Executive Summary

The Prickett Dam Tract is in Laird Township, southern Houghton County in Michigan’s Upper Peninsula, USA. The legal description of the Prickett Dam tract is:

N ½ of the SE ¼ & SW ¼ of the SE ¼, Section 9, Township 50 N, Range 35 W.

The tract is located about 1½ miles south of M-38 on the Prickett Dam Rd. Although, the deed states this tract is 120 acres the current actual acreage comprises 126.2 acres.

Many different individuals, two lumber companies (Consolidated Timber Co. and Worchester Lumber Co.), as well as the state of Michigan owned the tract before it was deeded to the Michigan College of Mines in February 15, 1945. During the year of 1906 the land changed ownership six times in three months. When the Michigan College of Mines acquired the property, the deed restricted the land to be used for forestry only.

Social dimensions are a huge factor one has to consider when writing management prescriptions. Michigan Technological University has many different users on the property who use it for many different reasons, hiking, bird watching, and hunting just to name a few. Hunting from an observation point is what the land is mainly used for at the present time. We located five deer blinds on and around the property and also many deer tracks during our cruising of the property.

The Prickett Dam Tract will play a vital role in the overall landscape after being managed. Many different wildlife species will benefit from the managing of this land, not to mention the people who use the land for hunting. Many non-game species will also benefit by having new habitat types to live in and also to feed off of.

There are three main soil types present on the Prickett Dam tract. Gay Muck comprises the majority of the tract. However, the Houghton County Soil Survey mistyped this soil, and the true soil series is unknown. The other types of soil are Rudyard Silt Loam, 0-3% slopes and Froberg-Rudyard Silt Loam, 1-8% slopes. All the soils on the site, present a major concern for harvesting. Soil compaction, rutting and possible erosion could happen if logged any time other than the winter months. Hydrology of the land consists of relatively flat-sloped terrain. The tract is part of the Silver river watershed, which is part of the Lake Superior watershed. All Best Management Practices must be taken in to account while working on this site due to the wetness of these soils.

The Prickett Dam Tract has four different forest types, which are hemlock, lowland hardwoods, aspen and northern hardwoods. This forest types have been divided into five management units: 1a, 1b, 2, 3, and 4. The hemlock, unit 4, is located in the middle of the tract and is the largest section within the tract of fifty-three acres. Currently the hemlock stand has a liquidation value of $936.91 per acre, which is low compared to a mediocre stand of northern hardwoods. The lowland hardwood, unit 3, located in the western half consists of thirty-five acres and has a liquidation value of $559.78 per acre. The aspen stand, unit 2, located in the western half and along the eastern edge is comprised of twenty-five acres and has a liquidation value of $809.50, which is a good return for aspen stands. The northern hardwood stands, units 1A and 1b, consist of 4.7 and 7.4 respectively. Stand 1a has a liquidation value of $624.46 per acre and 1b has a liquidation value of $544.09 per acre, which are both very low compared to other northern hardwood sites.

The Prickett Tract will have five management units within it, these being a hemlock unit, lowland hardwoods unit, aspen unit, and two northern hardwoods units.

The hemlock unit is going to be used for a study of regeneration tactics, utilizing gap dynamics. Currently, Michigan Technological University is focusing on the regeneration of eastern hemlock, in hopes of restoring this species to the regional landscape. The study gaps set up on the Prickett Dam tract will be part of the research occurring on the Ford Forestry Center.
The other four units will be managed on a 60 year rotation cycle, to minimize the impact of equipment on the soils, which are highly susceptible to damage. The aspen unit will have a coppice cut performed at the end of each 60 year period.

The northern hardwoods unit in the Northeast corner of the tract will be gradually converted to an aspen stand, cutting half of the stand away during each aspen clear-cut to encourage the aspen to sprout in to the former hardwood area. Regeneration must be monitored in order to determine the effectiveness of the treatment. This conversion will take two rotation periods, cutting half of the 4.7 acre stand out each time. If the conversion is unsuccessful, the stand will be converted to white spruce.

The northern hardwoods stand in the Southeast corner of the tract will have more traditional uneven-aged management applied to it. The unit will have most of the timber in the larger size classes removed, and our hopes are that the smaller classes will grow into higher quality sawtimber by the next rotation through crop-tree release.

The lowland hardwood stand has a couple of options, and in order to decide which management path to take, must be monitored closely for the next few years. Due to the wet conditions in the unit, aspen may not come back well following the harvest. If this is the case, then the stand will be converted to black ash, for the production of high quality sawtimber or veneer. Otherwise it will be converted to aspen.

These management options comply with the goals of the Michigan Tech School of Forest Resources and Environmental Science, and will provide an educational experience for future students of the department.
Introduction

-Melissa Powers
**Location**

The Prickett Dam tract is in Laird township, southern Houghton County in Michigan’s Upper Peninsula, USA (Map I-1). The legal description of the Prickett Dam tract is: N ½ of the SE ¼ & SW ¼ of the SE ¼, Section 9, Township 50 N, Range 35 W. The tract is located off of M-38 on the Prickett Dam Rd. (Map I-2). Although, the deed states this tract is 120 acres the current actual acreage comprises 126.2 acres (Map I-3). The reason we found the property to be larger than the deed stated is because the lines in the area are crooked. The ‘hypothetical’ property lines which are shown on Map I-3 are where the lines should be if the section was ‘normal.’

**Map, I-1**

*General Area Map Western U.P., MI*

![Map showing location of Prickett Dam Tract](Image)
Map, I-2
Road Map of Prickett Dam Area
Property Boundaries

Legal Description: N ½ of the SE ¼ & SW ¼ of the SE ¼, Section 9, Township 50 N, Range 35 W

The Map, I-3 is an infrared aerial photograph. Softwood species show up as the maroonish color on this map while hardwoods typically show up as a blueish-green color.
Ownership/Goals

The Prickett Dam tract is owned by Michigan Technological University who acquired the property in the 1940’s from the state of Michigan. The state requires that Michigan Technological University only use the property for forestry or the tract shall revert to the state. The ownership goals of Michigan Technological University are:

- To promote research and the educational goals of the School of Forest Resources and Environmental Sciences.
- Provide revenue to maintain research and educational goals.
- Attain certification under the Sustainable Forestry Initiative (SFI), of the American Forest Products and Paper Association (AF&PA).
- To provide demonstrations of forest and wildland management that facilitates public education and understanding.
- To abide by all laws and regulations.

Overview

This report accesses the Prickett Dam property including: hydrology, soils and geology, vegetation and wildlife present at the property as well as historical and social aspects and how they interact with the surrounding area. The individual parts of this report build upon each other to help represent what is on the tract and how the tract relates to the local landscape. This detail provides the factual information which the management recommendations have been based upon.

The heritage resources chapter discusses the history of the property and the surrounding area. This includes how the property came into the current ownership, who historically owned it, what it was historically used for, and how the history of the region has affected the tract.

The social dimensions chapter discusses how and what laws influence management of the Prickett Dam Tract. This chapter goes into detail concerning laws and restrictions that are applicable and how they affect what can be done on the property. Also, discussed will be the recreation that occurs on the tract and the surrounding landscape, as well as how the tract influences and is influenced by the local society.

The ground resources chapter (soils / hydrology / geology) is key to the report since everything found on the property is based upon the soil and mineral characteristics. Operational conditions, water drainage, growth possibilities and what is suitable to be grown on the property based on soils shall be discussed. The hydrology portion of this chapter covers the drainage characteristics of the property and builds from the soils information.

The chapter on wildlife discusses what wildlife species were viewed on the tract and what species are possible based on available guides and the surrounding area. Habitat suitability indices were also used to determine how well some species would do if they were present on the property. Some species that evidence was found of or were physically seen on the tract are: black bear, coyote, sharp shinned hawk, piliated woodpecker, white tailed deer, snakes, and amphibians.

Further, the vegetation chapter evaluates what understory and overstory plant life is present on the tract and in what quantity and quality is discussed. Many characteristics of the vegetation on the tract were measured including but not limited to: habitat types, basal area, volume, forest health, tree diameter and regeneration. This survey was done in a systematic way over the entire tract using a 10 basal area factor prism.

Finally, management options are discussed for each of the five management units. These options are what we feel is best suited to occur on the property to improve the value and health of the property. These management options will be tied into the local forested landscape.
The Prickett Dam Tract has a history that tends to be somewhat similar to most of the Western Upper Peninsula of Michigan. Native Americans first inhabited the Western Upper Peninsula, and then in the mid-to-late 1800’s European settlers moved in. Many of these settlers came to mine copper in this region. Research for this chapter was done through the deed records at the Houghton County courthouse, the Achieves at the Robert J Van Pelt library, and ground truthing on the Prickett Dam Tract.

Past Ownership

The Prickett Dam Tract had several ownership changes in the years from 1900 to 1913 (Table H: 1). The ownership history is very confusing due to the fact that there have been legal disputes about the Tract. Over time ownership of the tract has transferred many times using a variety of legal means. The most common way that ownership transfers was through the use Quit Claim Deeds. In 1906 there was a probate order on the tract, this is one of the legal disputes. Also, on May 29 the ownership of the tract changed two times in one day! It seems rather interesting that the two people that sold the tract had the same last name, Sanborn. This dispute had to do with a discharge of mortgage. In 1906 the whole tract or some piece of the tract changed ownership 6 times that year. The changing of the ownership did not slow down until 1913. On most occasions, only a part of the tract changed ownership at that point in time.

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Table H-1 provides a description of previous ownership of the Prickett Dam Tract, from Houghton county deed records.

Native Americans

Before the European settlers came to this region to mine for copper, one or more Native American tribes used the land extensively. The Lake Superior Band of Chippewa Indians inhabited the land until the European settlers pushed them off of these lands and onto reservations. During the field assessment, no evidence was found that Native Americans used the Prickett Dam Tract. However, this does not mean that natives did not use the land.
European Settlement and Land Use

The area surrounding the Prickett Dam Tract is not thought to have been very active as far as mining is concerned. The European settlers that came to this region were mostly split between logging and mining.

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Photo, H-1

Photo H-1: Rotten Cedar stump from the Worcester Lumber Company era. –Jon Neuendorff

In 1909 Worcester built Railroad lines to the mill. They did this strictly as a way to receive logs from more distant areas, since there was virtually no road system early in the century. The rail system was a way for Worcester to guarantee a steady log supply to the mill. Worcester ran three locomotives right until the mill shutdown in 1928 (The Daily Mining Gazette Aug. 1961).

The Worcester Lumber Co. was based out of Chassell, Michigan. It first started in 1903 and remained in Chassell for 25 years before shutting down in 1928. The mill was located near the docks in Chassell, Michigan. The owner of the mill, C. H. Worcester, also lived in Chassell. His house was located at the current site of the Sigma Rho fraternity. The Daily Mining Gazette claimed that during the peak of the Worcester lumber company it had 120 mill employees, 300-400 men working in the logging camps, and 30 men working on the company railroad. Imagine the town of Chassell today with a lumber mill with
over a hundred workers and the capacity of producing thousands of board feet of lumber daily. If one were to drive westbound toward Baraga they would see the two tall stacks from the Worcester mill (Figure H-2). Also the figure shows the water where the hooker ships and barges used to be loaded with lumber.

The hooker ships were large steam power ships that usually visited the Worcester dock four to five times a year. These ships also towed two to three barges loaded with lumber every trip. The ships had crews ranging from fourteen to seventeen men and the barges had seven man crews. When the ship was at port the captain would hire 25 to 30 men to help load the ship. The ships had to be loaded by hand, which usually took two to three days. When one of the hooker ships arrived in Chassell many of the men wanted to help load the ship since the pay was far better than most other jobs in the area. The men received $5 to $8 dollars a day for ten-hour days (The Daily Mining Gazette June 1974). The lumber went to many different ports. Some of the ports included; Chicago, Milwaukee, Detroit, and even sometimes Canada. In October of 1928, the Elmira carrying 753,864 board feet of lumber, also the Elmira towed the barge Grampian carrying 300,000 feet of lumber (The Daily Mining Gazette June 1974). The Daily Mining Gazette claimed that this was the largest load of lumber ever shipped from Chassell. The may have occurred because the mill shutdown and this probably was the last load of lumber that Worcester ever shipped.

Photo, H-2

![Photo, H-2: Picture of the Worcester Lumber Company located in Chassell, Michigan. -Courtesy Copper Country Archives.](image)

Worcester produced many other products aside from the 750 million feet of lumber. Some of these products include; millions of cedar shingles and millions of strings of lathe, tanning bark, cedar poles and ties (Chassell 100 Year Centennial July 1988). In performing research for this section, a sales receipt (Figure H-3) was noticed in the Copper Country Archives. This receipt was made out to a man from Chassell and his name was Matt Kallio. As seen in the figure below, all products listed are what a person needed to build a house at that time. In 1911 it cost $171.37 for most of the materials to build a house (Copper Country Archives). This is very cheap when compared to the thousands of dollars it takes to buy materials for a house today.
Michigan Technological University

Michigan College of Mines, known today as Michigan Technological University, acquired the Prickett Dam Tract from the State of Michigan on February 15, 1945. In the deed the State of Michigan had a clause that the Prickett Dam Tract shall be used solely for forestry purposes, and if it didn’t it shall revert to the State of Michigan. Since the time the deed was signed there appears to be no harvesting activity occurring on the tract.

Figure, H-1: Sales receipt from the Worcester Lumber Company. -Courtesy Copper Country Archives
Conclusion

Native Americans used the Western Upper Peninsula extensively, until the movement of European settlers into the area. As the natives moved out, the immigrants moved in to work in the mines and logging camps. The Prickett Dam Tract has significant signs of past logging activities and was at one time very closely linked to the Worcester Lumber Company in Chassell, Michigan. However it was probably not effected by the mining industry as much as some other areas of the Upper Peninsula were, since it is not located on a body of water and no significant mineral deposits have been near the tract.
The Prickett Dam Tract has a history that tends to be somewhat similar to most of the Western Upper Peninsula of Michigan. Native Americans first inhabited the Western Upper Peninsula, and then in the mid-to-late 1800’s European settlers moved in. Many of these settlers came to mine copper in this region. Research for this chapter was done though the deed records at the Houghton County courthouse, the Achieves at the Robert J Van Pelt library, and ground truthing on the Prickett Dam Tract.

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The Worcester Lumber Co. was based out of Chassell, Michigan. It first started in 1903 and remained in Chassell for 25 years before shutting down in 1928. The mill was located near the docks in Chassell, Michigan. The owner of the mill, C. H. Worcester, also lived in Chassell. His house was located at the current site of the Sigma Rho fraternity. The Daily Mining Gazette claimed that during the peak of the Worcester lumber company it had 120 mill employees, 300-400 men working in the logging camps, and 30 men working on the company railroad. Imagine the town of Chassell today with a lumber mill with
over a hundred workers and the capacity of producing thousands of board feet of lumber daily. If one were to drive westbound toward Baraga they would see the two tall stacks from the Worcester mill (Figure H-2). Also the figure shows the water where the hooker ships and barges used to be loaded with lumber.

The hooker ships were large steam power ships that usually visited the Worcester dock four to five times a year. These ships also towed two to three barges loaded with lumber every trip. The ships had crews ranging from fourteen to seventeen men and the barges had seven man crews. When the ship was at port the captain would hire 25 to 30 men to help load the ship. The ships had to be loaded by hand, which usually took two to three days. When one of the hooker ships arrived in Chassell many of the men wanted to help load the ship since the pay was far better than most other jobs in the area. The men received $5 to $8 dollars a day for ten-hour days (The Daily Mining Gazette June 1974). The ships had to be loaded by hand, which usually took two to three days. When one of the hooker ships arrived in Chassell many of the men wanted to help load the ship since the pay was far better than most other jobs in the area. The men received $5 to $8 dollars a day for ten-hour days (The Daily Mining Gazette June 1974). The lumber went to many different ports. Some of the ports included; Chicago, Milwaukee, Detroit, and even sometimes Canada. In October of 1928, the Elmira carrying 753,864 board feet of lumber, also the Elmira towed the barge Grampian carrying 300,000 feet of lumber (The Daily Mining Gazette June 1974). The Daily Mining Gazette claimed that this was the largest load of lumber ever shipped from Chassell. The may have occurred because the mill shutdown and this probably was the last load of lumber that Worcester ever shipped.

Photo, H-2

Worcester produced many other products aside from the 750 million feet of lumber. Some of these products include; millions of cedar shingles and millions of strings of lathe, tanning bark, cedar poles and ties (Chassell 100 Year Centennial July 1988). In performing research for this section, a sales receipt (Figure H-3) was noticed in the Copper Country Archives. This receipt was made out to a man from Chassell and his name was Matt Kallio. As seen in the figure below, all products listed are what a person needed to build a house at that time. In 1911 it cost $171.37 for most of the materials to build a house (Copper Country Archives). This is very cheap when compared to the thousands of dollars it takes to buy materials for a house today.
Michigan Technological University

Michigan College of Mines, known today as Michigan Technological University, acquired the Prickett Dam Tract from the State of Michigan on February 15, 1945. In the deed the State of Michigan had a clause that the Prickett Dam Tract shall be used solely for forestry purposes, and if it didn’t it shall revert to the State of Michigan. Since the time the deed was signed there appears to be no harvesting activity occurring on the tract.

Conclusion

Native Americans used the Western Upper Peninsula extensively, until the movement of European settlers into the area. As the natives moved out, the immigrants moved in to work in the mines and logging camps. The Prickett Dam Tract has significant signs of past logging activities and was at one time very
closely linked to the Worcester Lumber Company in Chassell, Michigan. However it was probably not
effected by the mining industry as much as some other areas of the Upper Peninsula were, since it is not
located on a body of water and no significant mineral deposits have been near the tract.
Social Dimensions

-Melissa Powers
The Prickett Dam Tract is located in Laird Township, which is on the Eastern edge of Houghton County. Laird Township is a very rural area in the Upper Peninsula. The Prickett Dam Tract is a fair distance from any of the large communities in the area. Baraga is the closest town being approximately a twenty-minute drive to the east and the town of Houghton is approximately a forty-five minute drive to the north.

Current Neighbors

The Prickett Dan Tract has many different owners surrounding the tract. (Figure S: 1) To the north there are two owners that border the tract, Oswald and Beatrice Harju on the northwest half and James and Rosalie Rock on the northeast half. James and Rosalie Rock have a fairly new barbwire fence on the border that doesn’t seem to serve any purpose except to keep people off their land. Oswald and Beatrice Harju have had their land harvested sometime in the last year. Their land seemed to be mostly aspen and was clear-cut. To the west, the Prickett Dam tract borders the Ottawa National Forest, whose land is comprised of mostly mature aspen. The south has two owners that also border the tract. The Ottawa National Forest borders on the southwest half. Robert Erva borders on the southeast half and also borders on the south half of the east line. Robert Erva’s forty was harvested in the last ten years, it seemed to have been harvested mostly for hardwood pulp and some sawtimber. Erva’s tract mostly represents what our hemlock unit would look like if the hardwood were to be harvested from it. The east north half of the east line is the Prickett Dam road. The Ottawa National Forest maintains the ownership across the road in Baraga County.

Figure S-1

![Prickett Dam Tract on the Houghton County Platbook (2001)](image)

Figure S-2

![Prickett Dam Tract on the Houghton County Platbook (1911)](image)
**Current Land Use**

The Prickett Dam Tract is currently being used for hunting. During the vegetation cruise, some deer blinds were noticed on or adjacent to the tract. One blind was set up looking over the southeast corner of the tract. (Photo, S-1) One of the roads was receiving some four-wheeler traffic from the western boundary. Use of the road must have been minimal since there is virtually no road damage from the four-wheeler traffic.

**Photo, S-1**

![Deer blind looking into the Prickett Dam Tract.](photo_s-1)

_S-S-1: Deer blind looking into the Prickett Dam Tract. –Melissa Powers_

**Ethical Guidelines**

Michigan Technological University is a leader in maintaining a positive public impression about the forest products industry. One of the programs in the forest products industry is the Sustainable Forestry Initiative (SFI). Michigan Tech currently is in the process of enrolling their lands in the SFI program. SFI guidelines were developed through the collaborative effort of professional foresters, conservationists and other parties. Complying companies, landowners, and loggers are committed to supplying the needs of today’s consumers while preserving and improving present conditions for future needs. Other objectives include aesthetics, water quality, enhancing wildlife habitat, and education of the public.

In Michigan there are voluntary regulations concerning Best Management Practices (BMP’s). Most of the BMP’s in Michigan relate to the planning of harvest in sensitive areas, such as stream crossings, the use of vegetative buffers around water, harvesting on steep slopes, roads, and minimizing the debris that accumulate after harvest for aesthetic quality. Concerns for the Prickett Dam Tract on BMP...
compliance include, roads, harvest in sensitive areas, and minimizing the debris that accumulate after harvest. All of these concerns will be addressed for each management unit since only one or all of the concerns apply to each management unit.

The Prickett Dam Tract only relates to two topics listed above, roads and minimizing the debris that accumulate after harvest for aesthetic quality. Currently the roads are in very poor condition on the Prickett Dam Tract. The roads are covered with vegetation and have the width of a hiking trail. The poor road conditions are a direct attribute of no management activities taking place on the tract in over fifty years. Also the Prickett Dam Tract has half of the eastern boundary on the Prickett Dam Road. The Prickett Dam Road is the main road for people to access Prickett Dam Lake. Great care has to be taken to preserve aesthetic quality after harvesting.

