

Forest Stewardship Plan

Sparta Mountain Wildlife Management Area

Prepared for New Jersey Department of Environmental Protection Division of Fish and
Wildlife
P.O. Box 420 MC 501-03C
Trenton, NJ 08625

Property Location:
Sparta, Ogdensburg and Hardyston Townships in Sussex County
Jefferson Township in Morris County

Plan Acreage: 3,461.198
Plan Timeframe: 2016 – 2026

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- 17.6 - Forest Stewardship Council (FSC) Group Member Agreement
- 17.7 - NJA Group Hazardous Materials and Pesticides Policy
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- 17.9 - FSC 2007 Pesticides Policy
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1. INTRODUCTION

The intent of this plan is to provide the overall goals and objectives for the management of Sparta Mountain Wildlife Management Area and to outline the general areas (stands), practices, conservation measures, and a proposed timeline in which to achieve those goals and objectives during the 10-year duration of the plan.

Because this plan was initiated prior to the State Forest Service's 14-step process to create a forest steward plan on state lands, the implementation of the plan will follow a more detailed site-specific plan, also known as a *practice plan* or *operational plan*, which will be drafted as conditions allow for a management activity to occur. Each practice plan will include the management prescriptions for each individual project site location within a stand, which are guided by the umbrella recommendations provided in this forest stewardship plan for that designated forest stand, and apply more specific conservation measures for rare species that may be impacted from the management conducted at that project site location. This plan is envisioned as the first stage of a larger management vision designed to be implemented over a period of 60 years.

Under this system, each practice plan will need to undergo a NJDEP Lands Management Review Process, which means it will be reviewed internally by certain bureaus within NJDEP's Natural and Historic Resources prior to implementation. However, these bureaus will be consulted during the creation of each practice plan to discuss concerns prior to the official activity review.

1.1 - LANDOWNER GOALS AND OBJECTIVES

1. Maintain ecosystem health, diversity and integrity

- Create greater balance among the stages of forest succession throughout the property
- Establish up to 10% of property as young forest stands
- Favor trees with exfoliating bark and cavities for nesting birds and roosting bats
- Minimize further distribution of invasive exotic species
- Implement responsible silviculture to enhance biological diversity of native wildlife
- Enhance forest's vertical structure by mimicking natural "gap disturbances"

2. Protect and enhance hydrologic resources

- Adhere to NJ Forestry and Wetlands BMP Manual when managing in and around riparian areas
- Selectively remove portions of wetland overstory canopy to improve habitat for basking

turtles

3. Inventory and monitor priority wildlife populations and habitat

- Utilize data to support adaptive management decision making
- Monitor wildlife responses to habitat improvement activities and adjust as necessary
- Identify Rare, Threatened and Endangered (RT&E) species present and manage property to ensure their existence

4. Provide compatible wildlife related recreational opportunities and facilities

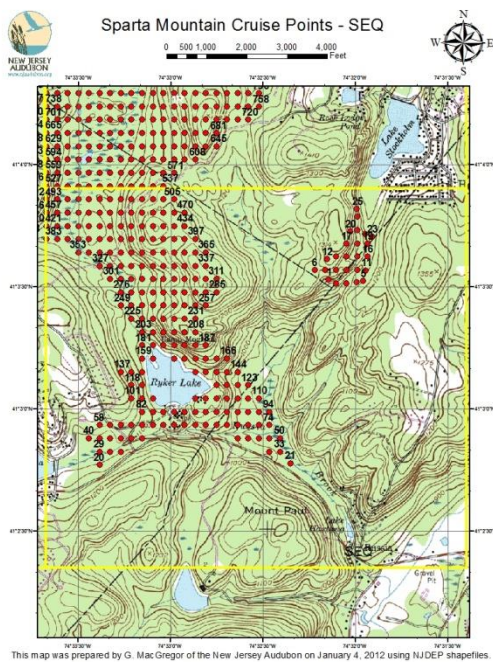
- Prevent illegal use on the property and employ more signs, barricades and gates
- Protect and maintain views around vistas and important locations including actively managed areas

5. Continue management in a manner compliant with Forest Stewardship Council (FSC) Principles and Criteria

- While funding exists satisfy requirements of annual, third party audits and five year re-assessments
- Ensure protection of environmental, social and economic high conservation values as defined by FSC
- Adhere to Montreal Process criteria and indicators as described in Montreal Process 2014, from which FSC standards are derived.

1.2 - PROCEDURES FOR INVENTORING GROWTH AND DYNAMICS

Beginning in January 2012 New Jersey Audubon (NJA) staff began forest inventory analysis of the property. The inventory concluded in August 2012. The property was systematically sampled using an un-stratified design at an intensity of one plot per five acres of forestland. The inventory was



conducted in a manner consistent with mathematical principals outlined in Avery and Burkhardt's Forest Measurements, Fourth Edition (Avery, 1994). The sampling intensity exceeded NJA's original objective of remaining 90% confident that final output data would remain within +/- 10% allowable error for the entire tract. NJA has also calculated stand level statistics at the 70% confidence interval. This information is found in section 15 of the Forest Stewardship Plan (FSP) and will be used to determine whether or not a more comprehensive re-inventory is required prior to implementation of forest treatments.

Field data was recorded using the NED (North East Decision model) Lite software platform (Knopp, 2009), and later uploaded and post processed through NED 2's desktop modeling software (Twery, 2012). NED software has the ability to incorporate management goals for multiple objectives, analyze current forest conditions,

recommend management alternatives, and predict future conditions under different alternatives. The software is designed and periodically updated to include a long-term, landscape-level view of

the forest as an interconnected ecosystem.

Information recorded during the inventory included the identification of overstory, shrub and ground layer species. Fixed radius plots of 1/100 and 1/500 of an acre were used to collect shrub and ground cover data respectively. Overstory data was collected using 15 basal area factor prisms on variable radius plots. Attributes collected during the inventory include tree diameter, height, size class, live crown ratio, quality, vigor, product, and defect. Other features such as geographic areas of interest, trails, and riparian crossings were also noted. Small portions of the property were not inventoried due to inaccessibility caused by standing water or extremely dense vegetation (utility corridors). Although vegetation tied to these features is not necessarily detailed in this plan, future management of these sites is also unlikely.

The property was divided into thirty-three forest stands based on the inventory. A summary of the Stand level data is located within the Stand Descriptions and Prescriptions section. In some instances, computer modeling was used to project data out to 2022, offering a snapshot of forest conditions under various treatment regimes. Modeling different scenarios allows for the tracking of conservation values and sustainable growth.

Sparta Mountain Wildlife Management Area (SMWMA) receives Forest Stewardship Council (FSC) certification via the Rainforest Alliance (RA) through NJA's Group Certificate. The property will continue to remain monitored by the NJ Division of Fish and Wildlife (NJDFW), NJA, and RA for changing conditions to ensure conformance with this plan. NJA and the NJDFW make annual visits to the property to complete FSC approved forest monitoring checklists and annual conformance reports, which are reviewed by RA's third party auditors. If issues arise through this monitoring or during stakeholder consultation, they can be quickly addressed.

1.3 - DESCRIPTION OF STAKEHOLDER CONSULTATION PROCESS

Recently, the NJ State Forest Service (SFS) proposed a 14-step process in the creation of forest stewardship plans on state lands with guidance from stakeholders throughout the planning process. This plan was initiated years prior to this process; therefore it has not observed all 14 steps. However, measures have been taken to consult stakeholders during the early phases of this plan, and in recognition of this new process, measures will continue to be taken to solicit stakeholder comments prior to implementation of management activities.

NJA worked together with staff members of the NJDFW to create an exhaustive stakeholder list. The chosen stakeholders represented a range of interests, and they typically maintained direct contact with the public as it pertained to their area of expertise. Stakeholder communications are conducted by either NJA or NJDFW via email, however, in some cases telephone calls were also used. At times, representatives of the RA also contacted stakeholders directly. Results and findings from the stakeholder consultation processes were recorded, stored, and are publically available at NJA's central office location at Wattles Stewardship Center. Planning documents and supporting data are also available for viewing at NJA's Wattles Stewardship Center.

Beyond compliance with FSC indicators 4.4d and 9.2a, NJA consulted with stakeholders during preparatory stages of this plan (See FSC Standards in Appendix 17.91). First, stakeholders were extended the opportunity to comment or share concerns regarding the forest inventory procedures to be used for raw data collection, and for areas of High Conservation Value. Second, interested parties were allotted time to comment on the proposed outline and content. The third opportunity for stakeholder input and comments will be upon completion of the draft plan before it becomes a final document.

Stakeholders and the general public may express concerns and grievances during the NJA Stakeholder Input Process, or by contacting NJA staff foresters at: Wattles Stewardship Center, 1024 Anderson Road, Port Murray, NJ 07865. All questions will be addressed and documented. If conformance with the FSC standards is in question, NJA will issue an internal Non-Conformance Report (NCR) to NJDFW. The internal NCR will provide a description and timeframe outlining the necessary steps required to resume conformance. Typically the NCR will need to be addressed before the next RA audit. Failure of the NJDFW to adequately address the NCR within the documented timeframe may result in temporary and/or permanent suspension from FSC certified status. Internal NCR's are shared with RA at the time of NJA's annual audit. If the stakeholder does not feel NJA has addressed the issue satisfactorily, they may contact RA directly via phone at 802.434.5491. At that point RA will guide the stakeholder through their formal grievance process and contact NJA and NJDFW to further investigate.

2. GENERAL PROPERTY DESCRIPTION

2.1 - PROPERTY LOCATION

The SMWMA spreads through two counties and four townships. In Morris County it sits within Jefferson Township, and in Sussex County it lies within Sparta Township, Hardyston Township, and the Borough of Ogdensburg.

The property is generally bound by the following features; in the north by NJ Route 23 near the highway's intersection with Beaver Lake Road, in the south by Glen Road (Sussex County Route 620), in the west by the New York Susquehanna and Western Railroad Company (NYSW) tracks, and in the east by the communities of Tamarack Lake and Lake Stockholm.

The most frequented sections of SMWMA are in the vicinity of Ryker Lake and Edison Monument, which are both along Edison Road.

2.2 - PROPERTY BOUNDARIES

Well-maintained boundary lines are important to meeting the standards of forest certification and for the management of forest assets. The boundary line is the definitive and legal declaration of the limits of what is owned. A clear deed description and survey map provide the basis for accurate, well-marked boundaries.

As per FSC Indicator 1.5a and 2.1c property boundaries of land ownership and use rights must be clearly identified on the ground and on maps prior to commencing management activities within the vicinity of the boundaries. Boundary designations, by FSC standards, do not necessarily have to be comprehensive, but must be adequate to assure that management activities are implemented where intended. If the boundary cannot be established, then the manager shall postpone management until the boundaries are established and marked either by legal survey or through mutual agreement with the adjacent property owner.

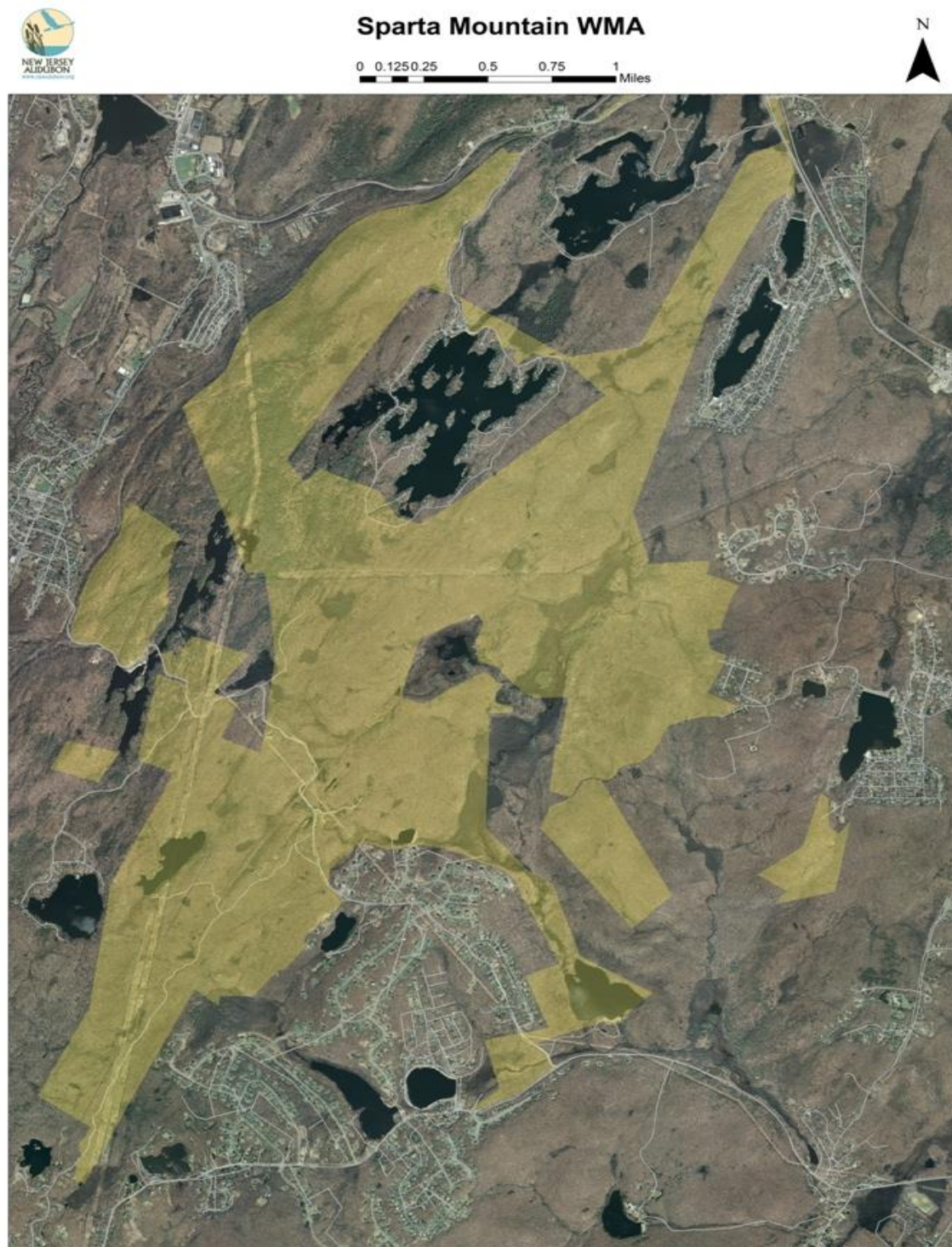
NJA recommends that NJDFW establish well marked and maintained boundaries regardless of proposed future management to prevent illegal activities, such as timber trespass and unauthorized vehicular use. Additionally, when proposed activities are within close proximity to a property line, that line shall be confirmed for accuracy prior to commencing management.

2.3 - DEED AND TAX INFORMATION

Table 1. Lot and blocks within Sparta Mountain WMA by county and township with total acreages.

Ogdensburg Township	Sparta Township	Hardyston Township	Jefferson Township
Sussex County	Sussex County	Sussex County	Morris County
Block 1; Lot 2	Block 1; Lot 2, 3, 1.01, 1.02, 1.03, 16	Block 1; Lot 1.04	Block 555; Lot 9
Block 11; Lot 21	Block 3; Lot 1, 20.03	Block 59; Lot 12	Block 59; Lot 1
	Block 7; Lot 3, 4, 88	Block 60 ; Lot 1, 1.01, 17, 2.01, 3.02,	
	Block 1.02; Lot 45		
	Block 60; Lot 2.02		
19.75 Acres	1,842.558Acres	1,542.89 Acres	56.0 Acres
			3,461.198 Acres

2.4 - FOREST STEWARDSHIP PLAN MAPS



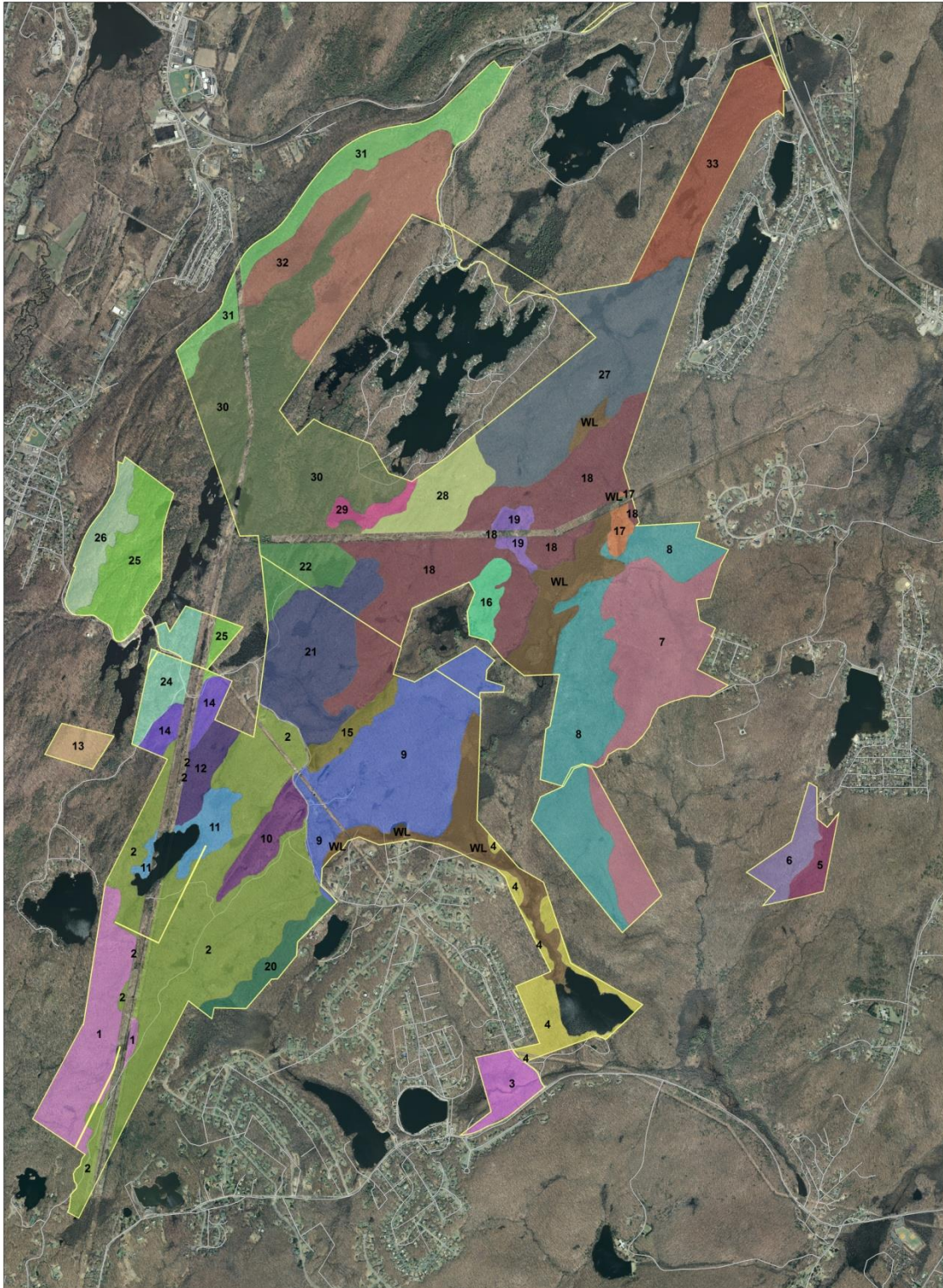
This map was prepared by G. MacGregor of New Jersey Audubon. Stand data was generated by NJ Audubon. Parcel data is from NJ DEP. 2007 Aerial imagery was used. October 2012

Figure 1. Aerial imagery map depicting Sparta Mountain Wildlife Management Area (yellow)



Sparta Mountain WMA Stand Map

0 0.125 0.25 0.5 0.75 1 Miles



This map was prepared by G. MacGregor of New Jersey Audubon. Stand data was generated by NJ Audubon. Parcel data is from NJ DEP. 2007 Aerial imagery was used. October 2012

Figure 3. Map depicting the different forest stands in Sparta Mountain Wildlife Management Area

2.5 - ROAD AND ACCESS SYSTEM

Because of the land use history as an industrial site, SMWMA has an extensive preexisting road network throughout the property. However, many of the roads have become degraded and are in need of improvements to minimize continued erosion. In order to employ the Best Management Practices (BMP) guidelines and protect against excessive erosion, some projects may require altering the location of existing roads or creating temporary access lanes stemming from these roads. The NJ Forestry and Wetlands BMP Manual (further detailed in the General Property Description section) will be the guidance tool for constructing or improving access roads, landings, and stream crossings to minimize environmental impact. While specific guidance is provided in the BMP manual, roads will generally follow the contour of the land and avoid traversing slopes greater than 10% when possible. Water bars, ditches, and other erosion control measures will be constructed as needed, and revisited after use to assess the need for repair.

The main arteries of Ridge Road and an unnamed road extending north from the Edison Monument provide access to most of the property. Almost all areas that are not directly accessible from these major arteries can be reached from other un-named trails, paved municipal roads, or utility easements. Below is a basic description of the existing road network and how project sites may be most easily accessed.

Ridge Road is a Sparta Township road that bisects the southwest corner of the property from southwest to northeast. It originates from County Route 620 (Glen Road) and turns into a dirt road when it enters the property in Stand 2. It follows the border of Stands 1 and 2, and then heads northwest into the heart of Stand 2. It eventually meets Edison Road just south of the Edison Monument parking lot. Enhanced erosion control measures were put in place on the lower half of Ridge Road prior to it being used as logging truck access for the spring 2012 timber harvest. The upper half remains less improved due to a few steep sections of eroded bedrock. There are a few unimproved roads that branch off to the Public Service Electric & Gas Company (PSE&G) easement. These provide access to Stand 1, and Stands 11 and 12 on the west side of Collins Pond. Stands 11 and 12 can also be accessed from the old railroad bed that extends south from Edison Road.

Edison Road is also a Sparta Township road that bisects the southwestern end of the property. It is a paved road, with connections to numerous unimproved roads that access the forest interior to the north and south. Edison road provides direct access into Stands 2, 3, 4, 9, 10, 14, 15, 20, 21, 24, 25 and 26. There are also a number of telephone and utility line easements that are accessible from Edison Road. The primary access to Ryker Lake is also from Edison Road.

There are a few significant unimproved roads that extend north and east from Edison Road near the Edison Monument. Collectively, these roads provide access into Stands 9, 16, 18, 19, 21 and 22. The most stable of these roads is an old mining roadbed, which is relatively flat and straight. It received some minor erosion control improvements prior to the 2012-2013 work conducted north of the Edison Bog. In addition to PSE&G, Jersey Central Power & Light (JCP&L) maintains some access roads connecting to their utility easements in this region.

Stands 5 and 6 are part of a non-contiguous parcel on the southeast side of the WMA, and are only accessible through the private Lake Stockholm community. Stand 5 can be accessed from a forest road that extends from a private driveway on Lakeside Avenue in Lake Stockholm.

Hawthorne Lake Road is a private improved road that could potentially be used to access Stands 13, 14 and 24.

Rock Lodge Road is a Hardyston Township road on the eastern side of the property. It extends into Stand 7 from a paved cul-de-sac into the WMA as a dirt road. The dirt road is passable only with a four wheel drive vehicle, but also does provide entry into Stand 8.

Beaver Lake is a private lake community within the northern portion of SMWMA. Its main point of entry is Beaver Lake Road, a paved road extending south from Route 23. This road could be used to access Stands 31 and 32. The lake community also contains a number of other roads that, with permission, could potentially be used to access Stands 27, 28, 29 and 30.

The NYSW freight rail lines that bound northern portions of SMWMA connect Bergen County, NJ to Syracuse, NY. The feasibility of utilizing a train as an effective means of transporting logs and/or milled lumber will be explored as an option. New Jersey Transit has been working on restoring the historic Lackawanna Cut-Off railroad between metropolitan New York and northeastern Pennsylvania. The Lake Hopatcong and Andover section is only twelve miles from SMWMA, and might also be a possible way to transport forest products in the future.

2.6 - BEDROCK GEOLOGY

SMWMA sits within the New Jersey Highlands, which contain some of the oldest rock in New Jersey. Primary bedrock materials are Pre-Cambrian granites, and Paleozoic clastic/carbonate rocks. Kittatinny and Franklin formations overlie Hardyston Quartzite throughout the region. The hard granite created steep mountains and hillsides which have been mostly resistant to the impacts of erosion. The area is considered mountainous, with an elevations reaching upwards of 1,500 feet. Sparta Mountain has an elevation of 1,232 feet.

Because of its rich mineral deposits, the Highlands were mined extensively. Iron, zinc, and marble were commonly mined from the area, and Franklinite was first discovered at nearby Sterling Hill Mine. More information regarding the areas recent geologic history is in the Land Use History portion of this plan.

2.7 - SURFICIAL GEOLOGY

Most soils at SMWMA are a coarse-loamy till developed from granite and gneiss. They are typically rocky and well-drained. The most common soil occurring here is the Rockaway-Chatfield-Rock complex (RokD), which covers about 57% (1,860 acres) of the WMA. This complex consists of three individual soil types within a matrix of such small inclusions that they are not shown separately on a map. The general percentage of each soil type is: Rockaway fragipan at 45%, Chatfield at 25%, Rock outcrop at 20% and other minor components at 10%.

The second most abundant soil group in SMWMA is the Chatfield-Hollis-Rock outcrop complex (ChkC) covering about 9% of the area. It has very similar qualities to RokD except that it is found on gentler slopes, ranging from 0-15%. ChkC is most abundant in the southwest portion of the WMA, near stands 2 and 10, but other large patches are located in Stands 8 and 30.

The third most abundant soil is Catden mucky peat (CatbA) covering about 7% of the WMA. Unlike the aforementioned soils, CatbA is a poorly drained soil that experiences frequent ponding and inundation. These soils are always associated with wetlands, and are located in depressions or on nearly level ground. Because of this, they have a high organic content. Small clusters of CatbA are found scattered throughout SMWMA.

More detailed information on the soil characteristics can be located within the Custom Soil Resource Report for SMWMA (USDA NRCS WSS, 2013).

