MASSACHUSETTS STATE FOREST ACTION PLAN

2020

dcr
Massachusetts

EXECUTIVE OFFICE OF ENERGY & ENVIRONMENTAL AFFAIRS
DEPARTMENT OF CONSERVATION & RECREATION
MASSACHUSETTS BUREAU OF
FOREST FIRE CONTROL & FORESTRY

Cover Photo by Benjamin Engel, Forest Legacy Program easement in Lenox, Massachusetts

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Franklin Regional Council of Governments
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Massachusetts Audubon Society
Massachusetts Department of Fish and Game
Massachusetts Forest Alliance
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EXECUTIVE SUMMARY

The Forest Action Plan is designed to be a comprehensive resource on the condition and trends of, as well as threats to, the forests and trees of Massachusetts across rural, suburban, and urban landscapes. This document also fulfills a fundamental requirement from the Forest Service, U.S. Department of Agriculture (USDA), which makes Massachusetts eligible to receive federal funding that directly support the work of stewarding the forest resources of the Commonwealth while also meeting the national priorities set by the U.S. Forest Service. Every ten years, states must produce a Forest Action Plan that comprises an assessment and strategies for activities related to trees and forests. This current plan consists of updates to two documents produced in 2010: *An Assessment of the Forest Resources of Massachusetts* and *Forest Resource Strategies of Massachusetts*. The intended audience for this plan includes government agencies, educational institutions, non-profit organizations, and the public.

The plan is comprised of six chapters. Chapters One and Two provide an assessment of trees and forests and associated ecosystem services. Chapter Three discusses the ability of forests to produce timber. Chapter Four examines the related socioeconomic benefits, while chapter Five discusses the legal and institutional framework pertinent to trees and forests. Chapter Six presents landscapes that are priorities for action in Massachusetts as well as priority areas that cross state boundaries. Additionally, the plan highlights successes since the last plan, as well as continued challenges for trees and forests. The plan includes 10 overarching goals related to the forests and trees of Massachusetts, as well as assemblages of specific strategies that may be undertaken to work toward achieving those goals. This plan is a tool to help guide the activities of all stakeholders with an interest related to trees and forests over the next 10 years.

The 2020 Forest Action Plan goals for Massachusetts forests are:

- Goal 1: Increase resistance and resilience of trees and forests to mitigate and adapt to the effects of climate change
- Goal 2: Manage forest ecosystem health and biodiversity
- Goal 3: Support and enhance forest economy
- Goal 4: Maintain and increase urban tree canopy
- Goal 5: Enhance the connection between forests and people
- Goal 6: Increase land base of conserved forests (keep forests as forests)
- Goal 7: Advocate for a legal and institutional framework pertinent to the conservation and management of trees and forests
- Goal 8: Maintain and enhance soil, water, and air resources
- Goal 9: Support the role and use of prescribed fire in the landscape
- Goal 10: Cultivate and support partnerships with forestry and conservation stakeholders

These goals correlate with the four challenges and threats identified and highlighted in the plan that encompass the greatest issues our forests face.

- Climate Change
- Forest Conversion
- Invasive Pests and Plants
- Disconnection Between Local Wood Production and Consumption

The priority areas designate where activities utilizing federal funding will be emphasized. Geospatial analysis was used to identify priority areas based on several themes, while other areas (marked with a * below) are existing program areas.

- Priority Urban Forests
- Mohawk Trail Woodlands Partnership*
- Greening the Gateway Cities*
- High Elevation Forests
- Forest Vulnerability to Conversion
- National Theme: Conserve Working Forest Landscapes
- National Theme: Protect Forests from Threats
- National Theme: Enhance Public Benefits from Trees and Forests
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    - Connecticut River Watershed*
    - Berkshire-Taconic Regional Conservation Partnership*
    - Last Green Valley*
    - Quabbin-to-Cardigan Partnership*

FORESTS OF MASSACHUSETTS

Although Massachusetts is the third most densely populated state in the country, it is also the 11th most forested state by percent forestland (Oswalt et al. 2019). The 3.2 million acres of forest in the Commonwealth make up 63% of the state's area. These forestlands comprise state forests and reservations, town forests and conservation lands, small family forests, non-profit owned conservation land, commercially owned working forests, and even wooded backyards. Each contributes to the multitude of essential benefits that forests provide to the Commonwealth and its residents.

More than 2.1 million acres of the forestland in Massachusetts are owned by private landowners. These lands are owned and managed for a variety of reasons ranging from aesthetic to economic. The Commonwealth is responsible for over 525,000 acres of forestland, the majority of which is managed by the Department of Conservation and Recreation or the Department of Fish and Game. These lands are managed for the conservation of diversity in wildlife and plants, the protection of drinking water, recreation, ecosystem services, and wood products. Municipalities protect 262,000 acres of land for similar public purposes including water supply protection, habitat, and public recreation. Nonprofit land trusts own 129,000 acres and another nearly 196,000 acres in private ownership are protected from development by conservation restrictions.

Massachusetts has many forest habitats arising from variations in topography, bedrock soils, and climate, further shaped by land use history and the effects of natural disturbances like hurricanes, tornados, and ice storms. Human use played a particularly important role in how our forests look today. We are in a transition zone between central and northern forest types. Coastal areas are covered with pitch pine and scrub oak forest, while inland forests are predominantly central and transition hardwoods. The higher elevations in the west are northern hardwoods and spruce-fir forests. Transition hardwoods, dominated by oak species, cover the largest amount of area (O'Keefe and Foster 1998).

Springtime in New England, photo by Jennifer Fish

The forests and trees of Massachusetts collectively provide cascading benefits, including clean air and water, recreation, wildlife habitat, climate resiliency, and forest products. While many of these ecosystem services cannot be replaced, the economic benefits of our forests must also be considered as thousands of people are employed or engaged in activities to deliver these diverse services to the people of Massachusetts.

THREAT: CLIMATE CHANGE

Climate change is already exacerbating natural hazards and extreme weather events, leading to new impacts to our forests as well as the entire Commonwealth. Current projections show that Massachusetts should expect increases in precipitation, sea level, and average annual temperature

(Commonwealth of Massachusetts 2018). These changes will have direct impacts on the forests of Massachusetts including decreases in suitable habitat for boreal species and other cold-adapted ecosystems, changes to soil moisture patterns, increased drought, flooding, and tree mortality resulting from increases in outbreaks of forest insects and pathogens. Increased insect activity in combination with other stressors related to climate change such as drought, may increase the vulnerability of our forests to secondary insects and diseases that historically have been of little concern at the landscape scale. Severe weather events such as windstorms, hurricanes, tornados, and ice storms have caused tremendous change in New England forests and projected increased frequency of these events under a changing climate will likely increase structural damage to trees, as well as property damage caused by uprooted trees or breaking limbs.

Massachusetts forests will play an important role in climate resiliency and mitigation. The carbon they accumulate and store above and below ground in live vegetation, soil, and dead wood assists in lowering net carbon dioxide emissions. It has been estimated that Massachusetts forests hold about 270 million oven-dry tons of carbon, or an average estimate of about 89 tons per acre (U.S. Forest Service 2018a). The quantity of carbon sequestered and stored by a given forest is dependent on a variety of factors including forest age, forest type, and ecological site conditions.

Annually, forests in the Northeast sequester 12 to 20% of the carbon emissions from the region. Research shows this percentage could be increased through improved application of sustainable forest management practices (Perschel et al. 2007), however both active and passive forest management strategies should be considered in terms of trade-offs in net forest carbon storage (Catanzaro and D'Amato 2019). Strategies that could increase forest carbon sequestration and storage in Massachusetts include forestland protection, afforestation, minimizing forest disturbance, reducing harvest intensity, increasing forest growth rates, thinning to reduce fuel accumulation, increasing urban forest canopy levels, substitution of wood and biomass for fossil fuels, and carbon storage in long-lived forest products (Ontl et al. 2020, Ryan et al. 2010).

Both natural and human disturbances often result in the release of stored carbon from forests through tree mortality and the resulting decay and decomposition of plant material, however human disturbances are a far more dominant and ubiquitous source of carbon emissions. The conversion of forests to developed uses in Massachusetts, at a rate of 13.5 acres per day (Ricci et al. 2020), is releasing substantial amounts of carbon and reducing both potential future statewide sequestration rates and total carbon storage capacity of the state.

In 2018, the Commonwealth adopted the *Massachusetts State Hazard Mitigation and Climate Adaptation Plan*. It was the first of its kind to comprehensively integrate climate change impacts and adaptation strategies with hazard mitigation planning. In 2020, Massachusetts became only the third state in the nation to legally require that its greenhouse gas emissions are reduced to net zero by 2050. To achieve net zero, the Commonwealth must reduce its GHG emissions to at least 85% below 1990 levels while annually sequestering at least an equivalent volume of carbon. The health, preservation, and sustainable management of Massachusetts' forests will be critical in achieving that goal.

Mount Greylock fall foliage, photo by Molly Hudlin

THREAT: FOREST CONVERSION

During the last 70 years, Massachusetts has lost a considerable amount of open space – wetland, forest, and agricultural land – to development. The loss of forest results in the loss of all the benefits that forestland provides, reduction in ecological integrity, loss of habitat, and loss of carbon storage and potential climate resilience. Development has been concentrated in a few areas, including southeastern portions of the state and the southern Connecticut River Valley. Areas north and south of Boston as well as west of Boston to the Worcester metropolitan area have had higher rates of land conversion than other areas of the state. For the most part, development has been driven by economic trends, transportation investments, and zoning policy, rather than by population growth. With increased awareness and conservation activity, development has slowed to 13.5 acres a day, down from 22 acres a day at the time of the last Forest Action Plan, while the pace of conservation has increased to 54.8 acres a day (Ricci et al. 2020). As of 2019, 1.353 million acres of land are conserved in Massachusetts (Ricci et al. 2020).

State and municipal government use several methods to enforce and encourage land conservation. Zoning reform, including minimum lot sizes, is one of the most important means of stopping suburban sprawl and associated environmental damage. The Chapter 61 tax incentive program eases financial burden on private forest owners and discourages the conversion of forestland. Development of a management plan and enrollment in this program reduces the landowner’s tax bill in order to incentivize the retention of a covered area as managed forest. Landowners who do not wish to practice forest management but want to keep their forest as forest for recreation or carbon storage can enroll in Chapter 61B and still receive a tax benefit.

Several programs are also available to help fund the protection of forestland. The Community Preservation Act has helped communities protect their open space through a small property tax surcharge and state matching funds. Conservation grant programs like the Landscape Partnership Grant and the Forest Legacy Program managed by the Executive Office of Energy and Environmental Affairs and the U.S. Forest Service have also helped protect thousands of acres of forestland in the Commonwealth. Programs such as these, as well as the work being done by local land trusts, is vital to preventing conversion of forestland.

THREAT: EXOTIC INVASIVE PLANTS AND PESTS

Exotic invasive pests and diseases have a significant impact on the forest. Their effects can alter species composition, reduce growth rates, disrupt forest management activities, and cause mortality across many acres of mature trees. Exotic invasive insect pests and diseases have threated Massachusetts forests since the 19th century, causing extensive damage in many instances. The gypsy moth, introduced in 1869, continues to cause periodic defoliation and tree mortality. During the 20th century, chestnut blight eliminated the American chestnut as an overstory species; Dutch elm disease killed street trees in towns throughout New England; and beech bark disease infected and killed large numbers of mature beech trees in northern hardwood forests in western Massachusetts. These pathogens continue to infest sprouts and new seedlings today, while recently introduced pests present new dangers.

Over the last decade, gypsy moth and winter moth have caused the most canopy damage in Massachusetts forests, totaling over 1.78 million acres. Hemlock woolly adelgid and emerald ash borer are now being seen extensively across the state, and a 110-square-mile area of central Massachusetts is regulated for the Asian longhorned beetle (ALB). In the fight to eradicate this non-native beetle, over 24,000 infested trees have been cut and chipped. Additionally, hundreds of acres of high-risk trees have been removed and destroyed to slow the spread of this invasive pest.

Exotic invasive plants, while pervasive, typically take longer than insect pests to degrade forest health. They do, however, threaten biodiversity by out-competing native plants, causing declines in native plant populations, and consequently, altering established ecosystems and the habitat they provide.

Global trade has accelerated the introduction of pest species from around the world. At the same time, modern technology enhances the ability of public agencies to monitor pest populations and plan for pests that pose a potential threat. The internet makes it possible to quickly warn large numbers of people against actions that may spread pests and disease, such as transporting firewood from affected areas. Community volunteers are a large part of efforts to monitor insect pests and invasive plants.

State agencies, conservation organizations and land trusts are currently working to conserve forests, especially large forest blocks, sometimes by aggregating several individual parcels into one block. Conserving large intact blocks of forest, hindering forest fragmentation, may help to slow the spread of invasive plants that often become established in disturbed areas. Through its licensing program Massachusetts has the opportunity to educate foresters and timber harvesters regarding management practices that can sustain forest health. Active forest management and planning can also help landowners prepare for and control exotic invasive species.

Threat: Disconnection Between Local Wood Production and Consumption

Almost 90% of Massachusetts forestland is classified as timberland, based on the U.S. Forest Service definition, which is capable of producing merchantable timber. However, it is a continuing trend that annual net growth of forests in Massachusetts exceeds annual harvest removals. Several programs are in place to incentivize long-term goal setting for forest management, through a forest management plan or forest stewardship plan, and responsible harvesting on private land.

Local wood production (the number and total output of sawmills) has declined precipitously in the last 30 years in Massachusetts. While at the same time, annual harvest volumes have remained relatively constant. An increasing proportion of Massachusetts wood is being exported to northern New England, Canada, and even overseas. Wood products harvested and processed in Massachusetts represent a $500 million segment of a $3 billion wood products economy (NEFA 2015). There are several biophysical, technological, and policy reasons that most harvested timber leaves the state for primary processing, including diverse forest types, limited affordable access to computer automation for small producers, higher delivered electric rates, and pressure from states and provinces with larger agricultural economies vying for access to customers in metro Boston.

Timber harvesting is among the most controversial component of forest management but is vital for many larger forest landowners. Local production of wood products provides landowners with an essential way to generate income, pay taxes, meet expenses, and say no to conversion proposals and the consequent loss of ecosystem services to local communities and the Commonwealth.

Every board foot of wood that is grown, processed, and sold in Massachusetts is a positive contribution to our economy and helps to right the lopsided proportion of our consumption coming from outside the state. The differences in the carbon footprint of a truckload of lumber from Quebec versus within Massachusetts should inspire more environmentally responsible purchasing decisions. At present, logs are sold on the export market by local harvesters and mills when the only alternative is to saw them into lumber locally at a loss. Development of local markets and effective outreach to consumers could help to correct this imbalance.

Conclusion

While the Department of Conservation and Recreation was empowered to draft this Forest Action Plan, it is up to all stakeholders with an interest in the trees and forests of Massachusetts to implement, utilize, learn from, and improve on it for 2030. Achieving the goals outlined in this plan and applying the myriad strategies is impossible for one entity to accomplish alone and will depend on partnerships and coordinated efforts. It is our hope that this plan will provide a framework for creating new partnerships and strengthening existing ones to work toward achieving the goals for the forest resources of Massachusetts.

Introduction

The Department of Conservation and Recreation (DCR), Bureau of Forest Fire Control and Forestry is responsible, under Massachusetts General Laws Chapter 132, for the management and custodial care of the Commonwealth's forests. The Bureau offers programs to promote, protect, and enhance healthy and diverse forests throughout our Commonwealth, including grant opportunities for urban forestry and volunteer fire assistance, staff assistance to municipalities for fire control, private consulting forestry and forest stewardship for private lands, oversight of forest health issues, including insect and disease control and storm related response, regulatory guidance on timber harvests, as well as forest management and timber sales on DCR lands. A healthy forest maintains a full capacity for self-renewal through conservation of intact ecosystem processes such as water, nutrient, and energy cycling.

The Cooperative Forestry Assistance Act (CFAA) provides federal funding to states that makes many of these programs possible. To be eligible to receive those funds, a state must develop a "Statewide Assessment and Strategies for Forest Resources," collectively known as the State Forest Action Plan. The Forest Action Plan is a strategic plan for each state to show how they are using federal resources to advance three national priorities:

- **Conserve** and manage working forest landscapes for multiple values and uses,
- **Protect** forests from threats, and
- **Enhance** public benefits from trees and forests.

The 2020 Massachusetts Forest Action Plan is an update to *An Assessment of the Forest Resources of Massachusetts* and *Forest Resource Strategies of Massachusetts* published in 2010 and will serve as the guiding document for the work of the DCR. In this document you will find:

- An analysis of conditions and trends of the forest resources of Massachusetts,
- Threats to our forestland and resources,
- Priority areas where resources will be focused, and
- Strategies to address threats to forest resources.

