Conservation Enhancements for a Living Landscape

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2013 Conservation Activities
Edward L. Rose Conservancy

2013 Overview

In 2013 cooperative conservation and monitoring efforts involving the Cornell Conservation Education and Research Program and the Edward. L. Rose Conservancy focused on six overarching issues including: 1) continued expansion of forest inventory efforts; 2) research on the effects of natural gas pipeline development on forest amphibians; 3) hemlock woolly adelgid surveys, monitoring, control, education, and research; 4) baseline data collection for amphibians and reptiles through participation in the North American Amphibian and Reptile Monitoring Program and the Pennsylvania Amphibian and Reptile Survey; 5) forest stewardship and forest regeneration assessment; and 6) education and outreach. Through biological inventories, we continue to elevate the knowledge of biological communities on the Conservancy's fee-owned properties and surrounding areas. Two Cornell undergraduate students were formally incorporated into inventory and research activities through summer undergraduate internships funded by Cornell's Arnot Forest Internship Program and other sources of grant funding. In addition to biological inventories, Cornell students also assisted with outreach events for the public.

Environmental Monitoring Programs

North American Amphibian Monitoring Program

The North American Amphibian Monitoring Program (NAAMP) is a long-term monitoring program designed to track the status and trends of frog and toad populations. The program was created to coordinate national and local efforts to collect long-term data on amphibian populations across much of the United States. These efforts are coordinated by the U.S. Geological Survey and a network of Regional Coordinators with data collection conducted according to a scientifically peer-reviewed protocol. In 2013, with the help of Conservancy board members and volunteers, we conducted three surveys along the Montrose Route, a 5-mile route which begins at Montrose and continues north along Route 167 (Figure 1). Each survey entailed stopping for five minutes at each designated stop and recording the species heard as well as the calling intensity for each. Seven frog and toad species were detected during the surveys (Table 1).

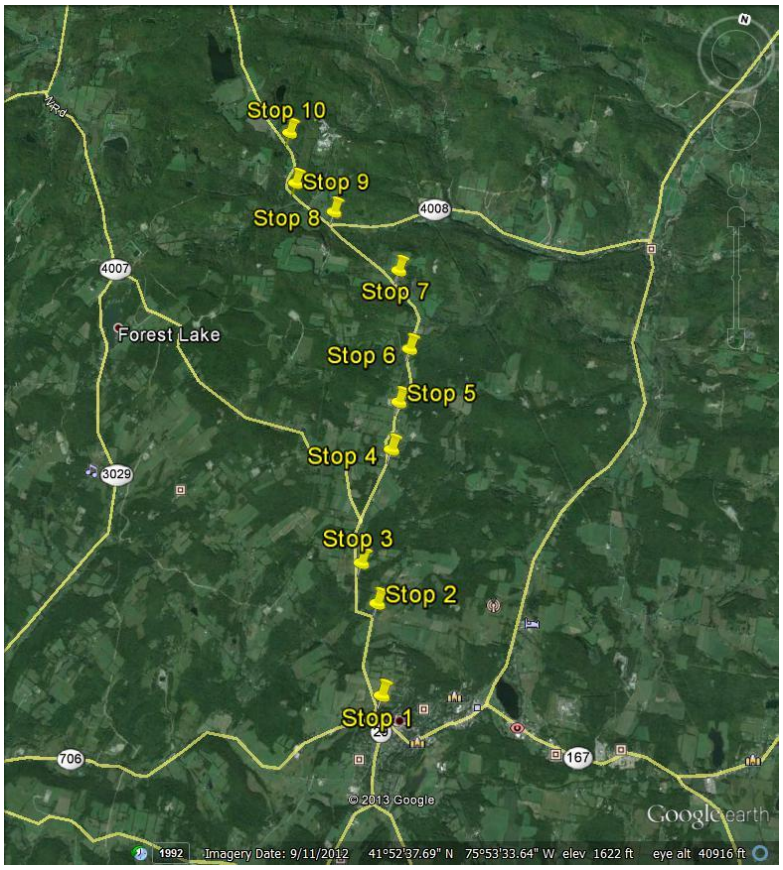


Figure 1. The Montrose NAAMP route includes 10 stops beginning at Montrose and running north along Route 167.

Table 1. Seven frog and toad species were detected along the Montrose Route during three surveys conducted in 2013.

Species	Stop 1	Stop 2	Stop 3	Stop 4	Stop 5	Stop 6	Stop 7	Stop 8	Stop 9	Stop 10
American Bullfrog *Lithobates catesbeianus*		X								
Eastern American Toad *Anaxyrus americanus*		X								X
Gray Treefrog *Hyla versicolor*			X		X	X	X			
Green Frog *Lithobates clamitans*										X
Pickerel Frog *Lithobates palustris*					X	X				
Spring Peeper *Pseudacris crucifer*	X	X	X		X	X	X		X	X
Wood Frog *Lithobates sylvaticus*					X	X				X

Pennsylvania Amphibian and Reptile Survey

The Pennsylvania Amphibian and Reptile Survey (PARS) was launched in 2013 with the goal of determining the distribution and status of all amphibians and reptiles throughout Pennsylvania, The project is a joint venture between the Pennsylvania Fish & Boat Commission (PFBC) and the Mid-Atlantic Center for Herpetology and Conservation (MACHAC), and relies on volunteers to find, and document locations for, amphibians and reptiles. Amphibians and reptiles are important animals found in just about every Pennsylvania landscape. Very little information about these animals has been collected through the years when compared to other groups of organisms. This is unfortunate as amphibians and reptiles are important indicators of the health of our natural places and the very presence of certain species can tell us much about an area.

The wood frog and the spotted salamander were detected during field surveys in 2013.

In 2013, Cornell conservation team members, interns and volunteers conducted amphibian and reptile searches several times at both Greenwood Sanctuary and Highpoint Preserve. We recorded nine species (Table 2) and submitted 74 total location records for the animals detected during these searches, as well as the animals detected through the NAAMP surveys. Our data comprises over 80% of the 92 total amphibian and reptile location records submitted by volunteers for all of Susquehanna County in 2013. We submitted records for 13 of the 28 total species recorded in the county.

Table 2. Nine species of amphibians and reptiles were detected during field surveys from May to August, 2013.

Scientific Name	Common Name	Greenwood	Highpoint
Ambystoma maculatum	Spotted Salamander	X	
Anaxyrus americanus	Eastern American Toad	X	X
Desmognathus ochrophaeus	Allegheny Mt. Dusky Salamander	X	X
Lithobates sylvaticus	Wood Frog		X
Lithobates clamitans	Green Frog		X
Notophthalmus viridescens	Eastern Newt	X	X
Plethodon cinereus	Eastern Red-backed Salamander		X
Plethodon glutinosus	Slimy Salamander	X	X
Thamnophis sirtalis sirtalis	Eastern Garter Snake		X

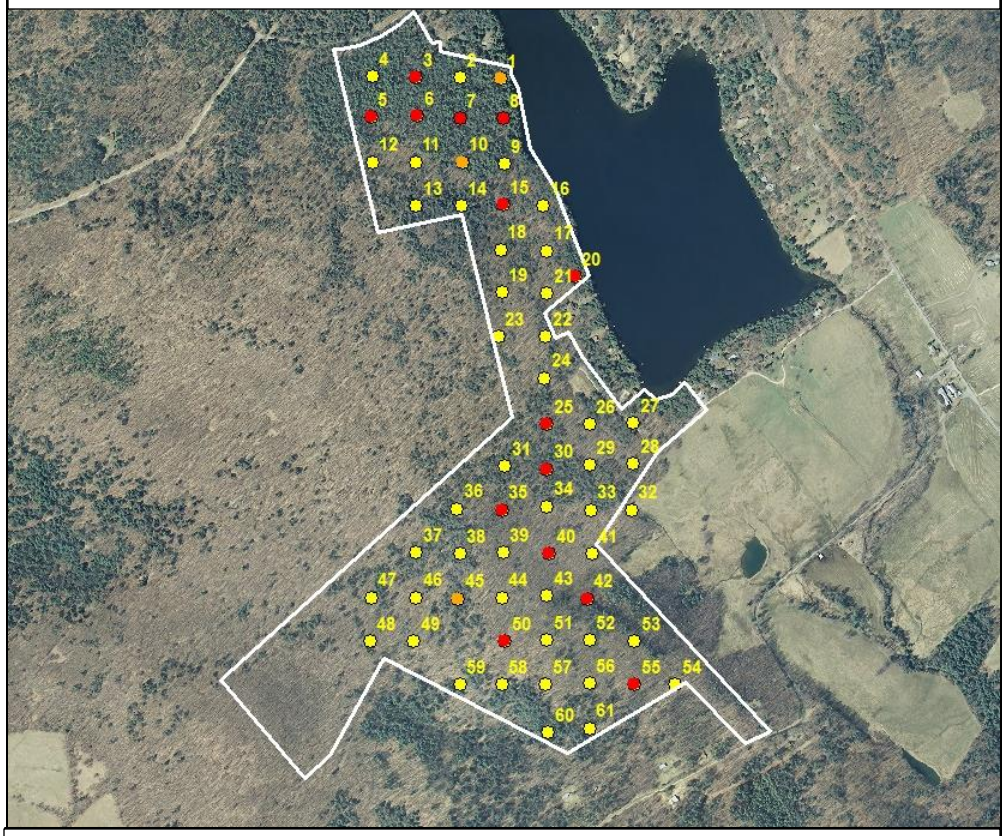
Permanent Forest Inventory Plots at Greenwood Sanctuary and Highpoint Preserve

Our natural environment is facing many different pressures today, including climate change, invasive plants and insects, emerging diseases, and forest fragmentation. By establishing Permanent Forest Inventory (PFI) plots, valuable information can be gathered on species composition, species distribution, presence of invasive pests, and other forest health indicators, for both current analyses and future comparisons.