2.8 - NJ BEST MANAGEMENT PRACTICES FOR FORESTRY AND WETLANDS

The New Jersey Forestry and Wetlands Best Management Practices Manual (hereafter referred to as the BMPs) is a practical, comprehensive guide outlining the best methods for minimizing adverse effects to soil and water quality while implementing forest management practices. While the manual was developed in 1995 specifically for use in New Jersey, it incorporates well established practices that have been mirrored from widely accepted strategies for mitigating soil and water concerns across the United States. The BMPs will be referenced throughout this Plan when discussing particular situations. A copy of the BMPs can be obtained by contacting NJDEP directly or by visiting the website:

http://www.state.nj.us/dep/parksandforests/forest/nj_bmp_manual1995.pdf

2.9 - HYDROLOGY

Hydrology and the impact of active management can be viewed through multiple lenses at SMWMA. At the micro level, individual water bodies can be directly impacted through physical manipulation and destabilization by equipment. At this level, resource concerns are generally addressed by employing the proper BMPs described earlier. Examples of resource degradation occurring from forestry activities can usually be traced back to improper BMP implementation. The second lens for viewing forest hydrology is the possible indirect effects that forestry activities might have on down-slope water chemistry, sediment loads, and water temperatures at a watershed, or sub-watershed scale. These effects tend to be less tangible because they are more difficult to measure, and they may occur over long periods of time. Fortunately, an extensive amount of long term research has been done to better understand the effects of forest management practices on watershed health. Some of the best available science comes from the Coweta Hydrologic Laboratory, which was established in 1934 as a research facility of the USDA Forest Service, Southern Research Station. Other notable watershed research areas include the Fernow Experimental Forest in Parsons West Virginia, and the Hubbard Brook Experimental Forest in central New Hampshire. A synthesis of the comprehensive data coming from years of monitoring the long term effects of silvicultural, particularly clear-cutting, at these research facilities was recently published (Swank, W.T., and J.R. Webster, 2014). The study areas include a number of similar forest types to those found at SMWMA, and present a reasonable comparison to the expected conditions at SMWMA. In fact, given that most of the research clear-cut areas are exponentially larger (upwards of 150 acres in size) than typical projects in New Jersey, the data gleaned from these studies could be viewed as a conservative estimate of what would occur at the WMA. While many values and conditions have been measured and described in the synthesis of research, some extraordinary consistencies occur.

- Clear-cutting generally resulted in short-term water yield increases due to decreased evapotranspiration, but returned to pre-harvest levels within a few years as regeneration became established.
- The greatest sediment load problems arose from poor road construction delivering suspended material directly to streams. Overland flows were rarely observed.
- Selection method harvesting had no obvious effect on watershed stream temperatures. In clear-cuts where no vegetated buffer was maintained along streams, stream temperatures generally were a few degrees higher during the growing season and a few degrees lower during the dormant season, but returned to pretreatment levels with 3-5 years. When a 50-foot-wide buffer strip was maintained, clear-cutting had no effect on stream temperature. This would imply that subsurface groundwater down-slope of a clear-cut treatment with a vegetated buffer would also maintain a stable, pre-harvest temperature.

Within the larger watershed of SMWMA are varied hydrologic features including natural and

manmade ponds, streams, wetlands, flooded forests and vernal pools. Any proposed work in the vicinity of these features will integrate the appropriate conservation measures and recommendations outlined in the BMP manual, which have proven to be effective when properly implemented. Conducting forestry activities within wetlands and the riparian zones of streams can be exempt from having individual permits issued from NJ Division of Land Use Regulation (DLUR), provided the following criteria are met:

- 1.) The activities are prescribed in a Forest Management or Stewardship Plan that has been approved by the NJ Forest Service (NJFS) prior to the activities taking place.
- 2.) The activities are conducted in accordance with the BMP Manual.
- 3.) The activities are small in scale and they do not obstruct the water flow.
- 4.) The work does not consist of “clear-cuts” in a wetland, exempt under certain circumstances deemed necessary by the NJFS to regenerate the stand.
- 5.) Any potential impacts to Threatened or Endangered species are addressed.

For all management activities occurring along bodies of water, a Streamside Management Zone (SMZ) will be established prior to commencing work. Equipment use will be limited or restricted in the SMZ. As deemed appropriate, temporary bridges and other conservation measures will be employed to reduce erosion and sedimentation into the water body in accordance with the BMPs. The width of the SMZ is determined based on the erodibility of neighboring soils and slopes. The SMZs referenced below are general sizes ascertained from the BMPs based on the general surrounding conditions. However, given the variability found within each site, the actual SMZ will be adjusted according to field conditions at the time of practice implementation. The list below focuses on the primary hydrologic features found at SMWMA. Other smaller water features not included on this list will receive identical considerations and buffers per the BMPs prior to management. Bodies of water that are directly adjacent to the property will also receive the same BMP considerations.

Ponds

- Collins Pond: Located in the southwestern portion of the WMA just east of Hawthorne Lake Road, directly underneath the PSE&G Utility ROW. Surrounding slopes range between 11-20 percent, requiring a minimum 40 foot SMZ.
- Edison Pond: Located in the southeastern portion of the WMA less than 0.1 miles east of Edison Road. The pond is a manmade product of mining, and is located near the Edison Monument. Surrounding slopes range between 0-10 percent, requiring a minimum of 25 foot SMZ.
- Ryker Lake: Located in the southeastern corner of the WMA directly north of Glen Road, with access from Edison Road. The lake is categorized as a bass and perch conservation lake by NJDFW. The surrounding slopes range from 0-20 percent, requiring a minimum 40 foot SMZ.

Streams

- Russia Brook: The headwaters of Russia Brook are found in a series of tributaries and wetlands in the southeastern portion of the WMA. Russia Brook is classified by NJDEP as an FW2-TP, meaning it has trout production waters with reproducing trout. The surrounding slopes range from 0-20 percent, requiring a minimum 40 foot SMZ.
- Unnamed stream between Lake Gerard and Beaver Lake: Surrounding slopes range from 0-10 percent, requiring a minimum 25 foot SMZ.

- Unnamed stream west of Tamarack Lake: Surrounding slopes ranging from 0-10 percent, requiring a minimum 25 foot SMZ.

Wetlands

- Southeast Wetland: The wetland encompasses the stream that flows from the north into Ryker Lake. This wetland has exceptional resource value since it is known to harbor several Rare, Threatened, or Endangered Species (RTEs).
- Hawthorn Lake Road Wetland: Narrow strip of wetlands lying near the intersection of Hawthorne Lake Road and Edison Road. It contains evidence of ephemeral streams that were completely dry during the summer months.
- Other Small Forested Wetlands: There are several other small wetlands pockets on the WMA that are generally less than two acres in size. They are typically forested with an overstory of red maple and/or yellow birch. The understory is often swamp azalea and highbush blueberry.

Vernal Pools

Vernal pools are temporary bodies of water that provide habitat for a rich diversity of vegetative, aquatic, and amphibious species. After being inundated with the winter-spring precipitation, the pools dry up for a portion of the year, eliminating fish and other predators that are dependent on year round water.

A map detailing the known or suspected locations of vernal pools (NJDEP GIS layer) on SMWMA is included in the attachments to this plan. The property may contain other vernal pools that are not mapped, but will be addressed during the layout phase prior to implementation of management activities at project sites. Although vernal pool recommendations may be adjusted by NJDFW's Endangered and Nongame Species Program (ENSP) staff at specific locations in accordance with the site conditions encountered, the default conservation measures employed at vernal pools will be the management recommendations provided for "Pool Depressions, Protection Zones, and Life Zones" detailed in the NRCS - Vernal Pool Habitat in Conservation Planning document (Vermont Biology Technical Note 1., 2010).

2.10 - LAND USE HISTORY

Hunter-gatherer tribes roamed this region of New Jersey as early as the first retreat of the glaciers. The extent of their impact on the land continues to be debated, although there seems to be agreement that they did manipulate the environment through purposeful burning and selective tree cutting. Anthropogenic influences continued to increase with the development of slash and burn agriculture and the establishment of semi-permanent villages along streams and lakes. Landscape level changes were firmly established with European settlement, as forests were converted to pastures and cultivated fields. Timber was utilized to build homes and supply warmth. Then, the fuel needs of the industrial revolution in the late 19th and early 20th centuries further enhanced the conversion of forests to barren land. Maximum deforestation of New Jersey is thought to have occurred around 1850. The state had been essentially cleared of trees, with very few isolated pockets of forests escaping untouched. Today, New Jersey has fewer than 2,000 acres of forest remaining intact since before the deforestation occurred. SMWMA does not contain any of these pockets.

Old stone home foundations, rock walls, apple trees, and old barbed wire fencing can be found in various locations throughout the property - providing evidence of past farming activities. However,

it was Thomas Edison who had the greatest impact on this region. In the 1890's he purchased much of the land in the area, including most of SMWMA, where he established an iron mining and processing company. Here, a large scale iron processing plant converted the ore from five local mines into briquettes for iron smelters. Today the five mines are known collectively as the Edison Mines. Edison also built a railroad system on the property to ship the briquettes to Pittsburgh.

The property also contains the remains of two large strip mines where limestone was extracted. Significant amounts of zinc and Franklinite were also mined from the area. Several smaller mines are either still exposed, or have caved-in over time. Despite all of the mining, the property has reverted to woodland, and is primarily covered by mid-succession forests that are less than one hundred years old (NPS, 2014).

2.11 - LANDSCAPE LEVEL CONSIDERATIONS

Management activities proposed within this FSP will conserve landscape level biological diversity, water resources, soils and other high conservation values within the New Jersey Highlands in multiple ways. Landscape considerations include general uses and trends, forest types and conditions, waterways crossing SMWMA, diversity of habitats, and wildlife species affected by habitat changes.

Objectives are aimed at maintaining, enhancing, or restoring under-represented ecological conditions that would naturally occur on sites with appropriate conditions. Habitat connectivity at the multi-stand and multi-ownership scale has been considered. Sections of SMWMA where old growth plant communities would have likely occurred will be managed to enhance old growth characteristics. Other areas might be managed for different attributes. While some recommendations may seem to focus on individual species, it should be recognized that these “umbrella” species are used to demonstrate why a particular condition is under-represented on the landscape, and that management for these species will benefit a suite of species requiring similar habitat, but are of no less importance. A relevant example is management directed towards the Golden-winged warbler (GWWA). The Golden-winged Warbler Working Group designated focal areas to target management for GWWAs based on forest cover and proximity to known GWWA breeding locations. Public and private parcels in northwestern NJ were further prioritized for GWWA management based upon elevation, size, and distance to known GWWA breeding locations. SMWMA is within the focal area and all parcels in the WMA ranked highest for GWWA suitability.

According to a recent Forest Stewardship Plan developed for nearby Weldon Brook WMA (Kallesser 2013), there is greater than 14,000 acres of public land within relative proximity to SMWMA, as depicted in the table below.

Rockaway River WMA	2,800 acres
Weldon Brook WMA	1,550 acres
Sparta Mountain WMA	3461 acres
Mt. Paul tract (Division Parks & Forestry)	1,165 acres
Other DEP or Natural Lands Trust	290 acres
Mahlon Dickerson Reservation	3,805 acres
Newton Water Commission & Sparta Glen	900 acres
Other county & municipal lands	<u>340 acres</u>
Subtotal known public lands	14,311 acres

Using the 2007 Land Use/Land Cover GIS data, NJDFW examined the amount of known habitat available to GWWA within the roughly 14,000 acre landscape. Habitat considered usable by

GWWA includes: Deciduous Brush/Shrubland, Deciduous Forest (10-50% canopy closure), Mixed Scrub/Shrub, Mixed Forest (10-50% canopy closure), and Old Field (<25% brush) (State of NJ, 1996-2013). The total area usable to GWWA within the landscape is 831 acres, amounting to less than 3% of the forest and wetland land mass (Kalleser 2013). Based on the GWWA Habitat requirements outlined in the Appalachian Region GWWA BMPs, we believe there is even less usable acreage. The GIS data layer did not consider elevation, or surrounding landscape matrix – GWWAs prefer young forest that is surrounded by at least 70% deciduous forest. Further, the data range of 10-50% canopy closure includes acreage beyond the more typical 30% canopy cover associated with GWWA habitat, and it is impossible to determine the amount or species of shrubs with this GIS data layer.

The GWWA focal area within the Highlands Region also includes private forests. While some are of substantial size, the average private forest parcel in NJ is 12 acres (U.S. Forest Service 2011). The management occurring on these family forests has been driven during the past few decades by the tax abatement requirements of the Farmland Assessment Act (FLA). FLA requires landowners to produce annual income from forest products, which has proven to reduce the ability of small landowners to employ even-aged management techniques that produce early successional forests and promote certain forest types. This, along with other social perceptions of forest management in New Jersey has significantly contributed to reduced habitat diversity throughout the region. Because of these limitations, managing for species like GWWA rests almost entirely on the management of public lands. Despite this, NJDFW has made efforts to work with nearby private landowners to incorporate landscape management concerns when possible. Outreach to forestry consultants managing other nearby tracts has yielded positive results towards collective management efforts. Since 2009, several GWWA management projects have been implemented on surrounding properties through collective management. NJA manages the adjacent Sparta Mountain Preserve with the same issues in mind. This collective landscape management effort helps to concentrate (or distribute) management efforts more effectively.

Catastrophic landscape level natural disturbances occur infrequently, but can significantly alter ecosystems when they happen. American chestnut blight, Dutch elm disease, and most recently Hemlock Woolly Adelgid are all evidence of how this can happen. With the continued emergence of new threats (Emerald Ash Borer and Beech Bark Disease to name a few), a more proactive approach is needed to buffer concentrated stresses. This requires landscape level approaches.

Under most climate change models the frequency of extreme weather events is projected to increase, presenting additional implications for forest health. We saw in 2012 how Hurricane Sandy affected certain forest types more than others. A forest managed for landscape level diversity will be more resistant to these influences. Management prescriptions in this plan incorporate elements of enhancing age class diversity and forest species diversity to meet this goal.

2.12 - AREAS OF ARCHEOLOGICAL, CULTURAL AND TRIBAL SIGNIFICANCE

Following stakeholder consultation with municipalities and research using the New Jersey Geographic Information Network, there were no areas of archeological significance identified on SMWMA. Like many other undeveloped forests in the region, there are old stone foundations and rock walls on the property. Any such structures in the vicinity of stewardship activities will be identified and preserved.

Areas of cultural significance are limited to the area around Edison Monument. Edison Monument and Edison Pond are located on the east side of Edison Road, roughly two miles north of the intersection with Glen Road in Sparta Township. There are no planned management activities that will disturb these cultural features.

The Native American Lenni-Lenape people are known to have had a historical presence in New Jersey. There are two state recognized bands of the Lenni-Lenape tribe located within the region of SMWMA; the Nanticoke and the Ramapough. To date, only the Nanticoke band is federally acknowledged. In January of 2012, phone calls and correspondence were sent to both bands soliciting information on the tribal significance of the SMWMA lands, to which only the Ramapough Nation responded. Their response, coupled with on-the-ground research, stakeholder input, and a GIS database search, concluded that there are no areas of tribal importance within the SMWMA or on adjacent properties. Per FSC standards it has been determined that the means in which inquiries were made with the tribe were culturally appropriate.

3. SOCIOECONOMIC IMPACTS OF FORESTRY

Approximately 35% of the land in New Jersey is forested (~2 million acres). While the total amount of forest has remained relatively constant since recovery from maximum deforestation in the late nineteenth century, the ownership and use patterns have changed dramatically. Today, roughly 63% of the forestland is privately owned and 37% is public (U.S. Forest Service 2011).

In the earlier part of the 20th century, much of Sussex County's economy had been based around agriculture and mining. Areas that weren't farmed were heavily logged to produce charcoal for forges and furnaces. Wood and charcoal was also freighted by rail to nearby cities where it was burned by homeowners as their primary source of heat. The logging activities were unsustainable, and eventually the industries crawled to a standstill when trees were no longer available for harvest.

As the New Jersey economy shifted from agrarian to industrial, many farms were abandoned as workers took jobs in urban centers. Abandoned lands and lands logged for fuel gradually reverted back to the forests that we see today. Despite these changes, much of NJ remained rural. Then, as development pressure increased in the 1960s, New Jersey began aggressively acquiring open space through public bond initiatives such as the Green Acres program. Along with similar funding initiatives on the local level, thousands of acres have since been preserved from development. While resources were concentrated on preservation efforts, little attention was afforded to the impacts of converting this much land to public ownership in such a short time. The public's attitude towards "preserving" public land became ingrained on passive ownership, and local industries associated with the harvesting and processing of forest products from these properties declined steadily. The industry decline was compounded by the increased availability of lucrative land clearing work associated with the large scale development clearing. While development has slowed some, the industry dynamics remain, and very much affect stewardship possibilities. The absence of a viable market for forest products eliminates any income potential from wood products to offset the costs associated with stewardship work. It creates a financial burden that prevents landowners from enacting practices to enhance forest health and resiliency. Because of this, it is important for leaders in conservation to find environmentally sustainable and socially responsible ways to utilize New Jersey's renewable forest resource as a way to offset costs associated with stewardship on a meaningful level. With public land occupying a significant proportion of New Jersey's forests, it is imperative that public officials consider the socioeconomic impacts of their actions, as well as how this impacts surrounding private forest lands. A decision to do nothing can have many consequences that are equal to, or greater than, the consequences of taking a management action.

Management activities in this plan are recommended based on ecological criteria, but they also create opportunities to generate revenue by capturing some of the inevitable mortality of trees. This revenue can help offset the costs of stewardship, making it sustainable. Public land management that does not consider the monetary value of natural resources within the long term stewardship framework is not only irresponsible, but should be considered a violation of the public trust. This

should be an easy task, since there is overwhelming public support of using locally sourced products to decrease carbon footprints and promote “green” jobs.

4. MAJOR FOREST TYPES

SMWMA contains an array of forest types. Most of the forestland is mixed hardwoods, but there are also areas dominated by declining eastern hemlock, pure red maple, or pure black birch (mostly occurring in scattered pockets too small to be considered their own stand). The mixed hardwood stands may be split into two main categories based on soil type and hydrology. On drier upland sites, oak and hickory species dominate. These include red, scarlet, black, white and chestnut oaks, along with mockernut, pignut and shagbark hickories. On the more mesic sites, red maple, sugar maple, sweet birch, yellow birch and white ash are more common, with lesser amounts of tulip poplar, basswood and black cherry. The utility easements are managed regularly by the power companies and tend to be dominated by a mix of primary successional species including gray birch and sassafras. Aside from the easements, most of the co-dominant overstory trees on SMWMA are within the range of 65 to 100 years old (as determined by tree ring coring completed during the inventory).

5. WILDLIFE

5.1 - DESCRIPTION OF WILDLIFE ON SPARTA MOUNTAIN WMA

Because of the relatively large size of SMWMA and its position within a larger forested landscape, it is reasonable to expect that suitable habitat should be available for a wide range of wildlife. A number of species were observed daily during the forest inventory process. Most are considered common in New Jersey and are not unique to SMWMA. Typical examples include white-tailed deer, black bear, eastern wild turkey, gray squirrel, chipmunk, coyote, red fox, beaver, several types of turtles and snakes, bats, and a variety of song birds. Other less common species have been documented on the property by others, many of which are labeled as threatened, endangered, or species of special concern. They are documented in the Natural Heritage Program database report for SMWMA. Ruffed grouse is a species that has become increasingly rare and was documented during seasonal monitoring efforts.

The mission statement of the NJDFW is to: *protect and manage the State's fish and wildlife to maximize their long-term biological, recreational and economic values for all New Jerseyans*. With this mandate there is an obligation to maintain, to the extent possible, existing wildlife populations at levels that are viable and sustainable. For some species that thrive under the existing environmental conditions in New Jersey, this task requires no effort. However, given the fragmented landscape and anthropogenic influences on New Jersey forests, for other species this requires more than passive land acquisition efforts.

On the roughly 63% of NJ forests that are private property, the only tools available to maintain stable wildlife populations are via regulatory controls; e.g.: setting bag limits for game species, enforcement of laws related to the “take” of an endangered species, or the enforcement of laws surrounding habitat degradation for wetland obligate species. While these actions have their place, they do not enhance conditions for any species that may be declining. Therefore, the burden of counteracting the negative influences of having over 8 million people residing within an area of 8,729 square miles rests largely on managing public forest land. Given the varied and sometimes conflicting objectives for different publically owned tracts, it is clear that in regard to NJDFW, the best opportunity to manipulate or curtail population declines reside within the wildlife management areas that they control.

Declines associated with wildlife populations on SMWMA are not easily attributed to one factor, especially since the species involved do not all share the same habitat requirements. It is likely that a combination of influences have a cumulative negative effect on certain species. However, recent research projects are beginning to illustrate that many species thought to be obligates to a particular ecological community, also require additional communities for less well understood phases of their life (nesting, post fledging, foraging, breeding, raising young, etc.). It is this complexity of habitat types within a larger forest matrix that supports and sustains biologically rich environments. While other factors may also play a role, it is difficult to otherwise explain the continually declining populations of such a varied compilation of species in what is otherwise considered large, protected, undeveloped tracts of land. This phenomenon is not exclusive to SMWMA, but is present throughout New Jersey.

With a more proactive management approach for declining wildlife species, SMWMA should be capable of harboring larger populations of those species that have been known to occupy the site in the past, while maintaining suitable strongholds for those species that are currently stable and can persist in larger forest blocks of uniform age and character. This is especially true given the landscape considerations described earlier.

5.2 - CONSERVATION OF RARE, THREATENED AND ENDANGERED SPECIES

Portions of section 5.2 have been adapted and reprinted from Land Dimension Engineering's 2009 FSP, written by Robert Williams (Williams 2009). Specific material referenced by Williams is cited within text of the 2009 FSP. Specifically, an updated Natural Heritage Program data report for this property was requested in 2013 and is included in Appendix 17.1.

Rare Wildlife

Forty-one wildlife species listed as state endangered, threatened, or special concern, were identified at Sparta Mountain WMA based on the Natural Heritage report. The list of wildlife species included in the report is summarized in Table 2.

Table 2. Endangered, Threatened, and Special Concern Wildlife, Sparta Mountain WMA.
E=Endangered, T=Threatened, SC=Special Concern, D=Delisted, P=Petitioned

Common Name	Scientific Name	State Status	Federal Status
Arrowhead Spiketail	<i>Cordulegaster obliqua</i>	SC	
Bald Eagle	<i>Haliaeetus leucocephalus</i>	E	D
Barred Owl	<i>Strix varia</i>	T	
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	SC	
Blackburnian Warbler	<i>Dendroica fusca</i>	SC	
Black-throated Blue Warbler	<i>Dendroica caerulescens</i>	SC	
Black-throated Green Warbler	<i>Dendroica virens</i>	SC	
Blue-headed Vireo	<i>Vireo solitarius</i>	SC	
Bobcat	<i>Lynx rufus</i>	E	
Bog Turtle	<i>Glyptemys muhlenbergii</i>	E	T
Broad-winged Hawk	<i>Buteo platypterus</i>	SC	
Bronze Copper	<i>Lycaena hyllus</i>	E	
Brown Thrasher	<i>Toxostoma rufum</i>	SC	
Brush-tipped Emerald	<i>Somatochlora walshii</i>	SC	

Canada Warbler	<i>Wilsonia canadensis</i>	SC	
Cerulean Warbler	<i>Dendroica cerulea</i>	SC	
Cooper's Hawk	<i>Accipiter cooperii</i>	SC	
Eastern Box Turtle	<i>Terrapene carolina carolina</i>	SC	
Golden-winged Warbler	<i>Vermivora chrysoptera</i>	E	P
Great Blue Heron	<i>Ardea herodias</i>	SC	
Harris' Checkerspot	<i>Chlosyne harrisii</i>	SC	
Hooded Warbler	<i>Wilsonia citrina</i>	SC	
Indiana Bat	<i>Myotis sodalis</i>	E	E
Jefferson Salamander	<i>Ambystoma jeffersonianum</i>	SC	
Least Bittern	<i>Ixobrychus exilis</i>	SC	
Least Flycatcher	<i>Empidonax minimus</i>	SC	
Longtail Salamander	<i>Eurycea longicauda longicauda</i>	T	
Northern Copperhead	<i>Agkistrodon contortrix mokasen</i>	SC	
Northern Goshawk	<i>Accipiter gentilis</i>	E	
Northern Parula	<i>Parula americana</i>	SC	
Pied-billed Grebe	<i>Podilymbus podiceps</i>	E	
Red-shouldered Hawk	<i>Buteo lineatus</i>	E	
Spatterdock Darner	<i>Rhionaeschna mutata</i>	SC	
Timber Rattlesnake	<i>Crotalus horridus horridus</i>	E	
Veery	<i>Catharus fuscescens</i>	SC	
Whip-poor-will	<i>Caprimulgus vociferus</i>	SC	
Williamson's Emerald	<i>Somatochlora williamsoni</i>	SC	
Winter Wren	<i>Troglodytes troglodytes</i>	SC	
Wood Thrush	<i>Hylocichla mustelina</i>	SC	
Wood Turtle	<i>Glyptemis insculpta</i>	T	
Worm-eating Warbler	<i>Helmitheros vermivorum</i>	SC	

If the proposed treatment schedule is adhered to, at the end of this plan period SMWMA will have between 110 – 310 acres (3% – 9% of its total), being managed in various stages as “Early Successional Habitat” and 140 – 335 acres (4% – 10% of its total) being managed in various stages for the development of “Old Growth” conditions, or in some cases, “Climax Forest” conditions. This balance will ensure the longevity of species breeding in mature forests while allowing for the eventual recovery of species breeding in young forests.

Treatments that involve vegetation or tree removal can potentially have a negative impact, either directly or indirectly, on rare, threatened, and endangered species that occupy the site (see Appendix 17.1). For federally-listed species, a summer bat survey that follows the most recent [Service guidelines](#) will be conducted by ENSP in 2015 and again at year five of the FSP. If any potential winter habitat (mines) occurs at SMWMA, winter surveys will be conducted in coordination with the USFWS. While our field surveys for rare plant species found no evidence of *Isotria medeoloides* on Sparta Mountain WMA, this federally-listed plant species has been documented within 1 mile of the property. Therefore, we will work closely with the Office of Natural Lands Management (ONLM) during the development of our forestry practice plans to ensure that this species is not impacted during the implementation of our forestry activities.

