Forest Health

An Introductory Guide for Conservation Volunteers of Eastern Massachusetts

Metrowest
Conservation Alliance

Working together to protect local land and water.

Acknowledgments

This booklet was prepared by Matthew Morris and Sara Amish, TerraCorps/AmeriCorps Members hosted by Sudbury Valley Trustees. Sudbury Valley Trustees is a member of the **Metrowest Conservation Alliance** (MCA).

The MCA is a partnership of organizations that work collaboratively and land protection and management to achieve regional conservation success. The MCA works in the 36-community region that makes up the Sudbury, Assabet, and Concord River watershed, covering approximately 377 square miles. Partners include municipalities, state agencies, land trusts, and other non-profit organizations. Read more at **svtweb.org/mca**.

MCA programs are supported by Sudbury Valley Trustees.

We would like to thank the organizations and people who answered our questions or reviewed the booklet in various stages of the process:

- Ashland Town Forest Committee
- Carlisle Conservation Foundation
- Ethan Belair, University of New Hampshire
- Phil Benjamin, Benjamin Forestry Services
- Chris Pryor, New England Forestry Foundation
- Jeff Ritterson, Mass Audubon
- Steven Roberge, UNH Cooperative Extension
- Marc Sevigny, Harvard Conservation Trust

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Table of Contents

Last Updated: 7/22/2020

Introduction

The Metrowest Conservation Alliance (MCA) produced this booklet as part of our Forest Health Initiative, which is an effort to raise public awareness in the SuAsCo watershed about the importance of healthy forests.

Forests cover more than 60% of the land In Massachusetts and provide countless benefits to both people and the environment.[1] They provide valuable habitat and provide ecosystem services such as cleaner air and water and opportunities for recreation. It is important, therefore, for landowners to be able to "read" their properties and recognize the factors that threaten the health of their wooded lands.

This guidebook is intended for conservation organizations, municipal committees, and individuals in the Metrowest region who are interested in assessing forest health as the first step in developing stewardship and management plans for their land.

Reading **forest health** is a skill that you can develop with practice. Using the visual cues we describe in this guidebook, you will be able

Words or phrases that are **bolded and blue** are further defined in the Glossary section.

Lisa Vernegaard

to assess some of the key components of forest health, such as diversity, invasive species, and habitat features.

We have also provided information that you can use to educate the public about forest health and the need for forest management. The Additional Resources section includes talking points for nature walks as well as a sample presentation for a seminar setting.

We believe these resources will help you educate community members about the need for various stewardship and management strategies.

What is Forest Health?

There are many definitions of forest health.[2] To some landowners, health may equal the beauty of a forest. To a forester or logger, health may equate to the amount of high-quality timber.

For the Forest Health Initiative, we view health through the lens of ecological integrity. An area with high ecological integrity has and sustains the living and nonliving components and processes that are natural to its region.[3]

The health of a forest involves a complex balance of interrelated factors. This booklet covers three elements you should consider as you assess forest health:

- **Diversity.** The diversity of native plant species and vegetative structure adds resiliency to the forest and provides a variety of wildlife habitat.
- **Invasive species.** Non-native invasives degrade forest health by directly or indirectly harming ecologically valuable native species.
- **Habitat features.** Native plants—both living and dead—provide food and shelter for wildlife and enable nutrient recycling.

An assessment of forest health requires more than a current snapshot. It must also consider how well a forest can be expected to fare in the future.

Forests change imperceptibly on the human timescale but can change significantly in a few centuries. In New England, if a forest is cleared, whether by a natural disturbance (a hurricane) or by human intervention (clearing land for agriculture), it can take about 300 years for the forest to rebound and reach old growth stage.

The barren land will first grow grasses and forbs, which will subsequently be replaced by woody shrubland, young forest, mature forest, and finally old growth. This process is known as forest **succession**. Most forests in Massachusetts today have succeeded to the mature stage (80 to 100 years old), having grown from land that was cleared for farmland or timber harvesting.

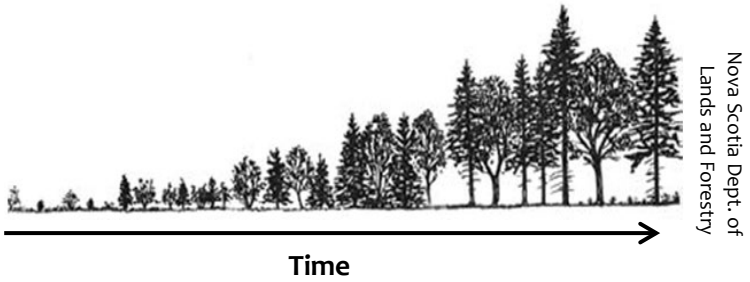

Figure 1: Over time, forests develop from areas of forbs and shrubs to stands of large trees. This is known as succession.

The characteristics of a healthy forest depend on the forest type. For common forest types in Massachusetts, such as oak-hickory and oak-pine, a diversity of trees of many sizes and ages adds to a forest's resilience to pests. In contrast, healthy pitch pine-scrub oak barrens have less than 30% canopy cover and a low diversity of tree types.

Historical Context

Today's forests have been shaped by past land uses and events. Before the arrival of European colonists, Native Americans cleared small patches of land for agriculture. The colonists then cleared significantly larger sections of forest that reset succession on a large scale.[4] Most land in New England remained pastoral until around 1850, when local farming declined as agriculture shifted to the Midwest.

