

Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

Forest Management Plan for the

Nineteen Mile Brook Lot

34.2 acres

Rt. 109A

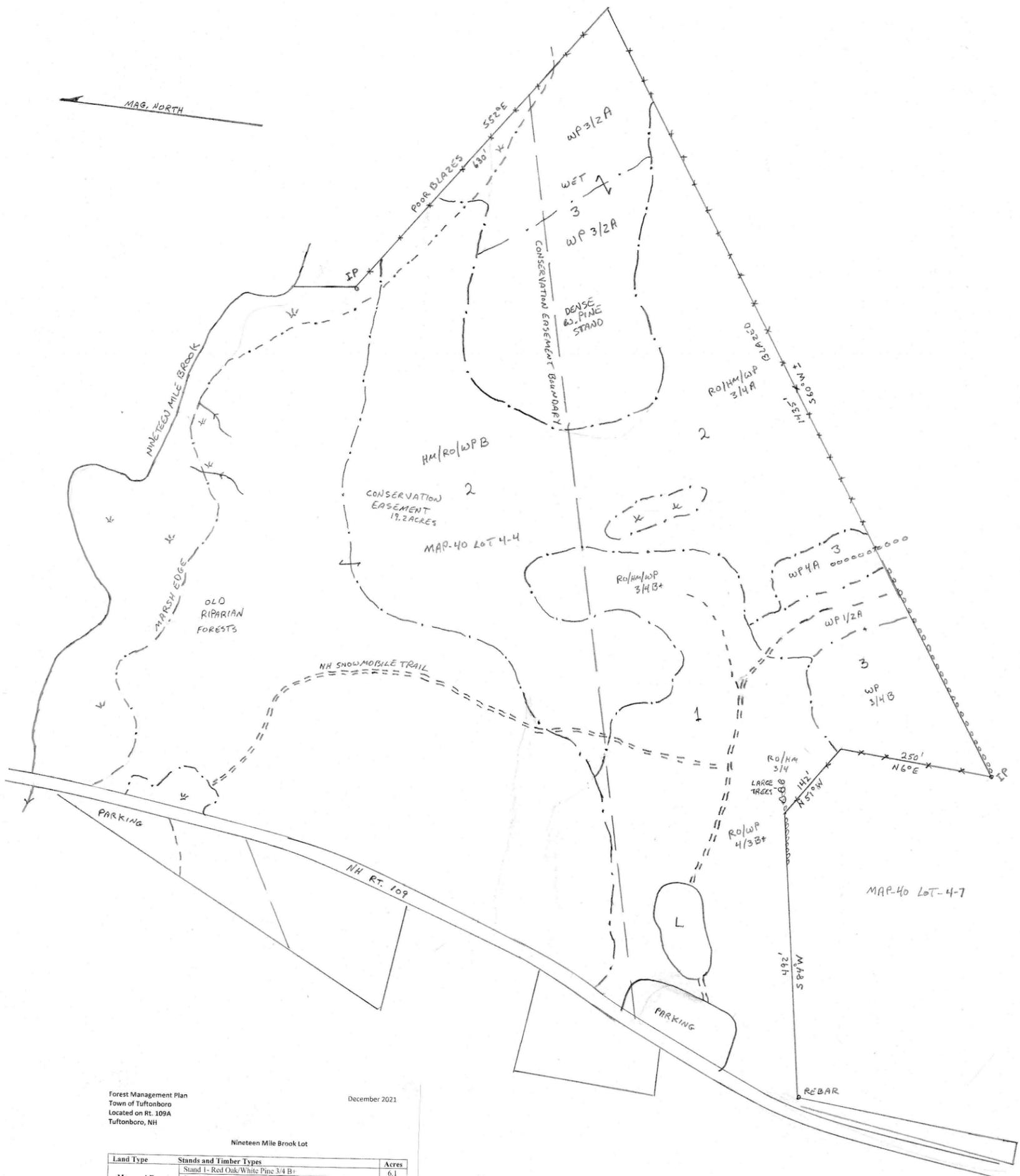
Center Tuftonboro, NH

December 2021

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Forest Management Plan
 Town of Tuftonboro
 Located on Rt. 109A
 Tuftonboro, NH
 December 2021

Nineteen Mile Brook Lot

Land Type	Stands and Timber Types	Acres
Managed Forest Land	Stand 1- Red Oak/White Pine 3/4 B+	6.1
	Stand 2- Red Oak/Hardwood 3/4 B+	10.3
	Stand 3- White Pine/Hardwood 2/3 B	6.3
	Total Forest Acreage	Subtotal 22.7
Other	Forested Wetlands, Marsh, Riparian Forest	11.0
	Parking Lot, Log Landing, Woods Roads	.5
	Total Acreage	34.2

TREE SIZE CLASSES

- Saplings
- Poles 2-8 in Diameter Breast Height (DBH)
- Small Sawtimber 8-14 in DBH
- Large Sawtimber 16+ in DBH

TREE DENSITY

- Overstocked
- Adequately stocked
- Understocked

TREE SIZE CLASSES

- Saplings
- Poles 2-8 in Diameter Breast Height (DBH)
- Small Sawtimber 8-14 in DBH
- Large Sawtimber 16+ in DBH

- Vernal Pool - VP
- Timber Type Line
- Permanent Stream
- Intermittent Stream
- Wetland
- Stone Wall
- Wire Fence - X-X-X
- Trail -
- Truck Road - = = = = =
- Log Landing Area - L
- IP - Iron Pipe (boundary line corner)

Map Key

- TIMBER TYPES
- WP- white pine
 - RO- red oak
 - HM- hemlock
 - HDWD- hardwood species
 - SFTWD- softwoods
- EX. WP/RO 3A

- Tree Density
- Overstocked
 - Adequately stocked
 - Understocked

Scale: 1 inch = 100 +/- ft.

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Acreages & Timber Types

Land Type	Stands and Timber Types	Acres
Managed Forest Land	Stand 1- Red Oak/White Pine 3/4 B+	6.1
	Stand 2- Hemlock/Red Oak 3 B+	10.3
	Stand 3- White Pine/Hardwood 3/2 B	6.3
	Total Forest Acreage	Subtotal 22.7
Other	Forested Wetlands, Marsh, Riparian Forest	11.0
	Parking Lot & Log Landing	.5
Total Acreage		34.2

TREE SIZE CLASSES

1. Saplings
2. Poles 2-8 in Diameter Breast Height (DBH)
3. Small Sawtimber 8-14 in DBH
4. Large Sawtimber 16+ in DBH

TREE DENSITY

- A. Overstocked
- B. Adequately stocked
- C. Understocked

Introduction

This forested property is identified in the Tuftonboro town tax maps as Map- 40, lot- 4-4. The parcel is 34.2 acres in size, and is owned by the Town of Tuftonboro. A 19.2 acre conservation easement (see Type Map) exists in the eastern portion of the property. The easement is held by the NH Department of Transportation.

This lot provides opportunities for both non-timber forest management, as well as for timber oriented forest management to occur. Select forest habitats can be allowed to develop, allowing ecological processes to occur without human intervention. This will allow the public to have access to view the attributes of an old forest. This property is well suited for this purpose, having undisturbed old forests in Stand 2 adjacent to Nineteen Mile Brook.

This diversity of this landscape will enable the public to observe, recreate, and enjoy a property that follows for an ecosystem management approach. Proper management of this forest will encourage and benefit native flora, fauna, and public welfare.

