

Forest Stewardship Plan

Lacawac Sanctuary

94 Sanctuary Road

Lake Ariel, PA 18436

c/o Janice Poppich, Executive Director
(570) 689-9494 or director@lacawac.org

Wayne County

Salem & Paupack Townships

November 15, 2006

460 Acres of Forest/ 520 acres Total



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Introduction

1. Landowner's Management Goals: The 520 acre property is a nature preserve originally donated by Arthur and Isabel Watres and existing today as a non-profit corporation operated by a volunteer board of directors and an Executive Director. The mission is simply stated by a plaque mounted at the entrance which lists "Preservation, Education, Research" as the goals of the property and the non-profit foundation. A more detailed description of the mission of the foundation from a recent pamphlet states "to preserve Lake Lacawac, its watershed, the surrounding forest and historic structures; provide a venue for ecological research, scholarly interaction and the training of scientists; provide public education on environmental and conservation issues; and conserve open space in Pennsylvania."

The Science and Resource Management Committee in their RFP for a Stewardship Plan noted the landowner goals as managing a second-growth forest so as to maximize biodiversity and sustainability with special attention to several issues including protection of the Ledges forest community, controlling the deer impact, hemlock die-off, controlling invasive species, and forest understory recovery. Management recommendations will be directed primarily at these issues.

2. Directions to Property: From I-84 take Exit 20 (Greentown) and proceed north on Route 507 approximately 0.6 miles to a left onto Ledgesdale Road. Follow Ledgesdale Road across Wallenpaupack Creek Bridge to stop sign at T. Turn right and proceed 1 mile to another right onto St. Mary Church Road. Go 0.2 mile to right onto Lacawac Road and proceed 0.6 miles past marina and along Lake Wallenpaupack to a right on Sanctuary Road. Follow Sanctuary Road up hill to entrance to Lacawac Sanctuary.

3. The Property Within the Landscape: The property lies south of Route 590 on the north shore of Lake Wallenpaupack in an area of mainly deciduous forests with scattered farm fields, wetlands and herbaceous openings. An increasing number of rural residences and seasonal homes are being built in what was previously a mixed farm and forest landscape. The tremendous recreational draw of Lake Wallenpaupack and the migration of families from metropolitan NYC have driven development pressure in the area. Wallenpaupack Lake Estates is a major subdivision bordering the subject property to the northeast and numerous seasonal and permanent

residences are concentrated around the lake on the adjoining private lands. Forested cover is 75% or more in the immediate vicinity of the subject property. The predominant forest type is a mixed oak, northern hardwoods and hemlock mix on the upland acres and hemlock, maple and shrub wetlands.

4. Property Maps: Attached is a map of the property boundary plotted on an aerial photo and topographic background along with a Soil Map from the NRCS. During fieldwork, additional features were mapped using GPS data collector and downloaded to ArcGIS files for incorporation into the property map files. The trail system, forest stands, buildings and features, soils, and the property boundary are all stored as “layers” in the mapping software and available for production of property maps.

5. Survey Available: A deed or survey map were not provided but corner markers were easily found and the property boundaries are clearly marked.

6. Deed and Tax Map Numbers: There are 10 separate tax parcels owned by the Lacawac Sanctuary Foundation per the Wayne County Assessment Records. Tax Map #'s and deed references are listed in the Appendices.

7. Species of Special Concern: A Pennsylvania Natural Diversity Inventory (PNDI) search for the property resulted in 3 “hits” of species or communities of special concern. All three are under the jurisdiction of the PA Dept of Conservation and Natural Resources (DCNR). Scientists working at Lacawac Sanctuary are probably aware of these and possibly other sensitive areas which must be protected from disturbance and invasive species. Any planned projects should be submitted to the DCNR Ecological Services Section for review and description prior to commencing activities. A report of the PNDI Search and instructions on reviews is included in the Appendices.

8. Forest Health: Several forest health issues were noted during fieldwork which should be factored into management plans. First and most important, **elevated deer herds** have depleted the structure and diversity of understory seedling/shrub layer and prevented acceptable forest recovery from any recent disturbance within the forest communities. Our oak and northern hardwood forests rely on a “bank” of seedlings, seed and shrubs which exist in the understory of the forest and responds to fill openings created by any disturbance. Overpopulations of deer will browse and destroy this bank of

seedlings/shrubs over time, starting with the preferred or most palatable species and progressing to all vegetation within reach at high deer densities. This leaves the forest susceptible to disturbances from insects, disease, logging or storms from which it cannot recover.



Lacawac hemlock/red oak forest showing limited understory response (other than hayscented fern) to natural disturbance from blowdown and woolly adelgid mortality.

Currently, the deer herd should be lower than in the recent past due to increased harvest allotments/harvesting efforts of hunters and two severe winters which limited reproduction and survival, but the herd must be lowered and kept down for years to allow the seedling/shrub layer to be restored to its potential structure and diversity. Particular emphasis can be placed on monitoring the browse pressure on certain preferred species such as maple, ash, viburnum and elderberry to gauge the extent of the current problem and any changes in the deer pressure on the vegetation. Observations during fieldwork indicate only 1-2 year old seedlings are present in the understory and there is considerable evidence of heavy browse on even the beech saplings/sprouts which are not a preferred species, indicating a severe problem.

If the Sanctuary can manage deer hunting safely, it should focus on removing deer and especially does throughout the various seasons from archery and early muzzleloader through rifle and late muzzleloader. The Sanctuary should consider applying for DMAP (Deer Management Assistance Program) tags through the PA Game Commission for use specifically on the subject property. Scheduling hunting access may create challenges and inconvenience other users of the property, but should be pursued vigorously if this problem is to be managed. Several other management activities will be recommended in the Timber Stand Unit discussion as this is the major threat to the research and conservation goals of the Sanctuary.

The main forest type on the property is a mixed oak/conifer forest of red oak, chestnut oak, hemlock and pine. These species have been affected by a variety of forest pests and stresses over the past 15 years. The oak have been defoliated by **Gypsy Moth Caterpillars** periodically over the past 30 years. A recent local outbreak was evident on the property this past season, but natural mortality seems to have collapsed the population and very few egg masses were noted during fieldwork. Past defoliations coupled with drought stress led to significant mortality and dieback of oak on some of the ridges.

A more current threat is the **Hemlock Woolly Adelgid** infestation that has plagued the hemlock on the property. An introduced aphid from Asia, this insect slowly builds up populations on hemlock trees and eventually will weaken the tree to the point of mortality. The regional outbreak of woolly adelgid was temporarily halted by several cold/icy winters. However, moderate winters have allowed populations to begin to build once again and this will be a continual threat to the hemlocks. Older hemlocks and those growing on upland or drier sites are most susceptible while younger trees and those on moist sites show better resilience. Critical trees can be treated every 2-3 years with injections of imaclor systemic insecticide, but this is generally not a feasible option in forest landscapes. Releases of predatory beetles and applications of micronutrients have shown inconclusive results. The primary approach to contending with the outbreak will be management to favor pine and spruce as ecological substitutes of hemlock and initiating establishment of younger, more resistant age classes of hemlock.

The northern hardwood forests on the property have a different set of insect and disease threats. Of primary concern is a recent outbreak of **Forest Tent**

Caterpillars, a native insect related to the Eastern Tent Caterpillars common on fruit trees in Spring. The Forest Tent Caterpillars (FTC) do not create “tents” and typically defoliate sugar maple, ash, cherry and red oak. The sugar maple in particular has experienced widespread mortality from severe outbreaks, especially when they occur in conjunction with anthracnose fungus attack. **This is particularly critical due to the value of the Ledges Maple Forest and a severe 2006 defoliation in sugar maple stands across the Lake.** Aerial spray with Bt insecticide (*Bacillus thuringiensis* bacterium applied to foliage) is the safest protection option when applied early in the caterpillar life cycle and generally kills only Lepidoptera species which feed on treated foliage.

Ash has seen an accumulation of stresses which have led to “ash decline”, a general weakening and mortality of certain trees based on stress from past droughts, a virus, and potentially acid deposition. Beech has suffered from beech bark disease, an introduced fungal disease which can kill or weaken much of the beech stocking. Maple borer, *Nectria* canker of birch, white pine weevil, and cherry black knot fungus were all noted but these are all common in our forests and not of particular concern. Storm damage in the form of blowdown is evident on the ridges east and south of the Lake and in the wetland areas. This is a natural phenomenon associated with many areas of thin soils or shallow rooting depth from high water tables. The “pit and mound” microtopography in several areas of the Sanctuary is a relic of past episodes where large trees were uprooted en masse by major storms. It would not be of particular concern were it not be for the compromised status of the forest understory from decades of excessive deer browse.

9. Forest Soils: The property has generally good soils for tree growth with some limitations from high water tables, shallow depth to bedrock, ledges and stone content. The Soil Survey of Wayne County Pennsylvania, USDA Natural Resources Conservation Service, Sept 1985 maps the Lacawac Sanctuary in the Mardin-Volusia-Lordstown Soil Association of deep and moderately deep, nearly level to sloping, somewhat poorly drained to well drained soils that formed in grayish and brownish glacial till. These soils rest on the Catskill sandstone bedrock which is close to the surface in certain areas. The attached Soils Map has an Index of Soil Types on the reverse which covers all the mapped units. Each has associated estimate of fertility or “site index” listed for tree growth. The site index denotes the estimated height of a 50 year old tree of the listed species in a dominant crown position. For instance, a soil type with a predicted site index of 60 for sugar