Methodology

Given that hemlock woolly adelgid has been found at both Greenwood Sanctuary and Highpoint Preserve, we focused our inventory plot efforts on areas dominated by eastern hemlock this year. Baseline data in these areas will allow us to document effects of the inevitable mortality of at least a portion of the eastern hemlock growing on these sites. Two additional plots were inventoried at both Greenwood Sanctuary and Highpoint Preserve, bringing the total number of plots to 14 at Greenwood and 17 at Highpoint (Figure 2). The PFI plot methodology (Appendix A) is based on protocols we developed and implemented at Cornell University's Arnot Teaching and Research Forest. In addition to providing information on the current conditions, PFI plots will be used to monitor short- and long-term changes in forest health and composition.

Highpoint Preserve Permanent Forest Inventory Plots



Greenwood Sanctuary Permanent Forest Inventory Plots

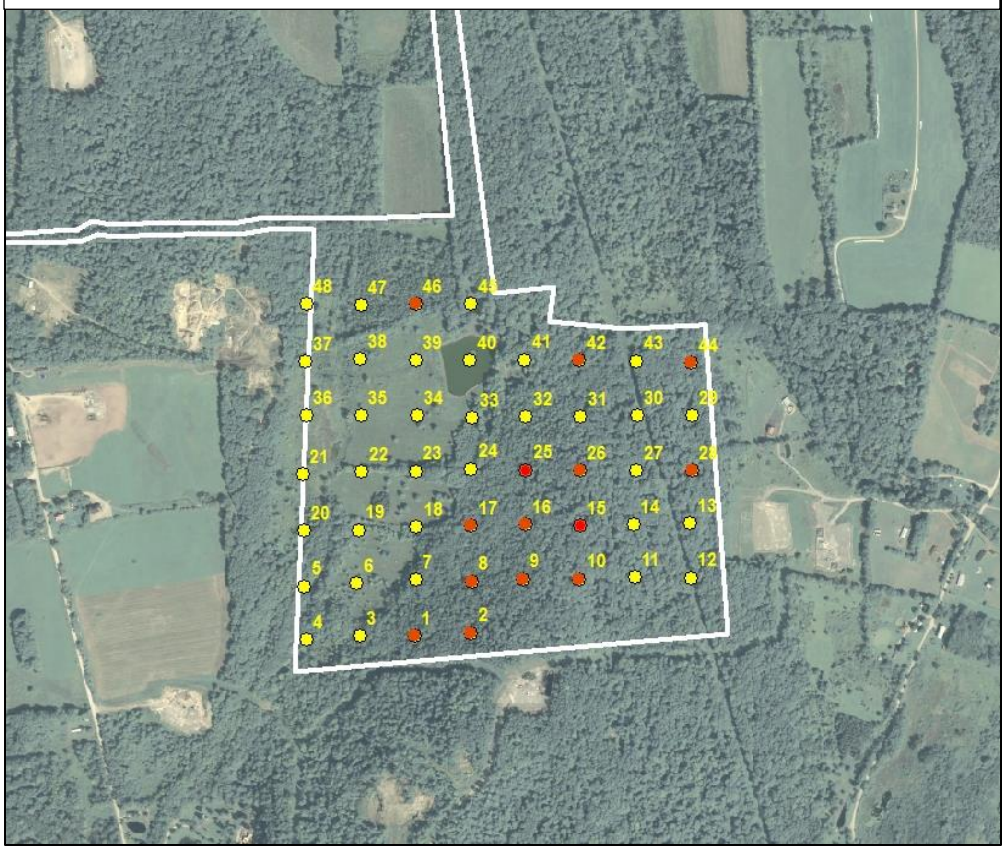


Figure 2. A total of 17 plots have been sampled at Highpoint Preserve, and 14 plots have been sampled at Greenwood Sanctuary.

LEGEND

- Plots sampled once
- Plots sampled twice
- Plots to be sampled

Greenwood Sanctuary Overstory and Understory Characteristics

In 2013, 104 overstory trees were recorded, measured, classified and tagged in two plots at Greenwood. Ten tree species were present within the new plots, bringing the total recorded number of species to 21. Species present include American basswood (*Tilia americana*), American beech (*Fagus grandifolia*), eastern hemlock (*Tsuga canadensis*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), black birch (*Betula lenta*), gray birch (*Betula populifolia*), yellow birch (*Betula alleghaniensis*), white birch (*Betula papyrifera*), black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), northern red oak (*Quercus rubra*), northern white oak (*Quercus alba*), eastern hop hornbeam (*Ostraya virginiana*), American hornbeam (*Carpinus caroliniana*), big tooth aspen (*Populus grandidentata*), quaking aspen (*Populus tremuloides*), white pine (*Pinus strobus*), red pine (*Pinus resinosa*), bitternut hickory (*Carya cordiformis*), and shagbark hickory (*Carya ovata*). Dominant species comprising 30% or more of the trees in one or more plots include eastern hemlock (6 plots), black birch (3 plots), quaking aspen (1 plot), red maple (1 plot), and sugar maple (2 plots) (Table 3).

At Greenwood, 17 different tree and shrub species have been recorded in the understory (Table 4). Thirteen of the 17 species growing in the understory were also observed growing in the overstory. American beech (12 of 14 plots) and white ash (11of 14 plots) were most prevalent in the understory. Bitternut hickory, hop hornbeam, red maple, and sugar maple were also common and were documented in at least 30% of the plots. The number of seedlings present in the plots varied and, although quite a few seedlings were present in some of the plots, very few (85 total) have grown to sapling size in the plots sampled. With relatively little sunlight reaching the forest floor due to a closed forest canopy, combined with moderate to heavy deer browsing, it is not surprising that the understory is not well-developed. Several herbaceous species of note were found in the understory plots including maidenhair fern, Christmas fern, trillium, blue cohosh, and jack-in-the-pulpit. Invasive species (garlic mustard, multiflora rose) were present in three of the 14 plots.

Table 3. Overstory tree composition (percent) of PFI plots at Greenwood Sanctuary; species comprising 30 percent or more of overstory trees in the plot are highlighted.

	PFI Plot Number													
Overstory Trees	**1**	**2**	**8**	**9**	**10**	**15**	**16**	**17**	**25**	**26**	**28**	**42**	**44**	**46**
American Basswood	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
American Beech	6.7	4.8	3.3	5.1	5.6	0.0	7.9	1.2	0.0	0.0	20.0	0.0	0.0	0.0
American Hornbeam	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	10.8	0.0	0.0
Big Tooth Aspen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
Bitternut Hickory	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.7	6.7	0.0	3.5	0.0
Black Birch	35.0	11.3	3.3	6.8	0.0	0.0	23.8	67.4	0.0	0.0	3.3	8.1	73.7	0.0
Black Cherry	0.0	0.0	0.0	1.7	0.0	12.5	0.0	1.2	40.6	5.7	0.0	2.7	0.0	0.0
Eastern Hemlock	45.0	69.4	88.3	55.9	0.0	0.0	28.6	4.6	0.0	0.0	43.3	2.7	1.7	0.0
Gray Birch	0.0	0.0	0.0	0.0	0.0	22.5	0.0	0.0	1.6	0.0	0.0	0.0	0.0	7.9
Hop Hornbeam	1.7	0.0	0.0	0.0	25.0	10.0	0.0	1.2	0.0	14.3	0.0	0.0	0.0	0.0
Northern Red Oak	1.7	0.0	0.0	6.8	2.8	0.0	3.2	1.2	0.0	11.4	0.0	10.8	0.0	0.0
Northern White Oak	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	2.9	0.0	0.0	0.0	0.0
Quaking Aspen	1.7	0.0	0.0	0.0	0.0	0.0	3.2	0.0	6.3	0.0	0.0	2.7	1.7	92.1
Red Maple	5.0	6.5	1.7	13.6	19.4	7.5	12.7	7.9	18.7	0.0	0.0	32.4	3.5	0.0
Shagbark Hickory	0.0	0.0	0.0	0.0	0.0	5.0	3.2	9.3	1.6	17.1	0.0	0.0	0.0	0.0
Sugar Maple	0.0	3.2	0.0	0.0	30.6	30.0	0.0	0.0	0.0	5.7	16.7	8.1	5.3	0.0
White Ash	1.7	0.0	0.0	10.2	16.7	0.0	15.9	1.2	0.0	17.1	10.0	18.9	7.0	0.0
White Birch	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0
White Pine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0
Yellow Birch	1.7	3.2	3.3	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 4. Number of seedlings and saplings by species in each PFI plot at Greenwood Sanctuary.

