FORECAST MANAGEMENT PLAN

Hawk Mountain Sanctuary

FOREST MANAGEMENT PLAN 2017

Prepared for:

Hawk Mountain Sanctuary

2415 acres

1700 Hawk Mountain Road
Kempton, PA 19529

West Brunswick, East Brunswick Townships – Schuylkill County
Albany Township - Berks County

Phone: 610-756-6961
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Prepared by:

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Certificate Holder: TNC Certified Resource Manager;
FSC Certificate Number: SW-FM/CoC-000238
Implemented: 2017
FSC Audited: 2017
Revised: TBD
Expiration: 2027

This plan was written to meet the standards of the Forest Stewardship Council (FSC) and excedes the requriements for approval through the USDA Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) Conservation Activities Plan (CAP 106).

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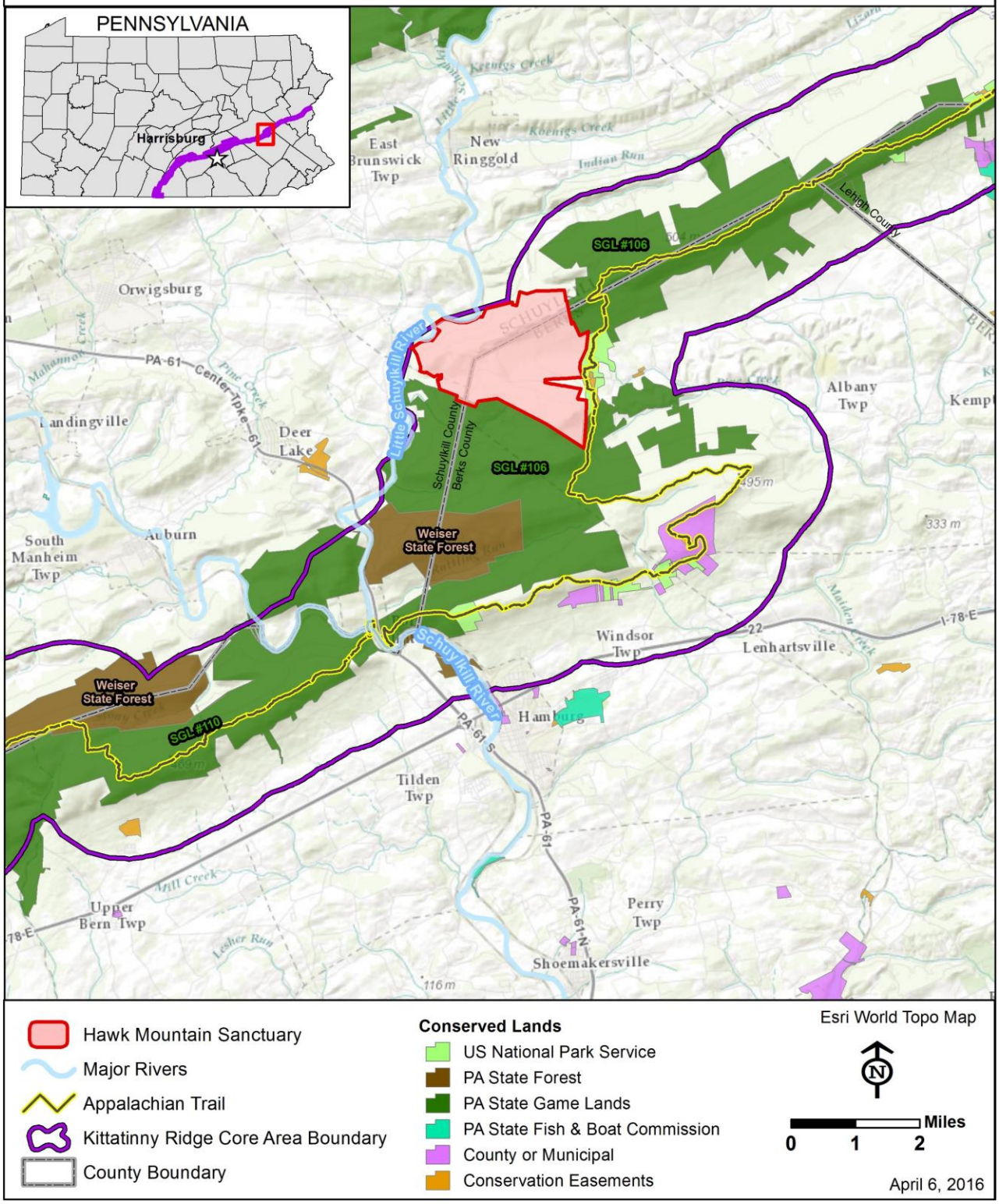
Schuylkill Gap-Kittatinny Ridge (Hawk Mountain Sanctuary)

Berks and Schuylkill Counties, PA



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Property Overview

Location

Hawk Mountain Sanctuary is located within the Kittatinny Ridge Corridor, a globally-recognized Important Bird Area for migratory raptors and songbirds and a Pennsylvania Important Mammal Area. The 2400-acre property is situated on the Blue Mountain, the 'first' or southernmost ridge in the Ridge and Valley Physiographic Province in Pennsylvania, just east of the water gap through which the Schuylkill River flows. The ownership encompasses portions of three townships and straddles the divide between Berks and Schuylkill counties. Its northwestern boundary adjoins segments of the Little Schuylkill River and its eastern boundary borders the scenic Appalachian Trail near the community of Eckville. In total, the property occupies nearly 4 square miles of private land nestled between two large tracts of public land in State Gamelands 106.

Directions from Harrisburg

To get to Hawk Mountain Sanctuary from Harrisburg, follow Interstate-81 N/US-322 East for approximately 2 miles. Keep left at the fork and continue on I-81 North for nearly 20 miles, following signs for I-78/Hazleton/Allentown. Use Exit 89 to merge onto Interstate-78 East toward Allentown and proceed 29 miles. Take Exit 29, onto Pennsylvania State Route 61 and travel North approximately 9 miles towards Pottsville before turning East onto PA-895. Proceed 2.5 miles and turn (Right) onto Hawk Mountain Road heading southeast for another 1.5 miles before turning (right) into Visitor Center parking area. Overall distance is 62 miles with a drive time of roughly an hour.

Property Access

Hawk Mountain Road serves as the primary access to the Sanctuary, its facilities, and trail heads. The road runs east to west with one-third of the property on south side of road. There are a limited number of secondary and tertiary roads or trails, that link the more remote and distant sections of the Sanctuary. For example, both the Blue Mountain Railroad right-of-way and Sawmill Lane, a dead end private road can be used to enter the western-most reaches of the Sanctuary. Similarly, the Scenic Appalachian Trail runs parallel to the Sanctuary's eastern boundary and can be used to quickly and more definitely navigate to the eastern portions of the ownership. Hawk Mountain maintains two one-lane access roads that are passable by four-wheel drive trucks, one accesses the eastern slope containing the River of Rocks and the other accesses the southern ridgetop forest and terminates at the rocky promontory named Owls Head.

Landscape Context

The regional landscape is highly fragmented due to its agricultural history and ongoing development pressure in the valley bottomlands. The Sanctuary however is within one of the largest blocks of contiguous forest in southeastern Pennsylvania. Adjoining public lands, including State Forest and Gamelands and National Park Service land, combined with the Sanctuary creates a large expanse of forest cover along the ridge of the Blue Mountain extending more than 15,000 acres. This forest provides important wildlife habitat through its size and biodiversity and protects the water quality of the Little Schuylkill River and its associated tributaries on west slopes. Sanctuary streams from the eastern slopes feed into the Pine Creek which drains into the Maidencreek River in Berks County, part of the Delaware River watershed.

The Sanctuary straddles the Kittatinny Ridge and contains several prominent rock-strewn lookouts that face to the north or east. Because more raptors use the Kittatinny Ridge during the fall migration than the other parallel ridges of the Appalachians, Hawk Mountain autumn migration counts regularly tally 18,000 to 20,000 each fall. More than 60,000 other birds also are spotted migrating along or above the sanctuary forest each fall as well. The Sanctuary's forested landscape provides important migration stopover areas

for many of the fall migrants using the Kittatinny Corridor and provides important breeding habitat for many forest-interior birds, mammals, amphibians and reptiles.

Ownership Context

Hawk Mountain is owned by the Hawk Mountain Sanctuary Association, a non-profit raptor conservation organization first established in 1934 and incorporated in 1938. The Association is governed by a Board of Directors.

Once the site of an annual raptor slaughter, the Sanctuary was initially leased and then subsequently purchased by Mrs. Charles Noel Edge in 1934 to protect the raptors as they migrate south each fall. Early conservation efforts of the Sanctuary focused on stopping the shooting of birds of prey along the ridge and throughout the region. Considerable time was spent educating the public about birds of prey, their migration biology, and integral role in the environment. Since then, the Sanctuary has become a world-renown raptor conservation science and education site which is visited by over 80,000 people each year and supported by 9,000 members throughout the world. Seventeen staff work with part-time staff, trainees and interns to pursue the Hawk Mountain mission in science and education, "*to conserve birds of prey worldwide by providing leadership in raptor conservation science and education, and by maintaining Hawk Mountain Sanctuary as a model observation, research and education facility".*

Land Use History

Before the turn of the century, much industrial activity took place on what is now Sanctuary lands. Excavation of sand for building purposes and for glass occurred from late 1800s through early 1900s. Originally the sand was carted to Drehersville. Later, about 1890, the area came into the ownership of the J.D. Stone Company. This company built a gravity railroad on the extremely steep north slope of the mountain to the mountain top. Cars were loaded and pushed through the cut to a level area at the head of the tracks where huge drums with steel cables stood. A blacksmith shop also stood nearby. The track ran to the Little Schuylkill River and railroad on bottom of north slope

During the late 1800s and early 1900's, most of Hawk Mountain's forest was logged or burned. White Pine and other large trees were selectively harvested for mine timbers while charcoal colliers created many mule trails into the forest to burn trees to make charcoal. Circular charcoal heaths are still visible occasionally amid the forest. The demise of the American chestnut (*Castanea dentata*) (which on average made up a third of the Eastern forest) in the early 20th century fostered the current dominance of oak species within the state and present-day Sanctuary. Despite several infestations by the introduced gypsy moth (*Lymantria dispar dispar*) over the last few decades, oak still dominates the upper forest canopy stratum.

Since the founding of the Sanctuary in 1934, it has been maintained as a relatively untouched preserve and allowed to regenerate and evolveafter the last sequences of human disturbance. Small openings and some building has occurred in small areas to accommodate visitation and other mission-based activities.

Although human influences have been minimized, the Sanctuary has experienced an array of stress factors and agents including native and non-native defoliating insects, pests and diseases, along with periodic drought conditions that have collectively resulted in overstory tree mortality. Furthermore, decades of high white-tailed (*Odocoileus virginianus*) deer populations have had a profound impact on understory plant diversity and have shifted species composition away from the traditional suite of species associated upland oak hardwoods. Although recent Sanctuary efforts to better manage deer populations have shown signs of improvement in forest health.

Management History

The following documents encompass past efforts to quantify ecosystem health and forest conditions within the Sanctuary along with corresponding recommendations produced to guide stewardship and conservation activities. These products were funded through a variety of state, federal, local, and private foundation grants and are now identified as historic Sanctuary plans. Information from these documents were used and referenced to inform this updated 2017 Forest Management Plan.

1. Hawk Mountain Long Range & Strategic Plans, 1997, 2005, and 2015 (draft)
2. 1998 Forest Stewardship Plan
3. December 2000 Land Management Plan
4. December 2000 Land Management Plan ATLAS
5. December 2000 Beyond the Sanctuary's Boundaries (adjoining lands conservation assessment)

To develop the 2000 management plan reports, sanctuary staff and partners inventoried and mapped many physical, biological, and cultural attributes of Hawk Mountain and surrounding areas. Bird communities, both wintering and breeding were mapped. Migrant birds were sampled in an array of habitats and elevations to gain understanding of habitat associations. Plant and forest communities were inventoried and mapped. Additionally, attempts were made to census and develop a comprehensive species list of many taxa groups, such as fungi, mosses, Lepidoptera, mammals, and amphibians that exist within the sanctuary. Historic records were also researched and incorporated, particularly for rare species. This body of work was developed to serve as a basis for developing management guidelines and for encouraging future inventory efforts to further the knowledge of Sanctuary and regional biodiversity. In addition, the sanctuary lookout vistas, which attract many of the annual visitors, had their primary, secondary and tertiary viewshed areas mapped and overlaid to create list of priorities for land conservation.

Protection

The late 1990's inventory and compilation of management plan documents created a new knowledge and concern for areas outside the Sanctuary boundaries that harbor or have potential to support important species and habitats along with concern that if developed, could seriously degrade the forest ecosystem (for adjoining properties) or the scenic views from the Sanctuary's scenic lookouts (for nearby properties). In response to these concerns, Hawk Mountain staff and partners developed a Land Protection & Conservation Policy that:

- defined the need to engage in land protection beyond the Sanctuary's borders
- recognized that partnerships with other conservation organizations would be required for success
- devised a three-part strategy to deal with 1.) land immediately around the Sanctuary 2.) lands within the viewsheds of the Sanctuary 3.) the Kittatinny Ridge/Blue Mountain Corridor

(refer to Appendix - Beyond the Boundaries report and Land Management Plan Atlas)

Adjacent Ownerships

The Blue Mountain (Kittatinny Ridge) is forest dominated but quickly transitions to agriculture and residential development in the nearby valleys and lowlands. A high percentage of Hawk Mountain Sanctuary is adjoined by heavily forested State Gamelands 106 that is open to public access. Other adjoining parcels are primarily private, non-industrial forest and farm lands of smaller acreages ranging from 2 to 250 acres in size.

Local Communities

Historically, this region of the state was known for its rural farming communities along with natural resource based employment opportunities associated with mining and lumbering. The nearest town/small community is the Borough of Hamburg, located 5 miles due south of the Sanctuary. As of the 2010 census, it has an estimated population of 4,300 people and is the home of the largest Cabela's store in the country, a prime indication of expanding road infrastructure and changing land use patterns. Since the early 1990's, both Schuylkill and Berks counties have been experiencing residential and commercial development pressures. County planners recognize Blue Mountain (Hawk Mountain) as important open space for recreational opportunities, watershed protection, and forest industry, therefore they utilize tools and programs, such as Clean and Green along with zoning designations (e.g., Agriculture Security Areas) to conserve and maintain these core areas. As part of their protection strategy, Hawk Mountain Sanctuary is participating in a local coalition of land conservation organizations to protect lands that contribute to the immediate viewshed of the Sanctuary along with broader statewide efforts to conserve the Kittatinny Ridge/Blue Mountain Corridor (refer to Appendix - Beyond the Boundaries report).

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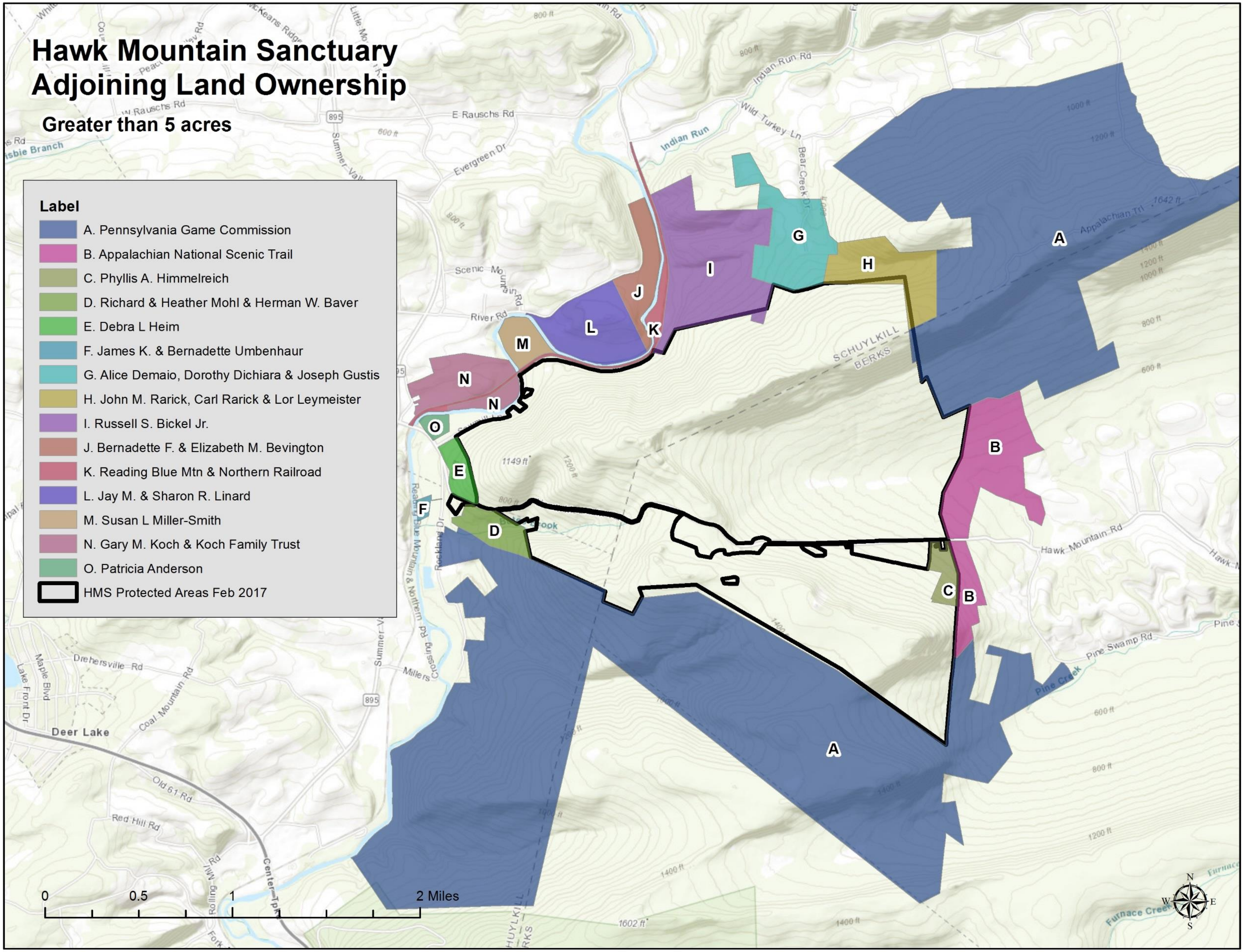

Hawk Mountain Sanctuary
Adjoining Land Ownership
Greater than 5 acres
Label
A. Pennsylvania Game Commission
B. Appalachian National Scenic Trail
C. Phyllis A. Himmelreich
D. Richard & Heather Mohl & Herman W. Baver
E. Debra L Heim
F. James K. & Bernadette Umbenhaur
G. Alice Demaio, Dorothy Dichiara & Joseph Gustis
H. John M. Rarick, Carl Rarick & Lor Leymeister
I. Russell S. Bickel Jr.
J. Bernadette F. & Elizabeth M. Bevington
K. Reading Blue Mtn & Northern Railroad
L. Jay M. & Sharon R. Linard
M. Susan L Miller-Smith
N. Gary M. Koch & Koch Family Trust
O. Patricia Anderson
HMS Protected Areas Feb 2017
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
0
0.5
1
2 Miles
Indian Run
Indian Run Rd
Wild Turkey Ln
E Rauschs Rd
W Rauschs Rd
Evergreen Dr
River Rd
Appalachian Trl
SCHUYLKILL
BERKS
Hawk Mountain Rd
Pine Swamp Rd
Pine Creek
Drehersville Rd
Coal Mountain Rd
Deer Lake
Old 61 Rd
Red Hill Rd
Furnace Creek
1149 ft
1642 ft
1602 ft

Indigenous Peoples and Historical and Cultural Resources of the Region

This region has a long and rich cultural history, from Native Americans to European Settlement, throughout the Age of Agriculture and the rise and fall of the Anthracite Industry and into the Contemporary Era. The historical events of the area have shaped both its landscape and its peoples. Hawk Mountain Sanctuary ownerships hold neither indigenous peoples' lands nor known sites of special cultural, ecological, economic, or religious significance to indigenous peoples.

The Pennsylvania Department of Transportation (Penn DOT) Bureau of Design's Cultural Resources Management Program works closely with other Federal and state agencies, local interest groups, preservation advocates, Native Americans, and the general public to ensure that its projects are designed to meet the transportation needs of the state and promote stewardship of our cultural heritage. Within Pennsylvania, there are 15 federally recognized Tribes who ascribe cultural significance to part of or all of the land within the Commonwealth. Therefore, Penn DOT has established a systematic approach that will be replicated in a similar manner by TNC to facilitate consultation with select Tribes when a project/management activity occurs on historic properties of religious or cultural significance.

The Nature Conservancy has established direct contact with Penn DOT regional archaeologists, who provide guidance in addressing additional questions or concerns relating to Native American site preservation and/or Tribal contacts.

A list tribes and additional relevant information is maintained at the Bureau of Indian Affairs website: www.doi.gov/bureau-indian-affairs as well as within the Penn DOT shared drive, under PENNDOT Shared/BEQ/Cultural Recources/Tribal Consultation/FHWA CD/ (refer to www.penndotcrm.org).

Approach

To adequately assess participating properties within Working Woodlands for known historical or archaeological sites, the Conservancy has applied for and been granted Planner Level access to the Culture Resource Geographic Information System (CRGIS) owned and operated by the PA Historical and Museum Commission Bureau for Historic Preservation (PHMC). The CRGIS is a three-tiered GIS program consisting of state-wide historic and geologic site data combined with Pennsylvania Natural Diversity Inventory (PNDI) information.

On June 9th, 2017 a formal letter was sent to eight tribal contacts identified through the CRGIS network to make them aware of the Hawk Mountain Sanctuary project and to solicit their response to identify any interest or concern associated with managing the properties.

Management Restrictions

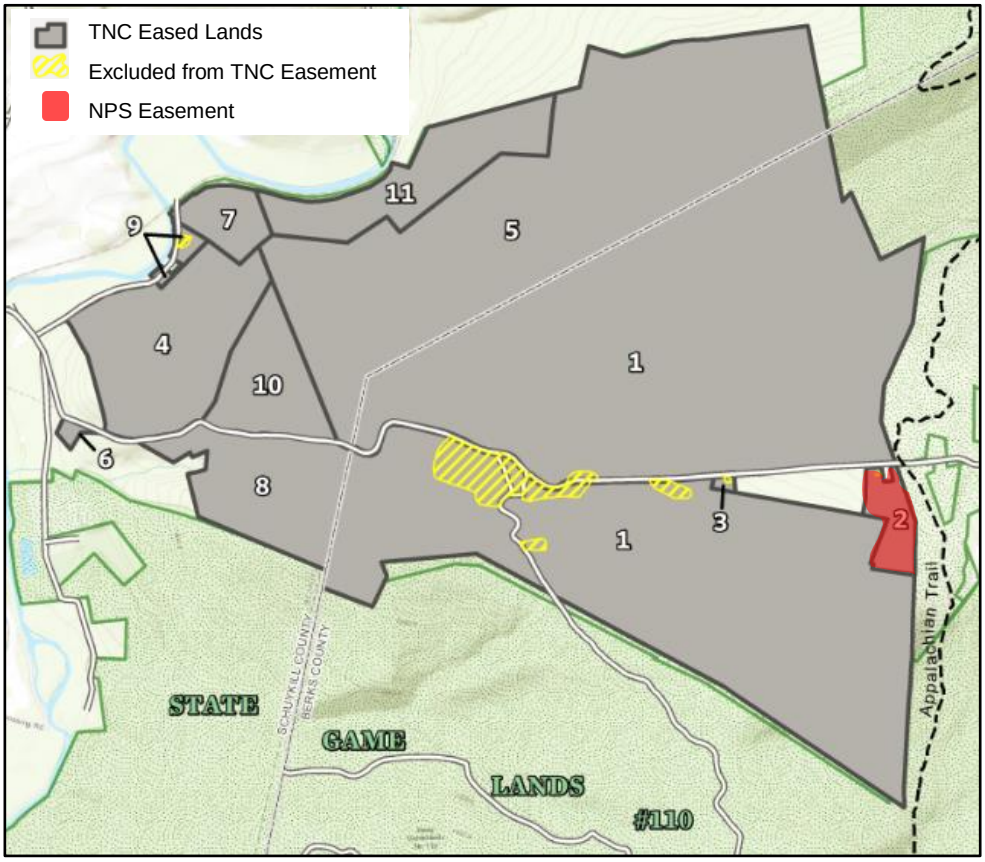
National Park Service Easement

Hawk Mountain Sanctuary granted a perpetual easement to the US Department of Interior National Park Service in 2016 that forever preserves the designated 25-acre parcel of land in its natural state to maintain the natural and scenic environment of the Appalachian National Scenic Trail.

These arrangements impose parameters whereby Hawk Mountain Sanctuary shall not use this parcel for any commercial purposes, enterprises, nor will any advertising of a commercial nature be permitted. Furthermore, no motorized equipment shall be used on the premises with the exception to repair or maintain existing facilities or road infrastructure. If there is a circumstance whereby vehicle use is required, Hawk Mountain staff must notify the Appalachian National Scenic Trail (Park Office) in writing at least 30 days in advanced of any planned activities.

To meet the intent of this agreement, the parcel shall be considered and zoned as a 'no-management area' while instituting the following guidelines:

- Extra care will be taken in planning, preparing, and conducting forestry activities that occur near this parcel to ensure the designated ground is not accidently impacted.
    - The existing parcel boundaries are well signed.
- Prior to implementing any forestry activities or operations within the Sanctuary that immediately adjoin the eased parcel, HMS staff will reinforce the boundary of the easement area with high-visibility flagging and perform periodic inspections to ensure no encroachments occur.
- If the eased parcel is accidently impacted, no corrective actions will be taken without first notifying the Park Office Staff.



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Forest management activities must comply with all relevant federal, state and local laws, regulations and ordinances.

Local Municipalities

Within both Schuylkill and Berks counties and their relevant townships, forestry and timber harvesting is defined as exempt from any restrictive ordinance and does not require permitting at the local level to practice management.

Pennsylvania State Laws

The following laws are relevant and influential to natural resources management:

- Department of Environmental Protections (DEP) Chapter 102 Erosion and Sediment Control Regulations
- DEP's Chapter 105 Dam Safety and Waterway Management Regulations
- Chapter 189, Road Bonding Regulations
- Right to Practice Forestry Act of 1992

Erosion and Sedimentation Control

Mandated by the State and enforced by county Conservation Districts, erosion and sedimentation control plans (E&S plans) are required for every proposed timber harvest. The plan should outline the extent of the proposed harvest, Best Management Practices (**BMPs)** and other erosion control measures to be implemented and additional information pertaining to post harvest site stabilization. Maps showing the harvest area, skid trail and log landing locations, topography and soils should be included with the plan. Signed copies of the plan must be maintained on site during the entirety of every timber harvest.