The following report includes a suggested schedule of forest management activities to sustain the vegetative and structural diversity of the forest using good silviculture practice while promoting recreational opportunities and wildlife habitat.

Management Objectives

- The Town of Tuftonboro wishes to manage this forest for the long-term benefit of the citizens Tuftonboro.
- A goal for this public land is to use the site to demonstrate how to manage forests sustainably.
- Forest management will protect and enhance habitats for all native species.

History

A minor harvest was conducted 12 years ago. The harvest was discretionary, and was apparently conducted by a forester. The harvest concentrated on mature white pine trees, and resulted in the good regeneration of white pine saplings. A more wide-ranging harvest was carried out perhaps twenty- five years ago. This harvest occurred in Stand 1, along with portions of Stands 2 and 3. The

results were favorable resulting in the current well-stocked, diverse forest condition. A Town parking area was constructed 10 years ago along Rt 109.

Location

The land is located on the east side of Rt. 109 in the Town of Tuftonboro, NH. The northern boundary of the property is Nineteen Mile Brook.

Recreation

The property is not posted, and is open to the public for walking, skiing, snowshoeing, fishing and hunting. There are no designated hiking trails on the property. A State of NH snowmobile trail passes through the property (see type map). Two old deer stands were found on the land.

Topography

The land gently slopes down from Rt 109 in a northeasterly direction towards the Nineteen Mile Brook flowage. There are no significant slopes present on the property.

Boundaries

Two of the long boundaries of this property are along Rt 109 and Nineteen Mile Brook. The lines around the excluded developed lot (Map 40 Lot 4-7) are in very poor condition. The line markings for this lot leading from Rt 109 are non-existent. The back portion of the developed lot line has remnants of wire fence along with two old red blazes which are on dead trees leading to an iron pipe at the end of a stone wall. These lot lines need to be re-blazed and painted. From here the southern line begins with

200 ft. of stone wall which then becomes an old wire fence, with blazes extending 1435+/- ft. to a tree with triple blazes in thick young hemlock (see Type Map).



A marsh along Nineteen Mile Brook

Wetlands and Waterbodies

Nineteen Mile Brook provides a major inflow into Lake Winnepesaukee. The wide shrub/sedge swamp which is situated along the shoreline of Nineteen Mile Brook is a major wetland on this property. This shrub area has winterberry holly, northern wild raisin and numerous serviceberry shrubs growing in it. These shrubs all produce soft mast fruit that is valuable to birds. There are meandering wet flowages in

Stand 2 which all connect, directly or indirectly, to Nineteen Mile Brook. All wetlands in the State of NH are under the auspices of the NH Wetlands Board.

Forest Protection

This land is, and will continue to be, owned by the Town of Tuftonboro. A conservation easement, held by the NH Department of Transportation, exists on 19.2 acres of this 34.2 acre property, and will thus remain protected from development pressures of any sort for perpetuity (see map). This arrangement was negotiated by the Town to allow the State of NH to rebuild Rt 109 on a portion of this property.

Access

The property has a town parking area on Rt 109 which provides access to a woods road leading a short distance to a well-constructed log landing. A network of skid roads, becoming less well defined as they extend further from the landing, provide access to most of the operable portions of the property. This is the only current known road access to this forest.

Cultural Resources

The predominant cultural resource on the land are its stone walls and wire fences. The land behind the buildings on the adjacent lot, Map 40 lot 4-7, was an old farm pasture with apple trees, farm machinery, in it. This setting extends for a short distance onto the Nineteen Mile lot, although nearly all of the old field on this lot has characteristically grown into a white pine stand. There is a line of immense red oak trees along a stone wall, which demarcates the former field edge, which also serves as the edge of Stand 1 (see type map).

Forest Health & Invasive Species

There is Asian bittersweet along Rt 109 which also extends into the log landing. Well stocked forests with a closed forest canopy do not facilitate the growth of Asian bittersweet.

The invasive plant which is most damaging to forest ecology in NH is the European buckthorn, one species of which is the glossy buckthorn, which was found in the old log landing, and along the snowmobile trail. It is important that this shrub not become firmly established here, for it can form an understory canopy throughout a forest which will not allow the growth of any ground vegetation, trees, or shrubs. This invasive shrub needs to be eliminated (see Action Items).

The invasive hemlock wooly adelgid exists in Tuftonboro, and will begin to cause the gradual decline of hemlock trees. The forester had a long discussion with NH's Forest Pathologist Kyle Lombard, while preparing to write management plans for the Town of Tuftonboro. Kyle spoke to the fact that the hemlock wooly adelgid seems to have reached its current northern-most point where it can cause serious damage in northern Strafford County or southern Carroll County. This is due to our current winter low temperatures (-5 f) being just cold enough to cause 95% of the adelghids to not survive temperatures much below 0 F. As the climate continues to warm, this control mechanism will likely become less effective. This will be a gradual process. There is hope however, as biological controls have been implemented in NH. A few species of Asian black beetles have been released throughout NH. The beetles have been found to prey solely upon the Asian hemlock wooly adelgid and they hold promise. The western silver fly, native to the pacific coast holds even greater promise of control, as it effectively controls the adelghid in western hemlock.

The mature ash trees will all die, due to the emerald ash borer. The small ash trees, not yet having developed the ash's corrugated bark, will likely not be affected. They may live to see the biological controls that are being put in place lead to a good outcome. Non-stinging wasps are being introduced to lay eggs in the larvae of the ash borer. White ash does not have a significant presence on this land.

Aesthetics

Nineteen Mile Brook marsh has a wealth of birdlife to behold. The logging roads here provide pleasant short walks in this lovely forest. There are some very large red oak and white pine trees to admire in Stand 1, along with the densely canopied dark forests in the brook floodplain.

Rare and Endangered Species

The only species of concern found by the NH Heritage Bureau (see Addendums) was the Common Loon, which will not be impacted by any forest management activities carried out on this parcel.



A dense hemlock understory is used as a deer yard along Nineteen Mile Brook in Stand 3

Wildlife

A broad array of wildlife species and habitats occur on the Nineteen Mile lot. The land provides habitat features including red and white oak acorn production (hard mast*), a high closed forest canopy, shrub and sedge marshes, layered understory canopies, along with a very old hemlock/hardwood forest in Stand 2. This stand has hemlock trees that are over 225 years old. Productive mast trees can often be identified by bear claw marks on beech and oak trees. Stand 1 has a stocking of large red oaks that produce large crops of mast. All mast trees greatly benefit a multitude of wild creatures such as deer, bear, grouse, and turkeys, along with a large number of smaller birds and mammals. The release of trees with strong mast production allows for the development of large, super-canopied trees. During the autumn, bears spend time building nests in the tops of both beech and oak trees eating beech nuts and acorns. These are not really a nest at all, but are simply their dinner chair. In the harvested portion of Stand 1 there is a location which has a number of white oaks in it. The white oak trees with healthy crowns should not be harvested due to the high value of their acorns to wildlife. White oak acorns fall earlier than the red oak, and are higher in fat and caloric content. Timber marking and forest management can also encourage the proliferation of soft mast (fruit) in the forest. Good sources of soft mast include black cherry, serviceberry (colloquially known as sugar plums), Rubus species (raspberry,

blackberry, dewberry, and thimbleberry), blueberry, apple, hobblebush, viburnum, partridgeberry, bearberry and wintergreen etc. Think cedar waxwings. The soft mast shrub layer on this property includes hobblebush, raspberry, blackberry, serviceberry and black cherry. A mature well-managed forest provides ample food sources for our native wildlife and birds. The forester has seen sign of white tailed deer, turkey, and snowshoe hare on this tract.