To further minimize any risks to rare species or their habitat, heavy machinery will be washed offsite before use and the following conservation measures will be employed on SMWMA where applicable:

1. Mechanical removal of woody or herbaceous vegetation will occur between November 15 and April 1.
 - a. According to ENSP, currently there are no known or documented active raptor nests within SMWMA, but there are documented nests near SMWMA. If an active nest, or territorial behavior is observed indicating a nest, is nearby, work in the area will cease from January 1 through November 15 for bald eagle nests and March 1 through November 15 for all other raptor nests.
 - b. Areas with un-even aged management prescriptions will retain at least 60% canopy cover. Areas with even-aged regeneration management prescriptions will be < 30 acres in size and irregular in shape as the topography allows. Stumps ≥ 1.5 m in height will be retained. Trees to be retained vs. removed will be clearly demarcated. Large diameter (≥ 11 inches dbh) shagbark hickory trees will be retained. Snags and trees with cavities will be retained. Select trees will be girdled if necessary.
 - c. All known primary or secondary roost trees used by Indiana bats or northern long-eared bats will be retained with a 500-foot forested (>60% canopy cover) buffer.
 - d. Selective foliar herbicide will be avoided between May 1 and August 15 to minimize possible bioaccumulation in bats and impacts to nesting birds.
2. Wetlands:
 - a. A 100-foot forested buffer from all wetlands as well as a minimum 50-foot undisturbed vegetated buffer between all rare plants (S1-S3) and intense management activities will be retained. Any trees and snags ≥ 5 inches dbh with exfoliating bark will be retained within 300 feet of all wetlands. If necessary, motorized equipment will only be used in wetlands (not vernal pools or wood turtle streams) between November 1 and March 31.
 - i. Motorized equipment, selective foliar and radiarc herbicide applications will not be used within 900 feet from a vernal pool between March 1 and August 31
 - ii. Motorized equipment will not be used within 300 feet from wood turtle streams
 - iii. If forest management is to be done near bog turtle habitat, temporary flagging will be used to mark a 100-foot buffer from bog turtle habitat during forestry activities and removed when completed.
 - iv. No heavy machinery will be used within 100 feet of bog turtle habitat, including the creation of logging roads or skid trails.
 - v. Only hand application of glyphosate or other wetland-approved herbicide to control invasive plant species will be used within 100 feet of bog turtle habitat, if needed.
 - b. According to ENSP, currently there are no known nesting colonies of great blue herons or other colonial waterbirds. If an active nest or nesting colony is observed work will cease in that area from March 1 through November 15
 - c. Pesticides are not proposed to be used in this FSP, but select herbicides may be used as needed. No broadcast herbicide application will be done within 100 feet of wetlands, vernal pools, or ephemeral ponds.
3. Provided the area does not meet any of the instances above, mechanical removal of herbaceous or low woody vegetation may be done any time of year in areas with sparse vegetation, such as logging roads and skid trails. If so, caution will be used

while using motorized equipment to avoid hitting basking snakes.

Although active habitat manipulation has been a fixture of game management for decades, the concept is more novel when considered for nongame wildlife or rare plants. As mentioned earlier, our strategy here is to promote managing for habitat types that will benefit a wide range of species using examples of rare species commonly thought to be indicative of those underrepresented habitats. The following is a discussion of how the SMWMA forest of today differs from past conditions, and a description of key ecological conditions that are currently under represented and might be targeted for management.

Structural Change

Pre-Columbian era SMWMA would have looked similar to today's forest in the context of overall cover, but it would most certainly have looked different on the stand level than it does now. Obviously, this is largely attributed to the direct anthropogenic influences of the last century. Mass deforestation and a simultaneous regrowth created a homogenous forest that now contains a narrow age class distribution, unlike any former forest composition would have been. This is true at the regional landscape level also, as 75% of New Jersey's forests fall within the ages of 40 – 99 years old (US Forest Service 2011). In comparison, pre-settlement New Jersey would have contained a much less homogenous age class distribution due to relatively frequent natural disturbance patterns (Lorimer and White, 2003). Now however, development fragmentation has skewed how natural disturbances affect forests. For example; numerous studies have demonstrated that forest fire played a natural role in perpetuating oak forests throughout the eastern US in pre-settlement times, and that those processes have been short-circuited by a number of human induced factors since then (US Forest Service 2005). The simplest example being that today, fires are extinguished or controlled long before they affect significant acreage. Even if we consider disturbance factors beyond fire (*i.e.* severe storms, flood scouring, beaver activity, etc.) human development has altered the frequency with which these factors affect the remaining undeveloped forests in New Jersey. Today, New Jersey has about 35% of the forests that occurred before European settlement, and the probability of a disturbance element affecting a house or a farm is twice that of a forest. This probability may be even further skewed when we consider that certain landscape features have a higher predisposition to being affected (coastal forests for hurricanes and severe storms, riparian corridors for flooding and scouring, xeric ridge-tops for forest fires), and these same areas have been the most highly developed in New Jersey. Clearly, a more diversified forest mosaic containing varied ecological successional stages would be more representative of prior conditions when ecosystem function was more effective. Therefore, we need to explore management techniques that purposefully mimic those conditions on specific sites in order to restore ecosystem balance and function.

Old Growth

Because the values we associate with old growth (*i.e.* larger diameter trees, stand complexity, and copious amounts of coarse woody debris in various stages of decay) are similar across different forest types despite their age, old growth forests are probably best defined by these characteristics rather than an absolute age. Embedded within this complexity is the simple fact that all trees eventually die, and in the absence of a stand replacement disturbance event, they do so at different times. Therefore, an old forest must continually recruit new trees under a relatively continuous canopy through a process known as gap-phase replacement, whereas trees become established in the small canopy gaps occurring as individual trees die. As such, old growth forests contain a complex of many different aged trees. In forestry terms, these forests are referred to as *uneven-aged* forests. The key to understanding uneven-aged growth dynamics is that certain suites of species are favored under this process, and that most other species cannot germinate or grow well under the limited light conditions created by small canopy gaps. The limited number of overstory tree species that have evolved enough shade tolerance to persist in these conditions are therefore self-

perpetuating, and over a protracted period of time, tend to develop into what is otherwise known as a climax forest. Conversely, large scale disturbances cause significant tree mortality and subsequent stand-wide replacement with new trees. Because of this, old growth forests are unlikely to occur in places that are subject to relatively frequent, large scale disturbance factors. This explains why old growth historically dominated places such as inland New England, New York and Canada, which are less prone to large scale disturbances than New Jersey is (Lorimer and White, 2003).

When considering the geography and topography at SMWMA, old growth stands would have most likely been associated with ravines and moist coves that are protected from both fire and excessive wind events. The overstory tree species that are typical of these sites are hemlock, beech, yellow birch, red maple and sugar maple. These species continue to exist at SMWMA, and should be favored in sites that are most conducive to their long term success, where old growth stands can be maintained.

The current dominance of even-aged forests on SMWMA greatly diminishes the habitat quality of those species generally considered old growth obligates, or at least those showing preferences for nesting among large trees. At least three species matching this description are found on the SMWMA: the Northern goshawk, Barred owl and Cerulean warbler. While they all seemingly have a nesting preference for large trees, the forest composition, structure and mosaic of habitats are equally important. For example, in a study conducted on goshawk populations in the southwest, it was demonstrated that goshawk habitat can be categorized into three critical spatial components: nesting habitat, post fledging areas, and foraging areas (Reynolds et al. 1992). Reynolds noted that while nesting habitat is dominated by large trees and old growth characteristics, the other two critical habitats contain a mosaic of forest structures and age classes that better support prey species. While the forage base is different for ceruleans, similar habitat variations exist as reported in the Management Guidelines for enhancing Cerulean Warbler Breeding Habitat in Appalachian Hardwood Forests (Wood et al. 2013). The varied forest structure that comes with this mosaic of habitats could also benefit another suite of species that nest in dense midstory and understory (e.g., Wood thrush, Kentucky warbler, Indigo bunting, Hooded warbler, and Worm-eating warbler). Habitat for these species is greatly limited in SMWMA also, mostly due to the lack of vertical structure in the mid-successional even-aged forest.

Clearly, old growth stands are important components of forest ecosystems, and although it may seem counterintuitive to actively manage for old growth, certain silvicultural techniques can be used to enhance old growth attributes by accelerating individual tree diameters, creating canopy gaps to build vertical stand structure, and leaving behind residual coarse woody material. As we begin to better understand the importance of stand heterogeneity with regards to forest interior species within large areas of contiguous forest, it becomes clear that if we are to keep certain rare species on the landscape at SMWMA, there is a need to maintain a matrix of varied forest conditions in relative proximity to developing old growth areas.

Hemlock Ravines

One of the most disastrous examples of the impact that invasive species can have on an entire ecosystem can be seen in the hemlock ravines found on SMWMA. For many rare species found at SMWMA, hemlock ravines may be the only habitats they nest in (Northern Goshawk, Winter Wren, Black-throated Green Warbler, Broad-winged Hawk, and Blue-headed Vireo) and their future survival in the region is certainly in doubt. Without something to effectively counteract the impact of the hemlock Woolly Adelgid, many of these species will disappear from the region. In addition to the decline of habitat for rare plants and animals, the loss of hemlock from SMWMA will have other far-reaching results. Given the cooling shade and soil stabilization qualities of hemlocks along riparian corridors, trout stream temperatures may rise and siltation is likely to increase. This will affect overall water quality within the watershed. The options available to

mitigate hemlock loss are currently limited, but could include strategies that concentrate growth on the best existing individuals that exhibit some possible genetic resistance. This will maintain seed sources until biological controls are identified. Another option could be introducing alternate conifer species that could serve as an ecological surrogate.

Rare Plants

A Natural Heritage Database report prepared on January 3, 2013 identified eight species of rare plants, three of which are state endangered, documented from within or in the immediate vicinity of Sparta Mountain WMA. An additional nine state endangered rare plant species were reported within the one mile search requested for projects subject to the Flood Hazard Control Act (FHCA) Rule. The one mile search results are limited to only those state endangered, wetland plant species that are covered by the FHCA rules.

In a separate effort, DFW and NJ Audubon contracted out an extensive field survey for rare plants. Between July and October 2013 and again between May and June 2014 plant surveys were performed by Wild Ridge Plants, LLC (Rosenbaum 2013 and 2014; See Appendix 17.8). Due to financial constraints, the entire 3,000-acre WMA could not be inventoried. Therefore, NJA and DFW provided guidance to the botanists contracted to conduct the surveys in stands where forestry activities are likely to occur as well as any areas likely to contain rare plants based on past surveys, historical sightings, and the botanists' expertise on the ecological niches NJ's rare plants are known to occupy. Based on the completed survey reports, it appears that these areas primarily consisted of either mesic forests around wetlands (both forested and emergent), or xeric environments (open areas along the utility corridors, thin soil outcrops and road edges).

This effort resulted in 32 additional species of rare plants, six of which are state endangered. The specific findings of the Heritage Database review and the rare plant field surveys are included in Appendices 17.1 and 17.8, respectively, and are summarized in Table 3.

Table 3. State Endangered Plant Species and Plant Species of Concern, Sparta Mountain WMA.

Scientific Name	Common Name	S-Rank	State Status
<i>Anemone cylindrica</i>	Long-head Anemone	S1	E
<i>Aplectrum hyemale</i>	Puttyroot	S1	E
<i>Asclepias quadrifolia</i>	Four-leaf Milkweed	S3	
<i>Aster urophyllus</i>	Arrow-leaf Aster	S2	
<i>Bromus ciliatus</i> var. <i>ciliatus</i>	Fringed Brome	S2	
<i>Calla palustris</i>	Wild Calla	S3	
<i>Carex aggregata</i>	Glomerate Sedge	S2	
<i>Ceratophyllum echinatum</i>	Spiny Coontail	S2S3	E
<i>Chenopodium simplex</i>	Maple-leaf Goosefoot	S2	
<i>Desmodium cuspidatum</i> var. <i>cuspidatum</i>	Toothed Tick-trefoil	S2	
<i>Dicentra canadensis</i>	Squirrel-corn	S1	E
<i>Doellingeria infirma</i>	Cornel-leaf Aster	S2	
<i>Elymus trachycaulus</i>	Slender Wheatgrass	S1	E
<i>Epilobium leptophyllum</i>	Bog Willowherb	S2	
<i>Equisetum sylvaticum</i>	Woodland Horsetail	S3	
<i>Eragrostis frankii</i>	Frank's Love Grass	S2	

<i>Galium trifidum</i> var. <i>trifidum</i>	Small Bedstraw	S2	
<i>Glyceria grandis</i> var. <i>grandis</i>	American Manna Grass	S2	E
<i>Juncus articulatus</i>	Jointed Rush	S2	
<i>Juniperus communis</i> var. <i>depressa</i>	Dwarf Juniper	S1	
<i>Kalmia polifolia</i>	Pale-laurel	S1	E
<i>Lactuca hirsuta</i> var. <i>sanguinea</i>	Red-stem Hairy Lettuce	S2	
<i>Lechea intermedia</i> var. <i>intermedia</i>	Large-pod Pinweed	S2	
<i>Lilium philadelphicum</i> var. <i>philadelphicum</i>	Wood Lily	S2	
<i>Lycopodium hickeyi</i>	Hickey's Ground-pine	S3	
<i>Lysimachia thyrsiflora</i>	Tufted Loosestrife	S3	
<i>Milium effusum</i>	Tall Millet Grass	SH.1	E
<i>Panicum oligosanthos</i> var. <i>scribnerianum</i>	Scribner's Panic Grass	S2	
<i>Phegopteris connectilis</i>	Northern Beech Fern	S2	
<i>Platanthera psycodes</i>	Purple Fringed Orchid	S2	
<i>Poa languida</i>	Drooping Spear Grass	S2	
<i>Potamogeton obtusifolius</i>	Blunt-leaf Pondweed	S1	E
<i>Potamogeton robbinsii</i>	Robbin's Pondweed	S2	
<i>Salix lucida</i> ssp. <i>lucida</i>	Shining Willow	S1	
<i>Selaginella rupestris</i>	Rock Spike-moss	S2	
<i>Sphagnum angustifolium</i>	Narrow-leaf Burr-reed	S1	E
<i>Sphagnum fuscum</i>	Sphagnum	S2	
<i>Sphagnum subsecundum</i>	Sphagnum	S1	E
<i>Sphagnum teres</i>	Sphagnum	S2	
<i>Spiranthes ochroleuca</i>	Yellowish Nodding Ladies'-tresses	S3	
<i>Utricularia intermedia</i>	Flat-leaf Bladderwort	S3	
<i>Utricularia minor</i>	Lesser Bladderwort	S1	E
<i>Vaccinium oxycoccos</i>	Small Cranberry	S2	

The survey report provides details that will be incorporated into the specific management activities with input from ONLM and other stakeholders prior to implementation. All plants with a conservation value of S1-S3 will be considered during the implementation of this plan, which will occur during the development/implementation of practice plans. By consulting with the ONLM and by submitting Practice Plans through the NJDEP Lands Management Review Process, our forestry work will minimize impacts and maximize benefits for these plants species to the maximum extent practical. In situations where existing data sources do not provide a high degree of confidence that RTE plants are accounted for, the acreage in question may be re-inventoried for increased certainty. Otherwise, if a treatment is to take place in a stand(s) known to have a plant or plant community actively listed on the NHP report, then that area will receive one of three high conservation value considerations explained below. More information about Representative Sample Areas (RSAs) and PSI may be found in subsequent sections within this FSP or within FSC-US FM Standard v.1.0, Criterion 6.4, found at: <http://us.fsc.org/download.fsc-us-forest-management-standard-v1-0.95.pdf>

Consideration 1: A state endangered plant or plant community is found within the treatment stand and treatment is expected to enhance habitat suitability for said plant or plant community. An RSA preserved in a fixed location, within the eco-region, of similar size, distribution and abundance will be established, maintained and documented as per FSC Criterion 6.4.

Consideration 2: A state endangered plant or plant community is found within the treatment stand and treatment is not expected to enhance habitat suitability for said plant or plant community. An RSA preserved in a fixed location, within the Forest Management Unit (FMU), of similar size, distribution and abundance will be established, maintained and documented as per FSC Criterion 6.4.

Consideration 3: A federally threatened or endangered plant or plant community is found within the treatment stand. The specific location of the endangered plant or plant community will be determined, delineated and buffered, as necessary from any treatment activities.

Existing threats to rare species vary, but include changes in habitat, habitat fragmentation, invasion by non-native species, and deer herbivory. The information obtained from the plant surveys contracted out, while not comprehensive, indicated that most of the rare plants found were located in open environmental conditions along the utility rights-of-way (ROWs). The fact that these plants continue to persist in the face of repeated manipulation and herbicide treatments by the power companies is a testament to their ability to thrive in highly disturbed environments. However, as regulations promulgated by the Board of Public Utilities increase pressure on companies to more effectively limit woody vegetation growth within the ROWs, these plants may succumb to intense herbicide use and much more frequent maintenance measures. Instead of leaving their existence to the fate of the utility companies, we can manage areas outside of the ROWs near existing source populations to become reservoirs for these plants by mimicking conditions on the ROW. That strategy may be easier said than done, given that little is known about the life cycle for many of these plants. However, it seems certain that the current conditions outside of the ROWs are largely not conducive to their growth, and the first step to manage these plants is to create similar habitat nearby, and employ adaptive management strategies to better understand what does and does not work.

Other rare plants known to be in SMWMA are located in wetlands, or in moist woodlands near hydrological features. Effective protection of these species will be taken into account before initiation of any stewardship activities. Since hydrology seems a key feature associated with these plants, management activities that significantly alter soil moisture and temperature around these plants will be avoided. Fortunately there have been long-term watershed monitoring studies conducted in conjunction with large scale forestry projects at the Coweta, Fernow, and Hubbard Brook Experiment stations that have examined how watersheds react to intense silvicultural treatments (Swank, W.T., and J.R. Webster, 2014). We can look to these studies to understand conditions that cause significant water temperature fluctuations that might affect these species. As mentioned earlier, partial cutting scenarios showed no detectable changes in downstream water temperatures, nor did clear-cuts that maintain a 50-foot-wide buffer to surface water. It would be assumed then, that plants suspected of being sensitive to soil moisture would not be affected by selection method harvesting systems, or larger stand openings that are buffered by at least 50 feet. In this plan, however, a 100-foot forested buffer from all wetlands will be retained.

While there is generally little known about the reproductive needs of many of these plants, for some of them, moderately small increases of sunlight might enhance flowering and seeding potential. Spring ephemerals are clear evidence of this, since by definition they emerge, flower and store reserves during a seasonal period that affords them more sunlight than they would otherwise receive during different growing times. This must occur within a small window of time between the last frost and full overstory canopy emergence. While we may not be able to suggest succinct forestry techniques that would indisputably expand that growth window for these plants, there is literature available for some of them suggesting increased flowering and seeding success with small increases in filtered light. Using the extensive watershed studies as the basis for management recommendations around moisture sensitive plants, we might be able to enhance conditions that are

more favorable for some of these species to reproduce. The obvious preferred silvicultural techniques would consist of specific thinning or partial cutting. Should this be implemented, the specific strategy for each plant will be addressed during development of individual practice plans for those sites, and be done in concert with knowledgeable botanists. In the instances where we are not attempting to target these species, maintaining a minimum 50-foot undisturbed vegetated buffer between moisture-sensitive plants and intense management activities, in addition to a 100-foot forested buffer around all wetlands, will avoid significant fluctuations in soil moisture temperature and protect those populations.

Early Successional Habitat

Early successional habitats (ESH) are not simply open areas; they are transitional stages between open conditions and a closed forest canopy. They are typically associated with some sort of disturbance, but in some cases ESH is perpetually free of large amounts of tree cover because of site constraints (e.g. excessively hydric or xeric soils). Regardless of their origin, they are characterized by a mix of grasses, forbs, shrubs and young trees. On SMWMA, ESH includes beaver ponds, shrub-dominated riparian corridors, bogs and utility ROWs. The ROWs are by far the most common type, and they are probably the least desirable form of ESH because of their linear nature. These features create permanent forest fragmentation that enhances predation on many species. Also, the manner in which they are currently maintained is problematic; as power companies become more efficient at eliminating woody vegetation with herbicides, these environments become increasingly less diverse and useful for a diversity of wildlife.

The signature species for early successional habitat on the SMWMA is GWWA, which has very specific nesting habitat needs. Management emphasizing these needs will benefit numerous other species, including those not generally considered dependent on ESH. Studies are now finding that many forest interior species utilize ESH during post fledging periods because of the increased insect and forage diversity found there (Stoleson 2013).

During the past 45 years, the GWWA has experienced one of the steepest declines of any North American songbird. This decline is attributed to the loss of habitat and regional land use changes (GWWA Working Group 2013). Despite the widespread decline, localized GWWA populations have positively responded in recent years to deliberate habitat manipulation in central Pennsylvania (Larkin pers. comm. 2014), so it is possible to increase breeding success if high quality habitat is purposefully created.

Another problem for GWWA has been invasion of its habitat by the closely related Blue-winged Warbler (BWWA). BWWA populations have expanded as historic GWWA shrub-scrub habitats have succeeded into young forest. GWWA and BWWA hybridize readily, and BWWA can often out-compete GWWA to claim nesting sites on marginal GWWA habitat. Two significant differences between the species are an elevation threshold (BWWA generally preferring below 900 feet), and the overall forest cover within the landscape (GWWA preferring greater than 70% overall forest). Therefore, to maintain habitat for GWWA, sites must be located in a largely forested landscape of relatively high elevation. Additionally, because of the narrow ecological window where the proper complex of vegetation exists, sites must either be continually manipulated to hold back succession, or new territories of sufficient acreage need to be recruited regularly. Utility ROWs have offset some habitat loss in the past, as vegetation maintenance intervals were typically very irregular, sometimes extended upwards of 20+ years between re-entry. This allowed for natural succession and woody stem development to occur. However, recent regulatory changes accompanied by stiff fines for non-compliance have made power companies more aggressive about preventing woody vegetation development within easements. This increasingly reduces habitat availability for GWWA and other ESH dependent species. If we are to stabilize or restore ESH dependent wildlife populations, we need to have ESH on the landscape at a

sustainable level, and if that no longer occurs naturally (due to anthropogenic influences discussed earlier), then we need to purposefully create it. Maintaining approximately 7-15 % of the forest matrix in early successional habitat at any given time would mimic natural disturbance patterns for age class distributions within the New Jersey region (Lorimer and White 2003). This could be accomplished by periodically setting back succession in the same locations, or by continually recruiting new acreage and allowing disturbed areas to transition to more mature forests. The latter option provides greater age class and habitat diversification on a landscape level.

The following recommendations are meant to broadly describe target treatments using GWWA as an umbrella species for ESH creation. Actual implementation will follow the guidelines set forth by the GWWA Working Group - *Best Management Practices for GWWA in the Appalachian Region 2013*.

The silvicultural treatment used to establish regeneration associated with ESH is dependent on a number of factors including the species involved, the size of the treatment area, and the size of the overstory trees. With poor outlets existing for forest products in New Jersey, we anticipate that treatment areas will generally be much smaller than those being implemented in other states – probably on the order of 5 – 10 acres at a time. The preferred silvicultural technique for cuts of this size is referred to as: *Seed Tree with Wildlife Reserves* harvesting. Areas targeted for treatment preferably should be within ½ mile of the power lines or other GWWA habitat, and should be spaced at least ¼ mile apart to avoid having too much open area in relation to overall forest cover and to avoid territory overlap (Larkin pers. comm. 2014). Treatment areas should be five or more acres in size and have a residual 10% - 30% tree canopy cover (generally greater 9” inches DBH). A high degree of heterogeneity is important, so treatments may leave small clusters to make up the proper residual stocking rather than having it uniformly spaced. If cuts are adjacent to the ROW, a tree buffer will be maintained between the two in order to avoid expanses that lack a forested edge or residual tree cover. Ideally, treatments should be transitioned into more mature forest by creating a feathered edge with heavy thinning or shelter-wood harvesting to provide enhanced shrub structure and a gradual transition from the more intense seed tree harvest. This mature forest/dense shrub adjacency is important GWWA fledgling habitat (Larkin pers. comm. 2014).

The ideal vegetation structure generally takes three to five years post treatment to develop into suitable GWWA habitat, and may remain so for up to ten years. The treatment area may receive prescribed fire near the end of its lifespan to reduce woody stem density and extend suitability for GWWA (GWWA Working Group, 2013).

6. RECREATION AND AESTHETICS

The SMWMA offers many opportunities for public recreation including; hunting, hiking, mountain biking, running, fishing, cross country skiing, and wildlife viewing. Although wildlife management should be the primary emphasis for any Wildlife Management Area, it is paramount to balance habitat treatments at SMWMA with the recreational needs that users have grown to expect from this property. This balance will be achieved by treating small acreages at a time (where public use might be restricted for safety concerns), leaving most of the property undisturbed and completely open to the public. Management activities proposed throughout this FSP will improve recreational experiences by enhancing ecosystem services. However, silvicultural treatments may be temporarily unattractive to many. This can be mitigated to some degree through the use of leave-tree buffers around treatment areas known to receive more use, like well-known trails and vistas. Educating the public to the idea that an open park-like understory is less ecologically valuable than dense forest with downed trees and slash, may help to redefine the public’s view of forest aesthetics. This could be accomplished through strategic interpretive station placement.

Unpermitted motorized vehicle use (ATV's, cars, and dirt bikes) are causing noticeable negative impacts to the forest resource (e.g. trail erosion and watercourse sedimentation, introduction of invasive plants). This pressure will only increase as the human population increases. Illegal motorized vehicle use may be curtailed through enhanced law enforcement efforts, additional signage informing riders that vehicle use is not permitted, and strategic installation or repair of forest gates.