- **Local municipal ordinances often require official review and approval of E&S plans. Review local zoning and use restrictions prior to harvest commencement.**
- **Conservation District and PA Department of Environmental Protection (DEP) review and approval of E&S plans and stream crossing permit applications are required if a stream draining more than 100 acres will be crossed during a timber harvest.**
- **Signed E&S plans must be kept on site through the duration of timber harvesting activities.**

Best Management Practices

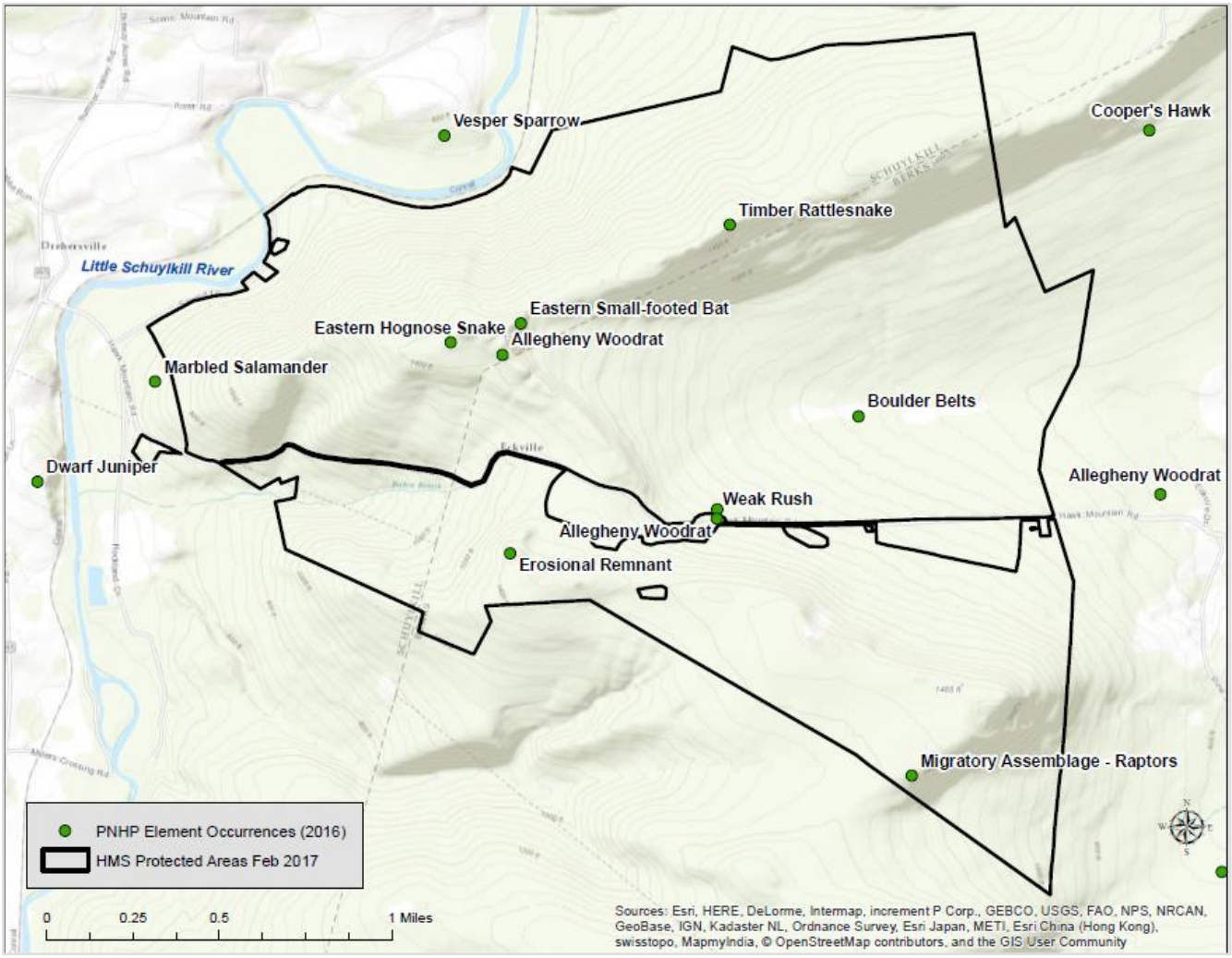
To protect sensitive water resources, **BMPs** were developed by the PA DEP, with contributions from County Conservation Districts, DCNR Bureau of Forestry, PA Game Commission and others. BMPs are intended to reduce erosion and sedimentation during and after timber harvests and other land use practices. Among the practices, buffer zones widths were established to help protect perennial streams, seeps, ponds and other wetlands.

- **Refer to the document entitled: "*Best Management Practices for Silvicultural Activities in Pennsylvania's Forest Wetlands, A Pocket Guide for Foresters, Loggers, and Other Forest Land Managers"*located in Appendix for information on State law, BMPs, buffers and other protective measures.**

Pennsylvania Natural Diversity Inventory (PNDI)

The Pennsylvania Natural Diversity Inventory is a project of the Pennsylvania Natural Heritage Program (PNHP). It is designed to record the approximate location and status of important ecological resources including: invertebrates, vertebrates, plants, natural communities and geologic features. PNHP offers users the ability to search their geographic location for records of important resource occurrences. Four government agencies hold jurisdiction over the protection of listed resources.

A search of the PNDI database revealed the following results:



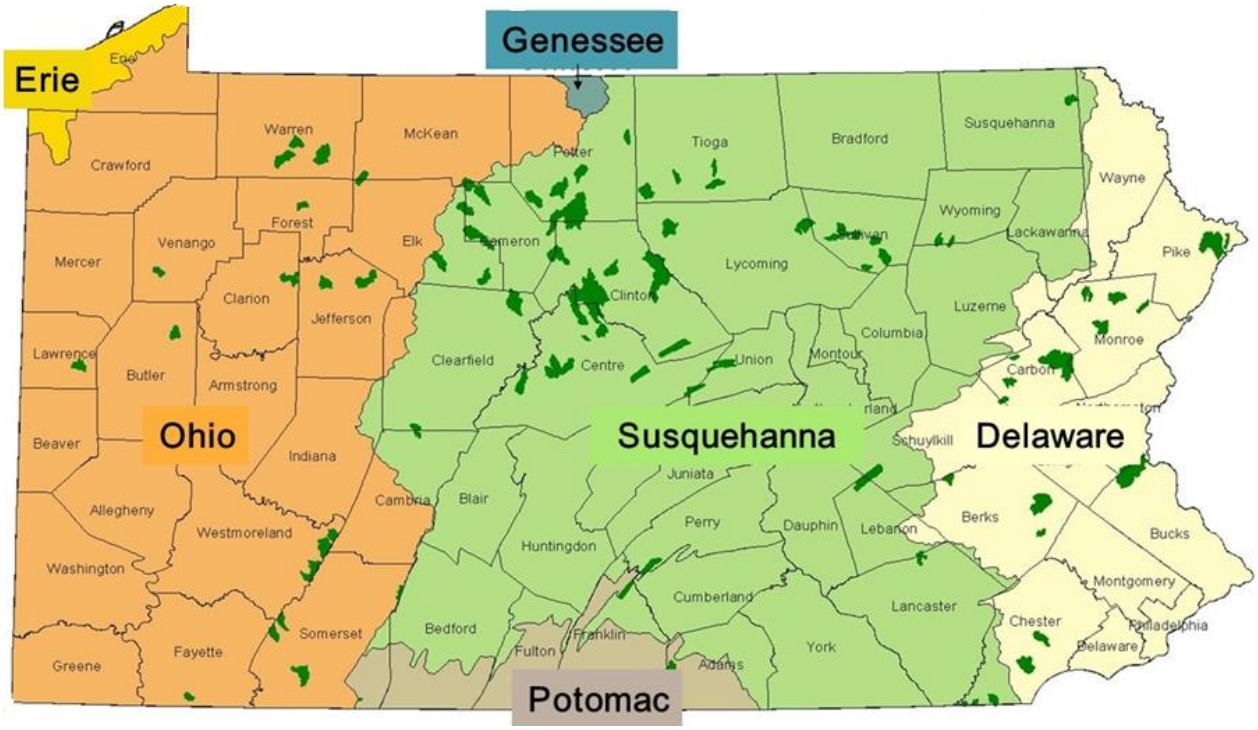
Scientific Name	Common Name	Global Rank	State Rank
Boulder Belts	Boulder Belts	GNR	SNR
Accipiter cooperii	Cooper's Hawk	G5	S4B,S5N
Myodes gapperi rupicola	Kittatiny Red-backed Vole	G5TSQ	SNR
Pooecetes gramineus	Vesper Sparrow	G5	S4B
Neotoma magister	Allegheny Woodrat	G3G$	S2
Juncus debilis	Weak Rush	G5	S3
Erosional remnant	Erosional Remnant	GNR	SNR
Juniperus communis var. depressa	Dwarf Juniper	G5T5	S1S2
Neotoma magister	Allegheny Woodrat	G3G4	S2
Neotoma magister	Allegheny Woodrat	G3G4	S2
Heterodon platirhinos	Eastern Hognose Snake	G5	S3S4
Myotis leibii	Eastern Small-footed Bat	G3	S2
Crotalus horridus	Timber Rattlesnake	G4	S3S4
Migratory Assemblage - Raptors	Migratory Assemblage - Raptors	GNR	SNR
Ambystoma opacum	Marbled Salamander	G5	S3

Prior to any forest management activities or operations, including vegetation management, prescribed fire, tree cutting, or trail or road building, any rare species or communities (G1-G3, S1-S3) within the Hawk Mountain Sanctuary ownership will be located and mapped.

- In advance of herbicide applications, tree cutting, trail or road building, and/or prescribed fire operations, staff will check the databases of the Pennsylvania Department of Conservation and Natural Resources (DCNR),Pennsylvania Game Commission (PGC), the Pennsylvania Fish and Boat Commission, Western Pennsylvania Conservancy (WPC), and the U.S. Fish and Wildlife Service by running a formal PNDI report inquiry to see if rare species or communities are likely to occur in stands proposed for treatment. Hawk Mountain internal biodiversity database maintained by conservation science staff also will be checked.

- If necessary upon unique circumstances, such as the findings of undocumented RTE's in the field, TNC will be contacted to assess their interest in contracting for surveys to more thoroughly assess such elements and develop necessary prescriptions or safeguards to protect the species or communities.

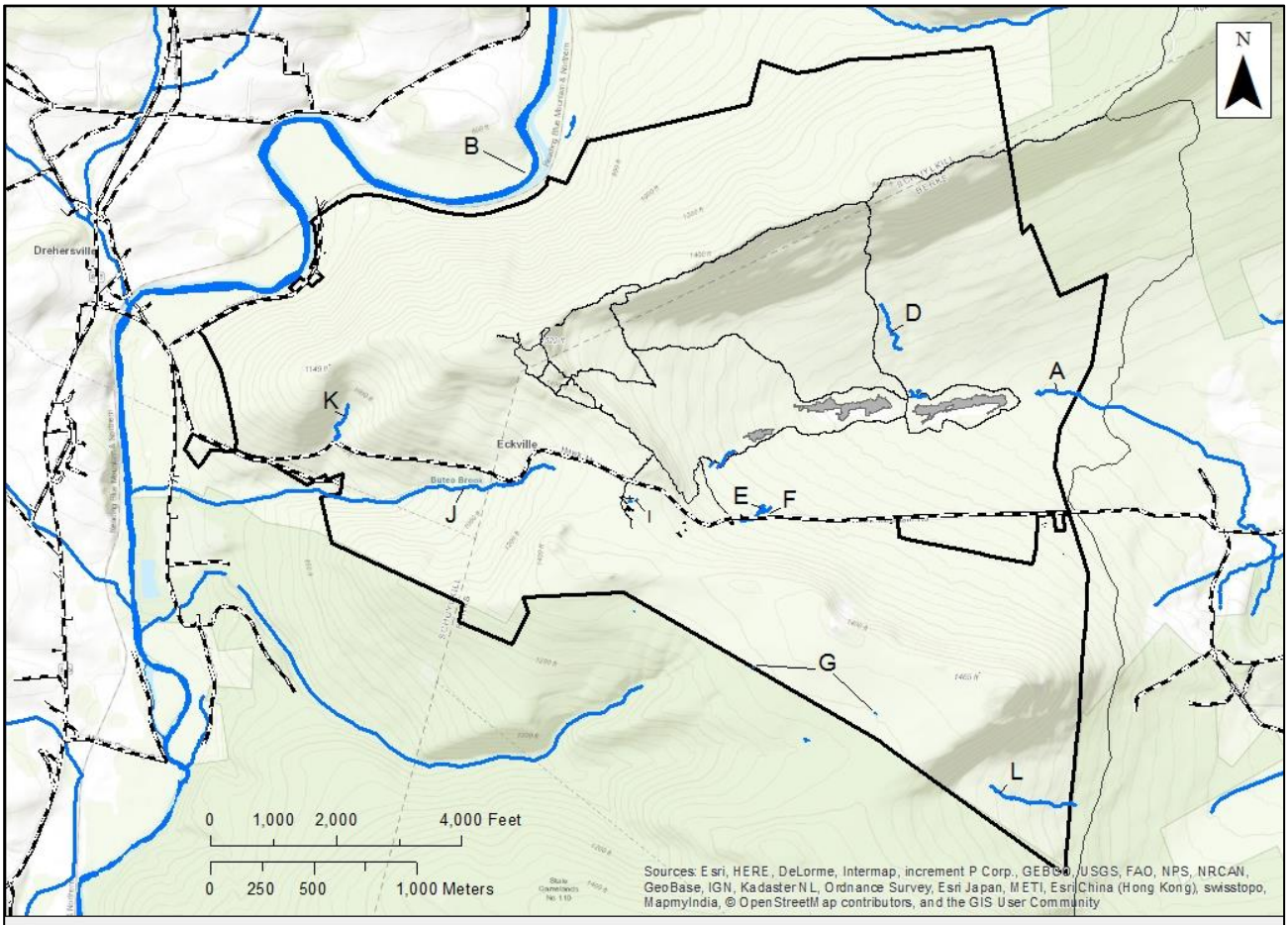
Water Resources



Six Primary Watersheds within Pennsylvania

Hawk Mountain Sanctuary is located within the Schuylkill River Watershed of the Delaware River Basin. The higher elevation ridges and steeper slopes of the Sanctuary drain into the Little Schuylkill River that flows nearby to the west. The interior, east-central sections of the Sanctuary flow into the Pine Creek that connects to the Maiden Creek. Both the Maiden Creek and the Little Schuylkill River flow into the historic Schuylkill River that meanders southeast through the heart of Philadelphia before emptying into the Delaware River.

Water resources within the Sanctuary are not abundant in terms of surface area, but they are sufficient in number and type to diversify the habitat and provide water for terrestrial animals and breeding sites for amphibians and aquatic insects.



Water Resources

ID	Feature Name	Description	Channel Width	Buffer Area
A	Kettle Creek River Rocks	Headwater boulders transitioning to pronounced surface flow	10 feet	6.4 acres
B	Little Schuylkill River	Perennial stream with diverse riparian areas	100 feet	4.0 acres
C	Unnamed Intermittent Stream 1	Distinguished channel located between River of Rocks and Hawk Mountain Road	2 feet	N/A
D	Unnamed Intermittent Stream 2	Distinguished channel located North of River of Rocks	2 feet	7.9 acres
E	Unnamed Intermittent Stream 3	Feeder stream into Schaumbach's Pond	2 feet	4.1 acres
F	Schaumbach's Pond	Productive pond but threatened by runoff from Hawk Mountain Road	2 feet	2.9 acres
G	Natural Ponds	Created by a combination of springs and small feeder streams	TBD	4.6 acres
H	Unnamed Intermittent Stream 4	Outlet to Natural Ponds	2 feet	N/A
I	Wetland Shrub Marsh	Moderate mesic site conditions		2.5 acres
J	Buteo Brook	Distinguished channel located in southwest corner of property	3 feet	N/A
K	Unnamed Intermittent Stream 5	Distinguished channel located on west side of property north of Hawk Mtn. Rd.	2 feet	6.5 acres
L	Unnamed Intermittent Stream 6	Distinguished channel located in the southwest corner of the property	2 feet	11.3 acres

Note: two small man-made ponds are located near Hawk Mountain Visitor Center but lie outside the easement area.

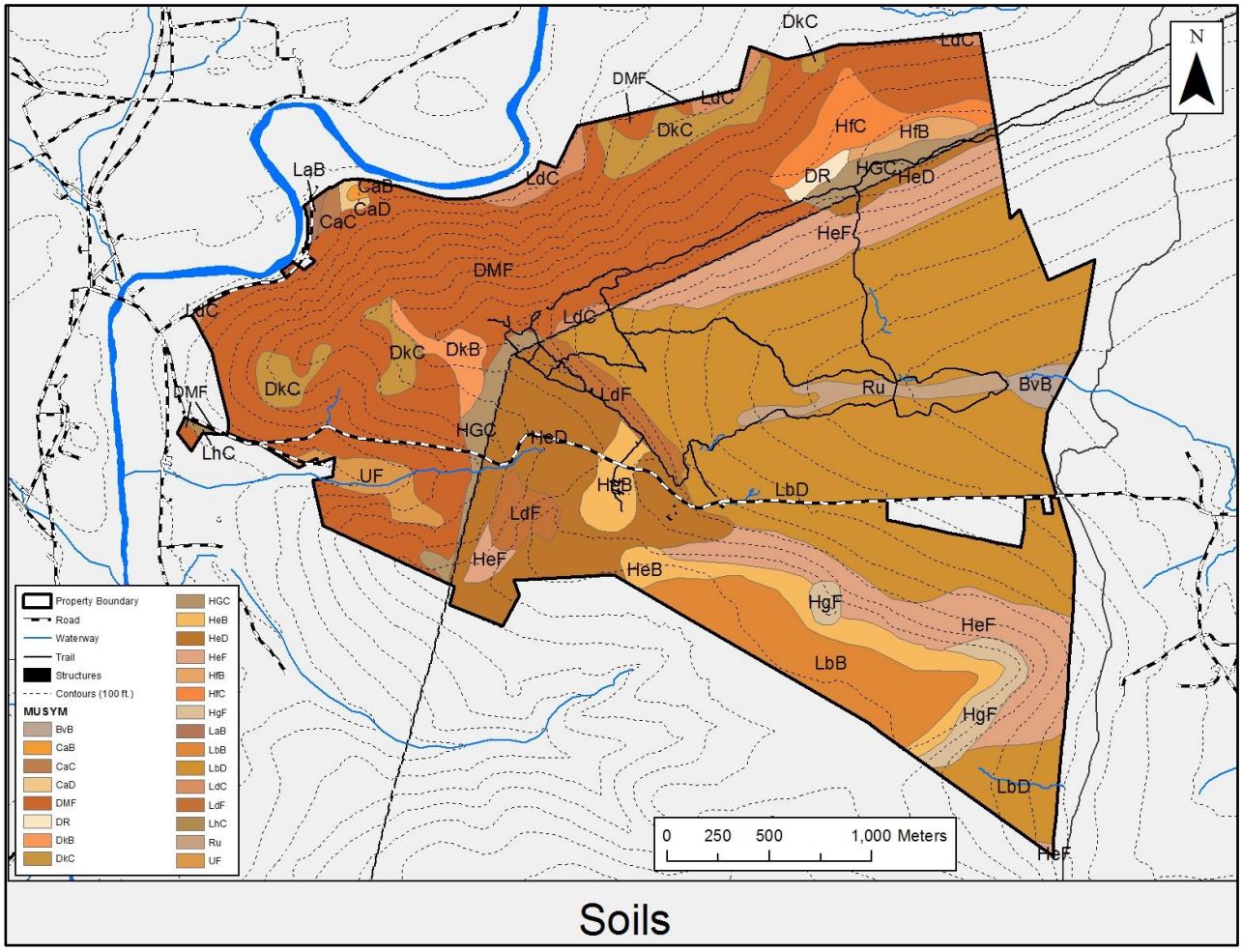
Stream-Side Management Protection

Although the property isn't formally zoned in a manner to recognize its water resources, HMS staff have embraced an approach to address riparian areas matching Municipal Water Authorities participating in Working Woodlands.

FSC US National SMZ management guidelines will be met or exceeded. A 50-foot Inner Zone and additional 100 foot Outer Zone (total 150 foot buffer) will be recognized along all surface water, including perennial and intermittent streams, ponds, etc., as mapped. These distances will be doubled (300 foot total buffer with a 100 foot Inner Zone and 200 foot Outer Zone) around both water supply reservoirs and along the main stem of major creeks and rivers. No harvesting will be pursued within the Inner Zone and harvesting in the Outer Zone will be limited to thinning to retain 60% or greater stocking. There will be no Regeneration Harvests within the Outer Zone. No roads or main skid trails will be located within the total buffer zone except where they approach stream crossings. Stream crossings will be designed and maintained according to BMP's to protect water quality and preserve stream function.

Buteo Brook, a primary tributary to the Little Schuylkill River, is a small 1.31-mile-long perennial stream that supports a naturally reproducing brook trout (*Salvelinus fontinalis*) population (refer to Appendix). The stream originates on Hawk Mountain and is highly susceptible to acid rain. Hawk Mountain Sanctuary owns and is responsible for 47% of the riparian habitat of the creek.

Soils



The main soil types found within the Hawk Mountain Sanctuary are common components of the Udorthents-Dekalb-Hazleton association (upper ridges) and Laidig-Buchanan-Andover association (lower slopes). The Dekalb and Hazleton association is formed from residual material on uplands and is underlain by sandstone and conglomerate.Laidig, Buchanan, and Clymer soils are minor members of the association and have the same general characteristics of Dekalb-Hazleton. Udorthents soils are the mixed overburden material derived from strip mining, of which is not found on Hawk Mountain. The Laidig-Buchanan-Andover found on the lower elevational slopes of Blue Mountain are derived from colluvium. This association exhibits deeper soils, a higher moisture retention capacity, and moderate natural fertility. Nevertheless, these soils are typically very stony, often with moderately slopes and areas of rubble; therefore, they are not recommended for cultivation.

Soil Composition Table

Soil Symbol	Soil Name	Slopes	Acreage	% Area
BvB	Buchanan Gravel Loam	0-8%	10	0.44
CaB	Calvin Shaly Silt Loam	3-8%	1	0.06
CaC	Calvin Shaly Silt Loam	8-15%	3	0.16
CaD	Calvin Shaly Silt Loam	15-25%	3	0.13
DkB	Dekalb Channery Sandy Loam	0-8%	19	0.80
DkC	Dekalb Channery Sandy Loam	8-25%	68	2.83
DMF	Dekalb and Lehew Extremely Stony, Steep	>40%	675	27.92
DR	Dekalb-Rubble Land Association	0-3%	7	0.29
HeB	Hazleton Very Channery Loam	0-8%	84	3.5
HeD	Hazlelton Very Channery Loam	8-25%	188	7.76
HeF	Hazleton Very Channery Loam	25-60%	225	9.32
HfB	Hazleton Extremely Stony Fine Sandy Loam	3-8%	13	0.54
HfC	Hazleton Extremely Stony Fine Sandy Loam	8-25%	44	1.82
HGC	Hazleton-Clymer Association, Sloping	3-8%	48	1.99
HgF	Hazleton-Rubble Land Complex	25-60%	34	1.41
LaB	Laidig Gravelly Loam	3-8%	3	0.14
LbB	Laidig Very Gravelly Loam	0-8%	113	4.66
LbD	Laidig Very Gravelly Loam	8-25%	753	31.06
LdC	Laidig Extremely Stony Loam	8-25%	29	1.20
LdF	Laidig-Rubble Land Complex	25-55%	44	1.82
LhC	Lehew Extremely Stony Loam	8-25%	1	0.06
RU	Rubble Land	0-3%	25	1.04
UF	Udifluvents, Gravelly	0-3%	25	1.05
Total			2415	100

Soil Protection

BMPs 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.

Approach

Before any commercial timber harvesting occurs, soils within the treatment area will be visually assessed to check the compatibility of the soils for operations. Attributes that will be checked include the development of the landings and skid/haul roads for suitability and erosion potential. Harvest equipment operability will also be checked for tire and track based machinery. The ratings given in each survey are based on an interpretation of slope, rock fragments on or below the surface, plasticity index, content of sand, depth to a water table and ponding in the soils present. Some soils may be considered "seasonal soils" which means only during certain times of the year when conditions are appropriate, that they will allow for harvesting on with minimal disturbance and damage. Some examples include during the winter months when soils are frozen or during the summer months when soils are bone dry. Best Management Practices (BMP'S) will also be used to minimize environmental impact.

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 and control invasive plant intrusions
- Limit land use operations on sensitive sites 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 woodchip or other mulch material on well used foot trails to reduce compaction and erosion and replant trails or work areas with Hawk Mountain native forest vegetation after harvest operation.
- Plant annual grasses, sedges and other hydrophytic vegetation in open culvert washes to help filter periodic surface flow

Topography

Within this section of the Ridge and Valley Region, elevations gradients vary widely, from as low as 200 feet above sea level in the southern portions of the Schuylkill River watershed near Schuylkill Haven and Port Clinton, to above 1,800 feet along the ridgetops within the northeastern corner of Schuylkill County.

The average elevation throughout Hawk Mountain Sanctuary is approximately 1,025 feet above sea level. The lowest elevational point is approximately 500 feet where Hawk Mountain Road fronts against the Sanctuary's west-central boundary. The highest elevational points reaching slightly over 1,500 feet corresponding with the multiple scenic lookouts that include Sunset Lookout, Owls Head, and the North Lookout. Overall, the terrain is quite variable ranging from relatively flat and rolling within the central and east-central portions of the property and along its many ridgetops to becoming moderately steep to very steep throughout the northern and western-most sections of the Sanctuary.

Scenic Vistas and their unique Geology

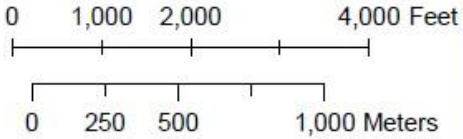
The Hawk Mountain area provides highly scenic views of the Blue Mountain and Great Valley sections of the Ridge and Valley physiographic province. The mountain is underlain by the resistance Shawangunk Formation sandstone. Several outstanding geologic features are present on the grounds of Hawk Mountain Sanctuary, including North Lookout, South Lookout, Cobble, River of Rocks, Hemlock Heights, and Owls Head. Rough outcrops and angular blocks of hard quartz sandstone dominate the ridgelines. The rocks are broken pieces and bedrock protrusions of the sharply folded and faulted Shawangunk Formation. These erosion-resistant rocks stand above the surrounding countryside, and their outcrop pattern reflects their folded structure beneath the ground. North Lookout is 1,520 feet in elevation, and from here one can see a span of almost 80 miles from the west-southwest to the northeast. South Lookout provides views to the east-northeast and of the Great Valley to the east as far as New Jersey. From South Lookout, a boulder field known as River of Rocks can be seen in the center of the eastern slope. The boulders moved downward from the ridges under periglacial conditions. River of Rocks is segmented into three separate patches of open fields, which together extend about a mile and cover several hundred feet in width. The large boulders overlay a creek which drains to the east.