Plan Components

The Massachusetts State Forest Action Plan describes and quantifies the remarkable array of functions, products, and values provided by the forests of Massachusetts. You will find data on topics such as species composition and age, forest industries, like timber production and recreation, as well as carbon sequestration, and water quality. This plan highlights the diverse, complex, and inter-connected nature of forests and people in the Commonwealth.

The 2020 Forest Action Plan combines the two separate 2010 Assessment and Strategies documents into one cohesive plan. In 2010, the Assessment was formatted using the sustainability criteria developed by the Montreal Process Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests. In 2020, the plan format has moved away from the Montreal Process and was written in five chapters:

- Forest Ecosystem Health and Biodiversity,
- Ecosystem Services,
- Productive Capacity of the Forest,
- Socioeconomic Benefits, and
- Legal, Policy, and Institutional Framework.

Each of these five chapters provides an assessment of Massachusetts forests through a different lens. The information in the assessment has been updated from 2010 with the newest available data to reflect current conditions and trends in our forests. Issues and threats that influence the character and condition of our forests are also discussed

Goals and Strategies

This plan identifies strategies that the DCR, as well as state agencies, municipalities, land trusts, private landowners, and federal government partners, may undertake to achieve our goals for healthy, diverse, and productive forests in Massachusetts.

The complete list of strategies and how they relate to the national priorities can be found in the Strategies Matrix. Additionally, each chapter concludes with the strategies that may be implemented to address the forest threats outlined in that assessment chapter. Each strategy is placed under the chapter it best applies to, but it may apply to other chapters as well. We have identified 10 key goals which encompass the areas in which we will focus our work:

- Goal 1: Increase resistance and resilience of trees and forests to mitigate and adapt to the effects of climate change
- Goal 2: Manage forest ecosystem health and biodiversity
- Goal 3: Support and enhance forest economy
- Goal 4: Maintain and increase urban tree canopy cover
- Goal 5: Enhance the connection between forests and people
- Goal 6: Increase land base of conserved forests (keep forests as forests)
- Goal 7: Advocate for a legal and institutional framework pertinent to the conservation and management of trees and forests
- Goal 8: Maintain and enhance soil, water, and air resources
- Goal 9: Support the role and use of prescribed fire in the landscape
- Goal 10: Cultivate and support partnerships with forestry and conservation stakeholders

Priority Areas

The maps in the Priority Areas section highlight the geographic regions of the state that are at highest risk for various threats identified in the assessment as well as those that provide extraordinary benefits. State and federal resources will be focused in these areas.

STAKEHOLDER ENGAGEMENT

When the Forest Action Plan update process began in 2017, a multitude of stakeholders with various interests in or involvement with the diversely owned forests of the Commonwealth were identified. This group included other state and governmental agencies active in Massachusetts, academic institutions, and non-profits that work in forestry and land conservation. Stakeholders were asked to participate in a written survey, and they were invited to a full-day, interactive, working group meeting. This outreach was intended to gather input from our stakeholders on the issues, challenges, and strategies related to protecting our forest resources in Massachusetts that they encounter in their work. We learned how these stakeholders were using the 2010 assessment and strategies documents and how they thought the documents could be improved. The meeting featured a discussion based on the World Café method in which four major threats to Massachusetts forests were discussed: Climate; Invasive Plants and Pests; Declining Markets; and Forest Fragmentation. The feedback garnered from this dialogue served as a launching point into the framework of the 2020 Forest Action Plan.

Once the draft of the 2020 plan was complete, we connected with stakeholders a second time. Stakeholders were invited to review the draft plan in early 2020 and to provide comment. Two meetings, one in central Massachusetts and one in western Massachusetts, were held in mid-February 2020, where the Forest Action Plan Working Group heard feedback from stakeholders on the goals and strategies identified in the plan. Stakeholders were also encouraged to submit written comments and edits on the plan. The stakeholder groups included in our outreach were:

Appalachian Mountain Club
Berkshire Regional Planning Commission
DCR Forest Reserve Science Advisory Committee
Forest Stewards Guild
Franklin Land Trust
Franklin Regional Council of Governments
Hanscom Air Force Base
Harvard Forest
Highstead
Massachusetts Arborists Association
Massachusetts Audubon Society
Massachusetts Maple Producers Association
Massachusetts Tree Farm
Massachusetts Tree Wardens' and Foresters' Association
Massachusetts Army National Guard
Massachusetts Association of Conservation Commissions
Massachusetts Association of Conservation Districts
Massachusetts Department of Agricultural Resources
Massachusetts Department of Fish and Game
Massachusetts Forest Alliance

Massachusetts Forest Stewardship Coordinating Committee
Massachusetts Land Trust Coalition
Massachusetts Woodlands Institute
National Park Service
New England Forestry Foundation
New England Chapter - International Society of Arboriculture
New England Society of American Foresters, Mass Chapter
Northeast Climate Adaptation Science Center
Northeastern Forest Pest Council
Northeast Forest Fire Protection Compact
Natural Resources Conservation Service
The Nature Conservancy
The Trustees of Reservations
UMass Arboriculture Program
UMass Extension
United States Army Corps of Engineers United States Fish and Wildlife Service
United States Forest Service
Wendell State Forest Alliance
Westover Air Force Base

Granville State Forest, photo by Ian McKenzi

KEY MASSACHUSETTS FOREST FACTS

Forest Facts	
Total Land Area (acres)	5,175,349
Forested Area (acres)	3,242,113
Timberland Area (acres)	2,874,000
Old-Growth Forest (acres)	1,119
Highest Point	Mount Greylock – 3,491 feet
State Tree	American elm
Most Common Forest Trees	Red maple, eastern white pine, eastern hemlock, red oak
Forestland owned by Private Landowners (acres)	2,193,496 (67.7% of Massachusetts forestland)
Average Number of Cutting Plans Filed each year	513
Growth to Harvest Removal Ratio on Timberland (in 2017)	6.8:1
Trees Planted by the Urban and Community Forestry Program 2009-2019	46,035
Annual Gross Output of Massachusetts' Forest Products Industry	$3 Billion
People Employed in Forest Products Industry	17,000
Active Licensed Foresters	168
Active Licensed Timber Harvesters	468
Land Lost to Development	13.5 acres a day
First Land Trust Established	1891, The Trustees of Reservations
Continuous Forest Inventory Plots	Since 1960, 102,000 trees monitored
Carbon stored on DCR-Division of State Parks and Recreation forests in soil and standing live and dead trees (million tons)	21.5

STATE AND PRIVATE FORESTRY NATIONAL PRIORITIES: HIGHLIGHTS AND ACCOMPLISHMENTS

Many programs managed by the Department of Conservation and Recreation (DCR) are made possible by federal investment. This section of the Forest Action Plan highlights some of those programs and the progress they have achieved in the last five years. Though this list is not complete, it represents a sample of the work being done by the DCR in and for our forests. These success stories are presented with the three national priorities identified by the U.S. Forest Service.

NATIONAL PRIORITY 1: CONSERVE AND MANAGE WORKING FOREST LANDSCAPES FOR MULTIPLE VALUES AND USES

Mohawk Trail Woodlands Partnership

In August 2018, the State Environmental Bond Bill established the Mohawk Trail Woodlands Partnership (MTWP) in the 21-town Mohawk Trail region of north-western Massachusetts (Figure 6.2). This designation was enacted to bring financial and technical resources to the region, specifically to:

- Increase sustainable economic development related to forestry and natural-resource-based tourism,
- Support forest conservation on private lands and use of sustainable forestry practices, and
- Improve fiscal stability and sustainability of the 21 municipalities in the Mohawk Trail region.

The Mohawk Trail region has great biological diversity due to the convergence of different forest types. However, these communities are among the most economically distressed in the state, and many are experiencing declines in population, loss of businesses, and low wages. The goals of the partnership aim to address these issues and revitalize the area through natural-resource-based programs.

The MTWP will conserve the region's forests and bring new sources of funding and assistance to landowners, communities, and local businesses. Five programmatic priorities were chosen:

- forestland conservation,
- municipal financial sustainability,
- sustainable forestry practices,
- forest based economic development, and
- natural-resource-based tourism.

Involvement in the partnership is voluntary for each town. To be a part of the program, each town must opt-in through a vote by their Select Board. As of July 2020, 16 of the 21 municipalities have opted in, allowing for the formation of the MTWP Board. The board coordinates the development and implementation of programs and activities and will pursue Federal legislation based on the State legislation to conserve and steward forests, enhance natural resource-based economic development, and the economic viability of communities.

On November 21, 2019, the Commonwealth and the U.S. Forest Service signed a Shared Stewardship Agreement. Through this agreement, they will partner with communities to advance the goals of the MTWP to conserve forests and enhance economic development in the region. This is the first Shared Stewardship Agreement in the U.S. Forest Service Eastern Region and the first in the 10 states that do not have a National Forest.

Quabbin Reservoir to Wachusett Mountain Forest Legacy Project

Completed in February 2019, the Quabbin Reservoir to Wachusett Mountain Forest Legacy Project conserved 3,105 acres of forestland. This project weaved together 29 properties in six towns into a landscape scale conservation project on a level not previously seen in the Forest Legacy Program. Nearly all the protected land lies within the Quabbin, Ware River, and Wachusett watersheds. Protecting this land provides considerable benefits to the Commonwealth as these watersheds are part of an unfiltered drinking water supply system that provides water to three million people. This land also provides new recreational opportunities and preservation of the scenic quality of this region of the state, while also allowing for the continuation of forestry practices and management.

Working Forest Initiative

With support from the U.S. Forest Service Eastern Region State and Private Forestry, DCR's Working Forest Initiative (WFI) is achieving its goals of engaging with family forest landowners, promoting sustainable forestry, and forging key partnerships to create critical wildlife habitat on private and municipal lands. Through a diverse range of outreach programming, innovative cost-sharing opportunities, and invaluable one-on-one technical assistance, Service Foresters provide the multitude of private landowners in Massachusetts with expert advice and guidance to help them make informed and ecologically sound decisions pertaining to their forestland. Below are some of the key successes achieved since the 2010 assessment.

FOREST STEWARDSHIP PROGRAM

DCR's Forest Stewardship Program, a core component of the state's Working Forest Initiative, provides cost-share support to private and municipal forest landowners to engage with professional forestry services and create long-term plans for the sustainable management of their forestland.

In the decade leading up to this Forest Action Plan (FY2010-2019), DCR awarded $2.7 million in support of Forest Stewardship planning, which has supported the sustainable stewardship for an additional 160,000 acres of forestland, more than 1,700 landowners, and 49,000 acres of municipally owned forestland covered by more than 200 Forest Stewardship Plans.

Municipal landowners with active Forest Stewardship Plans may also apply for the competitive Community Forest Stewardship grant, which reimburses 75% (up from 50% prior to FY2018) of the cost of implementing practices outlined in the municipality's Forest Stewardship Plan. Projects funded through this grant program have been as diverse as the communities that implement them. Examples include such disparate activities as creating habitat for Blanding's turtles, controlling invasive species, creating community outreach materials and programming, and using prescribed fire to effect ecological restoration of pitch pine barrens. Through FY2019, 23 projects have been funded involving more than 7,600 acres. Funding provided by DCR totaled $261,350, which, accounting for match contributions from municipalities, corresponds to a combined value of $335,770 for all completed projects.

ESTATE PLANNING

Recognizing that our forested landscape is predominantly in private ownership, and that the vast majority of landowners are over 55 years old, Estate Planning Outreach was incorporated into the WFI framework. Anticipating and preparing for the transfer of land between generations is a critically important activity that can directly prevent the loss of forestland to development and fragmentation. This partnership between UMass Extension Forestry, the Mount Grace Land Conservation Trust, and the DCR Service Forestry Program delivers outreach programming and publications to landowners, communities, land trusts, and other conservation professionals across the Commonwealth to help all parties navigate the complex – yet critically important – process of land protection and conservation. Through work with conservation partners, the conservation-based estate planning message has reached thousands of landowners. To date, the partners have held more than 60 outreach events across the state, directly reaching over 1,500 landowners who collectively own more than 60,000 acres of land. Detailed outreach publications distributed outside of these events also provide to landowners expert, yet accessible, summaries of weighty issues in estate planning; to date over 17,000 copies of "Protecting Your Legacy" have been distributed. Following outreach events, seventy percent (70%) of landowners surveyed indicated that they subsequently took action to prepare for the future of their land, and nearly half describe sharing information with another landowner. The sustained efforts of estate planning outreach remain essential as family forest landowners continually arrive at critical moments in planning for the future of their land.

GREEN CERTIFICATION

For 11 years, the WFI offered a "green certification" program for private and municipal forestland owners through a Forest Stewardship Council (FSC) group certificate. This certification was available to interested forest landowners at no cost simply by updating and enhancing the content of their forest management plans and committing to the principles set forth by the FSC. Cost-share funding was available for such upgrades through the WFI from FY2009-FY2020. The program certified over 52,000 acres across 315 parcels and 144 unique landowners, becoming the largest opt-in program in the country.

FORESTERS FOR THE BIRDS

Building off the demonstrated success of Vermont's pioneering work with the Foresters for the Birds Program, the DCR Service Forestry Program began a unique partnership with the Massachusetts

Audubon Society (Mass Audubon) in 2013-14 to promote bird-conscious forest management in Massachusetts. In what has come to be known as DCR's Bird Habitat Assessment Program, Service Foresters and Mass Audubon biologists train consulting foresters how to recognize the elements of quality habitat for forest-breeding bird species, and then how to create, enhance and maintain that habitat in support of a broad suite of forest-dependent bird species. Forest landowners interested in forest bird habitat may have their property certified under this program, which includes the creation of a Bird Habitat Assessment that is integrated into a Forest Stewardship Plan for the property. To date, more than 40 licensed foresters have become "bird-certified" through this program, and more than 200 landowners with over 27,000 acres have opted for a Bird Habitat Assessment.

NATIONAL PRIORITY 2: PROTECT FORESTS FROM THREATS

Asian Longhorned Beetle

The Asian longhorned beetle (ALB) was first discovered in 1996 in Brooklyn, New York and has since been found in Illinois (1998), New Jersey (2002), Massachusetts (2008), and Ohio (2011). Two separate infestations have been found in Massachusetts, the first was in Worcester in 2008. Two years later in July 2010, a satellite infestation of ALB was found infesting six trees on the grounds of Boston's Faulkner Hospital. After about three years of survey, no other signs of ALB were found, and Boston was declared eradicated in May 2014. The Worcester infestation is still ongoing however every year there are fewer and fewer infested trees found. The number of infested trees detected has decreased from 11,716 in 2009 to six in 2019. As of January 1, 2020, just over 24,000 ALB infested trees have been removed and over nine million trees have been surveyed by the program. Additionally, hundreds of acres of high-risk trees have been removed and destroyed to slow the spread of this invasive pest.

The task of eradicating ALB from Worcester has been taken up by the ALB Cooperative Eradication Program which consists of the DCR, the U.S. Department of Agriculture, the Massachusetts Department of Agricultural Resources, and local municipalities. Teams from the ALB Cooperative Eradication Program survey the trees year-round for any signs of the pest including egg sites, exit holes, and galleries. They do this visually from the ground with binoculars or by climbing the tree. When a tree is confirmed infested with ALB it is cut down and chipped into pieces no larger than one inch in two dimensions. Only then can the material be considered deregulated and is safe to leave the ALB regulated area without the danger of spreading the insect. The Worcester ALB regulated area is 110 square miles and includes the cities and towns of Worcester, West Boylston, Boylston, Shrewsbury, the eastern portion of Holden, and the northern piece of Auburn.

Forest Pest First Detectors in Priority Landscapes

In 2017, the U.S. Forest Service funded a Landscape Scale Restoration grant in Massachusetts to help communities prepare for the emerald ash borer (EAB). Through this grant, the DCR Forest Health Program organized a series of workshops and sessions to train individuals from across the state how to monitor and prepare for emerald ash borer. These individuals would become part of a network of 'First Detectors' in the state. Topics included identification of ash trees and EAB, different monitoring techniques, treatment options, inventory and assessment steps, and how to create a response plan for a community. The Urban and Community Forestry program assisted with these workshops and events, covering inventory, assessment, and planning options. To date, two larger events and six smaller, field-based events have taken place. The program has trained 160 individuals and resulted in 20 traps placed across the state in 2018 and 2019.

Myles Standish State Forest Pine Barrens, photo by William Hill

Pine Barrens Restoration Joint Project with MassWildlife

The Myles Standish Complex (Complex) is more than 16,000 acres of mixed barrens habitats that include pine oak woodlands, scrub oak thickets, heathlands, coastal plain ponds, and sandplain grasslands. Animals and plants depend on these open habitats, including many that are protected by the Massachusetts Endangered Species Act. Without these special habitats, a number of rare animal and plant species would vanish. Currently, restoration is planned for a 2,400-acre portion of the complex. The Department of Conservation and Recreation, in coordination with the Department of Fish and Game, has already restored over 700 acres.