Forests for the Birds

The old hemlock trees Stand 2 are a particularly desirable habitat for many forest birds. These include the black throated green, magnolia, and Blackburnian warblers, along with blue headed vireos and ovenbirds. When forest management occurs in this stand, a high proportion of these old hemlock trees should be allowed to remain in the stand, providing the habitat needed for these birds. There are some old white pine trees on the property for bird roosting and nesting. The development of multi-layered tree and shrub canopies greatly enrich bird habitats, along with the ability to sequester a higher amount of carbon dioxide per acre. An understory habitat of white pine, hemlock and oak regeneration has begun to develop in the portion of Stand 1 which was harvested 12 years ago. Additional softwood regeneration will continue to be a goal on this property, which will improve habitats for the Canada warbler, the black-throated blue warbler, and the wood peewee.

The sedge and shrub swamps along Nineteen Mile Brook have a distribution of white pine snags* which provide a preferred habitat for cavity nesting birds. Cavity nesting bird habitat is dependent upon trees that can be easily excavated into nesting cavities. Senescent (easily excavated) tree species such as aspens, white pine, basswood, and red maple are all well-suited. There are older red maples, pine snags and aspen trees fulfilling this need. The birds and mammals using these habitats include, kingbirds, flickers, woodpeckers, nuthatches, wrens, flycatchers, tufted titmice, barred and saw-whet owls, along with flying and red squirrels, fishers, and bats. There are some mature yellow birch trees in the stand. These trees provide a large seed source for pine siskins, hooded juncos, goldfinches, chickadees, juncos, the purple finch, and the tufted titmouse, along with visitors from the north such as, redpolls and crossbills.

Woody debris

Large downed woody material is referred to as coarse woody debris. There is a moderate supply of this material on portions of this property. In Stand 3, nature's thinning process, along with blowdown in these moist stands, have provided ample dead white pine woody debris and standing snags. In Stand 2 there is also ample debris as old, crowded, and blown over trees have fallen to the forest floor. This ample wood on the forest floor is a significant feature for the maintenance of biodiversity in this forest. It provides habitat for a wide array of organisms from insects, and amphibians, to bears and ruffed grouse. A portion of Stand 2 along the Nineteen Mile Brook wetland has not been harvested in modern times, providing a location for bird habitats to flourish. When a timber harvest takes place, one goal is to leave woody debris

(slash)* throughout a harvested forest. During timber harvests, the cull butt portions of logs are best bucked off in the forest, versus on the log landing, to enhance the large woody debris habitat throughout the forest. These large tree butts are valuable as den sites, shelter, and habitat for mammals, birds, reptiles, insects, and amphibians. Bears and woodpeckers use them extensively for feeding on grubs, ruffed grouse use them as drumming locations, and they provide direct and indirect food sources for all manner of forest creatures. Large woody debris is also very beneficial as a repository of symbiotic miccorrhizal fungi, which have a symbiotic relationship with tree roots. These fungi provide minerals and soil nutrients to the roots, while the trees return the favor by providing carbohydrates to the fungal mycelium.

Vertical Structure and Crown Closure

Vertical structure is the layering of both live and dead woody plant crowns within a forest stand. The goal of management, with regard to vertical structure, is to maintain diverse age classes and to have varying degrees of crown closure and height throughout the forest. Over much of this forest the structure is rich with snags, along with shade tolerant old hemlock trees providing perches for forest birds on their dead lower limbs. The uneven aged older forests are well stratified with layers of limbs and understory trees supporting a far greater array of plant and animal species than even-aged stands of younger trees. Typical late successional overstories in north-central NH are composed of hemlock, spruce, beech, yellow birch, sugar maple, and red maple along with red oak, and basswood. In this forest, red oak and red maple are the predominant large hardwoods present in the stands, combined with a few yellow birches.

Uneven-age* management encourages the growth and layering of vertical crown structure which is important to the habitat requirements of many mid-story songbirds. In these heavily-stocked stands a light individual tree removal can be used to increase the amount of understory, and mid-story vegetation. This is a silvicultural method that would be a good fit in this forest (see Stand Prescriptions).

When harvesting trees in this forest it is important to regenerate an understory of both desirable future canopy tree species, along with shade tolerant shrub layers of species such as maple leaf viburnum, hobblebush, and hophornbeam. Tree species such as red spruce, hemlock, beech, and sugar maple are shade tolerant and can survive for many years in the understory (advance regeneration). These saplings have the ability to begin rapid growth when a timber harvest or a natural disturbance allows the sunlight to penetrate to the forest floor.

Climate Change

Currently, a leading silvicultural consideration is the warming of our climate. Most of our trees will take 85+ years to mature. There is a wide range of species projected to decline in the warming trend (fir, spruce, paper birch, aspens, etc.). The species that we wish to regenerate on the land will lean towards those trees possessing a genotype and phenotype projected to endure or thrive in the warming weather

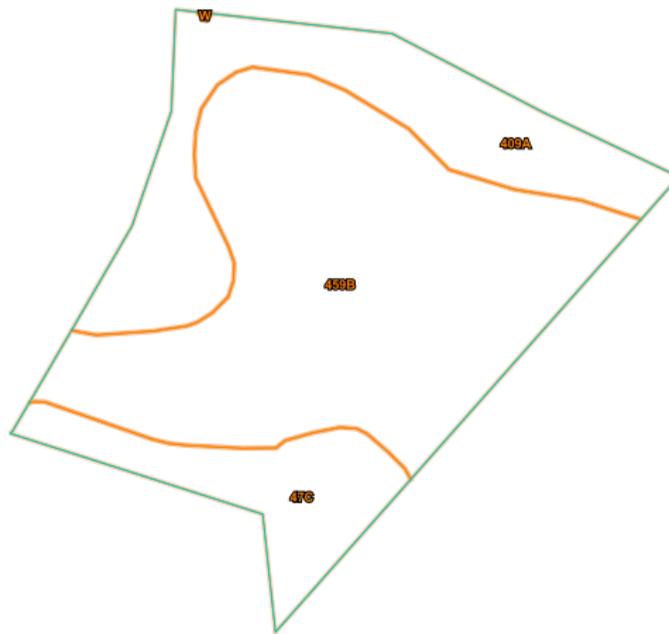
scenarios. The US Forest Service's projections are that red and white oaks, maples, and white pines will do well in our changing climate, while our other softwoods will be challenged. This is silviculturally accomplished by the harvest or retention of selected tree species, the season of harvests, the size of harvest openings, and the years chosen for harvest to coincide with the seed production of desired tree species. The future tree species composition in this forest can be adjusted by the forester providing a gentle nudge to the species that are projected to thrive in the future. Species projected to prosper as the warming continues include white and red oak, white pine and black birch. Even so, maintaining a diversity of species along with maintaining high stocking levels remains a safe mechanism.

Certain trees have already begun to decline, both due to the reduction of calcium levels in the soils as a result of acid precipitation, along with the introduction of alien insects and pathogens. Paper birch and white ash, even before the ash borer, have no longer been living as long as they once did on less than optimal sites due to soil acidification, drought cycles, and climate change (research by Cornell University).