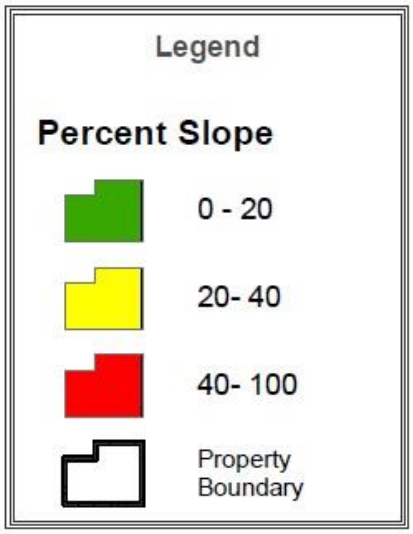
Approach

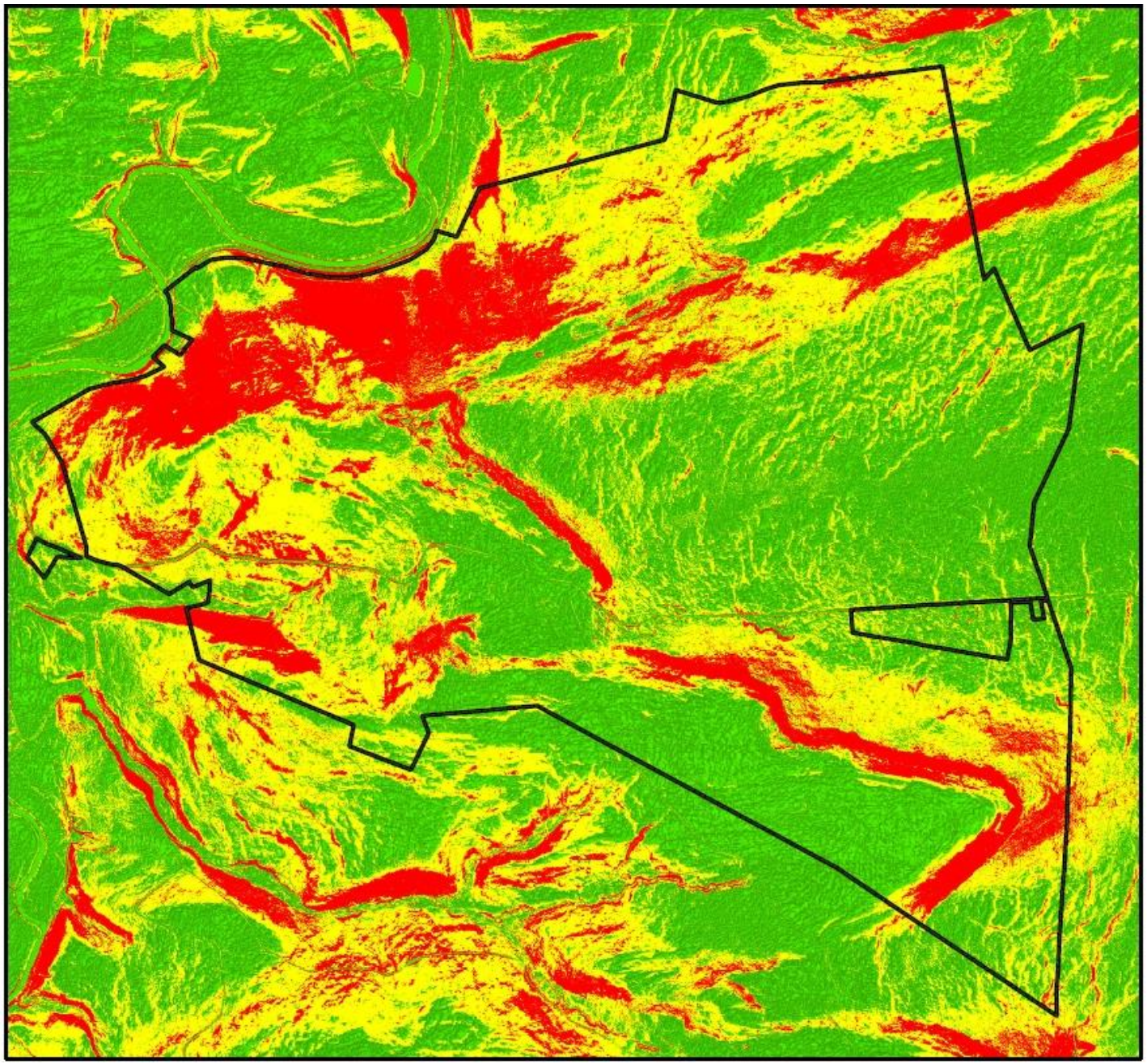
The Sanctuary's vistas serve as a valuable asset and contributes in many ways to helping achieve programmatic objectives. Each vista is protected by a 100 foot no-disturbance buffer. The only exception to the no-disturbance buffer being the removal of hazardous trees that could pose a danger to visitors and judious pruning of regenerating trees or shrubs that might block the views from the designated lookouts, particularly North and South Lookouts. The Cobble Lookout is considered an outstanding geologic feature of Pennsylvania that supports rare moss and lichen species, thus it is designated as a ***Representative Sample Area***. Hawk Mountain staff do not advertise this location to public and the site is not open to visitation except for research. Refer to RSA Summary.

SLOPE MAP

SLOPE %	ACRES
0-20	1,000
20-40	900
>40	500







Forest Community Types

Hawk Mountain Sanctuary is part of the Appalachian Oak Forest that covers most of Pennsylvania. This forest community type is also known as the mixed oak forest and is found in the Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow ecoregion and Eastern Broadleaf Forest (oceanic) ecoregion. It is common habitat on rolling hills and slopes with soils ranging from moderately well-drained and acidic to highly fertile. It is dominated by various oaks in association with maple, hickory, tuliptree, birch and pine. The specific oak dominant and associated species at any particular site is largely determined by elevation, hydrology, and aspect. Although most of the Sanctuary is dominated by hardwood forest, there are areas with conifer cover and open rock scree terrain.

Appalachian Oak Forest Type (Penn State University Extension)

Overstory	Understory and Shrubs	Plants
white oak	mountain laurel	sweet fern
northern red oak	*huckleberry*	*false Solomon's seal*
sugar maple	scrub oak	
beech	*wintergreen*	
sweet birch	flowering dogwood	
white pine		
tulip poplar		
bitternut hickory		
scarlet oak		
chestnut oak		
black oak		
pignut hickory		
blackgum		

Non-Timber Forest Products (NTFP's): Description and Approach

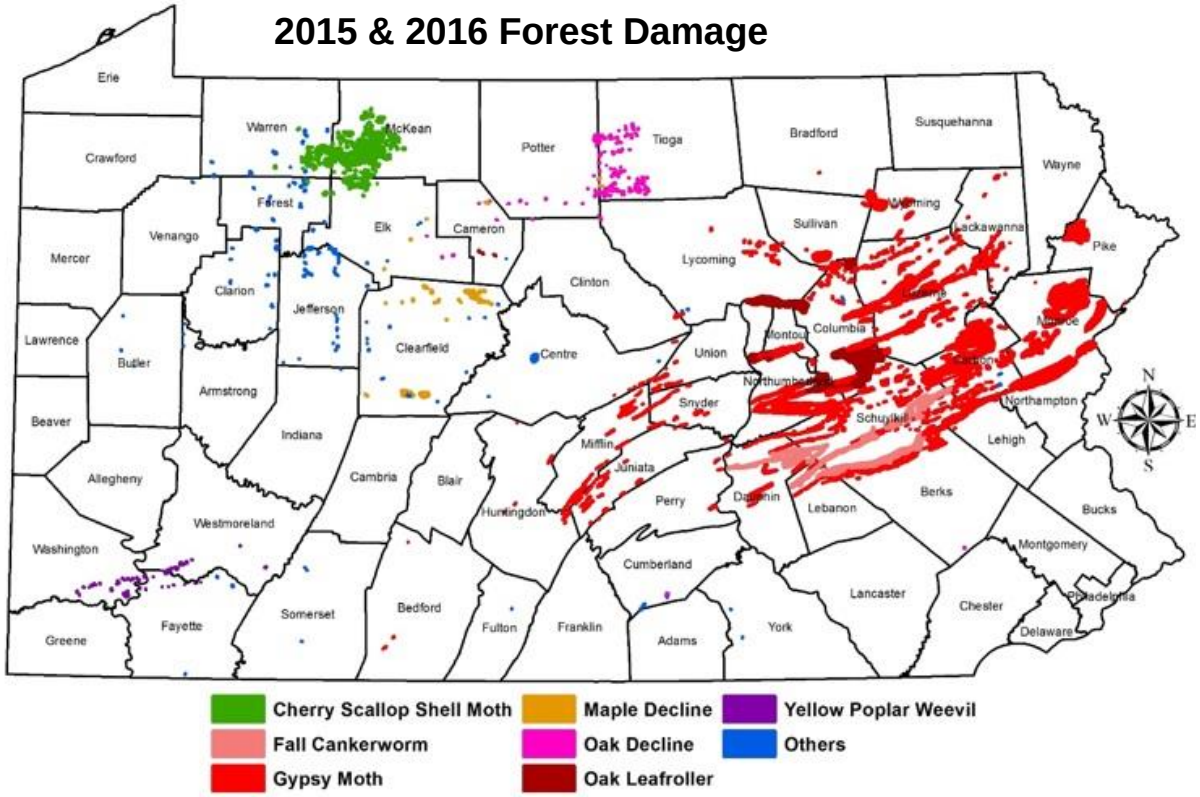
Gathering plant material for food, medicine, and utilitarian means was the original relationship between human beings and forests. Even today, people throughout the world turn to forests and associated open lands to feed and heal themselves and find materials for making such things as baskets and brooms. Non-timber forest products can represent a diverse array of living or dead plant materials, lichens, fungi, or other forest organisms that are used in a variety of ways to benefit people. The common categories of NTFP's include medicinal and herbal products, decorative and specialty wood products, along with edible products. While NTFP's have perceived economic and/or consumptive value for humans, they can also represent forms of biodiversity that are critical to maintain on the landscape from an ecosystem management perspective.

Approach

There is no commercial harvest of NTFP's on Hawk Mountain land. Well established rules that restrict such activities are imparted upon visitors through a combination of signage, electronic and written informational materials, and through verbal communications with Sanctuary staff.

Forest Pests and Diseases

Forests of eastern Pennsylvania, including Blue Mountain have experienced severe defoliation cycles caused primarily by gypsy moth outbreaks over the past 45 years. The Sanctuary's 1998 Forest Stewardship Plan cites *repeated defoliation by gypsy moths having occurred in 1971, 1973, 1981, 1982, and 1990*. Additional defoliation events followed averaging one major incidence per decade. Reports from PA DCNR Forest Health Specialists in 2015-2016 identify Hawk Mountain as being on the edge of a 'hot spot' for outbreaks of several caterpillar species. These events cause significant stress to trees, particularly the oak resource which dominates much of the region. The stress of defoliation occurred simultaneous with drought conditions in 2016 resulting in noticeable oak mortality, especially among chestnut oak.



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The following is a summary of Pennsylvania forest pests and diseases that may affect the health of Hawk Mountain Sanctuary:

COMMON NAME	THREAT RATING TO HMS
Gypsy Moth	High
Hemlock Woolly Adelgid	High
Emerald Ash Borer	High
Armillaria Root Disease	High
Asian Longhorned Beetle	High
Beech Bark/Beech Scale Complex	Moderate
Eastern Tent Caterpillar	Moderate
Fall Cankerworm	Moderate
Leafrollers	Moderate
Twolined Chestnut Borer	Moderate
White Pine Weevil	Moderate
Maple Anthracnose	Moderate
Leaf Galls	Moderate
Elm Spanworm	Moderate
Scale Insects	Low
Spruce Gall Adelgid	Low
Fall Webworm	Low
Black Knot or Cherry	Low
Thousand Canker Disease	Low

Approach

HMS staff maintain an active vigilance for invasive pest species and maintain close communications with DCNR Bureau of Forestry, including local service foresters and regional pest management specialist to stay informed of current and emerging forest pest and disease threats, along with potential opportunities to engage in cooperatives to address such issues through Integrated Pest Management programs.

DCNR Forest Pest Management Specialist
Eastern Area Contact
Scott Stitzer
PO Box 315
Aristes, PA 17920
570-875-6450 ext. 114
sstizer@pa.gov

DCNR Schuylkill CountyService Forester
Weiser Forest District
Steve Ziegler
PO Box 315
Aristes, PA 17920
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stziegler@pa.gov

Top Threats to HMS Forest Health:

Non-Native Defoliating Insects:

Gypsy Moth:

Accidentally introduced to Massachusetts in 1869, the gypsy moth caterpillar spread throughout New England and the Mid-Atlantic region of the country. By the 1970's, gypsy moth populations ravaged the eastern and central oak forests of Pennsylvania, leading to the loss of many oak trees and other hardwoods. Since the worst outbreaks in the 1970's and 80's gyspy moth populations have generally shifted to endemic levels with periodic outbreaks resulting in moderate to regionally severe defoliation episodes.

Gypsy Moth Caterpillar

Forestlands throughout Schuylkill and Berks counties are prone to periodic gypsy moth outbreaks. Sequential defoliation episodes combined with other stress factors often lead to tree decline and mortality. Additionally, gypsy moth defoliations can severely impact acorn production. Studies in Pennsylvania have shown a decrease of 50% in per acre acorn production for several years following severe defoliations, which negatively impacts wildlife.

Predicting epidemic outbreaks and severe defoliation episodes is difficult. Egg masses can serve as an indicator of future defoliation potential, though future mortality levels will determine eventual caterpillar populations and their impact. Natural mortality will build and collapse populations, depending on a variety of factors including stage of the outbreak, weather patterns and biological control factors. Monitoring of caterpillar activity, egg mass prevalence and favorable environmental factors should be the first step in developing management guidelines for control.

Female Gypsy Moth laying eggs

Gypsy moth populations can be controlled with the use of commercially available pesticides. Pesticides are usually applied by plane or helicopter in mid spring when the caterpillars are in the first "crawler" stage. The most commonly used pesticide is Bacillus thuringiensis (BT), a naturally occurring microorganism that produces chemicals toxic to host insects. However, pesticides can have negative impacts on other invertebrates. Since the1970s, Hawk Mountain has maintained a "no-spray" approach to gypsy moths and served as a control site for Bureau of Forestry in gypsy moth population monitoring, using its staff time to monitor control plots across the forest from 1970 to 1988. Since 1990s outbreaks became less frequent and have dramatically lessened on the Sanctuary whereas disease and natural predators of the caterpillars has built up to dampen impacts of the gypsy moth whenever outbreaks are initiated. Large scale defoliation caused by gypsy moth has not been observed since 1990 (HMS data)

- Maintain communications with your local DCNR Bureau of Forestry, Service Forester (Steve Zeigler) to stay aware of pest reports, predictions and opportunities to collaborate.

Sap-Sucking and Wood Boring Insects:

Hemlock Woolly Adelgid

Hemlock Woolly Adelgid (Adelgis tsugae; HWA) is a fluid-feeding insect that feeds on hemlock trees thro eastern North America. It was introduced into the US from Asia and was first discovered in PA in 1967. It has since spread throughout 49 counties in the eastern two-thirds of the state, including Centre and Clinton counties. Cold winter temperatures can slow the spread and even prevent the establishment of the HWA, however once established, hemlocks usually begin to die within four years. Trees that don't die often persist in a weakened state often appearing grayish-green. Healthy hemlocks naturally have a shiny, dark green colored foliage. Biological controls (e.g., beetles) are being explored for controlling the hemlock woolly adelgid in hopes that they might be a long-term solution to conserve our native hemlock resources. Chemical treatment options exist, but are short-lived and very costly. Hawk Mountain hemlocks along the Little Schuylkill River appear to show greater resilience than higher elevation trees.

Emerald Ash Borer

The ***Emerald Ash Borer (Agrellis panimellis; EAB)*** is another introduced pest from Asia that first showed up in the Lake States. It was detected in western PA in 2007 and has since expanded. The beetle creates D-shaped holes in the trunk of trees, boring and eating the inner tree cells of Ash species just below the bark, which essentially girdles the stem, killing it within a short time-frame. The PA Department of Agriculture in collaboration with the DCNR Bureau of Forestry and other partners are monitoring the spread of EAB. As of September, 2016, the Emerald Ash Borer has been found within 62 PA counties, which includes Schuylkill and Berks counties. Chemical control options exist, but are short-lived and very costly. The 2016 forest inventory did not reveal any significant densities of ash trees remaining within the Sanctuary. ***Time and effort to protect ash and hemlock through chemical treatments is not recommended for this property due to the high costs and low likelihood of the tree's long-term survival.***

White-tailed Deer Impacts:

Deer feed heavily on tree buds during the winter months

Deer, unlike most other wildlife species, have a direct and sometimes profound effect on the quality of the habitat in which they live because they consume the vegetation that they rely on for habitat. Deer can completely shift the character of a woodlot; or destroy one type of habitat and create a wetland habitat in its place. White-tailed deer are herbivores, browsers of succulent new growth on trees and shrubs. They have preferred foods and will select those that they like first, consuming up to 5 to 10 pounds of browse per day. Once preferred plant and woody stem species are consumed, deer will then move on to secondary species that they like less, but can tolerate. If deer densities increase beyond the carrying capacity of a specific habitat, the results of over-browsing can quickly cripple a forest ecosystem, putting it into a degraded state that could take years if not decades to recover.

Deer browse impacts rated **Moderate** throughout the Hawk Mountain Sanctuary property.

Deer Impact: Inside Fence (left) Outside Fence (right)

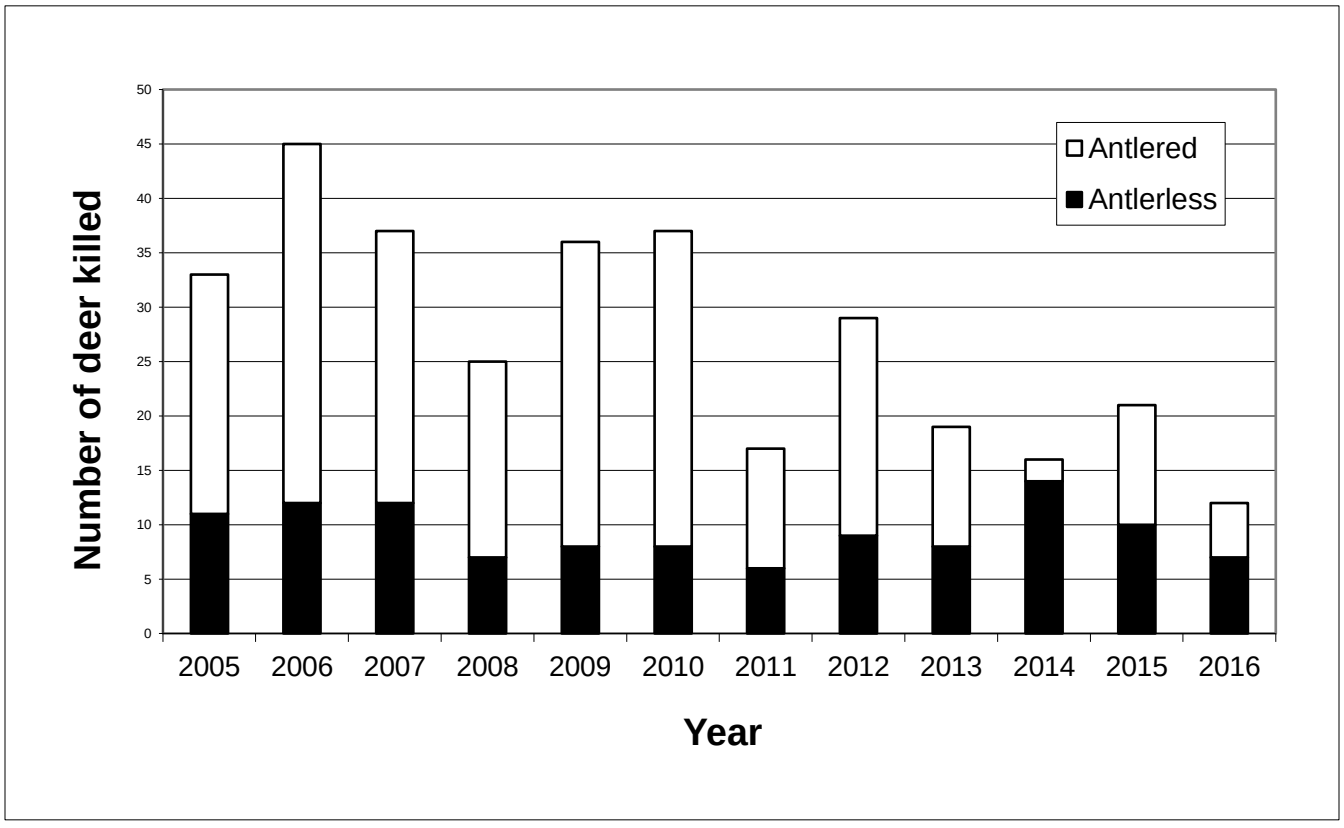
The diversity and stocking of young trees (seedlings), particularly in areas that have increased light availability reaching the forest floor have been negatively influenced by deer. In order to promote maximum seedling survival and tree, shrub, and plant species diversity, it is critical to keep deer activity at a minimum on the Sanctuary, particularly throughout the winter months when deer are most reliant on browsing buds from new seedlings.

The PA Game Commission has struggled to successfully manage the state's deer herd at a responsible level for the past 70 years. This failure has resulted in a statewide forest health and condition crisis, whereby an unprecedented amount of forest land across the Commonwealth is unable to regenerate (grow a new forest) because of the legacy effects of high deer impact. Today, in many cases, hunting alone does not result in the reduction of deer densities to a level that can be sustained for a long enough period to allow the forest to recover; therefore, deer fencing has become a viable tool. In response to Pennsylvania's forest regeneration issues, multiple businesses have become established to provide specialized forest regeneration services. Installation of 8 foot tall woven-wire fencing is the most effective approach to controlling deer, but costs are prohibitive at $3 a linear foot, therefore in most cases, is not an affordable option for the average forest landowner. (For more information on protecting trees from deer, refer to Appendix: Forest Stewardship Chapters 2 & 7.)

Deer Management History at Hawk Mountain Sanctuary

The Sanctuary has a long history (since the 1950s) of allowing deer hunting on the property. Historically, the Sanctuary allowed deer hunting on weekdays only during the rifle season and the late muzzleloader/archery season and the main trail to North Lookout was posted to prevent hunter access. In 2001, in an effort to increase the number of deer killed on the Sanctuary all trails, including the main trail, were closed for the first two days (Monday and Tuesday after Thanksgiving) of rifle season to allow hunters access to the whole Sanctuary excepting the safety zones around buildings. The main Lookout Trail re-opened after the first two days, but all the other trails remained closed. In order to better track the number of deer harvested on the Sanctuary a mandatory check station was also implemented in 2001 for hunters shooting antlerless deer. In 2005, a new system of hunter reporting was implemented. Hunters apply for hunting permits and those that receive permits are required complete and return a hunting report after the season that details whether they hunted, how many days and, if they killed a deer on the Sanctuary, the sex and location of the kill. Hunters are not eligible for a hunting permit the following year until they turn the previous years' report.

Since 2005, on average 268 deer hunting permits have been given out, 27 deer (18 antlerless) were harvested. Both hunter participation and harvest rates have declined since 2005 (see below).



Unfortunately, the hunting program has been unable the to reduce deer densities to a level that enables optimal understory biodiversity. In 2015, the Sanctuary successfully applied for and received 48 Deer Management Assistance Program (DMAP) from the Pennsylvania Game Commission (PGC). Of the 48 permits given out to "alpha-hunters", i.e., hunters who have had a history of harvesting deer on the Sanctuary, 46 were purchased. Post hunting season reports from the PGC and the Sanctuary indicated that 12 of the DMAP tags were filled by way of a successful antlerless deer harvest. The Sanctuary did not receive tags in 2016, but did receive 48 DMAP tags in 2017. In addition, in an effort to increase hunting opportunities for hunters and increase harvest rates the Sanctuary is allowing Saturday hunting during the concurrent antlered/antlerless firearm season in 2017.

Hawk Mountain Sanctuary is within PA Game Commission's Wildlife Management Unit 4C

Non-Native Invasive Plant Encroachment

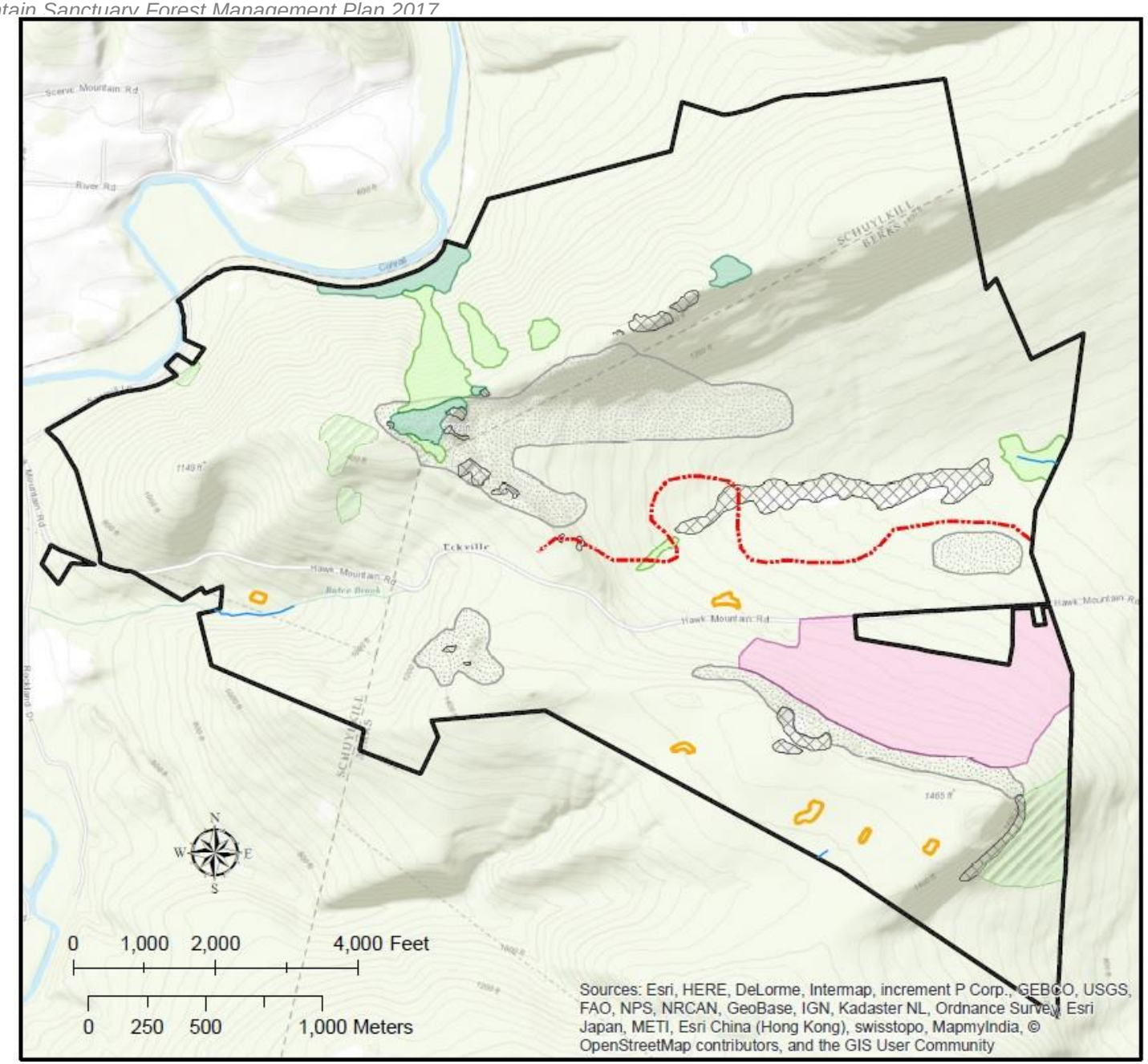
Past ecological assessments and management plans for the Sanctuary document the presence of non-native invasive plants (i.e., grass, vines, shrubs, trees), and allude to the interaction between high deer densities and invasive species encroachment (e.g. Hawk Mountain Forest Stewardship Plan 1998). Management recommendations were primarily focused on increasing monitoring efforts while working aggressively to reduce the Sanctuary's deer population through public hunting along with selective removal of the largest patches of non-native invasive plants – primarily shrubs. The 2016 forest inventory detected non-native invasive plants in a high percentage of the sampled plots. These findings indicate that there has been limited success in controlling non-native invasive vegetation since the plan was formed. With additional resources available a large-scale control effort was adopted in 2014 and has been continued to date. Several methods of management are being utilized depending on selected species and their abundance and location. Field notes portray that invasives are well established within the core visitor areas, along much of the Sanctuary's trail network, and are especially concentrated along both sides of Hawk Mountain Road within the eastern half of the Sanctuary. It is now known that storm water is the main culprit in further distributing invasive plant impact and efforts to manage storm water is also a land management priority along roadways and trails. The area along the eastern side of Hawk Mountain Road is considered the 'leading edge of invasive encroachment' with the highest number of invasive species and densities of both invasives and undesirable competing vegetation which occupies much of the immediate growing space. Throughout the remainder of the property, invasive plants were documented at much lower levels. Of notable concern is the trend of isolated patches of Japanese stiltgrass (*Microstegium vimineum*) and Japanese barberry (*Berberus thunbergii*) shrubs that appear to be pioneering deeper into the heart of the Sanctuary.