Over the past 50 years, pine trees and tall shrubs have grown in high densities within the Complex. This dense growth increases the risk from wildfires in the area. Wildfires that start in the Complex can be extremely difficult to safely control. Major wildfires have occurred within the area in 1900, 1957, and 1964, burning thousands of acres. To make the area safe for visitors, nearby residents, and for the unique animals and plants to thrive here, trees need to be thinned and tall, dense shrubs mowed.

The expansion of southern pine beetles to Massachusetts is also a concern for the Complex. These beetles reached Massachusetts in 2015, when they were seen in beetle traps from the Connecticut River Valley to Cape Cod and Martha's Vineyard. These beetles are responsible for widespread tree loss throughout the southeastern United States where they are native and have recently expanded their range northward due to warming winter temperatures. Decreasing the density of trees and managing the area with prescribed fire will help the remaining pitch pine trees resist the beetles and limit the beetle's ability to spread through the Complex.

The dense pine trees covering the Complex are being thinned to create a more open landscape with widely spaced trees and low rolling glades of plants like scrub oak, blueberry, and grasses.

NATIONAL PRIORITY 3: ENHANCE PUBLIC BENEFITS FROM TREES AND FORESTS

Forest Legacy Program Assessment of Need Update

Since the original Forest Legacy Program Assessment of Need was completed in 1993, the Massachusetts Forest Legacy Program has expanded our Forest Legacy Areas many times. In 2020, the Assessment of Need was completely updated and once again the Forest Legacy Area was expanded, adding land in 40 towns. These towns are all east of our previous Forest Legacy Areas and many are in what is considered the urban sprawl frontier in Massachusetts. These towns face great threat of development as population spreads further outside Boston, but also were determined to have valuable and environmentally significant forests in need of protection. New data available since the original Assessment of Need showed the environmental importance of the forests in these areas. Their addition to the Forest Legacy Area greatly increases the opportunities for protection of significant areas of forestland in Massachusetts from the threat of development. The Assessment of Need is found in Appendix D.

Greening the Gateway Cities

The Massachusetts Greening the Gateway Cities program (GGC) is an environmental and energy efficiency program designed to reduce household heating and cooling energy use by increasing tree canopy cover in urban residential areas in the state's Gateway Cities. The program plants trees (ranging from six to ten feet tall) on private properties with a goal of planting 2,400 trees in each city, covering 5-10% of the target neighborhoods in new tree canopy cover. Since 2014, 27,000 trees have been planted in 14 of the Gateway Cities. As of 2020, the state supports the program in the amount of $5 million annually. The program targets the parts of Gateway Cities that have lower tree canopy, older housing stock, higher wind speeds, and a larger renter population. In addition, plantings are concentrated in Environmental Justice neighborhoods, to benefit those most in need.

Under Massachusetts law, there are 26 cities with the designation of Gateway City (Figure 6.3). All have a population between 35,000 and 250,000, with an average household income and educational attainment rate below the state average. At one time, these cities were thriving urban industrial communities, offering good jobs, a future, and a gateway to the American Dream. These jobs have slowly disappeared over the years.

Trees are planted by DCR Urban and Community Forestry crews hired from within the local communities during two seasons: April to June and September to November. GGC provides local employment and economic activity and is the only energy efficiency program where almost all of the investments stay in the local economy by hiring local planting crews and growing trees at local nurseries. In addition, healthy urban forest ecosystems improve the quality of the water we drink, the air we breathe, the stability of our neighborhoods, and our sense of community and individual pride.

Greening the Gateway Cities tree planting in Haverhill, Photo by DCR

Concentrating tree plantings in target areas maximizes energy savings and provides the greatest benefits when established over an entire neighborhood. Trees planted near a home directly shade structures, significantly lowering surface temperatures, while trees planted up to 1,500 feet away from a home still provide a benefit. Program goals are to plant five to 10 trees per acre (roughly one third of a block) in high density urban neighborhoods, which will provide benefits to 15 to 25 households, depending on building density; reduce the urban heat island effect; and decrease summer air temperatures in city neighborhoods through shading and increased transpiration. Additionally, in the winter months, mature tree trunks and branches help to randomize wind patterns and decrease heat loss by air infiltration in poorly insulated homes.

Most trees are planted in yards where they grow quickly with the care provided by residents. Planting this number of trees will increase canopy by an estimated 1% in eight years, and 5% in 30 years. Return on investment is realized as soon as 15 years, after which additional energy savings are realized for the life of the trees.

The GGC is a partnership between the DCR Urban and Community Forestry Program, the Executive Office of Energy and Environmental Affairs (EEA), the Department of Energy Resources (DOER), and the Department of Housing and Community Development, along with Gateway Cities and local non-profit organizations that help with outreach to residents. The GGC is funded by EEA and DOER’s Alternative Compliance Payment program. GGC is administered by the DCR Urban and Community Forestry Program.

Community Wood Bank Program

Founded in 2015 with the support of a U.S. Forest Service Landscape Restoration Grant, the Community Wood Bank Program works to empower municipalities to improve the utilization of surplus trees and provide wood for home heating to families in need.

Thirteen thousand rural households in Massachusetts struggle with energy insecurity (U.S. EIA 2009). A wood bank works as a cooperative project between local and state governments, volunteers, and community groups, providing firewood at no cost to those who need it. Currently the program operates in three municipalities and provides 45 cords per year to 73 households.

Volunteering is key to the success of wood banks and the project is an excellent opportunity to build lasting tangible connections between people and forests. Over the past five years, the program has provided more than 1,000 hours of volunteer service. One especially beneficial partnership has been the relationship built between students at the University of Massachusetts Amherst and surrounding communities. This experiential learning opportunity has helped natural resources students go on to gain successful entry level employment in the conservation profession.

Initial support for the project was made possible by the “Small Forest Landowner Outreach Initiative” funded by a FY14 Landscape Scale Restoration Grant. Additional support for the project has been made possible by a $100,000 award from the Massachusetts Clean Energy Center (CEC). With this additional support the program has been able to offer grants to establish and grow wood banks under the DCR Urban and Community Challenge Grant platform. The Mass CEC award has also made it possible to upgrade equipment necessary for continued program growth and fuel supply reliability. The near-term program goal is to grow the service area to 10 municipalities with an annual production of 150 cords.

Massachusetts Qualified Tree Warden

In 2015, the DCR Urban and Community Forestry Program began working with the Massachusetts Tree Wardens’ and Foresters’ Association on the development of a new qualification program for tree wardens in Massachusetts. Many of the more populated cities and towns across the state have tree wardens who are qualified in arboriculture and urban forestry by education, training, or an arborist certification. Many of the smaller communities do not have a tree warden qualified in this manner. In these communities, the tree warden may have little knowledge about trees and how to manage them in a way that will maximize benefits while minimizing risk. The intent of the Massachusetts Qualified Tree Warden (QTW) program is to provide a comprehensive, achievable, and affordable program for tree wardens in communities of all sizes, with the aim of improving the level of professionalism among tree wardens and improving the management of community trees across the state.

The DCR Urban and Community Forestry Program took the lead in developing the program materials. This included the initial task of establishing curriculum and learning objectives. These were designed to cover what tree wardens should know and include both classroom and field components. Some of the topics include roles, responsibilities, and work priorities of tree wardens, tree laws in Massachusetts, tree biology, urban tree problems, tree risk, tree identification, diagnosing tree health problems, budgeting, contracting, and standards, construction zone management, safety, tree inventories, i-Tree, tree planting, working with utility arborists, and working with the DCR Urban and Community Forestry Program. The QTW program consists of six daylong sessions: five sessions take place in a classroom and one takes place outside, with the participants demonstrating tree identification, tree risk assessment, and tree planting. At the end of each classroom session, participants take a quiz to demonstrate that they have understood the material. The sessions are designed to encourage discussion and to foster the development of a community and network of tree wardens.

The QTW program brings together about 15 presenters, most of whom are tree wardens, though other presenters include DCR urban foresters, faculty from the University of Massachusetts, and staff from the U.S. Forest Service. The inaugural program ran in the fall 2017 through spring 2018, and the second program took place in fall 2019. The course will take place every other year. To date, the program has produced 99 Qualified Tree Wardens. These Qualified Tree Wardens maintain their qualification through continuing education.

Town Forest Celebrations

Massachusetts has a long history of promoting municipal forest stewardship, beginning with the Fitchburg Town Forest in 1914. Recognizing this history and the increasing prominence of municipal lands enrolled in the Forest Stewardship Program, DCR re-established a long-lost tradition of an annual Town Forest Celebration beginning with the city of Fitchburg in 2013, coinciding with the 100th anniversary of the Town Forest Act of 1913. Town Forest Celebrations since have occurred across the state, each as unique as the community that hosts the event, but all with the commonality of people coming together to celebrate forests and their role within the community.

STRATEGIES MATRIX

The Strategies Matrix provides a complete list of 72 identified strategies that the Department of Conservation and Recreation, as well as other agencies and stakeholders, may undertake to achieve the Forest Action Plan's 10 goals for healthy, diverse, and productive forests in Massachusetts. Included in the matrix are the funding resources available to implement the strategy, associated DCR Bureau of Forest Fire Control & Forestry programs, and other state agencies that would participate, how each strategy relates to the three Forest Service State and Private Forestry national priorities, and the chapter topic each strategy best relates to.

DFG = Dept. of Fish and Game; **DWSP** = Water Supply Forestry; **EEA** = Executive Office of Energy and Environmental Affairs; **FA** = Forestry Administration; **FC** = Fire Control; **FH** = Forest Health; **FLP** = Forest Legacy Program; **MF** = Management Forestry; **MU** = Markets and Utilization; **SF** = Service Forestry; **UCF** = Urban and Community Forestry; **USDA** = U.S. Department of Agriculture; **USFS** = U.S. Forest Service

#	Strategy	Resources Available	Associated Programs	National Priorities	Ch.
GOAL 1: Increase resistance and resilience of trees and forests to mitigate and adapt to the effects of climate change					
1	Encourage forest management that promotes resiliency in future climatic scenarios	State, Federal, NGO	MF, SF, DFG	Protect forests from threats Enhance public benefits	1
2	Research feasibility of augmenting forests via assisted migration	State, NGO	MF, SF, DFG	Protect forests from threats	1
3	Support programs that assess, maintain, and enhance tree canopy in urban areas to reduce urban heat island effect, manage stormwater, and provide other benefits	State, Federal	UCF	Protect forests from threats Enhance public benefits	2
4	Use long term monitoring to assess carbon storage trends in Massachusetts	State, Federal, NGO	MF, DFG	Enhance public benefits	2
5	Develop initiatives that showcase science-based forest management as a viable carbon storage tool	State, Federal, NGO	MF, SF, DFG	Enhance public benefits	2
6	Increase community participation in fire adapted community programs in high-risk areas	State, Federal, Municipal	UCF, FC	Protect forests from threats	1
7	Encourage preparation for severe storms and the recovery of damaged or deteriorated landscapes – Massachusetts State Hazard Mitigation and Climate Adaptation Plan	State, Federal, Municipal	FH, UCF, MF, FC, SF	Protect forests from threats Enhance public benefits	1
8	Provide leadership to increase landowner knowledge on how sustainable forest management can increase forest resistance, resilience, mitigation, and adaptation to climate change while meeting social and economic goals of communities	State, Federal, NGO	SF, MF, DFG	Conserve forest landscapes Protect forests from threats Enhance public benefits	4

#	Strategy	Resources Available	Associated Programs	National Priorities	Ch.
GOAL 2: Manage forest ecosystem health and biodiversity					
9	Monitor forest cover and health conditions using aerial and ground survey methods	State, Federal	DWSP, FH, MF, UCF	Protect forests from threats	1
10	Implement programs to mitigate forest threats	State, Federal, Private	All programs	Protect forests from threats Enhance public benefits	1
11	Continue to develop and implement forest resource management plans on state land	State	MF, FC, EEA, DWSP, DFG	Conserve forest landscapes Protect forests from threats Enhance public benefits	3
12	Advocate for balanced, long-term sustainable forest management on public and private land	State, Private, Municipal	FH, UCF, MF, FC, FLP, SF, EEA, FA	Conserve forest landscapes Enhance public benefits	3
13	Encourage private landowners and municipalities to develop forest stewardship and management plans	State, Federal, Municipal, NGO, Private	SF, UCF, FH, FC, FLP, EEA, DFG	Conserve forest landscapes Enhance public benefits	3
14	Work with partners such as Mass Audubon, Massachusetts Forest Alliance, New England Forestry Foundation, Natural Resources Conservation Service, and The Nature Conservancy to encourage landowners to implement forest management practices	State, Federal, Municipal, NGO, Private	SF, FLP	Conserve forest landscapes Enhance public benefits	1
15	Collaborate with UMass, USDA, USFS, and other institutions in the management of forest pests and disease and research related to management	State, Federal	FH, MF, UCF, SF	Protect forests from threats	1
16	Conduct ecological restoration of degraded land through various methods including timber harvesting, invasive species management and prescribed fire	State, Federal, Municipal, NGO	MF, FC, UCF, DFG, DWSP	Protect forests from threats Enhance public benefits	1
17	Maintain, enhance, and expand forestry programs that support specific wildlife habitat and biodiversity goals	State, Federal	MF, FC, UCF, EEA, DFG, SF, DWSP	Protect forests from threats Enhance public benefits	1
18	Protect rare species habitats within the context of a resilient landscape	State, Federal	FH, UCF, MF, FC, FLP, SF, EEA, DFG, DWSP	Protect forests from threats	1
19	Maintain a strong fire tower detection program, providing suppression ground resources and facilitating helicopter operations, providing sound fire weather and fuels intelligence data, and assisting fire officers with wildfire management and tactics.	State, Federal	FC	Protect forests from threats	1
GOAL 3: Support and enhance forest economy					
20	Promote firewood as a local resource and economy	State, Municipal	SF, MF, MU	Conserve forest landscapes Enhance public benefits	4
21	Build and strengthen connections between Massachusetts forestland, timber harvesting, wood processing, and utilization of local wood products	State, Municipal	SF, FLP, MF, MU	Enhance public benefits	4
22	Create and support recreational opportunities in forests (e.g., birdwatching, camping, fishing, hunting, hiking, biking, snowmobiling, foliage viewing, forest bathing, geocaching, etc.)	State, Municipal, NGO, Private	FLP, DFG, EEA	Enhance public benefits	4

#	Strategy	Resources Available	Associated Programs	National Priorities	Ch.
23	Support training and development opportunities for licensed foresters, timber harvesters, arborists, and urban foresters in the state	State, Federal, NGO, Private	FH, UCF, MF, SF	Conserve forest landscapes	5
24	Support forest-based rural economies through forest producer organizations such as the Massachusetts Maple Producers Association, Massachusetts Forest Alliance, and Tree Farm	State, Municipal, NGO, Private	SF	Conserve forest landscapes Enhance public benefits	4
25	Advocate for and provide educational opportunities for students interested in forestry and related disciplines	State, NGO	FH, UCF, MF, FC, FLP, SF, MU	Conserve forest landscapes	5
26	Provide leadership in the use of local wood in construction and support efforts to market local wood and local wood products	State, NGO	SF, MU	Conserve forest landscapes Enhance public benefits	4
GOAL 4: Maintain and increase urban tree canopy cover					
27	Support programs and activities that plant and retain trees in urban areas	State, Federal, Municipal, NGO	UCF, EEA	Enhance public benefits	4
28	Encourage municipalities to adopt ordinances that protect urban tree canopy	State	UCF	Enhance public benefits	1
29	Enhance monitoring of tree canopy levels in the state	State, Federal	UCF	Protect forests from threats Enhance public benefits	1
30	Drive innovative state-level programs that plant trees in priority urban areas, such as Greening the Gateway Cities	State, Federal	UCF, EEA	Enhance public benefits	4
31	Encourage the use of emerging technology and practices to plant and monitor trees in urban areas, such as iNaturalist, i-Tree and stormwater tree pits	State, Federal, Municipal	UCF	Protect forests from threats Enhance public benefits	1
32	Implement grants to maintain, protect, enhance, and measure urban tree canopy	State, Federal	UCF, EEA	Protect forests from threats Enhance public benefits	5
GOAL 5: Enhance the connection between forests and people					
33	Support environmental education to teach children and young adults the value of trees and forests using programs, such as the Massachusetts Envirothon, Project Learning Tree, and through Arbor Day and Earth Day events	State, Federal	IS, FA, UCF, SF	Enhance public benefits	5
34	Provide leadership for public programs, such as Firewise USA, Tree Campus USA, Tree City USA, and Tree Line USA	State	UCF, FC	Enhance public benefits	5
35	Coordinate and participate in annual Town Forest events	State, Federal	SF, UCF, FH	Conserve forest landscapes Protect forests from threats Enhance public benefits	4
36	Create and support dynamic multimedia approaches to communicate information with stakeholders and the public	State	FH, UCF, MF, FC, FLP, SF	Conserve forest landscapes Protect forests from threats Enhance public benefits	4
37	Provide grants and support for developing and maintaining community wood banks	State, Federal	MU, UCF	Enhance public benefits	5
38	Support programs that engage underserved communities and increase diversity, equity, and accessibility in forestry and urban forestry	State	UCF, SF, MF	Enhance public benefits	4