Fieldwork

This inventory was conducted using a systematic grid pattern of 20 points on 22.7 acres. At each point location an assessment was made of forest conditions, habitat features, tree health, tree pathogens species and processes, bird and wildlife signs, nests, and all manner of pertinent features. The assessments made at each sample point also included extensive notes, the drawing of the forest type map (including forest and land features), wildlife habitats and use, land history, and the general condition of the forest leading to fully assess each stand.

Soils & Descriptions



The soils data below is useful in deciding how to manage this land. Soils are the basis of terrestrial life, and have immense value in determining which tree species to propagate and grow on your land.

47C Henniker- fine sandy loam 5.3 acres- This soil is well suited to growing red oak and white pines. There is enough moisture in this soil type, combined with fine soil particles providing enough soil surface area to supply an adequate supply of available nutrients to facilitate a moderate site index.

409 Limerick- silt loam 10.3 acres- The silt inherent in this floodplain soil would provide a high site index for the growth of hardwood trees were it not for its high water table. As it is those areas in Stand 2 that are elevated

459 Metacomet- sandy loam 18.6 acres - The words 'silt' or 'fine' in the previous soil descriptions indicate that those soils are richer than this one. Metacomet soil remains well-suited to the growth of

white pine and red oak, although the trees will be a bit shorter, with lower productivity in the hardwood versus softwood species. The coarse soil particles here lead to lower available water capacity, and nutrient levels. The soil is clearly better suited to the growth of softwood trees than to hardwoods.

General Silvicultural Recommendations and Forest Health

The forests of northern New England are diverse in both age class and species distribution. Therefore, written silvicultural prescriptions are but generalizations, as the composition of each location in a forest stand varies considerably. Only by careful selection of when, if, and how to manage, can the best decisions be made for the management and regeneration of our heterogeneous forests. Higher site index locations with their adequate moisture levels, rich soils, and favorable slope positions allow for timber to be maintained at higher stocking levels, while conversely, lower site indexes, should be maintained at lower levels of the allowable stocking levels in order to allow for trees to grow at a healthy rate. During a stand harvest there must be areas in each stand which are not included in the harvest areas. There are numerous benefits to leaving exclusion zones in any harvest area. These areas allow for the maintenance of lower quality trees to fill out the volumes needed to conduct subsequent economically viable timber harvests without having to harvest only high-quality trees. There is also the benefit of full crown closure and increased standing snags in these excluded zones, which are favored by numerous bird and mammal species. Light harvests allow for a sustainable yield in a forest stand over a long period of time. A general rule of thumb is to leave a basal area of 90-100 ft²/acre in a harvested hardwood stand with 120 ft²/acre in softwood stands.

Timber

Some timber harvesting is prescribed here. An effort to create a harvest of sufficient size to attract a logging contractor is something to be considered. A harvest will need to be carried out in more than one stand for economic viability. Also of concern is the difficulty of accessing the landing across the Town's parking area, along with the areas of wet soil. These issues will limit harvesting activity to the cold winter season. A general concern is the diminishing availability of small logging contractors. There are very few people working who still have one skidder, and are willing to harvest conventionally (with a chainsaw). This style of logging, once a mainstay, often led to very good results. An effort to employ a logger who still employs this method of harvesting would be a good fit for harvesting on this lot.

Note- The calculations of timber ingrowth prior to the subsequent harvests in each stand, some 20 years hence, were calculated using conservative metrics with no compounding of the projected growth rates. This was done to ensure that the figures would be understated.



Healthy high quality red oak trees in Stand 1

[Stand 1- Red Oak, White Pine 3/4 B- 6.3 acres](#)

Stand Description

This is a small red oak and white pine stand with some very large trees. Portions of the stand were harvested twelve years ago. This stand is situated upon a relatively rich soil which has good soils with adequate to ample moisture levels. These features provide a high site index* (see glossary) for red oak, a species which will be promoted to grow here when management activities take place. The forest inventory results for the stand (see appendix), show that it is well-stocked with a basal area* of 137 ft²/acre and a relatively high sawtimber volume of 13,625 board feet/acre.

There are large white pines in the stand which are showing signs of decline. Areas in the stand are overstocked with red oak sawtimber trees 16-18" DBH. This is a handsome forest to walk through.

Prescriptions

The majority of the high canopy red oak trees in the stand are exhibiting adequate growth rates. The largest white pine trees in the stand are quite old, with some large trees being older than 120 years. Some of these large white pines are showing signs of decline. Any timber harvesting in this stand must be very selective in order to not change the beautiful character of the stand. The trees harvested will be limbed where they fall to protect tree regeneration from deer browse, and to help retain the nutrients and organic matter in the limbs on site (see Woody Debris). A gentle harvest in the stand will be focused upon releasing red oak trees where they are overstocked. The goal will be to redirect which trees are receiving the available sunlight, more so than to significantly change the forest composition in the stand.

This is a beautiful stand where there is an aesthetic reason for leaving the largest red oak trees in the stand as they are for the next twenty years. These sections will be left out of the current harvest plans. However, a harvest to improve the health of portions of stand is in order. The timber marked for harvest would focus upon the old white pine trees in decline, along with thinning those portions of the oak forest where the basal areas are over 140 ft²/acre. The harvest will take place just prior to, or during a white pine seed year to assure successful regeneration of this species. This harvest will be marked to reduce the average basal area to 110 ft²/ac. While harvesting, the following board foot volumes/acre will be cut from the stand, white pine 2,600, red oak & pallet 2,300, hemlock 300. This will reduce the total sawlog volume from the current volume of 13,630 bd ft/acre to 8,430/acre. The harvest will also involve the harvest of white birch, red maple and red oak pulpwood (firewood) trees reducing the cord volume/acre from 18 to 9 cord/acre. This harvest will earn the Town a net** income of \$980/acre. In 2022 the product prices are WP sawlogs \$150/m bd ft, red oak \$350/m** and \$15/cord pulp/firewood. The forester feels that a subsequent harvest could be considered 20 years after the first, when the total timber volume will have grown to 11,800bd ft/acre, which will be then be reduced to 9m bd ft/acre. At this time the volume will be heavily skewed to red oak sawtimber. This next harvest will be marked with the same criterion in place, as during the first harvest, in order to maintain the nature and high stocking levels in this beautiful stand.

* see glossary

** net income is net of logging, trucking and the forester's work

** /m = per thousand board feet



Red oak and hemlocks in Stand 2

[Stand 2- Hemlock/Red Oak/ White Pine 3/4 B- 10.3 acres](#)

Description

This stand is situated where the land begins to descend in elevation toward the Nineteen Mile marsh. The stand is heavily stocked with an average basal area of 138ft²/acre. There are many old trees present in the stand that are older than 140 years. The soils here are relatively shallow, with a seasonable high water table within three feet of the soil's surface. This stand is stocked with 35% large hemlock, 32% red oak, 11% large white pine, along with 15% red maples, mixed hardwood, white oaks

and balsam fir. In this stand there is a high degree of variability in forest composition due primarily to soil moisture level correlations. On the higher portions there are stands of oak/pine forest mixed with hemlock. These higher soils also have some fine mature white pine stands. On lower sections the forest is primarily a hemlock/red maple/red oak stand. There are areas of the stand that will respond very well to a light thinning. Some portions of Stand 2 will be difficult to reach due to the high water table. In the southern portion of Stand 2 there are patches of very slow growing red oak trees with basal areas over 200 ft²/acre.

