



FOREST MANAGEMENT PLAN 2017

MOUNT HOLLY MARSH PRESERVE

This plan provides an overview of past practices, summarizes current forest conditions, and presents recommendations for sustainable resource management and maintenance of forest health.

FOREST MANAGEMENT PLAN 2017

MOUNT HOLLY MARSH PRESERVE

Prepared for:

Cumberland County Planning Department Stephanie Williams

310 Allen Road

Carlisle, Pennsylvania 17013

planning@ccpa.net

www.ccpa.net/planning

Prepared by:

Green Leaf Consulting Services, LLC Josh Flad

SAF Certified Forester, ISA Certified Arborist

24 Shady Hill

Beach Lake, PA 18405

glcs.jf@gmail.com

www.greenleafconsultingservices.com

Additional Stakeholders

The Nature Conservancy

2101 North Front Street Building #1, Suite 200

Harrisburg, PA 17110

www.nature.org



SOUTH MOUNTAIN
PARTNERSHIP



pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES



APPALACHIAN TRAIL
CONSERVANCY

This project was funded in part by a grant from the Community Conservation Partnership Program, Environmental Stewardship Fund, under the administration of PA Department of Conservation and Natural Resources, Bureau of Recreation and Conservation. The grant was awarded through the South Mountain Partnership, with management oversight of the Appalachian Trail Conservancy. Cumberland County is a partner of the South Mountain Partnership, an alliance of organizations working to preserve and enhance the cultural and natural assets of the South Mountain Landscape in Central Pennsylvania.

To learn more, visit www.southmountainpartnership.org

Abstract

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This plan provides an overview of past practices, summarizes current forest conditions, and presents recommendations for sustainable resource management and maintenance of forest health.

Plan Conformity

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The contents of this plan exceed the requirements for approval through the USDA Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) Conservation Activities Plan (CAP 106), the American Tree Farm System forest management plan and the Forest Stewardship Program forest management plan. Application and review by corresponding organization is required prior to official approval.

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Introduction

This plan is a multi-use forest management plan intended to address the goals and objectives of Cumberland County and The Nature Conservancy. The plan includes general information on forest ecology, forest management, hydrology, soils and wildlife management. In depth summaries of the forest community types found on the combined +/-900 property have been enclosed. Management recommendations are listed for each community type and summarized on the enclosed recommendation schedule.

Property Overview

Location

Mount Holly Marsh Preserve occupies much of Mount Holly, a summit near the northern end of South Mountain, from which it derives its name. Considered a northern extension of the Blue Ridge Mountain range, South Mountain stretches from near Knoxville, Maryland to Dillsburg, Pennsylvania. A total of approximately 70 miles, dividing the Hagerstown and Cumberland Valleys from the piedmont regions of Maryland and Pennsylvania.

Mount Holly Marsh Preserve is located in three municipalities: Mount Holly Borough, Dickinson Township, and South Middleton Township. To access the property, proceed south on Route 34 through the town of Mount Holly Springs, approximately 0.3 miles to a gravel road on the right (southwest side) of Route 94. A parking area with trail signage is found at the intersection of the gravel road, Ridge Road and Parkway Boulevard.

A property location map is located in the Appendices.

Ownership

Mount Holly Marsh Preserve property is currently owned by Cumberland County. Through the grassroots fundraising efforts of the Holly Gap Committee, a committee consisting of local community members, the property was acquired by The Nature Conservancy in 1992. The property is managed by the County with cooperation from The Nature Conservancy.

Land Use History

Early records of settlement date back to the 1750's in the area which would later be known as Mount Holly Springs. Since the mid-1760's, Mount Holly Springs has supported natural resource based industry including, iron works, brick manufacturing and paper production. Beginning in the late 1800's, tourists frequented the town and "Holly Park", a summer resort located on the grounds of the subject property. Tourist came for the scenic beauty of the lake, (created by a dam on



Figure 1 Remains of Historic Dam on Mountain Creek

Mountain Creek) walking paths mountain springs, and other attractions. At first glance, little is left of the industrial age and resort era on the property today. A closer analysis reveals more clues including the possible location of carriage paths and building sites. Abnormal depressions in the topography suggest earthen kiln charcoal production was practiced in numerous sites on the property. A network of severe logging roads switchback across the south face of Mount Holly, testifying to 20th century timber harvests. Old stumps and current stocking levels suggest past harvest practices varied in intensity.

Map sets showing the location of the historic dam and other property features are located in the Appendices.

Public Use

The property is open to the public for hiking and wildlife viewing.

Hunting is permitted in the upland forest. Fishing is permitted along Mountain Creek, a state designated “approved trout water”. The stream is stocked by the Pennsylvania Fish and Boat Commission. Numerous hiking trails have been blazed and mapped for visitor use. A number of the trails utilize old logging roads and historic access roads. Portions of upland trails contain excessive rock content. Some trails have become overgrown with young shoots and shrubs.

Likewise, fishing access to Mountain Creek may be limited by dense Japanese barberry and briar thickets growing along the stream banks.



Figure 2 Upland Hiking Trail

Adjacent Properties

To access Mount Holly Marsh and the southeastern slopes of the property, hikers must follow “Broadway Boulevard” a streamside road running along the base of the mountain. Several private house lots are located along the access road and mountain base. Two outparcels are located within the Preserve boundary on the southwestern hilltop. Michaux State Forest occupies upland acreage to the east and southwest of the Mount Holly Marsh Preserve property. State Game Lands 305 and Kings Gap Environmental Education Center are located less than 4 miles from the subject property along the South Mountain Ridgeline.

Trespass Issues

Signs identifying the approximate property boundary have been posted around much of the property perimeter. Additional signage has been posted along the approximate Marsh Preserve boundary (off limits to hunters). A significant pile of discarded household appliances, mattresses, and other debris are found along Ridge Road in the southwestern portion of the property has been scheduled for cleanup in 2017. Abandoned automobiles, containers and other “historic” debris is found near the southern property line. Accessing this debris pile would likely require improvements to the property trail network.

Primary Goals and Objectives

Defining management goals, both short term and long term, is the primary step in developing an effective management plan. The following goals were adapted from the 2015 Mount Holly Marsh Preserve Management Plan outline:



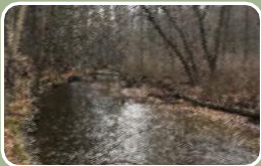
Wildlife Habitat

- Enhance and maintain wildlife habitat for game species and non-game species
- Protect and maintain special plant and animal communities
- Maintain and encourage ecological diversity



Forest Health

- Restore native plant species
- Control invasive species
- Monitor/manage pests and pathogens
- Promote resiliency through diversity



Water Quality

- Protect and maintain riparian and wetland water quality
- Reduce erosion and sedimentation
- Upgrade and maintain crossings, culverts and other infrastructure



Sustainable Forest Management

- Explore potential for periodic income derived from sustainable timber harvests
- Use commercial and non-commercial silvicultural practices to advance complimentary goals and objectives
- Use silviculture to increase resiliency in regards to forest health issues and climate change projections



Recreational Use

- Expand and upgrade existing trail network and infrastructure
- Enhance/highlight unique natural and historic cultural features on the property
- Increase signage and outreach information



Community/Stakeholder Engagement

- Increase opportunities for volunteer projects and public engagement on the property
- Maintain and expand existing partnerships with public and private organizations
- Promote property use through traditional advertising, social media and/or mobile technology
- Gain exposure through themed events and outings

Management Restrictions

Species of Special Concern

According to the “Mount Holly Preserve Site Action Plan” prepared by Sarah Cronlund of The Nature Conservancy in 1992, five species of special concern were identified in the Marsh Preserve seepage swamp: bog turtle (*Glyptemys muhlenbergii*), glade spurge (*Euphorbia purpurea*), golden club (*Orontium aquaticum*) horned pondweed (*Zannichellia palustris*), and alderleaf buckthorn (*Rhamnus alnifolia*). Cronlund notes three bog turtles were found at the preserve on April 20, 1987.

A recent search of the **Pennsylvania Natural Diversity Inventory (PNDI)** confirmed the continual presence of special concern species since the 1992 Site Action Plan and revealed additional potential impacts. The search receipt lists the great blue heron (*Ardea herodias*), as a species of special concern on the property. Alderleaf buckthorn does not appear on the search receipt from April 2017.

Both passive and active management activities must respect protection measures required and recommended by governing agencies. A copy of the search receipt is enclosed in the Appendices.



Figure 3 Great blue heron photo courtesy of: “Blue Heron Homecoming showcases Akron’s environmental sustainability efforts” – Staff Report, April, 2015. www.akromist.com

Special Habitat Areas

In addition to the Marsh Preserve, numerous ephemeral streams and vernal pools are found on the Mount Holly Marsh Preserve property. These areas serve as important breeding and feeding sites for many invertebrates and herptofauna. Management practices should respect seasonal and perennial aquatic features.

Talus openings are found across the steep Mount Holly mountainside. These areas may be suitable habitat for snakes and other reptiles native to southern Pennsylvania. Some talus areas are relatively free of forest cover and may serve as basking sites. Additional monitoring may be warranted prior to the commencement of disruptive management activities to help ensure special sites are not detrimentally impacted.



Figure 4 Talus Opening on the Northeast Hillside

Municipal Regulations

Township ordinances restricting timber harvest practices are becoming more common in Pennsylvania. These ordinances often restrict the size and intensity of timber harvests and include property boundary buffers, logging

slash reductions and other aesthetic regulations. Review local ordinances as part of the timber harvest planning process.

Additional Regulations

The Mount Holly Marsh Preserve property is subject to additional restrictions in accordance with the Natural Areas Protection Agreement with The Nature Conservancy, deed restrictions, and the Pennsylvania Commonwealth Act 1984-106, Recreational Improvement and Rehabilitation Act. In all cases, restrictions on land use generally pertain to preservation of the natural aesthetic, habitat quality protection, and public use. A review of all deeds and land use agreement documents should be completed prior to implementation of any new land use activity. The following outline provides a brief summary of rights and restrictions with respect to land management activities on the Mount Holly Marsh Preserve property:

1. Under the Natural Areas Protection Agreement, March 10th, 1992, The Nature Conservancy retains the following rights and restrictions:

- A. Regarding management:

“The Conservancy shall have the right but not the obligation to prescribe and undertake management of the Preserve to ensure the perpetuation of the natural features thereon including, but not limited to, the right to post and/or fence areas of the Preserve to restrict public access to sensitive natural areas, and the right to reintroduce beneficial natural phenomena such as prescribed or controlled burns.”

- B. Regarding hunting and fishing:

“Hunting and trapping shall be prohibited in all or portions of the Marshland Preserve. Hunting may be permitted on the portion of the 900 acres not part of the Marshland Preserve. Fishing may be permitted and may be encouraged along the Marsh Creek by use of specific fishing access points. Fishing may be prohibited near the seepage swamp if detrimental impacts occur.”

2. Deed restrictions recorded in the conveyance between The Nature Conservancy and County of Cumberland, March 9th, 1992, relate to the following activities:

- A. Regarding the public Spring:

“The Northern 100 feet of this lot, a part of which is being referred to as the Spring tract on this subdivision plan [Book Z-23, Page 912], where the spring and spring house is located is conveyed UNDER AND SUBJECT to a perpetual easement in the public to take water from and use the spring, at its own risk as it has been used for these many years, which said easement and use shall run with the land and be perpetually known as “The Kitzmiller Spring,” to not interfere with the said spring and spring area as a nature entity as above provided however, nothing herein shall impose any obligation of any nature of the grantee, including but not limited to assuring the quantity and quality of the water.”

B. Regarding land use activities:

“The conveyance is made subject to the express condition and limitation that the premises shall forever be held as a nature preserve and shall be kept entirely in its natural state. The erection of fences, construction of foot trails and necessary property management essential to effectuate the foregoing purpose are permitted provided such activities do not impair the essential natural character of the premises or of the area designated “marsh preserve” on the map dated _____ and prepared by Walter Heine Associates.

Should the premises cease to be used solely as provided herein, then the estate hereby granted to the Grantee [County] shall cease to exist and shall revert to and vest in The Nature Conservancy, 1815 North Lynn Street, Arlington, Virginia 22209. Said reversion shall not be automatic, but in the nature of a right of entry for condition broken or executory interest, which right, if exercised by The Nature Conservancy upon violation of the above conditions, is exercised by mailing a notice of violation by certified mail to the Grantee. Said notice shall describe the breach and shall declare that the power of termination will be exercised if the breach is not corrected within a period of 90 days. A copy of the notice shall be simultaneously be recorded on the appropriate land records.

3. The Recreational Improvement and Rehabilitation Act (1984-106), which established funding for the acquisition of the Mount Holly Marsh Preserve, states the following regarding funding and land use:

A. *“Section 3. Eligible uses of funds.*

In order to foster economic development, funds shall be used only for the following purposes:

(1) Rehabilitation of existing parks, recreation facilities and public zoos where these facilities have deteriorated because they have met or exceeded their useful life or other reasons, where one responsible public agency has made reasonable efforts to address the deterioration or where such rehabilitation will significantly reduce the operation and maintenance costs for these facilities.

(2) Acquisition of land for public recreation or park areas, only where such acquisitions are made to obtain critical inholding or buffer areas adjacent to existing park and recreation areas, or to preserve critical wildlife habitat areas, including wetlands, or to develop hunting, fishing and boating areas and related support facilities.....”

Conversion or disposition of land acquired under Act 1984-106 requires prior written approval of the program administrator within the Department of Community Affairs. Should conversion or disposition occur without approval, the Department may require the municipality to refund all grant-in-aid funds for that particular project plus 10% annual interest compounded four times annually from the original date of received funds. The Department may also require the acquisition of equivalent replacement land, as determined by the department.

Water Resources

Streams

The Mount Holly Marsh Preserve is located in the Yellow Breeches Creek watershed of the Susquehanna River. Mountain Creek is a state designated **cold water fishery (CWF)** and approved trout water stream. Mountain Creek drains into Yellow Breeches Creek, a state designated **high quality cold water fishery (HQ-CWF) suitable for migratory fish (MF)**, approximately 2.6 miles downstream, north of the Mount Holly Marsh Preserve. From the confluence of Mountain Creek and Yellow Breeches Creek, water flows in a meandering easterly direction approximately 30 miles to the Susquehanna River.

Two unnamed intermittent streams drain the upland reaches of the Mount Holly Marsh Preserve property, cutting southeastwardly downhill towards Mountain Creek. The headwater basin of a third intermittent stream is located within the southwest property boundary. In addition, numerous ephemeral flows are found across the property.



Figure 5 Intermittent Stream

Wetlands

Freshwater resources are complex and interdisciplinary. Water quality, quantity and availability is influenced by biotic and abiotic factors including natural and man-made disturbances. Hydrologic features on the Mount Holly Marsh Preserve property have been influenced by historic land use practices and natural development.

In the mid-1800s, Mountain Creek was dammed to generate power and supply water for paper mills in the town of Mount Holly Springs. The dam flooded a portion of the Mountain Creek floodplain, creating a lake which later served as a scenic component of Mount Holly Park, a popular tourist destination of the early 20th century. The dam was breached in the 1980s due to safety concerns however remnants of the dam and spillway are still visible today.



Figure 6 Red Maple Forested Wetland

Today a mosaic of riparian channels and wetlands occupy much of the old lake bed on Mountain Creek. Approximately 67 acres on the Marsh Preserve property have been recorded in the US Fish and Wildlife Service National Wetland Inventory (NWI). Of these acres, approximately 65 are designated freshwater forested/shrub wetlands. Pond and riverine designations account for the remaining +/-2 acres. Additional wetlands including forested vernal pools and other seasonally wet sites are found on the subject property and have yet to be registered with the National Wetland Inventory.

According to Sarah Cronlund’s Site Action Plan (1992), “The wetland also contains a degraded open marsh dominated by sedges, rushes, and cattail”. She characterizes the Marsh Preserve as a “rich seepage swamp dominated by black ash, red maple, spicebush, winterberry, poison sumac, royal and cinnamon ferns, and skunk cabbage”. While many of the same species are found on the site today, red maple, white pine and willow species have become more numerous since the time of the Site Action Plan. Japanese barberry and white pine saplings have become prominent in the understory of all but the most saturated wetland areas.

Two small but significant wetlands are located outside the Mountain Creek corridor, near the base of Mount Holly. These forested wetlands reside in topographic depressions. Black gum and red maple trees are dominant over highbush blueberry and other hydrophytic shrubs. These wetlands may function as vernal pools, providing valuable breeding and feeding habitat for invertebrates, amphibians and some reptiles. Songbirds and mammal species may also make use of these seasonal sites.

The fragility of wetlands and riparian corridors must be considered prior to any management activity. Sensitive wetland sites should be buffered from disturbance as much as possible to reduce the potential for negative impacts. The Pennsylvania Department of Natural Resources and Conservation in cooperation with Penn State University, has developed mandatory “**Best Management Practices**” (BMPs) for silvicultural activities in forested wetlands and controlling erosion and sedimentation during timber harvest operations. Loggers and other land use contractors are required to follow Best Management Practices during periods of active harvest and harvest retirement. Additional voluntary measures should be considered when planning management activities including the following list summarized from the Pennsylvania Natural Heritage Program management guidelines:

- *Maintain a closed canopy in a 100ft buffer zone around vernal pool edge. Retain 50% canopy in additional buffer zone 100ft to 400ft from pool edge.*
- *Control invasive species and encourage native vegetation around wetland edge*
- *Leave dead standing trees and fallen logs and branches for habitat*
- *Minimize soil compaction and tire ruts by restricting vehicle and equipment to a minimum of 100ft from wetland edges*
- *Conduct timber harvests when soils are frozen or under dry conditions*

Adaptive management strategies are necessary for protecting and maintaining riparian water quality and aquatic ecosystem health. The list below highlights management recommendations adapted from *Riparian Management in Forests*, Verry, Hornbeck and Dolloff, 2000.

- *Identify and classify priority protection areas and sensitive sites. Set goals for water resource management. Incorporate riparian protection into silvicultural management objectives.*
- *Buffer width depends on landscape context. Minimum BMP buffer widths should always be maintained. Additional width or additional buffer zones of varying permitted use should be considered for sites of ecological, historical or aesthetic sensitivity.*
- *Floral composition of protective buffers should be considered. Diversity of species, size and cover should be maintained. Restore native species by controlling aggressive exotic invasive species (e.g. Japanese knotweed) Native plant species provide a natural detritus that supports the needs of macroinvertebrate communities.*
- *Sedimentation yields from well-regulated forests are small. Intensify timber sale administration including BMPs to minimize erosion potential.*
- *Limit “emergency cleanup” of natural woody debris following storm events. Leave dead and down trees for habitat and to avoid destabilizing the integrity of stream banks.*
- *Maintain hardwood forest canopies to retain leaf litter, coarse woody debris and microclimate. Maintain conifer cover to maintain microclimate favoring cool water species.*
- *Manage riparian areas for a continued supply of coarse woody debris, floral diversity and wildlife habitat.*
- *Harvesting over 25% of basal area on an entire watershed generally increases summer flows. No more than 2/3 of a watershed should be converted to young forest stands (<15 years old) where spring flows may result in channel erosion.*
- *Develop methods and conventions for evaluating and sharing information on riparian area management, performance evaluation and restoration efforts.*

Soil Resources

Soil Map Units

Channery loam and stony loam soils represent the main composition on the Holly Marsh Preserve Property. Hazleton channery loam soils account for almost half of the soil composition on the property. Clymer very stony loam and Laidig very stony loam soils are the second and third most dominant type on the property. Lesser amounts of Buchanan very stony loam, Monongahela silt loam and Middlebury soils are found in small acreage on the property. Due to the heavy stone content, much of the property is poorly suited for agriculture or supplemental tree planting.

A map depicting the soil types found on the property is enclosed in the Appendices.

Site Index

Some soil types have been evaluated for tree growth and productivity. This derived estimate of fertility is commonly known as “**site index**”. 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 red oak should grow red oak trees that reach 60 feet in height by age 50 years. Hazleton channery sandy loam for example, is the only soil on the property with site index ratings for red oak. These soils have been rated for 70 feet of growth for red oak at age 50. Laidig and Middlebury soils have been rated for sugar maple and white pine growth. These and all other site index ratings are reported for soils in each Management Unit located in the Management Unit Summary.

Soil Protection

Best Management Practices have been developed to protect soils from erosion and sedimentation. Loss of surface soil through erosion can lead to degradation of site fertility and productivity as well as stream degradation. Compaction from heavy equipment and repeated horse or pedestrian traffic also degrades soil productivity and can lead to shifts in vegetation and habitat conditions. Steps to reduce soil degradation include:

- *Locate new skid trails, walk paths and multi-use trails along topographic contours as much as possible to reduce steep slope water velocity*
- *Install waterbars, broad-based dips and other drain devices to reduce erosion*
- *Limit land use operations on sensitive sights to dry summer periods or frozen ground conditions*
- *Limit whole tree chipping operations to dormant seasons to reduce nutrient loss by keeping leaf litter onsite.*
- *Install gravel, woodchip or other mulch material on well used foot trails to reduce compaction and erosion*
- *Plant grasses, sedges and other seed mixes for stabilization*

Forest Ecology Overview

Forest Ecology Overview

Before measurements and management recommendations, it is important to have a basic understanding of ecology in the eastern forests. Forest ecology in simple terms, is the study of vegetative establishment and forest development over time. It includes the study of biotic community interactions and the influence of natural and anthropogenic factors. Acknowledging the complexity of the natural world is the first step in responsible resource management.

Requirements for Life

At the core, all life on earth is dependent on 3 elements: sunlight, water and nutrients. This triangle of essential elements governs the development of forest ecosystems. As simple as it may seem, nearly all forest management principles are based on allocating these three elements.