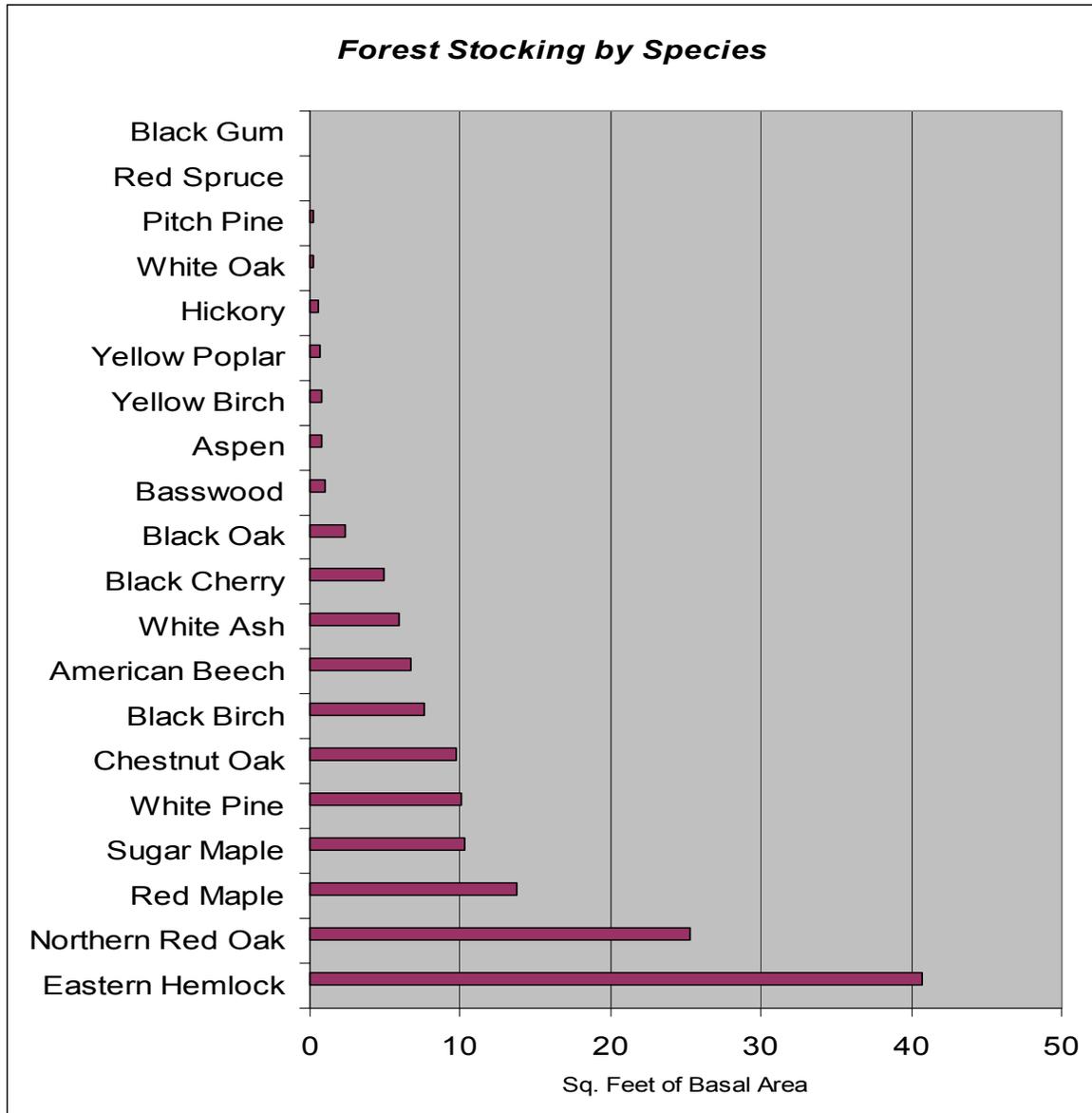
maple should grow sugar maple trees that reach 60 feet in height by age 50 years.

10. General Forest and Wildlife Management Concepts: Forest management seeks to achieve the goals of the landowner through activities which protect or manipulate the forest community. Management activities can influence the species make-up, stocking and age classes of trees in the forest and these in turn will determine forest health, growth rates, and habitat characteristics for different plants and animals. There are two general forest management regimes in our hardwood forests. The first is uneven age management which seeks to maintain numerous age classes of trees by periodically recruiting new seedlings into the stand through light harvests. This management approach mimics small natural disturbances caused by mortality of single large trees or groups of trees. This generally requires low deer densities and a mix of species which are fairly shade tolerant such as sugar maple, hemlock or beech. The excessive deer pressure and forest health risks to beech and hemlock make this a difficult approach at best on the subject property without protective fencing.

The second approach is even age management where all trees in a stand are relatively the same age and management seeks to thin this age class as it matures and eventually to initiate regeneration during heavier harvests over a short period, thus giving rise to another forest of similar age trees. The current forest on the subject property appears to be an even aged forest of at least 100 years of age with numerous large trees and very little recruitment of desirable seedlings/saplings. The current forest undoubtedly arose from the heavy cutting during the later part of the 19th century when lumber was in great demand by the housing, railroad and coal mining industries and wood energy was still a major part of everyday life.

This was also a period when whitetail deer were virtually eliminated from the landscape by unregulated hunting for sustenance and commercial venison markets. Since that period, the forest on the subject property has matured with only modest timber harvesting 40 or more years ago. The whitetail deer herd grew through the decades of the 40's and 50's on habitat improved by forest regrowth and farmland abandonment. By the 60's and 70's deer densities were at all time highs and habitat depletion began and accelerated through the 1980's and 1990's. At present, forests such as the subject property may have some of the lowest food supplies for the deer herd

experienced during the last century, placing increasing pressure on the remaining accessible vegetation.



The various forest species are depicted on the Bar Chart above based on their stocking level as measured by square feet of basal area per acre. Since amount of canopy foliage is well correlated with the cross sectional area of the trunk of the tree (basal area), foresters use this number to represent stocking levels of forest communities or stands since it is much easier to measure. As noted, red oak, eastern hemlock, chestnut oak, red maple, sugar maple and white pine are the 6 tree species of highest stocking. Lesser amounts of black cherry, hickory, black birch, yellow birch, beech, white

ash, black oak, white oak, yellow poplar and others were noted on the sample plots. Most of the undergrowth is beech brush, striped maple, hay scented fern and blackberry with very little low vegetation of the matching species of the overstory trees.



Severe “browse” line and lack of any groundcover under a hemlock/oak stand

Deer rely on seedling/shrub browse to maintain body weights through the winter. When insufficient food is available for the local population during this critical period, the herd consumes all palatable vegetation within reach, wiping out tree species, shrubs and low hanging branches and creating a noticeable “browse” line of sparse vegetation below the reach of an adult deer. Beech, striped maple and fern usually survive this pressure since they are very low on the preference list of the white tailed deer and these species can claim much of the growing space following disturbance. This feeding pressure in turn eliminates nesting habitat and cover for a variety of ground nesting birds and small mammals. Restoring a diverse species mix in the understory would both replenish the winter food supply of the local deer herd and add critical food and cover for other wildlife. Understory hemlock and pine can also be a key winter cover feature for birds and mammals and produce a more diverse mix of forest conditions.

As dominant trees reach the range of 16-24” diameter at chest height, the production of seed and acorns increases dramatically. Year to year variation in seed crops with periodic “bumper” crops is an adaptive strategy of the tree species to overwhelm seed predator populations and allow establishment of age classes of seedlings. Tree health and the thickness of the crown can also have an effect on seed production. Thinning harvests can favor certain seed trees by freeing them from crowding to increase their seed production.

Seeds of some species can remain viable in the forest floor for long periods of time awaiting the right conditions to germinate. Seeds of other tree species will only last one growing season. The subject property has a diverse mix of overstory trees in the larger diameter classes to produce abundant seed supplies and this should not be a constraining factor. Controlled timber harvests such as shelterwood, seedtree cuts or group selection can be used to favor establishment and release of seedlings. By manipulating the stocking and seed sources, forest management can control the conditions for seedling establishment and in turn influence the make-up of the next forest. Once sufficient stocking of seedlings is present, some or all the older trees can be removed to turn the site over to the new age class of trees. At present, protective fencing is the only tool that allows this process to proceed in the face of the high deer browse pressure.

11. Forest Resource Inventory:

The subject property was evaluated using approximately 110 temporary sample plots spaced on a regular grid pattern across the property, each used to measure size, species, stocking and condition of forest trees and note ground conditions, forest health issues, and management history.

Preliminary forest stand mapping was accomplished using aerial photos and these were modified during work in the field to produce a Stand Map which represents distinct forest community types and conditions within each unit. Forest typing was accomplished using the breakdown and descriptions reviewed in *Terrestrial & Palustrine Plant Communities of Pennsylvania*, (Fike, et al, June 1999). The most common associations on the subject property according to these breakdowns are listed below with the map code and the published description of the typical species:

FR- Hemlock (white pine)- red oak- mixed hardwood forest

This type is similar to the “Red oak- mixed hardwood forest” type but with *Tsuga canadensis* (eastern hemlock) and/or *Pinus strobus* (eastern white pine) contributing

more than 25% relative cover. Conifers may be scattered, locally abundant, may dominate the subcanopy, or may occur as a relict supracanopy (*Pinus strobus*), or in large former canopy gaps (*Pinus strobus*). *Quercus rubra* (northern red oak) is usually present, often dominant/codominant, most often with *Acer rubrum* (red maple), *Quercus velutina* (black oak), *Q. alba* (white oak), *Carya tomentosa* (mockernut hickory), *Betula lenta* (sweet birch), *Fraxinus americana* (white ash), *Fagus grandifolia* (American beech), and/or *Liriodendron tulipifera* (tulip tree). Shrubs include *Viburnum acerifolium* (maple-leaved viburnum), *Rhododendron periclymenoides* (pinxter-flower), *Amelanchier laevis* (smooth serviceberry), *A. arborea* (shadbush), *Carpinus caroliniana* (hornbeam), *Ostrya virginiana* (witch-hazel), and *Lindera benzoin* (spicebush). Herbaceous species include *Smilacina racemosa* (false Solomon's-seal), *Gaultheria procumbens* (teaberry), *Maianthemum canadense* (Canada mayflower), and *Podophyllum peltatum* (may-apple).
Range: Entire state except the Coastal Plain.

BB – Northern hardwood forest

Dominant trees usually include *Fagus grandifolia* (American beech), *Acer rubrum* (red maple), *A. saccharum* (sugar maple), *Prunus serotina* (wild black cherry) – at less than 40% relative cover, *Betula lenta* (sweet birch), *B. alleghaniensis* (yellow birch), *B. papyrifera* (paper birch), *Q. rubra* (northern red oak), and *Fraxinus americana* (white ash). This type may contain scattered *Pinus strobus* (eastern white pine) and/or *Tsuga canadensis* (eastern hemlock), but combined conifer cover does not exceed 25% of the canopy. *Rhododendron maximum* (rosebay) may be locally abundant. Other common shrubs include *Hamamelis virginiana* (witch-hazel), *Acer pensylvanicum* (moose-wood), *Viburnum lantanoides* (witch-hobble), *Ilex montana* (mountain holly), *Amelanchier laevis* (smooth serviceberry), *A. arborea* (shadbush), and *Carpinus caroliniana* (hornbeam). The herbaceous layer is generally sparse and reflects a northern affinity; common components include *Maianthemum canadense* (Canada mayflower), *Trientalis borealis* (starflower), *Thelypteris novaboracensis* (New York fern), *Dryopteris carthusiana* (fancy fern), *Lycopodium lucidulum* (shining clubmoss), *Gaultheria procumbens* (teaberry), *Mitchella repens* (partridge-berry), *Aralia nudicaulis* (wild sarsaparilla), *Medeola virginiana* (Indian cucumber-root), and *Maianthemum canadense* (Canada mayflower).

Range: Glaciated NE, Glaciated NW, Pocono Plateau, Unglaciated Allegheny Plateau.

