Forest Management Plan

Great Pond Mountain Conservation Trust – Orland, Maine

Hothole Core Ownership Block

January, 2017

Prepared by: Roger H. Greene, CF#476, LPF #23 (Maine) TSP 13-9363

Forest Science & Management Consultant

41 Morningside Place

Stockton Springs, Maine 04981

207-567-3458

FOREST MANAGEMENT PLAN

NRCS EQIP Contract # (741218160ZG)

Planning Period: 2017 - 2027

Great Pond Mountain Conservation Trust

PO Box 266, Orland, Maine 04472

Landowner Phone #207-469-6929

FSA TRACT # 1930

Town of Orland

Hancock County, Maine

3,246 Forested Acres in Plan

January, 2017

Roger H. Greene, CF #476, LPF #23 (ME), TSP #13-9363

41 Morningside Place, Stockton Springs, Maine 04981

Phone #207-567-3458

Certification of Conservation Activity Plan:

I assume responsibility for the development of the above stated Conservation Activity Plan/Stewardship Plan Addendum provided. The plan provided: (1) complies with all applicable Federal, State, Tribal ands local laws and requirements; (2) meets applicable Department standards, specifications, statements of work and program requirements; (3) is consistent with the particular conservation program goals and objectives for which the program contract was entered into by the Department and the participant; and (4) incorporates alternatives that are both cost effective and appropriate to address the resource issue. Conservation alternatives will meet the objectives for the program and participant to whom assistance is provided.

Forester License #_______Signature ____________________________Date _______

Landowner/Producer Signature_______________________ Date_______

NRCS Signature____________________ Acceptance Date _____

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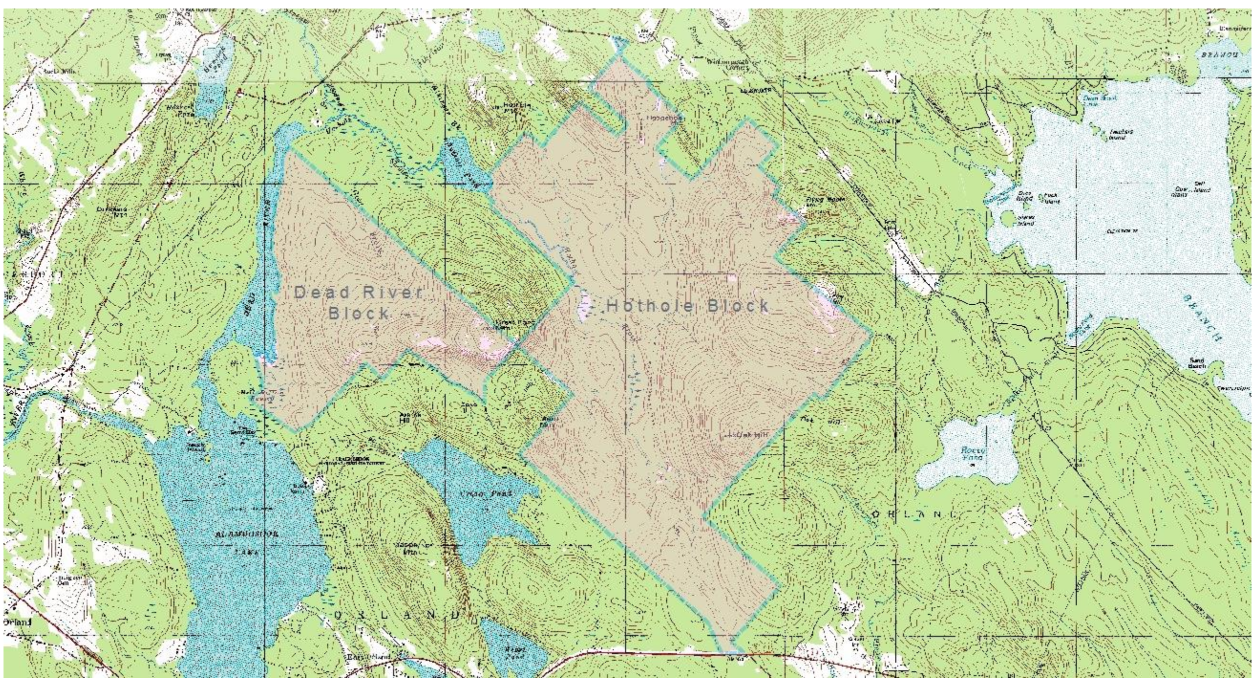
A. Introduction & Executive Summary

This Forest Management Plan builds upon the initial plan prepared by Joachim Maier, LPF #3177 in 2007 and includes additional detail about the current and projected future condition of the Great Pond Mountain Conservation Trust (GPMCT) forest from data not available for the previous edition. The foundation for recommendations and specific plans, however, is similar – managing on a conservative ecological basis that includes all aspects and components of a forested landscape. Additionally, this plan has been prepared according to guidelines of the Natural Resources Conservation Service (NRCS) and for which, supporting funding has been approved. Required sections of the plan content are referenced to the latest NRCS Forest Management Plan checklist (January, 2013), found in the front pocket of this document's binder.

The core fee-owned area of the GPMCT acreage occupies about 4,600 acres, or 15% of the area of Orland, Maine. The GPMCT Core property lies near Orland's east boundary between U. S. Route 1 and the Bald Mountain Road. This plan covers the Hothole block's 3,415 acres of which, 3, 247 acres are forested, and its location is shown below in Figure 1.

Figure 1 - General Location of Hothole and Dead River Blocks



It encompasses nearly the entire valley drained by Hothole Stream with its many tributaries. Purchased in 2005, the current forest is continuing to recover from heavy, exploitive cutting by the former owner. As such, much of the tree cover present is not in a condition of either size or quality which could offer some level of immediate recompense to fund cultural improvements or growing stock adjustments to improve forest health and vigor. Additional maps showing more specific details may be found in Appendix A, page 127.

From its inception, the GPMCT has been forward-looking in establishing a better forest to meet the stated goals of the Trust while understanding that it will take a long time to build a forest whose visual characteristics include larger trees, diverse habitats, abundant wildlife, a mix of high-quality timber and non-timber products and a blend of uses for all to enjoy. This is an example of the "long view" necessary to rebuild a better forest and the GPMCT's commitment to the expected duration is, indeed, commendable. There is also a realization that most of the objectives for wildlife, recreation, education, water quality, scenic views and income will depend upon active cultural operations favoring healthy trees and removing poorer ones in order to make adjustments that advance the forest recovery process. Just how these adjustments and changes are made encompasses a "land ethic" approach adopted by the Trust and is woven throughout the details of forest management. In short, this ethical view recommends that treatments to any aspect of the land (forest stands, wetlands, roads, streams, trails, infrastructure, etc.) be designed and implemented in a way that does not impair the regenerative capacity of the many attributes that comprise the forest as a whole. Clearly, the GPMCT understands that the organizational capacity, level of stewardship and community ties through outreach all need to be developed to support the conservation and protection of all forest resources. Involving the Trust membership in volunteerism supporting maintenance activities in all aspects has been proven to be an effective way to show progress towards intended goals over long periods of time.

Since the core ownership in general, and the Hothole Block in particular contains the headwaters of Hothole Stream and its tributaries as well as significant mountains and hills of interest to the GPMCT, it was felt that an effort to protect these forested resources was necessary. During the time when fund raising towards acquisition was being considered, a spate of large forested parcels which were then cut heavily, were subdivided and sold for development. This practice has been going on in Maine for a long time, at first for generating revenue through sales of raw material and more recently to capitalize on a market for "developed" large properties. This situation has been present throughout the state. Preventing such a fragmentation of land used in this area became a driving force behind acquisition. Being such a large parcel in the midst of smaller ones within Orland and adjacent towns was seen as an advantage. The eventual purchase of properties making up the Hothole and Dead River Blocks was envisioned as a conservation, rather than a preservation effort, since the majority of the forest had been heavily cut-over. While protection of rare, threatened or endangered species has been a concern of the GPMCT, there are not many present on the Hothole Block. Critical wading bird habitat is present, however, and a small plant – Smooth Sandwort is on the State list of rare plants and can be found on the low bald summit of Great Pond Mountain as well as Flag Hill (see Appendix C, page 129).

The prime reason for a Forest Management Plan is to help a forest owner make whatever changes might be necessary to achieve a desired condition in an organized, logical fashion over a given period of time. To be truly effective, such plans need to be sufficiently detailed that a land owner realizes what changes need to be made, when to make them and where they should be applied. On the other hand, they should also be general enough that the user of the plan's content can keep the larger picture in mind. Managing a forest towards a desired future condition is serious business and can often be expensive to boot. If one is serious about actually making substantive changes to a landscape (no matter how large or small), then the management plan should be both general enough to view details in the larger sense of their impact over time, while being providing details necessary to fully understand what, where, when and how to make the necessary adjustments. It is in this context that this plan has been prepared.

The stated mission of the GPMCT is to: "Conserve land, water and wildlife habitat for the communities of northwest Hancock County." To achieve this mission on the core ownership area, there are five objectives (GPMCT Strategic Plan Update, 2013):

- ***Maintain/Enhance wildlife habitat and water quality.***
- ***Provide low-impact recreation opportunities.***
- ***Maintain scenic views.***
- ***Provide educational opportunities.***
- ***Provide a sustainable level of income from forest product sales.***

To reach these objectives, such a multifunctional forest will need to possess the following characteristics:

1. *Have a continuous forest cover except for the regeneration of early successional, shade intolerant species mixes.*
2. *Be composed of a mixture of species most suited to growing places.*
3. *Possess a well-developed irregular structure where trees of several ages and development stages are present.*
4. *Contain a mix of successional stages to diversify wildlife habitat that should be present across the landscape.*

5. *Begin cultural interventions that mimic natural disturbances.*
6. *Improved stand stability and resilience.*

The type of forest that would best meet the above goals and objectives is that of a ***Mixed-species, Multi-cohort, Irregular Unevenaged*** condition. This type of forest contains trees of all sizes and species that are adapted to the site upon which they are growing. Changes from silvicultural treatments are subtle and mimic natural disturbances. To achieve this condition, management actions must focus on improving forest health where individual tree potential, quality and diversity guide tending operations. Improving ecosystem functionality and the optimum use of each individual tree while ensuring successful recruitment to the main stand should guide the design and implementation of cultural activities at all stages. For management to be truly effective, the forest itself as well as its data and information must be organized in such a way that planning actions can be focused, concise and targeted. Results from silvicultural treatments need to be tracked to ensure that the desired effects from treatment were, indeed, obtained. More specific forest management objectives directly related to the goals of ownership are the following:

- *Rehabilitate the existing forest from early development stages to balanced immature/ mature stages of mixed species with increasing vertical strata. Maintain a continuous high-forest cover.*

- *Move the forest through development stages in a way that seeks to balance forest habitat structures according to a stated, definitive objective distribution designed to afford increased opportunity for wildlife of all kinds to flourish.*

- *Ensure that conditions ensuring the minimization of soil movement are met and that water flows, temperature regimes and clarity are improved whenever possible.*

- *Identify and balance species mixtures, development and density classes with varying understories and ground vegetation to provide visual interest.*

- *Design specific treatments to keep views open within defined extents by periodic treatments that provide interest within the viewing area.*

- *Design and implement a monitoring system to keep track of changes in a manner that can be used to contrast forest conditions and silvicultural treatment methods over time.*

- *Identify areas that are representative of both the old (largely removed) and new, developing forest with its varying conditions of species composition, ground vegetation and the gradual return of mature forest conditions. Make allowances for observation and study.*

- *Improve the health and growth rate of all tree species present while producing the highest value marketable product mix from all species.*

- *Concentrate removals on the poorest quality and vigor trees to most rapidly improve each stand's stability by allowing healthier trees to take full advantage of soil quality and growing space afforded.*

- *Keep costs of administration and management as low as possible to perform the required tasks in an economically efficient fashion.*

The current condition of the Hothole Block forest is young (17-35 years) and the species mix is unbalanced (too many of one species and not enough of others). As a young forest, lower stocking levels in both basal area and volume are present – there is very little merchantable wood from which to generate supportive revenue. Habitat areas by type is also unbalanced and somewhat limited due to an insufficiency of tree size classes and an overabundance in others. Tree quality, the primary attribute of forest health is poor, with only 22% of all trees classed as Acceptable Growing Stock (AGS) and 32% of the total trees are worthless culls – best suited as cavity trees. As a result of the foregoing, overall diversity is also limited. See Section D4, page 52 for a more detailed discussion of existing forest condition.

The effects on the forest from climate changes take decades to manifest themselves and, along with weather, insects and diseases can have adverse consequences. Taking an "adaptive" approach towards these effects should ease any transition necessary to adapt to a changing climate in our area.

There are three areas where we can plan for changes and specific tactics we can employ are part of our ongoing forest management to build our future forest, keeping the GPMCT goals in mind. The first area of focus is ***Resistance*** to adverse changes. Two strategies to combat negative changes to the landscape are:

- **Continue to prevent the introduction of invasive species**
- **Protect sensitive or at-risk species and communities**.

The second area of focus is ***Resilience*** to adverse changes. Some of the recommendations to apply tactically and help increase resilience to climatic change could be:

- **Promote diverse age classes**.
- **Maintain/restore diversity of native tree species**.
- **Retain biological legacies**.
- **Maintain/Restore soil quality and nutrient cycling**.

Third, and last of the three focus items is ***Transition***. How we go about making a climatically-induced shift from present forest community structures to those better suited for future stability. This task can be easily incorporated into our recommendations for forest management. Matching the right species with the right growing conditions and sites will ensure that treated stands will be adjusted towards future stability of both species composition and structure. Specific strategies and silvicultural regimes for adapting to climate changes can be found in Section E3, page 78. Two key tactics for adaptive management are:

- **Favor those native species that are expected to be better adapted to future conditions.**
- **Emphasize drought and heat-tolerant species and populations.**

Changes to forest composition, structure and overall health take a long time to achieve but beginning as early as practically possible in the life of forest stands can shorten the improvement cycle. For example, under a more "preservationist" approach, where land is held, but not tended, it may be 60 to 80 more years before income generation to support administrative operations becomes a reality. In the meantime, roads would deteriorate, boundary lines would become more obliterated and the quality and dimensions of material that could generate some income would be much less. Currently, the forest is in what is called the "stem exclusion stage" where fierce competition among young trees results in the death of others. This is self-thinning. Instead, tending operations consisting of careful thinning by several methods to save time by releasing the most promising trees to develop better and faster. Thus far, since 2007, 231 acres of thinning has be completed by methods shown below in Table 1.

Table 1 - Summary of Thinning Treatments: Hothole Block

Conifer spacing	23
Hvy. Thin	10
Lt. Thin	109
Wildlife Habitat	21
1/3 ac Patch	9
Crop-Tree Release	44
Understory removal	15

Summarized treatment acres by GPMCT ownership block is shown in Table 2 (below). [Note: DR is the Dead River block and HH is the Hothole block].

Table 2 - Cultural Treatments Acreage by Block and Year

DR	**62**
2011	**21**
2014	**17**
2012-2013	**24**
HH	**169**
2008	**2**
2009	**6**
2010	**10**
2011	**5**
2014	**20**
2015	**25**
2016	**101**
Grand Total	**231**

Tending operations, consisting of light, moderate or heavy thinnings in a forest's early stages, advance the development process by making it happen sooner. Instead of the 60 to 80 year period required to approach a desired condition or appearance, a better, more stable forest could be reached in 30 to 50 years with a well-designed program of silvicultural treatments. The actual time will vary with the amount of treated acres able to be completed. Our third NRCS cost-reimbursement contract covering 2017 to 2021 can triple the average number of acres treated annually and help move towards the "ideal" forest sooner. Being able to complete an average of 60 (or more) acres per year will ensure that forest productivity of healthier, better quality trees increases. This rate approximates one-half of the average 125-year rotation age for most species. Successive treatments (as few as 3 or as many as 6 at intervals of 10 to 15 years) should gradually create the characteristics mentioned above on all forested acres in approximately 100 years. Early treatments should focus on improving species composition while later treatments address improvements in tree health and quality as well as development of a deeper crown habitat layer. In addition, as larger trees are developing, some may be selected for retention beyond the general 125-year rotation age limit. This provides for very large trees in most places that occur as individuals of interesting or unusual form or other visual characteristics.

At some point in time, a sufficient amount of forest area will begin generating small amounts of more valuable products that could produce a gradually increasing revenue stream. Early treatments will continue to produce low-value products like firewood. With the loss of five paper mills statewide, the market for conifer pulpwood like spruce, fir and pine as well as mixed hardwood species had been greatly diminished. It is the low-value products that constitute most, if not all, of the volume removed in early treatments and if no markets are economically available, material removed must remain on the ground where it is felled. There is some benefit to this approach in that the land base is deficient in the amount of coarse woody debris, which provides additional habitats. Whole-tree removals by the former owner eliminated much of the woody matter that would ordinarily occur to provide nutrients and habitats for small creatures that help to decompose such material. Adding some now will ameliorate this deficit.

In time, as treated stands develop more rapidly, their ability to generate cost-offsetting income will increase. Based on conservative estimates, income sufficient to support the forestry budget may occur in as little as 20 to 25 years. However, the level of income from forestry operations to fully support the total operations budget will probably not begin for 35 to 40 years. See Section C4g, page 41 for additional information on cost & revenue projections.

This forest management plan has been prepared with the two most important components of information in place – forest stand maps and a forest inventory. Without such information it is impossible to construct a workable plan or predict future outcomes, so a bit of discussion about these key elements is advisable. The forest mapping project was approved and completed in early 2012 and consisted of new, digital aerial imagery being obtained for a larger area surrounding the Dead River and Hothole Blocks. Deliverables consisted of color-infrared digital image mosaic, Stand Polygon, Water and Road files for a Geographic Information System (GIS). All data referencing a stand cover type (Primary, Secondary Species, Development Class and Density Class) was included in a database file along with acreage of each polygon. This was done to enable rapid information development for adjacent parcels that may be considered for acquisition. An example of this has been the ability to link our very specific forest cover types to other useful, albeit, more generally useful classifications like the following:

- GPMCT WILDLANDS Detailed Forest Cover Types
- GPMCT WILDLANDS Forest Habitat Communities
- Maine Species Groups
- Forest Inventory Strata
- GPMCT WILDLANDS Forest Structural Classes (Horizontal & Vertical)
- Maine Natural Communities
- Society of American Forest Cover Types
- World-wide Ecosystem Classes (NatureServe)
- National Vegetation Cover Types (NRCS)
- Landscape Position

Likewise, the area-wide forest inventory covering forest land in both blocks was approved and completed in early 2014. This inventory consisted of measurements on 3,076 trees on 593 sample locations (426 on the Hothole Block and 167 on the Dead River Block). Specific tree measurement data consisted of the following:

- Species
- Diameter at 4.5 feet above ground (known as DBH)
- Position in the crown canopy
- Product potential (a measure of tree quality)
- Total height from equations specific to species.

Now we know what we have, how much there is and where it is located. We also have the ability to project current forest conditions forward by use of a forest inventory data management system called MBG Tools™, a product of Mason, Bruce & Girard – Natural Resource Consultants in Portland, Oregon. This system allows rapid compilation and reporting of inventory information and uses the widely-available Forest Vegetation Simulator (FVS) to project forest conditions into the future.

Development of specific recommendations for treatment has been done on a "Broad Forest Type" basis. These broad types [**IH**-*Hardwoods intolerant of shade*; **TH**-*Shade tolerant northern hardwoods*; **PH**-*Pine and Hemlock mixtures*; **SF**-*Mixtures of Red spruce and Balsam fir* and **LC**-*Lowland conifers like Cedar, Tamarack and Black spruce*] are recognized by the most predominant species or species group with treatment recommendations as follows:

In cases where the majority of the stocking consists of **Intolerant Pioneer Hardwoods** like Aspen, White or Gray birch, Pin cherry and sometimes Black cherry or Red Oak combined with lesser amounts of other, more moderately tolerant hardwoods like Red maple, Striped or Mountain maple or other similar species, these stands should continue to be managed on an evenaged basis. The Aspen-birch broad type is a prime habitat for a number of wildlife species and in order to maintain sufficient area in this type (about 350 acres) efforts should be made to encourage a mix of various development stages within each stand. This can be accomplished by thinning in irregularly-shaped strips or patches until such time as an effort to regenerate these stands should be made – normally at about 40 to 60 years, depending on stand health and site quality. At that time, regeneration efforts will require more light for seeds of Aspen and Birch species to become established, so openings in the stand will need to be in a series of open patches of three or four acres in size, irregularly shaped to conform to the landscape. The schedule of regeneration patches should cover a period of 10 years between treatments. Larger stands will have a greater range of patch ages than smaller stands. Adjacent stand conditions, especially of the same broad type group should be considered for treatment at the same time, or maintained to offer more cover and protection to the regenerated patches.

Other species in these Intolerant Pioneer Hardwood stands in lesser amounts may be an indication that the more realistic management direction may be to encourage these other species (especially if there are abundant conifers present in an understory) towards dominance of the site. This will involve a species conversion over a period of time and in areas where the possibility of managing an evenaged stand of Aspen-birch species exists, it should be applied. Site quality will be the most important factor in the decision of whether or not to encourage a species conversion.

The mix of **Tolerant Hardwoods** consist of species that are predominantly shade-tolerant. Typically the Beech-Birch-Maple cover type where the birch referred to is Yellow birch. Red maple also in part of the component along with Sugar maple. The intolerant White ash is also found on the moister portions of this type, as can White or Gray birch but in minor amounts on the Hothole Block. Striped and Mountain maple, along with Eastern hop hornbeam occur in the understory, usually dominated by succeeding smaller Beech. Usually found on the more northerly-facing slopes, this combination used to cover most of the hardwood sites on the Hothole Block, but it is now broken up into large swaths of Beech-dominated stands of poor quality with scattered remnants of the other species.

Of particular interest is a species that is found rarely but can be very useful in selected habitats. This species is American basswood (sometimes called American linden), which may have been more widely distributed in a predominant mixture with Sugar maple. Found on deep, moist sites, this species prefers lower slopes and there is some found alongside the Valley Road north of the Flag Hill road intersection. On Oak Hill's north side, a remnant stub of Basswood 34 inches in diameter has been found. Where possible, this species should be an encouraged associate of the Tolerant Hardwood types containing a larger proportion of Sugar maple. Basswood is also an additional species that supports pollinator habitats. White ash should serve as an indicator of where Basswood could flourish.

Stands of predominantly tolerant hardwoods should be managed towards developing an irregular structured unevenaged condition. Currently, the present stands are all evenaged and should be lightly thinned at a 10 to 15 year interval to first adjust species composition and improve basal area growth by reducing poor-quality Beech, then by retaining better, more vigorous Sugar maple, Red maple, Beech, Yellow birch, White ash, Red oak and understory Hop hornbeam. As the stand reaches an age of from 50 to 70 years, the transition to the unevenaged condition may begin by initiating a series of small, irregular openings no larger than perhaps 3/4 acre in size and limited to 10% of the stand's area at each entry at the same 10 to 15 year interval. With maximum basal area stocking of 100 sq. ft./acre or more, management as an irregular stand may begin by conducting light removals to afford more crown expansion room in all development classes from poles to large sawtimber. Small regenerated patches should also be treated, but largely to make adjustments to species composition.

Where scattered conifer species like Red spruce, White pine and Hemlock are found in the stand, some of these better quality trees should be carried to maturity in order to increase diversity and offer habitats that tolerant hardwoods do not.

Since these stands will have species that will last longest, rotation ages with associated maximum size should be in the neighborhood of 100 years up to perhaps 125 years, with carefully selected Retention Trees of from 125 to 175 years old.

PH stands are dominated by White pine and Hemlock, are scattered and may be only a secondary component. In riparian areas, Hemlock is generally the major component, rather than White pine, which has always been a preferred species to remove. The White pine now usually occurs as a scattered overstory that developed from residual trees too small to harvest during the last major cutting by the previous owner. Where it is found, it is scattered among hardwoods of either tolerant or intolerant species or a minor stand component where spruce and fir are the more dominant conifers.

Where White pine is present, it should be encouraged to take a more prominent place in the stand. This can be done by releasing subordinate trees with live–crown ratios of at least 40% and of good quality during early light thinning treatments while the stands are still evenaged. As the transition to the unevenaged, irregular structure begins and small patches of regeneration are created, the openings must be large enough to allow White pine to become established in greater numbers along with Hemlock and other species. Keeping the newly-regenerated patches dense will discourage weevil damage to pine leaders and allow the accelerated height growth characteristic of the species. Using other species as a "nurse crop" will further protect the White pine from weevil damage and produce healthy, straight stems rapidly. Using Hemlock along with any hardwoods present (tolerant or intolerant) to encourage self-pruning until the pine reaches 40 feet in total height with a 40% - 60% live-crown ratio could be the point at which a heavier thinning of other trees to adjust both species composition, diversity, spacing and individual tree quality might be made. Further thinning to increase growth rates in individual trees should be made based on the latest thinning guides for White pine and mixed species stands. Vertical dimensionality will increase rapidly at this point as pine becomes a "superstory" above the main crown canopy while the remainder of the species coexist between and beneath the White pine.

In terms of maximum age carried, White pine could live well beyond the 100-year mark and some individuals could be carried to 150 years and very large size to occupy a semi-permanent place in the stand until they succumb to old age (400+ years). Hemlock present in the stand could be carried as long but in fewer numbers as its value has been historically low. If this improves, there could be more of it in the maturing stand. Once these trees increase beyond 80-100 years of age, their financial return through additional growth becomes lower, but since financial return is not an immediate priority, it can be ignored for the next 50 years. For some level of revenue to be generated from all managed stands, the limit on the largest diameters to be grown by species should be specified as it relates to the availability of equipment designed to handle and process larger diameter stock. The maximum DBH could vary from 14 to 16 inches for Quaking aspen, Balsam poplar and Black spruce to 25 or more inches for White pine, Hemlock, Sugar maple, Yellow birch and Red oak. Much depends on the growing site and how the trees are developing, along with tree vigor and risk of loss.

Stands of **Lowland Conifers** are usually found in on poorly-drained sites where growth is slow and stocking is high. Species like Northern white cedar, Tamarack, Red and Black spruce and some Balsam fir predominate. Hardwood associates like Red maple and the occasional Yellow birch along with alders, winterberry and other shrubs (as well as the invasive honeysuckle) may be found.

Depending on stand composition and the type of site, many of these currently low stocked areas could become prime quality deer wintering yards if managed towards that end. Only stands that have regenerated to a preponderance of Red or Black spruce and Balsam fir with Hemlock would suffice for an attempt at "rebuilding" an adequate deer wintering area. Managing these stands for forest products is a very low priority due to the low productivity of the sites upon which they are found and are better off as maintained wildlife habitats. With sufficient stocking, these stands can withstand heavy snow and ice storms while providing good cover. Currently, though, their stocking has been reduced by past excesses and it will take time for them to increase to the point where they can be managed properly, even though the management will be limited and extensive, rather than intensive.

Spruce/Fir conifer stands predominantly composed of Red spruce and Balsam fir are usually found on what are called "primary" or "secondary" conifer sites. Primary softwood sites are those with poor or impeded drainage in lower topographic locations such as spruce-fir flats or swamps. Here, Red spruce and Balsam fir will dominate the site, with few hardwoods like Red maple, Yellow birch or Aspen found scattered throughout. Secondary softwood sites are those that occur on more well-drained soils at a slightly higher topographic position like lower and mid-slopes and also on the thin soils of ridgetops and bald summits. On the former two, there may be hardwood species that could occupy from 25 to 75% of the stand. Hardwood species found here include Sugar maple, Yellow birch, Beech, Striped and Mountain maple. Generally, the lower the site, the sooner both spruce and fir will completely occupy the stand.

Areas on the Hothole Block with a good showing of Red spruce and Balsam fir with some Hemlock, too, generally have some scattered hardwoods. Due to the previous heavy cutting, the composition of these stands has changed and in time, many of these sites will produce the typical softwood sites mentioned above. For the time being, if we look at the Soil/Site Productivity map, the fair sites may develop into primary softwood sites regardless of what is present now. The good sites, on the other hand, could become secondary softwood or mixed species sites, depending on a variety of factors which should be assessed as they become candidates for treatment.

Conifer stands composed of spruce and fir should be transitioned to the desired unevenaged, irregular structure with a sequence of light, low thinnings that should begin at age 30 to 35, or when the stand average size reaches 4.5 inches and has a minimum total basal area of more than 75 sq. ft. Removals should not be greater than 25% of the total cubic foot volume. These thinnings should continue on a 10 to 15-year interval until a mean stand diameter of 7 inches is reached. At that time, the transition to the unevenaged, irregular structure can be initiated by making small openings no larger than ¼ acre by group selection methods. Like the hardwoods, the number of openings made in each entry period should not exceed 10% of the stand area.

Since these conifer species on poorer sites are subject to windthrow during extreme weather events, thinning treatment in all diameter classes should seek to develop trees with at least 40% live crown ratios and a height to DBH ratio of less than 80%. The object here is to avoid trees too slender to resist the forces of moderate winds (Kamimura et al, 2008; Wonn, 2001; Gardiner et al, 2008; Ruel, 1995; Canham et al, 2001).

A final recommendation for forest management includes the identification and creation of **Strategic Ecological Reserve** areas where no active forest management will be applied, unless some catastrophic event occurs, requiring remediation efforts.

These set-aside forest stands are designed to provide locations within the interior of the Hothole Block that can be left to develop without efforts at rehabilitation. In that way, there should exist some basis of comparison with those similar stands on similar sites that have undergone the full regimen of rehabilitative treatments to create an irregular, unevenaged forest structure.

One area mentioned in Dibble and Rees is the area to the north of the Hothole Pond Road and west of the Valley Road suggested as an ecological reserve. This area of about 24 stands falls in a region of large rocks, steep slopes and wetland forest area in the extreme northwest corner and include a very diverse variety of habitats as well as an old-forest remnant in Stand 79 along the west side of Hothole Brook.

Another prominent area is that on the upper slopes and crest of Great Pond Mountain where a bald summit and a spruce forest is present. It makes no sense to attempt to grow good forest trees in this location as the soils are thin, shallow and subject to windthrow during heavy storms.

As far as other areas in the Strategic Ecological Reserves, I would suggest that 10% of each of the area in 5 major forest cover types be set aside as reference areas. These should be selected as entire stands as they would be easier to locate and contain sufficient variety within to make a good comparison to similar types treated. They should also be on similar quality sites and not merely in places where it is difficult to operate. Below are the acreages suggested for each major forest cover type.

- Tolerant hardwoods – 230 acres
- Intolerant hardwoods – 40 acres
- Pine/Hemlock – 5 acres
- Spruce/Fir – 48 acres

- Lowland Conifer – 2 acres (all of current type)

It is most certain that forest cover types will change composition as treatments achieve their desired objectives for composition modifications. As they do, the acreage by broad forest type will change somewhat and that the Pine/Hemlock type will surely increase in area. The White pine in some stands where it is found is now a secondary species, but should rise to prominence in a few decades.

Scheduling of treatments for each of these groups above will be made on a stand basis with very specific treatment criteria. These criteria are part of the development of complete silvicultural regimes that list what treatments should be applied, how intensive they will be and when they should be applied during the development cycles for each stand within a group. Once this first initial treatment is made, there may be up to six successive treatments conditioning these stands up until the point where the transition to a more unevenaged, irregular structure is made.

For the first 5-year planning period (2017-2021), plans have been proposed to complete 290 acres of light thinning (NRCS practice 666-Forest Stand Improvement) in the Tolerant Hardwood Stratum. Stand candidates have been selected for this first 5-year planning period and are listed below.

Table 3 - Planned Treatment Schedule 2017-2021

THINNING SCHEDULE 2017-2021								
Stand No.	Stand Acres	Thinned	Unthinned	2017	2018	2019	2020	2021
289	3	3	0	3				
8	8	8	0	8				
17	40	37	3	37				
35	9	9	0	9				
43	30	30	0		30			
65	69	69	0		30	39		
131	30	30	0			21	9	
150	109	109	0				51	58
Totals:				57	60	60	60	58

Treatment priorities are for the TH and PH groups first, followed by the IH and SF groups. No activity is planned in the next 10 to 15 years for the LC group. One exception here is that Stand 289 is a small-pole stand of Balsam fir and Red spruce which is extremely dense. Along the Mead Mountain Road, this small stand is an ideal candidate for thinning to add to that already completed in 2009 in the same area. The stand has developed to the point where a light thinning would be useful to adjust species composition and stocking to improve growth rates and crown expansion. Due to the extra work involved in completing a conifer thinning, the NRCS reimbursement for this type of operations is $757.62/acre.

This forest stand improvement work will be conducted under a new NRCS contract for practice Code 666, Forest Stand Improvement – HU-thinning for Wildlife and Forest Health, plus the single spruce/fir stand scheduled also. Work on design plans and installation will commence upon contract execution. Stands scheduled to receive treatment are shown in the following map (a copy can be found in Appendix D, Page 117). Cost estimates for this work should be adequately covered by NRCS reimbursement for improving "Forest Health and Wildlife Habitat" at a contracted rate of $574.86 per treated acre, provided that rates current in 2016 stay the same. Work should commence once the new contract is executed sometime in March of 2017.

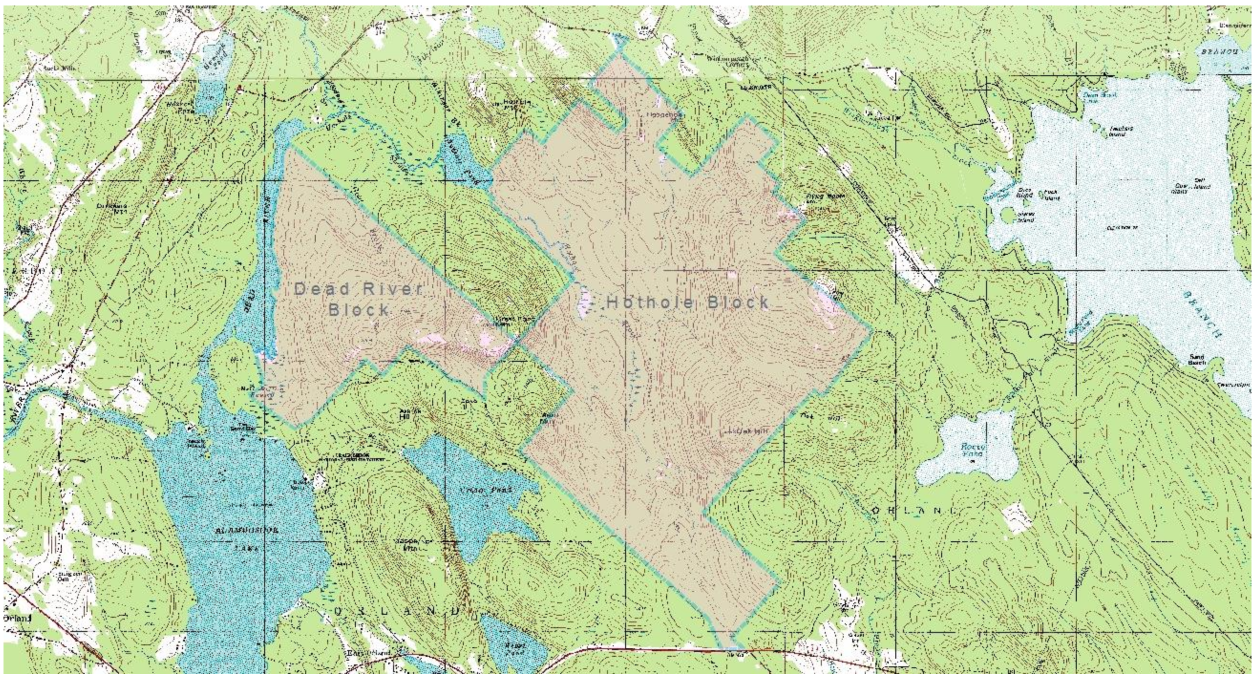
B. Property Summary and Setting [NRCS Checklist Item 1]

B1 Property Summary

B1a) Owner Name, Location and Acreage

The Hothole Block portion of the core Great Pond Mountain Conservation Trust (GPMCT) is wholly located in Orland, Maine between the Bald Mountain Road on the north side and U.S. Route 1 on the south. The landowner's mailing address is PO Box 266, Orland, Maine 04472. Figure 3 (below) shows the location of the GPMCT core blocks against U.S. Geological Survey Map data for the area.