Approach

In 2014, the Sanctuary developed and instituted an internal 'spray program' focused on controlling invasive plants. The program is administered by Todd Bauman, Director of Land and Facilities. The focus is on controlling Japanese stilt grass, Japanese barberry, and tree-of-heaven (*Ailanthus altissima*) through spot treatments with a backpack sprayer. Garlic mustard (*Allaria petiolata*) is controlled with weed-whacking equipment prior to flowering. And, stilt grass and other invasives are pulled by hand by staff and volunteers along the Sanctuary's main trail and lookouts (a one mile extent). It is estimated that over 130 acres of the Sanctuary is impacted by these invasive plants. To date, 85 acres has received spot treatments with herbicides contained forestry approved labe In 2014 HMS developed and instituted a management approach utilizing several methods: pulling, mowing, and spraying. Large impacted areas of invasive shrubs such as japanese barberry and tartarian honeysuckle, were manually pulled. Mowing is utilized for garlic mustard control in spring prior to plant producing seed. An ongoing internal 'spray program', administered by Todd Bauman, Director of Land & Facilities, is focused on controlling japanese stilt grass and tree-of-heaven. Areas of light impact along high use trails are hand pulled by staff and volunteers. . . Resources have been focused on consistency of treatments within heavily impacted areas and looking to expand efforts with additional resources in near future. Additional efforts followed to control storm water. Along Hawk Mountain Road forebays and retention basins were constructed on several culverts with plans to address all culverts. Retention basins have been constructed along areas of runoff on trails with plans to continue to improve trails for users and surrounding land protection. It is estimated that over 130 acres of the Sanctuary is impacted by these invasive plants. To date, 85 acres has received treatments with a Glyphosate herbicide containing forestry approved labels.

FEATURE MAP

Date: 5/6/2017



Common Non-Native Invasive Plants Found within the Region

Autumn Olive Bush and Tartarian Honeysuckle Japanese Barberry

Tree-of-Heaven **Mile-A-Minute Weed** **Garlic Mustard**

Multi-Flora Rose **Oriental BittersweetJapanese Stiltgrass**

Chinese Privet **Buckthorn** **Royal Paulownia**

Non-Native Invasive Vegetation detected within Hawk Mountain Sanctuary

Interrelationship of **C**ompleting Plants, **D**eer, and **L**ight (CDL):

Regeneration Threshold:

***Deer impact affects forest regeneration thresholds*.** With high deer densities, it is necessary to have a count of 50 seedlings per plot which equates to an average of 50,000 seedlings per acre. Under low deer impact, the required count is 15 seedlings per plot or 15,000 seedlings per acre.

Species that dominate where deer density is high:

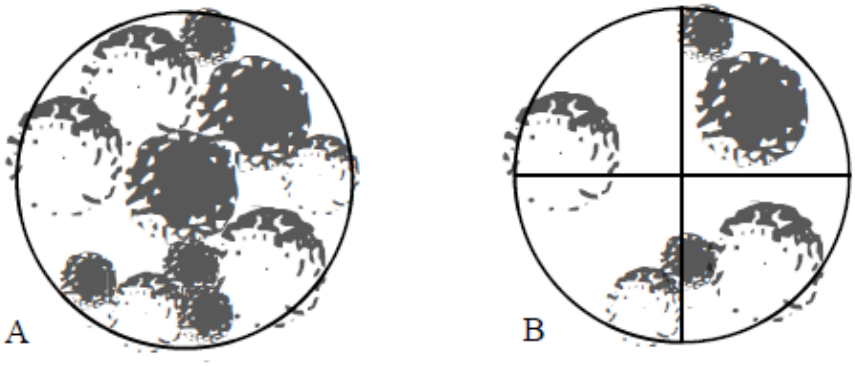
Herbaceous plants: ferns, grasses

Shrubs: blueberry, mountain laurel, sweet fern, spicebush

Woody species: beech, striped maple

Canopy Density Threshold:

Canopy closure of less than 50 percent reinitiates the understory and promotes the development of a new growth.



Hay-scented Fern Threshold:

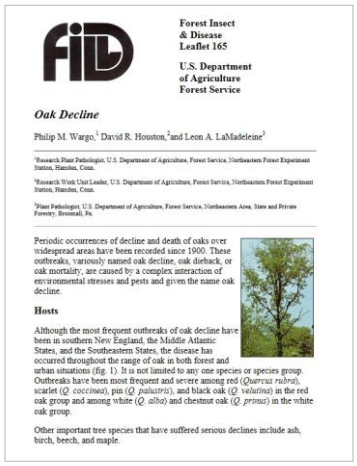
When 30 percent or more of an area is covered by hay-scented fern (*Dennstaedtia punctilobula*), it is likely to interfere with the establishment of regeneration after a natural or man-made disturbance that increases availability of sunlight to the forest floor.

Enrollment into The Nature Conservancy's Working Woodlands Program:

Hawk Mountain's long-term plan for its holdings includes the goal to protect and steward a healthy, ynamic native forest, allowed to mature naturally. Enrollment into the Working Woodlands program will enable access and participation in ecosystem markets, which can help to generate a new revenue stream by demonstrating improved forest management compared to the regional common practices of selective high-grading. Forest carbon markets have stimulated a renewed focus on uneven-aged silviculture and non-traditional treatment applications that enhance carbon storage while providing other co-benefits, such as late-successional biodiversity and improved stand structure; all of which are compatible with Hawk Mountain management philosophy.

Forest management considerations for Hawk Mountain Sanctuary will be prepared by TNC foresters after evaluation of forest inventory results and will center on methods and approaches to vegetation and brush management, invasive species control, and possible sophisticated timber stand improvement prescriptions, all of which may come at a cost, either in the form of internal staff time and labor, or contractual work to qualified vendors with reputations for being open-minded to new concepts.

The following documents should be reviewed before proceeding into the next chapter of this Forest Management Plan. The information they present is relevant, thought-provoking and corresponds directly to the current-day Hawk Mountain Sanctuary forest health and stewardship issues.



Forest Insect & Disease Leaflet 165

U.S. Department of Agriculture Forest Service

Oak Decline

Philip M. Wargo,[1] David R. Houston,[2] and Leon A. LaMadeleine[3]

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[3]Plant Pathologist, U.S. Department of Agriculture, Forest Service, Northeastern Area, State and Private Forestry, Broomall, Pa.

Periodic occurrences of decline and death of oaks over widespread areas have been recorded since 1900. These outbreaks, variously named oak decline, oak dieback, or oak mortality, are caused by a complex interaction of environmental stresses and pests and given the name oak decline.

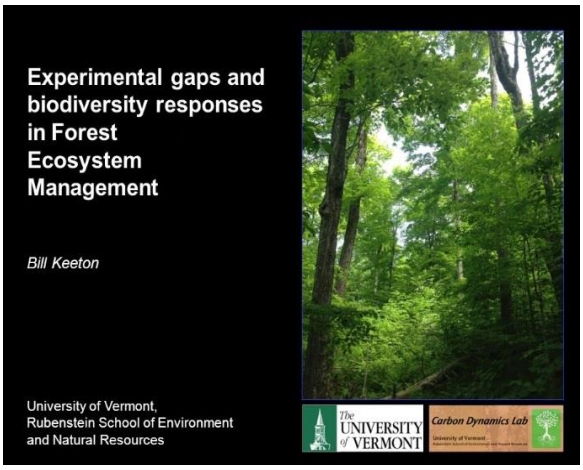
Hosts

Although the most frequent outbreaks of oak decline have been in southern New England, the Middle Atlantic States, and the Southeastern States, the disease has occurred throughout the range of oak in both forest and urban situations (fig. 1). It is not limited to any one species or species group. Outbreaks have been most frequent and severe among red (*Quercus rubra*), scarlet (*Q. coccinea*), pin (*Q. palustris*), and black oak (*Q. velutina*) in the red oak group and among white (*Q. alba*) and chestnut oak (*Q. prinus*) in the white oak group.

Other important tree species that have suffered serious declines include ash, birch, beech, and maple.

Oak Decline

https://www.na.fs.fed.us/spfo/pubs/fidls/oakdecline/oakdecline.htm



Structural Complexity Enhancement

https://phys.org/news/2017-04-growth-school-forestry-technique-imitates.html

Sarah E. Ford, William S. Keeton. **Enhanced carbon storage through management for old-growth characteristics in northern hardwood-conifer forests**. *Ecosphere*, 2017; 8 (4): e01721 DOI: 10.1002/ecs2.1721

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Primary Goals and Objectives

Forest Ecosystem Stewardship

- *Promote the establishment and growth of native vegetation through tending activities and targeted site treatments*
- *Control stormwater runoff into forest*
- *Reduce and contain non-native invasive plants within the forest*
- *Utilize forest condition data to monitor changes and impacts to forest health*
- *Reduce deer numbers to a level that enables adequate forest regeneration*
- *Continue to monitor bird populations as indictors of forest health and biodiversity*
- *Monitor forest for early detection of threats such as pests, pathogens, and diseases*
- *Establish and maintain good working relationship with state forestry personell*

Protect and Maintain Special Habitat Areas & Unique Fauna

- *Identify and properly maintain areas of rare species and special habitats*
- *Compile and verify reports of rare species from visiting scientists and naturalists*
- *Encourage surveys of taxonomic groups not well known on the Sanctuary*
- *Develop and implement protection strategies as needed*

Enhance Habitat for Migrating, Wintering, and Nesting Birds

- *Preserve unfragmented forest*
- *Restrict human access from large portions of Hawk Mtn. to enhance habitat value for birds and other wildlife*
- *Restrict new trails to Standard Protection Area; limit new trails and structures to conserve native forest habitat*
- *Minimize and assess the impacts of HMS buildings and structures on birds, including limiting llight dispersion, towers, window kills, fencing, etc.*
- *Continue long-term monitoring of migrating, breeding, and wintering birds of Hawk Mountain*

Balance Monitoring, Research, & Education with Resource Protection

- *Minimize impact and disturbance to the forest from conservation science and educational programs*
- *Reduce or limit impacts from infrastructure (trails, signage, etc.) to protect forest health and integrity*
- *Implement policy of project review by Director of Land and Facilities for all program projects within easement area to ensure resource protection is maintained*
- *Maintain and update annually a database of locations of species of concern and habitats on Hawk Mountain*

Manage Trails and Lookouts for Visitor Experience

- *Keep trails and lookouts natural to allow authentic Central Appalachian experience*
- *Maintain views from lookouts with judicious pruning of trees and other vegetation*
- *Ensure design of signage and trailside structures or features are consistent with the natural environment and enhance the visitor experience*
- *Monitor trail impacts on native fauna and flora*
- *Address trail issues in a timely fashion to reduce long-term impacts*

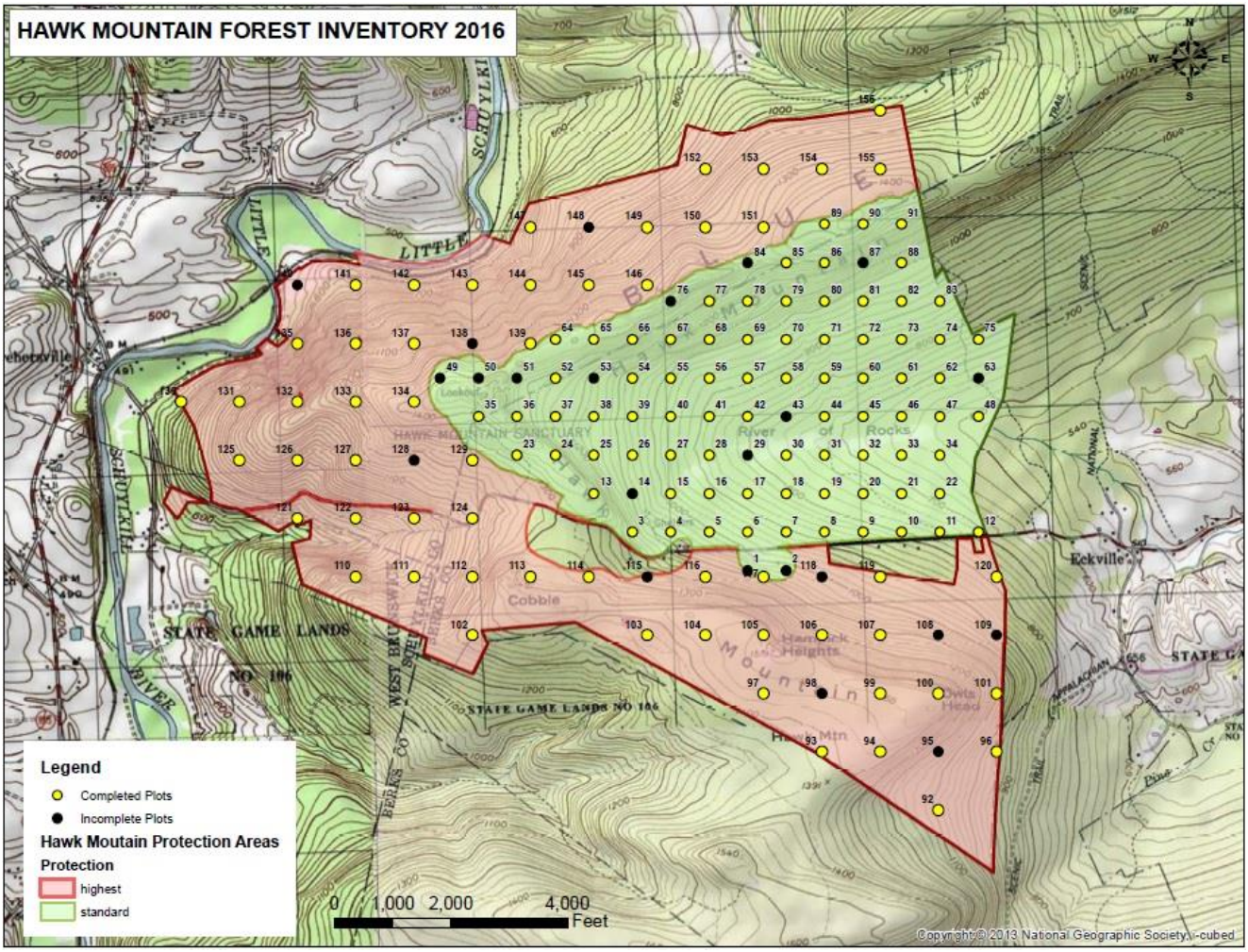
Promote Forest Health to Improve Carbon Sequestration

- *Evaluate forest inventory data to create five-year forest health management goals*
- *Use best management practices to reduce and contain non-native invasive plants within forest*
- *Continue to reduce white-tailed deer numbers*
- *Consult with outside foresters and ecologists to develop management actions to improve forest health*

Meet the Standards of Forest Stewardship Council Certification

- *Educate staff, donors, and stakeholders on the Principles of Forest Stewardship Council Certification*
- *Designate a person to serve as lead for tracking activities and assembling required annual documentation for FSC audits*

2016 Field Inventory



Zone	Acres	Sampling Spacing (chains)	InventoryPlots
Highest Protection Zone	1490	15x15	64
Standard Protection Zone	901	10x10	79

Aug.-Sept. 2016, a total of 8 days were spent collecting forest data throughout HM.

143 points were sampled

More than 24 tree species were detected

1,960 individual trees were measured, assessed, & rated based on health criteria

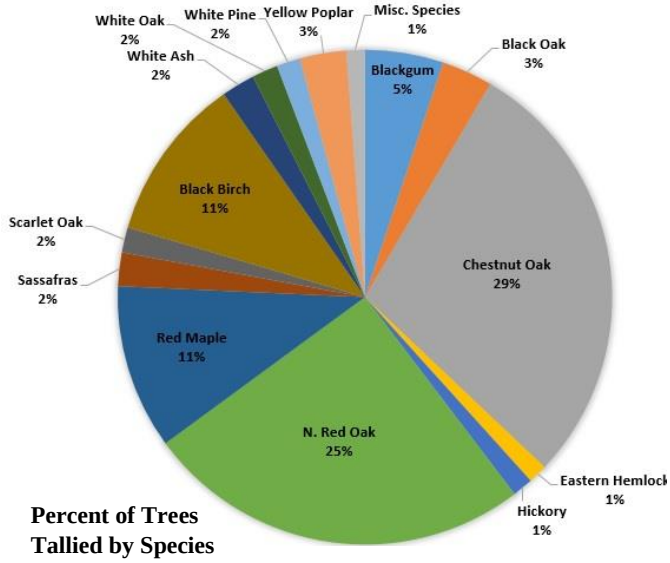
Average tree diameter – 11.6 inches at breast height

Diameter ranges from 2 to 38 inches at breast height

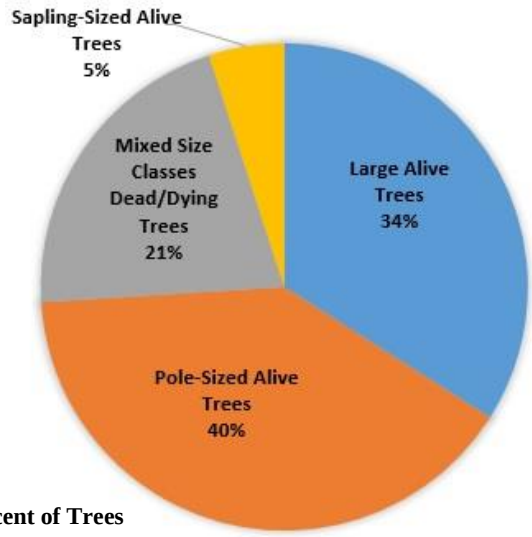
Tree cores indicate average age of +/- 95 years

Demonstrating Inventory Procedures to Hawk Mountain Staff and Board Members (August 2016)

An inventory of the ecological resources (timber, shrub, understory vegetation, wildlife habitat) was completed at Hawk Mountain during the late summer of 2016. Trees two inches in diameter at breast height and larger were tallied at 143 locations. Each tree selected for measurement was carefully assessed and assigned a product classification and crown rating. Furthermore, at each point, vegetation within the forest's understory and midstory was documented and unique features noted, all of which correspond to help define current conditions as it relates to forest health, diversity, and wildlife habitat values.



Percent of Trees Tallied by Species

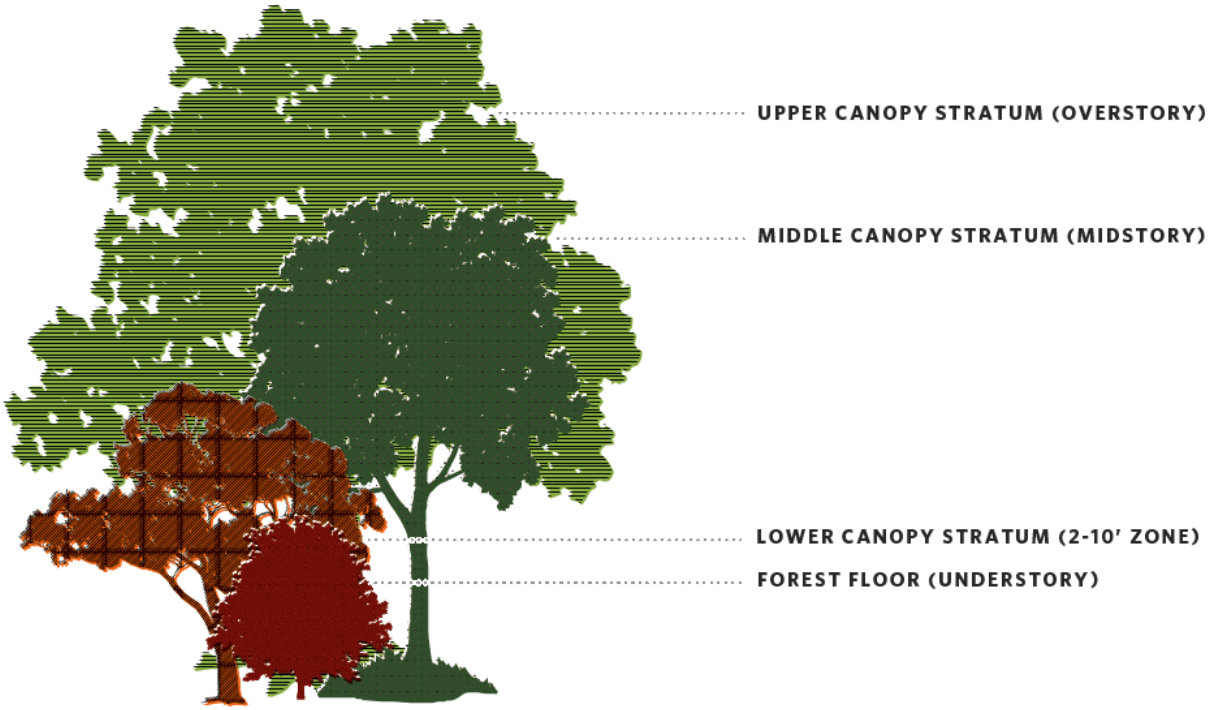


Percent of Trees Tallied by Size Class

Defining Size Classes: Saplings = 1-4" DBH; Poles = 6-10" DBH: Large Trees = 12"+ DBH

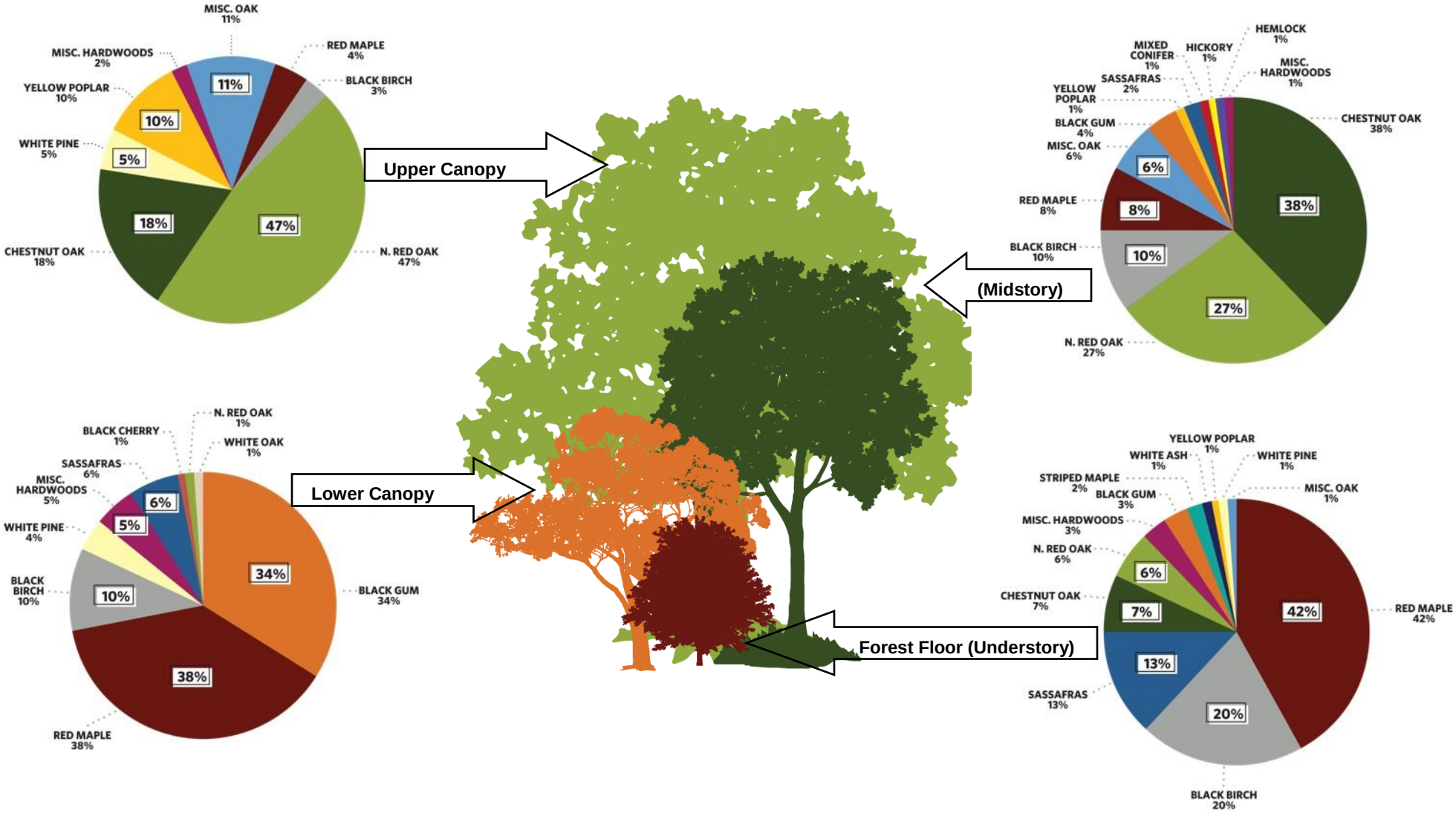
HAWK MOUNTAIN | Green Leaf Consulting Services | The Nature Conservancy Protecting nature. Preserving life.

Current Forest Conditions (Tract-Level Overview)



Since the founding of the Sanctuary in 1934, the forest has been maintained as a relatively untouched preserve, allowed to regenerate naturally from disturbances that cut over or burned most the Sanctuary in late 1800s and early 1900s. The property is dominated by forest cover with much of the growing space comprised of shallow soils, characterized as stony sandy loam, yet capable of supporting the growth of diverse plant, tree, and shrub species. Currently, timber stands are well stocked with relatively high species diversity; however, a combination of biotic and abiotic stress factors experienced periodically throughout the past century, including defoliating insects, drought, bud-killing spring frosts, and diseases have collectively resulted in modest forest health declines, most evident by overstory tree mortality. Corresponding changes in the availability of light received on the forest floor and middle canopy stratum has created a structurally diverse forest. Unfortunately, high deer populations and their selective browsing has negatively influenced the composition of new growth. In general, two to three distinct age-classes or tree cohorts exist within each stand throughout the property, distinguished by their canopy location (overstory, midstory, and lower-midstory). Quality of timber in terms of form and merchantable value is fair to good. Overall, mixed oak species account for nearly 75% of the total merchantable timber volume that exists within the property today (2017). Average tree diameter is approximately 8.6 inches and more than 80% of the timber volume is comprised of low-grade products (pulpwood). See glossary in Appendix) Specifically, the property is averaging 3,573 board feet of sawtimber and 80 tons of pulpwood per acre. Overall health of the forest is fair to good but there is increased risk for continued decline, particularly associated with the threat of current and anticipated non-native invasive species. The mid-story and understory levels of the Sanctuary's forest are where most of the challenges are found. Higher value, hard-mast producing trees within the overstory are exhibiting signs of decline corresponding with age along with the stress of periodic drought and defoliation (i.e., gypsy moth) indicated by epicormic branching, reducing live-crown-ratios, and increasing tree mortality.