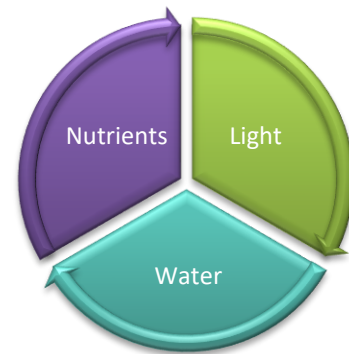


Figure 7 Essential Elements for Life

Succession

Over time, forests grow in relatively predictable stages of vegetation/ecological development called succession. Ecologists have classified two general patterns of succession: primary and secondary. Primary succession traces the natural development of sites from the initial rock or soil stage all the way through old growth forest whereby the dynamic nature of vegetative establishment and growth is categorically divided into a series of sequential stages defined by the dominant vegetation of the stage. The primary succession model is most relevant today on sites of massive disturbance (e.g. abandoned crop fields, strip mine sites, lava flows, etc.).

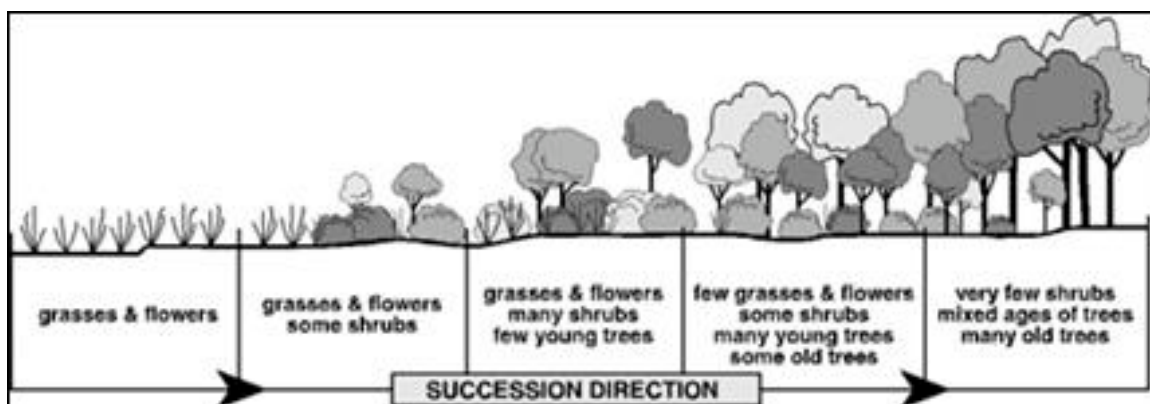


Figure 8 Primary Succession

Secondary succession refers to a conceptual model of post-disturbance forest development. It assumes a

disturbance event has occurred in a previously existing forest stand where tree seedbanks, roots or stumps may rapidly reforest the site.

Examples of secondary succession sites include tornado blowdown sites, timber harvest areas and abandoned pastureland. Due to the history of land use in the region, the secondary succession model is the most applicable to the study of our local forests. The model generally consists of four stages:

Four Stages of Secondary Succession

- I. Stand Initiation:** the establishment stage where plants naturally regenerate the disturbed area either by newly dispersed seeds, seed stores in the soil or sprouting from existing root systems.
- II. Stem Exclusion:** the point at which all growing space is occupied and tree crowns are so close in the canopy that they close off the understory. Weak, less competitive trees and overtopped seedlings die from the lack of sunlight and nutrients. Early pioneering species from the stand initiation phase are also out competed and begin to die off.
- III. Understory Retention:** dominant overstory trees emerge and the overstory canopy begins to break up enough to let some sunlight through to the understory and ground levels. The increased sunlight fosters the growth and development of saplings in gap openings.
- IV. Old Growth:** the late successional forest comprised of large, dominant overstory trees and varying levels of shade tolerant seedlings, saplings and understory trees and shrubs. Age, pests and pathogens cause tree crowns to disintegrate over time, allowing increasing levels of sunlight to reach the understory and ground level.

The secondary succession model as described above, refers to a generally accepted pattern of forest development. Variations of these four stages of development can occur in many ways depending on site conditions, vegetation, type of disturbance and other variables. Complete, linear stage-to-stage succession does not occur as new disturbances or impacts can disrupt the pattern at any point. However, these models more or less predict the sequence of vegetational stages over time and can be used to help determine appropriate forest management recommendations.

Though examples of all four stages can be found on the subject property, Stages 3 and 4 are most prevalent, respectively. Oak heath complex, dominant in upland stands and oak and white pine stands exhibit characteristics of Stage 3 forest types. Pockets of mature oak and white pine in stream side stands contain characteristics of Stage 4 communities.

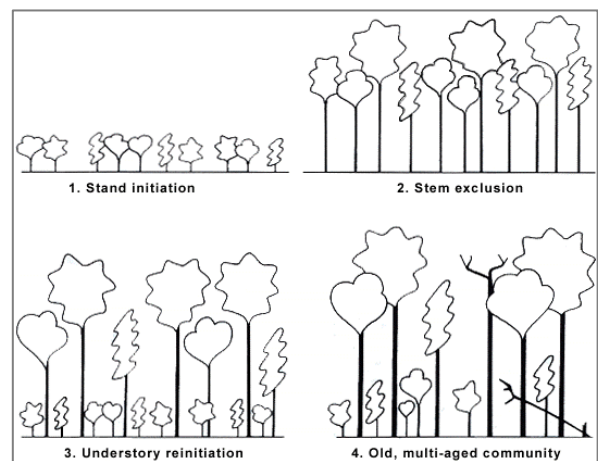


Figure 9 Graphic Depiction of the 4 Stages of Secondary Succession, courtesy of The University of Tennessee <http://fwf.ag.utk.edu/Sites/Silviculture>

In ideal conditions, saplings and suppressed understory trees are “released” by the overstory disturbances. Unfortunately, more common to eastern Pennsylvania, hay-scented fern, grasses and invasive shrubs (e.g. Japanese barberry) out-compete desirable vegetation and quickly dominate the site. The loss of competitiveness among desirable seedlings and saplings in regards to fern and other invasive species is a pervasive problem derived from complex interactions.

Growth Strategies

Closely tied to succession patterns, individual tree species have developed growth strategies to gain competitive advantage in forest stands. Response to sunlight is perhaps the greatest determining factor of tree survival in relation to growth strategies. Some species such as aspen and tulip poplar grow rapidly to reach dominant crown positions. These species tend to share similar characteristics including relatively short natural life spans, upright growth form, and high mortality rates. Other species such as red oak and white pine, exhibit varying levels of shade tolerance and as a result are better able to survive shaded understory conditions. Intermediate shade tolerant species tend to have moderate growth rates, moderate mortality rate and relative medium lifespans. Other species such as eastern hemlock and sugar maple have adapted to low light conditions and adopted a long-term growth strategy. These species “wait” in shade of dominant intolerant and intermediate tolerant species until disturbance events in the canopy layer allow sunlight to reach the forest floor. Typically, these species share relative long life spans, low mortality rate and slow growth rate.

Understanding tree growth strategies and forest successional patterns helps predict the natural response to disturbance in a given forest. For example, given no additional setbacks (e.g. deer browse preference, drought tolerance), it is unlikely for hemlock seedlings to out-grow aspen seedlings on open ground. Conversely, aspen seedlings are not likely to be found under a dense hemlock canopy.

Forest Structure

- **Overstory:** trees at the canopy level in dominant and codominant positions.
- **Understory:** tree and shrubs found below the canopy. Mid-story trees and shrubs.
- **Forest Floor:** seedlings, shrubs, herbaceous vegetation, moss and fungi found at ground level

SHADE TOLERANCE

INTOLERANT SPECIES

Tulip poplar

Black cherry

Aspen Sassafras

Tamarack

INTERMEDIATE TOLERANCE

Red oak

White oak

White pine

Shagbark hickory

Black birch

TOLERANT

Hemlock

Red maple

Sugar maple

American beech

Basswood

Forest Health

Changes in forest ecosystem species composition, diversity, structure and habitat value are all driven by disturbance events. Good, bad or indifferent, the true measure of impact often comes down to a matter of perspective and the response of each ecosystem to disturbance. Several common agents of disturbance have affected the Marsh Preserve property:

Abiotic

Heavy winds, ice storms and flooding tend to play the biggest role in abiotic forest health impacts. Autumn ice storms are sometimes devastating to deciduous trees like red and sugar maple, white oak and beech. Red and sugar maple branches seem especially prone to breakage from ice loads. Oak and beech trees tend to retain their leaves, adding surface area for ice to build up.

Wind and flooding are also problematic, especially when combined. Saturated soils do not hold root systems as readily as in well-drained conditions. Several large trees in Unit 16 were toppled by recent wind events. Though small in nature, these disturbances allow more sunlight to reach the forest floor and stimulate new growth.

Biotic

Pests

Gypsy Moth Caterpillars- are exotic forest pests that particularly threaten oak and other hardwood species in our region. Caterpillars were introduced in New England in the late 1800's for silk production and slowly adapted to the oak forest of the eastern United States. Periodic epidemic population outbreaks can have devastating effects on hardwood stands, especially oak stands in eastern Pennsylvania.

Monitor gypsy moth activity annually by looking for gypsy moth egg masses on the trunks of hardwood trees. An egg mass evaluation should be performed in late autumn or over the winter months. When an epidemic outbreak is looming, many egg masses can be seen on the bark of the main stem and large branches. Refer to the Gypsy Moth Caterpillar Factsheet in the Appendices for more information.

Forest Tent Caterpillars - A native insect, Forest Tent Caterpillars are related to the Eastern Tent Caterpillars commonly found on fruit trees in Spring. Forest Tent Caterpillars do not create "tents" and typically defoliate sugar maple, ash, cherry, and red oak. The sugar maple in particular on this property has experienced widespread dieback and some mortality from the defoliations, especially when they occur in conjunction with anthracnose fungus attack. Aerial spray with Dimilin, Confirm, or Bt insecticides applied to foliage soon after leaf out in Spring is the safest protection option when applied early in the caterpillar life cycle. These insecticides generally kill only Lepidoptera species (moths and butterflies) which feed on treated foliage and should protect the leaves and health of the sugar maple and ash trees.

Hemlock Woolly Adelgid is another introduced pest from Asia that has affected hemlock stands in the area. An

aphid, this insect slowly builds up populations on hemlock trees and eventually, through parasitic- like feeding, will weaken the tree to the point of mortality.

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 have shown inconclusive results. The primary approach to contending with the outbreak could be management to favor pine and spruce as ecological substitutes of hemlock and initiating establishment of younger, more resistant age classes of hemlock.

Emerald Ash Borer (EAB) is an exotic insect pest first detected in Michigan. It slowly infests all species of ash and over several years will completely kill the tree. It has been confirmed across Pennsylvania. Slowly building and expanding populations of the insect can be expected to kill most of the ash component in area forests over a 10-20 year period. There is an effective treatment of individual trees through injection of either MERIT or TreeAGE insecticides, although this is impractical in a forest setting.

Salvage harvests should be undertaken to recoup the economic value of significant ash sawtimber volume prior to EAB driven mortality. **Ash sawtimber stocking on the Mount Holly Marsh Preserve Property is not of significant volume and therefor would not support a commercial salvage harvest.** Sawtimber sized ash trees found within future commercial silvicultural treatment sites should be considered for harvest.

Spotted Lanternfly is another exotic insect pest first detected in Pennsylvania in 2014. A native of Asia, the fly feeds on a variety of hosts including apples, plums, cherries, peaches, oak, walnut, poplar and grapes. Tree of heaven is the preferred food and egg-laying host for adults of the species. Nymphs and adults feed by sucking sap from the stems and leaves of their host. In addition to tree oozing and weeping caused by feeding wounds, the insects also excrete large quantities of honeydew, a medium for mold and attractant for other insects.

Currently, lanternfly has been confirmed in the following Pennsylvania Counties: Berks, Bucks, Chester, Lehigh and Montgomery. The Preserve property contains an abundance of tree of heaven in select areas. Though the spotted lanternfly has not yet been confirmed in Cumberland County, periodic monitoring of tree of heaven should be undertaken in late summer and fall. Report new sightings of spotted lanternfly to the Pennsylvania Department of Agriculture (PDA) email:

badbug@pa.gov or call the Invasive Species Hotline at 1-866-253-7189. Additional information has been included on the enclosed CD, located in the Appendices.



The best defense against various insect and disease threats is to maintain a healthy, diverse forest with as many species and age classes as possible. The understory should be stocked with a mix of small seedlings and shrubs to fill any gaps caused by mortality of overstory or dominant trees. This protects against catastrophic loss.

Pathogens

Beech Bark Disease, a common complex caused by a bark boring scale insect and a nectria fungus is attacking mature and maturing beech on the property. The fungus uses the holes made by the beech scale to invade the bark tissue. The fungus kills tree tissue often in strips or patches but can encircle the bole in a girdling fashion. Once girdled host trees usually die. Other trees are weakened by the disease and transfer energy to their root system causing new shoots to sprout around the host tree. The resulting patch of dense and poorly formed stems is commonly referred to as “beech brush”. Beech brush may inhibit the establishment of seedlings and saplings of more desirable species and is often considered undesirable. However, dense brush patches may have some value as cover for various wildlife species.

Chestnut Blight, a fungal pathogen from Asia was introduced to America in the early part of the century. Chestnut may have comprised 25-50% of the young upland forests in the area at that time. It was a fast growing tree with wonderful wood properties and edible nuts. By the 1920’s, 1930’s and 1940’s the blight had killed almost all the chestnut, resulting in a major disruption to the development and structure of the forest and its wildlife habitat values.

The blight organism is not viable in the soil environment so it does not always completely kill the root systems of these trees. Above ground dieback commonly results in the root system re-sprouting. Several cycles of root sprouts growing into 4-10” trees, reinfection by the blight, dieback to ground level and re-sprouting, have brought a few resident chestnuts through the past 70-80 years. Several American chestnut saplings and poles were encountered and sampled during the field inventory of the subject property. These small trees serve as reminders of the past forest composition.



There has never been any significant resistance to the disease documented within the American chestnut range, although a breeding program by the American Chestnut Foundation is pursuing a strategy to breed resistance from the Chinese chestnut into lines of American chestnut for its reintroduction into the former range of the species.

Herbivory

Over the past century, white-tailed deer populations in Pennsylvania rose dramatically from less than 2-3 deer/m² in 1900 (estimated) to an estimated average of 10-15 deer/ m² for much of the 20th century (3). The dramatic increase in deer numbers correlates to the reforestation of Pennsylvania's landscape following near-complete deforestation by the 1930s. Low deer populations allowed seedling and sapling growth over millions of acres, which in turn set the table for a population explosion of white-tailed deer (4). In addition to abundant sources of food, other factors including the lack of natural predators and a hunting tradition focused on buck harvests lead to overabundant populations.

For every 100 pounds of body weight, white-tailed deer will eat 5 to 9 pounds of vegetation a day. Preferred food sources include buds, twigs and leaves of numerous seedlings, saplings, shrubs and trees.

Overabundant deer populations deplete the structure and diversity of the understory seedling/shrub layer and prevent acceptable forest recovery from any disturbance within forest communities. The lack of natural predators allowed deer populations to reach beyond carrying capacity (i.e. the size of a population that can be supported in an area without degrading the habitat.) throughout Pennsylvania.

Given the complex dynamics associated with ecological systems, the impact of overpopulation and over-browsing is exhibited in many ways including:

- *Reduced tree regeneration(5)*
- *Reduced breeding songbird diversity(6)*
- *Reduced rare species abundance(3)*
- *Decreased plant size and fecundity(3)*
- *Increased fern cover (3)*
- *Facilitated exotic plant invasions*
- *Altered species diversity(7)*
- *Increased Lyme disease risk*

This area's northern hardwood and oak forests rely on a "bank" of seedlings, seed and shrubs that 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. For example, black birch trees are not preferred food sources for deer, they establish aggressively in some areas of the understory while hay-scented fern and other herbaceous vegetation dominate other areas.

Currently, the deer herd should be somewhat lower than in the recent past due to increased harvest allotments, but the herd must be lowered and kept at low population levels for several years to allow the seedling/shrub layer to be restored to its potential structure and diversity, which in turn increases the winter food supply for the herd. 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.

Deer Management

Much of the subject property is open to public hunting. Changes to hunting approach and herd monitoring may be necessary to increase the positive outcome of habitat enhancement projects. Engagement with local hunters is a necessary step in developing a deer management program. Consider enrolling in the PA Game Commission **Deer Management Assistance Program (DMAP)**, a program designed to help lower deer populations on degraded tracts by increasing the potential for antlerless deer harvest. Program permits are issued to prospective hunters allowing the potential harvesting of antlerless deer (one per permit tag) in addition to the antlered deer license and antlerless license a hunter may acquire outside of the DMAP program. A reduction in antlerless deer numbers may help reduce the deer population on the property and relieve browsing pressure on developing seedlings.

In tandem with increased hunting opportunities, outreach and educational events should be considered to engage local hunters. The PA Game Commission and organizations such as **Quality Deer Management Association (QDMA)** offer valuable information on hunting and deer herd management. Consider sponsoring/attending local programs to connect with the hunting community and promote herd control efforts on the subject property. Information on programs and events can be found here: <https://www.qdma.com/pennsylvania/>

To further control efforts, professional deer management consultants could be engaged to assist with data collection and herd management. Deer populations could be surveyed using thermal imaging technology, pellet counts or other methods to help establish harvest goals. A record of deer harvested from the property could be kept to track the success of annual hunting efforts.

Research suggests the reduction of deer populations alone may not directly lead to understory recovery. Sustaining lower populations over time is necessary to permit the establishment of new seedlings, shrubs and herbs and recovery of previously suppressed vegetation. Control of competing vegetation (invasive species) is vital. Supplemental plantings may be necessary to re-established desirably native vegetation in select areas.

While increased hunting opportunities may provide some relief of browse pressure, hunting should not be relied on to create favorable conditions for forest regeneration in the short term. The cost of protective deer fencing should be included when considering the feasibility of management activities such as supplemental planting or silvicultural harvests.

Invasive Species

Loosely defined, an invasive species is a species of any taxonomic group (plant, fungus, virus, fish, amphibian, bird, mammal, etc.) that has been introduced to area outside its native range. Typically, invasive species thrive in their new environment as new ecosystems lack the natural control agents (predators and pathogens) which kept the population of the invasive species in balance with their native ecosystem. Sometimes disruptions in a local ecosystem remove natural control agents for native species creating favorable conditions for endemic species to cause a multitude of ecologic and economic problems. Native and/or exotic invasive species are often associated with the endangerment and extinction of native species and sometimes pose public health problems in human populations.

Several exotic invasive species are prevalent in our region. Aside from forest pests and pathogens, exotic invasive plant species pose the greatest threat to health forest ecosystems. The spread and establishment of invasive plant species is largely attributable to past and current land use practices, white-tailed deer population management and global trade.

Seeds (and plant tissue) from invasive species are often disseminated through foot and vehicle traffic. Recreational activities including hiking, hunting and off-road vehicle use help to spread invasive species. Some species, such as Japanese knotweed, are commonly spread by flooding and seasonal high water events.