Figure 1-Core Ownership Blocks Location



These ownership blocks comprise approximately 4,500 acres in total (15% of the area in the Town of Orland). The Hothole Block portion contains 3,375 total acres or 75% of the total acreage. It is the largest contiguous portion of the core ownership. The Dead River Block contains the remaining acreage (1,125 ac.).

B1b) Legal Description

Within the Town of Orland, the Hothole Block contains parcels according to the town's tax map as follows:

Table 4 - Orland Tax Map & Lot Numbers by Block

Ownership Blk.	Tax Map No.	Lot No.	Sub-Lot No.
Hothole	7	30	0
Hothole	7	42	0
Dead River	10	35	A
Dead River	11	8	A
Dead River	11	10	0
Dead River	11	11	A
Dead River	11	14	0
Hothole	12	7	0
Hothole	12	8	0
Hothole	12	14	0
Hothole	12	16	0
Hothole	12	18	0
Hothole	12	19	0
Dead River	13	1	0
Hothole	14	23	0
Hothole	14	24	0
Hothole	14	25	0

B1c) Acquisition Date & Prior Owners

Ownership of both blocks was consolidated by the previous owner (Oak Leaf Realty, part of the Henderson Realty Trust) from individuals and Diamond International Corporation and its successors. Deeds for each particular parcel conveyed to the Great Pond Mountain Conservation Trust are bound in an indexed volume in the GPMCT office in Bucksport.

Most of the core ownership parcels were acquired in 2005. Additional properties acquired from DiPaolo, McAllian and Ginn adding to the Dead River

Block as well as the top of Great Pond Mountain were acquired in 2015. These additions are included in the boundaries shown in Figure 3.

B1d) Conservation Values/Attributes

Since the core ownership in general, and the Hothole Block in particular contains the headwaters of Hothole Stream and its tributaries as well as significant mountains and hills of interest to the GPMCT, it was felt that an effort to protect these forested resources was necessary. During the time when fund raising towards acquisition was being considered, a spate of large forested parcels which were then cut heavily, subdivided and sold for development. This practice has been going on in Maine for a long time, at first for generating revenue through sales of raw material and more recently to capitalize on a market for "developed" large properties. This situation has been present throughout the state. Preventing such a fragmentation of land used in this area became a driving force behind acquisition. Being such a large parcel in the midst of smaller ones within Orland and adjacent towns was seen as an advantage. The eventual purchase of properties making up the Hothole and Dead River Blocks was envisioned as a conservation, rather than a preservation effort, since the majority of the forest had been heavily cut-over. Remedial work guided by this Forest Management Plan will help to restore the health and productivity of this forest ecosystem and ultimately, provide a sustainable source of income while protecting other attributes described in the Section C3 – Goals and Objectives, page 35.

Given the condition of the land at the time, erosion from skid trails running vertically up slopes carried large loads of silt into the existing stream networks as well as adversely impacting gravel roads. Improvement in water quality became an immediate as well as prime objective for acquisition as Hothole Stream has a good population of native Brook trout. In addition to adverse impacts on water quality, former wildlife habitats had been severely depleted. However, from a conservation viewpoint, the necessary work to rebuild the forest would offer some interesting educational aspects of this type of work to those who would use the forest for recreational pursuits. Additionally, there exists an opportunity to offer supporting outdoor laboratory time for a variety of subjects for local schools, which are currently being developed.

B1e) Restrictions on Use

There are a number of areas within the boundaries of this property that are impacted by environmental zones that place limits on timber harvest. Protection of water features (ponds, streams, wetlands, etc.) are covered by shoreland zoning at the local level (Orland). The Maine Natural Areas office was contacted to discern whether areas of critical habitat were located anywhere on the properties (both Blocks). Any areas of critical habitat will be identified on the ground with appropriate management recommendations found later on in this plan (Section F3, page 92). A map of critical habitat areas may be found in Appendix C, page 129.

Existing State laws that impact activities on the property consist of the following:

- Protection and Improvement of Waters Law
  Applies to discharge of pollutants into water bodies, including soil erosion.
- Erosion & Sedimentation Control Law
  Applies specifically to soil erosion and sedimentation into water bodies.
- Natural Resources Protection Act (NRPA)
  Regulates activity in, on, over and adjacent to water bodies. Harvesting activities must comply with standards in FPA.
- Shoreland Zoning Law
  Regulates all activities (including timber harvest) in all areas near all water bodies. Targeted towards development to preserve natural beauty & habitat.
- Forest Practices Act (FPA)
  Regulates timber harvest practices (clear-cuts, regeneration) for all owners of over 100 acres by defining standards for residual trees, area harvested and regeneration minimums.

More specific application of standards for each of these laws are covered in the Best Management Practices (BMP) Section G, page 114.

The GPMCT has restrictions on access where and when motorized vehicles (except for those where management operations are in progress) may travel. While cars and trucks are limited to portions of the Valley Road, Flag Hill and Mountain View roads during summer months on weekends, snowmobiles are permitted on gravel roads during while snow-covered. No ATV traffic is allowed during any season.

It is also important to note that there are no restrictions on hunting, fishing or trapping, other than access to selected areas be by foot or bicycle travel.

The most recent restriction on use pertains to the flying of unmanned drone aircraft anywhere on or over GPMCT lands.

B1f) Threats to Values or Areas of Concern

Any natural feature in the wild is threatened from time to time by any number of damaging agents: fire, windstorm, heavy snow, ice, flooding, insects, disease, visitor use, neglect and invasive species, etc. Among the more specific adverse impacts are the following:

* Heavy snow and ice damage to young and older conifers and young birch along Valley Road and in areas along Hothole Stream.
* Widespread Beech Bark disease throughout the ownership.
* Culvert washouts from heavy rains in 2015.
* Heavy use erosion damage to some popular hiking trails.
* Beaver dams on streams causing warming of water-loss of native trout habitat.
* Loss of early successional habitats due to maturation of the forest.
* Unfettered ATV access across boundary lines in remote locations.

B1g) Threatened/Endangered Species

According to the Maine natural areas program database the following species and their current status (statewide) are present. See their report in Appendix C, page 129.

- **Smooth Sandwort** (*Minuartia glabra*) on Flying Moose Mountain and Great Pond Mountain.

Not necessarily threatened, but important habitats exist for Inland Waterfowl and Wading bird habitats along the deadwater sections of Hothole Stream and the margins of Hothole Pond. Habitats for wild Brook trout and Atlantic salmon are also present in the lower reaches of many of the brooks and streams on the Hothole Block and these should be carefully managed also. A rare habitat is also found on the bald summits of several of the mountains within the Hothole Block. The *Three-toothed Cinquefoil – Blueberry Low Summit Bald* natural community type (Gawler & Cutko, 2010) can be found on Flag Hill, Great Pond and Flying Moose Mountains and there may be some on Mead Mountain also.

B1h) Nearby Conservation Lands

Within the Penobscot Bay area in a radius of 35 miles are lands of the Blue Hill Heritage Trust, the Frenchman's Bay Conservancy, Maine Coast Heritage Trust, Coastal Mountains Land Trust, Holden Land Trust, Bangor Land Trust, Brewer Land Trust, Orono Land Trust, Island Heritage Land Trust, Islesboro Land Trust, Landmark Heritage Trust, North Haven Conservation Partners, Vinalhaven Land Trust.

B1i) Adjacent Properties Characteristics

The area surrounding the Hothole Block is largely forested, with some small agricultural fields on the north and northeast sides. Terrain physiography is also similar in that it is hilly with an abundance of rocks of all sizes.

B2 Setting

B2a) Historic Context

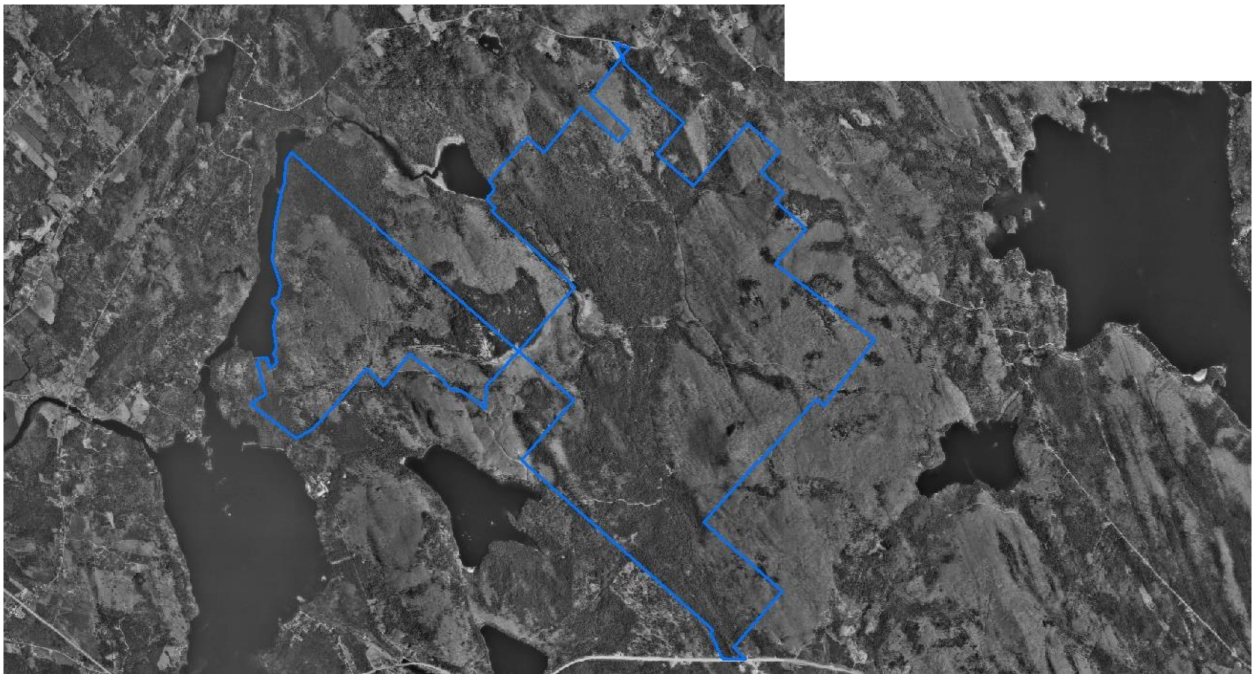
In the early history of Orland, this property remained as woodland for its primary use. Steep slopes, wet areas and the presence of rocks and large boulders throughout the Hothole Block precluded development for agriculture, with the exception of a small area adjacent to the South Gate. In this area lies an old rock cellar hole, stone walls, a barn foundation of granite slabs and a distinct plow layer in those soils within rock walls are visible. Based on old maps (1860 by Lee & Marsh and Colby's Atlas of 1881) that covered the towns in Hancock County, this area may have been the subsistence farm of one I. Thompson in 1860 and by 1881 was occupied by a Mrs. Armor.

Due to the unsuitable nature of the land now within the GPMCT boundaries for agriculture, the opportunities for generating income and useable commodities came from supplying sawtimber to a number of local sawmills either on the Dead River: (Swazey mill complex, Joseph Bray mill), at Toddy Pond outlet: (Mason's Mills); Meadow Brook: (Rufus Buck), North Orland: (Richardson Bros.), Upper Falls: (Fickett & Witham) and Lower Falls: (Hutchins). The production of White pine, Cedar, Spruce and Hemlock lumber for laths, cooperage, shingles and other products has ebbed and flowed from the early 1800's until around 1946, when mills were either bought out by the Seaboard Paper Company or declined until they were closed. During that period, it is probable that some of the fine, large Sugar maple, Oak, Birch and Beech in the GPMCT ownership area was also cut, but probably in smaller amounts. Hardwoods were desired once the brick kilns (at least 10) for the local Gross, Leach, and Hutchins brick yards were built starting from around 1869 and eventually ceased operations around the late 1940's. Mason's mills along the outlet to Toddy Pond sawed some hardwood, probably for the furniture woodworking shop. Any remaining volumes of hardwood cut during this period undoubtedly supplied wood heat for businesses and residences as well as frame stock and parts for horse-drawn vehicles, etc. (Ames and Bray, 2000)

After the Second World War, a large portion of the Hothole Block was purchased by the Diamond Match Company (later, Diamond International). This land was used to support the contractor work force during the spring mud season, since the ground dried out earlier than the company's more northerly holdings. White pine, Spruce and hardwood logs were often cut while Spruce and Fir pulpwood were supplied to Diamond's mill in Great Works (part of Old Town and not to be confused with "Great Works" an unlocated part of Orland) as well as Seaboard Paper Company (later St. Regis, Champion, International

Paper and finally, Verso). This 1960 black and white aerial photo composite shows extensive stands of conifers that are no longer as common. Darker shades indicate conifers or mixtures of conifers and hardwoods, predominantly conifers.

Figure 2 - 1960 Aerial Photo Forest Cover



After extensive heavy harvesting from about 1993 to 2005 by the immediate previous owner, the forest cover scene changed dramatically as this aerial photo mosaic in Figure 5 (below) shows clearly.

Figure 3 - 2003 Aerial Photo Forest Cover

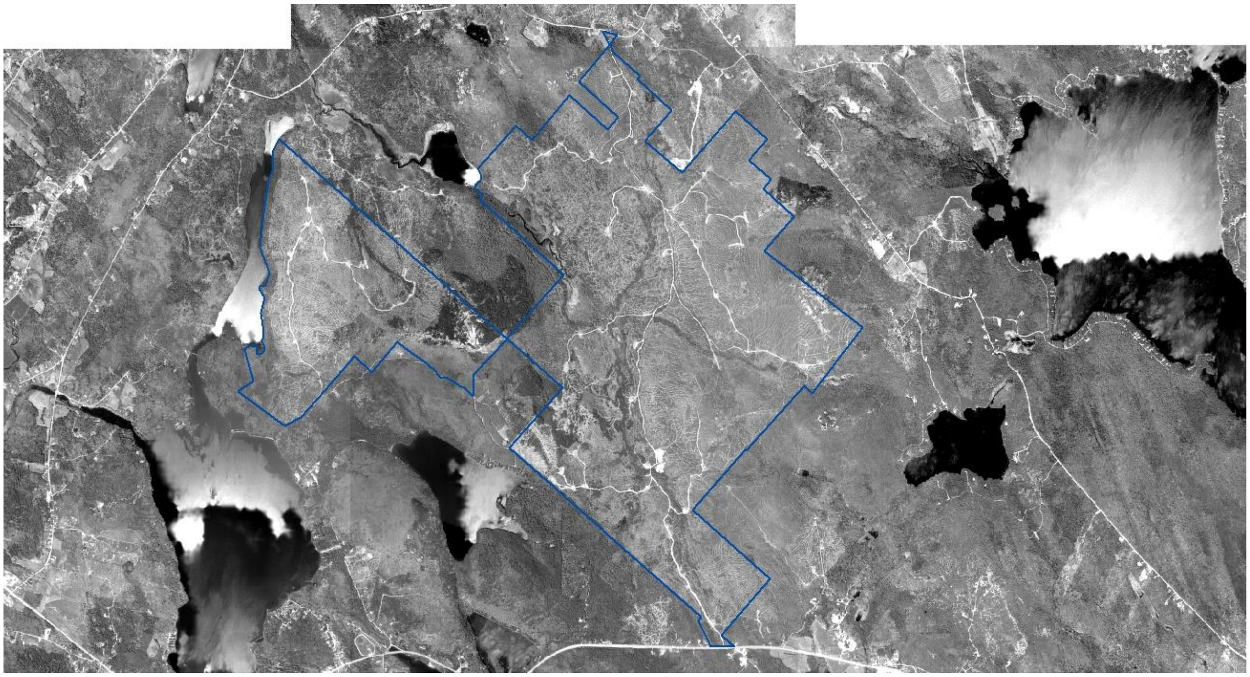
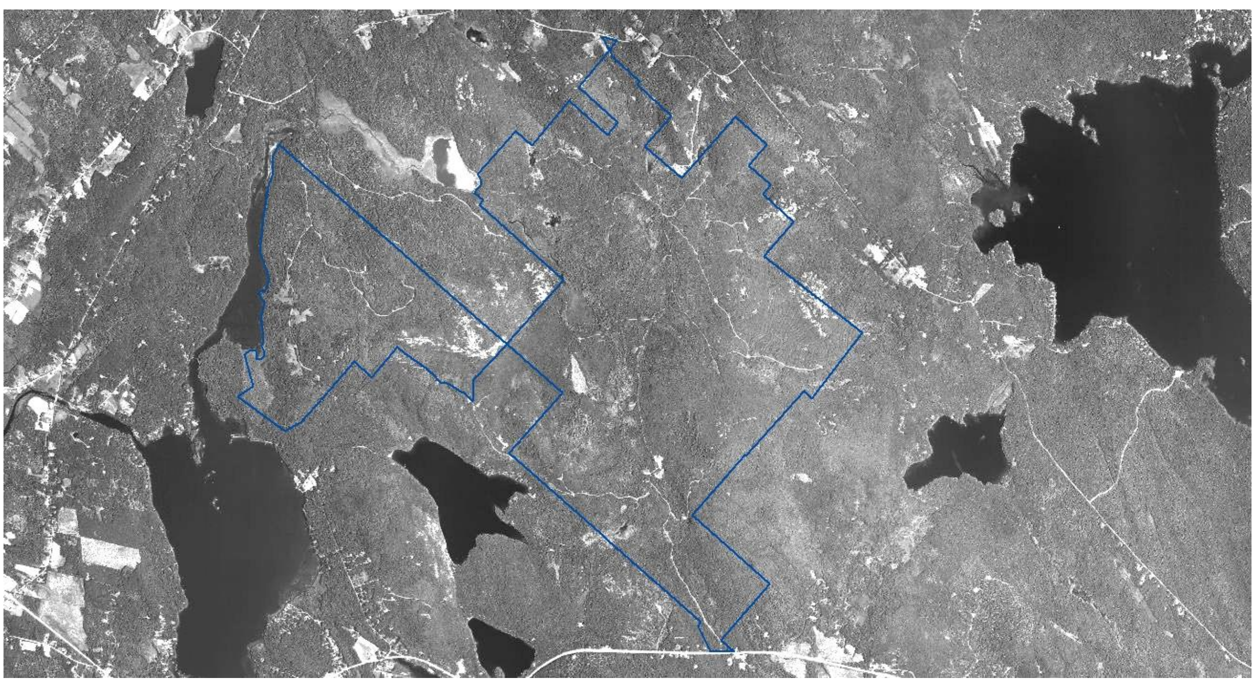


Figure 4 - 2015 Aerial Photo Forest Cover



Since 2005, the forest stands of the Hothole and Dead River Blocks have been rapidly reoccupying the nearly bare, cut-over landscape. These newly regenerated stands have closed canopies and are now between 17 and 35 years old as seen in Figure 4 (above). Older stands are those that had a more established understory of regeneration following some of Diamond's partial harvests. The heavy cutting of merchantable material by the previous owner effectively released this understory, which grew rapidly. The average age of this component is from 60 to 70 years. Scattered throughout the forested lands are older remnants of the preexisting forest. Left because the trees were too defective and larger than machinery could safely handle, these individuals generally exceed 100 years up to around 175 years. There may be some of greater age.

B2b) Cultural Importance

Jane Clifton, in her report as Appendix III in the Natural Resource Inventory (Dibble and Rees, 2006) studied two sites on the GPMCT lands. These sites, although no visible surface evidence of prehistoric occupation was found, suggested that populations of ancient Native American peoples subsisting in and around the Alamoosook Lake/Craig Pond area and very probably had campgrounds along most, if not all, of the major watercourses in the area. Dead River, Hothole Stream and its tributaries might be likely candidates.

B2c) Socioeconomic Context

The main communities within the core area of the Great Pond Mountain Conservation Trust are Bucksport, Verona and Orland. A bit further out and adjacent to the core area are Dedham, Holden, Penobscot, Surry, Ellsworth, Prospect and Orrington. Population change in the core area has changed very little according to the US Census data from the year 2000 to 2010, a scant 1.6%. In the adjacent area, however, the magnitude of the change is larger at 11.9%. On the surface it would seem that recent population trends have more impact on the surrounding adjacent area then on the core area. This may not be true, though, as the sampling of population conducted by the Census Bureau tends to confuse the results. Students from other states, borders, lodgers, servants, etc. are also included and may present a bias in the overall count. However, for our purposes the counts reported during these two periods provide the only evidence of population trends available, unless the total number of taxpayers were used from each town’s tax rolls.

In December of 2015, the paper mill in Bucksport closed permanently. From a forestry standpoint, this has had a major impact on the ability to sell poorer-quality spruce, fir and aspen pulpwood and chipped biomass for energy production within the core area. Since 2000, a total of nine pulp and paper mills have closed their doors permanently and some have been dismantled. While it is true that a few have attempted resuming production of some type with limited success, the overall market for smaller material of a number of species has been severely restricted. Employment that was among the highest paid both in the mills and in the woods as well as supporting businesses has ceased to exist for the forest resources economy of Maine in general and our core area in particular. The resource is still here (largely in various stages of regrowth), but the means to use it in support of a local economy is been greatly reduced. That is not to say that it is gone forever. As the forest resources add growth every year, they will continue to improve and if sufficient foresight is brought to bear on the problem, new and assuredly different opportunities for both improving and using the local forest resources will arise.

As part of its 2016 Strategic Initiative, the GPMCT seeks to strengthen its ties to the core and adjacent area communities by collaborating with others to improve both environmental and economic vitality and quality of space – beauty as well as bread, to paraphrase John Muir. For the Trust to achieve its goals of ownership (see Section C, page 33) it must improve its forest. To do that, poor quality growing stock must be continually removed. Unless there is a market for a large portion of this material that supports its removal to some extent, the amount of improvement will be limited. Currently, the total local market for firewood can handle some volume (perhaps 2,000 cords), but if our currently subsidized (by NRCS) removals generate an average of 3.5 cords of firewood per acre, the GPMCT lands have about 12,000 cords that need to be removed to improve the whole forested area. At our current rate of improvement by treating 60 acres per year, this would take 57 years to complete.

One idea that has surfaced is that of encouraging small to medium sized wood-using businesses (for whom local supply is a competitive advantage) in sufficient number to positively affect the local economy. Current efforts, though small, are underway to investigate the level of existing activity. Additionally, the GPMCT has stepped-up its presence in the local school systems by offering outdoor laboratory space where students may investigate real-world conditions that enhance math and science subjects like chemistry, physics, algebra, geometry, geography, history, general science, etc.

B2d) Landscape Context

The landscape in which this subject parcel is found consists of rolling hills with a mountain or two, U-shaped glacial valleys with incised slightly-meandering stream channels and numerous lakes and ponds. The land cover is principally forest, farm or open fields, small town residential areas and some light to moderate industrial areas.

B2e) Legal Context

Grant Restrictions –

In order to effect the purchase of this property, the GPMCT obtained partial funding from the Maine Land for Maine's Future program. One of the restrictions attached to this funding was that the land remain open to the public for hunting, fishing and trapping. GPMCT has fulfilled its responsibility in this regard by allowing these traditional outdoor activities as long as access is by non-motorized vehicles or on foot. Persons wishing to hunt, fish or trap on the Wildlands need to obtain an access permission slip from the Land Steward. This gives some idea of how many people use the land for these purposes.

Federal or State Regulations – [See page 23 Section B, 1, e – Restrictions on Use]

Easements, Rights-of-Way, Other Restrictions

The only known restriction on use at this time is that due to having received State funding from Land for Maine's Future, hunting, fishing and trapping must be allowed.

C: Ownership Goals & Forest Mgt. Objectives [NRCS Checklist Item 2]

C1: Vision Statement

The original forest management plan (Maier, 2007) contained a vision statement was prepared by the membership in a cooperative fashion. It presented a number of scenic vignettes that helped describe what the members would like to see. Paraphrasing this statement we can arrive at the following:

> *"We envision the restoration of a great forest of mature trees with a mix of diverse habitats for plants and animals. Many species of trees should exist in mixtures through all stages of development. We see sweeping views, clear streams, glades and small meadows. We also see carefully planned forest trails, strong, healthy and valuable trees where great solitude is found. This forest should be rehabilitated by forestry processes that are light upon the land using the best technology available. We see the use of this landscape by many people as a multi-generational involvement for educational purposes, general enjoyment through outdoor activities with a close relationship between the GPMCT and the communities it serves. We envision these lands as a flourishing, self-sustaining enterprise involving the growing and careful harvesting of forest and non-forest products in a setting where a harmonious relationship exists between the forested environment and the people that who benefit from it."*

There is also a broader long-term vision, developed from a Strategic Planning effort by the GPMCT Board of Directors. This addendum to the original vision for the Trust lands themselves, encompasses the towns in northwestern Hancock County (Bucksport, Verona Island, Orland, Dedham) and addresses the economic, community and demographic changes that have occurred. The GPMCT as part of this wider community recognized the following facts:

- Conservation and outdoor recreation positively shape people's lives, from youth to seniors.
- The region's economy and identity is closely linked with clean lakes and rivers, sustainable fishery and forest resources, farms, recreation, and diverse, abundant wildlife habitat.
- More residents and visitors are active outdoors-walking, hiking, fishing, hunting, skiing, biking, horseback riding and participating in programs and events.
- There exists a well-maintained, widely-used network of conserved lands, including recreational trails close to home, community forests, water access and large tracts of wildlife habitat like the Wildlands.

In this Vision Statement, whether in the original or abridged form above, there are a number of implicit elements that must happen to achieve this vision. The trick is to carefully craft a list of the things necessary to alter the trajectory of the development of the existing forest towards the desired forest. It begins with the explicit mission of the Trust and the definition of a set of Ownership Goals.

C2: Mission

The mission of the GPMCT is dedicated to conserving land, water and wildlife habitat not only on its own ownership, but also elsewhere (through conservation easements) for the benefit of the communities of northwestern Hancock County. The values of the GPMCT are rooted in <u>Respect for the Land</u> - its inhabitants and history; a sense of <u>Community</u> and <u>Stewardship</u> as well as the high standard of the <u>Integrity</u> necessary to succeed. Guiding principles include the following:

- ❖ CONSERVE – Working with community groups, individuals and others to identify and conserve high-priority lands in northwestern Hancock County.
- ❖ STEWARD – take exemplary care of GPMCT's conserved lands; involve partners, users and community members in stewardship.
- ❖ ENGAGE – Inspire and facilitate greater use of the outdoors, especially among students, families and seniors.
- ❖ CONNECT – Identify ways of bringing people together on and for the land and contributing to the greater Bucksport region's revitalization in a manner and scale appropriate for GPMCT.
- ❖ STRENGTHEN – Explore practical, creative ways to expand GPMCT's capacity and impact.

Viewed in its entirety, this mission is one of active, focused activity to both promote and protect sufficient landscape throughout the defined area such that whole communities of people will benefit, in perpetuity. A noble enterprise, to be sure.

C3: Purpose of Plan, Ownership Goals & Related Forest Management Objectives

C3a) Forest Management Philosophy and Purpose of Planning

A conservationist is one who is humbly aware that with each stroke he is writing his signature on the face of his land. Signatures of course differ, whether written with axe or pen, and this is as it should be." Aldo Leopold.

The prime focus of preparing a forest management plan is to establish what is important to the client, describe the current versus the desired condition of the resource and identify what needs to be done in the way of improvement. Also, a forest management plan is used to design silvicultural treatment alternatives that can achieve the desired results and where they might be applied most effectively.

My philosophy regarding a forest management plan is that such a plan should be readily understood by each client, relative to their needs. The reporting should be in narrative format for easy reading and with a glossary to help a client understand the necessary jargon of the forestry profession in an effort to be specific. Doing these things helps each client understand their forest's existing needs as they relate to their goals of ownership and how to achieve those goals. Making a plan understandable to either client or another forester provides for consistency of approach over time, whether the plan is designed for near-term or future generations. Working with those whose legacy will be the improved forest, a plan so constructed offers a better possibility that the plan will be followed and goals achieved to everyone's satisfaction.

The approach of the Great Pond Mountain Conservation Trust is a long-term one of first, rehabilitating the existing resources and then ensuring that improvement is made in the overall health, viability and productive capacity of the forest within the existing constraints of soils, climate and other environmental and economic considerations. By extending the time horizon of management actions and changing uses, the process becomes more adaptive to changing conditions that provide for more easily recognized alternatives.

While a long-term view of managing the forest is commendable, actually doing the work necessary to achieve ownership goals involves not only how to do things, but also how they are considered. Combining both elements (philosophy of ownership and an approach to managing resources): how we think about the forest and what values are applied to its management describes an ethical approach that embodies Stewardship – what we consider to be a responsible way to plan and manage all resources. Since Aldo Leopold's seminal essay, "The Land Ethic," published in 1949, where he argued that we have an ethical relationship with the environment, much has been made of "ethical approaches." While it's good to say that you have an ethical approach to what is being done, it may be better to really understand what this ethical approach really means. During the middle part of the 1990's as ethics crept more and more into land management in various sectors, a conference was held in Pennsylvania by the Pinchot Institute with the objective of determining what, specifically, was involved in the stewardship of forest resources. The result was a set of four guiding principles for resource managers known as "The Grey Towers Protocol," (Sample, 1995) named for the home of the first Chief Forester of the U. S. Forest Service - Gifford Pinchot. These stewardship principles were regarded as a moral imperative and hoped to avoid the lopsided application of forest management based solely on economic self-interest. Here they are:

I. Management activities must be within the physical and biological capabilities of the land, based upon comprehensive, up-to-date resource information and a thorough scientific understanding of the ecosystem's functioning and response.

II. The intent of management, as well as monitoring and reporting, should be making progress toward desired future resource conditions, not on achieving specific near-term resource output targets.

III. Stewardship means passing the land and resources, including intact, functioning forest ecosystems – to the next generation in better condition than they were found.

IV. Land stewardship must be more than good "scientific management;" it must be a moral imperative.

These statements of a "Land Ethic" mesh well with the GPMCT view of its forest and how it intends to manage towards achieving their vision, as contained in the section on both ownership goals and related, broad forest management objectives. Guaranteeing that, in time, the forest will become closer to the vision of the Trust members requires the use of the axe to make the adjustments necessary to fulfill each ownership goal as stated below, without permanently diminishing any of the other characteristics of other goals. Time is the essential element of the rehabilitation/improvement processes and as adjustments are made to each stand, the overall characteristics of the forest will change in a positive fashion.

C3b) Ownership Goals & Related Forest Management Objectives

Each stated ownership-level goal can be related to a broad forest management objective. These forest management objectives are directed towards general forest conditions of species mix and structure as well as specifying the things that an improved species mix and structure can help to achieve.

Ownership Goal 1:

Improve and enhance wildlife habitat diversity and provide for clean water quality.

Related General Forest Management Objectives:

Rehabilitate the existing forest from early development stages to balanced immature/mature stages of mixed species with increasing vertical strata. Maintain a continuous high-forest cover.

Move the forest through development stages in a way that seeks to balance forest habitat structures according to a stated, definitive objective distribution designed to afford increased opportunity for wildlife of all kinds to flourish.

Ensure that conditions ensuring the minimization of soil movement are met and that water flows, temperature regimes and clarity are improved whenever possible.

Ownership Goal 2:

Increase low-impact recreational opportunities.

Related General Forest Management Objective:

Identify and balance species mixtures, development and density classes with varying understories and ground vegetation to provide visual interest.

Ownership Goal 3:

Maintain scenic views.

Related General Forest Management Objective:

Design specific treatments to keep views open within defined extents by periodic treatments that provide interest within viewing area.

Ownership Goal 4:

Increase educational opportunities for individuals, schools and others.

Related General Forest Management Objective:

Design and implement a monitoring system to keep track of changes in a manner that can be used to contrast forest conditions and silvicultural treatment methods over time.

Identify areas that are representative of both the old (largely removed) and new, developing forest with its varying conditions of species composition, ground vegetation and the gradual return of mature forest conditions. Make allowances for observation and study.

Ownership Goal 5:

Increase a sustainable level of income sufficient to cover administrative costs of ownership and management. Optimize both donor revenues and costs.

<u>Related General Forest Management Objective:</u>

Improve the health and growth rate of all tree species present while producing the highest value marketable product mix from all species.

Concentrate removals on the poorest quality and vigor trees to most rapidly improve each stand's stability by allowing healthier trees to take full advantage of soil quality and growing space afforded.

Keep costs of administration and management as low as possible to perform the required tasks in an economically efficient fashion.

C4: Desired Forest Benefits, Condition and Attributes

C4a) Forest Health -

Naturally-developing cut-over forests typically suffer not only from an imbalance of more desirable species, but are also poorer in vigor with a higher risk of loss. Vigor refers to how healthy a tree is in relation to its potential for growth and development. Risk, on the other hand, refers to how long a tree is expected to be able to remain in place over time. Risk is influenced by the kind and amount of mortality-causing defects that, when present, subject a tree to an increased risk of loss. For forests developing in an untended fashion, overall productivity is lower than for healthier, tended forests. Production of high-quality trees and their associated products is limited. Healthy forests grow at the levels afforded by their growing places in the landscape and soils upon which they are rooted. Healthy trees have better roots and larger crowns and can take better advantage of the growing space. These trees are also more stable in the face of things that damage them – storms, wind, ice, snow, insects, disease, etc. Their ability to grow well allows them to adjust quickly to treatments designed to achieve ownership goals through forest management objectives.