Plot	American basswood	American beech	American hornbeam	Bitternut hickory	Black birch	Black cherry	Elderberry	Dogwood sp.	Eastern hemlock	Hop hornbeam	Ironwood	Maple-leaved viburnum	Northern red oak	Red maple	Sugar maple	Shagbark hickory	White ash
1	0	6	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2
2	0	30	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
8	0	6	0	0	27	0	0	0	0	0	0	0	1	32	0	0	15
9	0	24	0	0	0	0	0	0	0	0	0	0	0	61	0	0	0
10	2	3	0	1	0	3	0	0	0	22	0	0	0	5	8	0	3
15	0	2	10	0	0	3	1	0	0	0	0	0	0	10	0	0	8
16	0	3	0	0	5	0	0	0	0	4	0	20	0	0	0	0	21
17	0	6	2	0	11	0	0	0	0	0	0	0	0	3	0	8	0
25	0	0	0	0	0	1	0	0	0	40	0	0	0	0	0	0	17
26	4	4	0	20	0	0	0	0	0	74	0	0	16	4	36	5	4
28	0	4	0	16	0	0	0	0	0	20	0	0	4	0	80	0	24
42	0	6	0	21	0	0	0	4	0	46	0	0	0	13	0	15	8
44	0	9	0	28	0	0	0	8	0	0	8	0	0	0	24	0	15
46	0	0	0	0	0	0	0	0	0	0	18	0	0	0	8	4	38

Highpoint Preserve Overstory and Understory Characteristics

In 2013, 145 new overstory trees were recorded, measured, classified and tagged in two plots at Highpoint Preserve. Seven tree species were present within the new plots, bringing the total recorded number of species to 14. Species include American basswood (*Tilia americana*), American beech (*Fagus grandifolia*), eastern hemlock (*Tsuga canadensis*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), striped maple (*Acer pennsylvanica*), black birch (*Betula lenta*), yellow birch (*Betula alleghaniensis*), black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), eastern hophornbeam (*Ostraya virginiana*), American hornbeam (*Carpinus caroliniana*), white pine (*Pinus strobus*), and hickory (*Carya sp.*). Dominant species comprising 30% or more of the trees in one or more plots included eastern hemlock (10 plots), American beech (1 plot), red maple (3 plot), sugar maple (6 plots), and white pine (1 plot) (Table 5).

At Highpoint Preserve, eight tree species have been recorded in the understory (Table 6). Seven of the eight species growing in the understory were also observed growing in the overstory. American beech (3 of 14 plots) and white ash (9 of 14 plots) were most prevalent in the understory. The number of seedlings present in the plots varied, and very few have grown to sapling size in the plots sampled. Although quite a few seedlings were present in some of the plots, only 80 saplings were documented in the plots sampled, and a majority of saplings were of only two species, beech and sweet birch. With relatively little sunlight reaching the forest floor due to a closed forest canopy, it is not surprising that the understory is not well-developed. Several herbaceous species of note were found in the understory plots including maidenhair fern, Christmas fern, trillium, sensitive fern, blue cohosh, and jack-in-the-pulpit. One invasive species (barberry) was found in one of the 14 plots sampled.

Table 5. Overstory tree composition of PFI plots at Highpoint Preserve; species comprising 30 percent or more of overstory trees in the plot are highlighted.

	PFI Plot Number																
Overstory Trees	**1**	**3**	**5**	**6**	**7**	**8**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**42**	**45**	**50**	**55**
American Beech	13.1	3.8	3.2	15.4	4.9	1.6	0.0	9.5	5.6	22.0	9.7	3.3	27.8	5.7	32.7	11.0	2.3
American Basswood	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	6.9	0.0	0.0	0.0	0.0	0.0	2.3
American Hornbeam	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0
Black Cherry	13.1	0.0	0.0	0.0	0.0	0.0	2.0	4.8	0.0	2.4	1.4	0.0	1.8	0.0	0.0	0.0	6.8
Eastern Hemlock	47.5	24.5	43.3	44.2	45.7	65.1	39.2	20.6	53.3	41.5	33.3	1.7	1.8	11.4	42.9	0.0	2.3
Hickory sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.4	4.6
Hop Hornbeam	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0
Red Maple	6.6	24.5	33.9	20.2	32.1	23.8	33.3	3.2	5.6	7.3	8.3	10.0	5.6	0.0	10.2	14.8	2.3
Striped Maple	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0
Sugar Maple	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.7	0.0	24.4	23.6	73.3	37.0	62.9	4.1	63.0	65.9
Sweet Birch	11.5	1.9	15.0	12.5	0.0	0.0	0.0	0.0	13.3	0.0	4.2	3.3	18.5	8.6	4.1	0.0	0.0
White Ash	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	2.4	12.5	6.7	7.4	0.0	2.0	0.0	13.6
White Pine	0.0	43.4	2.4	5.8	12.4	1.6	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0
Yellow Birch	8.2	0.0	2.4	1.9	2.5	6.4	23.5	14.3	22.2	0.0	0.0	0.0	0.0	8.6	0.0	0.0	0.0

Table 6. Number of seedlings and saplings by species in each plot at Highpoint Preserve.

Plot	American beech	Black cherry	Red maple	Shagbark hickory	Sugar maple	Striped maple	Sweet birch	White pine
1	10	51	16	0	0	0	0	2
3	11	1	0	0	0	0	0	0
5	6	10	0	0	0	0	0	0
6	1	1	0	0	0	0	0	0
7	2	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
10	5	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
20	2	0	0	0	19	0	0	0
25	10	0	5	0	10	1	0	0
30	1	0	0	0	4	4	0	0
35	2	0	0	0	80	0	0	0
40	5	0	0	0	13	302	0	0
42	5	0	0	1	9	2	0	0
45	42	1	10	0	8	39	46	0
50	25	0	20	0	75	6	0	0
55	0	0	100	0	100	0	0	0

Wildlife Research

Effect of Gas Pipeline Development on Amphibians

In 2013, we continued a research project to study to the effects of Marcellus Shale gas exploration and development on forest amphibians in northern Pennsylvania, using Greenwood Sanctuary as one of our study sites. Amphibians reach their highest diversity within eastern forests and are highly sensitive to changes in forest cover and increased road densities making understanding effects of Marcellus activity on this group extremely critical. Direct loss of forest habitat, as well as changes in remaining forest due to forest fragmentation, may have a substantial effect on forest salamander populations. When sizable openings in the forest tree canopy are created, forest floor temperatures may rise, and soil moisture may decrease considerably. Salamanders are sensitive to heat and prone to desiccation when soil moisture is low.

To measure the effects of gas pipeline openings on adjacent populations of forest salamanders, we conducted natural cover and artificial cover salamander surveys in 2012 and

2013. Natural cover surveys were conducted by walking slowly along each transect, recording all amphibians found on the surface or under cover objects. All amphibians seen on the surface or under cover (rocks, logs) within a 3-m wide strip centered on each transect were recorded. Artificial cover surveys were conducted by turning over all cover boards along each transect, and recording the number and species of salamanders found under each board. Natural cover searches were conducted three times from July to September, and artificial cover searches were conducted from June to October. Results from each of the methods show a general increase in the number of red-backed salamanders from the edge of the pipeline into the interior of the forest (Figures 3 and 4).

Figure 3. During natural cover searches, fewer red-backed salamanders were found near the pipeline edge than further into the forest interior.

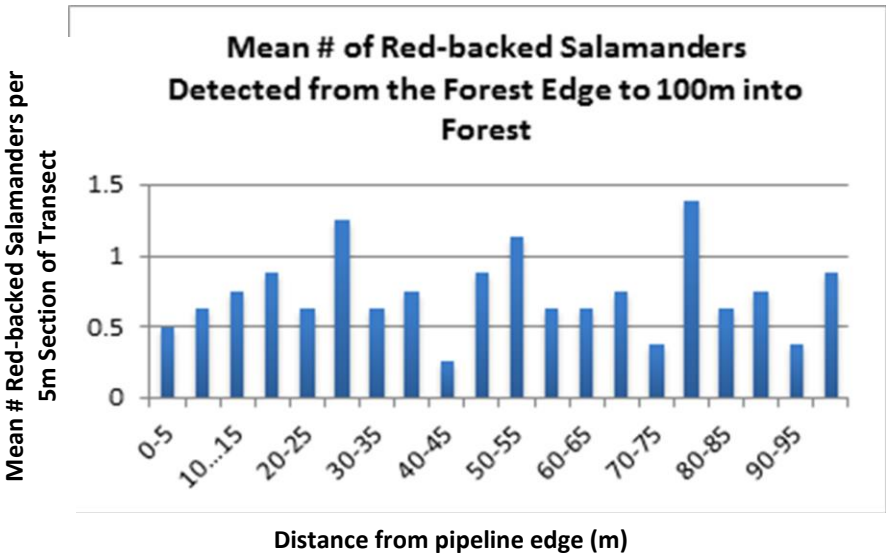
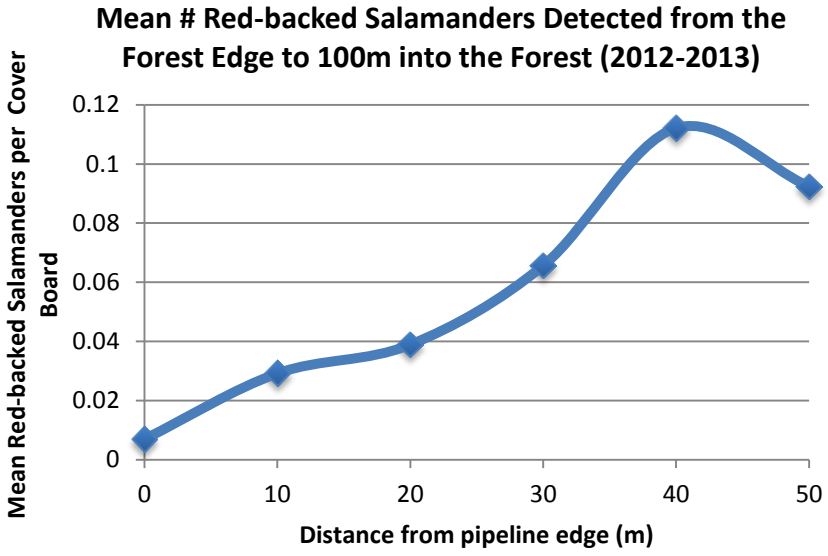


Figure 4. Artificial cover surveys yielded fewer red-backed salamanders near the pipeline edge than further into the forest interior. Few salamanders were found within the first 10 m from the pipeline opening.