Exotic Invasive Species in the Region

- **Japanese Barberry:** A thorny shrub, Japanese and European barberry are prolific seed producers that often form dense shrub layers in the understory of moist woodlands, abandoned pastures and bottomlands. Barberry displaces native plant species and has been found to alter soil ph and biological activity. *The unwanted shrub is abundant on the Preserve property.*
- **Japanese Stiltgrass:** A delicate grass resembling small bamboo, Japanese stiltgrass quickly establishes and spreads on hiking & ATV trails, moist woodlands and uplands. Stilt grass displaces native vegetation, alters soil nutrient cycling and inhibits seedling growth. *Stiltgrass is established in patches and along trails on the Preserve property.*
- **Japanese Knotweed:** An annual herbaceous perennial, Japanese Knotweed is responsible for the displacement of many native herbaceous riparian plants and wildflowers. Knotweed spreads primarily through rhizome sprouting. Cut rhizomes give rise to new colonies of knotweed stems. This characteristic makes controlling knotweed patches extremely difficult without the use of systemic herbicides. *Knotweed was not observed during the field inventory however the broad and meandering Mountain Creek stream corridor is vulnerable to knotweed and should be monitored for knotweed on an annual basis.*

- **Oriental Bittersweet:** Introduced in the 1860s this vine is not a forest species in its native China, Japan and Korea. Oriental bittersweet is related to native bittersweet and is capable of hybridizing however, hybrid crosses generally exhibit low fertility. Germination occurs in shade but oriental bittersweet responds prolifically to sunlight exposure. *Bittersweet is established on the ridgetop and hillside of the Preserve property.*
- **Tree of Heaven:** A native of China, Ailanthus or “tree of heaven” was introduced to the USA multiple times since the 1780’s. Most often associated with disturbed habitats (roadsides, culvert washes, etc), tree of heaven survives in a variety of site conditions including poor, droughty soils. Extensive cloning can be expected. Crushed roots, stems and leave smell of rancid peanut butter. *Tree of Heaven is established on the ridge and hillside of the Preserve property.*
- **Princess Tree:** A native of China, princess tree was imported to America in the mid 1800’s. Tolerant of infertile and acid soils, the tree is highly adaptable to a wide variety of habitat conditions. The tree is primarily spread by seed which it produces in abundance. *Princess tree is established on the rocky hillside of the Preserve property.*
- **Japanese Honeysuckle:** This climbing vine was introduced to American in the mid 1800’s for ornamental use. Leaves of the vine often stay green through much of the winter, giving the plant a growth advantage over native deciduous vegetation. The vine is capable of girdling shrubs and small trees. *Japanese honeysuckle can be found across the Preserve property but is most abundant in the dense barberry patches along the riparian corridor.*
- **Multiflora Rose:** Native to Japan, multiflora rose was once recommended by the US Soil Conservation Service for erosion control in the early part of the 20th century. Overtime the tenacious growth habit was revealed but not before it had become a noxious weed in many states. Like Japanese barberry, multiflora rose forms dense, thorny thickets in the understory of woodlands, abandoned pastures and other openings. Once established, dense thickets prevent desirable trees and shrubs from growing, are hard to eradicate and offer little value to local wildlife. *Individual shrubs and small clusters of multiflora rose can be found in the lowland areas of the Preserve property.*

Native Invasive Species

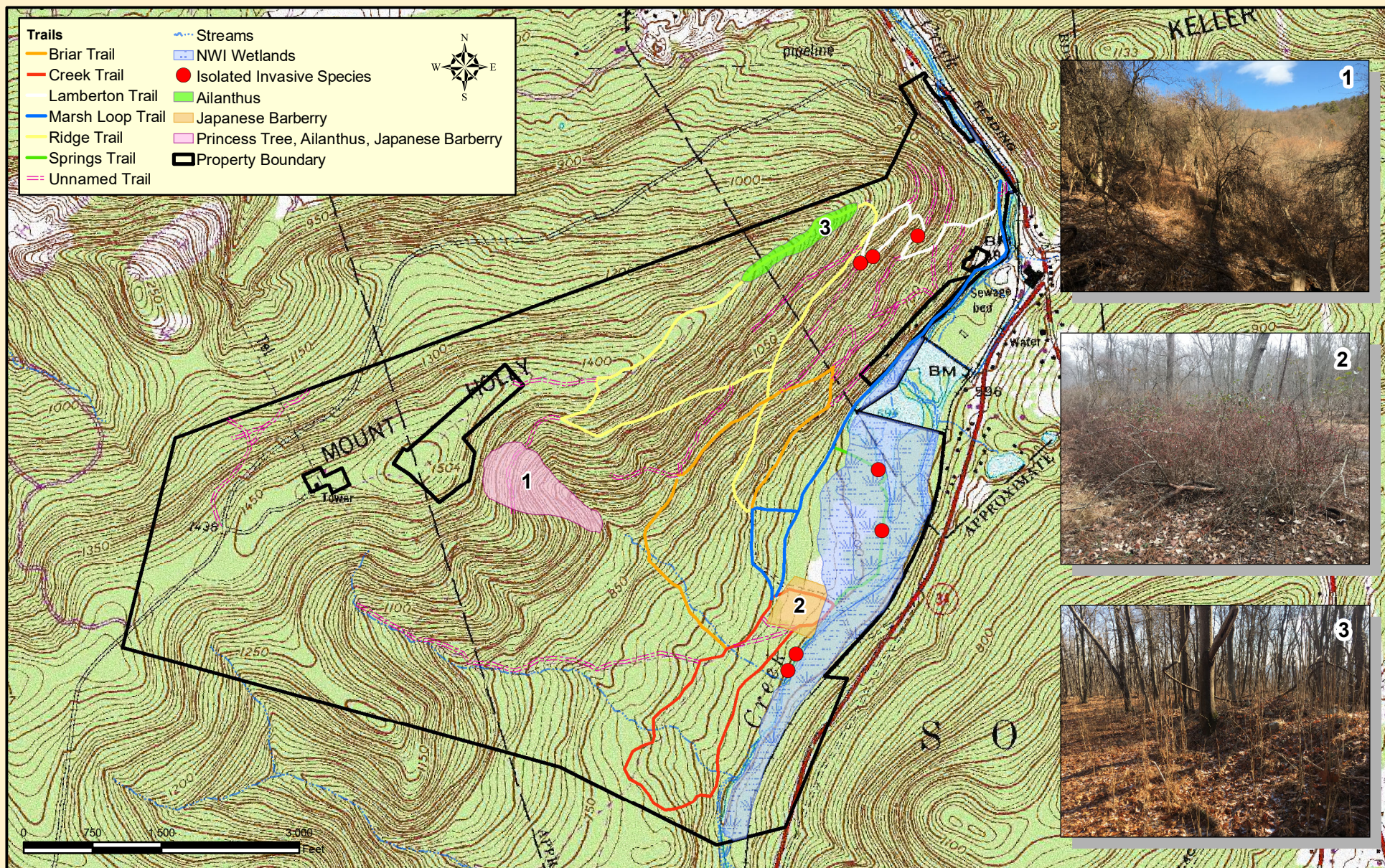
- **Hay-scented Fern:** Due in part to over-browsing of white-tailed deer on seedling and saplings, hay-scented fern has become an invasive component of forest stands in the Northeast. The fern is not utilized by insects or herbivores. If left unchecked, hay-scented fern will produce frond after frond from rhizome system, creating an impenetrable mat that prevents seedling establishment. Once established on site, dominant hay-

scented fern will persist for a long time.

- **Wild Grape:** Numerous species of wild grape grow throughout Pennsylvania. Large and abundant grape vines laden with snow or ice are capable of damaging or toppling trees. For that reason, some managers consider wild grape an invasive species. *Wild grape is prevalent on the rocky hillsides and ridgetop of the Preserve property. The abundance of grape in these areas is beneficial to wildlife including songbirds and small mammals.*

Photo from top left: Japanese barberry, knotweed, stilt-grass. Middle from left: Oriental bittersweet, tree of heaven, princess tree. Bottom from left: Japanese honeysuckle, multiflora rose, hayscented fern. Courtesy of USDA plant database.





MOUNT HOLLY MARSH PRESERVE

INVASIVE SPECIES PRIORITY AREAS MAP

Biodiversity

Biodiversity Defined

The term “Biodiversity” has come to represent a general measure of the variety of life and its processes. A further examination of biodiversity, as defined by the Society of American Foresters and mainstream academia suggests biodiversity refers to a multi-level measure of variety between species composition, genetic variation, landscape characteristics and ecosystems complexity.

SPECIES: *variety of living organisms, number of species and the abundance of each on a localized basis.*

GENETIC: *the variation in genetic makeup of individuals of the same species within a population or group of populations in a prescribed geographic area.*

LANDSCAPE: *diversity of landscapes within a given geographic area or region*

COMMUNITY/ECOSYSTEM: *variety of communities or ecosystems that occur over a broad geographic range or landscape*

Figure 10 Four Components of Biodiversity – Yahner 1995 (2)

Maintaining diversity on all scales (genetic to landscape) is important for the health and function of any ecosystem. Given the complex interaction between organisms and the environment, it is often difficult to understand how a loss or change in one species, community or landscape characteristic will affect the other components. In recent years, science has sought to understand these interactions and determine how best to measure biodiversity and assess potential threats.

Measuring biodiversity at general local level can be complicated and time consuming for the average landowner or resource manager given the complex relationships between species, ecosystems and landscapes. While an accurate measure of biodiversity may not be achievable or feasible, landowners and resource managers can maintain and/or enhance diversity by adhering to a few basic principles:

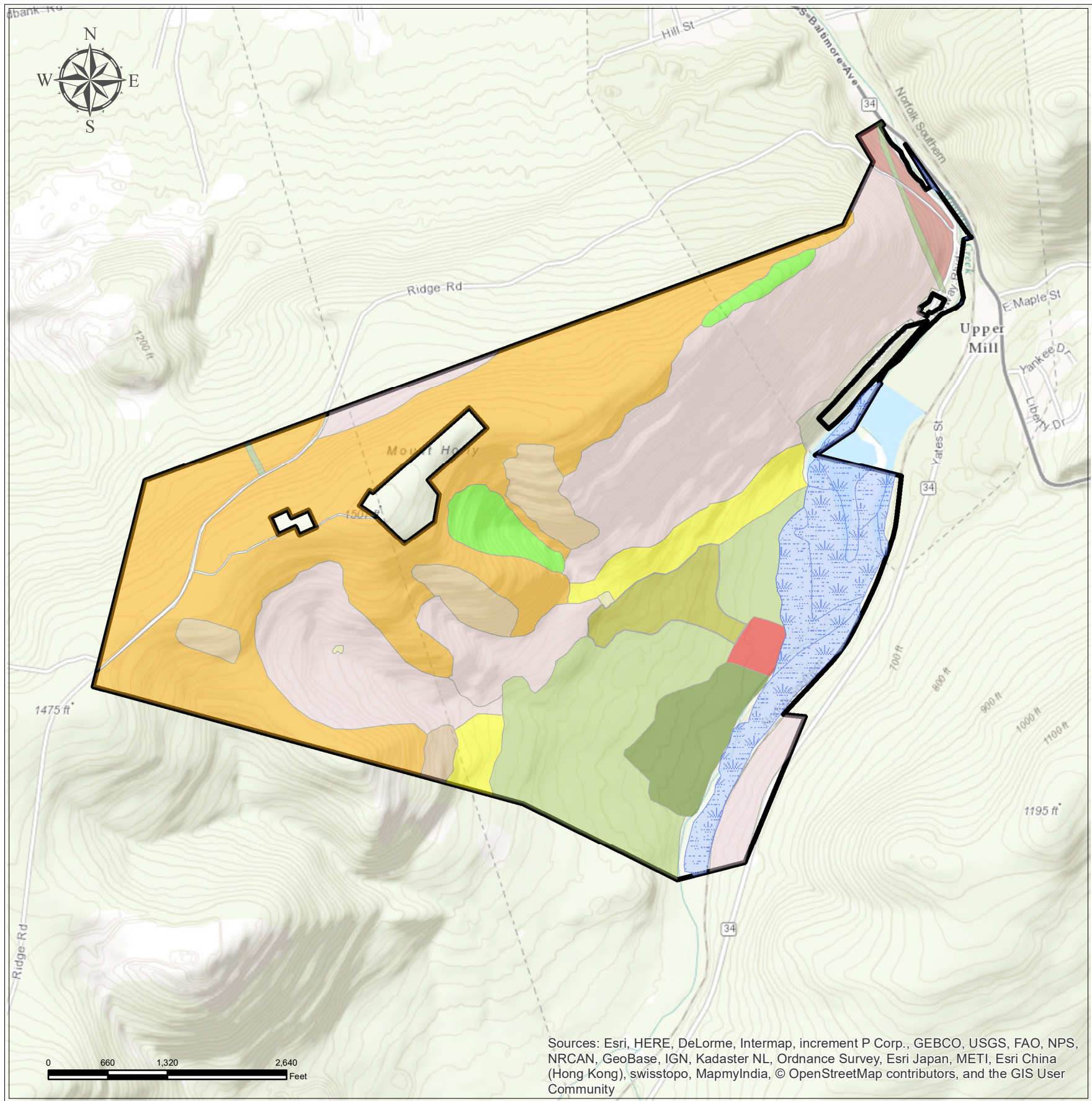
- **Species Retention:** retain a diverse range of species when conducting harvest activities, mowing or herbicide treatments
- **Timing:** avoid disrupting natural cycles by timing land-use activities to avoid disturbing feeding or breeding habitat during peak use
- **Invasive Species:** control non-native and invasive species by manual, mechanical or carefully planned herbicide application. Avoid planting ornamental species known to naturalize readily and displace native flora.

Like all things in the natural world, biodiversity is not static. Species composition, richness and abundance will change over time as natural processes (i.e. succession, forest stand maturation) occur.

Chestnut oak, red oak, white pine, and red maple are dominant tree species on the Mount Holly Marsh Preserve property. This composition is a reflection of site conditions, land use (past and present), and tree age. Some forest stands on the property are dominated by a handful of species (white pine and chestnut oak). Other stands are more diverse in composition.

The following foldout map entitled “**Forest Community Map**” depicts forest community types on the Marsh Preserve property. The foldout also contains a table summarizing tract level basal area, number of trees and quadratic mean diameter (tree size) of species per acre.

According to the table, 4 of the 21 listed species (chestnut oak, white pine, red oak and black gum) comprise over 60% of the stocking. That said, on a evenness scale of 0 to 1 where a value near 0 indicates every species in the sample is the same and a value near 1 indicates the number of individuals is evenly distributed among species, tract level species evenness was calculated at 0.76. This number represents a fairly even distribution of individuals by species and is comparable to similar forest communities in the region. The occurrence of 21 sampled species represents moderate to high species richness in comparison to similar forest communities.



Forest Community Types

- Dry Oak - Heath

Dry Oak - Mixed Hardwoods

Dry Oak - White Pine

Exotic

Herbaceous

Mixed Hardwoods

Northern Hardwoods

Pitch Pine
- Red Maple -White Pine

Sassafras

Utility ROW

White Pine

White Pine - Oak

NWI Wetland

Property Level Stocking Summary by Species

SPECIES	BASAL AREA		TREES per ACRE	QMD
chestnut oak	29	23.8%	62	9.2
white pine	19	16.0%	34	10.2
northern red oak	14	11.6%	20	11.3
black gum	13	10.7%	71	5.8
red maple	10	8.0%	33	7.3
sassafras	7	6.1%	37	6.0
pitch pine	5	4.5%	8	10.9
yellow poplar	5	4.1%	6	12.6
white oak	4	3.7%	10	9.2
sweet birch	4	3.3%	11	8.1
scarlet oak	4	3.1%	8	9.0
black oak	2	1.3%	2	11.3
black cherry	2	1.3%	4	8.0
hickory	1	0.7%	3	7.7
locust	1	0.7%	4	6.2
ailanthus	0	0.4%	2	7.0
white ash	0	0.3%	2	6.0
beech	0	0.1%	0	8.7
hemlock	0	0.1%	0	12.5
aspen	0	0.1%	0	12.0
American chestnut	0	0.0%	1	4.0
Tract Total	120	100.0%	318	8.3



MOUNT HOLLY MARSH PRESERVE

FOREST COMMUNITY MAP

Wildlife Habitat

Simply defined, **habitat** is a composition of space and resources which support a population over time. Habitat generally refers to the living requirements necessary to support a viable population of a given species not a single individual. Habitats are often generalized and described according to their associated communities of plants, wildlife and other organisms. It is useful to view habitats as functioning systems of energy transference. Sunlight, water, and nutrients, the building blocks of “Essential Elements Pyramid”) serve as the energy inputs of the habitat system.

Sunlight, nutrients and water provide fuel for the system. An additional spatial element, cover, provides necessary refuge for energy conservation. Together, these elements (food, water and cover) form the foundation of wildlife habitat. Manipulation of these components is fundamental to wildlife habitat management.

Food

In the forest setting, sunlight is the critical source of energy in the habitat “system”. Through photosynthesis, energy from the sun is converted into starches and sugars, fuel for growing plants. A huge component of the food web, plants provide nutrients for herbivores from white-tailed deer to woolly bear caterpillars. Flowers provide nutrients for numerous insects while **soft mast** like berries and **hard mast** like acorns provide stable, supplemental and emergency food for insects, birds, reptiles and mammals.

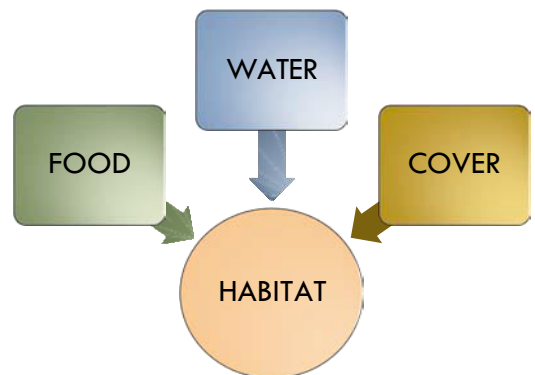


Figure 11 Elements of Wildlife Habitat

While not all factors affecting food availability can be managed, forest management can be used to enhance and maintain browsing plants, fruit and mast production.

Water

Nearly all wildlife species require daily water intake. Streams, wetlands and lakes are essential habitat for many aquatic organism and attract terrestrial wildlife as well. Many forest herptofaunal species including wood frogs and spotted salamanders are dependent on fish-free vernal pools.

Cover

Wildlife species are dependent on cover for protection from weather and predation. Cover needs are diverse and include forest and non-forest features, live and dead vegetation, geologic features and water. Diversity of tree and shrub size classes and vegetative cover types increases wildlife diversity. Foresters estimate wildlife cover within forest stands in terms of vertical structure; the amount of herbs, shrub and overstory cover growing within the stratified layers of forest stands (ground level, understory, and overstory).

Forest Management and Silviculture

A primary tool for forest management, Silviculture in practice is applied forest ecology for the purpose of controlling forest establishment, species composition, growth and structure (8). In theory, silviculture can be compared to agronomy in agriculture as both are dedicated to growing vegetation. Timber harvesting is the most commonly applied practice of silviculture as the value of harvested products greatly reduces the cost of the treatment. The following section describes in brief several considerations and practices common to silviculture in the eastern United States.

Even-Aged vs. Uneven-Aged

Forest stands derived from disturbance events generally give rise to an aggregation of saplings during the early stages of succession. This aggregation of new canopy trees is referred to as a cohort, meaning a group of trees at relatively the same age (also known as even-aged). Sometimes repeated disturbances require only partial reforestation when significant numbers of the original cohort survive the event. As new cohorts develop under existing stands, the overall age distribution becomes stratified into multiple age classes (also known as uneven-aged). The significance of even aged forests versus uneven aged forests may not be readily apparent however the application of silvicultural practices are tied to age classes and become much more complex when dealing with uneven aged forest stands.

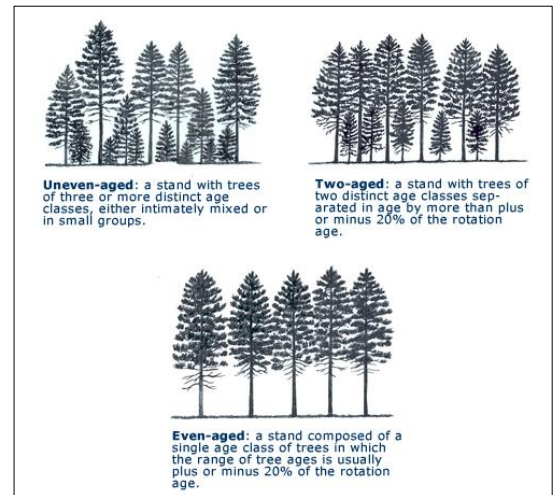


Figure 12 Depiction of Stand Age Structure
 Courtesy of: Web-Based Forest Management Guides;
 US Forest Service,
<http://www.nrs.fs.fed.us/fmg/nfmg/fm101/silv/index.htm>

A majority of forests in Pennsylvania are even aged or two-aged (containing a second cohort but still managed as even aged).

Many even aged and two-aged forest stands exist on the Mount Holly Marsh Preserve property. Due to several factors including silvicultural practices, regeneration issues, forest pest impacts and pathogens, uneven aged forests will likely become more common in the region.

Methods & Practices

Timber harvest are the most common and recognizable tool in silviculture. Timber harvest are perhaps most common because the value of harvested products reduces the cost of performing the treatment. However, many timber harvest methods are utilized in silvicultural and some practices call for the removal of products that have little or no value. The following section summarizes, in general, the most common practices in the region. Other practices exist and new techniques are developed and applied locally.

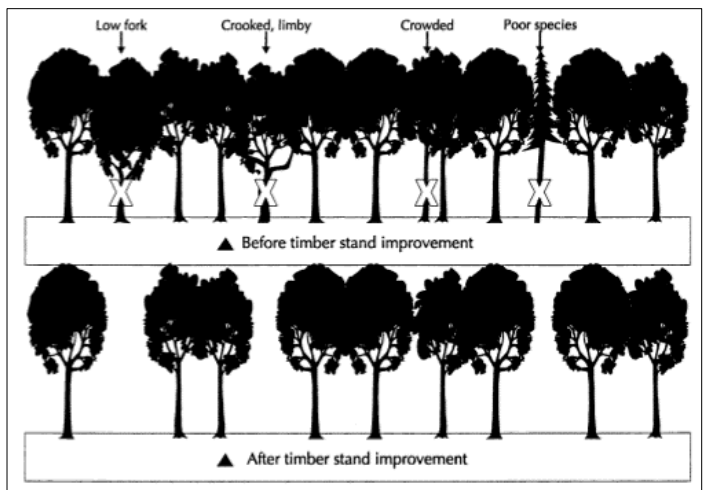
Pre-commercial or Non-commercial Treatments

- 1) **Herbicide treatments** - foliar or systemic applications of herbicide commonly used to control impeding vegetation (fern, grass) or kill undesirable plants of little commercial value.
- 2) **Forest Stand Improvement** – also known as Timber Stand Improvements, these cuts are intended to remove poor quality, weak or undesirable tree species growing in competition with more desirable, healthy growing stock. Sometimes FSI cuts can generate enough firewood or pulpwood for commercial sale, but generally these types of treatments are performed on young forest stands with trees of <6” diameter at breast height.

Commercial Harvests

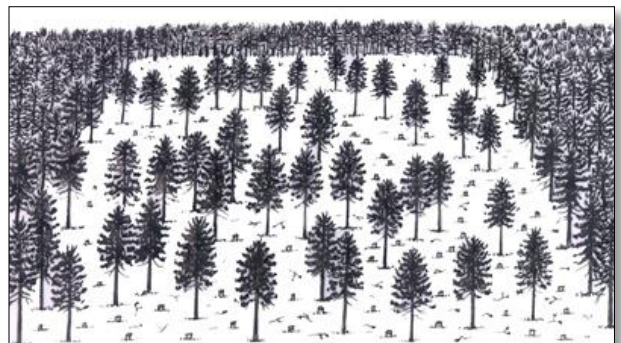
Even Aged Management Practices

- 1) **Thinning**- this style of cut is similar to the *forest stand improvement* as it is intended to remove diseased, damaged and other undesirable trees growing in competition with more desirable growing stock. Pulpwood usually accounts for the majority of harvested trees though some sawtimber sized trees will also be removed. As the name implies, a thinning creates more growing space for residual trees, spurring growth with increased sunlight and nutrients.