C4b) Water Quality –

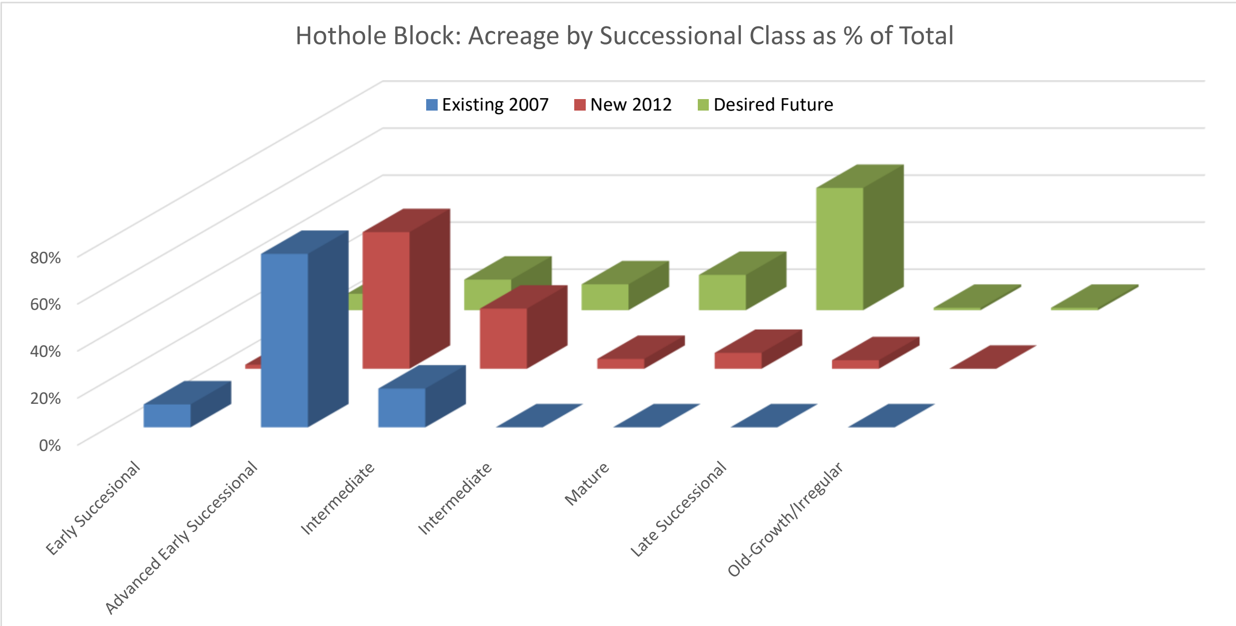
The quality of the water yield from the forest could be better, as it relies on an absence of silt entry, good oxygen aeration and a cooler temperature year-round. The continuing erosion from old forest skid trails that have channeled silty runoff into the many streams hasn't done much to improve water quality. Much has been done so far to reduce the obvious locations where runoff has been silt-laden. One example is the erosion control method used in the old gravel pit adjacent to the Valley Road. Since that time, a road maintenance plan has been put into effect where culverts have been replaced, water crossings made better and new forest access trails for machinery have cut off many of the older up/down slope skid trails. In recent years we have had some major storms that have dropped large amounts of water in a short period of time on the Wildlands. These downpours have increased erosion of old, exposed skid trails as well as culverts which were unable to carry this increased water flow. Exposure to sunlight from large openings adjacent to the narrow, regulated 75 foot stream protection zone has increased stream temperatures. Native Brook Trout, a preferred and diminishing resource, depends upon stream temperatures to stay at or below 75 degrees Fahrenheit. As stream temperatures spend more time at higher temperatures, trout habitat becomes less suitable. The limit is about 200 hours for temperatures at or above 75 degrees, where trout habitat is considered impaired. For example, in Baker Brook, where an investigation into stream conditions was made during bridge replacement work, the average time at or above 75 degrees was over 1,000 hours! Decreasing siltation, improving stream flow rate and increasing tree cover in a wider zone to improve shade will all help reverse the current situation. There is still much to be done and improvement of water quality, as well as access, will be a continuing process.

C4c) Wildlife Habitat –

The early successional habitats that were widespread when the Wildlands were purchased have grown into advanced early successional stages. Creating a balance of successional stages is being done by early, light thinning of overstories and understories through subsidies from the Natural Resource Conservation Service (NRCS), a Federal agency.

Improving growth of treated stands will help to move them into more advanced stages sooner and eventually, the Wildlands will begin to conform to the recommended percentages of land area in DeGraff et al (1992). The current distribution of habitat types is changing as shown in the figure below, along with the established structure percentages according to DeGraff et al.

Figure 5: Percentage of Hothole Block Acres by Habitat Class



Since much of the early successional habitats are being lost due to natural succession, efforts are being undertaken to create more where possible and where funding from NRCS is available. Three such areas totaling 19 acres have been created on the Dead River Block. Some existing log yards that have graduated to early successional annual weeds and grasses have been stabilized in that stage by mowing on a regular basis, principally on the Hothole Block. In addition to the recommendations by DeGraff et al, for forest areas, Aldo Leopold suggested including 10% of the area in slash and 10% in open meadows. Both of these suggestions are being addressed. As mentioned previously, some old log yards are being mowed and new habitat openings may be mowed to maintain meadow-like characteristics. The creation of some slash (limbs, tops, and in some cases whole trees) has been made in areas where crop-tree release and light thinning practices have been applied. While it appears a bit messy, the new accumulation of coarse, woody debris provides micro-habitats while slowly adding organic matter back into the soil.

C4d) Recreation –

Affording opportunities for low-impact recreation helps encourage visitors to become supporting members of the Trust. Creating a boost in members helps to provide annual financial support for both management and administration of these properties. But, how much is enough and at what point does increased recreational activity begin to have an adverse impact on the very attributes being conserved? This is a question that needs to be addressed sooner, rather than later.

C4e) Visual Qualities –

Appearance is important whether interviewing for a job or looking at a famous landscape painting. Thus it is that the appearance of the forest can either be pleasing, or not, depending upon who is doing the looking. Large drastic changes to areas, with unchanged adjacent areas present a dramatic contrast to the casual observer and often are met with revulsion – even if the dramatic change was warranted. Slow change, on the other hand, whether from untreated annual growth and development or from light, but frequent silvicultural operations can actually enhance the appearance of stands by allowing visibility to a greater depth, revealing larger trees, improving the opportunity to view wildlife, etc. As the current forest continues its rapid development towards maturity, some trees will die naturally, while others in treated stands will be cut and overall appearances will change, but not so dramatically. Viewsheds will be maintained and are good places for picture points so that over a period of time changes in the appearance of a larger portion of forest land will become more readily apparent.

C4f) Educational Outreach Opportunities –

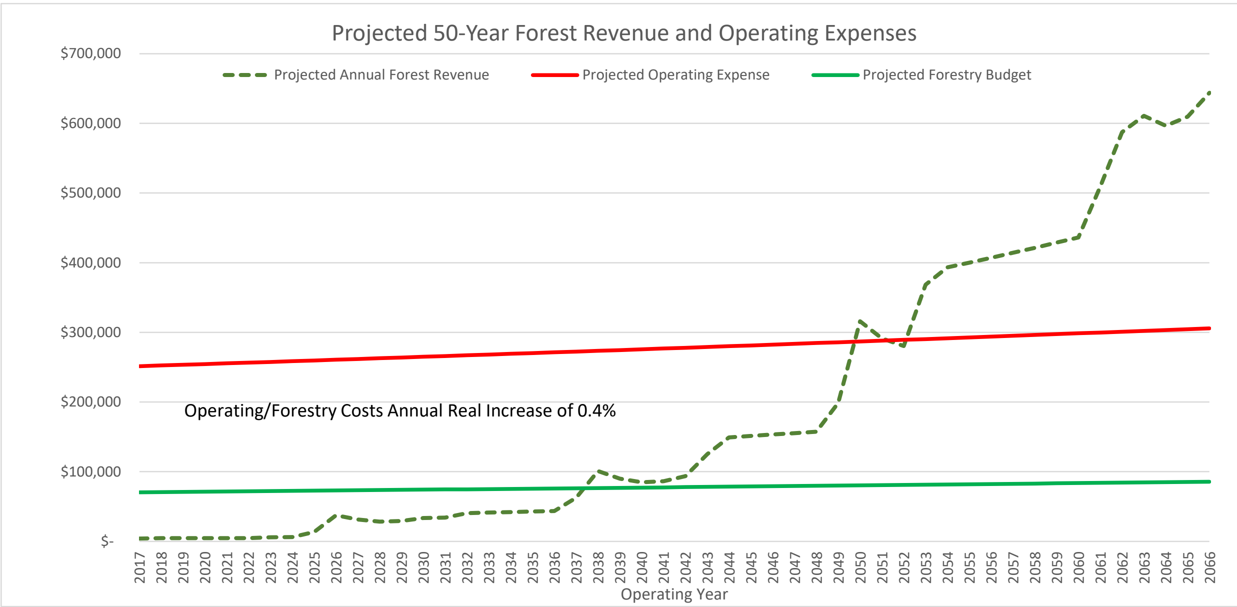
One of the GPMCT's goals is to better connect with the communities such that a greater proportion of the area's students, families and seniors may benefit from a wide variety of educational uses. Part of this strategic direction is collaboration with local schools, colleges and other land trusts. Providing access and identification of specific educational examples of the variety of conditions in the Trust landscape is a priority.

C4g) Income –

Ownership Goal 5 may be last, but certainly not least in importance. Without a financial means to support the activities necessary to achieve the goals of ownership, it is likely that those goals will not be adequately met. Generating income from a young forest is difficult, if not impossible due to the lack of saleable commodities. Even firewood is not generated in sufficient volume to be feasible to recover. This is a critical time for active silvicultural work to be undertaken, though, for improving each treated stand's ability to let better trees grow faster means that some of them will reach marketable size and quality in a shorter period of time (as much as 30 to 40 years). As many as 6 thinnings may be applied starting when a stand reaches about 30 years of age. Each of these thinnings, by removing poorer-quality trees, concentrates growth on better individuals that, over time, produce more volume and value from future treatments. Stand stability, health and resistance to changes in insect activity, disease outbreaks and changing climatic conditions are improved as well. Following current plans for thinning from 50 to 60 acres per year should begin to cover 25% of the total operating budget in approximately 23 years; 50% in 30 years and the entire operating budget in 35 to 40 years.

These estimates are based on projections of income where costs increase at 0.4% annually. As better quality sawtimber becomes a larger portion of the silvicultural removal volume, a conservative estimate of price increases in this product is set at 1.6% annually based on Maine's historical average increases in sawtimber stumpage value. Better growth response to thinning and/or larger increases in the stumpage value of sawtimber will make operating budget coverage happen sooner. Figure 6 (below) illustrates these projected results.

Figure 6: 50-Year Operating Costs & Forest Product Revenue Projections



C4h) Special Features –

There are a number of interesting features within the landscape of the Hothole Block that have been identified so far and are continuing. Such things as caves, cliffs, wetlands, large remnant trees from the original forest, geological features like eskers, vernal pools, etc. contribute to the variety of attractive elements that people like to see. All these are valuable to educational endeavors, too.

C4i) Range of Uses –

Right now, visitors use the forest of the Hothole Block for hiking, cross-country skiing, biking, horseback riding, running, strolling, star gazing, camping on the two campsites, birdwatching, wildlife viewing, photography, solace and quiet contemplation, hunting, fishing, trapping, exercising, as well as participating in programs and events held on this area. It is expected that the existing uses will increase and that new uses will be proposed – each will need to be addressed in planning for the future. One of these is the growing, culturing (minimal) and sale of Christmas trees and greens.

C4j) Ecological Issues –

Among ecological issues that need to be resolved are the following:

* Improvements to fish passage where water crossings occur.
* Storm drainage improvements from correct culvert sizing, placement and installation.
* Improving vegetative cover along streams where it is insufficient.
* Reducing the amount of diseased beech found in northern hardwood and stands of mixed species.
* Determining how the effects of long-term changes to local climate might affect our resources.
* Understanding how much effort is needed to maintain the existing foot-trail network for existing and anticipated traffic.

C5: Sustainability of Desired Forest Elements/Conditions

Based on the definition of the term in several dictionary sources, the general meaning is “the capacity to endure.” This use of “sustainability” is meaningless without specifying what is to be sustained. For the purposes of a forest management plan here are some things to sustain that relate directly to plans.

- Continuous forest cover.
- Diverse habitats.
- The capacity to produce clean water.
- The capacity to generate a continuous income at some level.
- The capacity to provide support to the economy of the core communities.
- The capacity to offer educational and recreational opportunities of various kinds at various levels.
- The capacity to provide additional benefits: aesthetics, spring flowers, scenic views, etc. throughout the forested area.
- The ability to provide continuity in the GPMCT ownership and direction.

Once upon a time, sustainability as related to forests meant stability of the soil – the producing medium of all forests with their wide array of components. In the early 1900’s, this concept of sustainability shifted to the continuous yield of forest products as a principal goal, along with other forest elements. This was misconstrued as meaning that “sustained-yield” meant that other forest benefits were to be excluded or reduced from primary consideration to an afterthought. This was not true in the classical definition of sustained-yield (which implicitly included all the other types of benefits) in concept, but not always in practice. For example, a forest could be considered "sustainable" if it were clearcut every 90 years, as long as it was allowed to recover naturally. This was mining, not management of a resource.

Now, however, the definition of sustainability applied to all things that forests produce, regardless of the interests of a single beneficiary, i.e., some people like birds, some bears, some mushrooms. Each interest can be satisfied by managing the entire ecosystem as a whole. Hence, we have the term "sustainable ecosystem management" which encompasses all the goals of the GPMCT, stated or implicit. The key thing to remember is that a single use should not diminish other uses. It must also be realized that as forest conditions change from improvements, the place where vegetative things of interest are found will shift from their original location across other places in the forest.

Of those in the list above, perhaps the most difficult one to ensure is that of continuity in ownership and direction. Over a long period of time, directors, membership and managers will change and in a few cases on record, land trusts have simply dissolved and the land was sold because of an inability to maintain the level of effort needed to manage for the long-term. So, the stated goals and how to achieve them needs to be sustainable, too.

D: Forest Assessment – Existing Conditions [NRCS Checklist Item 3]

This is the first step in managing a forested area – understanding what the existing conditions really are, then making a plan to develop means to accomplish the objectives of ownership with the techniques, methods and procedures of forest management. Many components of a forest need to be examined in some detail as they will undoubtedly be affected by how management actions are applied (they are individually detailed below, in items 1 through 12). A landscape-level view of the current forest is desirable to take a hard look at what we have to adjust and how difficult it might be in some respects. It's like a look in the mirror that reflects everything back to the viewer, the good, the bad and the ugly!

The forest land of GPMCT has resulted from heavy, exploitive harvesting and has created a new forest of mixed species that is between 17 and 35 years old. This is a dense, <u>Evenaged</u> forest where the range of stand ages is narrow and conditions are very similar, except for the mix of species. A review of both the land cover mapping and forest inventory data compiled as the State of the GPMCT Forest report (Greene, 2015) has revealed the following salient characteristics of the existing forest on both the Hothole and Dead River Blocks:

- The forest is composed largely of hardwood or mixed hardwood/conifer species (83% of the forest area).
- 54% of the trees are Beech, White birch or Striped maple.
- Of the above, Beech accounts for nearly 24% of the total trees.
- Species of high value only account for 16.5% of the total trees.
- Short-lived species account for nearly 39% of the total trees.
- Only 0.35% of the trees are larger than 5 inches in diameter, just barely saleable for pulpwood or firewood.
- The trees are mostly sapling (1 inch to 4.5 inches) to small pole size (<9.5 inches in diameter).
- Only 22% of the trees are of Acceptable Growing Stock (AGS) suitable for long-term growth.
- 32% of the trees have no commercial value (Culls).

This seems pretty depressing that we have a small, poor-quality forest that doesn't have much value – either for future growing stock or larger trees. However, it's understandable when we consider how this forest was managed (or not) by many previous owners. In each case, the more valuable species of larger size and high-quality were removed in variable amounts that reflected market demand and preferences at the time. Still, there is a light at the end of the tunnel…and it's not an oncoming train.

One item we have in our favor is that our soils, while not of top agricultural quality, are good growing sites for trees (covered in detail in Section D3, page 47). The second is that we have abundant moisture that favors a diverse mix of species and provides good opportunities regenerating new trees, when it's required. In addition, large gains in quality, health and habitat diversity are possible by designing a series of treatments that provide for rehabilitation of this degraded forest. It is with this in mind that we undertake an active, rather than passive approach – Conservation rather than Preservation.

D1: Property Boundaries

The exterior perimeter boundaries of the GPMCT total ownership contains 21.3 miles of boundary line that must be maintained. Locating and renewal efforts began in July of 2011. Thus far, on the Hothole Block, 11.7 miles have been cleared of brush, re-blazed and painted – amounting to 55% of the total boundary perimeter on this block. See Appendix A, page 127 for a map showing boundary renewal progress.

A boundary maintenance plan aims to renew all perimeter boundaries every 10 years, which amounts to efforts of slightly more than 2 miles to complete every year. As of this plan date, we are on schedule to complete the maintenance activities for the entire boundary perimeter by 2021.

After much initial field examination of the perimeter lines, it was estimated that maintenance work had not been carried out for a period ranging from 50 to 90 or more years. Evidence of old paint, corner monuments and blazes was obscured, obliterated in some segments, and difficult to locate in the remainder. Where large segments of some lines were completely obliterated, those segments were reflagged by a Registered Land Surveyor, then renewed immediately. Most corner monuments are iron rods, rebar or pipe. There are some, though, that were hewn wooden posts. Those have almost completely disappeared. There are a total of 64 corner monuments, either marking GPMCT corners or corners of intersecting, adjacent lots. Around 54 of these corners are GPMCT ownership monuments and these must be maintained. When the boundary survey (Plisga and Day, 2007) was completed the type of corner monuments found as evidence of ownership were indicated on a large-scale map. Fifteen of these were wooden posts or blazed trees. Most of these have deteriorated to the point that they are unrecognizable. As encountered, new sawn cedar posts will be set into the center of old supporting stone rings still evident.

Work on renewing boundary lines has been done completely with a volunteer work force of some 26 people. Regular work sessions on particular line segments are held, with anywhere between 3 to 6 people making up the line crew for that day. It is a credit to the enthusiasm of the GPMCT members who have taken a personal interest in these lands that fully one-half of all the lines have been renewed in a four-year period (no line work was done in 2015).

D2: Topography & Morphology

From a landscape perspective, the rolling hills and mountains of the Hothole Block constitute a typical post-glacial, eroded profile. Originally part of the ancient European continent (everything southeast of Orrington), elevation above mean sea-level runs from 21 feet on the Dead River to 1036 feet at the summit of Great Pond Mountain. At the lower reaches, the valley runs generally southeasterly from the confluence of Moosehorn Stream and Hothole Pond outlet (Hothole Stream) along the upper portion of Hothole Brook and its tributaries.

The Hothole Block is surrounded on all sides by (clockwise from Great Pond Mountain): Hothole Mountain, Condon Hill, Hedgehog Hill, Flying Moose

Mountain, Flag Hill, Oak Hill and an unnamed hill between Craig and Heart Ponds, whose easterly ridge runs across to connect with Oak Hill.

Within the boundaries of the Hothole Block are upper slopes that contain scoured granite bedrock with a patchy, thin layer of organic matter that supports shrubs and some conifers, except where bare. Upper slopes contain mixtures of glacial till – the unsorted deposits of various-sized (house-size boulders to small pebbles) ground up rock fragments. Soil depths vary, but are generally shallow (less than 18 inches deep). Lower slopes contain more glacial debris that includes various kinds of till, but also deposits that are the direct result of the rapidly-melting of the retreating glacier from about 14, 000 years ago. These mostly gravel soils occur in kames, eskers and drumlins of small size. The lower regions and flats of the Hothole Valley consist of soils that originated from ocean sediments overtopped with ground moraine material deposited during glacial retreat. There are also areas where large boulders collected during glacial melting, with some that are quite large and high. Also, dissection of the hillsides due to rainfall and winter snowmelt moved large quantities of soil from the upper reaches in a leveling action that accumulated on the lower slopes. Continued erosion over the eons created the network of deeply-incised perennial steam tributaries like Baker, Cascade, Hillside and a few unnamed brooks that we have today. Hothole Pond, with only a small portion abutting the GPMCT ownership, is a kettlehole pond formed when a large block of glacial ice broke away from the retreating glacier and melted in place.

Topography is generally rolling/sloping and only exceeds 25% on the steeper upper slopes of the hills and mountains. There are some relatively flat areas along the Valley Road, but most of these are elevated to some degree and not at the lowest point.

D3: Soils and Sites

The 24 kinds of soil present on the Hothole Block constitute 28% of the total soils found in Hancock County. Most of the better soils in Hancock County are found in areas that are currently tilled or fallow for agricultural uses. Woodland soils, on the other hand, usually have some limitations that precluded their use for growing crops. Some are wet, most are very rocky and a good number of them are found on slopes too steep to be farmed. While most soils are of the woodland capability class, there are some small areas of what NRCS terms "Prime Farmland" that consist of the Colton-Adams-Sheepscot association or Tunbridge-Lyman-Marlow complex soils. These soils are typically found adjacent to the Valley Road, but there are two or three spots away from the main road where these soils can be found (see Prime Farmland map in Appendix A, page 127).

To better understand the capabilities of our woodland soils, a Soil/Site Productivity classification (Soil/SitePro™) was applied (Greene, 1997 and 2003). Other site classification systems have been in use for some time, but have usually been tailored to either specific species or species groups and sometimes to geographic regions (Briggs, 1994; Belli & Hodges, 1998; Baker & Broadfoot, 1979; Jones & Saviello, 1991).

The Soil/SitePro™ system used readily available soil characteristic data from the Natural Resource Conservation Service's most recent National Soil Survey. Data on suitability for a number of purposes, engineering, forestry, agricultural, waste disposal and development uses as well as physical and chemical properties have been compiled into a relational database. Supplementing this tabular data are mapped soil polygons that have been identified in the field and from large-scale aerial photographs for each county in the United States. These mapped soil features have been compiled as Geographic Information Systems (GIS) files. Combining many kinds of ancillary data, this spatial and tabular information can be utilized in a number of ways, one of which is the Soil/SitePro™ application. This approach was developed to supply several forestry landowners with specific, easy to use information to identify areas where the capability of the soil to grow trees can be found and linked to a variety of forest information like tree cover classes, growth and yield, product production capabilities and wildlife habitat suitability.

Those variables that contribute most to tree growth and development, regardless of species are those that have been found of greatest influence to soil value as a growing medium, moisture and nutrient availability as well as the degree of aeration for tree roots. Following are the soil characteristics variables used in the system:

- **Soil texture** class in the B-horizon (the rooting area). Mixtures of sand, silt and clay particles, along with rock fragments of various sizes form specific textures. Texture impacts root penetration, moisture and nutrient availability.
- **Topsoil depth –** This is the upper layer of soil, right beneath the organic pad, where nutrients from decomposed organic matter begin to accumulate.
- **Rooting depth**
- Presence and influence of impermeable layers (**fragipan**)
- Percent of **organic matter** by weight found in the rooting zone.

- ❖ Degree of **stoniness** for stones from 3 to greater than 10 inches.
- ❖ **Drainage** class for the rooting zone.
- ❖ **Water table depth** (average seasonal)

In addition to the above physical characteristics are several important physiographic characteristics. These relate to where the soil is found on the landscape, since an individual soil type may offer better or worse capability for tree-growing depending on where it is found. The physiographic variables are:

- ❖ **Aspect** direction – *a range of azimuths that show which way a slope is facing. Aspect affects soil and tree crown temperature, directly impacting microbial activity, transpiration, rates of photosynthesis and exposure to prevailing winds. Northerly-facing slopes are generally more favorable sites, while southerly-facing slopes are warmer and more exposed to drying from winds.*

- ❖ **Slope percentage** rise – *degree of slope in rise versus run. For example, a 45 degree slope angle yields a percentage of 100, since the rise and run of the slope are equal. Steeper slopes shed moisture more quickly and if their aspect is southerly, they will be drier sites of generally poorer quality.*

- ❖ **Slope shape** – *combinations of planform (across the face of a slope) shape (convex or concave) and profile (shape of slope in an up/down direction of the gradient). Convex sites generally have more exposure to wind and solar radiation. They also tend to shed water more rapidly, resulting in lower productivity. Concave sites, on the other hand, are more protected and drain less rapidly. These sites tend to accumulate nutrients and are more productive.*

- ❖ **Slope position** – this is a site's relative location along a line from a ridgetop or plateau to a local drainage (stream, intermittent stream or concave cove). Environmental conditions are more severe on ridgetops and upper slopes and moderate as one moves down to mid and lower slope positions.

Each of these variables has a scored value across the range of conditions found. These scores are summed for all variables and spread across a maximum possible range of 0 to 100. The results are grouped into 5 classes of tree-growing potential:

Excellent – 81 to 100 points

Good – 61 to 80 points

Fair – 41 to 60 points

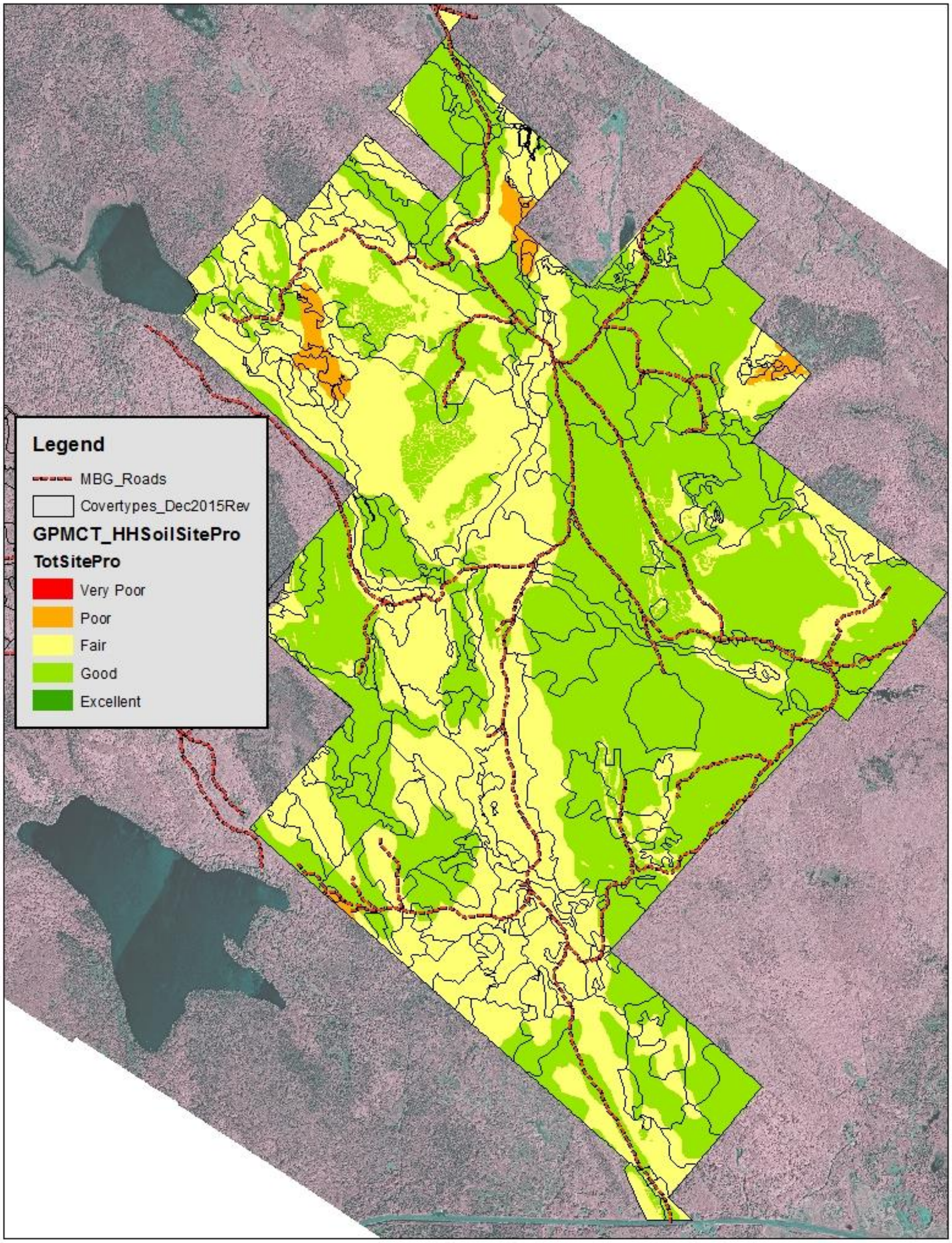
Poor – 21 to 40 points

Very Poor – 0 to 20 points

The use of 5 classes provides a rating that is more easily understood and related to the measured variables representing tree, stand and forest productivity. Use of this system can help schedule silvicultural treatments by avoiding areas adversely impacted by weather events, relate monitored stand conditions to growing sites, evaluate rates of change to the forest based on the those key elements that define how a forest can be influenced over time - Site, Cover Type, Age/Development, Silvicultural Regime.

The rating and location of each of these Soil/Site Productivity classes is colored on maps where Red = Very Poor; Orange = Poor; Yellow = Fair; Light green = Good and Darker green = Excellent. Below is a map for the Hothole block showing the distribution of Soil/Site Pro areas with superimposed forest stand polygons.

Figure 7 - Soil/Site Productivity for the Hothole Block



For informational purposes, the list of soil types present, their Soil/SitePro™ growing quality score and percent of area are shown in the table below.

Table 5 - List of Soil Types, Score & Area on Hothole Block

MUSYM	Soil Name	Soil/SitePro	Acres
BgB	Brayton fine sandy loam, 0 to 8 percent slopes, very stony	51	8.00
BSB	Brayton-Colonel association, gently sloping, very stony	52	315.00
BTB	Brayton-Colonel association, gently sloping, rubbly	53	205.00
Ch	Charles silt loam	71	65.00
CRE	Colton-Adams association, steep	46	63.00
CSC	Colton-Adams-Sheepscot association, strongly sloping	54	236.00
DbC	Dixfield fine sandy loam, 8 to 15 percent slopes, very stony	63	1.00
DsB	Dixfield-Colonel complex, 3 to 8 percent slopes	64	6.00
DtB	Dixfield-Colonel complex, 3 to 8 percent slopes, very stony	58	13.00
KW	Kinsman-Wonsqueak association	51	77.00
LCB	Lamoine-Scantic-Buxton association, gently sloping	55	80.00
LTE	Lyman-Schoodic-Rock outcrop complex, very hilly, very stony	46	237.00
LWC	Lyman-Tunbridge-Schoodic complex, rolling, very stony	61	302.00
MbE	Marlow fine sandy loam, 15 to 45 percent slopes, very stony	64	1.00
MDC	Marlow-Dixfield association, strongly sloping, very stony	65	1028.00
MDE	Marlow-Dixfield association, steep, very stony	64	481.00
MGC	Marlow-Dixfield association, strongly sloping, extremely bouldery	62	45.00
MGE	Marlow-Dixfield association, steep, extremely bouldery	59	117.00
MXC	Monadnock-Hermon-Dixfield complex, rolling, extremely bouldery	61	274.00
MXE	Monadnock-Hermon-Dixfield complex, very hilly, extremely bouldery	61	35.00
SGE	Schoodic-Rock outcrop-Lyman complex, very steep	44	41.00
SKC	Schoodic-Rock outcrop-Naskeag complex, rolling	30	1.00
TWC	Tunbridge-Lyman-Marlow complex, strongly sloping	67	154.00
WT	Wonsqueak, Bucksport, and Sebago soils	27	40.00

D4: Existing Forest Conditions

While the general condition of both the Dead River and Hothole Blocks was covered earlier in this section, this part deals with the Hothole Block forest conditions in more detail.

D4a) Forest Stands & Strata (Overview)

The basic units of management focus for forests are called stands. These are polygon-shaped areas with similar species mix, stage of development and density of crown cover. They range in size from about 5 acres to several hundred and reflect forest development since the most recent disturbance (natural or man-made). The same analytical processes that apply to stands may also apply, in a more general sense, to entire forests. The Hothole Block contains 233 individual forest stands that range in size from 0.2 to 304 acres. The largest (Stand 206) is a high-density sapling to small pole-size northern hardwood stand composed of a mix of tolerant species with a high component of Beech. It is typical of many stands in this portion of the ownership. The smallest (Stand 18) occupies just under a quarter-acre and is found along the edge of the boundary with the Boyle lot on the northwest portion of the block. This small stand is a moderate-density tolerant-hardwood stand of small to medium sawtimber with a high proportion of Red oak. Stands of this type are not too common on the Hothole Block and are found only in areas that were inaccessible during the last major harvesting operation conducted by the previous owner.

While individual stands are an efficient way to recognize sometimes subtle differences and account for them in designing improvement treatments, taken as a whole, they appear to represent a crazy quilt of different things. Summarization into groups of similar general character offers the opportunity to view the forest area in a more understandable manner. It also allows the process of conducting a forest inventory to be done in a cost-effective way by reducing the number of elements to consider when preparing a strategy to meet the objectives of a landowner. These groups are called "strata" and the process of organizing the many individual stands into more general groups is called "*stratification.*"

The various forest cover types were organized for the inventory sampling into strata according to their **general forest cover** [*Spruce/Fir; Pine/Hemlock; Lowland Conifer; Tolerant Hardwood and Intolerant Hardwood*], **stage of development** [*Seedlings; Saplings; Poles and Sawtimber*] and **broad density classes** *[Low to Moderate and Moderate to High].* The number of samples required for an accurate assessment of each stratum could be held to a number that was reasonable to complete in a single growing season and within a reasonable budget. The stratification, resulted in 136 possible strata, of which, each of the 26 present received a share of the 496 samples in the Hothole Block. From the 2012 Cover Type Mapping and the 2014 Forest Inventory, a picture of the Hothole Block's existing condition can be derived. The following information is based on summarizations of both sources. This data provides a baseline description of the Hothole Block that can be compared against measured changes as the forest moves forward. A table showing which strata are present within the range of development classes which were sampled during the 2014 inventory follows.