#	Strategy	Resources Available	Associated Programs	National Priorities	Ch.
39	Partner with nonprofit organizations, public lands forest management entities, land trusts, and municipalities to demonstrate the connection between sustainable forest management and ecosystem services, such as clean water and clean air	State, Federal, Municipal, NGO	MF, FLP, SF	Conserve forest landscapes Protect forests from threats Enhance public benefits	2
GOAL 6: Increase land base of conserved forests (keep forests as forests)					
40	Protect private forest from development using diverse mechanisms, including state acquisition of lands, permanent protection by conservation restriction, temporary restrictions such as conservation covenants or easements, and municipal policies like Natural Resource Zoning	State, Federal	FLP, SF	Conserve forest landscapes Protect forests from threats Enhance public benefits	1
41	Provide innovative programs such as estate planning, current use tax programs, buy local, Forest Stewardship, and neighbor-to neighbor networks which provide landowners options, tools, and guidance for conservation	State, Federal	SF, MU	Conserve forest landscapes Protect forests from threats Enhance public benefits	1
42	Engage with Regional Conservation Partnerships	State	MF, FLP, SF, DWSP	Protect forests from threats Enhance public benefits	1
43	Propose landscape-scale projects composed of multiple tracts of lands needing protection utilizing programs such as the Forest Legacy Program and EEA's Landscape Partnership, Conservation Partnership, Conservation Land Tax Credit, and LAND grants and Natural Resources Conservation Service's Regional Conservation Partnership Program	State, Municipal, NGO	FLP	Protect forests from threats Enhance public benefits	1
44	Support the Mohawk Trail Woodlands Partnership and forest conservation in Northern Berkshire and Western Franklin counties	State, Federal, Municipal, NGO	MF, FLP, SF	Conserve forest landscapes Protect forests from threats Enhance public benefits	1
45	Support conservation commissions and non-profit land conservation groups in their work to conserve trees and forestland	State, Federal	FLP, SF	Conserve forest landscapes Enhance public benefits	1
GOAL 7: Advocate for a legal and institutional framework pertinent to the conservation and management of trees and forests					
46	Advocate for appropriate forestry and fire management related positions within Environmental Agencies	State, Federal	FH, UCF, MF, FC, FLP, SF, MU, DFG	Enhance public benefits	5
47	Participate in training and development opportunities for state forestry and forest fire control staff to ensure competency with current standards and practices	State, Federal	FH, UCF, MF, FC, FLP, SF, DFG	Enhance public benefits	5
48	Improve compliance with the Forest Cutting Practices Act	State, Federal	SF	Conserve forest landscapes Enhance public benefits	5
49	Identify forestry-related laws and regulations - for example, the Public Shade Tree Law - that require clarification, modernization, or strengthening and work to remediate	State	FH, UCF, MF, FC, FLP, SF, MU	Conserve forest landscapes Protect forests from threats Enhance public benefits	5
50	Increase communication and collaboration with other state agencies through shared stewardship	State	FH, UCF, MF, FC, FLP, SF, MU, DFG	Enhance public benefits	5
51	Ensure state agencies have the appropriate structures to allow for participation in national and international emergency responses.	State	FH, UCF, FC	Protect forests from threats	5

#	Strategy	Resources Available	Associated Programs	National Priorities	Ch.
52	Ensure forestry Best Management Practices reflect the latest research and standards	State	SF	Protect forests from threats Enhance public benefits	5
53	Promote forest activities and associated programs relative to carbon storage	State, Federal	FH, UCF, MF, FLP, SF, DFG	Protect forests from threats Enhance public benefits	2
54	Advocate for programs and incentives that promote clean energy options and discourage forest conversion	State, Federal, NGO	UCF, MF, FLP, SF, MU	Conserve forest landscapes Protect forests from threats Enhance public benefits	5
55	Support the goals of the Northeast Region Cohesive Wildland Fire Management Strategy: 1) Restoring Resilient Landscapes, 2) Creating Fire Adapted Communities, and 3) Safe and Effective Wildfire Response	State, Federal	FC, DFG	Conserve forest landscapes Protect forests from threats	5
56	Encourage municipalities to adopt ordinances and bylaws such as Low Impact Development, Natural Resource Zoning, and Open Space that reduce the loss of trees and forests	State	FA	Conserve forest landscapes Protect forests from threats	5
GOAL 8: Maintain and enhance soil, water, and air resources					
57	Engage with conservation partners to promote understanding of forestry BMPs	State, NGO	SF	Enhance public benefits	2
58	Develop and support projects and practices to retain tree canopy in urban and suburban areas	State, Federal	UCF	Enhance public benefits	2
59	Support green infrastructure and low-impact development to reduce the impact of stormwater and air pollution	State, Federal, Municipal, NGO	UCF	Protect forests from threats Enhance public benefits	2
60	Promote land conservation in important drinking water supply areas	State, Federal, Municipal, NGO	FLP, SF, DWSP	Conserve forest landscapes Protect forests from threats Enhance public benefits	2
61	Promote ecological restoration and stream connectivity to enhance stream stability for wildlife passage and habitat and protection of infrastructure	State, Federal	MF, SF, DFG	Conserve forest landscapes Enhance public benefits	2
GOAL 9: Support the role and use of prescribed fire in the landscape					
62	Support municipal fire agencies across the state with quality assistance in the form of detection, suppression, prevention, intelligence sharing, and grants	State, Federal, Municipal	FC	Protect forests from threats Enhance public benefits	1
63	Work with federal and state agencies, tribal entities, and partners to promote training programs and qualification opportunities for wildland fire resources in Massachusetts	State, Federal, Municipal	FC	Protect forests from threats Enhance public benefits	1
64	Promote public understanding of the benefits of prescribed fire relative to conservation and risk mitigation	State, Federal, Municipal, NGO	MF, FC, DFG	Protect forests from threats Enhance public benefits	1
65	Provide a strong prescribed fire program that supports both hazard fuels mitigation, while at the same time providing a tool for ecosystem restoration in fire dependent ecosystems.	State, Federal, Municipal, NGO	FC	Protect forests from threats Enhance public benefits	1
66	Utilize and support the use of prescribed fire as a tool in forest management on state and private land	State, Federal, NGO, Private	MF, FC, DFG	Conserve forest landscapes Protect forests from threats Enhance public benefits	1

#	Strategy	Resources Available	Associated Programs	National Priorities	Ch.
GOAL 10: Cultivate and support partnerships with forestry and conservation stakeholders					
67	Expand financial and technical support of programs that further state forest priorities	State	FH, UCF, MF, FC, FLP, SF, MU	Enhance public benefits	5
68	Seek multi-level funding opportunities that are tied to the state forest priorities	State	FH, UCF, MF, FC, FLP, SF, MU	Enhance public benefits	5
69	Engage with local, regional, and national partners in on-going activities and projects	State, Federal, Municipal, NGO	FH, UCF, MF, FC, FLP, SF, MU	Conserve forest landscapes Protect forests from threats Enhance public benefits	5
70	Maintain presence at regular meetings of stakeholders to stay abreast of interests, activities, and concerns	State, Municipal, NGO	FH, UCF, MF, FC, FLP, SF, MU	Enhance public benefits	5
71	Improve coordination with government agencies on implementation of projects across jurisdictions	State, Federal, Municipal	FH, UCF, MF, FC, FLP, SF, MU	Enhance public benefits	5
72	Actively participate in forest fire control and forest health compacts as well as the urban forest strike team to share resources for national response opportunities	State, Federal, Municipal	FH, UCF, FC	Protect forests from threats Enhance public benefits	5

Chapter 1 – FOREST ECOSYSTEM HEALTH & BIODIVERSITY

Massachusetts has a wide range of forest ecosystems providing habitat for plant and animal species. However, the health and diversity of these ecosystems is threatened by invasive plants and pests, diseases, and a changing climate. Geospatial technology and endangered species records have allowed us to identify the most important areas in the Commonwealth for biodiversity and resilience to climate change. Protection of these areas through legal prohibition of development and planned, long-term management practices is essential to the conservation of biological diversity.

INTRODUCTION

The Commonwealth of Massachusetts is one of the smallest and most densely populated states in the nation, but that does not limit the ecological importance of its landscape. Massachusetts has the 11th highest percentage of forestland in the nation (Table 1.1) (Oswalt et al. 2019) and many regions that are renowned for their biodiversity.

Massachusetts has experienced a long history of changing land use, including widespread forest clearing throughout much of the 19th century. Near the end of that century, fields cleared by settlers were abandoned, and forests regrew. A strong tradition of broad-based support for the conservation of forests and the natural world developed concurrently, inspired in part by the writings of Massachusetts native Henry David Thoreau. At present, land is being conserved at a rate of 54.8 acres a day, higher than conservation rates in recent history (Ricci et al. 2020). Many organizations recommend that the rate of land protection be doubled to combat climate change and development sprawl.

This chapter will discuss the variation among Massachusetts ecosystems, the history of how our landscape developed, the structure of our forests, and how these ecosystems are being managed to protect diversity and minimize threats.

Massachusetts Profile: Land and Population	Area and Population Estimates	Ranking among the 50 States
Total Land Area (acres)	5,175,349[1]	45
Population	6,902,149[2]	15
Population Density (people/sq. mi)	839	3
Forested Area (acres)	3,242,113[1]	NA
Percent forestland	63%	11[3]

Table 1.1. Massachusetts land and population facts. [1]NLCD 2016. [2]U.S. Census Bureau Population Estimates Program 2018. [3]Oswalt et al. 2019.

MASSACHUSETTS TOPOGRAPHY

Massachusetts forest habitats arise from substantial variations in topography, bedrock and surficial geology, soils, and climate. Elevations range from sea level at the coast to 3,491 feet at the summit of Mount Greylock in the western part of the state in the Taconic Mountains ecoregion (Figure 1.1). The diverse topography of the state is the result of its complex geologic history involving multiple tectonic plate collisions over a period from 1.2 billion to 200 million years ago. These collisions created a series of north-south mountain ranges as the North American continent collided with other continents and volcanic island chains; each collision resulting in the accretion of new bedrock material to the continental core. These ancient mountain ranges have since eroded away leaving the hills and low mountains that define the landscape today. Variations in bedrock composition are another result of the region's geologic history. While most of the bedrock underlying the state is acidic, there are substantial areas of calcareous bedrock, consisting of limestone and marble, most notably in the western part of the state in the New England Marble Valley. Additional calcareous deposits are present in the eastern Berkshire foothills. These limestone and marble deposits originated as carbonate material in coral reefs. The reefs were pushed up against the continental basement rock as North America collided with a chain of offshore volcanic islands, during the Taconic Orogeny (mountain building event), 450 million years ago (Skehan 2001).

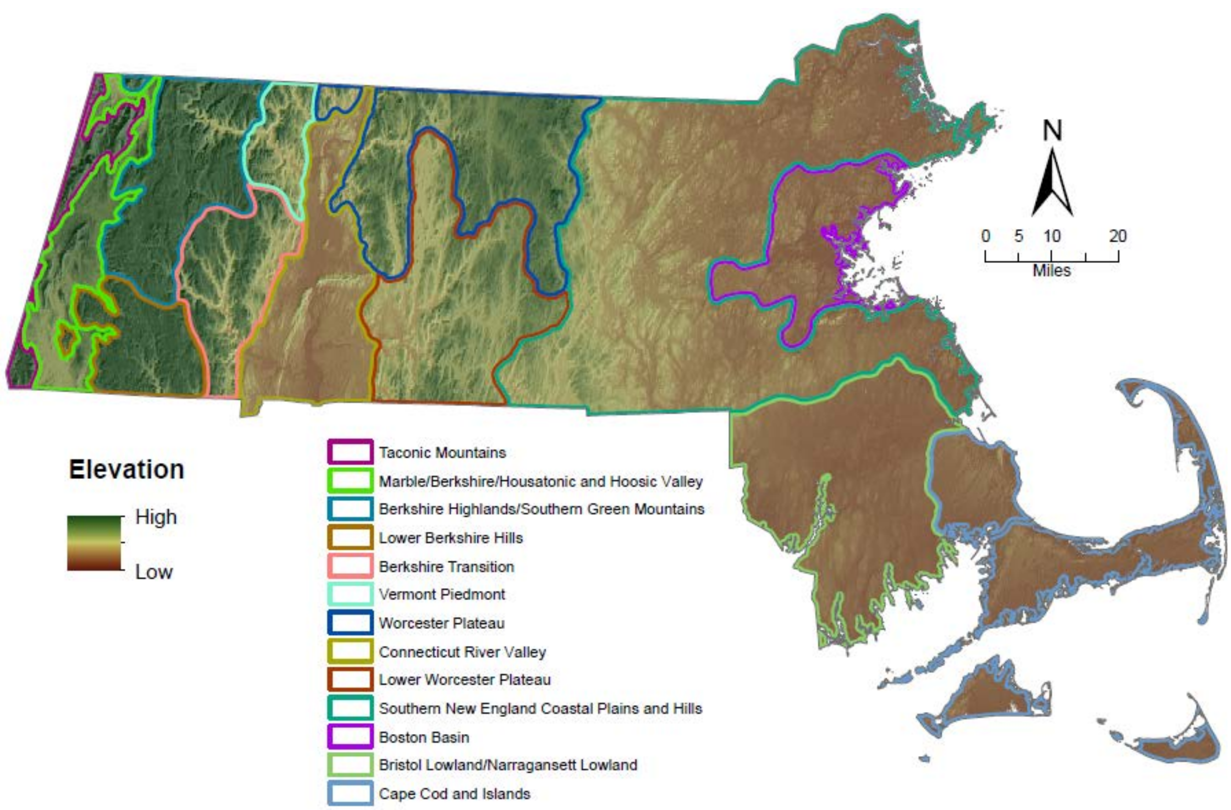


Figure 1.1. Topography and ecoregions of Massachusetts (data: MassGIS).

Soils formed from surficial deposits left during repeated episodes of glaciation. Mountains of ice advanced from the north, scraping away existing material. As the ice retreated, massive amounts of debris were left behind. The most recent glacial retreat occurred between 21,000 and 12,000 years ago, leaving the Massachusetts uplands covered with thick deposits of poorly sorted glacial till. In low-lying areas, well-sorted sands and gravels were deposited on the shores of ancient glacial lakes by fast flowing glacial melt waters, while clays and silts accumulated in the lake beds. Sandy outwash deposits are prevalent today in several areas including the valleys of the Connecticut, Housatonic, Hoosic, and Ware Rivers. Deep sands also cover areas of the eastern Coastal Plain, Cape Cod, and the Islands. More recent alluvial deposits are found in river floodplains.

The state experiences climate variations from east to west, and in a less pronounced fashion, from north to south. Higher elevations in the central uplands and in western Massachusetts have lower temperatures, shorter growing seasons, and more precipitation. The climate in the Connecticut River Valley and Marble Valley is more similar to the eastern part of the state than to the neighboring Berkshire Uplands and Taconic Mountains (Hall et al. 2002).

LAND USE HISTORY

The forests of southern New England have been and continue to be naturally altered by windstorms, ice, snow, and floods. However, humans have caused the most dramatic changes to our landscape.

European colonial settlement began along the eastern seaboard in the Plymouth and Massachusetts Bay Colonies in the 1620s. The Connecticut River Valley was also first settled in the 1600s. Settlements were not established in higher elevation regions - the Worcester Plateau and the Berkshire Uplands - until the mid-to-late 1700s. The 19th century was a period of widespread forest clearing, the height of which occurred between 1830 and 1885 when 70 percent of the land in Massachusetts was cleared for pasture, cropland, orchards, and buildings (O'Keefe and Foster 1998, Hall et al. 2002). Remaining woodlots were repeatedly harvested for fuel and timber. Improved transportation, the growth of competing agricultural development outside the New England region, and the growth of urban-industrial population centers led to the decline of the agricultural economy in Massachusetts and New England generally. Farms were abandoned leading to natural reversion of open land to forest. In the early 1900s, there was a period of large-scale clear-cutting in response to the development of markets for fuelwood, boxboards, and tanbark. These markets declined between 1920 and 1950 as new technologies developed and these products were replaced (Kelty and D'Amato 2005).

Despite the natural appearance of much of the modern landscape, a distinct legacy of intensive use is evident in vegetative structure and composition, in landscape patterns, and ongoing dynamics (Foster and O'Keefe 2000). Forest cover began to decline again in the 1960s and 1970s with land clearing and conversion to residential, commercial, and industrial uses (Figure 1.2). That trend continues as the population steadily grows. Current estimates of forest ownership are shown in Table 1.2. The majority of Massachusetts land, 63%, is forest, followed by residential and urban lands (Figure 1.3). The distribution of forests, water, and developed land across the state are shown in Figure 1.4.