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The abandoned fields filled in with saplings of white pine and other species that establish quickly. Over about 50 years, the predominantly white pine forests grew into woodlands of high-quality timber.

This led to our forests being cleared again, as much of the timber was logged during the early twentieth century. Two other significant disturbances were the 1938 New England hurricane and the chestnut blight of the early 20th century.

As a result, forests in Massachusetts are largely homogenous in age, and their species composition has been altered in comparison to pre-colonial times. Our forests have been, and continue to be, shaped as much by people as by natural ecological processes.[5]

Threats to Forest Health

Human activity continues to threaten the health of our forests in several ways:

Fragmentation. As residential and commercial development continue to expand, the amount of forested land is reduced, and previously continuous tracts of woods become fragmented. Fragmented forests pose numerous problems for both forests and the wildlife that inhabit them.

Many wildlife species are known as "forest interior species," which means they need large areas of continuous forests for breeding and foraging. For example, wood thrushes need hundreds of forested acres to support a viable breeding population.[6] Without large forests, interior species are at-risk, which reduces biodiversity.

Edges. With more fragmentation, there are more edges between forests and other land cover. Edges allow more sunlight to reach into the forest, which increases temperature and lowers moisture. Additionally, edges are usually more susceptible to invasive plants than forest interiors. It has also been found that higher levels of forest edge in suburban landscapes increase bird and turtle nest predation by opportunistic species such as raccoons and skunks

Ken Lund

Deer over-browse. Edges are also the preferred habitat of white-tailed deer, which at high densities threaten forest **regeneration** by over-browsing understory trees. Deer populations may have also increased from reduced hunting pressure from humans and the extirpation of large predators such as wolves and mountain lions.[7,8]

Invasives. Introduced and invasive plants, insects, and diseases are among the leading threats to biodiversity. They displace or kill native species with very little natural predators or controls.

Recreation. Other threats to forest health include some recreational activities such as bicycling and motorized vehicles. People and dogs walking off-trail can harm sensitive areas.

Pollution. Air pollution and **climate change** also have numerous consequences for our forests.

Terri Ackerman

With an understanding of these threats and by learning to evaluate the diversity, invasive species, and habitats of you forests, you can communicate some components of forest health to members of your community and make well-considered plans for the stewardship of your lands.

I. Diversity

A significant indicator of forest health is its diversity in both species and structure. *Species diversity* refers to how many different types of organisms make up the forest. *Structural diversity* refers to the variety of vegetation height and types of forests in a landscape.

Species Diversity. Species diversity creates **resilience** against threats like pest outbreaks.[9] Most pests attack a small number of species. A diverse forest will still have healthy, unaffected trees after an outbreak as opposed to a forest that comprises only the tree species affected by the pest.

Species diversity can also mitigate the effects of climate change, because some tree species will tolerate warming temperatures better than others.[10] A diverse forest will fare better than a forest composed solely of species not as adaptable to climate change.

Terri Ackerman

Structural Diversity. Forests can vary in structure both vertically and horizontally. Vertical structure refers to a forest containing multiple layers of trees, shrubs, and herbaceous plants. Horizontal diversity refers to a landscape that spans areas of different forest types and ages.

Debbie Pullen

Diversity in vertical structure is important for forest regeneration and wildlife habitat.[6] Multiple layers of trees and shrubs underneath the canopy facilitate regeneration when a gap is created by a tree dying or falling. Different species of wildlife, especially birds, utilize the forest at different heights, depending on their needs for food and shelter. A forest with more vertical diversity will have more wildlife species.

Horizontal diversity is also important for wildlife habitat. A landscape with forests that differ in stages of succession or plant composition provide habitat for different wildlife species. Ruffed grouse have evolved to use forest openings and young forest. Eastern towhees nest in forests that have shrubby areas rather than a full

canopy. Black-throated blue warblers inhabit mature forests with dense understories.

In this booklet, we will explain how to evaluate vertical diversity as a measure of forest health, because it can be assessed while simply walking through a forest. We will not address horizontal diversity, however, because it requires examination at the landscape level and cannot be fully assessed from visual cues while walking.

Species

There are many ways to describe species diversity. We suggest you measure plant diversity by focusing on the genus level (i.e., oaks, maples, and pines), rather than concerning yourself with the finer points of species identification (red oak, white oak, and scrub oak).

To measure the diversity of plants, simply count how many different types of plants you see while walking through the forest. Consider all levels of the forest: canopy, midstory, understory, and ground cover layers. Generally, more plant types mean higher diversity and healthier forests.

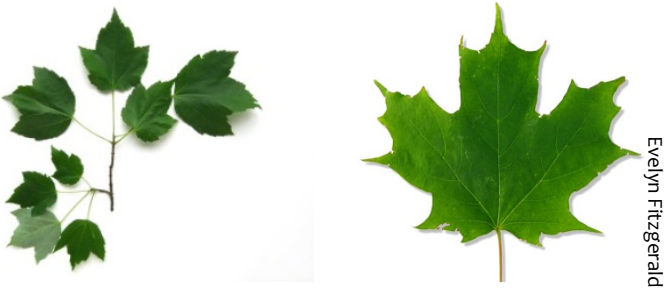
You do not need be an expert dendrologist to recognize differences in trees. In fact, identifying the genus is not as important as recognizing one tree is different from another. Genera are most easily distinguished by leaf shapes, although bark and buds are also defining characteristics.