Table 6 - Broad Strata, Density & Sampled Development Classes

						Count of
	Average		***Development Class***			Density by
STRATUM Description	**Density**	Sapling	Poles	Sawtimber		Stratum
Spruce-Fir	Moderate-High	☑				1
Spruce-Fir	Low to Moderate					0
Spruce-Fir/Pine-Hemlock	Moderate-High					0
Spruce-Fir/Pine-Hemlock	Low to Moderate					0
Spruce-Fir/Lowland Conifers	Moderate-High					0
Spruce-Fir/Lowland Conifers	Low to Moderate	☑	☑	☑		3
Spruce-Fir/Mixed Hwds	Moderate-High	☑	☑			2
Spruce-Fir/Mixed Hwds	Low to Moderate					0
Pine-Hemlock	Moderate-High					0
Pine-Hemlock	Low to Moderate					0
Pine-Hemlock/Mixed Conifers	Moderate-High					0
Pine-Hemlock/Mixed Conifers	Low to Moderate					0
Pine-Hemlock/Lowland Conifers	Moderate-High					0
Pine-Hemlock/Lowland Conifers	Low to Moderate					0
Pine-Hemlock/Mixed Hwds	Moderate-High			☑		1
Pine-Hemlock/Mixed Hwds	Low to Moderate		☑			1
Lowland Conifers	Moderate-High					0
Lowland Conifers	Low to Moderate					0
Lowland Conifers/Mixed Conifers	Moderate-High					0
Lowland Conifers/Mixed Conifers	Low to Moderate					0
Lowland Conifers/Mixed Hwds	Moderate-High					0
Lowland Conifers/Mixed Hwds	Low to Moderate					0
Tolerant Hwds	Moderate-High	☑	☑			2
Tolerant Hwds	Low to Moderate		☑	☑		2
Tolerant Hwds/Mixed Conifers	Moderate-High	☑	☑	☑		3
Tolerant Hwds/Mixed Conifers	Low to Moderate	☑	☑	☑		3
Tolerant Hwds/Intolerant Hwds	Moderate-High	☑				1
Tolerant Hwds/Intolerant Hwds	Low to Moderate		☑			1
Intolerant Hwds	Moderate-High					0
Intolerant Hwds	Low to Moderate					0
Intolerant Hwds/Mixed Confiers	Moderate-High	☑				1
Intolerant Hwds/Mixed Confiers	Low to Moderate		☑			1
Intolerant Hwds/Tolerant Hwds	Moderate-High	☑	☑			2
Intolerant Hwds/Tolerant Hwds	Low to Moderate		☑	☑		2
Count of Strata by Development Class:		9	11	6		26

The representation of the 136 possible strata on the Hothole Block reveals several salient points. The first, is that strata in the sawtimber class are not widely represented, which indicates that this is a younger, but developing forest. The fact that it is in a younger, developing condition is seen from the number of strata represented in both the sapling and pole classes, which account for 77% of the total strata present. If we look at the number of strata found by broad species groups (Spruce-Fir, Pine-Hemlock, Lowland Conifers, Tolerant and Intolerant Hardwoods), we can see that the most abundant species group is Tolerant Hardwood, followed by both Intolerant Hardwood and Spruce-fir, equally. The least present broad species groups are the Pines and Hemlock and Lowland conifers like Northern white cedar and Tamarack. Seedling-size classes (under 4 feet in total height), although not sampled until they reach sapling size, are present, but rapid development into the sapling class have only left 58 acres still classed as seedlings. Most are of moderate to high density.

D4b) Species Composition & Structure

Twenty-five commercial tree species were found during the inventory on the Hothole Block. That's almost 60% of the tree species found in Maine. There are a few that escaped detection by the inventory sampling, though. Basswood is the most notable exception, but is so scarce that the chances of having one occur on an inventory plot was extremely rare. The same is true of tamarack (Eastern larch). Both of these species are present, but pretty scarce – either due to the places they are found being small, or resulting from removal. Where possible, efforts at increasing their representation on suitable sites should be made.

Species composition may be represented in several ways: numbers of trees by species or as a percent of the total number. The percent of all species method clearly shows which species have a large share, but only as trees per acre. The following pie charts show conifer and hardwood species separately. Overall, though, hardwood species comprise 80% of the total number of trees.

Figure 8 - Conifer Trees/Acre by Species as % of Total Conifers

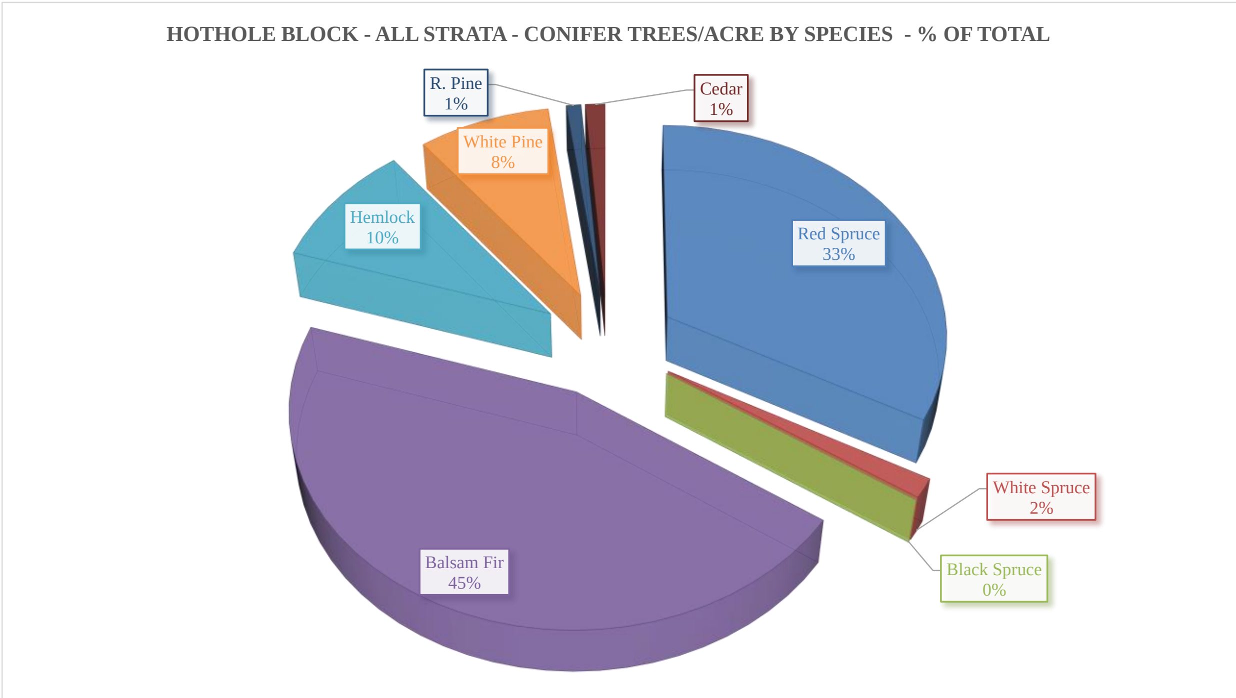
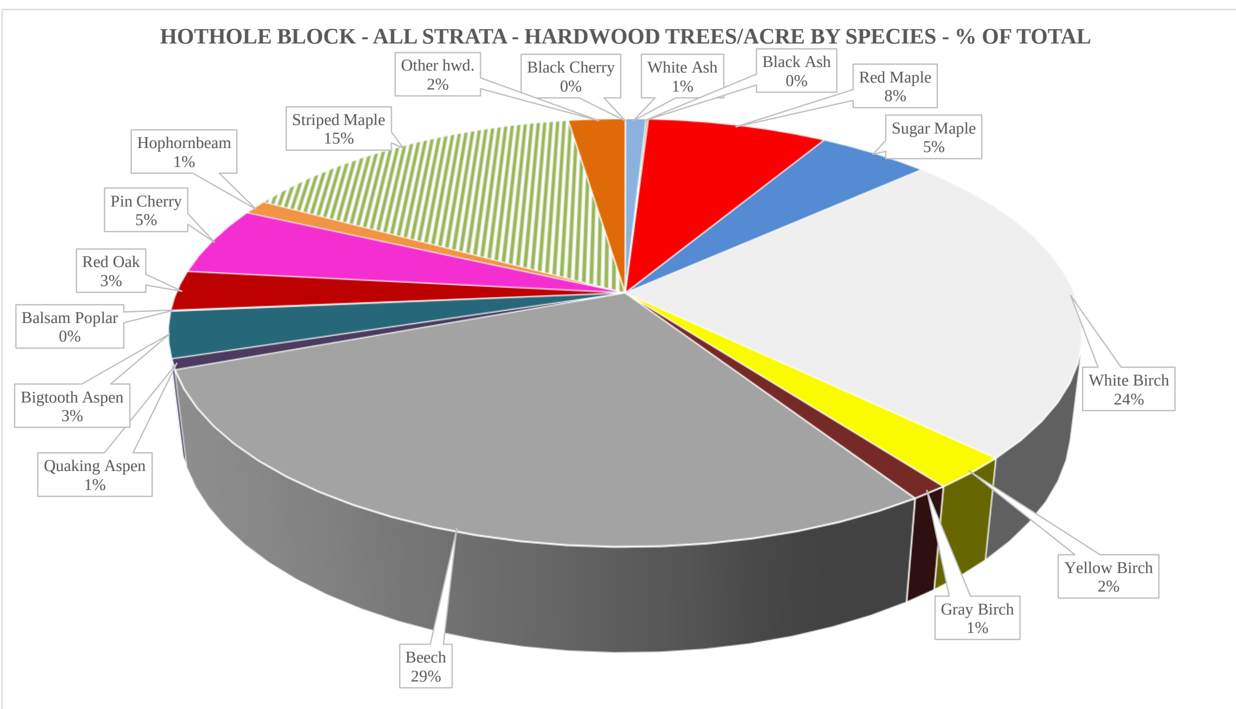


Figure 9 - Hardwood Trees/Acre by Species as % of Total Hardwoods



If we look at all those species that make up more than 5% of the number of trees per acre within their broad species group, we have the following most predominant species in order from most to least:

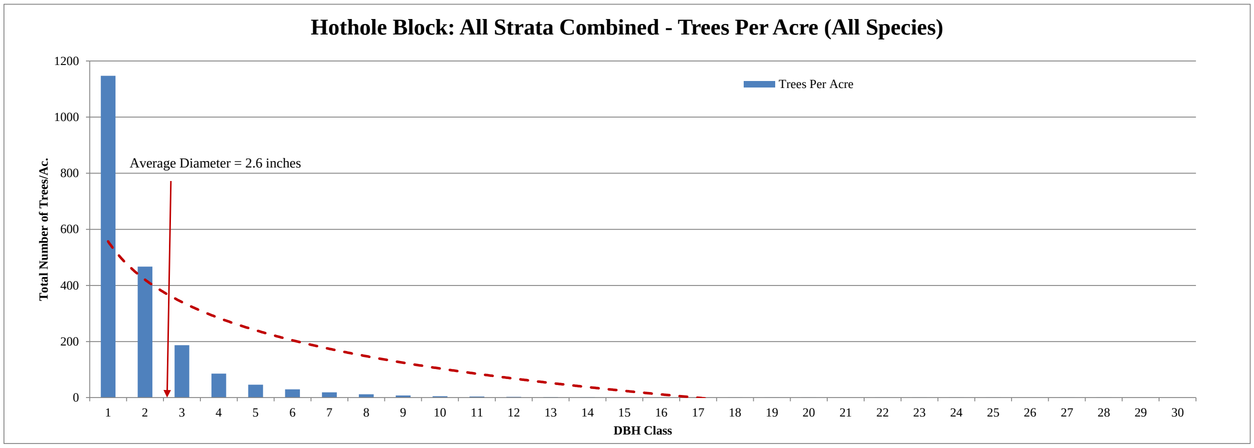
- Beech
- White birch
- Striped maple
- Balsam fir
- Red spruce
- Red maple

Together, these species make up slightly more than 75% of the total number of trees of all species on the Hothole Block. In terms of long life, only Beech and Red spruce can live longer than 200 years, if healthy. The others have biologically shorter life spans with Red maple at about 150 years, White birch and Balsam fir at about 80 years and Striped maple may reach 100, but is usually gone after about 60 years.

The structure of the forest on the Hothole Block is largely evenaged. That means that the trees in any given stand (regardless of species, except for Beech) are probably within ±20 years of age from each other. Evenaged stands move together through time and development stages from seedlings to mature trees. The heavy cutting by the previous owner of the Hothole Block created conditions that allowed almost all stands to reproduce and start over in their life cycle. These stands range from about 20 to 35 years of age, the difference being due to when they were last heavily harvested by whichever owner at the time.

Evenaged stands go through several growth phases as some trees die and some get larger in size. Initially, there are high numbers of trees in the smaller diameter classes with sharply reducing numbers in larger classes. A curve plotting number of trees in each succeeding larger diameter class will show a reduction in numbers of trees per acre. Younger stands will show a steeper curve with fewer diameter classes being occupied. As evenaged stands mature the shape of the curve becomes more bell-shaped as the average tree size increases. The curve then flattens out a bit when stands become more mature and older. So, being able to recognize stand (and forest) development from actual field data is important towards understanding the current phase of development. From the 2014 forest inventory, the shape of the distribution of diameter classes is shown below.

Figure 10 - Hothole Block Diameter Distribution



This chart shows the number of trees per acre by diameter class as vertical bars. The dashed red line follows a negative logarithmic form fit to the range of all diameters from 1 to 30 inches. This is a very wide range and it includes all trees in all stands sampled during the inventory. So, some stands have larger trees (especially in riparian areas where large Hemlock were left). The curve would be steeper if we only considered diameter classes up to 12 inches.

This type of structure (range of tree sizes) is called horizontal structure and depending on the range of diameters within stands of a whole forest offers an opportunity of describing how diverse it may be. Complexity of horizontal structure can be found by statistical analysis of all sized trees measured during inventory sampling. More on this subject may be found in the State of the Forest report for 2014 (Greene, 2015) included in Appendix B, page 128.

Another kind of forest structure is a vertical one. This refers to the height and levels of foliar crowns of the trees within a stand or forest. Since smaller trees are generally shorter, the mix of smaller and larger trees offers more opportunity for wildlife habitat as more “crown depth” is available. In the developing, young forest of the Hothole Block, there are one or two layers.

D4c) Stocking Level & Quality of Growing Stock

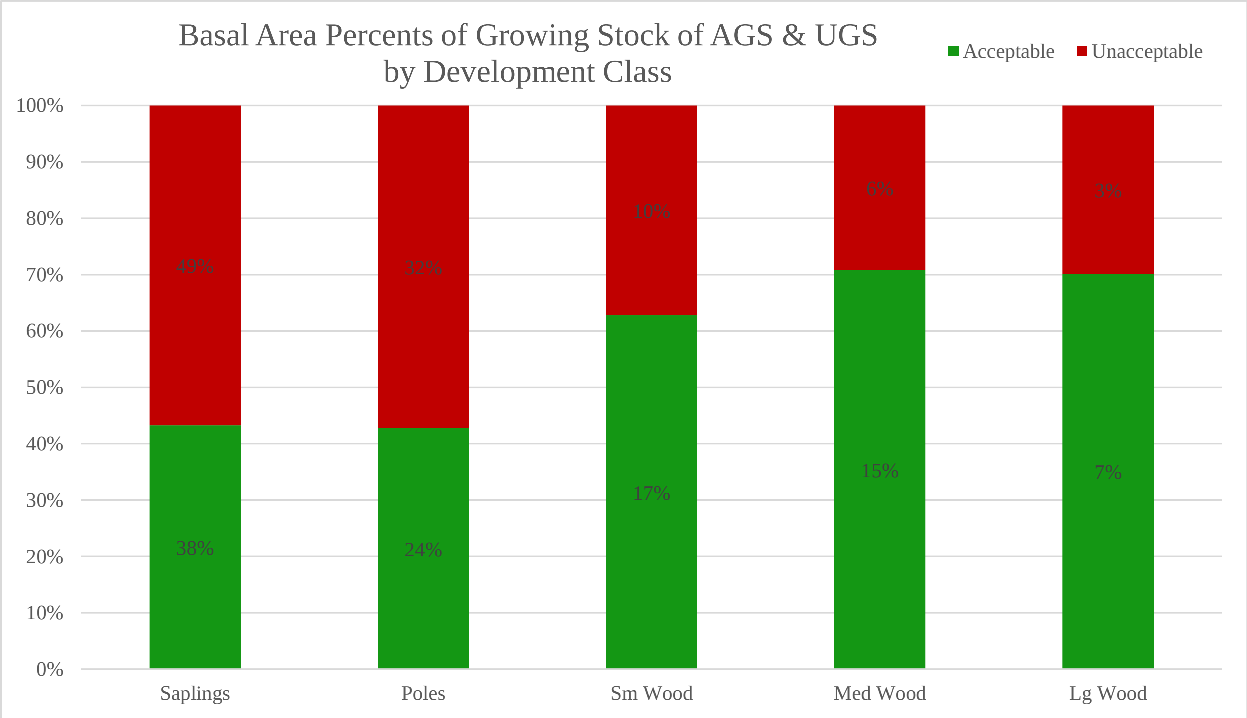
Stocking refers to the amount of tree material present compared to some amount considered normal (or optimum) for a forest of given species mix, age, soil, etc. related to a unit of area. Generally, it refers to an amount in terms of numbers of trees, volume of wood, density of crown area or basal area per acre. If we speak about the number of trees per acre for the Hothole Block, that value would be 2,018. If the volume of wood of all species and products is the preferred value, then it would be presented in units per acre of whatever measurement was appropriate (cubic feet, board feet, cords, cunits, etc.). So, if the average number of merchantable cubic feet were the desired value, then, the Hothole Block would contain an average of 679 cubic feet of merchantable wood per acre, about 8 cords.

Another way of measuring stocking is by basal area, mentioned previously. Basal area refers to the average cross-sectional area of each tree measured at a point 4.5 feet above ground level. The value for each tree is summed to derive a total basal area per acre. Basal area has been found to be an easy to derive, useful measure since it relates very closely to other values like volume, tree height, etc. Usually expressed in square feet per acre, basal area is a useful measure of stocking density – a measure of solid wood (and bark) material. This value is rather low for young stands and as the stand or forest grows, the basal area increases to a maximum value that is dependent upon the mix of species, exposure, slope, elevation, soils, etc. For hardwood stands the average value for basal area at maturity is between 120 and 150 square feet/acre, while for conifer stands the range may be between 160 to 275 square feet/acre. For all the stands on the Hothole Block, the average basal area per acres stands at 73 square feet. This value is low because the stands are young and developing. It will rise as time passes.

The quality of the growing stock of trees includes the overall health of the tree, its straightness of form, the number of defects observed (such things as crooks; rot; curvature of the stem; broken large branches or top; damaged bole or roots; etc.) and fullness and vigor of the crown area. Those trees that have a high probability of surviving for at least the next 10 or 20 years and making good growth during that period are termed "Acceptable Growing Stock, or "AGS." Those not making the grade, so to speak, and in risk of deteriorating or dying within the same period are termed "Unacceptable Growing Stock, or "UGS." The latter are trees that we would like to remove to make their space available to roots and crowns of better trees. Sometimes, however, a number of these UGS need to remain as place-holders until additional growing space is needed for the AGS.

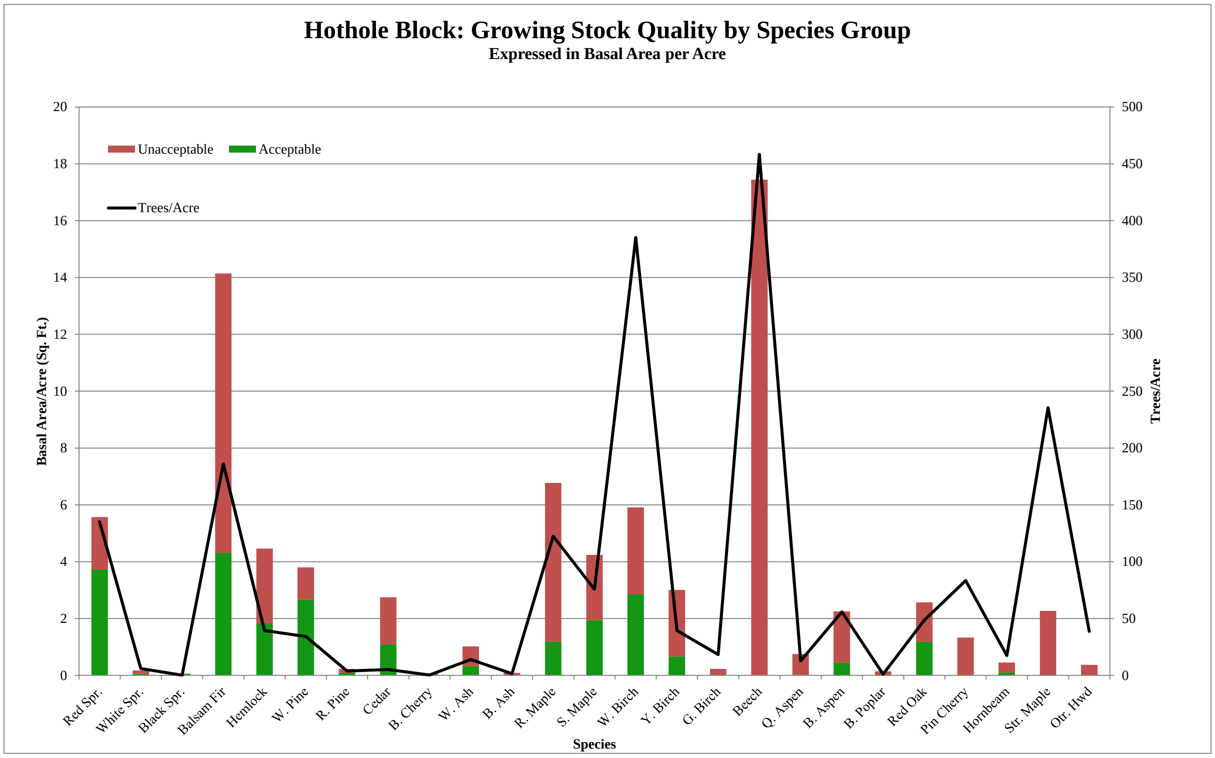
When looking at the size ranges as development classes present on the Hothole Block we find that the saplings and pole classes have more than half of their total basal area in poor-quality material. Development classes of larger material (Small, Medium and Large wood) are just the opposite. Figure 11, below, shows this relationship clearly.

Figure 11 - Growing Stock Quality in Percent of Total Basal Area/Acre



We can also see how quality is distributed among the species on the Hothole Block, as shown in the following graph.

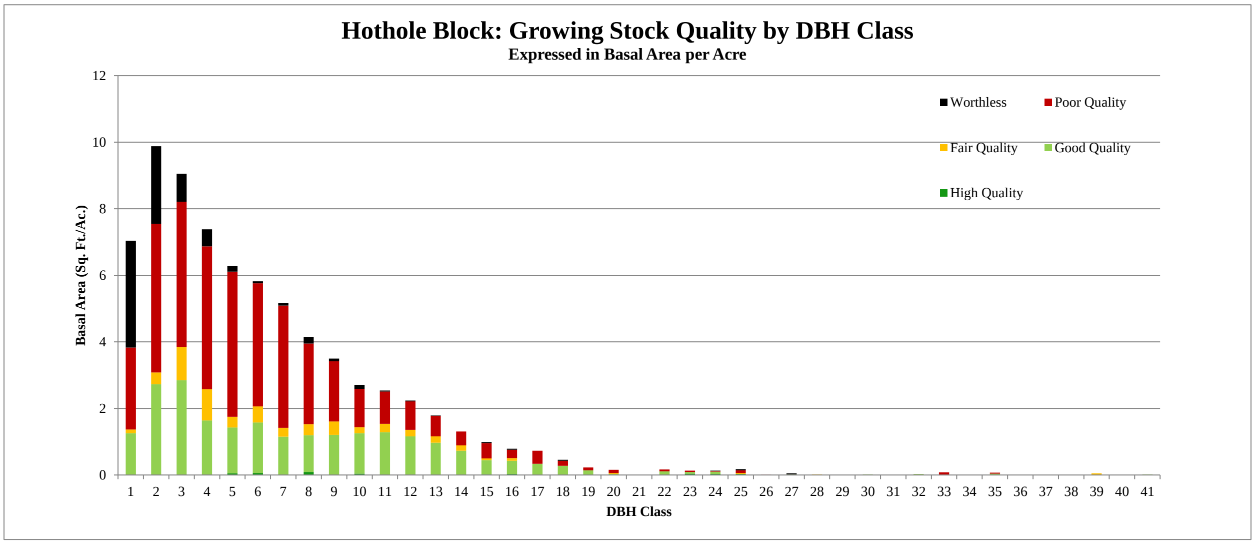
Figure 12 - Growing Stock Quality by Species Basal Area/Acre



Of the 25 species present on the Hothole Block, only two (Red spruce and White pine) have over 50% of their basal area in acceptable growing stock. White birch and Red oak are about 50/50, while the rest have higher levels of unacceptable growing stock that is at risk and should be removed, eventually.

Looking at quality from a size perspective, we can see where the existing quality material resides as shown below.

Figure 13 - Growing Stock Quality by Diameter Class



D4d) Forest Products Volumes & Value

Using current measures of volume and the definitions of products, the forest products that are present (standing) on the Hothole Block consist of the following:

- 9 board feet/acre of Veneer
- 729 board feet/acre of Sawtimber
- 93 board feet/acre of Pallet or Tie-grade sawlogs
- 11 board feet/acre of Boltwood
- 13.3 green tons/acre of Pulpwood
- 0.4 green tons/acre of Cull material

This is not much marketable volume, but the stands are still young. The value of this merchantable material amounts to about $232 per acre. That is if it was completely cut! However, some light thinning to begin the removal of poor-quality material from the more developed stands, on the better sites, would help to rehabilitate this forest a great deal. At the current prices for removed material and the amounts it would be helpful to remove, a contractor doing the thinning would find himself in a financial loss situation and couldn't afford to do the necessary work. Hopefully, market prices will rebound after their long decline, which will make some additional thinning work possible.

D4e) Forest Health & Vigor

Overall, the current health of growing stock on the Hothole Block is fair to poor, primarily due to the large amount of risky growing stock. With the large amount of diseased Beech present, this species accounts for the largest percentage of UGS. While there are good trees sparsely scattered through the hardwood stands, there are far too many poor trees of this and other species. If this forest was left to develop naturally, without intervention, many trees would be lost to mortality and those left to add some growth would decrease in vigor, creating a generally poor-quality forest that would be gradually falling apart. Of course, as some trees would die, room would be made for new trees and surely, there would be regeneration in the small patches that would occur. However, these patches, since they would mostly be small unless some catastrophic event occurred, would become stocked with shade-tolerant species and of that, most of it would be Beech. This new crop of Beech would be trying to grow up amidst the remaining diseased trees and infection would soon spread to the new trees, thus perpetuating the problems of today.

Efforts to rehabilitate this degraded forest should begin as soon as possible on a scale sufficient to be operationally possible to complete the job in the most damaged stands in a 20-year period. Such a program would need to cover at least 100 acres per year and if possible, more than that. Currently, with the existing poor markets for anything but the best veneer, dependence on the available subsidies from the Natural Resources Conservation Service's EQIP program is the only vehicle to make such a program possible.

D5: Access Roads & Trails

There are 18.1 miles of roads present on the Hothole Block. Most of the existing roads were built by previous owners. There are 14 miles of good gravel roads that serve as primary and secondary access to most portions of the Hothole Block. Winter or rough machine trail main access accounts for the remaining 4.1 miles.

A road, ditch, bridge and culvert maintenance program was established in 2014 and is ongoing to keep the main access roads in good condition for both recreational use and forest operations. Shortly after the purchase by GPMCT, two steel and concrete bridges with timber decks were constructed over Hothole Stream (one on the Mead Mountain Road and the other on the Hothole Brook Road). Two other fine timber bridges on the Valley Road were rebuilt with hemlock timbers from the Hothole Block by Brian Keegstra, Land Steward and volunteers. One across the East Branch of Hothole Stream and the other crossing of Cascade Brook. Due to a substantial rainstorm that dropped 9.5 inches of precipitation on these lands in 2015, several water crossings were lost, but the two newer bridges remained undamaged. Culverts at the upper West Branch of Baker Brook, the main portion of Baker Brook, both on the Valley Road, Upper Cascade Brook on the Hillside Road and four additional culverts on the Valley Road were either damaged or washed out completely. Repairs to the smaller culverts on the Valley Road were completed by volunteers and staff personnel from GPMCT.

To address the necessary repairs for the other washouts, funding was sought from both NRCS and the Nature Conservancy. New, more permanent crossings were designed and subsequently constructed by Dirigo Timberlands. Three concrete bridges with concrete decks were installed in 2016 as well as one rock ford and culvert diversion to prevent water movement down one of the previous owner's main skid trails directly upward on the north slope of Oak Hill. This trail has eroded badly (as have most old logging trails) and major amounts of silt have been washed into Hillside Brook, which joins Cascade Brook a short ways downstream from the repair work.

The Trust has also been fortunate to have grader services for several segments of the Valley Road as well as the Flag Hill Road donated by Lane Construction. Raking and small grading projects are now accomplished by a tractor purchased by the GPMCT in 2014.

D6: Water Features & Management

There are a number of water features present on the Hothole Block. These include some shore frontage on Hothole Pond, beaver flowages along Hothole Stream itself and several smaller streams feeding into Hothole Stream, which is the main drainage channel through the wildlands. The East and West Branches of Hothole Stream in the Southern portion of the block, Oak Hill Brook, Cascade Brook, and Baker Brook to name a few. The remainder are unnamed and are typically first-order, headwater streams that either join others to form a second-order or higher-order streams. While some of these brooks and streams run continuously throughout the year (perennial), others are dry during mid to late summer months (ephemeral) unless heavy, prolonged rain occurs.

All these streams fall under state and local regulatory jurisdiction. At present, along all these streams, a 75-foot buffer zone is established (not on the ground, but in the zoning regulations) to control the types of disturbance that would adversely impact water temperatures and the amount of silt and debris that would otherwise increase beyond normal geological limits. In theory, this 75-foot zone appears to serve the purpose of protecting streams from erosion and sedimentation as well as wide temperature fluctuations. However, for these small, generally cold swiftly-running feeders to Hothole Brook there needs to be a different type of protection area to accomplish the goals of keeping water clear and cold. Take, for example, Hillside Brook that runs along the northern side of Oak Hill. Mapped as a single first-order stream, this brook actually has 5 branches consisting of several first and two second-order streams. As one travels upstream, it is easy to see how these branches diverge from their confluence with others and spread far wider than shown on a map. All of these branches of Hillside Brook are located in a "bowl" where rain drains toward the location of each of these small, often intermittent streams. To properly afford erosion protection to this network of drainage channels, a wider buffer zone is needed. Prior to beginning thinning operations in early 2016, a 100-foot buffer zone was located by flagging around the outside area where all the stream channels were located. Thinning within this buffer zone consisted of crop-tree release by hand and no machinery entered the buffer zone. The result of this thinning has left completely undisturbed soil and ground vegetation within the zone and no siltation occurred, even after several heavy rains. For the type of topography present on the Hothole Block, it makes sense to extend the limit of a stream protection zone to a minimum of 100 feet and perhaps wider as one moves uphill and encounters additional feeder streams.

The Hothole Block also contains transient water features in the form of beaver impoundments along Hothole Brook, other small brooks and Beaver Brook – a small stream draining a wetland area between Hothole Mountain and Condon Hill, off the Trust property. There are about 60 acres of these flowages on the Hothole Block scattered about. Some have been abandoned, but new ones have also been built. The numbers will change slightly over time, but with the population of beavers on this block, there will always be active beaver bogs.

Another water feature that doesn't get much attention is that of vernal pools - those that hold a bit of water for a short period in late spring through mid-summer at the latest. It is unknown at this time exactly how many of these small, ephemeral wet spots exist. They are good places for amphibians and reptiles to reproduce and during April and May are beehives of activity. As they are encountered, their locations should be mapped for any monitoring activities that may be deemed necessary.

Hothole Pond is the only large-sized water area present on the Hothole Block since the GPMCT owns a small portion of its southeastern shore. A 250-foot protection zone is in force adjacent to the shoreline and should be sufficient to avoid activity that adversely impacts water quality in this shallow pond. The surrounding area is very steep and rocky and does not offer that type of tree quality or terrain that would make a favorable place to practice forest management in a way that was greater than extensive or custodial.

D7: Wildlife

As the improvement of conditions for wildlife is one of the GPMCT's ownership goals, a forest that is more diverse in habitats is desirable. That is not to say that there is a scarcity of wildlife on the Hothole Block. Quite to the contrary, wildlife species that favor early successional habitats are quite numerous – especially snowshoe hare and porcupines.

Early successional habitats, in abundance following the clearcutting by the previous owner, have gradually diminished as new stands of trees have reached the small to medium sapling stage. There are also some stands that, as saplings avoided during the past harvest, have grown into small to medium poles. In general, the Hothole Block, with its evenaged, relatedly uniform assemblage of stands and cover types, offers a multiplicity of habitats that are available to numerous species. However, while there are many habitats available, the rather uniform development of these new forest stands does not provide the breadth of opportunity that a more diverse landscape might provide. The early successional habitats, once widespread, have largely entered more of a sapling-small pole habitat with most of these stands being quite dense. "Patchiness" is a condition conducive to occupation by many species and provides a great deal of "edge" preferred by some species. Currently, the stand edges present may be between those of the same broad forest type (Spruce-Fir, Aspen-Birch, Northern hardwoods, Swamp hardwoods, Pine-Hemlock and Oak-Pine), but slightly different species composition and of the same development class and density. Not much patchiness exists, though there may be some damaged, large pole residual trees that offer perches for raptors, but not sufficient open space for successful hunting of prey species. So, while there is a large area of forested habitat, it is rather too uniform to appeal to a wider variety of creatures. As the forest continues to develop naturally, it will pass through more advanced development (structural) classes like medium to large poles, small to medium sawtimber, medium to large sawtimber, etc. As it does so, the populations and variety of wildlife will change along with the forest, but the breadth of species will remain about the same or slightly less because more mature forests tend to be less diverse – both horizontally and vertically. Patches will be created by larger trees falling when they die and, in the process, creating small gaps. Of course, larger gaps or patches can be created by major catastrophic events like fire, windstorms, ice, etc. but these are generally infrequent. As early successional conditions become mid to late successional, those species that prefer the early or mid-successional conditions will become more sparse.

To be able to increase the breadth of species inhabiting the Hothole Block, some early successional conditions should be created as well as gaps and patches in the rapidly-developing forest stands. Horizontal diversity, mentioned above, refers to the complexity of plant communities and habitats. Different forest cover type mixtures with a wider range of tree sizes present a greater potential that more wildlife species will be present. Vertical diversity, on the other hand, refers to the degree to which plant species are layered within a forest stand. Greater layering is achieved when tree species are mixed with different heights and crown characteristics and by trees of a wider range of ages is present. At present on the Hothole Block, most stands contain a single layer or at most, two layers. Having a higher degree of vertical diversity characteristically develops multiple vegetative layers consisting of overstories with rich (numbers) species composition and well-developed herbaceous, shrub understory and woody mid-story layers. Diversity of both kinds are treated in detail in the *State of the GPMCT Forest – Fiscal Year 2014* report found in Appendix B, page 128.

Increased diversity of habitats creates opportunities for more and different species to be present. Habitat Opportunity Classes (DeGraff et al, 1992) have been defined to present an idea of how breadth of habitat, size-class and forest cover type distribution may indicate habitat opportunity. There are four classes of landscapes with different wildlife opportunities:

- *Habitat Opportunity Class I* – landscapes that are at least 90% forested.
- *Habitat Opportunity Class II* – landscapes that are at least 90% forested with more than 5% in water and wetland non-forest cover types.
- *Habitat Opportunity Class III* – landscapes with at least 70% forested with less than 5% in water and wetland non-forest cover types.
- *Habitat Opportunity Class IV* – landscapes that are at least 70% forested with more than 5% in water and wetland non-forest cover types.