Composition of Hawk Mountain Sanctuary Forest Canopy Strata (Tract-Level Summary)

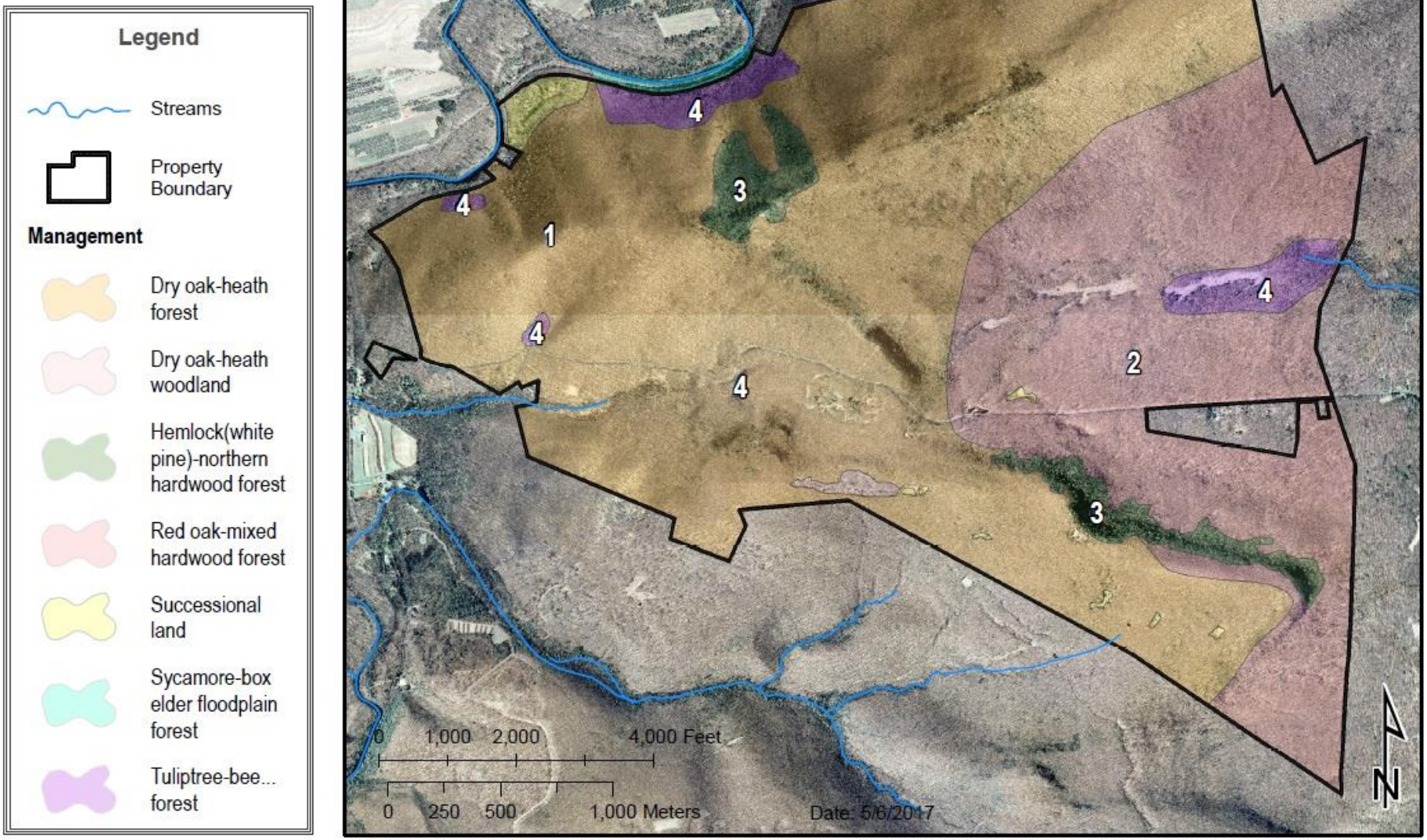


Decades of overabundant deer populations and associated browse impacts have greatly impacted the forest, evident by the shade-tolerant, non-mast producing trees, e.g. Red Maple, that are beginning to dominate the composition of the lower midstory (refer to composition charts). Equally degraded is understory conditions (forest floor) where dense canopy cover of the lower midstory combined with high levels of deer browsing is suppressing desirable regeneration and giving advantage to continued encroachment of undesirable native and non-native competing vegetation. Overall, forest stand dynamics are changing in a manner that reflects an old growth natural pattern of uneven-aged forest conditions.

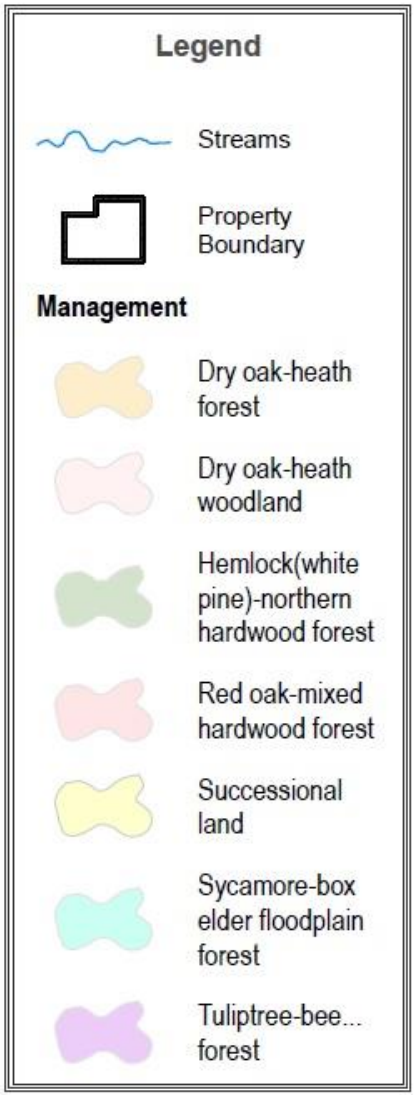
Desired Future Forest Conditions (Tract-Level)

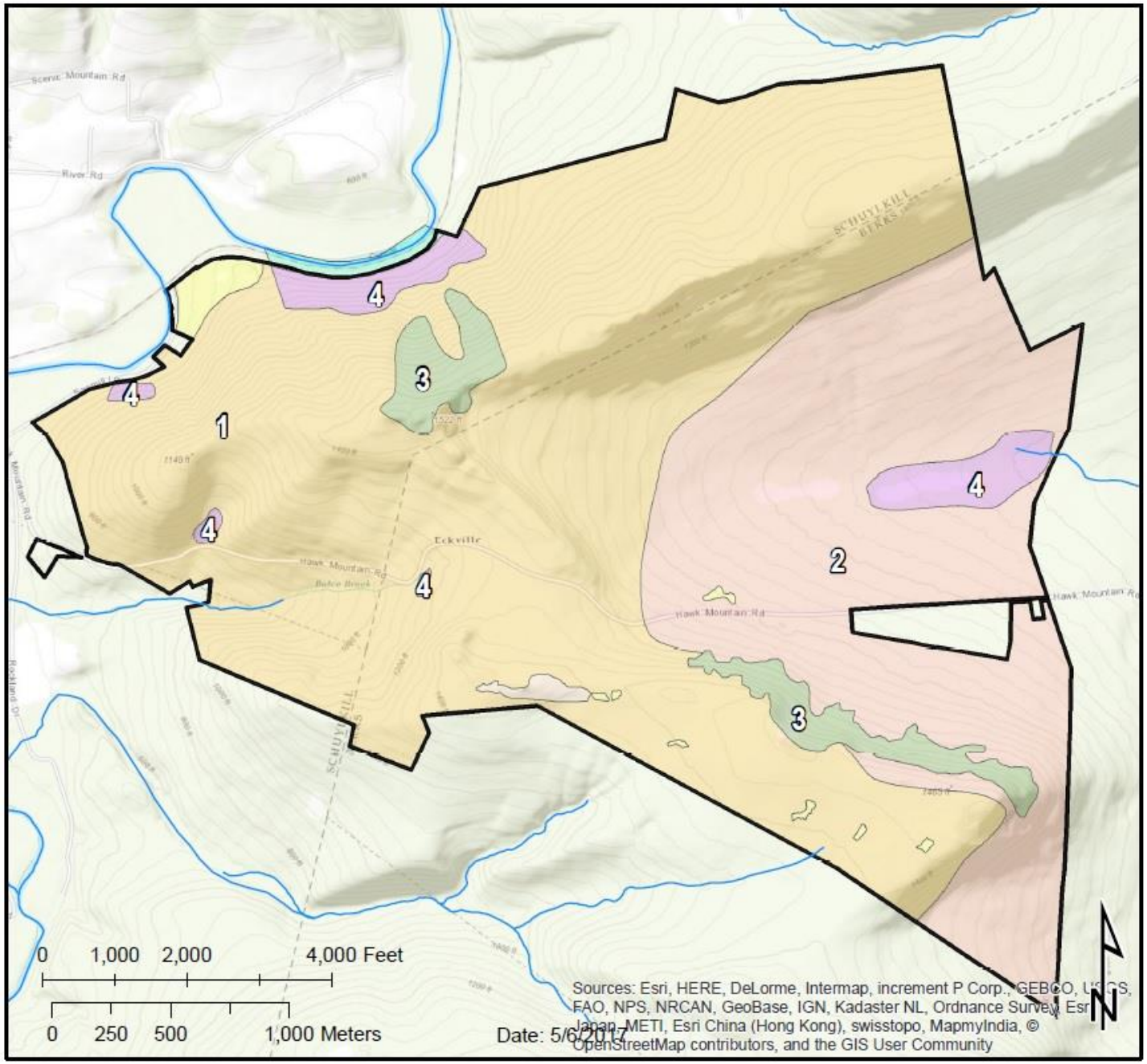
Hawk Mountain seeks to promote and maintain the natural ecological integrity of the Central Appalachian Forest ecosystem on the Sanctuary. Hawk Mountain seeks to maintain naturally-occurring native forest cover, allowing forests to mature and evolve with minimal human interference. Staff will promote or allow natural forest succession, while discouraging non-native and invasive plant-life that interfere with natural succession or regeneration.

MANAGEMENT UNIT MAP



MANAGEMENT UNIT MAP





Forest Vegetative Management Units Summary

HAWK MOUNTAIN SANCTUARY VEGETATIVE MANAGEMENT UNITS (STANDS)

ID	Acres	Community Type	Size Class	Stocking	Basal Area	Number Trees	Sawtimber Mbf	Pulpwood Tons	Percent AG/UG	Dead Trees	Desirable Regeneration Levels
1	1509	Dry Oak Heath Forest	Large Poles & Small Sawtimber	Overstocked	117	338	3.0	84	23/77	18	Inadequate
2	722	Red Oak/Mixed Hardwoods	Large Poles & Small Sawtimber	Overstocked	122	302	4.9	71	31/69	10	Inadequate
3	88	Hemlock/Northern Hardwoods	Poletimber	Fully Stocked	105	167	0.2	90	3/97	4	Inadequate
4	77	Tulip-tree/Beech/Maple Forest	Small & Medium Sawtimber	Overstocked	152	211	5.4	84	42/58	3	Inadequate

NOTES:
All values represent **per acre** basis
Dbh = Diameter at breast height (4.5 feet). **Basal Area** measured in square feet/acre. **Mbf** = Thousand board feet
*Stocking level (basal area, trees per acre and Avg. Dbh) are derived using the Roche and Gingrich Upland Hardwood Stocking Guide
AG = **A**cceptable **G**rowing Stock (Healthy Trees), desirable species that exhibit healthy visual characteristics and will likely persist another 15 years
UG = **U**nacceptable **G**rowing Stock (Unhealthy Trees), trees that exhibit stress and visual characteristics of decline and/or are unlikely to persist another 15 years
Dead tree tally excluded from all categories except Dead Tree Summary which is expressed as trees per acre within each Vegetative Management Unit.
Management Unit acreage does not include non-forested areas

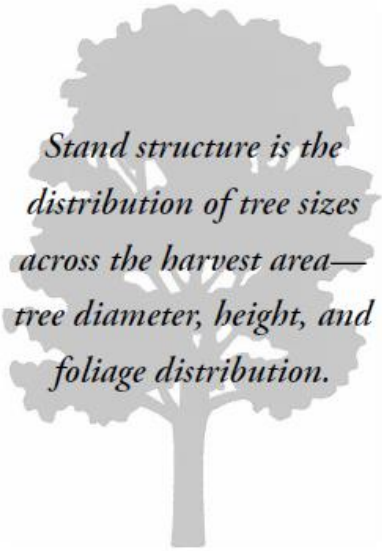
Forest Condition Report Card

The following Chart represents a comprehensive report that quantitatively summarizes and thematically rates the current condition of Hawk Mountain forest by attributes that together characterize the health, productivity, diversity, and overall sustainability of the Hawk Mountain Sanctuary forest. In chart below green colors indicate "good' condition for attribute listed, yellow indicates "fair' and red indicates 'poor'.

Mgmt. Unit*	COMPOSITION				STRUCTURE		REGENERATION		
	Stocking (%)		Tree Species		live>/= 16"dbh	snags>/= 10" dbh	all stems (regen)	% desirable (regen)	Deer Browse Impact
	TOTAL	AGS	Diversity	Evenness					
1	110	50	20	0.67	17	18	9867	31	3
2	112	63	22	0.73	24	10	7881	44	3
3	89	2	7	0.82	11	4	3000	0	3
4	112	78	12	0.73	41	3	14333	28	3

RATING	Stocking (%)		Tree Species		live>16"dbh	snags>/= 10" dbh	all stems (regen)	% desirable (regen)
	TOTAL	AGS	Diversity	Evenness				
POOR	< 44	<40	</=3	0 to 0.6	0 to 3	0 to 2	0-10k	<25
FAIR	45 to 58	41 to 53	4-8	0.61to 0.7	4 to 8	3 to 5	10,001-15k	26 to 54
GOOD	59 to 79	54 to 69	9-12	0.71 to 0.8	9 to 16	6 to 8	15,001-50k	55 to 74
V. GOOD	80+	70+	>12	0.81+	17+	9+	>50k	>75

For further explanation on how to interpret the above Forest Condition Report refer to the KEA Report Card Summary within the Appendix.



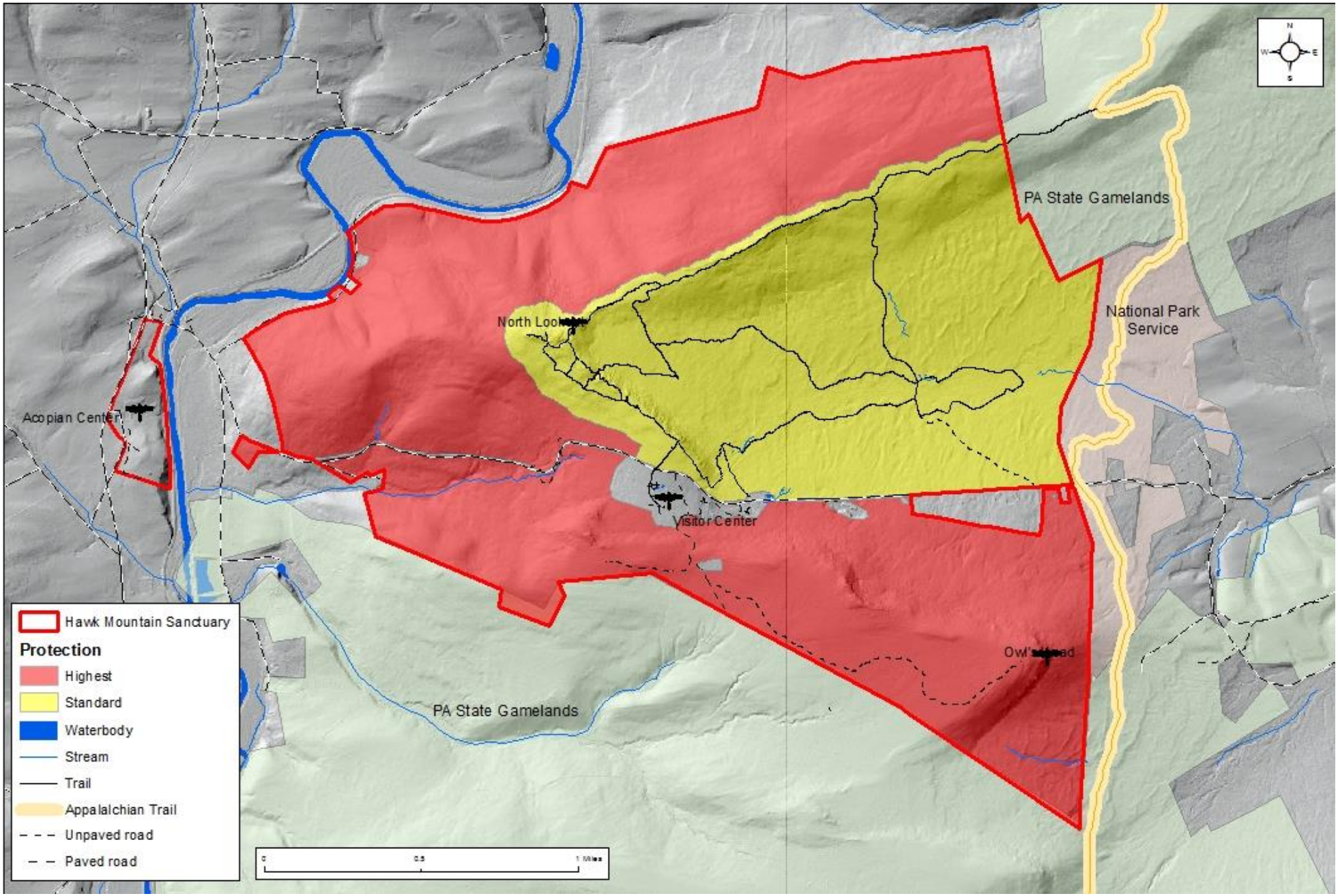
RATING	Deer Browse Impact Rating
5	V. High Impact
4	High Impact
3	Moderate Impact
2	Low Impact
1	No Impact

Management Zones

The development of the Hawk Mountain Sanctuary Land Management Plan in 2000 went through a process to distinguish **Protection Areas** and **Use Areas** within the Sanctuary that have been widely accepted, well integrated into planning and operations, and functional for staff and board members.

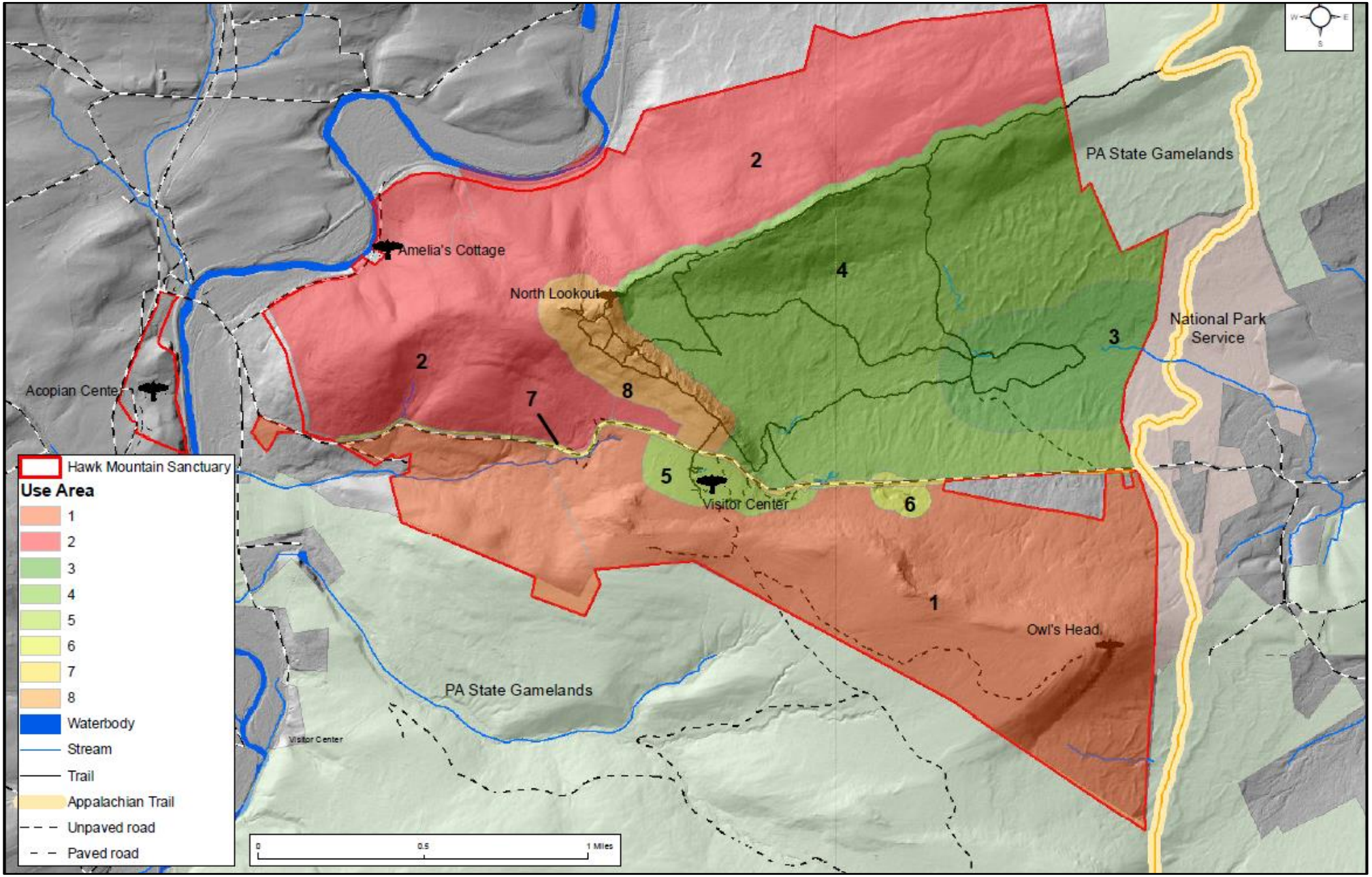
1) Standard Protection Areas
This zone includes trails and lookouts and forest nearby. High and low use trails and lookouts with educational programming, interpretation, and approved research activities are permitted and encouraged. Two outhouse toilets, a small outdoor amphitheater, and eight miles of trails occur in zone and a wheel chair accessible trail runs from entrance gate to the first Lookout. A single track non-public rugged lane is maintained to lower elevation forest in River of Rocks region to allow for management and emergency access. Management focus is conserving forest integrity and natural habitats for wildlife and wildlife viewing. Forest canopy is preserved where possible. Several lookouts are pruned annually to maintain vista for visitors.

2) Highest Protection Areas
These areas of sanctuary have no public access, excepting for approved research and monitoring, forest management, or deer hunting during permitted hunting periods. Goals are to maximize natural ecological function, health and values of forest for wildlife and forest integrity. Some limited, small group staff guided education is also permitted. Management activity includes deer management, invasive plant control.


PA State Gamelands
National Park Service
North Look
Acopian Center
Visitor Center
Owl's Head
PA State Gamelands
Hawk Mountain Sanctuary
Protection
Highest
Standard
Waterbody
Stream
Trail
Appalalchian Trail
Unpaved road
Paved road
0
0.5
1 Miles

Use Area designations were created to portray human activity-levels within the Sanctuary and are derived on a 5-point scale; VERY LOW, LOW, MODERATE, HIGH, and VERY HIGH.

Unit	Description	Human Use	Natural Lands Management Emphasis	Special Needs
1	Forest south of Hawk Mountain Road	**Very Low** Primarily natural lands management, research and limited education purposes	**High** Maximize natural ecological function, health and values	Deer management; invasive plants control; monitor health of hemlocks
2	Forest north of Hawk Mtn Rd and ridgeline	**Very Low/Moderate** Primarily natural lands management and research purposes	**High** Maximize natural ecological function, health and values	Deer management; monitor health of hemlocks
3	East low elevation forest	**Low** Primarily natural lands management and research activities with some passive recreation and education	**High** Maximize natural ecological function, health and values	Close area to human use during bird breeding season; deer management; address AT trail issues
4	Kettle Creek basin	**Low** Primarily natural lands management and research activities with some passive recreation and education	**High** Maximize natural ecological function, health and values	Address trail issues; erosion and habitat encroachment; deer management
5	Existing facilities comples	**High** All permitted human uses occur here	**Low** Focus is on mitigation of human impact and education	Address impact from high use and facilities, e.g., erosion
6	Campground	**Moderate** Moderately used, seasonal campground facility	**Low** Focus is on mitigation of human impact and education	Address impact from facilities, e.g., erosion
7	Hawk Mountain Road corridor	**High** Public road use and maintenance, road drainage	**Low** Focus is on mitigation of road impacts, especially drainage, invasive plants	Control invasive plants, mitigate erosion; requires working with PennDOT
8	Lookout and high use trails	**Moderate to High** High use trails and lookouts, educational programming, monitoring activities	**Moderate** Focus is on mitigation of human impacts, monitoring and education	Trail and lookout maintenance


Amelia's Cottage
North Lookout
Acopian Center
Visitor Center
Owl's Head
PA State Gamelands
National Park Service
PA State Gamelands
Visitor Center
1
2
2
3
4
5
6
7
8
Hawk Mountain Sanctuary
Use Area
1
2
3
4
5
6
7
8
Waterbody
Stream
Trail
Appalachian Trail
Unpaved road
Paved road
0
0.5
1 Miles

High Conservation Value Areas: Description and Approach

I. High Conservation Value (HCV) Area Identification

Within Working Woodlands and for Hawk Mountain Sanctuary, our method to define and meet the HCV requirement follows the four-phased approach of *assessment, consultation, inventory,* and *monitoring* as outlined in the Standard and applied as follows. Contiguous forest blocks in the High Allegheny Plateau and Central Appalachians have been identified as a priority for The Nature Conservancy.

In conjunction with HMS staff, state ecologists, Conservancy ecologists and outside experts, TNC staff have embarked on a process to identify and map HCV areas. At least one type of HCV has been identified on HMS through a combination of biological database reviews, internal team expertise, and review of ecological priorities of state agencies and other conservation groups operating in the region. A map demarcating HCVs is also embedded.

The HCV framework includes the following six categories:

HCV 1: Forest areas containing globally, regionally or nationally significant concentrations of biodiversity (e.g., endemism, endangered species, refugia)

1.1 There are no legally protected or managed areas on the property

1.2 There are no areas on HMS that contain significant concentrations of rare species, identified and ranked as globally or state rare by Heritage.