To explain the effects of pipeline openings on the abundance of red-backed salamanders, we measured temperature and light from the edge of the opening into the forest. Hobo temperature and light data loggers were installed on the ground at 10-m intervals along one of the artificial cover transects at Greenwood, beginning at the edge and extending 100m into the forest. Each data logger measured and archived temperature and light readings every two hours, from the end of July through the beginning of October. Light levels (Figure 5) and temperature (Figure 6) were both higher near the pipeline edge. The mean temperature at the pipeline edge was just below 30 degrees Celsius, and the temperature frequently was above the critical thermal maximum temperature (Figure 7) (temperature at which mortality occurs) for the red-backed salamander. Most of the time, the temperature was above 20 degrees C at the pipeline edge. At temperatures above 20 degrees, red-backed salamanders expend more energy for metabolism, potentially leaving a smaller proportion of the energy budget available for reproduction or fat storage. In addition to increasing maintenance costs of salamanders, warmer temperatures could decrease the amount of energy assimilated from their prey and further contribute to a negative energy budget. In contrast, the temperature inside the forest never reached the critical thermal maximum, and was below the temperature at which energy deficit occurs,

Figure 5. Light intensity is highest at the pipeline edge and decreases to a much lower level by 10 m into the forest.

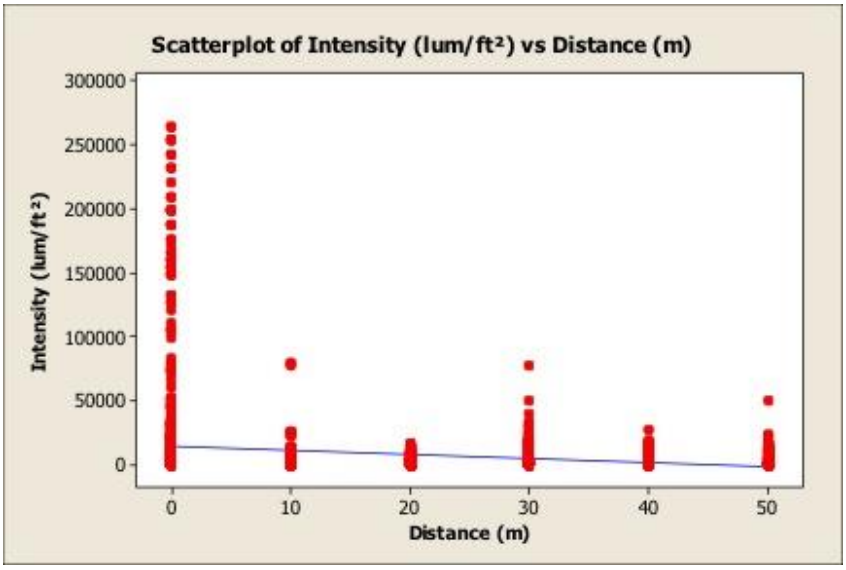


Figure 6. Mean temperature on the ground was highest at the pipeline edge, and decreased further into the forest.

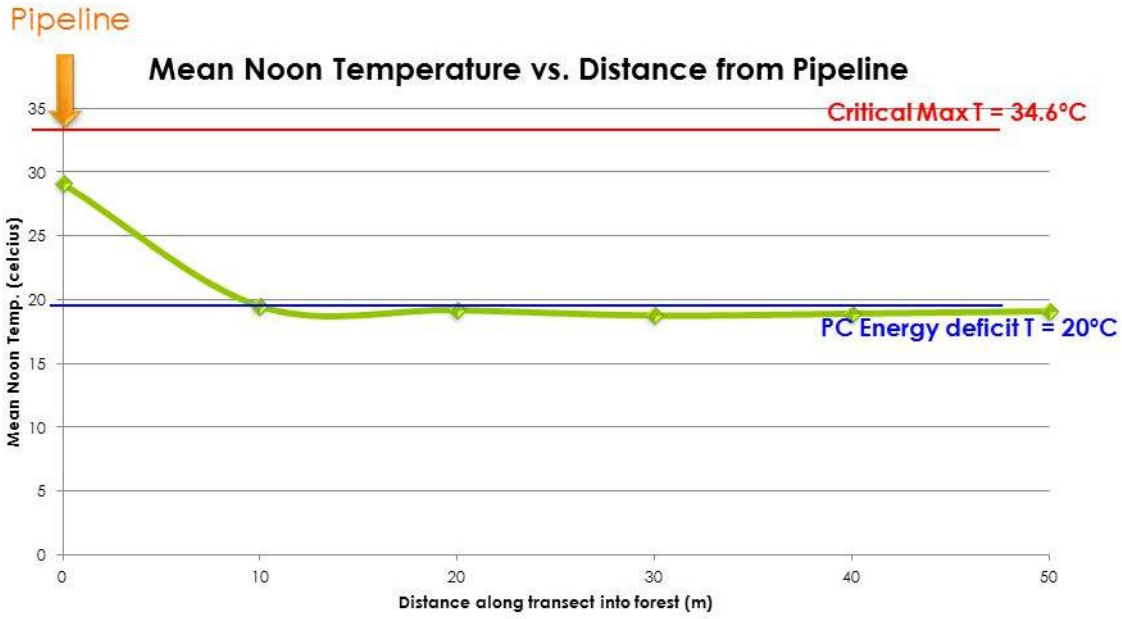
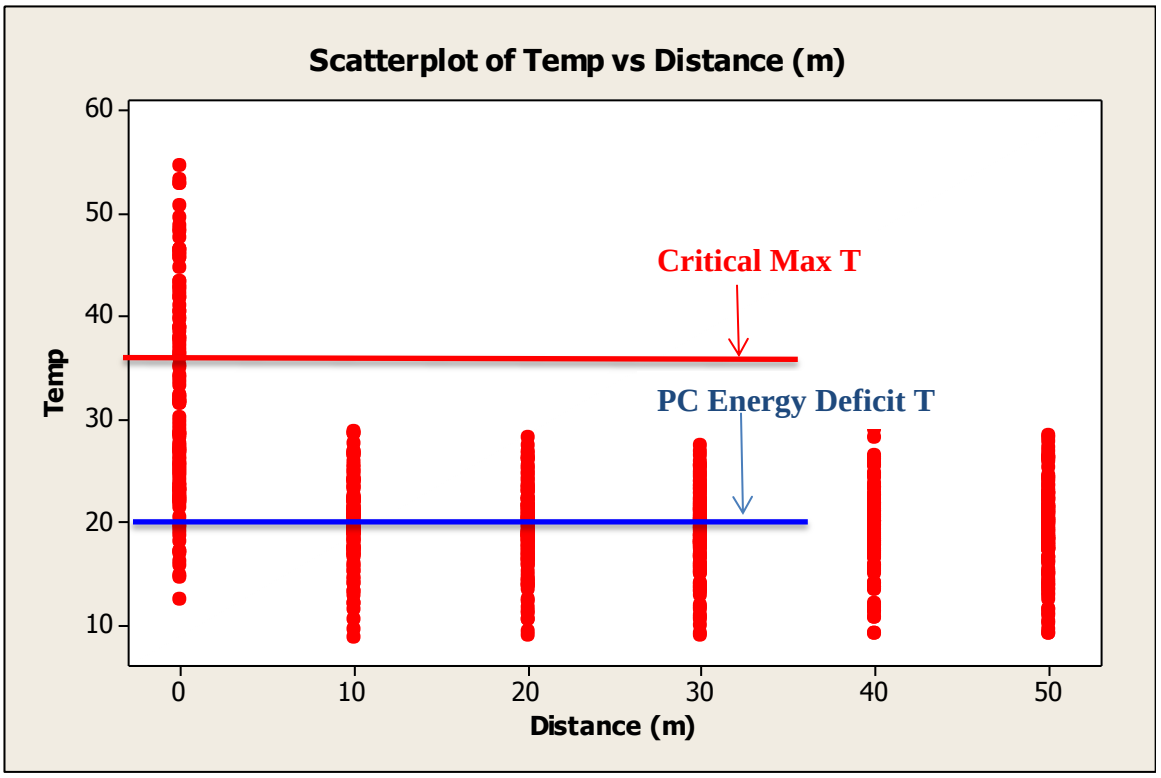


Figure 7. Throughout the summer, ground temperature at noon was higher at the pipeline edge and lower in the forest.



Hemlock Woolly Adelgid Research, Monitoring, and Control

In 2012, hemlock woolly adelgid (HWA) was discovered at Greenwood Sanctuary, and property-wide surveys for HWA were subsequently conducted at both Greenwood Sanctuary and Highpoint Preserve. This year, we expanded our survey efforts to include not only Greenwood and Highpoint, but the Longford Lake property as well. The adelgid is a destructive, non-native insect pest which presents a serious danger to eastern hemlock trees. Once infested, untreated hemlock trees often die within 4-10 years. The level of infestation is moderate to heavy and widespread at Greenwood Sanctuary. At Highpoint Preserve, the HWA infestation expanded in 2013 and can now be found on all sides of Silver Lake, but remains at a relatively low level. The HWA infestation at the Longford Lake property is also fairly light at this time.