7. FOREST HEALTH AND ECOLOGY

7.1 - PRESENT AND POTENTIAL FOREST HEALTH ISSUES

The SMWMA has several current forest health related issues. This section presents the most prevalent problems. Strategies to deal with forest health issues are embedded within the Stand Prescriptions.

Hemlock decline was discussed earlier, but is worth mentioning again here. Eastern hemlock is found mostly in northwestern stands of the SMWMA, and has been decimated by the Hemlock Woolly Adelgid (HWA). Elongated hemlock scale is another persistent pest of hemlock that is often found in association with HWA. Affected trees turn from healthy dark green to a yellow-green color with a grayish hue, and have sparse foliage. Tree mortality typically occurs four to ten years following initial infestation. There are very effective controls available for controlling HWA on individual trees, but stand-wide treatments are financially and logistically impractical. Several biological controls have been developed, and may eventually prove successful at keeping HWA at moderate levels.

Gypsy moth outbreaks have also occurred in the region and continue to present a concern. Although Gypsy moth they are known to feed on over 300 tree species, they prefer oak. While they don't always kill trees outright, repeated defoliations can make trees highly susceptible to other stressors, such as drought and pathogens. When this occurs, entire stands may be killed simultaneously. In recent years, gypsy moth outbreaks have been less frequent due to two biological control agents; the first is *Nucleopolyhedrosis Virus* (NPV), and the second is *Entomophaga maimaiga* fungus. NPV and the fungus control normally lag slightly behind caterpillar development, which often allows for some level of defoliation to occur. A key to combating this problem is maintaining tree vigor, which can be an issue for heavily stocked stands.

Emerald Ash Borer (EAB) was identified in New Jersey in 2014, prior to the final draft of this plan. Since its first occurrence in Michigan in 2002, it has quickly spread into many states, causing near 100% mortality among ash trees. By the time the insect is found, population levels have typically already reached infestation levels, and quarantines have been unsuccessful. Mitigation strategies include reducing the amount of ash in ash dominated stands in order to convert them to other stand types, and favoring mid-sized vigorous stems that have shown the best resilience to EAB. Several systemic insecticides are effective at controlling EAB, but their use in forest settings is not applicable. Fortunately, SMWMA does not have any significant ash dominated stands, but ash is a component of the forest, and EAB impacts will need to be considered when implementing habitat treatments. Generally, it is recommended that ash not be favored as leave trees in silvicultural treatments.

American beech groves throughout the SMWMA periodically display signs of Beech Bark Disease, however, the disease is not widespread. The vector for Beech bark disease in the United States is the beech scale insect, *Cryptococcus fagisuga*. As the insect feeds through the tree's thin bark, it exposes the host to two different fungi (*Nectria coccinea* var. *faginata* and *Nectria galligena*) that cause a canker to form. As the canker expands in size, it disrupts nutrient transport through the

phloem and the tree eventually dies. Some beech trees are believed to be genetically resistant to the fungus and will be carefully favored through management. Affected beech trees commonly respond to infection by asexual propagation through root sprouts, which also will be genetically predisposed to the disease and may further exacerbate its spread.

Forest type conversion is a threat to the overall ecosystem health at SMWMA. Much of SMWMA is considered oak-hickory forest type, and those species play an important role in the ecology of northern New Jersey. In fact, oak forests in the region have been remarkably stable over the past 9,000 years (Maenza-Gmelch 1997), allowing oak dependent species to co-evolve with the forests. The recent anthropogenic disruption of natural disturbance (particularly fire) creates a positive feedback loop that promotes the natural conversion from oak-hickory overstory, to a shade tolerant northern hardwood mix that is dominated by maple-beech-birch. Most shade tolerant northern hardwood species evolved in the absence of fire and are relatively thin-barked, making them susceptible to scorching by low intensity ground fire. Regular, low intensity ground fires will remove shade tolerant regeneration from the understory, creating more open conditions conducive to oak regeneration, thus preventing that forest type conversion from occurring. Today, red maple is the second most numerous tree species statewide, and *the* most numerous tree species in northern New Jersey (U.S. Forest Service 2013). The vast majority of these red maple stems are small diameter understory trees, which over the last 25 years have increased from saplings size to pole sized trees fourfold (U.S. Forest Service 2013), pointing to a maturation and conversion to shade tolerant dominance. Considering that the current conversion trend favors forest composition that is projected to be less suitable for this region under all climate change models, bigger implications may be realized in the future. If fire cannot be effectively utilized in suburban landscapes to maintain natural species composition, then we must either accept the inevitable decline of oak and its companion species, or purposefully manipulate sites to mimic fire to extent possible.

7.2 - DEER HERBIVORY

White-tailed deer have historically been part of this landscape, and continue to exist within SMWMA. As such, some level of herbivory should be expected within the forest, and evidence of deer browse can be found in the areas most likely to harbor deer. During the course of collecting data for this plan, actual observations of deer were relatively infrequent compared to other forests in the central portion of New Jersey. When the ground is snow covered, large expanses of forest can be traversed without crossing a set of deer tracks. The general condition of the understory, including herbivory indicators, is also better than those found in the central portion of the state. Anecdotal support of these observations were also provided through discussions with people hunting on the SMWMA, who generally felt that hunting here was more difficult than the agricultural areas in central New Jersey, because there are fewer deer. While deer herbivory must always be a concern for forest stewardship, current impacts from deer on SMWMA do not appear to be as detrimental to natural tree regeneration and a healthy herbaceous layer as do other factors.

Overall on SMWMA, species richness of herbaceous plants is high, but plant robustness (flowering and fruiting) is generally considered as low (Section 7.3: Herbaceous Layer). The extent to which deer are the major factor for this lack of robustness is debatable. Some might argue that site conditions correlating to plant community development under changing successional stages are an equal, if not greater factor than deer. An indication of this is that in pockets where site conditions are otherwise favorable, robustness is high. In these locations, tree regeneration (including oak) is also robust and diverse in height. Regeneration on these sites has exceeded normal browse height. Where site conditions are less than optimum, most of the understory is stagnant and low in height, making it more susceptible to browse. These observations imply that SMWMA likely experiences adequate hunting pressure to maintain a deer population that is compatible with the resource. It is important that deer browse be carefully analyzed on a parcel by parcel basis in order to alter

management strategies when necessary. FSC certification requires annual forest health monitoring of this property. Data will be collected during annual site visitations, and evidence of deer browse will be recorded and tracked. If it becomes necessary during the term of this plan, NJDEP will ensure the SMWMA's deer herd has not exceeded its ecological carrying capacity or has become detrimental to forest regeneration.

7.3 - HERBACEOUS LAYER

The herbaceous layer at SMWMA was inventoried systematically throughout the 3,281 acres with 1/500 acre fixed radius sample plots. Several professional ecologists and staff from Bowman's Hill Wildflower Preserve helped NJA field staff strengthen their herbaceous layer identification skills during the inventory. Observations were recorded from July 24, 2012 to August 6, 2012.

Percent coverage and density of groundcover was variable throughout the property. Forested plots had a relatively low groundcover diversity and density, while plots located near power line easements and in wetlands had significantly higher amounts. Overall, 250 plant species (71 of which are native herbs), were recorded during the 2012 inventory process. Common species that were found include: Pennsylvania sedge, striped wintergreen, goldenrods, asters, partridgeberry, Christmas fern, cinnamon fern, false Solomon's seal, Canada mayflower, Virginia creeper, sensitive fern, wild sarsaparilla, bedstraw, poison ivy, woodland sedge, mapleleaf viburnum, and common cinquefoil. Other interesting flowering herbaceous plants that were observed outside of inventory plots include pink lady slipper, yellow lady slipper, and cardinal flower.

An additional vegetation study was conducted by M. Van Clef et al. (2013) (See Appendix 17.93 for full report). This study covered 1,904 of the roughly 3,200 acres that make up the SMWMA, and did not utilize the same inventory design or stands as presented within this FSP. The report notes that optimal woody cover within the deer browse zone at SMWMA is presently less than half of his targeted threshold values.

Additional information on herbaceous species may be found in Section 5.2 – Conservation of Rare, Threatened and Endangered Species, Rare Plants.

7.4 - PLANT STEWARDSHIP INDEX (PSI)

The SMWMA PSI (Bowman's Hill Wildflower Preserve) was calculated on overall plant data from all 33 stands (Table 4). NJA's aggregated PSI site report is available in Appendix 17.4 of this plan. The data is publically available from NJA for future stand or treatment comparisons.

Table 4. Summary of the Plant Stewardship Index at Sparta Mountain WMA.

Site Summary			
This list contains 127 plants, of which 86% (109) are native to New Jersey			
Average statistics			
Plant Stewardship Index	Total Mean C	Native Mean C	Floristic Quality Index
27.04	5.31	5.51	28.15
Aggregate statistics			
Plant Stewardship Index	Total Mean C	Native Mean C	Floristic Quality Index
47.10	4.51	5.26	54.88

7.5 - INVASIVE SPECIES

Invasive exotic species pose a threat to the native plants and wildlife of the SMWMA. Although invasive plants are not abundant throughout the property, there are some occurrences and they will be closely monitored to minimize future spread. Invasive, non-native plants observed at SMWMA are mostly concentrated along roads and the most frequently traveled trails. The most prevalent species of concern found on the property include Japanese barberry, multi-flora rose, Japanese stiltgrass, Japanese knotweed and garlic mustard. (See Appendix 17.3 for NED Ground Vegetation Reports). The general observation is that these plants are not outcompeting native plants on a scale large enough to warrant management independent of other activities.

Before implementing management proposed in this plan, invasive species populations will be evaluated at project sites, and when more than five percent of the vegetation consists of invasive plants, the site will be pre-treated with mechanical or herbicide applications deemed most appropriate for the species in question. Post management project evaluation for invasive species will occur at a frequency no less than: after year one to assess immediate resource concerns, again at year three to assess newly emerging concerns resulting from the project, and at year ten to evaluate long term success of the project with respect to minimizing the proliferation of invasive plants. Should the population of invasive vegetation exceed five percent of the total during an evaluation period, then the subject plants will be treated with a combination of mechanical or herbicide treatments deemed most appropriate to the species in question. While treating invasive plants, compliance with all NJ Forestry and Wetland BMPs will occur. Herbicides may be applied in the form of soil spots, basal sprays, hack and squirts, stem injections, or direct foliar sprays. It is paramount to choose the proper time of year for application, and any chemicals used shall not be found on FSC's Highly Hazardous List.

8. RATIONALE FOR RATE OF ANNUAL HARVEST AND SPECIES SELECTION

The management activities that are prescribed in this plan are compliant with all NJ State laws and BMPs, and they conform to the principals and criteria of the FSC. Harvesting considerations include: species regional occurrence, maintaining vegetative biological diversity, and overall health and vigor. Rates and methods of timber harvest are driven by desired future conditions, and are expected to improve or maintain health across SMWMA. Stocking levels that are below or above optimum, regardless of the cause, will be managed to achieve desired stocking levels and composition at the earliest practicable time. The rate of annual harvest at the SMWMA shall never exceed levels that can't be permanently sustained per FSC Criteria 5.6.

The term "sustained yield" harvest refers to harvesting at a rate that does not exceed growth over successive harvests, and harvesting in a manner that contributes directly to achieving desired future conditions in a way that does not diminish the long term ecological integrity and productivity of the site.

The maximum sustainable yield of SMWMA is 1,197 cords per year. This volume had been mathematically determined using USFS Forest Inventory Analysis (FIA) Data for New Jersey (US Forest Service 2013). FIA data provides average in-growth volume annually for each forest type, which was applied on a per acre basis to the individual forest types in SMWMA. Since 2011, a total of 639 cords of wood were harvested from the property as part of habitat improvement projects. This *three year* total is roughly half of the *annual* sustainable yield allowed.

9. REPRESENTATIVE SAMPLE AREAS (RSAs)

RSAs are areas of a property that are preserved due to their unique, *regionally* un-duplicated vegetative characteristics. These unique ecosystems (within the landscape) shall be protected in their natural state and recorded on maps, appropriate to the scale and intensity of operations and the uniqueness of the affected resources per FSC Criterion 6.4. They are established as ecologically viable representative samples to serve one or more of the following purposes:

- 1) To establish and/or maintain an ecological reference condition
- 2) To create or maintain an under-represented ecological condition
- 3) To serve as a set of protected areas or refugia for species, communities, and community types not captured in other FSC standards; as to prevent them from becoming rare

Those RSAs fulfilling purposes one and three will generally be fixed in location. RSAs serving purpose two may move across the landscape as under-represented conditions change, or may be fixed in area and manipulated to maintain the desired conditions.

SMWMA consists of one naturally occurring major ecosystem, classified as: *Mid-Atlantic Mixed Hardwoods*, which is not regionally unique or uncommon. All minor forest types found in this ecosystem are also found in several state parks (including Wawayanda State Park less than five miles away), which are all preserved from conversion to non-forest use, and are not actively managed. Therefore an RSA on SMWMA is not required. More information on Wawayanda State Park may be found on NJ DEP's website:

<http://www.nj.gov/dep/parksandforests/parks/wawayanda.html>

10. NON-TIMBER FOREST PRODUCTS (NTFPS)

NTFPs are considered all *commercially* harvested forest products except timber, including other materials obtained from trees such as resins and leaves, as well as other plant and animal products. There are no NTFPs harvested commercially from SMWMA.

11. DESCRIPTION OF HARVESTING TECHNIQUES AND EQUIPMENT

As per FSC requirements, management plans must discuss harvesting techniques, and how timber will be extracted from the property. This section explains the regulatory framework, potential equipment that might be used, and the potential silviculture employed.

All NJDEP timber sales are legal contracts governed by state law, and all NJDFW timber sale contracts require that employees and contractors adhere to the 1995 Forestry and Wetlands BMP manual. Embedded within that BMP manual, among other things, is required compliance with freshwater wetlands laws, flood hazard control act laws, and threatened & endangered species laws. Noncompliance with the provisions of these laws is considered a breach of contract, subject to fines or other penalties to the extent allowed under New Jersey law for each offense.

The trees designated for harvest are always delineated in some fashion, typically using paint to mark a harvest boundary and individual trees. Trees may be felled by hand using a chainsaw, or by mechanical shears and cutters. Site operability, harvest complexity, and size of the timber harvest dictate the appropriate equipment and contractor. The logger and their agents must always carry solvent insurance and be adequately trained in case of an emergency or hazardous spill.

Skidders are the most common piece of equipment used on timber harvests in northern New Jersey. There are two types of skidders that have specific benefits. Cable skidders, oftentimes smaller in size, allow the logger to drag or winch logs around obstacles using metal cables to minimize residual damage while accessing hard to reach spots. Grapple skidders have one large grappling

claw on the back, and tend to be larger than cable skidders. The grapple skidder is oftentimes too large for the slopes and rocky outcrops indicative of SMWMA.

The common trade terminology used in silvicultural operations is often unfamiliar to those without formal training in forest ecosystem sciences. Below is an explanation for the four silvicultural systems applied within this FSP.

1. Seed Tree with Reserves - A form of even-aged management, where the objective is to regenerate a single cohort of trees that are the same age. Almost all trees, regardless of size are harvested. Traditional seed tree harvests only retain widely scattered individuals to supply future seed for regeneration. Normally, about 10-30% of the canopy is retained. On smaller projects (less than 5 acres) residual canopy cover is typically closer to 10%, and when projects are greater than 10 acres in size, 30% canopy will be maintained. Trees selected to be retained will have the best phenotype characteristics to pass on desirable genetic attributes. "Reserves" refers to trees that are retained for reasons beyond phenotype characteristics. Reserve trees that have been retained in past treatments at SMWMA are used as wildlife den trees, roost habitat for bats, and to maintain mast or seed crop diversity. Seed trees can be harvested once regeneration stocking is achieved in a final overstory removal (OSR) to further release the young trees. Alternatively, seed trees can also be left as future legacy trees. Given that projects implemented at SMWMA are not driven by the need to capture maximum financial returns from timber, it is unlikely that an OSR would be considered in the future.

2. Shelterwood - Another even-aged management system in which existing trees within the stand are harvested in a series of two or three of cuts. The purpose of the shelterwood system is to foster even-aged natural regeneration under the shelter of retained trees. Normally, about 40%-60% of the canopy is retained during the first cut, which removes suppressed and undesirable stems to make conditions suitable for regeneration to develop. After regeneration has reached adequate stocking density, an OSR is implemented to fully release those young trees (often 10 – 15 years later). Without an OSR, the new stand will eventually become suppressed under the existing canopy. The negative aspects to the shelterwood method are the increased likelihood of damage to regeneration during the OSR, and the higher operating costs for implementation and follow-up. By virtue of the fact that a significant portion of the stand remains intact during all stages of a shelterwood harvest, maintaining "Reserves" is implicit, and the word is not commonly used to describe the system.

3. Single Tree Selection - An un-even aged silvicultural technique which results in a forest with multiple ages and sizes. These are considered low intensity harvest activities, and are often distributed over a large area. To properly implement this system, trees must be removed from all size classes to more evenly distribute residual basal area among different size groups, and the residual stand must be comprised of stems that are of equal or better quality to those that were removed. If done properly, this will improve the overall vigor of retained trees. However, this harvesting system is not appropriate for all forest types, since many species cannot regenerate under the conditions created during single tree selection. It is not usually appropriate for oak-hickory types, and when employed in non-compatible forest types, it can exacerbate invasive species problems and result in a high-graded forest. As it pertains to SMWMA, this system can enhance understory conditions in existing shade tolerant stand types by allowing more filtered light to reach the forest floor. Single tree selection can be applied multiple times in a stand over a period of time. By virtue of the fact that a significant portion of the stand remains intact during all stages of a shelterwood harvest, maintaining "Reserves" is implicit, and the word is not commonly used to describe the system.

4. Group Selection with Reserves - Another uneven aged silvicultural system that focuses on creating small openings that can mimic natural gap disturbances caused by events like windthrow

and snow storms. Small groups of trees are removed to create openings that may be large enough to allow for some shade intolerant species to regenerate. The size of an opening varies, but is usually at least 1-2 times the height of the canopy trees, and less than an acre. Group Selection is the best application at SMWMA for areas being impacted by HWA. Group selection can be used to expand the openings around hemlock mortality so that conditions would allow for the incorporation of surrogate softwood species, or at least a variety of vegetation can become established in the absence of hemlock. The word “Reserves” here has the same meaning as explained for seed tree with reserves.

12. CARBON STOCKS

A main goal of this plan is to sustain a healthy, vigorously growing forest, capable of providing ecosystem services indefinitely. Healthy, vigorously growing forests sequester carbon more rapidly than stressed, slowly growing forests. Conventional thinking has been that as trees age, their rate of sequestration drops. However, a recent study has documented that trees continue to accumulate carbon at high rates even as they mature (Stephenson 2014). The study indicates that in the absence of disease, pests, and other stresses that hamper growth and cause eventual mortality, trees have the ability to continuously sequester carbon. Even with stress, large trees can proportionally sequester more carbon than small trees, even though the incremental growth appears slower. However, the same study recognizes that the additional carbon stored in fewer large trees does not outweigh the cumulative storage in many younger trees that can otherwise occupy the same amount of growing space in forest settings (Stephenson 2014). The authors further acknowledge that this age-related reduction in tree population density within forests is well documented in many other studies (Ryan, Binkly & Fownes 1997). Therefore, silvicultural recommendations that focus on concentrating growth on individual trees in areas designated for old growth development (uneven aged management) may be the most effective carbon sequestration techniques in those areas, while treatments designed to recruit new young stands with high stem densities (evenaged management) in other areas will serve to maximize carbon sequestration across the entire parcel. The NED software used to compile data for this plan calculates and tracks forest carbon sequestration. Accordingly, young forest carbon sequestration stabilizes at approximately 1.5 metric tons per acre per year in the region. To date, the forests of the SMWMA have actively sequestered approximately 126,981 metric tons of carbon in both dead and live standing vegetation (See Appendix 17.3 SMWMA NED 2 Inventory Data). Forest products removed during management activities are always utilized at their highest and best use, with much of it used as durable goods that trap sequestered carbon for extended periods.

13. STAND DESCRIPTIONS AND PRESCRIPTIONS

To best interpret this section of the FSP, the reader should also refer to the plan’s Ten Year Management Schedule and Stand Map. The Ten Year Management Schedule can be used as a tool to quickly guide readers to prescriptions of particular interest for any given year. Below are abbreviated data summaries for each of the 32 stands. More comprehensive data is provided for each stand in appendix 17.3.

Silviculture by definition is the “art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis” (Helms, 1998). The primary goal of any silvicultural recommendation contained in this plan is to enhance habitat for wildlife. The specific forestry practices are well documented, scientifically proven methods of vegetation management that have been employed extensively throughout similar forests elsewhere. Each prescription below refers to an aforementioned silvicultural treatment (i.e. - Seed Tree, Single Tree Selection, Group Selection and Shelterwood). The prescriptions outline the preferred treatment using the science behind

silviculture, while the art is usually applied in the field according to the conditions encountered. Embedded within the prescriptions are secondary goals such as the retention of large cavity trees, increasing mast production, maintaining plant diversity, and increasing the amount of coarse woody material on the forest floor. To avoid the redundancy of providing the same prescription details for multiple stands, once a prescription is initially explained, it is then referred to in subsequent instances where the same details are applicable.

Stocking levels referenced within the prescriptions are evaluated in relation to the appropriate species stocking charts found within the 2008 Edition of the *Timber Management Field Book*, published by the USDA Forest Service, Northeast Area State and Private Forestry, Newtown Square PA. Cordwood volume has been estimated from solid cubic foot volumes by dividing an average of 80 ft³ to adjust for the air voids contained in stacked firewood (Avery & Burkhardt 1994). Cordwood volume was then rounded to the nearest whole number integer.

Stand 1 Description

Size: 100.4 acres

Age: ~ 75 years

This is a mixed upland central hardwood forest type. It is considered overstocked for optimum individual tree growth based on the basal area in comparison to the number of trees per acre and average DBH. The forest is middle aged, and exhibits stem exclusion characteristics. Very little light reaches the forest floor, which inhibits natural regeneration and understory development. The average live crown ratio for co-dominant stems is less than 30% and the height to DBH ratio is high, indicating elevated inter-tree competition for sunlight. The stand is experiencing a moderately high degree of overstory mortality as a result of over-crowding. NED 2's Stand Visualization Simulator depicts the canopy cover at approximately 87%.

Operability: Excellent, gentle slopes in the west and stable soils allow for good access.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, sugar maple, chestnut oak

Understory: sweet birch, American witchhazel, pignut hickory

Basal Area/Ac & Quad. Mean DBH:

Red oak: 19.2 ft² -7.7"

Sugar maple: 18.3 ft² -6.3"

Chestnut oak: 12.5 ft² -14.1"

Total stand: 97.5 ft² -5.3"

Net Board Feet / Ac: 3,642 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1,035 cuft

Net Pulpwood Cords / Ac: 13 cords

Net Total Cubic Feet (cuft) / Ac: 1,537 cuft

Total Cords / Ac: 19 cords

Stems / Ac: 633

Unique and/or High Conservation Value Features: Stand 1 is bound by a PSE&G power line easement in the east. Stand 1 is also one of the locations where a small GWWA habitat improvement harvest took place in late 2011 into early 2012.

***Stand 1 Prescription:**

Portions of this stand will receive a Seed Tree with Wildlife Reserves treatment to increase age class diversification on the landscape scale. Other portions of the stand will receive a heavy uniform crown thinning to reduce crowding stress on co-dominant stems, enhance residual tree vigor, and enhance understory development. At seed tree



Image 1: SMWMA Post Seed Tree Conditions

management locations, widely spaced seed-bearing reserves of the best phenotype will remain to serve as a seed source for the new even-aged forest community. The management goal is to regenerate a cohort of shade intolerant species that are similar in terms of composition to the existing overstory. Non-target species that are otherwise well suited to wildlife uses may be retained for attributes such as den or roost trees, mast production, or to maintain under-represented species. Depending on the site conditions and the target species seed dispersal mechanisms, residual tree cover may be evenly distributed, or clumped in groups. The primary treatment goal is to create ESH targeting GWWA while regenerating shade intolerant oak species and other common associates, however, many other wildlife species are expected to benefit equally. Figure 5 below depicts the stand prior to being treated, and Figure 6 depicts the stand following the seed tree treatment. In treatments where the distance to a forested edge will exceed 250 meters, optimal GWWA tree retention is 10-15 trees per acre (TPA) – comprised of stems greater than 9" DBH. Where possible, large diameter trees with exfoliating bark will be retained as roost habitat for bats. The young forest regenerating after the seed tree harvest will develop into suitable GWWA habitat roughly 4-5 years post harvest, and will remain suitable for another 5-10 years. This timeframe may be lengthened by continued mechanical, herbicide, or prescribed burning treatments used to keep sapling stocking between 1,000 and 3,000 TPA and the shrub layer between 100 – 300 stems per acre. During the course of a recent adaptive management review of the 2011-2012 harvest blocks with GWWA experts, it was observed that treatment areas connected directly to the large utility easement at SMWMA may be too expansive to provide preferred GWWA habitat - when considered in the macro landscape context (Larkin, J. pers. Comm. 2014.). It is therefore suggested that a forested buffer is maintained between the easement and future treatment blocks to break the continuity between the two. The buffer can simultaneously be treated with a heavy thinning or shelterwood harvest to enhance understory development that has been found to be critical post fledging habitat for a number of bird species (Sheehan et. al. 2014.).