AR – Red oak – mixed hardwood forest

This broadly defined community type includes much of Pennsylvania's hardwood-dominated forests occurring on fairly mesic sites, and is therefore quite variable in composition. *Quercus rubra* (northern red oak) is usually present, often dominant/codominant, most often with *Acer rubrum* (red maple), *Quercus velutina* (black oak), *Q. alba* (white oak), *Carya tomentosa* (mockernut hickory), *C. ovata* (shagbark hickory), *Betula lenta* (sweet birch), *B. alleghaniensis* (yellow birch), *Fraxinus americana* (white ash), *Fagus grandifolia* (American beech), and/or *Liriodendron tulipifera* (tuliptree). Shrubs include *Viburnum recognitum* (northern arrowwood), *V. dentatum* (southern arrowwood), *V. acerifolium* (maple-leaved viburnum), *Amerlanchier laevis* (smooth serviceberry), *A. arborea* (shadbush), *Kalmia latifolia* (mountain laurel), *Carpinus caroliniana* (hornbeam), *Ostrya virginiana* (hop-hornbeam), *Hamamelis*

virginiana (witch-hazel), and *Lindera benzoin* (spicebush). The herbaceous layer is highly variable. Representative species include *Uvularia sessilifolia* (wild-oats), *Smilacina racemosa* (false Solomon's-seal), *Podophyllum peltatum* (may-apple), *Chimaphila maculate* (pipissewa), *Gaultheria procumbens* (teaberry), *Medeola virginiana* (Indian cucumber-root), *Caulophyllum thalictroides* (blue cohosh) – on richer sites, *Dryopteris* spp. (wood ferns), and *Dennstaedtia punctilobula* (hayscented fern).

Range: Entire state, although less common on the Unglaciaded Allegheny Plateau.

FA- Dry white pine (hemlock)- oak forest

This community type occurs on fairly dry sites, often with 25% or more of the forest floor covered by rocks, boulders, and/or exposed bedrock. The canopy may be somewhat open and tree growth somewhat depressed. The tree stratum is dominated by a mixture of *Pinus strobus* (eastern white pine), or occasionally *Tsuga canadensis* (eastern hemlock), and a mixture of dry-site hardwoods, pre-dominantly oaks. On most sites the conifer and the hardwood component both range between 25% and 75% of the canopy. The oak species most often associated with this type are *Quercus montana* (chestnut oak), and *Q. alba* (white oak), although *Q. velutina* (black oak), *Q. coccinea* (scarlet oak), or *Q. ruba* (northern red oak) may also occur. Other associated trees include *Nyssa sylvatica* (black-gum), *Betula lenta* (sweet birch), *Fraxinus americana* (white ash), *Prunus serotina* (wild black cherry), and *Castanea dentata* (American chestnut) sprouts. There is often a heath-dominated shrub layer with *Kalmia latifolia* (mountain laurel) being especially important; *Gaylussacia baccata* (black huckleberry), *Vaccinium* spp. (blueberries), and *Kalmia angustifolia* (sheep laurel) are also common. Other shrubs, like *Cornus florida* (flowering dogwood), *Hmamelis virginiana* (witch-hazel), *Viburnum acerifolium* (maple-leaved viburnum) may also occur on less acidic sites. There is typically a sparse herbaceous layer with a northern affinity; *Aralia nudicaulis* (wild sarsaparilla), *Pteridium aquilinum* (bracken fern), *Maianthemum canadense* (Canada mayflower), *Gaultheria procumbens* (teaberry), *Trientalis borealis* (star-flower), and *Medeola virginiana* (Indian cumber-root) are typical. The successional status of this type seems variable, in some cases, especially on harsher sites, it appears relatively stable, and in other cases it appears to be transitional.

Range: Most typical of the Ridge and Valley, also occurs on South Mountain, Glaciaded NE, Glaciaded NW, Pittsburgh Plateau.

FF- Hemlock (white pine) forest

Tsuga canadensis (eastern hemlock), *Pinus strobes* (eastern white pine), or more often a combination of the two dominates these forests. Conifer cover generally exceeds 75% of the canopy. Associate species include a variety of northern hardwoods and oaks. Typical representatives include *Betula lents* (sweet birch), *B. alleghaniensis* (yellow birch), *Acer saccharum* (sugar maple), *A. rubrum* (red maple), *Quercus rubra* (red oak), *Q. velutina* (black oak), *Fagus grandifolia* (American beach), and *Liriodendron tulipifera* (tulip tree). Representative shrubs include *Rhododendron maximum* (rosebay), *Viburnum lantanoides* (witch-hobble), *V. acerifolium* (maple-leaved viburnum), and *Hamamelis virginiana* (witch-hazel). Typical herbs and creeping shrubs include *Maianthemum canadense* (Canada mayflower), *Mitchella repens* (partridge-berry), *Lycopodium* spp. (ground pine), *Gaultheria procumbens* (teaberry), *Thelypteris noveboracensis* (New York

fern), *Medeola virginiana* (Indian cucumber root), and *Polystichum acrostichoides* (Christmas fern).

Range: Glaciated NE, Glaciated NW, Pocono Plateau, Unglaciated Allegheny Plateau.

FB - Hemlock (white pine) – northern hardwood forest

Any of the three named components may be dominant; at least two are present in some amount. Conifers and hardwoods each contribute between 25 and 75% of the canopy. Characteristic hardwood species include *Fagus grandifolia* (American beech), *Acer rubrum* (red maple), *A. saccharum* (sugar maple), *Betula lenta* (sweet birch), and *B. alleghaniensis* (yellow birch). The conifer component may be *Tsuga canadensis* (eastern hemlock), *Pinus strobes* (eastern white pine), or a combination of the two. The forests occur on mesic sites, often north facing, sometimes rocky and steep. This type is fairly widespread in northern PA. *Rhododendron maximum* (rosebay) may be locally abundant. Other common shrubs include *Hamamelis virginiana* (witch-hazel), *Acer pensylvanicum* (moosewood) and the Viburnums (*Viburnum spp.*). The herbaceous layer is generally sparse and reflects a northern affinity; Common components include *Maianthemum canadense* (Canada mayflower), *Trientalis borealis* (starflower), *Thelypteris noveboracensis* (New York fern), *Medeola virginiana* (Indian cucumber root), *Mitchella repens* (partridge-berry), *Lycopodium spp.* (ground pine), and *Clintonia borealis* (bluebead lily). There is often a rich bryophyte layer.

Range: Entire state except the Coastal Plain, Piedmont, and South Mountain.

UM – Red maple – highbush blueberry palustrine woodland

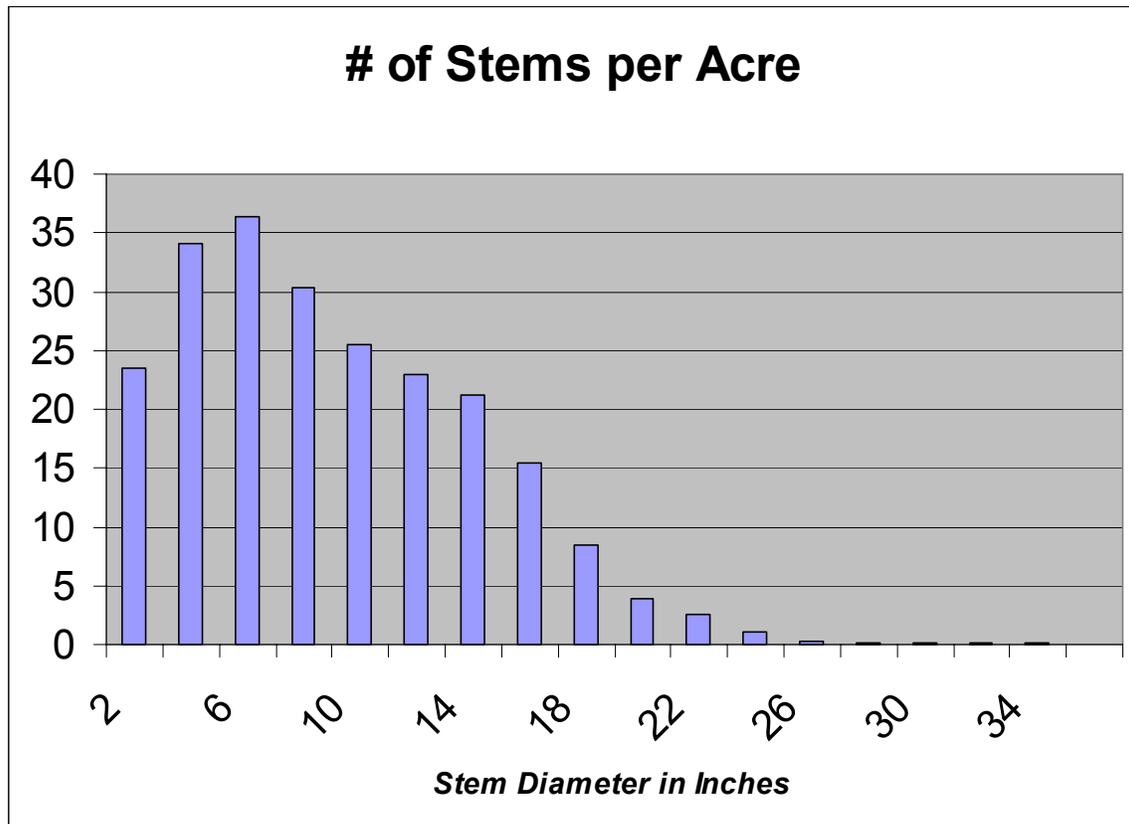
This community type usually occurs on mineral soil often with a layer of muck (occasionally occurs on peat). These woodlands may occur as isolated pockets in small depressions or as part of larger wetland complexes, and are often associated with past impoundment (beaver or other). This type is most typical of northern portions of the state. *Acer rubrum* (red maple), *Nyssa sylvatica* (black-gum), and *Betula populifolia* (gray birch) are the most common trees, although other species may also be present, including *Pinus strobus* (eastern white pine), *P. rigida* (pitch pine), *Betula alleghaniensis* (yellow birch), *Tsuga canadensis* (eastern hemlock), *Larix laricina* (tamarack), and *Picea rubens* (red spruce). The most characteristic shrub species is *Vaccinium corymbosum* (highbush blueberry). Other shrubs that commonly occur are *Rhododendron viscosum* (swamp azalea), *Alnus incana* (speckled alder), *Gaylussacia baccata* (black huckleberry), *Lyonia ligustrina* (maleberry), *Nemopanthus mucronatus* (mountain holly), *Viburnum cassinoides* (withe-rod), *V. recognitum* (arrow-wood), *Spiraea latifolia* (meadow-sweet), *S. tomentosa* (hardhack), *Sambucus canadensis* (American elder), and *Ilex verticillata* (winterberry). Herbaceous species include *Carex stricta* (tussock-sedge), *C. folliculate* (a sedge), *Juncus effuses* (soft rush), *Glyceria spp.* (mannagrass), *Dulichium arundinaceum* (three-way sedge), *Eleocharis palustris* (creeping spike-rush), *Triadenum virginicum* (marsh St.-John's-wort), and *Osmunda cinnamomea* (cinnamon fern).