Courtesy of: University of Minnesota, Woodland Stewardship
http://woodlandstewardship.org/?page_id=31

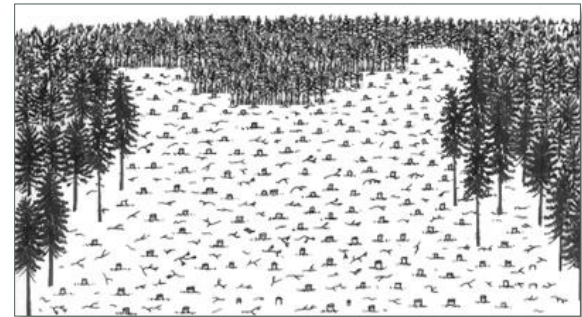
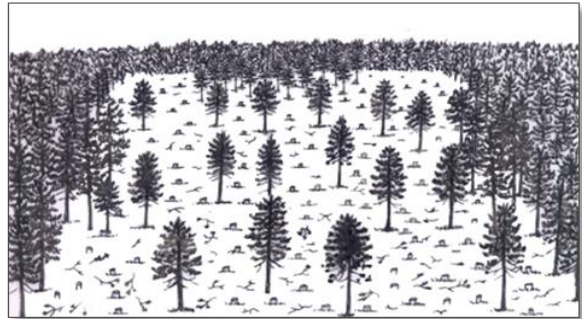
- 2) **Shelterwood** - a shelterwood harvest is intended to foster a new cohort of seedlings and saplings. A mix of pulpwood and maturing/mature sawtimber trees are removed from the stand while large seed producing trees of desirable species are retained to “shelter” developing saplings and serve as a seed source for new seedlings. The residual stocking is light though not as severe as seed-tree or clearcuts. After some time (5-10 years), a second harvest is conducted to remove “shelter” trees of commercial value and release the saplings below.



Shelterwood Harvest

Courtesy of: Web-Based Forest Management Guides; US Forest Service, <http://www.nrs.fs.fed.us/fmg/nfmg/fm101/silv/index.htm>

- 3) **Seed-tree** - this technique is similar to clearcutting however large overstory trees are retained to serve as seed sources for the next forest stand.
- 4) **Clearcut**- as the name implies, this method removes the forest stand and is intended to restart forest succession. Often performed for wildlife habitat, clearcuts drastically change the appearance of an area and draw concern and ridicule. Despite the drastic appearance, clearcutting can be an effective practice for creating early successional habitat and managing for shade intolerant tree species.



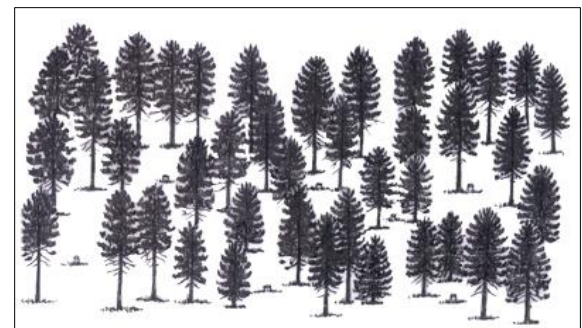
Seed-tree Harvest (middle), Clearcut (bottom)

Courtesy of: Web-Based Forest Management Guides; US Forest Service, <http://www.nrs.fs.fed.us/fmg/hfmg/fm101/silv/index.htm>

Uneven- Aged Management Practices

- 1) **Single Tree and Group Selection**- are used to diversify even- aged stands. Selectively removing trees from the dominant, co-dominant and suppressed stand levels adds structural diversity and can be used to alter the species composition of the stand. Single tree selection is used to selectively remove individual trees with no specific attention to spacing or residual stand growing space.

**The label of “single tree selection” often invokes negative connotations as this method is often used to justify “high grading” or diameter limit cuttings. These practices remove the most valuable sawtimber trees without regard for residual stand composition, structure or regeneration.*



Single Tree Selection

Courtesy of: Web-Based Forest Management Guides; US Forest Service, <http://www.nrs.fs.fed.us/fmg/hfmg/fm101/silv/index.htm>

- 2) **Group selection** as the name implies, is used to remove groups or clusters of subject trees. This practice is often employed to release established seedlings, increase low – brush cover for wildlife, and diversify total species composition.

Management Decisions

When to Harvest Trees

Well-defined property goals should drive management decision. Before prescribing any treatments, it helps to look at each potential treatment area in context with the rest of the property and the local landscape. Many management goals can be successfully incorporated under a comprehensive approach starting at the property level scale.

Individual Stand management decisions should be determined by several key factors:

Forest Stand Species Composition

Forest community species have unique strategies for seedling establishment, growth, survival and reproduction. Sustainable management is dependent on an understanding of these characteristics. For example, species such as red oak generally respond positively to improvement thinnings and shelterwood regeneration harvests. Seed-tree and clearcut harvests successfully regenerate high value and shade intolerant species such as black cherry. For these reasons, traditional silvicultural practices in eastern Pennsylvania emphasized even-aged management. However, as threats to forest health (exotic pests, invasive species, etc.) increase, as poor harvest practices continue to degrade forest stand conditions, as concern over loss of sensitive habitats and biodiversity grows; uneven-aged and adaptive management practices will be more readily employed to favor desirable species.

Forest Stand Stocking

Tree size and number per acre varies over time. Stand age, site conditions and species composition influence the growth rate and number of stems per acre in a given Stand. Stocking guidelines are used to help determine the appropriate treatment (if any) to achieve management objectives. Stocking tables help simplify management decisions for overstocked, adequately stocked and understocked Stands.

Basal area, a representation of the cross-sectional area of wood per acre, and the number of trees per acre are used to determine Stand stocking level (see figure below). From this determination and other considerations (goals, species, regeneration levels), appropriate silvicultural recommendations should be made.

Seedlings and Saplings

An evaluation of natural seedling and saplings per acre is essential in determining appropriate management recommendations. Competitive seedlings and saplings are largely absent from eastern woodlands. Controlling competing vegetation, lowering deer browse impacts and other measures may be required to permit the establishment of seedlings, saplings, shrubs and herbs. Seedling recruitment through natural regeneration is preferred over reforestation plantings.

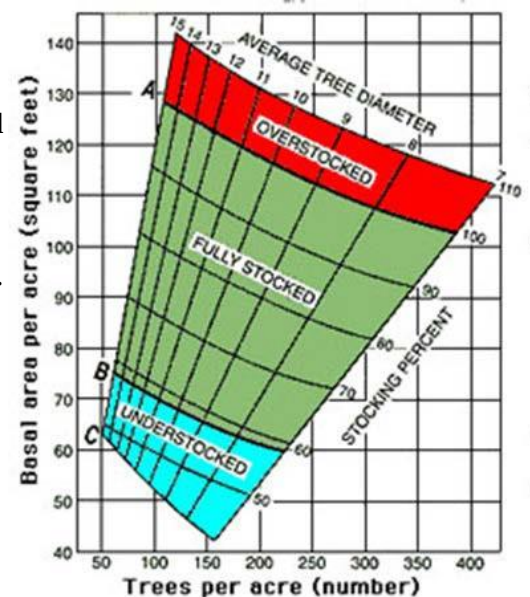


Figure 18 Stocking Guide Showing Basal Area, Trees per Acre, Average Diameter and Stocking Percent

Forest Products

Forest products are the driving force behind all commercial timber management activities. The most obvious of which is timber.

Growing Stock

A classification system for forest trees developed by the US Forest Service was used for assessing growing stock on the subject property. The convention requires an assessment of sawlog potential for each measured tree. Trees that exhibit good form and growth habit and are of sawtimber size or potential sawtimber size (in the future), capable of producing at least one 8 foot sawlog are classified as **Acceptable Growing Stock** (AGS). Conversely, trees that exhibit poor form and/or growth habit, not capable of producing (now or in the future) one 8 foot sawlog are classified as **Unacceptable Growing Stock** (UGS).

Modifications to this convention are often employed to account for other forest stand variables that may contribute to management considerations. Additional variables may include standing dead, cavity trees, or large legacy or seed/crop trees.

Grade

Sawtimber trees are graded based on diameter, length and number of clear faces. Though an industry standard log is 16 feet long, a potential sawtimber tree must be at least 8 feet long (1/2 log) with a small end diameter of at least 11" (locally). It must also have at least 2 clear faces or two sides clear of bumps, scars, branches or seems for the entire length of the side. Logs that do not have 2 clear sides are often used for pallet wood or pulp. Logs that are clear on all 4 sides have the potential to be sold for veneer and bring the highest value.

Pulpwood trees are usually between 6"-12" in diameter at breast height and are utilized down to a 4" top end diameter. These trees are used for paper pulp or wood fiber products (plywood, particle board).



Mount Holly Marsh Preserve Management Unit Summary

Forest Cover Overview

Overstory

Chestnut oak, white pine, red oak and black gum are the most prominent tree species across the Mount Holly Marsh Preserve property. Red maple, pitch pine, yellow poplar and sassafras represent much of the remaining composition however white oak, black birch, hickory, locust, hemlock and other hardwoods are found on the property in lesser numbers.

The property is composed of four major forest community

types: **Dry Oak–Heath, White Pine, White Pine–**

Hardwoods and Mixed Hardwoods. Topographic

position, site conditions and past land use practices have

influenced the location, size and stocking of each major community type. The Dry Oak – Heath community type is primarily located on the central hilltop and upper slopes of Mount Holly. Mixed Hardwoods, White Pine – Hardwoods and White Pine community types are found downslope and at the base of Mount Holly respectively.



Figure 20 Dry Oak- Heath Forest Community

Understory

Heath species including lowbush blueberry, huckleberry species and sheep laurel are prevalent in upland oak stands on the Preserve property.

Mountain laurel is established in select patches. Though largely devoid of sub-canopy and understory trees, some serviceberry, witch hazel, sassafras and American holly trees are found across the property.

Hardwood saplings including: red maple, white oak, chestnut oak, black birch, yellow birch and yellow poplar occur in small numbers and select areas of the property.

Japanese barberry has become established on the property. In some lowland acres, barberry has established dense thickets, displacing native vegetation. Ailanthus (tree-of-heaven) is growing in some numbers in several locations on the property. Ailanthus clusters are forming as a result of parent tree -root shoots and saplings. Pawlonia (Princess tree) and other invasive species are invading open spaces on the property, displacing native vegetation and altering natural stand development.



Figure 9 Holly (green center)

Ground

Overall, the Mount Holly Marsh Preserve property is lacking adequate levels of seedlings from desirable species. This is due to several factors including deer browse pressure, competing vegetation, and light and site conditions. Wintergreen, partridgeberry, wood fern species, hay-scented fern, bracken fern, common mosses, and other herbaceous vegetation are found at ground level. Sphagnum moss, tussock sedge, skunk cabbage, false hellebore, common violet and other hydrophytic vegetation are found in wetlands and lowland areas.

Forest Inventory

Pre-inventory reconnaissance was conducted on the Mount Holly Marsh Preserve property in October of 2016. A forest inventory was conducted in the winter of 2016/2017. One hundred and seventy two nested variable radius and fixed area inventory sample plots were collected between December and March 2017. Overstory trees were sampled using basal area 10 factor prism selection, diameter tape and digital clinometer measurements. Understory cover (woody shrubs and small trees) were sampled using 1/5th acre, fixed area estimation. Seedlings and saplings were sampled using industry standard 1000th acre fixed area measurement.

Management Units

Forest community types on the subject property were divided into Management Units for statistical analysis. Units were grouped by forest community type and summarized by location and stocking level. Each Unit was assigned an identification number that corresponds to the label on the Management Unit Map. In some cases (the Pitch Pine Unit for example), several isolated stands of the same community type that displayed similar characteristics, were analyzed and summarized as one Unit.

The following Management Unit summaries were designed to be viewed in tandem with the foldout

Management Unit Map located in the back of the summary section. Simply unfold the map first, so that the locations of each labeled Management Unit can be easily identified when viewing the Unit summary pages.

Management recommendations follow the data summary section for each Unit. Additional general property level recommendations follow the Unit summary section. A recommendation summary table is also enclosed.

Key Terms

Several terms are used to describe forest conditions in the following section. Many of these terms may be unfamiliar to the average landowner. Please review the list on the following page for reference prior to viewing the summary section.

Acceptable Growing Stock (AGS): trees exhibiting good form, health and vigor, capable of producing at least one 8ft commercial grade log now or in the future.

Unacceptable Growing Stock (UGS): trees exhibiting poor form, health and vigor, not capable of producing at least one 8ft commercial grade log now or in the future. Still has commercial pulpwood value.

Basal Area: The square foot total of wood (cross section of trees) per acre. Used to express Unit (per acre) stocking levels.

Cull: trees exhibiting severe decline, cavities or other deformities not capable of producing any commercial products (except perhaps carbon capture). May be suited for wildlife habitat and seed production.

DBH: “Diameter at Breast Height” or 4.5ft standard

MBF: Thousand board feet (used for grade 2 and grade 3 sawtimber volume).

Quadratic Mean Diameter: The diameter of the average basal area tree. Used to express tree size.

Percent Stocking: A percentage representation of stand basal area and trees per acre compared to the desired number for optimal growth and management purposes.

Sawtimber: Trees containing grade quality sawlogs of at least 8 feet in length and 11” small end diameter (inside bark). Softwood sawlogs were cruised to a 10” small end diameter (inside bark).

Pulpwood: Sound trees typically between 6” and 12” dbh measured in tons. Merchantable heights measured to a 4” top diameter.

Pallet Wood: Sawtimber sized logs not meeting sawtimber grades due to defect. Measured in tons.

Topwood: Pulp or pallet wood volume from the portion of the tree above sawtimber logs. Measured in tons.

Management Unit 1: Dry Oak – Heath 294 acres

Overstory

These upland acres are primarily stocked with pole-sized (6"-12" dbh) chestnut oak, black gum, pitch pine and red oak. Other hardwoods including scarlet oak, black oak, hickory are also represented in small numbers. Larger sawtimber trees were removed from Unit 1 in past timber harvests.



Figure 22 Dry Oak - Heath

Approximately **37 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **52 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. **Cull** trees account for **6 sqft** of basal area per acre. Total basal area per acre is estimated at **107 sqft** with approximately **345 trees per acre**. This stocking is considered fully stocked with an estimated stocking percent of 97% according to Gingrich and Roach stocking guidelines.

Table 1: Unit 1 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood. Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
chestnut oak	49	112	9	36.3	10,669	330.0	97.03
black gum	23	132	6	11.6	3,400	-	-
pitch pine	10	15	11	6.1	1,789	197.8	58.15
northern red oak	9	14	11	6.6	1,949	290.4	85.38
red maple	5	24	6	2.8	830	22.2	6.52
sassafras	5	29	5	2.3	665	-	-
scarlet oak	3	7	8	1.7	509	-	-
yellow poplar	1	3	9	0.6	164	93.9	27.61
black cherry	1	2	9	0.5	151	-	-
black oak	1	1	12	0.8	235	-	-
black birch	1	2	7	0.3	94	-	-
hickory	0	1	7	0.2	65	-	-
locust	0	1	8	0.2	52	-	-
American chestnut	0	2	4	0.1	23	-	-
Stand Total	107	345	7.5	70.0	20,594	934.4	274.70

Understory and Ground Level

Lowbush blueberry, huckleberry and other *vaccinium* species (heath) are prevalent in the understory and ground level. Mountain laurel is also found in clusters and dense thickets, especially on the north facing slopes in the Unit. Regeneration of desirable species is inadequate for forest development.

Species	Seedling	1" Sapling	Stand Total
chestnut oak	200	-	200
sassafras	91	-	91
red oak	55	-	55
red maple	18	18	36
Stand Total	364	18	382

Table 2 Unit 1 Regeneration Summary

Forest Health

The lack of adequate regeneration levels threatens the health of future forest development. The invasion of exotic species including ailanthus and Japanese barberry compounds the risk to future forest health and composition.

Other forest health risks include:

- a. **Species diversity** – chestnut oak and black gum account for a major portion of the overstory composition. Though these species are common dry oak community species, promotion of other hardwood species in the forest overstory would improve stand resiliency.
- b. **Forest Pests** – Gypsy moth, two-lined chestnut borer and forest tent caterpillar are three main forest pest threats to dry oak heath communities in the region. No signs of infestation or pending outbreak were observed during the field inventory. Future monitoring for potential outbreaks is recommended.
- c. **Forest Pathogens** – Armellaria (shoestring rot) and chestnut blight are two common fungal pathogens that persist in dry oak communities. A few American chestnut saplings and small poles can be found in Unit 1. These small sprouts indicate chestnuts previous place in the species composition of the region (prior to the blight). The size and quantity of chestnut stocking in Unit 1 does not significantly affect forest conditions today. No severe impacts from listed pathogens is anticipated following the field inventory.

Soils

According to the Soil Survey of Cumberland County, Management Unit 1 is composed of Hazleton channery sandy loam and Clymer very stony loam soils. High rock content and shallow soil depth limit the vegetative productivity of these soils. Site index ratings for red oak, sugar maple or white pine have not been recorded for these soil types. While water availability and rock content may limit growth rates, these soils are generally suited for woodland and recreation use.

Clymer soils are less suited for road/trail construction due to rock content.

Wildlife Habitat

A member of the white oak group, chestnut oak are capable of producing acorns on an annual basis. Some research suggests acorns from the white oak group are favored by white-tailed deer and other mast consuming wildlife species. Other Unit features including rocky outcrops and openings provide sunning and foraging habitat for invertebrates, reptiles and songbirds. Maturing pitch pine provide escape cover for songbirds and small mammals. Pitch pine cones and seeds are utilized by red squirrels, juncos, chickadees and mice. Deer, cottontail rabbits and meadow mice are known to feed on pitch pine saplings.

Special Features

Wildfire community: The dry oak and pitch pine component in Unit 1 suggests a history of wildfire on the property. Serotinous cones produced by pitch pine need periodic wildfire to scarify the seed for germination.

Thick bark of chestnut oak protects the species from low to moderate fire damage. Both oak and pine species have adapted to fire as a release strategy for seedlings which can re-sprout more readily than there non-fire adaptive competitors following wildfire events.

Viewshed: Unit 1 encompasses much of the Mount Holly ridgeline. Though numerous trails run through the Unit, a permanent vista has yet to be established. Several potential vista locations within Unit 1 were modeled using GIS spatial analysis. Resulting viewshed projections have been depicted on the map entitled: Scenic Viewshed Map. The Map shows a series of potential view point locations along the Yellow Ridge Trail.

Management Unit 1 Recommendations

1. Exotic plant species are becoming established in the understory and overstory of Unit 1. Ailanthus trees are sprouting along the main access road on the ridgeline. The density of ailanthus stems along the trail varies though the area containing the highest density of ailanthus trees has been typed out and identified on the enclosed Invasive Species Priority Areas Map (see page 24).

Consider adopting an aggressive strategy for controlling the spread of exotic invasive species. Inject ailanthus trees with glyphosate based herbicides using the stem injection or “hack and squirt” method. Using a hatchet, cut into the cambium layer of target trees. With the hatchet still in the tree, apply herbicide to the wound using a squirt bottle. Make one incision per inch of breast height diameter on the target tree. Treat trees late in the growing season when absorption in the root system is highest.



Figure 23 Hack and Squirt - Courtesy of University of Maryland Extension

Do not attempt to girdle or dig out ailanthus trees! Killing parent trees will likely encourage numerous sprouts to shoot up from the root systems. Systemic herbicide is highly recommended for this reason.

The cost of hack and squirt treatments will vary depending on the number of stems to be treated, tree size and other factors such as terrain and site accessibility. Average cost of treatment may exceed \$60 per acre.

Japanese barberry and invasive species are not established at high levels within the Unit. Consider targeting “pioneering” clusters of barberry and other shrubs with systemic herbicides late in the growing season (along with ailanthus treatments) to prevent the establishment of dense clusters and displacement of native vegetation. Apply herbicides using manual powered backpack sprayers or gas powered mist blowers. The cost of such treatments will likely total between \$155 -\$200 per acre depending on the number of shrubs, terrain, accessibility and other factors.

Refer to the US Forest Service “Manual Herbicide Application Methods for Managing Vegetation in Appalachian Hardwood Forests” by Jeffrey D. Kochenderfer, James N. Kochenderfer and Gary W. Miller, for more information on herbicide treatment techniques, chemical formulations and estimated costs. A digital version of the manual has been included on the enclosed CD. The document can also be downloaded from the following website: https://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs96.pdf

2. To increase recreational usage of the property, consider constructing scenic viewing points along the yellow ridge trail. Consider using the enclosed Scenic View Point Map (and/or associate GIS files) to help locate viewing points along the Yellow Ridge Trail. At each point, it will be necessary to fell select trees to open up the view. Viewshed clearing could be combined with ailanthus control treatments. Promote the view points as a hiking destination. In addition to the scenic view, signs could be constructed identifying locations visible from each point (e.g. Land O’Lakes Inc.: 1.7 miles, Mount Holly Springs Cemetery: 1.4 miles). Directional markers could be used to orient visitors towards far off destinations (e.g. Harrisburg: 20 miles, State College: 58 miles, Philadelphia: 100 miles). Use GIS mapping to identify points of interests.
3. Consider adopting a forest health monitoring protocol involving seasonal assessments of health indicators. During the growing season, look for yellowing of foliage and defoliation of dominant trees. Look for wild flowers, seedlings and other indicators of lowered deer browse pressure. In late fall and winter, monitor gypsy moth and forest tent caterpillar egg masses.