The images below are examples of common leaves that you could see in the forest. If you wish to learn more about identifying plants, check out *A Field Guide to Trees and Shrubs* by George A. Petrides.

For simplicity, we are limiting the scope of this booklet to tree identification, although shrubs and other woodland plants obviously contribute to forest diversity as well. You can make note of how many different types of these other plants you observe without knowing the specific scientific identities.

Bruce Kirchoff

Oaks



Evelyn Fitzgerald

Maples

Homer Edward Price

Birches

Cyndy Sims Parr

Pines

Scott Zona

Hemlock

Katja Schulz

Beech

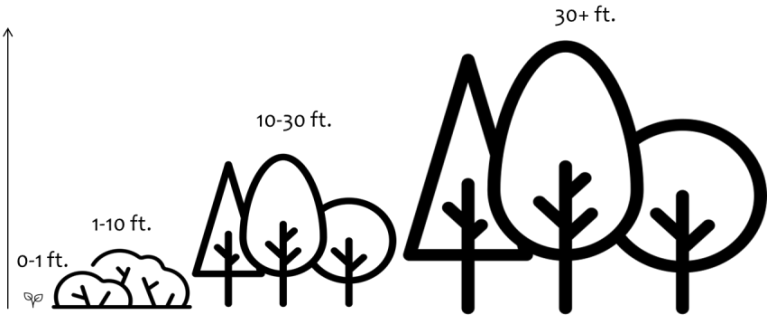
Evelyn Fitzgerald

Ashes

Vertical Structure

Forests have four layers: ground cover (0-1 ft.), understory (1-10 ft.), midstory (10-30 ft.), and overstory (30+ ft.). Note how many layers are well represented in your forest. For a layer to count as being present in a forest, it must cover at least half of the area you observe.

To determine the layer in which a plant belongs, estimate the height of the highest point of the plant. A 60-ft. tree is part of the overstory even if it has foliage in the 10–30 ft. range.



From left to right: ground cover, understory, midstory, and overstory

Lacking Understory

Forests in eastern Massachusetts typically lack a prevalent understory. This can occur for a number of reasons. Most forests are not yet old enough for many large trees to have fallen to create significant canopy gaps. The forest floor may be too shaded for most plants to grow there. The microclimate or soil conditions may not allow much to grow. High densities of deer may be browsing on any palatable plants in their 7-ft. reach. It is often a combination of factors that lead to a sparse understory.

Deer Browse

In the woods of eastern Massachusetts, excessive deer browse is a persistent problem.[11,12] In some areas, deer densities have reached levels that may threaten the long-term health of forests.

Signs of excessive browse are a lack of saplings, evidence of browse on plants that are usually of low preference for deer (see the table on the next page), an overwhelming dominance of hay-scented fern in the ground cover layer, and visibility of 100 ft. or more into the forest. (To learn how to conduct a detailed deer browse survey, see the Additional Resources.)

Alternatively, if the deer population is at a lower level, saplings of species like oaks and red maple should be more common. Plants like barberry or hay-scented ferns would be less common. Visibility into the forest would be reduced, due to an increase in understory vegetation.

When searching for signs of deer browsing, look for stems that lack buds and have ragged edges. From MassWildlife.

Browse preference of Deer

Adapted from MassWildlife. Invasive plants are denoted by asterisks.

Preferred		
Would expect browsing even at low deer densities (e.g., 6-18 deer/sq. mi. of forest)		
Trees	Shrubs	Herbaceous
Arborvitae	Common Buckthorn*	Enchanter's Nightshade
Aspen (spp.)	Dogwood (spp.)	Evening Primrose
Cedar	Multiflora Rose*	Jewelweed
Red Maple	Pin Cherry	Lady's Slipper
Oak (spp.)	Raspberry/Blackberry	Trillium (spp.)
Sugar Maple	Sumac	White Wood-aster
White Ash	Viburnum (spp.)	Wild Sarsaparilla
Moderate-Preference		
Unlikely to be browsed much at low deer densities, but typically browsed at medium to high densities		
Trees	Shrubs	Herbaceous
American Beech	Autumn Olive*	Aster (spp.)
American Chestnut	Beaked Hazelnut	Bracken Fern
Balsam Fir	Choke Cherry	Canada Mayflower
Birch (spp.)	Greenbriar	Goldenrod (spp.)
Black Cherry	Honeysuckle (spp.)	Indian Cucumber-root
Hemlock	Oriental Bittersweet*	Trout Lily
Hickory (spp.)	Winged Euonymus*	
Sassafras	Witch Hazel	
Low-Preference		
Typically avoided or only browsed at very high deer densities (e.g., above ~50 deer/sq. mi. of forest)		
Trees	Shrubs	Herbaceous
Pine (spp.)	Glossy Buckthorn*	Ferns (most spp.)
Norway Maple*	Japanese Barberry*	Garlic Mustard*
Spruce (spp.)	Mountain Laurel	Jack-in-the-pulpit
Striped Maple	Rhododendron	Milkweed
	Sheep Laurel	Pennsylvania Sedge
	Sweet Fern	Skunk-cabbage

Lisa Vernegaard

Dominance of hay-scented fern, a less-preferred plant, in the ground cover layer is a sign of excessive browse.