Range: Glaciated NE, Glaciated NW, Pocono Plateau, Ridge and Valley.

A Stand Summary Table, included in the Appendices, shows the average stocking (as sq ft of basal area), trees per acre, average tree size (diameter breast height in inches), and estimated sawtimber (thousand board feet or

Mbf) and pulpwood (tons) per acre. These and other measures allow characterization of the stands as an even aged forest which is at full stocking, meaning growing space/resources are fully claimed by the trees present and further size growth of the dominant trees requires mortality of suppressed trees to free up space and resources. The size distribution of trees indicates one of the more mature or larger stands in the region with statistical average tree size of almost 11” diameter and average size of dominant trees more in the 18-24” range. The forest is somewhat unique within the area with a large number of trees in the 24-36” diameter range.

The size distribution on the Chart below shows pictorially a maturing forest with good representation of large diameter trees. Normally, shade tolerant species would be expected to continually fill in the smaller size classes as saplings are recruited in large numbers and older suppressed trees linger in these size categories filling in the left side of the distribution. In this forest, the high stocking and crowding and the complete lack of recruitment of new age classes has left a full, maturing overstory and fewer smaller trees. This again emphasizes the need to address understory and regeneration issues.



The forest inventory estimated approximately 3,998,000 board feet of sawtimber on the property with a standing value of approximately \$780,000 or \$1700 per forested acre. Using available software based on growth studies in similar forest types, timber growth was projected at 230 bf/acre/year. This is on the high side for other stands in the region and is a result of the high stocking of sawtimber trees. It is probably a bit higher than should be expected with the mortality which has resulted from the insect, disease and stress problems in the forest. It equates to about \$21,000/year in continuous value growth at average timber prices.

Producing timber revenue is not a goal of the Sanctuary, but the salvage of dead or downed trees or removal of trees to reduce crowding may be considered as a financial tool to support the primary goals. The goals of research and education could also be extended into a study and demonstration of sustainable forestry in an area of the property with proper thinning and treatments to promote regeneration.

Since the forest structure is relatively unique in the area as an undisturbed second growth forest, the Sanctuary might consider joining a research effort just started by The Nature Conservancy to explore methods for manipulating these stands through management to “accelerate” their progression to the old growth characteristics of 1) wide distribution of tree sizes with many large trees, 2) significant amounts of large down & dead woody material, 3) more complex species and structural characteristics, etc. The author could direct the Sanctuary Board to the appropriate contacts at the Nature Conservancy.

Management Units

The property was broken into Management Stand Units of similar characteristics, each typed according to the system discussed above. This allows an assessment of the forest conditions across the property and allows management recommendations to be focused on the conditions within each particular stand unit. A map of the individual management stand units is attached and a description of each follows. Stand units of similar species

composition, size and structure are combined in the description of conditions and management.

Two general management objectives which apply to almost all of the Stands are the control of the deer herd and resultant browse pressure and the restoration of the forest understory structure and diversity. These are obviously related and some general management recommendations are in order that apply across the property.

Deer Management:

The deer browse damage is simplistically caused by too many deer for the available food base for too long. Continuous selective browsing has eliminated shrubs such as the viburnums, elderberry, dogwoods, and spicebush and severely limited witchhazel and winterberry. There is no significant forest seedling/sapling understory within reach of the deer. Food supplies in the form of browse and herbaceous growth are very limited and only periodically supplemented with acorn mast. This habitat will probably only support 12-15 deer per square mile or 10-12 deer on the entire property. Strategies to lessen browse impact will be to lower deer densities and increase food supplies. Hunting is the only currently effective technique for controlling populations although contraceptives are being researched and may prove to be viable option at some point.

Deer behavior is a key determinant of hunting success. Local deer migrate into communities and utilize nearby open fields for summer food supplies. Food sources on the Sanctuary are dispersed and include only small seedlings, wetland shrubs, growth in the small herbaceous openings and hard and soft mast dropped on the forest floor. This makes the deer hard to predict or “pattern”. To improve hunting success, foodplots will concentrate feeding during seasons of legal hunting. Foodplots are simply herbaceous or grass plantings of palatable species. They could contain annuals such as winter wheat, soybeans, turnips or buckwheat (more labor intensive and expensive!!) or a mix of perennials such as white clover, Ladino clover, birdsfoot trefoil, chicory, or grasses. I would recommend establishing a mix of clover/chicory/ryegrass on small foodplots of 0.3-1.5 acres at several locations across the property as noted in the Management Unit discussion. The Sanctuary could also consider subsidizing foodplots on neighboring fields which are open to hunting to draw deer away from the Sanctuary for harvest. Foodplot production will not make a very large contribution to food needs but it will 1) relieve some of the summertime browse pressure on

seedlings when they are least able to withstand it and 2) make harvesting of deer more effective. Harvesting one deer will eliminate the need for almost one ton of vegetative browse or seed consumption per year.

A second potential option in controlling deer would be a restrictive fence along the entire eastern boundary from the outlet of Lake Lacawac to the Wallenpaupack shore, a distance of approximately 4500 feet. A 7 foot woven wire fence installed by a contractor would cost approximately \$11-12,000, much cheaper than fencing the entire property. It should prevent much of the migration of deer from Wallenpaupack Lake Estates, allowing control within the Sanctuary to occur without continual migration. It would also restrict and funnel movements of deer and allow hunting efforts to be more effective. Maintenance of the fence would be needed to avoid deterioration.

Hunting will be a necessary part of annual scheduling and should be diligently planned and communicated so as to maintain safety and increase effectiveness. Inconveniences will occur, but the critical nature of this deer control effort should be communicated to everyone associated with the Sanctuary. Stand hunting along frequented deer trails is preferable and will be more successful with a foodplot program. This should commence in September archery season, continue with the October muzzleloader season and on into rifle and possibly late muzzleloader if possible. "Driving" deer toward standers is a common practice but is both less safe and typically less effective and should probably be restricted to a few days in rifle season. Harvest of does should be emphasized although I would not recommend being overly restrictive if a hunter has any safe opportunity to harvest deer. DMAP tags (property specific antlerless tags) should be acquired through the PA Game Commission to be made available to serious hunters.

The most aggressive option for deer control would be a controlled or contracted harvest effort. USDA and several private contractors provide deer control services. Authorization is necessary through the PA Game Commission and the local Township. Once permits are in place, the contractor assesses safety and deer habits on the property. They commence periodic efforts to bait and harvest deer (usually at night) until targeted numbers are removed. This option, once approved, can quickly bring the deer numbers down but is quite expensive. Maintenance of the herd could be accomplished with recreational hunting or by periodic controlled harvests.

Understory Recovery:

Once the deer numbers are brought in balance with the food supply and habitat, forest understory recovery will begin at a pace determined by seed availability, seedbed disturbance, light levels and level of competing vegetation. Under undisturbed forest canopies and at low light levels the process can be quite slow to develop. It is therefore essential that deer numbers remain low (probably 8-10 deer per square mile) for extended periods to allow the most sensitive species to reestablish.

The only short term solution will be the use of protective fencing to control the deer impact. Given the investment in fencing (construction & maintenance), it is recommended that a combination of thinning the overstory and treating any competing vegetation, mainly hay scented fern, be accomplished in conjunction to accelerate development of a more diverse understory and get it above the reach of the deer in the shortest time possible, usually 5-6 years. If the fence is then removed, a significant volume of food is made available to what is hopefully a reduced deer herd and the pressure on vegetation is reduced across the property. This becomes a risk/reward assessment where the landowner can weigh the cost of achieving objectives entirely within costly fences at low risk or of achieving some balance where vegetative growth overwhelms the demands of browsing deer and the impact of the deer herd subsides, saving the cost of fencing but running constant risks of damage to the understory. Knowing if the balance will be achieved is problematic as it depends not only on current conditions but also on future events such as weather, mast crops, and hunting success (or failure) which are impossible to predict.

Other techniques to encourage forest understory development could include direct seeding to fill any gaps in available seed, underplanting, seedbed scarification, controlled burning, or other treatments. Presently, any reasonable evaluation of these would require protection from the current deer herd. As the deer herd is reduced, opportunities may exist to study and educate the forestry and landowner community in methods to restore and regenerate our forests.

The following are the individual Stand Unit descriptions and recommendations:

Management Unit 1 **(Natural Bog 7.1 acres)**

Management Unit Description

Management History: This area is undisturbed and a result of past glaciation which formed Lake Lacawac and resulted in the accumulation of sphagnum moss and other organic sediment as a substrate to the plant growth in this area. There has not been any recent management activity or disturbance.

Description of Dominant Vegetation, Stand Age & Size Class: This a low nutrient, acidic bog environment with specialized plants and stunted specimens of certain upland species such as red maple, grey birch and tamarack.

Stocking and Growth Rate: Tree growth and stocking are constrained by the low nutrient, acidic environment and saturated peat soils. These sites will approach fuller stocking of tree species over the next several thousand years.

Timber Quality or Potential Quality: Timber quality is irrelevant as these are sensitive sites on wetland, organic soils with very limited potential to grow trees.

Regeneration and Invasive Plants: This bog environment has a more steady state assemblage of shrubs, vines, mosses and sedges under scattered trees. There was no evidence of invasive plants. Purple loosestrife is certainly a risk to the region's wetlands.

Soils and Site: The soils are organic bog soils, noted as Medihemists and Medifibrists in the Soil Survey. They are organic peat deposits with high water tables, saturated conditions, high acidity, low nutrient availability and shallow rooting depths. The soils place significant limitations on plant growth.

Forest Health: No particular forest health issues were noted.

Understory Trees, Shrubs, Herbaceous Plants: Woody shrubs include meadow-sweet, leatherleaf, huckleberry, highbush blueberry, winterberry, Smilax and possibly cranberry. Sedges and aquatic plants such as golden club, pickerel weed and arrowhead are typical in and along the edges of this type.

Wildlife Habitat Evaluation and Species Use: The bog mat and shrub cover provide some unique habitat on the property and would attract a particular set of wildlife species including bitterns, herons, marsh hawks, flycatchers, yellow and common yellowthroat warblers, cedar waxwings and red winged blackbirds along with mink, muskrat, bobcat, beaver, and black bear. This stand will also serve as escape cover for deer.

Streams, Ponds, or other Wetlands and Water Quality Issues: This stand is a natural bog complex and provides a research and educational asset on the Sanctuary property. Runoff from the adjacent residential property could provide nutrients, weed seeds or

sediment that could cause problems at excessive levels. This is in the Highest Priority Protection Area.