Hemlock trees help maintain cool water temperatures for fish and other aquatic organisms and provide important and unique habitat and food resources for wildlife. Therefore, the loss of hemlocks could have far-reaching effects beyond just the trees. Sudden and widespread death of hemlock trees at Silver Lake and Greenwood could further lead to soil erosion on steep slopes. The cooling shade which hemlock trees now provide along the waters' edge would be lost, and could contribute to warmer water temperatures in Silver Lake.

In 2012, 23 hemlock trees at Greenwood Sanctuary were treated professionally with Dinotefuran to provide immediate control of HWA. In the fall of 2013, 26 trees were treated using Coretect tablets applied beneath the soil along the drip-line of the tree canopy (Figure 8). Protection should persist for 5-7 years in these trees. Each treated tree was measured and tagged to allow long-term monitoring of tree health.

Figure 8. Coretect tablets are buried just under the organic layer of the soil, along the drip edge of the tree canopy.

Forest Conservation and Management

Today, there are many challenges to regenerating forests in the northeast. Mortality caused by invasive insect pests, over-browsing of plants by deer, and other environmental factors such as a changing climate, challenge us to be proactive in considering management and conservation options for any given parcel of land. This year, we involved forest science experts from Cornell in assessing the potential for forest regeneration at Greenwood Sanctuary in light of projected tree mortality from hemlock woolly adelgid, compounded by the potential effects of emerald ash borer when it arrives on site.

Currently, there is a nice diversity of tree species in the forest overstory at Greenwood Sanctuary. Northern red oak and white ash are the most abundant species with timber value on today's market. Red oak is also arguably the most valuable wildlife food-producing species on site. Although there is some economic value in the trees currently present, many of the trees are not yet economically mature, and the site is not fully stocked (e.g. there are not as many trees as you might like to have in the overstory prior to a harvest).

Adhering to the principles of good silviculture, establishing new seedlings (regeneration) in a forest prior to removing the parent trees from the overstory is critically important. At Greenwood, deer browsing impacts are moderate to heavy (Figure 9), and very few seedlings have reached a height of 5 feet or greater (the point at which they can be considered established or safe from deer browsing). In some parts of the forest, invasive plant species are growing in the understory (Figure 9), also preventing native plants or tree seedlings from becoming established.

Figure 9. Invasive plants growing in the understory and deer browsing are two factors limiting the growth of new tree seedlings at Greenwood Sanctuary.

Given the current forest conditions, steps should be taken to promote regeneration before a natural disturbance (e.g. mortality from invasive insect pests) or a timber harvest takes place. Such steps could include reducing or excluding the deer herd as much as possible, removing invasive plants that are currently preventing growth of native species in the understory and would be expected to expand in the event of a disturbance, and employing other strategies for

protecting small seedlings that are unable to grow due to deer browsing (plant tubing, tree tops, natural barricades, etc.). A full overview and summary report was delivered to the board of directors (Appendix B).

Education and Outreach

Once again, this year we participated in several educational outreach efforts. We delivered several presentations at the Conservancy's Annual Meeting including a presentation highlighting the Pennsylvania Amphibian and Reptile Survey, and an overview of hemlock woolly adelgid and emerald ash borer, signs of infestation, and control measures. We developed a poster about hemlock woolly adelgid for use at various education events, and a handout for distribution to members (Appendix B). Our undergraduate students also shared their knowledge of amphibians with members and the public at a summer event at Greenwood Sanctuary. In addition, we provided materials for the updated Conservancy web site.

Summary

Through our collaborative efforts in 2013, we continued to expand and enhance our collective knowledge about the ecology of the Conservancy's fee-owned properties, the status of animal populations throughout the region, and the health of the overall landscape. We expanded biological survey, inventory, research and monitoring efforts, and addressed critical invasive species issues. We incorporated Cornell undergraduate students into all aspects of our work with the Conservancy, in an effort both to provide them with hands-on experience and to bring their skills and knowledge to bear on Conservancy-related issues.

Appendix A. Permanent Forest Inventory Plot Methodology

Permanent Forest Inventory Plot Methodology

(Adapted in 2008 from methodology developed for Cornell's Arnot Forest)

Objective: Establish permanent plot samples throughout the forest to measure the change in various forest characteristics through time. Be able to describe changes in forest species composition, structure, health and habitat availability that result from natural forest dynamics and management practices.
Assumptions/Constraints: Plots will be established annually. Each point will be re-sampled every 5 to 8 years and allow an analysis of change through time. Some plots may be sampled more frequently to assess short-term forest dynamics.
Methods: Establish 10-15 plots per year, distributed among properties owned or managed by the E.L. Rose Conservancy in Susquehanna County, Pennsylvania. Plots will be numbered sequentially. Plot center is marked with a white 2.5" PVC pipe 5' long. A GPS unit will be used to record UTM coordinates. A "Permanent Plot Location Sheet" will be completed for each plot. This sheet will include written directions/map to the plot, a general description, and information about deer impact. Each plot will include:

- A fixed radius overstory plot (0.25 acres, 58.9 ft. radius) where all live trees $\geq$ 4" dbh will be tagged with aluminum numbered tags and aluminum nails at 12" above ground, and tallied by species, dbh, presence of cavities > 1" diameter, and crown class. DBH will be measured to the nearest 0.1 inch using a diameter tape located at the top of a 3.5' stick placed on the nail. Nails should face plot center. All dead trees will be tallied and diameter will be recorded.
- Within each overstory plot record elevation, aspect, % slope, slope shape, percent fern cover, and presence or absence of grass, seeps or wet areas, trails or roads, logs in water, perches, soft or hard mast species, rock piles, rock crevices, caves, and cavities in living or dead trees. Also make note of the presence or absence of accumulate litter on the forest floor, and note the presence or absence of forest pests including beech blight, hemlock woolly adelgid, and emerald ash borer.
- Within each plot, N/S and E/W lines transecting the diameter of the plot will be established to record the percent cover of coarse woody debris > 3" diameter at the point of their intersection with the transect. Record diameter at the intersection, condition, and whether bark is present.
- At the north and south cardinal directions on the edge of the overstory plot, establish sapling/ground layer plots having an 11.8' radius to equal 0.01 acres each. Subplot centers should be marked with a 30" wooden stake and flagged. Record the number of woody stems by species in the ground layer (height of 4"

– 54″) and sapling/shrub layer (height > 54″ up to 3.99″ dbh) using decadal increments (1-10 by one; 11 to 100 by tens; 101+ by hundreds).

- Within each sapling subplot (11.8′ radius), record presence or absence of the following herbs: sensitive fern, maiden-hair fern, Christmas fern, true ginseng, dwarf ginseng, blue cohosh, jack-in-the-pulpit, or trillium. Also record presence or absence of invasive species including garlic mustard, barberry, multi-flora rose, honeysuckle, or autumn olive, and the percent of inhibiting fern cover, percent of other fern cover, and percent grass and sedge cover.

List of Equipment Needed

1. PVC Pipe: preferably white 2.5″ PVC pipe 5′ long
2. Short wooden stakes
3. Blue spray paint (for the top of the PVC)
4. Tags for the pipe (the soft etch-able aluminum one work)
5. Round aluminum tree tags from Forestry Suppliers Co.
6. Multiple tape measures
7. Data sheets, pencils, and permanent marker
8. DBH tape
9. Hammer
10. Aluminum nails (aluminum makes it safe for loggers)
11. Small sledge hammer (to pound in stakes)
12. Flagging
13. Field guides if necessary

Definitions of Variables Recorded at Permanent Forest Inventory (PFI) Plots

Deer Impact: An estimate of the browsing pressure that deer are having on tree seedlings in the area of the sample plot. Code is as follows:
1= low pressure; 2= low/medium; 3= medium; 4=medium/high; 5= high
Travel Description: A narrative description of travel from the nearest permanent location or landmark.
Map: A hand sketch of the travel description.
Overstory Plot Size: The length of the plot's radius in feet. Typically 58.9′ unless otherwise noted.
Sapling Plot Size: The length of the subplot's radius in feet. Typically 11.8′ unless otherwise noted.
Seedling Plot Size: The length of the subplot's radius in feet. Typically 11.8′ unless otherwise noted.
Aspect: The direction of the downward slope coded as: North, Northeast, East, Southeast, South, Southwest, West, or Northwest.