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High visibility through the forest is also a sign of excessive browse. The only low-growing plant is barberry, which is less-preferred for deer.

II. Invasive Species

Invasive species are aggressive, non-native species that are ecologically harmful. They spread prolifically and outcompete or kill native species. Because invasive species did not evolve in their introduced environment, they lack natural predators and controls, and they are a major threat to forest health.

Invasive plants take resources away from native plants. They quickly spread throughout the landscape and thrive in disturbed areas. They grow faster than native plants and overshadow young plants, which hinders forest regeneration.

Studies have shown that invasive plants are less valuable for wildlife. Native insects will typically not eat leaves of introduced plants.[13] Berries of invasive plants can be less nutritious than native plants.[14] Some birds fledge fewer chicks when they nest in invasive shrubs rather than natives.[15]

Invasive insects, fungi, and diseases can also negatively impact forests. Some affect a large array of plants, while others target a genus or species.

Plants

While there are a variety of ways to quantify the spread of invasive species, we recommend using the relative cover comparison method.[16] With this technique, you evaluate the ratio of invasive plants to native plants in the forest.

While walking around your forest, take note of the relative covers in each forest layer: ground cover (0-1 ft.), understory (1-10 ft.), midstory (10-30 ft.), and overstory (30+ ft.). Is there more coverage of invasive species compared to native species at each layer? Less? Or are they about equal?

Below are photos of six species of invasive plants typically found in our forests (*For a full list of invasive species of eastern Massachusetts, visit the SuAsCo CISMA website:* **cisma-suasco.org**.):

MR Burne

Glossy Buckthorn

MR Burne

Oriental Bittersweet

MR Burne

Japanese Barberry

James H. Miller

Leslie J. Mehrhoff

Multiflora Rose

MR Burne

Burning Bush

MR Burne

Garlic Mustard

Insects, Fungi, and Diseases

There are many exotic pests (insects, fungi, and diseases) that have become well-established in Massachusetts, such as chestnut blight and Dutch elm disease. Due to their pervasive nature, wide-scale treatment of these pests would be impractical, although you might have success applying a treatment to save a valued individual tree.

Some invasive insects, however, are relatively new to the region. For these pests, early detection and treatment is possible to prevent reduction in forest health.

Two pests to look out for as of 2020 are the emerald ash borer and the Asian long-horned beetle (see below). For up-to-date information about other pests, refer to **mass-nrc.org/pests**.

Bob MacInnes

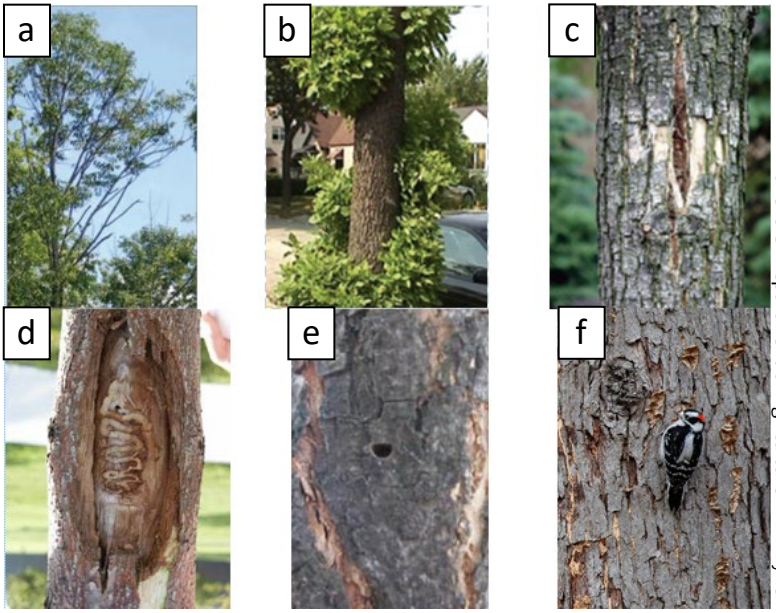
Once widespread in New England, the American chestnut has been severely impacted by the chestnut blight.

Emerald Ash Borer

U.S. Department of Agriculture

This beetle exclusively attacks ash trees, including white and green ash. Look at your ash trees for signs of emerald ash borer (EAB): (a) canopy dieback, (b) dense shoots sprouting from the bark, (c) bark splitting, (d) tunneling, (e) exit holes, and (f) woodpecker activity.[17]

Unhealthy ashes may also occur due to *ash yellows*, an established bacterial disease. Trees infected with ash yellows may have canopy dieback and increased woodpecker activity, but they will not exhibit the other signs of emerald ash borer infestation.



a–e: U.S. Department of Agriculture. f: Bill Lynch

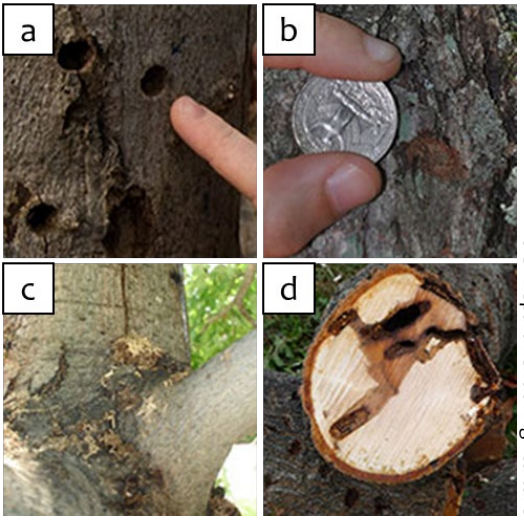
Asian Long-horned Beetle

U.S. Department of Agriculture

This insect lays its eggs on trees, and the larvae burrow into the trunk while feeding. Excessive feeding kills the tree.