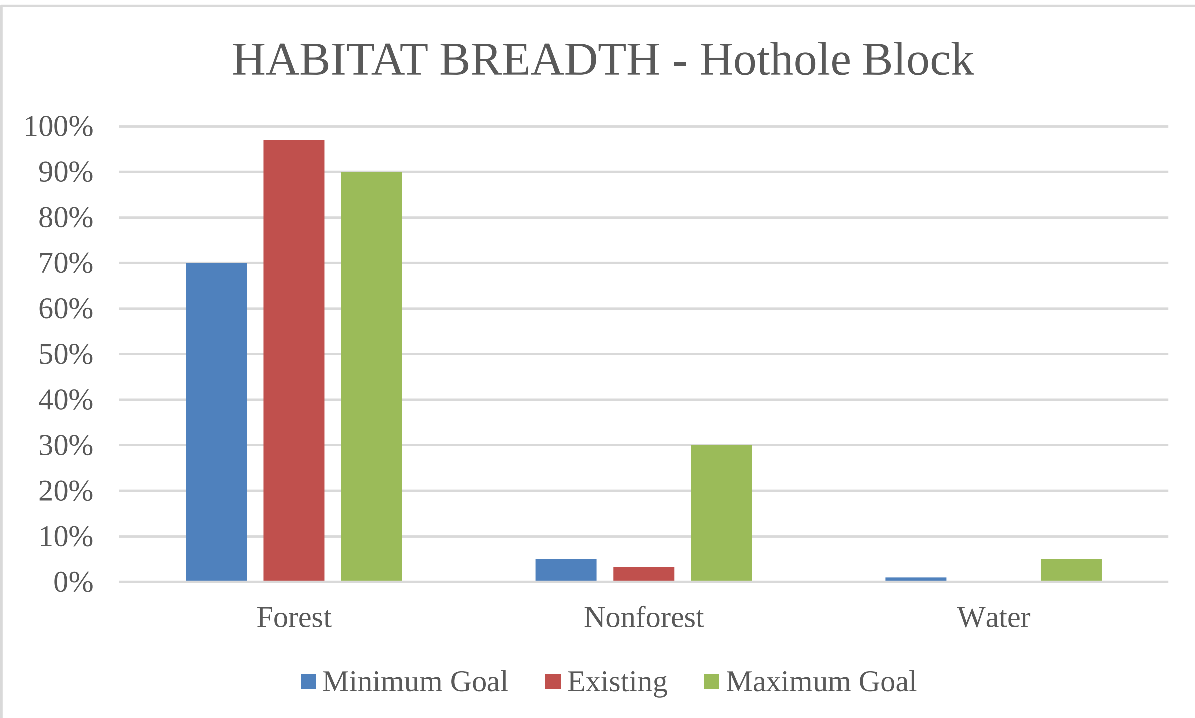
The Hothole Block is 97% forested and has 2.6% of its area in water and wetland non-forest types and 1% in upland non-forest cover types. It is in Habitat Opportunity Class III. Goals for this opportunity class in terms of cover type area are as follows:

- ✓ Non-Oak Deciduous Species: Short Rotation – 5-10%
  Long Rotation – 20-40%
- ✓ Hard Mast – Oak: 5-25%
- ✓ Coniferous: 10-35%

✓ Non-forest: Upland Openings – 15-30% Wetlands – 1-3%

When we compare the published minimum and maximum goal values for Habitat Breadth, Size-Class Distribution and Cover Type Distribution against the current existing conditions on the Hothole Block, we can see very quickly where we are related to where we'd like to be. The compilation of forest and nonforest area and water was made from an acreage summary by Maine Natural Community according to Gawler and Cutko (2010) which were identified in the Natural Resources Inventory by Dibble and Rees (2007).

Figure 14 - Habitat Breadth Existing vs. Goal

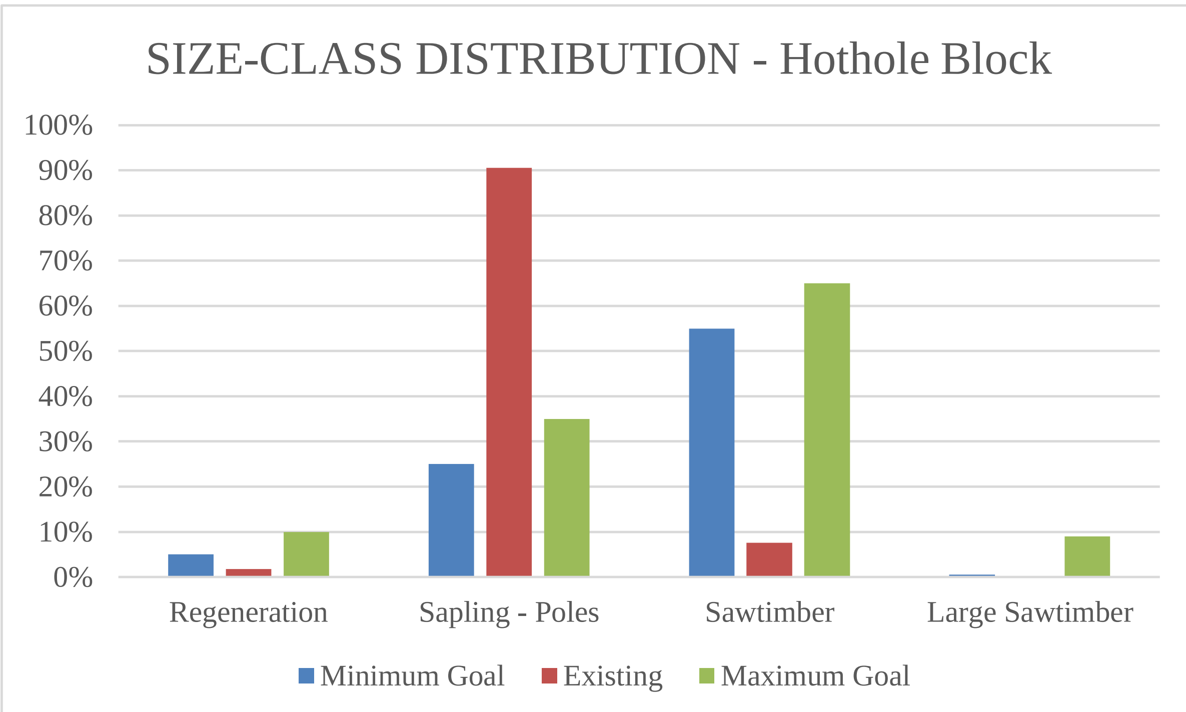


These are general kinds of habitats which include many more discrete habitat types, but they are reflective as a broad level of guidance. There is plenty of forested acreage in the Hothole Block and perhaps we could have some additional non-forest land if some was created. One opportunity lies in the maintenance of old log yards as openings with annual plants or planted wildlife seed mixtures such as that offered for sale by the Sportsman's Alliance of Maine. This seed mix was designed by Gerry Lavigne, a very experienced wildlife biologist. This mix would make early-season green forage available to many species trying to recover from long winters. This mix would benefit a number of species from deer, turnkeys, partridge, bear and other mammals and birds.

There was a category for Krummholz, but it is really confined to alpine areas over 3,500 feet in elevation and we don't have any of that. Instead, I have listed those bald summits in the general upland nonforest category. There's not much more pure water area that could be created due to the limitations of the Hothole landscape unless a pond was created.

The distribution of sizes is really a surrogate for stages of development regardless of how long it takes a stand to move through each stage. While we actually keep track of 7 development stages, the list has been reduced to 4 for better understanding.

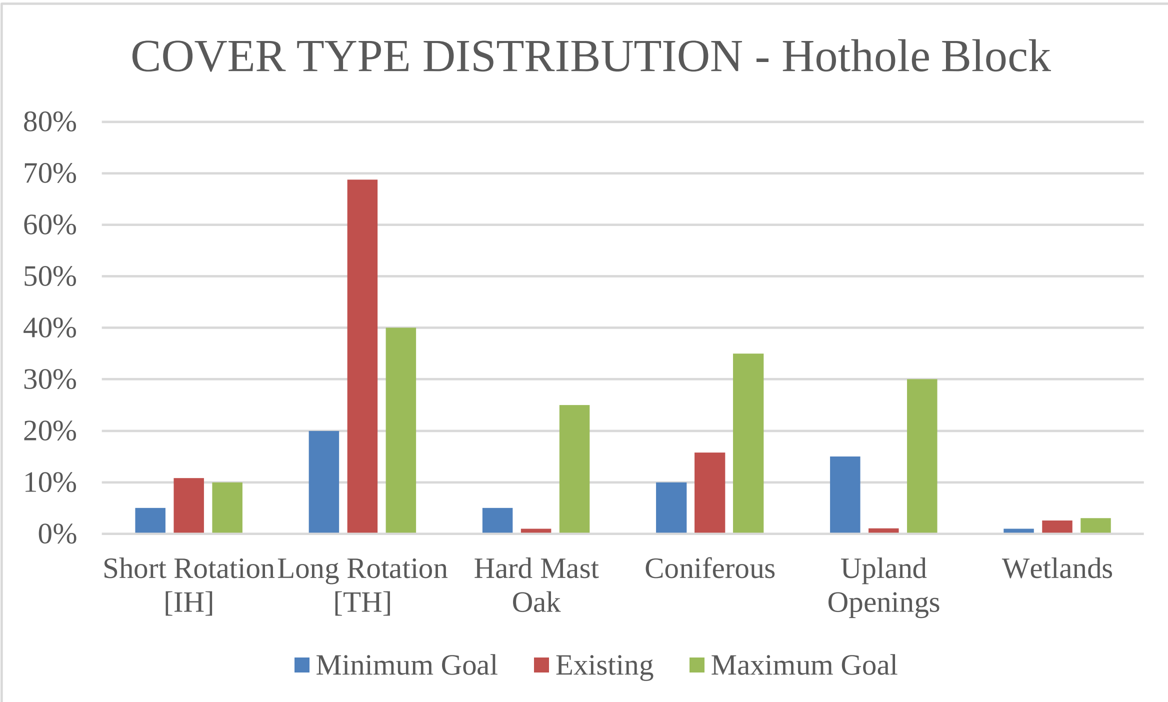
Figure 15 - Size Class Distribution: Existing vs. Goal



Here we can see very quickly how the Hothole's young, developing forest compares to where a better opportunity for diverse wildlife populations should be. While work is being undertaken to move the sapling and pole material into the sawtimber classes, the need to add back some area in regeneration or early succession cannot be forgotten. Doing so populates all development classes on the "conveyor belt" of forest dynamics. There is a shortage of more mature large sawtimber with the exception of a couple small stands adjacent to water courses that escaped harvest.

For New England cover type distribution in our area, the following chart shows in general cover type terms, how the Hothole Block is distributed. Notice that the cover types listed are rather limited in that no species mixtures are specified. In Nature, especially a heavily disturbed area like the Hothole Block, many species become established in various mixtures and some stands will develop with mixtures of both conifers, intolerant hardwoods like Aspen and Birch as well as tolerant hardwoods like Beech, Red and Sugar maple and Yellow birch. When looking at the chart, be aware that these types of mixtures are implicit in the chart and do exist!

Figure 16 - Broad Cover Type Distribution: Existing vs. Goal



The Hothole Block is composed mostly of hardwoods that are tolerant of shade and would be found in the "Long Rotation" category. Since those species that are intolerant of shade have rather short lives when compared to those species that are more tolerant and have longer lives, the time spent growing the shorter-lived intolerants is less and stands containing them will need to be regenerated sooner – at about 50 to 60 years. These intolerant species grow and develop very well in stands that are evenaged, which is where the trees are within about 10 or so years of each other in actual age. They should continue to be grown in this manner and the total acreage kept to about 350 acres. Doing so will create better and more varied habitat for Ruffed grouse, Woodcock and many other species. Creation of more area in upland openings could be made by holding newly-created log landings in grasses and annual plants as was done on the Dead River Block.

Making changes to the landscape to better benefit wildlife is best accomplished by changing existing habitat. That can be most effectively done by designing silvicultural treatments that have wildlife diversity as a goal along with improvements to forest health and value. Adjustments made to improve forest composition to include/increase the proportion of hard and soft mast trees, retention of cavity trees, addition of coarse woody debris can all be integrated into silvicultural regimes designed to address existing problems. A discussion of some of treatments can be found in Section F4, page 105.

E. Forest Protection

In this section, protection of the Hothole Block forest against invasive pests, insects, disease, climate/weather, fire and trespass are considered and recommendations made.

E1: Forest Health & Vigor

Overall good health is the goal of almost every landowner, whether that goal is implicit or explicit. Given the current condition of the forest trees that suffer from many maladies, improvement in tree health and vigor allows stands of healthy trees to grow in both height and diameter more quickly as they pass through development stages, thus reaching the GPMCT long-term objectives sooner, rather than later. Improvements in both health and vigor not only makes trees more stable and resistant to adverse conditions mentioned below, but also allow improvements in value to occur earlier.

E1a) Insects and Disease

The list of indigenous insects that inhabit Maine coastal forests is large, but most cause little long-term damage when endemic levels are normal. There are some, however, whose presence represents a threat to certain species. Damage caused by these insect pests can be substantial with not only the loss of tree vigor, decline in health, but also a loss in value as damaged trees may not improve in product development toward the highest and best use sought. In addition, alterations to habitats from epidemic insect or disease outbreaks may result in undesirable conditions that directly affect wildlife populations. If we look at the insects that plague individual species, rather than listing just the insects, it should be more intuitive which ones to worry about. Oftentimes, inset damage is caused by stresses of advanced age, drought, or attacks by other insects or pathogens.

- ***Arborvitae (Northern white cedar):***

  Leaf miners – the tiny gray moths fly in abundance around the end of June near cedar trees. They lay their eggs on the edges of the leaf scales and when the larvae hatch, they are of a yellowish or gray color with a brown head. These very small worms bore into the tips of the leaves, which die and turn brown.

A second type of leaf miner causes similar damage with moths appearing in mid-June. Full-grown larvae are about ¼ inch long and have a black head and pinkish body. These mine into the cedar foliage and pupate in mined galleries, then appear as small, gray moths the following June.

- ***Ash (White and Black):***

    The Emerald Ash Borer, is a bright green beetle that lays eggs which hatch into larvae that bore into the bark to get to the cambium (growth layer of cells). Another very damaging pest from Asia, they devour the cambium in a pattern, like other borers, that radiates out from the initial bore hole until the tree is girdled and killed. The exit holes are somewhat D-shaped. This insect has devastated ash trees in all states where it has been found and has been confirmed in both New Hampshire and Quebec. However, since our population of White and Black ash combined is less than 1% of the total number of trees, damage on the Trust lands may not be too severe.

- ***Beech:***

    This species is most affected with a scale insect that entered the U.S. from the maritime provinces of Canada in the early part of the last century. The distribution of the scale insect has been from east to west and the "killing front" of the bark canker disease this insect spreads is now in Michigan and Wisconsin. The scale insect occurs in mass and appears as a cotton-like surface on the trunks and branches of Beech. During the summer, they feed on sap by piercing the outer bark. White, waxy threads coat the body of the insect. Adults are 1/32 inch in diameter, round, wingless and legless. Dense stands of Beech favor the insect as there is not much air movement to hinder their spread.

- ***Birch:***

    Generally found most on White or Gray birch, the Birch Casebearer first appeared in 1926 in Bar Harbor and spread to the east and north. The small, grayish-brown moths appear in early July and lay their yellow eggs on the underside of leaves. Larvae hatch, mine the leaves, then cut out a piece of the leaf to form a tubular case which is used for protection as they move about to feed on leaf tissue. As they mature, larger cases are formed. The larvae spend the winter in a case on twigs with feeding resumed in the spring. While unsightly, the damage is usually not severe.

    Another insect on Birch species is the Birch Skeletonizer which appears in great numbers about every 11 years in episodic outbreaks. This is also a leaf-eating insect which mines the interior on the underside of the leaves. It then emerges, spins a flat web and continues to consume the leaf cells, causing them to turn brown and die.

The Birch Leaf Miner is another insect that damages leaves in the same way as the skeletonizer. This one, however, seems to begin at the center of the leaves and works its way to the outside margins. There are also a couple of leaf-mining sawflies, one of which affects Yellow and Gray birch as well as White birch. Both originated elsewhere.

Perhaps the insect that may have been most damaging in the past has been the Bronze Birch Borer. This insect caused a great deal of damage to both White and Yellow birch in stands throughout New England. The olive-colored beetles appear in June or early July as they feed on the foliage of several tree species in sunny locations. Eggs are laid in bark crevices or lichens on the bark. Young larvae penetrate the bark and create serpentine tunnels that girdle the trees. Healthy trees will actually drown the larvae by their rapid growth and translocation of sap. A severe outbreak occurred during 1939 to 1951 following several years of drought and defoliation of trees that were over-mature.

Lastly, the Forest Tent Caterpillar plagues both White and Gray birch and Aspen (Bigtooth and Quaking) as well as other hardwoods in years of severe outbreak. Unlike the Eastern Tent Caterpillar that is found on fruit trees, alders, etc., the Forest Tent Caterpillar does not make a tent or web. Light, inch-long, buff-colored moths with two diagonal stripes on the fore wings lay eggs masses in brown, ring-like patterns and are held together with a grayish substance completely encircling twigs. Sometimes called “army worms” the caterpillars are blue-black, about 2 inches long with two yellowish bands on the sides of the body and cream-colored spots along the middle. During the late 1970’s in Northern Maine, an outbreak occurred just as the effects of the Spruce Budworm were declining. A massive population of caterpillars spread far and wide devouring any and all birch or aspen leaves they encountered. I personally have seen masses of these insects moving along the ground as an army and in one place, were completely covering the road for a quarter-mile. In another instance, they were so thick along a Bangor & Aroostook railroad track that they stopped a trail due to their slippery bodies on the rails. A bad character altogether.

- ***Elm and Oak:***

One of the chief insect pests of these species is the Gypsy Moth, a particularly damaging insect. While not always found in our area, the presence of Red oak is an attractant. Populations of epidemic proportions are a regular visitor to the Southern New England states and have been known to pay a visit to Western and Southern Maine. The brown moths lay buff-colored clusters of about 400 eggs each. Caterpillars are brown, hairy and have a double row of six blue and four red spots. They also enjoy almost any species of pine and have been found on Norway, Blue and White spruce. Peak populations occur about every 7 or 8 years. While American elm is consumed eagerly, the species has been limited due to Dutch Elm disease and there are insufficient trees to support an outbreak. That is not to say that American elm has no other insect pests. The Dutch Elm Disease is spread by the Elm bark Beetle, which has two varieties, the native and the European (arrived in 1904 near Boston). These dark-brown beetles lay their eggs in the crotches of twigs and the larvae bore into the stem beginning their work of creating galleries that radiate out from a central corridor. Two or more generations occur each year, killing trees by eventually girdling along with the growth of the fungus throughout the vascular system of the tree that interrupts nutrient flow, causing the typical yellow leaf “flagging” leading to the eventual death of the tree.

- ***Hemlock:***

The most notorious insect pest in current fashion is the Hemlock Wooly Adelgid, a serious pest responsible to basically eliminating Hemlock in the Middle Atlantic States and Southern New England. A small, waxy-colored insect covered with a wool-like substance (similar to the Beech scale) is located on the undersides of needles and twigs or in masses at the axils of twig and branch. It has been found in southern, coastal Maine and has extended its reach into Lincoln County. While Hemlock only makes up 2% of the trees on the Hothole Block, it does occur more abundantly in conifer-dominated stands along with Balsam fir and Red spruce. It is these stands of more concentrated Hemlock that are threatened most. Vigilance is the watchword here and if discovered, remedial harvesting methods are necessary to reduce the adverse impact of this pest. Repeated loss of foliage eventually results in crown dieback and death of the trees infected. Of particular note, is the presence in streamside zones of larger Hemlock left after the past heavy harvest. Should these trees be attacked, the crowns will become thinner and the eventual death of these trees will cause an increase in water temperatures that may have serious consequences for fish, especially trout.

There are some silvicultural options that should make our conifer stands less susceptible to attack by this insect. If hemlock represents greater than 20% of the total basal area in any given stand, it should be reduced to less than that amount. Doing so will make these stands more resistant to destruction. However, pests of other species in the stands needs to be taken into account also.

If this insect wasn't enough, there are two others of note. The first is the Hemlock Borer which attacks Hemlock that are stressed and weakened. A small, dark bronze-colored beetle with yellow spots on its back, this insect appears in late May to lay its eggs in crevices in the bark. Larvae burrow in a fashion typical of wood borers into the cambium layer where it feeds. This insect is a favorite of woodpeckers. Avoiding stress on the shallow-rooted Hemlock by too much exposure or harvesting injury is very important. The second one is the Hemlock Looper, a ravenous defoliator of not only Hemlock, but also of spruce, pine and hardwoods! The moths that lay eggs are light brown to yellowish-gray with a double, wavy line across the wings. Eggs are usually laid on the lower foliage, trunk and twigs. The worms are pale green and marked with numerous black flecks and lines.

- ***Larch (Tamarack):***

The Larch Case-bearer is a defoliating insect that, at times, causes major damage in Maine. The ashy-gray moths lay orange-colored eggs on the needles in July. Young larvae tunnel into the needles until September when they cut off a portion of the needle to use as a cocoon. They then migrate to the twigs, branches and trunk of the tree to overwinter.

Another serious pest of larch is the Larch Sawfly that has caused billions of board feet of larch to be destroyed in the Northeast. Eggs are laid in June and July by a small jet-black fly about three-eighths of an inch long with a red band around its body and portions of its legs. The eggs hatch in about a week and the larvae feed on foliage for 17 to 24 days. At that time, the black-headed, green worms form pupal cases in the ground beneath the trees.

- ***Maple:***

The key insect pest of Sugar maple is the Sugar Maple Borer. This black, yellow-marked beetle appears in July or August and lays its eggs in slits cut in the bark of the tree. The larvae tunnel beneath the bark and later into the wood itself causing loss of vigor and degradation of the wood in terms of its usefulness.

There is also a defoliator of not only all maples (Red and Sugar), but aspen and Beech as well. This one is the Bruce Spanworm, a looper that caused significant damage to 330,000 acres in Northern Maine during 1982 and 1983. The light-brown moths emerge in late October or early November to lay pale-green eggs in bark crevices. The green caterpillars emerge in the spring and head directly to unfolding leaves, where they begin feeding on the undersides, leaving only the veins remaining. The other major defoliating loopers are the Spring and Fall Cankerworms, which, as their names suggest, occur at different times of the year. The looper caterpillars of these species can be either green, tannish or dark, making identification difficult.

- ***Pine:***

White pine is bothered principally by the White Pine Weevil, which attacks and kills terminal shoots, especially if trees are fully out in the open. The thick leaders attract these common small brown insects are egg-laying sites for the weevils that overwinter in the duff layers beneath trees. The hatching grubs then burrow into the last 2 to 3 years of leader growth, killing the tops and creating forked stems that in the open appear to look like cabbages. This weevil also attacks the leaders of Norway and sometimes White spruce. Another weevil that causes damage not only to the terminal leaders, but branch tips as well is the Pales Weevil and its damage occurs on most coniferous seedlings.

Red pine is pestered by three sawflies that strip the foliage of trees in late spring and during the summer. Two species, the Red-Headed Pine Sawfly and the Red-Pine Sawfly, lay eggs in needles for overwintering. The Introduced Pine Sawfly larvae spend the winter in cocoons made in the soil.

White pine is also bothered by an aphid called the Pine Leaf Chermid that spends part of its time on either Red or Black spruce. This insect causes galls to form as it feeds on the tips of spruce shoots. The migratory form of this insect then leaves the spruce gall in mid-June to fly to the needles of White pine where they pierce the tissue of shoots and feed. The shoot tips then droop, yellow and die. The second year, some aphids migrate back to the spruce to begin the process all over again. Two or three successive outbreaks may kill understory trees with thin foliage.

☸ ***Spruce and Fir:***

Finally, we come to the spruce/fir group which has a host of insect enemies. The most important two are first, the Spruce Budworm, which wreaks havoc every 17 to 20 or so years in epidemic proportions. There is an indigenous population of all insect pests, but the massive outbreaks that occur in the Canadian Maritime Provinces and Quebec send clouds of dull-gray moths on the prevailing wind to Maine augmenting the local populations. Each of the moths lays approximately 600 to 800 eggs on the underside of needles. These eggs hatch in about 5 days and the larvae pass the winter in small, silken cases tucked in crevices or at the base of needles. In spring, the larvae emerge and devour the needles closest to them to gain energy as they migrate to the newly opening buds and new growth. They continue to feed on foliage (new and older) and web needles in masses. The pupae are formed on the twigs after about 6 weeks. Though the preferred species is Balsam fir, Red and White spruce are also support budworm populations. Black spruce less so since its buds break much later in the spring months. During the previous epidemic outbreak from 1972 to 1981 or so, approximately 40 million cords of spruce and fir were killed. The budworm was found on not only Spruce and fir, but also on Hemlock, White pine and Tamarack – overstory as well as understory trees. A very serious pest, of which to be aware.

When trees are stressed from defoliation (like that above) it attracts bark beetles and in the case of budworm damage, the Eastern Spruce Beetle moves in to complete the task of total destruction. A small brown to black beetle about ¼ inch long bores directly through the bark to the wood, where it bores along the grain and lays eggs along alternate sides of the tunnel. As the eggs hatch, the new larvae tunnel at right angles along the inner layer of bark and cambium. As the trees die, the foliage drops, often while still green and woodpeckers will flake off the bark in search of the grubs.

Other damaging insects of spruce and fir are: The Balsam Fir Sawfly, Balsam Gall Midge, Eastern Spruce Gall Aphid (the one that makes swollen galls on spruce), the European Spruce Sawfly, Pine Leaf Aphid, Spruce Webworm, the Yellow-Headed Spruce Sawfly and the Hemlock Looper. All these defoliators cause damage in varying amounts depending on the size of local populations. There is one more, though, the Balsam Wooly Aphid.

Affecting Balsam fir, this insect is similar to both the Beech scale and Hemlock Wooly Adelgid in that the insect is small, hemispherical with a white, cottony covering. In winter, the tiny, black crawlers covered in white lodge in bark crevices or at the base of buds. In spring, they develop into adults covered in a cottonly mass. Here, they pierce the thin bark of smaller twigs and buds to suck the juices and in so doing cause the stems to swell and become distorted. As the tree loses vigor, the stem becomes brittle and is more easily broken by strong winds, ice or heavy snow. While it appears to be a coastal phenomenon, there have been instances of the insect in the interior of the state.

Reading this section, it may seem like all trees are under relentless attack by more insects than have been listed here, although these are the major ones that would impact trees on the Hothole Block. In reality, there are always insects in the forest and they are part of the whole ecosystem. Generally, the damage they do is small and limited to periodic defoliation, borer injury and some deformity developing out of those injuries. At endemic levels, we must accept a certain amount of damage. Much of the cause of growing populations of damaging insects is due to advanced tree age, poor growing sites or space and corresponding loss of tree vigor as health declines. A good deal of damage can be prevented by developing stands of healthy trees that have adequate growing space such that these trees may lead a longer life than would have been possible if left alone to grow naturally. It should be remembered that insects of all sorts are food for several varieties of wildlife species, especially birds. Insect outbreaks above endemic levels will benefit portions of the bird population that feed upon them, although the effect is a bit delayed as it is with all prey/predator relationships. While there is great production in Nature, there is also great waste, especially when conditions of age and decline make conditions ripe for an expansion of insects and diseases.

Of the diseases present in the forest, most consist of foliage or stem molds, bacterial or fungal diseases. The most important for forest trees are the fungi. In general, a disease may cause one of three possible conditions: Necrosis or death of tissues and, ultimately of the tree itself, Atrophy - where the rate of normal development is slowed or Hypertrophy, a case where an excess of growth of all kinds is possible. This latter condition results from an increase in the number of cells resulting from an abnormal rate of cell division, like a cancer.

Fungal spores causing foliage diseases are more common in our area because the coastal climate is much wetter and moisture is a necessary ingredient for fungi to flourish. Perhaps the best-known disease is Chestnut

Blight [*Endothia parasitica* (Murr.)] or Beech Bark Disease [*Nectria coccinea* var. *faginata* (Lohman, Watson & Ayers)]. Both of these diseases are necroses and cause cankers to form that eventually girdle the trees and kill them. While we hope that the Chestnut Blight never shows up in this northeasterly extreme of Chestnut's range, there is always a chance that it may. If it does not, our planted Chestnuts will gradually become a part of the northern hardwood stands in which they have been placed. As a very minor component of the hardwood cover types, it is hoped that they may persist to maturity and gradually form a more widespread component of the Hothole Block's forest.

The Beech Bark Disease, known in northern Europe is not usually virulent on European Beech and was not caused by an insect acting alone – like the Beech Scale. Once it arrived on the North American continent (1920 in Nova Scotia), things changed when the Beech scale insect spread the disease to epidemic proportions, causing high mortality over a wide area. As mentioned previously, the location of the "killing front" of the disease in now in the Lake States. In stands with a high proportion of Beech (>20% of the total basal area), the disease spread by the scale insect is rapid, first occurring on larger trees and in their absence, to smaller ones. At 24% of the total number of trees forest-wide, Beech in the Hothole Block will continue to suffer. There are some bright spots, though, as there are some trees who show no evidence of the disease. Those should be favored. Also, dense stands of steeper slopes, especially out of the wind seem to have higher levels of disease and thinning these stands to facilitate wind movement may help, since the scale insects are poor fliers.

Overall, planning to remove diseased trees each time a stand is entered and taking special care not to damage the residual trees will help keep the impacts of diseases from becoming more of a factor than they currently are. Identifying the presence, type and levels of infection will remain a stand-level assessment task prior to treatment decisions.

E1b) Weather

Heavy rain, snow, ice and wind, excessive sun exposure all contribute to tree damage in some form. The one thing that continuously may work in the favor of the forest is fog, as it provides additional moisture at all levels. Of course, that may mean more opportunity for fungal spores to grow and that could be good or bad, depending on circumstance. But, how do we mitigate against weather? How can we protect the forest trees and stands from the damage that may be caused? Let's take these one at a time.

Rain, heavy at times causes water to move along foliage, down branches and trunks to join that already on the ground directly. Trees soften the impact of rain on soil even if it's covered with leaves. Light rains of little duration have essentially no real effect other than watering the plants. Heavier rains, though, have the potential to overwhelm the soil's ability to absorb and hold moisture and then it begins to travel across the ground – downhill. If hills are steep and the rainfall is heavy the erosive forces of water multiply with speed and distance traveled. The deeply-eroded skid trails from the previous owner's operations in all weather is ample evidence of the impact made by the movement of surface water. In soils that are a bit moist anyway, trees act as pumps that through transpiration, remove moisture from the soil. Removing too many of these pumps leaves higher levels of residual moisture that can lead to runoff during heavy rains. So, making light silvicultural treatments on a more regular interval can increase growth of root systems that hold soil better. Another protection measure is the layout of forest access trails that move diagonally across slopes, rather than straight up and down. This design cuts off water movement at numerous places all the way down the slope and does a good job of reducing or eliminating erosion in the first place. Keeping forest machinery out of watercourses is another protection measure that pays big dividends. In short, following Best Management Practices (BMP's) reduces or prevents damage.

Heavy rain can also lead to flooding in poorly-drained soils at lower elevations. Not operating in such area until conditions improve helps protect forest resources.

Snow and ice, especially when heavy can and does break branches, tip over trees and generally raise havoc with the forest. Very dense stands of trees usually develop very small crowns and root systems. As such, they are more prone to tipping and breakage than trees grown in a bit more open setting with larger, healthy crowns and root systems. Another way to protect against ice and heavy snow damage can be found in keeping trees is rather close association – nearer one another. If silvicultural treatments to grow healthier trees opens stands too much and trees are spaced too far apart, they can't provide mutual support to one another. This is true for all species. During clearing weather there are usually windy conditions. If trees are spaced too far apart, especially as small to medium poles, the wind can cause excessive bending and result in breakage. In addition, heavy swaying can cause the tops of trees to whip into neighboring ones, damaging the finer branches. That may lead to infection from disease-bearing spores. Hail damage will cause that also. Stands of mixed conifers and hardwoods are easiest to protect since their different growth habits occupies more "between-tree" space. Conifers have somewhat triangular crowns that can fill in gaps between the hardwoods that have more upwardly conical or spherical crowns. A good mix makes good sense where applicable.

Wind makes trees bend and sway. Gentle wind = gentle sway and that's good. However, in high wind events, excess swaying can lead to breakage or windthrow as mentioned above. Silvicultural treatments should include practices that protect stands from strong winds by leaving a heavier buffer along edges exposed in the direction of prevailing winds. In our area we often get storm winds off the ocean and those living on coastal islands experience large blowdown events on a regular basis. Where stands are on slopes exposed to prevailing wind directions, treatment should initially be light and in strips beginning at the rear if, regeneration is desired. Trees growing in a dense crowd of other trees grow tall and taper little since these trees hold each other up – especially in thin, rocky soils. Research has found that if the ratio of total height to diameter is 0.8 or greater, the tree has a good chance of being blown-over. So, one way to minimize damage in windy areas is to make the trees have a heavier taper. More taper on shorter trees (as they grow) makes for a sturdier plant. Regenerating stands from the rear in strips working towards the wind will eventually create a wedge of crowns that lift the wind at the leading edge and send it over increasingly taller trees toward the rear of the stand.

Most people don't think of sunshine as a bad thing, but in some cases it can cause excess mortality in trees suddenly exposed to full sunlight when they have spent a goodly portion of their lives in shade. Trees on edges suddenly exposed on the southerly and southwesterly directions will have their surface temperatures raised to levels that can kill the cambium. This effect is all too common in clearcuts that face southward. The same type of edge buffer that reduces wind can also reduce the adverse effects of intense sunlight. Also, making the direction of forest access trails at an angle to the south or southwest can avoid exposure to both wind and excess sunlight.

E1c) Invasive Species

Species of plants deemed invasive means that they readily occupy space that would be occupied by native vegetation and can rapidly expand and choke out natural plant communities. A good example is Japanese knotweed (*Polygonium cuspidatum*), commonly called "bamboo." Once established, it is very difficult to eliminate – the very essence of an invasive. Another is Asian bittersweet that climbs native trees and gets heavy enough to pull them over or break them. The list of invasive plants gets longer every day and it is well to be able to recognize them and plan for their elimination. The current methods for removal is to physically remove them by digging up and burning, or by use of common herbicides like glyphosate or trichlopyr in a ground application by spray bottle.

E1d) Invasive Species Policy

The current GPMCT policy for invasive plants is to monitor the Wildlands and eradicate any invasive, either by digging up and removing/burning or herbicides as a last resort.

E2: Fire

Wild fire events on the Hotlhole Block have been relatively non-existent. Since the vegetation is in the early stages of development, there isn't a great deal of fuel to support a fire. Even in this very dry summer of 2016, there were no fires on the property. That's not to say they couldn't happen. Increases in recreational use, dry seasons, lightning strikes and forest debris from silvicultural treatments can all contribute to the ignition and spread of wildfire. Protecting against this agent of damage must involve the Orland Fire Department and the Maine Forest Service, whose job it is to protect large forested blocks beyond the capability of local fire departments. As the forest matures and becomes more valuable, protection from wildfire will become more important, therefore, some planning now is better than leaving fire suppression to chance. It might be a good idea to contact the departments in the adjoining towns and see what it would take to assemble a mutual aid agreement, much as they have currently for general fire-fighting within the towns. The Maine Forest Service could be of some help in this endeavor and given the size of the ownership, might coordinate what a proper response should be in the event of a small or larger fire. Much has been done over the last 5 years to improve equipment access with 5 new bridges, graded gravel roads and old log yards that could be used to stage equipment for fire-fighting. Improvement of water pumping areas for trucks and refueling areas for helicopters with buckets should be considered. Staging some equipment in the existing tool shed or another structure should also be considered. This equipment could consist of several backpack pumps, hand tools, pickup or trailer size collapsible water bladder, gasoline pump, 2-inch suction hose with strainer and perhaps 200 feet of 1 or 1½ inch fire hose with connections that are compatible with both local and Maine Forest Service connections. The amount of equipment available should meet the needs of the number of volunteers that could be assembled quickly and the value of the resource that is to be protected.