Management Unit 2: Mixed Hardwoods 153 acres

Overstory

Unit 2 is located on the steep south facing slopes of Mount Holly.

These side hill acres were intensively harvested in the past 60 years.

The harvest removed dominant – large sawtimber sized oak and other hardwoods.

Residual stocking is a mix of pole sized sassafras, black birch, and chestnut oak. Small sawtimber sized red oak and black oak trees are found across the Unit. Other hardwoods including black gum, yellow poplar, black cherry and red maple are also represented.



Figure 24 Mixed Hardwoods are Talus Slope

Approximately **21 sqft** of basal area per acre is considered acceptable growing stock (AGS). **61 sqft** of basal area per acre is considered unacceptable growing stock (UGS). Cull trees account for **8 sqft** of basal area per acre. Total basal area per acre is estimated at **100 sqft** with approximately **323 trees** per acre. This stocking is considered fully stocked with an estimated stocking percent of 95% according to Gingrich and Roach stocking guidelines.

Table 3: Unit 2 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
sassafras	21	114	6	10.0	1,534	-	-
black birch	19	62	8	13.0	1,987	32.4	4.96
chestnut oak	15	26	10	12.3	1,887	149.8	22.92
northern red oak	10	10	14	9.0	1,372	353.5	54.08
red maple	9	23	9	5.9	896	-	-
black gum	6	24	7	3.4	514	-	-
yellow poplar	5	9	10	3.3	499	152.5	23.33
hickory	4	12	8	2.6	397	-	-
black cherry	4	12	7	2.3	349	-	-
locust	3	19	6	1.2	188	-	-
black oak	1	1	15	1.2	178	15.9	2.43
pitch pine	1	1	12	0.6	96	27.0	4.14
white oak	1	5	6	0.5	79	16.5	2.53
ailanthus	0	2	6	0.2	28	-	-
white ash	0	5	4	0.1	19	-	-
Stand Total	100	323	7.5	65.5	10,024	747.5	114.37

Understory and Ground Level

The composition of Unit 2 has been affected by past management and site conditions. Small diameter black birch, red maple and sassafras saplings and poles are prevalent in understory patches throughout the Unit. Japanese barberry is also established in small clusters. Grapevine grows up through the overstory in some areas.

Species	Seedling	1" Sapling	Stand Total
sassafras	200	-	200
chestnut oak	120	-	120
red maple	-	80	80
red oak	80	-	80
Total	400	80	480

Table 4 Unit 2 Regeneration Summary

Wood fern species and hay-scented fern are found in open areas. Regeneration of desirable seedlings and saplings is inadequate for forest stand development.

Forest Health

The lack of adequate regeneration levels threatens the health of future forest development. The invasion of exotic species including ailanthus and Japanese barberry compounds the risk to future forest health and composition.

Other forest health risks include:

- a. **Forest Pathogens** – Armellaria (shoestring rot), and chestnut blight are two common fungal pathogens that persist in dry oak communities. No severe impacts from listed pathogens is anticipated following the field inventory.
- b. **Site Conditions** – Heavy stone content and patches of talus limit tree establishment and growth.

Soils

According to the Soil Survey of Cumberland County, Management Unit 2 is composed of Hazleton channery sandy loam soils. High rock content and shallow soil depth limit the vegetative productivity of these soils. Site index ratings for red oak, sugar maple or white pine have not been recorded for these soil types. While water availability and rock content may limit growth rates, these soils are generally suited for woodland and recreation use. Unit 2 contains areas of talus and excessive surface rock content.

Wildlife Habitat

Large red oak and chestnut oak trees provide food for mast consuming wildlife species. Some large oak trees are found in areas that are inaccessible for timber harvesting. Other large oak and hardwood trees contain cavities and may serve as nesting sites for small mammals, songbirds and birds of prey. Rocky talus slopes may harbor small mammals and snakes.

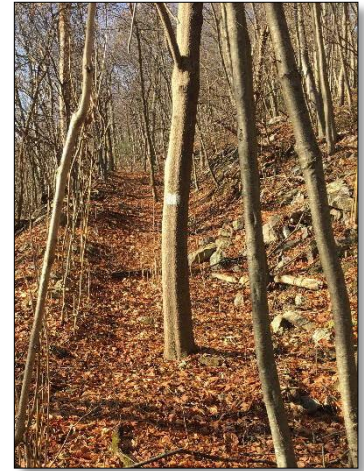
Special Features

Recreation: Skid trails created to access timber in past harvests switchback across Unit 2. Many of these trails have been adapted into hiking trails.

Cultural: Depressions mark the site of earthen kilns used in the 1800s for charcoal production. Numerous kiln sites are found within Unit 2. These sites are more easily located using Digital Elevation Models. *See cultural features on the Recreational Use Map and enclosed GIS files.*

Management Unit 2 Recommendations

1. Exotic plant species are becoming established in the understory and overstory of Unit 2. Ailanthus trees are growing along hiking trails and in some cases, on hiking trails (photo right) – tree with white trail mark). Density of ailanthus stems and barberry patches is not as severe as in other Units however, now is the time to try to contain the spread of unwanted species.



Consider spot treating ailanthus and other invasive species (see Invasive Species Priority Area Map) with systemic herbicide during the growing season. Use the “hack and squirt” method to treat large ailanthus stems. Foliar applications may be effective for small saplings and barberry bushes.

Refer to Unit 1 Recommendations for treatment details.

2. Consider upgrading trails and adopting an aggressive trail maintenance schedule. Fell black birch and other poles growing on main hiking trails. Engage local volunteers to perform routine monitoring and reporting of trail condition.

Consider constructing new signage labeling trails and identifying unique features such as charcoal kiln sites. Integrate signage with existing County Website Mount Holly Marsh Preserve page (<https://www.ccpa.net/3650/Mount-Holly-Marsh-PreserveConsider>), Cumberland Valley Trail Connections (<https://www.ccpa.net/3602/Cumberland-Valley-Trail-Connections>) and other sites such as Trails.com: (https://www.trails.com/tcatalog_trail.aspx?trailid=HGN217-070).

Interpretive sign systems which integrate mobile device applications such as QR readers and GPS mapping could be added to trail and feature markers. QR codes are being used to engage people with varying interests in outdoor recreation. Natural points of interest including site specific wildlife habitat information, bird and insect calls and other features (e.g. ongoing invasive species control efforts) could be highlighted along the trail system. Cultural and historic information including video clips, old photographs and audio dialogue could be made accessible to visitors of the old dam site, charcoal kilns, stonewalls and other features.

Consider exploring the potential for annual outdoor training and endurance style competitions to promote the region and property usage.

Management Unit 3: Dry Oak – Mixed Hardwoods 58 acres

Overstory

Unit 3 is found on the southwestern slopes of the Mount Holly Marsh Preserve property. This area was intensively harvested in the past 60 years. The old haul road and landing area are prominent features of the Unit. Poled sized chestnut oak, red maple, black gum and scarlet oak account for much of the species composition. Few sawtimber sized trees are found per acre.

Approximately **25 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **45 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. **Cull** trees account for **1 sqft** of basal area per acre. Total basal area per acre is estimated at 81 sqft with approximately 294 trees per acre. This stocking is considered fully stocked with an estimated stocking percent of 78% according to Gingrich and Roach stocking guidelines.

Table 5: Unit 3 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.
Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
chestnut oak	29	53	10	22.1	1,288	321.8	18.79
red maple	16	73	6	8.7	508	-	-
black gum	15	81	6	7.2	423	-	-
scarlet oak	11	21	10	8.4	488	51.3	3.00
sassafras	5	47	4	1.9	109	-	-
northern red oak	5	20	7	3.6	211	49.6	2.90
Stand Total	81	294	7.1	51.8	3,026	422.7	24.68

Understory and Ground Level

Due to past harvest practices, understory layers in Unit 3 are composed of small pole sized red maple and oak trees. Few seedlings persist aside from sassafras and scattered red maple sprouts.

Species	Seedling	1" Sapling	Stand Total
sassafras	125	-	125
Stand Total	125		125

Table 6 Unit 3 Regeneration Summary

Forest Health

Forest health risks include:

- Forest Pathogens** – Armellaria (shoestring rot) and chestnut blight are two common fungal pathogens that persist in dry oak communities. No severe impacts from listed pathogens is anticipated following the field inventory.
- Forest Pests** – Gypsy moth and forest tent caterpillars and two-lined chestnut borer present risks to oak species in the Units.

Soils

According to the Soil Survey of Cumberland County, Management Unit 2 is composed of Hazleton channery sandy loam soils. High rock content and shallow soil depth limit the vegetative productivity of these soils. Site index ratings for red oak, sugar maple or white pine have not been recorded for these soil types. While water availability and rock content may limit growth rates, these soils are generally suited for woodland and recreation use.

Wildlife Habitat

Oak trees in Unit 3 are maturing into small sawtimber size classes. Acorn production may increase as trees gain more crown area.

A small intermittent stream provides drinking water and breeding habitat for many species of wildlife including invertebrates, amphibians, songbirds and mammals. A tiny white pine component is found along the stream near the source and old log landing. These trees provide escape cover for songbirds and small mammals that may utilize the stream corridor and old log landing site.

Special Features

Hydrology: Unit 3 contains the source and significant frontage of an intermittent stream. The stream parallels the old haul road, flowing southeastwardly to Mountain Creek.

Management Unit 3 Recommendations

1. Consider planting warm season grasses and/or native forbs on the old landing site and open areas to increase habitat diversity on the property and herbaceous forage for upland species. Plantings of this type may require machinery for tillage. Funding for upland habitat creation may be available through NRCS EQIP or similar programs. Refer to the document entitled “Warm-Season Grasses and Wildlife”, by Colleen Delong and Margaret Brittingham, published by Penn State Extension, included with the rest of the PA Woodlands and Wildlife series on the enclosed CD.
2. Consider using old landing and haul road for educational purposes, expanding hiking trails and interpretive signage to the site.
3. Reassess Unit 3 in 10 years for tree growth.

Management Unit 4: Pitch Pine 31 acres

Overstory

Unit 4 is composed of 3 non-contiguous forest stands dominated by maturing pitch pine. Stands within Unit 4 are located on the south facing slopes of Mount Holly, adjacent to Unit 1 (dry oak-heath). Like minor pitch pine components in Unit 1, Unit 4 likely developed as a result of past wildfires. Overstory composition is comprised of maturing pitch pine, and pole – sized chestnut oak, black gum, and scarlet oak.

Approximately **52 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **58 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. **Cull** trees account for **4 sqft** of basal area per acre. Total basal area per acre is estimated at **114 sqft** with approximately **350 trees per acre**. This stocking is considered overstocked for optimal timber growth with an estimated stocking percent over 100% according to Gingrich and Roach stocking guidelines.

Table 7: Unit 4 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
pitch pine	41	65	11	21.5	665	1,562.1	48.43
chestnut oak	34	110	8	23.5	728	-	-
black gum	21	123	6	9.7	300	-	-
scarlet oak	11	34	8	7.4	228	-	-
northern red oak	6	15	8	4.0	124	44.1	1.37
black oak	1	1	12	1.0	30	-	-
Stand Total	114	350	7.7	67.0	2,076	1,606.2	49.79

Understory and Ground Level

The pitch pine stands making up Unit 4 are largely devoid of understory growth aside from sassafras stems and mountain laurel in sunlit openings. Native grasses, partridgeberry, low bush blueberry and other *vaccinium* species are found at ground level.

Species	Seedling	1" Sapling	Stand Total
sassafras	222	-	222
Stand Total	222		222

Table 8 Unit 4 Regeneration Summary

Forest Health

Forest health risks include:

- Wildfire**—Wildfire suppression in Pennsylvania may have adverse ecologic impacts on fire-adapted plant communities. Pitch pine are largely dependent on wildfire for seedling establishment and release from competing vegetation. The absence of period wildfire may exclude pitch pine from the species composition of Mount Holly Marsh preserve over time.

Soils

According to the Soil Survey of Cumberland County, Management Unit 2 is composed of Hazleton channery

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sandy loam and Clymer very stony loam soils. High rock content and shallow soil depth limit the vegetative productivity of these soils.

Site index ratings for red oak, sugar maple or white pine have not been recorded for these soil types. While water availability and rock content may limit growth rates, these soils are generally suited for woodland and recreation use.

Wildlife Habitat

Maturing pitch pine trees provide forage for juncos, chickadees, red squirrels and other small mammals. The canopy of conifer stands may provide some escape cover for songbirds and small mammals under the eye of birds of prey.

Special Features

Wildfire: Pitch pine stands are indicators of possible historic wildfires on the property. A fire-adapted species, pitch pine trees are largely reliant on wildfire for seed germination and seedling release.

Management Unit 4 Recommendations

1. The relationship between pitch pine and dry-oak forest communities and wildfire could be explained with interpretive signage along hiking trails near these pitch pine stands. Along with fire ecology, pitch pine was once an important species for supply resinous “pitch” used to help make wooden ships watertight. Timber from pitch pine was used for shipbuilding, mine timbers, shipping crates, caissons and railroad ties. Though a “yellow pine” (as in southern yellow pine used for treated lumber projects), pitch pine generally holds low commercial value.
2. Reassess Unit 4 in 10 years for tree growth.

Management Unit 5: Dry Oak – Mixed Hardwoods 26 acres

Overstory

This Unit contains one transitional dry oak stand located at the base of Mount holly on the south side of the property. The Unit is stocked with small sawtimber and pole sized chestnut oak, red oak, white oak, black oak and red maple trees. Other hardwoods including yellow poplar, hickory and scarlet oak are also represented. Scattered white pine trees, more prevalent in southern adjacent Units, grow throughout the Stand.

Approximately **64 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **33 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. **Cull** trees account for **5 sqft** of basal area per acre. Total basal area per acre is estimated at **103 sqft** with approximately **195 trees per acre**. This stocking is considered fully stocked with an estimated stocking percent of 87% according to Gingrich and Roach stocking guidelines.

Table 9: Unit 5 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
chestnut oak	54	75	12	44.1	1,147	853.6	22.19
northern red oak	14	15	13	12.6	327	311.1	8.09
white oak	7	9	12	5.5	143	191.0	4.97
black oak	6	5	15	4.9	128	194.8	5.07
red maple	4	26	5	2.1	54	-	-
black gum	4	15	7	2.5	65	-	-
hickory	3	6	9	2.0	52	-	-
yellow poplar	3	3	13	2.1	56	92.1	2.40
sassafras	3	33	4	1.0	26	-	-
white pine	1	4	8	0.6	15	-	-
scarlet oak	1	2	12	1.2	31	-	-
pitch pine	1	1	14	1.1	28	-	-
Stand Total	103	195	9.8	79.7	2,073	1,642.7	42.71

Understory and Ground Level

The understory of Unit 5 is largely devoid of shrubs and small trees. Sassafras saplings and poles are found in small numbers along with scattered witch hazel stems. Chestnut oak seedlings were detected in 1/1000th acre subplots however total estimates are less than 100 seedlings per acre. Though numerous, these seedlings were less than 4.5 feet tall. Some resources suggest a minimum of 400 – 4.5 feet (or taller) seedlings per acre is necessary for adequate reforestation. Browsing deer and competing vegetation pose a threat to the growth and survival of seedlings under 4.5 feet. Unit 5 should be reevaluated periodically to assess seedling development.

Forest Health

Forest health risks include:

- a. **Herbivory:** Natural oak regeneration is developing in Unit 5. Many seedlings are still under 4.5 feet in height, at risk of browsing deer.
- b. **Forest Pathogens** – Armellaria (shoestring rot) and chestnut blight are two common fungal pathogens that persist in dry oak communities. No severe impacts from listed pathogens is anticipated following the field inventory.
- c. **Forest Pests** – Gypsy moth and forest tent caterpillars and two-lined chestnut borer present risks to oak species in the Units.

Soils

According to the Soil Survey of Cumberland County, Management Unit 5 is composed of Hazleton channery sandy loam, Clymer very stony loam and Laidig very stony loam soils. High rock content and shallow soil depth limit the vegetative productivity of these soils. Site index ratings for red oak, sugar maple or white pine have not been recorded for Hazleton and Clymer soil types. Laidig very stony loam soils are rated 80 feet for sugar maple and 90 for white pine.

Wildlife Habitat

Maturing oak trees in Unit 5 are capable of producing large crops of acorns, important autumn food sources for many wildlife species. White oak, a preferred acorn source, is more prevalent in Unit 5 than other Units on the property. Both chestnut oak and white are annual producers of acorn with periodic bumper crops. Red, black and scarlet oak acorns require two growth seasons to mature. The mix of white and red oak species in Unit 5 is beneficial to mast consuming species such as gray squirrels, turkey, white-tailed deer and even black bear.

Special Features

Cultural: Depressions from earthen kilns used to make charcoal are found in Unit 5.

Management Unit 5 Recommendations

1. Oak trees are maturing in Unit 5. Stocking levels are adequate though growth rates of dominant trees may be slowing due to canopy closure. A silvicultural thinning across all diameter classes may be warranted to increase growing space for desirable stocking and adjust species diversity. A thinning of this type would remove 1/4-1/3 of the basal area, targeting weak, damaged, diseased or poorly form trees that crowd healthy trees of desirable species. Since it is relatively uncommon on the property and highly beneficial to wildlife, consider favoring dominant and co-dominant white oak trees. Target poor quality red maple, black gum, chestnut oak and other hardwoods for removal. Retain live and dead trees with cavities for wildlife when possible.

A harvest of this kind is a preliminary step in stand management. It is intended to foster growth and seed production of residual stocking. It is not intended for stand regeneration however established seedlings may benefit from increased light levels. Consider monitoring seedling development before and after the harvest. If economically feasible, construct fence around the harvest site to foster the growth and development of desirable seedlings, shrubs and herbs.

2. Commercial viability of a thinning harvest may be marginal. If a thinning is scheduled, consider combining the thinning in Unit 5 with other commercial silvicultural treatments in adjacent Units to increase marketability. Access to Unit 5 is a limiting factor. A harvest in adjacent Unit 6 may increase the viability of a thinning.
3. Prior to thinning, spot treatment of Japanese barberry and other pioneering invasive species should be undertaken to reduce the risk of spread after the harvest. Increased sunlight levels from canopy reduction will improve conditions for sub-canopy and understory growth. Targeting unwanted vegetation prior to the harvest will reduce the risk of seedling displacement in the future. Treat unwanted vegetation with systemic herbicide applied with a manual pump backpack sprayer or gasoline powered mistblower. The cost for such treatment may average \$155-\$200 per acre. See treatment recommendations for Unit 1 (page 39).
4. Cultural features in Unit 5 (kiln sites) are perhaps more easily accessible to hikers than those located on the steep side slopes of Mount Holly. Consider routing trails and constructing interpretive signage at kiln sites. Additional land use history dating back to the resort era may be uncovered in Unit 5. Additional cultural investigation should be considered.
5. Consider conducting seasonal forest health monitoring in Unit 5. Look for signs and symptoms of stress and infestation including: defoliation, yellowing of leaves, egg masses and fungal “shoe strings” (and other factors).

Management Unit 6: Northern Hardwoods 34 acres

Overstory

Unit 6 contains two isolated northern hardwood forest community stands. Both stands are located along the lower slopes of Mount Holly and contain a mix of oak and northern hardwood species. Yellow poplar accounts for the largest portion of basal area and estimated sawtimber. Many yellow poplar trees are large in diameter (+18" dbh) and height. Chestnut oak, black gum, red maple and red oak comprise much of the remaining stocking. Minor amounts of white oak, sassafras, scarlet oak and black birch are also represented across both stands.



Approximately **81 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **44 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. **Cull** trees account for **9 sqft** of basal area per acre. Total basal area per acre is estimated at **134 sqft** with approximately **280 trees per acre**. This stocking is considered overstocked for optimal timber growth with an estimated stocking percentage above 110%.

Table 10: Unit 6 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
yellow poplar	53	35	17	35.1	1,193	5,214.7	177.30
chestnut oak	23	49	9	17.1	580	185.7	6.31
black gum	18	102	6	9.2	312	-	-
red maple	15	53	7	10.6	360	84.5	2.87
northern red oak	15	21	12	11.8	400	512.1	17.41
sassafras	5	14	8	2.9	100	-	-
white oak	4	3	16	2.6	90	220.3	7.49
scarlet oak	1	1	14	1.1	38	-	-
black birch	1	2	12	0.9	30	-	-
Stand Total	134	280	9.4	91.3	3,103	6,217.3	211.39

Understory and Ground Level

Like much of the subject property, the understory of Unit 6 is largely devoid of desirable trees, shrubs, and saplings. Witch hazel and spicebush are found in both stands within Unit 6. Partridgeberry, wood fern species, hay-scented fern and grape vine are also found in small quantities. Red maple saplings were tallied in the 1/1000th acre subplots, however overall regeneration levels of desirable species are inadequate for forest regeneration.

Species	Seedling	1" Sapling	Stand Total
red maple		125	125
Stand Total		125	125

Table 11 Unit 6 Regeneration Summary

Forest Health

Forest health risks include:

- a. **Seedlings:** The lack of seedlings and saplings of desirable species is a threat to the development of future forests on the site.
- b. **Invasive Species** –The presence of “pioneering” invasive species and abundance of invasive species in adjacent stands (primarily Japanese barberry), presents an additional threat to the successful regeneration of future forests on the site.

Soils

According to the Soil Survey of Cumberland County, Clymer very stony loam soils are the predominant soil type in the both stands of Unit 6. Site index ratings for red oak, sugar maple or white pine have not been recorded for Clymer soil types. Small portions of the Unit may contain Laidig or other, more fertile soil types.

