



*Silviculture Prescription
Breezy Knoll*

*Massachusetts Department of Conservation and Recreation
Bureau of Forestry*

*Western Connecticut Valley District
Leyden State Forest
Leyden, MA*

Prepared by:

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March 2013

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Date: March 21, 2013

INTRODUCTION

The Breezy Knoll Forest Management Project encompasses the entire Leyden State Forest which is located in a very rural section of northern Franklin County (see Locus Map). The State Forest is a 61 acre isolated “reforestation lot” plantation composed of mostly Norway spruce and eastern white pine in the town of Leyden, MA. It is surrounded entirely by a working dairy farm.

SITE DATA

Hydrology and watershed:

The Leyden State Forest lies in the watershed of the Green River, which in turn drains into the Deerfield River and eventually into the Connecticut River. The headwaters of Brandy Brook are formed from two separate wetland systems in the forest. The eastern system is located in the northerly section of the forest and is formed by the saddle of two low ridges. The westerly system is formed the western boundary of the forest. Brandy Brook flows into Glen Brook, which is part of the Greenfield reservoir system located approximately three miles south of the forest in the town of Leyden.

Geology and Landforms:

Parent material in the Leyden State Forest is composed of glacial material derived mainly from gray mica schist that contains some impure limestone in places. The Westminster soil series is formed from this parent material (NRCS). The Leyden State Forest has a 50 foot wide cleared and maintained utility right of way running east-west through the middle of it. The section north of this line has significant areas with slopes less than 5%, along with a few steeper sections, while the area south of the line consists almost entirely of gentle to mainly moderate rolling terrain. The slope averaged out for the whole parcel is roughly 16%. There are a number of rock outcrops, two streams, and a wetland complex located within the sale area, which runs from bottomland to the top of the hill.

Climate:

The elevation of Leyden is 969 feet. It has a wet climate, receiving an average of 46.2 inches of rainfall and 59.2 inches of snowfall per year. The record high temperature recorded was 104 degrees F and the record low temperature was -28 degrees F. The mean temperature is 50 degrees F. The Leyden State Forest is located at the top of a hill and can receive strong winds, usually out of the west, but also an occasional big storm from the northeast. The average wind speed is 6.8 miles per hour with a recorded high of 40 miles per hour from the west and a recorded highest gust of 54 miles per hour from the northwest.

Soils:

The Leyden State Forest has a single soil type, classified as WrD, which is a Westminster extremely rocky loam on slopes ranging from 3 to 25%. These tend to be well-drained shallow loams which are formed in a layer of glacial material derived from gray mica schist with some impure limestone content. A typical Westminster soil that is forested has a thin, crumbly, black loam surface layer approximately 4” thick. This is covered by 3 or 4 inches of forest litter in various stages of decomposition. The subsoil is a dark yellowish brown loam. It is underlain at a depth of about 18” by dark-gray schist bedrock. They are found in gently sloping to very steep foothills of the western highlands. Rock outcrops are less than 50 feet apart in some parts of the forest. Historical usage of this area has been for unimproved pasture as the soils are too thin and

rocky for cultivation. Soil productivity is generally towards the lower end for this type, but micro sites will exist that can be quite productive. Typical soil associates include the well-drained Colrain and Shelburne soils, the moderately- drained Peru and Buckland soils and the poorly drained Ridgebury and Cabot soils. The shallow nature of the soils and presence of surface stones and bedrock will influence tree growth and mortality as well as the ability to place suitable access roads.

Potential Vegetation:

The Leyden State Forest is approximately 97% forested, with the exception being a cleared utility right of way. This is primarily a coniferous forest composed of planted Norway spruce (*Picea abies*) and eastern white pine (*Pinus strobus*), along with native eastern hemlock (*Tsuga canadensis*) and red spruce (*Picea rubens*). There are two small hardwood inclusions of roughly 2 acres a piece, consisting primarily of Sugar maple (*Acer saccharum*), along with black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), black birch (*Betula lenta*) and American beech (*Fagus grandifolia*). These hardwood species are also interspersed in the main coniferous stand.



Site Productivity:

General overall site quality is low due to the shallow, acidic soils and stony nature of the Westminster soil group. Site index numbers average in the low 50s for much of the forest. The exception to this is isolated pockets of deeper soil found at the bottom of ridges and along the drainages. Site date for ash was in the 75 to 80 range in these areas. The Franklin County Soil Survey

published by the United States Department of Agriculture lists the Westminster soil group as being in woodland suitability group 11, which is at the lower end of the scale. It also cautions against the hazard of windthrow and potential high seedling mortality due to droughty soil characteristics.

Cultural and Archeological Features:

An internal review and evaluation of the Leyden State Forest was conducted by the DCR in 2012. It was determined that there were no pre-contact sites within a mile of the forest. Because of the 3-25% slope and extremely rocky conditions, the forest was considered to have low sensitivity in terms of past cultural use and presence of historical artifacts. All stone features, including stone walls will be avoided during harvest operations and these features will be treated according to guidelines set forth in the “Bureau of Forestry-Cultural Resource Management Protection Standards and Guidelines”.