Laws and Regulations

Endangered Species Act (ESA) of 1973 is intended to protect species from becoming extinct (Tobin 1990). The ESA has two main purposes; the designation of species and their critical habitat through listing and protection. Listing is very important because it can trigger certain species to receive more attention than they normally would. The Bald Eagle would have probably gone extinct if it would have not been listed. Listing usually raises concern through news coverage.

Forest Pest Management Act of 1947 instituted efforts and funding for pest control and diseases, regardless of land ownership (Cubbage). The act allows funding for potential or emergency outbreaks of forest pests. The funding often depends on large outbreaks to stimulate interest in control programs. For example, the Prickett Dam Tract could one day qualify if a large outbreak of the Hemlock Woolly Adelgid were to occur.

Access from highway M-38 is obtained through the Prickett Dam Road. The Prickett Dam Road is a county gravel road that is subject to spring weight restrictions. Houghton County historically has enforced the spring weight restrictions earlier than the other counties in the Western Upper Peninsula. Since the tract is going to be harvested in the winter, planning must be made to ensure all the forest products get hauled out of the woods.

Conclusion

Michigan Technological University is obligated by many laws and regulations to protect and manage the land to keep it in balance with nature. It is recommended that great care be taken when determining any management of the Prickett Dam Tract. This will not only prevent any legal disputes, but also help Michigan Tech and the forest products industry maintain its positive image with the public.
Ground Resources

J. Neuendorff
Ground resources are important for understanding an area, and hold a key place in accessing a tract and its potential. Many things comprise an area’s ground resources including the underlying geology, soils and hydrology of a region. These help to determine the mineral availability and rate of change of mineral availability to biotic resources. As well they determine the appearance of the surface of the earth and how quickly the surface changes.

The Prickett tract is part of the Silver River watershed, which in turn flows into the Sturgeon River and then Lake Superior.

There is very little over ground flow of water on the property, so any actives on the property should have little effect on the watershed. This will be the case unless extreme impacts are done to the property, such as channeling the flow of water so that it is not dissipated over the land. This justifies a winter harvest, so that the soil is protected by frost and snow cover.

The underlying bedrock formation found in this area is Jacobsville sandstone (Map G-1). This bedrock feature is dominant in the surrounding area. There are not any rock outcroppings on the property.

Soils

Many things are based upon the underlying soil. Conditions ranging from equipment use to the plant species that could be present all depend on the various characteristics of the soil. Hydrology is closely connected to the soils on this tract as well. The soils and hydrology of the area restrict equipment usage and are key for determining what species of plants are suited well for the tract.

According to the Houghton County Soils Survey book, the Prickett Dam Tract contains three soil series. The locations of the soil series can be seen in the below Map G-2. These consist of:

- 12 – Gay Muck
- 65A – Rudyard Silt Loam, 0-3% Slopes
- 73B – Froberg-Rudyard Silt Loam, 1-8% Slopes
Series 12: Gay Muck

Even though this series is listed for the hemlock stand on the tract, it is actually not present. This is almost the highest part of the property and also one of the driest. This series is in the middle of the tract, in the Green color in Map G-2 and consists of about 80 acres.

The soil found in this area is a sand loam. There are wet spots within the stand that are Gay Muck, however they are small in size and not very abundant. It is difficult to determine what this soil type is from the surrounding area because the property is at the edge of the soil survey. Perhaps future soils classes can type this area for their final project. This can be seen on Map G-2.

Series 65A: Rudyard Silt Loam, 0-3% Slopes

This soil series is almost flat and somewhat poorly drained and covers approximately 20 acres. Slow runoff on the property is the result of a high water table of 0.5 to 1.5 feet.

Seedling mortality can be as high as 25 to 30 percent. Bedding or drainage site preparation can reduce the mortality rate. Wind-throw is also a concern because of the shallow rooting characteristic of this series.

Habitat Types

Many of these areas are used as farmland. This soil is well suited to cultivated crops, but compaction will occur if worked while wet. This soil is habitat typed TTP with a secondary type of TAM-Eq. TTP (Tsuga-Thuja-Petasites) is dominated by eastern hemlock and northern white cedar. Other species are fir, red maple and black spruce. Productivity for this type is low for aspen. TAM-Eq (Tsuga-Acer-Mitchella/Equisetum phase) has a climax overstory of sugar maple and eastern hemlock, however the water table is too high to support these species. Other species that could be present are black ash, American elm, red maple, American basswood, white ash and yellow birch. The potential productivity for northern hardwoods is low and moderate for aspen.

Equipment

Harvesting should not be done during the fall, spring, or other excessively wet periods. Equipment should only be used when adequate snow cover is present or when dry. Operating on this series during wet periods risks damaging root systems and compacting the soil. Any unsurfaced roads become slick and rut easily. Landing sites will probably need to be stabilized so they can withstand heavy equipment traffic.

Logging areas, skid trails, landings, and haul roads have severe hazards due to wetness. The preferred operating seasons for this soil are summer or winter. During the preferred operating conditions there are only slight concerns with haul roads, landings, skid trails, and skid areas. The present road system is in poor condition and will need to be cleared and improved. Roadwork should be done during a dry period; cross culverts, ditches and water turnouts should be installed to help maintain a solid roadbed. Roads on the tract should also be frozen before use to help prevent rutting.

Wildlife Properties

The Houghton County Soil Survey lists the Rudyard series to have good potential of habitat elements for: herbaceous plants, hardwood trees, conifer trees and wetland plants. The habitat potential for

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth (inches)</th>
<th>Description</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0 to 4</td>
<td>Silt Loam</td>
<td>Slighty Acid</td>
</tr>
<tr>
<td>E</td>
<td>4 to 9</td>
<td>Silt Loam</td>
<td>Slighty Acid</td>
</tr>
<tr>
<td>Bt1</td>
<td>9 to 16</td>
<td>Clay</td>
<td>Slighty Acid</td>
</tr>
<tr>
<td>Bt2</td>
<td>16 to 24</td>
<td>Clay</td>
<td>Slighty Acid</td>
</tr>
<tr>
<td>C</td>
<td>24 to 60</td>
<td>Clay</td>
<td>Mildly Alkaline</td>
</tr>
</tbody>
</table>
animals it is rated good for openland and woodland animals and fair for wetland animals. A complete
discussion of animal species that could be found on this tract is provided in the Wildlife Chapter.

Series 73B: Froberg-Rudyard Silt Loam, 1-8% Slopes
This soil series is very deep, almost
to gently sloping on broad plains. Water permeability of this series is moderately slow
to very slow depending on the mix of the
series. The Rudyard series appears to cover
approximately 26 acres of the property. The
Rudyard series has a perched water table at a
depth of 3 to 6 feet. The combination of poor
drainage and a perched water table limit what
tree species can successfully occupy the site.
The poor drainage also results in acidic conditions throughout the soil horizons. Top dieback on this site is
evident in the scattered pole-sized sugar maple trees.

The tree species found on this soil series on our property are aspen and red maple on the front
(eastern) strip and black ash with aspen on the back (western) strip, these locations coincide with the
locations of series 73B on Map G-2. Table G-2 shows a high correlation between soil texture and pH with
the tree species that are found on this series. The strong acid in this series is due to the wetness of the soil.

Habitat Types
Most of this series is forested with little used as farmland. This series is habitat typed TTL and as
TTP for a secondary type. TTP (Tsuga-Thuja-Petasites) is dominated by eastern hemlock and northern
white cedar. Other species are fir, red maple and black spruce. Productivity for this type is low for aspen.
TTL (Tsuga-Thuja-Lonicera) has a climax overstory of eastern hemlock with northern white cedar. Other
species are red maple, sugar maple, balsam fir and eastern white pine. The productivity for northern
hardwoods is moderately low; productivity is high for aspen while red pine is moderate, but cannot be
considered because the site it too wet for the successful growth of red pine.

Equipment
Equipment limitations on this series are rutting from skidding when soils are wet. The risk ratings
for logging areas, landings and haul roads during the limiting seasons are severe due to wetness. The
preferred operating seasons are summer and winter. The ratings for skidding trails, haul roads and landings
are slight during the preferred operating seasons.

Rutting is a serious problem on this series. Any operations on this soil series should be done
during the dry season or under frozen ground conditions to prevent rutting. Rutting restricts lateral
drainage and will expose roots. Compaction is also a hazard along with wind-throw on this soil series. Soil
compaction here will also damage the tree roots.

Wildlife Properties
This soil series is rated good for several key wildlife habitat elements. These include: herbaceous
plants, hardwood trees, conifer trees and, wetland plants. From the soil survey this series appears to have
good potential for openland wildlife as well as woodland wildlife. For wetland wildlife, it is rated very
poor to fair. The aspen that is present on the majority of this series produces good wildlife habitat, in
particular for game species. The possible species that could be found on this site are listed in the Wildlife
Chapter.

Table G-2. Froberg-Rudyard horizon properties

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth (inches)</th>
<th>Description</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oi</td>
<td>2 to 0</td>
<td>Recent Hwd Litter</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0 to 5</td>
<td>Silt Loam</td>
<td>Strongly Acid</td>
</tr>
<tr>
<td>E</td>
<td>5 to 7</td>
<td>Silt Loam</td>
<td>Strongly Acid</td>
</tr>
<tr>
<td>Bt1</td>
<td>7 to 19</td>
<td>Silty Clay</td>
<td>Strongly Acid</td>
</tr>
<tr>
<td>Bt2</td>
<td>19 to 28</td>
<td>Silty Clay</td>
<td>Strongly Acid</td>
</tr>
<tr>
<td>2C</td>
<td>28 to 60</td>
<td>Sandy Loam</td>
<td>Strongly Acid</td>
</tr>
</tbody>
</table>
**Hydrology**

The hydrology of the Prickett Dam tract is based upon the soils that are present. There are no recognizable streams on the property. Drainage flows toward the northwest in this area, which can be seen in Map G-3. The soil survey map (Map G-2) shows there was a stream flowing through the northwest corner of the property show by the red arrow in Map G-3. This stream is no longer present. The stream could have filled in over time. There is a depression running from south to north on the tract that appears to have been a ‘stream’ historically. The stream is not found on quadrangle maps, Map G-3. However, this fall has been historically wet, so if this depression were a stream there would have been running water. This was not observed.

Normally, according to the National Weather Service in Marquette, September averages 3.74 inches of rain, while 5.71 inches fell this year. Historic average rainfall amounts can be seen in Graphic G-1.

The road running along the eastern side of the property could have impeded drainage to the east from the very eastern edge of the property. This is not likely though because the slopes all go to the northwest on the property.

Care will have to be taken to avoid rutting on the wet soft soils present in this area. This will be addressed by limiting operations to avoid unfavorable weather conditions. The soil present is heavy with clayey characteristics, which impedes drainage. This relates back to the equipment operation constraints for the Prickett tract mentioned earlier in this chapter.

The hydrology of the tract also affects the tree species that are present. The lower, wetter stand is comprised primarily of black ash with a minor component of aspen. These species do well in wetter areas. Hemlock is found on the highest and driest part of the Prickett dam tract, which runs south to north through the property. Hemlock favors a little dryer soil than the other species found on the property. The sugar maple on the property shows signs of top dieback. Top dieback is characteristic of wet soils and often affects sugar maple. Dieback was also evident in the black ash on the property.

This area of Houghton country historically gets heavy snows. Average snow amounts can be seen in Graphic G-2. The snow cover will help reduce ground impacts of the machinery.
Graphic G-1. Mean precipitation by month for Houghton County in inches.
The average annual precipitation over the last 40 years is 34.01 inches.
http://www.crh.noaa.gov/mqt/climate/normals/houghton.htm

Graphic G-2. Mean snowfall amount by month in inches.
The average annual snowfall over the past 40 years is 216.2 inches.
http://www.crh.noaa.gov/mqt/climate/normals/houghton.htm
According to the national wetlands inventory, there are two areas on the property that are classified under the National Wetlands Inventory (NWI), these can be seen on Map G-4. The dark green area is a forested wetland and light green is a shrub/scrub wetland as described by the NWI (Map G-4). These areas relate to where the roads are on the property. The roads are wet and have been covered by tag-alder. The reason these areas are so wet is because the soil has been compacted and now holds water. We feel the wetland areas that are present are manmade because of these reasons. To reroute the roads, more damage would be done to the landscape than if the current wet roads were improved and properly put to bed.

**Map G-4, National Wetland Inventory Map Of The Prickett Dam Area**

**Conclusion**

The ground resources present in an area greatly affect how it can be managed along with what impacts might be felt. A strong understanding of soils is important for all parts of management including vegetation and timber. Aspen and lowland hardwoods occupy the wetter areas, while the drier soils have hardwoods and hemlock present.
Vegetation

- Jon Neuendorff
Forest management is based on the current vegetation and site characteristics; and the ability to manipulate the vegetation and site to achieve a state that is favorable to the landowner. Limits to the degree of manipulation are created by time, natural processes, extraneous events, and social acceptability. The degree of manipulation to this property is abnormally limited by social acceptability; deed restrictions for this property limit its use to forestry if it is to remain in the control of Michigan Technological University. The fiscal value of this land that can be utilized by the current landowner exists only in its current and potential vegetation; therefore the vegetation on this property is of major concern. The vegetation on this tract can be divided into four major forest types, which are separated into five management units on this tract (Map V-1), they are as follows:

- **Unit 1a, Northern Hardwoods.** Comprising approximately four acres total.
- **Unit 1b, Northern Hardwoods.** Comprising approximately seven acres total.
- **Unit 2, Aspen.** Two separate stands for a total of twenty-five and a half acres.
- **Unit 3, Lowland Hardwoods.** A contiguous unit of thirty-five acres.
- **Unit 4, Hemlock.** A contiguous unit of fifty-three acres.

**Field Data Sampling Procedure**

During field sampling, a systematic point cruise was chosen with one point for approximately every two acres, using a 10BAF prism. The cruise started two chains west and two and a half chains south from the northeast corner. Points were then taken at a distance of four chains apart as the cruise proceeded on a line in a westward direction, which due to property line adjustments turned out to be 281°. Once the cruise reached point ten, which was approximately two chains from the western property boundary, it then went south for a distance of five chains. After point eleven, the cruise headed on a line east (101°) with the same spacing (four chains) as the first row. The cruise continued in the same order until the final point (point 60) was cruised. Later it was discovered that the property was not 120 acres but actually approximately 126 acres so the western property line was slightly further from the property boundary than thought. However when you consider the confidence interval below this slight change in acreage (less than five percent) the change in results from the additional three sample points would be minimal.
At each sampling point the following data was systematically collected, starting with a “start tree” (usually the tree closest to the direction in which the survey line was proceeding and continuing clockwise until all in trees and other factors on the point had been collected). The variables and information that was collected were the following:

- Timber Type
- Plot Location
- Tree Number
- Tree Species
- Diameter
- Total Height
- Merchantable Height
- Crown Ratio
- Crown Class
- Canopy Closure
- Percent Soundness (sawlog)
- Tree Grade or Decay Class
- CWD Transect
- Tree Disease
- Understory Plot Presence

Understory vegetation was sampled in 1/100th acre plots nested in the point centers. These plots occurred every six acres (once every three points) and have a minimum of at least two plots in each unit.

We wanted to assure that we were 95% confident that the estimated basal area was within 10% of the true basal area. Using the equation: 

\[ A = \frac{1}{\left( T \cdot CV \right)^2 / m} \]

to obtain the confidence levels. In this equation \( T \) is the t-value, which is 1.96. CV is the coefficient of variation, which changes for each of the units. The value \( m \) is the number of plots measured in each unit. \( A \) is the percentage of the mean given by the sample size (Lessard et al. 14). In Unit 1a and 1b, three point samples were taken giving a 23.8 percentage of the mean for the 95% confidence limit using a CV of 21. Unit 2 had thirteen point samples recorded giving a 11.9 percentage of the mean for the 95% confidence limit with a CV of 22. In Unit 3 there were seventeen point samples recorded resulting in a 9.9 percentage of the mean for the 95% confidence limit with a CV of 21. Finally in Unit 4 there were twenty five points taken resulting in a 10.9 percentage of the mean for the 95% confidence limit with a CV of 28. Therefore, we did not fall within our desired ten percent of the mean for the ninety-five percent confidence interval for three quarters of our tract. However, we did fall within 24% of the mean for the 95% confidence limit for each cover type on the entire tract, which we find to be acceptable error. We feel that the data is still statistically valid and in general represents the conditions that actually occur on the property.

**Habitat Types**

Current vegetation can tell an informed landowner many things about the future probabilities of a particular tract of land. Vegetation is generally thought to follow a certain predictable successional pathway if left to its own devices. These pathways are mapped in habitat type guides which correlate the more sensitive understory vegetation with the overstory to determine the particular pathway. On this tract four different habitat types were located (one generally corresponding with each of the management units on this tract) using a habitat typing guide: *A Guide to Forest Communities and Habitat Types of Northern Wisconsin*. As well habitat types were considered from the soil survey guide: *Soil Survey of Houghton County, MI*. The types for the soil survey guide depend on the underlying soil types and so the boundaries may not correspond accurately with the delineated management units. The habitat types for this tract were found to be as follows:

1. **Unit 1**
   - **ATD: Acer-Tsuga/dryopteris**, Based on field testing of understory vegetation, this type is typically known to be comprised of sugar maple and aspen as well as some basswood, white ash, red maple, red oak, yellow birch and hemlock. Typically the small trees and shrubs are not very well developed in this habitat type. The soils present in this habitat type usually are well...
to moderately well drained sandy loams, loams, and silt loams. Our unit would fall into the middle of the successional pathway, the blue boxed area, using this habitat type guide (Type pathway, V-1).

- **TTL: Tsuga-Thuja-Lonicera**, Based on an underlying soil series of 73B, Froberg-Rudyard Silt Loam, this type is typically known to be comprised of eastern hemlock and northern white cedar with components of balsam fir, hard maple and soft maple. The understory vegetation is comprised of bigleaf aster, woodfern, sedge, American fly honeysuckle, and Canada mayflower.

2. **Unit 2**

- **ACI**: *Acer/Clintonia*, Based on field testing of understory vegetation, this type typically consists of red oak, red maple, sugar maple, white birch and aspen. The small trees and shrubs usually represented are hazel, and fly honeysuckle with occasional appearances of juneberry and alternate-leaved dogwood. The soils that occur with this type primarily are well drained sandy loams. If this is the habitat type for this unit, the unit would fall into the blue boxed area, early successional stages – aspen and white birch - turning towards maple and basswood (Type Pathway, V-2)

- **FI**: *Fraxinus-Impatiens*, Based on an underlying soils series of 12, Gay Muck, (which is thought not to exist in this tract even though its recorded as such) this type is known to usually have a dominate overstory of white ash and soft maple, with some component of hard maple, black ash, and balsam fir. Understory species which indicate this type include: jewelweed, sedge, alpine circnea, woodfern, ladyfern, scarlett elder, and field mint.

- **TTL**: *Tsuga-Thuja-Lonicera*, Based on an underlying soil series of 73B, Froberg-Rudyard Silt Loam, this type is typically known to be comprised of eastern hemlock and northern white cedar with components of balsam fir, hard maple and soft maple. The understory vegetation is comprised of bigleaf aster, woodfern, sedge, American fly honeysuckle, and Canada mayflower.

- **TTP**: *Tsuga-Thuja-Petasites*, Based on an underlying soil series 65A, Rudyard Silt Loam, this habitat type is known to be dominated by eastern hemlock and northern white cedar. Occurring with these dominant species are balsam fir, soft maple, and hard maple. Understory vegetation indicative of this type include palmate-leaved sweet coltsfoot, bigleaf aster, sedge, barren strawberry, northern dewberry, bunchberry dogwood, wild sarsaparilla, and black snakeroot.

3. **Unit 3**

- **ATM**: *Acer-Tsuga/Maianthemum*, Based on field testing of understory vegetation, this habitat type is typically comprised mainly of sugar maple, eastern hemlock, and wild lily of the valley. The major vegetation found in this habitat type includes mainly every northern Wisconsin and Michigan tree species and cover type except xeric species. The small trees and shrubs layers are moderately well developed in younger and early successional stands of ATM. In more mature stands the tree and shrub layers are represented poorly with hazel, alternate-leaved dogwood, fly and bush honeysuckle. The soils underneath the vegetation typically consist of well to moderately well drained sandy loams, silt loams, and loamy sands. Unit 3 would be in the early to middle stages of succession with this habitat type as designated by the blue box in: Type Pathway, V-3.
FI: Fraxinus-Impatiens, Based on an underlying soils series of 12, Gay Muck, (which is thought not to exist in this tract even though it’s recorded as such) this type is known to usually have a dominate overstory of white ash and soft maple, with some component of hard maple, black ash, and balsam fir. Understory species which indicate this type include: jewelweed, sedge, alpine circeaea, woodfern, ladyfern, scarlett elder, and field mint.

TTL: Tsuga-Thuja-Lonicera, Based on an underlying soil series of 73B, Froberg-Rudyard Silt Loam, this type is typically known to be comprised of eastern hemlock and northern white cedar with components of balsam fir, hard maple and soft maple. The understory vegetation is comprised of bigleaf aster, woodfern, sedge, American fly honeysuckle, and Canada mayflower.

TTP: Tsuga-Thuja-Petasites, Based on an underlying soil series 65A, Rudyard Silt Loam, this habitat type is known to be dominated by eastern hemlock and northern white cedar. Occurring with these dominant species are balsam fir, soft maple, and hard maple. Understory vegetation indicative of this type include palmate-leaved sweet coltsfoot, bigleaf aster, sedge, barren strawberry, northern dewberry, bunchberry dogwood, wild sarsaparilla, and black snakeroot.