Recreational Opportunities: I did not see a trail that accesses the edge of this feature. A trail could possibly encourage educational visits and wildlife viewing opportunities.

Important Natural Features: Glacial bog.

Management Objectives for Unit #1

Wildlife habitat, research and hiking/wildlife viewing are the primary objectives for this stand. This is in the Highest Priority Protection Area of the Sanctuary.

Management Recommendations

Feature this stand with a trail extension off the northwestern trail loop to the edge of the bog. This would allow viewing and a potential educational opportunity for visitors using signage similar to that found elsewhere on the trail system. No other management recommended due to the sensitive nature of the plant community in this area.

Management Unit 2 & 4
(Hemlock/Pine Type:28.2 total acres)

Management Unit Description

Management History: These stands are second growth hemlock/pine stands. Both stands probably originated from past timber harvests. They have not had any recent timber harvesting or management activity.

Description of Dominant Vegetation, Stand Age & Size Class: Hemlock is the dominant species with 58% of the stocking, followed by red maple 10% and red oak 6% with lesser amounts of white pine, sugar maple, chestnut oak, black birch and yellow birch. The stands are over 100 years old, average tree diameter is 14” of dominant trees ranges from 16-28” in diameter.

Stocking and Growth Rate: These stands are fully stocked where mortality is resulting from crowding. Basal area in square feet averaged almost 220. Growth rates are slowed by the dense stocking in some areas.

Timber Quality or Potential Quality: There is some potential for timber value due to the significant volumes of sawtimber sized trees. Most of the volume is in lower value hemlock so average values are lower in these stands.

Regeneration and Invasive Plants: There is very little tree regeneration anywhere in these stands. A noticeable browse line exists and due to the heavy stocking and low light levels, seedling establishment and growth would be very slow, allowing prolonged periods of exposure to deer browse pressure. No invasive plants were noted.

Soils and Site: Stand # 4 is on Oquaga soils on a ridge site. These soils should be well drained and have led to some drought stress in the past. Overall, these soils should provide for average to good tree growth. Stand #2 looks to be mistyped as these are upland soils, not the Norwich/Chippewa soil type listed. There may be pockets of this type along the lower margins of the stand, but most will probably be the adjoining Wellsboro stony loam type with good tree growth characteristics.

Forest Health: The hemlock in Stand #4 has suffered from hemlock wooly adelgid and drought and significant mortality has occurred in pockets. Stand #2 is at risk but has not seen as much infestation to date. There is some storm damage along the eastern shore of the lake which has uprooted a significant number of trees in Stand #2 and #6. Areas of beech have been heavily affected by the beech bark disease with mortality and dieback.

Understory Trees, Shrubs, Herbaceous Plants: The understory in fully stocked/undisturbed areas is very sparse with a few hemlock or 1 year old red maple seedlings, scattered rhododendron, clubmoss or beech suckers. In areas where the canopy is opened up from hemlock mortality, hayscented fern has established a thick mat.

Wildlife Habitat Evaluation and Species Use: The thick hemlock cover provides habitat for various birds including magnolia, blackburnian and black throated green warblers, purple finch, red breasted nuthatch and saw-whet owls. Grouse and turkeys use the hemlock for roosts and winter cover. This thick conifer cover provides a protected wintering area for the whitetail deer herd by reducing the snow pack and providing thermal cover from the coldest temperatures and wind chills. Normally, hemlock seedlings/saplings would provide a suitable winter food supply but most of these have been eliminated, leaving less food for deer and less cover for birds and small mammals.

Streams, Ponds, or other Wetlands and Water Quality Issues: Stand #2 adjoins the lake to the east and should be retained as a buffer.

Recreational Opportunities: One of the two main walking trails passes through Stand #4 for a short distance.

Important Natural Features: Rock ledges along the eastern perimeter of Stand #4

Management Objectives for Units 2 & 4

Wildlife cover and protection of the existing forest and groundwater drainage are the two main objectives for this stand, and particularly addressing the threat posed by hemlock wooly adelgid and heavy deer browse.

Management Recommendations

Protect area of Stand #2, no active management recommended. In Stand #4, adelgid mortality has begun to open the forest canopy and hayscented fern is the only significant ground level growth resulting from the increased light. Along the hiking path treat a small 1-2 acre area with ROUNDUP and fence to provide a demonstration of the response of the forest community to disturbance with and without protection from deer. Signage could explain what visitors are looking at and the demonstration could provide a test of how to treat larger areas if significant hemlock mortality occurs again in the future. Fencing techniques and costs are reviewed in the Appendices. If severe infestation of adelgid threatens most of the hemlock, the Board should consider options to salvage/fence versus allowing major mortality episode to possibly convert the stand to a fern “savannah” with very limited diversity or habitat value. No other active management recommended due to the proximity to Lake Lacawac.

Management Units 3,19&27
(Red Maple/Highbush Blueberry wetlands:18.4 acres)

Management Unit Description

Management History: These stands are wetlands dominated by red maple, hemlock and scattered yellow or grey birch over a shrub understory. No recent disturbance or management activity has impacted the stands

Description of Dominant Vegetation, Stand Age and Size Class: Dominant trees are mostly red maple, yellow birch, hemlock and scattered red spruce over a rhododendron, highbush blueberry, and winterberry shrub layer. Average tree size was 8 inches.

Stocking and Growth Rate: The stand has stocking limited by the high water table which slows growth and leads to frequent blowdown. Stocking is variable and near maximum levels for the constraints posed by the hydrology. Growth rates are slow.

Timber Quality or Potential Quality: These are not commercial timber stands and are sensitive sites where timber is not a consideration.

Regeneration and Invasive Plants: There is scattered hemlock and red spruce in the seedlings/sapling categories, but most tree regeneration is being eliminated by the deer. There was no evidence of invasive plants.

Soils and Site: The soils in these stands are a combination of the Norwich and Chippewa extremely stony loams and the organic Medihemists and Medifibrists mentioned above. All these soils are hydric soils with water tables at or near the surface and limited growing conditions due to lack of aeration, limited rooting depths and acidity.

Forest Health: Lack of regeneration is the major forest health issue in these stands, made more pressing by mortality caused by blowdown and hemlock wooly adelgid. Wetland environments are also responsible for added plant diversity which is limited by the selective deer browsing.

Understory Trees, Shrubs, Herbaceous Plants: These stands have significant shrub cover from a combination of highbush blueberry, rhododendron, winterberry and other wetland shrubs with a few birch, hemlock and red maple saplings. Sphagnum moss is prevalent throughout with areas of tussock sedge, *Panicum sp.*, burreed, wild iris and other wetland species.

Wildlife Habitat Evaluation and Species Use: This is an area with better low cover and provides escape and nesting cover for many species of birds and mammals. Berry producing shrubs and various buds provide food for songbirds, grouse, deer and bear. Dead snags and blowdown and dead woody material provide good habitat features for woodpeckers, squirrels, chipmunks, insects and amphibians and the small open water areas provide breeding areas for amphibians.

Streams, Ponds, or other Wetlands and Water Quality Issues: Stand #3 drains directly into Lake Lacawac and is particularly important for protection. Stands #21 & 29 are in small drainages that drain away from Lake Lacawac and toward Lake Wallenpaupack.

Recreational Opportunities: Wildlife viewing because of the different habitat characteristics.

Important Natural Features: These stands are important for any wetland research projects pursued on the property.

Management Objectives for Units 3, 19 & 27

Protection and wildlife cover are the main objectives for these stands.

Management Recommendations

Because of the proximity to Lake Lacawac and the sensitive site conditions, these stands should be protected and left undisturbed.

Management Unit 5&13
(Hemlock/Pine and Northern Hardwoods: 32.0 total acres)

Management Unit Description

Management History: These stands have different histories as #5 was similar to adjoining stands which originated from past timber harvests 100 plus years ago. Stand #15 probably originated from farmland abandonment at least 80 years ago as evidenced by the stone walls surrounding the stand and the significant amount of white pine and red maple, two species with a propensity for colonizing old fields and pastures. Neither stand has had any recent management activities.

Description of Dominant Vegetation, Stand Age and Size Class: The stands are 80-120 years in age and dominated by a conifer overstory. In Stand #5 this is mainly hemlock with scattered white pine. In Stand #15 it is primarily white pine with scattered hemlock. On average, hemlock makes up 19% of stocking, white pine 18%, red maple, 17% and birch 16% with a mix of beech, sugar maple, white ash and other species composing the remainder. Average stand diameter is 9 inches. Dominant trees are mainly in the range of 14-24" diameter.

Stocking and Growth Rate: The stand is fully stocked with just over 180 sq ft of basal area. Growth rates should be good, but are slowing due to crowding and maturation of the stand where mortality becomes a significant factor in net growth.

Timber Quality or Potential Quality: Generally good quality trees with no major defects or past timbering. A few of the white pine have evidence of white pine weevil. Hemlock is generally healthier with less mortality than the nearby ridge stands of weakened hemlock.

Regeneration and Invasive Plants: Significant stocking of white pine saplings in Stand #15 is the best regeneration on the property. There are also some 1-2 year old red oak and ash seedlings which will probably not survive the deer pressure. There are also some areas of stiltgrass in Stand #15, which may be the exotic, invasive species or the native variety.

Soils and Site: These stands are on Oquaga and Wellsboro extremely stony loams which make for good growth of forest vegetation and should not present any limitations to management activities. Red oak site index should be 70-78 feet at age 50.

Forest Health: Effects of hemlock wooly adelgid, beech bark disease, nectria canker of birch and white pine weevil were all noted at typical levels for these types of stands. Wooly adelgid is the greatest threat to maintaining the health of these stands and this insect should be observed for building populations.

Wildlife Habitat Evaluation and Species Use: The thick pine saplings in sections of Stand #15 provide some of the best cover for ground nesting birds on the property.

Rhododendron and beech saplings provide marginal low cover in other areas of this type. Some periodic mast is produced from the beech stocking which is still healthy.

Streams, Ponds, or other Wetlands and Water Quality Issues: Stand #5 is close to the Lake Lacawac shoreline and part of the drainage.

Recreational Opportunities: Wildlife viewing, research and hiking.

Important Natural Features: N/A

Management Objectives for Units 5 & 13

Wildlife habitat, viewing, hiking.

Management Recommendations

Maintain the current trail system and monitor hemlock health. No other management recommendations due to the proximity to Lake Lacawac and the Visitor Center.

Management Unit 6, 7, 21 & 23
(Red Oak – Mixed Hardwoods: 92.4 acres)

Management Unit Description

Management History: This area, like most of the property, probably originated from timber harvesting events over a hundred years ago. There was little or no evidence of harvesting within the last 50 years and the forest is fully stocked.