STAND DATA

Forest History and Stand Resources: The Leyden State Forest was established under the Reforestation Act in the early 1900’s. The land was abandoned pasture and converted to plantation

with Eastern white pine (*Pinus strobus*) and Norway spruce (*Picea abies*). Non-commercial thinnings were done in several parts of the forest in the late 1950's and in 1968-69. A commercial harvest was carried out in 1968 to thin the northern portion of the plantation. This was done by removing every third or second row of trees. Several other small sales were carried out in the southern part of the forest which treated the small inclusions of northern hardwoods. The current forest condition resulting from these past practices is an even-aged stand of Norway spruce and Eastern white pine with scattered northern hardwood trees such as Black cherry (*Prunus serotina*), Sugar maple (*Acer saccharum*) and White ash (*Fraxinus americana*). A small section of the north western corner of the forest was heavily damaged by fire in the 1990s and has resulted in large amounts of damaged and dead trees.

Composition:

Table 1 gives a breakdown of the species found in the forest and the composition in percent and stems per acre.

Table: 1 - Overstory only - Trees $\geq 5''$ Diameter Breast Height (DBH)

	All species	Norway spruce	Eastern white pine	Black cherry	Sweet birch	Sugar maple	White ash	American hornbeam	Red maple	Eastern hemlock	American beech
Basal Area (square feet)	200.0	91.3	84.3	7.8	3.5	3.5	2.6	1.7	1.7	0.9	0.9
Percentage of stand basal area (%)	100.0	45.7	42.2	3.9	1.7	1.7	1.3	0.9	0.9	0.4	0.4
Stems Per Acre	311.2	55.0	52.6	4.9	8.0	7.3	1.6	6.5	8.9	2.0	4.4
Quadratic Mean DBH(inches)	10.9	17.5	17.1	17.1	9.0	9.3	17.3	7.0	6.9	9.0	6.0
Relative Density (%)	66.71	24.27	28.37	2.62	2.22	2.92	0.89	1.40	1.52	0.38	0.81
Percentage of Stand	100.00	36.39	42.52	3.93	3.32	4.37	1.33	2.11	2.29	0.58	1.22

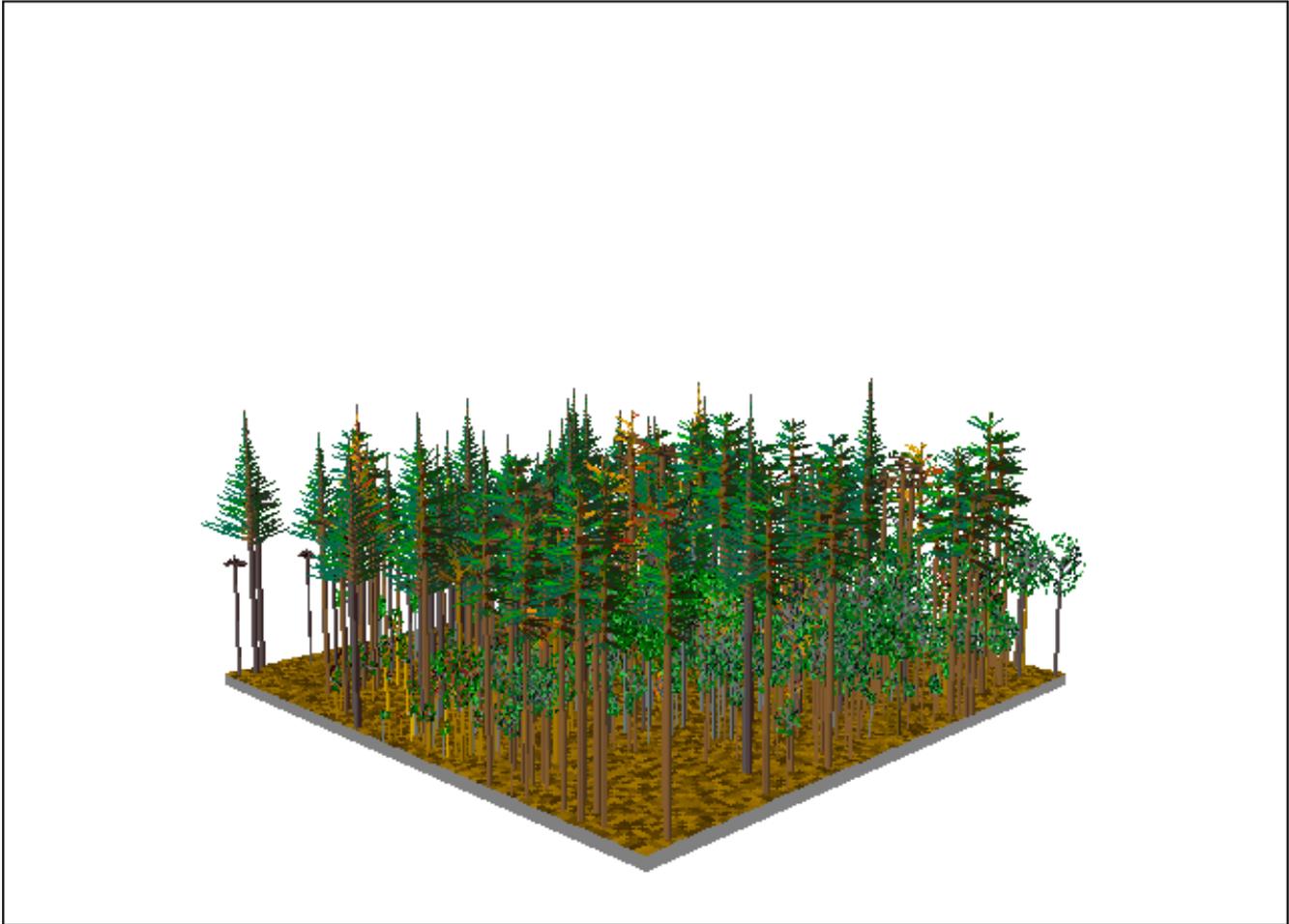
Understory only - Trees $< 5''$ Diameter Breast Height (DBH)