4. Unit 4

TMC: Tsuga/Maianthemum-Coptis, Based on field testing of understory vegetation, this habitat type consists of mainly aspen, red maple, balsam fir, and sugar maple with occasional white and yellow birch, hemlock, and white spruce. The small trees and shrubs typically found on these sites are hazel, fly and bush honeysuckle, with blackberries and dwarf raspberries occasionally making an appearance. Soils usually found on these habitat types are somewhat poorly drained, podzolized sandy loams, and occasionally loamy sands and loams. If this is the habitat type for Unit 4, this unit has reached the dominate habitat type that it is capable of succeeding into, indicated by the blue box on the graphic: Type Pathway, V-4.

FI: Fraxinus-Impatiens, Based on an underlying soils series of 12, Gay Muck, (which is thought not to exist in this tract even though its recorded as such) this type is known to usually have a dominate overstory of white ash and soft maple, with some component of hard maple, black ash, and balsam fir. Understory species which indicate this type
include: jewelweed, sedge, alpine circaea, woodfern, ladyfern, scarlett elder, and field mint.

- **TTP: Tsuga-Thuja-Petasites.** Based on an underlying soil series 65A, Rudyard Silt Loam, this habitat type is known to be dominated by eastern hemlock and northern white cedar. Occurring with these dominant species are balsam fir, soft maple, and hard maple. Understory vegetation indicative of this type include palmate-leaved sweet coltsfoot, bigleaf aster, sedge, barren strawberry, northern dewberry, bunchberry dogwood, wild sarsaparilla, and black snakeroot.

As discussed earlier habitat typing is generally thought to predict the successional pathway of a particular habitat type, however not without flaws. This system of classification does have some serious pitfalls; what do you do when the published guides don’t correlate with what you see before you? As you can see from the information presented, there are several sources of habitat types and they don’t always agree. This is partly because habitats change slowly over time – slower than one person can observe them – therefore the guides are based on the “best scientific guess” as to what will happen in the future. As well, the guides are generic based on the average or typical stand type (so if your stands’ type has not been previously considered or is very limited on the landscape a suitable guide for it may not have been developed). Another possibility when using habitat guides is user inexperience, failure to properly identify understory vegetation, or the proper percentage of understory vegetation can make the guides unusable, further the time of year when the guides are used can influence the particular results achieved as certain vegetation is only viewable at certain times of the year.

In particular, classification categories TMC, ATM, ACI, and ATD were developed in the state of Wisconsin where some of the environmental elements are different (soil, climate, weather, etc...) therefore the current cover types found on the stands do not necessarily correlate well with the hypothetical successional pathway. The habitat types FI, TTL, and TTP were developed for Northeastern Wisconsin and the Upper Peninsula of Michigan and so the environmental elements may be move closely correlated, but the method to how the habitat types are attached to soil series may be in question. As well, management practices have influenced the current vegetative cover. It is thought that the cedar was harvested from Unit Four near 1900, as well Units Two and Three are thought to have been clear-cut in the 1940s. This harvesting may have changed the successional pathways of these units. Therefore although the habitat types may give a reasonable general estimation of the succession of this tract they should not be thought to be flawless.

In conclusion we are more apt to recommend using the habitat types for this property from the **Soil Survey of Houghton County, MI** rather than the types from **A Guide to Forest Communities and Habitat Types of Northern Wisconsin**, since the soil survey habitat types seem a better fit to this property. Therefore, each management unit is comprised of more than one habitat type, since the management units are not based on the underlying soils where the habitat types are.

**Species of Concern**

Although the US Fish and Wildlife Service has not found any Federally listed species of threatened, endangered, proposed or candidate plant species in Houghton County or neighboring Baraga County there are several plant species which may cause management concern to Michigan Technological University.

The State of Michigan lists several plants in Houghton and Baraga counties as threatened they are as follows (Mead, et al. 237-239).

- Fern, Walking (*Asplenium rhizophyllum*), found in moist limestone cliffs and boulders where shaded. Known to exist near tract.
- Ragwort, Rayless Mountain (*Senecio indecorus*), found in many forest types
- Reedgrass, Northern (*Calamagrostis lacustris*), found in rock outcroppings. Known to exist near tract.
- Spleenwort, green (*Asplenium viride*), found in moist limestone cliffs, and surrounding moist woods. Known to exist near tract.
- Gentian, Narrow-leaved (*Gentiana linearis*), found in wet meadows and lowland brush

Even though none of these plants were identified on our tract, there is a possibility that they may exist on the tract or close enough to the tract to be influenced by activities on the tract. Continued surveying for threatened and
endangered species should occur prior to future management activities on the tract, as well as continued awareness of additional species’ listing to ensure compliance with all applicable laws.

Two commercial timber species may also be cause for concern for MTU. The first of these species that is found on the tract is American elm, which was found in Unit 2. American elm is highly susceptible to mortality from Dutch Elm Disease (see below). A past epidemic of Dutch Elm Disease nationwide has made mature American elm a rarity on the landscape. Although the American elm found on the tract is not yet mature it may be a species of interest to promote diversity on the tract in the future.

Another species of concern in this tract is the eastern hemlock, historically unmanaged for and often selected against: large areas of hemlock typically aren’t found on the landscape, whereas this unit has a large unit which is dominated by hemlock. This species may also be threatened by the spread of the Hemlock Woolly Adelgid (see below).

**Insects and Diseases**

Insects and diseases are a major concern for forest landowners. Insects and diseases have the potential to damage trees ruining their potential for use as high quality, higher priced products. As well insects and diseases can kill trees decreasing land values and visual ascetics. Listed below is an illustrated list of known or potential insects and diseases that may occur on the Prickett Dam tract. Included for each insect or disease is the identification characteristics, the damages caused and any potential controls for that insect or disease.

**Sugar Maple Borer**

The sugar maple borer (*Glycobius speciosus*) is a long-horned wood boring beetle. This beetle attacks sugar maple and many other hardwood species. Trees are seldom killed by infestations, but wood quality is extensively degraded (Hoffard & Marshall).

- **Identification:**
  
  The larva of the sugar maple borer is a dirty white in color (see photo V-1). The adult beetles are black with yellow lines on them and also have a yellow ‘W’ on their backs. There is one generation of beetles a year. Trees that are infected by the sugar maple borer posses a ‘J’ shaped wound, that appears on the trunk.

- **Cause:**
  
  The larva feed on the trunk of trees creating ‘J’ shaped wounds. These wounds can girdle the tree if it is heavily infested; the wounds are also weak points (photo V-1). Stress failures will commonly occur at these wounds.

- **Control:**
  
  It is thought that sugar maple borer is a secondary insect. The trees that are infected are most likely under stress. Stand vigor should be promoted. Infected trees can be harvested in early June to prevent emergence of adult beetles; the wood should be removed from the forest so that the beetles are not able to infest other susceptible trees. A flexible wire can be fed into the burrow to kill the larva under urban or high value situations.

Photo. V-1

The above photos illustrate the damage caused by sugar maple borer as well as an adult sugar maple borer.
Eutypella Canker

Eutypella canker of maple (Eutypella parasitica) attacks several maple species.

- **Identification:**
  Eutypella cankers resemble a cobra hood (Photo, V-2). These are commonly found less than nine feet above the ground and on the main stem of the tree. One year of infection is needed before an obvious visual indication is present. Failure to the tree stem may result in time.

- **Cause:**
  Spores of the Eutypella canker are dispersed by the wind or by water splashing. Wounds to the cambium of trees are needed for the spores to enter.

- **Control:**
  There is little control for Eutypella canker. Infected trees should be considered hazard trees and removed from the stand as soon as possible. Care should be taken to avoid damaging residual trees during the harvest to reduce infection courts.

Nectria Canker

Nectria canker (Nectria cinnabarina) attacks several tree species including maples.

- **Identification:**
  Cankers appear sunken and look like targets, they can be found on the trunk and also branches of trees (Photo, V-3). Leaves may also wilt and fall due to girdling caused by the fungus canker. The fungus takes approximately a year to become evident by the production of a callus. The spores over winter in the infected wood as well.

- **Cause:**
  Spores are spread by rain splash and possibly pruning tools. A wound to the cambium is needed for an infection court.

- **Control:**
  Little can be done to prevent Nectria from infesting an area. Attention should be given to maintaining tree vigor and having the proper tree for the site characteristics.

Gypsy Moth

Gypsy moth (Lymantria dispar) is an exotic species and at present has not established a major population in this area. This pest favors oak species but will also feed on most all other tree species throughout its life cycle.

- **Identification:**
  Larva can be recognized by five pairs of red spots on the front half and six pairs of red spots on the back half. The larva are also covered by hair that can cause irritation (Photo, V-4). Mature larva form cocoons commonly under loose bark or on human structures in June to Mid-July. The adult male moths are brown in color with black markings. Female moths are a buff color, larger, and unable to fly. Egg
masses are commonly found under bark crevices, on firewood, equipment, lawn furniture, and other dry protected places. The masses are covered with hairs from the female moth, and have a light brown fuzzy appearance. Eggs are laid in August and over winter. There is only one generation a year.

**Cause:**
Major outbreaks will cause complete defoliation of most forest trees. Shot hole feeding occurs after hatching in May until the larva have grown. Complete consumption of leaves will occur as the larva mature. Conifers may be less affected, but if heavily defoliated can die. Hardwoods will re-flush if they are defoliated early in the growing season. Repeated outbreaks can weaken trees and leave them open to infestation by other organisms and possibly lead to mortality.

**Control:**
Biological and chemical control agents are available for the control of the gypsy moth. The most commonly used control agent is *Bacillus thuringiensis* var. *kurstaki* (known as BT). BT is a microbial insecticide agent and is most effect when sprayed in early to mid-May. Spraying of Diflubenzuron in mid-May also is effective and has a longer residual presence.

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**Bronze Birch Borer**

Bronze birch borer (*Agrilus anxius*) is a native insect to North America.

**Identification:**
Bronze birch borers are slender, have a copper-like reflection color, and are olive-brown in color. The larva feed beneath the bark in a zigzag pattern (Photo V-5). There is only one generation a year.

**Cause:**
Birch trees in poor health are often associated with the borer. Native birch species show resistance to the borer. Introduced landscape birches are commonly attacked. Healthy trees are able to over come attack by healing over the callus caused by the feeding galleries of the borer. Trees predisposed to significant damage have usually been weakened by other factors. Death can result from stem failure and girdling.

**Control:**
Planting of ornamental birch trees should be avoided in off site areas. Trees should be well watered and maintained as well. Pesticides can also be applied to the surface of the bark to kill emerging larva.

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**Hemlock Woolly Adelgids**

Hemlock woolly adelgid (*Adelges tsugae*) is an insect that was introduced into the U.S. in 1924. There has been one known case in Michigan but it is thought to have been eradicated through a quarantine of the affected area. On going health monitoring will be the primary means of control in the future.

**Identification:**
The formation of white cottony sacs at the base of needles is a good indication of infestation (Photo V-6). These sacs are present the entire year but are prevalent in the spring.

**Cause:**
The woolly adelgid sucks sap from the stems of the needles, causing the tree’s growth to slow. Needles will become discolored and drop early, reducing the health of the tree. Complete defoliation can occur over several years.

**Control:**

There is a biological control agent for the woolly adelgid, it is an exotic lady beetle (*Pseudocynmenus tsugae*). Preliminary data shows high levels of control (D. Smith-Fiola, 2001).

**Asian Longhorned Beetle**

Asian longhorned beetle (*Anoplophora glabripennis*) was introduced to the United States from Asia. Beetles have also been discovered in Michigan in a warehouse. The beetle is a serious problem in China where it kills hardwood trees.

- **Identification:**
  
  It is uncertain but believed that there is only one generation of beetles per year. Adult beetles are present from May to October (Photo V-7). Adults generally stay on the infested tree or only travel to nearby trees to reproduce and feed. Females lay between 30 and 70 eggs in crevices that are chewed in the bark. The larva tunnel under the bark where they will feed and pupate. After pupation the beetle emerges from the wood by boring a round exit hole.

- **Cause:**
  
  Maple and aspen species are preferred hosts by the beetle. The larva create large feeding galleries that seriously degrade the wood. The exit holes formed by the emerging adults also cause serious damage; they are approximately 3/8 of an inch in diameter. Death to trees also results from infestation.

- **Control:**
  
  The only known control method is to remove and destroy the infected trees by burning or chipping. Quarantines have been established in infected areas.

**Sterile Canker Rot**

Sterile canker rot of birch (*Inonotus obliquus*) affects a few tree species, most commonly birch.

- **Identification:**
  
  Black conks, masses of fungal tissue that emerge from bark tissue indicate this disease. The conks are dark black, cracked, rough, and hard. Spores enter trees through wounds on the tree (Photo, V-8).

- **Cause:**
  
  Infected trees are seriously damaged. By the time the canker is evident the wood is of little value. Decay carries through the stem of the tree.

- **Control:**
  
  Damage should be minimized on birch trees to reduce infection courts. Infected trees should be removed from the stand to reduce infectious material.
Dutch Elm Disease

Dutch elm disease was first found in the United States in 1930, in Ohio. Since then, it has spread to nearly every state, the exclusions being the desert Southwest, decimating the elm population. Susceptible species include both American and red elms, and the non-domestic elms (Siberian or Chinese) are tolerant, but not immune. This tolerance is due to the vascular path sizes being smaller in the non-domestic elms, hindering the spread of the fungal tissue.

- **Identification:**
  Dutch elm disease causes, yellowing and wilting of leaves in the upper crown during periods of warm and dry weather, evidence of elm bark beetles in or around the tree, and the presence of brown streaking in the sapwood underneath the bark.

- **Cause:**
  This disease is spread in two manners: through infestation of the tree with one or both of the varieties of elm bark beetle (European and domestic), or through root grafts underground to infected trees. The fungus itself is *Ophiostoma ulmi*, which is carried on the backs of the beetles, and deposited in the tree when they feed. The smaller European beetles feed in the topmost branches of the elms, whereas the larger domestic beetles feed in branches from 2-4” in diameter. Once the fungus is introduced into a new host, it spreads through the vascular canals, clogging them, and preventing the passage of water to the upper branches.

- **Control:**
  The most effective manner of control for Dutch elm disease is through the sanitation of all tools and equipment used to work on the trees, and the prompt removal of infected specimens. Fungicidal injections have been used in some communities, but there is no guarantee of prevention, and the costly injections must be continued annually to maintain protection.

Volumes Estimations

Volumes for this property were determined using two separate methods based on product class. Sawtimber volumes were developed using the merchantable board foot volume table for whole trees based on the Scribner Decimal C log rule; a copy of this table can be seen in Appendix X. This method considers the volume of the merchantable saw log portion of the tree and dismisses the rest of the tree as waste. This table was developed by, Gevorkiantz and Olsen. Pulpwood volumes were estimated using an all species cordwood volume table also developed by Gevorkiantz and Olsen. This table provides a generalized estimate based on the “average” tree, thus some species’ volumes may be over estimated by this formula and some species’ volumes under estimated by this formula, but the average volumes should be accurate. A copy of the pulpwood volume table can be seen in Appendix X.

**Product Prices Used**

Current prices used for this property were developed by Carl Lockhart a local timber buyer who tracks current market prices. The prices used were based on the winning bids from USDA Forest Service, State of Michigan, Industrial, and some private sales. All of the prices used for this tract are viewable in table V-1. From these prices you can also see that only hardwood species were considered as sawtimber. Due mostly to low quality, no softwood species were considered for sawtimber.

<table>
<thead>
<tr>
<th>Table V-1, Prices Used</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
</tr>
<tr>
<td>Pulp</td>
</tr>
<tr>
<td>Mixed Hardwoods</td>
</tr>
<tr>
<td>Mixed Conifer</td>
</tr>
<tr>
<td>Aspen</td>
</tr>
<tr>
<td>SawTimber</td>
</tr>
<tr>
<td>Mixed Hardwoods</td>
</tr>
<tr>
<td>Hard Maple</td>
</tr>
<tr>
<td>Yellow Birch</td>
</tr>
<tr>
<td>Paper Birch</td>
</tr>
</tbody>
</table>
**Unit 1a, Northern Hardwoods**

This unit is 4.7 acres is located in the northeast corner of the tract, the following species are found in this unit:

- Hard Maple (*Acer saccharum Marsh.*), 126.1 trees per acre
- Soft Maple (*Acer rubrum L.*), 52.1 trees per acre
- Basswood (*Tilia Americana L.*), 18.1 trees per acre
- Hemlock (*Tsuga canadensis (L.) Carr.*), 14.6 trees per acre
- Ironwood (*Ostrya virginiana (Mill.) K. Koch*), 9.5 trees per acre
- Yellow Birch (*Betula alleghaniensis Britton*), 1.9 trees per acre

The diameter distribution by species (Graphic V-1) contains some very useful information about Unit One a. It shows that the majority of sawlog sized trees (those trees greater than twelve inches) are primarily soft maple, and hemlock with other species making up the remainder. The graphic also shows that hard maple make up the majority of trees under twelve inches. The age of these smaller trees will determine their response to being released. That is, if the canopy is opened through harvest or natural disturbance, if the trees are young enough they will increase their growth rate, moving them quickly into the next diameter class; however if the trees are too mature their response will be slower or immeasurable. This unit has the fewest number of commercial species of any of the units on this tract, but also covers the least acreage which reduces the chance of sampling a specific species.

**Graphic, V-1**

![Diagram of Unit 1a, Diameter Distribution](image-url)
Another way to look at diameter distribution is by a general category, Graphic V-2, shows the diameter distribution of Unit One a by hardwoods and softwoods. This type of distribution shows that hardwoods dominate this stand with a very limited component of hemlock. This shows that the softwood component of the stand is being limited by the dominate hardwoods as well as the effects of deer browse (Photo, V-9).

Photo, V-9

The softwood component of this unit is limited by the more aggressive dominate maples.
**Basal Area, Unit 1a**

The total basal area per acre for this unit is 133.33 feet squared per acre, the break-down per species can be seen in Graphic V-3.

**Graphic, V-3**

![Bar graph showing basal area by species for Unit 1a.](image)

As graphic V-3 shows the maple species dominate the growing space in this unit followed by hemlock and basswood with a minor component of yellow birch and ironwood.

**Volumes, Unit 1a**

The pulpwod volume (Table V-2) for this unit is approximately 27 cords per acre, or 126.9 cords for the entire unit. Of this, 19.26 cords per acre are maple and 5.73 cords per acre are hemlock.

Sawtimber volumes for Unit 1a consist mostly of maple: approximately 273.3 board feet an acre, and basswood which comprises 120.8 board feet per acre. The total sawtimber volumes consist of 429.2 board feet per acre or approximately 2,017.24 board feet for the entire unit.

When you compare the diameter distributions to the volumes you can see that many of the sawlog sized trees on this stand are of low quality and are considered to be of pulp class.

**Liquidation Value, Unit 1a**

If the entire merchantable volume of this unit is liquidated the gross return will be $624.46 per acre (see table V-2). This equals a total unit value of $2,934.96. It should be

![Table showing pulp and sawtimber volumes and prices for Unit 1a.](image)

<table>
<thead>
<tr>
<th>Species</th>
<th>Avg. Vol</th>
<th>$ value/cord</th>
<th>Total value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Maple</td>
<td>6.79</td>
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<td>Hemlock</td>
<td>5.73</td>
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<td>$64.63</td>
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<td>Hard Maple</td>
<td>12.47</td>
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<td>$254.10</td>
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<td>Basswood</td>
<td>1.36</td>
<td>$20.38 MIXED</td>
<td>$27.71</td>
</tr>
<tr>
<td>Ironwood</td>
<td>0.65</td>
<td>$20.38 MIXED</td>
<td>$13.24</td>
</tr>
</tbody>
</table>

**Total Value of pulp/acre =** $498.05

<table>
<thead>
<tr>
<th>Species</th>
<th>Avg. Vol</th>
<th>$ value/mbf</th>
<th>Total value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Maple</td>
<td>213.33</td>
<td>$240.70 MIXED</td>
<td>$51.35</td>
</tr>
<tr>
<td>Yellow Birch</td>
<td>35.00</td>
<td>$292.64</td>
<td>$10.24</td>
</tr>
<tr>
<td>Hard Maple</td>
<td>60.00</td>
<td>$595.68</td>
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</tr>
<tr>
<td>Basswood</td>
<td>120.83</td>
<td>$240.70 MIXED</td>
<td>$29.08</td>
</tr>
</tbody>
</table>

**Total Value of sawtimber/acre =** $126.42

**Total Value/acre =** $624.46
remembered that this return is based on winning bids of primarily government timber sales; contract stipulations and sale methods may influence the value of the standing timber in the event of a sale.