Prescriptions

A light harvest is prescribed within ten years in portions of this stand. This operation will primarily be a thinning to remove the suppressed trees from the stand. A conventional harvest, using a moderate sized skidder, would be the preferred harvest method. One goal will be to release worthy trees on two sides by reallocating the newly available crown space by the removal of suppressed or decaying trees. Reducing the average basal areas from 138 to 110 would be appropriate. This thinning will not be a regeneration harvest due to the lack of post-harvest sunlight on the forest floor. As a result species other than the shade tolerant hemlock, spruce and fir, and red maple will not successfully regenerate. The volumes of red oak and hemlock per acre are similar, along with patches of white pine sawtimber. The species to be marked for harvest will target the hemlock overstory trees impinging upon the growth of the red oaks and white pine. When large trees are felled in the stand, there will be some small patch cut openings created to give these large trees a space to fall. The forester will need to mark additional trees to facilitate this. All spruce and fir trees should be retained in the stand for habitat purposes to replace the hemlock due to the eventual hemlock adelgid damage. This harvest will have to occur either during a cold winter, or a dry August/September period due to the high water table in the stand. The forester will have to carefully monitor the soil conditions during the harvest. One way to proceed will be to have the logger establish the tote roads by making one pass on them, and then leaving the roads alone for a time, in order to allow a freeze to take hold under the roads prior to proceeding with the harvest. The logger would be able to work elsewhere on the lot while waiting for this to take place.

This stand is old with many slow-growing trees in need of additional light. The average basal area of 138 is deceiving as there are numerous locations in the stand with very high basal areas of over 200 ft²/acre. Of the average 9,320 board feet/acre, 6,253 bd ft are in larger size classes with 16-22' DBH. The harvest will reduce the volume/acre from 9,320 to 6,100 acre with an average basal area reduction from 138 to 110. The harvest will remove these volumes of timber /acre +/- 2,000 bd ft hemlock @\$50/m, 1400 ft red oak/pallet @ \$350/m*, 800 bd ft white pine/acre @\$150/m, and 13 cord of pulp/cordwood @15/cord. At 2022 prices, net to the Town will be \$815/acre.

A subsequent thinning could be scheduled 18-20 years after the initial thinning. At this time the volume present/acre will have grown to 8,500 board feet, which will be reduced to 6,500 bd ft, along with a pulpwood volume reduction. During this second harvest the cutting of a few regeneration openings, to

regenerate white pine, will be appropriate. The silvicultural prescriptions for the first harvest will also hold true during the second cutting. One caveat could be that the hemlock trees will need to be salvage harvested due to the woolly adelgid's advance.



White Pine in Stand 3 along Nineteen Mile Brook

Stand 3- White Pine/Hardwood 2/3B - 6.6 acres

Description

This is a well-stocked stand primarily composed of 10– 20" DBH white pine trees with some smaller red oaks. The site capabilities vary from the higher, well-drained soils able to grow good quality white pine and red oak trees, to poorer sites situated on shallow soils with a water table within 12" of the soil's surface in the stand adjacent to the marsh. On the low ground, the white pine in the stand is subject to wind-throw, with the exposed edges already experiencing this. There was some harvesting carried out on the high ground twelve years ago, and it led to significant barking of the residual trees in the stand. The basal area of the stand is 73% white pine with 16% red oak. Sixty percent of the sawlog volume is 16" DBH or larger.

Prescriptions

The low elevation portions of the stand adjacent to the marsh are inappropriate for timber harvesting activity, due to a very high risk of blowdown on these shallow soils. A type line was drawn through Stand 3 to demarcate the wet soils from the manageable portion on higher ground. The higher elevation portions of the stand are appropriate for management. On the high ground, nearly the entire stand was harvested twelve years ago, which resulted in numerous trees having serious bark damage. The trees with large areas of bark damage now have advancing decay, and should be harvested within the next ten years. Trees with small areas of bark damage will be fine for the next twenty years. In some locations there are dense white pine stands where trees with poor crown position should be marked for harvest. Harvesting will be carried out using either a cable skidder, or a small cut-to-length harvest system.

The stand currently has 12,940 board feet of white pine/acre, with a high stocking variability due to the previous harvest. The stand has 34% of its w. pine trees at 20" DBH or larger. The harvest within ten years will remove no more than 2,000 bd ft/acre, which will be largely made up of injured or defective trees. This will net the Town $2 \times \$150/m = \$300/\text{acre} \times 5 \text{ acres}$ of harvest for a net return to the Town of \$1,500. This harvest will occur along with harvests in the adjoining stands.

The next harvest, 18-20 years after the first, will take place in a stand that will have grown to at least 18,000 bd ft/acre. By this time there will be numerous trees in the stand with a DBH over 26". This harvest will again first remove trees with health issues, although there will also be a harvest of large some mature white pine trees. The harvest will entail the cutting of 4m bd ft/acre, with openings made to facilitate appropriate tree regeneration.

Activities Schedule

- The glossy buckthorn in the old log and along the snowmobile trail should be eliminated. The best method is to cut off the stems in early September and to carefully apply Roundup to

the cut stump surfaces along with any remaining leaves using a small paintbrush. This procedure will need to be done repeatedly to be assured of success. This procedure can only be done commercially by a licensed applicator. The active ingredient, glyphosate, is toxic to marine organisms so great care must be taken to not introduce it into water.

- A light thinning in portions of all three stands is prescribed to take place within the next ten years. The forester will then inspect the stands every five years. A subsequent harvest will be needed in some locations twenty years after the first.
- The eleven acre riparian zone will be allowed to grow undisturbed, other than for trail development and maintenance.
- A large white pine tree with a structure of limbs suitable for nest construction could be girdled along the marsh edge in the riparian zone to create a nesting site for ospreys, or bald eagles.
- The boundary lines around the excluded lot 40-4-7 need to be blazed and painted, as does the short back line until it extends into the nineteen mile brook marsh.

New Hampshire Natural Heritage Data Check



New Hampshire Natural Heritage Bureau

DNCR - Division of Forests & Lands
 172 Pembroke Road, Concord, NH 03301
 Phone: (603) 271-2214 Fax: (603) 271-6488

To: Daniel Stepanauskas
 Northern Forest Resources
 135 High Street
 Silver Lake, NH 03875

From: NH Natural Heritage Bureau

Date: 2021-12-07

Re: Review by NH Natural Heritage Bureau of request dated 2021-11-19

NHB File ID: 3800

Town: Tuftonboro, NH

Project type: Landowner Request

Location: 40-4-4; Town of Tuftonboro

We have searched our database for records of rare species and exemplary natural communities on the property(s) identified in your request. Our database includes known records for species officially listed as Threatened or Endangered by either the state of New Hampshire or the federal government, as well as species and natural communities judged by experts to be at risk in New Hampshire but not yet formally listed.