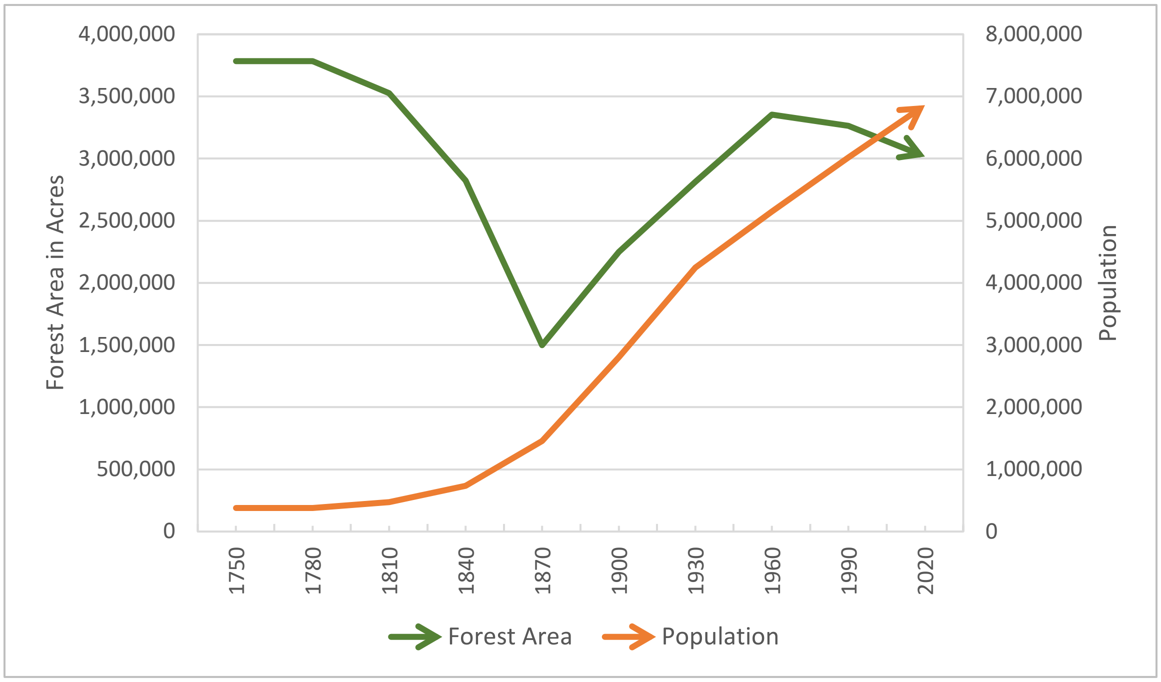


Figure 1.2. The trend of Massachusetts forest area (acres, left axis) and population (right axis) over time (data: Foster and Gould 2009, FIA EVALIDator 2017, US Census).

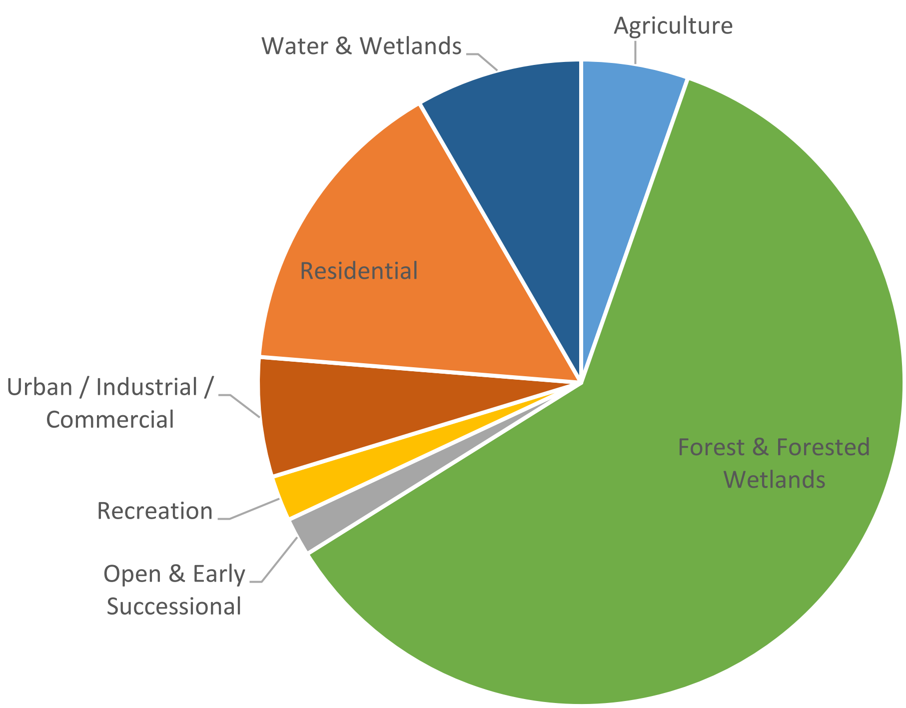


Figure 1.3. Land use of Massachusetts. Pie chart with relative land cover (data: MassGIS).

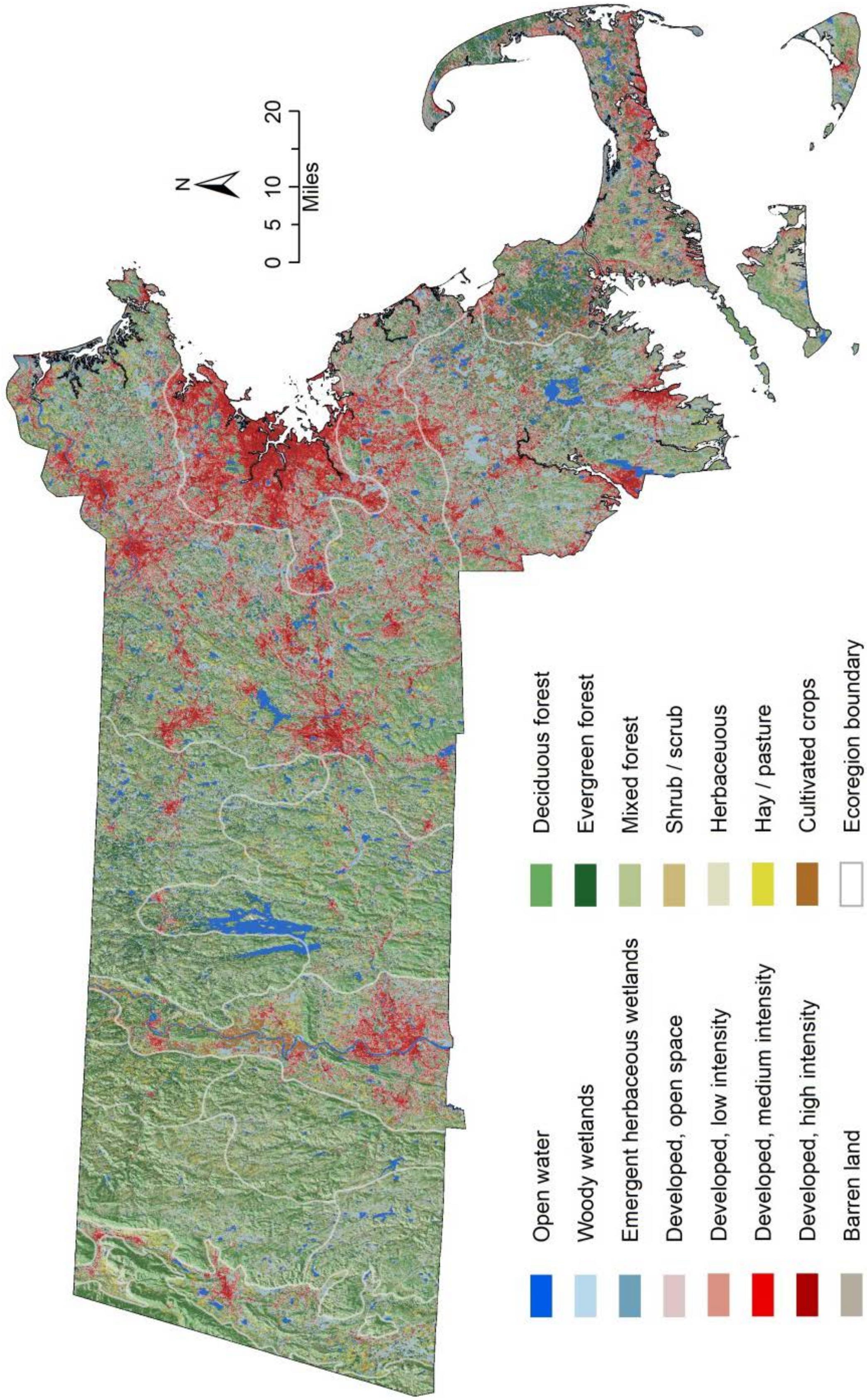


Figure 1.4. Map showing the distribution of land development and land cover across the state (data: NLCD 2016).

PATTERNS OF POPULATION AND DEVELOPMENT

The population of Massachusetts is largely concentrated in the eastern part of the state, with locally dense populations in central Massachusetts in the metropolitan area of Worcester, and in the lower Connecticut River Valley (Springfield/Holyoke) (Figure 1.5). The estimated 2,286,500 residents of the 42 municipalities of the Boston area, account for 33% of the total population of the Commonwealth, which the U.S. Census Bureau estimated to be 6,902,149 in 2018. Estimates for population densities for those 42 cities and towns range from 398 people/mi² in Dover to 19,863 people/mi² in Somerville. In central and western Massachusetts, the largest cities are 1) Worcester, with a population of 185,877 and density of 4,949 people/mi²; 2) Springfield, population 155,032, density 4,829 people/mi²; and 3) Pittsfield, population 42,533, density 1,044 people/mi² (U.S. Census Bureau 2018).

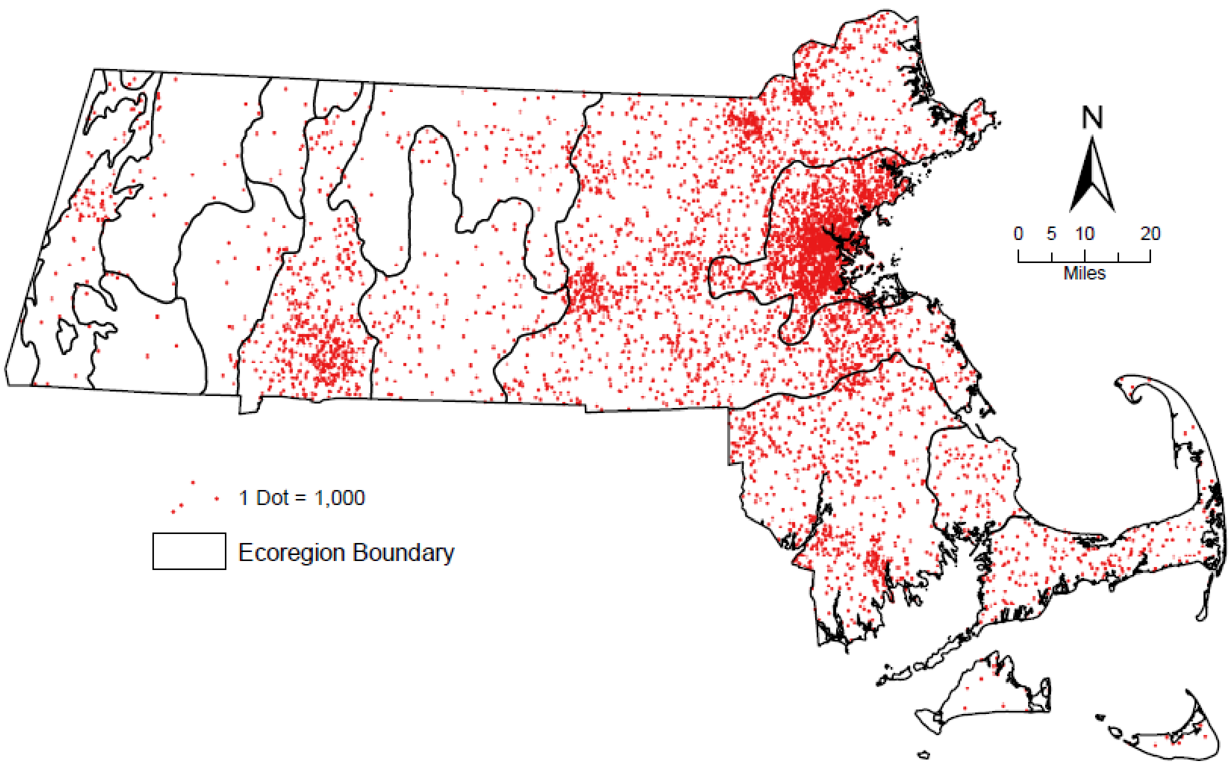


Figure 1.5. Massachusetts population density. 1 dot is equal to 1,000 people per square mile (data: MassGIS CENSUS2010TOWNS_POLY.SHP).

FOREST OWNERSHIP

The majority of Massachusetts' forestland is in private ownership, including private citizens and non-governmental organizations (NGOs) such as land trusts. In total, over 2.1 million acres of forest, or approximately 68% of the state's total of 3.2 million acres (Table 1.2), are privately owned. While NGOs own and manage a significant portion of private land, the remainder is owned by over 200,000 private landowners across the state. Most of these ownerships are very small parcels, although they collectively may comprise larger contiguous blocks of forest. It is estimated that there are over 26,000 family forest landowners with 10 or more acres who collectively own more than 1.0 million acres of Massachusetts forestland (SFFI 2020). These family forest landowners, also known as non-industrial private forestland owners, own forestland for diverse reasons, including scenic beauty, privacy, natural resource value, investment potential, and personal recreation. Parcel sizes in Massachusetts are generally small, with 45% of family forest ownerships (about 12,000 landowners) under 50 acres, although there are also parcel sizes in excess of 500 and even 1,000 acres in western portions of the state.

Many estimates of acres of forestland and protected open space in Massachusetts have been published, but various discrepancies and inconsistencies in these values make it difficult to meaningfully compare estimates or monitor changes over time. For this report, we have executed a repeatable GIS-based analysis of forestland in Massachusetts, with subsets by ownership type and level of protection, using the most currently available Level 3 Assessors' Parcel data, MassGIS Protected and Recreational Open Space (MassGIS 2020) and the current National Land Cover Dataset (NLCD 2019). The results of this analysis are summarized below and presented in Table 1.2. We recognize that there may be discrepancies between these values and those published in other reports, but this represents the most current and comprehensive analysis of forestland across all ownerships in Massachusetts and we intend for it to form a baseline for comparison in future reports.

Land identified as "permanently protected" has been legally protected in perpetuity and recorded as such in a deed or other official document. Land is considered protected in perpetuity if it is owned by the town's conservation commission or water department; if a town has a conservation restriction on the property in perpetuity; if it is owned by one of the state's conservation agencies (thereby covered by Article 97); if it is owned by a non-profit land trust; or if the town received federal or state assistance for the purchase or improvement of the property. Private land is considered protected if it has a deed restriction in perpetuity, or if an agricultural preservation restriction or a conservation restriction has been placed on it (MassGIS 2020). Forestland without permanent protection includes land without any formal protection against development as well as some lands with limited or temporary protections in place.

The Commonwealth of Massachusetts owns and manages 525,377 acres of forestland (Table 1.2, Figure 1.6). Of these, the Massachusetts Department of Conservation and Recreation (DCR) owns 376,947 acres. This acreage is managed by two divisions. The Division of State Parks and Recreation (DSPR) manages 280,196 acres of State Forests and Parks and the Division of Water Supply Protection (DWSP) manages 96,751 acres of state watershed land to provide drinking water for Boston and 50 other municipalities. The Massachusetts Department of Fish and Game Division of Fisheries and Wildlife (MassWildlife) owns 143,294 acres including Wildlife Management Areas and Wildlife Sanctuaries. Approximately 40,000 acres of DSPR, DWSP, and MassWildlife land have been set aside as large forest reserves where timber harvesting is prohibited.