**Understory Vegetation**

Understory vegetation is an important component to the forest. It provides a food source and habitat for many creatures. As well, understory vegetation can indicate the general health of the forest. Understory species are also used to indicate habitat type as mentioned previously. The following species were identified to exist in the understory of this unit:

- Moss
- Grass
- Jewel weed
- Beaked hazelnut
- Goldenrod
- Tag alder
- Club moss
- Lily of the valley
- Sagarilla
- Large leaf aster
- Wood fern
- Honeysuckle
- Sedges

**Regeneration Potential**

The regeneration potential of this unit may be decreased from excessive deer browse which affects all vegetation. This stand averages 25669.2 trees per acre of advanced regeneration. This regeneration is comprised of hard maple, soft maple and white ash. If left to natural regeneration, according to the habitat guide that we used (see habitat type section) this stand has the potential to become a climax maple – basswood cover type.
**Unit 1b, Northern Hardwoods**

This unit is 7.4 acres is located in the southeast corner of the tract, the following species are found in this unit:

- Soft Maple (*Acer rubrum* L.), 115.0 trees per acre
- Hard Maple (*Acer saccharum* Marsh.), 28.3 trees per acre
- Hemlock (*Tsuga canadensis* (L.) Carr.), 27.5 trees per acre
- Cedar (*Thuja occidentalis* L.), 9.6 trees per acre
- Yellow Birch (*Betula alleghaniensis* Britton), 7.6 trees per acre

The diameter distribution by species (Graphic V-4) contains some very useful information about Unit One b. It shows that the majority of sawlog sized trees (those trees greater than twelve inches) are primarily hemlock with other species making up the remainder. The graphic also shows that soft maple make up the majority of trees under twelve inches. The age of these smaller trees will determine their response to being released. That is, if the canopy is opened through harvest or natural disturbance, if the trees are young enough they will increase their growth rate, moving them quickly into the next diameter class; however if the trees are too mature their response will be slower or immeasurable. This unit has the fewest number of commercial species of any of the units on this tract, but also covers the least acreage which reduces the chance of sampling a specific species.

**Graphic, V-4**
Another way to look at diameter distribution is by a general category, Graphic V-5, shows the diameter distribution of Unit One b by hardwoods and softwoods. This type of distribution shows that hardwoods dominate this stand until the fourteen inch class with a very limited component of softwoods (cedar and hemlock). In the larger size classes the softwood and hardwood components are more closely competitive.
**Basal Area, Unit 1b**

The total basal area per acre for this unit is 110.00 feet squared per acre, the break-down per species can be seen in Graphic V-6.

***Graphic, V-6.***

![Graph showing basal area by species](image)

The graphic V-6 shows that this unit’s basal area is dominated by soft maple with hemlock leading a close second. The hemlock is concentrated along the edge of the hemlock stand and is not wide spread through out the unit.

**Volumes, Unit 1b**

The pulpwood volume (Table V-3) for this unit is approximately 30.4 cords per acre, or 224.96 cords for the entire unit. Of this, 16.54 cords per acre are maple and 10.34 cords per acre are hemlock.

Sawtimber volumes for Unit 1b consist entirely of maple: approximately 46.66 board feet per acre. The total sawtimber volumes consist of approximately 345.28 board feet for the entire unit.

When you compare the diameter distributions to the volumes you can see that many of the sawlog sized trees on this stand are of low quality and are considered to be of pulp class.

**Liquidation Value, Unit 1b**

If the entire merchantable volume of this unit is liquidated the gross return will be $544.09 per acre (see table V-3). This equals a total unit value of $4,026.26. It should be remembered that this return is based on winning bids of primarily government

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**Table V-3, Unit 1b Volumes & Prices**

<table>
<thead>
<tr>
<th>Species</th>
<th>Avg. Vol.</th>
<th>$ value/cord</th>
<th>Total value</th>
</tr>
</thead>
<tbody>
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<td>PULP</td>
<td></td>
<td></td>
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<td>Soft Maple</td>
<td>13.57</td>
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<td>Hemlock</td>
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<td>$116.64</td>
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<tr>
<td>Cedar</td>
<td>0.48</td>
<td>$11.28 MIXED</td>
<td>$5.41</td>
</tr>
<tr>
<td>Yellow Birch</td>
<td>3.04</td>
<td>$20.38 MIXED</td>
<td>$61.95</td>
</tr>
<tr>
<td>Hard Maple</td>
<td>2.97</td>
<td>$20.38 MIXED</td>
<td>$60.52</td>
</tr>
<tr>
<td><strong>Total Value of pulp/acre =</strong></td>
<td></td>
<td></td>
<td>$521.02</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAWTIMBER</th>
<th></th>
<th></th>
<th>Total value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Maple</td>
<td>13.33</td>
<td>$240.70 MIXED</td>
<td>$3.21</td>
</tr>
<tr>
<td>Hard Maple</td>
<td>33.33</td>
<td>$595.68</td>
<td>$19.85</td>
</tr>
<tr>
<td><strong>Total Value of sawtimber/acre =</strong></td>
<td></td>
<td></td>
<td>$23.06</td>
</tr>
</tbody>
</table>

**Total Value/acre =** $544.09
timber sales; contract stipulations and sale methods may influence the value of the standing timber in the event of a sale.

**Understory Vegetation**

Understory vegetation is an important component to the forest. It provides a food source and habitat for many creatures. As well, understory vegetation can indicate the general health of the forest. Understory species are also used to indicate habitat type as mentioned previously. The following species were identified to exist in the understory of this unit:

- Moss
- Grass
- Jewel weed
- Beaked hazelnut
- Goldenrod
- Tag alder
- Club moss
- Lily of the valley
- Saparilla
- Large leaf aster
- Wood fern
- Honeysuckle
- Sedges

**Regeneration Potential**

The regeneration potential of this unit may be decreased from excessive deer browse which affects all vegetation. This stand averages 25669.2 trees per acre of advanced regeneration. This regeneration is comprised of hard maple, soft maple and white ash. If left to natural regeneration, according to the habitat guide that we used (see habitat type section) this stand has the potential to become a climax maple – basswood cover type.
Unit 2, Aspen

The Aspen Unit comprises 25.5 acres in two separate stands of similar species composition, age, stocking, and quality, on the property (see map V-1). The following species are found in this unit:

- Aspen (*Populas spp. Michx.*), 125.8 trees per acre
- Hard Maple (*Acer saccharum Marsh.*), 19.2 trees per acre
- Cedar (*Thuja occidentalis L*), 17.9 trees per acre
- Black Ash (*Fraxinus nigra Marsh.*), 8.8 trees per acre
- Soft Maple (*Acer rubrum L.*), 7.4 trees per acre
- Balsam (*Abies balsamea (L.) Mill.*), 7.6 trees per acre
- Black Ash (*Fraxinus nigra Marsh.*), 8.8 trees per acre
- Hemlock (*Tsuga canadensis (L.) Carr.*), 5.3 trees per acre
- American Elm (*Ulmus americana L.*), 3.6 trees per acre
- White Spruce (*Picea glauca (Moench) Voss.*), 0.6 trees per acre
- Eastern White Pine (*Pinus strobus L.*), 0.2 trees per acre

As the diameter distribution shows, this unit is dominated by aspen (Graphic V-7). Most aspen, approximately 100 trees per acre are in the seven to twelve inch range; this means that the aspen products are mostly in the pulpwood or bolt (8”-12”) areas. Shade tolerant species: hard maple, cedar, balsam, and mid-tolerant American elm are found in the small diameter classes and may eventually replace aspen as the dominant species if the stand is left undisturbed. The dominance of aspen and the relatively low number of trees above sixteen inches may indicate that the stand was clear-cut in the past. The Aspen on the tract averages at sixty years old. The remnant larger diameter trees may have been left as a seed source or may have been of poor quality if the stand had been clear-cut.

Graphic, V-7
When you compare the diameter distribution of Unit Two by Hardwood and Softwood categories (Graphic V-8) you can see that hardwoods dominate this unit more than they dominated Unit One. Softwood trees per acre start to become similar with hardwood species around the sixteen inch diameter class, however there are very few trees in this unit that are that large.
**Basal Area, Unit 2**

The total basal area per acre for this unit is 98.57 feet squared per acre, the break-down per species can be seen in Graphic V-9.

**Graphic, V-9**

![Basal Area Graph](image)

This unit is clearly dominated by aspen, with a basal area of over sixty square feet per acre the aspen comprises the majority of the stand. The other species present show more evenness with four species being around ten basal area per acre each, and the other five species with less than five basal area per acre each.
Volumes, Unit 2

Aspen dominates the pulpwood volume of this unit with 23.45 cords per acre, the total volume of pulp is 32.72 cords per acre (Table V-4). The entire Unit 2 has a volume of 834.36 cords of pulpwood.

Sawtimber volumes on this stand are more conservative with only soft maple and black ash contributing to the sawtimber volumes. Both soft maple and black ash contribute nearly evenly in this unit to generate a total volume of 148.2 board feet per acre or 3,780.1 board feet for the entire unit. This low sawtimber volume in this stand is due largely to the lack of larger sawtimber sized trees in this unit. As well the larger trees tend to be of poor quality.

Liquidation Value, Unit 2

If the entire merchantable volume of this unit is liquidated the gross return will be $809.50 per acre (see Table V-4). This equals a total unit value of $20642.25. It should be remembered that this return is based on winning bids of primarily government timber sales; contract stipulations and sale methods may influence the value of the standing timber in the event of a sale.

Understory Vegetation

Understory vegetation is an important component to the forest. It provides a food source and habitat for many creatures. As well, understory vegetation can indicate the general health of the forest. Understory species are also used to indicate habitat type as mentioned previously. The following species were identified to exist in the understory of this unit:

- Lady fern
- Downy yellow violet
- Wild lily of the valley
- Starflower
- Beaked hazelnut
- Thimbleberry
- Bluebead
- Wild sarsaparilla
- Barren strawberry
- Club moss
- Grass
- Sedges
- Wood fern
- Sensitive fern
- Raspberry
- Strawberry
- Moss
- Large leaved aster
- Goldenrod

Regeneration Potential

The regeneration potential of this unit may be decreased from excessive deer browse (Photo, V-10). This stand averages 13293 trees per acre of advanced regeneration. This regeneration is a mix of hard maple, soft maple, basswood, aspen, and elm. If left to succession this stand has the potential to become a mixed hardwood cover type. If clear-cut, vegetative reproduction should return this stand into an aspen stand type.
This Maple sapling was killed by many years of deer browse, which depleted the tree’s ability to produce new foliage. Excessive deer browse may be a problem in regenerating vegetation on this tract, especially for slow growing species such as Hemlock and Hard Maple.
**Unit 3, Lowland Hardwoods**

The Lowland Hardwoods Unit comprises 35.4 acres on the western edge of the property (see map V-1). The following species are found in this unit:

- Black Ash (*Fraxinus nigra* Marsh.), 71.4 trees per acre
- Soft Maple (*Acer rubrum* L.), 26.7 trees per acre
- Aspen (*Populas spp. Michx*.), 22.1 trees per acre
- Hard Maple (*Acer saccharum* Marsh.), 15.3 trees per acre
- Cedar (*Thuja occidentalis*), 14.9 trees per acre
- Balsam (*Abies balsamea* (L.) Mill.), 11.2 trees per acre
- Hemlock (*Tsuga canadensis* (L.) Marsh.), 6.2 trees per acre
- White Spruce (*Picea glauca* (Moench) Voss.), 2.8 trees per acre
- Yellow Birch (*Betula alleghaniensis* Britton.), 1.1 trees per acre
- Eastern White Pine (*Pinus strobus* L.), 0.2 trees per acre

**Graphic, V-10**

This unit contains the same number of species as Unit Two, the aspen unit; however, the distribution of these species varies greatly from the aspen unit. As Graphic V-10 shows, black ash is the most common species in Unit 3 indicating wet soils. The majority of the black ash are under the twelve inch sawlog limit, meaning that they are in the lower priced bolt and pulp categories. After the ash, soft maple, aspen, and hard maple make up the majority of species in this unit. The majority of the maples tend to be below the twelve inch diameter class, while only the aspen, white pine, and ash seem to have any significant showing in the sawlog categories; with balsam, spruce, yellow birch and cedar making a brief appearance in the 18 inch class. The large number of species classified as “other” (five total) contributes to the slant of this graph in the larger size classes, although no single species has a large TPA together they produce significant volumes.
When comparing the diameter distribution by category (Graphic, V-11), hardwood and softwood components for this unit are more closely related than the other units on this tract. Hardwoods do comprise the majority of trees in the unit less than eight inches, but after the eight inch class the components are more closely aligned indicating near even spread of softwood and hardwood components in this stand.
The total basal area per acre for this unit is 102.94 feet squared per acre, the break-down per species can be seen in Graphic V-12.

Black ash occupies the most space in this unit as seen in Graphic V-12. It is closely followed by aspen, maple, and cedar as well. The other species complete the matrix and provide some diversity to the unit.
Volumes, Unit 3
Table V-X, Unit 3 Prices and Volumes

<table>
<thead>
<tr>
<th>Species</th>
<th>Avg. Vol.</th>
<th>$ value/cord</th>
<th>Total value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Maple</td>
<td>3.15</td>
<td>$20.38 MIXED</td>
<td>$64.09</td>
</tr>
<tr>
<td>Hemlock</td>
<td>1.60</td>
<td>$11.28 MIXED</td>
<td>$18.05</td>
</tr>
<tr>
<td>Cedar</td>
<td>4.16</td>
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<td>$46.92</td>
</tr>
<tr>
<td>Yellow Birch</td>
<td>0.12</td>
<td>$20.38 MIXED</td>
<td>$2.44</td>
</tr>
<tr>
<td>Aspen</td>
<td>7.55</td>
<td>$26.88</td>
<td>$202.93</td>
</tr>
<tr>
<td>Black Ash</td>
<td>6.02</td>
<td>$20.38 MIXED</td>
<td>$122.70</td>
</tr>
<tr>
<td>Hard Maple</td>
<td>1.18</td>
<td>$20.38 MIXED</td>
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<tr>
<td>White Pine</td>
<td>0.24</td>
<td>$11.28 MIXED</td>
<td>$2.71</td>
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<tr>
<td>BalsamFir</td>
<td>1.02</td>
<td>$11.28 MIXED</td>
<td>$11.51</td>
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<tr>
<td>White Spruce</td>
<td>0.38</td>
<td>$11.28 MIXED</td>
<td>$4.30</td>
</tr>
</tbody>
</table>

Total Value of pulp/acre = $499.70

Sawtimber

<table>
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<tr>
<th>Species</th>
<th>Avg. Vol.</th>
<th>$ value/mbf</th>
<th>Total value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Maple</td>
<td>78.82</td>
<td>$240.70 MIXED</td>
<td>$18.97</td>
</tr>
<tr>
<td>Yellow Birch</td>
<td>20.59</td>
<td>$292.64</td>
<td>$6.02</td>
</tr>
<tr>
<td>Black Ash</td>
<td>75.88</td>
<td>$240.70 MIXED</td>
<td>$18.26</td>
</tr>
<tr>
<td>Hard Maple</td>
<td>28.24</td>
<td>$595.68</td>
<td>$16.82</td>
</tr>
</tbody>
</table>

Total Value of sawtimber/acre = $60.08

Total Value/acre = $559.78

Liquidation Value, Unit 3
If the entire merchantable volume of this unit is liquidated the gross return will be $559.78 per acre (see table V-5 at right). This equals a total unit value of $19592.30. It should be remembered that this return is based on winning bids of primarily government timber sales, contract stipulations and sale methods may influence the value of the standing timber in the event of a sale.

Understory Vegetation
Understory vegetation is an important component to the forest. It provides a food source and habitat for many creatures. As well, understory vegetation can indicate the general health of the forest. Understory species are also used to indicate habitat type as mentioned previously. The following species were identified to exist in the understory of this unit:

- Strawberry
- Wood fern
- Lady moss
- Lily of the valley
- Grass
- Sedges
- Large leafed aster
- Moss
- Beaked hazelnut
- Bracken fern
- Honeysuckle

Regeneration Potential
The regeneration potential of this unit may be decreased from excessive deer browse. This stand averages 29947.4 trees per acre of advanced regeneration. This regeneration includes hard maple, soft maple, basswood, aspen, balsam, and white birch. If left to natural succession this stand has the potential to become a mixed hardwood type.
**Unit 4, Hemlock**

The Hemlock Unit is 53.3 acres which run down the center of the property (see map V-1). The following species are found in this unit:

- Hemlock (*Tsuga canadensis* (L.) Carr.), 79.5 trees per acre
- Soft Maple (*Acer rubrum* L.), 34.4 trees per acre
- Cedar (*Thuja occidentalis* L.), 28.5 trees per acre
- Yellow Birch (*Betula alleghaniensis* Britton.), 16.9 trees per acre
- Hard Maple (*Acer saccharum* Marsh.), 8.0 trees per acre
- Aspen (*Populus spp.* Michx.), 6.0 trees per acre
- White Birch (*Betula papyrifera* Marsh.), 5.1 trees per acre
- Black Ash (*Fraxinus nigra* Marsh.), 0.9 trees per acre
- Eastern White Pine (*Pinus strobus* L.), 0.6 trees per acre
- Balsam Fir (*Abies balsamea* (L.) Mill.), 0.4 trees per acre
- Basswood (*Tilia americana* L.), 0.3 trees per acre

The most diverse unit with eleven commercial species, Unit Four is also the only unit which is dominated by softwoods (Graphic V-13). Hemlock is the most dominate species in this unit and is found in large numbers in every diameter class until the twenty-one inch diameter class. Soft maple is the second most common species in this unit it too occurs in every diameter class in a prominent position until the twenty-one inch class. Other major components of this unit are cedar and yellow birch, each having over sixteen trees per acre.
When you consider the diameter distribution by category (Graphic V-14), Unit four is dominated by softwoods. This unit generally has fewer trees per acre than the other units; however the diameters of the trees in this unit tend to be greater than the diameters in any of the other units, meaning that there are fewer but larger trees in this unit utilizing the available resources (Photo, V-11).

Photo, V-11

Large white pine and other trees this size utilize more resources, meaning that few trees per acre can survive in a stand with trees of this magnitude.
**Basal Area, Unit 4**

The total basal area per acre for this unit is 164.58 feet squared per acre, the break-down per species can be seen in Graphic V-15.

**Graphic, V-15**

Unit four is dominated by hemlock with over eighty basal area per acre in hemlock. Other species with large basal areas are soft maple with approximately thirty-five basal area per acre, as well as cedar and yellow birch which each have over fifteen basal area per acre.
Volumes, Unit 4

The pulpwood in the unit is dominated by hemlock, 26.27 cords per acre of a total 45.5 cords per acre (table V-6), this is because hemlock is the dominate forest cover type for the unit. The total pulpwood found in this unit is 2411.5 cords, since softwoods were not considered for sawtimber.

Sawtimber on the unit is dominated by soft maple with 661.4 board feet per acre. The total board footage per acre of sawtimber is 1,118.9 board feet. The total unit sawtimber volume is 59,303.3 board feet.

Liquidation Value, Unit 4

If the entire merchantable volume of this unit is liquidated the gross return will be $936.91 per acre (see table V-6). This equals a total unit value of $49656.23. It should be remembered that this return is based on winning bids of primarily government timber sales, contract stipulations and sale methods may influence the value of the standing timber in the event of a sale.

Understory Vegetation

Understory vegetation is an important component to the forest. It provides a food source and habitat for many creatures. As well, understory vegetation can indicate the general health of the forest. Understory species are also used to indicate habitat type as mentioned previously. The following species were identified to exist in the understory of this unit:

- Downy yellow violet
- Wild sarsaparilla
- American fly honeysuckle
- Bracken fern
- Lady fern
- Star flower
- Wild lily of the valley
- Hepatica
- Large leafed aster
- Thimbleberry
- Bush honeysuckle
- Moss
- Wood fern
- Beaked hazelnut
- Grass
- False solomon’s seal
- Blue bead
- Sedges
- Sweet fern
- Club moss
- Beaked hazelnut

Regeneration Potential

The regeneration potential of this unit may be decreased from excessive deer browse. This stand averages 16272.5 trees per acre of advanced regeneration. Tree species found in the understory include hard maple, red oak, basswood, soft maple, and black cherry. If left to natural regeneration this stand is already at its climatic cover type.
Summary

Current vegetation is an important part of this tract’s history, value, and future potential. As well overstory and understory vegetation provide important habitat niches for wildlife. The vegetation on this tract was sampled using a systematic grid type survey.

There are four main cover types on this site: Northern Hardwoods, Lowland Hardwoods, Aspen, and Hemlock: these cover types are divided along cover type into five management units. The tract’s vegetation has an estimated total value of $96,852.00. This value is derived from an on tract volume of 72.6 thousand board feet and 4,487 cords of timber products. This value may be decreased by the threat of insects and diseases.

The potential of the vegetation will be discussed further in the management options that have been developed for this tract.
Wildlife

Photo W-0: White-tailed Deer
-Melissa Powers
Introduction

Wildlife has a very strong impact on the overall health of the forest. Animals forage for food, and seek water and shelter; and in doing so they impact forest ecosystems, which may in turn effect overall forest management. Society is beginning to consider wildlife more valuable now than ever before. With more research being done every day, we are seeing the importance of conservation of wildlife. The Prickett Dam tract has the potential for a variety of wild animals including; amphibian, mammal, and avian species. There are four different stand types in the Prickett Dam tract, which are Aspen, Lowland hardwood, Hemlock, and Northern hardwood stand types (see Vegetation, pg. V-2, Unit Delineation Map). These vegetation types will support a variety of wildlife, each differently from the others. Of great importance to this project are threatened and endangered species, game species, and non-game species which all make up wildlife species. All the information in this section will be considered in the management section of the report.

Observations

Throughout the vegetative cruise performed on the Prickett Dam tract, any observations of wildlife activity were recorded. These observations included visual or audio confirmation, scat piles, tracks in soft soil, and signs such as skeletal fragments or carcasses. Table W-1 below provides a listing of the observed species, and the manner in which their presence was noted.