	All species	Sugar maple	Sweet birch	American beech	Eastern hemlock	White ash	American hornbeam	Yellow birch	Striped maple
Basal Area (square feet)	8.4	2.9	2.6	1.3	0.5	0.5	0.4	0.1	0.0
Percentage of stand basal area (%)	100.0	34.6	31.4	15.3	6.5	6.5	4.5	1.1	0.0
Stems Per Unit Area (stems per acre)	417.4	117.4	108.7	117.4	4.3	21.7	4.3	8.7	30.4

Understory only - Trees <5" Diameter Breast Height (DBH)

	All species	Sugar maple	Sweet birch	American beech	Eastern hemlock	White ash	American hornbeam	Yellow birch	Striped maple
Quadratic Mean DBH(inches)	2.2	2.1	2.2	1.6	4.8	2.1	4.0	2.0	0.0

Stand=310001 Year=2013 Beginning of cycle



Visualization of Current Forest Structure of Leyden State Forest

The structure of the forest can be described as a single-storied even-aged forest. It is dominated by large (>14"DBH) Norway spruce and Eastern white pine of varying quality. Small gaps exist in the canopy where trees have died and allowed light to reach the forest floor. It is in these areas that patches of regeneration have begun to grow. Northern hardwoods have also grown in the gaps left along stone walls and in between the original plantings. These have grown into the canopy and in some cases overtopped the softwoods. The overstory is approximately 94 years old with small patches of regeneration in the various gaps. These represented age classes from 5-10

years old. Areas that have received past silvicultural treatments have a more uniform diameter distribution and less stems per acre.

Ground cover, shrubs and forbs vary in intensity and abundance throughout the forest. The major factors that affect the distribution are light intensity and available seed sources. Areas under the densest spruce canopies have a forest floor covered in ferns, moss, and dead and down woody material, beech and partridgeberry. The portions of the forest along the open pastures, power lines and in or near gaps in the canopy have a mix of hardwood trees species such as ash, black cherry, yellow birch, red maple, sugar maple and beech. Woody shrubs present include hornbeam and striped maple. Also present are ferns, grasses and brambles. The growing sites are variable due to the varied nature of the topography and hydrologic features. A small wetland complex is present on the northern portion of the forest and ground cover is limited to mosses, grasses, ferns and lichens. These wetlands are shallow and will dry out during the summer and early fall. Tree species are present along the edges of these well-defined shallow depressions. There is also a stream that flows out of these wetlands along a channel that primarily flows to the south. This riparian zone offers better growing conditions for most species due to the presence of well-drained soils on and adjacent to the stream banks. Rocky outcrops and ledges are scattered among the forest and represent some of the poorer growing conditions. Plants growing in these sections are shallow rooted and exhibit poor form due to the lack of soil and nutrients.

Wildlife Habitat Conditions:

Current wildlife habitat conditions are predominately mature spruce and white pine canopy with inclusions of northern hardwoods. Standing dead snag density is 68 snags/acre in the 6” to 24” diameter range. Potential and actual live cavity trees are also prevalent on the site. Coarse woody debris is averaging approximately 2,067 cubic feet/acre in the 3” to 24” diameter range. Red squirrels are actively using the forest as evidenced by both squirrel middens and observations. Deer scat and tracks were also evident throughout the forest and it is highly probable that this area is used as winter cover. Other mammals that may be found in the forest include black bear, fisher, raccoon, fox, coyote and pine marten. Bird species would include forest dwelling species such as



black-throated green warbler, brown creeper and golden-crowned kinglet. Other species that prefer more open areas will be found near the powerline that bisects the property and in the open agricultural land that borders the forest. Wild turkeys were observed in the open powerline area and red tailed hawks were also observed circling above the forest.