As the forest matures and treated areas develop into more mature, valuable trees, the need for fire protection becomes acute and a fire plan should be developed. The most dangerous times for fire are from April to June and again from October to December, when material is exposed, dry and green vegetation to impede fire spread is unavailable. Dead River, Alamoosook Lake, Craig Pond, Hothole Pond, Heart Pond and Rocky Pond could all be considered water sources for firefighting.

E3: Climate Change – Considerations for Mitigation and Adaptation

Over the years we have seen both wet and dry weather in all seasons and each time the climate has an impact on forest vegetation communities. It is felt by many that a warming trend is underway and speculate that winters will be wetter and summers drier than has usually been the case. Changes occurring to the vegetation within the Trust ownership will be a slow process, but could have major long-term impacts on the essential character of the resource.

The most general effects wrought by a warming climate tend to push temperatures higher by a one or two degrees per decade (at last prediction). With temperature increases a concomitant effect is an increase in solar radiation, unless weather patterns shift towards more frequent storms, where cloudy weather would prevail. Increased temperatures may increase the growing season somewhat and may actually increase the rate of growth through transpiration, provided that sufficient moisture in the soil is present. Precipitation shifts in winter from snow to ice and freezing rain might increase and along with it, a greater chance of damage to tops and branches of species present on the Hothole Block. With the Atlantic Ocean's influence in our coastal area, changing seasons may bring more fog-laden days that would increase precipitation to benefit the tree species present. Changes to wind direction, frequency and duration could have a drying effect during rain-free periods, or a wetting effect if rain occurs.

Orland receives more precipitation (49.94 inches annually) than the rest of Maine by about 3.44 inches and 28% more than the national average over the last 30 years. This is due to the coastal effect and provides more moisture through rain, snowmelt and fog as an additional resource to support tree growth. Additional available moisture is a good thing unless increased drying negates its positive effect. However, since this area receives more moisture, there may be some ability to buffer the drying effect of increasing temperatures longer than other parts of the state.

From a species basis, some of the more southerly species may move northerly with temperature increases and longer growing seasons. Our mix of species contains many whose best development occurs further north, and these may decrease and withdraw northward with increasing temperature and dryness. Depending on the magnitude of changes during the next 70 to 90 years, we may not see as many White birch, Red spruce, Balsam fir, Black spruce, Northern White cedar or Mountain maple if the change turns out to be mild. If the change is more severe, we can add Tamarack, Balsam poplar, Quaking aspen, Striped maple and Yellow birch to the list as these species retreat to the northward.

Again, if the change results in mild warming, we may see more of the following species: Red pine; American elm (unless Dutch Elm Disease kills them); Black cherry; Black locust; Black willow; Silver maple; White ash, Beaked hazelnut and Witch hazel. If great warming occurs, we can add to the list above: Jack pine; Basswood; Red oak, Burr oak, Slippery elm; Sweet birch and White oak to the list of newcomers. Additionally, there are some species who could move north as new habitat is available. These are Butternut, Shagbark hickory, Scarlet oak, Sassafras, Swamp white oak, Sycamore and Yellow poplar. Those species that can weather a severe change in climate are Pitch pine, Scotch pine, Alder and Red maple (our most ubiquitous species). If the change is mild, then we'll still see most of our familiar species except those mentioned in the previous paragraph. Chestnut should be fine.

In the end, trees are adaptable and we must be also. There are three areas where we can plan for changes and specific tactics we can employ are part of our ongoing forest management to build our future forest, keeping the GPMCT goals in mind. The first area of focus is ***Resistance*** to adverse changes. Two strategies to combat negative changes to the landscape are:

- **Continue to prevent the introduction of invasive species** and remove those found. We're already doing this, though we probably could put more effort into keeping an eye out for invasive species.
- **Protect sensitive or at-risk species and communities**. Through the Resource Inventory of Natural Communities and recommendations of Dibble and Rees (2006), we can safeguard these areas by making the most sensitive ones a refugia for the species of plants that are found. Along those same lines, I would recommend that we set aside several Strategic Reserves of existing forest types to assess possible change on unmanaged stands. Perhaps a total of 10% of the Wildlands forested acres, proportionally allocated by the natural communities identified by Dibble and Rees. Where this might done is suggested in Section F3, Page 92 under Management Recommendations.

The second area of focus is ***Resilience*** to adverse changes. Some of the recommendations to apply tactically and help increase resilience to climatic change could be:

- **Promote diverse age classes**. Having multiple age classes present in each stand as well as across the forest is the best way to mitigate against damaging changes from climate shift.

- **Maintain/restore diversity of native tree species**. This happens to be one of our primary forest management objectives using specific silvicultural regimes to accomplish the task.
- **Retain biological legacies**. There's not too much legacy stands or trees from the original forest left after the heavy cutting, but as we locate untreated areas or even large, old remnant individuals, we can and should easily retain them. Any unharvested stands where the trees are quite old should be part of the Strategic Reserve area mentioned above.
- **Maintain/Restore soil quality and nutrient cycling**. Also part of the forest management direction, this tactical response should consist of making small openings though light thinnings to assure regeneration when necessary and to allow additional sunlight to penetrate portions of each stand's canopy. Such sunlight will accelerate decomposition of fine and coarse woody debris which will improve nutrient composition, water absorption and retention, while speeding up nutrient cycling. The result will be better growth of better trees.

Third, and last of the three focus items is ***<u>Transition</u>***. How we go about making a climatically-induced shift from present forest community structures to those better suited for future stability. This task can be easily incorporated into our recommendations for forest management. Matching the right species with the right growing conditions and sites will ensure that treated stands will be adjusted towards future stability of both species composition and structure. Specific strategies and silvicultural regimes for adapting to climate changes can be found in Section F6, page 103. Two key tactics for adaptive management are:

- **Favor those native species that are expected to be better adapted to future conditions.**
- **Emphasize drought and heat-tolerant species and populations.**

One item that cannot be forgotten, regardless of the cause of changes in a forest, is long-term monitoring. Planning for the implementation of a monitoring system can be a simple or as complex as financial resources are able to bear and the owners are willing to spend. Either of these factors (design and installation) can be a long-term burden and are often abandoned after a few cycles of measurement. However, one way of supporting a monitoring effort is to make it do double duty as it serves another function. A stand monitoring plot network has already been designed and should be installed in treated stands next year (2017). As each new stand is treated, there will be 10 permanent plots installed to record pre-treatment conditions and immediate results of treatment. Then, the plots will be remeasured every 5 years to access the best time for the next treatment. Most of the data recommended by the U. S. National Climate Assessment Indicators System is already being collected on a coarse scale (county, region, etc.). At a finer scale, a periodic review of overall forest condition can be assessed using the color-infrared image data offered by the USDA National Aerial Imagery Project (NAIP) image data in digital form.

The 2014 forest-wide inventory system produced a set of baseline data. A "Rolling Inventory" process (see Section F2, page 89) has been initiated to keep the inventory current by both replacing/adding new inventory plots as stands are treated and growing plots in untreated stands forward. In this way, the emphasis is where is should be – to see how the forest is responding to treatment and also to track changes that may be occurring to the forest as a whole from other influences.

E4: Forest Security

Ensuring the security of the Hothole Block forest means knowing more about the GPMCT landbase than anyone else and making sure that access to the Wildlands is controlled in some fashion. Having a secure forest means that any attempt at willful trespass and associated timber theft is eliminated. While the existing resource isn't too valuable now, it will gradually become more valuable and it should be protected. Paying attention to renewing boundaries and corner monuments, keeping gates operational and secure and reducing or eliminating uncontrolled access points may pay huge dividends in the future.

The forest management strategy of improving the forest health and condition of growing stock will lead to a great deal of high-quality material. Part of this strategy is the continued extraction of forest resource material from adjacent lands and woodlots around our core area and beyond. The more we become a noticeable "treasure trove" of valuable timber commodities, the more we become the "only game in town" for large, high-quality sawtimber and veneer. Security of the forest means keeping this forest asset intact and useful to GPMCT.

Timber theft or property damage can be done by anyone who knows that the owner isn't paying any attention. They can cross from operations on an adjacent property and set up a logging operation if the Wildlands isn't watched with regular entries to inspect the property. Cultivating good relationships with adjoining property owners helps a great deal, too.

Buyers of timber can often make an absurdly low bid for existing timber and unless an owner knows how much volume and value there is, it's a real threat. Having good knowledge of volume by species and value is a real asset and we're already underway with our 2014 Forest Inventory and Valuation.

This can be kept up-to-date by adjusting for areas changed due to silvicultural treatments and adjusting map data for where those changes have taken place.

When a harvest activity has been approved, it needs to be inspected and the volumes of removals needs to be accounted properly so that all removed timber matches with removal volume. Lots of value has been lost by not paying attention to the monitoring of harvest operations and trucking. Having trip ticket copies for each and every load to its final destination is essential.

Another area of concern for uncontrolled access points is unlawful dumping of refuse of all kinds. It has been this major factor that led landowners in northern and western Maine to establish a system of locked or manned gates.

F. FOREST MANAGEMENT & ORGANIZATION [NRCS Checklist Item 4]

This section on forest management provides detail on what has been done to organize the Hothole Block forest area so that management activities can continue. Work done prior to mapping and inventory work has been added to the mapping data and some pre-commercially thinned conifer stands were sampled during the 2014 inventory.

Here, is where recommendations at the general forest level are further refined toward the definition of specific silvicultural practices to be applied to a range of forest stand types. Since the timing of stand improvement activities needs to be accountable to a budget, a schedule of activities, where they should be applied and the timing of a sequence of treatments for those places is also provided.

Forest management efforts have long been directed towards the production of volumes in forms desired for pulp, paper, and fiberboard along with the traditional product mix from sawmill industries. Now, we see the number of outlets for low-quality wood fiber diminishing and the focus has once again returned to the historical demand for sawtimber, often thought to be the highest and best use for forest yields. That view is changing and now, in many instances, a broader picture of what a forest must be includes amenity values, wildlife, non-marketable plant species, scenic views, etc. Now the forest becomes something else altogether and it is expected to contain a lager basket of benefits to a wider audience. It doesn’t make forest management more difficult – just wider focused and a bit different. There is a tension that now exists between “value” as seen by financial interests and “values” such as natural beauty, tranquility, ecosystem services, recreation and educational opportunity, etc. All these things bring more demands to the forest that must be addressed. Oh, yes, there's also the need to make sure that anything done to the forest results in it being "sustainable," depending on the definition of what must be sustained (see the State of the Forest -2014 report, Appendix B, page 128). Satisfying myriad demands calls for a pathway that first must succeed in maintaining the landscape in forest, as well as the following (underlined items are also explicit GPMCT goals):

- ✓ <u>Provide habitat for wildlife</u>
- ✓ <u>Offer recreational and educational opportunities</u>
- ✓ Be adaptable to any changes to climate
- ✓ <u>Produce clean air and water</u>
- ✓ Grow more wood than in an unmanaged condition
- ✓ Help create local jobs and cultivate new businesses
- ✓ Provide more wood for building
- ✓ Help reduce the dependence on foreign oil
- ✓ Grow as much as we use (be sustainable).

This is a tall order, but if all these things improve the quality of life and economic competitiveness for our local core area, then it's time to get started. The road will be long and fraught with pitfalls, but in the end the new forest will be better, prettier and more useful than any previous old ones that were here before the Pilgrims landed or since!

Any privately-held enterprise, whether it be a large, family ownership, land trust, or conservation organization must deal with whatever existing markets are available to take material produced from forest improvement operations and hope to do a little better than "break-even." This is a difficult task when an untended reasonably mature forest is subjected to forest management efforts and a nearly impossible task if nearly all the merchantable material has been extracted prior to current ownership and the bulk of forested area is supporting young stands from 17 to 35 years old. In this latter case, the standing new forest can be the result of actions that may have had a deleterious effect spanning more than a single rotation of tree growth. Putting things to rights in such a forest is more a project of long-term rehabilitation than short-term improvement to an existing, manageable forest. Seeking a balance among the multiple functions of a forest is the purpose of a forest management plan

F1: Forest Classification and Mapping

During the spring and summer of 2012, the core forest area of the GPMCT ownership was aerially mapped. This mapping identified forest stands that were classified by a primary and secondary species, a development class (seedlings, saplings, poles and sawtimber) and a stand density based on the percent of crown closure across the area of each stand. There are 223 polygons mapped on the Hothole Block, some of which are non-forest types like water, beaver flowages, alders, etc. These non-forest types account for only 35 acres of the Hothole Block total acreage. The remaining forest cover types, though quite specific, are grouped into larger categories called strata for general summarization of both land area distribution and for inventory results (see G2, below). The resulting digital map data was organized into a Geographic Information System (GIS) as a series of explicitly-related data tables so that area summation by other commonly used classifications was possible. Thus, the delineation of areas during the Dibble & Rees Resource Inventory project according to Natural Community types is now possible. In addition, linkages were made to the following classification systems:

- GPMCT WILDLANDS Detailed Forest Cover Types
- GPMCT WILDLANDS Forest Habitat Communities
- Maine Species Groups
- Forest Inventory Strata
- GPMCT WILDLANDS Forest Structural Classes (Horizontal & Vertical)
- Maine Natural Communities
- Society of American Forest Cover Types
- World-wide Ecosystem Classes (NatureServe)
- National Vegetation Cover Types (NRCS)
- Landscape Position

Keeping this data current can be a daunting task, but it is made easier by the ability to change stand cover type assignments based on sample field data. This is usually the case when a stand of some type designation has been treated and an adjustment to the cover type becomes necessary. As the forest grows, changes may occur to species mix, development stage and density. These changes may be incorporated as updates to the GIS database as they occur or on a regular planned basis.

In addition to forest and non-forest cover types, additional mapping was done to identify roads and water features present on the Hothole and the Dead River blocks. Road features have been classified as to their use and condition and will soon add another database for culverts and bridges that will be related to specific road segments. Each culvert and bridge has been mapped and the size, condition and placement information has been recorded and will make road maintenance planning much easier. Mapped stream features have corrected, where necessary, those originally mapped by the U. S. Geological Survey.

Shortly after the acquisition of the Hothole and Dead River blocks in 2005, a survey of property boundaries was completed by Plisga & Day of Bangor, Maine, a very experienced and reputable firm. The result of this survey was a plan showing the location and condition of all boundary lines and corners (see Section D1, page 42 and Appendix A, page 114 for map). This boundary data was also made available to GPMCT as a digital file which was added to the GIS system and forms the basis for records of boundary maintenance.

F2: Forest Inventory

In early 2014, an inventory of the entire forest was completed in an effort to fully describe the condition and quantitative characteristics of the resource. This inventory consisted of a sample design that first, organized the forest lands of GPMCT into strata that contained forest stands defined by their broad forest type (**IH** - Intolerant Hardwood; **TH** - Tolerant Hardwood; **PH** - Pine/Hemlock; SF – Spruce/Fir and LC – Lowland conifer). Further stratification consisted of organizing stands by a combination of development class (Seedling, Sapling, Poles, Sawtimber) and density of cover measured by a range of crown closure. The design also specified that 593 variable-radius plots would be employed using Basal Area Factor - 15 glass prisms to select trees to be measured. These plots were allocated to strata based on stratum variability and area. Individual stands with a minimum area of 8 acres were randomly selected within each stratum and a minimum number of 5 plots were randomly located within selected stands. Data compiled in the field captured forest characteristics as of the completed 2013 growing season before the start of the growth period for 2014. Reporting of inventory results is detailed in the State of the Forest – 2014 report in Appendix B, page 128. Some highlights that cover the entire core area landbase are:

- *Total land area has increased 11.6% (due to 2011/2012 acquisitions)*
- *Forested area has increased by 9%*
- *25 tree species are found on the lands of GPMCT WILDLANDS. (57% of all trees listed in the Trees of Maine publication).*
- *13 natural communities are found on the lands.*
- *15 cover types described by the Society of American Foresters are present.*
- *13 vegetation types from the National Vegetation Classification are present.*
- *10 distinct terrestrial ecosystems recognized by NatureServe are present.*

- *Growing stock levels are only 27% of what they should ultimately be.*
- *Only 32% of the total growing stock consists of healthy trees acceptable for continued growth and quality improvement.*
- *Bare land value has increased by 24% over the past 9 year period (2.69%/Year)*
- *Value of standing inventory has increased by 1,945% over the same 9-year period. (216%/Year)*
- *Total, combined value (bare land + standing inventory) has increased by 64.6% (7.17%/Year)*

From a forest management standpoint, the two facts highlighted above represent a serious condition that needs attention. This evenaged new forest (with rare exception, most stands are within 20 years of age) is generally understocked, largely because it is still quite young, but the fact that the quality of the growing stock is low and if left untended, well produce a surfeit of material that isn't worth much at all. Data on the existing condition of the forest resource in the Hothole block (Section D4, page 52) underscores the need to begin rehabilitating this degraded (some would say "looted") forest.

The Hothole Block inventory consisted of 426 sample plots where data was taken on tree species, DBH, Product potential, Crown position, Defect percentage, and Merchantable product limiting height. These sample points generated an average total basal area value of 75 square feet that varied ±12.9% at a probability level of 90%. Another way of saying this is that, with a similar sample, 9 times out of 10 the new estimate would not exceed 12.9% of the new average total basal area. This is a good, reliable sample. For individual strata for which silvicultural recommendations were developed, the following standard errors on total basal area were obtained for the NRCS-specified 67% confidence interval (two times out of three):

- Intolerant Hardwoods – Avg. basal area of 73 sq. ft. ±8.25%
- Tolerant Hardwoods – Avg. basal area of 101 sq. ft. ±9.39%
- Pine/Hardwood Mix – Avg. basal area of 81 sq. ft. ±6.96%
- Spruce/Fir – Avg. basal area of 90 sq. ft. ±6.74%
- Lowland Conifers – Avg. basal area of 117 sq. ft. ±15.82%

Volumes for each tree measured in the inventory sampling were computed on the basis of total height, diameter at breast-height (DBH) and current limits of merchantability in our area for commercial products within broader species groups. Computations were based on total height equations for this region (Greene, 2009) and tree taper functions developed for our species, regionally (Honer, 1968). These equations allow for computing inside bark diameter at any point along the stem, so that as merchantability specifications change over time, volumes may be adjusted to these new specifications. All volumes are computed in cubic feet and commonly accepted conversions are used to generate volumes in cords and green or dry tons. Board foot volumes are computed by determining log lengths that minimize non-merchantable residual segments and applying a direct application of the International ¼ log rule values to the computed top-end, inside-bark diameters of each log. Log volumes were summed for each tree and then further processed to generate inventory volumes on a per-acre basis for each stratum and for all strata combined.

Keeping a forest inventory up-to-date is a task that is usually completed at the same time as updating the GIS database. Inventory updates are also a part of the State of the Forest report and these updates are accomplished by a "Rolling Inventory" process (Greene, 1999). For long-term forest management, the need for revised estimates of current standing inventory has been satisfied by either a periodic re-inventory, or by the remeasurement of a network of permanent sample plots. Estimates of the amount of area represented by each stratum typically have come from forest mapping efforts that may, or may not have coincided with periodic inventories. In the latter case, the number of plots in each stratum has been taken to be representative of the actual distribution of stratum acreage.

The *Rolling Inventory* method relies on the use of successive sampling to validate the projection of an original inventory. Using GIS to keep track of changes in stratum acreage (numerically and spatially), and a growth model specific to the forest types involved, a small sample from stand-level plots can be used to validate the original projections by stand and focus on portions of the forest, if desired. Stands not treated have original sample plots that will be grown forward to a current time period and added to as necessary. Generation of statistical data to evaluate the reliability of comparison between the projected sample and the smaller, *Rolling* sample is an essential component of such a system. The effects on overall sample error of multiple successive samples is reported in clear, concise form.

Use of this approach aids managers at all levels in focusing on methods to make stand and forest level decisions (and their effects) more understandable. For this method to work properly, sufficient data and information on growth and yield of various forest types must be obtained and formulated for use in the widely-used model formulation known as the Forest Vegetation Simulator or FVS.

In a test of the effectiveness of the Rolling (annualized) Inventory approach over a 7-year period in North-central Pennsylvania on an ownership of approximately 65,000 acres, a comparison with an intensive re-inventory showed that the prediction of total volume from the Rolling Inventory was within 2.8% of the new inventory. For those species comprising 95% of the total volume, the difference between the Rolling Inventory and the new field inventory was 1.3%. Differences among species groups varied from 1.5% to 25%, depending on the species frequency of occurrence and overall variability in volume. Several medium and large companies are now using an annualized inventory process to keep costs down and to improve stratum estimates over time.

F3: Management Recommendations – Strategic and Tactical

It has been previously stated that the current GPMCT Hothole Block forest is young, in relatively poor condition and evenaged. General forest management recommendations made in Section C3b, page 37, consist of several tasks that, if fully applied, should address each of the 5 ownership-level goals. These recommendations, taken as a whole, deal with the following:

- Rehabilitating the forest to improve forest health, stability, tree quality, ecological functionality and productive capacity.
- Establishing a balance among the multiple functions of the forest by improving diversity of species and structures while maintaining a natural appearance.
- Providing for sustainability of forest and non-forest communities without adversely impacting other attributes of the landscape.

The best way to approach meeting all these and ownership goals is to rebuild the forest in a different manner than it would ordinarily develop without intervention. Developing a continuous high-forest cover seems to be an essential desired component for most of the forest. So, how should we go about doing this – changing a young, evenaged poor-quality woodland to a majestic forest of healthy trees of all species, both large and small, with all sizes in between? The direction, or form of management that may be most suitable to apply has many descriptions:

- Continuous Cover Forestry
- Close to Nature Forestry
- Natural Disturbance Silviculture
- Near-Natural Forestry (Europe)
- Unevenaged Forestry (North America)
- Plenter System Forestry
- Irregular Forest Management

All these types have one thing in common – a continuous forest cover. The focus is on individual trees and groups of individual trees. Selection of trees to remove as well as to retain is made by evaluating risk of loss, overall health and vigor, crown development, rooting firmness, presence of defects, etc. In the past, most large, forested tracts owned privately tended to be managed for either a continuing supply of raw material or to generate a continuing source of revenue or return on investment (ROI). The easiest way to accomplish these management objectives was to grow forests in evenaged stands, where ages would vary across the landscape and provide a steady flow of either wood or income. Plantation forestry in the Southern Forest is a good example of this approach, where stands of a single species were planted and grown for a specific time period, then completely harvested and replanted. This is a monoculture and often exposes the forest to devastating attacks by insect or disease pests. If one planted and grew a crop of trees for a given time period, say 35 years, then if one acre was to be cut each year, 35 acres – each a year apart, would be necessary to provide a sustainable yield. It's simple and sustainable if done properly.

In the Northern Forest, it's a bit more difficult in that the mix of species is greater and very prolific. Evenaged plantation management has difficulties in that while the costs of establishment are similar, the result of planting allows other native trees to seed into the plantation, sometimes overwhelming the planted trees and slowing the growth on all of them. Removing sufficient extra trees (volunteers) costs money and if done a few times in the length of growing time planned (the rotation), may make planting trees cost-prohibitive. That is not to say that managing stands in the Northern Forest should not be done on an evenaged manner. It does work nicely with native species, but the regeneration process of harvest often creates large openings and a dramatic change in appearance. The ownership goals and conversations with GPMCT Board members and others have expressed a preference for more of a continuous forest cover approach, which brings us to something referred to as "unevenaged" management. In this method, stands always have trees standing. There are, however, periodic gaps in stands as measures for regeneration are created. Even in natural, undisturbed unevenaged stands, openings are created where large trees fall and create spaces with more light.

Efforts to mimic this natural disturbance process consists of making smaller openings in the forest whose size is adjusted to the light requirements of the desired species to regenerate. Both the existing and newly-regenerated growing stock have several simultaneous objectives:

- <u>*Manage the present condition*</u> before seeking an ideal composition and structure. The current growing stock is still developing in both size and volume, but will need time to reach the point at which the transition from evenaged to unevenaged, irregular structure can be made. This time period should cover about 60 years with some 5 to 6 light thinnings spaced from 10 to 15 years apart.

- *Protect and encourage younger stems of good quality* by maintaining older trees of moderate value. Using older trees of acceptable quality and vigor to help train the smaller, younger trees that will eventually replace them will provide for the earliest income of more valuable products and ensure a continuing supply.
- *Create a healthy forest*, resistant to diseases, insects and extreme weather events.
- *Increase species diversity and adaptability* of stands to better respond to market demands and in a response to climate changes.
- *Control costs* by making the best use of biological automation and available funding.

Growing stock treatments will vary, depending on the species mix that occurs in each stand. Silvicultural treatment regimes should recognize differences in composition that will change naturally or with treatments as stands develop. Present combinations of species have been made unclear due to the intensity and extent of past heavy harvest activity. How and where certain combinations will appear and flourish, will depend on monitoring the effects of silvicultural treatments as stands are guided towards conditions of species mixes that may be perpetuated more easily. In the meantime, it is easier not to apply hard and fast composition labels to what we see before us, but rather, to allow broad labels to define a range of species mixtures that, treated or untreated, develop into more sustainable groups. The grouping possibilities most useable come from preparations for the forest inventory stratification and consists of the following combinations in the figure below.

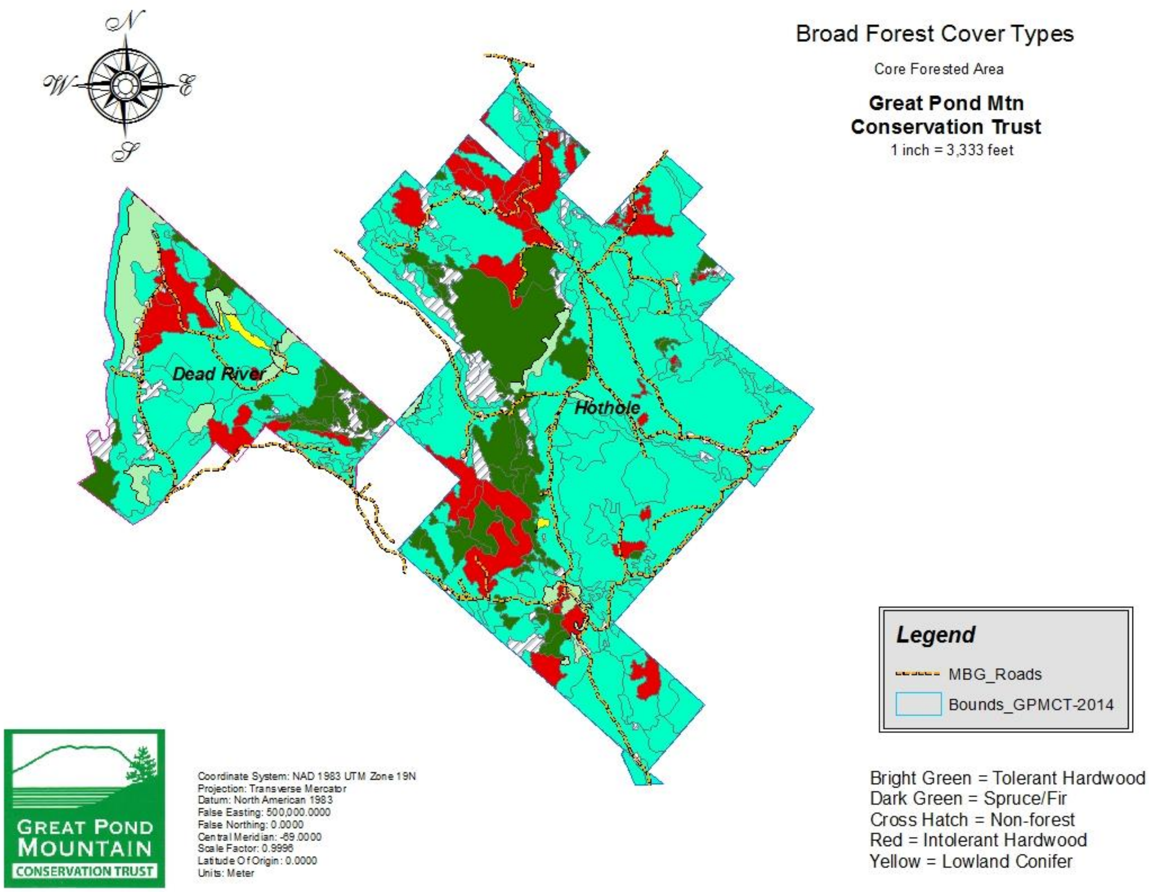
Figure 17 - Species Group Mixtures for Silvicultural Regimes

	Primary Spp Group				
Secondary Spp. Group	*Spruce-Fir*	*Pine-Hemlock*	*Lowland Conifer*	*Tolerant Hwd.*	*Intolerant Hwd.*
Spruce-Fir [SF]	**SF**	PHSF	LCSF	THSF	IHSF
Pine-Hemlock [PH]	SFPH	**PH**	LCPH	THPH	IHPH
Lowland Conifer [LC]	SFLC	PHLC	**LC**	THLC	IHLC
Tolerant Hwd. [TH]	SFTH	PHTH	LCTH	**TH**	IHTH
Intolerant Hwd. [IH]	SFIH	PHIH	LCIH	THIH	**IH**

F3a) Recommendations for Broad Forest Types

The map below, shows the distribution of the broad forest cover types shown in Figure 17 (above) for the entire Core Area of the GPMCT ownership. Maps specific to the Hothole Block can be found in the Appendix (A).

Figure 18 - Broad Forest Cover Types for Core Area



Intolerant Hardwoods

In cases where the majority of the stocking consists of **Intolerant Pioneer Hardwoods** like Aspen, White or Gray birch, Pin cherry and sometimes Black cherry or Red Oak combined with lesser amounts of other, more moderately tolerant hardwoods like Red maple, Striped or Mountain maple or other similar species, these stands should continue to be managed on an evenaged basis. The Aspen-birch broad type is a prime habitat for a number of wildlife species and in order to maintain sufficient area in this type (about 350 acres) efforts should be made to encourage a mix of various development stages within each stand. This can be accomplished by thinning in irregularly-shaped strips or patches until such time as an effort to regenerate these stands should be made – normally at about 40 to 60 years, depending on stand health and site quality. At that time, regeneration efforts will require more light for seeds of Aspen and Birch species to become established, so openings in the stand will need to be in a series of open patches of three or four acres in size, irregularly shaped to conform to the landscape.

The schedule of regeneration patches should cover a period of 10 years between treatments. Larger stands will have a greater range of patch ages than smaller stands. Adjacent stand conditions, especially of the same broad type group should be considered for treatment at the same time, or maintained to offer more cover and protection to the regenerated patches. Current characteristics of this stratum are shown in the following table. These tables show composition and structure attributes for all material 5 inches DBH or greater as they are recognized as the most dominant vertical component.

Table 7 - Characteristics of the Intolerant Hardwood Stratum

Broad Stratum	Species	Trees/Ac	BA/Ac.	QMD	Avg. Ht.	Merch. Cubic Ft.	Sawtimber Cubic Ft.	Gross Bd. Ft.
IH	Red spruce	0.72	0.7	13.4	61	15	2	13
	Balsam fir	2.24	2.37	6	43	37	6	33
	Hemlock	0.25	0.26	13.7	55	6	0	3
	White pine	12.17	6.61	10	61	157	111	746
	Cedar	4.33	2.79	10.9	44	45	26	173
	White ash	0.72	0.28	8.4	70	7	0	0
	Red maple	9.86	5.51	10.1	64	116	22	136
	Sugar maple	6.56	2.89	9	62	60	2	13
	White birch	3.52	1.17	7.8	43	15	3	17
	Yellow birch	10.91	3.05	7.2	50	41	4	21
	Beech	8.47	1.58	5.9	47	22	0	0
	Quaking aspen	1.87	0.53	7.2	51	9	0	0
	Bigtooth aspen	7.39	1.13	5.3	38	3	0	0
	Red oak	5.41	3.84	11.4	59	61	30	215
	TOTALS:	**84.44**	**32.71**	**8.4**	**52**	**592**	**207**	**1371**

Other species in these Intolerant Pioneer Hardwood stands in lesser amounts may be an indication that the more realistic management direction may be to encourage these other species (especially if there are abundant conifers present in an understory) towards dominance of the site. This will involve a species conversion over a period of time and in areas where the possibility of managing an evenaged stand of Aspen-birch species exists, it should be applied. Site quality will be the most important factor in the decision of whether or not to encourage a species conversion.

From a wildlife standpoint, the creation of irregularly-shaped patches every 10 to 15 years will assure that early successional trees and brush offer cover, food and nesting habitat on a continuous basis as stands regenerate.

Tolerant Hardwoods

This mix of predominant species that are shade-tolerant. Typically the Beech-Birch-Maple cover type where the birch referred to is Yellow birch. Red maple also in part of the component along with Sugar maple. The intolerant White ash is also found on the moister portions of this type, as can White or

Gray birch but in minor amounts on the Hothole Block. Striped and Mountain maple, along with Eastern hop hornbeam occur in the understory, usually dominated by succeeding smaller Beech. Usually found on the more northerly-facing slopes, this combination used to cover most of the hardwood sites on the Hothole Block, but it is now broken up into large swaths of Beech-dominated stands of poor quality with scattered remnants of the other species. Characteristics of this stratum for trees 5 inches DBH or greater are shown below.