Table W-1: Wildlife species noted on the Prickett Dam tract during cruise, September, 2002.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Latin Name</th>
<th>Method of Presence Confirmation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sighting Tracks Scat Calls Other</td>
</tr>
<tr>
<td>White tailed deer</td>
<td>Odocoileus virginianus</td>
<td>x x x</td>
</tr>
<tr>
<td>Black bear (Photo W-3)</td>
<td>Ursus americanus</td>
<td>x</td>
</tr>
<tr>
<td>Northern leopard frog (Photo W-2)</td>
<td>Rana pipiens</td>
<td>x</td>
</tr>
<tr>
<td>Red-backed salamander</td>
<td>Plethodon cinerus</td>
<td>x</td>
</tr>
<tr>
<td>Black-capped chickadee (Photo W-1)</td>
<td>Poecile atricapillus</td>
<td>x x</td>
</tr>
<tr>
<td>Red squirrel</td>
<td>Tamiasciurus hussonicus</td>
<td>x</td>
</tr>
<tr>
<td>Hairy woodpecker</td>
<td>Picoides villosus</td>
<td>x</td>
</tr>
<tr>
<td>Pileated woodpecker</td>
<td>Dryocopus pileatus</td>
<td>x</td>
</tr>
<tr>
<td>Downy woodpecker</td>
<td>Picoide pubescen</td>
<td>x</td>
</tr>
<tr>
<td>Wood frog</td>
<td>Rana utricularia</td>
<td>x</td>
</tr>
<tr>
<td>Garter snake</td>
<td>Thamnophis sirtalis</td>
<td>x</td>
</tr>
<tr>
<td>Chipping sparrow</td>
<td>Spizella pallida</td>
<td>x</td>
</tr>
<tr>
<td>Coyote</td>
<td>Canis latrans</td>
<td>x</td>
</tr>
<tr>
<td>Blue jay</td>
<td>Cyanocitta cristata</td>
<td>x</td>
</tr>
<tr>
<td>Cedar waxwing</td>
<td>Bombycilla cedrorum</td>
<td>x</td>
</tr>
<tr>
<td>Sharp shinned hawk</td>
<td>Accipiter striatus</td>
<td>x</td>
</tr>
<tr>
<td>American Robin</td>
<td>Turdus migratorius</td>
<td>x</td>
</tr>
<tr>
<td>Winter Wren</td>
<td>Trogodytes troglodytes</td>
<td>x</td>
</tr>
<tr>
<td>White-breasted nuthatch</td>
<td>Sitta carolinensis</td>
<td>x</td>
</tr>
</tbody>
</table>

Many of these species have habitat requirements, which included mature timber and open woodlands. The hemlock stand on the Prickett Dam tract provides for both of these preferences, as the trees are of large sizes, with snags distributed throughout. Some of these snags were at one time super-canopy white pine, so are very useful as den trees, as well as a source of insects for many wildlife species. Porcupines and raccoons love hollowed out standing snags for den sites, they provide suitable living quarters for their young. Porcupines feast off of leaders on the hemlock trees as well as other confer species, and raccoons will eat other predators leftovers.
Because the trees are mature, the canopy cover is very thick, allowing for little understory to develop. The white-tailed deer browse heavily here in the winter, making it very difficult for the hemlock and cedar in the stand to regenerate. Though no tracks were found for black bears, several piles of scat were noted in the stand near the drainage areas where the dominant tree species is black ash. In these areas, the undergrowth is much thicker, and includes such species as blackberry, raspberry, and thimbleberry, which bears commonly feed upon. Bears are omnivorous, so they also feed upon small and mid-sized mammals, amphibians, and insects. Other animals such as ruffed grouse, woodcock, whitetail deer, cottontail rabbit, and the snowshoe hare prefer young regenerating aspen stands. These stand types provide food as well as shelter for these animals. Increasing the habitat of this stand type will also increase the number of predators; such as bobcat, gray wolf, and possibly the fisher, on these species. Predators have the advantage on our tract because of the relatively close proximity of the food source. Also due to very little course woody debris on the ground, which provides habitat for small mammals, very few small mammal species were observed during the timber cruise of the Prickett Dam tract. This may be attributed to the fact that it is difficult to detect smaller mammals when humans are present. Many are nocturnal, and also timid. If we were to visit the stand when there is snow on the ground, we would likely observe many signs and trails of smaller mammals such as red squirrels, mice, and voles.

Opening up all four timber types will increase sunlight on the ground and also put course woody debris on the ground for animals to live. The sunlight will allow new plants to grow and then the animals can feed off of them, creating a modified food chain.

Potential Wildlife Species
Wildlife Models

The Prickett Dam Tract has the potential to support a very diverse selection of wildlife, as there are several varieties of habitat available. These habitats range from the open areas underneath the canopy of hemlock and cedar, to the very thickly vegetated understory of the lowland hardwoods, to the mild regeneration coming in under the mature aspen and the northern hardwoods. Each of these provides a niche for certain species to thrive. Two lists of potential wildlife species have been compiled, one using the MIWild software, the other using the Species Occurrence Database, courtesy of Peg Gale. After examining the output from these applications, it was decided that the information provided by MIWild was more appropriate, considering that it could be manipulated depending on the management methods that we chose, and provided output based on our location, Houghton County. Table A7-1 in the Appendix displays the potential species present on the Prickett Dam tract, as well as the effect of land management on those species. Note: List will change slightly following the Management portion of the project.

Much of the wildlife potential depends on the forms of management we choose to employ. Several species not currently residing on the tract may move in following the removal of timber, especially in the aspen stand. Many smaller mammals, and some birds will prefer to live in regenerating aspen stands, as the vegetation is very thick. These species may include the Eastern cottontail, American woodcock, and possibly even ruffed grouse, a popular game bird not currently present on the tract. Due to recent management in aspen stands surrounding the tract, however, these species are likely present around the borders already.

Habitat Suitability

Habitat Suitability Index models (HSI’s) have been researched and compiled for many species common to the Great Lakes area. Included among these are the fisher (Figure W-4), downy woodpecker and pileated woodpecker; which have been chosen by the crew to examine on the tract. These species were chosen on the basis of the likelihood of presence, and our ability to gather the appropriate information from our original cruise data for use in the model. Each HSI includes a set of variables that refer to characteristics found in the field, i.e. percent canopy closure, basal area, and snags per acre. In turn, each variable translates to a value reflecting the importance of the characteristic to the suitability of the habitat for a particular species. These values range between zero (very poor) and one (excellent). Once the value for each variable has been determined, it can be entered into a formula designed for the species, and the resulting number is the overall HSI value for that species in that area.
Each of the four stand types on the Prickett Dam tract was used to determine an HSI value for the three species selected. The results can be seen below in Table W-3. Fisher habitat is very poor in each of the stands except for the hemlock due to the fact that there were no stumps in evidence in these stands. In the hemlock stand, however, there are still remains of cedar stumps resulting from a harvest between the turn of the century and about 1920 (see Heritage section for further details). Another factor in the suitability of habitat for fishers is the percent canopy closure. This averaged about 83% in the hemlock stand, but only between 62-80% for the other stands. Habitat quality for the downy woodpecker is approximately the same in each stand, as the HSI for this species is based only on basal area or snags per acre, whichever provided the lower value in either life requisite. The HSI value for the pileated woodpecker, however, is variable. This is likely due to the fact that there are fewer snags in each of the hardwood stands than in the aspen and hemlock stands, and the equation, which depended on more of the life requisite variables.

<table>
<thead>
<tr>
<th>Stand Type</th>
<th>Fisher HSI</th>
<th>Downy Woodpecker HSI</th>
<th>Pileated Woodpecker HSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemlock</td>
<td>0.45</td>
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<td>0.56</td>
</tr>
<tr>
<td>Lowland Hardwoods</td>
<td>0</td>
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</tr>
<tr>
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</table>

**Endangered and Threatened Species**

The Endangered Species Act of 1973 is an act to help protect endangered and threatened species, which include fish, wildlife and plants from further decline. Wildlife species are put on and taken off the list by scientific reasoning and research. Possible endangered species on our tract include Canadian lynx (Figure W-6) and gray wolf (Figure W-5), both of which are predators of small and large animals. The Canadian lynx is said to be present in the Upper Peninsula of Michigan but there remains a heated debate over it’s existence. The Canadian lynx lives in boreal forests along with mixed and deciduous –coniferous forest. The lynx’s main diet consists of snowshoe hare, but when populations are low they will forage on other small animals. Many facts are still unknown about the Canadian lynx, for instance how to manage for them, what impact ownership of land has on the lynx, and whether or not they really need large continuous land tracts to survive. The gray wolf is another topic of heated debate in this area. State wildlife biologists say we need them to control whitetail deer population, but hunters say we don’t need them. As far as our tract is concerned we need them to control the population of whitetail deer because of the heavy browsing they do on the regeneration.

**Conclusion**

The current wildlife inhabiting our stand include white-tail deer, coyote, red-backed salamander, red squirrel, and a variety of small songbirds. These wildlife species are very common to the Upper Peninsula of Michigan. Society now is placing greater value on wildlife.
species, thus encouraging more diversity in wildlife species. Our tract has potential for many different types of wildlife if managed properly. The current stand conditions have relatively few wildlife species due to the lack of management in the previous years. The stand has a dominant canopy without much of a subcanopy or a suppressed canopy. Without the lower canopies smaller wildlife species will not inhabit the area due to lack of food and shelter. When managed appropriately, our stand has the potential to increase the population of the current species and encourage new wildlife species to migrate into the area. Wildlife species may migrate if there is an increase in the availability of food and habitat structure.
This tract is divided into five separate management units, as seen in the map Management 1. These units will be treated at the same time due to the limited amount of acreage owned by Michigan Technological University.

Management Boundaries

N 1/2, SE 1/4 & SW 1/4, SE 1/4. Section 9, T50N R35W

Management Plans, In Brief

**Unit 1a, Northern Hardwoods**

Management Objective

This unit will be managed for aspen with two cutting cycles consisting of 60 years each to become an even aged system.

To promote research and the educational goals of the School of Forest Resources and Environmental Sciences.

Provide revenue to maintain research and educational goals.

Attain certification under the Sustainable Forestry Initiative (SFI), of the American Forest Products and Paper Association (AF&PA).

To provide demonstrations of forest and wildland management that facilitates public education and understanding.

To abide by all laws and regulations.
Management Timeline
The entry rotation for this unit, based on the time between harvesting entries in the other units, will be 60 years. Basal area will be reduced to a level that will promote good growth while still protecting from wind-throw.

Considerations
Care must be taken in this stand to avoid damage to the soil condition, and accidental raising of the water table due to removal of too much timber. Winter harvests are recommended for this unit. The Northern hardwoods left could look out of place being on two acres in size. If aspen does not take in the buffer zone, white spruce should be planted.

**Unit 1b, Northern Hardwoods**
**Management Objective**
This unit will be managed for low to medium quality sawtimber in an un-even aged system typical of surrounding northern hardwoods stands.

**Management Timeline**
Entry intervals for this stand will be 60 years as well, to allow sufficient time for the stand to reach a higher basal area and produce good timber as well as regeneration for subsequent stands.

**Considerations**
Again in this unit, the water table is of some concern. Top die-back is very common in sugar maple that grow in wet soils. In order to promote better quality wood, the soils must be maintained in their current condition or better. Cutting cycles may be too long to promote good growth in this stand.

**Unit 2, Aspen**
**Management Objective**
This unit will be managed for the continued production of Aspen in an even aged system.

**Management Timeline**
This unit will be entered on a rotation of sixty years, based on the site index guide for this site. This site should be expected to only mature to the bolt size class before starting to decline and so should be harvested at that time (Approximately 60 years). No thinnings or other entries besides final harvest should need to be made within this stand. Only winter entries should be made in this unit because of soil conditions.

**Considerations**
Interest and diversity will be maintained by reserving the conifer component of this unit. Soil damage is a major concern on this stand because of the characteristics of the soil series.

**Wildlife Benefits**
Game birds rabbits and deer along any of their predators are expected to benefit from this management.

**Unit 3, Lowland Hardwoods conversion**
**Management Objective**
This unit will be converted for the production of Aspen in an even aged system.

**Management Timeline**
This unit will be entered on a rotation of fifty five to sixty years, based on the site index guide for this site. This site should be expected to only mature to the bolt size class before starting to decline and so should be harvested at that time (Approximately 60 years). No thinnings or other entries besides final harvest should need to be made within this stand. Only winter entries should be made in this unit due to soil conditions. Herbicide applications may be necessary to remove the sedges from this unit if regeneration of aspen is being retarded.
Considerations
Interest and diversity hall be maintained by reserving the conifer component of this unit. The black ash component will be reserved for observation. Soils should be a major concern to any harvesting operation.

Wildlife Benefits
Game birds rabbits and deer along any of their predators are expected to benefit from this management.

Unit 4, Hemlock
Management Objective
This Unit will be managed for research and Wildlife only. Student work will be utilized to create the research plots.

Management Timeline
This unit will be entered as dictated by the research occurring there; if possible this should be timed with entry into the other management units. Otherwise, research activities should take place during seasons when disturbance to the soils will be the least.

Considerations
Some of the gaps created in this unit will be fenced to keep deer from feeding on the hemlock regeneration. These fences must be maintained in order for the research to be successful.

Wildlife Benefits
This Unit is a deer yarding area so deer should benefit from its preservation.

Conclusion
When managing different forest types there are many variables to consider in making long-term forest management goals. Considerations such as wildlife, sociological ideas, short-term goals, overall forest landscape, public insight, and the next future were all thought about while making our forest management prescriptions. The prescriptions listed below will give a complete understanding for what should be done to each forest type. It will have, stand objectives, current conditions of the stands, sivlicultural recomdations, growth and yields of the stands, wildlife aspect, concerns, aesthetic and resource protection, and harvest information. This information will allow current and future land managers to make informed decisions regarding this land.
FOREST MANAGEMENT PRESCRIPTION
Management Unit 1a

Existing Conditions: Poor quality, moderately stock Northern Hardwoods
Ownership: Michigan Technological University
Acres: Approx 4.7 acres
Forest Type and Major Tree Species: Northern Hardwoods, Sugar maple, Red maple and Basswood
Stand Identification: Approximately, NE ¼ of NE ¼ of NE ¼, of SE ¼ Section 9, T50N R35W, Houghton County, MI

Size Class: Poletimber
Stand Density: Medium
Site Quality: Wet
Basal Area: 111.6 sq ft
Total Volume: 27 cds/acre, 429.16 bf/acre, 222.27 TPA
Stand Age: Uneven
Site Index: 45

PLANNED MANAGEMENT ACTIVITIES (PRESCRIPTIONS)

Stand Objectives
1) To regenerate aspen on this stand to better or equal stocking as stand 2 within 60 years.
2) Provide a demonstration area to convert un-even aged land management to even aged management.
3) To provide a sustainable timber resource.

Timber Management
Current Stand Conditions
Unit 1a at this time is primarily sugar maple and red maple, with a component of: eastern hemlock, northern white cedar, yellow birch, basswood, and ironwood with a site index of forty-five. A site index of forty-five which is very low index for a given species. Advanced regeneration includes: American elm, red maple, sugar maple, balsam fir which indicates potential for regeneration. The surrounding area serves as a yard for wintering deer, and they feed on any new growth within the browse line.

Silvicultural Recommendations
The Silvicultural objective in this unit is to slowly convert the stand to aspen over time by putting a one hundred fifty buffer on the southern edge of this stand consisting of 2 acres see figure 1. By doing this in time should convert the stand to be a more productive site. Inside this buffer will be clear-cut to promote aspen to take over this stand type within sixty years by root suckering or graphing. In addition to aspen growing in this clear-cut area, recruitment of any white pine, balsam fir, and white spruce would help in species diversity. The mature trees in this stand are harvested to allow areas for regeneration to take place. Five years after the harvest the school forester should check for regeneration of the aspen as well as all conifer species on this sight. A sixty-year cutting cycle was chosen for this stand strictly because the stand will be harvested every time the aspen management unit gets harvested. Our residual BA of 80 sq ft/acre was chosen to get a removal volume that was feasible.

Figure 1, Buffer Map

Unit 1a with Buffer

N 1/2, SE 1/4 & SW 1/4, SE 1/4. Section 9, T50N R35W
Consideration of advanced conifer regeneration will be met with a winter harvest. Harvesting when the snow cover is deep enough to protect the advanced regeneration from direct impact shall help limit residual damage. Leaving these species will increase the diversity of the stand and also aid in the aesthetics after harvesting.

Concerns
There are several factors that raise concern in unit 1a.
- A residual of 80 sq ft per-acre could possibly reduce maximum growth since there is a sixty-year cutting cycle.
- Poor sites for northern hardwood are usually more susceptible to insect and disease damage.
- After harvest, the poorly drained soil makes the residual stand more susceptible to wind throw.
- Pines cannot be easily managed with the more tolerant Northern hardwoods.
- Possibility of not regenerating aspen in the clear-cut area would be an eye soar being adjacent to the Prickett Dam Road.
- After harvesting the remaining northern hardwood stand could look out of place being such a small sliver left.
- Deer browse could effect the regeneration of some species such as sugar maple and aspen.
- Wounds greater than 50 square inches and more than 10 years old will cause significant damage. (Managers guide for northern hardwoods)
- If the buffer cut does not convert the site to be aspen dominate plant spruce and not tamarack or eastern larch due to markets in the future.

Financial section
Inside the buffer area consists of 2 acres of 4.7 using the liquidation value of 624.46 from the vegetation section Table V-3 the present value of the two acres would be $1248.92 for the two acres. The breakdown between pulpwood and saw timber goes as follows $996.10 for pulpwood and 252.84 for saw timber. The remaining 2.7 acres of northern hardwood values are calculated by taking the present basal area (114) subtracting it from what we want it to be, which is eighty and dividing them by present basal area. (114-80/114)=.30 After you get the percentage of the basal area your taking out multiple that number by the liquidation value from Table V-3 in the vegetation section. (.30x624.46)= $187.20 in value per acre. The numbers talked about here are valid numbers at current stumpage prices, they are subject to change with time or markets.

Wildlife Aspect
All species of wildlife mentioned in the wildlife section of this report should be kept in mind. Silvicultural practices try to mimic natural disasters, along with creating new habitat for all different kinds of wildlife species. In unit 1a being such a small area will have very little effect on the overall landscape for large roaming animals, but will effect small animals and birds such as voles, mice, shrews, chickadees, and other small birds by providing habitat for them to live on or around. Due to the south half of unit 1a being clear-cut, a small open area will provide feeding habitat for predators such as eagles, hawks, and owls. The predators can take an aerial advantage by using the residual trees in the northern half of unit 1a. Due to the potential growth of new aspen in the clear-cut area species such as rabbits, woodcock, and ruffed grouse should increase in numbers. An increase in prey species will also increase the abundance of predators such as fox, coyote, and bobcat. A further detailed assessment of wildlife concerns can be found in the wildlife section of this report.

Aesthetic and Resource Protection
1) Extreme care should be taken during felling and skidding to maintain the condition of the soil and drainage pathways throughout the unit. This is especially important during the initial creation of the group-selection openings, as any disturbance of drainage in the heavy soil may cause severe blockage and water build-up.
2) The removal of the over story may increase the level of the water table limiting future growth.
3) All tops and limbs should be left on the site as coarse woody debris to replenish soil nutrients, as well as to act as nurse logs for regeneration.
4) Harvest and other management activities should take place only during the winter.
5) Any poor quality trees that are cut, but not removed from the stand should be left near the stump as coarse woody debris.
6) All tops and logging residuals should be removed from on and within 30 feet of all logging roads and lopped within 5 feet of the ground.
7) All roads used for logging and removal should be returned to their pre-harvest state or better following harvest activities. All Best Management Practices (BMP’s) regarding wetland buffers must be followed.

8) Whenever possible, unless there is a question of safety, snags should be left standing for utilization by wildlife.

9) All conifers except balsam within the unit should be preserved as a seed source for the surrounding units as well as the research unit.

10) In the logging contract, require good utilization of hardwood pulp (down to 4 inch top or less) thus reducing visual impacts and obtaining greater volumes of cordwood.

Harvest Information
Recommended Treatment
All merchantable trees within the buffer zone will be cut, along with ones of poor quality. Sugar maple borer, cankers, burls, seams, excessive rot, holes, and old logging damage such be considered first when marking the stand. Basal area should not get below 80 sq. ft/acre in the non buffer zone. Any lower than this and the trees would be susceptible to wind throw. A light selection thinning of scattered poor quality stems in the residual should be removed.

Treatment Year: 2003  Access: Prickett Dam Road
Harvesting Cutting Cycle: 60 years
Recommended Operating Season: Winter
FOREST MANAGEMENT PRESCRIPTION
Management Unit 1b

Existing Conditions: Poor quality, moderately stock Northern Hardwoods
Ownership: Michigan Technological University
Acres: Approx. 7
Forest Type and Major Tree Species: Northern Hardwoods, Sugar maple and Red maple
Stand Identification: Approximately, SE ¼ of SE ¼ of SW ¼, of SE ¼ Section 9, T50N R35W, Houghton County, MI

<table>
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<td>Stand Age:</td>
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Future Conditions: High quality, well stock Northern Hardwoods

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<tr>
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<th>Poletimber &amp; Sawtimber</th>
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</thead>
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PLANNED MANAGEMENT ACTIVITIES (PRESCRIPTIONS)

Stand Objectives
1) To regenerate northern hardwood on this stand to better or equal stocking within 60 years.
2) Provide a demonstration area of un-even aged land management.
3) To provide a sustainable timber resource.

Timber Management

Current Stand Conditions
Unit 1b at this time is primarily red maple eastern hemlock, with a component of: sugar maple, northern white cedar, yellow birch, basswood, and ironwood. Advanced regeneration includes: red maple, sugar maple, and balsam fir, which indicate potential for regeneration. The surrounding area serves as a yard for wintering deer, and they feed on any new growth within the browse line.