Key resources: the Pennsylvania Natural Heritage interactive website, http://www.naturalheritage.state.pa.us/cnhi/cnhi.htm and the following fact sheet http://www.naturalheritage.state.pa.us/cnhi/docs/Statewide%20CNHI_Nov_2010.pdf

Total Number of HCV 1 Areas: 0

HCV 2: Forest areas containing globally, regionally or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance

Essentially all of the forests in this area, except for small wet and inoperable patches, have been logged or cleared at least once, if not several times. As such, there are no large unroaded areas or areas that lack a history of human disturbance.

2.1 No large, roadless areas are known to occur on the property. Much of the property is bisected by roads and much of it harvested during the late 1800's.

2.2 There are no landscape-scale forests within the FMU recognized as being significant to biodiversity conservation at the ecoregion scale.

Key resources: publicly available Natural Area Inventories

Total Number of HCV 2 Acres: 0

HCV 3: Forest areas that are in or contain rare, threatened or endangered ecosystems

3.1 Old growth. There is no old-growth within HMS.

3.2 No roadless areas are known to occur on the property due to prior management activities.

3.3 There are no rare ecosystems recorded on HMS properties

Total Acres of HCV 3: 0

HCV 4: Forest areas that provide basic services of nature in critical situations (e.g., watershed protection, erosion control)

4.1 HMS does not contribute to a source of drinking water

4.2 The property does not lie within a source-water or public drinking water watershed.

4.3 There are no floodplains and wetlands within HMS that contribute to a nearby water-supply watershed.

4.4 There are no areas on HMS lands that would be considered critical to prevent erosion, landslides, avalanches, etc.

Total Acres of HCV 4: 0

HCV 5: Forest areas fundamental to meeting basic needs of local communities (e.g., subsistence, health)

5.1 HMS land would not be considered fundamental to meeting basic needs of local communities.

HCV 6: Forest areas critical to local communities´ traditional cultural identity (areas of cultural, ecological, economic or religious significance identified in cooperation with such local communities)

6.1, 6.2 HMS lands would not be considered as fundamental to traditional cultural identity in the area.

II. Consultation with appropriate experts for the purposes of this assessment:
For the purposes of this assessment and more generally, HMS and TNC staff regularly consult with biologists from the Pennsylvania Natural Heritage Program (Tony Davis), Pennsylvania Game Commission (Rich Fritsky), DCNR Bureau of Forestry (Ellen Shultzabarger), and other conservation organizations, such as Western Pennsylvania Conservancy. In particular, the PA Natural Heritage database helped provide information on HCV 1, 2, and 3 designations. Further, TNC has deeply invested in hiring biologists and foresters and consults with conservation staff throughout the organization on various aspects of this assessment, from identifying unique ecosystems to implementing prescribed fire prescriptions, to monitoring the impacts of those activities over time. Hawk Mountain staff maintain a database of Hawk Mountain biota, or species present on sanctuary. Rare species are mapped and sightings or records compiled each year by conservation science staff.

Representative Sample Areas

Cobble Outlook is recognized an outstanding geologic feature of Pennsylvania. This rock outcrop supports rare moss and lichen communities, such as knothole moss (*Anacamptodon splachnoides*). Visitors are not encouraged to visit the site and a 100-foot no entry/no disturbance buffer is imposed for protection. The exact location of the moss is kept confidential.

Total Acres of RSA: 1.3 acres

Management Unit Forest Condition Summary

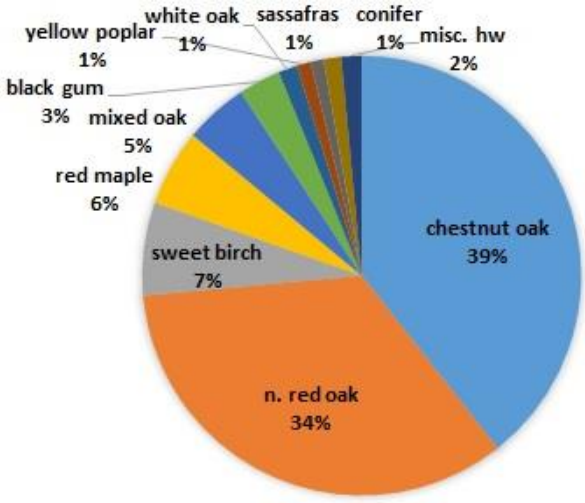
Unit 1 – Encompasses Western 2/3rds of the Sanctuary

Acres	Size Class	Stocking	Basal Area Acre	Number Trees Acre	Bd. Ft. Vol.	Pulpwood Tons	Percent AG/UG	Dead Trees Acre	Desirable Regeneration Levels
1509	Pole & Sm. Sawtimber	Overstocked	117	338	3.0	84	23/77	18	Inadequate

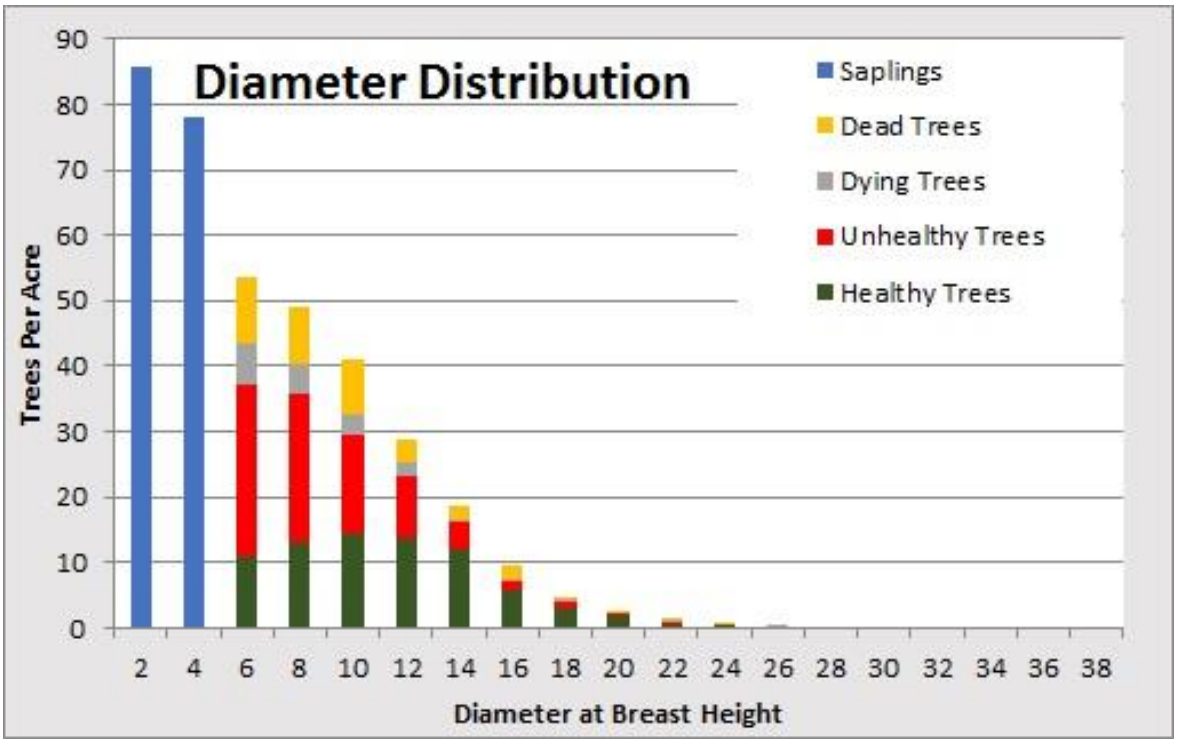
DESCRIPTION

Edited Excerpt from 1998 Plan – Mostly understocked polesize to mature (75-100-year-old) Xeric Central Hardwood Forest. Although most of the canopy trees are 8-14" in diameter, there are frequent individuals and groups of trees over 20" in diameter. Despite repeated defoliations (1971, 1973, 1981, 1982, 1989, 1990, 2008, 2015, 2016) by gypsy moths, oaks continue to dominate this unit which constitutes over half of the Sanctuary. With an average 50% of the growing space oaks (chestnut, red, scarlet, black, white) control the canopy. Other major canopy components include red maple (15%), black birch (15%) blackgum (10%), and sassafras (2%). On the upper slopes the balance consists of scattered pitch pine, white pine, and hemlock; on the mid slopes the balance consists of tuliptree, aspen, and black cherry. The low to medium tree quality and the relatively open character of the forest (particularly on the upper slopes) reflects the impact of the gypsy moth and the very stony soil conditions that exist throughout the unit.

2016 Forest Inventory Summary:



Tree Species Composition by Volume (left) and Picture of Ridgeline with Noticeable Tree Mortality (right)



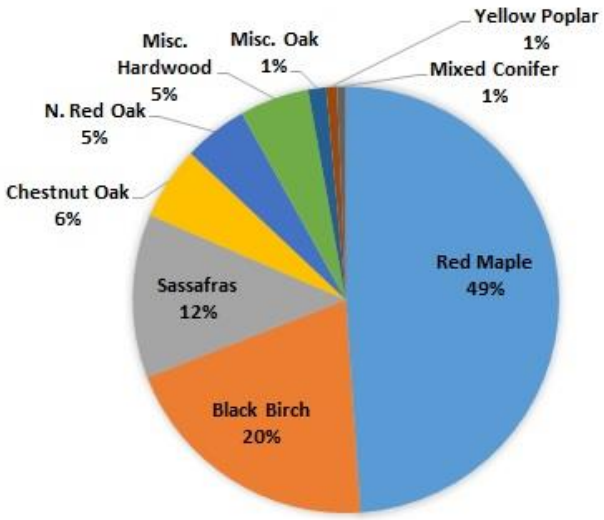
Diameter Distribution of Trees based on Health Rating Criteria

Midstory and Understory (Herbaceous Layers):

Excerpt from 1998 Plan – The understory varies widely in density from very sparse to very dense patches of striped maple. Blackgum (40%), red maple (20%), striped maple (20%), and witchhazel (10%) are the major components. Mountain laurel, rhododendron, Japanese barberry, white pine, sheep laurel, ailanthus, sweetfern, pignut hickory, shadbush, smilax, and American chestnut sprouts make up the remainder of the understory trees and shrubs. There is spotty regeneration of oaks, maple, black birch, and blackgum, but all seedlings are below 6 inches in height (probably protected by snow pack) due to deer browse. The presence of advanced regeneration (>2') is sparse to none with only white pine reaching this stage.

Together, low-bush blueberry and huckleberry constitute 60% of the ground cover followed by hayscented fern (15%), Japanese stitlgrass (15%), grasses, mosses, forbs, and partridgeberry. Like the understory, the ground cover varies widely in density from bare to very dense stands of blueberry/huckleberry, fern, or stiltgrass. Vines are currently not a concern, although grape is available to invade any future gaps. The current distribution of the invasives is patchy and principally found along road and trail edges, woodland gaps, and stormwater channels.

2016 Forest Inventory Summary (Forest Floor):



Species Composition of Regeneration - seedlings per acre

Major Forest Health Issues:

- *Oak Decline & Mortality*
- *Lack of Desirable Seedlings*
- *Non-Native Invasive Plants*
- *Undesirable Competing Plants*
- *Deer Browse Impacts*

TPA Species	Size Class Competitive Seedl	Established	New Seedling	Sapling	Stand Total
red maple	427	2,400	1,947	53	4,827
sweet birch	240	480	1,200	67	1,987
sassafras	240	547	360	80	1,227
chestnut oak	53	453	40	-	547
n. red oak	13	293	173	-	480
black gum	53	67	107	-	227
Other or unknown live	40	133	-	40	213
black oak	-	93	-	13	107
yellow poplar- mounta	-	-	80	-	80
white pine- App	-	-	13	27	40
black cherry	13	13	-	-	27
white oak	-	27	-	-	27
striped maple	13	-	-	13	27
hickory	-	13	-	-	13
WP	13	-	-	-	13
hemlock	-	-	-	13	13
American chestnut	-	-	-	13	13
Stand Total	**1,107**	**4,520**	**3,920**	**320**	**9,867**

Regeneration Summary by Size Class Rating

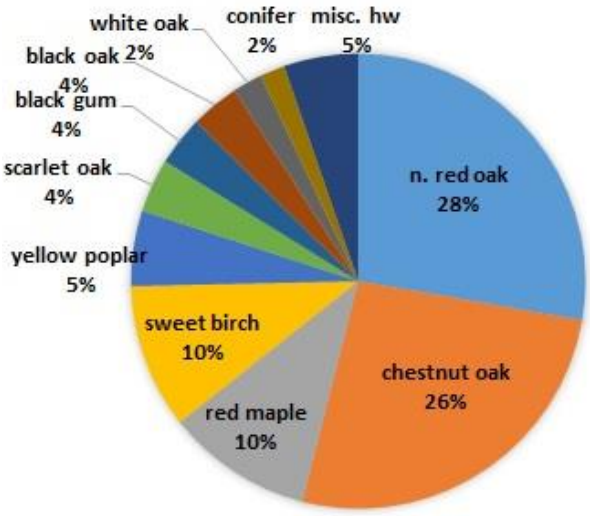
Unit 2 – Encompasses Eastern 1/3rd of the Sanctuary

Acres	Size Class	Stocking	Basal Area Acre	Number Trees Acre	Bd. Ft. Vol.	Pulpwood Tons	Percent AG/UG	Dead Trees Acre	Desirable Regeneration Levels
722	Pole & Sm. Sawtimber	Overstocked	122	302	4.9	71	31/69	10	Inadequate

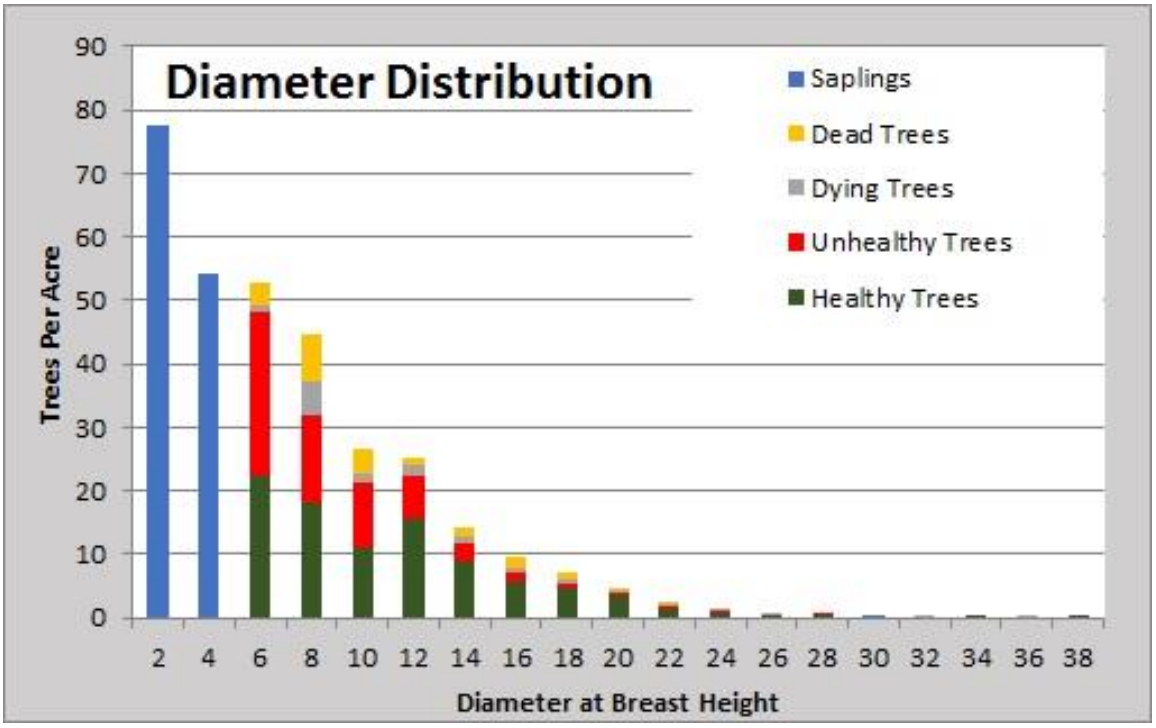
DESCRIPTION

Excerpt from 1998 Plan – Overall this mature (75-100 year old) Dry-Mesic Acidic Central Hardwood Forest is just slightly understocked, but there are large gaps in the area to the south of Owl's Head-probably due to recent gypsy moth and ice damage. Although approximately a third of the canopy trees are in the 8-14" diameter range, most of the trees are approaching 20" and greater in diameter and are of medium quality. Despite repeated defoliations (1971, 1973, 1981, 1982, 1989, 1990, 2008, 2015, 2016) by gypsy moths, oaks continue to be abundant in this unit. With an average 40% of the growing space oaks (chestnut, red, white) dominate the canopy. Other major canopy components include tuliptree (20%) and blackgum (10%). The balance is filled in decreasing number by red maple, white pine, white ash, black cherry, beech, aspen, hemlock, and pitch pine.

2016 Forest Inventory Summary:



Tree Species Composition by Volume (left) Picture of Interior Forest with Noticeable Mortality Canopy Gaps (right)



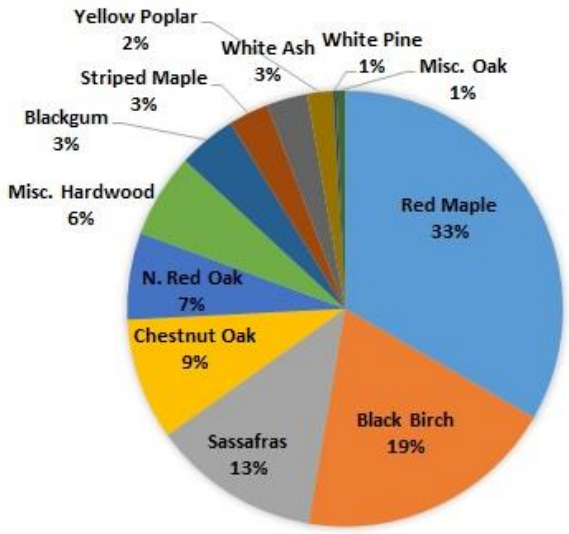
Diameter Distribution of Trees based on Health Rating Criteria

Midstory and Understory (Herbaceous Layers):

Excerpt from 1998 Plan – The understory varies in density from sparse to somewhat dense. Striped Maple (40%), witch-hazel (20%), blackgum (10%), black birch (10%), and red maple (5%) are the major components. Mountain laurel, rhododendron, Japanese barberry, white pine, ailanthus, multiflora rose, smilax, spicebush, bush honeysuckle, hemlock, mountain ash, sassafras, sugar maple, hawthorne, tuliptree, and American chestnut sprouts make up the remainder of the understory trees and shrubs. Advanced regeneration is sparse and limited to patches of black birch near gap edges and scattered sassafras, white pine, and hemlock.

Overall, the ground cover is average in density, but spotty. Together, low-bush blueberry and huckleberry constitute 60% of the ground cover followed by ferns (15%), including hay-scented, Christmas, marsh, cinnamon, and common polypody, along with Japanese stiltgrass (20%), grasses, mosses, forbs, and partridgeberry. Vines (grape, Virginia creeper, poison ivy) are currently a concern as grape has invaded many existing gaps. The current distribution of invasives is patchy, but their impact is moderately severe where they are found, principally along road and trail edges, woodland gaps, and stormwater channels.

2016 Forest Inventory Summary (Forest Floor):



When the American chestnut perished, oaks filled the void for wildlife. Prior to gypsy moth impacts, mature oak forests were producing 173 lbs of acorns per acre on nearby Gamelands. After gypsy moths, acorn production fell to 67 pounds per acre. Based on how valuable oaks are for wildlife – the agency can't afford not to invest in spraying. Unfortunately, across the landscape we are seeing birch and maple replace oak stands lost to gypsy moth.

Excerpt from PA Game Commission Report 2016

Species Composition of Regeneration -seedlings per acre- (left)

TPA	Size Class				
Species	Competitive S	Established	New Seedling	Sapling	Stand Total
red maple	610	949	966	-	2,627
sweet birch	17	271	1,136	102	1,525
sassafras	237	627	51	68	983
chestnut oak	136	576	-	-	712
n. red oak	-	356	153	-	508
Other or unknown live tree	34	288	-	85	407
black gum	51	203	34	51	339
striped maple	102	51	51	34	237
white ash	-	186	51	-	237
yellow poplar- mountains	-	153	-	-	153
hwd (misc)	-	51	-	-	51
white pine- App	-	-	-	17	17
white oak	-	17	-	-	17
hophornbeam	-	17	-	-	17
hickory	-	17	-	-	17
black oak	-	17	-	-	17
scarlet oak	-	17	-	-	17
(blank)	-	-	-	-	-
Stand Total	**1,186**	**3,797**	**2,441**	**356**	**7,881**

Regeneration Summary by Size Class Rating

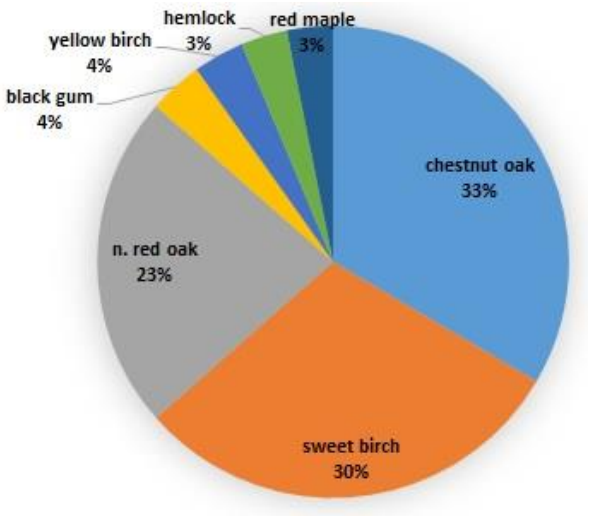
Unit 3 – Two small areas distinguished by conifer cover

Acres	Size Class	Stocking	Basal Area Acre	Number Trees Acre	Bd. Ft. Vol.	Pulpwood Tons	Percent AG/UG	Dead Trees Acre	Desirable Regeneration Levels
88	Poletimber	Fully Stocked	105	167	0.2	90	3/97	4	Inadequate

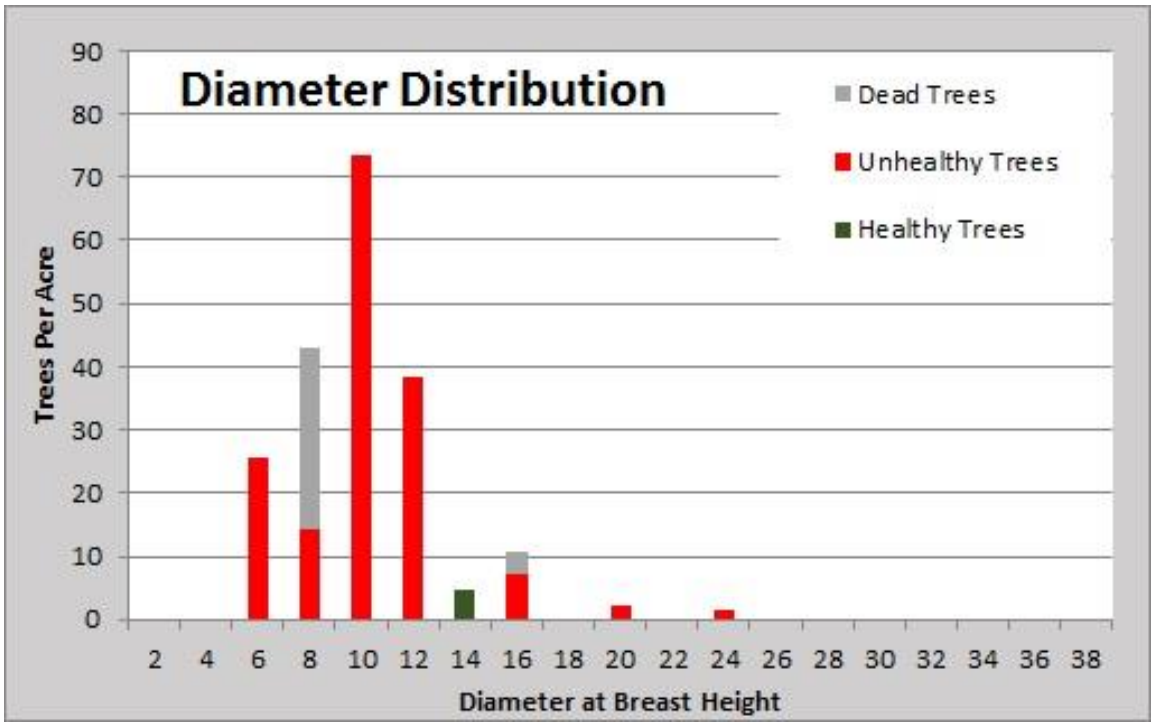
DESCRIPTION

Excerpt from 1998 Plan – This 100+ year old Northern Conifer Forest is comprised of Eastern hemlock (30%), yellow birch (30%), and black birch (20%) which constitutes most of the canopy. Chestnut and red oak, white and pitch pine, along with blackgum make up the balance. The stand is understocked with medium to low tree quality due to the poor (stony and boulder) soils and exposed conditions. Hemlock has the best size and quality and is the only species with advanced regeneration, although it is spotty.

2016 Forest Inventory Summary:



Tree Species Composition by Volume (left) Picture of skeletonized Hemlock being replaced by Birch in Unit 3 (right)

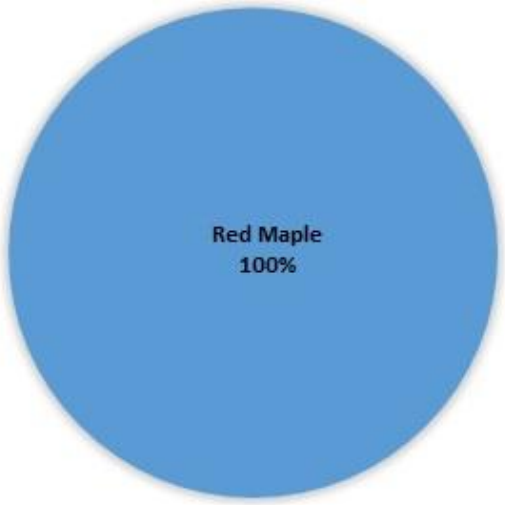


Diameter Distribution of Trees based on Health Rating Criteria

Midstory and Understory (Herbaceous Layers):

Excerpt from 1998 Plan – In general, the understory is fairly dense, with some very dense patches of rhododendron. Also present in decreasing quantity are hemlock, witch-hazel, black birch, mountain laurel, sassafras, mountain holly, low-bush blueberry, and red maple. Ground cover (ferns, grasses, and mosses) and vines (Virginia creeper and grape) are sparse. Japanese stiltgrass is present in a forest gap. This area is the most botanically important area within the Sanctuary and should be given special attention in both monitoring and management.

2016 Forest Inventory Summary (Forest Floor):



Relative residual tree quality threshold:
The intent is to increase the relative proportion of good quality trees (i.e., AGS to UGS) by proactively removing undesirable, poor quality trees.