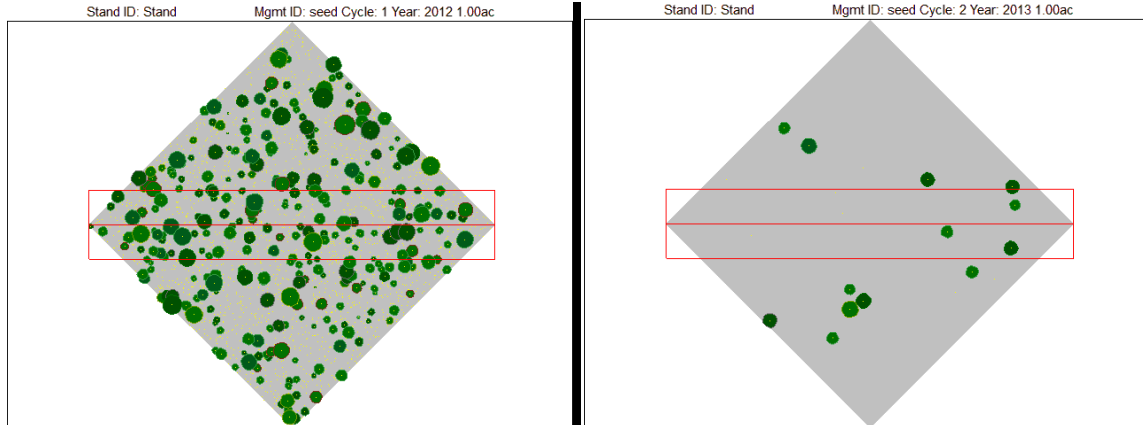


Figure 5: Stand 1 Overhead View Pre-treatment Figure 6: Stand 1 Overhead View Post-treatment

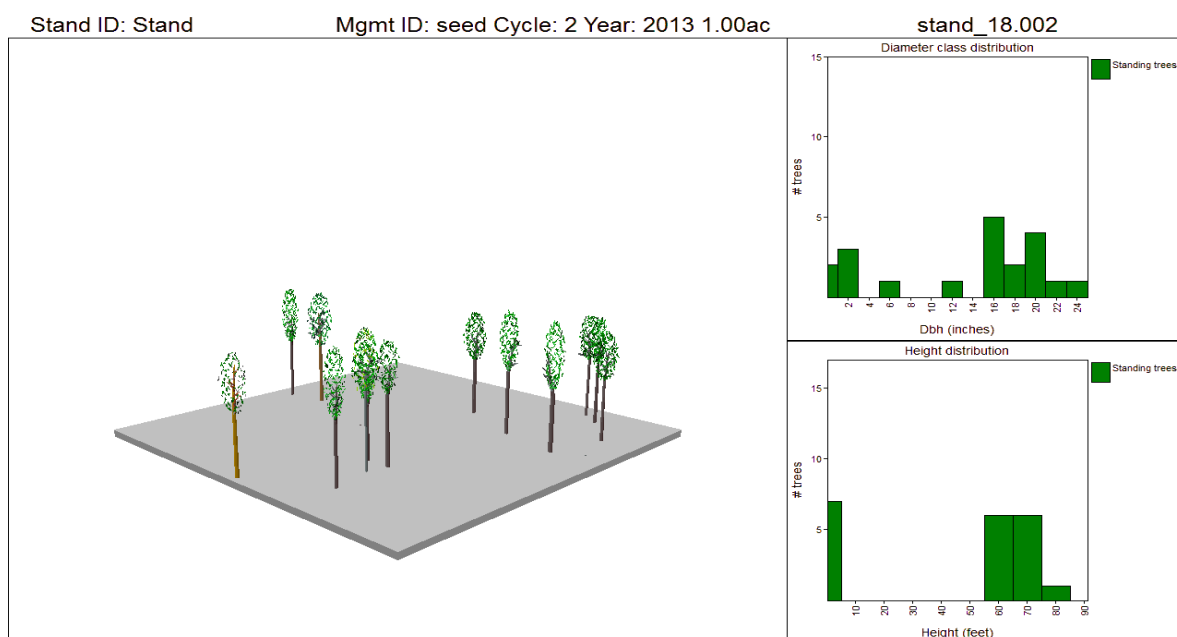


Figure 7: Stand 1 Overstory Conditions Post Seed Tree Treatment

Where needed, interfering understory plants that inhibit seedling development will be thinned from below mechanically during the seed cut, or treated with FSC compliant herbicide in conjunction with the cutting. Slash will remain on the ground to create favorable micro-climates for germination, protect new seedlings from browsing forest mammals, buffer soil erosion, and return nutrients back into the soil as they decompose. Some seed trees may be cut at a future time if they begin to inhibit new forest development, but more likely they will be left as “legacy” trees. Inventory observations conclude that the majority of invasive species within SMWMA are near roads, easements, streams and heavily traveled foot trails. Each harvest area will be evaluated for invasive species outbreaks and treated accordingly. As funding allows, a 100 foot corridor along all roads within this stand will be treated for invasive species as needed. Based on inventory observations, species of specific concern are multiflora rose, Japanese barberry, winged euonymus and Japanese knotweed.

Herbicides are generally the most effective treatment method for invasive plants. Herbicides will be selected based on their efficacy for the plants in question, and be applied by a licensed applicator in accordance with the manufacturer’s label. When possible, directed foliar and basal bark sprays can be used to minimize effect on non-target species.

Stand 2 Description

Size: 291.2 acres

Age: ~ 75 years

Stand 2 is classified as an upland oak stand type. It has a quadratic mean diameter of 7.9” and an average basal area per acre of 102ft². According to NED 2 projection models, within ten years the stand will be overstocked; with a predicted 124 ft² of basal area and roughly 1,400 TPA. At that time the stand’s second most dominant species, chestnut oak, will be overtaken by sugar maple indicating a stand species shift towards a shade tolerant northern hardwood species composition as illustrated in the table below.

Table 5. Shade tolerance versus stratum by basal area in Stand 2.

Crown Class	very intolerant	intolerant	intermediate	tolerant	very tolerant
open grown	0	0	0	0	0
dominant	0	0	0.7	0.2	0
codominant	2.3	2.3	48.7	9	0
intermediate	1.8	0.2	22	4.7	0
suppressed	0.7	0.2	6.5	0.8	0

There are no present health issues facing the stand, however, it is important to note that 5% of the stand's basal area is comprised of white ash. This species will remain monitored periodically for the presence of EAB.

The 2013 Rare Plants Survey (Rosenbaum 2013) indicates that state endangered Slender wheat grass is establishing on edges of Seed Tree harvests in Stand 2 and Stand 18.

Operability: Good; however there are steep rocky outcrops around the south-eastern section of Collins Pond. Portions of the stand also contain thickets of mountain laurel and boulders in the northwest. Slopes exceeding 10% are found northwest of the pond.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, chestnut oak, sugar maple

Understory: sugar maple, red maple, American witchhazel

Basal Area / Ac & Quad. Mean DBH:

Red oak: 23.0 ft²-7.9"

Chestnut oak: 14.3 ft²-11.4"

Sugar maple: 9.6 ft²-8.8"

Total stand: 102.4 ft²-7.9"

Net Board Feet / Ac: 3,964 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1,139 cuft

Net Pulpwood Cords / Ac: 14 cords

Net Total Cubic Feet (cuft) / Ac: 1,660 cuft

Total Cords / Ac: 21 cords

Stems / Ac: 301

Unique and/or High Conservation Value Features: Stand 2 includes a section of the PSE&G power line easement and is adjacent to Collins Pond, which is controlled by a man made dam on its south end. Stand 2 is also one of the locations where a GWWA habitat improvement harvest took place in 2011- 2012.

***Stand 2 Prescription:**

This stand will receive a Seed Tree with Wildlife Reserves treatment similar to Stand 1. As with stand 1, the goal of the treatment is to regenerate shade intolerant oak and associate species to create ESH focusing on GWWA requirements. Areas surrounding the seed tree treatments may receive heavy thinning or shelterwood treatments to feather the transition between seed tree and untreated forest, enhancing understory diversity in these locations.

The stand contains interfering understory plants that inhibit the development of more diverse vegetation. As with stand 1, these species will be thinned from below mechanically during the seed cut, or treated with herbicides as needed. Slash from the cutting will remain on the ground and overstory seed trees may be retained indefinitely as Legacy trees.

As resources allow, invasives will be treated with appropriate herbicides by a licensed applicator in the harvest area and along a 100 foot corridor on both sides of all roads within this stand.



Image 2: NRCS photo of slender wheatgrass

Additional caution will be taken during management so as not to interfere with slender wheatgrass populations existing in or around the stand. Slender wheatgrass is a state endangered, native, cool season, perennial grass that can quickly establish itself on sites following overstory treatment activity or disturbance. According to NRCS literature, this grass has the ability to occupy various sites, and both the foliage and seed provide a good year round source of food for a variety of wildlife.

Since this grass was found where harvest edges meet existing utility right of ways, it will be important to monitor the progress and future establishment of this endangered, ecologically valuable grass in more interior areas of the treated stand.

Stand 3 Description

Size: 31.2 acres

Age: ~ 80 years

Stand 3 is comprised of forested and scrub – shrub wetlands. The forest is represented by hardwood bottomland vegetation. White ash is the most dominant tree in the stand, and is well suited to the site. The emergence of EAB is a concern, and the stand will be monitored for it accordingly. Stand development and regeneration are poor due to hydrology and the presence of invasive species, e.g.: multiflora rose and Japanese barberry.

Operability: Poor; hydrology and boulders inhibit access without a solid winter freeze. FW2-TP waters within Stand 3 further limit access.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: white ash, sugar maple, red maple

Understory: American hornbeam, serviceberry, northern spicebush

Basal Area / Ac & Quad. Mean DBH:

White ash: 18.8 ft²-15.7"

Sugar maple: 11.3 ft²-3.1"

Red maple: 7.5 ft²-18.9"

Total stand: 48.8 ft²-4.8"

Net Board Feet / Ac: 3182 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 378 cuft

Net Pulpwood Cords / Ac: 5 cords

Net Total Cubic Feet (cuft) / Ac: 848 cuft

Total Cords / Ac: 11 cords

Stems / Ac: 226

Unique and/or High Conservation Value Features: Stand 3 is split by Russia Brook, a FW2-TP classified watercourse. The Russia Brook corridor connects this stand to existing areas known to harbor Federal and State Endangered species. Although the subject endangered species are not known to be here, the possibility exists. Therefore, all relevant management considerations for those species will be employed here before management occurs.

***Stand 3 Prescription:**

No overstory treatments are being proposed due to operability constraints and the relative sensitivity of the site. Invasive treatment is not warranted at this time because of the low probability for eradication of these well-established species. For now, the stand will receive annual monitoring

for EAB. Invasive understory treatments may become warranted if EAB affects the stand, as the subsequent ash mortality exacerbates their proliferation.

Stand 4 Description

Size: 49.4 acres

Age: ~ 80 years

Stand 4 includes a transition area between upland hardwoods and cove bottomland species found along the riparian corridor of the creek flowing south from the Bog to Ryker Lake. It contains the SMWMA's most significant areas of hydrology. Beaver dams and dens can be found throughout the wetland corridor, and have affected pockets of trees that are unable to tolerate the wet conditions in newly inundated areas. There are a few natural eskers within the wetland where the overstory vegetation flourishes. The rocky steep edges in the stand hold a few groves of American beech with minor signs of scale insect and Beech Bark Disease. Some of the Beech regeneration from root sprouts is undoubtedly a response to the disease.

Operability: Poor; wet areas, SMZ's, boulders and highly erodible soils limit the access potential to this stand.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: sugar maple, chestnut oak, northern red oak

Understory: American beech, serviceberry, sweet birch

Basal Area / Ac & Quad. Mean DBH:

sugar maple: 20.0 ft²-12.7"

chestnut oak: 15.0 ft²-16.4"

red oak: 12.5 ft²-10.6"

total stand: 85.0 ft²-9.9"

Net Board Feet / Ac: 3920 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 972 cuft

Net Pulpwood Cords / Ac: 12 cords

Net Total Cubic Feet (cuft) / Ac: 1492 cuft

Total Cords / Ac: 19 cords

Stems / Ac: 158

Unique and/or High Conservation Value Features: Stand 4 is bound in the east by the 319 acre Sparta Mountain Preserve owned by NJA. The wetlands of Stand 4 are known to contain rare species. The stream that divides the stand is the headwaters for Russia Brook, and is classified as an FW2-TP watercourse. The stand also contains a substantial component of trees with exfoliating bark, such as red maple and shagbark hickory. These species, coupled with an abundant insect food source along the riparian corridor, may provide good roosting and foraging habitat for the Indiana bat and northern long-eared bat.

***Stand 4 Prescription:**

Due to site conditions as well as species composition, this stand will contribute to the percentage of SMWMA acreage dedicated towards developing at least 10% of the property into an old growth stage of forest succession; balancing the 10% of the property (maximum) proposed to be managed in early successional stages at all times. It will remain integral that this stand receives regular monitoring throughout the term of this plan as to ensure its continued health and transition towards old growth.

The development of large diameter trees in a riparian corridor will enhance mature forest attributes and provide for the habitat needs of old growth obligates like Barred Owl, Cerulean Warbler and Northern Goshawk. Within the slotted treatment year, this stand will undergo a comprehensive FSC compliant Forest Health Checklist prepared by NJA; including among other things, sections on insects, disease, vigor, regeneration, stocking, riparian zones, roads, trails, and wildlife. The American beech component of this stand will require ongoing monitoring for evaluation of beech

bark disease, and those affected by the disease could be harvested and removed to help slow the spread of the disease. Stumps will be immediately treated with an appropriate herbicide to kill the susceptible root stock.

The modeled tables below depict the shift towards shade tolerant old growth stand structure characteristics between 2012 and 2063. The numerical values assigned reference species basal area. It would be expected that a more rapid basal area increase in shade tolerant species in comparison to shade intolerants, as well as recruitment of additional shade tolerant species exceeding the 2" DBH overstory threshold, will be observed in 2063.

Table 6. 2013 basal area vs. shade tolerance in Stand 4

species	very intolerant	intolerant	intermediate	tolerant	very tolerant
sugar maple	0	0	0	20	0
chestnut oak	0	0	15	0	0
northern red oak	0	0	12.5	0	0
sweet birch	0	0	7.5	0	0
American beech	0	0	0	7.5	0
scarlet oak	0	5	0	0	0
red maple	0	0	5	0	0
hophornbeam	0	0	0	5	0
mockernut hickory	0	0	2.5	0	0
white ash	0	0	2.5	0	0
shagbark hickory	0	0	2.5	0	0

Table 7. 2063 basal area vs. shade tolerance in Stand 4

species	very intolerant	intolerant	intermediate	tolerant	very tolerant
sugar maple	0	0	0	23.2	0
chestnut oak	0	0	18.39	0	0
northern red oak	0	0	16.62	0	0
sweet birch	0	0	10.26	0	0
American beech	0	0	0	10.04	0
hophornbeam	0	0	0	8.25	0
scarlet oak	0	5.71	0	0	0
red maple	0	0	5.2	0	0
white ash	0	0	4.05	0	0
mockernut hickory	0	0	2.9	0	0
shagbark hickory	0	0	2.34	0	0
American	0	0	0.96	0	0

witch hazel					
pignut hickory	0.5	0	0	0	0
highbush blueberry	0	0	0	0.27	0
serviceberry	0	0	0	0	0

Stand 5 Description

Size: 16.9 acres

Age: ~ 65 years

Stand 5 is fully stocked with a northern hardwood mixture of species that are generally shade tolerant and well suited to be positioned on the northwest facing aspect of a 1,355 foot mountain. By the end of this plan's 10 year term, the stand will be considered overstocked with a basal area of roughly 125 ft². White ash occupies a significant proportion of the basal area, and will be monitored for future EAB outbreaks. Although not typically inventoried as a tree, American witchhazel has reached significant size here, and accounts for over 7% of the basal area. While it has limited value for a broad range of wildlife species, witchhazel serves an important ecological function for several insects, including certain migrating moths and butterflies.

Currently, the stand also has a healthy herbaceous layer and is mostly devoid of invasive species. However, the quantity of witchhazel, coupled with hayscented fern covering 13% of the ground, may begin to compete excessively and inhibit other plant development at some point - even those species considered somewhat shade tolerant.

Table 8. Understory Species Occurrence and Abundance Live Stems Only Stand 5 SMWMA

Species	Density	Rel Density	Frequency	Rel Frequency	Percent cover	Rel Percent cover	Importance Value
northern spicebush	1400	37.33	50	11.11	20	25	24.48
highbush blueberry	500	13.33	50	11.11	15	18.75	14.4
American witch hazel	400	10.67	50	11.11	15	18.75	13.51
huckleberry	450	12	50	11.11	5	6.25	9.79
serviceberry	250	6.67	50	11.11	5	6.25	8.01
sugar maple	100	2.67	50	11.11	5	6.25	6.68
yellow and sweet birch	50	1.33	50	11.11	2.5	3.13	5.19

Table 9. Ground Species Occurrence and Abundance Live Stems Only Stand 5 SMWMA

Species	Density	Rel Density	Frequency	Rel Frequency	Percent cover	Rel Percent cover	Importance Value
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Canada mayflower	9000.00	43.48	100.00	8.33	10.00	13.33	21.71
Hay-scented fern	2000.00	9.66	100.00	8.33	10.00	13.33	10.44
Pennsylvania sedge	3000.00	14.49	100.00	8.33	5.00	6.67	9.83
Japanese barberry	1000.00	4.83	100.00	8.33	10.00	13.33	8.83
violet	1500.00	7.25	100.00	8.33	5.00	6.67	7.42
partridgeberry	1000.00	4.83	100.00	8.33	5.00	6.67	6.61
cinnamon fern	1000.00	4.83	100.00	8.33	5.00	6.67	6.61
skunk cabbage	500.00	2.42	100.00	8.33	5.00	6.67	5.81
royal fern	500.00	2.42	100.00	8.33	5.00	6.67	5.81
common goldstar	500.00	2.42	100.00	8.33	5.00	6.67	5.81
aster	400.00	1.93	100.00	8.33	5.00	6.67	5.64
Jack in the pulpit	300.00	1.45	100.00	8.33	5.00	6.67	5.48

Operability: Good, mostly limited by primary road frontage. Although the stand has steep sections, the soils are not very vulnerable to erosion and degradation due to the high rock content. There is a network of former mining trails that have been converted to ATV trails and being used illegally. These trails stem from the Lake Stockholm community in the north.

Species Composition - Top Three Species by % of Stand Basal Area (plus witchhazel)

Overstory: yellow birch & sugar maple, white ash, American witchhazel

Understory: red maple, sugar maple, serviceberry

Basal Area / Ac & Quad. Mean DBH:

yellow birch: 22.5 ft²-12.9"

sugar maple: 22.5 ft²-14.8"

white ash: 15.0 ft²-20.0"

witchhazel: 7.5 ft²-3.0"

total stand: 97.5 ft²-4.9"

Net Board Feet / Ac: 3344 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 662 cuft

Net Pulpwood Cords / Ac: 8 cords

Net Total Cubic Feet (cuft) / Ac: 1106 cuft

Total Cords / Ac: 14 cords

Stems / Ac: 741

Unique and/or High Conservation Value Features: None

***Stand 5 Prescription:** None, management of this stand will be deferred to a later period.

Stand 6 Description

Size: 31.1 acres

Age: ~ 60 years

Stand 6 has many representative characteristics of an overstocked oak-hickory upland forest stand. While the present species composition is well suited for the site and a southeastern aspect, live crown ratio is low, and little light reaches the forest floor – limiting understory diversity and development. With the exception of Pennsylvania sedge and wild sarsaparilla, herbaceous layer biodiversity is moderate. The stand is slowly reverting to shade tolerant species as indicative in reports modeled by NED for 2022 where the hickory component is projected to be outcompeted by sugar maple.

Operability: Good, but also limited by primary road frontage. Although the stand has steep areas, the soils are rocky and stable. There is also a network of existing mining trails that are illegally being used as ATV trails.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, scarlet oak, pignut hickory

Understory: sugar maple, white oak, serviceberry

Basal Area / Ac & Quad. Mean DBH:

red oak: 30.0 ft²-12.8"

scarlet oak: 30.0 ft²-9.2"

pignut hick: 15.0 ft²-8.0"

total stand: 120.0 ft²-7.4"

Net Board Feet / Ac: 3734 bdf

Net Pulpwood Cubic Feet (cuft) / Ac: 1329 cuft

Net Pulpwood Cords / Ac: 17 cords

Net Total Cubic Feet (cuft) / Ac: 1823 cuft

Total Cords / Ac: 23 cords

Stems / Ac: 397

Unique and/or High Conservation Value Features: None

***Stand 6 Prescription:** None, management of this stand will be deferred to a later period.

Stand 7 Description

Size: 182.0 acres

Age: ~ 75 years

Stand 7 is contained on a hilltop at an elevation from 1,300 to 1,382 feet above sea level. It is an upland site, composed of mostly oak and hickory species. Presently, it is overstocked by nearly 20 square feet of basal area. Most of the overstory has complete canopy closure, with live crown ratios of 30% or less. There is minimal advance regeneration over 1" DBH, and smaller trees found regenerating are moderately shade tolerant species including red maple, sugar maple and birch. Over 60% of the stand's ground cover is Pennsylvania sedge. NED modeling predicts that in less than 10 years, red maple basal area will exceed that of mockernut hickory, making it the third most dominant species in the stand.

Operability: Good. Even though the stand has portions which are steep, may slopes are less than 10% and soils are not highly erodible. There is a drivable road extending west from Rock Lodge Road that passes through the stand. The initial quarter mile of road is bound to the south by the Passaic River Coalition before crossing entirely onto the SMWMA. There are portions of the eastern facing aspect that will be inoperable due to steepness, as well as wetlands in the north. It is expected that less than 20% of the stand is inoperable.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, sugar maple, mockernut hickory

Understory: American witchhazel, hophornbeam, sugar maple

Basal Area / Ac & Quad. Mean DBH:

red oak: 25.0 ft²-13.9"

sugar maple: 15.0 ft²-7.3"

mockernut: 13.5 ft²-7.3"

total stand: 122.5 ft²-8.5”
 Net Board Feet / Ac: 3930 bdf
 Net Pulpwood Cubic Feet (cuft) / Ac: 1467 cuft
 Net Pulpwood Cords / Ac: 18 cords
 Net Total Cubic Feet (cuft) / Ac: 2019 cuft
 Total Cords / Ac: 25 cords
 Stems / Ac: 312

Unique and/or High Conservation Value Features: Stand 7 contains the headwaters for Ryker Lake and into Russia Brook. On the west facing aspect of the northern most hill there is an old home site with a dried up well, potential remnants of past mining workers. These sites will be identified ahead of any management to determine their historical significance (if any), and protected from disturbance during management activities as needed.

***Stand 7 Prescription:**

This stand will receive a seed tree system with wildlife reserves treatment that will be similar to the recommendations provided for stands 1 & 2. Stand 7 and 8 are adjacent to one another and share the same prescription. Because of that, they may receive a simultaneous treatment at some point. The treatment will be applied near to the PSE&G power line easement that runs east to west or close to the NJA property where other similar management is occurring.

Below are a series of SVS images. The first depicts current conditions in 2013. The next image shows conditions immediately following the 2021 Seed Tree treatment. The following two SVS views offer a glimpse of conditions 20 and 40 years following the 2021 treatment.

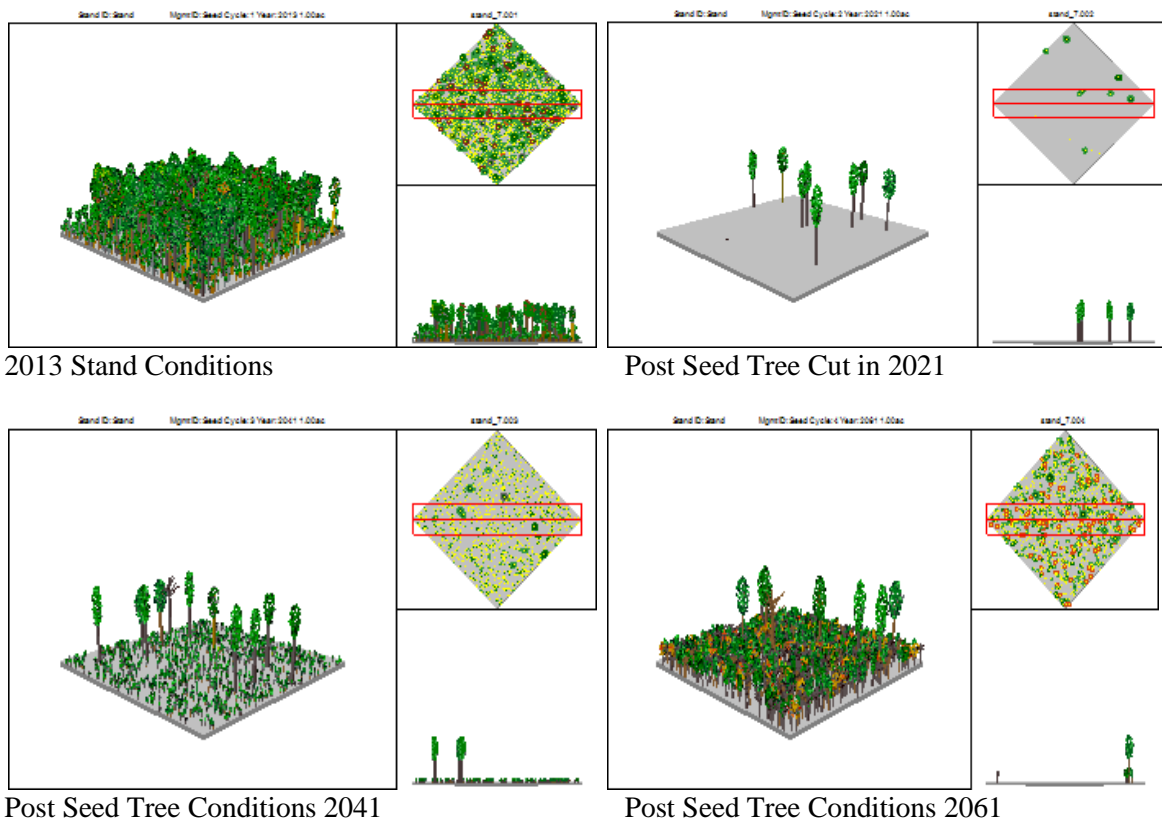


Figure 8. Stand 7 Overstory Conditions Pre- and Post- Seed Tree Treatment

Stand 8 Description

Size: 205.3 acres

Age: ~ 70 years

Stand 8 is an oak-hickory stand that is about 15% overstocked for optimum tree growth based on existing stem densities. More than 50% of the overstory volume is from oak; however, oak is only the twelfth most common understory species found regenerating. The stand has over 500 American witchhazel shrubs per acre, and similar to adjacent Stand 7, over 50% of the ground cover is Pennsylvania sedge. There is a rapidly declining eastern hemlock component along the western edge of the stand next to the large wetland owned by NJA. In the openings where hemlocks once stood, there are many small pockets of more diverse vegetation comprised of woody seedlings, asters, blackberry and jewelweed. The stand also has scattered pockets of American beech, which show signs of beech bark disease.