The Asian long-horned beetle (ALB) forages on twelve species of trees, eight of which are native to New England: ashes, birches, elms, sycamores, maples, mountain ash, poplars, and willows.

ALB has been found in the city of Worcester and surrounding towns, which resulted in the removal of thousands of trees. Increased vigilance is recommended if your forests are close to outbreak locations. Signs of the beetle include (a) exit holes, (b) egg sites, (c) **frass**, and (d) tunneling.[18]



U.S. Department of Agriculture

III. Habitat Features

The third component of forest health is a pair of features that provide important wildlife habitat and are vital for nutrient recycling: dead wood and wetlands.

Dead Wood

Dead wood is an important component of a healthy forest. Standing dead trees, also known as **snags**, provide habitat for bats, birds, and other wildlife. Large pieces of dead wood lying on the forest floor, known as **coarse woody debris** (CWD), provide cover for wildlife like salamanders and small mammals. CWD is also an important component for soil health. Fungi and bacteria decompose dead wood back into the soil for the growth of future plants.

Simply put, dead wood is good wood.

There are measurable quantities of snags and CWD that are expected to accumulate in a forest by the time it reaches its mature stage of succession.

Lisa Vernegaard

Snags. For every acre of a mature forest, you should expect to see around eight snags of at least 10 in. in diameter.[19] Eight snags per acre converts to roughly two snags every 100 ft. x 100 ft. As a rough guide, you should walk by at least one snag within your arm span every 1,000 ft.

Coarse Woody Debris. The expected volume of CWD in mature common forests is about 150 to 250 ft^3 per acre.[19] In practical terms, if you are walking in a straight line, you should step over a piece of wood larger than 5 in. in diameter at least every 75 ft., or every 30 steps.

Ashley Davies

Wetlands

Wetlands, including **vernal pools** and streams, are another integral part of a forest ecosystem. Wetlands are vital not just for forest health but for the environment in general. They contribute to wildlife habitat, water and air quality, and flood control. A healthy wetland provides additional groundwater storage and complements a forest by adding more plants and habitat features, thus adding to the diversity of the forest.

As forest science has progressed, we have become more knowledgeable about the important and intertwined relationship between aquatic and terrestrial systems. Many wildlife species use habitats in both wetlands and forested uplands. Wetlands also mitigate climate change because they are efficient at sequestering carbon.

While assessing forest health, look for evidence of degradation to wetlands. Eroded banks alter stream flow and anatomy, which degrades habitats and corridors for fish and aquatic invertebrates.

Heavy traffic of people and pets can degrade stream banks and vernal pools. Invasive plants can use disturbed ground as opportunities to replace the native vegetation that is characteristic of wetlands.

Raj Das

A typical invasive plant found in wetlands is common reed; it is also known by its genus, *Phragmites*. This Eurasian grass can dominate wetlands, increase fire potential, and change wetland hydrology and wildlife habitat.

Leslie J. Mehrhoff

IV. Assessing Forest Health

With a basic knowledge of the three components of forest health—diversity, invasive species, and habitat features—you can successfully assess the health of your forests. The following pages contain a form to guide your assessment. A link to a blank form can be found in the Additional Resources section.

The best time of year to complete the assessment is when trees and shrubs have their leaves, June through September. The foliage helps with distinguishing different tree types, forest layers, and live and dead trees.

It is beneficial to visit the forest at other points in the year, too, because you may notice different things. For example, spring provides a better opportunity to view the impacts of some invasive insects like gypsy moth.

Expect to spend one to three hours of observation for every 10 acres of forest, although this will vary based on forest complexity and your experience. For larger forests, you will need to perform multiple assessments or else evaluate an area that is representative of most of the forest. Spend time both on and off the trail to see a fuller picture of your forest.

Lisa Vernegaard

Key Assessment Features

This section outlines the key features to look for in each of the three main components of forest health. The key features are also denoted on the assessment form (pg. 29).

Diversity

Species. Make note of the different types of woody plants you see in the forest. A healthy forest contains many different genera of woody plants. Remember, you do not need to identify individual species; simply recognize differences between plants (oaks, maples, birches, etc.).

Layers. Determine the number of layers in your forest. For a layer to be well represented, it must be present in least half of the area you observe.

Deer Browse. Finally, look for signs of excessive deer browse. This includes signs of browsing on plants that are typically of moderate or low-preference for deer, a dominance of ferns in the ground-cover layer, and visibility deep into the forest (about 100 ft.).

Invasive Species

Plants. First, determine if there are any invasive plants in or around your forest. Then, determine the relative cover of invasive plants to native plants. Is the proportion of invasives higher, lower, or about the same as native plants? Assess the cover of invasive plants for each of the four forest layers.