Wildlife Habitat

Seeds of yellow poplar (also called tulip poplar or tulip tree) are consumed by northern cardinals, white footed mice, and red squirrels. The tender shoots of yellow poplar saplings are relished by deer and are often over-browsed. One of the tallest trees in the eastern woods, yellow poplar has remarkably few pests and pathogens. The oak component of Unit 6 provides acorns for mast consuming wildlife species while fruits of blackgum and spicebush are consumed by very, wood thrush and other songbirds. Witch Hazel seeds are sometimes consumed by ruffed grouse.

Special Features

Species: Yellow poplar is thought to belong to one of the most primitive groups of seed bearing plants. Yellow poplar fossils the back to the Upper Cretaceous period. Flower pollination is largely dependent on “accidental” beetle, fly and bee visitation.

Spicebush, a small understory shrub of the Laurel family, or once regarded as an indicator of soil fertility. During the colonial period, fleshy fruits of spicebush were dried and ground to powder. The ground powder was used as a substitute for allspice.

Cultural: Trails running through both stands in Unit 6 may date back to the 1800s. A large trail running along the 25 acre stand, may have been constructed during the days of charcoal production on the property.

Management Unit 6 Recommendations

1. Compared to other Units on the property, Unit 6 contains a high volume of sawtimber stocking. Most of the estimated 6,000 board feet of sawtimber per acre is comprised of maturing yellow poplar. Red oak accounts for a smaller but significant amount of sawtimber per acre. Traditional forestry conventions may suggest a

regeneration harvest (two-staged shelterwood) to reduce mature and over-mature stocking in the canopy and promote the establishment and growth of red oak, a high value sawtimber species. Red oak trees in the Unit are perhaps the highest in timber quality and value on the property.

Given the lack of adequate levels of desirable seedlings and saplings, and the threat of invasive species in the understory, a regeneration style harvest is not recommended at this time. While under ideal conditions, increasing sunlight to the forest floor through overstory reduction would possibly benefit both oak and yellow poplar, the risk of regeneration failure at this time is high. Reevaluate both stands in Unit 6 for understory development prior to scheduling intensive silvicultural harvests.

2. To increase food availability for wildlife and potentially foster the establishment and growth of new seedlings, consider the crop tree release treatment for select trees in Unit 6. Release maturing red oak, chestnut oak, white oak and other hardwood trees with well-formed crowns. Choose trees that are being crowded by poorly formed or undesirable trees. Fell or girdle competing trees of low commercial value, freeing the crop tree from competition on three sides of the crown when possible (freeing means removing those trees which touch or grow very close to the crown of the crop tree). Downed trees of low or no commercial value should be left on the ground for structure and habitat.

The intent of this style of release is to create more growing space and therefore the potential for larger crowns and more acorn production from selected crop trees. The intensity of this release should not be as high as the thinning proposed for Unit 5. Though the thinning in Unit 5 may have a similar benefit to residual stocking, the crop tree release in Unit 6 should be more selective and remove only targeting competition around selected crop trees. Coordination between the thinning in Unit 5 and the crop tree release in Unit 6 may increase commercial viability. Some mature yellow poplar sawtimber trees could be harvested if the removal would benefit adjacent trees of good quality.

Refer to the US Forest Service document “Crop Tree Management in Eastern Hardwoods” by Arlyn W. Perkey and Brenda L. Wilkins, located on the enclosed CD, for more information. The document can be downloaded at the following link:

<http://www.forestenterprise.org/resources/Forestry/Crop%20Tree%20Management%20in%20Eastern%20Hardwoods.pdf>

3. If a crop tree release is considered for Unit 6, invasive species in the understory should be treated by herbicide application prior to the release. Controlling the spread of invasive species should be undertaken regardless of harvests however, impending soil disturbance and increased light levels (as a result of harvesting) should elevate the Unit’s position on the invasive species priority treatment schedule. See treatment recommendations for Unit 1.

4. In addition to controlling invasive species, consider constructing temporary deer fencing in crop tree release areas. If possible, woven wire fencing would provide adequate protection and reasonable durability however the costs for wire fencing can be expensive out of pocket. Fencing would also require multiple gates to maintain use of numerous hiking trails. Smaller, plastic or woven wire fences distributed throughout the Unit in areas of highest crop tree concentration, could still be effective in protecting potential seedlings and shrubs, and allow use of the trail system.

The cost of woven wire fence installation may vary considerably based on several factors including equipment access and site conditions. Average price for woven wire fence installation may range between \$2.50 and \$3.30 a linear foot. In general, the most cost effective professionally installed fence projects are 10 acres or more in size. Smaller fences could be constructed by staff or volunteers.

Management Unit 7: White Pine – Oak**90.5 acres****Overstory**

Maturing white pine trees are dominant across much of Unit 7. Accounting for nearly 43% of the total basal area and trees per acre. Red oak, red maple, white oak, chestnut oak and yellow poplar are also found within the Unit. Some red and white oak trees are large in diameter.

Approximately **92 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **56 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. **Cull** trees account for **6 sqft** of basal area per acre. Total basal area per acre is estimated at **154 sqft** with approximately **325 trees per acre**. This stocking is considered overstocked for optimal timber growth with an estimated stocking percentage above 110% by Gingrich and Roach stocking guidelines for oak.

Table 12: Unit 7 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
white pine	66	140	9	45.2	4,086	3,185.6	288.30
northern red oak	18	31	10	15.7	1,417	400.2	36.21
red maple	18	34	10	12.7	1,149	-	-
white oak	16	26	11	11.9	1,075	368.0	33.31
chestnut oak	14	27	10	10.9	983	110.7	10.02
yellow poplar	8	7	14	5.0	453	517.7	46.85
scarlet oak	5	16	8	4.2	378	42.3	3.83
black gum	5	34	5	2.0	185	-	-
black oak	2	2	13	1.7	150	23.3	2.11
beech	1	1	13	0.9	82	-	-
black cherry	1	3	6	0.2	17	-	-
hickory	1	3	6	0.3	26	-	-
Stand Total	154	325	9.3	110.5	10,003	4,647.9	420.64

Understory and Ground Level

White pine seedlings and sapling are present in the understory throughout Unit 7. Most pine seedlings occur in patches where diffuse sunlight reaches the forest floor. Witch hazel and Japanese barberry are also found in the understory. The latter being more prevalent.

Species	Seedling	1" Sapling	Stand Total
white pine	1,118	59	1,177
beech	59		59
Stand Total	1,177	59	1,236

Table 13 Unit 7 Regeneration Summary

Forest Health

Forest health risks include:

- a. **Forest Pathogens** – Armellaria (shoestring rot) and chestnut blight are two common fungal pathogens that persist in dry oak communities. No severe impacts from listed pathogens is anticipated following the field inventory.
- b. **Forest Pests** – Gypsy moth and forest tent caterpillars and two-lined chestnut borer present risks to oak species in the Units. White pine weevil poses a threat to the future timber value of white pine saplings. An endemic pest in Pennsylvania, the weevil destroys the terminal leader young white pine trees. In absence of a terminal leader, lateral branches bend upward in competition for sunlight and apical dominance, resulting in forked or multi-stemmed trees.
- c. **Invasive Species** –The presence of “pioneering” invasive species and abundance of invasive species in adjacent stands (primarily Japanese barberry), presents an additional threat to the successful regeneration of future forests on the site.

Soils

According to the Soil Survey of Cumberland County, Clymer very stony loam, Laidig very stony loam soil and Buchanan gravelly loam soils are the predominant soil types in Unit 7. Site index ratings for red oak, sugar maple or white pine have not been recorded for Clymer or Buchanan soil types. Laidig soils have a site index rating of 80 feet for sugar maple and 90 feet for white pine.

Wildlife Habitat

Unit 7 may provide valuable habitat for many species of wildlife on the property. Dense conifers growth provides escape cover and nesting habitat for songbirds and small mammals. Large white pine trees are often chosen for nesting sites by red tailed and red shouldered hawks, great horned owls, barred owls, ravens and even bald eagles. Raccoons are known to use white pines as daytime resting sites. White pine seeds are eaten by many songbirds including red-breasted nuthatches, black capped chickadees, pine warblers, white-breasted nuthatches and pine siskins. Eastern chipmunks, white-footed mice, and red squirrels are known to utilize white pine seeds as well.

The white pine component is complimented by the mix of oak species within the Unit. Many wildlife species rely on acorns for autumn forage. The dense conifer cover in Unit 7 provides thermal and protective cover.

Two unrecorded wetlands (NWI) and two intermittent streams are found within the Unit and provide unique habitat for terrestrial invertebrates and herptofauna. The diversity of food, cover and water features within Unit 7 is unique on the Mount Holly Marsh Preserve property.

Special Features

Hydrology: Two forested wetlands are centrally located in Unit 7. These sites contain a mix of black gum, red maple, white pine and ash trees over dense highbush blueberry thickets. In addition, two intermittent streams

drain eastwardly through Unit 7 towards Mountain Creek.

Cultural: At least one charcoal kiln site and several trails are located within the Unit. Additional cultural features dating from the 1800s may be uncovered through further investigation.

Management Unit 7 Recommendations

1. The threat of Japanese barberry expanding through the understory looms over silvicultural prescriptions. Before moving ahead with other recommendations for Unit 7, begin an invasive species control plan targeting Japanese barberry and other aggressive invaders. Start control treatments in high priority areas within the Unit (see following recommendations). Spot treat with systemic herbicides (glyphosate) during the growing season (backpack or mistblower application) or as recent studies suggest (see Ward and Williams, 2011 disc in Appendices) consider basal treatments applied during the dormant season to minimize risk of herbicide exposure to desirable herbs. The latter method using a backpack sprayer may be most suitable for seasonally wet sites.

Identify invasive species treatment areas and track treatment progress using GPS and GIS database. Repeated treatments will likely be necessary to achieve control. Spatial project management through GIS systems will facilitate budgeting for treatments and provide an archive of land use.

2. Habitat features in Unit 7 benefit an array of wildlife species. One attribute of quality habitat missing from Unit 7 is a healthy mid-story layer. In the healthiest forests, mid and understory layers are stocked with saplings, shrubs and herbaceous growth. Across most of Pennsylvania, white-tailed deer and competing vegetation (hay-scented fern) have limited the development of understory layers. Other factors including tree age and stage of stand development also impact understory levels.



Patches of white pine seedlings and saplings are found throughout Unit 7 (photo right). Consider releasing white pine seedlings by manipulating light conditions. Fell or girdle select trees overtopping white pine seedlings. Target poorly formed white pine trees (those with “bottlebrush” like crowns), red maple, birch or other non-mast producing trees (retain oak and hickories). Do not clear the entire treatment site. Employ crop tree like thinning practices around the best quality trees overtopping white pine seedlings. The goal is to increase sunlight levels on the white pine seedlings while maintaining or improving dominant tree growth. In time, increased sunlight levels should stimulate seedling growth and create mid-

story habitat.

Choose areas where white pine seedlings are abundant and unwanted vegetation (barberry) has been controlled. Maintain a 100 foot no-disturbance buffer around the perimeter of the two main wetlands within the Unit. If treatment sites are isolated from hiking trails and other attractions, consider girdling targeted trees instead of felling. Standing dead trees may provide nesting sites and feeding opportunities for birds and small mammals. To avoid creating potential hazards, fell target trees that are located near hiking trails or other attractions.

3. Monitor forest health in Unit 7 on a seasonal basis.
4. Consider constructing interpretive signs along hiking trails and cultural attractions. Consider involving/developing local non-profit and educational groups with an interest in forest ecology, wildlife habitat, bird watching or cultural history.

Management Unit 8: White Pine

30.5 acres

Overstory

Maturing white pine trees are dominant and excessive in Unit 8. Possibly derived from old field seeding, this Unit is overstocked with approximately 125 sqft of white pine basal area. Red oak, white oak, red maple and chestnut oak are found in small numbers throughout the Unit. Trace amounts of beech, black cherry and scarlet oak are also represented.

Approximately **126 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **43 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. **Cull** trees account for **9 sqft** of basal area per acre. Total basal area per acre is estimated at **178 sqft** with approximately **288 trees per acre**. This stocking is considered fully stocked according to Leak and Lamson revised stocking guidelines for unmanaged white pine.



Table 14: Unit 8 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
white pine	125	177	11	86.6	2,640	9,295.8	283.52
northern red oak	21	32	11	18.4	560	227.7	6.94
white oak	15	24	11	10.7	325	452.1	13.79
red maple	9	31	7	5.3	161	-	-
chestnut oak	4	8	9	2.6	81	51.3	1.56
beech	1	6	6	0.6	17	-	-
black cherry	1	6	6	0.4	12	-	-
scarlet oak	1	4	8	0.8	24	-	-
Stand Total	178	288	11	125.3	3,821	10,026.8	305.82

Understory and Ground Level

The density of white pine trees in Unit 8 casts heavy shade on the forest floor, preventing understory growth. White pine seedlings are numerous in small patches. Highbush blueberry and scattered Japanese barberry bushes can be found within the Unit.

Species	Seedling	1" Sapling	Stand Total
white pine	2,500		2,500
Stand Total	2,500		2,500

Table 15 Unit 8 Regeneration Summary

Forest Health

Forest health risks include:

- a. **Forest Pests**—White pine weevil poses a threat to the future timber value of white pine saplings. An endemic pest in Pennsylvania, the weevil destroys the terminal leader young white pine trees. In absence of a terminal leader, lateral branches bend upward in competition for sunlight and apical dominance, resulting in forked or multi-stemmed trees.
- b. **Invasive Species**—The presence of “pioneering” invasive species and abundance of invasive species in adjacent stands (primarily Japanese barberry), presents an additional threat to the successful regeneration of future forests on the site.

Soils

According to the Soil Survey of Cumberland County, Laidig very stony loam soil and Buchanan gravelly loam soils are the predominant soil types in Unit 8. Site index ratings for red oak, sugar maple or white pine have not been recorded for Buchanan soil types. Laidig soils have a site index rating of 80 feet for sugar maple and 90 feet for white pine.

Wildlife Habitat

Dense conifers growth provides escape cover and nesting habitat for songbirds and small mammals. Large white pine trees are often chosen for nesting sites by red tailed and red shouldered hawks, great horned owls, barred owls, ravens and even bald eagles. Raccoons are known to use white pines as daytime resting sites. White pine seeds are eaten by many songbirds including red-breasted nuthatches, black capped chickadees, pine warblers, white-breasted nuthatches and pine siskins.

Eastern chipmunks, white-footed mice, and red squirrels are known to utilize white pine seeds as well.

Special Features

Hydrology: Two intermittent streams drain eastwardly through Unit 8 towards Mountain Creek. Unit 8 borders the riparian corridor of Mountain Creek.

Cultural: Unit 8 bares the scars of past land use. GIS digital elevation model (DEM) analysis reveals moderate levels of terraforming in the Unit. General geometric shapes resembling farm fields or graded earth can be seen with hill-shade algorithms. It is likely that this Unit was once used for agriculture or recreational purposes during the Mount Holly resort era. *See Hillshade Map.*

Management Unit 8 Recommendations

1. Spot treat invasive species within Unit 8 while numbers are manageable. Consider systemic herbicide applications in coordination with treatments in adjacent stands. Control treatments in Unit 8 should be mid-level in priority ranking next to control treatments in more ecological unstable Units. Heavy shade from the dense white pine canopy will slow the development of barberry thickets.
2. Under ideal conditions, maturing white pine in Unit 8 could be thinned for stand growth. Given the patches of abundant white pine seedlings, group selection or other uneven-aged management practices could be prescribed to create habitat and increase diversity (size and age). Current conditions are not ideal in adjacent Units. Prioritize invasive species control efforts and mid-story development in adjacent Units (7, 13). Reevaluate Unit 8 in 5-10 years to assess the potential for uneven- aged management or other silvicultural treatments.
3. Monitor forest health conditions in Unit 8 seasonally. Identify and track invasive species locations and treatments using GIS database. Monitor mature white pine trees for hawk, owl or eagle nesting sites.

Management Unit 9: Sassafras

4.2 acres

Overstory

This tiny Unit located near the southeast base of Mount Holly on the near the southern property boundary is mainly composed of large sassafras trees. Large diameter sassafras trees account for a whopping 140 sqft of basal area per acre in Unit. Red maple is also represented, though less impressive.



Approximately **155 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **70 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. **Cull** trees account for **15 sqft** of basal area per acre. Total basal area per acre is estimated at **155 sqft** with approximately **265 trees per acre**. This stocking is considered well overstocked for optimal timber growth with an estimated stocking percentage above 110%.

Table 16: Unit 9 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
sassafras	140	144	13	84.0	353	4,286.9	18.01
red maple	15	121	5	7.5	32	-	-
Stand Total	155	265	10	91.5	384	4,286.9	18.01

Understory and Ground Level

Understory species include sassafras, Japanese barberry, native grasses and grape vine.

Species	Seedling	Stand Total
sassafras	1,000	1,000
Stand Total	1,000	1,000

Forest Health
n/a

Table 17 Unit 9 Regeneration Summary

Soils

According to the Soil Survey of Cumberland County, Hazleton channery sandy loam soils are found Unit 9. Site index ratings for red oak, sugar maple or white pine have not been recorded for this soil type.

Wildlife Habitat

Sassafras foliage is eaten by several caterpillars including swallowtail butterfly and promethea silkmoth. Fruits are fed on by numerous bird species including turkey, pileated woodpeckers, red-eyed vireos and gray catbirds. White-tailed deer and cottontail rabbits feed on new shoots and twigs.

Special Features

Cultural: The remains of a large earthen kiln once used for charcoal production is located within the Unit.

Management Unit 9 Recommendations

1. Unit 9 is largely insignificant compared to other Units on the property however, the large diameter and height of sassafras trees in this Unit are not replicated anywhere else on the property. It is somewhat rare to find so many sassafras trees of such diameter and height. Large sassafras trees are said to exist along ravines and stream corridors of central and southern Pennsylvania. More commonly, sassafras trees are found along field edges and poorly stocked upland dry-oak forests where they frequently reach a diameter no more than 12".
2. The large earthen kiln site in Unit 9 could be highlighted as a stop for visitors interested in cultural history of the region. The large sassafras trees may serve as an added attraction to the site. Consider extended hiking trails to this location and constructing interpretive signs or web-based applications.



Management Unit 10: Dry Oak – White Pine 21 acres

Overstory

Close in resemblance to Management Unit 5, this Unit contains one transitional dry oak stand. The Unit is stocked with small sawtimber and pole sized chestnut oak, white pine, red oak, white oak, black oak, scarlet oak and red maple trees. Other hardwoods including yellow poplar, black gum, black cherry, white ash and sassafras are also represented.

Approximately **73 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **63 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. **Cull** trees account for **9 sqft** of basal area per acre. Total basal area per acre is estimated at **144 sqft** with approximately **394 trees per acre**. This stocking is considered overstocked for optimal timber growth by Gingrich and Roach stocking guides for oak.

Table 18: Unit 10 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.
Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
chestnut oak	31	88	8	21.9	461	56.7	1.19
white pine	27	56	9	18.3	383	1,878.4	39.45
northern red oak	26	40	11	20.5	431	411.1	8.63
red maple	20	65	7	13.9	291	-	-
white oak	10	48	6	6.0	127	-	-
black oak	9	19	9	6.9	145	-	-
scarlet oak	9	11	12	7.1	149	56.7	1.19
sassafras	4	31	5	1.5	32	-	-
black gum	3	24	5	1.2	25	-	-
black cherry	3	4	12	1.5	32	-	-
yellow poplar	1	1	16	0.8	18	162.2	3.41
white ash	1	7	6	0.7	14	-	-
Stand Total	144	394	8	100.3	2,107	2,565.2	53.87

Understory and Ground Level

The understory of Unit 10 is largely devoid of shrubs and small trees. White pine saplings and poles are found in small numbers along with Japanese barberry and *vaccinium* species.

Species	Seedling	1" Sapling	Stand Total
white pine	714		714
Stand Total	714	-	714

Table 19 Unit 10 Regeneration Summary

Forest Health

Forest health risks include:

- Forest Pests** –White pine weevil poses a threat to the future timber value of white pine saplings. An endemic pest in Pennsylvania, the weevil destroys the terminal leader young white pine trees. In absence of a terminal leader, lateral branches bend upward in competition for sunlight and apical dominance,

resulting in forked or multi- stemmed trees.

- b. **Forest Pests** – Gypsy moth, two-lined chestnut borer and forest tent caterpillar are three main forest pest threats to dry oak heath communities in the region. No signs of infestation or pending outbreak were observed during the field inventory. Future monitoring for potential outbreaks is recommended.
- c. **Forest Pathogens** – Armellaria (shoestring rot) and chestnut blight are three common fungal pathogens that persist in dry oak communities. No severe impacts from listed pathogens is anticipated following the field inventory.
- d. **Invasive Species** –The presence of “pioneering” invasive species and abundance of invasive species in adjacent stands (primarily Japanese barberry), presents an additional threat to the successful regeneration of future forests on the site.

Soils

According to the Soil Survey of Cumberland County, Laidig very stony loam soil and Clymer very stony loam soils are the predominant soil types in Unit 10. Site index ratings for red oak, sugar maple or white pine have not been recorded for Clymer soil types. Laidig soils have a site index rating of 80 feet for sugar maple and 90 feet for white pine.

Wildlife Habitat

Much like Unit 7, the combination of oak mast production and conifer cover provides habitat for a variety of songbirds, small mammals and game species.

Special Features

Hydrology: One intermittent streams drain southeastwardly through Unit 10 towards Mountain Creek.

Cultural: Unit 10 may have been cleared for agricultural or recreational use during the resort era.

A significant roadbed now used for hiking winds through the eastern and southern portions of Unit 10. This roadbed is evident on aerial photography of the property dating back to 1958. It is likely that this roadbed was constructed in the early 1900s or perhaps even earlier.