TPA	Size Class	
Species	New Seedlir	Stand Total
red maple	3,000	3,000
Stand Total	**3,000**	**3,000**

Regeneration - Species Composition of seedlings per acre (left) and Size Classes (right)

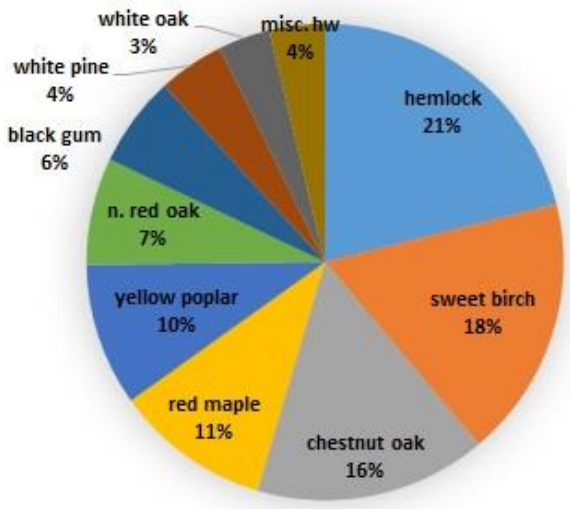
Unit 4 – Four small areas characterized by mesic site qualities

Acres	Size Class	Stocking	Basal Area Acre	Number Trees Acre	Bd. Ft. Vol.	Pulpwood Tons	Percent AG/UG	Dead Trees Acre	Desirable Regeneration Levels
77	Sm-Med Sawtimber	Overstocked	152	211	5.4	84	42/58	3	Inadequate

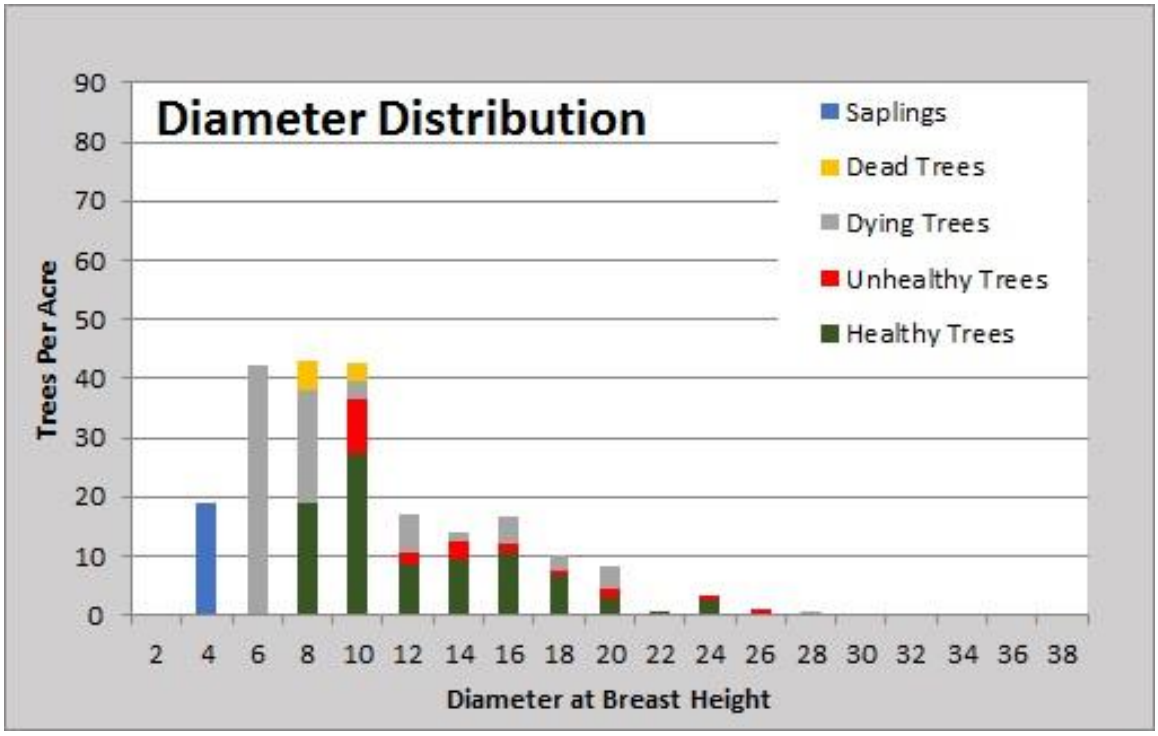
DESCRIPTION

Excerpt from 1998 Plan – This 75-100 year old Mesic Central Forest is mature. Tuliptree (25%), red maple (20%), and eastern hemlock (15%) dominate the canopy. Red oak, black birch, chestnut oak, aspen, white pine, white ash, basswood, and yellow birch make up the balance. The stand is mostly understocked, although the best tree quality (medium with some areas of above average) on the Sanctuary occurs within this management unit, due to their position on less exposed lower and north-facing slopes. Hemlock and white pine are the sole constituents of the spotty tree regeneration.

2016 Forest Inventory Summary:



Tree Species Composition by Volume (left) Picture of Kettle Creek and hemlock blowdown in Unit 4

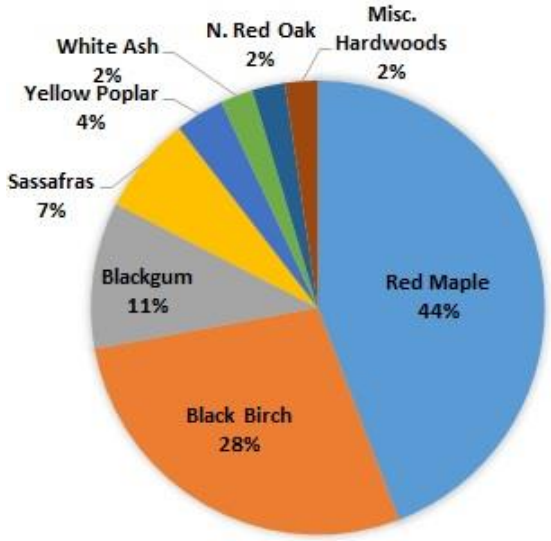


Diameter Distribution of Trees based on Health Rating Criteria

Midstory and Understory (Herbaceous Layers):

Excerpt from 1998 Plan – In general, the understory is fairly dense, with some very dense patches of rhododendron and hemlock. Also present in decreasing quantity are witch-hazel, striped maple, sassafras, sugar maple, low-bush blueberry, blackgum, red elderberry, and American chestnut sprouts. The sparse ground cover includes ferns (50%), grasses (30%), mosses (10%), and herbaceous perennials (white baneberry, horsebalm, spotted knapweed, wild sarsaparilla, starflower, Solomon's seal, and partridgeberry. Vines (poison ivy, grape, Virginia creeper) are sparse and currently not problematic, except in the small patch just north of Mountain Road. Grape, Japanese stiltgrass, and hay-scented fern are poised to colonize any future gaps. This unit is probably the most healthy and diverse, both in structure and species composition. It has a wide variety of both hardwood and conifer species with a relatively healthy understory. The major problems lie in the presence of invasive species and lack of hardwood regeneration.

2016 Forest Inventory Summary (Forest Floor):



Species Composition of Regeneration-seedlings per acre- (left) Picture of red maple dominated plot (right)

TPA Species	Size Class Competitive	Established	New Seedling	Sapling	Stand Total
red maple	2,000	3,000	1,333	-	6,333
sweet birch	1,500	1,833	-	667	4,000
black gum	667	833	-	-	1,500
sassafras	-	500	500	-	1,000
yellow poplar- mountai	-	-	500	-	500
white ash	333	-	-	-	333
n. red oak	167	167	-	-	333
Other or unknown live	333	-	-	-	333
Stand Total	**5,000**	**6,333**	**2,333**	**667**	**14,333**

Regeneration Summary by Size Class Rating

RECOMMENDATIONS

The following recommendations are arranged by key themes and were developed for your consideration. Most concepts outlined within this section of the plan are applicable to the entire Sanctuary. Each recommendation has economic, social, and environmental influences and consequences that need to be carefully considered. In some circumstances, recommendations may conflict or adversely affect the results of one another based on a number of potential variables.

Forest Tending – Silvicultural Applications

Vegetation Management (Undesirable Competing Plants & Invasive Species Control)

1. Work to eliminate the concentration of non-native invasive plants and hay-scented fern occupying much of the growing space within the zone distinguished as the **Leading Invasive Edge**.

    - Contract a licensed forest pesticide applicator who is experienced with projects of this size and complexity to broadcast spray the area with an appropriate herbicide.
    - Annually monitor the treated area(s) to ensure control efforts are successful.
    - Follow-up tending work will likely be needed in which HMS staff and volunteers will want to selectively treat missed patches of undesirable species or newly developing cohorts that seed in afterwards
    - Consideration may be given to performing enrichment plantings protected by small-scale woven-wire fencing to help restore understory site conditions with increased species diversity.

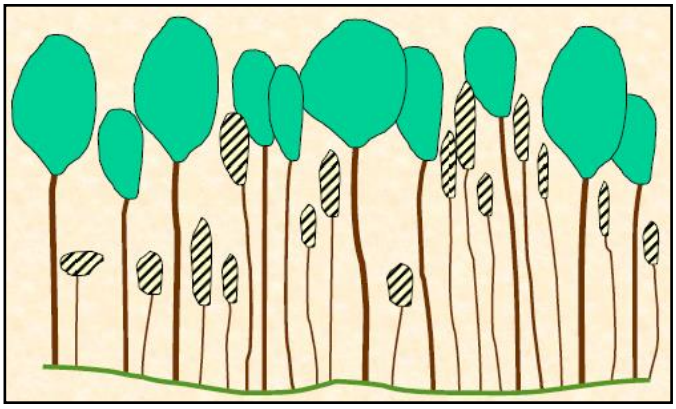
2. Eliminate tree-of-heaven that has established sporadically throughout the Sanctuary

    - Use inventory data and field notes to map out known locations of tree-of-heaven.
    - During the late summer, chemically poison the trees and monitor annually to ensure adequate control.
        - Give priority to seed-producing stems, treating with hack-and-squirt approach
        - Smaller trees can be treated with either a basal stem application or foliar treatment

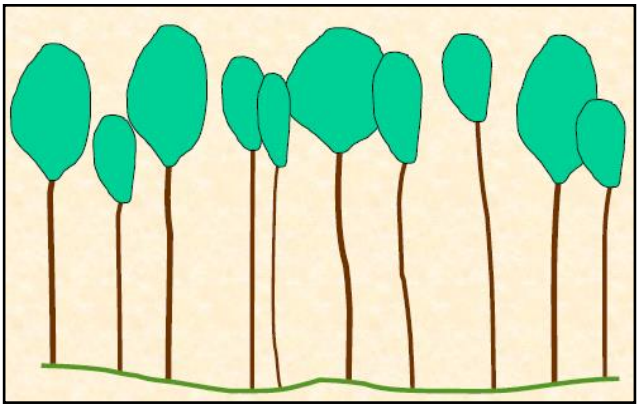
Graphic Image & Photograph portraying hack-and-squirt treatments

Intermediate Forest Cleanings and Thinnings

Low to moderate intensity thinnings are well suited for achieving Hawk Mountain Sanctuary habitat (*structural complexity*) and forest health objectives (*species diversity*). The approach is to cut undesirable trees, vines, and shrubs that are either directly competing with established desirable trees or are contributing to casting low-shade, which negatively impacts regeneration and stand development. Depending on location, forest conditions, and size of the treatment area, this silvicultural activity could be performed as a commercial operation.



Low Intensity Thinning (Marked)



Low Intensity Thinning (Completed)

Most-Relevant Scenarios:

1. Considering the extensive upper canopy crown dieback and increased tree mortality throughout the Sanctuary, this approach could be focused on 'tending' to improve existing canopy gaps. Give priority to **canopy gaps** that exhibit the **highest stocking of desirable regeneration** (refer to map depicting established and competitive hardwood regeneration).
    - Manually fell and/or hinge-cut all undesirable large sapling and pole-sized trees to improve lighting to accelerate growth on desirable regeneration and adjoining desirable trees.

2. Recruit y**ellow poplar** regeneration by strategically creating adequately sized gaps that are receptive to seedling establishment downwind of known yellow poplar cohorts and seed sources.
    - Use inventory data and field notes to map out known locations of seed-producing yellow poplar.
    - Layout and develop ¼-acre or larger units that are free from competing vegetation using the same techniques described above.

3. Multiple cohorts of established w**hite pine** seedlings and saplings were documented within the lower midstory of the forest during the 2016 inventory.
    - Improve lighting for the white pine resource by reducing competing upper midstory stems which is primarily pole-sized black birch, red maple, sassafras, striped maple, and witch-hazel.
    - Refer to appendix documents.

Annual Allowable Cut

Defined as:
The volume of timber that may be harvested during a given period (usually a year) that is specified by a sustained-yield forest plan (*The Dictionary of Forestry*)

The amount that can be harvested over time without cutting more than the net growth (*Ecology and Management of Central Hardwood Forests – Ray Hicks*)

This estimate serves as a guiding document for ***Annual Allowable Cut*** on the Hawk Mountain Sanctuary Property. The table below summarizes volume and estimated growth of forested stands as described in the 2016/2017 Forest Management Plan.

CURRENT CONDITIONS 2017					ESTIMATED CONDITIONS 2027			
ID	Acres	Sawtimber BF/acre	Total Sawtimber BF	Percent Annual Growth	BF/acre YR 10	BF Growth/acre YR 10	BF Total Year 10	BF Growth Year 10 Total Increase
1	722	4,942	3,568,206	2.2%	6,143	1,201	4,435,246.00	867,122.00
2	1,509	3,037	4,582,161	2.2%	3,775	738	5,696,475.00	1,113,642.00
3	41	3,835	155,300	2.2%	4,757	922	192,658.50	37,341.00
4	20	234	4,677	2.2%	291	57	5,820.00	1,140.00
5	67	5,425	363,501	2.2%	6,744	1,319	451,848.00	88,373.00
TOTAL:			**8,673,845**				**10,782,047.50**	
	AV TOTAL BF/AC:		**3,677**		**AV TOTAL BF/AC:**		**4,517**	

Growth estimates in this document are based on analysis of the most recent USFS FIA data for similar forest stand types in Pennsylvania (2015). The estimated annual net growth rate across all forest types on timberlands in Pennsylvania was calculated at **2.2%**. Gross annual growth was calculated at **3.1%** while net annual loss due to mortality was estimated at **0.9%**.

For this analysis, percent change in board foot volume by species over a 5-year period was used to calculate growth and annual growth rate for FIA data. An average annual growth rate was calculated across all species, yielding an estimate **2.22%** annual increase in board foot volume. This rate was used to estimate 10-year volume increases on the Hawk Mountain Sanctuary property. **To increase accuracy and include projected loss from mortality, this exercise should be recalculated following the results of the growth analysis for carbon sequestration.**

Assuming FIA derived growth rates are reasonably accurate, **annual volume growth averages 85 board feet per acre across all 5 Stand types**.

HMS staff and board members do not prefer or anticipate commercial timber harvesting to occur within their ownership now or in the foreseeable future. If this preference changes and commercial timber harvesting were to be considered and permitted, there are numerous opportunities to implement silvicultural prescriptions through commercial harvests. Given the current stocking volume, timber quality/potential, and growth rates, an **Annual Allowable Cut of 1.2Mbf/acre on area scheduled 20 year cutting cycle could be instituted**. A 20-year cycle would permit harvesting on approximately 118 total acres per year (5%*2,356 acres). Scheduled harvest areas can be made up of numerous non-contiguous sites, so long as the total harvest area does not exceed 118 acres per year. **Harvests should not exceed 1.3Mbf/acre or 153Mbf total on the 118 acre annual cut sites.** This acreage and rate of removal maintains the estimated Annual Allowable Cut, **removing less than 62 board feet per acre per year overall.** This total is well below the estimated average annual 85 board foot growth per acre.

Mature and maturing oak trees on the Sanctuary property are at risk from several stress factors including: defoliating insects, fungal pathogens and advanced age. In the event that a salvage harvest is considered to recoup value of declining oak of sawtimber size and quality, an exception to the 118 acre area scheduled *AAC* may be necessary. That is, oak salvage volume may exceed the annual allowable cut. This would only apply to severely declining but still live salvage candidates. It may be possible to "bank" board footage from past years within the cutting cycle where harvests did not occur.

Table 2 Analyzed FIA Data Summary Table

Species	2015 Volume Million Board Feet	Percent Change 2010 to 2015	5 Year Growth	2010 VolumeMillion Board Feet	Annual 10 Year Growth Rate
Red Maple	17,869.00	9.90	1,769.03	16,099.97	2.11%
Black Cherry	13,247.00	9.10	1,205.48	12,041.52	1.93%
Northern Red Oak	15,035.00	12.50	1,879.38	13,155.63	2.71%
Sugar Maple	8,475.00	10.20	864.45	7,610.55	2.18%
Chestnut Oak	7,356.00	7.60	559.06	6,796.94	1.59%
Hemlock	5,802.00	13.40	777.47	5,024.53	2.92%
Yellow-Poplar	8,030.00	10.50	843.15	7,186.85	2.24%
White Ash	5,610.00	8.40	471.24	5,138.76	1.77%
Sweet (Black) Birch	3,121.00	9.10	284.01	2,836.99	1.93%
White Oak	5,756.00	7.90	454.72	5,301.28	1.66%
Other Softwoods	5,912.00	13.70	809.94	5,102.06	2.99%
Other Hardwoods	20,883.00	10.80	2,255.36	18,627.64	2.31%
All Species	**117,094.00**	**10.40**	**12,177.78**	**104,916.22**	**2.22%**

Recommendations on White-tailed Deer Management

Quality Deer Management Approach

White-tailed deer (*Odocoileus virginianus*) are the most popular big game species in North America and one of the focal species for managing in this forest dominated property. A successful deer management program is developed through science-based strategies that create and maintain high quality habitat while regulating deer populations through adequate annual harvest levels. Historically, deer managers concentrated on increasing deer populations by protecting antlerless deer from harvest. Recent research has demonstrated that the overall quality of a deer herd can be improved through management practices commonly referred to as quality deer management (QDM). Numerous landowners and hunting clubs across the United States have successfully adopted this approach to managing white-tailed deer populations. An increasing number of Pennsylvania deer hunters and landowners are interested in the potential for implementing QDM strategies on property they hunt or own. Quality deer management promotes the philosophy of managing deer herds in a biologically and socially sound manner within the existing habitat conditions in an area. QDM is not trophy deer management, where the emphasis isplaced on producing bucks with trophy-sized antlers, nor is QDM a program that promotes shooting only does. QDM simply encourages active participation of landowners and hunters in establishing and achieving defined deer management goals.

QDM strives to produce healthy deer herds in balance with existing habitat conditions by protecting young bucks from the harvest and ensuring an adequate number of antlerless deer are harvested. A recommended antlerless harvest is determined by the following criteria:

- Deer density (number of deer in an area)
- Sex ratio (number of bucks relative to the number of does in an area)
- Habitat condition
- Landowner objectives

HERD MANAGEMENT
HABITAT MANAGEMENT
HUNTER MANAGEMENT
HERD MONITORING

Hunters who adopt and practice QDM become the managers of the deer herd by improving the age structure (allowing bucks to survive to maturity) and sex ratio, managing the habitat, and keeping detailed records on deer observed and harvested to ensure program success. In essence, QDM promotes sound deer management. Every area or property has its limitations. Property size, landscape context, habitat quality, soil productivity and land-use practices influence management decisions.

Determining Deer Management Goals

Scientific research suggests that the average home range of a white-tailed deer is approximately 1 square mile (640 acres). To be successful and have a meaningful effect on managing a local deer herd, landowners must work together cooperatively. Implementing a QDM program takes time and commitment among landowners and hunters. Changing the quality of the deer herd and improving the quality of available habitat may take quite a few years to accomplish. The ability to communicate goals and objectives and work with others is essential. The first step is to set realistic goals and collect appropriate data to help guide management decisions. Every group should strive to attain the following goals:

- Collect and record data, including the age and weights of harvested deer
- Maintain the deer population within the carrying capacity of available habitat
- Improve the buck-to-doe sex ratio
- Improve the age structure

Deer Management Recommendations

As part of a strategy to improve local white-tailed deer herd health, balance the buck to doe ratio, and reduce the severity of deer browse impacts on regeneration, Hawk Mountain Sanctuary should join the Quality Deer Management Association and work with its hunting constituents, including adjoining neighbors to apply the principles and practices of Quality Deer Management to the local properties.

Collaborative Deer Management:

1. Communicate with the adjoining neighbors on your forest condition objectives. Inform them of the activities taking place and try to obtain their support in managing the local deer population through increased antlerless harvesting.
2. Educate yourself on Quality Deer Management and how the Quality Deer Management Association's Cornerstones of Deer Management can be applied to your property (www.qdma.com)
3. Subscribe to the Quality Deer Management Association (refer to the enclosed Quality White-tails Magazine)

Private Hunting Lease

The Hunting Industry is considered to contribute $1.6 billion dollars to Pennsylvania's economy (2013). A core element is the steadily increasing demand for recreational leasing, whereby hunting groups are willing to pay significant dollar amounts to access private hunting land. Hawk Mountain Sanctuary is well positioned to capitalize on this market considering its location, the size of its forest, local deer population, access, and accommodations that could be provided through its facilities. A strategically crafted and properly advertised and managed hunting lease could generate meaningful revenue. Obtaining $10 to $20 per acre for a restrictive hunting lease may be within reason, especially if HMS facilities are utilized for overnight accommodations and select trails permitted for ATV use. The benefit of working through a private hunting lease can be numerous and in addition to generating a new revenue stream, the lease terms can add pressure or incentivize increased harvesting of antlerless deer. In contrast to allowing public hunting, the span of control obtained through private hunt leases often results improved success in instituting the principles of QDM, particularly annual harvest objectives and generates revenue.

Enrollment into Public Access Program (Forest Game Cooperator)

Consideration may be given to enrolling the Sanctuary or portions of its ownership into the Game Commission's Public Access Program. Participating landowners can select the game species that are permitted to be hunted and restrict seasons. Benefits include increased Wildlife Law Enforcement and access to Habitat Incentive Project funding that could be leveraged to help implement vegetation management and precommercial forestry operations at a meaningful scale.

For more information visit Hunter Access Programs website.

Special Youth Mentored Hunt Event

There is a growing movement to connect youth and women with the outdoors through mentored hunting events. Hawk Mountain Sanctuary would be an ideal location to hold such an event in partnership with Cabela's and the Quality Deer Management Association. Such an event could also be used to develop new donor prospects and fundraise for stewardship activities. The Quality Deer Management Association has a full-time staffer devoted to working with interested cooperators to design and execute mentored youth hunts across the United States.

For more information contact:

Hank Forester
Youth Programs Coordinator/Hunting Heritage Program Manager
Quality Deer Management Association
1-800-209-3337
hforester@qdma.com

Continuing Education: QDMA's Deer Steward Program

A three-tiered White-tailed Deer Steward educational program has been established by the Quality Deer Management Association. Courses are offered electronically or over a multiple day period each summer at a selected field location.

- Deer Steward I provides participants with a comprehensive understanding of the key principles of deer and habitat biology, ecology, and management.
- Deer Steward II teaches students how to apply the principles learned in level one through hands-on and field experience.
- Deer Steward III, the most prestigious, must be earned through an individual's long-term service to practicing Quality Deer Management.

Course instructors are certified wildlife biologists who specialize in white-tailed deer management.

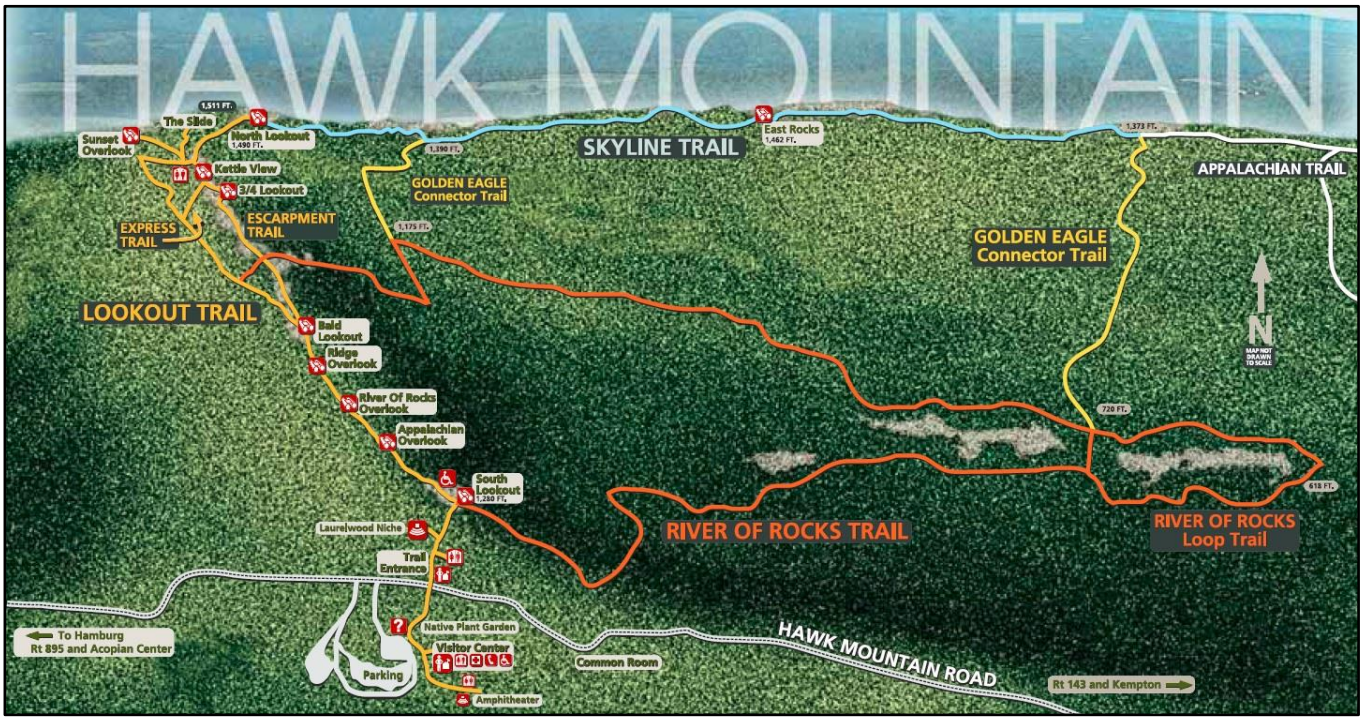
For more information, refer to www.qdma.com/corporate/deer-steward-courses

- David Barber and other Hawk Mountain Sanctuary staff may benefit from participating in these courses

Summary

The amount of forage and browse within the local forested landscape is limited. Nearby agricultural lands and food plots may serve to inflate the carrying capacity of the land through artificial foods (crops) that attract and benefit deer throughout portions of the year. Typically, when those food sources are exhausted, overwintering deer congregate and rely upon interior forest browse. Decades of high deer populations resulted in browse impacts that suppressed desirable new growth from establishing and advancing. In more recent decades, encroachment of undesirable vegetation, most of which is less preferred or unpalatable to deer, now occupies more of the growing space. The availability of light reaching the forest floor has and continues to increase with increased canopy gaps associated with storm damage and pest and disease induced tree mortality. Even with lighting conditions being improved for promoting new growth, desirable vegetation is unlikely to establish without proactively reducing interfering competing plants while simultaneously reducing and maintaining deer numbers at a level (<12 deer per square mile) viewed by area residents and stakeholders as unacceptable and too low.

Deer fencing is a costly investment, however for the Hawk Mountain Sanctuary– it may prove the most critical tool required in highest priority areas to help ensure a desired forest condition outcome over the long-term.