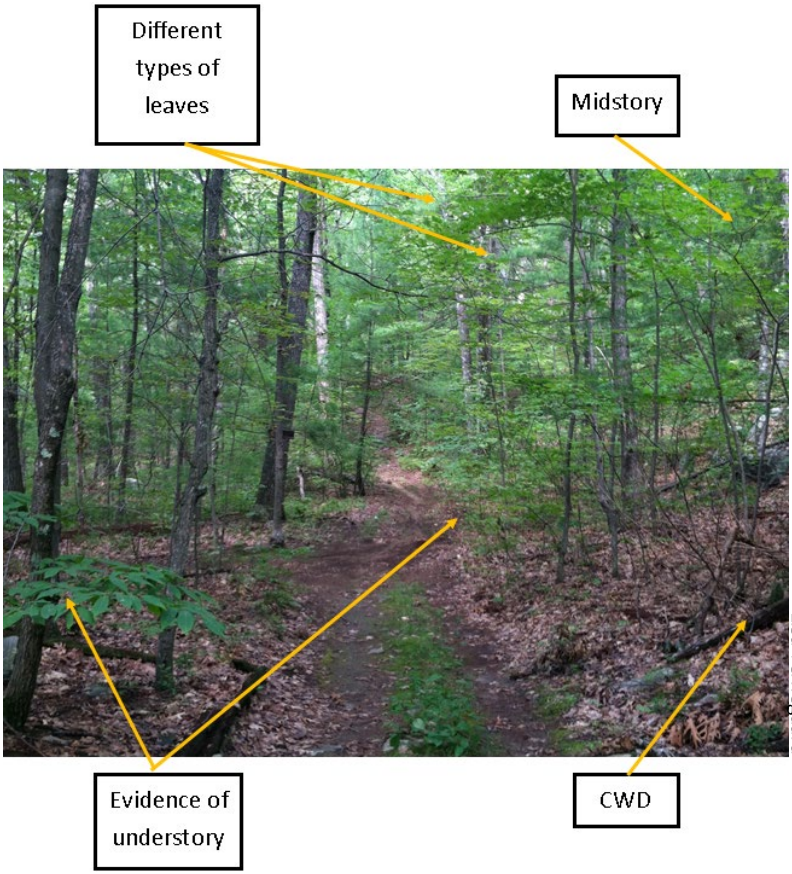
Insects, Fungi, and Diseases. Look for the signs of invasive pests like EAB and ALB. Look for signs of any other pests that have recently been found in the surrounding area.

Habitat Features

Dead Wood. There should be at least eight snags and 150 ft^3 of coarse woody debris per acre.

Wetlands. If your forest contains wetlands, look for and record signs of erosion and disturbance.

Below is a snapshot of a local forest. Note the different forest layers and types of leaves represented. Also note the course woody debris off of the trail.



Forest Health Assessment Form

Assessor: _____ Date: _____

Property: _____

Diversity:

Number of tree and shrub types found (pg. 10):

1 2-3 4-5 6-7 8-9 10+

Plants Observed:

Number of layers that cover at least half of the forest (pg. 13):

1 2 3 4

Signs of Excessive Deer Browse (pg. 14):

- ☐Browsing on moderate or low preference plants
- ☐Understory of hay-scented ferns
- ☐Far visibility (100+ ft.)

Invasive Species:

Are there invasive plants in or near the property? (pg. 17)

Yes No

Relative cover of invasive plants compared to native plants? (pg. 17)

Ground Cover (0–1 ft.):
More invasives / Equal / More native

Understory (1–10 ft.):
More invasives / Equal / More native

Midstory (10–30 ft.):
More invasives / Equal / More native

Overstory (Above 30 ft.):
More invasives / Equal / More native

Number of invasive insects, fungi, and diseases (pg. 20):
0 1-2 3+

Habitat Features:

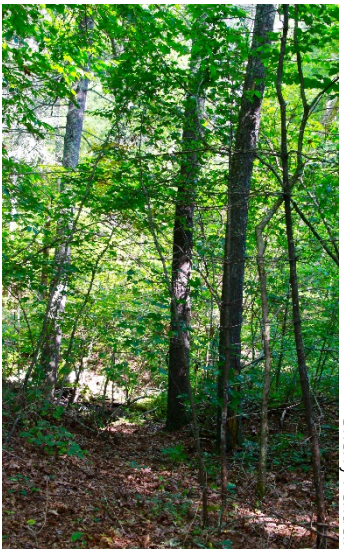
Are there at least 8 snags per acre? (pg. 23)
Yes No

Is there least 150 ft^3 per acre of coarse woody debris? (pg.23)
Yes No

If applicable, are there signs of erosion or disturbance in any wetlands? (pg. 24)?
Yes No

Notes:

V. Stewardship Options


Sherry Fendell

The first step in stewarding a forest is to assess its current condition and areas for potential improvement. You can then develop a management plan for maintaining and improving forest health. A good management plan will list stewardship objectives, specific and achievable goals, and strategies for achieving those goals.

In this section, we will describe general management options, not specific prescriptions for your forest. Remember that choosing to do nothing is also a management decision that could promote forest health. The best approach depends on your forest and your goals, and passive management may be the best option for reaching your objectives.

Any management decision should be carefully considered based on its feasibility and potential outcomes. A **professional forester** can provide specific assessments and recommendations and answer questions you may have for your specific forest and management plan. Check the Additional Resources section for a website with a directory of licensed foresters in Massachusetts.

Clear communication with the residents of your community is important when conducting any active management. People who learn about your plans second-hand or through newspaper articles may not fully understand your strategy or how your management choices may improve forest health. It is important that you give community members an opportunity to discuss their concerns, and you may choose to host public educational forums about your plans.