NHB records on the property(s): **None**

NHB records within one mile of the property(s):

	Last Reported	Listing Status		Conservation Rank	
		Federal	NH	Global	State
Vertebrate Species					
Common Loon - <i>Gavia immer</i>	2020	--	T	G5	S2B

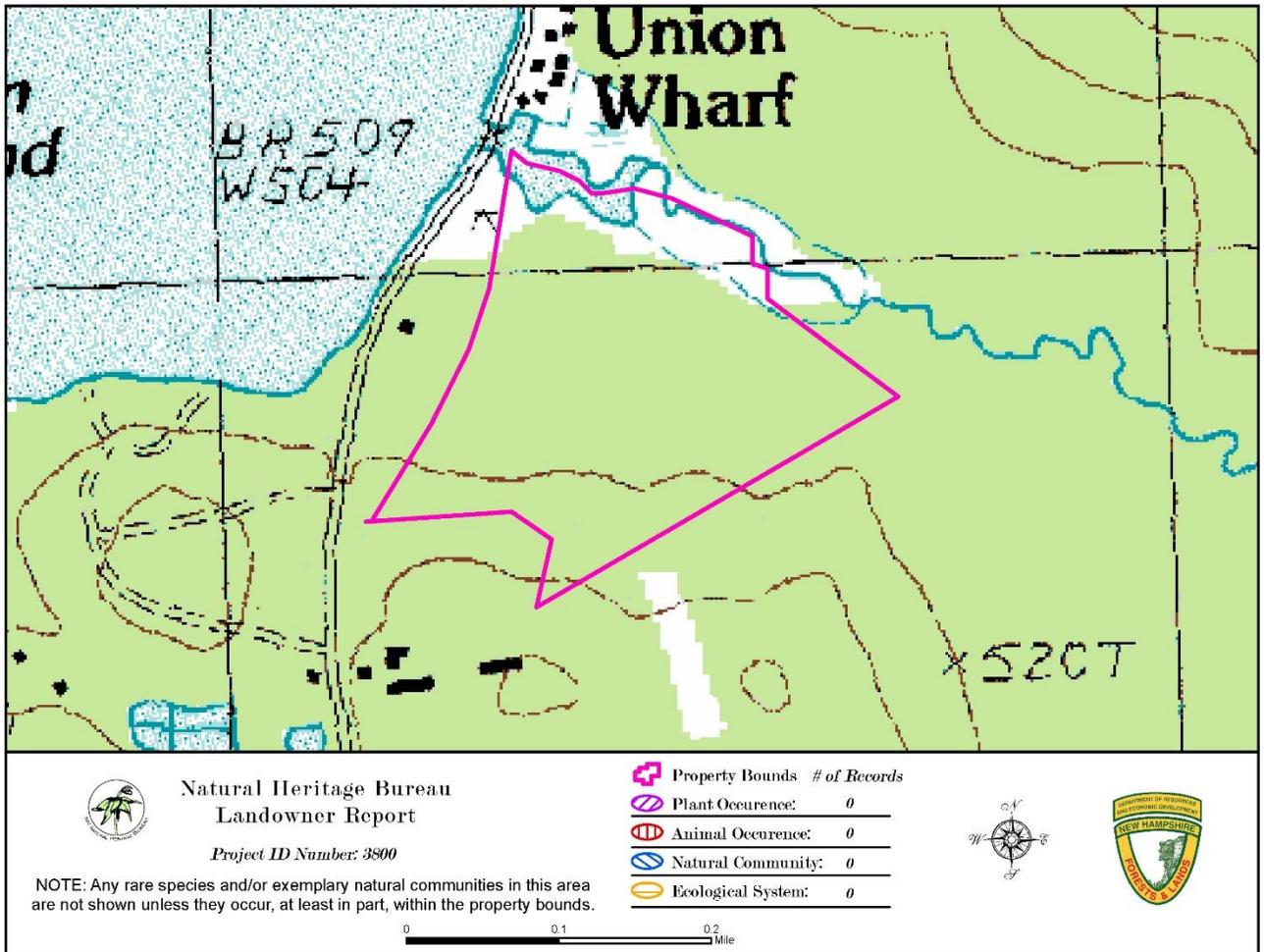
Listing codes: T - Threatened, E - Endangered, SC - Special Concern

Rank prefix: G - Global, S - State, T - Global or state rank for a sub-species or variety (taxon)

Rank suffix: 1-5 - Most (1) to least (5) imperiled, "--", U, NR - Not ranked, B - Breeding population, N - Non-breeding, II - Historical, X - Extirpated.

A negative result (no record in our database) does not mean that no rare species are present. Our data can only tell you of known occurrences, based on information gathered by qualified biologists and reported to our office. However, many areas have never been surveyed, or have only been surveyed for certain species. An on-site survey would provide better information on what species and communities are indeed present.

NOTE: This review cannot be used to satisfy a permit or other regulatory requirement to check for rare species or habitats that could be affected by a proposed project, since it provides detailed information only for records actually on the property.



Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

DAN STEPANAUSKAS

PAGE 1

Job Title--NINETEEN MILE BROOK LOT: 22.7FO, 10WET, .65PRKNG/LNDNG = 33.35ACS TO

Stand Title--STAND 1: RO/WP 3/4

Forest Tally

by

Loon's Echo

Date Run: 12/07/21

B.A.F. = 20.00

NUMBER OF POINTS SAMPLED = 6

DIAMETER CLASS SIZE = 1

STAND # 1

ACREAGE OF TRACT = 6.30

CONFIDENCE LEVEL = .90

LEVEL = ALL Trees

Licensed To

Forest Land Improvement

Donald Johnson

P. O. Box 188

Tamworth NH 03886

(603) 323-8298

Serial Number

900401-0002

Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

DAN STEPANAUSKAS

PAGE 2

Job Title—NINETEEN MILE BROOK LOT: 22.7FO, 10WET, .65PRKNG/LNDNG = 33.35ACS TO

Stand Title--STAND 1: RO/WP 3/4

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*
*                               ALL SPECIES                               LEVEL = ALL Trees
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	BASAL AREA	TREES	SAWLOG	PULP	BOX PINE	PALLET	VENEER	MAT LOG
DIAMETER	PER	PER	INT. 1/4"	CORDS	INT. 1/4"	INT. 1/4"	INT. 1/4"	INT. 1/4"
CLASS	ACRE	ACRE	VOL / ACRE	VOL / ACRE	VOL / ACRE	VOL / ACRE	VOL / ACRE	VOL / ACRE
8	20.0	57.3	.0	6.1	.0	.0	.0	.0
10	13.3	24.4	.0	3.8	.0	.0	.0	.0
12	16.7	21.2	1307.2	2.2	.0	501.7	.0	.0
14	20.0	18.7	1657.5	2.1	.0	395.2	.0	.0
16	30.0	21.5	3973.2	1.8	30.1	144.8	.0	.0
18	20.0	11.3	2794.4	.8	70.0	172.3	.0	.0
20	6.7	3.1	711.8	.3	.0	136.8	.0	.0
22	6.7	2.5	875.3	.3	.0	206.7	.0	.0
24	3.3	1.1	551.4	.1	99.1	.0	.0	.0
TOTAL	136.7	161.1	11870.8	17.6	199.1	1557.5	.0	.0
S.E.			± 29%	± 29%	± 197%	± 60%	± 0%	± 0%
C.V.			37%	36%	245%	74%	0%	0%