The stand comprises mostly of poletimber class timber stocked at a medium density. Stand 1b is mostly pulpwood, 30.4 cords per acre with a small component of sawtimber 46.67 board feet per acre. There is no evidence that the stand has been harvested within at least the last 40 years. The stand quality is very poor when compared to most northern hardwood sites, which carry approximately 3 to 5 thousand board feet per acre. Also, the stand has diameter distribution that is skewed left. Most of the trees in the distribution are smaller trees and this also accounts for the small amount of sawtimber per acre.

Silvicultural Recommendations

The Silvicultural objective in this unit is to manage this stand on a long-term hardwood sawtimber production. This type of harvesting leaves a high degree of vertical structural diversity. The mature trees in this stand are harvested to allow areas for regeneration to take place. A sixty-year cutting cycle was chosen for this stand strictly because the stand will be harvested every time the aspen management unit receives treatment. Our residual BA of 60 sq. ft/acre was chosen to get a removal volume that was feasible. A 14-inch diameter limit was also chosen since there is a sixty-year cutting cycle. When dealing with the 60 year cutting cycle only “crop trees” will chosen to be released. “Crop trees” are trees that are of very good quality now, but there are generally smaller in diameter usually 6-12 inches dbh. In sixty years these “crop trees” should be very high quality sawlogs.

Consideration of advanced conifer regeneration will be met with a winter harvest. Harvesting when the snow cover is deep enough to protect the advanced regeneration from direct impact shall help limit residual damage. Leaving these species will increase the diversity of the stand and also aid in the aesthetics after harvesting.
Concerns

There are several factors that raise concern in unit 1b.

- A residual of 60 sq ft per-acre could possibly reduce maximum growth since there is a sixty-year cutting cycle.
- Poor sites for northern hardwood are usually more susceptible to insect and disease damage.
- After harvest, the dry soil makes the residual stand more susceptible to wind throw.
- Pines cannot be easily managed with the more tolerant Northern hardwoods.
- Deer browse could effect the regeneration of some species such as Sugar maple.
- Wounds greater than 50 square inches and more than 10 years old will cause significant damage.
  (Managers guide for northern hardwoods)

Growth and Yield

Growth and Yield was determined using the Adams and Ek model for northern hardwood. The model was used to determine the sawtimber volumes for the sixty-year cutting cycle. The model predicts a well-stocked stand in sixty years. This should be true to a point, but the sawtimber volume of 14,489 bf/acre seems a little too high. It predicts the basal area to a reasonable 150 sq ft and 192 tpa. The model must predict all the trees to in the smaller diameters to grow into sawtimber class trees. This does not happen due to circumstances in nature: some trees are infected by insects and diseases and others are poor quality, just to name a few things that can happen to a trees in their lifetime. A more reasonable number for the sawtimber volume per acre in sixty years would be 4 to 6 mbf.

Financial Criteria

The stand harvest values are calculated by taking the present basal area (112 sq ft), subtracting it from the basal area we want to achieve (60 sq ft), and dividing by the present basal area, (112 sq ft). (112-60/112)= .46. This number then is multiply that number by the liquidation value from Table V-3, Unit 1b in the vegetation section. (.46x$544.09)= $250.28 in a per acre value.

Aesthetic and Resource Protection

1) Extreme care should be taken during felling and skidding to maintain the condition of the soil and drainage pathways throughout the unit. This is especially important during the initial creation of the group-selection openings, as any disturbance of drainage in the heavy soil may cause severe blockage and water build-up.
2) The removal of the over story may increase the level of the water table limiting future growth.
3) All tops and limbs should be left on the site as coarse woody debris to replenish soil nutrients, as well as to act as nurse logs for regeneration.
4) Harvest and other management activities should take place only during the winter.
5) Any poor quality trees that are cut, but not removed from the stand should be left near the stump as coarse woody debris.
6) All tops and logging residuals should be removed from on and within 30 feet of all logging roads and lopped within 5 feet of the ground.
7) All roads used for logging and removal should be returned to their pre-harvest state or better following harvest activities. All Best Management Practices (BMP’s) regarding wetland buffers must be followed.
8) Whenever possible, unless there is a question of safety, snags should be left standing for utilization by wildlife.
9) All conifers within the unit should be preserved as a seed source for the surrounding units as well as the research unit.
10) In the logging contract, require good utilization of hardwood pulp (down to 4 inch top or less) thus reducing visual impacts and obtaining greater volumes of cordwood.
Harvest Information
Recommended Treatment

The trees to be harvested are to be the ones of poor quality. Sugar maple borer, cankers, burls, seams, excessive rot, holes, and old logging damage such be considered first when marking the stand. Basal area should not get below 60 sq. ft/acre. Any lower than this and the trees would be susceptible to wind throw. A light selection thinning of scattered poor quality stems in the residual should be removed.

Treatment Year: 2003       Access: Prickett Dam Road
Harvesting Cutting Cycle: 60 years
Recommended Operating Season: Winter
FOREST MANAGEMENT PRESCRIPTION
Management Unit 2

Existing Conditions: Aspen Stand with Mixed Hardwoods  Acres: 25.5
Ownership: Michigan Technological University
Forest Type and Major Tree Species: Even-Age Aspen
Stand Identification: Unit 2, N ½ & SW ¼ of SE ¼, Section 9, T50N R35W, Houghton County, MI

Size Class: Poletimber & Bolts  Stand Density: Normal
Site Quality: Normal  Basal Area: 98.6 sq ft
Total Volume: 30.5 cds/acre, 148.23 bf/acre 191 Tpa  Stand Age: Even
Site Index: 60-65 at 50 years (Perala p. 13)

PLANNED MANAGEMENT ACTIVITIES (PRESCRIPTIONS)

Stand Objectives
1) To regenerate aspen on this stand to better or equal stocking within 60 years.
2) Provide a demonstration area of clearcut aspen management.
3) To provide a sustainable timber resources in an even age state.
4) Maintain forest health.

Timber Management
Current Stand Conditions
Unit 2 at this time is primarily aspen, mixed with maple spp, hemlock, northern white cedar, and ash. A small percentage of the timber also includes a few super-canopy white pine. Aspen suckers are present in the stand indicating a good regeneration potential. The surrounding area serves as a yard for wintering deer, and they feed on any new growth within reach.

The aspen currently appears healthy, the balsam fir on the site has indications of bark beetle activity. The sugar maple that is scattered is off site and has excessive dieback. This further justifies keeping aspen the dominate tree species.

The soil series that is present is 73B Forberg-Rudyard Silt Loam, which has a severe wind throw hazard and moderate to severe equipment limitations. This indicates that any residual will likely blow down. The equipment limitations support a winter harvest, which will also be best for the effective regeneration of the stand. This is because the maximum nutrient content will be in the roots during the winter and the clone will have a large amount of carbohydrates to use for growth of suckers.

Silvicultural Recommendation
Clearcut all trees over two inches that are not of the following species: hemlock, cedar, white spruce, and eastern white pine. Consideration of advanced conifer regeneration will be met with a winter harvest. The conifer regeneration is below two feet, which is below the snow line so will not be of concern. Leaving these species will increase the diversity of the stand and also aid in the aesthetics after harvesting. The residual stand will have approximately 17.8 BA and 24 trees per acre following treatment.

There will be a 150-foot buffer on the eastern aspen stand on its north side. This will be done to slowly convert Unit 1a to high quality aspen. This will be done every entry till Unit 1a is converted. There are several different age classes of aspen in the a joining area, so the harvest will fit well into the landscape.

Growth and Yield
Currently the stocking at 60 years is heavy to bolts, the Aspen Managers Guide suggests that aspen be managed at an age of 60 years for the production of bolt quality trees. The decision is to manage for bolt quality, since it has been shown that it is possible to achieve such growth on the site (Perala p. 21).

The Aspen Managers Guide indicates that with a basal area of 100 sq ft and a height of 70 feet the yield will be 29 cunits per acre (Perala p. 23). This is believed to be a typo (maybe should be cords not cunits) because this number is at year 50, and we currently have a volume of 30.5 cords an acre total. Since the rotation will be the same, 60 years. If managed as an aspen cover type, with clearcut rotations and no thinnings, the expected net present value of the stand is $886.45 per acre at a four percent interest rate. A total liquidation value for the aspen stands is approximately $20,642.30.
Concerns

There are several factors that can impact aspen growth.

- Residual basal area of 10 to 15 sq ft per-acre can reduce aspen growth 35 to 40 percent (Perala p. 3).
- Pines cannot be easily managed with aspen (Perala p. 6).
- Dense stands are initially more pest resistant but the diameter growth is slower (Perala p. 6).
- Soil compaction from machinery can reduce aspen growth 5 to 10 percent by reducing aeration (Perala p. 9).
- Fiber production can be increased in stands that incorporate spruce and balsam fir (Perala p. 5).
- Tree length harvesting scarifies and reduces competing vegetation (Perala p. 4).

Future

The anticipation is this stand will fully restock with aspen trees within a period of four years. If this does not occur then it will need to be reforested. A species that has been suggested for this is tamarack because it would do well in the wet soils and would add diversity to the landscape. Of course the hope is that this will not need to be done because the property is currently fully stocked with aspen.

Aesthetic and Resource Protection

1) This stand borders a county road so care should be taken to maintain a clean appearance of the job. Tops should be lopped so they are at an even height and all stumps should be returned to an upright position to aid aesthetics.
2) Care should be taken during skidding to maintain the condition of the soil and drainage pathways throughout the unit. This is especially important because the disturbance of drainage in the heavy soil may cause sever blockage and water build-up.
3) The balsam fir in the stand will be removed because it is exhibiting infestation by bark beetles and is a health hazard to the surrounding balsam fir.
4) All tops and limbs should be left on the site as coarse woody debris to replenish soil nutrients.
5) Harvest should only be done in the winter to protect the soil.
6) Any poor quality trees that are cut, but not removed from the stand should be left near the stump as coarse woody debris.
7) All tops and logging residuals should be removed from on and within 30 feet of all logging roads.
8) All roads used for logging and removal should be returned to their pre-harvest state or better following harvest activities. All Best Management Practices (BMP’s) regarding wetland buffers must be followed.
9) Roads to be used for research purposes should be maintained at a level guaranteeing they shall be passable during fair weather seasons. This will enable research teams access to the sites without causing severe rutting and drainage impedance.
10) Whenever possible, unless there is a question of safety, snags should be left standing for utilization by wildlife.
11) All living white pine within the unit should be preserved as a seed source.

Harvest Information

Recommended Treatment

All trees above two inches diameter should be harvested unless they are of the following species: eastern hemlock, spruce, white pine, and northern white cedar. This will be done to regenerate the stand to a full stocking of aspen. The reason for leaving the variety of tree species is to provide diversity across the stand, which benefits wildlife. Some species such as ruffed grouse and white tailed deer will benefit from additional cover and forage habitat.

Treatment Year: 2003 Access: Prickett Dam Road
Harvesting Cutting Cycle: 60 years
Recommended Operating Season: Winter
FOREST MANAGEMENT PRESCRIPTION
Management Unit 3

Existing Conditions: Lowland Hardwoods with Aspen Mix
Ownership: Michigan Technological University

Forest Type and Major Tree Species: Lowland Hardwoods, Aspen & Black Ash
Stand Identification: Unit 3, N ½ & SW ¼ of SE ¼, Section 9, T50N R35W, Houghton County, MI (see map)

Size Class: Poletimber & Sawtimber
Site Quality: Wet
Total Volume: 25.4 cds/acre, 203.5 bf/acre 177 Tpa

Acres: 35
Basal Area: 102.94 sq ft
Site Index: 55ft at 50 years (based on Aspen)

Stand Density: Medium
Stand Age: Even

PLANNED MANAGEMENT ACTIVITIES (PRESCRIPTIONS)

Prescription Objectives
1) To regenerate healthy aspen on this unit to better stocking with a 60 year rotation.
4) Provide a demonstration area of clearcut land management.
5) To provide a sustainable timber resource in an even aged state.
6) Maintain Forest health.
7) Provide habitat for known wildlife.
8) To provide options to modify species composition should environmental conditions change.

Timber Management

Current Stand Conditions

Unit 3 at this time is primarily aspen and black ash, with a component of: maple spp., balsam fir, hemlock, and northern white cedar. Advanced regeneration includes black ash, aspen suckers, and American elm indicating regeneration potential exists within this unit. The surrounding area serves as a winter deer yard, and the deer feed on any new growth within reach. This yarding area impacts the advanced regeneration of this unit, limiting upgrowth. Currently aspen averages 26.41TPA, 20BA, and 7.55 cords/acre.

Silvicultural Recommendations

The goal of this prescription is to convert the unit to an even-aged aspen unit. This unit is predicted to convert to aspen upon clearcutting, currently there are an average of 26.41TPA of aspen in this unit, which equals a tree every 40.6 feet. Since it is generally thought that the roots of a tree expand to distance that is equal to the height of the tree (currently over 60 ft.), sufficient root spread exists for new clones to arise from and dominate this unit. To achieve this the following recommendations shall be followed.

Clearcut trees over two inches with the following exceptions:
- All trees of the following species: hemlock, cedar, white spruce, and eastern white pine will be retained.
- Trees eight inches and under that are of the following species: black ash and American elm which are healthy and don’t exhibit any signs of top dieback will be retained.

Consideration of advanced conifer regeneration will be met with a winter harvest. Harvesting when the snow cover is deep enough to protect the advanced regeneration from direct impact shall help limit residual damage. Leaving these species will increase the diversity of the stand and also aid in the aesthetics of the stand after harvesting. The residual stand after harvesting will have approximately 22.6 sq. ft. BA and 38 trees per acre. Clearcutting the unit will hopefully overwhelm the deer with browse allowing for sufficient upgrowth, slash left in place will also impede deer’s ability to browse new growth.

The young black ash and American elm will be reserved on the site for the possibility that the water table will rise following harvest. If a rise in water table occurs, conditions which favor the black ash instead of aspen will exist and the reserve of healthy black ash will insure that the unit remains forested. If the black ash do not compete well following this initial treatment they should be removed at the next rotation allowing more growing space for aspen. If the black ash develops disease or severe dieback between the first and second rotation they should be felled to improve the growth rate of the aspen. Poor quality black ash that is felled due to disease or dieback, should

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be left in situ for use as CWD for wildlife habitat purposes. The black ash should be surveyed at the same time that the hemlock research plots in Unit four are observed to monitor for deteriorating conditions.

**Growth and Yield**

For optimum production this unit will be managed on a 60 year rotation for bolts as predicted from table five in the *Managers Handbook for Aspen in the North Central States* (Perala p. 21). This is based on the site index of the unit. Predicted yield for this unit will be 22.64 cunits per acre \([4*(BA*Height)/1000]\) based on *Managers Handbook for Aspen in the North Central States* (Perala p. 23), this measurement may actually be in cords not cunits since the conversion factor to cords from cunits (2.605) seems to reduce to yield to unlikely numbers: 8.7 cords per acre.

The black ash should be treated at the same time as the aspen if it proves to be lucrative, the black ash should be managed for quality sawtimber production. If the black ash proves to be more productive than the aspen it should be favored over the aspen and be evaluated for a black ash dominated cover type at the end of the first aspen management rotation. The rotation age for the black ash as well as converting the stand to a black ash cover type will have to be determined at the end of the first rotation, any attempt to set guidelines for the black ash now would be premature and foolhardy.

If managed as an aspen cover type, with clearcut rotations and no thinnings, the expected net present value of the stand is $572.59 with a four percent interest rate if the black ash management proves impractical. The net present value of this stand if managed with a black ash component is immeasurable, the value of the stand will depend on the amount of healthy black ash that can be reserved in the stand and that remains healthy. The value of the stand if managed for black ash sawtimber is assumed to be higher than the value for an aspen cover type.

**Concerns**

The ground water level may be a concern in this unit, since this units soils consists of areas of Gay Muck, Froberg-Ruddy Silt Loam, and Rudyard Silt Loam. All of these series have moderate to severe equipment limitations and severe wind throw risk. The residual stand component may be damaged by wind throw, however the advantage of diversity and aesthetic potential outweighs the risk.

There are several factors that can impact aspen growth:

- A residual of 10 to 15 sq ft per-acre can reduce aspen growth 35-40 percent (Perala p. 3). Therefore retaining black ash, American elm, and conifers may reduce the growth rate of the aspen. Retaining trees in clumps were possible will help to limit this problem
- Tree length harvesting scarifies and reduces competing vegetation (Perala p. 4). While this will increase aspen growth care needs to be taken to avoid damaging the residual conifer component and compacting soils.
- Fiber production can be increased in stands that incorporate spruce and balsam fir (Perala p. 5). Balsam fir and spruce force the aspen to grow faster and straighter boosting fiber production.
- Dense stands are initially more pest resistant but the diameter growth is slower (Perala p. 6).
- Soil compaction from machinery can reduce aspen growth 5-10 percent by reducing aeration (Perala p. 9). The heavy soils of this unit are at a high risk from compaction, winter harvesting may help alleviate this problem but care should be exercised.

**Wildlife Management**

Certain species of wildlife are expected to benefit from the Silvicultural management that will occur in this unit. The harvest itself will bring tree buds into the reach of deer during the winter, a period when food supplies are scarce. The slash from the harvest will provide cover for small mammals and amphibians. The young aspen will provide cover for deer, bear, grouse, rabbits, and other animals. The nearby hemlock stand will provide habitat for birds of prey and predatory mammals such as fisher, this animals will hunt in and along the edges of the aspen stand.

**Aesthetic and Resource Protection**

1) Extreme care should be taken during felling and skidding to maintain the condition of the soil and drainage pathways throughout the unit as any disturbance of drainage in the heavy soil may cause sever blockage and water build-up.
2) The removal of the over story may increase the level of the water table limiting future growth.
3) All tops and limbs should be left on the site as coarse woody debris to replenish soil nutrients.
4) Harvest and other management activities should take place only during the winter.
5) Any poor quality trees that are cut, but not removed from the stand should be left near the stump as coarse woody debris.
6) All tops and logging residuals should be removed from on and within 30 feet of all logging roads.
7) All roads used for logging and removal should be returned to their pre-harvest state or better following harvest activities. All Best Management Practices (BMP’s) regarding wetland buffers must be followed.
8) Roads to be used for research purposes should be maintained at a level guaranteeing they shall be passable during fair weather seasons. This will enable research teams access to the sites without causing severe rutting and drainage impedance.
9) Whenever possible, unless there is a question of safety, snags should be left standing for utilization by wildlife.
10) All conifers within the unit should be preserved as a seed source for the surrounding units as well as the research unit.

Treatment Year: 2003 Access: Prickett Dam Road
Harvesting Cutting Cycle: 60 years
Recommended Operating Season: Winter
FOREST MANAGEMENT PRESCRIPTION
Management Unit 4

Existing Conditions
Ownership: Michigan Technological University
Acres: 53.3

Forest Type and Major Tree Species: H8/M5 Eastern Hemlock; Soft Maple, Northern white Cedar, Yellow Birch

Stand Identification: Unit 4, N ½ & SW ¼ of SE ¼, Section 9, T50N R35W, Houghton County, MI. For Unit definition and location, please see Map V-1, page V-2 in the Vegetation Section.

- Size Class: Poletimber & Sawtimber
- Stand Density: High
- Site Quality: Poor to Medium
- Basal Area: 164.6
- Total Volume: 45.5 cfs/acre, 1118.9 bf/acre
- Stand Age: Uneven – unknown # of classes

PLANNED MANAGEMENT ACTIVITIES (PRESCRIPTIONS)

Stand Objectives
1) To develop Silvicultural prescriptions aimed at maintaining and restoring viable populations of eastern hemlock on the regional landscape.
2) To improve our understanding of canopy gap dynamics and the utility of group selection for maintaining species diversity under the selection system.

Timber Management
Current Stand Conditions
Unit 4 at this time is primarily heavily stocked Eastern hemlock, mixed with soft maple, northern white cedar and yellow birch. A small percentage of the timber also includes hard maple, aspen and white birch, as well as a few super-canopy white pine (see Vegetation section, Unit 4, beginning page V-21). Currently, signs of regeneration are scarce in the unit, as the area serves as a yard for wintering deer, and they feed on any new growth within reach. Much of the cedar within the unit was removed during harvests at the beginning of the 1900’s (please see Heritage section). Eastern hemlock has become relatively rare in the landscape, due to slow growth and heavy browsing on regeneration. This expansive area of hemlock provides excellent an opportunity for research on regeneration techniques.

Silvicultural Recommendations
Proposed Study Design
1) Create 18 small group-selection openings in hemlock stands on Michigan Technological University lands. Six replicates of three opening sizes will be created (100-200, 201-300, 301-400 m²). Half of the openings in each size class will be fenced off to exclude deer.
2) Within each opening, a grid of 2x2 m sample plots (with a 1 m buffer between plots) shall be established. Three replicates of six treatments shall be randomly assigned to the grid cells in each opening. The treatments will include site preparation methods aimed at promoting hemlock establishment as well as control of competing vegetation.
   a) Mechanical scarification: 50% mixing of organic material and mineral soil with the aid of a rototiller.
   b) Prescribed fire: low intensity burn administered in the fall to set back hardwood regeneration and expose mineral soil for seedling establishment.
   c) Herbicide: spot treatment of hardwood regeneration and herbaceous vegetation with Accord®. Accord® is registered for application in wetland areas by the EPA.
   d) Plant 1: plant hemlock without herbicide control of competing vegetation.
   e) Plant 2: plant hemlock and control competing vegetation with herbicide.
   f) Control: no site preparation or planting.
   g) In larger openings, (d) and (e) will be repeated with white pine.
3) Within each cell, a number of measurements shall be made throughout the course of the growing season:
   a) Monitor seed input with mast traps set up in the rows between sample plots.
   b) Monitor soil moisture, temperature, base saturation and bulk density.
   c) Census regeneration and herbaceous plants.
   d) Monitor height growth and development of regeneration.
   e) Monitor browsing by deer and hare.
4) Trees bordering each opening will also be monitored to assess their response to the creation of the opening.
   a) Monitor crown expansion in to the opening by trees bordering the gaps.
5) Monitor basal area growth response of trees bordering the opening.