Operability: Fair. While the stand contains a passable access road stemming from Rock Lodge, maneuverability in the woods is challenged by rock outcrops, boulders and localized soil hydrology. Operability is also restricted along the significant wetlands buffer within the western edge of the stand.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, chestnut oak, sugar maple

Understory: American witchhazel, red maple, sugar maple

Basal Area / Ac & Quad. Mean DBH:

red oak: 22.1 ft²-14.8"

chestnut oak: 20.3 ft²-10.3"

sugar maple: 15.4 ft²-6.9"

total stand: 120.9 ft²-7.6"

Net Board Feet / Ac: 4357 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1365 cuft

Net Pulpwood Cords / Ac: 17 cords

Net Total Cubic Feet (cuft) / Ac: 1964 cuft

Total Cords / Ac: 25 cords

Stems / Ac: 386

Unique and/or High Conservation Value Features: None

***Stand 8 Prescription:**

This stand will receive a seed tree system with wildlife reserves treatment that will be similar to the recommendations provided for stands 1, 2 & 7.

Stand 9 Description

Size: 207.5 acres

Age: ~ 70 years

Stand 9 is an oak-hickory stand type. It is fully stocked and experiencing many of the same, age related - population density issues noted for the other stands previously described at SMWMA. The understory is currently dominated by one to three foot red maple, with lesser amounts of sweet birch and sugar maple also present. The stand has a patchy shrub layer, which in some areas is very densely stocked with serviceberry and American witchhazel.

Stand 9 is the second most frequented portion of the SMWMA by recreationists due to the parking lot for the Edison Monument and pond. There is an access road that splits off to the north-northeast from Edison Road that receives heavy foot traffic and has been a pathway for increased amounts of invasive species in this area. Japanese barberry, multiflora rose, Norway maple and other invasive species are all found near the parking lot and trail corridors, but are less common and at much more manageable levels with increasing distance from the parking lot. Generally these species are not widespread throughout the stand. White ash represents six percent of the stand's basal area, and is

therefore a lower concern for EAB outbreaks than in other stands.

Operability: Excellent. Caution will be taken around abandoned mining pits found near Edison Road.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, sweet birch, scarlet oak

Understory: red maple, serviceberry, sweet birch

Basal Area / Ac & Quad. Mean DBH:

red oak: 35.4 ft²-14.2"

sweet birch: 9.2 ft²-6.1"

scarlet oak: 8.8 ft²-13.8"

total stand: 110.0 ft²-8.3"

Net Board Feet / Ac: 5190 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1154 cuft

Net Pulpwood Cords / Ac: 14 cords

Net Total Cubic Feet (cuft) / Ac: 1863 cuft

Total Cords / Ac: 23 cords

Stems / Ac: 296

Unique and/or High Conservation Value Features: Edison Pond and Edison Monument

***Stand 9 Prescription:**

This stand's prescription will employ prescribed fire (as possible in accordance with applicable burning policies) and shelterwood harvesting to promote understory development and regeneration while maintaining an open oak forest type for a period of time. The northern portion of this stand is directly adjacent to existing wetland habitat. Shelterwood treatments will begin outside of the appropriate wetland buffer and progress south and westward towards the interior of the stand while feathering into the untreated forest. As with the other treatments, overstory species besides oak will be retained; especially those that contain significant amounts of exfoliating bark, such as shagbark hickory, to provide roost habitat for bats. The first harvest in this shelterwood system should reduce the stand's overstory by approximately 50 percent of the current stocking. Priority will be given to removing trees of lower crown positions leaving roughly 50 -100 trees per acre (TPA). This cut will stimulate understory development while creating an open oak forest condition that will favor certain wildlife species such as Red-headed woodpecker (RHWO) - which has been observed successfully nesting nearby in 2013 & 2014.

If possible within a few years following the cut, prescribed fire will be used to kill young trees and shrubs like red maple that are poorly adapted to fire in the understory. This will favor a cohort of regeneration that may look different than in other unburned treatment areas, and provide an opportunity to evaluate the effectiveness of prescribed burning as a tool for maintaining oak forest types. The stand will be monitored and treated as needed over subsequent years for regeneration response, browse pressure and invasive species. The usefulness of this treatment for RHWO habitat, or as an underrepresented habitat type on the WMA may be extended with periodic burning every few years. If repeated burning is not an option or is deemed ineffective, then future management should emphasize the release of the regeneration that becomes established. The final "Overstory Removal Cutting" (OSR) should not occur until after approximately 500 oak saplings per acre, that are about five feet in height or greater, become established. It is possible that these parameters may take more than ten years to develop.

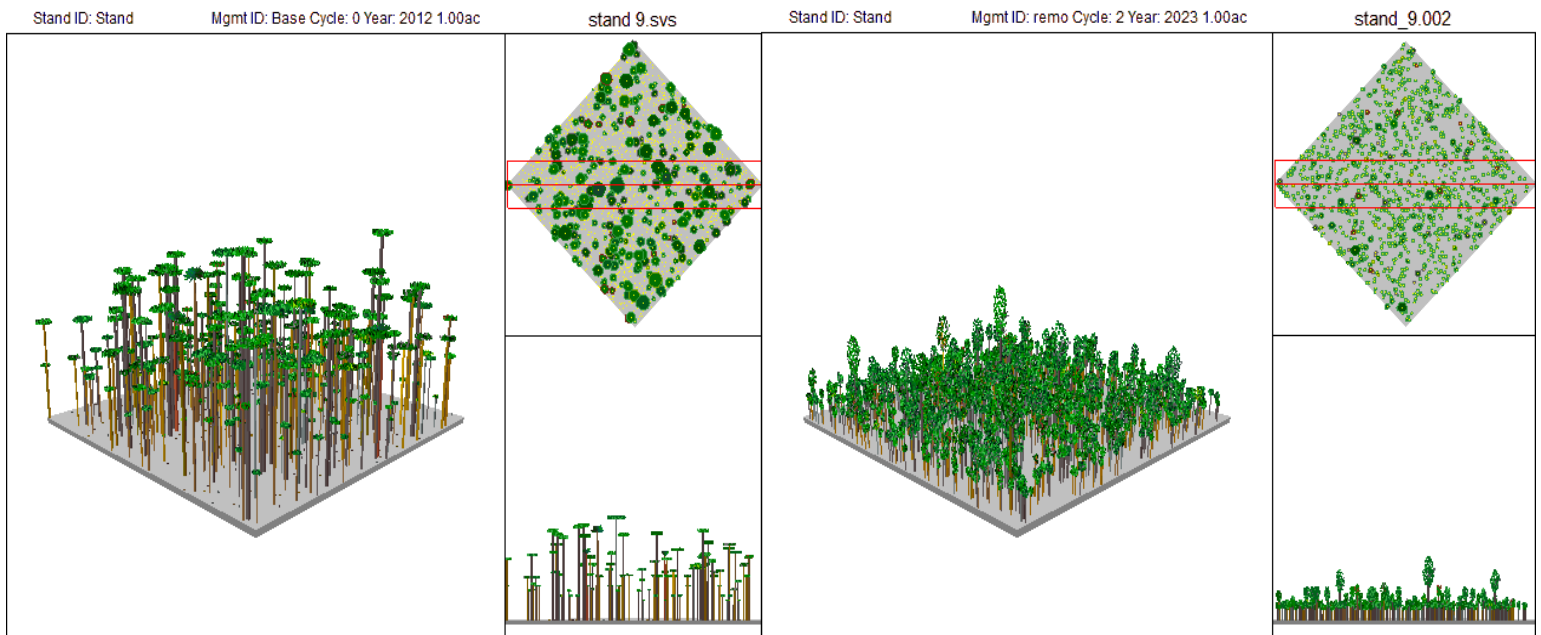


Figure 9. Stand 9 Overstory Conditions Pre-treatment and Post Overstory Removal

Stand 10 Description

Size: 34.0 acres

Age: ~ 60 years

Stand 10 is a small intrusion into Stand 2 that extends southwest from Edison Road near the parking lot for Edison Monument. The primary reason Stand 10 has different vegetation from the surrounding forest is because it was part of a former strip mine, and the forest developed on thinner soil and more exposed sandy deposits. The stand is dominated by smaller diameter oaks and very dense mountain laurel (representing over 40 percent of the stand's understory). The mountain laurel ranges from three to eight feet in height, and from one to three inches in diameter. It accounts for over 2,300 stems per acre, and by 2022 it will be the third most dominant species if considered in terms of basal area. This stand's herbaceous layer is also unique. While there isn't great vegetative diversity, the percentage of striped prince's pine and starflower were much higher than in surrounding stands.

The stand is considered to have an adequately stocked overstory. Norway maple is an exotic species that comprises 12 percent of the basal area. After mountain laurel, sugar maple and Norway maple are the most dominant species found naturally regenerating. If these maples eventually grow above the laurel component and occupy overstory growing space, they will fundamentally change the forest composition. Interestingly, there are sporadic, small diameter hemlock trees that appear unaffected by HWA.

Operability: Fair. Equipment and hand crews will have a very difficult time working in the mountain laurel thicket. Operating equipment around old mine sites also poses a risk for cave-ins and equipment rolling.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: sweet birch, northern red oak, Norway maple

Understory: mountain laurel, sugar maple, hophornbeam

Basal Area / Ac & Quad. Mean DBH:

sweet birch: 22.5 ft²-7.6"

red oak: 17.5 ft²-6.5"

Nor. maple: 12.5 ft²-7.4"

total stand: 102.5 ft²-6.9"

Net Board Feet / Ac: 1012 bdf
Net Pulpwood Cubic Feet (cuft) / Ac: 1063 cuft
Net Pulpwood Cords / Ac: 13 cords
Net Total Cubic Feet (cuft) / Ac: 1211 cuft
Total Cords / Ac: 15 cords
Stems / Ac: 397

Unique and/or High Conservation Value Features: Former mining area may hold some historical artifacts.

***Stand 10 Prescription:** None, management of this stand will be deferred to a later period.

Stand 11 Description

Size: 31.1 acres

Age: ~ 70 years

Stand 11 is adjacent to Collins Pond. It has high herbaceous species richness, probably due to its complex of rocky ground intermixed with low areas of significant hydrology. The eastern bank of the pond is rocky and steep and contains thickets of mountain laurel. The northern portion of the stand is a rocky forested wetland that holds wetland obligates like sensitive fern and skunk cabbage. These areas have relatively high concentrations of spicebush. On the drier ground closer to the PSE&G power line easement the stand contains more witch hazel than spicebush. The stand contains approximately 25 white ash stems per acre, which could significantly impact the stand composition if they are affected by an EAB outbreak.

Operability: Very Poor. The western portion of this stand is very steep leading to Collin's Pond. The stand has large boulders throughout, and an ephemeral creek was observed flowing in a wetland area in the north during the inventory in March. Collin's Pond requires a buffer, and the surrounding thickets of laurel make skidding and hand felling trees very challenging. There is a network of forest trails and roads leading around the southern edge of the pond that then parallel its western edge before tying back into the right of way on the north end of the pond.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, chestnut oak, white ash

Understory: mountain laurel, serviceberry, red maple

Basal Area / Ac & Quad. Mean DBH:

red oak: 32.1 ft²-11.9"

chestnut oak: 21.4 ft²-12.2"

white ash: 10.7 ft²-8.9"

total stand: 107.1 ft²-9.1"

Net Board Feet / Ac: 3641 bdf

Net Pulpwood Cubic Feet (cuft) / Ac: 1260 cuft

Net Pulpwood Cords / Ac: 16 cords

Net Total Cubic Feet (cuft) / Ac: 1766 cuft

Total Cords / Ac: 22 cords

Stems / Ac: 235

Unique and/or High Conservation Value Features: The stand partially surrounds Collin's Pond and has the PSE&G power line easement bisecting the pond itself.

***Stand 11 Prescription:** None, management of this stand will be deferred to a later period.

Stand 12 Description

Size: 28.5 acres

Age: ~ 75 years

Stand 12 is an overstocked oak-hickory upland forest. Over 50 percent of the stand's basal area is comprised of well-formed northern red oak sawlogs with little to no apparent defect. While the

present species composition is well suited for the site, inventory observations depict low live crown ratios with little light reaching the forest floor. There is minimal shade intolerant regeneration, and in this case, oak regeneration is the ninth by relative abundance. This stand is also trending towards an eventual species composition that is more shade tolerant, predominantly sugar maple. By 2022 sugar maple will make up 25 percent of the trees per acre. It is estimated that there are over 180 shagbark hickory trees per acre that average less than five inches in diameter. Although they are currently too small to provide significant bat habitat now, they might be more significant in the future if they are favored during forestry treatments.

Operability: Good. Stand 12 can be accessed by the PSE&G power line right of way.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, shagbark hickory, pignut hickory

Understory: sugar maple, American witchhazel, sweet birch

Basal Area / Ac & Quad. Mean DBH:

red oak: 69.0 ft²-12.4"

shagbark: 21.0 ft²-4.6"

pignut: 18 ft²-7.1"

total stand: 132.0 ft²-8.0"

Net Board Feet / Ac: 4504 bdf

Net Pulpwood Cubic Feet (cuft) / Ac: 1507 cuft

Net Pulpwood Cords / Ac: 19 cords

Net Total Cubic Feet (cuft) / Ac: 2154 cuft

Total Cords / Ac: 27 cords

Stems / Ac: 376

Unique and/or High Conservation Value Features: The stand is bound in the west by the PSE&G power line right of way.

***Stand 12 Prescription:** This stand will receive a seed tree system similar to stands 1, 2, 7 & 8.

Stand 13 Description

Size: 18.4 acres

Age: ~ 70 years

Stand 13 is non-contiguous portion of the SMWMA located southwest of Heaters Pond on the western side of the tract. The stand is predominately oak – hickory with insignificant quantities of sweet birch mixed in throughout. Beavers have flooded Heaters Pond in the south and wetlands are subsequently encroaching into the northeastern corner of the stand. Flooding damage decreases westward from Heaters Pond as the elevation increases. Although the stand is heavily stocked, there are localized concentrations of oak regeneration throughout the stand.

Operability: Inoperable. There is no legal access to this stand. Hawthorn Lake Road turns into a private road before crossing the stream south of Heaters Pond hence making the stand inaccessible.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: mockernut hickory, northern red oak, sweet birch

Understory: northern red oak, chestnut oak, sweet birch

Basal Area / Ac & Quad. Mean DBH:

mockernut: 40.0 ft²-6.1"

red oak: 20.0 ft²-3.7"

total stand: 60.0 ft²-4.8"

Net Board Feet / Ac: 362 bdf

Net Pulpwood Cubic Feet (cuft) / Ac: 575 cuft

Net Pulpwood Cords / Ac: 7 cords

Net Total Cubic Feet (cuft) / Ac: 627 cuft

Total Cords / Ac: 8 cords

Stems / Ac: 472.6

Unique and/or High Conservation Value Features: Expanding Heaters Pond in the northeast corner of the stand.

***Stand 13 Prescription:** None, management of this stand will be deferred until access has been established.

Stand 14 Description

Size: 26.0 acres

Age: ~ 70 years

The stand is adequately stocked with a mixture of hardwoods. The site is a little more mesic than some of the surrounding ridges, and species such as red maple and yellow birch seem to be doing fairly well on the site. Sugar maple, sweet birch and American witchhazel dominate the majority of the understory.

Operability: Good.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, chestnut oak, red maple

Understory: American witchhazel, sugar maple, sweet birch

Basal Area / Ac & Quad. Mean DBH:

red oak: 37.5 ft²-13.1"

sweet birch: 22.5 ft²-12.8"

red maple: 18.8 ft²-7.7"

total stand: 105.0 ft²-8.7"

Net Board Feet / Ac: 4814 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1112 cuft

Net Pulpwood Cords / Ac: 14 cords

Net Total Cubic Feet (cuft) / Ac: 1784 cuft

Total Cords / Ac: 22 cords

Stems / Ac: 252

Unique and/or High Conservation Value Features: Stand 14 is split in half by the PSE&G power line right of way.

***Stand 14 Prescription:** None, management of this stand will be deferred to a later period.

Stand 15 Description

Size: 21.1 acres

Age: ~ 60 years

Stand 15 is similar to Stand 10 in that it was significantly altered during the former mining operations. It also has thin soils and dense mountain laurel in spots. There are several dirt bike and hiking trails in the stand; stemming from the old mining roads on the property. Compared to the rest of SMWMA, Stand 15 has more invasive species; especially along the road and trails. The overstory is dominated by oak and there is a significant amount of pole size eastern hemlock that remains alive in the lower canopy strata. Red oak was observed regenerating along trails and near gaps maintained by dirt bikers and ATV users. Currently there is an average of 260 northern red oak seedlings per acre, most of which are between one and three feet in height.

Operability: Very Good. Caution will be taken around Edison Pond and the monument. As always, equipment operators will be mindful of potential cave-in and settling around old mining sites. The former mining road was improved to address erosion issues in 2012, making it drivable to the JCP&L power line easement in the north. The matrix of pre-existing dirt bike/ATV trails will be considered for skidding before new skid trails are established.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: chestnut oak, northern red oak, eastern hemlock

Understory: mountain laurel, American witchhazel, northern red oak

Basal Area / Ac & Quad. Mean DBH:

chestnut oak: 33.0 ft²-14.0"

red oak: 18.0 ft²-11.6"

hemlock: 12.0 ft²-8.6"

total stand: 102.0 ft²-8.9"

Net Board Feet / Ac: 4014 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1148 cuft

Net Pulpwood Cords / Ac: 14 cords

Net Total Cubic Feet (cuft) / Ac: 1690 cuft

Total Cords / Ac: 21 cords

Stems / Ac: 239

Unique and/or High Conservation Value Features: None known, possible historical significance from past mining operations.

***Stand 15 Prescription:** None, management of this stand will be deferred to a later period.

Stand 16 Description

Size: 22.2 acres

Age: ~ 65 years

This small stand is situated on high ground between two large wetlands. The stand has a thick component of mountain laurel beneath a mature, well-formed chestnut oak and red oak overstory. The overstory is well stocked, and will approach the maximum optimum stocking capacity by 2022. The stand has an average of 366 chestnut oak seedlings per acre. Red maple encroachment into this oak stand is less of an issue that elsewhere on the WMA.

Operability: Fair. The only access to the stand is from the recently improved road running through Stand 18. Appropriate wetland buffers will need to be established prior to implementing management here.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: chestnut oak, northern red oak, red maple

Understory: mountain laurel, chestnut oak, sweet birch

Basal Area / Ac & Quad. Mean DBH:

chestnut oak: 35.0 ft²-6.7"

red oak: 30.0 ft²-6.3"

red maple: 10.0 ft²-6.4"

total stand: 90.0 ft²-4.9"

Net Board Feet / Ac: 1352 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 886 cuft

Net Pulpwood Cords / Ac: 11 cords

Net Total Cubic Feet (cuft) / Ac: 1064 cuft

Total Cords / Ac: 13 cords

Stems / Ac: 688

Unique and/or High Conservation Value Features: The stand is surrounded in the south and west by forested wetlands.

***Stand 16 Prescription:** None, management of this stand will be deferred to a later period.

Stand 17 Description

Size: 9.7 acres

Age: ~ 55 years

Stand 17 is a small, fully stocked stand adjacent to wetlands in the east and west, with the PSE&G power line easement cutting through it in the north. It contains a declining hemlock grove just south of the easement. The stand contains a significant percentage of potential wetland species like red

maple and yellow birch in the overstory, with roughly 2,000 spicebush stems per acre in the understory. American beech represents roughly 15 square feet of basal area per acre, mostly found in intermittent groves. It is anticipated that the beech population will increase significantly over time, and will reduce the stand's bio-diversity in the long-term. There is 10 square feet of pole size white ash which could be lost when EAB arrives.

Operability: Poor. Over 75 percent of the stand's soils are Catden Mucky Peats, which are hydric and very prone to rutting. The only access to the stand is from the JCP&L power line easement. There were no existing trails or mining roads observed in the stand. Operability along the western boundary will also be inhibited by wetland buffers.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: yellow birch, red maple, northern red oak

Understory: northern spicebush, yellow birch, red maple

Basal Area / Ac & Quad. Mean DBH:

yellow birch: 25.0 ft²-7.8"

red maple: 25.0 ft²-9.1"

red oak: 20.0 ft²-25.9"

total stand: 120.0 ft²-7.8"

Net Board Feet / Ac: 4070 bdf

Net Pulpwood Cubic Feet (cuft) / Ac: 1384 cuft

Net Pulpwood Cords / Ac: 17 cords

Net Total Cubic Feet (cuft) / Ac: 1909 cuft

Total Cords / Ac: 24 cords

Stems / Ac: 365

Unique and/or High Conservation Value Features: Stand 17 has the JCP&L power line easement cutting through its northern most section and is bound in the west by an exceptional resource value wetland.

***Stand 17 Prescription:** None, management of this stand will be deferred to a later period.

Stand 18 Description

Size: 250.0 acres

Age: ~ 70 years

Stand 18 is a large oak-hickory site roughly split in half by the JCP&L power line easement. The eastern half of the stand is adjacent to the large wetland that drains south into Ryker Lake. The stand is fully stocked with 99 square feet of basal area per acre; 60% of which is derived from red, chestnut, scarlet, white and black oaks. Figure 8 represents a view of a one acre representative block of the stand as well as DBH and height vs. number of trees graphs.

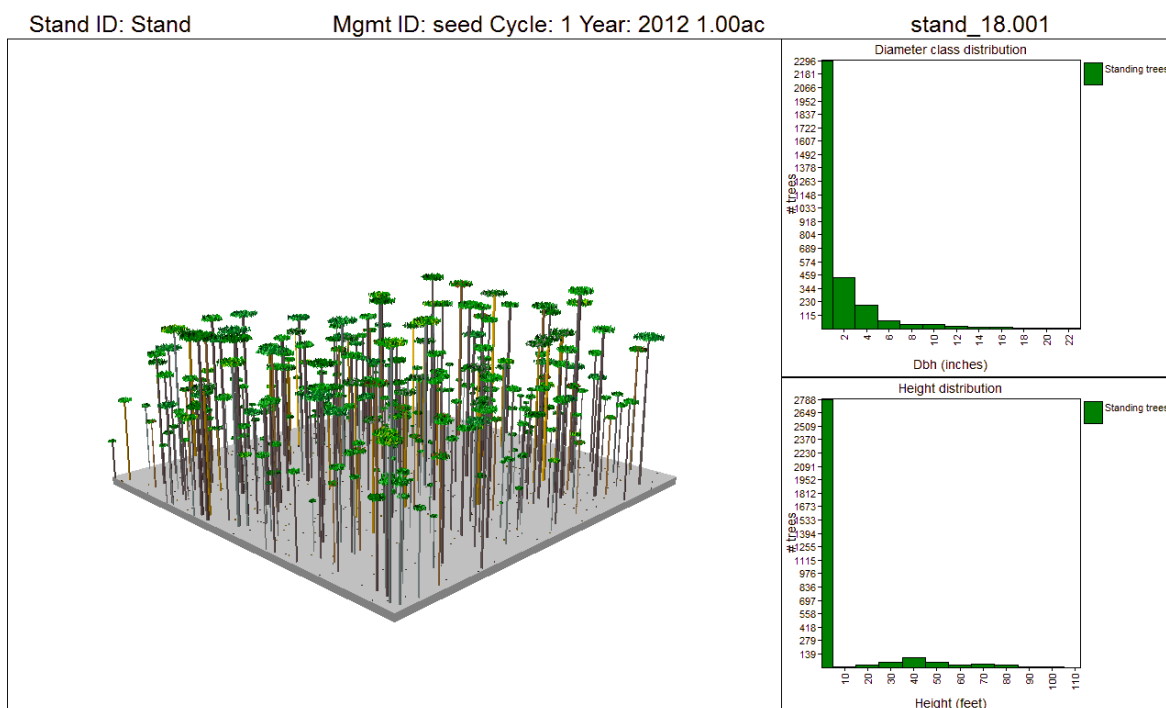


Figure 10: Stand 18 Present Overstory Conditions

Red maple is the third most abundant species (by basal area and trees per acre), and is twice as numerous as hickory in terms of stems per acre. By 2022, witchhazel and serviceberry are projected to occupy roughly 10 square feet of growing space per acre.

Throughout the stand are pockets of co-dominant white ash that may be susceptible to EAB outbreaks. The “edge effect” occurring on the south side of the easement has increased the number of early successional species in these areas. Sassafras and gray birch are found in the overstory along this corridor, as well as aster and goldenrod in the herbaceous layer.

Operability: Very Good. This upland site is accessible from the improved road that splits north northeast from Edison Road. There are several spur trails coming from this road into the stand.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, chestnut oak, red maple

Understory: serviceberry, northern red oak, red maple

Basal Area / Ac & Quad. Mean DBH:

red oak: 31.6 ft²-7.4”

chestnut oak: 13.7 ft²-8.4”

red maple: 10.5 ft²-8.1”

total stand: 99.3 ft²-7.4”

Net Board Feet / Ac: 2489 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1175 cuft

Net Pulpwood Cords / Ac: 15 cords

Net Total Cubic Feet (cuft) / Ac: 1517 cuft

Total Cords / Ac: 19 cords

Stems / Ac: 336

Unique and/or High Conservation Value Features: The eastern portion of the southern half of this stand is bound by an exceptional resource value wetland.

***Stand 18 Prescription:**

This stand will receive a seed tree system with wildlife reserves treatment similar to what was

prescribed for earlier stands. As with Stand 2, awareness of the location of slender wheatgrass populations will help to inform management decisions.