MEAN STAND DIAMETER = 12.5

MERCHANTABLE M.S.D. = 12.5

PERCENT CRUISE = 4.0%

Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

DAN STEPANAUSKAS

PAGE 3

Job Title-----NINETEEN MILE BROOK LOT: 22.7FO, 10WET, .65PRKNG/LNDNG = 33.35ACS TO

Stand Title--STAND 1: RO/WP 3/4

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*
*                               SPECIES COMPOSITION BY PERCENT                               *
*                                                                                             LEVEL = ALL Trees *
*
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SPECIES	AREA	TREES	SAWLOG	PULP	BOX PINE	PALLET	VENEER	MAT LOG
			INT. 1/4"	CORDS	INT. 1/4"	INT. 1/4"	INT. 1/4"	INT. 1/4"
WHITE PINE	17.07	10.92	30.67	6.65	100.00	3.88	.00	.00
HEMLOCK	4.88	7.10	3.94	6.57	.00	.00	.00	.00
RED OAK	56.10	44.46	65.39	36.23	.00	96.12	.00	.00
RED MAPLE	17.07	29.94	.00	40.27	.00	.00	.00	.00
WHITE ASH	2.44	3.79	.00	5.15	.00	.00	.00	.00
WHITE BIRCH	2.44	3.79	.00	5.15	.00	.00	.00	.00
ALL SOFTWOODS	21.95	18.02	34.61	13.21	100.00	3.88	.00	.00
ALL HARDWOODS	78.05	81.98	65.39	86.79	.00	96.12	.00	.00

Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

DAN STEPANAUSKAS

PAGE 5

Job Title-----NINETEEN MILE BROOK LOT: 22.7FO, 10WET, .65PRKNG/LNDNG = 33.35ACS TO

Stand Title--STAND 1: RO/WP 3/4

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*
*                               VOLUME TOTALS EXPANDED BY ACREAGE                               *
*                               LEVEL = ALL Trees                                           *
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	SAWLOG	PULP	BOX PINE	PALLET	VENEER	MAT LOG
	INT. 1/4"	CORDS	INT. 1/4"	INT. 1/4"	INT. 1/4"	INT. 1/4"
	VOLUME	VOLUME	VOLUME	VOLUME	VOLUME	VOLUME
WHITE PINE	22937	7	1254	380	0	0
HEMLOCK	2943	7	0	0	0	0
RED OAK	48906	40	0	9432	0	0
RED MAPLE	0	45	0	0	0	0
WHITE ASH	0	6	0	0	0	0
WHITE BIRCH	0	6	0	0	0	0
ALL SOFTWOODS	25880	15	1254	380	0	0
ALL HARDWOODS	48906	96	0	9432	0	0
ALL SPECIES	74786	111	1254	9812	0	0

Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

DAN STEPANAUSKAS

PAGE 6

Job Title-----NINETEEN MILE BROOK LOT: 22.7FO, 10WET, .65PRKNG/LNDNG = 33.35ACS TO
Stand Title--STAND 2: HM/RO 3

Forest Tally
by
Loon's Echo

Date Run: 12/07/21

B.A.F. = 20.00

NUMBER OF POINTS SAMPLED = 8

DIAMETER CLASS SIZE = 1

STAND # 2

ACREAGE OF TRACT = 10.30

CONFIDENCE LEVEL = .90

LEVEL = ALL Trees

Licensed To

Forest Land Improvement

Donald Johnson

P. O. Box 188

Tamworth NH 03886

(603) 323-8298

Serial Number

900401-0002

Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

DAN STEPANAUSKAS

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Job Title---NINETEEN MILE BROOK LOT: 22.7FO, 10WET, .65PRKNG/LNDNG = 33.35ACS TO

Stand Title--STAND 2: HM/RO 3

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*
*                               VOLUME TOTALS FOR ALL SPECIES                               LEVEL = ALL Trees
*
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SPECIES	SAWLOG	PULP	BOX PINE	PALLET	VENEER	MAT LOG
	INT. 1/4"	CORDS	INT. 1/4"	INT. 1/4"	INT. 1/4"	INT. 1/4"
	VOL / ACRE					
WHITE PINE	1736.2	1.3	35.6	.0	.0	.0
HEMLOCK	3253.8	7.6	.0	.0	.0	.0
BALSAM FIR	.0	.6	.0	.0	.0	.0
RED OAK	3246.4	5.0	.0	606.3	.0	.0
RED MAPLE	.0	6.3	.0	.0	.0	.0
WHITE ASH	.0	.9	.0	.0	.0	.0
YELLOW BIRCH	.0	.7	.0	.0	.0	.0
WHITE OAK	442.6	.6	.0	.0	.0	.0
ALL SOFTWOODS	4989.9	9.5	35.6	.0	.0	.0
ALL HARDWOODS	3688.9	13.4	.0	606.3	.0	.0
ALL SPECIES	8678.9	23.0	35.6	606.3	.0	.0

Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

DAN STEPANAUSKAS

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Job Title—NINETEEN MILE BROOK LOT: 22.7F0, 10WET, .65PRKNG/LNDNG = 33.35ACS TO
Stand Title--STAND 3: WP/HDWD 3/2

Forest Tally
by
Loon's Echo

Date Run: 12/07/21

B.A.F. = 20.00

NUMBER OF POINTS SAMPLED = 6

DIAMETER CLASS SIZE = 1

STAND # 3

ACREAGE OF TRACT = 6.10

CONFIDENCE LEVEL = .90

LEVEL = ALL Trees

Licensed To

Forest Land Improvement

Donald Johnson

P. O. Box 188

Tamworth NH 03886

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Serial Number

900401-0002

Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

DAN STEPANAUSKAS

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Job Title--NINETEEN MILE BROOK LOT: 22.7FO, 10WET, .65PRKNG/LNDNG = 33.35ACS TO

Stand Title--STAND 3: WP/HDWD 3/2

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*
*                               ALL SPECIES                               LEVEL = ALL Trees
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*
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	BASAL AREA	TREES	SAWLOG	PULP	BOX PINE	PALLET	VENEER	MAT LOG
DIAMETER	PER	PER	INT. 1/4"	CORDS	INT. 1/4"	INT. 1/4"	INT. 1/4"	INT. 1/4"
CLASS	ACRE	ACRE	VOL / ACRE	VOL / ACRE	VOL / ACRE	VOL / ACRE	VOL / ACRE	VOL / ACRE
8	6.7	19.1	.0	2.0	.0	.0	.0	.0
10	16.7	30.6	148.7	4.7	.0	.0	.0	.0
12	10.0	12.7	863.3	1.4	.0	78.7	.0	.0
14	16.7	15.6	2130.6	.6	.0	45.8	.0	.0
16	23.3	16.7	3003.1	1.6	71.5	.0	.0	.0
18	16.7	9.4	2636.1	1.1	49.2	49.2	.0	.0
20	13.3	6.1	2402.8	.3	.0	.0	.0	.0
22	16.7	6.3	2828.2	.7	428.6	.0	.0	.0
24	3.3	1.1	611.8	.1	38.7	.0	.0	.0
TOTAL	123.3	117.6	14624.6	12.4	588.0	173.7	.0	.0
S.E.			± 41%	± 82%	± 57%	± 141%	± 0%	± 0%
C.V.			52%	102%	71%	175%	0%	0%

MEAN STAND DIAMETER = 13.9

MERCHANTABLE M.S.D. = 13.9

PERCENT CRUISE = 5.2%

Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

DAN STEPANAUSKAS

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Job Title--NINETEEN MILE BROOK LOT: 22.7FO, 10WET, .65PRKNG/LNDNG = 33.35ACS TO