Aesthetic and Resource Protection
a. Extreme care should be taken during felling and skidding to maintain the condition of the soil and drainage pathways throughout the unit. This is especially important during the initial creation of the group-selection openings, as any disturbance of drainage in the heavy soil may cause severe blockage and water build-up.
b. All tops and limbs should be lopped within 2 to 3 feet of the ground and left on the site as coarse woody debris to replenish soil nutrients, as well as to act as nurse logs for regeneration.
c. Harvest and other management activities should take place only during the winter. For research purposes, the unit may be entered during summer and fall, in order to perform necessary scarification, raise fencing, and establish experiments during fair weather.
d. Any poor quality trees that are cut, but not removed from the stand should be left near the stump as coarse woody debris.
e. All tops and logging residuals should be removed from on and within 30 feet of all logging roads.
f. All roads used for logging and removal should be returned to their pre-harvest state or better following harvest activities. All Best Management Practices (BMP’s) must be followed.
g. Roads to be used for research purposes should be maintained at a level guaranteeing they shall be passable during fair weather seasons. This will enable research teams access to the sites without causing severe rutting and drainage impedance when they enter the stand to monitor conditions.
h. Buffers must be maintained between research plots to reduce the chance of blowdown and creation of edge-effect within the study plots.
i. Whenever possible, unless there is a question of safety, snags should be left standing for utilization by wildlife.
j. All living white pine within the unit should be preserved as a seed source for the surrounding units as well as the research unit.

Research Execution

The first step in initiating the research in Unit 4 must be the determination of gap centers. These will be chosen based on not only their proximity to the edge of the hemlock stand, but also on relative proximity to one another, and the make-up of timber within the gap area. Desirable gap locations will have the low quality hardwoods as well as some hemlock and cedar removed as required to create the necessary cleared radius. A hard line in the canopy around the gap is preferred, but need not be perfectly circular. Some potential gap locations have been marked with flagging, as well as with a GPS. These gaps, 1-3, are labeled in Figure 1. Due to the topography and hydrology of the tract, the best season during which to determine the gap locations will be during late spring or summer, after spring thaw. This is necessary in order to ensure that the locations chosen for gaps are not emergent wetlands, or low spots that gather large amounts of water that will impede the regeneration of hemlock. Because of this, the task must be carried out on foot to avoid damaging the soil structure and drainage pathways.

The second step will be the removal of all trees within the gaps that need to be cut. Care should be taken to not damage the trees to be left around the gap, as these will serve not only as seed trees, but also to shelter the gaps. It is especially important to remove the hardwoods within the gaps, as the progeny of these trees will easily out-compete the hemlock regeneration for nutrients and access to sunlight and water. Additional poor quality hardwoods will be removed from the unit to supplement some of the research cost. Scarification of the soil will also take place at this time, to prepare the seed bed appropriately for hemlock seedlings.

Third will be the construction of exclosures around half of the gaps. Some of the timber cut in order to create the gaps may be usable in this step. A Wood Miser and competent operator can cut all the necessary wood for the fencing with little waste for a very low cost. Additional materials needed will include 5’ concrete stabilizer mesh for the fencing, materials for 18 gates, nails and staples, and support hardware to keep the fences upright under harsh weather conditions. An estimated 1300 hours of labor will be required to build the exclosures, based on a time of 3 days for each fence, and a crew of 3 students or prison laborers. It is likely that once the first fences are constructed, the time it takes to erect each subsequent one will decrease.

Finally, the gaps will be monitored semi-annually by students to record the success of regeneration in both the control gaps and the exclosures.
Figure 1: Proposed gap locations for research in Unit 4 of the Prickett Dam tract.
Introduction to Management Decisions
This tract is divided into five separate management units, as seen in the map Management 1. These units will be treated at the same time due to the limited amount of acreage owned by Michigan Technological University.

Management Boundaries

N 1/2, SE 1/4 & SW 1/4, SE 1/4. Section 9. T50N R35W

Management Plans, In Brief

**Unit 1a, Northern Hardwoods**

Management Objective

This unit will be managed for aspen with two cutting cycles consisting of 60 years each to become an even aged system.
Management Timeline
The entry rotation for this unit, based on the time between harvesting entries in the other units, will be 60 years. Basal area will be reduced to a level that will promote good growth while still protecting from wind-throw.

Considerations
Care must be taken in this stand to avoid damage to the soil condition, and accidental raising of the water table due to removal of too much timber. Winter harvests are recommended for this unit. The Northern hardwoods left could look out of place being on two acres in size. If aspen does not take in the buffer zone, white spruce should be planted.

**Unit 1b, Northern Hardwoods**
**Management Objective**
This unit will be managed for low to medium quality sawtimber in an un-even aged system typical of surrounding northern hardwoods stands.

**Management Timeline**
Entry intervals for this stand will be 60 years as well, to allow sufficient time for the stand to reach a higher basal area and produce good timber as well as regeneration for subsequent stands.

**Considerations**
Again in this unit, the water table is of some concern. Top die-back is very common in sugar maple that grow in wet soils. In order to promote better quality wood, the soils must be maintained in their current condition or better. Cutting cycles may be to long to promote good growth in this stand.

**Unit 2, Aspen**
**Management Objective**
This unit will be managed for the continued production of Aspen in an even aged system.

**Management Timeline**
This unit will be entered on a rotation of sixty years, based on the site index guide for this site. This site should be expected to only mature to the bolt size class before starting to decline and so should be harvested at that time (Approximately 60 years). No thinnings or other entries besides final harvest should need to be made within this stand. Only winter entries should be made in this unit because of soil conditions.

**Considerations**
Interest and diversity will be maintained by reserving the conifer component of this unit. Soil damage is a major concern on this stand because of the characteristics of the soil series.

**Wildlife Benefits**
Game birds rabbits and deer along any of their predators are expected to benefit from this management.

**Unit 3, Lowland Hardwoods conversion**
**Management Objective**
This unit will be converted for the production of Aspen in an even aged system.

**Management Timeline**
This unit will be entered on a rotation of fifty five to sixty years, based on the site index guide for this site. This site should be expected to only mature to the bolt size class before starting to decline and so should be harvested at that time (Approximately 60 years). No thinnings or other entries besides final harvest should need to be made within this stand. Only winter entries should be made in this unit due to soil conditions. Herbicide applications may be necessary to remove the sedges from this unit if regeneration of aspen is being retarded.
Considerations
Interest and diversity hall be maintained by reserving the conifer component of this unit. The black ash component will be reserved for observation. Soils should be a major concern to any harvesting operation.

Wildlife Benefits
Game birds rabbits and deer along any of their predators are expected to benefit from this management.

Unit 4, Hemlock
Management Objective
This Unit will be managed for research and Wildlife only. Student work will be utilized to create the research plots.

Management Timeline
This unit will be entered as dictated by the research occurring there; if possible this should be timed with entry into the other management units. Otherwise, research activities should take place during seasons when disturbance to the soils will be the least.

Considerations
Some of the gaps created in this unit will be fenced to keep deer from feeding on the hemlock regeneration. These fences must be maintained in order for the research to be successful.

Wildlife Benefits
This Unit is a deer yarding area so deer should benefit from its preservation.

Conclusion
When managing different forest types there are many variables to consider in making long-term forest management goals. Considerations such as wildlife, sociological ideas, short-term goals, overall forest landscape, public insight, and the next future were all thought about while making our forest management prescriptions. The prescriptions listed below will give a complete understanding for what should be done to each forest type. It will have, stand objectives, current conditions of the stands, silvicultural recomdations, growth and yields of the stands, wildlife aspect, concerns, aesthetic and resource protection, and harvest information. This information will allow current and future land managers to make informed decisions regarding this land.
FOREST MANAGEMENT PRESCRIPTION

Management Unit 1a

Existing Conditions: Poor quality, moderately stock Northern Hardwoods
Ownership: Michigan Technological University
Acres: Approx 4.7 acres
Forest Type and Major Tree Species: Northern Hardwoods, Sugar maple, Red maple and Basswood
Stand Identification: Approximately, NE ¼ of NE ¼ of NE ¼, of SE ¼ Section 9, T50N R35W, Houghton County, MI

Size Class: Poletimber
Site Quality: Wet
Total Volume: 27 cfs/acre, 429.16 cf/acre, 222.27 TPA
Site Index: 45
Stand Density: Medium
Basal Area: 111.6 sq ft
Stand Age: Uneven

PLANNED MANAGEMENT ACTIVITIES (PRESCRIPTIONS)

Stand Objectives
1) To regenerate aspen on this stand to better or equal stocking as stand 2 within 60 years.
2) Provide a demonstration area to convert un-even aged land management to even aged management.
3) To provide a sustainable timber resource.

Timber Management
Current Stand Conditions
Unit 1a at this time is primarily sugar maple and red maple, with a component of: eastern hemlock, northern white cedar, yellow birch, basswood, and ironwood with a site index of forty-five. A site index of forty-five which is very low index for a given species. Advanced regeneration includes: American elm, red maple, sugar maple, balsam fir which indicates potential for regeneration. The surrounding area serves as a yard for wintering deer, and they feed on any new growth within the browse line.

Silvicultural Recommendations
The Silvicultural objective in this unit is to slowly convert the stand to aspen over time by putting a one hundred fifty buffer on the southern edge of this stand consisting of 2 acres see figure 1. By doing this in time should convert the stand to be a more productive site. Inside this buffer will be clear-cut to promote aspen to take over this stand type within sixty years by root suckering or graphing. In addition to aspen growing in this clear-cut area, recruitment of any white pine, balsam fir, and white spruce would help in species diversity. The mature trees in this stand are harvested to allow areas for regeneration to take place. Five years after the harvest the school forester should check for regeneration of the aspen as well as all conifer species on this sight. A sixty-year cutting cycle was chosen for this stand strictly because the stand will be harvested every time the aspen management unit gets harvested. Our residual BA of 80 sq ft/acre was chosen to get a removal volume that was feasible.

Figure 1, Buffer Map

Unit 1a with Buffer

N 1/2, SE 1/4 & SW 1/4, SE 1/4. Section 9, T50N R35W
Consideration of advanced conifer regeneration will be met with a winter harvest. Harvesting when the snow cover is deep enough to protect the advanced regeneration from direct impact shall help limit residual damage. Leaving these species will increase the diversity of the stand and also aid in the aesthetics after harvesting.

**Concerns**

There are several factors that raise concern in unit 1a.

- A residual of 80 sq ft per-acre could possibly reduce maximum growth since there is a sixty-year cutting cycle.
- Poor sites for northern hardwood are usually more susceptible to insect and disease damage.
- After harvest, the poorly drained soil makes the residual stand more susceptible to wind throw.
- Pines cannot be easily managed with the more tolerant Northern hardwoods.
- Possibility of not regenerating aspen in the clear-cut area would be an eye soar being adjacent to the Prickett Dam Road.
- After harvesting the remaining northern hardwood stand could look out of place being such a small sliver left.
- Deer browse could effect the regeneration of some species such as sugar maple and aspen.
- Wounds greater than 50 square inches and more than 10 years old will cause significant damage. (Managers guide for northern hardwoods)
- If the buffer cut does not convert the site to be aspen dominate plant spruce and not tamarack or eastern larch due to markets in the future.

**Financial section**

Inside the buffer area consists of 2 acres of 4.7 using the liquidation value of 624.46 from the vegetation section Table V-3 the present value of the two acres would be $1248.92 for the two acres. The breakdown between pulpwood and saw timber goes as follows $996.10 for pulpwood and 252.84 for saw timber.

The remaining 2.7 acres of northern hardwood values are calculated by taking the present basal area (114) subtracting it form what we want it to be, which is eighty and dividing them by present basal area. (114-80/114)=.30 After you get the percentage of the basal area your taking out multiple that number by the liquidation value from Table V-3 in the vegetation section. (.30x624.46)= $187.20 in value per acre. The numbers talked about here are valid numbers at current stumpage prices, they are subject to change with time or markets.

**Wildlife Aspect**

All species of wildlife mentioned in the wildlife section of this report should be kept in mind. Silvicultural practices try to mimic natural disasters, along with creating new habitat for all different kinds of wildlife species. In unit 1a being such a small area will have very little effect on the overall landscape for large roaming animals, but will effect small animals and birds such as voles, mice, shrews, chickadees, and other small birds by providing habitat for them to live on or around. Due to the south half of unit 1a being clear-cut, a small open area will provide feeding habitat for predators such as eagles, hawks, and owls. The predators can take an aerial advantage by using the residual trees in the northern half of unit 1a. Due to the potential growth of new aspen in the clear-cut area species such as rabbits, woodcock, and ruffed grouse should increase in numbers. An increase in prey species will also increase the abundance of predators such as fox, coyote, and bobcat. A further detailed assessment of wildlife concerns can be found in the wildlife section of this report.

**Aesthetic and Resource Protection**

1) Extreme care should be taken during felling and skidding to maintain the condition of the soil and drainage pathways throughout the unit. This is especially important during the initial creation of the group-selection openings, as any disturbance of drainage in the heavy soil may cause severe blockage and water build-up.
2) The removal of the over story may increase the level of the water table limiting future growth.
3) All tops and limbs should be left on the site as coarse woody debris to replenish soil nutrients, as well as to act as nurse logs for regeneration.
4) Harvest and other management activities should take place only during the winter.
5) Any poor quality trees that are cut, but not removed from the stand should be left near the stump as coarse woody debris.
6) All tops and logging residuals should be removed from on and within 30 feet of all logging roads and lopped within 5 feet of the ground.
7) All roads used for logging and removal should be returned to their pre-harvest state or better following harvest activities. All Best Management Practices (BMP’s) regarding wetland buffers must be followed.

8) Whenever possible, unless there is a question of safety, snags should be left standing for utilization by wildlife.

9) All conifers except balsam within the unit should be preserved as a seed source for the surrounding units as well as the research unit.

10) In the logging contract, require good utilization of hardwood pulp (down to 4 inch top or less) thus reducing visual impacts and obtaining greater volumes of cordwood.

**Harvest Information**

**Recommended Treatment**

All merchantable trees within the buffer zone will be cut, along with ones of poor quality. Sugar maple borer, cankers, burls, seams, excessive rot, holes, and old logging damage such be considered first when marking the stand. Basal area should not get below 80 sq. ft/acre in the non buffer zone. Any lower than this and the trees would be susceptible to wind throw. A light selection thinning of scattered poor quality stems in the residual should be removed.

- **Treatment Year:** 2003
- **Access:** Prickett Dam Road
- **Harvesting Cutting Cycle:** 60 years
- **Recommended Operating Season:** Winter
FOREST MANAGEMENT PRESCRIPTION
Management Unit 1b

Existing Conditions: Poor quality, moderately stock Northern Hardwoods
Ownership: Michigan Technological University
Forest Type and Major Tree Species: Northern Hardwoods, Sugar maple and Red maple
Stand Identification: Approximately, SE ¼ of SE ¼ of SW ¼, of SE ¼ Section 9, T50N R35W, Houghton County, MI

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<th>Stand Density</th>
<th>Site Quality</th>
<th>Basal Area</th>
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<td>Medium</td>
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<td>112.31 sq ft</td>
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<td>Stand Age</td>
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<tr>
<td>Total Volume</td>
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<td>Site Index</td>
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Future Conditions: High quality, well stock Northern Hardwoods

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<th>Basal Area</th>
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<tr>
<td>Poletimber &amp; Sawtimber</td>
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PLANNED MANAGEMENT ACTIVITIES (PRESCRIPTIONS)

Stand Objectives
1) To regenerate northern hardwood on this stand to better or equal stocking within 60 years.
2) Provide a demonstration area of un-even aged land management.
3) To provide a sustainable timber resource.

Timber Management

Current Stand Conditions
Unit 1b at this time is primarily red maple eastern hemlock, with a component of: sugar maple, northern white cedar, yellow birch, basswood, and ironwood. Advanced regeneration includes: red maple, sugar maple, and balsam fir, which indicate potential for regeneration. The surrounding area serves as a yard for wintering deer, and they feed on any new growth within the browse line.

The stand comprises mostly of poletimber class timber stocked at a medium density. Stand 1b is mostly pulpwood, 30.4 cords per acre with a small component of sawtimber 46.67 board feet per acre. There is no evidence that the stand has been harvested within at least the last 40 years. The stand quality is very poor when compared to most northern hardwood sites, which carry approximately 3 to 5 thousand board feet per acre. Also, the stand has diameter distribution that is skewed left. Most of the trees in the distribution are smaller trees and this also accounts for the small amount of sawtimber per acre.

Silvicultural Recommendations

The Silvicultural objective in this unit is to manage this stand on a long-term hardwood sawtimber production. This type of harvesting leaves a high degree of vertical structural diversity. The mature trees in this stand are harvested to allow areas for regeneration to take place. A sixty-year cutting cycle was chosen for this stand strictly because the stand will be harvested every time the aspen management unit receives treatment. Our residual BA of 60 sq. ft/acre was chosen to get a removal volume that was feasible. A 14-inch diameter limit was also chosen since there is a sixty-year cutting cycle. When dealing with the 60 year cutting cycle only “crop trees” will chosen to be released. “Crop trees” are trees that are of very good quality now, but there are generally smaller in diameter usually 6-12 inches dbh. In sixty years these “crop trees” should be very high quality sawlogs.

Consideration of advanced conifer regeneration will be met with a winter harvest. Harvesting when the snow cover is deep enough to protect the advanced regeneration from direct impact shall help limit residual damage. Leaving these species will increase the diversity of the stand and also aid in the aesthetics after harvesting.
Concerns

There are several factors that raise concern in unit 1b.

- A residual of 60 sq ft per-acre could possibly reduce maximum growth since there is a sixty-year cutting cycle.
- Poor sites for northern hardwood are usually more susceptible to insect and disease damage.
- After harvest, the dry soil makes the residual stand more susceptible to wind throw.
- Pines cannot be easily managed with the more tolerant Northern hardwoods.
- Deer browse could effect the regeneration of some species such as Sugar maple.
- Wounds greater than 50 square inches and more than 10 years old will cause significant damage.

(Managers guide for northern hardwoods)

Growth and Yield

Growth and Yield was determined using the Adams and Ek model for northern hardwood. The model was used to determine the sawtimber volumes for the sixty-year cutting cycle. The model predicts a well-stocked stand in sixty years. This should be true to a point, but the sawtimber volume of 14,489 bf/acre seems a little too high. It predicts the basal area to a reasonable 150 sq ft and 192 tpa. The model must predict all the trees to in the smaller diameters to grow into sawtimber class trees. This does not happen due to circumstances in nature: some trees are infected by insects and diseases and others are poor quality, just to name a few things that can happen to a trees in their lifetime. A more reasonable number for the sawtimber volume per acre in sixty years would be 4 to 6 mbf.

Financial Criteria

The stand harvest values are calculated by taking the present basal area (112 sq ft), subtracting it from the basal area we want to achieve (60 sq ft), and dividing by the present basal area, (112 sq ft). (112-60/112)= .46. This number then is multiply that number by the liquidation value from Table V-3, Unit 1b in the vegetation section. (.46x$544.09)= $250.28 in a per acre value.

Aesthetic and Resource Protection

1) Extreme care should be taken during felling and skidding to maintain the condition of the soil and drainage pathways throughout the unit. This is especially important during the initial creation of the group-selection openings, as any disturbance of drainage in the heavy soil may cause severe blockage and water build-up.
2) The removal of the over story may increase the level of the water table limiting future growth.
3) All tops and limbs should be left on the site as coarse woody debris to replenish soil nutrients, as well as to act as nurse logs for regeneration.
4) Harvest and other management activities should take place only during the winter.
5) Any poor quality trees that are cut, but not removed from the stand should be left near the stump as coarse woody debris.
6) All tops and logging residuals should be removed from on and within 30 feet of all logging roads and lopped within 5 feet of the ground.
7) All roads used for logging and removal should be returned to their pre-harvest state or better following harvest activities. All Best Management Practices (BMP’s) regarding wetland buffers must be followed.
8) Whenever possible, unless there is a question of safety, snags should be left standing for utilization by wildlife.
9) All conifers within the unit should be preserved as a seed source for the surrounding units as well as the research unit.
10) In the logging contract, require good utilization of hardwood pulp (down to 4 inch top or less) thus reducing visual impacts and obtaining greater volumes of cordwood.
**Harvest Information**

**Recommended Treatment**

The trees to be harvested are to be the ones of poor quality. Sugar maple borer, cankers, burls, seams, excessive rot, holes, and old logging damage such be considered first when marking the stand. Basal area should not get below 60 sq. ft/acre. Any lower than this and the trees would be susceptible to wind throw. A light selection thinning of scattered poor quality stems in the residual should be removed.