Diversity

Species

The diversity of plant species in your forest is likely indicative of the successional stage and site conditions of the forest. One option is to choose passive management to allow the forest to naturally succeed and maintain the diversity that already exists.

Active management options include a variety of **silvicultural** methods, but these methods come with many caveats.[20] Some methods may promote early successional species, but they will likely promote invasive plants as well. Careful consideration of the different approaches is critical.

Layers

It is unlikely that your forest will contain all four vegetation layers. Most New England forests are not old enough to have accumulated many canopy gaps. Without many gaps and the consequent sunlight, there are fewer opportunities for regenerating trees to grow in the lower layers.

Through active forestry, you can diversify your forest by restarting succession.[20] Keep in mind that with any forestry, you need to diligently treat invasive plants before and after, because the new disturbance would make your forest more susceptible to invasive plants.

Lisa Vernegaard

Aim to maintain the plant diversity you already have. You can actively maintain meadows and shrublands by mowing and selectively clearing tall trees. Additionally, you could maintain or restore rare habitats (like pitch pine-scrub oak) that occur in your forest.

If the forest lacks an understory, try to assess why. If high densities of deer are a primary suspect, consider implementing deer hunting if it is currently prohibited on the property. Hunting may help manage deer populations and encourage forest regeneration.[21]

Jan Mosimann

Invasive Species

Plants

Invasive plants are bound to be either in or near your forest. Due to their nature and prevalence, they are incredibly difficult to eradicate. Consistent monitoring is essential for early detection of invasive plants. It is best to identify and remove invasive plants before they establish in a new area. This method is known as early detection and rapid response.

Once invasive plants become established, removing them can require a lot of effort, time, and money, so pick your battles wisely.[22] A forest with large dense patches of glossy buckthorn would require significant resources to treat, and the buckthorn would likely return the following year. You may find it more worthwhile to shift

your focus to forests with valuable native habitats and lower densities of invasive plants.

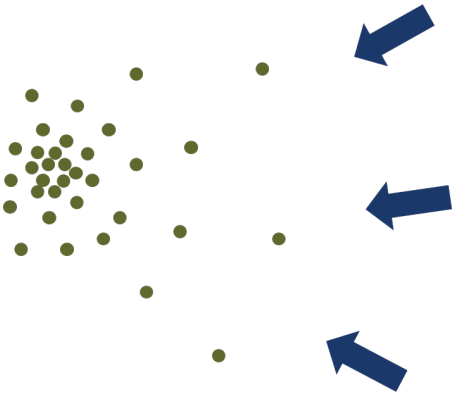
There are four broad methods for removing invasives: mechanical, biological, chemical, and burning. Different invasive species call for different removal methods.

Most effective herbicides require a licensed applicator. Visit the SuAsCo CISMA website (see Additional Resources) for detailed guidance for treatment. CISMA also offer grants for invasive species removal projects in the SuAsCo watershed.

Method	**Specific Treatments**
Mechanical	Hand pulling Mowing Cutting
Biological	Introduced predators Goats
Chemical	Direct spraying Paint over cut stems
Burning	Prescribed burning

Invasive plant control often requires multiple treatments over many years. It is best to start removing invasive plants at their lowest density as shown in the diagram below. Kill the stragglers and work your way in toward the densest patch of invasives. Properly dispose of the plants as you cut or pull them, because many plants can sprout even when fragmented.

There is strength in numbers; recruit volunteers to help. Advertise invasive plant removal days with press releases, social media, and **NatureGroupie.org** to spread the word.



Treat invasive plants starting from the sparsest patch and then work inward toward the densest area.

Insects, Fungi, and Diseases

If you spot signs of an invasive insect, fungus, or disease, the first action to take is to report it to USDA Animal Plant Health Inspection Service (APHIS) or to the Massachusetts Department of Agricultural Resources (MDAR). These agencies track the spread of invasives and use the information to plan statewide treatment.

Different pests need different treatments, which may include pesticides, removing infected trees, or introducing a predator. Search the MDAR and APHIS websites for control and management practices of the pests in your forest.

Habitat Features

Dead Wood

Leave any dead wood you see in the forest, and let snags fall naturally.

Be sure to consider safety to human life and property when you find dead wood and snags. If there are snags that could fall on a popular trail or a building, consider taking them down. A large dead tree, especially one that is leaning on other trees, is often difficult and dangerous to move and may require a professional.

In either case, leave the beneficial dead wood in the forest, away from the trail. Likewise, if you pursue any silviculture in your forest, leave behind logs and branches as CWD.

Wetlands

Disturb wetlands as little as possible. Encourage trail walkers and their dogs to stay on trails and to avoid going into streams, vernal pools, and other wetlands to prevent erosion and disturbance of wildlife.

Redirect trails to avoid vernal pools. Build bridges and boardwalks to keep visitors on the trail. Additionally, you should block access to wetlands around these structures to further encourage people, pets, and livestock to stay on trails.

When engaging in active forest management, you should avoid disturbing wetlands. You also should avoid practicing any silviculture within at least 100 ft. of vernal pools, which may dry up without shade from a canopy.[23]

For more information on managing wetlands, read *Massachusetts Wildlife Habitat Protection Guidance for Inland Wetlands* and *Vernal Pool Best Management Practices* in the Additional Resources.