Description of Dominant Vegetation, Stand Age & Size Class: Dominant trees are mostly red oak 22%, hemlock 23%, red maple 17% , chestnut oak 7%, with smaller amounts of black oak, sugar maple, white pine, beech, black birch, yellow birch, ash and black cherry. Dominant trees are in the 16-26” diameter range and oak trees up to 34” diameter at chest height were sampled. Average diameter for the type was 11 inches. Stands 6, 7 and 25 are 100-125 or more years old. Stand 23 is a bit younger and smaller in average size and may have originated from farmland abandonment 80-100 years ago.

Stocking and Growth Rate: Generally full stocking throughout meaning trees are fully occupying all growing space (and have for some time) and further diameter growth results in mortality of some trees from crowding and competition for light and resources. Basal area stocking averages 162 square feet. Growth rate has slowed due to crowding but should be good for the species on these soils.

Timber Quality or Potential Quality: Timber quality is very good, with a good percentage of trees capable of producing grade sawlogs or veneer material.

Regeneration and Invasive Plants: No exotic invasives were noted in these stands. Hayscented fern has developed fairly consistent stocking through Stands 6 and 23.

Soils and Site: The soils under Stands 6 and 25 are Wellsboro, Stand 7 soils are Wellsboro and Lordstown and Stand 23 soils are Morris. The Wellsboro soils have the highest site index for red oak at 78 feet whereas the Lordstown and Morris soils are site index 65.

Forest Health: There was a regional outbreak of gypsy moth which arrived at the subject property and caused some significant oak defoliation in 2006. The outbreak appears to have collapsed based on the presence of dead late instar caterpillars on the trunks of most trees and the lack of new egg masses throughout these stands. Forest tent caterpillars which have also been building in this region will also defoliate red oak and both these insects should be watched and any severe defoliations factored into the high stocking level of the stands, lack of any understory or regeneration, the mature condition, and the annual weather patterns and drought condition. Beech bark disease, ash dieback and hemlock wooly adelgid have also had some minor influence on the forest health of these stands. Stand 6 has had some past storm damage in the form of blowdown which has opened up the canopy and resulted in a thick mat of hayscented fern.

Understory Trees, Shrubs, Herbaceous Plants: The understory is becoming dominated in areas by hayscented fern. Other species that should be present are spotty, sparse or missing over large areas. There some areas of 1-2 year old red oak, chestnut oak, red maple and hemlock seedlings and areas of significant beech seedlings saplings which have been heavily browsed. A few black birch saplings made it up through the deer browse in the area of the blowdown but other regeneration is absent. A few witchhazel specimens were present and very little else in the way of shrubs. Drier areas of stands 7 and 25 had only grass, moss and dead leaves for ground cover.

Wildlife Habitat Evaluation and Species Use: The oak trees produce a significant acorn crop which provides seasonal food for a wide range of wildlife species from small rodents to turkeys, grouse, deer and bear. The high canopy and mixed species with scattered conifers provide habitat for many songbirds, but the lack of low structure and groundcover limits the habitat for ground nesting birds and small mammals requiring food and cover in this zone.

Streams, Ponds, or other Wetlands and Water Quality Issues: The Heron Pond and another small pond lie along the southern edge of Stand 7 and a small stream runs in a southwesterly direction along the eastern edge of Stand 23.

Recreational Opportunities: The nature trail runs through Stand 25 and all areas afford opportunities for hiking, birdwatching and nature study.

Important Natural Features: None noted.

Management Objectives for Units 6,7,21&23

Wildlife habitat, protection, research and restoration of understory.

Management Recommendations

Monitor the stand for defoliation in 2007. The eastern areas of Stand 6 & 7 along with Stand 31 have some of the most depleted understory conditions on the property caused by the deer browse pressure over several decades. Stand 6 also incurred natural disturbance from a storm event 8-10 years ago which resulted in significant blowdown. The response of the forest is indicative of the risk to the entire property of major disturbance as only ferns have filled in the openings. This area could be targeted for an understory recovery effort through active management and could

also serve as an educational demonstration of key issues in forest management. Areas of well established fern and beech brush should be treated in late summer with an application of glyphosate at label application rates using a mist blower. Recommendations are to relieve crowding stress in the overstory trees through an improvement thinning over the eastern 50-60 acres. Reduce stocking from 140-160 sq ft of basal area to approximately 100-110 sq ft by removing dead, dying, crowded and higher risk trees and leaving a well spaced canopy of healthy trees in the 14-24" diameter range. Thinning decisions will favor a diverse species mix of healthy trees to favor seed production and spacing to relieve crowding and improve energy budgets of individual trees. Below is a stocking guide for mixed oak stands developed by Gingrich (see footnote below). The subject stands contain some hemlock, red maple and beech which on a relative basis, can achieve higher stocking rates because they are more shade tolerant species. Currently the stands have an average "merchantable" tree diameter of 14-15" and basal area stocking is in the range 150-160 sq feet, putting it clearly in the overstocked range. The thinning would lower stocking below the A-line on the attached.

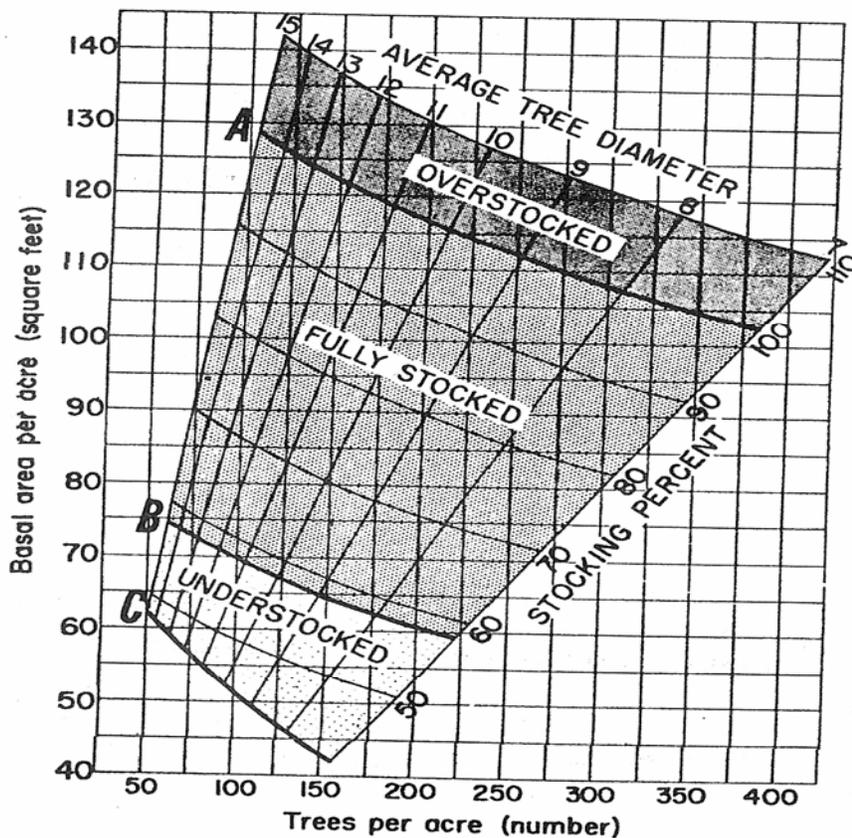


Fig. 17. Use of tree-area ratio and crown competition concepts to describe stand density-management conditions for upland hardwoods. The A line represents 100% stocking as determined by the tree area ratio for fully stocked stands and the B line represents 55-58% of that stocking. The B line was determined using a tree area ratio equation based on open-grown tree crown coverage. It represents the condition where the sum of open grown crown areas just equals the stand area, i.e., full site utilization. Gingrich, S. F., 1967. Measuring and evaluating stocking and stand density in upland hardwood forests in the Central States, *Forest Science* 13:38-53.)

Following the thinning, a significant portion (at least 10 acres and preferably up to 30 acres) should be fenced to exclude deer as much as possible. If research of the vegetative response inside and outside the fence were planned, I would recommend a woven wire 7 foot fence as it is the most durable over longer periods. Current costs would be approximately \$2.40-2.60/lineal foot installed by a contractor. A suitable alternative would be plastic 7 foot fencing with at a cost of approximately \$1.25 -1.35/lineal foot installed by a contractor or \$1.00/lineal foot or less for materials if volunteer labor were available. A write up procedure for the plastic is included in the Appendices. The combined herbicide/thinning treatment should stimulate seed germination of a variety of species and protection from deer should allow significant regrowth to develop in height and density. Higher light levels will stimulate more rapid response of the understory. The timber harvest landing area could also be enlarged and seeded as an herbaceous opening with clover/grass/trefoil and used as a strategic deer hunting area for deer control.

Revenue from the thinning should be in the \$400-500/acre range and could finance the herbicide treatment and fencing of a significant portion of the area. Control plots and treatment tests could be laid out if research or educational demonstration objectives were determined prior to treatment. Fences should be retained for at least 5 years with certain maintenance costs, and may be maintained for longer periods of time to allow maximum diversity as variable seed crops and slow establishing species fill in the understory. The overstory will eventually grow toward crown closure and slow the growth of the understory, resulting in some stratification of the vegetation structure and a wider distribution of diameters from multiple age classes.

Management Units 8,24 &25 **(Northern Hardwood: 69.2 acres)**

Management Unit Description

Management History: This is a northern hardwood mix which looks to mainly second growth forest in the 100 plus age range with Stand 27 possibly being some remnant uncut forest of significantly greater age. There has been no recent timber harvesting and the only management has been the construction of a road access to the Lake Wallenpaupack shore.

Description of Dominant Vegetation, Stand Age and Size Class: The dominant trees are sugar maple 34%, white ash 16%, red oak 9% and eastern hemlock 9% with minor amounts of beech, basswood, black birch, yellow birch, red maple, hickory, yellow poplar, black cherry and chestnut oak. Average tree diameter is 10 inches. The trees are at least 100 years ago and Stand 27 may be significantly older. Access to this Stand is very difficult under the ledges but it should be noted that 100 years ago when the major wave of timber harvesting was ending, Lake Wallenpaupack didn't exist and there was probably road access along the creek at the bottom of the hill. Large boulders were difficult to deal with and may have restricted harvesting and protected the stand. It might be possible to increment core some of the largest trees to accomplish growth ring analysis or to destructively sample one tree to verify age and potentially verify the forest as virgin forest.

Stocking and Growth Rate: Stocking is variable with dense areas and some openings and was probably "undersampled" as several plots fell in openings. Basal area stocking averaged 122 sq feet but several plots were as high as 200 sq feet in the undisturbed areas. Growth rates should be good on these moist slopes where adequate soil drainage is present.

Timber Quality or Potential Quality: There is some high value timber in the mix, but these are sensitive soils with significant slope. Stand 27 is potentially the oldest forest area on the property and should be protected. Sections of Stand 8 are listed as moderate priority on the Sanctuary Resource Mgt Plan Map and are well roaded and not as steep. This area has potential for some level of timber management.