Slope: The calculated percent slope. Can be calculated in the field or from a topographic map.
Slope Shape: An visual estimation coded as: 1=convex; 2=linear; 3=concave
Topographic Position: Coded as: 1=Upland Plateau; 2=Upland Bottom; 3=Ridge Top; 4=Upper Slope or Shoulder; 5=Mid-slope; 6=Bench; 7=Lower Slope; 8=Bottomland/Flatland.
Riparian %: The percentage of the plot that characterized by stream channels, wetlands, floodplains, and immediately adjacent terrestrial ecosystems.
Seep: Enter either "present" or "absent" as to the presence of seeps or springs within or adjacent to the plot. A seep is a source of surface ground water without a well-defined point of origin. A spring has a well-defined point of origin. Seeps and springs may or may not have vegetation around them.
Streams: Enter "present" if perennial streams are within the stand or immediately adjacent to the stand.
Temporary Ponds: Enter "present" if any temporary or vernal pools are within or adjacent to the plot. Temporary ponds must be greater than 6 inches deep and greater than 1 square yard; water must be present for at least two months during the growing season. The exact month differs for each species that uses temporary ponds. Areas covered by a fine layer of silt and depressions filled with blackened leaves me serve as dry season indicators of temporary ponds.
Permanent Ponds: Enter "present" if any permanent ponds of lakes are within or adjacent to the plot. Permanent ponds are any size of depth, but larger is generally better; water must be present year-round, although the top layer can freeze.
Logs in water: Enter "present" if any downed logs are partially or wholly in a permanent water source.
High Perch: Enter "present" if any high exposed perches occur in the plot. A high perch is any live or dead tree that clearly towers above the canopy such as a supracanopy white pine, or a single tree or group of trees standing above ground vegetation such as a lone elm in a pasture or a snag in a clearcut.
Hard mast: Enter "present" if there are any plant species in or near the plot that provide hard mast such as acorns or hickory.
Loose soils: Enter "present" if there is soil that can be easily burrowed into.
Rock Piles: Enter "present" if there are any natural or man-made piles (rock walls), as long as they provide hiding places for small mammals, amphibians, or reptiles.
Rock crevices: Enter "present" if there are openings in the rocks that lead below the frost line.
Caves: Enter "present" if there are any caves or larger rock openings that lead below the frost line.

Live cavities: Enter "present" if there are any live trees in or near the plot with cavities at least 1" in diameter. This is collected in the overstory plot and may be determined from field data.

Dead cavities: Enter "present" if there are any dead trees in or near the plot with cavities at least 1" in diameter. This is collected in the overstory plot and may be determined from field data.

Coarse Woody Debris: Any fallen logs or trees that are longer than three feet and greater than three inches in diameter.

Condition: Coded as: 1=solid/good; 2=rotten/ poor

Species: For every tallied tree, enter the tree species using either the 3-digit forest survey code or the mnemonic abbreviation.

DBH: The diameter at breast height (typically four feet above the ground).

Crown Class: Determine the position of the tree crown using the following codes:

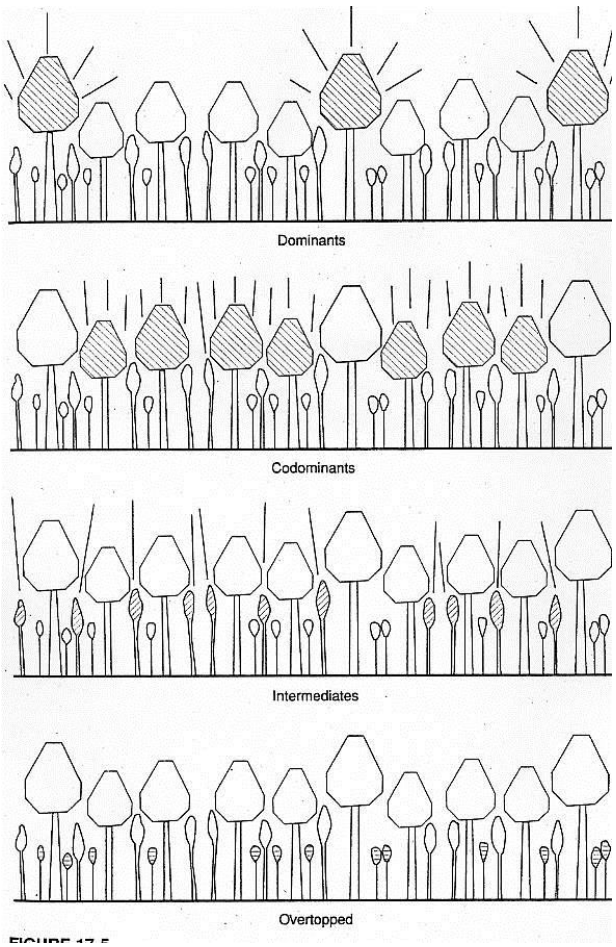
1= open grown- a tree that is free of competition and receives light on top and all sides of the crown as a result of a very heavy thinning or being in an isolated, open-grown position.

2= dominant- a tree with the crown extending above the general level of the main crown canopy and receiving full light from above and partly from the sides.

3=codominant-a tree with a crown forming the general level of the main canopy, receiving full light from above but little from the sides.

4=intermediate- a tree with a crown extending into the lower portions of the main crown canopy, but shorter than the codominants and receiving little direct light from above and none from the sides.

5=suppressed- a tree whose crown is entirely below the general level of the canopy and receives no direct light from either above or the sides.



Data Sheets for Permanent Forest Inventory (PFI) Plots

Tally date _____/ _____/ _____ Page _____ of _____
PFI Plot Number _____ Tallied by_____

Overstory Plot Size (radius, ft)	58.9
Sapling/ Seedling Plot Size (radius, ft)	11.8

Elevation	
Aspect	
Slope	
Slope Shape	
Topo Position	
UTM Coordinates:	

Trail on Road (y/n)	
Riparian %	
Wetland %	
Adjacent water(y/n)	
Seep (p/a)	
Stream (p/a)	
Temp. Pond (p/a)	
Perm. Pond (p/a)	

Logs in water (p/a)	
High Perch (p/a)	
Low Perch (p/a)	
Soft Mast (p/a)	
Hard Mast (p/a)	
Rock Pile (p/a)	
Rock Crevice (p/a)	
Cave (p/a)	
Live Cavity (p/a)	
Dead Cavity (p/a)	
# of Snags	
Accumulate litter (p/a)	

Comments:

_____
_____
_____
_____
_____

Sapling/Seedling Plot Features

Indicator Species	North	South
Ginseng (p/a)		
Dwarf ginseng (p/a)		
Sensitive fern (p/a)		
Maiden-hair fern (p/a)		
Christmas fern (p/a)		
Trillium (p/a)		
Blue cohosh (p/a)		
Jack-n-the-pulpit (p/a)		
Invasive Exotics		
Garlic mustard (p/a)		
Barberry (p/a)		
Multi-flora rose (p/a)		
Honeysuckle (p/a)		
Autumn Olive (p/a)		
Inhibiting Fern Cover (%)		
Other Fern Cover (%)		
Grass and Sedge Cover (%)		
Soggy Ground (%)		
Surface Stone > 50% (y/n)		

Forest Health

Beech blight (p/a)	
Hemlock woolly adelgid (p/a)	
Emerald ash borer (p/a)	
Other:	

Coarse Woody Material

N-S Transect (117.8ft)			E-W Transect (117.8ft)		
Diam. (ft.)	**Cond. (1/2)**	**Bark (y/n)**	**Diam. (ft.)**	**Cond. (1/2)**	**Bark (y/n)**

-PFI Herp Search Data and Wildlife Sign

PFI Plot Number _____ Tally Date _____/ _____/ _____
Tallied By _____ Page _____ of _____

Time of day	
Days since significant rain	
Litter moisture rating	Dry Moist Wet
Number of turn-overs (minimum 10)	

Species Name **Number Found**

1. _____ _____
2. _____ _____
3. _____ _____
4. _____ _____
5. _____ _____

Wildlife Sign / Special Features

_____
_____

-Greenwood Preserve Permanent Plot Location Sheet

PFI Plot Number _____ Tally date: ____/ ____/ _____
Tallied by _____ Page _____ of _____

Pictures _____ -_____

Plot Habitat Description	
Deer Impact	

Comments/ Travel Description:
_____
_____
_____
_____

Map / Directions

-PFI Seedling-Sapling Sample Data Sheet

PFI Plot Number _____ Tally Date _____/ _____/ _____
Tallied by _____ Page _____ of _____

Subplot : 11.8′ radius
Seedlings: 4″-- 54″ tall
Saplings: 54.1″ tall -- 3.99″ dbh

North Subplot		
SPP	**#SDL**	**#SPL**

North (cont.)		
SPP	**#SDL**	**#SPL**

South Subplot		
SPP	**#SDL**	**#SPL**

South (cont.)		
SPP	**#SDL**	**#SPL**

-PFI Overstory Tree Sample Data Sheet

PFI Plot Number _____ Tally Date _____/ _____/ _____

Tallied By _____

Tree #	Species	dbh	Cavity (y/n)	Crown class

Tree #	Species	dbh	Cavity (y/n)	Crown class

Appendix B. Education and Outreach Materials

- **Hemlock woolly adelgid poster**
- **Handout – Hemlock woolly adelgid control options for homeowners**
- **Forest stewardship overview – Greenwood Sanctuary**

Cornell University

HEMLOCK WOOLLY ADELGID

Kristi L. Sullivan, Cornell University Department of Natural Resources kls20@cornell.edu
Kristina M. Chyn, Cornell University Department of Natural Resources

Overview

- The hemlock woolly adelgid (HWA) is a non-native aphid-like insect
- They are native to Asia and the Pacific Northwest, where they rarely achieve pest outbreak densities because natural predators and host resistance keep HWA populations in check
- They were first found in Richmond, Virginia in the 1950s
- They have piercing sucking mouthparts that extract nutrients from host trees

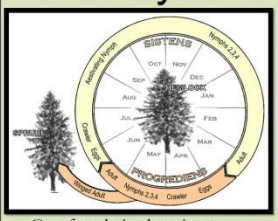
< 1.5 mm long

Eastern Hemlock

- HWA is a destructive pest that is a serious threat to Eastern Hemlock trees
- Hemlocks are a shade tolerant species and a vital component of Northeast forest systems. They provide:

- Erosion protection along stream banks
- Shade – unique stream and forest microclimates
- Habitat – food and shelter for many animals

Life Cycle and Biology



- One female in the winter generation produces an average of 200 eggs, of which each female produces on average another 100 eggs. That's 20,000 eggs from one individual female in one year!