Water Resources:

A prominent tributary of Brandy Brook flows from the state forest. The existing forest stand provides protection to downstream

water resources in the form of filtration of overland flow and interception of precipitation. Complete canopy cover results in a shaded micro-climate producing cooler water temperature and cool, moist growing conditions along the riparian zones.

The photo above shows the tributary of Brandy Brook flowing south through Leyden State Forest. Hardhat used to show relative size of stream channel. Dead pine tree in background from previous silvicultural treatments.

Recreation:

Recreational opportunities are limited to passive activities such as bird watching, hunting and walking. There are no approved trails in the forest with the exception of the remnants of a snowmobile trail constructed in the 1970's. Access is difficult due to the lack of frontage.



Tree Mortality in Norway Spruce. Leyden SF.
Photo by N. Anzuoni 2012

Forest Protection Concerns:

The Leyden State Forest is located on a hilltop with rocky, relatively shallow soils. Predominately west winds are constantly pushing against the shallow-rooted Norway spruce and as a result some of the larger trees have toppled over. This was also exacerbated by the December 2008 ice storm which also toppled trees and broke some of the stems. The effects of this damage will accelerate the natural decline that is already taking place in this forest. It also appears that the spruce is exhibiting

additional mortality in the form of reduced crown density and dieback. It is suspected that Armillaria root rot disease, a fungal root rot disease, is present in the stand. Also present are sugar maple borers which attack the stems of sugar maples and cause extensive damage. White ash trees are a component of this forest and may be attacked by Emerald Ash Borer as it spreads from the west. Beech bark disease is common in this stand and causes serious damage and eventually death to infected trees. A brush fire impacted several acres in the northwestern corner of the forest and was caused by a fire on private property that spread to state land. This caused heavy mortality and damaged every softwood tree within the fire perimeter. The main form of damage was caused by the fire killing a portion of the lower stem and allowing rot and decay to enter the tree. It is expected that almost all of the damaged trees will die within the next ten years.

EVALUATION OF DATA AND PROJECTED RESULTS

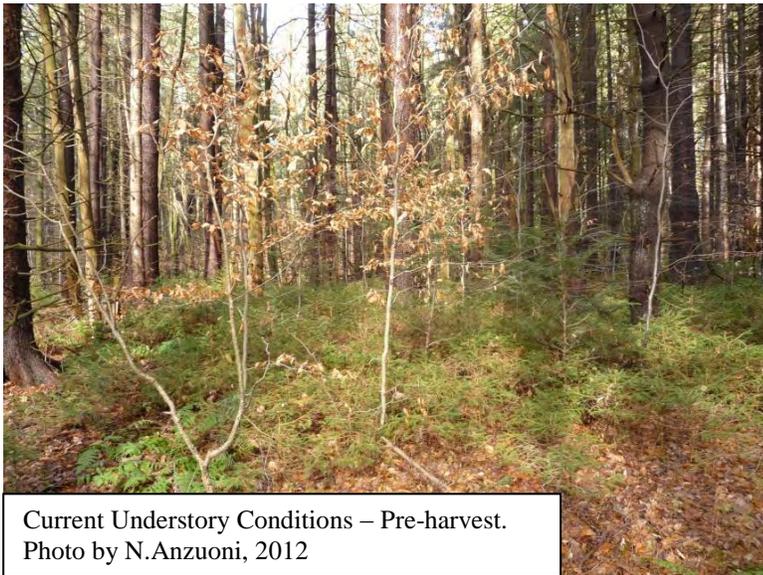
Objectives of Forest Management:

- Demonstrate use of silvicultural practices to convert even-aged Norway spruce plantation to multi-aged forest with an increased component of northern hardwoods.
- Increase plant species diversity
- Create vertical structural diversity by varying age classes throughout the forest.
- Establish a network of skid roads and trails to facilitate future access to the forest.

- Demonstrate use of Best Management Practices to conduct sustainable forestry operations on state lands.
- Maintain Coarse Woody Debris levels to agency guidelines.

Silvicultural Prescription:

The group-selection system will be used to create openings not to exceed 1/3 acre, which will comply with current DCR Management Guidelines. The small size of the group openings will decrease the chances of windthrow in the residual stand and gradually convert the stand to multiple age classes. Approximately 10 acres of group openings will be created with the intent to produce an uneven age structure after 5 subsequent similar entries. The openings will be located near seed trees such as Sugar maple and Black cherry in order to secure regeneration. Openings will also be located near existing patches of desirable advanced regeneration with the objective of releasing it from competition. A commercial thinning will be used along the skid roads and trails and between group selections to remove poorly formed stems, trees with low vigor and trees with signs of obvious damage. Stocking level of the stand, in terms of basal area per acre (outside of the group selections) will be reduced with commercial thinning by approximately 25%.



