or disease.

**Sapling**: Trees taller than 4.5 feet but less than 5.0 inches dbh.

**Sawlog**: A log considered suitable in size and quality for producing lumber. Regional standards apply for diameter, length and freedom from defect. Sawlog is also used to refer to a tree that has reached sufficient size to produce a sawlog. Small sawlog trees are 12-16 inches dbh, medium sawlog trees are 17-20 inches dbh, and large sawlog trees are 22 inches dbh or greater.

**Sawtimber**: Trees that have obtained a minimum diameter at breast height that can be felled and processed into sawlogs. Typical minimum size limits for commercial species in Vermont are 8 inches dbh for softwoods and 12 inches dbh for hardwoods.

**Seedlings**: Trees that are less than 4.5 feet tall.
Seed Tree: An even-aged silvicultural method in which most of the merchantable trees are removed in the first cut, leaving a few scattered trees of desirable species to serve as a seed source for the new stand. The seed trees are removed after successful regeneration has developed. The seed tree method is a regeneration cut used to create an even-aged stand of shade intolerant species.

Selection method: An uneven-aged silvicultural system where individual trees, or groups of trees, are removed from a stand to ensure a sustained yield from an uneven-aged stand.

Shade tolerance: The ability of trees to reproduce and grow in the shade of other trees. Tolerance ratings are very tolerant, tolerant, intermediate, intolerant, and very intolerant.

Shelterwood: An even-aged silvicultural system in which the mature trees are removed in a series of partial cuts that take place over a small portion of the rotation. The residual trees are left as a seed source and to provide shade and protection for the new seedlings. Three types of cuttings are used in this method:

(1) The preparatory cut, in which the least desirable trees are removed to improve the quality and growth of the stand, (2) The seed cut, in which the regeneration is established, (3) The removal cut (or cuts) in which the mature trees are cut to release the regeneration.

Variations of this method include the group, irregular, strip, and uniform shelterwood.

Silviculture: Manipulation of the forest ecosystem to achieve specific goals and objectives.

Site Class: A measurement of the quality of the soil in terms of its potential productivity. A site class of 1 indicates that the soil is highly productive and a site class of 4 is considered non-productive, usually due to excessively wet, dry, or thin soil.

Site Index: A measure of the relative productive capacity of an area. Site index is species specific and is based on a comparison of tree age and height.

Skid Trail: Any path in the woods over which multiple loads of logs are hauled, usually by a skidder or tractor. Primary skid trails are the main pathways that enter the landing.

Skidder: A four wheel drive, tractor-like vehicle, articulated in the middle for maneuverability, with a cable or grapple on the back end designed to bring logs or whole trees to the landing once that they have been felled.

Slope: A relative measure of steepness of the ground. Slope can be computed by dividing the rise in elevation by the horizontal distance traveled. Slope is usually expressed in percent (rise ft /run) X 100. Slope can be derived automatically using various forest measurement tools.

Snag: A standing, dead tree.

Softwood: Coniferous trees, usually 'evergreen' (the exception being tamarack), with needles or scale-like leaves.

Stand (Treatment Unit): A community of trees possessing sufficient uniformity in regards to
composition, constitution, age, spatial arrangement or condition to be distinguishable from adjacent communities.

**Stocking:** An indication of the number of trees in a stand as compared to the optimum number of trees required to achieve some management objective, usually improved growth rates or increased timber values.

**Stocking Level:** Stocking levels are calculated by comparing either the basal area or the number of trees the site could support, if the growth potential of the land was fully utilized, to the basal area or number of trees actually on the site.

**Strip Cut:** A timber harvesting operation where all of the merchantable trees are cut within a long narrow strip. An even-aged cutting method usually used to regenerate spruce and fir.

**Stumpage:** The value of timber as it stands in the woods just before harvest (on the stump). Loggers are usually bid on timber based on its stumpage value. Stumpage can also be used to refer to standing timber.

**Succession:** The orderly and predictable replacement of one plant community by another over time in the absence of disturbance.

**Suppressed:** Trees with crowns entirely below the general level of the forest canopy that receive no direct sunlight from above or the sides.

**Thinning:** A silvicultural treatment that reduces stand density to allow the best trees to grow with less competition. There are three kinds of thinning: crown thinning, low thinning, and free thinning.

**Timber Stand Improvement (TSI):** A non-commercial timber harvest conducted in stands of timber to improve the health, growth rate, and form of the remaining trees.

**Tolerant Species:** Trees that can grow satisfactorily in the shade of other trees. Tolerant species of commercial importance in Vermont include sugar maple, beech, red spruce, and hemlock.

**Truck Road:** A road capable of supporting a trailer truck that hauls logs from the landing to the mill.

**Understory:** Those plants growing under the main canopy.

**Uneven aged:** An age class description of a stand of trees that contains more than two distinct age classes and a variety of size classes.

**Uneven-aged (All-aged) Management:** Timber management that produces a stand composed of a variety of age classes. Harvesting methods used in uneven-aged management include individual tree and group selection.

**Vigor:** The health and vitality of a tree. Vigor can most accurately be assessed by observations of foliage (density, width and color) and percent live crown.

**Volume Table:** A table that utilizes tree dbh or log diameters and log length (usually 16 feet) to estimate board foot volumes according to a set of assumptions (“log rules”) about how the log will be processed.
into boards.

**Windthrow:** A tree or trees that have been toppled by high winds. A common phenomena along the edge of strip cuts and clear-cuts.

**Xylem:** Vascular tissue of the outer wood that conducts water and nutrients from the roots to the upper part of the tree.

**Yield:** Total forest growth over a specified period of time, less mortality, unmarketable fiber and cull.

**Yield Table:** A species-specific representation of the amount of useable wood fiber a forest can be expected to produce during a single rotation based on site index

*The above definitions have been adopted from the Northwest Illinois Forestry Association website, see citation below.*
Appendix: Student Generated Maps

Harwood Union HS Forest Stand Map

Created by: Nicole Groholski