The Federal government owns 40,708 acres of forestland in Massachusetts including 11 National Wildlife Refuges managed by the U.S. Fish and Wildlife Service, the Cape Cod National Seashore managed by the National Park Service, and 11 flood risk management reservoirs and the Cape Cod Canal

Forest Ownership by Protection Status	Forested Acres
Permanently Protected Forestland	
State Forestland	
DCR Division of State Parks and Recreation	280,196
DCR Division of Water Supply Protection	96,751
DFG Division of Fisheries and Wildlife	143,294
Jointly held lands, DCR and DFG	5,136
Subtotal: DCR and DFG State-owned Forestland	***525,377***
Other Permanently Protected Forestland	
Federal[1]	40,708
Municipal	262,480
Non-Governmental Organizations (NGOs)[2]	88,174
Private	135,051
Other[3]	59,311
Subtotal: Other Permanently Protect Forestland	***585,724***
All Permanently Protected Forestland	***1,111,101***
Forestland without Permanent Protection	
Public (state, municipal, and federal)[4]	160,741
Non-Governmental Organizations (NGOs)[5]	40,940
Private	1,929,331
All Forestland without Permanent Protection	***2,131,012***
Total Forestland, All Ownerships	**3,242,113**

Table 1.2. Forestland by ownership category and protection status. Forestland without permanent protection may have limited or temporary protection measures in place, but it predominantly includes land without and formal protections against development or conversation (data: MassGIS 2020, NLCD 2019). [1]Includes lands of the U.S. Dept. of the Interior (National Park Service, U.S. Fish and Wildlife Service), U.S. Army Corps of Engineers, and Dept. of Defense. [2]NGOs include land trusts, conservation entities, and miscellaneous non-profit landowners. [3]Includes miscellaneous permanently protected parcels not fitting into any of the above categories (e.g., joint state ownerships between DCR and the Massachusetts Dept. of Agriculture. [4]Non-protected public land includes forestland owned by public entities that are not explicitly for forest conservation purposes (e.g., state highway medians). [5]Non-protected NGO lands do not have any formal level of protection, such as a conservation restriction, although they may likely be held explicitly for conservation purposes.

managed by the U.S. Army Corps of Engineers. Municipalities own 262,480 of permanently protected forestland for water supply protection, habitat, and public recreation.

Massachusetts has two federally and state recognized tribes, the Mashpee Wampanoag Tribe and the Wampanoag Tribe of Gay Head (Aquinnah) of Massachusetts, and one additional state recognized tribe, the Nipmuc Nation, all of which manage forested land in the state. Additionally, in the Freetown/Fall River State Forest, 227 acres are managed as a Wampanoag Reservation. This reservation was strengthened by a 1976 Executive Order by Governor Michael Dukakis (Massachusetts Executive Order No. 126) (Mass.gov 2019a). The Mashpee Wampanoag Tribe is involved in a partnership with federal

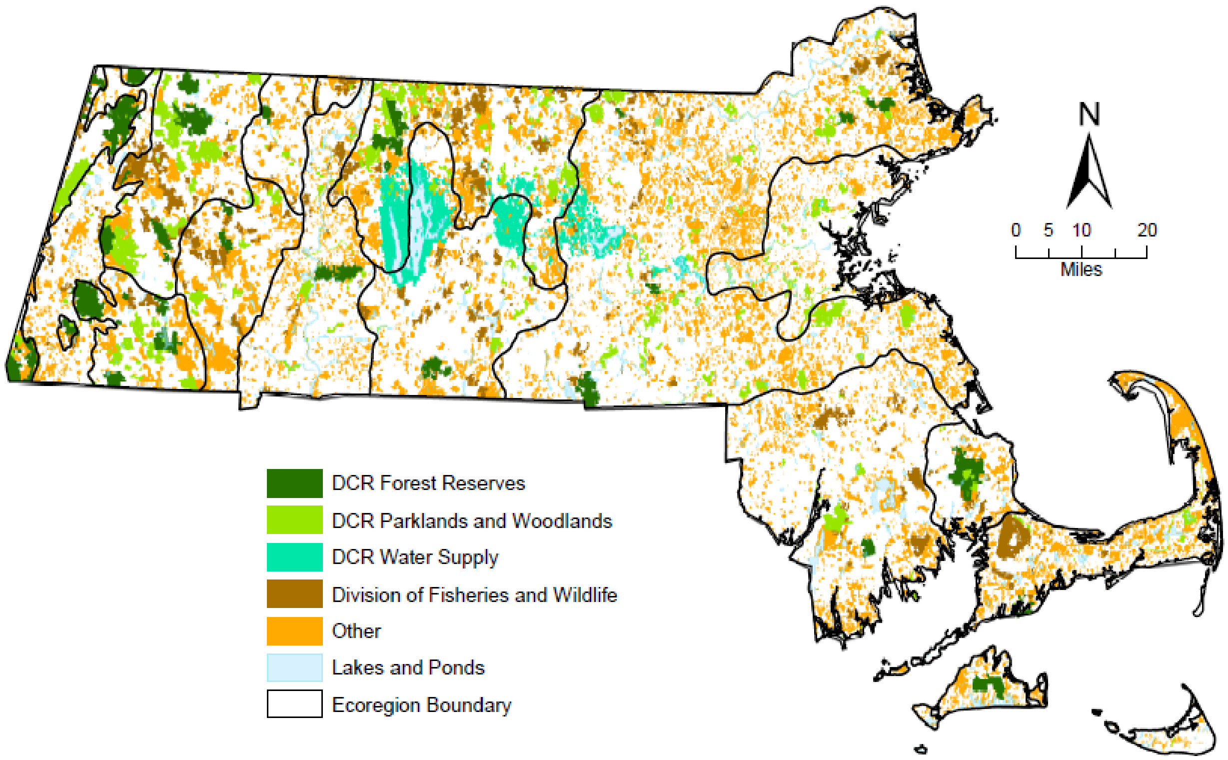


Figure 1.6. Permanently protected forestland in Massachusetts (data: MassGIS).

and state agencies and private conservation groups to preserve and protect natural resources of the Mashpee National Wildlife Refuge.

FOREST TYPES

Massachusetts lies in a transition zone between central and northern forest types (Figure 1.7) and as you move east to west, forest composition changes. Sandy coastal areas in the southeastern part of the state, including Cape Cod and the Islands of Martha's Vineyard and Nantucket, are covered with pitch pine and scrub oak forests. Central hardwoods/hemlock/white pine forests predominate in eastern and lowland areas. Transition hardwood species (red oak and black birch) and white pine and hemlock are more common to the north and west as elevations increase. Northern hardwoods, hemlock, and white pine are predominant in the upland regions of western Massachusetts. Red spruce and red spruce-balsam fir mix with northern hardwoods at higher elevations in the Berkshire Uplands and Taconic Mountains. True spruce-fir boreal forest is found at the highest elevations in the state, along the upper ridges of the Mount Greylock range (O'Keefe and Foster 1998, de la Crétaz and Kelty 2008).

FOREST STRUCTURE AND CONDITION

Estimates from U.S. Forest Service Forest Inventory and Analysis (FIA) data show that central and transition hardwood forests, dominated by oak species (O'Keefe and Foster 1998) cover more area than

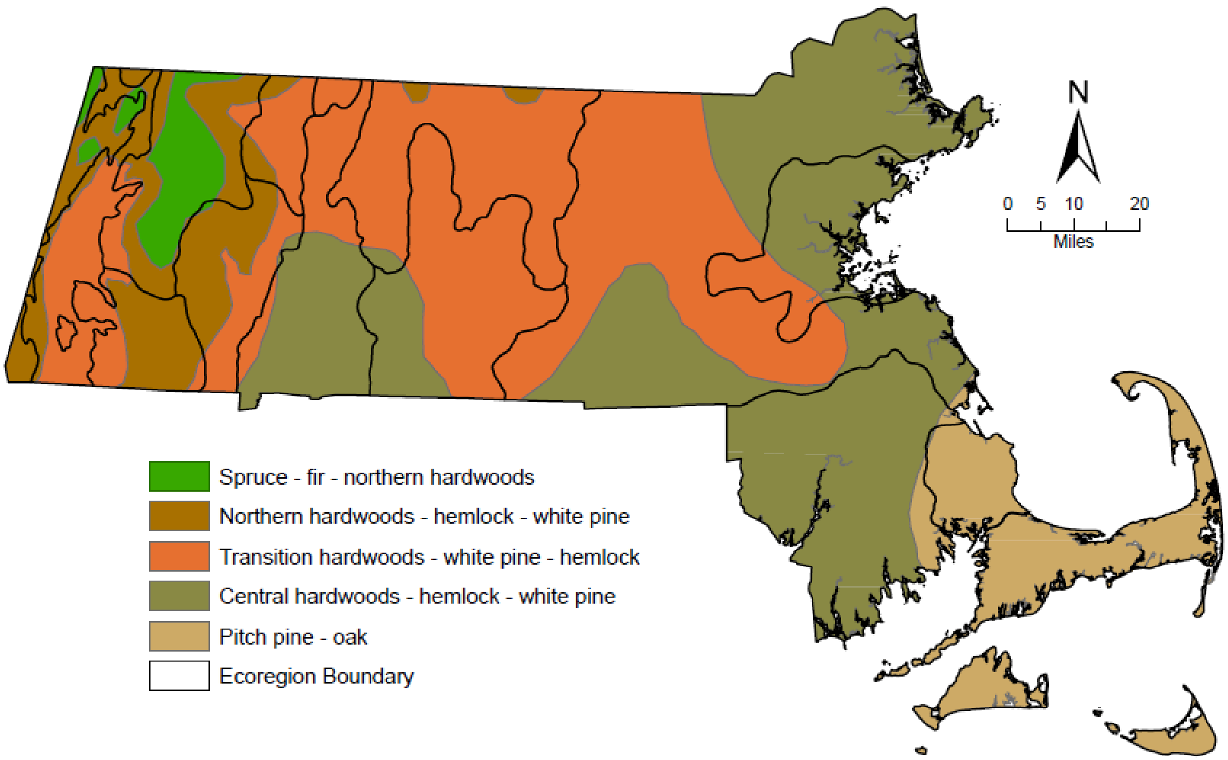


Figure 1.7. Massachusetts forest types (modified from Westveld et al. 1956).

any other forest type in Massachusetts. Northern Hardwood forests, dominated by American beech, yellow birch, and sugar maple, cover the next largest area (Figure 1.8). Northern hardwoods are found throughout the uplands of western Massachusetts (Figure 1.7).

Between 1998 and 2018, the area of forestland covered with large diameter trees increased, while the area of medium and small diameter trees decreased (Figure 1.9). Most of the forest is between 65 and 95 years old (Figure 1.10). Young and mature forests (late seral or old-growth habitat) are the least common forest habitat types. Old-growth forests consist of at least two trees that are older than 225 years and exceed 50% of the maximum longevity for species commonly encountered per acre in the forest overstory as determined through the collection of increment core samples (D'Amato et al. 2006). Massachusetts has 1,119 acres of old-growth forest spread out in 33 different locations mostly in Berkshire County and on Wachusett Mountain. These stands show no evidence of past land-use such as cut stumps, stone walls, or structures. Structural characteristics that are indicative of old growth include large snags, pits and mounds, gnarled tree crowns, and the large accumulation of course woody debris. These stands are mostly located in rugged topography which may have been one of the reasons they were never developed (D'Amato et al. 2006).

Local and regional changes in plant and animal populations have been attributed to the general increase in forest cover and loss of young forest habitat (DeGraaf and Yamasaki 2000; Primack et al. 2009). Grassland and shrubland species, especially birds, have declined rapidly as agricultural land has become reforested. In contrast, the population of pileated woodpeckers, an interior forest species that requires large trees, has significantly increased since 1975. Populations of some forest-based species, bear and

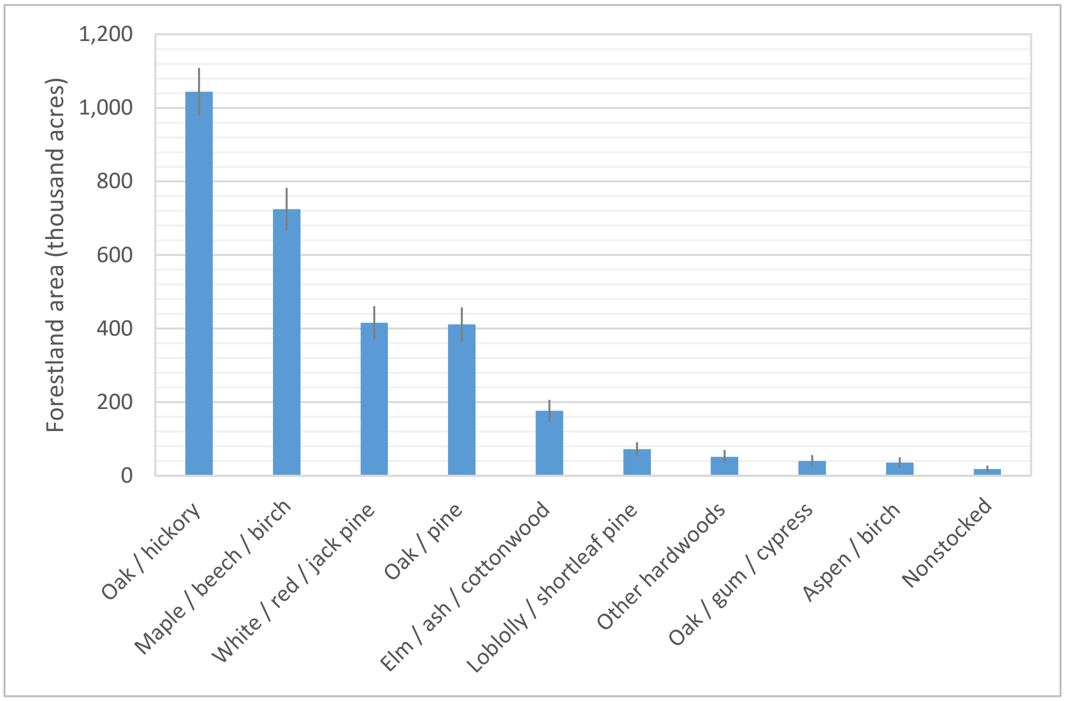


Figure 1.8. Forestland area by forest type. Nonstocked areas are timberland with less than 10% live trees. Error bars represent one standard deviation (data: FIA EVALIDator 2017).

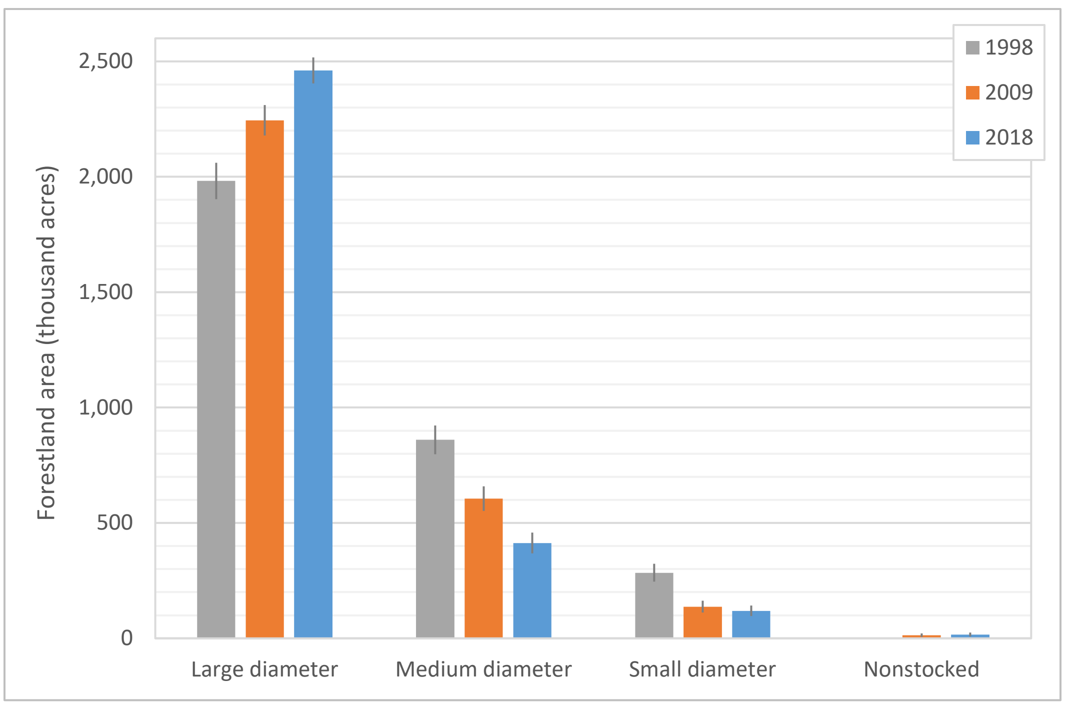


Figure 1.9. Forestland area by size class. Size classes are determined by the dominant size class represented in each stand (greater than 50% stocking). The "large" class is defined as 11+ inch diameters for hardwood and 9+ inch diameters for softwood, the "medium" class is greater than 5 inches, and the "small" class is less than 5 inches. Nonstocked areas are timberland with less than 10% live trees. Error bars represent one standard deviation (data: FIA EVALIDator 2017).