**Treatment Year:** 2003  
**Access:** Prickett Dam Road  
**Harvesting Cutting Cycle:** 60 years  
**Recommended Operating Season:** Winter
FOREST MANAGEMENT PRESCRIPTION
Management Unit 2

Existing Conditions: Aspen Stand with Mixed Hardwoods
Acres: 25.5

Ownership: Michigan Technological University

Forest Type and Major Tree Species: Even-Age Aspen

Stand Identification: Unit 2, N ½ & SW ¼ of SE ¼, Section 9, T50N R35W, Houghton County, MI

Size Class: Poletimber & Bolts
Stand Density: Normal
Site Quality: Normal
Total Volume: 30.5 cfs/acre, 148.23 bf/acre 191 Tpa
Site Index: 60-65 at 50 years (Perala p. 13)

Site Quality: Normal
Basal Area: 98.6 sq ft
Stand Age: Even

PLANNED MANAGEMENT ACTIVITIES (PRESCRIPTIONS)

Stand Objectives
1) To regenerate aspen on this stand to better or equal stocking within 60 years.
2) Provide a demonstration area of clearcut aspen management.
3) To provide a sustainable timber resources in an even age state.
4) Maintain forest health.

Timber Management

Current Stand Conditions
Unit 2 at this time is primarily aspen, mixed with maple spp, hemlock, northern white cedar, and ash. A small percentage of the timber also includes a few super-canopy white pine. Aspen suckers are present in the stand indicating a good regeneration potential. The surrounding area serves as a yard for wintering deer, and they feed on any new growth within reach.

The aspen currently appears healthy, the balsam fir on the site has indications of bark beetle activity. The sugar maple that is scattered is off site and has excessive dieback. This further justifies keeping aspen the dominate tree species.

The soil series that is present is 73B Forberg-Rudyard Silt Loam, which has a severe wind throw hazard and moderate to severe equipment limitations. This indicates that any residual will likely blow down. The equipment limitations support a winter harvest, which will also be best for the effective regeneration of the stand. This is because the maximum nutrient content will be in the roots during the winter and the clone will have a large amount of carbohydrates to use for growth of suckers.

Silvicultural Recommendation

Clearcut all trees over two inches that are not of the following species: hemlock, cedar, white spruce, and eastern white pine. Consideration of advanced conifer regeneration will be met with a winter harvest. The conifer regeneration is below two feet, which is below the snow line so will not be of concern. Leaving these species will increase the diversity of the stand and also aid in the aesthetics after harvesting. The residual stand will have approximately 17.8 BA and 24 trees per acre following treatment.

There will be a 150-foot buffer on the eastern aspen stand on its north side. This will be done to slowly convert Unit 1a to high quality aspen. This will be done every entry till Unit 1a is converted. There are several different age classes of aspen in the a joining area, so the harvest will fit well into the landscape.

Growth and Yield

Currently the stocking at 60 years is heavy to bolts, the Aspen Managers Guide suggests that aspen be managed at an age of 60 years for the production of bolt quality trees. The decision is to manage for bolt quality, since it has been shown that it is possible to achieve such growth on the site (Perala p. 21).

The Aspen Managers Guide indicates that with a basal area of 100 sq ft and a height of 70 feet the yield will be 29 cunits per acre (Perala p. 23). This is believed to be a typo (maybe should be cords not cunits) because this number is at year 50, and we currently have a volume of 30.5 cords an acre total. Since the rotation will be the same, 60 years. If managed as an aspen cover type, with clearcut rotations and no thinnings, the expected net present value of the stand is $886.45 per acre at a four percent interest rate. A total liquidation value for the aspen stands is approximately $20,642.30.
Concerns

There are several factors that can impact aspen growth.

- Residual basal area of 10 to 15 sq ft per-acre can reduce aspen growth 35 to 40 percent (Perala p. 3).
- Pines cannot be easily managed with aspen (Perala p. 6).
- Dense stands are initially more pest resistant but the diameter growth is slower (Perala p. 6).
- Soil compaction from machinery can reduce aspen growth 5 to 10 percent by reducing aeration (Perala p. 9).
- Fiber production can be increased in stands that incorporate spruce and balsam fir (Perala p. 5).
- Tree length harvesting scarifies and reduces competing vegetation (Perala p. 4).

Future

The anticipation is this stand will fully restock with aspen trees within a period of four years. If this does not occur then it will need to be reforested. A species that has been suggested for this is tamarack because it would do well in the wet soils and would add diversity to the landscape. Of course the hope is that this will not need to be done because the property is currently fully stocked with aspen.

Aesthetic and Resource Protection

1) This stand borders a county road so care should be taken to maintain a clean appearance of the job. Tops should be lopped so they are at an even height and all stumps should be returned to an upright position to aid aesthetics.
2) Care should be taken during skidding to maintain the condition of the soil and drainage pathways throughout the unit. This is especially important because the disturbance of drainage in the heavy soil may cause severe blockage and water build-up.
3) The balsam fir in the stand will be removed because it is exhibiting infestation by bark beetles and is a health hazard to the surrounding balsam fir.
4) All tops and limbs should be left on the site as coarse woody debris to replenish soil nutrients.
5) Harvest should only be done in the winter to protect the soil.
6) Any poor quality trees that are cut, but not removed from the stand should be left near the stump as coarse woody debris.
7) All tops and logging residuals should be removed from on and within 30 feet of all logging roads.
8) All roads used for logging and removal should be returned to their pre-harvest state or better following harvest activities. All Best Management Practices (BMP’s) regarding wetland buffers must be followed.
9) Roads to be used for research purposes should be maintained at a level guaranteeing they shall be passable during fair weather seasons. This will enable research teams access to the sites without causing severe rutting and drainage impedance.
10) Whenever possible, unless there is a question of safety, snags should be left standing for utilization by wildlife.
11) All living white pine within the unit should be preserved as a seed source.

Harvest Information

Recommended Treatment

All trees above two inches diameter should be harvested unless they are of the following species: eastern hemlock, spruce, white pine, and northern white cedar. This will be done to regenerate the stand to a full stocking of aspen. The reason for leaving the variety of tree species is to provide diversity across the stand, which benefits wildlife. Some species such as ruffed grouse and white tailed deer will benefit from additional cover and forage habitat.

<table>
<thead>
<tr>
<th>Treatment Year: 2003</th>
<th>Access: Prickett Dam Road</th>
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<tbody>
<tr>
<td>Harvesting Cutting Cycle: 60 years</td>
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<tr>
<td>Recommended Operating Season: Winter</td>
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</tbody>
</table>
FOREST MANAGEMENT PRESCRIPTION
Management Unit 3

Existing Conditions: Lowland Hardwoods with Aspen Mix
Ownership: Michigan Technological University
Acrees: 35
Forest Type and Major Tree Species: Lowland Hardwoods, Aspen & Black Ash
Stand Identification: Unit 3, N ½ & SW ¼ of SE ¼, Section 9, T50N R35W, Houghton County, MI (see map)

Size Class: Poletimber & Sawtimber
Site Quality: Wet
Total Volume: 25.4 cds/acre, 203.5 bf/acre 177 Tpa
Site Index: 55ft at 50 years (based on Aspen)

Stand Density: Medium
Basal Area: 102.94 sq ft
Stand Age: Even

PLANNED MANAGEMENT ACTIVITIES (PRESCRIPTIONS)

Prescription Objectives
1) To regenerate healthy aspen on this unit to better stocking with a 60 year rotation.
4) Provide a demonstration area of clearcut land management.
5) To provide a sustainable timber resource in an even aged state.
6) Maintain Forest health.
7) Provide habitat for known wildlife.
8) To provide options to modify species composition should environmental conditions change.

Timber Management
Current Stand Conditions
Unit 3 at this time is primarily aspen and black ash, with a component of: maple spp., balsam fir, hemlock, and northern white cedar. Advanced regeneration includes black ash, aspen suckers, and American elm indicating regeneration potential exists within this unit. The surrounding area serves as a winter deer yard, and the deer feed on any new growth within reach. This yarding area impacts the advanced regeneration of this unit, limiting upgrowth. Currently aspen averages 26.41TPA, 20BA, and 7.55 cords/acre.

Silvicultural Recommendations
The goal of this prescription is to convert the unit to an even-aged aspen unit. This unit is predicted to convert to aspen upon clearcutting, currently there are an average of 26.41TPA of aspen in this unit, which equals a tree every 40.6 feet. Since it is generally thought that the roots of a tree expand to distance that is equal to the height of the tree (currently over 60 ft.), sufficient root spread exists for new clones to arise from and dominate this unit. To achieve this the following recommendations shall be followed.

Clearcut trees over two inches with the following exceptions:
- All trees of the following species: hemlock, cedar, white spruce, and eastern white pine will be retained.
- Trees eight inches and under that are of the following species: black ash and American elm which are healthy and don’t exhibit any signs of top dieback will be retained.

Consideration of advanced conifer regeneration will be met with a winter harvest. Harvesting when the snow cover is deep enough to protect the advanced regeneration from direct impact shall help limit residual damage. Leaving these species will increase the diversity of the stand and also aid in the aesthetics of the stand after harvesting. The residual stand after harvesting will have approximately 22.6 sq. ft. BA and 38 trees per acre. Clearcutting the unit will hopefully overwhelm the deer with browse allowing for sufficient upgrowth, slash left in place will also impede deer’s ability to browse new growth.

The young black ash and American elm will be reserved on the site for the possibility that the water table will rise following harvest. If a rise in water table occurs, conditions which favor the black ash instead of aspen will exist and the reserve of healthy black ash will insure that the unit remains forested. If the black ash do not compete well following this initial treatment they should be removed at the next rotation allowing more growing space for aspen. If the black ash develops disease or severe dieback between the first and second rotation they should be felled to improve the growth rate of the aspen. Poor quality black ash that is felled due to disease or dieback, should
be left in situ for use as CWD for wildlife habitat purposes. The black ash should be surveyed at the same time that the hemlock research plots in Unit four are observed to monitor for deteriorating conditions.

**Growth and Yield**

For optimum production this unit will be managed on a 60 yield rotation for bolts as predicted from table five in the *Managers Handbook for Aspen in the North Central States* (Perala p. 21). This is based on the site index of the unit. Predicted yield for this unit will be 22.64 cunits per acre \[\left(\frac{4\times(BA\times\text{Height})}{1000}\right)\] based on *Managers Handbook for Aspen in the North Central States* (Perala p. 23), this measurement may actually be in cords not cunits since the conversion factor to cords from cunits (2.605) seems to reduce to yield to unlikely numbers: 8.7 cords per acre.

The black ash should be treated at the same time as the aspen if it proves to be lucrative, the black ash should be managed for quality sawtimber production. If the black ash proves to be more productive than the aspen it should be favored over the aspen and be evaluated for a black ash dominated cover type at the end of the first aspen management rotation. The rotation age for the black ash as well as converting the stand to a black ash cover type will have to be determined at the end of the first rotation, any attempt to set guidelines for the black ash now would be premature and foolhardy.

If managed as an aspen cover type, with clearcut rotations and no thinnings, the expected net present value of the stand is $572.59 with a four percent interest rate if the black ash management proves impractical. The net present value of this stand if managed with a black ash component is immeasurable, the value of the stand will depend on the amount of healthy black ash that can be reserved in the stand and that remains healthy. The value of the stand if managed for black ash sawtimber is assumed to be higher than the value for an aspen cover type.

**Concerns**

The ground water level may be a concern in this unit, since this units soils consists of areas of Gay Muck, Froberg-Rudyard Silt Loam, and Rudyard Silt Loam. All of these series have moderate to severe equipment limitations and severe wind throw risk. The residual stand component may be damaged by wind throw, however the advantage of diversity and aesthetic potential outweighs the risk.

There are several factors that can impact aspen growth:

- A residual of 10 to 15 sq ft per-acre can reduce aspen growth 35-40 percent (Perala p. 3). Therefore retaining black ash, American elm, and conifers may reduce the growth rate of the aspen. Retaining trees in clumps were possible will help to limit this problem
- Tree length harvesting scarifies and reduces competing vegetation (Perala p. 4). While this will increase aspen growth care needs to be taken to avoid damaging the residual conifer component and compacting soils.
- Fiber production can be increased in stands that incorporate spruce and balsam fir (Perala p. 5). Balsam fir and spruce force the aspen to grow faster and straighter boosting fiber production.
- Dense stands are initially more pest resistant but the diameter growth is slower (Perala p. 6).
- Soil compaction from machinery can reduce aspen growth 5-10 percent by reducing aeration (Perala p. 9). The heavy soils of this unit are at a high risk from compaction, winter harvesting may help alleviate this problem but care should be exercised.

**Wildlife Management**

Certain species of wildlife are expected to benefit from the Silvicultural management that will occur in this unit. The harvest itself will bring tree buds into the reach of deer during the winter, a period when food supplies are scarce. The slash from the harvest will provide cover for small mammals and amphibians. The young aspen will provide cover for deer, bear, grouse, rabbits, and other animals. The nearby hemlock stand will provide habitat for birds of prey and predatory mammals such as fisher, this animals will hunt in and along the edges of the aspen stand.

**Aesthetic and Resource Protection**

1) Extreme care should be taken during felling and skidding to maintain the condition of the soil and drainage pathways throughout the unit as any disturbance of drainage in the heavy soil may cause sever blockage and water build-up.

2) The removal of the over story may increase the level of the water table limiting future growth.
3) All tops and limbs should be left on the site as coarse woody debris to replenish soil nutrients.
4) Harvest and other management activities should take place only during the winter.
5) Any poor quality trees that are cut, but not removed from the stand should be left near the stump as coarse woody debris.
6) All tops and logging residuals should be removed from on and within 30 feet of all logging roads.
7) All roads used for logging and removal should be returned to their pre-harvest state or better following harvest activities. All Best Management Practices (BMP’s) regarding wetland buffers must be followed.
8) Roads to be used for research purposes should be maintained at a level guaranteeing they shall be passable during fair weather seasons. This will enable research teams access to the sites without causing severe rutting and drainage impedance.
9) Whenever possible, unless there is a question of safety, snags should be left standing for utilization by wildlife.
10) All conifers within the unit should be preserved as a seed source for the surrounding units as well as the research unit.

Treatment Year: 2003 Access: Prickett Dam Road
Harvesting Cutting Cycle: 60 years
Recommended Operating Season: Winter
FOREST MANAGEMENT PRESCRIPTION
Management Unit 4

Existing Conditions
Ownership: Michigan Technological University                  Acres: 53.3
Forest Type and Major Tree Species: H8/M5 Eastern Hemlock; Soft Maple, Northern white Cedar, Yellow Birch
Stand Identification: Unit 4, N ½ & SW ¼ of SE ¼, Section 9, T50N R35W, Houghton County, MI. For Unit
definition and location, please see Map V-1, page V-2 in the Vegetation Section.

Size Class: Poletimber & Sawtimber  Stand Density: High
Site Quality: Poor to Medium       Basal Area: 164.6
Total Volume: 45.5 cfs/acre, 1118.9 bf/acre  Stand Age: Uneven – unknown # of classes

PLANNED MANAGEMENT ACTIVITIES (PRESCRIPTIONS)

Stand Objectives
1) To develop Silvicultural prescriptions aimed at maintaining and restoring viable populations of eastern
   hemlock on the regional landscape.
2) To improve our understanding of canopy gap dynamics and the utility of group selection for
   maintaining species diversity under the selection system.

Timber Management
Current Stand Conditions
Unit 4 at this time is primarily heavily stocked Eastern hemlock, mixed with soft maple, northern white
cedar and yellow birch. A small percentage of the timber also includes hard maple, aspen and white birch, as well
as a few super-canopy white pine (see Vegetation section, Unit 4, beginning page V-21). Currently, signs of
regeneration are scarce in the unit, as the area serves as a yard for wintering deer, and they feed on any new growth
within reach. Much of the cedar within the unit was removed during harvests at the beginning of the 1900’s (please
see Heritage section). Eastern hemlock has become relatively rare in the landscape, due to slow growth and heavy
browsing on regeneration. This expansive area of hemlock provides excellent an opportunity for research on
regeneration techniques.

Silvicultural Recommendations
Proposed Study Design
1) Create 18 small group-selection openings in hemlock stands on Michigan Technological University
   lands. Six replicates of three opening sizes will be created (100-200, 201-300, 301-400 m²). Half of
   the openings in each size class will be fenced off to exclude deer.
2) Within each opening, a grid of 2x2 m sample plots (with a 1 m buffer between plots) shall be
   established. Three replicates of six treatments shall be randomly assigned to the grid cells in each
   opening. The treatments will include site preparation methods aimed at promoting hemlock
   establishment as well as control of competing vegetation.
   a) Mechanical scarification: 50% mixing of organic material and mineral soil with the aid of a
      rototiller.
   b) Prescribed fire: low intensity burn administered in the fall to set back hardwood regeneration
      and expose mineral soil for seedling establishment.
   c) Herbicide: spot treatment of hardwood regeneration and herbaceous vegetation with Accord®.
      Accord® is registered for application in wetland areas by the EPA.
   d) Plant 1: plant hemlock without herbicide control of competing vegetation.
   e) Plant 2: plant hemlock and control competing vegetation with herbicide.
   f) Control: no site preparation or planting.
   g) In larger openings, (d) and (e) will be repeated with white pine.
3) Within each cell, a number of measurements shall be made throughout the course of the growing
   season:
   a) Monitor seed input with mast traps set up in the rows between sample plots.
   b) Monitor soil moisture, temperature, base saturation and bulk density.
   c) Census regeneration and herbaceous plants.
   d) Monitor height growth and development of regeneration.
   e) Monitor browsing by deer and hare.
4) Trees bordering each opening will also be monitored to assess their response to the creation of the opening.
   a) Monitor crown expansion in to the opening by trees bordering the gaps.
5) Monitor basal area growth response of trees bordering the opening.

Aesthetic and Resource Protection
a. Extreme care should be taken during felling and skidding to maintain the condition of the soil and drainage pathways throughout the unit. This is especially important during the initial creation of the group-selection openings, as any disturbance of drainage in the heavy soil may cause severe blockage and water build-up.
b. All tops and limbs should be lopped within 2 to 3 feet of the ground and left on the site as coarse woody debris to replenish soil nutrients, as well as to act as nurse logs for regeneration.
c. Harvest and other management activities should take place only during the winter. For research purposes, the unit may be entered during summer and fall, in order to perform necessary scarification, raise fencing, and establish experiments during fair weather.
d. Any poor quality trees that are cut, but not removed from the stand should be left near the stump as coarse woody debris.
e. All tops and logging residuals should be removed from on and within 30 feet of all logging roads.
f. All roads used for logging and removal should be returned to their pre-harvest state or better following harvest activities. All Best Management Practices (BMP’s) must be followed.
g. Roads to be used for research purposes should be maintained at a level guaranteeing they shall be passable during fair weather seasons. This will enable research teams access to the sites without causing severe rutting and drainage impedance when they enter the stand to monitor conditions.
h. Buffers must be maintained between research plots to reduce the chance of blowdown and creation of edge-effect within the study plots.
i. Whenever possible, unless there is a question of safety, snags should be left standing for utilization by wildlife.
j. All living white pine within the unit should be preserved as a seed source for the surrounding units as well as the research unit.

Research Execution

The first step in initiating the research in Unit 4 must be the determination of gap centers. These will be chosen based on not only their proximity to the edge of the hemlock stand, but also on relative proximity to one another, and the make-up of timber within the gap area. Desirable gap locations will have the low quality hardwoods as well as some hemlock and cedar removed as required to create the necessary cleared radius. A hard line in the canopy around the gap is preferred, but need not be perfectly circular. Some potential gap locations have been marked with flagging, as well as with a GPS. These gaps, 1-3, are labeled in Figure 1. Due to the topography and hydrology of the tract, the best season during which to determine the gap locations will be during late spring or summer, after spring thaw. This is necessary in order to ensure that the locations chosen for gaps are not emergent wetlands, or low spots that gather large amounts of water that will impede the regeneration of hemlock. Because of this, the task must be carried out on foot to avoid damaging the soil structure and drainage pathways.

The second step will be the removal of all trees within the gaps that need to be cut. Care should be taken to not damage the trees to be left around the gap, as these will serve not only as seed trees, but also to shelter the gaps. It is especially important to remove the hardwoods within the gaps, as the progeny of these trees will easily out-compete the hemlock regeneration for nutrients and access to sunlight and water. Additional poor quality hardwoods will be removed from the unit to supplement some of the research cost. Scarification of the soil will also take place at this time, to prepare the seed bed appropriately for hemlock seedlings.

Third will be the construction of exclosures around half of the gaps. Some of the timber cut in order to create the gaps may be usable in this step. A Wood Miser and competent operator can cut all the necessary wood for the fencing with little waste for a very low cost. Additional materials needed will include 5’ concrete stabilizer mesh for the fencing, materials for 18 gates, nails and staples, and support hardware to keep the fences upright under harsh weather conditions. An estimated 1300 hours of labor will be required to build the exclosures, based on a time of 3 days for each fence, and a crew of 3 students or prison laborers. It is likely that once the first fences are constructed, the time it takes to erect each subsequent one will decrease.

Finally, the gaps will be monitored semi-annually by students to record the success of regeneration in both the control gaps and the exclosures.
Figure 1: Proposed gap locations for research in Unit 4 of the Prickett Dam tract.

Proposed Gap Locations and Sizes

N 1/2, SE 1/4 & SW 1/4, SE 1/4, Section 9, T50N R35W

- **Small Gap (100-200 sq meters)**
- **Medium Gap (201-300 sq meters)**
- **Large Gap (301-400 sq meters)**
- **Property Lines**
- **Old Roads**