Table 8 - Characteristics of the Tolerant Hardwood Stratum

Broad Stratum	Species	Trees/Ac	BA/Ac.	QMD	Avg. Ht.	Merch. Cubic Ft.	Sawtimber Cubic Ft.	Gross Bd. Ft.
TH	Red spruce	8.44	2.08	6.7	40	36	10	54
	Balsam fir	8.14	1.8	6.4	45	30	4	21
	Hemlock	8.12	5	10.6	45	101	22	131
	White pine	3.55	1.89	9.9	62	47	28	186
	Red pine	0.26	0.04	5	0	0	0	0
	Cedar	2.41	1.72	11.4	43	26	11	84
	Black cherry	0.34	0.09	6.8	49	1	0	0
	White ash	2.37	0.64	7	60	14	0	0
	Black ash	0.18	0.08	9.1	69	2	1	4
	Red maple	7.27	2.95	8.6	59	58	4	29
	Sugar maple	12.04	4.09	7.9	58	73	12	77
	White birch	3.02	0.85	7.2	40	12	2	13
	Yellow birch	5.93	2.21	8.3	54	37	2	15
	Gray birch	0.04	0.01	5.6	35	0	0	0
	Beech	46.46	10.92	6.6	50	187	0	0
	Quaking aspen	1.01	0.21	6.2	44	3	0	0
	Bigtooth aspen	1.31	0.28	6.3	44	4	0	0
	Balsam poplar	0.59	0.15	6.9	46	3	0	0
	Red oak	2.81	1.31	9.2	56	24	7	47
	Eastern Hophornbeam	1.28	0.22	5.6	40	2	0	0
	Striped maple	0.27	0.04	5.2	40	0	0	0
	Other Hwd.	0	0	5.9	42	0	0	0
	TOTALS:	**115.85**	**36.57**	**7.6**	**50**	**659**	**104**	**661**

Of particular interest is a species that is found rarely but can be very useful in selected habitats. This species is American basswood (sometimes called American linden), which may have been more widely distributed in a predominant mixture with Sugar maple. Found on deep, moist sites, this species prefers lower slopes and there is some found alongside the Valley Road north of the Flag Hill road intersection. On Oak Hill's north side, a remnant stub of Basswood 34 inches in diameter has been found. Where possible, this species should be an encouraged associate of the Tolerant Hardwood types containing a larger proportion of Sugar maple. Basswood is also an additional species that supports pollinator habitats. White ash should serve as an indicator of where Basswood could flourish. As limited species are found in greater abundance due to treatments designed to increase them (like Basswood), wildlife will benefit. In the case of Basswood, the flowers are very good sources of nectar for pollinators, as is Chestnut, once they begin flowering.

Stands of predominantly tolerant hardwoods should be managed towards developing an irregular structured unevenaged condition. Currently, the present stands are all evenaged and should be lightly thinned at a 10 to 15 year interval to first adjust species composition and improve basal area growth by reducing poor-quality Beech, then by retaining better, more vigorous Sugar maple, Red maple, Beech, Yellow birch, White ash, Red oak and understory Hop hornbeam. As the stand reaches an age of from 50 to 70 years, the transition to an unevenaged condition may begin by initiating a series of small, irregular openings no larger than perhaps 3/4 acre in size and limited to 10% of the stand's area at each entry at the same 10 to 15 year interval. As maximum basal area stocking of 100 sq. ft./acre or more, management as an irregular stand may begin by conducting light removals to afford more crown expansion room in all development classes from poles to large sawtimber. Small regenerated patches should also be treated, but largely to make adjustments to species composition.

Where scattered conifer species like Red spruce, White pine and Hemlock are found in the stand, some of these better quality trees should be carried to maturity in order to increase diversity and offer habitats that tolerant hardwoods do not. A mix of scattered conifers offers roosting habitat for birds such as turkey, partridge and other song birds.

Since these stands will have species that will last longest, rotation ages with associated maximum size should be in the neighborhood of 100 years to a maximum of perhaps 125 years. As stands of healthier trees matures, there should also be an increase of both hard and soft mast as healthier trees produce large seed crops on a more frequent basis. Numerous species of wildlife will benefit. In areas where Sugar maple predominates, the opportunity may exist to establish a small sugarbush for the production of an annual crop of maple syrup.

Pine-Hemlock

Stands dominated by White pine and Hemlock are scattered and may be only a secondary component. In riparian areas, Hemlock is generally the major component, rather than White pine, which has always been a preferred species to remove. The White pine now usually occurs as a scattered overstory that developed from residual trees too small to harvest during the last major cutting by the previous owner. Where it is found, it is scattered among hardwoods of either tolerant or intolerant species or a minor stand component where spruce and fir are the more dominant conifers. Characteristics of this stratum for trees greater than 5 inches DBH are shown below.

Table 9 - Characteristics of the Pine-Hemlock Stratum

Broad						Merch.	Sawtimber	Gross
Stratum	**Species**	**Trees/Ac**	**BA/Ac.**	**QMD**	**Avg. Ht.**	**Cubic Ft.**	**Cubic Ft.**	**Bd. Ft.**
PH	Red spruce	43.63	14.58	7.8	43	306	183	1032
	Balsam fir	27.09	6.67	6.8	47	123	0	0
	Hemlock	21.43	9.54	9	39	177	63	376
	White pine	25.53	12.51	9.5	62	284	142	884
	Cedar	6.2	3.44	10.1	42	54	15	81
	Red maple	25.75	18.13	11.4	68	372	56	355
	White birch	6.06	3.22	9.9	50	56	27	151
	Yellow birch	3.34	3.33	13.5	69	68	28	152
	Bigtooth aspen	1.68	1.15	11.2	65	29	0	0
	Red oak	1.19	1.03	12.6	69	9	9	62
	TOTALS:	**161.9**	**73.69**	**9.1**	**52**	**1480**	**522**	**3094**

Where White pine is present, it should be encouraged to take a more prominent place in the stand. This can be done by releasing subordinate trees with live–crown ratios of at least 40% and of good quality during early light thinning treatments while the stands are still evenaged. As the transition to the unevenaged, irregular structure begins and small patches of regeneration are created, the openings must be large enough to allow White pine to become established in greater numbers along with Hemlock and other species. Keeping the newly-regenerated patches dense will discourage weevil damage to pine leaders and allow the accelerated height growth characteristic of the species. Using other species as a "nurse crop" will further protect the White pine from weevil damage and produce healthy, straight stems rapidly. Using Hemlock along with any hardwoods present (tolerant or intolerant) to encourage self-pruning until the pine reaches 40 feet in total height with a 40% - 60% live-crown ratio could be the point at which a heavier thinning of other trees to adjust both species composition, diversity, spacing and individual tree quality might be made. Further thinning to increase growth rates in individual trees should be made based on the latest thinning guides for White pine and mixed species stands. Vertical dimensionality will increase rapidly at this point as pine becomes a "super-story" above the main crown canopy and the remainder of the species coexist between and beneath the White pine.

In terms of maximum age carried, White pine could live well beyond the 100-year mark and some individuals could be carried to 150 years and very large size to occupy a semi-permanent place in the stand until they succumb to old age (400+ years). Hemlock present in the stand could be carried as long but in fewer numbers as its value has been historically low. If this improves, there could be more of it in the maturing stand. Once these trees increase beyond 80-100 years of age, their financial return through additional growth becomes lower, but since financial return is not an immediate priority, it can be ignored for the next 50 years. For some level of revenue to be generated from all managed stands, the limit on the largest diameters to be grown by species should be specified as it relates to the availability of equipment designed to handle and process larger diameter stock. The maximum DBH could vary from 14 to 16 inches for Quaking aspen, Balsam poplar and Black spruce to 35 or more inches for White pine, Hemlock, Sugar maple, Yellow birch and Red oak. Much depends on the growing site and how the trees are developing, along with tree vigor and risk of loss.

Lowland Conifers

These stands are usually found in on poorly-drained sites where growth is slow and stocking is high. Species like Northern white cedar, Tamarack, Red and Black spruce and some Balsam fir predominate. Hardwood associates like Red maple and the occasional Yellow birch along with alders, winterberry and other shrubs (as well as the invasive honeysuckle) may be found. Summary of trees 5 inches DBH and larger are shown below.

Table 10 - Characteristics of the Lowland Conifer Stratum

Broad Stratum	Species	Trees/Ac	BA/Ac.	QMD	Avg. Ht.	Merch. Cubic Ft.	Sawtimber Cubic Ft.	Gross Bd. Ft.
LC	Black spruce	5.34	2.33	8.9	48	42	34	207
	Balsam fir	24.17	5.82	6.6	48	105	14	68
	Cedar	75.3	27.31	8.2	36	349	186	1077
	Red maple	19.28	7.66	8.5	60	163	0	0
	TOTALS:	**124.09**	**43.11**	**8**	**43**	**659**	**234**	**1353**

Depending on stand composition and the type of site, many of these currently low stocked areas could become prime quality deer wintering yards if managed towards that end. Only stands that have regenerated to a preponderance of Red or Black spruce and Balsam fir with Hemlock would suffice for an attempt at “rebuilding” an adequate deer wintering area. Managing these stands for forest products is a very low priority due to the low productivity of the sites upon which they are found and are better off as maintained wildlife habitats. With sufficient stocking, these stands can withstand heavy snow and ice storms while providing good cover. Currently, though, their stocking has been reduced by past excesses and it will take time for them to increase to the point where they can be managed properly, even though the management will be limited and extensive, rather than intensive.

Spruce & Fir

Conifer stands predominantly composed of Red spruce and Balsam fir are usually found on what are called “primary” or “secondary” conifer sites. Primary softwood sites are those with poor or impeded drainage in lower topographic locations such as spruce-fir flats or swamps. Here, Red spruce and Balsam fir will dominate the site, with few hardwoods like Red maple, Yellow birch or Aspen found scattered throughout. Secondary softwood sites are those that occur on more well-drained soils at a slightly higher topographic position like lower and mid-slopes and also on the thin soils of ridgetops and bald summits. On the former two, there may be hardwood species that could occupy from 25 to 75% of the stand. Hardwood species found here include Sugar maple, Yellow birch, Beech, Striped and Mountain maple. Generally, the lower the site, the sooner both spruce and fir will completely occupy the stand. This stratum’s characteristics are shown below.

Table 11 - Characteristics of the Spruce-Fir Stratum

Broad Stratum	Species	Trees/Ac	BA/Ac.	QMD	Avg. Ht.	Merch. Cubic Ft.	Sawtimber Cubic Ft.	Gross Bd. Ft.
SF	Red spruce	20.59	7.81	8.3	45	157	71	403
	Black spruce	0.75	0.42	10.1	50	8	7	40
	Balsam fir	32.83	7.85	6.6	46	130	11	62
	Hemlock	6.01	2.53	8.8	39	45	7	43
	White pine	9.09	4.65	9.7	61	100	57	354
	Cedar	14.81	7.16	9.4	40	102	19	121
	Red maple	15.72	8.81	10.1	63	191	21	138
	Sugar maple	0.2	0.19	13	73	2	2	14
	White birch	1.62	0.68	8.8	47	8	1	8
	Yellow birch	4.2	1.41	7.8	54	26	0	0
	TOTALS:	**105.82**	**41.5**	**8.5**	**49**	**770**	**197**	**1183**

Areas on the Hothole Block with a good showing of Red spruce and Balsam fir with some Hemlock, too, generally have some scattered hardwoods. Due to the previous heavy cutting, the composition of these stands has changed and in time, many of these sites will produce the typical softwood sites mentioned above. For the time being, if we look at the Soil/Site Productivity map, the fair sites should develop into primary softwood sites regardless of what is present now. The good sites, on the other hand, could become secondary softwood or mixed species sites, depending on a variety of factors which should be assessed as they become candidates for treatment.

Conifer stands composed of spruce and fir should be transitioned to the desired unevenaged, irregular structure with a sequence of light, low thinnings that should begin at age 30 to 35, or when the stand reaches 4.5 inches and has a minimum total basal area of more than 75 sq. ft. Removals should not be greater than 25% of the total cubic foot volume. These thinnings should continue on a 10 to 15-year interval until a mean stand diameter of 7 inches is reached. At that time, the transition to the unevenaged, irregular structure can be initiated by making small openings no larger than ¼ acre by group selection methods. Like the hardwoods, the number of openings made in each entry period should not exceed 10% of the stand area.

Since these conifer species on poorer sites are subject to windthrow during extreme weather events, thinning treatment in all diameter classes should seek to develop trees with at least 40% live crown ratios and a height to DBH ratio of less than 80%. The object here is to avoid trees too slender to resist the forces of moderate winds (Kamimura et al, 2008; Wonn, 2001; Gardiner et al, 2008; Ruel, 1995; Canham et al, 2001).

One of the products to be marketed soonest are Christmas trees. In the past, two stands (87 and 160) containing Balsam Fir, Red Spruce, White pine along with other species of intolerant hardwood have produced an ample supply of "Wild-grown" trees for sale during two days scheduled in late November and early December. The scattered Balsam fir growing on the Hothole Block have been growing in height at a rate between 1.5 and 2.5 feet per year for the last several years and many are now either out of reach or too large to be useful as Christmas trees. About 70 to 100 trees have been sold as Christmas trees for the last 8 years and the available supply has diminished rapidly. The sale of minor forest products is important in that it contributes, no matter how small, to the revenue gained directly from the forestlands and in a way, helps fill a gap in the production of saleable goods. In the present condition of Stand 189, there is little room for new trees to become established, unless it occurs in old skid trails where the birch (mostly) was delayed in becoming established by the heavy mechanical disturbance. Due to the abundance of light on these old trails, a heavy grass cover has also developed. While the main objective is to guide the development of the existing stand into a healthy mixed-species, irregular structure typical of a multi-aged forest with continuous cover, a secondary objective can be to produce Balsam fir and White pine for use as Christmas trees.

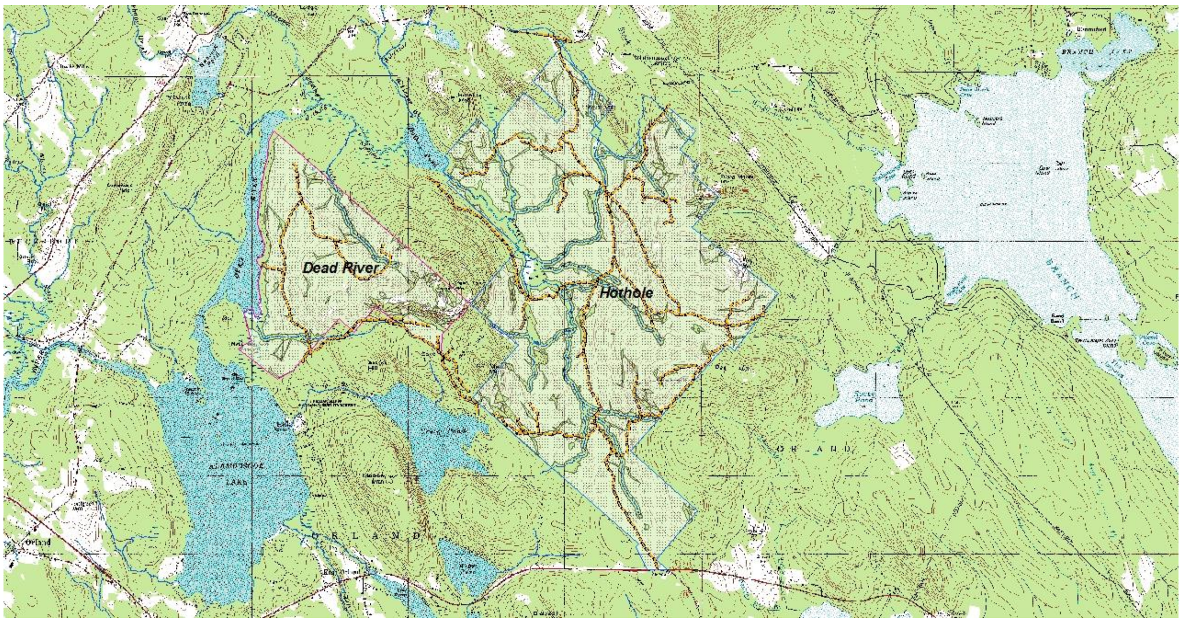
To accomplish these objectives, the limited volunteer resources available has been put to good use by creating semi-cleared strips 50 feet wide by 400 feet long – about a half-acre. Oriented in an east/west direction and beginning just beyond the old log yard, each of these strips would provide a seedbed for Balsam fir, Red spruce and White pine seeds available from the rapidly maturing overstory. Two such strips may be connected end-to-end in order to span the approximately 800 foot distance between the outermost skid trails. The 50-foot width should be adequate to provide sufficient light, while conserving moisture for successful regeneration. Selected overstory trees of the three preferred species (Red spruce, Balsam fir and White pine) would be retained to provide some protective cover, without inhibiting the development of the newly established trees. Residual basal area for these overstory trees should be at least 65 sq. ft. in their current stage of development (small poles). They would also help control the numbers of germinating seedlings with the partial shade they provide, so instead of 40,000 or more new seedlings, there might be 4,000 or less. This will make the initial thinning to remove competing hardwoods and identify potential crop trees (both for Christmas trees and future high-quality sawtimber) more efficient. Ideally, after the first tending entry after the seedlings have reached about 3 feet in height (about 6 or 7 years) there should be 1000 to 1200 trees per acre of crop trees. These crop trees may become Christmas trees if Balsam fir or selected White pine and the others (Red spruce, White pine or a few high-value hardwood) retained to grow to sawtimber size. Another stand, 150, contains a portion of area that has a reasonable understory of Balsam fir with a light overstory of Quaking aspen. If the aspen can be cut and removed from the site, this area may also represent another area where Christmas trees may be managed. Its adjacent position to the Valley Road, a short distance north of the old gravel pit, makes access easy when the other stands may not be.

Repeat entries for tending both crops may be made at 2 year intervals for the Christmas trees and 6 year intervals for the trees destined for sawtimber. In Stand 160, a new strip should be established the following year, then wait for 7 years and establish two more in the next two years, waiting a year before the second one is cleaned. Each strip established and subsequently tended every 2 years, covers about a half-acre and should produce 400 saleable Christmas trees over a 9-year period until the height of the remaining trees exceeds 12 feet. At that time, a decision can be made whether to allow the trees to transition to logs or continue cutting for Christmas trees and taking the topmost portions for another two years or so. A total length of 4,000 feet of 50-foot wide strips will yield an indefinite supply of Christmas trees sheared every other year.

F3b) Operable Area for Forest Management

Where does managing the forest make sense? There are obviously places where trees grow poorly, slopes are too steep, too wet, near riparian zones or other places with unique characteristics that should not be disturbed. Areas identified as non-forest Natural Communities, slopes at or exceeding 25%, bald summits, streamside zones of 100 feet on each side and areas of highly-erodible soils, should be avoided. The result has been the identification of an area in which to concentrate forest management activities towards rehabilitating the Hothole Block forest. This area encompasses 3,706 acres on both the Hothole and Dead River Blocks. The Hothole Block operable portion is approximately 3,200 acres, or 94% of the total acreage. What this means is that sensitive areas, adverse slopes and the other features mentioned above, do not materially impact the ability to practice rehabilitative forest management on this area. Forest management operations should regard any features in areas to be treated that need to be avoided or receive special care due to their location or condition. The figure below shows the extent of the manageable forest area for both Dead River and Hothole Blocks.

Figure 19 - Operable, Managed Forest Area - Core ownership



F3c) Critical or Sensitive Areas

There are areas that have been identified by the Dibble and Rees study that were felt to warrant special attention due to their sensitive nature, collection of unusual plants and infrequency within the forested landscape. A large portion of sensitive area occurred in steeper locations on hillsides where soils might be subject to erosion if disturbed greatly. Operating in the Oak Hill area and following Best Management Practices (BMP's) for forest operations, we found that orienting access trails (designed to be permanent) at a crossing angle to the prevailing slopes offered good protection to the soils that even a 9.5-inch rainfall failed to disturb. Placing forest debris in the trails during thinning operations helped cushion machinery and prevent rainfall directly contacting the soil surface. A report of located natural areas in need of protection from the Maine Natural Areas Program is attached in Appendix C, page 129.

Wetland areas along streams should be protected and the buffer zones recommended by Dibble and Rees should be adequate at 250 feet for wetlands and 100 feet for streams on moderate slopes. Where small streams are present on more steeply-sloping mid to upper slopes, the water runs faster and poses an erosion threat if disturbed. These should be buffered according to the slope percent and if necessary, a 100 foot buffer should be placed around the entire portion of the upslope drainage basin. This has been done for the upper reaches of Hillside Brook and its 5 branches on Oak Hill with good effect.

There are also other areas where the use of forest machinery is either difficult, or impossible and while not mapped, these areas, usually with a high concentration of large boulders, will be avoided and left to develop on their own as they are encountered.

Areas of Inland Waterfowl and Wading Bird Habitat are present along the margins of Hothole Pond and Hothole Brook adjacent to the boundary line with Goodwin et al. These areas should be respected and avoided as the soils are wet and the areas tend to be swampy, particularly in the habitat along Hothole Brook where a large stand of Red maple swamp is located. Patches of rare Smooth Sandwort (*Minuartia glabra*) as well as early successional Swarthy sedge (*Carex adusta*), found in openings and usually lost to forest succession are found on the GPMCT lands and should be noticed, identified and avoided. The more common sheep sorrel (*Rumex acetosella*) is easily threatened by trampling around exposed bedrock summits and ledges as is sandwort.

Other marshes, swamps and wetlands, including the presence of vernal pools should be avoided and protected where found adjacent to stands undergoing remedial treatments.

F4: Silvicultural Regime Development

The development of silvicultural regimes specific to existing conditions and the management recommendations of each broad type group discussed above are currently under development. Included with the regime descriptions, timings and intensities is a decision key to determine under what circumstances and objective stand criteria each regime should be applied. As these are developed, they will be incorporated into this management plan as a normal revision made when appropriate.

Some initial treatments that could be incorporated into complete regimes have been made during the beginning of the 2016 operating season. Conducted entirely on the Hothole Block, these initial treatments were designed to install what should become permanent access trails and to make reductions in Beech within a 20-foot band on each side of an access trail. A variation has been designed to completely remove the Beech/Striped maple understory where is dominates the lower stratum of vegetation. In this treatment, the remaining overstory will remain for 10 to 15 years, at which time the second entry will seek to remove the worst of the pole-sized trees. Residual basal area is planned to be kept at between 75 and 90 square feet. A third variant has been tried that created patches of 1/3rd acre on one-third of the stand area where Beech was the dominating species at 87% of the total basal area. Species other than Beech were left standing where found. Subsequent entries into this stand will seek to add additional patches and examine the need to remove some trees in the first patches.

It will take a good deal of time to make the final adjustments to each stand such that treatments will be consistent (in both methods and income flow) and familiar to all. This is called the ***adjustment period*** and it applies to any situation where purposeful forest management is initiated in an unmanaged forest. At present, I expect initial treatments to begin at age 25 to 30 as stands are available and to continue every 10 to 15 years for a period of 50 to 60 years until the transition to unevenaged, irregular structures can begin. At that time this transition should take an additional 60 to 75 years to complete the structural adjustments and enter into a maintenance phase that will be consistent and lasting, at which time the job of rehabilitation of the Hothole Block forest will be complete. Trying to force the transition earlier will delay the process by reducing the amount of material available for harvest (and cost-covering revenue) within each stand.

In the meantime, unless the treated stands are monitored for their progress towards the ultimate goal, the small adjustments to treatments or the need to make revisions will be unknown. Monitoring the process of change will help to validate the changes that are made and the way in which they are applied.

F5: Establishment of Strategic Reserves

A final recommendation for forest management includes the identification and creation of **Strategic Ecological Reserve** areas where no active forest management will occur, unless some catastrophic event occurs, requiring remediation efforts.

These set-aside forest stands are designed to provide locations within the interior of the Hothole Block that can be left to develop without efforts at rehabilitation. In that way, there should exist some basis of comparison with those similar stands on similar sites that have undergone the full regimen of rehabilitative treatments to create an irregular, unevenaged forest structure.

One area mentioned in Dibble and Rees is the area to the north of the Hothole Pond Road and west of the Valley Road suggested as an ecological reserve. This area of about 24 stands falls in a region of large rocks, steep slopes and wetland forest area in the extreme northwest corner and include a very diverse variety of habitats as well as an old-forest remnant in Stand 79 along the west side of Hothole Brook.

Another prominent area is that on the upper slopes and crest of Great Pond Mountain where a bald summit and a spruce forest is present. It makes no sense to attempt to grow good forest trees in this location as the soils are thin, shallow and subject to windthrow during heavy storms.

As far as other areas in the Strategic Ecological Reserves, I would suggest that 10% of each of the area in major 5 forest cover types be set aside as reference areas. These should be selected as entire stands as they would be easier to locate and contain sufficient variety within to make a good comparison to similar types treated. They should also be on similar quality sites and not merely in places where it is difficult to operate. Below are the acreages suggested for each of the major forest cover types.

- Tolerant hardwoods – 230 acres
- Intolerant hardwoods – 40 acres
- Pine/Hemlock – 5 acres
- Spruce/Fir – 48 acres
- Lowland Conifer – 2 acres (all of current type)

It is most certain that forest cover types will change composition as treatments achieve their desired objectives for composition modifications. As they do, the acreage by broad forest type will change somewhat and that the Pine/Hemlock type will surely increase in area. The White pine in some stands where it is found is now a secondary species, but should rise to prominence in a few decades.

F6: Stratum Management Strategies

These strategies are in order of treatment priority for each stratum. Total stratum acres and the stands containing them will be examined in the field prior to final selection for treatment design, installation, operations and checkout. As full silvicultural regimes containing several treatments are developed and tested, the regimes may be applied to any and all stands within each broad forest type. How specific treatments will be applied will depend on the development class and density of chosen stands. The intensity of treatment will vary, but still remain light and conservative to avoid major changes that would expose any stand to damage by wind and weather.

Priority for treatment is a combination of broad forest type and soil-site quality as shown below:

Table 12 - Treatment Priority by Site Quality and Type

BROAD TYPE	NO. STANDS	ACRES	EXCELLENT	GOOD	Soil/SitePro Quality FAIR	POOR-V. POOR
TH	108	2316		**1**	**2**	**5**
IH	31	399		**2**	**3**	**5**
PH	7	47		**1**	**2**	**5**
SF	36	482		**3**	**4**	**5**
LC	1	2		**3**	**4**	**5**

There are no excellent sites on the Hothole Block, which is not unusual for forest soils in an area of extensive agriculture. As such, the first priority is to treat stands in the Tolerant Hardwood and Pine/Hemlock strata on good or fair sites, but also those intolerant hardwood stands on good sites. Immediate efforts and rehabilitating stands in these categories will concentrate on improving stands with a higher percentage of high-value acceptable growing stock in stands of small to medium poles in moderate to high densities. Spruce/fir stands (either pure or mixed) should be allowed to develop further before treatments shift to include them (at least 15 more years). Lowland conifer stands should be left to grow until higher priority stands have been treated at least once or twice.

F6a) Tolerant Hardwood Stands:

Tolerant hardwoods make up the bulk of the growing stock basal area and selected stands should be at least 30 years old and contain at least 85 sq. ft. of total basal area. They should also contain a higher proportion of high-value (from both forestry and wildlife habitat views) species that can provide tangible benefits to wildlife populations and income from increasing growth sooner than other candidates.

Among the initial treatments available to chosen stands are:

- ✓ *Understory removal if largely Beech and Striped maple.*
- ✓ *Light, free thinning in all crown classes to reduce diseased Beech and competition from poor-quality trees of all species.*
- ✓ *Small patch cuts covering no more than 1/3rd of the stand acreage with patches of 1/3rd acre spaced no less than 1 residual patch away. Desirable species of acceptable growing stock should be left to accelerate growth within patches.*

F6b) Intolerant Hardwood Stands

Stands chosen in this category should be on good sites so they can respond rapidly. Habitat considerations will lead decision-making as these stands need to be managed on an evenaged basis. Recommended proportion of short-rotation intolerant hardwoods needs to have about 350 acres (ultimately). Since we have 399 acres to choose from, finding suitable stands for initial treatment should not present a problem. Good sites will have a site index value of at least 60 (trees reach 60 feet in 50 years) and these sites should be treated first. Stands with a high proportion of well-established conifer species should be considered for advancing succession towards conifer species before treating as a short-term aspen or birch stand.

Thinning from below should commence when stands reach a total basal area of over 100 square feet and leave a well-spaced residual of dominant and codominant trees of acceptable growing stock that is no lower than 75 square feet. Successive thinnings should follow similar guidelines, but leave a higher residual basal are of perhaps 80 to90 square feet. Any high-value species should be retained if they are of acceptable quality, health and vigor and free from defects. These individuals can be released during the second thinning.

F6c) Pine/Hemlock Stands

Selected stands in this broad forest type should be at least 30 years of age and of moderate to high density with a mean stand diameter of at least 6 inches. By this time, there should be a relatively clear delineation between the total height of white pine and any hemlock of the same age in the stand as the pine will have started to emerge above other species. Invariably, these stands will contain other species including Red spruce, Balsam fir, Red maple, Red oak, quaking and Bigtooth aspen, White birch and others. Managing this as a mixed-species stand would be desirable to offer an abundance of habitats, while growing high-quality pine sawtimber. Early thinning should seek to release White pine and use intolerant hardwood species to provide some protection from weevil damage and to train the pine to shed branches cleanly at an earlier age.

In mixed stands like these, basal areas will be high and a reduction to perhaps 75 square feet should be the goal of an initial treatment. In future thinnings for tree quality, Hemlock should be used as a place-holder and should be the first species to remove to add growing space, unless other species of unacceptable growing stock are in abundance and crowding acceptable growing stock trees of any species. If White pine is in abundance, future thinnings can concentrate on releasing pine such that the residual basal area is between 50 and 60 square feet to provide room for the pine to accelerate in both height and diameter growth. Intolerant hardwoods should be completely removed by the time that stand reaches 60 years of age.

Since the acreage of this type is small, treatments to stands where White pine is a secondary species could add 31 acres to the total, if White pine is favored.

F6d) Spruce/fir Stands

Entering these stands once the higher-priority types have been nearly completed will offer stands that are more highly stocked than they currently are. Provided markets improve, these stands should be entered when they reach 40 to 45 years of age. There will be more merchantable-sized trees to help pay for thinning and favoring Red spruce at the expense of Balsam fir will improve the growth and income potential for these stands on good to fair sites.

Initial entry into these stands will be to apply a conditioning treatment to remove poor-quality, high-risk trees of all species and to retain a residual basal of 80 square feet. Future thinnings should be from below to improve the quality of growing stock until the stand reaches a transition age at which evenaged techniques could switch to the unevenaged single tree or group selection system. Residual basal area in the latter thinnings should leave 90 to 95 square feet.

F6e) Lowland Conifer Stands

No stand should be selected for treatment for at least 20 years, when remedial work to improve the health and habitat diversity of these stands could be done during periods of frozen ground and in a limited way with extremely light thinning.

F7: Treatment Scheduling

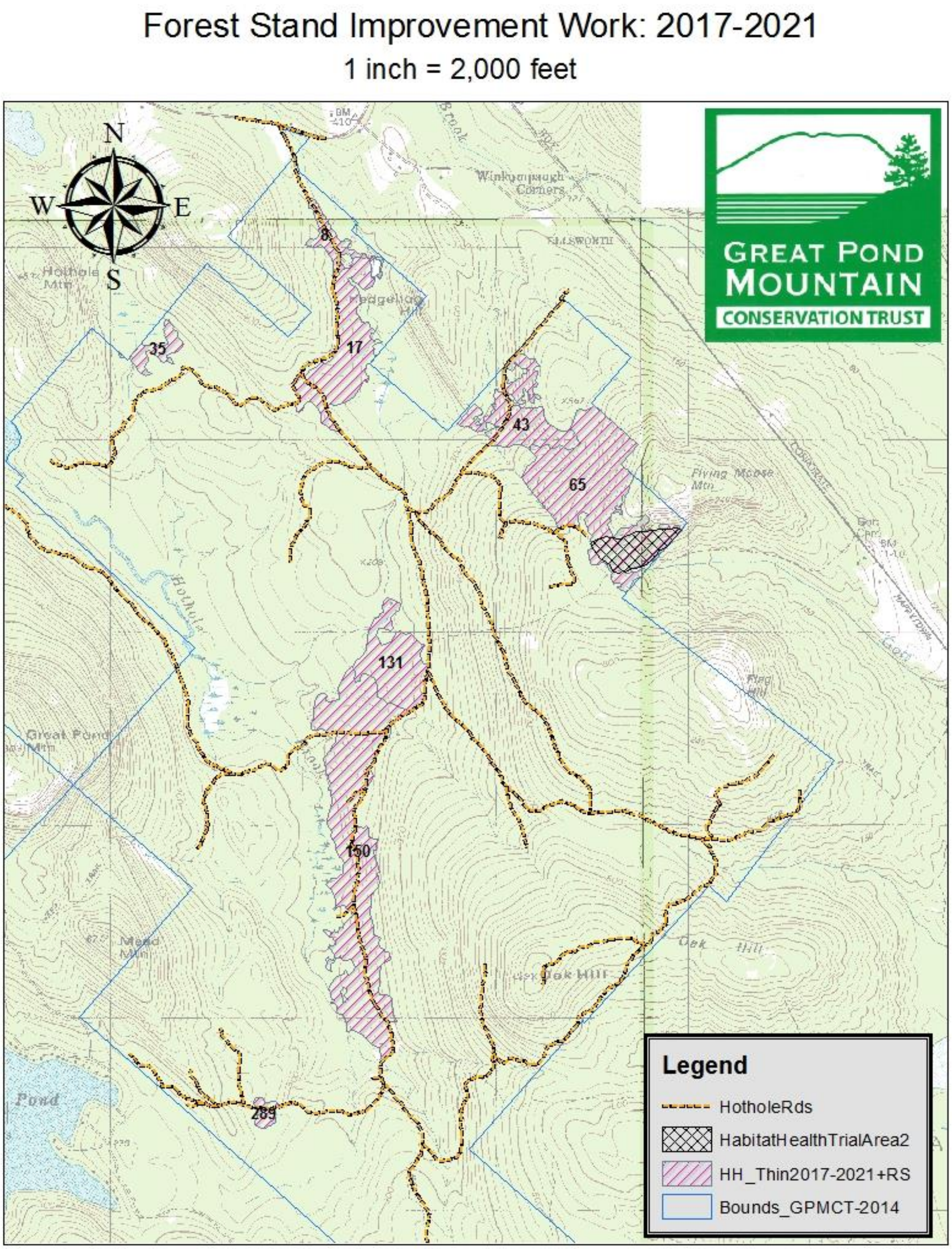
For the first 5-year planning period, plans are to complete 290 acres of light thinning (NRCS practice 666-Forest Stand Improvement) in the Tolerant Hardwood Stratum. Stand candidates have been selected for this first 5-year planning period and are listed below.

Table 13 - Planned Forest Stand Improvement 2017-2021

THINNING SCHEDULE 2017-2021								
Stand No.	Stand Acres	Thinned	Unthinned	2017	2018	2019	2020	2021
289	3	3	0	3				
8	8	8	0	8				
17	40	37	3	37				
35	9	9	0	9				
43	30	30	0		30			
65	69	69	0		30	39		
131	30	30	0			21	9	
150	109	109	0				51	58
Totals:				57	60	60	60	58

This forest stand improvement work will be conducted under a new NRCS contract for practice Code 666, Forest Stand Improvement – HU-thinning for Wildlife and Forest Health. Work on design plans and installation will commence upon contract execution. Stands scheduled to receive treatment are shown in the following map (a copy can be found in Appendix D, Page 130). The map in Figure 20 (below) shows the location of stands included in this 5-year program to improve the health and vigor of tolerant hardwood stands by adjusting species composition, horizontal and vertical structures and increasing the diversity of wildlife habitats.

Figure 20 - Planned Forest Stand Improvement Locations 2017-2021



F8: Access Recommendations

At this point the last 5 years have seen a good deal of activity on the Hothole Block to improve the condition of gravel roads, culverts and bridges. The grading of gravel surfaces, mowing of roadsides to reduce incursion by weeds and grasses into the right-of-way and the repair or replacement of several culverts has been conducted in an increasing amount during that period. A road maintenance plan that included culvert and bridge repairs, along with an annual budget is now in place. Additionally, a detailed inventory of bridges and culverts has been made showing not only physical location, but several characteristics that help determine appropriate sizing and condition.