Regeneration and Invasive Plants: There is no significant regeneration and a very sparse understory in these stands. Japanese barberry has colonized several areas and is beginning to spread through the understory. In conversations with Wayne Poppich it was noted that some control efforts are underway to eradicate this exotic invasive.

Soils and Site: Soils are of the Mardin, Lordstown and Swartswood types of extremely stony loams and should be well suited to forest growth with site indices of 65 to 70. Slopes and proximity to Lake Wallenpaupack create some sedimentation issues and the existing road system should be adequately maintained to prevent erosion and runoff.

Forest Health: Forest tent caterpillar is an immediate risk to these stands, particularly with the highest priority protection level of Stand #27 and the eastern end of Stand #8. Recent outbreaks of this insect in other areas of Wayne County have led to significant mortality of sugar maple in as little as one year of complete defoliation. The reasons for this are probably a combination of the state of energy reserves of the maples, secondary attack by anthracnose fungus and moisture stress. Deer browse pressure has eliminated most seedling and shrub stocking and increased risk of regeneration failure if the overstory experiences significant mortality of any kind.

Understory Trees, Shrubs, Herbaceous Plants: Shrub/sapling layer is almost completely devoid of vegetation in the 10 foot zone. Some smaller sugar maple and beech saplings and poles are suppressed remnants of past regeneration events from heavy seed or natural disturbance. There are a few red oak and sugar maple seedlings of 1-2 year age classes which have very little chance of establishing into viable recruits in the stand. Barberry is the only significant shrub in the stand.

Wildlife Habitat Evaluation and Species Use: This stand offers very little cover for most species. Some interior forest birds, especially flycatchers prefer the open understory and high canopy of the current forest. Seedlings of the current species mix are highly palatable deer browse and so are quickly eliminated.

Streams, Ponds, or other Wetlands and Water Quality Issues: The Stands lie above Lake Wallenpaupack and a small drain cuts through the middle of Stand #8, making erosion and runoff and issue for any soil disturbance in this area. Proper erosion and sedimentation control practices should be employed for any activities.

Recreational Opportunities: Birdwatching, hiking, and views of Lake Wallenpaupack.

Important Natural Features: This stand sits on the north side of Lake Wallenpaupack and below the significant ledges for which Ledgesdale is named.

Management Objectives for Units 8, 24 & 25

Protection, water quality, research and hiking are the main objectives for this stand.

Management Recommendations

Because of the potential old growth condition in Stand 25 and the proximity to Lake Wallenpaupack, management should be limited to protection of forest health. Monitor stand for forest health and infestation of forest tent caterpillars. Priority to evaluate egg masses during winter of 2006-2007 and using guidelines, predict potential defoliation for May/June of 2007. If defoliation is predicted, Spray

decision should be made to protect stands using BT, which is safest pesticide. *Bacillus thurengensis* is a bacterium applied to foliage in the form of spores which will infect defoliating caterpillars and cause significant mortality at the early instar stages. It must be applied at the correct time of the caterpillar life cycle and normally costs \$26-32/acre for aerial application of large blocks. If the insect outbreak from across the Lake spreads into these stands, significant mortality of much of the sugar maple and possibly defoliation of red oak is a definite possibility. The forest response to this disturbance is heavily affected by the lack of an understory and continuing elevated deer herd.

Treat the Japanese barberry with August applications of glyphosate using a mistblower or backpack sprayer. Repeat annually until barberry is completely killed.

Sections of Stand #8 along road system could be thinned at some point in the future to encourage larger diameter growth and relieve crowding stress if deemed appropriate. The Lake shore should be buffered and harvesting accomplished in winter to minimize disturbance.

Management Units 9&10
(Water Impoundments: 5 acres)

Management Unit Description

Management History: These are constructed ponds which were added to the property in past years and have been managed for wildlife and visual features.

Description of Dominant Vegetation, Stand Age and Size Class: The ponds have a grass and sedge margin and significant aquatic vegetation in the shallow margins.

Stocking and Growth Rate: N/A

Timber Quality or Potential Quality: N/A

Regeneration and Invasive Plants: Shrub cover around the margins is somewhat lacking and purple loosestrife and *Phragmites* are potential invasive threats although neither was noted .

Soils and Site: The ponds were constructed in the Lordstown and Wellsboro soil types and there seems to be no issues with drainage or integrity of the impoundments.

Forest Health: N/A.

Understory Trees, Shrubs, Herbaceous Plants: There is opportunity for a different species mix in the littoral zones and upland margins of these ponds with more structure and cover. The current species mix was not inventoried.

Wildlife Habitat Evaluation and Species Use: An osprey nest platform has been added on the southern shore of Stand #10 and the site provides habitat for wading birds, ducks, kingfishers, muskrats, raccoons, various fish, damselflies, dragonflies and a variety of other wildlife not found elsewhere on the property.

Streams, Ponds, or other Wetlands and Water Quality Issues: Manmade impoundments.

Recreational Opportunities: The area provides hiking, fishing and wildlife viewing opportunities and a trail works its way around both sites.

Important Natural Features: Osprey nest.

Management Objectives for Units 9 & 10

Wildlife habitat and protection.

Management Recommendations

Potential exists to add speckled alder (fairly deer resistant) and silky dogwood along some of the margins to increase cover for some wildlife species. Planting should only occur once the deer herd is reduced.

Management Units 11,12 & 29
(Dry Hemlock/Mixed Oak: 45 acres)

Management Unit Description

Management History: This stand appears to be the same age and origin as the surrounding stands. Recently significant mortality from woolly adelgid, drought and gypsy moth left the some areas understocked .

Description of Dominant Vegetation, Stand Age and Size Class: The area is dominated by hemlock 47%, chestnut oak 20%, and red oak 12% with minor stocking of white pine, white oak, black oak, black birch, red maple and white ash. Dominant trees are in the range of 14-24" diameter and the stands are in the same age class of 100 plus year old second growth as the majority of the property. Average diameter is 11 inches.

Stocking and Growth Rate: The stocking is variable based on past mortality, especially on the drier sites and ranges from understocked patches to dense hemlock/oak areas with little past mortality. Growth rates are limited by crowding and moisture. Basal area stocking averaged 150 sq feet with a wide range.

Timber Quality or Potential Quality: This area is somewhat limited by health problems and a lower value species mix dominated by hemlock and chestnut/white oak. Stem quality is average to good for this forest type in the region.

Regeneration and Invasive Plants: The understory is very sparse in the fully stocked areas and as hemlock and oak mortality have occurred, fern patches, native grass and moss on the driest site have all colonized the openings. There is little or no suitable seedling stocking. One of the long term deer exclosures straddles the southern boundary of Stand # 12 and within the fence is a slowly developing mix of witchhazel, lowbush blueberry, hemlock, red oak, red maple, Indian cucumber root, starflower, teaberry and other herbaceous vegetation.

Soils and Site: Soils are typed as Lordstown and Oquaga with average site quality where sufficient soil depth is found above the bedrock and outcrops. The ridgetops and edges of benches have thin soils and excessive drainage, leaving them susceptible to drought stress and blowdown from shallow rooting.

Forest Health: Generally poor health with evidence of past mortality from crowding, moisture stress, hemlock woolly adelgid and gypsy moth. *Armellaria* root rot looks to be a secondary problem as it attacks stressed trees, especially oak.

Understory Trees, Shrubs, Herbaceous Plants: The understory is a mix of native grasses, moss and hayscented fern in some of the drier areas where overstory mortality is greatest. Undisturbed areas have very sparse understory conditions with patches of fern, 1-2 year old mixed oak and red maple seedlings and a few patches of black birch saplings and scattered witchhazel.

Wildlife Habitat Evaluation and Species Use: This area could serve as a bedding area and winter cover for deer but offers low value food supplies other than small seedlings. The overstory conifers provide roosting and nesting cover for certain bird species. The lack of understory limits habitat value for groundnesting birds and small mammals.

Streams, Ponds, or other Wetlands and Water Quality Issues: N/A

Recreational Opportunities: Research, hiking and wildlife observation.

Important Natural Features: None.

Management Objectives for Units 11, 12, & 29

Improve regeneration and wildlife habitat characteristics.

Management Recommendations

These are areas where understory establishment is most critical. Consider a larger deer exclosure in the areas of Stand #31 where mortality is opening the stand with very poor response. Higher light levels will probably allow a quicker understory response than within the deer exclosures under undisturbed canopy conditions. Plastic fencing should be adequate and lower cost to install with the added benefit of being easy to move in a sequence type approach for adjoining areas.

Management Unit 14,16,18,22,26,28,&30
(Hemlock/Red Oak/Hardwood :: 167 acres)

Management Unit Description

Management History: This is the primary forest type on the property and originated from timber harvesting 100-120 years ago. There has been no timber harvesting within the past 40 years and no other significant management activity of any type.

Description of Dominant Vegetation, Stand Age and Size Class: The stand is dominated by red oak 33%, eastern hemlock 22%, and red maple 11%, with lesser amounts of white pine, chestnut oak, beech, black birch, yellow poplar, black oak, white ash and black cherry among others. Average diameter is 11". Dominant trees are in the 16-30" diameter range with scattered red oak, chestnut oak and white pine from 30-40" in diameter. The stands are approximately 120 years old.

Stocking and Growth Rate: Stocking is generally good throughout and close to the full stocking level for a mixed forest of this size and age at 132 sq ft of basal area. Growth rates should be good but will be slowing due to crowding and natural aging of the trees.

Timber Quality or Potential Quality: Generally good stem form, height and species mix contribute to a fairly high quality and high value timber resource in these stands.

Regeneration and Invasive Plants: There is almost no forest regeneration under these stands except for some yearly seedlings of red oak, chestnut oak and red maple with smaller areas with beech saplings and root sprouts. Stand #30 has much more hayscented fern.

Soils and Site: Soils are mostly Wellsboro extremely stony loam with a red oak site index of 78 feet, which is one of the better sites on the property.

Forest Health: Some evidence of gypsy moth, wooly adelgid and beech bark disease but no significant threats of mortality. Deer browse pressure and the lack of understory are the major risks for forest health and function in these stands.

Understory Trees, Shrubs, Herbaceous Plants: Beech root suckers, witchhazel and a few sugar maple saplings are the only sapling/shrub layer species in most areas of these stands. Stand #30 has a scattered stocking of Rhododendron and a few areas of mountain holly. 1-2 year old seedlings of red oak, chestnut oak, red maple and cherry were noted. Starflower and patches of fern are present in areas.

Wildlife Habitat Evaluation and Species Use: This stand has significant mast production in the form of acorns and to a much lesser extent bechnuts. This provides periodic food supplies for a wide range of wildlife. Large pine and hemlock provide roosting sites and nesting sites for many species of birds. The large developing down and

dead woody material and large cavities provide valuable habitat for certain species of birds, small mammals and amphibians.