Management Unit 10 Recommendations

1. Current conditions in Unit 10 are relatively stable. The lack of adequate hardwood seedlings poses a threat to future forest development if a catastrophic event should occur (major defoliation/mortality, wind damage, etc.). Current conditions in Unit 10 may persist with relatively little change over the next 10 years. If silvicultural treatments are unfavorable due to aesthetics or other reason, do nothing to the overstory of Unit 10 and reevaluate in 10 years.
2. Spot treat invasive species within Unit 10 while numbers are manageable. Consider systemic herbicide applications in coordination with control treatments in adjacent Stands (5, 6, 7, and 13). Use a backpack sprayer for spot treatments late in the growing season. *See Unit 1 treatment recommendations page 39.*
3. For more active management based on silviculture, consider a silvicultural thinning across all diameter classes in Unit 10. A thinning of this type would remove 1/4-1/3 of the basal area, targeting weak, damaged, diseased or poorly formed trees that crowd healthy trees of desirable species. Favor oak, black cherry, yellow poplar and white pine trees exhibiting good form and crown structure. Target poor quality red maple, black gum and white pine for removal. Retain live and dead trees with cavities for wildlife when possible.

A harvest of this kind is a preliminary step in stand management. If adequate levels of hardwood and conifer seedlings were established, regeneration harvest could be staged at this time. However, due to the lack of seedlings and potential for creating conditions favorable to invasive species, a thinning of this kind would benefit maturing high quality trees and extend the rotation of the Stand. It is intended to foster growth and seed production of residual stocking. It is not intended for stand regeneration however established seedlings may benefit from increased light levels. Consider monitoring seedling development before and after the harvest.

Commercial viability of a thinning harvest may be marginal. If a thinning is scheduled, consider combining the thinning in Unit 10 with the proposed commercial thinning in Unit 5 and crop tree release in Unit 6 to increase marketability. Access to Units 5, 6 & 10 is a limiting factor.

Prior to thinning, spot treatment of Japanese barberry and other pioneering invasive species should be undertaken to reduce the risk of spread after the harvest.

4. Monitor forest health conditions in Unit 10 seasonally. Identify and track invasive species locations and treatments using GIS database. Monitor mature white pine trees for hawk, owl or eagle nesting sites.

Management Unit 11: White Pine – Northern Hardwoods 18 acres

Overstory

Unit 11 is stocked with maturing white pine, red maple, red oak, yellow poplar and chestnut oak trees. Lesser amounts of white ash, black cherry, black gum, aspen, white oak, hemlock, black birch, locust and scarlet oak trees are found within the Unit.

Approximately **109 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **35 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. **Cull** trees account for **13 sqft** of basal area per acre. Total basal area per acre is estimated at **156 sqft** with approximately **284 trees per acre**. This stocking is considered overstocked for optimal timber growth by Gingrich and Roach stocking guides oak and northern hardwood stocking guidelines.

Table 20: Unit 11 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.
Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
white pine	78	103	12	46.4	834	5,996.0	107.93
red maple	18	55	8	11.1	199	102.9	1.85
northern red oak	16	23	11	13.2	237	302.9	5.45
yellow poplar	10	21	9	6.3	114	694.1	12.49
chestnut oak	9	15	10	7.0	127	-	-
white ash	5	18	7	2.9	52	233.1	4.20
black cherry	5	14	8	2.8	50	51.3	0.92
black gum	4	7	10	3.0	54	-	-
aspen	3	3	12	2.0	37	-	-
white oak	3	15	6	1.5	27	86.5	1.56
hemlock	3	1	24	2.4	42	294.8	5.31
black birch	3	3	13	2.0	37	49.6	0.89
locust	1	6	6	0.4	7	-	-
scarlet oak	1	1	16	1.2	22	-	-
Stand Total	156	284	10	102.1	1,838	7,811.3	140.60

Understory and Ground Level

An understory layer stocked with spicebush, witch hazel and greenbrier is developing in the northern reaches of Unit 11. Japanese barberry is also found in some areas. Hardwood seedlings are largely absent however white pine seedlings are numerous in clusters.

Species	Seedling	1" Sapling	Stand Total
white pine	2,375		2,375
Stand Total	2,375	-	2,375

Table 21 Unit 11 Regeneration Summary

Forest Health

Forest health risks include:

- Forest Pests** –White pine weevil poses a threat to the future timber value of white pine saplings. An

endemic pest in Pennsylvania, the weevil destroys the terminal leader young white pine trees. In absence of a terminal leader, lateral branches bend upward in competition for sunlight and apical dominance, resulting in forked or multi- stemmed trees.

- b. **Invasive Species** –The presence of “pioneering” invasive species and abundance of invasive species in adjacent stands (primarily Japanese barberry), presents an additional threat to the successful regeneration of future forests on the site.

Soils

According to the Soil Survey of Cumberland County, Laidig very stony loam, Clymer very stony loam, Buchanan gravelly loam and Monongahela silt loam soils are the predominant soil types in Unit 11. Site index ratings for red oak, sugar maple or white pine have not been recorded for Clymer or Buchanan soil types. Laidig soils have a site index rating of 80 feet for sugar maple and 90 feet for white pine. Monongahela soils are rated 72 feet for white pine.

Wildlife Habitat

In addition to overstory mast production and conifer cover, understory shrubs including spicebush, witch hazel and greenbrier provide food and structural habitat for many songbirds and small mammals. Gray catbirds, hermit thrushes, and brown thrashers feed and nest in greenbrier thickets. As do cottontail rabbits. White-tailed deer favor tender shoots of greenbrier in spring.

Special Features

Hydrology: Unit 11 borders the red maple forested wetland and tussock – shrub wetland complex along Mountain Creek.

Cultural: Springs trail (green) snakes through Unit 11 from along the Mountain Creek corridor. This trail may be a relic from the resort era of the late 1800s and early 1900s.

Management Unit 11 Recommendations

1. Current conditions in Unit 11 are relatively stable. White pine seedlings are established and positioned for release following natural disturbance events. The lack of hardwood seedlings threatens to narrow the diversity of overstory tree species should a catastrophic canopy disturbance occur. Native understory growth is encouraging within the Unit. Spicebush, witch hazel and greenbrier are more prevalent here than in many other places on the property. Consider reevaluating Unit 11 in 5-10 years for hardwood seedlings and overstory stocking.
2. Spot treat invasive species within Unit 11 while numbers are manageable. Spot treat with systemic herbicides (glyphosate) during the growing season (backpack or mistblower application) or as recent studies suggest (see Ward and Williams, 2011) consider basal treatments applied during the dormant season to minimize risk of herbicide exposure to desirable herbs. Using a backpack sprayer, the latter method may be most suitable for seasonally wet sensitive sites.

Identify invasive species treatment areas and track treatment progress using GPS and GIS database. Repeated treatments will likely be necessary to achieve control. Spatial project management through GIS systems will facilitate budgeting for treatments and provide an archive of land use.

3. Monitor forest health conditions in Unit 11 seasonally. Identify and track invasive species locations and treatments using GIS database. Monitor mature white pine trees for hawk, owl or eagle nesting sites.

Management Unit 12: Exotic Species 14 acres

Overstory

Unit 12 occupies a gentle fold in the southeastern slopes of Mount Holly. The overstory composition of this Unit is composed of ailanthus, paulownia (princess tree), black gum, black oak and chestnut oak. Red oak, sassafras and red maple trees and small poles are also found on site.

Approximately **10 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **53 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. Exotic invasive trees account for many UGS calls. **Cull** trees account for **5 sqft** of basal area per acre. Total basal area per acre is estimated at **68 sqft** with approximately **269 trees per acre**. Under general stocking guidelines for northern hardwood stands and oak stands, Unit 12 would be considered fully stocked however with exclusion of the basal area and trees per acre totals from invasive species, the stocking would be considered understocked.

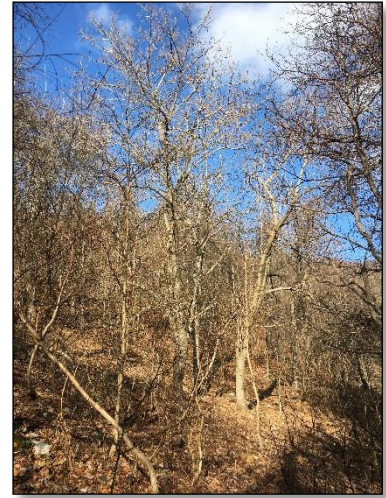


Table 22: Unit 12 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
ailanthus	18	61	7	7.6	106	-	-
black gum	15	55	7	8.5	119	-	-
scarlet oak	8	22	8	5.0	70	-	-
black oak	8	14	10	5.6	78	99.2	1.39
chestnut oak	8	23	8	5.0	70	-	-
northern red oak	5	31	5	3.6	50	-	-
sassafras	5	57	4	1.7	24	-	-
red maple	3	5	10	1.5	21	-	-
Stand Total	68	269	7	38.5	540	99.2	1.39

Understory and Ground Level

Unit 12 derived from abandoned open land. Canopy closure has not occurred throughout the Unit. Grape, native grasses, hay-scented fern, Japanese barberry, and ailanthus root shoots are found in the understory. Some red oak and red maple seedlings are also established at ground level.

Species	Seedling	1" Sapling	Stand Total
Red oak	250	-	250
		-	
Stand Total	250	-	250

Table 23 Unit 12 Regeneration Summary

Forest Health

Forest health risks include:

- a. **Invasive Species** –Unit 12 is dominated by unwanted exotic species. The Unit may present a hazard to adjacent stands.

Soils

According to the Soil Survey of Cumberland County, Hazleton channery loam soils are found within Unit 12. Site index ratings for red oak, sugar maple or white pine have not been recorded for Hazleton soil types.

Wildlife Habitat

Grape and relic apple trees may provide soft mast for songbirds, game birds, small mammals and white-tailed deer. Few oak trees large enough to produce bumper acorn crops. Paulownia and ailanthus trees are of little value to regional wildlife.

Special Features

Hydrology: Unit 12 may form the headwaters of one of the two intermittent streams which flow through the southern portion of the property towards Mountain Creek. Surface flow may not be apparent within Unit 12 spring and run-off water may flow in channels under areas containing heavy surface rock.

Cultural: The remains of two large earthen charcoal kilns are found along the main hiking/old skid trail on the northwest side of the Unit.

Management Unit 12 Recommendations

1. Unit 12 is stocked with large, seed producing ailanthus and paulownia trees. Japanese barberry and other unwanted species exist in the understory. **Eradication of ailanthus and paulownia trees in Unit 12 is a high priority.** These unwanted crop trees will aid the spread of invasive species across the property, especially towards stands downhill.

Target ailanthus and paulownia trees for eradication. Consider using stem injections of systemic herbicides late in the growing season. Use of the fungal biocontrol agent (*Verticillium nonalfalfae*) may also be considered for ailanthus treatments however, careful monitoring and following treatments should be scheduled to ensure control agents achieve desirable results. Foliar or basal applications of systemic herbicide should be scheduled for Japanese barberry and other unwanted vegetation as well. Eradication of paulownia, ailanthus and barberry from the Unit will likely necessitate multiple chemical or biocontrol applications. *See Unit 1 treatment recommendations page 39.*

2. Following control treatments of unwanted vegetation, supplemental seedling planting should be considered to try and establish desirable species in the restored growing space. Due to heavy stone

content in Unit 12's soil, field scouting will be required to identify areas within the Unit most suitable to seedling planting. Consider planting a mix of 2 or 3 year old chestnut oak, red oak, scarlet oak, and white oak seedlings along with white pine or pitch pine seedlings (if available), and mountain holly, American holly or serviceberry. Plant seedlings at a rate of 200-300 per acre in early Spring when ground conditions permit. Given tough site conditions, seedling survival may be less than 60%.

Seedling cost at this rate may range from \$300 - \$800 per acre depending on species. Planting equipment including planting bars and buckets for carrying seedlings may add \$60 per user. A planting this size is best attempted with volunteer or staff labor.

Refer to the document entitled "Forest Landowners Guide to Tree Planting Success" by Dave Jackson and Ruth Lunt, Penn State Extension, included in the enclosed CD, for more information.

3. Temporary fencing should be constructed around the planting sites. *See fencing recommendation from Unit 6, pages 46 and 47 for more information on fencing.*
4. Monitor tree of heaven trees for spotted lanternfly activity late in late summer and fall. Report any new lanternfly findings to Pennsylvania Department of Agriculture (PDA) email: badbug@pa.gov or call the Invasive Species Hotline at 1-866-253-7189 *See Appendices for more information*
5. Unit 12 is a good demonstration area for habitat restoration. Consider extending hiking trails to the site and constructing interpretive signage at the earthen kiln sites and areas overlooking invasive species eradication efforts. If biocontrol agents are used, consider additional signage on the use of biocontrol agents for *ailanthus* control.
6. Use GIS database systems to map and track treatment areas.

Management Unit 13: Red Maple - White Pine 6 acres

Overstory

Unit 13 is another priority treatment area for invasive species. Overstory trees include white pine, red maple and black cherry and red oak. Pole sized black locust, black oak and white oak are also found within the Unit.

Approximately **70 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **40 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. Exotic invasive trees account for many UGS calls. **Cull** trees account for **30 sqft** of basal area per acre. Total basal area per acre is estimated at **140 sqft** with approximately **232 trees per acre**. Under general stocking guidelines for white pine and northern hardwood stands, this would be considered fully stocked.

Table 24: Unit 13 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
white pine	60	104	10	36.5	219	4,931.2	29.59
red maple	30	51	10	20.0	120	552.4	3.31
black cherry	15	17	13	9.1	55	198.5	1.19
northern red oak	15	9	17	13.0	78	757.6	4.55
locust	10	40	7	3.5	21	-	-
black oak	5	5	14	4.8	29	-	-
white oak	5	6	12	4.0	24	-	-
Stand Total	140	232	11	90.9	545	6,439.6	38.64

Understory and Ground Level

Unit 13 is derived from abandoned open land. It appears the Unit may have been used for agricultural at one point in the past. Canopy closure has not occurred throughout the Unit. Japanese barberry has formed a dense thicket across much of the understory layer. The density of barberry has displace native saplings, shrubs and herbaceous plants.

Forest Health

Forest health risks include:

- Invasive Species** –Unit 13 is dominated by unwanted exotic species. The Unit may present a hazard to adjacent stands.

Soils

According to the Soil Survey of Cumberland County, Monongahela silt loam soils are the dominant soil type found within Unit 13. Monongahela soils have a site index rating of 72 for white pine.

Wildlife Habitat

Several large black cherry trees are found within Unit 13. Cherries provide soft mast utilized by numerous songbirds and small mammals. Even black bear are known to eat black cherry fruit.

Portions of Unit 13 appear to be seasonally wet and may have provided high quality – seasonally wet habitat prior to the establishment of Japanese barberry. The proximity of Unit 13 to Mountain Creek and ephemeral flows adds to the habitat value of the site.

Special Features

Hydrology: Unit 13 may contain seasonal wet areas or permanent wetland sites. The Unit is adjacent to the Mountain Creek Corridor and ephemeral streams.

Cultural: Unit 13 appears to have been used for agriculture in the past. Other land use activities dating from the resort era or later, may have help shape the species composition.

Management Unit 13 Recommendations

1. Along with Unit 12, Unit 13 is stocked with alarmingly high levels of unwanted invasive species. The relatively small size of Unit13 may make the eradication (or at least containment) of Japanese barberry feasible. Addressing Japanese barberry in Unit 13 should be a high priority.

Consider a mix of control treatments including: foliar applications of systemic herbicides (glyphosate) formulated for aquatic environments and applied late in the growing season, basal applications of systemic herbicide during the dormant period, manual removal and possibly even heat treatments. The latter two treatments performed prior to late season herbicide application. *See Unit 1 treatment recommendations, page 39.*

Repeated treatments will be necessary to reduce the density of barberry plants within the Unit. Planning and budgeting should reflect 3-4 years of treatments.

2. Once barberry is controlled or reduced, consider supplemental planting of conifer, hardwood and shrub seedlings to occupy the growing space and deter the reestablishment of barberry and other unwanted vegetation. Consider a mix of conifer seedlings including hemlock, white pine, larch and red spruce. Hardwood seedlings including black cherry, alder species, redosier or gray dogwood could be considered for diversity and habitat value. Plant seedlings in early Spring at a spacing of 200-300 per acre. *See Unit 12 planting recommendations pages 61 and 62.*
3. Unit 13 is a good demonstration area for habitat restoration. Consider constructing interpretive signage at areas overlooking invasive species eradication efforts.
4. Use GIS database systems to map and track treatment areas. Encourage public interaction through written log books and/or web based reporting applications.

Management Unit 14: Dry Oak – Mixed Hardwoods 8 acres

Overstory

Unit 14 is located on the north facing slopes of Mount Holly. This small Unit is largely composed of chestnut oak, black gum, red maple and red oak trees.

Approximately **30 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **80 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. Exotic invasive trees account for many UGS calls.

Cull trees account for **3 sqft** of basal area per acre. Total basal area per acre is estimated at **113 sqft** with approximately **535 trees per acre**. Unit 14 is fully stocked with excessive non-commercial sized black gum poles inflating the estimated number of trees per acre.

Table 25: Unit 14 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
chestnut oak	40	74	10	30.0	300	631.2	6.31
black gum	33	190	6	15.5	155	-	-
red maple	13	98	5	6.5	65	-	-
northern red oak	13	42	8	8.8	88	-	-
sassafras	10	115	4	3.5	35	-	-
black cherry	3	17	6	1.5	15	-	-
Stand Total	113	535	6	65.8	658	631.2	6.31

Understory and Ground Level

Unit 14 resembles dry oak heath and other dry oak – mixed hardwood

Units on the property. Mountain laurel and witch hazel are found in the

understory but at levels that are likely not interfering with seedling establishment. Chestnut oak seedlings are found in clusters.

Species	Seedling	Stand Total
chestnut oak	667	667
Stand Total	667	667

Table 26 Unit 14 Regeneration Summary

Forest Health

Forest health risks include:

- Forest Pests** – Gypsy moth, two-lined chestnut borer and forest tent caterpillar are three main forest pest threats to dry oak heath communities in the region. No signs of infestation or pending outbreak were observed during the field inventory. Future monitoring for potential outbreaks is recommended.
- Forest Pathogens** – Armellaria (shoestring rot) and chestnut blight are three common fungal pathogens that persist in dry oak communities. No severe impacts from listed pathogens is anticipated following the field inventory.

Soils

According to the Soil Survey of Cumberland County, Hazleton channery sandy loam and Clymer very stony loam soils are found within Unit 15. High rock content and shallow soil depth limit the vegetative productivity of these soils. Site index ratings for red oak, sugar maple or white pine have not been recorded for these soil types. While water availability and rock content may limit growth rates, these soils are generally suited for woodland and recreation use.

Wildlife Habitat

A member of the white oak group, chestnut oak are capable of producing acorns on an annual basis. Some research suggests acorns from the white oak group are favored by white-tailed deer and other mast consuming wildlife species.

Special Features

n/a

Management Unit 14 Recommendations

1. Unit 14 is relatively stable. Aggressive management activities are not warranted at this time. Consider reserving Unit 14. Reevaluate in 5-10 years.
2. Consider reposting/maintaining the property boundary line along the northern edge of Unit 14.

Management Unit 15: Dry Oak – Heath 9 acres

Overstory

Unit 15 is composed of several forested parcels located along the north facing slopes of the property. These areas are divided by the utility right-of-way, Ridge Road and the main access road to the property. Forest cover is composed of maturing red oak, black birch, red maple, chestnut oak and hemlock trees.

Approximately **87 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **60 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. Exotic invasive trees account for many UGS calls. Total basal area per acre is estimated at **147 sqft** with approximately **169 trees per acre**. Unit 15 is considered overstocked for optimal timber growth by Gingrich and Roach stocking guidelines.

Table 27: Unit 15 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
northern red oak	67	41	17	56.3	507	4,898.5	44.09
black birch	50	86	10	37.5	337	137.7	1.24
red maple	10	15	11	8.0	72	-	-
chestnut oak	10	9	14	9.1	82	274.5	2.47
black gum	3	4	12	3.4	30	-	-
hemlock	3	10	8	1.9	17	-	-
locust	3	4	12	2.8	25	-	-
Stand Total	147	169	13	118.9	1,070	5,310.8	47.80

Understory and Ground Level

Unit 15 is largely devoid of seedlings and saplings in the understory. A small amount of striped maple is established near the western property line (in the small northern tip). Suppressed hemlock trees in the understory provide some vertical structure.

Forest Health

Forest health risks include:

- Forest Pests** – Gypsy moth, two-lined chestnut borer and forest tent caterpillar are three main forest pest threats to dry oak heath communities in the region. No signs of infestation or pending outbreak were observed during the field inventory. Future monitoring for potential outbreaks is recommended.
- Forest Pests** – Hemlock woolly adelgid and elongate hemlock scale are two pest threatening the health and survival of hemlock trees in Pennsylvania.
- Forest Pathogens** – Armellaria (shoestring rot) and chestnut blight are three common fungal pathogens that persist in dry oak communities. No severe impacts from listed pathogens is anticipated following the

field inventory.

Soils

According to the Soil Survey of Cumberland County, Hazleton channery sandy loam soils are found within Unit 15. High rock content and shallow soil depth limit the vegetative productivity of these soils. Site index ratings for red oak, sugar maple or white pine have not been recorded for these soil types. While water availability and rock content may limit growth rates, these soils are generally suited for woodland and recreation use.

Wildlife Habitat

Large and mature red oak and chestnut oak found in Unit 15 are capable of producing large crops of acorns. Mid-story hemlock and black gum trees provide vertical structure and nesting sites for songbirds and small mammals.