Stand 19 Description

Size: 14.8 acres

Age: ~ 55 years

Stand 19 is a young Allegheny hardwood mixture that contains a variety of upland species including white ash, cherry, birch and beech. The stand is split in half by the JCP&L easement. The north-west portion of the stand contains hydric pockets where concentrations of wetland plant communities occur. Mountain laurel is locally dense in places, and there is little to no tree regeneration with the exception of small amounts of sweet birch.

Operability: Inoperable. Rocky outcrops, boulders and wetlands make this stand inoperable with heavy equipment.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: chestnut oak, northern red oak, white ash

Understory: northern red oak, American beech, red maple

Basal Area / Ac & Quad. Mean DBH:

chestnut oak: 45.0 ft²-10.5"

red oak: 18.8 ft²-4.6"

white ash: 11.3 ft²-5.8"

total stand: 105.0 ft²-6.9"

Net Board Feet / Ac: 1932 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1131 cuft

Net Pulpwood Cords / Ac: 14 cords

Net Total Cubic Feet (cuft) / Ac: 1389 cuft

Total Cords / Ac: 17 cords

Stems / Ac: 405

Unique and/or High Conservation Value Features: The stand is split by the JCP&L easement and is bound in the south by the SMWMA's exceptional resource value wetland.

***Stand 19 Prescription:** None, management of this stand will be deferred to a later period.

Stand 20 Description

Size: 29.6 acres

Age: ~ 50 years

This is a small, well stocked, pole size stand that is just over 400 feet across at its widest point. It is predominantly composed of sweet birch, with some scattered larger diameter red oak. Occasional groves of beech are intermittent throughout the stand also. It is situated to the west of private property surrounding Lake Acquackanonk in the southern end of the WMA. A small stream makes up the stand's western boundary.

Operability: Fair. Access to the stand is from the north via Stands 2 & 9 near Edison Road.

Careful attention to the application of BMP's are required to ensure that erosion control measures minimize sedimentation into tributaries of Fox Trail Lake.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: sweet birch, northern red oak, red maple

Understory: northern red oak, red maple, sweet birch

Basal Area / Ac & Quad. Mean DBH:

sweet birch: 27.0 ft²-5.5"

red oak: 21.0 ft²-15.8"

red maple: 21.0 ft²-5.3"

total stand: 111.0 ft²-6.9"

Net Board Feet / Ac: 2809 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1141 cuft

Net Pulpwood Cords / Ac: 14 cords

Net Total Cubic Feet (cuft) / Ac: 1531 cuft

Total Cords / Ac: 19 cords

Stems / Ac: 428

Unique and/or High Conservation Value Features: None

***Stand 20 Prescription:** None, management of this stand will be deferred to a later period.

Stand 21 Description

Size: 129.3 acres

Age: 70 years

Stand 21 is a heavily stocked mixed hardwood stand that contains roughly 120 square feet of basal area. It includes large areas of forested wetlands. Red oak represents 12 percent of the stand's overall basal area, and is largely confined within the northwest facing slope on the eastern side of the stand. The stand contains a substantial component of shade tolerant species. Table 5 depicts the stand's shrub density in percent cover. Most of this stand's tree regeneration is between one and three feet tall and there are no significant signs of deer browse, which might otherwise account for the limited seedling height. White ash is only a small component of the stand, so concerns regarding the effects of EAB in this stand should be limited. The stand contains shagbark hickory that average 13 inches DBH, and will be favored when possible for bat habitat.

Operability: Fair. The stand can be accessed directly from Edison Road, or via the 2012 improved road in Stand 18. Since the stand contains significant acreage that is forested wetlands, equipment will be limited to times of the year when the ground is firm and well drained, if not frozen. Corduroy and other applicable BMPs will be used as needed depending on localized site conditions.

Table 10: Shrub Layer Density of Stand 21

Species	Shrub <10' Percent Cover	Shrub >10' Percent Cover
witchhazel	24.72	33.33
sweet birch	19.1	10.34
chestnut oak	5.62	2.3
red oak	1.12	11.49
spicebush	24.72	0
sugar maple	3.37	5.75
hophornbeam	6.74	6.9
A. hornbeam	6.74	4.6
red maple	0	8.05
serviceberry	2.25	0
mountain laurel	1.12	0
white ash	0	2.3
Totals:	95.5	85.06

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: sugar maple, sweet birch, northern red oak

Understory: American witchhazel, sweet birch, northern red oak

Basal Areas / Ac & Quad. Mean DBH:

sugar maple: 23.2 ft²-7.0"

sweet birch: 18.4 ft²-7.2"

red oak: 15.0 ft²-7.3"

total stand: 119.3 ft²-7.2"

Net Board Feet / Ac: 3771 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1282 cuft

Net Pulpwood Cords / Ac: 16 cords

Net Total Cubic Feet (cuft) / Ac: 1810 cuft

Total Cords / Ac: 23 cords

Stems / Ac: 419

Unique and/or High Conservation Value Features:
None

***Stand 21 Prescription:**

This stand will be treated with an uneven aged

management approach known as Single-tree Selection with Wildlife Reserves. The management objective is to accelerate old growth attributes within a forest type that is better suited to developing a climax forest. This system mimics the natural regeneration processes of an old-growth forest through a concept known as “gap-phase replacement”. Gap-phase replacement means that the small canopy gaps created via the death (natural or anthropogenic) of individual or small groups of trees provide opportunities to release preexisting shade tolerant trees, or to stimulate some new shade tolerant regeneration. The proposed treatment of this stand is aimed at maintaining its ecological integrity; specifically the shade tolerant and potentially moisture sensitive species composition. Uneven-aged management entails the continual recruitment of new cohorts of trees into the stand, eventually having three or more age classes existing at any given time. Proper implementation requires removal of trees from all size classes to avoid skewing the residual tree distribution into a singular stand structure. Trees targeted for removal are those declining in health, or those unlikely to persist under the site conditions that are perpetuated under a climax forest ecosystem. The small openings also present opportunities for moisture sensitive herbaceous plants to benefit from additional, but moderate amounts of light that are often associated with increased flowering and seed production. In short, this system enhances stand complexity while buffering the short-term, but extreme, changes to the site conditions experienced under some other silvicultural and natural disturbances. Proactively manipulating the stand, rather than waiting for natural mortality to occur, helps to increase the forest’s resilience to the sometimes more severe impacts resulting from natural causes (e.g. severe storm events or widespread pathogen outbreaks).

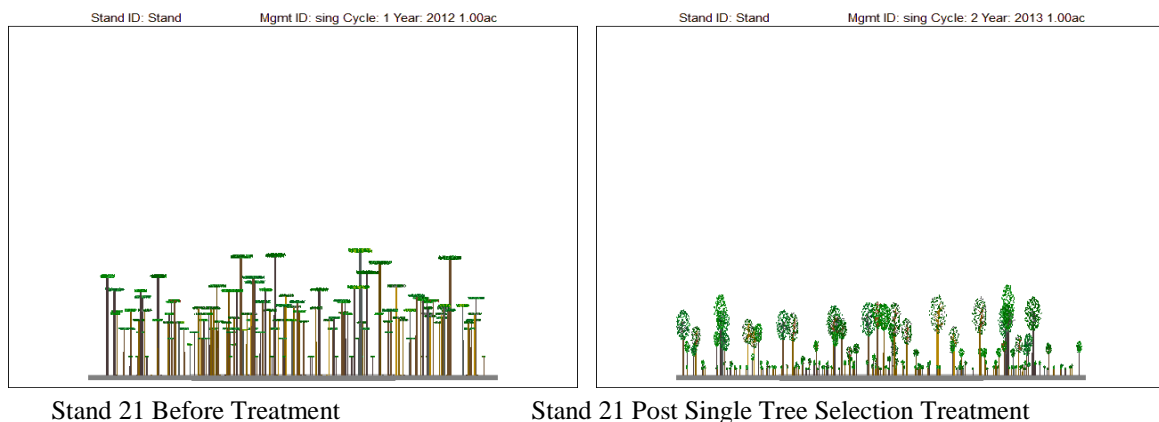


Figure 9. Stand 21 Overstory Conditions Pre- and Post-treatment

To improve herbaceous layer conditions on the forest floor, the treatment should mechanically reduce dense monoculture shrub pockets from 95.5% percent to approximately 70%. The stand also contains clumps of hay-scented fern which makes up over 11% percent of the stand’s forest floor. Within the treatment area, as funding allows, it is recommended that large expanses of hay-scented fern are reduced using foliar applications of glyphosate to enhance the opportunities for other herbaceous plants to flourish in their place. Table 6 depicts common plant densities within the herbaceous layer. The table is quite representative of the herbaceous layer found growing under other similar shade tolerant overstory stands in SMWMA.

Table 11: Ground Cover Species Occurrence and Abundance Stand 21

Species	Density	Rel Density	Frequency	Rel Frequency	Percent cover	Rel Percent cover	Importance Value
Pennsylvania sedge	2285.71	41.03	71.43	15.15	13.57	27.94	28.04
hay-scented fern	1000	17.95	14.29	3.03	11.43	23.53	14.84
Canada mayflower	628.57	11.28	28.57	6.06	1.43	2.94	6.76

deer tongue	257.14	4.62	42.86	9.09	2.14	4.41	6.04
wild sarsaparilla	128.57	2.31	42.86	9.09	2.14	4.41	5.27
manna grass	242.86	4.36	28.57	6.06	2.14	4.41	4.94
Virginia creeper	114.29	2.05	28.57	6.06	2.14	4.41	4.17
Virginia strawberry	214.29	3.85	14.29	3.03	1.43	2.94	3.27
feathery false lily of the valley	42.86	0.77	28.57	6.06	1.43	2.94	3.26
common gold star	42.86	0.77	28.57	6.06	1.43	2.94	3.26
unidentified plant	185.71	3.33	14.29	3.03	1.43	2.94	3.1
aster	114.29	2.05	14.29	3.03	1.43	2.94	2.67
cinnamon fern	42.86	0.77	14.29	3.03	1.43	2.94	2.25
wild yam	71.43	1.28	14.29	3.03	0.71	1.47	1.93
Jack in the pulpit	71.43	1.28	14.29	3.03	0.71	1.47	1.93
violet	28.57	0.51	14.29	3.03	0.71	1.47	1.67
spotted geranium	28.57	0.51	14.29	3.03	0.71	1.47	1.67
sensitive fern	28.57	0.51	14.29	3.03	0.71	1.47	1.67
maple leaf viburnum	28.57	0.51	14.29	3.03	0.71	1.47	1.67
striped prince's pine	14.29	0.26	14.29	3.03	0.71	1.47	1.59

Control of invasive plants will be initiated during post treatment monitoring under the same parameters as described for earlier treatments.

Stand 22 Description

Size: 44.3 acres

Age: ~ 70 years

Stand 22 sits along the southwestern side of the east to west utility easement that bisects the WMA. It is a mixed upland oak stand that has exceeded its optimum stocking by approximately five square feet of basal area. Aside from oak, red maple is the next most common species occurring here. The understory has approximately 3,000 stems per acre, mostly comprised of witch hazel, mountain laurel and serviceberry. In locations where the shrub layer is less thick, oak and hickory regeneration can be found up to four inches DBH - exceeding 10 feet in height. Six percent of the basal area is comprised of HWA infested eastern hemlock. The stems that are less than 10 inches DBH appear to be less affected, and many have LCR's between 40 and 70 percent.

Operability: Good. It can be reached using an existing road that meets Edison Road approximately 0.4 miles north of the road improved in 2012.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, chestnut oak, red maple

Understory: serviceberry, mockernut hickory, northern red oak

Basal Areas / Ac & Quad. Mean DBH:

red oak: 21.8 ft²-9.3"

chestnut oak: 20.5 ft²-12.3"

red maple: 16.4 ft²-9.3"

total stand: 113.2 ft²-8.3"

Net Board Feet / Ac: 3495 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1333 cuft

Net Pulpwood Cords / Ac: 17 cords

Net Total Cubic Feet (cuft) / Ac: 1822 cuft

Total Cords / Ac: 23 cords

Stems / Ac: 299

Unique and/or High Conservation Value Features: Stand 22 is bound by the JCP&L power line easement in the north.

***Stand 22 Prescription:**

This stand will receive a heavy thinning / modified shelterwood type cut as described for Stand 9. The objective of the treatment is two-fold. Because of its close proximity to successful RHWO breeding sites, some portions of the stand will be treated to enhance conditions for RHWO habitat. In places where intermediate sized hemlocks appear to be minimally affected by HWA, a crown thinning technique will be employed to release those trees so that they are free to grow. This silvicultural technique has been pioneered through research conducted by Dr. Mary Ann Fajvan with the USFS in Morgantown West Virginia. The purpose of the release cut is to concentrate resources and improve vigor on stems that are not already over-taxed by HWA, thereby allowing them to be more resistant to moderate insect feeding in the future as emerging biological controls keep HWA at acceptable levels.

Stand 23WL – Wetlands

See “Hydrology” section of the Forest Stewardship Plan

***Stand 23WL Prescription:**

At one time this site was largely an open emergent wetland, and it had been known to historically harbor Bog turtles. Over time, much of it has succeeded into a young red maple/alder swamp, which is not optimal open habitat required for bog turtles. Bog turtles spend substantial periods of their life basking in the sun, and like all reptiles, their ability to thermo-regulate internal body temperature is essential for controlling various metabolic processes. Additionally, shaded wetlands also inhibit warmer temperatures required for egg incubation. In order to restore suitable Bog turtle habitat, it is recommended that small openings of roughly 0.5 acres in size are created in the dense vegetation along the bank of open waters. This will mimic NJA activities on their adjacent part of this same wetland. Progressing slowly through the stand during the entire management period will minimize any drastic site alterations that might affect other important species. As funding allows, one half acre may be treated annually, commencing in the north and progressing southward in subsequent years.

Stand 24 Description

Size: 43.0 acres

Age: ~ 70 years

Stand 24 was a heavily stocked, mixed hardwood - hemlock stand up until about 2003. HWA has since devastated the eastern hemlock component, which now only makes up 12 percent of the stand's basal area. Most of the remaining hemlock that is over 10 inches DBH shows symptoms of HWA decline, often having LCR's of less than 10 percent. Hemlock and oak seedlings have regenerated in the gaps resulting from the loss of this species at a rate of over 200 and 150 stems per acre respectively. Current overstory stocking is 246 stems per acre within 100 sq. ft. of basal area per acre. The optimum residual basal area to promote the release and continued growth of the stand is roughly 80 square feet.

It is also important to note that the stream flowing south from Heaters Pond has active beaver dams, and the suite of species in this part of the forest are not well suited to inundation as the area floods.

Operability: Good. The stand can be accessed directly from Edison Road. The public section of Hawthorne Lake Road also cuts directly into Stand 24 and acts as the stand's southeastern boundary.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, sugar maple, eastern hemlock

Understory: eastern hemlock, American witchhazel, sugar maple

Basal Area / Ac & Quad. Mean DBH:

red oak: 22.5 ft²-11.4"

sugar maple: 17.5 ft²-11.8"

hemlock: 12.5 ft²-6.4"

total stand: 102.5 ft²-8.7"

Net Board Feet / Ac: 3304 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1120 cuft

Net Pulpwood Cords / Ac: 14 cords

Net Total Cubic Feet (cuft) / Ac: 1589 cuft

Total Cords / Ac: 20 cords

Stems / Ac: 246

Unique and/or High Conservation Value Features: Stand 24 is less than 100 feet from Heaters Pond.

***Stand 24 Prescription:** None, management of this stand will be deferred to a later period.

Stand 25 Description

Size: 74.0 acres

Age: ~ 65 years

Stand 25 is similar to Stand 24 in that it has lost significant quantities of eastern hemlock due to HWA. The major difference is that the stand contains significantly higher concentrations of shade intolerant species (overstory and understory regeneration). Besides hemlock, the overstory is comprised of chestnut oak, red oak, red maple, tulip tree and white oak (respectively by percentage of basal area). The stand contains thickets of mountain laurel and a dense ground cover of Pennsylvania sedge. Regeneration has been extremely limited in comparison to stand 24, probably due to the unfavorable conditions for existing overstory species to germinate in.

The stand's western boundary is a rocky ridge that overlooks the old New York – Susquehanna Railroad as it passes through the town of Ogdensburg. An interesting note is that pitch pine is found growing along this ridge top, providing what may be the only alternate conifer species to hemlock in the immediate area.

Operability: Fair. Although a quarter mile section of Edison Road acts as the southern boundary of this stand, there aren't any well-established roads into the stand for access into the interior.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: chestnut oak, eastern hemlock, northern red oak

Understory: eastern hemlock, northern red oak, mountain laurel

Basal Area / Ac & Quad. Mean DBH:

chestnut oak: 31.9 ft²-12.0"

hemlock: 30.0 ft²-6.2"

red oak: 20.6 ft²-13.9"

total stand: 106.9 ft²-8.0"

Net Board Feet / Ac: 1901 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1265 cuft

Net Pulpwood Cords / Ac: 16 cords

Net Total Cubic Feet (cuft) / Ac: 1522 cuft

Total Cords / Ac: 19 cords

Stems / Ac: 307

Unique and/or High Conservation Value Features: None

***Stand 25 Prescription:**

The goal for this stand is to maintain a softwood component on the WMA as hemlock decline continues. With only minimally successful strategies to mitigate the effects of HWA, the introduction of a surrogate alternate softwood species may be the only solid short term option to continue providing conifer habitat at SMWMA. In fact, historical accounts indicate that the region held significant quantities of conifers other than hemlock prior to the widespread clearing of the early 1900's. White pine, black and red spruce, larch and pitch pine are among the former



Image 3: Hemlock Woolly Adelgid Egg Masses

softwoods known to exist in the region. In order to enhance the softwood component, Stand 25 should receive a series of hybrid uneven aged management treatments that include both single-tree selection and group selections. Using the group selection method in areas that have been heavily impacted by HWA will enhance conditions to better allow for inter-planted softwood trees to grow well, since most are much less shade tolerant than hemlock, and they require more open conditions to do well. To treat the entire stand in a timely fashion, roughly 60 acres should be

implemented annually over the course of five years. The harvest treatment should be coupled with inter-planting of native softwoods such as White pine, Pitch pine, Red spruce, and possibly Red cedar or even Atlantic white cedar if the site permits.

One problem with this treatment is that most native softwoods have drastically different silvic characteristics than hemlock, and could do poorly on the same site, or might not serve the same function. Some, like Red spruce (a state endangered plant species) and larch, have declined in the region and are expected to do worse under future climate change scenarios. Although it is non-native, Norway spruce has not normally been considered invasive, and it has some similar silvic characteristics to hemlock. It may present the best option as a surrogate for hemlock. If a non-native like Norway spruce is considered, it will be vetted through a stakeholder input process before being used. The planted seedlings should be spaced roughly 7 to 8 feet apart from one another, equating to a rate of approximately seven to nine hundred seedlings per acre. The dense stocking regime will help to mimic natural conifer regeneration. As to further enhance survivability, seedlings should be planted in the early spring just before native vegetation begins to grow, on a day with a temperature between 35 and 60 degrees Fahrenheit, more than 40 percent relative humidity, and with winds less than 10 mph.

In portions of the stand where hemlock is less concentrated, single-tree selection silviculture will be the operative system that is applied. Trees favored in these areas will be shade tolerant, well formed, and contain the best phenotype characteristics to avoid high grading the stand. Preferred species to favor include healthy hemlock, sugar maple and yellow birch.

Stand 26 Description

Size: 39.1 acres

Age: ~ 80 years

Stand 26 is one of the oldest oak-hickory stands of the SMWMA, most likely because it is not easily accessible due to its steep slopes. It is situated adjacent to the New York Susquehanna Railroad, which acts as the stand's western boundary on a west-northwest facing hillside. The stand is predominately stocked with larger diameter co-dominant chestnut oak. The overall basal area is 145 square feet per acre. Approximately 20 percent of the stand's basal area consists of declining eastern hemlock. The majority of regeneration present is one to three foot sweet birch, with occasional pockets of white ash. As with other oak stands on the SMWMA, this stand contains approximately 10 square feet of well-established red maple basal area/acre that will likely persist at the expense of other intolerant species over time.

Operability: Inoperable. The likely access to Stand 26 would be from the railroad grade. The steepness of the stand, and lack of existing roads, makes the stand inoperable for traditional forestry equipment.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: chestnut oak, eastern hemlock, northern red oak

Understory: eastern hemlock, sweet birch, chestnut oak

Basal Area / Ac & Quad. Mean DBH:

chestnut oak: 47.5 ft²-12.9"

hemlock: 20.0 ft²-12.9"

red oak: 20.0 ft²-16.0"

total stand: 145.0 ft²-9.5"

Net Board Feet / Ac: 6092 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1742 cuft

Net Pulpwood Cords / Ac: 22 cords

Net Total Cubic Feet (cuft) / Ac: 2522 cuft

Total Cords / Ac: 32 cords

Stems / Ac: 293

Unique and/or High Conservation Value Features: None

***Stand 26 Prescription:** None, management of this stand will be deferred to a later period.

Stand 27 Description

Size: 191.8 acres

Age: ~ 70 years

Stand 27 is a well-drained, upland oak – red maple stand. Oak species make up roughly 40 square feet of basal area. In ten years, it is projected that the red maple will double in numbers, out-competing other shade intolerant species in the understory. Similar to other stands throughout SMWMA, ground cover is dominated by Pennsylvania sedge and Hayscented fern, which together occupy approximately 45 percent of the herbaceous stratum. The shrub layer is very thick, with nearly 700 American witchhazel stems per acre. The stand is bound in the north by a stream flowing from a forested wetland in the northwestern end into Tamarack Lake. Pockets of northern hardwoods are scattered within the more mesic and wet areas. There are roughly 30 mature white ash per acre throughout the stand, mostly in the northwest. Management of these trees in advance of EAB will be incorporated into any treatments here.

Operability: Very Good. The stand may be accessed by the 2012 improved road in Stand 18, and then by crossing the JCP&L easement. Access may also be possibly secured from the private communities of Beaver Lake and Tamarack Lake; where many of the existing trails (hiking and ATV) originate from.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: chestnut oak, northern red oak, red maple

Understory: serviceberry, American witchhazel, red maple

Basal Area / Ac & Quad. Mean DBH:

chestnut oak: 19.1 ft²-11.3"

red oak: 15.0 ft²-9.4"

red maple: 14.5 ft²-6.7"

total stand: 105.5 ft²-7.3"

Net Board Feet / Ac: 3601 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1146 cuft

Net Pulpwood Cords / Ac: 14 cords

Net Total Cubic Feet (cuft) / Ac: 1645 cuft

Total Cords / Ac: 21 cords

Stems / Ac: 361

Unique and/or High Conservation Value Features: None

***Stand 27 Prescription:**

This stand will receive a seed tree system with wildlife reserves treatment similar to that proposed for earlier stands.

Stand 28 Description

Size: 56.5 acres

Age: 70 years

The stand is predominantly oak, with a significant ash component. White ash is the third most common species in the stand, but most stems are less than 9 inches DBH; so the impact of EAB on the stand would be less drastic than in other stands where more mature ash are prevalent. The stocking is near the upper extent of the optimum level, and it is expected to exceed that level before 2022.

Operability: Good. This stand is bordered by the utility easement which could serve as an access area. The stand is characterized by a westward facing slope with some steeper, rocky areas at the top of the ridge to the east. Care will be taken when constructing roads or skid trails on the steeper, rockier portions of this stand.

Species Composition – Top Three Species by % of Stand Basal Area

Overstory: northern red oak, chestnut oak, white ash

Understory: red maple, white ash, pignut hickory

Basal Area / Ac & Quad. Mean DBH:

red oak: 30.0 ft²-6.8"

chestnut oak: 17.5 ft²-7.7"

white ash: 10.0 ft²-4.7"

total stand: 90.0 ft²-6.5"

Net Board Feet / Ac: 1,413 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 898 cuft

Net Pulpwood Cords / Ac: 11 cords

Net Total Cubic Feet (cuft) / Ac: 1092 cuft

Total Cords / Ac: 14 cords

Unique and/or High Conservation Value Features: None

***Stand 28 Prescription:**

This stand will receive a seed tree system with wildlife reserves treatment similar to that proposed for other stands earlier.

Stand 29 Description

Size: 15.6 acres

Age: 60 years

This stand contains cove hardwoods, including yellow birch maple and tulip poplar. It is currently overstocked, and considered within the stem exclusion stage. Witchhazel and mountain laurel are the primary shrubs in an otherwise limited understory.

Operability: Good. This stand includes a wetland with a stream which may limit operability to the winter months. The southern border of this stand is close to the utility easement, and could provide potential access.

Species Composition – Top Three Species by % of Stand Basal Area

Overstory: yellow birch, red maple, tuliptree

Understory: American witchhazel, northern spicebush, white ash

Basal Area / Ac & Quad. Mean DBH:

Yellow birch: 42.0 ft²-9.2"

Red maple: 42.0 ft²-12.1"

Tuliptree: 12.0 ft²-17.6"
total stand: 147.0 ft²-8.3"
Net Board Feet / Ac: 5,644 bdft
Net Pulpwood Cubic Feet (cuft) / Ac: 1,790 cuft
Net Pulpwood Cords / Ac: 22 cords
Net Total Cubic Feet (cuft) / Ac: 2,551 cuft
Total Cords / Ac: 32 cords
Stems / Ac: 391

Unique and/or High Conservation Value Features: None.

***Stand 29 Prescription:** None, management of this stand will be deferred to a later period.

Stand 30 Description

Size: 287.6 acres

Age: 70 years

This is a hemlock – hardwood stand located in the northwest end of the WMA. Eastern hemlock represents 29 percent of the basal area, and is severely impacted by HWA. All of the hemlock appear to be infected, and approximately 27 percent of the trees have already been killed. Despite the recent mortality, the stand remains adequately stocked with 120 sq. ft of BA/acre, and is projected to be overstocked again by 2022. The stocking data provides some insight into how overstocked the stand had been before HWA, and how that crowding may have impacted the susceptibility to total infestation as compared to the stocking in other hemlock stands that weren't as severely impacted.

There are extensive amounts of Hayscented fern in the groundcover that may need to be treated during management of the stand. Sporadic clusters of Japanese barberry are also found here, suggesting this stand could be susceptible to larger invasive species problems later on.