Current Understory Conditions – Pre-harvest.
Photo by N.Anzuoni, 2012

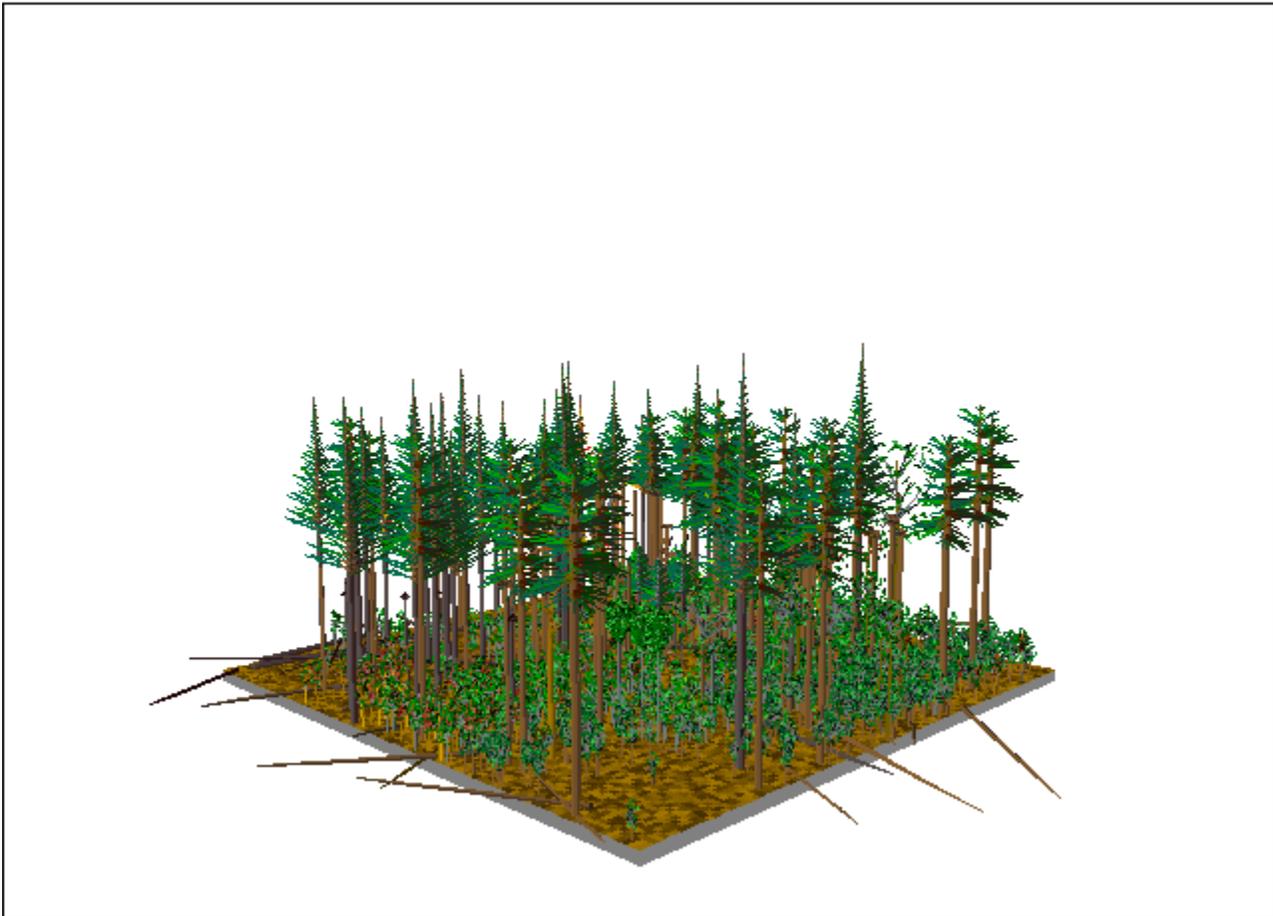
Herbicide applications will be used to remove beech from overtopping advanced desirable regeneration. The methods used will be to cut the beech and treat the stumps and a foliar spray as needed. The treatments may be done either pre or post harvest as needed. Much of the beech in the stand is less than 15' in height and will be able to be controlled with a selective foliar spray. Preference for non-diseased beech will be made when the opportunity presents itself. This species is an important food source to wildlife and only diseased individuals will be targeted.

Future entries will be at ten-year intervals and will focus on creating additional small openings and releasing advanced regeneration. Herbicide treatment may also be required to continue control of beech in the understory. Access roads created in the current harvest will facilitate the future entries.