SVT Staff

VI. Considering Climate Change

Forests play an important role in mitigating climate change by pulling carbon from the atmosphere and converting it to biomass. Mature trees and dead wood store carbon that otherwise would be in the atmosphere.

The ability of our forests to perform these essential functions will be negatively impacted by the effects of climate change. Threats include increased winter variability, intensity and frequency of storms and floods, drought severity, and pressures from invasive plants and herbivore browsing.[10]

As you assess the current state of your forests and consider taking steps to improve their health, you may be able to take additional actions that can mitigate the effects of a changing climate. To better understand how your forest will endure climate change, check out *Increasing Forest Resiliency in an Uncertain Future* by Paul Catanzaro, Anthony D'Amato, and Emily Silver Huff.

Many of the actions we can take to increase current forest health will also help protect our forests against climate change. A healthy forest will be better able to withstand the effects of climate change than a degraded forest.

To get started, the U.S. Forest Service has created a "menu of adaptation strategies and approaches" that outlines management options to consider for mitigating climate change.[24] Options include protecting future-adapted seedlings and retaining biological legacies. A link to the report with the full menu is provided in the Additional Resources section.

Jill Moonheron

Conclusion

Reading the visual cues of forest health allows you to recognize areas of strength and potential improvement for your forests. With this knowledge, different management options, passive or active, can be fully considered and implemented to improve the health of your forest.

Being able to read and interpret the signs will also allow you to communicate to your colleagues and the public what forest health means. Our sincere desire is for people to be more informed about the forests that surround them. We encourage you to use the content of this booklet, the sample presentation, and the talking points for a nature walk to educate members of your community. A link to these resources is located in the Additional Resources section.

Lisa Vernegaard

Additional Resources

Accompanied Materials for Forest Health: A Guide for Conservation Professionals

This link includes digital files for the forest health assessment sheet, the sample presentation, and talking points for nature walks.
svtweb.org/mca/fht

Massachusetts Licensed Foresters Directory

mass.gov/doc/directory-of-licensed-foresters-in-massachusetts/download

Keep Forests Healthy

A tool to assess forest health resiliency, health, and productivity.
forestadaptation.org/learn/resource-finder/ny-checklist

Deer Browse Impact Surveys

To learn more about the impacts of deer browse beyond the brief overview covered in this booklet, check out these two resources developed by MassWildlife and the U.S. Forest Service.
MassWildlife:
cdn.ymaws.com/www.maccweb.org/resource/resmgr/AEC_2017_Proceedings/B11/Deer_Impacts_Protocol_V3.pdf
USFS:
fs.usda.gov/naspf/publications/white-tailed-deer-northeastern-forests-understanding-and-assessing-impacts-0

Evaluating Forest Regeneration

This article provides guidelines for monitoring forest regeneration in the long term.
fs.usda.gov/treesearch/pubs/19209

SuAsCo CISMA

This is a partnership of local conservation organizations for information on invasive species.
cisma-suasco.org/

What is Early Detection and Rapid Response?

invasive.org/edrr/

Nature Groupie

This website can help you recruit volunteers to steward your forests. They also have information on how to recruit and manage volunteers on their Training Guides webpage. Join their email list for tips on how to recruit and engage volunteers.
naturegroupie.org/

Introduced Pests Outreach Project

Find information about other pests found in Massachusetts.
massnrc.org/pests/factsheets.htm

Massachusetts Wildlife Habitat Protection Guidance for Inland Wetlands

mass.gov/doc/massachusetts-wildlife-habitat-protection-guidance-for-inland-wetlands

Vernal Pool Best Management Practices

www.naturalheritage.state.pa.us/VernalPool_Management.aspx

Climate Change Response Framework

This website offers resources, information, and case studies on forest management and climate change. They occasionally offer an Adaptation Planning and Practices course. This is a free training for

land managers to learn how to consider climate change in forest management plans.
forestadaptation.org/

Climate Change Tools & Approaches for Land Managers

This report by the Forest Service offers tips and strategies for forest management through the lenses of climate change. The full "menu" is on page 34.
www.fs.fed.us/nrs/pubs/gtr/gtr_nrs87-2.pdf

Books

A Field Guide to Trees and Shrubs by George A. Petrides

Increasing Forest Resiliency in an Uncertain Future by Paul Catanzaro, Anthony D'Amato, and Emily Silver Huff.

Reading the Forested Landscape by Tom Wessels

Report Invasive Insects

MDAR: www.massnrc.org/pests/pestreports.htm
APHIS: www.aphis.usda.gov/aphis/resources/pests-diseases

Glossary

Climate Change: the change in global climate due to an increase of greenhouse gases in the atmosphere resulting from anthropogenic activities.

Coarse Woody Debris: Fallen, large dead wood that is at least 5 in. thick and 5 ft. long.

Frass: a powdery excrement from wood-boring insects.

Forest Health: the degree of which a forest has ecological integrity, or having biotic and abiotic parts and process natural to its area.

Regeneration: the act of renewing tree cover by establishing young trees naturally or artificially.

Resiliency: ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate.

Silviculture: the growing and cultivation of trees.

Snag: a dead tree that is still standing, which can provide habitat to wildlife.

Succession: the process of forests changing vegetation structure and species composition through time

Vernal Pool: a shallow body of water that is used by many amphibians for breeding. It is characterized by a lack of fish and can be seasonal. Vernal pools are often very sensitive to disturbance.

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