Hawk Mountain Sanctuary Trails Map

Forest Trails

A major attraction showcased on the Hawk Mountain Sanctuary website and visitor information pamphlets is its 8-miles of well-defined hiking trails. This extensive network of trails features nearly a dozen scenic lookouts, multiple loop hikes, and sections designated as handicap/wheelchair accessible. The trails are monitored bi-annually by Hawk Mountain staff for tree falls or hazards. Trails are marked with paint colors on rocks or trees to ensure visitors remain on the trails and trail junctures are marked with posts.

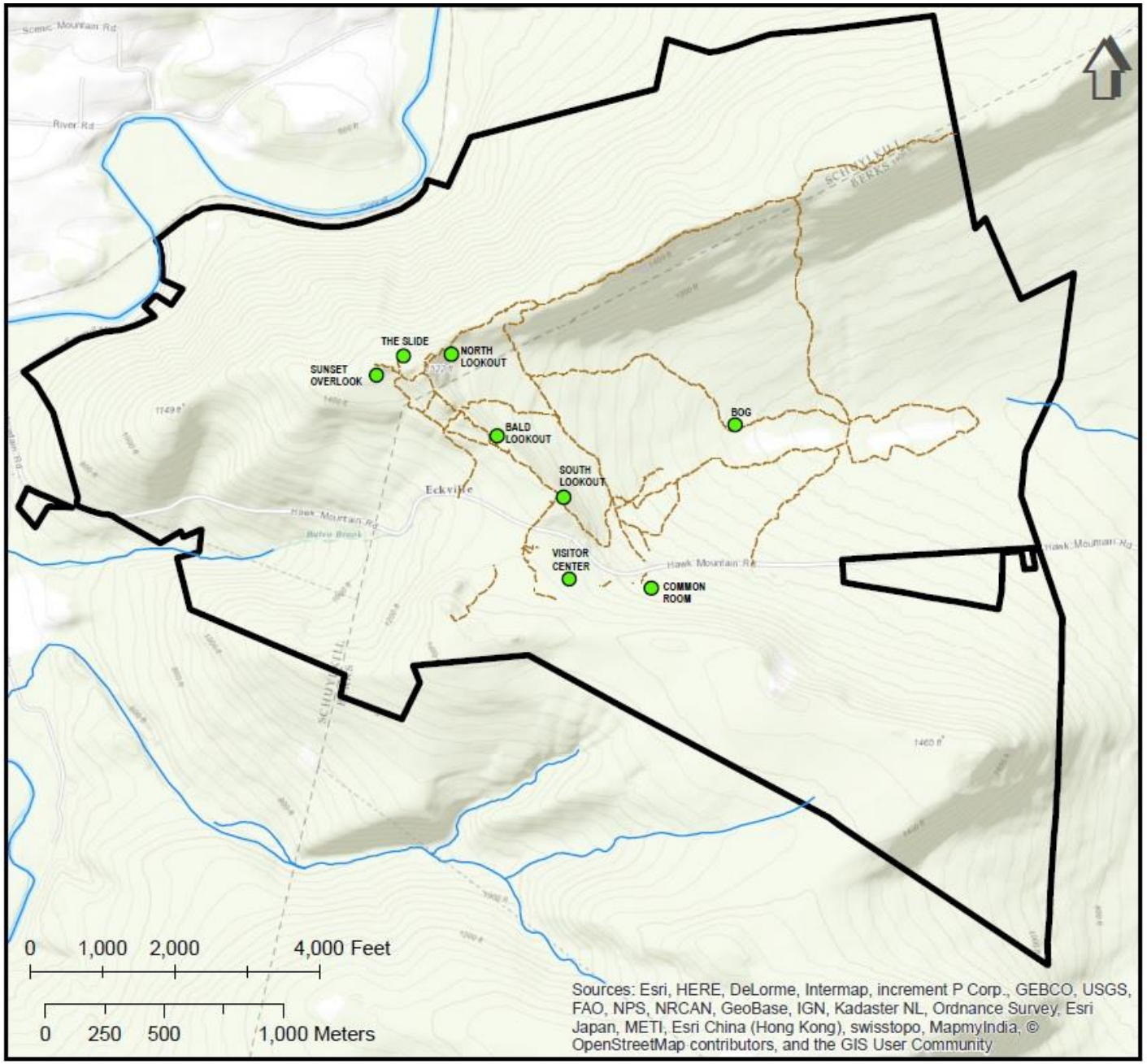
Recommendations for Monitoring for Hazardous Trees

1. The forest areas encompassing the high-use portions of trail network should continue to be thoroughly evaluated annually, in an effort to detect and remove hazardous trees that could pose a risk or danger to the Sanctuary's visitors, staff, and interns, along with its buildings and infrastructure.

2. Designate one Sanctuary staff as Forest Health Monitor or contract the services of a professional forester to perform these specified duties to minimize liability
    - Within the contract, define cutting and brush management parameters that minimize visual impacts

A. Proposed Duties for Internal Staff Forest Health Monitor:
- Gain knowledgeable and awareness of current forest health issues relevant to Southeastern Pennsylvania's Ridge and Valley Forests.
- Lean how to assess and rate individual tree health characteristics and be aware of current and emerging forest pests, diseases, invasives, and stress agents that influence their monitoring responsibilities.
- Attend Penn State's Annual Forest Health meeting to obtain relevant information on these subject matters and take lead in communicating with local service forester, Steve Ziegler.
- Responsible for coordinating annual forest health and hazardous tree assessments within Hawk Mountain Sanctuary areas zoned as High Intensity Visitor Use

FEATURES MAP



Date: 5/6/2017

Hazard Tree Reduction

In consideration of human safety, designate dead or dying trees (less than 20% live crown foliage and trees larger than 10 inches dbh) within 60 feet of main visitor trails (i.e. between Visitor Center and North Lookout)for removal; keep or create snags where possible to improve wildlife value and conserve natural forest features.

- Develop protocol for cutting and management of site that reduces impacts on forest, reduces invasive plant opportunities, and minimizes visual impacts define cutting and brush management parameters that minimize visual impacts

- Tree material could be processed and used, advertised and sold as firewood, or some left on forest floor to promote additional wildlife habitat.

Enrichment Plantings (Enhance Aesthetics & Increase Shrub Species Diversity)

Reduce the visual impacts associated with hazard tree removal by spot planting site appropriate shrubs native to Hawk Mountain. Plant a variety of species that have an affinity for specific micro-site conditions found at site (dry versus wet)

- Planting site preparations may be required through chemical applications (e.g., Glyphosate) to reduce competing plants
- Install one or two small (10'x10') woven-wire deer exclosures, also referred to as cribs to protect planted shrubs along with desired natural regeneration. These small exclosures can also be used to monitor vegetation development without deer brose impact.
  - Refer to article entitled Can small deer exclosures work? (Appendix)

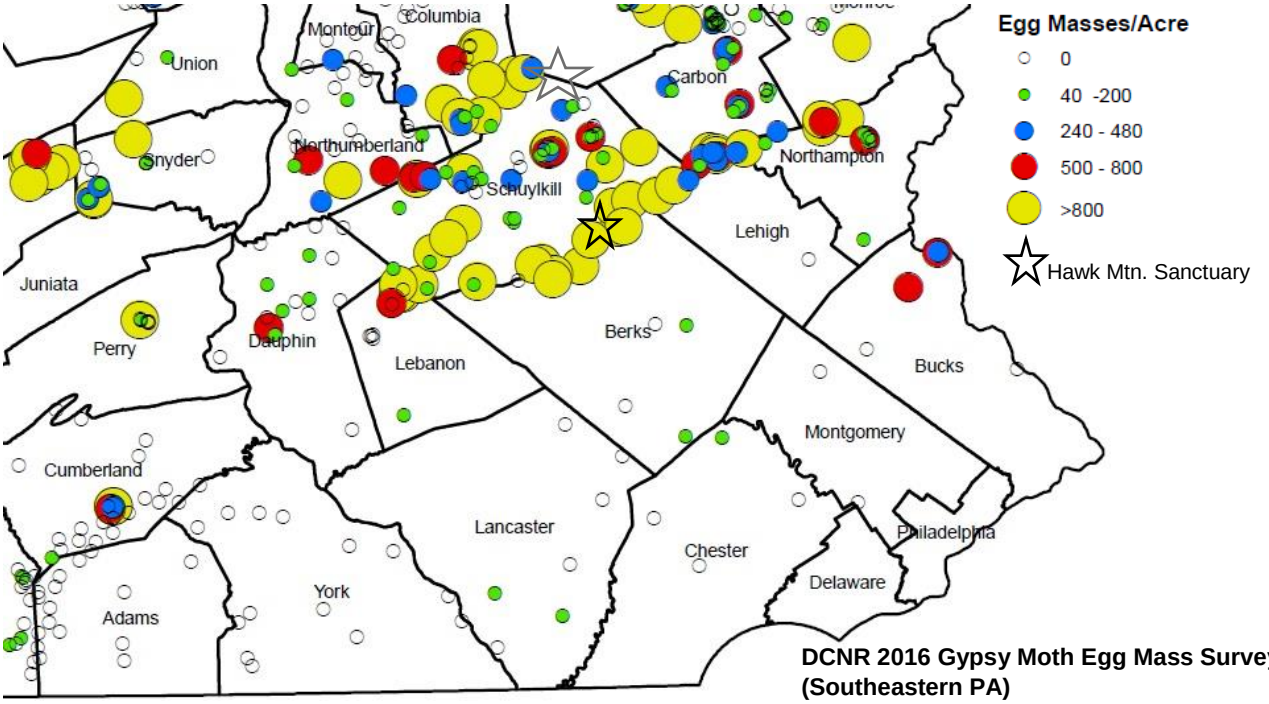
Provide Informational Signage for Visitors using Trails

An array of information relating to Hawk Mountain Sanctuary and hiking rules and regulations is available on the website and is available on signs placed at trail gate, in parking area, and at Visitor Center., Non-member visitors must purchase a trail pass for entrance and at that time they can obtain a trail map and ask questions or learn about sanctuary rules and educational programs.
The following Rules & Regulations are to be followed by Visitors to Hawk Mountain

- No firearms within the Sanctuary
- No Pets
- No Drones
- No smoking, radios, alcohol, bikes, camping, or fires
- Cell phones must be set to vibrate
- Carry-in and carry-out materials; Leave no trace
- Trails close at dusk
- Must remain on trails at all times
- Be courteous of other hikers
- Immediately report any first-aid emergency
- Employees cannot offer transportation for any visitors

Forest Health Monitoring

1. Develop an approach to monitor and quantify gypsy moth and other forest defoliator populations within the Sanctuary to help inform forest management decisions and activities. Remain engaged with Pennsylvania Bureau of Forestry to anticipate upcoming threats and recommended approaches. Establish database to keep long-term records on forest health issues, rainfall, etc. Create Hawk Mountain forest advisory group to work with Director of Land and Facilities to seek diversity of input when questions or challenges arise.



DCNR 2016 Gypsy Moth Egg Mass Survey (Southeastern PA)

Social Monitoring

Hawk Mountain is engaged with many communities of people that are important to its mission. The Sanctuary is governed by a 20-member Board of Directors while the day to day operations are overseen by a President. As of 2018, 17 full-time staff conduct programs and maintain the facilities assisted by seasonal or part-time staff. A world-renown conservation science training program invites more than 12 young biologists to the Sanctuary annually and a newly established education internship program brings another 4 to 5 young individuals for training. They assist with sanctuary programs as well. A 200-member volunteer corp assists staff with various activities including forest management.

As a non-profit supported by 9,000 members, the Hawk Mountain membership is vitally important to the mission. Hawk Mountain informs the membership of its decisions and activities through the bi-annual Hawk Mountain News and through weekly “e-updates’ that go out to any member or non-member subscribing to receive the emailed update. Another important community at Hawk Mountain is the visitors. Hawk Mountain welcomes approximately 75,000 to 80,000 visitors annually with large numbers visiting during autumn months. The visitors use the trails and facilities and appreciate the wild experience that Hawk Mountain forests provide. Visitors that are not members pay a trail fee that helps Hawk Mountain maintain trails and facilities in top-notch condition. Visitors are informed about rules and management conditions (e.g. deer hunting) by signage in Visitor Center and on the website.

Hawk Mountain also stays engaged with the local township supervisors and the township residents as various staff attend meetings and are involved in the communities. The local fire companies provide fire and rescue on site and the Director of Land and Facilities keeps in touch with their leadership to ensure their concerns are addressed. Wider engagement occurs by maintaining good relationships with the two county governments, Berks and Schuylkill counties as well as the state of Pennsylvania natural resource agencies. The Sanctuary President and staff invite representatives to function and maintain dialog as needed and staff serve of advisory boards for state and county level groups (e.g. Pennsylvania Biological Survey).

Glossary of Terms

The following glossary of terms was adapted from "A Guide for Foresters and other Natural Resource Professionals on using: Managing Your Woodlands: A template for your plans for the future." by The American Tree Farm Program, February 21, 2011.

Acceptable Growing Stock (AGS): Saleable trees that are of good form, species and quality and would be satisfactory as crop trees.

Adaptive management: A dynamic approach to forest management in which the effects of treatments and decisions are continually monitored and used to modify management on a continuing basis to ensure that objectives are being met (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Adverse regulatory actions: Written warning, citations or fines issued by law enforcement or regulatory bodies.

Aerial Photo: Photo taken from an elevated position like on an aircraft.

Afforestation: the establishment of a forest or a stand in an area where the preceding vegetation or land was not forest. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Age Class: A distinct aggregation of tree that originated at the same time, from a single natural event or regeneration activity or a grouping of trees (e.g. ten year age class) as used in inventory or management. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Aspect: The direction that a slope faces (north, south, etc.)

Basal Area: The cross-sectional area of a tree, in square feet, at 4.5 feet from the ground (at breast height). When the basal area of all the trees in a stand are added together, the result is expressed as square feet of basal area per acre, which is a measure of a stand's density.

Biomass: A renewable energy source of biological materials derived from living, or recently living organisms, such as wood, waste, and crop residues.

Biodiversity: The variety and abundance of life forms, processes, functions and structures of plants, animals and other living organisms, including the relative complexity of species, communities, gene pools and ecosystems at spatial scales that range from local through regional to global (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998).

Board Feet: A unit for measuring wood volumes. It is commonly used to express the amount of wood in a tree, sawlog, or individual piece of lumber. A piece of wood 1 foot long, 1 foot wide, and 1 inch thick (144 cubic inches).

Broadcast: to spread or apply seed, fertilizer, or pesticides more or less evenly over an entire area. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Canopy: The more or less continuous cover of branches and foliage formed collectively by the tops, or crowns of adjacent trees.

Carbon sequestration: the incorporation of carbon dioxide into permanent plant tissue. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Chip: a small piece of wood used to make pulp or wood composite or fuel. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Clearcut: 1. a stand in which essentially all trees have been removed in one operation – *note* depending on management objectives, a clearcut may or may not have reserve trees left to attain goals other than regeneration. 2. a regeneration or harvest method that removes essentially all trees in a stand. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Crop Tree: A tree identified to be grown to maturity for the final harvest cut, usually on the basis of its location with respect to other trees and its timber quality.

Cull: A tree, log, lumber or seedling that is rejected because it does not meet certain specifications for usability or grade. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Den Tree: A living tree with a cavity large enough to shelter wildlife.

Desired species: Those species of flora and fauna designated in the landowner's management plan and not known to cause negative impacts on the local environment.

Diameter Breast Height (DBH): The diameter of a tree at 4.5 feet above the ground.

Endangered Species: Any species of plant or animal defined through the Endangered Species Act of 1976 as being in danger of extinction throughout all or a significant portion of its range, and published in the Federal Register. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Even-Aged Management: Forest management with periodic harvest of all trees on part of the forest at one time or over a short period to produce stands containing trees all the same or nearly the same age or size.

Forest product: [Forest Produce] Any raw material yielded by a forest. Generally defined in Forest Acts or Ordinances, and subdivided conventionally into major forest products, i.e. timber and fuelwood, and minor forest products, i.e. all other products including leaves, fruit, grass, fungi, resins, gums, animal parts, water, soil, gravel, stone and other minerals on forest land (F. C. Ford –Robertson, Terminology of Forest Science Technology, Practice, and Products, Society of American Foresters, 1971.

Forest Stand Improvement: See timber stand improvement.

Forest type: A category of forest usually defined by it trees, particularly its dominant tree species as based on percentage cover of trees, e.g. spruce fir, longleaf-slash pine, Douglas fir.

Forest vitality: The health and sustainability of a forest.

Fuel management: the act or practice of controlling flammability and reducing resistance to control of wildland fuels through mechanical, chemical, biological, or manual means, or by fire in support of land management objectives. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Group Select: trees are removed and new age classes are established in small groups – *note* – 1. the width of groups is commonly approximately twice the height of the mature trees with smaller openings providing microenvironments suitable for tolerant regeneration and larger openings providing conditions suitable for more intolerant regeneration – *note* 2. the management unit or stand in which regeneration, growth, and yield are regulated consists of an aggregation of groups. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Girdling: Completely encircling the trunk of a tree with a cut that severs the bark and cambium of the tree. Herbicide is sometimes injected into the cut to ensure death of the tree.

GPS (Global Positioning System) Coordinates: a commonly hand held, satellite based navigational device that records x, y, z coordinators and other data allowing users to determine their location on the surface of the earth. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Hack-n-squirt: A tree treatment method where an axe or hatchet is used to make "hacks" (injections) into the tree's cambium layer. A plastic "squirt" bottle is used to spray a specific amount of herbicide into the cuts placed around the tree.

Harvesting: the felling skidding, on-site processing, and loading of trees or logs onto trucks. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

High conservation value forests (HCVF): Forests of outstanding and critical importance due to their environmental, social, biodiversity or landscape values. Due to the small scale and low-intensity of family forest operations, informal assessment of HCVF occurrence through consultation with experts or review of available and accessible information is appropriate.

High-grading: Cutting only the high-value trees from a forest property, leaving a stand of poor quality with decreased future timber productivity.

Incentive Programs: State and federal agencies will offer landowners the opportunity to apply for incentive programs that will provide support and financial assistance to implement forestry and agroforestry related practices through conservation programs. Assistance can also provided for multi-year and permanent easements to conserve forest land to meet program goals. For more information on the federal incentive programs, see Appendix 4.

Integrated Pest Management: The maintenance of destructive agents, including insects, at tolerable levels by planned use of a variety of preventative, suppressive, or regulatory tactics and strategies that are ecologically and economically efficient and socially acceptable (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998). A pest control strategy that uses a variety of complementary strategies including: mechanical devices, physical devices, genetic, biological or cultural management and chemical management (US EPA).

Intermediate Cut: Removing immature trees from the forest sometime between establishment and stand harvest to improve the quality of the remaining forest stand. Contrast this technique with a harvest cut.

Invasive species: Non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112 (Feb. 3, 1999). **Invasive Species**: is a species that is 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., insects, microbes, etc.). Human actions are the primary means of invasive species introductions. (Invasive Species Definition Clarification and Guidance White Paper Submitted by the Definitions Subcommittee of the Invasive Species Advisory Committee (ISAC), Approved by ISAC Apr 27, 2006.)

Landings: a cleared are in the forest to which logs are yarded or skidded for loading onto trucks for transport. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Large woody debris: any piece(s) of dead woody material, e.g. dead boles, limbs and large root masses, on the ground in the forest stands or in streams. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Log Rules: A table showing estimated amount of lumber that can be sawed from logs of given lengths and diameters. Two log rules are commonly used in Missouri: ***Doyle Rule*** is a simple formula rule used in the eastern United States. It underestimates the amount of lumber in small logs and overestimates large logs. ***International 1/4-inch Rule*** is a formula rule allowing 1/2 –inch taper for each 4 feet of length and 1/16-inch shrinkage for each one-inch board. This measure approximates the actual sawmill lumber tally.

Management plan: Documents that guide actions and that change in response to feedback and changed conditions, goals, objectives and policies. Management plans may incorporate several documents including, but not limited to, harvest plans, activity implementation schedules, permits, research, etc. For the purposes of the American Tree Farm System® eligible management plans, plan amendments may include letters, notes, and other forms of informal updates in addition to formal plan revisions.

Mast: Nuts of trees, such as oak, walnut, and hickory, that serve as food for many species of wildlife.

Mature Tree: A tree that has reached the desired size or age for its intended use.

MBF: Abbreviation for 1,000 board feet.

Noxious plant (weed): a plant specified by law as being especially undesirable, troublesome and difficult to control (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Nutrient cycle: the exchange or transformation of elements among the living and nonliving components of the ecosystem. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Overstocked: A forest stand condition where too many trees are present for optimum tree growth.

Overstory: That portion of the trees in a stand forming the upper crown cover.

Overstory removal: the cutting of trees constituting an upper canopy layer to release trees or other vegetation in an understory. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Pesticide: Pesticides include chemicals commonly known as herbicides and insecticides.

Pole Timber: Trees from 6 inches to 12 inches in diameter at breast height.

Prescribed Burn/Fire: To deliberately burn natural fuels under specific weather conditions, which allows the fire to be confined to a predetermined area and produces the fire intensity to meet predetermined objectives. A fire ignited by management to meet specific objectives (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998).

Pruning: Removing live or dead branches from standing trees to improve wood quality.

Pulpwood: Wood cut primarily for manufacture of paper, fiberboard, or other wood fiber products.

Rare species: A plant or animal or community that is vulnerable to extinction or elimination.

Reforestation: the reestablishment of forest cover either naturally (by natural seeding, coppice, or root suckers) or artificially (by direct seeding or planting) – *note* reforestation usually maintains the same forest type and is done promptly after the previous stand or forest was removed. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Regeneration: The number of seedlings or saplings existing in a stand. The process by which a forest is renewed by direct seeding, planting, or naturally by self-sown seeds and sprouts.

Regeneration Cut: Any removal of trees intended to assist regeneration already present or to make regeneration possible.

Release: To free trees from competition by cutting, removing, or killing nearby vegetation.

Riparian: related to, living or located in conjunction with a wetland, on the bank of a river or stream but also at the edge of a lake or tidewater – *note* the riparian community significantly influences and is significantly influenced by, the neighboring body of water. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Riparian Zone: The area adjacent to or on the bank of rivers and streams.

Sapling: Trees from 2 inches to 6 inches in diameter at breast height.

Sawtimber: Trees at least 12 inches in diameter at breast height from which a sawed product can be produced.

Seedling: a young plant.

Seed-tree Harvest: A harvest and regeneration method where nearly all trees are removed at one time except for scattered trees to provide seed for a new forest.

Selection Harvest: Harvesting trees to regenerate and maintain a multi-aged structure by removing some trees in all size classes either singly or in small groups.

Shelterwood Harvest: A harvesting and regeneration method that entails a series of partial cuttings over a period of years in the mature stand. Early cuttings improve the vigor and seed production of the remaining trees. The trees that are retained produce seed and also shelter the young seedlings. Subsequent cuttings harvest shelterwood trees and allow the regeneration to develop as an even-aged stand.

Single Tree Selection: Individual trees of all size classes are removed more or less uniformly throughout the stand, to promote growth of remaining trees and to provide space for regeneration. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Site Index: An expression of forest site quality based on the height of a free-growing dominant or co-dominant tree at age 50 (or age 100 in the western United States).

Skid: 1. to haul a log from the stump to a collection point (landing) by a skidder. 2. a load pulled by a skidder. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Skid Trail: A road or trail over which equipment or horses drag logs from the stump to a landing.

Skidding: Pulling logs from where they are cut to a landing or mill.

Slash: the residue, e.g., treetops and branches, left on the ground after logging or accumulating as a result of storm, fire, girdling, or delimbing. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Snag: a standing, generally un-merchantable dead tree from which the leaves and most of the branches have fallen – *note* for wildlife habitat purposes, a snag is sometimes regarded as being at least 10 inches in diameter at breast height and at least 6 feet tall; a hard snag is composed primarily of sound wood, generally merchantable, and a soft snag is composed primarily of wood in advanced stages of decay and deterioration. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Soil Compaction: The process by which the soil grains are rearranged, resulting in a decrease in void space and increasing bulk density. Can occur from applied loads, vibration or pressure from harvesting or site preparation equipment. Compaction can cause decreased tree growth, increased water runoff and soil erosion. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Soil map: A map showing the distribution of soils or other soil map units in relation to prominent physical and cultural features of the earth's surface. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Special sites: Those areas offering unique historical, archeological, cultural, geological, biological or ecological value. Special Sites include:

A. Historical, archaeological, cultural and ceremonial sites or features of importance to the forest owner;
B. Sites of importance to wildlife such as rookeries, refuges, fish spawning grounds, vernal ponds and shelters of hibernating animals;
C. Unique ecological communities like relic old-growth, springs, glades, savannas, fens and bogs; and
D. Geological features such as terminal moraines, cliffs and caves.

Stand: A group of trees with similar characteristics, such as species, age, or condition that can be distinguished from adjacent groups. A stand is usually treated as a single unit in a management plan.

Stand Density: A measure of the stocking of a stand of trees based on the number of trees per area and diameter at breast height of the tree of average basal area.

Stand Management Recommendations: The recommended management activities that should be done in that stand, based on the landowner's goals and objectives.

Stand Structure: The horizontal and vertical distribution of plants in the forest, including the height, diameter, crown layers, and stems of trees, shrubs, understory plants, snags and down woody debris. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

State forestry best management practice(s) (BMPs): Forestry BMPs are generally accepted forest management guidelines that have been developed by state forestry agencies with broad public stakeholder input.

Stocking: An indication of the number of trees in a stand in relation to the desirable number of trees for best growth and management.

Sustainability: The capacity of forests, ranging from stands to ecoregions, to maintain their health, productivity, diversity and overall integrity, in the long run, in the context of human activity (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998).

Sustainable forest management: The practice of meeting the forest resource needs and values of the present without compromising the similar capability of future generations (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998). *Note* – AFF's Standards of Sustainability reflect criteria of sustainability based on the Montreal Process, 1993, and the Pan-European Operational- Level Guidelines (PEOLGs).

Thinning: a cultural treatment made to reduce stand density of trees primarily to improve growth, enhance forest health, or recover potential mortality. Types of thinning include: chemical, crown, free, low, mechanical, selection. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Threatened Species: A plant or animal species that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future. A plant or animal identified and defined in the Federal Register in accordance with the Endangered Species Act of 1976. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Timber Stand Improvement (TSI): A thinning made in immature stands to improve the composition, structure, condition, health, and growth of the remaining trees.

Undesirable Growing Stock (UGS): Trees of low quality or less valuable species that should be removed in a thinning.

Understocked: Insufficiently stocked with trees.

Understory: all forest vegetation growing under an overstory. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Uneven-Aged Management or Stand: A stand of trees containing at least three age classes intermingled on the same area.

Volume: The amount of wood in a tree, stand of trees, or log according to some unit of measurement, such as board foot, cubic foot, etc.

Watershed: the area of land where all of the water that is under it or drains off of it goes into the same place. For example the Mississippi River watershed includes all the land that drains into the Mississippi River. This watershed is the fourth largest in the world and includes water from 31 states.

Wetland: A transitional area between water and land that is inundated for periods long enough to produce wet soil and support plants adapted to that environment. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)

Wolf Tree: A very large, overmature tree that is or was open grown. These trees tend to have large full crowns and numerous branches.

Woody Debris: Any piece(s) of dead woody material (e.g. dead tree trunk, limbs, large root ball) on the ground in the forest or in streams. (Helms et al, The Dictionary of Forestry, Society of American Foresters, 1998)