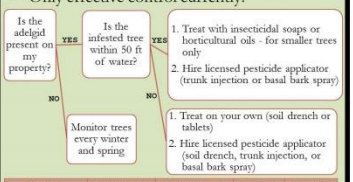
- Adelgids have 2 generations/year
- Early spring – females lay 100-300 eggs in woolly egg sacs under branches
- Larvae (crawlers) emerge in spring – active March-end of June
- Crawlers can be transported by wind, birds, mammals to nearby trees
- Become immobile nymphs in July – dormant until October or November and feed from then - early spring
- The insects and crawlers themselves are hardly visible to the naked eye

Symptoms and Impacts

- Hemlock needles will turn yellow and drop prematurely
- Defoliation can occur, and the tree may eventually die
- Damage is usually from bottom up, even though adelgid occurs throughout
- Death of hemlocks is 4-10 yrs., typically 6 yrs in this region
- Populations fluctuate until tree death occurs
- The egg sacs of white material are visible on the underside of branches

Chemical Control

- Chemical control should be applied during the fall or spring.
- Only effective control currently!



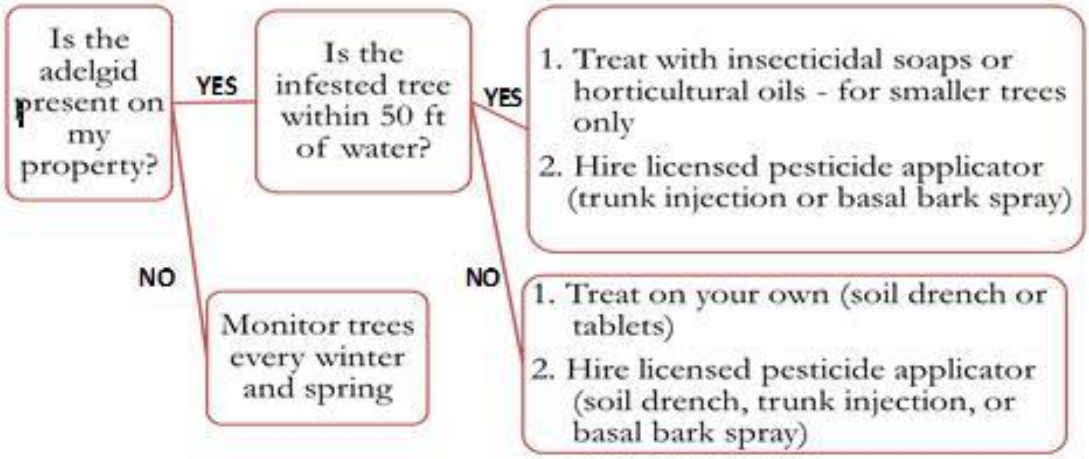
Chemical	Professional?	Homeowner?	Water concerns?	Duration
Imidacloprid Soil drench	x	x Bayer Advanced Tree and Shrub; Merit	Yes 50 ft	7 yrs
Tablets	x	x Core Tect	Yes	7 yrs
Trunk injection	x		No	7 yrs
Dinotefuran (Safari) Basal bark spray	x		No	1 yr
Horticultural Oils and Insecticidal Soaps		x (smaller trees only)	No	1 yr

Cultural Control

Around the Home

- Mulch to maintain soil moisture
- Water during periods of extended drought
- Do not apply nitrogen fertilizers, which enhance adelgid survival and reproduction
- Remove bird feeders near hemlocks - birds are known to transport crawlers for long distances
- Clip and burn heavily infested hemlock branches
- Avoid disturbing shallow roots with heavy equipment
- Avoid changing the grade (slope of the land) near hemlocks

Hemlock Woolly Adelgid Control Options for Homeowners



Chemical	Professional?	Homeowner?	Water concerns?	Duration
Imidacloprid Soil drench	x	x Bayer Advanced Tree and Shrub; Merit	Yes 50 ft	5-7 yrs
Tablets	x	x Coretect	Yes	5-7 yrs
Trunk injection	x		No	5-7 yrs
Dinotefuran (Safari) Basal bark spray	x		No	1 yr
Horicultural Oils and Insecticidal Soaps		x (smaller trees only)	No	1 yr

Cultural Controls for Trees Around the Home

- Mulch to maintain soil moisture
- Water during periods of extended drought (apply about 1 inch / week around drip line)
- Do not apply nitrogen fertilizers, which enhance adelgid survival and reproduction
- Limit movement of hemlock products such as firewood, branches, and seedlings from infested areas into areas that are not yet infested
- Remove bird feeders near hemlocks
- Consider removing isolated infested trees which may help to slow the spread of hemlock woolly adelgid (from August to February)
- Clip and burn heavily infested hemlock branches
- Avoid disturbing shallow roots with heavy equipment
- Avoid changing the grade (slope of the land) near hemlocks

Forest Stewardship Overview – Greenwood Sanctuary (January 2014)

What is Forest Stewardship?

Forest stewardship is all about maintaining and improving the productivity and diversity of the future forest. Being a good forest steward also means retaining future ecological and economic options. Silviculture (the care and cultivation of forest trees; forestry) focuses on making sure that forest stands are treated in a way that preserves or even enhances their productivity, usually from the perspective of growing healthy trees. To accomplish this objective, silviculture focuses on the trees that are left behind after a harvest in a forest stand. These *residual* trees produce seeds and seedlings that become established in the understory to become the next forest. Therefore, thoughtful silviculture is the foundation of successful forest regeneration. A timber harvest represents the most opportune time to have a positive impact on the forest, but without forethought a harvest can have long-term and significant negative impacts on the future forest.

The Legacy of a Timber Harvest

Two common ways that a timber harvest can have a significant impact on a forest are: 1) not paying enough attention to which trees are left standing, and 2) not ensuring the presence of young trees or seedlings prior to harvesting good-quality, seed-producing parent trees. Harvests described using terms such as "select cut", "selective cut", "diameter limit cut", or "all trees bigger than ....", should be considered with great caution. These terms commonly refer to a practice known as "high-grading", in which the best quality trees are taken for economic reasons, and the poorer quality trees are left behind (Figure 1). The future of that forest becomes bleak, with only poor quality, smaller, and less competitive trees remaining after the harvest to act as the parent trees for future generations of seedlings. Often, this practice also leads to fewer different kinds of trees in the forest of the future.

Today's Regeneration Challenge

Even when the best possible silviculture is used to determine an appropriate harvest for a stand, establishing the next forest can be a daunting challenge. In recent years there has been a continued failure of Pennsylvania forests disturbed by harvesting and natural disturbance events. This is mainly due to inadequate tree regeneration. In fact, only 4 of every 10 acres experiencing a canopy disturbance sufficient to initiate and sustain seedling growth and development have experienced desirable regeneration. In a recent study by the Nature Conservancy, regeneration of forest stands in New York State was classified as fair or poor in over half of all forest stands. Over-browsing of

seedlings by white-tailed deer is seriously limiting new seedling growth, as is competition from invasive plant species which are becoming established in the forest understory with increasing frequency.

Figure 1. A harvest focused on leaving some of the best trees behind to serve as parent trees for the next generation of forest, is a beneficial approach to forest management (top). In contrast, high-grading is a detrimental practice focused on taking the best, most economically valuable trees and leaving the rest behind (bottom).

Greenwood Sanctuary

Currently, there is a nice diversity of tree species in the forest overstory at Greenwood Sanctuary. Northern red oak and white ash are the most abundant species with timber value on today's market. Red oak is also arguably the most valuable wildlife food-producing species on site. Although there is some economic value in the trees currently

present, many of the trees are not yet economically mature, and the site is not fully stocked (e.g. there are not as many trees as you might like to have in the overstory prior to a harvest).

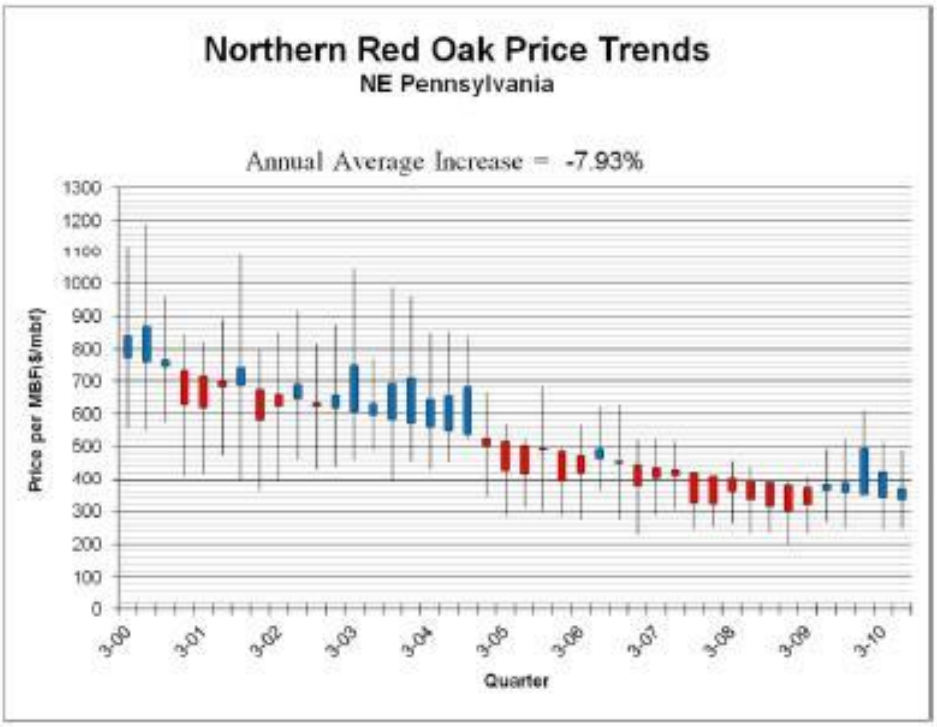
Adhering to the principles of good silviculture, establishing new seedlings (regeneration) in a forest prior to removing the parent trees from the overstory is critically important. At Greenwood, deer browsing impacts are moderate to heavy (Figure 2), and very few seedlings have reached a height of 5 feet or greater (the point at which they can be considered established or safe from deer browsing). In some parts of the forest, invasive plant species are growing in the understory (Figure 3), also preventing native plants or tree seedlings from becoming established. In 2009, consultant forester Bob

Figure 2. Deer are browsing seedlings at Greenwood, preventing them from growing above the height of the snowline in winter.