Streams, Ponds, or other Wetlands and Water Quality Issues: These stands adjoin Lake Lacawac along the drier shorelines along the southeastern side and lie above Lake Wallenpaupack on the southwestern side of the subject property.

Recreational Opportunities: Hiking, research, wildlife observation.

Important Natural Features: Large diameter trees up to 40” in diameter.

Management Objectives for Units 14,16,18,22,26,28,&30

Protection, understory establishment, wildlife habitat.

Management Recommendations

Most of these stands should be protected as a nature study and research site including the deer enclosure area in Stand 18. The large diameter trees and increasing accumulation of large down and dead woody material form the start of the combination of characteristics of “Old Growth” forest ecosystems. The stand is missing the multiple layered structure and species diversity which is limited by the deer. The Nature Conservancy has begun to look at the potential to accelerate development of these characteristics in some of our oldest second growth forests through active management and after initial contact they may be interested in looking at a research site on Lacawac Sanctuary. There is potential to use a combination of thinning (leaving much of the material on the forest floor for added large down and dead woody material) and fencing to 1) allow the largest trees to increase growth and survival, 2) increase forest understory development in the small openings, 3) increase species diversity and 4) add large diameter decomposing woody material. The Nature Conservancy is working on their metrics and experimental design and hope to set up research areas around the state of PA.

Management Unit 15
(Old field Successional Stand: 3.4 acres)

Management Unit Description

Management History: This stand is a former field which is slowly converting to woodland/forest. The oldest trees appear to be 25-30 years old and surround some old apple trees, indicating a former orchard site.

Description of Dominant Vegetation, Stand Age and Size Class: Dominant trees are mostly white pine with a few aspen and birch. Grasses, goldenrod and other herbaceous cover occupies most of the area.

Stocking and Growth Rate: The stand is slowly filling in with trees and is showing increasing limitations from deer browse. Individual tree growth is typically very high at this stage of development and at the low stocking levels.

Timber Quality or Potential Quality: Future timber quality is marginal due to the openness and low stocking. This area surrounds the Visitors Center and is primarily used for education, making timber quality irrelevant.

Regeneration and Invasive Plants: Reforestation is slowly taking place with mainly white pine. Aspen, ash, red maple and birch would typically be well represented but are all no doubt eliminated by deer. No evidence of invasive plants was noted.

Soils and Site: The soils in this stand are of the Wellsboro soil type.

Forest Health: This stand is susceptible to white pine weevil, a native insect that lays eggs in the terminal shoot of younger white pine trees, allowing larva to feed on the bud, resulting in dieback in the terminal bud and dominance of at least one of the lateral buds. The insect prefers open sunlight and is more prevalent in old field white pines.

Understory Trees, Shrubs, Herbaceous Plants: This stand is dominated by native grasses, goldenrod, milkweed, moss, lowbush blueberry and bracken fern among other species.

Wildlife Habitat Evaluation and Species Use: The stand has some low conifer cover for wildlife and is one of the few herbaceous openings on the subject property. It probably serves as a Spring/Summer/Fall feeding area for deer when the herbaceous and grass vegetation is actively growing. In years of adequate apple crops, it is probably a frequently visited feeding area for deer, allowing potential hunting opportunities during archery and early muzzleloader seasons.

Streams, Ponds, or other Wetlands and Water Quality Issues: N/A

Recreational Opportunities: Hiking, Nature Study & Wildlife Observation

Important Natural Features: Wildflower garden.

Management Objectives for Unit 15

Wildlife, education and hiking trails are the main objectives for this stand.

Management Recommendations

This stand does not warrant any forest management but should be maintained as a nature study area and possibly featured as a effective hunting area where deer movements to the apple trees and herbaceous growth can be patterned and safe ambush locations can be maintained for archers and muzzleloader hunters during the early season. Apple trees could be kept daylighted by trimming competing vegetation, pruned and treated with an all purpose fertilizer around the drip line in Spring.

Management Unit 17
(Old Shale Pit Stand: 0.6 acres)

Management Unit Description

Management History: This stand is a former shale pit which is reverting to herbaceous cover and woodland/forest

Description of Dominant Vegetation, Stand Age and Size Class: Dominant trees are mostly white pine and birch around the edges in the 4-10" diameter range.

Stocking and Growth Rate: The stand is slowly filling in with trees from the edges. The center remains unstocked with trees.

Timber Quality or Potential Quality: Future timber quality is marginal due to the open grown condition and low stocking and past quarry activity.

Regeneration and Invasive Plants: Reforestation is slowly taking place with mainly white pine and birch. No evidence of invasive plants was noted.

Soils and Site: The soils in this stand are Wellsboro extremely stony loam, but the topsoil and underlying shale were removed during past roadbuilding activities.

Forest Health: This stand is susceptible to white pine weevil and nectria canker of the birch.

Understory Trees, Shrubs, Herbaceous Plants: This stand is dominated by native grasses and moss.

Wildlife Habitat Evaluation and Species Use: The stand has some low conifer cover around the edges and is another one of the few herbaceous openings on the subject property. It has limited growth at present due to past quarry activity.

Streams, Ponds, or other Wetlands and Water Quality Issues: The stand lies immediately southwest of the Heron Pond.

Recreational Opportunities: Wildlife Observation by the Heron Pond, Hiking and Hunting.

Important Natural Features: Heron Pond.

Management Objectives for Unit 17

Wildlife observation and Hunting location.

Management Recommendations

The stand history as a shale pit presents some limitations but converting this area to a foodplot through grading, application of lime, fertilizer and a seeding of clover and chicory would establish it as a well used feeding area for deer. The foodplot would provide some alternative food for deer but more importantly would concentrate their activity and provide better/safer harvest opportunities, especially during archery season. The disturbed nature of the site make it of marginal value for research, education or timber growth.

Management Unit 20
(Old field Successional Stand: 3.5 acres)

Management Unit Description

Management History: This stand is a former field (probably pasture) which when abandoned converted to a red maple, grey birch and highbush blueberry thicket.

Description of Dominant Vegetation, Stand Age and Size Class: Dominant trees are mostly red maple, grey birch with a few aspen and black birch. Average diameter is 5 inches. Grasses, goldenrod, highbush blueberry and witchhazel dominate some of the open areas.

Stocking and Growth Rate: The stand is variable in stocking based on soil conditions and probably deer browse pressure. Growth rates are limited by high water tables in some areas and crowding.

Timber Quality or Potential Quality: Future timber quality is marginal due to the species mix, soil limitations and variable stocking.

Regeneration and Invasive Plants: Reforestation is fairly complete along the eastern band of the stand but areas in the western half remain understocked and still in a shrub/herbaceous opening condition. No invasive plants were noted.

Soils and Site: The soils in this stand are of the Norwich and Chippewa extremely stony silt loams with poor drainage and high water tables. The western end of the stand seems to have better drainage and drier conditions. Site quality is fair for tree growth.

Forest Health: No particular forest health issues were noted other than the impact of deer on the diversity and stocking.

Understory Trees, Shrubs, Herbaceous Plants: The understory includes a mix of highbush blueberry, witchhazel, winterberry, fern, goldenrod, grasses, dewberry, and clubmoss.

Wildlife Habitat Evaluation and Species Use: The stand has good low cover for wildlife in the shrub and sapling thickets. This provides habitat for grouse, woodcock and songbirds such as towhees and thrushes. It provides escape cover for deer and bear. The open herbaceous areas provide foraging habitat for young turkeys which rely on insects which they can glean from this vegetation.

Streams, Ponds, or other Wetlands and Water Quality Issues: A small stream flows along the western edge of this stand.

Recreational Opportunities: Wildlife Observation & Hunting

Important Natural Features: N/A

Management Objectives for Unit 20

Wildlife habitat and deer hunting location.

Management Recommendations

This stand does not warrant any forest management but should be maintained as an effective hunting area where deer movements can be patterned and safe ambush locations can be maintained for archers, muzzleloader and rifle hunters during all legal seasons. A significant foodplot could be established along the western edge of the stand using ROUNDUP and physically cutting competing vegetation and replacing with a clover/chicory perennial mix which will attract deer and benefit other wildlife. The area is fairly accessible for hunters to move in and out and strategically placed tree stands will allow safe hunting away from higher traffic areas of the Sanctuary.

Summary of Units and Treatments Table

Unit	Acs	Yr	Priority	Cover Type	Size Class	Silvicultural Treatment
8 & 27	70	2006	1	Northern Hrdwds	Medium Sawtimber	Perform Assessment of Forest Tent Caterpillar egg masses in canopy of Stands. If present at sufficient density, coordinate spray program for late Spring 2007 using aerial application of BT to protect foliage in this critical stand.
4	2-3	2007	3	Hemlock/Pine	Large Sawtimber	Select area of past hemlock mortality (wooly adelgid) which has opened canopy. Treat hayscented fern with August application of glyphosate using mistblower. Fence area using plastic mesh fencing and add signage to explain regeneration problem and treatment to visitors on the nature trail.
19 & 22	2	2007	2	Old field & shale pit	Shrub & herbaceous	Establish foodplots to improve deer hunting effectiveness. Select area with acceptable soils, perform soil analysis, clear and plant with suitable mix such as white clover/ladino clover and puna chicory, lime and fertilize as recommended.
18 & 30	40	2008	5	Hemlock/Red Oak/Hardwood	Large Sawtimber	In cooperation with The Nature Conservancy's PA Office, set up experiment to foster "old growth" characteristics through active management. Look for sources of funding to fence most/all of study area. Treat according to recommendations.
6,7 & 31	40-50	2009	3	Red oak mixed hardwood	Medium Sawtimber	Treat hayscented fern areas with August glyphosate application. Thin stands lightly to remove high risk, poor quality and a few mature trees. Favor healthy red oak, red maple, cherry and beech. Estimate \$20-25K revenue. Fence as much of the treated area as possible to protect seedling/shrub growth from deer browse.
31	4-5	2010	4	Dry Hemlock/Mixed Oak	Medium Sawtimber	Based on the results within test fence in Stand #4, select 4-5 acre area of hemlock mortality and open canopy conditions to fence. Use either woven wire or plastic and maintain for at least 5-6 years, at which time it can be rotated to adjoining area. Herbicide treatment may be necessary in some areas.
9&10	1	2012	5	Water	N/A	If deer herd is down, plant native shrubs such as speckled alder, buttonbush, or silky dogwood in margins of pond to improve wildlife habitat and diversity
8	3	Yearly	2	Northern Hardwood	Medium Sawtimber	Treat barberry with August application of glyphosate herbicide with mistblower. Monitor annually and retreat as necessary or where other stands of barberry begin to develop.



Lacawac Stewardship_Plan Forest Stands