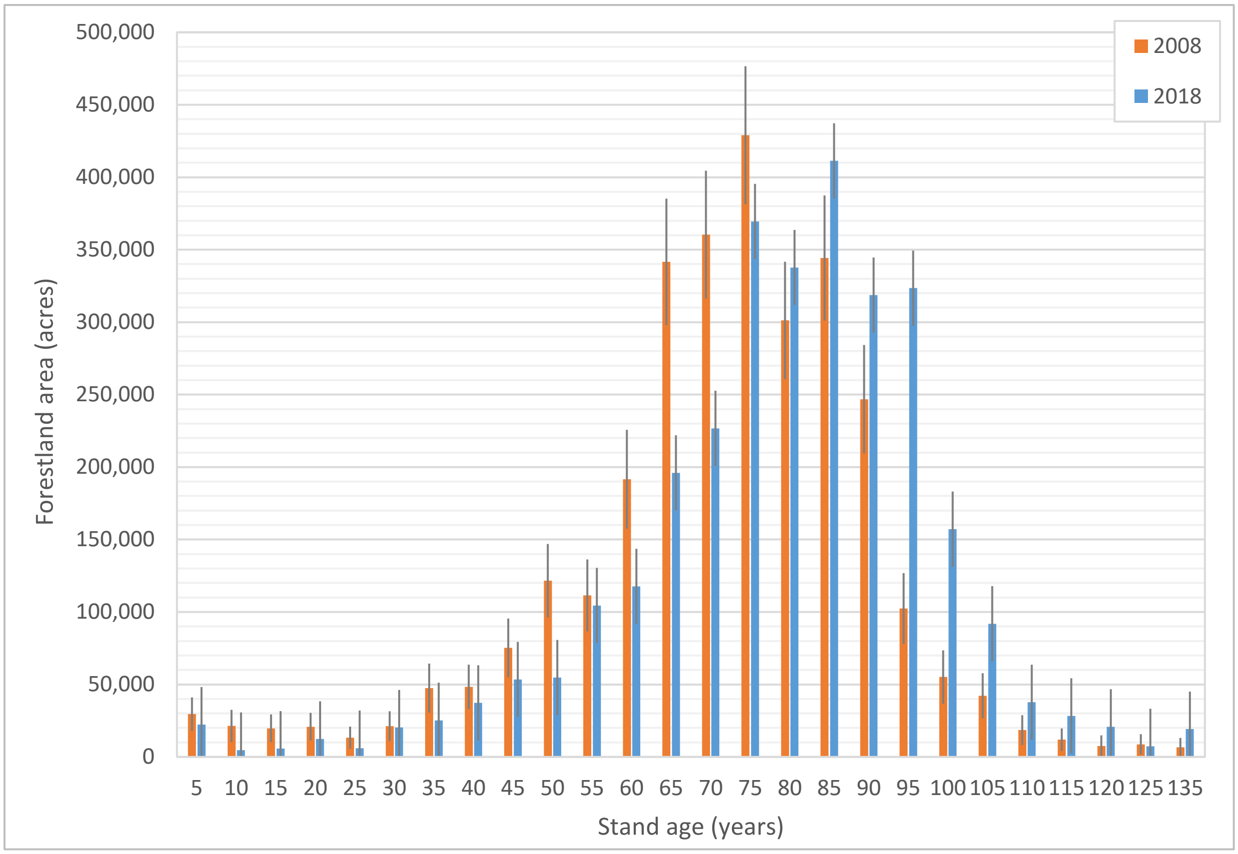


Figure 1.10. Stand age distribution on forestland in Massachusetts. Each stand age refers to the 5-year class ending in the age shown. Error bars represent one standard deviation (data: FIA EVALIDator 2019).

moose in particular, have also increased, with moose expanding their range from neighboring states to the north, and bears increasing within Massachusetts and expanding eastward. The bear population in Massachusetts was estimated at 975 to 1,175 in 1993. The current estimate of black bears in Massachusetts is 4,500 (Mass.gov 2019c, Mass.gov 2020d). Populations of species that thrive in fragmented landscapes, deer and coyote, have increased dramatically (DeStefano 2010). At the same time the conversion of open land to developed land, fragmentation of natural landscapes, and wetland loss threatens many populations of rare species (DeNormandie and Corcoran 2009).

URBAN AND COMMUNITY FORESTS

Urban and community forests are the trees, plants, and associated ecosystems anywhere where people live, from densely populated cities, to suburbs, and rural communities. Urban tree canopy provides important benefits to Massachusetts citizens including stormwater mitigation, reduction of the urban heat island (the phenomenon where urban areas are warmer than surrounding suburban and rural areas), reduction of energy use, and a host of other social and economic benefits. On a continuum from urban to rural, urban forests vary across the Commonwealth. Urban forests contain a mix of remnant trees and forests, as well as streetscapes. They often consist of both native and non-native trees purposefully planted and trees that have seeded in and been allowed to grow, often the case along

Charles River Esplanade, photo by Matt Heraifman

some suburban and rural roadsides. One way of examining urban forests is to consider urban tree canopy, which varies from community to community. Urban tree canopy (UTC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. In general, most UTC is in residential areas on private property and must be considered along with the highly visible street trees.

A 2006 pilot project that sampled street trees across Massachusetts estimated that the most common genera of street trees were maple, oak, and pine. This is not unlike our most common forest trees. The same study identified the most common species of street trees as Norway maple, red maple, northern red oak, and callery pear. Norway maple is non-native and invasive and has been listed on the state's Prohibited Plant List. Callery pear is also non-native and is problematic because of its growth habit and tendency to break apart under heavy snow or ice loading. It has been identified as invasive in Mid-Atlantic states, though is not currently regulated in Massachusetts. In many communities in Massachusetts, trees in the maple genus dominate the streetscape. Having one genus or family dominate the urban forest can become problematic if a pest or disease arises that is genus or family specific. Effects of this were felt in Worcester with the arrival of the exotic invasive Asian longhorned beetle (ALB). Nearly 80% of the street trees in Worcester were maples, the preferred host of ALB, and entire streets saw their street trees destroyed to prevent spread of the beetle. Diversifying urban tree plantings continues to be a goal for communities across Massachusetts to help increase resiliency to pests, disease, and effects of climate change.

Not much information about private, residential trees in Massachusetts is available, although some municipalities have developed comprehensive UTC assessments that give a sense of conditions of tree cover on both public and private land. UTC assessments have been completed in Chelsea, Cambridge, and Lawrence, which are all densely populated urban cities. UTC, as a percentage of land covered by trees, varies among these communities. In Chelsea urban tree canopy was 9%, while in Cambridge it was 30%, and in Lawrence 26%. In each of these studies, the most UTC is in residential areas. However, urban tree canopy is not evenly distributed in communities, leading to concerns about environmental justice and equitable access to the benefits associated with urban tree canopy. The Greening the Gateway Cities program (GGC), as part of the DCR Urban and Community Forestry Program, operates to plant trees in the Gateway Cities designated by the Massachusetts Legislature, with a goal of addressing environmental equity and energy savings. Moving forward, more information can be gathered about the urban forest, with the expansion of the traditional FIA program into urban areas. This plot-based sample inventory, conducted by the U.S. Forest Service, will begin including tree data from plots in urban areas in 2020. This will help provide a more complete picture of trees across landscapes in Massachusetts.

In many communities in Massachusetts, planting of street and public trees falls behind losses due to mortality or removal (Freilicher 2010). While street trees make up a small portion of the urban forest, they are a prominent and visible element and their location over impervious streets and sidewalks and near buildings, means that they can provide a lot of environmental services. While tree planting is critical in maintaining UTC, the most important action that communities can take is to protect their existing trees, both public and private, through local ordinances. A 2013 study in Worcester showed that despite all the tree removals due to ALB infestation, most UTC was lost to “business as usual” development (Hostetler et al. 2013). Without increased tree planting and tree protection, urban and community forests will continue to lose tree canopy.

BIOLOGICAL COMMUNITIES

The Massachusetts State Wildlife Action Plan

In the 2015 *Massachusetts State Wildlife Action Plan* (SWAP), MassWildlife identified 570 Species of Greatest Conservation Need (SGCN) and the 24 types of habitat that support these species. The SGCN include all federally listed species, as well as all state-listed Endangered, Threatened, and Special Concern species.

The SWAP assigns each of these species to one or more of the 24 habitats (Table 1.3) which are broken into three categories (large-scale, medium-scale, and small-scale) based on the relative acreages of the habitat. A species was assigned to a SWAP Habitat if the habitat is a major and essential component of the species’ life history. This method of grouping species is useful as species that use the same habitat often suffer from the same threats and need the same conservation action. The SWAP outlines conservation actions aimed at maintaining the biodiversity of the Commonwealth and protecting the habitats of the species in greatest need of conservation. Within these actions, land protection and

SWAP Habitats		
Large-scale habitats	**Medium-scale habitats**	**Small-scale habitats**

• Connecticut and Merrimack Mainstems
• Large and Mid-sized Rivers
• Marine and Estuarine Habitats
• Upland Forest
  ◦ Transition Hardwoods-White Pine[1]
  ◦ Northern Hardwoods-Spruce-Fir[1]
  ◦ Central Hardwoods-White Pine[1]
  ◦ Pitch Pine-Oak[1]
• Large Unfragmented Landscape Mosaics[1]
	• Small Streams
	• Shrub Swamps[2]
	• Forested Swamps[1]
	• Lakes and Ponds
	• Salt Marsh
	• Coastal Dunes, Beaches, and Small Islands
	• Grasslands
	• Young Forests and Shrublands[1]
	• Riparian Forest[1]
		• Vernal Pools[2]
		• Coastal Plain Ponds
		• Springs, Caves, and Mines
		• Peatlands and Associated Habitats
		• Marshes and Wet Meadows[2]
		• Rocky Coastlines
		• Rock Cliffs, Ridgetops, Talus Slopes, and Similar Habitats

[1]Forested habitats. [2]Habitats likely to be surrounded by a forest. Note: Inland aquatic habitats in general are dependent on the forest as a source of clean water.		

Table 1.3. Massachusetts habitat designations from the Massachusetts State Wildlife Action Plan (DFG 2015).

habitat management are considered to be of the highest priority (Harper 2017). Full descriptions of each SWAP Habitat, as well as the full list of SGCN can be found in the *Massachusetts State Wildlife Action Plan*.

BioMap2

BioMap2 is a framework for protection and stewardship of lands and waters that are most important for conserving biological diversity in Massachusetts. It was developed by the Natural Heritage and Endangered Species Program (NHESP) of MassWildlife and The Nature Conservancy (TNC).

The goal of the original BioMap, completed in 2001, was to "identify and delineate the most important areas for the long-term viability of terrestrial, wetland, and estuarine elements of biodiversity in Massachusetts." The Living Waters project aimed to identify rivers and streams that are important for freshwater diversity. Digital data, resulting from the two conservation plans, "are based on documented observations of rare species, natural communities, and exemplary habitats" (NHESP 2004).

Continued data collection and advances in GIS technology since 2001, as well as an enhanced understanding of species requirements, has led to improved habitat mapping for state-listed species by the NHESP and innovative ecosystem and landscape mapping by TNC resulting in the release of BioMap2 in 2010. While the first BioMap focused primarily on rare species protected under the Massachusetts Endangered Species Act (MESA), BioMap2 also addresses other Species of Conservation Concern, their habitats, and the ecosystems that support them, to create a spatial representation of most of the elements of the SWAP.

"BioMap2 identifies 1,242,000 acres of Core Habitat, key areas that are critical for the long-term persistence of rare species and other Species of Conservation Concern, as well as a wide diversity of natural communities and intact ecosystems across the Commonwealth (Woolsey et al. 2010)." BioMap2 Core Habitats (Figure 1.11) include 943,000 acres of upland habitat and 233,000 acres of wetland and

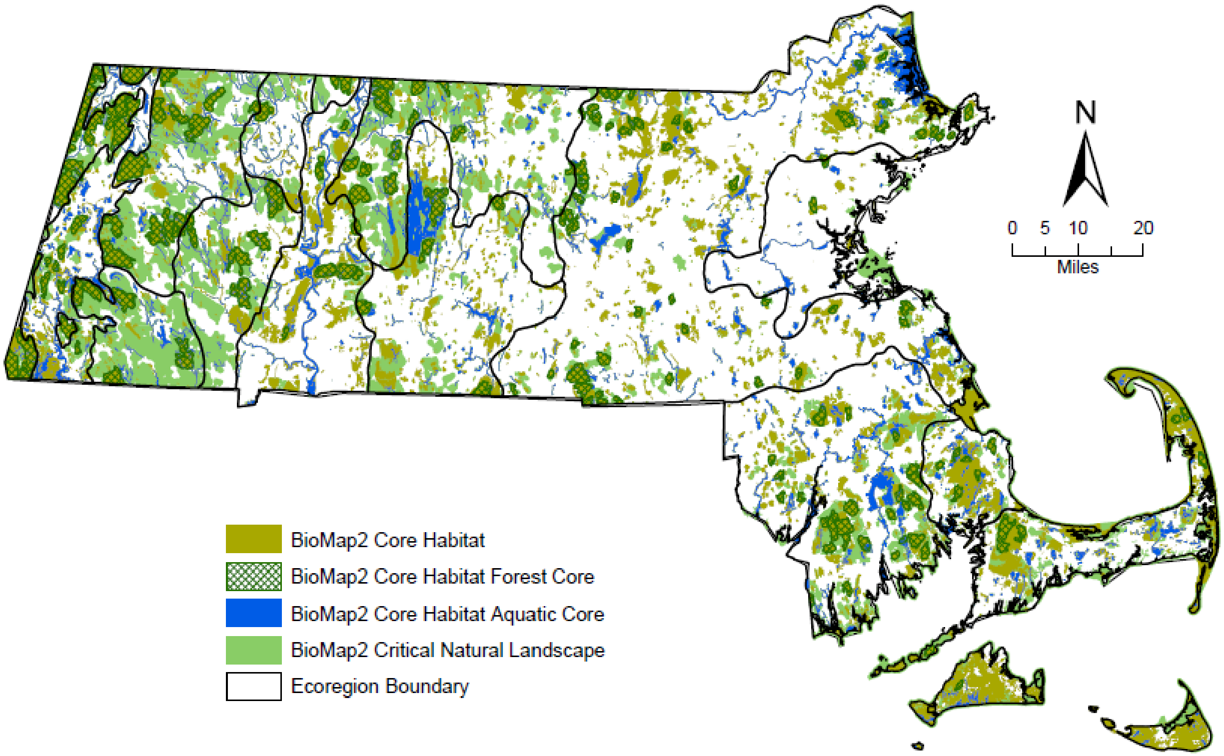


Figure 1.11. Natural Heritage and Endangered Species Program and The Nature Conservancy BioMap2 Core Habitats and Critical Natural Landscape (data: MassGIS).

aquatic habitat. Other BioMap2 datasets include Priority Habitats of Rare Species, Estimated Habitats of Rare Wildlife, Certified Vernal Pools, Potential Vernal Pools, BioMap Supporting Natural Landscape, Living Waters Critical Supporting Watersheds, and Natural Communities (Woolsey et al. 2010).

"BioMap2 Core Habitat includes the best examples of large, intact forests that are least impacted by roads and development, providing critical habitat for numerous woodland species. For example, the interior forest habitat defined by Forest Cores supports many bird species sensitive to the impacts of roads and development, such as the Black-throated Green Warbler, and helps maintain ecological processes found only in unfragmented forest patches. Of the approximately three million acres of forest and forested wetlands in Massachusetts, the largest and least fragmented forests in each ecoregion were selected based on the Ecological Integrity assessment. Minimum forest patch sizes range from about 500 acres in eastern Massachusetts and the Connecticut and Housatonic Valleys, to 1,500 to 2,000 acres on the Worcester and Berkshire Plateaus to over 3,000 acres in the Taconic Mountains (Woolsey et al. 2010)."

The Conservation Assessment and Prioritization System and the Index of Ecological Integrity

The Conservation Assessment and Prioritization System (CAPS) was developed by the Landscape Ecology Program in the Department of Natural Resources Conservation at the University of Massachusetts Amherst (UMass Amherst) (McGarigal et al. 2009). CAPS is a spatial model designed to assess the ecological integrity of lands and waters in the Commonwealth. Ecological Integrity is defined as "the ability of an area to support biodiversity and ecosystem processes necessary to sustain biodiversity over the long term." CAPS computes an Index of Ecological Integrity (IEI) that assesses the relative wildlife habitat and biodiversity value of any point on the landscape. Metrics used to calculate the IEI reflect various attributes of ecological communities including patch size, proximity to streams and rivers, and diversity of soil types or road density. The IEI for Massachusetts (Figure 1.12) shows that the largest areas of natural communities with relatively high IEI scores are found in the Central Uplands, Berkshire Uplands, and Taconic Mountains. Fragmentation and pollution associated with development and higher road density, among other factors, result in lower scores in much of the eastern part of the state, the Connecticut River Valley, and the Marble Valley.