Traditional silviculture in Norway spruce plantations would use even-aged methods such as the shelterwood system to regenerate the forest. This would eventually lead to a removal of the overstory and with very large gaps or even complete removal of the canopy. This method will favor spruce and white pine with favorable growth conditions for early successional species in the larger openings. The Massachusetts Division of Fish and Wildlife and several other groups are in favor of larger openings to increase this much needed habitat for wildlife. DCR has chosen to focus on the conversion to uneven or all-aged management for this project for several reasons. The most important one is the vulnerability of this stand to windthrow. Large openings will severely impact the residual trees' ability to withstand damaging north/northwesterly/westerly winds and

winter storms. Evidence of this is already present in the stand and large openings will only exacerbate the problem. A second reason would be to promote species that are already present in the stand such as sugar maple, black birch and yellow birch. These species are on the shade tolerant end of the light spectrum and will do well in the sunlight available in smaller openings.

Stand=310001 Year=2023 Beginning of cycle



Visualization of Forest Structure - 10 years after Group Selection, Thinning, Mortality and Regeneration

Desired and Expected Results:

The stand conditions to be found immediately after the cutting will be varied based upon the proximity to the group openings and thinnings. Direct sunlight will reach the forest floor in these openings and increase growth and seed germination. Oblique sunlight will filter into areas adjacent to the openings and in the thinned areas. A system of skid roads and trails will be in place to facilitate future access to the stand. Large amounts of coarse woody debris will remain on the ground and 3-6 large dead snags and cavity trees will remain in the residual stand. It is expected that the group openings will begin to get shaded within five years and decrease the available sunlight reaching the forest floor. Areas that have been thinned will also begin to fill the available growing space. The concept is to create favorable growing conditions with both direct and diffuse sunlight penetrating the canopy.

Species composition will begin to transition to a northern hardwood forest type which is composed of sugar maple, white ash, beech and yellow birch with associate species of black cherry

and red maple. Residual Norway spruce and white pine will be present in the stand with a small component of hemlock along the riparian zones.

Long term effects will not only include an increase in species diversity but an increase in structural diversity as well. This will eventually represent every size-class from seedlings, saplings, and poles, dead and live standing snags and large mature trees. Height classes will range from several inches in the seedling class to over 100' for the dominant tree species such as white ash and sugar maple.

Table: 2 – Predicted Results 2023 10 yrs after Harvest, Regeneration and Mortality - Overstory only - Trees ≥5” DBH

	All species	Norway spruce	Eastern white pine	Black cherry	Sweet birch	Sugar maple	White ash	American hornbeam	Red maple	Eastern hemlock	American beech
Basal Area (square feet)	158.3	66.0	78.1	6.2	3.5	.6	2.9	0.0	0.0	0.9	0.0
Percentage of stand basal area (%)	100	41.7	49.3	3.9	2.2	0.4	1.8	0.0	0.0	0.6	0.0
Stems Per Acre	94.2	27.8	37.1	2.4	13.0	4.5	5.2	0.0	0.0	4.3	0.0
Quadratic Mean DBH(inches)	16.2	20.7	19.6	21.6	6.1	5.1	8.6	0.0	0.0	6.2	0.0
Relative Density (%)	76.82	31.6	38.4	1.8	2.3	.68	1.3	0.0	0.0	.8	0.0
Percentage of Stand	100	41.1	50.0	2.3	3.0	0.9	1.7	0.0	0.0	1.0	0.0

Table 2 – Predicted Results 2023 10 years after Harvest, Regeneration, and Mortality - Understory only - Trees <5” Diameter Breast Height (DBH)

	All species	Norway spruce	White pine	Sugar maple	Sweet birch	American beech	Black cherry	Red maple	Eastern hemlock	White ash	American hornbeam	Yellow birch	Striped maple
Basal Area (square feet)	11.23	2.5	0.5	2.8	1.7	1.9	0.03	0.1	0	0.7	0.5	0.1	0.4
Percentage of stand basal area (%)	100	22	4	25	15	17	0	1	0	6	4	1	4
Stems Per Unit Area (stems per acre)	1107.5	56.2	160	278	204	251	5.1	18.3	0	36	17.8	17.8	63.3
Quadratic Mean DBH(inches)	2.2	2.8	<1	1.6	1.3	1.2	1.1	1	0	1.9	2.3	1	1.1

Logging System Requirements:

Harvesting operations will be carried out using a cut-to-length mechanized harvester. This type of equipment will leave all the branch wood and most of the top wood in the forest as coarse woody debris. Whole tree harvesting will not be allowed. The forest products will be removed using an articulated forwarder with no less than six wheels. Tracks on the front and/or rear wheels are acceptable. Frozen ground conditions, preferably with snow will be required in order to protect the roots of the residual trees. Advanced regeneration will be protected by locating skid roads away from the denser patches and directional falling away from residual trees and regeneration. The silviculture will be a mix of small group selection openings with thinning between the openings. These thinnings will be conducted along the skid roads where the mechanized harvester can reach into the stand with minimum impact to the residual trees.