Several culverts were completely washed out by a torrential rain in 2015 that dropped 9.5 inches on the Hothole Block in under 24 hours. The impact cut off access to most of the Hothole Block through the North Gate for most of the year. Funding was sought from NRCS, the Nature Conservancy and other sources that allowed the construction of three concrete box culverts with concrete-panel decks to be constructed on Baker Brook's West Branch and main crossing on the Valley Road, as well as a crossing over the upper reaches of Cascade Brook on the Hillside Road spur off the Flag Hill Road. A rock ford with 150 feet of cobbled rip-rap was also installed across Hillside Brook where the new west main access skid trail crosses.

Each year, conditions should be evaluated to schedule maintenance activities in the following categories:

- Culvert replacement based on improper sizing and condition.
- Removal of brush encroaching into the right-of-way.
- Rip-rap of steeply-sloping culvert outflows.
- Grading and ditching of roads prior to commencement of forestry operations.
- Raking/grading gravel road surfaces on several of the secondary branch roads.

All road data in the GIS system has been segmented in such a way that each road segment between connection points has a unique number. This data can be used to record places where work is needed during pre-season planning. The culvert inventory and GPS data on their location needs to be converted to a geographic database for use in planning and the production of maps for field use.

G. Best Management Practices

In the course of forest management activities, care should be taken to avoid creating damage to not only residual trees, but all other aspects of the forest. Attention is directed to a number of helpful references that should be consulted before, during and after making changes that can adversely affect water quality, erosion and sedimentation, wildlife populations, riparian habitats, roads and other infrastructure. The following is a list of relevant publications that should be on every manger's bookshelf.

Bentrup, G. 2008. *Conservation Buffers*. Gen. Tech. Rpt. SRS-109. USDA For. Serv. So. Res. Sta., Asheville, NC. 110 pp.

Forest Biomass Retention and harvesting Guidelines for the Northeast. 2010. Forest Guild Biomass Working Group, Santa Fe, NM. 17 pp.

Hunter, M. L., Jr. 1990. *Wildlife, forests and forestry: principles of managing forests for biological diversity*. Prentice-Hall, Englewood Cliffs, N. J. 370 pp.

Importance, Preservation and Management of Riparian Habitat: A Symposium. 1977. Gen. Tech. Rpt RM-43, USDA For. Serv. Rocky Mtn. For. Exp. Sta. Fort Collins, CO. 217 pp.

Moesswilde, M. 2004. *Best Management Practices for Forestry: Protecting Maine's Water Quality*. Maine Dept. of Conservation, Maine Forest Service, Augusta, Maine. 93 pp.

Murphy, A. A. 1982. *Forest Transportation Systems – Roads and Structures Manual*. Seven Islands Land Co., Bangor, Me. 55 pp.

Permanent Roads for Better Woodlot Management. 1973. USDA For. Serv. State and Private Forestry, Northeastern Area, Upper Darby, Pa. 45 pp.

I. Monitoring Changes & Trends – Adaptive Management

"In the case of trees and forests, as well as other living systems, improving on nature does not mean ignoring or distorting natural laws, but helping nature to express potentialities that enrich human life and increase ecological diversity, but that would have remained unexpressed in the state of wilderness." - Rene Dubos

I1: Long-Term Monitoring [Keeping up with changes]

Every time a tree falls, whether from wind and snow, old age, or from the axe, it changes the characteristics of the stand of which it was a member and (though the impact may be small) the whole forest. Many such changes occur every year and as the years pass the forest takes on a new look – hopefully better. But, how do we know if it IS better, compared to the original condition? The answer is to keep track of changes being made by man or nature that results in the current condition as seen by all. If the process is relatively simple, inexpensive and straightforward, it will be easier to find commitment to continue the process and that must be kept in mind.

The most objective way to keep track of the dynamic nature of a forest is to measure it – the parts that have been changed purposefully and those that have changed naturally. Sometimes keeping track of things is done on a periodic basis, like every 3 or 5 years. The danger with this approach is that it will be forgotten when it's time to do it and most likely, won't get done. The other way to do it is on an annual or regular basis during the year. This way, the updating of important data and information becomes a regular part of the organization's effort. Expense also enters into the approach chosen – whether it's better to budget for a regular annual cost, or to incur a periodic cost that may not be budget friendly. Let's take a look at the types of changes that occur and some suggestions on how to keep track of them.

I1a) Appearance

This is perhaps the first indication that something's different than what it was. Appearance will change sometimes subtlety or more dramatically, it depends on who's doing the looking. Since appearance is one of the elements that is important (see Section C4e, page 41), the best way to keep track of changes in this category is to simply, take a picture. One way to do this in repeatable fashion is to establish "picture points" that ensures that subsequent photos are taken in the same spot, direction and field of view. A series of picture points that highlight areas of interest and the rate of visual change is can be a welcome addition to discussions about changes that have taken place and what their visual impact has been.

I1b) Mapping

It's important to keep maps up to date to show the most current condition of not only forest stands, but roads, boundaries and other features of importance like forest openings, plantings, water features changes (like beaver influences) and the condition of planned vistas. Since the map data is contained in a Geographic Information System (GIS), changes in stand labels or minor changes to stand boundaries or property boundaries can be made easily to make the updated map information available rapidly.

I1c) Growing Stock Yield, Volume & Value

Trees grow and change along defined patterns of development that depends on how, when and with what intensity of silvicultural treatments over how long a time. The product of tree growth is a yield, over time, of possible products by species and quality. Keeping track of the current status of forest stands and the forest as a whole shows how it is changing and adapting to new circumstances. Judgements can be made a regular intervals as to whether the changes made have produced a desirable effect, or not. In this way, alterations may be made in future treatments to make "mid-course corrections" for changing circumstances, much like a spacecraft. As explained in Section F2, page 89, updating an original inventory can be handled more easily by the "Rolling Inventory" process. This process can, and should, be done at the same time as mapping updates.

Since products have value in the marketplace, standing trees containing products will also have value. That value (standing timber) called "stumpage" is an important characteristic of a forest asset. Larger tracts of forest land (several hundred acres or more) reflects a total land value better than a real estate value for bare land. In Orland, however, since it sits right smack in the developed corridor to Acadia, land has a development value that is reflected in the price of either bare or forested parcels. In the case of the Hothole Block, since there will be no development, the trees on the forest offer an estimate of asset value that cannot be ignored. How this value changes over time is a direct reflection of what has been done to improve it, so the effort and capital necessary to make improvement adds value to the forest asset as well, since in the absence of purposeful changes made, the forest asset may not be as valuable. Another aspect of value assessment depends greatly on the method of sale. If the sale of trees is as they are found standing (stumpage), at the roadside or delivered to a particular market has a huge effect on value received. When products are of low quality, stumpage sales can avoid the cutting and handling costs associated with getting the trees out of the woods and delivered to a market. As the Hothole Block's products become bigger, better and more valuable, a shift to either roadside or delivered sales might make sense. In this latter instance, cost of felling, loading and trucking to either a roadside yard ro a market are borne by the landowner, but the revenue gained from controlling all aspects of the market process should more than offset the costs of extraction and delivery. From a stewardship aspect, recognizing and keeping track of the forest asset value is a real, fiduciary responsibility.

I1d) Markets and Prices

Whether the trees and the products they contain have value and how much, depends on the number and kinds of markets available that turn raw trees into useful products. Keeping track of existing markets in close proximity to the Hothole Block is very important, as well as understanding what changes to markets and prices mean to the forest.

I2: Treatment Effectiveness

A key reason to keep track of stand changes is to see how well the silvicultural treatments (in whatever combination) are performing over time. One of the reasons I see for monitoring treated stands is that at some point in time, someone will want to know if the managing the forest is worth the expense. Demonstrated improvements in species composition, health, tree vigor, product value, diversity, rates of growth (by any measures), etc. can all be available from repeated measurements. Measuring on a regular basis (every 5 years, for instance) does have a cost, but it can be kept at a minimum by restricting the focus on measurement to that which is most important.

In terms of measurements of monitoring plots that could be established in each treated stand, a sample design that is efficient and easily repeatable by technicians or even trained volunteers. A sample design can have a main plot of variable radius (like the current forest inventory) where limited to only 12 to 20 trees that are highly important, which are the medium to large poles that will become high-quality sawtimber and veneer sooner than any smaller trees. These are trees from 8.6 inches DBH and larger.

Smaller trees are always more numerous. To assess the smaller growing stock from 4.6 to 8.5 inches DBH, which will eventually grow into larger pole and sawtimber trees, a smaller, fixed-radius plot can be employed. Doing so will keep reduce cost if fewer smaller trees are measured to still provide an estimate of how these trees are growing, but are further away from becoming more valuable. A similar approach can be taken to quickly assess new regeneration that will ultimately replace the larger trees when they grow to sawtimber size.

If this approach is used to assess the stand before and immediately after treatments are applied, an idea of what improvement in health and quality has been made can be gained immediately. Then again every 5 years to monitor development progress, but also to determine the timing of the next treatment when conditions are optimum to do so.

I3: Forest Records

What records should be kept, what should they look like and how many should there be? Besides budgets, GIS and other convenient, relational databases, there should be a few items that give a complete picture of the treatment/development history for each stand. Bearing in mind that there are 180 individual forested stands on the Hothole Block, it may be useful to create a new file on a stand that is scheduled for its first treatment. There are already 12 files for stands treated since 2012, so we have a little catch-up to do for those treated before that time. Beside the GIS data and the inventory database, there are two spreadsheets that I keep. The first is used to assess the development history of the stand and it looks like Figure 21 (below). This prints on a standard 8½ x 11 sheet of paper. Each time a treatment or remeasurement occurs, the summarized information can be presented clearly on this sheet. What condition the stand is in, how renewal is planned and what harvests have yielded can be seen quickly.

Figure 21 - Stand Development Record

GREAT POND MOUNTAIN CONSERVATION TRUST

Orland, Maine

RECORD OF STAND DEVELOPMENT FROM FOREST MANAGEMENT

January 26, 2016

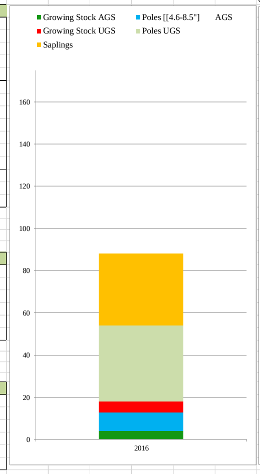
STAND DEVELOPMENT — STAND NUMBER 206

GROWING STOCK (Basal Area (Ft²/Acre)

Growing Stock	2016	2021	2026	2031	2036	2041
Volume (Ft³/Acre)	233					
Basal Area (Ft²/Acre)	9					
Percent Cover						
Quality						
% AGS	44%					
AGS (Ft²/Acre)	4					
UGS (Ft²/Acre)	5					
BA/Ac Hi Value A+B	9.0					
Structure						
% Small Wood [8.6-11.5"]	15%					
% Medium Wood [11.6-15.5"]	6%					
% Large Wood [15.6+]	0%					

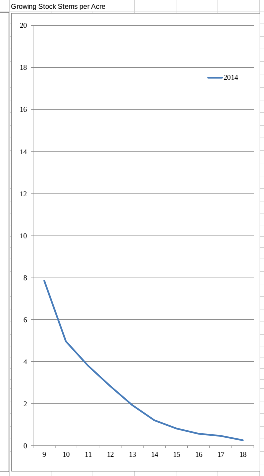
Understory (Ft²/Acre)	2016	2021	2026	2031	2036	2041
Saplings [0.6-4.5"]						
Total	34					
High Value Intol. Hwds.	2					
High Value Tol. Hwds.	14					
High Value Conifers	0					

Poles (Ft²/Acre)	2016	2021	2026	2031	2036	2041
Poles [[4.6-8.5"] AGS	9					
UGS	36					
High Value Intol. Hwds.	1					
High Value Tol. Hwds.	20					
High Value Conifers	1					



Stem Distribution

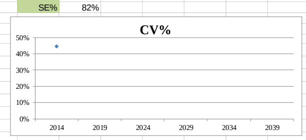
Growing Stock Stems per Acre



Spatial Variation

Basal Area (Ft²/Acre) [Main Crown Canopy]

Plots	2014	2019	2024	2029	2034	2039
1	30					
2	135					
3	135					
4	30					
5	75					
6	60					
7	90					
8	135					
9	90					
10	30					
11	105					
12	60					
13	60					
14	75					
15	90					
16	75					
17	105					
18	75					
19	30					
20						
Avg.	**78.15789**					
SD	34.8493					
SE	63.91967					
CV%	45%					
SE%	82%					



RENEWAL

Regeneration

	Number of Seedlings per Acre						Cover Percent					
	2016	2021	2026	2031	2036	2041	2016	2021	2026	2031	2036	2041
High Value Intol. Hwds.												
High Value Tol. Hwds.												
High Value Conifers												
Other Intol. Hwds.												
Other Tol. Hwds.												
Other Conifers												
TOTAL												

PAST MANAGEMENT

Harvested Growing Stock

	2016-2020			2021-2025			2026-2030			2031-2035			2035-2039		
	Volume	*Value*	*Unit Price*	*Volume*	*Value*	*Unit Price*	*Volume*	*Value*	*Unit Price*	*Volume*	*Value*	*Unit Price*	*Volume*	*Value*	*Unit Price*
Biomass															
Firewood															
Boltwood															
Pallet/Ties															
Studwood															
Sawlogs															
Veneer															

Volume by Product

Harvesting Rate	Biomass	Firewood	Boltwood	Pallet/Ties	Studwood	Sawlogs	Veneer	Total Vol.
	G. Tons	*Cords*	*MBF*	*MBF*	*G. Tons*	*MBF*	*MBF*	*Cu. Ft.*
Year								
2016								
2017								
2018								
2019								
2020								
Five-Year Period Totals:								
2021								
2022								
2023								
2024								
2025								
Five-Year Period Totals:								
2026								
2027								
2028								
2029								
2030								
Five-Year Period Totals:								
2031								
2032								
2033								
2034								
2035								
Five-Year Period Totals:								
2036								
2037								
2038								
2039								
2040								
Five-Year Period Totals:								

The second spreadsheet is used to provide an economic record by recording what events have occurred in a stand, the profit and loss from the event and the current vs. potential standing value. This latter item provides an indication of how a potential value is being realized by the management strategy. Figure 22 on the next page shows the form for Stand 206, thinned in January of this year (2016).

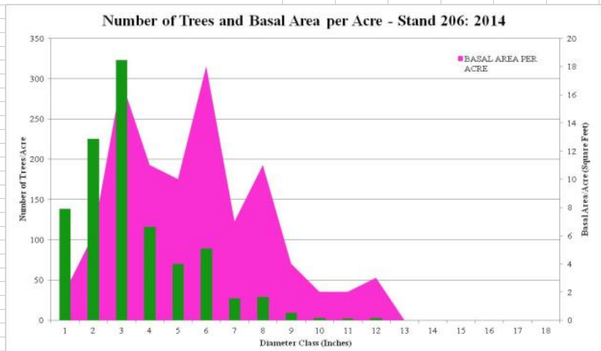
Figure 22 - Economic Record

Great Pond Mountain Conservation Trust

Management History and Economic Record

Stand No.:	206 (Portion)	Initial Year of Management:	2016
Stand Area (Acres):	**44**	Type of product sale:	None
		Treatment Cycle:	12 Years

Management initiated in 2012 with sampling, crop-tree identification/marking and herbicide release vs. manual trials.



Stand characteristics (following initial sampling in 2014)

Trees/Ac.:	**1,038**	Stems
Basal Area/Acre:	**88**	Square Feet
Volume:	**899**	Cubic Feet (Gross)
Average Age:	**20**	Years

Details of Silvicultural Operations

Year	Species	Volume [Ft³]	Units	Unit Price	Observations	Yield Ft³/Acre	Yield $/Acre
2016	Mix hwd	10164	Cords	$ 7.50	Initial layout for light thinning to improve spp composition & quality.	231	$ 21.66
2016	Mix hwd				Treatment consisted of understory removal and selection of nearby Beech.		

Economic Monitoring

Profit and Loss (breakdown of revenues/expenses):

Costs ($/Acre/Yr):

Harvesting Cost -	$ 283.00
Infrastructure -	$ -
Forest Maintenance-	$ -
Management Costs -	$ 165.75
TOTAL COSTS:	$ 448.75

Revenues ($/Acre/Yr):

Timber Sales:	$ -
NRCS Grant:	$ 358.15
Miscellaneous Income:	$ -
TOTAL REVENUES:	$ 358.15

NET PROFIT/LOSS: $ (90.60)

Capital appreciation (standing value and potential value):

	2016			
Standing Value (SV/Acre):	$ 232.02	**Standing Value Increment:**	$ 11.60	$/Acre/Yr
Potential Value (PV/Ac):		**Potential Value Increment:**		

Balance Sheet (Profit & Loss + Capital Appreciation)

Standing Value Balance Sheet (Net Profit & Loss + SV):	$ (79.00)	$/Acre/Yr
Potential Value Balance Sheet (Net Profit & Loss + PV):		$/Acre/Yr

A closing thought to keep in mind, stay the course and have faith in the future…

<u>A Forester's Life</u>

I am a forester and my attention and efforts are focused on the forest and the many aspects of its culture:

The wind, rain and snow that falls;

The sun, whose light shines upon it and helps it grow;

The soil that nurtures it;

The trees great and small that stand within it;

The creatures that populate it and call it home;

The sweeping landscape in which it is found;

The hills and waters that add dimension to its grandeur;

The products useful to society which it yields in abundance;

The ways in which its wood may be transformed into articles of great and lasting beauty;

The myriad plants of lesser stature that offer such intricate patterns of splendor;

The continuity of its dynamic and continual rebirth;

The aura of peacefulness and calm of its interior;

And the sanctity of its hallowed groves.

RHG, 2015

Respectfully submitted,

R. H. Greene, CF #476, LPF #23 (Maine), TSP 13-9363

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FOREST TERMINOLOGY

(Forest Ecology, Silvics, Silviculture)

Silviculture Generally, the science and art of cultivating (i.e. growing and tending) forest crops, is based on a knowledge of silvics. More particularly, the theory and practice of controlling the establishment, composition, constitution, growth and quality of forest stands.

Forest Type A descriptive term used to group forest stands of similar character as regards composition and development due to certain ecological factors, by which they may be differentiated from other groups of stands. The term suggests repetition of the same character under similar conditions. A type is temporary if its character is due to passing influences such as logging or fire; permanent if no appreciable change is expected and the character is due to ecological factors alone; climax if it is the ultimate stage of a succession of temporary types. A forest cover type now occupying the ground, no implication being conveyed as to whether it is temporary, permanent or climax.

Recognized forest types of North America are named following the principle of using species names which are descriptive of the composition of the type, e.g. Red Spruce Type, White Pine-Hemlock Type, Red Spruce-Balsam Fire Type, Sugar Maple-Beech-Yellow Birch Type. Furthermore, species that appear in the type name generally account in aggregate for 50% or more of the total number of trees occupying the main crown canopy.

Tolerance Ability of a tree species to become established and to grow satisfactorily, in the shade of and in competition with, other trees. Tree Species are classified according to their degree of tolerance as being very tolerant, tolerant, intermediate in tolerance, intolerant, or very intolerant.

Establishment Process of developing a forest crop to the stage at which the young trees may be considered established, i.e. safe from normal adverse influence e.g. frost, drought, weeds, or browsing and no longer in need of special protection or special tending, by only routine cleaning, thinning and pruning.

Forest Stand A community of trees possessing sufficient uniformity as regards composition, constitution, age spatial arrangement or condition to be distinguishable from adjacent communities so forming a silvicultural or management entity.

Composition Relative representation of each tree species in a forest stand expressed quantitatively as a percentage of either the total number, volume or basal area of all tree species in the stand.

Pure Stand A stand in which at least 75% of the trees in the main crown canopy are of a single species.

Mixed Stand A stand in which less than 75% of the trees in the main crown canopy are of a single species.

Constitution Distribution and representation of age and/or size classes in a forest stands.

a. Even-Aged Applied to stands composed of trees having no or relatively small differences in age. The maximum difference admissible is generally 10 to 20 years, though where the stand will not be harvested until it is 100 years or more of age, larger differences up to 25% of the rotation (period of years required to establish and grow timber crops to a specified condition of maturity) may be admissible.

b. Two-Aged Applied to stands in which trees of two distinct age classes are represented. The term is not applicable to a forest stands in the process of reproduction in which the appearance of two age classes is the temporary result of an incomplete process.

c. Uneven Aged Applied to stands in which there are considerable differences in the age of trees and in which trees of three or more age classes are represented.

1) All-Aged Applied to uneven-aged stands in which trees of all ages up to and including those of felling age are represented.

2) Balanced Uneven-Aged Applied to uneven-aged stands in which three or more different age classes spaces at uniform intervals all the way from seedlings to trees at or near rotation age are represented and in which the age classes represented occupy approximately equal areas.

3) Irregular Uneven-Aged Applied to uneven-aged stands in which three or more different age classes are represented by in which the age classes represented are not spaced at uniform intervals from seedlings to trees at or near rotation age and/or in which the age classes represented do not occupy approximately equal areas.

Stand Density Density of stocking expressed in number of trees, basal area, volume, or other criteria, per unit area.

a. Basal Area The area, usually expressed in square feet of the cross-section at breast height (point on the bole of a standing tree 4.5 feet from the ground) of a single tree or all trees per unit area.

Stocking An indication of the number of trees, basal area, or volume per unit area as compared to the desirable number of trees, basal area or volume needed to attain given objectives of management.

1) **Fully stocked** Applied to a stand in which all growing space is effectively occupied but having ample room for development of the crop tree.

2) **Overstocked** Applied to a stand in which overcrowding results in retarded growth of the crop trees.

3) **Understocked** Applied to a stand in which the growing space is not effectively occupied by crop trees.

Site Sum of the effective environmental conditions (climatic, edaphic, physiographic, and biotic) under which a plant or plant community lives.

a. **Site Quality** Relative potential productive capacity of a specific area to produce forest stands of a given species or combination of species.

b. **Site Index** An expression of site quality based on the average height attained by trees occupying the main crown canopy of a stand at an arbitrarily chosen age.

Stand Development Growth of even-aged stands and small even-aged groups in which trees in uneven-aged stands are seedling, sapling, pole and sawtimber development stages, to the stage of overmaturity.

a. Seedling Stage Stage extending from the time of germination or planting up to the time of canopy closure (the progressive reduction of space between the crowns of individual trees as they spread laterally) is complete. The boundary between the seedling and sapling stages is indefinite but may be fixed arbitrarily e.g. in North America usually a stand composed of trees averaging less than 1.5 inches DBH (diameter at breast height). Breast height is defined as being a point on the tree bole 4.5 feet from the ground.

b. Sapling Stage Stage beginning with the closing of the seedling stage and ending with the elevation of tree crowns well above the ground and with the death of many lower branches. During this stage, competition among trees for light, water and nutrients intensifies resulting in the death of many of the weaker trees. Trees' ranging in size from 0.6 to 4.5 inches DBH are classified as saplings.

c. Pole Stage Stage beginning with the closing of the sapling stage and ending when the growth in height of trees occupying the main crown canopy begins to decline. It is during this stage that growth in height, canopy density, natural pruning, and reduction in the number of trees per unit area resulting from suppression and natural mortality reaches a maximum. Trees ranging in size from 4.6 to 11.5 inches DBH are classified as poles.

d. Mature (Timber) Stage Stage beginning when the growth in height of trees occupying the main crown canopy begins to slow down and continuing until a decline in their health, vigor and/or soundness marks the beginning of the over mature stage.

During this stage, the stand continues strong and vigorous. A closed canopy is maintained. Seed production per unit area reaches a maximum. Natural pruning and reduction in the number of trees per unit area continues to occur but at a less rapid rate than previously.

e. Overmature Stage Stage beginning with a decline in the health ,vigor, and/or soundness of trees occupying the main crown canopy, usually accompanied by the death of occasional trees and the appearance of marked openings in the crown canopy.

From this time on even-aged stands suffer a gradual reduction in vigor and become progressively more susceptible to insects, diseases, wind throw, and other injurious agencies. Individual trees may remain vigorous and continue to grow and increase in value for extended periods of time beyond the beginning of the overmature stage. However, the integrity of an even-aged stand or group of trees steadily deteriorates and is soon entirely lost as mature trees die and are replaced by a young growth of trees, shrubs, and/or herbaceous plants.

Crown

The upper part of a tree carrying the main branch system, foliage and surmounting at the crown base a more or less clean stem.

a. Crown Cover The ground area covered by a crown as delimited by the vertical projection of its outermost perimeter.

b. Crown Density The thickness, both spatially (i.e., depth) and in closeness of growth (i.e. compactness) of an individual crown.

c. Crown Diameter A mean figure derived from two (when maximum and minimum) or more measurements of the span of the crown cover.

d. **Crown Diameter Ratio** Ratio for the crown diameter in feet to the DBH in inches.

e. **Crown Height Ratio** The vertical distance from the ground level to the base of the crown, measured either to the lowest live branch whorl (upper crown-height) or to the lowest level branch, excluding epicormic branches, i.e., a shoot arising spontaneously from either an adventitious or dormant bud on the stem or on a branch of a woody plant (lower crown height) or to a point halfway between (mean crown height).

f. **Crown Length** The vertical distance from the tip of the leader to the base of the crown measured either to the lowest live whorl (upper crown length) or down to the lowest live branch (lower crown length) or to a point halfway between (mean crown length).

g. **Crown Length Ratio (Live Crown Ratio)** The ratio of crown length to tree height.

h. **Crown Form** The general shape of the crown sometimes quantitatively assessed as the ratio of the crown length to crown diameter.

Canopy The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth.

a. **Canopy Closure** The progressive reduction of space between crowns as they spread laterally, increasing the canopy density.

b. **Canopy Density** The compactness of the canopy dependent upon the canopy closure and the crown density.

Crown Class A designation of trees in a stand having crowns of similar development and occupying a similar crown position relative to the crowns of adjacent trees and the general crown canopy.

Differentiation into crown classes results from intense competition for light, water, and nutrients among trees growing in even-aged stands and within the small even-aged groups in which trees in an uneven-aged stand are often arranged. Four crown classes commonly recognized and widely used as criteria of relative tree vigor in the practice of silviculture are defined below.

a. **Dominant Trees** with crowns extending above the general level of the crown canopy and receiving full light from above and partly from the sides; larger than the average trees in the stand, and with crowns well developed but possibly somewhat crowded on the sides.

b. **Codominant Trees** with crowns forming the general level of the crown canopy and receiving full light from above but comparatively little from the sides; usually with medium-sized crowns more or less crowded on the sides.

c. **IntermediateTrees** shorter than those in the two preceding classes but with crowns extending into the crown canopy formed by codominant and dominant trees; receiving a little direct light from above, but none from the sides; usually with small crowns considerable crowded on the sides.

d. **Overtopped Trees** with crowns entirely below the general level of the crown canopy receiving no direct light either from above or from the sides.

Overstory That portion of the trees in the forest stand forming the upper or main crown canopy, usually considered to include trees in both the dominant and codominant crown classes.

Understory That portion of the trees in a forest stand below the overstory, usually considered to include trees in the intermediate and overtopped crown classes.

Increment The increase in diameter, basal area, height, volume, quality, or value of individual trees or forest stands during a given period. Gross increment refers to values uncorrected for losses by mortality or deterioration. Net increment refers to values to values corrected for losses by mortality or deterioration.

a. **Current Annual Increment** Increment for a specific year.

b. **Mean Annual Increment** Total increment divided by the total age.

c. **Periodic Increment** Increment for any specified period, commonly from 5 to 20 years.

d. **Periodic Annual Increment** Increment for specified period divided by the number of years in the period.

e. **Ingrowth (Recruits)** The volume or number of trees that have grown past an adopted lower limit of measurement during a specified period.

Mortality Death or destruction of forest trees as a result of competition, disease, insect damage, drought, wind, fire or other factors.

Stand Table A table showing the number of trees by species and diameter classes, generally per unit area of a stand.

Volume Table A table showing, for one or more species, the average cubic contents of trees (tree volume table) or log (log volume table) for one or more dimensions.

Yield Table A table showing for one or more given species on given sites the progressive development of a stand at periodic intervals covering the greatest part of its useful life. It usually includes average diameter and height, basal area, number of trees, and final yields and may include volumes of thinnings and other data. An empirical yield table is prepared for actual average stand conditions; a normal yield table is prepared for fully stocked stand conditions.

Intermediate Cuttings Silvicultural treatments undertaken in immature even-aged forest stands and immature even-aged groups of trees in uneven-aged forest stands between the time of formation and the time of the first regeneration cutting. The two principal objectives of intermediate cuttings are:

To enhance the future value of existing forest stands by eliminating defective trees, wolf trees, weed trees, and surplus trees thereby improving the vigor, resistance to injury (insects, diseases and wind) growth and wood quality of the trees that remain.

To increase the total yield of stands by utilizing all of the merchantable wood produced during the rotation. Intermediate cuttings differ from regeneration cuttings in that no effort is directed toward obtaining regeneration and the creation of permanent openings in the crown canopy is carefully avoided. Eight different kinds of intermediate cuttings, each designed for a particular purpose and each applicable to either immature even-aged forest stands or immature groups of trees in uneven-aged forest stands are defined below.

Weeding A cultural operation performed in a forest stands not past the sapling stage and usually not past the seedling stage, for the purpose of releasing potential crop trees from the competition of other plants irrespective of whether they are woody plants or herbaceous plants or whether their crowns are above, beside, or below the crowns of the crop trees.

Cleaning A cutting made in a young forest stands, not past the sapling stage, for the purpose of releasing potential crop trees from other individuals of similar age but of less desirable species or from which are overtopping or are soon likely to overtop them.

Liberation Cutting A cutting made to release a young forest stands, not past the sapling stage, from the competition of older overtopping individuals which because of species, form, or defect are less desirable than the young growth.

Thinning A cutting made in an immature forest stand with the two fundamental objectives of:

i) maintaining and/or stimulation the growth of the trees that remain.

ii) utilizing all the merchantable material produced by the stand during the rotation.

In making thinnings, trees are selected for removal or retention on the basis of crown class. Among trees equal in form and quality, dominant trees are favored over codominant trees; codominant trees, over intermediate trees; and intermediate trees, over overtopped trees. Trees removed in a thinning represent a surplus when compared to the number required for optimum stocking.

Improvement Cutting A cutting made in a forest stand past the sapling stage for the purpose of improving its composition and quality by removing trees of undesirable species, form or condition from the main canopy (dominant and codominant crown classes).

Salvage Cutting A cutting made in a forest stand to remove trees killed or injured by fire, insects, disease or other harmful agencies for the specific purpose of utilizing merchantable material before it becomes worthless.

Sanitation Cutting A cutting made in a forest stand to remove trees killed or injured by fire, insects, disease or other harmful agencies for the specific purpose of preventing the spread of an insect or a disease.

Pruning A cutting in which live or dead side branches are removed from crop trees with the objective of producing knot free lumber on rotations shorter than those that would be required in the absence of pruning. Trees may also be pruned to improve access to stands during thinning operations, to prevent the spread of disease from branches into the boles of trees and to improve the appearance of forest stands.

Regeneration The renewal of a tree crop, whether by natural or artificial means.

a. **Natural Regeneration** The renewal of a tree crop by self-sown seed or by vegetative means e.g. coppice, sprouts, root suckers and layers.

b. **Artificial Regeneration** The renewal of a tree crop by planting seedlings, sowing seed, or setting cuttings.

Regeneration Method A silvicultural treatment undertaken near the end of the rotation with the purposes of :

- Harvesting mature even-aged forest stands or mature trees occurring singly or in small groups in uneven-aged forest stands.

- Replacing them with young stands established either naturally from seed or vegetative regeneration or artificially by planting tree seedlings or sowing seed.

- A regeneration method includes not only the harvesting of mature trees but also any subsequent cultural treatment that may be required to insure the rapid replacement of the trees harvested by adequately stocked stands of desirable tree species.

Numerous methods of regenerating a high forest (i.e. a forest stands originating from seed) and low forest (i.e. a forest stands origination vegetatively from coppice sprouts, root suckers or layers) have found application. However, any given method can usually be classified under one of six standard regeneration methods, each of which denotes distinctly different principles. The six standard regeneration methods are defined below.

a. **Clear Cutting Method** The removal of all trees on an area to be regenerated in one cutting with regeneration of desirable species being subsequently obtained either naturally from seed disseminated over the cutting area from adjacent forest stands and/or from trees removed in the harvesting operation and/or from advance regeneration or artificially by either planting tree seedlings or sowing seed on the cutting area.

b. **Seed-Tree Method** The removal of all trees on an area to be regenerated in one cutting save for a small number of seed-bearing trees, usually from one to ten trees per acre, retained either singly (single seedtree method) or in small groups (group seedtree method) to provide seed for the subsequent natural regeneration of the area. Following the establishment of adequate regeneration, the seed-bearing trees may be removed in a second cutting or left indefinitely.

c. **Shelterwood Method** The removal of all trees on an area to be regenerated in a series of cuttings extending over a period of years equal usually to no more than one-quarter and often not more than one-tenth of the rotation with the establishment of natural regeneration of desirable tree species being obtained under the partial shelter of the trees remaining after each cutting. Regeneration of a mature forest stand by the shelterwood method may involve a series of different kinds of cuttings applied in the order given below.

1) **Preparatory Cuttings** Cuttings made to prepare dense mature forest stands under which regeneration of desirable tree species has failed to become established for regeneration by;

Removing defective trees and trees of undesirable species improving the vigor, seed production and windfirmness of desirable tree species and/or increasing the rate of decomposition of thick humus layers that tend to preclude the establishment of natural regeneration.

2) **Seed Cutting** Cutting make in a mature forest stand to create permanent openings of sufficient size in the crown canopy to permit heat, light, and moisture to penetrate to the forest floor in amounts required for germination and seedling establishment of desirable tree species. The seed cutting should be made during a year when the desirable tree species bear seed in abundance, remove the least desirable trees in the stand, be confined to a single operation to secure uniformity of the regeneration in age and size.

3. **Selection Method** The removal of mature timber usually the oldest and largest trees, either as single or scattered individuals (single tree selection) or in small groups (group selection) from areas rarely exceeding 1/4acre in size in relatively short intervals, repeated indefinitely, by means of which the continuous establishment of the regeneration of desirable tree species is encouraged and an uneven-aged forest stand is developed and maintained.

4. **Coppice Method** Any type of cutting in which dependence is placed primarily on vegetative regeneration

(coppice sprouts, root suckers and layers).

5. **Coppice-With-Standards Method** The production of coppice and trees of seedling origin on the same area with selected trees of seedling origin being carried through much longer rotation than those of vegetation origin.

Rotation The period of years required to establish and grow timber crops to a specified condition of maturity.

Cutting Cycle The planned interval in years between regeneration cuttings in the same stand.

Silvicultural System A process following accepted silvicultural principles, whereby tree crops are tended, harvested and replaced,
resulting in the production of crops of distinctive form.

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