Operability: Excellent. The PSE&G power line easement runs through the stand providing potential areas for access. On the east side of this easement is a series of roads leading in and out of the stand. Access to the stand is limited in some respects by the overall distance from a paved road and occasional rough terrain along the utility easement.

Species Composition – Top Three Species by % of Stand Basal Area

Overstory: eastern hemlock, chestnut oak, red maple

Understory: eastern hemlock, red maple, northern red oak

Basal Area / Ac & Quad. Mean DBH:

hemlock: 29.1 ft²-7.2"

chestnut oak: 24.0 ft²-12.0"

red maple: 14.4 ft²-7.0"

total stand: 120.0 ft²-8.2"

Net Board Feet / Ac: 3,526 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1,304 cuft

Net Pulpwood Cords / Ac: 16 cords

Net Total Cubic Feet (cuft) / Ac: 1,786 cuft

Total Cords / Ac: 22 cords

Stems / Ac: 325

Unique and/or High Conservation Value Features: Wetlands are present in the southwestern portion of the stand. Some are larger than labeled on the map likely due to beaver activity.

***Stand 30 Prescription:**

This stand will receive the same hybrid group selection treatment (and subsequent inter-planting) as prescribed for stand 25, at roughly the same rate of implementation: 60 acres per year for five years.

Stand 31 Description

Size: 75.7 acres

Age: 70 years

Stand 31 is another oak stand with a significant witchhazel and mountain laurel understory component. It is currently fully stocked, and faces many of the same issues detailed for other similar oak stands in SMWMA; including a large amount of Hayscented fern.

Operability: Poor. It is characterized by a steep western facing slope that is rocky in many areas.

Species Composition – Top Three Species by % of Stand Basal Area

Overstory: chestnut oak, northern red oak, sweet birch

Understory: white ash, sugar maple, red maple

Basal Area / Ac & Quad. Mean DBH:

chestnut oak: 32.5 ft²-7.0"

red oak: 26.3 ft²-13.7"

sweet birch: 12.5 ft²-5.9"

total stand: 96.3 ft²-7.8"

Net Board Feet / Ac: 3,363 bdf

Net Pulpwood Cubic Feet (cuft) / Ac: 1,007 cuft

Net Pulpwood Cords / Ac: 13 cords

Net Total Cubic Feet (cuft) / Ac: 1,462 cuft

Total Cords / Ac: 18 cords

Stems / Ac: 292

Unique and/or High Conservation Value Features: Pitch pine was observed on this stand's ridge.

***Stand 31 Prescription:** None, management of this stand will be deferred to a later period.

Stand 32 Description

Size: 160.7 acres

Age: ~70 years

The stand is predominantly mixed oak with red maple. Portions of the stand have a moderately dense layer of witchhazel, mountain laurel and serviceberry. The stand is considered overstocked, which is visually evident by the tightly closed canopy and sparse understory.

Operability: Good. The southwestern tip of the stand borders the PSE&G power line easement and could be used for access. Some trails enter the stand from Beaver Lake Road, which will be considered for future forestry access. Operability is more challenging in some parts of the stand that contain steep, rocky slopes.

Species Composition – Top Three Species by % of Stand Basal Area

Overstory: northern red oak, chestnut oak, red maple

Understory: American witchhazel, red maple, northern red oak

Basal Area / Ac & Quad. Mean DBH:

red oak: 34.4 ft²-9.5"

chestnut oak: 21.3 ft²-9.1"

red maple: 15.2 ft²-6.1"

total stand: 123.7 ft²-6.4"

Net Board Feet / Ac: 3,813 bdf

Net Pulpwood Cubic Feet (cuft) / Ac: 1,150 cuft

Net Pulpwood Cords / Ac: 14 cords

Net Total Cubic Feet (cuft) / Ac: 1,676 cuft

Total Cords / Ac: 21 cords

Stems / Ac: 1,671

Unique and/or High Conservation Value Features: None

***Stand 32 Prescription:**

This stand will receive a seed tree system with wildlife reserves treatment similar to that proposed for earlier stands.

Stand 33 Description

Size: 103.6 acres

Age: ~ 70 years

Stand 33 is the northeastern most stand of SMWMA, bound by New Jersey State Route 23 to the north. It is a well-drained upland oak - hickory stand, positioned along a series of hilltops with a maximum elevation of roughly 1,300 feet. The red maple component represents almost 10 percent of the stand's basal area, and is projected to nearly double by 2022. The stand also contains beech groves in the lower elevations. Some beech are exhibiting root sprouting symptoms that may be linked to Beech Bark Disease. This will be monitored and further evaluated to assess if the disease becomes more prolific. If so, sanitation treatments may be warranted.

Most of the existing regeneration is shade tolerant sugar maple.

Operability: Very Good. Access can be established via Route 23, Lake Gerald or Tamarack Lake.

Species Composition - Top Three Species by % of Stand Basal Area

Overstory: northern red oak, chestnut oak, red maple

Understory: American witchhazel, red maple, American beech

Basal Area / Ac & Quad. Mean DBH:

red oak: 38.1 ft²-9.0"

chestnut oak: 31.2 ft²-11.0"

red maple: 9.2 ft²-7.5"

total stand: 110.8 ft²-8.7"

Net Board Feet / Ac: 3772 bdft

Net Pulpwood Cubic Feet (cuft) / Ac: 1332 cuft

Net Pulpwood Cords / Ac: 17 cords

Net Total Cubic Feet (cuft) / Ac: 1846 cuft

Total Cords / Ac: 23 cords

Stems / Ac: 270.5

Unique and/or High Conservation Value Features: None

***Stand 33 Prescription:**

This site will contribute to the percentage of SMWMA acreage dedicated to developing "Old Growth" attributes. The stand will be treated with an un-even aged management approach using both single-tree selection and group selection with wildlife reserves to mimic "gap-phase replacement". The treatment will be similar to the prescription for stand 21.

14. TEN YEAR MANAGEMENT SCHEDULE

The prior section entitled "Stand Descriptions and Prescriptions" should be consulted for specific stand treatments and silvicultural information. All treatment areas will be monitored by NJA and NJDEP in accordance to FSC Principal 8, to demonstrate progress towards the management objectives. The proposed treatment schedule is intended to be flexible and adaptive to changing conditions. Generally, individual practice plans will be generated for each treatment to address site specific concerns prior to implementation, and submitted through the NJDEP vetting process. Natural disturbances, such as windstorms or forest fires, could occur at a scale that meets the goals and objectives set forth to increase age class diversification through even-aged management techniques. In those instances, it may be warranted to forgo the scheduled treatments, even if the disturbance occurred in areas that were not slated for management. Additionally, monitoring of the

site and treatments may reveal unexpected responses that would warrant modifications to the proposed treatment schedule. This type of “adaptive management” will be employed throughout the 10 year plan.

If the proposed treatment schedule is adhered to, at the end of this plan period SMWMA will have between 110 – 310 acres (3% – 9% of its total), being managed in various stages as “Early Successional Habitat”. This level approximates what has been estimated to have naturally occurred as a result of stand replacement disturbance events historically in New Jersey (Lorimer and White 2003). Based on existing conditions, this level can be sustainably maintained in perpetuity while establishing a more evenly distributed age class representation throughout the SMWMA. However, even at these levels, early successional habitat will be severely under-represented at the regional landscape level.

Under the proposed treatment schedule, at the end of this plan period SMWMA will have between 140 – 335 acres (4% – 10% of its total), being managed in various stages for the development of “Old Growth” conditions, or in some cases, “Climax Forest” conditions. This percentage probably exceeds the amount of Old Growth forests that historically occurred in New Jersey (Lorimer and White 2003).

Year 1 - 2016 Total Treatment Acreage: 15.0-40.0 acres

Stand: 18

Acreage: 5-10

Prescription: Seed tree with wildlife reserves.

Acreage: 5-10

Prescription: Shelterwood cut with wildlife reserves.

Stand: 33

Acreage: 5-20

Prescription: Single tree improvement cutting with wildlife reserves.

Year 2 – 2017 Total Treatment Acreage: 44-99 acres

Stand: 8

Acreage: 5-10

Prescription: Seed tree with wildlife reserves

Stand: 21

Acreage: 25-75

Prescription: Single tree selection improvement cutting with wildlife reserves

Stand: 3

Acreage: 13

Prescription: Monitor for invasive species

Stand: 23WL (Wetlands)

Acreage: .5

Prescription: Annual overstory removal to promote habitat for basking turtles.

Year 3 – 2018 Total Treatment Acreage: 39-79 acres

Stand: 3

Acreage: 18

Prescription: Monitor for invasive species

Stand: 22
Acreage: 10-30
Prescription: Crown thinning / shelterwood

Stand: 12
Acreage: 10-30
Prescription: Seed tree with wildlife reserves

Stand: 23WL (Wetlands) Optional - Edge of Edison Bog wetlands that flow into Ryker Lake.
Acreage: .5
Prescription: Annual overstory removal to promote habitat for basking turtles.

Year 4 – 2019 Total Treatment Acreage: 16-51 acres

Stand: 9
Acreage: 10-30
Prescription: Shelterwood cut with wildlife reserves. Schedule follow up prescribed burn for 2019.

Stand: 4
Acreage: 5-20
Prescription: Monitor stand's transition to Old Growth

Stand: 23WL (Wetlands) Optional - Edge of Edison Bog wetlands that flow into Ryker Lake.
Acreage: .5
Prescription: Annual overstory removal to promote habitat for basking turtles.

Year 5 – 2020 Total Treatment Acreage: 41-111 acres

Stand: 22
Acreage: 10-30
Prescription: Crown thinning / shelterwood

Stand: 30
Acreage: 15-40
Prescription: Hemlock groves receive group selection other hardwoods receive single tree selection cuts.

Stand: 30
Acreage: 15-40
Prescription: Interplant native softwood species (i.e.: pitch pine, Atlantic white cedar, red spruce) in group selection openings. Treat thick pockets of hayscented fern and other unacceptable growing stock in group selection openings with FSC compliant pesticides to promote successful planting.

Stand: 23WL (Wetlands)
Acreage: .5
Prescription: Annual overstory removal to promote habitat for basking turtles.

Year 6 – 2021 Total Treatment Acreage: 31-91 acres

Stand: 18
Acreage: 10-30
Prescription: Seed tree with wildlife reserves

Stand: 9

Acreage: 10-30

Prescription: Shelterwood cut with wildlife reserves. Schedule follow up prescribed burn for 2021.

Stand: 9 (2019 harvest area)

Acreage: 10-30

Prescription: Prescribed burn to kill back young trees and shrubs in understory and foster oak seedling sprouts.

Stand: 23WL (Wetlands)

Acreage: .5

Prescription: Annual overstory removal to promote habitat for basking turtles.

Year 7 – 2022 Total Treatment Acreage: 45-120 acres

Stand: 30

Acreage: 15-40

Prescription: Hemlock groves receive group selection other hardwoods receive single tree selection cuts.

Stand: 30

Acreage: 15-40

Prescription: Interplant native softwood species (i.e.: pitch pine, Atlantic white cedar, red spruce) in group selection openings. Treat thick pockets of hayscented fern and other unacceptable growing stock in group selection openings with FSC compliant pesticides to promote successful planting.

Stands: 7 and/or 8

Acreage: 5-10

Prescription: Seed tree with wildlife reserves.

Stand: 33

Acreage: 10-30

Prescription: Single tree improvement cutting with wildlife reserves.

Year 8 – 2023 Total Treatment Acreage: 40-120 acres

Stands: 1 and/or 2

Acreage: 10-30

Prescription: Seed tree with wildlife reserves.

Stand: 25

Acreage: 10-30

Prescription: Hemlock groves receive group selection other hardwoods receive single tree selection cuts.

Stand: 25

Acreage: 10-30

Prescription: Interplant native softwood species (i.e.: pitch pine, Atlantic white cedar, red spruce) in group selection openings. Treat thick pockets of hayscented fern and other unacceptable growing stock in group selection openings with FSC compliant pesticides to promote successful planting.

Stand: 9 (2021 harvest area)

Acreage: 10-30

Prescription: Prescribed burn to kill back young trees and shrubs in understory and foster oak seedling sprouts.

Year 9 – 2024 Total Treatment Acreage: 30-90 acres

Stand: 33

Acreage: 10-30

Prescription: Single tree improvement cutting with wildlife reserves.

Stand: 32

Acreage: 10-30

Prescription: Seed tree with wildlife reserves.

Stand: 27

Acreage: 10-30

Prescription: Seed tree with wildlife reserves.

Year 10 – 2025 Total Treatment Acreage: 60.0-100.0 acres

Stand: 21

Acreage: 50-70

Prescription: Single tree improvement cutting with wildlife reserves.

Stands: 18 and/or 28

Acreage: 10-30

Prescription: Seed tree with wildlife reserves.

15. FOREST INVENTORY STATISTICS

NJA utilized NED 2 to process and evaluate the quantitative forest inventory information. A great number of Stand Visualization scenarios were produced as well as tables which aided in the preparation of this plan. NJA and NJDEP maintain the raw inventory data, and can produce specific reports upon request.

To interpret confidence interval values: Using the numbers for the Basal area column at the 70% percent confidence interval, NED estimates with 70% confidence that the true mean lies between the upper and lower limit values. Under similar conditions, about 70% of repeated samples in this stand (using the same number of plots) will contain the true mean. If the variation between the existing sample plots is representative of the whole stand, then the amount of sample plots listed is required to ensure that the calculated mean is within 15 or 10 percent of the true mean with 70 percent confidence.

Stand 1: degrees of freedom = 18

alpha = 0.300

t-value = 1.067

70% confidence interval

	Basal area (sq.ft/ac)	Net bdfit vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	81.72	2894.26	851.18	69.62	453.06
70% c.i. mean upper limit	113.28	4370.07	1219.79	96.13	813.52
70% c.i. # plots for w/in 15%	21	34	26	21	65
70% c.i. # plots for	48	75	58	47	146

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
w/in 10%					

Stand 2: degrees of freedom = 69

alpha = 0.300

t-value = 1.044

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	96.72	3873.92	966.32	79.97	268.40
70% c.i. mean upper limit	108.07	4604.03	1088.45	89.28	332.65
70% c.i. # plots for w/in 15%	10	23	11	10	36
70% c.i. # plots for w/in 10%	22	52	25	21	79

Stand 3: degrees of freedom = 3

alpha = 0.300

t-value = 1.250

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	11.75	499.52	97.90	6.72	0.00
70% c.i. mean upper limit	85.75	6159.70	610.71	52.17	452.68
70% c.i. # plots for w/in 15%	103	129	94	106	181
70% c.i. # plots for w/in 10%	231	289	210	239	406

Stand 3: degrees of freedom = 5

alpha = 0.300

t-value = 1.156

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	63.69	2992.58	640.88	50.21	79.67
70% c.i. mean upper limit	106.31	5425.14	1124.81	86.45	237.03
70% c.i. # plots for w/in 15%	17	23	21	19	66
70% c.i. # plots for w/in 10%	38	51	46	43	149

Stand 4: degrees of freedom = 1
alpha = 0.300
t-value = 1.930
70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	25.14	0.00	0.00	54.00	96.37
70% c.i. mean upper limit	169.86	9764.88	1705.47	114.00	1384.59
70% c.i. # plots for w/in 15%	49	331	260	12	68
70% c.i. # plots for w/in 10%	111	745	583	26	152

Stand 5: degrees of freedom = 3
alpha = 0.300
t-value = 1.250
70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	101.26	2667.45	1043.50	88.39	226.33
70% c.i. mean upper limit	138.74	5572.35	1431.90	125.77	568.20
70% c.i. # plots for w/in 15%	5	23	5	6	33
70% c.i. # plots for w/in 10%	10	50	10	13	75

Stand 6: degrees of freedom = 3
alpha = 0.300
t-value = 1.250
70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	101.26	2667.45	1043.50	88.39	226.33
70% c.i. mean upper limit	138.74	5572.35	1431.90	125.77	568.20
70% c.i. # plots for w/in 15%	5	23	5	6	33
70% c.i. # plots for w/in 10%	10	50	10	13	75

Stand 7: degrees of freedom = 29
alpha = 0.300
t-value = 1.055
70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
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70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	115.46	4041.12	1264.25	93.57	264.13
70% c.i. mean upper limit	129.54	4882.31	1456.53	106.50	360.53
70% c.i. # plots for w/in 15%	5	12	7	6	32
70% c.i. # plots for w/in 10%	10	27	15	13	72

Stand 8: degrees of freedom = 33

alpha = 0.300

t-value = 1.053

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	115.94	4188.99	1219.16	95.64	310.56
70% c.i. mean upper limit	125.83	4910.18	1353.23	105.61	460.67
70% c.i. # plots for w/in 15%	3	10	5	4	58
70% c.i. # plots for w/in 10%	6	22	10	9	129

Stand 9: degrees of freedom = 35

alpha = 0.300

t-value = 1.052

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	102.05	4805.79	999.11	81.94	251.26
70% c.i. mean upper limit	117.95	5957.46	1171.03	95.54	339.92
70% c.i. # plots for w/in 15%	9	19	11	10	36
70% c.i. # plots for w/in 10%	19	42	23	22	81

Stand 10: degrees of freedom = 5

alpha = 0.300

t-value = 1.156

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
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70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	78.64	968.75	704.71	64.32	312.99
70% c.i. mean upper limit	126.36	2496.17	1234.21	107.56	480.47
70% c.i. # plots for w/in 15%	15	52	20	17	12
70% c.i. # plots for w/in 10%	33	117	45	38	27

Stand 11: degrees of freedom = 6

alpha = 0.300

t-value = 1.134

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	87.35	3343.20	952.77	70.53	170.86
70% c.i. mean upper limit	126.94	5157.89	1352.73	101.97	299.92
70% c.i. # plots for w/in 15%	11	15	10	11	24
70% c.i. # plots for w/in 10%	24	32	22	24	53

Stand 12: degrees of freedom = 4

alpha = 0.300

t-value = 1.190

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	121.60	4832.02	1170.15	107.22	172.94
70% c.i. mean upper limit	142.40	8259.13	1286.22	133.59	578.72
70% c.i. # plots for w/in 15%	2	16	1	3	65
70% c.i. # plots for w/in 10%	4	35	2	6	146

Stand 13: degrees of freedom = 2

alpha = 0.300

t-value = 1.385

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	18.46	0.00	321.66	14.94	0.00

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean upper limit	101.54	912.85	848.85	105.07	1023.81
70% c.i. # plots for w/in 15%	64	256	28	76	182
70% c.i. # plots for w/in 10%	144	576	61	170	409

Stand 14: degrees of freedom = 3

alpha = 0.300

t-value = 1.250

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	61.04	2568.77	648.65	50.27	84.98
70% c.i. mean upper limit	148.96	7058.51	1575.30	124.86	418.83
70% c.i. # plots for w/in 15%	32	39	31	33	79
70% c.i. # plots for w/in 10%	71	87	70	73	176

Stand 15: degrees of freedom = 4

alpha = 0.300

t-value = 1.190

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	83.80	3488.28	837.58	62.11	155.64
70% c.i. mean upper limit	120.20	5523.28	1223.97	97.10	321.76
70% c.i. # plots for w/in 15%	8	12	8	11	27
70% c.i. # plots for w/in 10%	16	26	18	25	61

Stand 16: degrees of freedom = 2

alpha = 0.300

t-value = 1.385

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	58.27	811.57	707.72	52.62	114.67
70% c.i. mean upper limit	121.73	1803.75	1068.23	125.65	1261.74

70% confidence interval

	Basal area (sq.ft/ac)	Net bdfv vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. # plots for w/in 15%	17	20	6	23	93
70% c.i. # plots for w/in 10%	38	44	13	51	209

Stand 17: degrees of freedom = 2

alpha = 0.300

t-value = 1.385

70% confidence interval

	Basal area (sq.ft/ac)	Net bdfv vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit		260.23	1170.77	86.60	170.17
70% c.i. mean upper limit		7672.84	1459.56	99.88	559.31
70% c.i. # plots for w/in 15%		117	2	1	38
70% c.i. # plots for w/in 10%		262	4	2	86

Stand 18: degrees of freedom = 47

alpha = 0.300

t-value = 1.048

70% confidence interval

	Basal area (sq.ft/ac)	Net bdfv vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	92.58	2588.71	1016.68	78.68	282.89
70% c.i. mean upper limit	105.93	3173.77	1185.10	90.88	389.83
70% c.i. # plots for w/in 15%	10	22	13	11	53
70% c.i. # plots for w/in 10%	22	49	28	25	119

Stand 19: degrees of freedom = 3

alpha = 0.300

t-value = 1.250

70% confidence interval

	Basal area (sq.ft/ac)	Net bdfv vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	87.89	782.76	809.22	73.97	240.41
70% c.i. mean upper limit	122.11	2959.02	1417.20	110.28	569.59
70% c.i. # plots for w/in 15%	5	61	14	7	30

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. # plots for w/in 10%	11	136	30	16	67

Stand 20: degrees of freedom = 4

alpha = 0.300

t-value = 1.190

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	106.63	1875.98	1035.30	90.52	298.03
70% c.i. mean upper limit	115.37	4180.87	1161.38	101.24	557.24
70% c.i. # plots for w/in 15%	1	33	1	1	21
70% c.i. # plots for w/in 10%	1	73	2	2	46

Stand 21: degrees of freedom = 21

alpha = 0.300

t-value = 1.063

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	109.91	3343.07	1091.86	88.38	350.76
70% c.i. mean upper limit	128.73	4563.80	1341.23	103.49	488.09
70% c.i. # plots for w/in 15%	7	24	11	7	27
70% c.i. # plots for w/in 10%	14	53	24	14	59

Stand 22: degrees of freedom = 10

alpha = 0.300

t-value = 1.093

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	97.97	2925.55	1054.84	76.16	224.53
70% c.i. mean upper limit	128.40	4580.22	1458.65	97.09	372.98
70% c.i. # plots for w/in 15%	9	24	13	8	31
70% c.i. # plots for w/in 10%	20	54	29	17	68

Stand 23: degrees of freedom = 3

alpha = 0.300

t-value = 1.250

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	13.75	502.52	97.90	7.72	0.00
70% c.i. mean upper limit	98.75	6459.80	610.71	52.17	452.68
70% c.i. # plots for w/in 15%	107	129	104	104	181
70% c.i. # plots for w/in 10%	231	289	210	239	406

Stand 24: degrees of freedom = 6

alpha = 0.300

t-value = 1.134

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	76.62	1824.41	844.53	55.51	169.12
70% c.i. mean upper limit	128.38	5084.71	1265.75	97.91	322.06
70% c.i. # plots for w/in 15%	17	60	11	21	26
70% c.i. # plots for w/in 10%	39	134	24	46	59

Stand 25: degrees of freedom = 9

alpha = 0.300

t-value = 1.100

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	86.70	1246.10	937.98	60.11	229.29
70% c.i. mean upper limit	127.05	2743.66	1474.03	91.11	384.08
70% c.i. # plots for w/in 15%	13	51	18	15	23
70% c.i. # plots for w/in 10%	29	113	40	34	51

Stand 26: degrees of freedom = 5

alpha = 0.300

t-value = 1.156

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	137.69	5004.50	1412.84	97.10	160.89
70% c.i. mean upper limit	152.31	6943.78	1890.14	118.20	424.72
70% c.i. # plots for w/in 15%	1	8	6	3	55
70% c.i. # plots for w/in 10%	2	16	13	6	122

Stand 27: degrees of freedom = 32

alpha = 0.300

t-value = 1.054

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	98.63	3532.04	980.92	76.94	300.56
70% c.i. mean upper limit	112.28	4343.94	1146.04	87.22	421.30
70% c.i. # plots for w/in 15%	7	16	9	6	42
70% c.i. # plots for w/in 10%	14	36	20	13	93

Stand 28: degrees of freedom = 11

alpha = 0.300

t-value = 1.088

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	78.64	1204.83	660.29	69.62	295.43
70% c.i. mean upper limit	101.36	2578.50	994.04	91.55	481.91
70% c.i. # plots for w/in 15%	9	71	22	10	31
70% c.i. # plots for w/in 10%	20	159	49	23	70

Stand 29: degrees of freedom = 4

alpha = 0.300

t-value = 1.190

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	129.70	4899.60	1427.99	88.78	203.29
70% c.i. mean upper	164.30	7338.21	1920.53	114.70	578.04

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
limit					
70% c.i. # plots for w/in 15%	4	9	5	4	52
70% c.i. # plots for w/in 10%	7	20	11	9	116

Stand 30: degrees of freedom = 49

alpha = 0.300

t-value = 1.048

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	112.03	3532.74	1111.73	77.86	285.92
70% c.i. mean upper limit	127.97	4355.57	1276.08	89.43	364.95
70% c.i. # plots for w/in 15%	10	25	11	11	33
70% c.i. # plots for w/in 10%	23	55	24	24	74

Stand 31: degrees of freedom = 11

alpha = 0.300

t-value = 1.088

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	83.32	2636.76	789.23	69.29	194.38
70% c.i. mean upper limit	109.18	4552.12	1076.92	93.39	390.04
70% c.i. # plots for w/in 15%	10	38	13	12	60
70% c.i. # plots for w/in 10%	22	86	29	27	135

Stand 32: degrees of freedom = 36

alpha = 0.300

t-value = 1.052

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	95.11	3347.79	885.29	79.91	358.81
70% c.i. mean upper limit	107.60	4065.98	1032.85	90.65	558.47

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. # plots for w/in 15%	7	16	10	7	78
70% c.i. # plots for w/in 10%	15	35	22	15	176

Stand 33: degrees of freedom = 12

alpha = 0.300

t-value = 1.083

70% confidence interval

	Basal area (sq.ft/ac)	Net bdft vol (bd.ft/ac/ac)	Net pulp vol (cu.ft/ac/ac)	Rel. dens. (%/ac)	Stems/area (stems/ac)
70% c.i. mean lower limit	99.65	3768.32	1039.71	83.71	210.39
70% c.i. mean upper limit	121.89	5422.89	1336.44	103.52	330.61
70% c.i. # plots for w/in 15%	6	19	10	7	29
70% c.i. # plots for w/in 10%	14	43	21	15	65

16. REFERENCES AND LITERATURE CITED

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