Coarse woody debris levels are approximately 18 tons per acre based on a 2012 inventory. This high level of downed material is a result of natural decline and recent fire history. This amount exceeds the recommended minimum of 1 to 2 tons per acre.

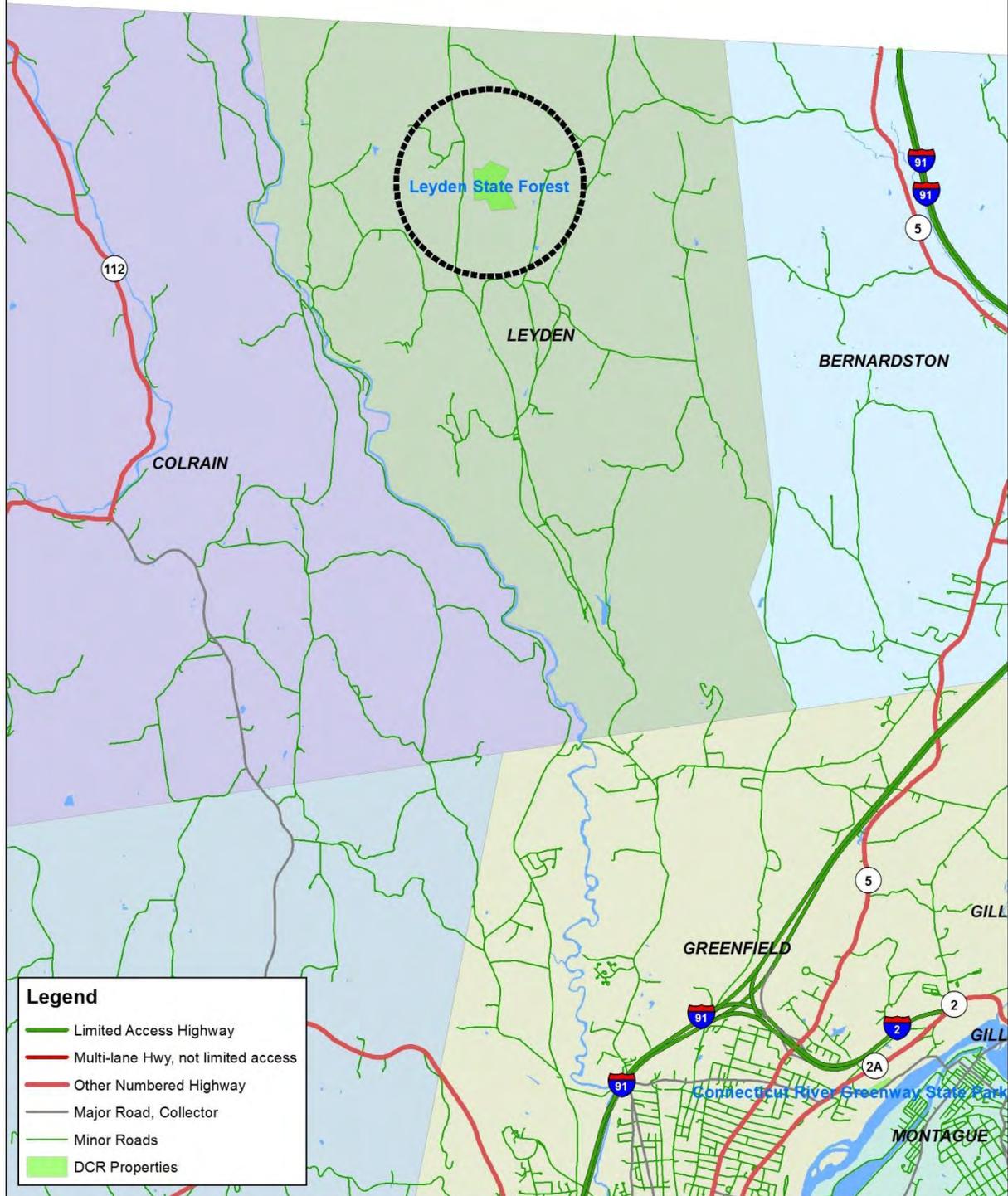
PRESCRIPTION DOCUMENTATION

Marking Instructions:

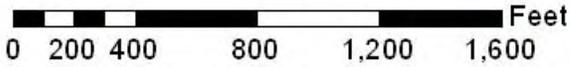
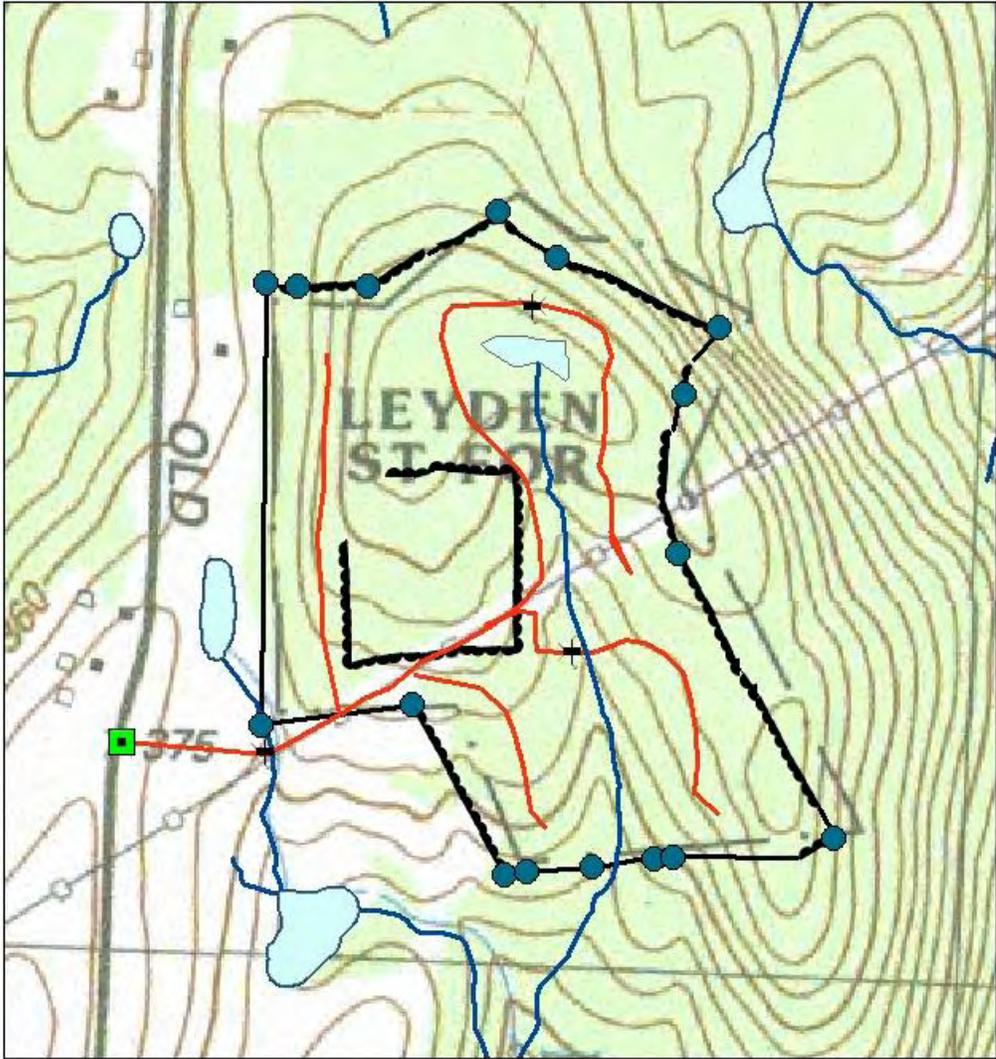
The main focus of silvicultural treatments is to begin a transition to an uneven-aged structure throughout the forest. This will be accomplished by creating small openings up to 1/3 acre in size in order to favor hardwood regeneration. Preferred species will be Black cherry (*Prunus serotina*), Sugar maple (*Acer saccharum*) and Yellow birch (*Betula alleghaniensis*). The overstory contains over 70% of Norway spruce (*Picea abies*) and White pine (*Pinus strobus*) and this must be removed in a series of harvests in order to reduce detrimental effects of prevailing winds and stay within the management guidelines of openings no larger than 1/3 acre. The general marking guidelines will be as follows:

1. Mark and GPS approximately 30 openings not to exceed 1/3 acre per opening. Size not to exceed 1/3 acre.
2. Identify preferred residual trees in order to create openings.
3. Create openings around preferred residual trees in order to initiate regeneration.
4. Identify patches of preferred regeneration to be released.
5. Release regeneration by creating openings in the overstory. These shall be orientated to favorable conditions in terms of windfirmness and micro-site conditions. Size not to exceed 1/3 acre.
6. Release individual preferred residual trees by thinning when possible. This may include crown thinning from when needed. Small diameter trees of desired species such as sugar maple, black birch, yellow birch, white ash and black cherry are prime candidates for release and protection from harvesting damage.
7. Remove all Norway spruce stems less than or equal to 10" dbh.
8. Retain 3-6 large dead or live snags per acre. Diameters should be greater than 10".
9. Thinning areas between the openings will be limited to twenty five percent of the basal area to be removed. Preference will be to retain well-formed northern hardwoods with a well-developed crown in the dominant and co-dominant crown class. Norway spruce and white pine will be also be retained based on the previously stated criteria.
10. Trees to be removed will be marked with paint.

Breezy Knoll Timber Sale, Leyden State Forest - Locus Map



Leyden State Forest Breezy Knoll Timber Sale



Prepared by NMA7/2012

Legend

- Boundary point
- ✦ Stream crossing
- Landing_
- Skid trail
- - - Stone wall
- Boundary line

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