Figure 3. Invasive plants, such as honeysuckle, are preventing establishment of native understory plants in some locations at Greenwood.

Hobbes visited Greenwood and concluded that there was little desirable regeneration present and that achieving satisfactory forest regeneration would require reduction of the current deer herd. He also concluded that the overstory trees were growing, but were not yet ready for another timber harvest, and that there was not an adequate inventory of large sawtimber-size trees to provide a commercial return for a harvest. He also noted that the market for red oak was down, further adding to low returns expected from any harvest there. Though the market has stabilized some, the value of red oak

and white ash is still considerably lower than in was a decade ago (Figure 4). In November 2013, a forester from Cornell University visited the site, and drew similar conclusions based on stand conditions at that time.



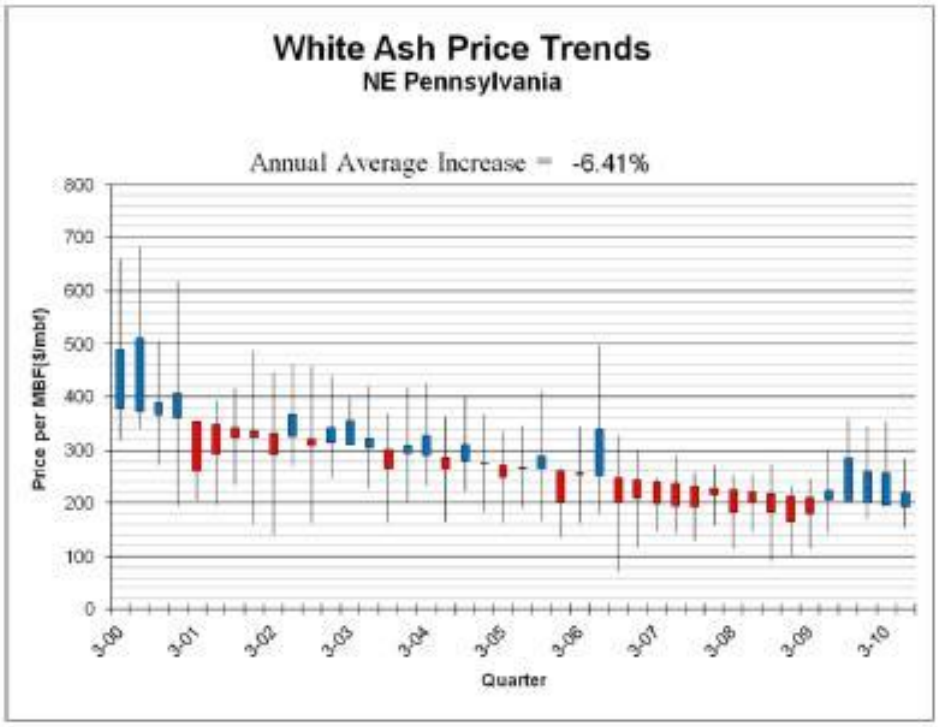


Figure 4. The value of northern red oak fell from $800/1,000 board feet in 2000, to $380/1,000 board feet in the 3rd quarter of2013. Similarly, the value of white ash fell from $450/1,000 board feet in 2000 to $218/1,000 board feet in the 3rd quarter of 2013.

seedlings by white-tailed deer is seriously limiting new seedling growth, as is competition from invasive plant species which are becoming established in the forest understory with increasing frequency.

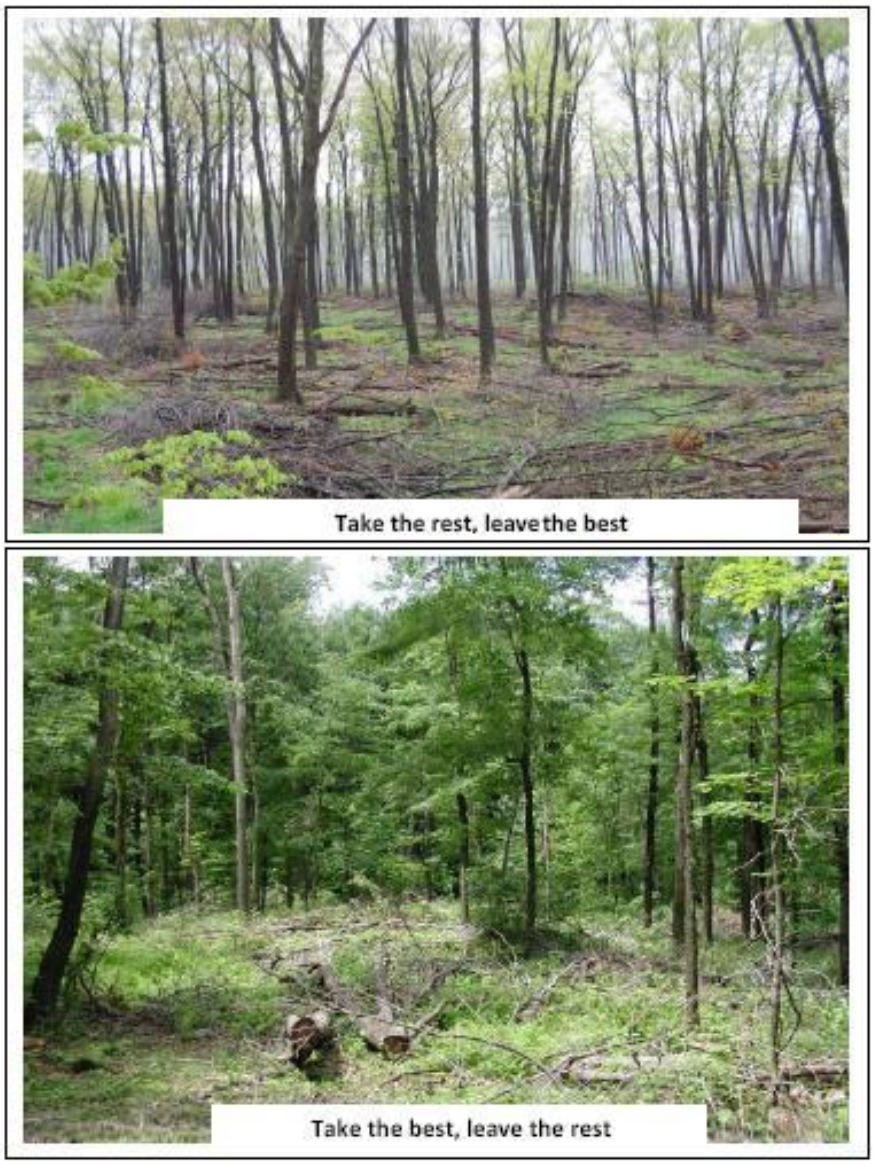


Figure 1. A harvest focused on leaving some of the best trees behind to serve as parent trees for the next generation of forest, is a beneficial approach to forest management (top). In contrast, high-grading is a detrimental practice focused on taking the best, most economically valuable trees and leaving the rest behind (bottom).

Greenwood Sanctuary

Currently, there is a nice diversity of tree species in the forest overstory at Greenwood Sanctuary. Northern red oak and white ash are the most abundant species with timber value on today's market. Red oak is also arguably the most valuable wildlife food-producing species on site. Although there is some economic value in the trees currently

Suggested Actions

Given the current forest conditions, a harvest is not recommended at Greenwood at this time, but the opportunity for a harvest should be revisited in 2017. In the meantime, the overstory trees will continue to grow toward financial maturity, and steps can be taken to promote regeneration before a harvest takes place. Such steps could include reducing or excluding the deer herd as much as possible, removing invasive plants that are currently preventing growth of native species in the understory and would be expected to expand in the event of a disturbance (e.g. timber harvest), and employing other strategies for protecting small seedlings that are unable to grow due to deer browsing (plant tubing, tree tops, natural barricades, etc.).

Until such time as the potential harvest is revisited, Greenwood Sanctuary will continue to be monitored for unexpected events which could make a more immediate harvest prudent. These factors include the arrival emerald ash borer at Greenwood or the nearby area, an extreme weather event causing blow-down of a substantial number of trees (such as the event in October 2011), or other unexpected occurrences.