Stand Title--STAND 3: WP/HDWD 3/2

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*
*                               VOLUME TOTALS FOR ALL SPECIES                               *
*                                                                                             *
*                                                                                             *
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SPECIES	SAWLOG	PULP	BOX PINE	PALLET	VENEER	MAT LOG
	INT. 1/4"	CORDS	INT. 1/4"	INT. 1/4"	INT. 1/4"	INT. 1/4"
	VOL / ACRE					
WHITE PINE	12939.0	6.3	588.0	49.2	.0	.0
HEMLOCK	292.8	.4	.0	.0	.0	.0
RED OAK	1212.6	3.1	.0	124.6	.0	.0
RED MAPLE	180.2	2.6	.0	.0	.0	.0
ALL SOFTWOODS	13231.8	6.7	588.0	49.2	.0	.0
ALL HARDWOODS	1392.8	5.7	.0	124.6	.0	.0
ALL SPECIES	14624.6	12.4	588.0	173.7	.0	.0

Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

DAN STEPANAUSKAS

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Job Title-----NINETEEN MILE BROOK LOT: 22.7FO, 10WET, .65PRKNG/LNDNG = 33.35ACS TO

Stand Title--STAND 3: WP/HDWD 3/2

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*
*                               VOLUME TOTALS EXPANDED BY ACREAGE                               *
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	SAWLOG	PULP	BOX PINE	PALLET	VENEER	MAT LOG
	INT. 1/4"	CORDS	INT. 1/4"	INT. 1/4"	INT. 1/4"	INT. 1/4"
	VOLUME	VOLUME	VOLUME	VOLUME	VOLUME	VOLUME
WHITE PINE	78928	39	3587	300	0	0
HEMLOCK	1786	2	0	0	0	0
RED OAK	7397	19	0	760	0	0
RED MAPLE	1099	16	0	0	0	0
ALL SOFTWOODS	80714	41	3587	300	0	0
ALL HARDWOODS	8496	35	0	760	0	0
ALL SPECIES	89210	76	3587	1060	0	0

Glossary and Acronyms

basal area (of a tree) - the cross-sectional area of the trunk 4 1/2 feet above the ground; (per acre) the sum of the basal areas of the trees on an acre; used as a measure of forest density.

BMPs - Best Management Practices: a set of guidelines to protect water quality. BMPs focus on careful road construction and maintenance, careful timber harvesting, minimal impact site preparation and protection of streamside management zones and wetlands.

board foot - a unit for measuring wood volume in a tree, log, or board. A board foot is commonly 1 foot by 1 foot by 1 inch, but any shape containing 144 cubic inches of wood equals one board foot.

browse - parts of woody plants, including twigs, shoots, and leaves, eaten by forest animals.

canopy - the continuous cover formed by tree crowns in a forest.

cord - a unit of wood cut for fuel that is equal to a stack 4 x 4 by 8 feet or 128 cubic feet. A cord is the legal measure of fuelwood volume in Maine and New Hampshire.

diameter at breast height (dbh) - standard measurement of a tree's diameter, usually taken at 4 1/2 feet above the ground.

DBH – tree diameter breast height

even-aged stand - a stand in which the age difference between the oldest and youngest trees is minimal, usually no greater than 10 to 20 years. Even-aged stands are perpetuated by cutting all the trees within a relatively short period of time.

forest types - associations of tree species that have similar ecological requirements. Northern New England forest types include white pine, spruce-fir, hemlock, northern hardwood, oak-pine, and others.

group selection - a process of harvesting patches of trees to open the forest canopy and encourage the reproduction of un-evenaged stands.

herbaceous vegetation - low-growing, non-woody plants, including wildflowers and ferns, in a forest understory.

high grading—The practice of removing only the biggest and best trees from a stand during a harvest operation and leaving only the poorest, lowest quality culls to dominate the site.

intolerance - a characteristic of certain tree species that does not permit them to survive in the shade of other trees.

landing - a cleared area within a timber harvest where harvested logs are processed, piled, and loaded for transport to a sawmill or other facility.

MBF - Thousand board feet. A unit of measure for tree volume or sawed lumber.

marking timber - indicating by paint or other means which trees are to be cut or otherwise treated. It is advisable to mark trees to be harvested twice-once at eye level and once on the stump.

mast - Fruits or nuts used as a food source by wildlife. Soft mast includes most fruits with fleshy coverings, such as persimmon, dogwood seed or black gum seed. Hard mast refers to nuts such as acorns and beech, pecan and hickory nuts.

overstocked - the situation in which trees are so closely spaced that they compete for resources and do not reach full growth potential.

pole timber - trees 4 to 10 inches dbh.

precommercial treatments - forestry operations that require landowner investment, such as cleaning or weeding stands to remove trees that have little or no cash value.

pruning - the act of sawing or cutting branches from a living tree. In forest management, pruning is done to promote the growth of clear, valuable wood on the tree bole.

pulpwood - wood suitable for use in paper manufacturing.

regeneration - the process by which a forest is reseeded and renewed. Advanced regeneration refers to regeneration that is established before the existing forest stand is removed.

regeneration cut - a timber harvest designed to promote natural establishment of trees.

release - to remove overtopping trees that compete with understory or suppressed trees.

residual stand - the trees remaining intact following any cutting operation.

sapling stand - a stand of trees whose average dbh is between 1 and 4 inches.

sawlog - a log large enough to be sawed economically on a sawmill. Sawlogs are usually at least 8 inches in diameter at the small end.

seed-tree harvest - the felling of all the trees in an area except for a few desirable individuals that provide seed for the next forest.

seep - where water comes to the surface of the ground at the head of drainage-ways. This most often occurs in rich forest soils settings.

selection harvest - the harvest of all individual trees or small groups at regular intervals to maintain an uneven-aged forest. Selection harvests are used to manage species that do not need sunlight to survive.

shelterwood harvest - the harvest of all mature trees in an area in a series of two or more cuts, leaving enough trees of other sizes to provide shade and protection for forest seedlings.

significant wildlife habitat - habitats identified and mapped by the Maine Inland Fisheries and Wildlife Department and afforded special protection including deer wintering areas, bald eagle nests, shorebird nesting areas, etc., or identified by NH Fish & Game's Wildlife Action Plan. However, the NH Action Plan provides no special protection for these critical areas.

site index - a measure of the quality of a site based on the height of dominant trees at a specified age (usually 25 or 50 years), depending on the species.

stocking level - the density of trees by species or timber type in a particular area

slash - branches and other woody material left on a site after logging.

slope - a measure of steepness of terrain and a feature that can limit equipment use; it is the vertical gain (rise) divided by the horizontal distance cover (run).

snag - a dead tree that is still standing. Snags provide important food and cover for a wide variety of wildlife species.

stand - a group of forest trees of sufficiently uniform species composition, age, and condition to be considered a homogeneous unit for management purposes.

stand density - the quantity of trees per unit area, usually evaluated in terms of basal area, crown cover and stocking.

stocking - the number and density of trees in a forest stand. Stands are often classified as understocked, well-stocked or overstocked.

stumpage - the value of standing trees in a forest.

Nineteen Mile Brook Lot Town of Tuftonboro Forest Management Plan 2021

thinning - a partial cut in an immature, overstocked stand of trees used to increase the growth of existing trees by concentrating on individuals with the best potential, no regeneration results

tolerance - a tree species' capacity to grow in shade.

understocked - a stand of trees so widely spaced, that even with full growth potential realized, crown closure will not occur.

understory - the level of forest vegetation beneath the canopy.

uneven-aged stand - Three or more age classes of trees represented.

well-stocked - the situation in which a forest stand contains trees spaced widely enough to prevent competition yet closely enough to utilize the entire site.