Special Features

N/A

Management Unit 15 Recommendations

1. Monitor forest health including signs and symptoms of insect pests and pathogens and the spread of invasive species.
2. Retain forest cover in Unit 15 as an aesthetic buffer.
3. Consider reposting/maintaining the western property line.

Management Unit 16: Dry Oak – Mixed Hardwoods**14.7 acres****Overstory**

Unit 16 is located along the east side of the railroad tracks and Mountain Creek. Maturing red oak, white pine, white oak, scarlet oak and red maple are dominant in the overstory. Chestnut oak and sassafras are also represented across the stand.

Approximately **87 sqft** of basal area per acre is considered **acceptable growing stock (AGS)**. **60 sqft** of basal area per acre is considered **unacceptable growing stock (UGS)**. Exotic invasive trees account for many UGS calls. Total basal area per acre is estimated at **147 sqft** with approximately **266 trees per acre**. Unit 16 is considered overstocked for optimal timber growth by Gingrich and Roach stocking guidelines.

Table 28: Unit 16 Summary Table.

Basal Area expressed in square feet per acre. QMD: Quadratic Mean Diameter, Tons per Acre includes topwood, pallet, pulp and firewood.

Bd Ft/Acre: Board Feet per Acre, MBF: Thousand Board Feet

Species	Basal Area	Trees/ Acre	QMD	Tons/ Acre	Total Tons	Bd Ft/ Acre	Total MBF
northern red oak	45	35	15	37.5	551	2,672.1	39.28
white pine	42	102	9	26.5	390	1,422.6	20.91
white oak	30	58	10	23.4	344	617.2	9.07
scarlet oak	17	17	14	14.1	207	651.9	9.58
red maple	10	33	7	6.3	93	-	-
chestnut oak	2	2	12	1.4	21	-	-
sassafras	2	19	4	0.6	9	-	-
Stand Total	147	266	10	109.8	1,614	5,363.7	78.85

Understory and Ground Level

White pine and red maple seedlings and saplings are developing in the understory of Unit 16. Some white pine saplings and small poles are reaching the mid-story level. Mountain laurel, witch hazel and huckleberry species are also found within the Unit.

Species	Seedling	1" Sapling	Stand Total
red maple	167		167
white pine	333	167	500
Stand Total	500		667

Table 29 Unit 16 Regeneration Summary**Forest Health**

Forest health risks include:

- Forest Pests** – Gypsy moth, two-lined chestnut borer and forest tent caterpillar are three main forest pest threats to dry oak heath communities in the region. No signs of infestation or pending outbreak were observed during the field inventory. Future monitoring for potential outbreaks is recommended.
- Forest Pathogens** – Armellaria (shoestring rot) and chestnut blight are three common fungal pathogens that persist in dry oak communities. No severe impacts from listed pathogens is anticipated following the field inventory.

Soils

According to the Soil Survey of Cumberland County, Laidig very stony loam soils are the predominant soil types in Unit 16. Laidig soils have a site index rating of 80 feet for sugar maple and 90 feet for white pine.

Wildlife Habitat

Many wildlife species rely on acorns for autumn forage. Large white pine trees are often chosen for nesting sites by red tailed and red shouldered hawks, great horned owls, barred owls, ravens and even bald eagles. Raccoons are known to use white pines as daytime resting sites. White pine seeds are eaten by many songbirds including red-breasted nuthatches, black capped chickadees, pine warblers, white-breasted nuthatches and pine siskins. Eastern chipmunks, white-footed mice, and red squirrels are known to utilize white pine seeds as well.

Special Features

Cultural – Unit 16 is located adjacent to the railroad tracks along Mount Creek.

Management Unit 16 Recommendations

1. Monitor forest health including signs and symptoms of insect pests and pathogens and the spread of invasive species.
2. Retain forest cover in Unit 16 as an aesthetic buffer between the State Road and the Mountain Creek corridor.
3. Consider reposting/maintaining the property line.

Wetlands and Non – Forested Areas

Wetlands 67 acres

Overview

Approximately 67 acres of the Mount Holly marsh preserve property have been identified by the US Fish and Wildlife Service National Wetland Inventory (NWI). These areas include red maple forested wetlands, shrub herbaceous wetlands, tussock sedge wetlands and open water (ponds and rivers). Much of the lowland acres found along Mountain Creek fall within these categories.

Forested wetlands along the riparian corridor contain pole and small sawtimber sized red maple, white ash, black gum, hemlock, basswood and red oak. Red maple is most dominant on the west side of Mountain Creek while the species composition on the east side is more diverse. Understory species in these areas include: witch hazel, spicebush, hornbeam, Japanese barberry, and grape. Japanese barberry is colonizing streambanks and drier sites, forming thickets and displacing native vegetation. Herbaceous and tussock sedge wetlands occupy sites within the stream corridor and former lake. These areas are less accessible on foot and may contain bog turtle habitat.



Wetland Management Recommendations

1. Employ protective “no disturbance” buffers of at least 100 feet around the central herbaceous and tussock sedge wetlands. A “minimum disturbance” buffer of 200 feet could be instituted from the 100ft buffer boundary. A total of 300 feet of disturbance buffer could help protect sensitive habitat. Follow **Best Management Practices** to minimize impact of temporary necessary activity.
2. Japanese barberry thickets developing within riparian corridor and forested wetlands displace native vegetation and lower the habitat value of the sensitive sites. A cautious but committed control effort could be undertaken to reduce the impact of unwanted species and restore habitat value. Complete eradication of barberry will not be feasible however the reduction of quantity is possible. Consider the dormant season basal herbicide applications coupled with manual/mechanical cutting. Target thickets established in sunlit openings

first. Plan to plant native shrubs in place of treated barberry following control. Consider seedling mixes containing: alder species, black willow, hemlock, redosier dogwood, gray dogwood and/or elderberry. Use a spacing of at least 200-300 seedlings per acre. Tree tubes or fencing may be required to protect planted seedlings from deer though dead barberry shrubs may provide some protection if planting directly in treated thickets.

Utility Right-of-Way (ROW) 3.5 acres

Overview

A utility right-of-way cuts through the northeast corner of the property. This area is mainly stocked with native grasses and *vaccinium* species as trees and tall shrubs are routinely trimmed. Invasive species including Japanese barberry and ailanthus are also established on the ROW.

ROW Management Recommendations

1. Monitor the growth and development of invasive species established on the ROW. Consider spot treating ailanthus and barberry shrubs with systemic herbicide late in the growing season to eliminate the seed source.

Recommendation Summary

The following recommendation summary is categorized by management goal however many recommended activities are interrelated to several property goals. The enclosed management recommendation table summarizes recommended activities by priority and project sequence.

1. Wildlife Habitat:

- a. Unit 3 - Consider planting warm season grasses and/or native forbs on the old landing site and open areas to increase habitat diversity on the property and herbaceous forage for upland species. Plantings of this type may require machinery for tillage. Funding for upland habitat creation may be available through NRCS EQIP or similar programs.
- b. Unit 6 -To increase food availability for wildlife and potentially foster the establishment and growth of new seedlings, consider the crop tree release treatment for select trees.
- c. Unit 7 – Release patches of white pine seedlings to increase vertical structure in the understory.

2. Forest Health:

- 1) Invasive Species:
 - a. Unit 12 – Eradicate ailanthus and paulownia trees through systemic herbicide use and/or biocontrol agents. Control barberry and other exotics using systemic herbicide late in the growing season.
 - b. Unit 13– Begin Japanese barberry reduction treatments. Consider a mix of control treatments including: foliar applications of systemic herbicides (glyphosate) formulated for aquatic environments and applied late in the growing season, basal applications of systemic herbicide during the dormant period, manual removal and possibly even heat treatments.
 - c. Unit 1 -Eradicate ailanthus trees on central ridge top through systemic herbicide use and/or biocontrol agents. Control barberry and other exotics using systemic herbicide late in the growing season.
 - d. Unit 2 -Eradicate ailanthus trees on hiking trails through systemic herbicide use and/or biocontrol agents.
 - e. Continue invasive species control effort across the property
- 2) Monitoring:
 - a. Develop seasonal monitoring schedule for all Units. Utilize GIS database for recording location and notes on findings.
 - b. Develop a reporting system for visitors to report observations.

3. Water Quality:

- a. Institute 100 foot “no disturbance” buffers around wetlands and stream corridor to retain canopy cover and minimize disturbance in the understory.
- b. Follow Best Management Practices during all land use activities.

4. Sustainable Forest Management:

- a. Unit 5 and Unit 10 – Consider a silvicultural thinning across all diameter classes. A thinning of this type would remove 1/4-1/3 of the basal area, targeting weak, damaged, diseased or poorly form trees that crowd healthy trees of desirable species.
- b. Unit 6 – Consider a crop tree release targeting maturing red oak, chestnut oak, white oak and other hardwoods.
- c. Unit 12, 13, riparian zone, - Following control treatments of unwanted vegetation, supplemental seedling planting should be considered to try and establish desirable species in the restored growing space.

5. Recreational Use:

Unit 1- To increase recreational usage of the property, consider constructing a scenic viewing platform along the ridgetop access trail. Consider locating the viewing platform at one of the locations identified on the Scenic View Point Map. It will be necessary to fell a few hilltop trees to open up the view. Viewshed clearing could be combined with ailanthus control treatments. The platform could be elevated to increase viewing opportunities. Promote the overlook as a hiking destination.

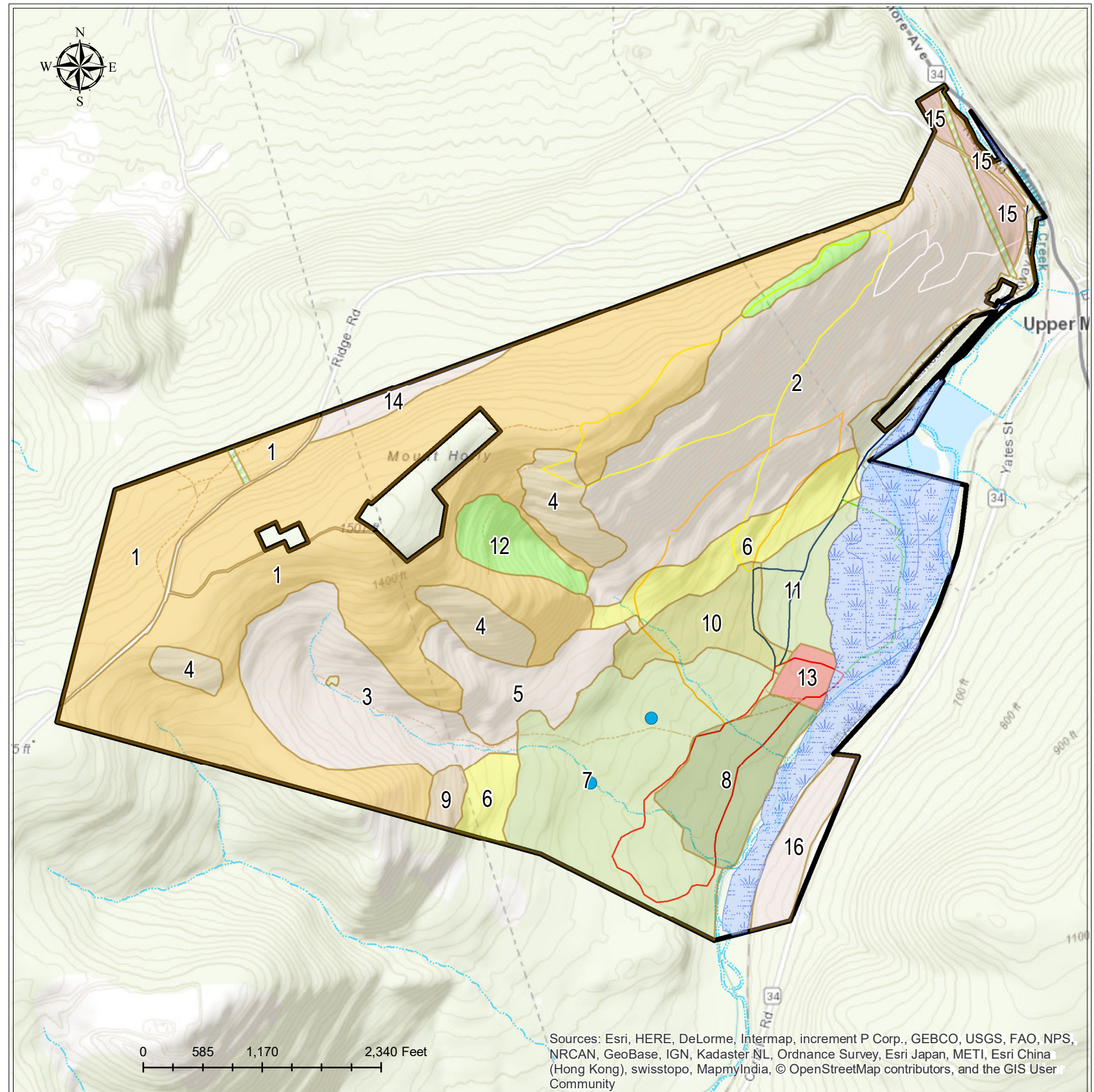
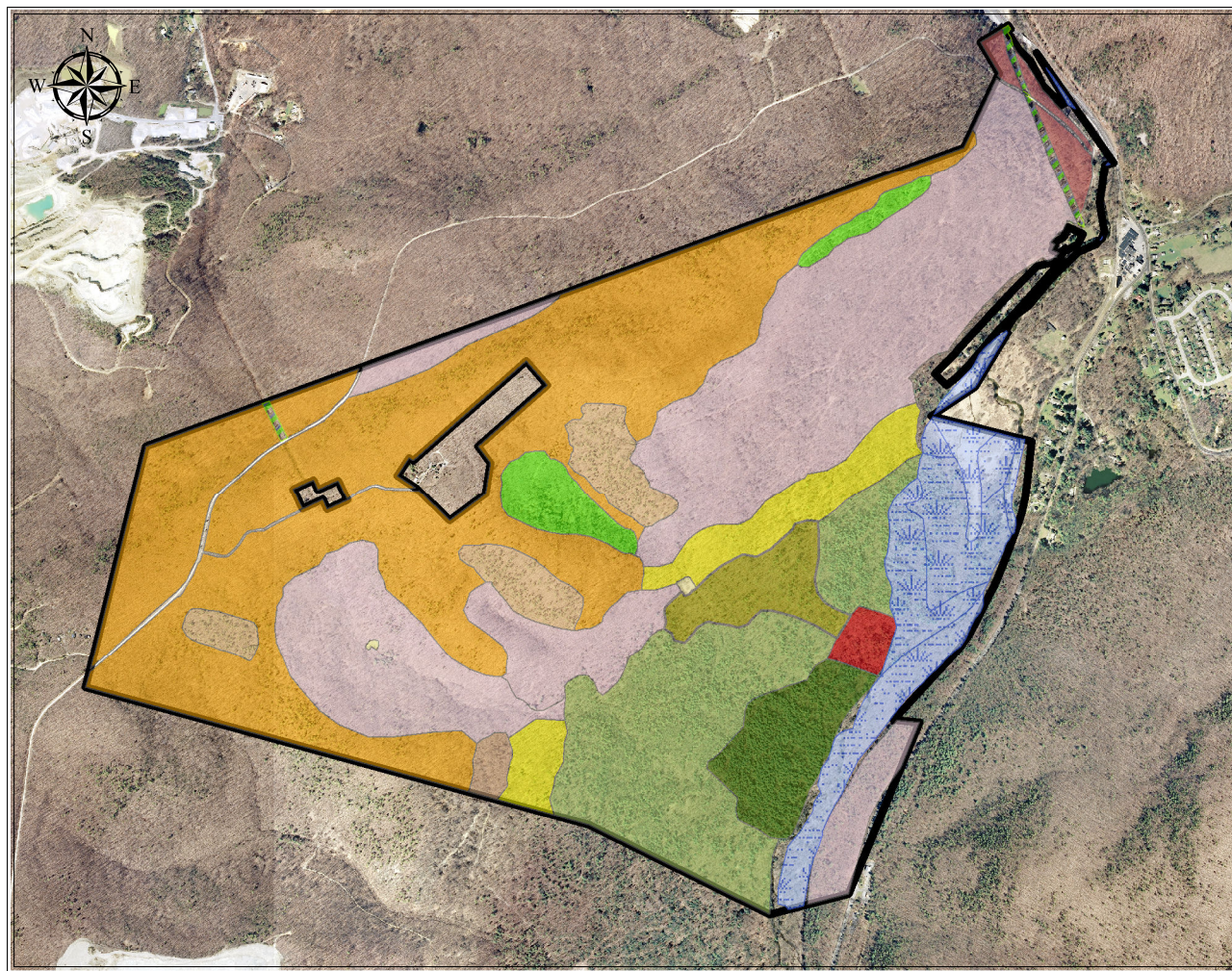
- 1) Unit 2, 3, 4, 7, 9, 10, 12, 13 Consider upgrading trails and adopting an aggressive trail maintenance schedule. Fell black birch and other poles growing on main hiking trails.
 - a. Construct new signage labeling trails and identifying unique features such as charcoal kiln sites.
 - b. Consider interpretive sign systems which integrate mobile device applications such as QR readers and GPS mapping.
 - c. Consider exploring the potential for annual outdoor training and endurance style competitions to promote the region and property usage.

6. Community/Stakeholder Engagement:

- a. Use DMAP program to increase potential for antlerless deer harvesting on the Mount Holly Marsh Preserve property. Engage local hunting community through educational events.
- b. Unit 2, 3, 4, 5, 7, 9, 10, 12, 13 -Encourage public interaction through written log books and/or web based

reporting applications.

- c. All Units - Consider involving/developing local non-profit and educational groups with an interest in forest ecology, wildlife habitat, bird watching or cultural history to conduct monitoring activities, hold interpretive events and assist with habitat improvement projects.
 - i. e.g. Trout Unlimited has expressed interest in helping with stream restoration
- d. Re-engage Holly Gap Committee to promote property events and fundraise for management activities.
- e. Organize a “Friends of the Preserve” type volunteer group to conduct monitor, boundary posting, trail maintenance and interpretive events.
- f. Engage local colleges and high schools for research and interpretive projects.



MOUNT HOLLY MARSH PRESERVE

MANAGEMENT UNIT MAP

Management Recommendation Priority Summary

The following table prioritizes numerous management recommendations for the Mount Holly Marsh Preserve Property. Numerous recommendations and suggestions for engaging the local community and developing public participation have not been included in the summary table. Though important, these recommendations may require long term growth and development. The table below prioritizes task oriented recommendations.

UNIT	RECOMMENDATION	PRIORITY RANKING
12	Begin invasive species control: target ailanthus, paulownia and barberry.	1
1	Control ailanthus off Yellow Ridge Trail	1
2	Control ailanthus on hiking trails	1
1	Institute 100' "no canopy disturbance" buffer around wetlands and stream corridor	1
12 & 13	Begin invasive species control	1
5 & 10	Consider a silvicultural thinning across all diameter classes	2
5 & 10	Consider deer fencing following thinning	2
6	Consider crop tree release in tandem with thinning in Unit 5	2
12 & 13	Plan supplemental planting follow invasive species control	2
12 & 1	Monitor existing ailanthus for spotted lantern fly	2
3	Warm season grass planting	3
7	White pine seedling release treatment	3
All	Develop seasonal schedule for forest health and maintenance monitoring	2
All	Consider enrollment in DMAP program	1

References

1. **Verry, Elon S., Hornbeck, James W. and Dolloff, C. Andrew.** *Riparian Management in Forests of the Continental Eastern United States*. London, New York, Washington D.C.: Lewis Publishers, 2000. ISBN 1-56670-501-0.
2. **Yahner, H. Richard.** *Eastern Deciduous Forest, Ecology and Wildlife Conservation*. Minneapolis : The University of Minnesota Press, 1995. ISBN 0-8166-2394-5.
3. *Restoring forest herb communities through landscape-level deer herd reductions: Is recovery limited by legacy effects?*
Royo, Alejandro A, et al. s.l. : Biological Conservation, 2010.
4. *Deer Carrying Capacity: Too Few, Too Many, and for Whom?* **McGuinness, Barbara.** s.l. : The Northern Logger and Timber Processor, 1997, Vol. 46.
5. *Forests too deer: Edge effects in Northern Wisconsin.* **Alverson, W. S., Waller, D. M. and Solheim, S. L.** s.l. : Conservation Biology, 1988.
6. **McShea, William J. and Rappole, John H.** *Herbivores and the Ecology of Forest Understory Birds. The Science of Overabundance, Deer Ecology and Population Management*. Smithsonian Institution Press : Washington and London, 1997.
7. *White-Tailed Deer Impact On the Vegetation Dynamics of a Northern Hardwood Forest.* **Horsley, Stephen B., Stout, Susan L. and deCalesta, David S.** 13, s.l. : The Ecological Society of America, 2003.
8. **Smith, David M., et al.** *The Practice of Silviculture, Applied Forest Ecology*. New York : John Wiley & Sons, Inc., 1997. ISBN 0-471-10941-X.
9. **Fergus, Chuck.** *Wildlife of Pennsylvania and the Northeast*. Mechanicsburg : STACKPOLE BOOKS, 2000. ISBN 978-0-8117-2899-7.
10. **Tiner, Ralph W.** *In Search of Swampland: A Wetland Sourcebook and Field Guide*: Rutgers University Press, 2005. ISBN-13: 978-0-8135-3681-1
11. **McComb, Brenda C.** *Wildlife Habitat Management: Concepts and Applications in Forestry*: CRC Press, 2008. ISBN - 979-0-8493-7489-0