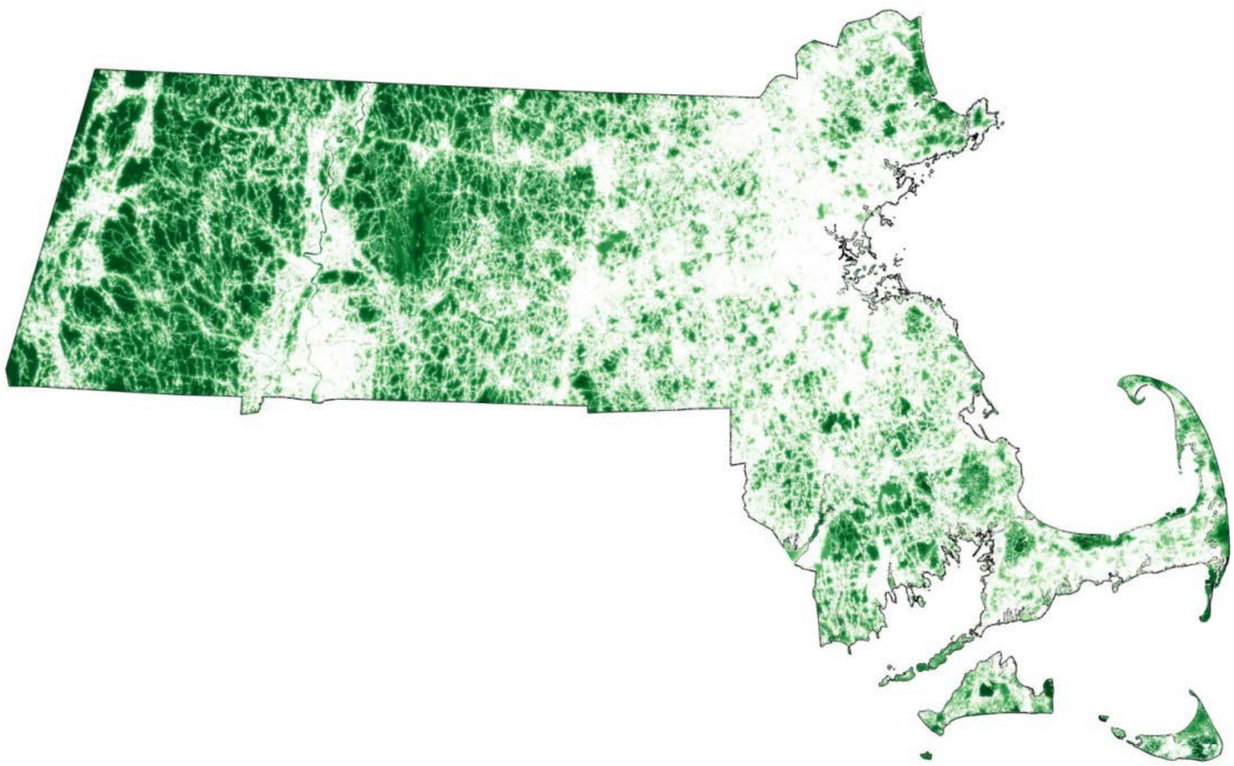


Figure 1.12. Index of ecological integrity (IEI) for Massachusetts. Darker areas denote higher IEI values; white areas are developed land (umasscaps.org).

Resilient and Connected Landscapes

The Nature Conservancy conducted an analysis of resilient landscapes in Massachusetts and other New England states to determine the areas that are likely to best support species in a changing climate. These are places where conservation actions and investments are most likely to succeed in the long term. As the climate changes, many places may no longer support wildlife and other important species, increasing the risk of extirpation or global extinctions. However, some places will retain high quality habitat and continue to support a diverse array of plants and animals. Sites that have both complex topography and connected land cover provide species with opportunities to access suitable microclimates. The Nature Conservancy mapped places with these characteristics (Figure 1.13) to identify conservation sites that will support biodiversity into the future (Anderson et al, 2016a). These

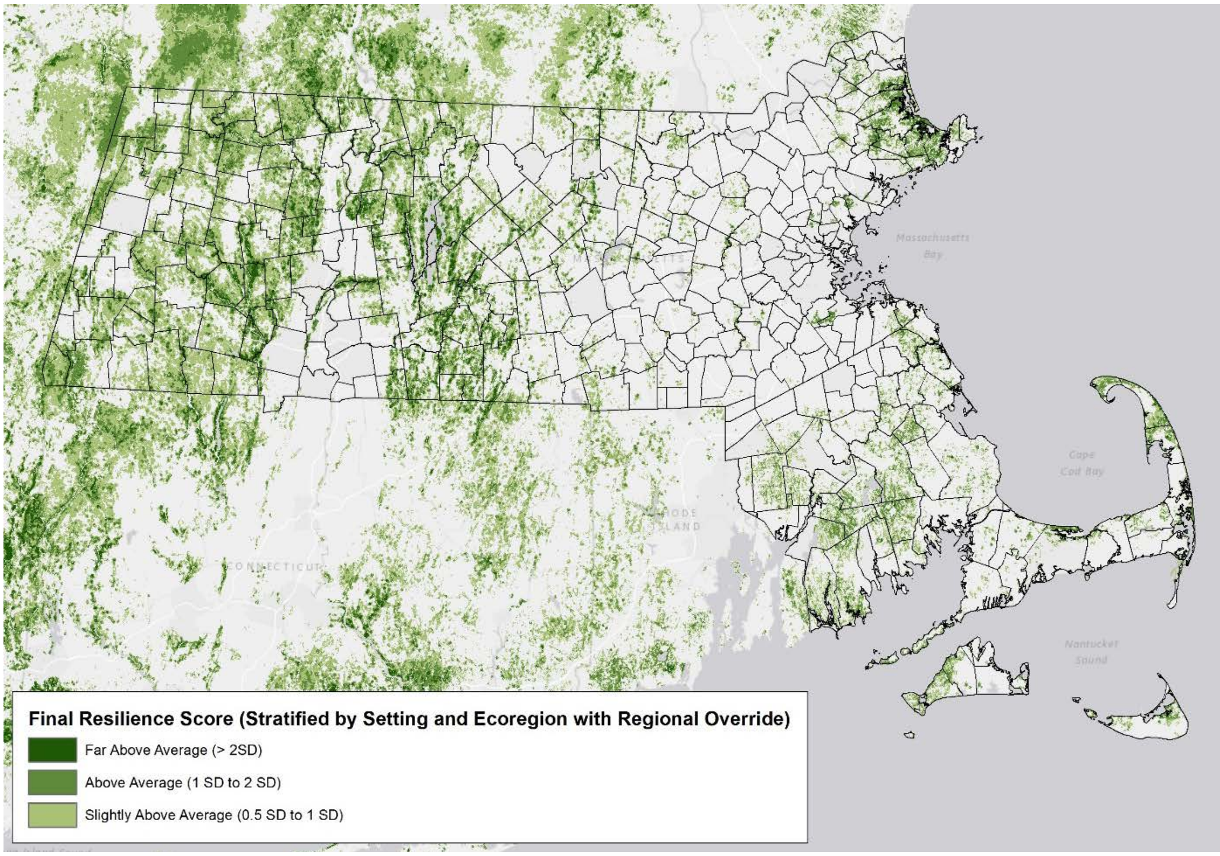


Figure 1.13. The Nature Conservancy's Resilient Landscape Analysis. Resilient areas, in green, are those with greater potential to support species in a changing climate. Resilient areas have scores greater than 0.5 Standard Deviation (http://nature.org/TNCResilience).

Resilient and Connected Landscape data, pioneered in the Northeast, have recently been developed for the entire continental United States. These data are being applied by state and federal agencies, land trusts, and municipalities to inform conservation priorities. Permanent conservation of resilient areas should be prioritized to ensure they can continue to support thriving biodiversity and provide habitat. TNC's resilience analysis is complemented by data identifying areas that support continental-scale species movement (i.e., range shifts) over long time frames, another key landscape factor to prevent local and global extinctions (Anderson et al. 2016b).

CLIMATE CHANGE

Climate change is already exacerbating natural hazards and extreme weather events, as well as leading to new impacts that will affect the Commonwealth. Climate change is defined as a change in the state of the climate that can be identified by statistical changes of its properties that persist for an extended period (Commonwealth of Massachusetts 2018). Projections for changes to Massachusetts' climate by the end of this century are found in Table 1.4.

Climate Projections	
PRECIPITATION	• Increase up to 7.3 inches in annual precipitation. • Increase up to 57% (+4 days) in days with rainfall accumulation greater than 1 inch. • Increase of 18% (+3 days) in consecutive dry days.
SEA LEVEL	• Increase of 4 to 10.5 feet in sea level.
TEMPERATURE	• Increase up to 10.8° Fahrenheit in average annual temperature. • Decrease up to 62 days with daily minimum temperatures below freezing. • Increase up to 11.4° Fahrenheit in average minimum winter temperature. • Increase up to 64 days with daily maximum temperatures over 90° Fahrenheit.
EXTREME WEATHER	• Increase in frequency and magnitude.

Table 1.4. Massachusetts climate change projections (Commonwealth of Massachusetts 2018).

Disturbances such as wildfire, insect and disease outbreaks, drought, invasive species, and weather events are part of the ecological history of most forest ecosystems. Climate influences the timing, frequency, and magnitude of these disturbances (Vose et al 2012). Climate change will pose direct and indirect impacts on the forests of Massachusetts. Potential impacts of climate change on Massachusetts forests include:

- Boreal species, such as balsam fir, red spruce, and black spruce, are projected to have reductions in suitable habitat, whereas species such as American basswood, hickory species, and oak species may have increases in suitable habitat (Table 1.5),
- Soil moisture patterns will be altered due to earlier snow melt in the spring and a longer growing season. This will likely reduce summertime soil moisture and increase the occurrence and length of droughts,
- Projected increases in seasonal drought and warmer temperatures will increase the risk of wildfire as well as extend the wildfire season,
- Changes in temperature and precipitation may increase chances of successful invasions of non-native species,
- Increase in outbreaks of forest insects and pathogens and related tree mortality due to warmer winters and associated increases in winter survival for insects or pathogens,
- Locations of suitable habitat may change faster than tree species can disperse, creating uncertainty about the future vegetation composition of Massachusetts forests, and
- Wildlife may be affected through direct thermal stress, shifts in habitat and food availability, increases in parasites and diseases, and responses to extreme weather events.

The U.S. Forest Service has assessed the suitability of habitat for tree species. Table 1.5 shows this assessment for trees in Massachusetts with respect to two climate scenarios. Projected changes in temperature and precipitation for “high change” represent a greater degree of greenhouse gas emissions and projected climate warming than the “low change” scenario. For instance, by the end of the century, mean annual temperature is projected to increase 2.6°F under the “low change” scenario and 7.6°F under the “high change” scenario.

Tree species	Low change scenario	High change scenario
Bigtooth aspen	Large decrease	Large decrease
Black spruce	Large decrease	Large decrease
Eastern hemlock	Large decrease	Large decrease
Eastern white pine	Large decrease	Large decrease
Northern white cedar	Large decrease	Large decrease
White spruce	Large decrease	Large decrease
Paper birch	Large decrease	Small decrease
Black ash	Small decrease	Large decrease
American beech	Small decrease	Small decrease
Bitternut hickory	Small decrease	Small decrease
Eastern hophornbeam	Small decrease	Small decrease
Gray birch	Small decrease	Small decrease
Northern red oak	Small decrease	Small decrease
Pitch pine	Small decrease	Small decrease
Quaking aspen	Small decrease	Small decrease
Red maple	Small decrease	Small decrease
Shagbark hickory	Small decrease	Small decrease
Sugar maple	Small decrease	Small decrease
Tamarack	Small decrease	Small decrease
Yellow birch	Small decrease	Small decrease
Balsam fir	Small decrease	No change
Striped maple	Small decrease	No change
American basswood	No change	No change
Chestnut oak	No change	No change
Pignut hickory	No change	No change
Red spruce	No change	No change
Sassafras	No change	No change
Scrub oak	No change	No change
White ash	No change	No change
Black birch	No change	Small decrease
Black cherry	Small increase	Small increase
Black gum	Small increase	Small increase
Black oak	Small increase	Small increase
White oak	Small increase	Small increase

Table 1.5. Potential changes in suitable habitat for trees in Massachusetts under a low (temperature increase of 2.6°F) and high (temperature increase of 7.6°F) climate change scenario (data: U.S. Forest Service Climate Change Atlas).

- *Large decreases refer to a greater than 50% decrease in suitable habitat.*
- *Small decreases refer to a greater than 20% decrease to no more than a 50% decrease in suitable habitat.*
- *No change represents less than a 20% change in future suitable habitat.*
- *Small increases refer to a greater than 20% increase to no more than a 200% increase in suitable habitat.*
- *Large increases refer to more than a doubling, 200% increase in suitable habitat.*

INVASIVE PLANT SPECIES

The Massachusetts Invasive Plant Advisory Group (MIPAG) defines invasive plants as “non-native species that have spread into native or minimally managed plant systems in Massachusetts, causing economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems.” Many species that have been introduced to Massachusetts, either accidentally or through landscape plantings, out-compete or displace native species. Invasive species monopolization can have economic consequences and negatively impact rare and endangered species. Not only do they often have biological traits that give them a competitive advantage over native species, invasive plant species are also free of the biological controls that restrict population in their native environment. Uncontrolled growth of invasive species can alter soils, increase erosion, and reduce habitat value for native wildlife. Early detection and rapid response are key components to successful invasive species control (MIPAG 2005).

MIPAG has identified 69 plant species that currently are, or threaten to become, invasive in Massachusetts. Of these, 35 have already spread into native or minimally managed plant systems. Thirty-one are identified as “likely invasives” indicating that they have naturalized in the state, but they have not yet proliferated widely. Three are identified as “potentially invasive.” These plants are not currently naturalized in Massachusetts but are expected to spread into the state in the future. MIPAG is a voluntary group charged by the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) with advising the Commonwealth regarding invasive plant species identification and management. Members of MIPAG represent research institutions, non-profit organizations, the green industry, and state and federal agencies (MIPAG 2019). MIPAG’s *Strategic Recommendations for Managing Invasive Plants in Massachusetts* identifies the essential components of a plan to control invasive plant species and suggests a management framework to maximize efforts.

Many of these groups also are affiliated with IPANE, the Invasive Plant Atlas of New England. IPANE has developed a database containing 29,950 observations of invasive plant populations in Massachusetts. All locations are entered with GPS latitude and longitude coordinates. Most of the work is done by a large group of trained volunteers. This database, combined with similar observations from other New England states, has been the basis for “a web accessible database of invasive and potentially invasive plants in New England that will be continually updated by a network of professionals and trained volunteers. The database will facilitate education and research that will lead to a greater understanding of invasive plant ecology and support informed conservation management. An important focus of the project is the early detection of, and rapid response to, new invasions (IPANE n.d.).”

FOREST PESTS AND DISEASES

Forest pests and diseases can have a significant impact on forest ecosystems. They can alter species composition, reduce growth rates, disrupt normal forest management activities, and can potentially kill many thousands of mature, healthy trees. A wide range of fungal diseases and insect pests are found in Massachusetts forests. Many fungal diseases are widespread and impossible to eradicate. Chestnut blight, Dutch elm disease, and beech bark disease are a few examples of fungi that persist throughout the forest. Some fungal pathogens, such as the White Pine Needle Disease, are native and have only been an issue in recent decades.

Some insect pest populations wax and wane with annual variation in climate (temperature and precipitation) and predator populations. In recent years, annual canopy damage from insects and diseases in Massachusetts ranged from 23,563 acres in 2012 to 939,051 acres in 2017 (Table 1.6). The average annual area of canopy damage was 201,681 acres (about 6% of total forest area) between 2009 and 2018. The three primary agents of canopy damage in total over that period were gypsy moth (1,481,115 acres), winter moth (300,571 acres), and weather events such as snow, ice, wind, tornado, frost, or hail (75,244 acres).

Year	Total Acres	1st Damage Causing Agent	Acres	2nd Damage Causing Agent	Acres	3rd Damage Causing Agent	Acres
2009	39,333	Winter Moth	18,936	Snow-Ice	9,705	Gypsy Moth	4,304
2010	139,135	Winter Moth	67,737	Frost	40,292	Gypsy Moth	5,879
2011	102,984	Winter Moth	89,006	Wind-Tornado/ Hurricane	11,424	Unknown	546
2012	23,563	Winter Moth	10,213	Black Oak Gall Wasp	3,815	Wind-Tornado/ Hurricane	3,444
2013	52,216	Winter Moth	16,250	Black Oak Gall Wasp	14,576	Hail	10,379
2014	50,823	Winter Moth	36,505	Red Pine Scale	4,955	Black Oak Gall Wasp	2,712
2015	112,108	Winter Moth	61,924	Gypsy Moth	38,175	Black Oak Gall Wasp	4,571
2016	363,595	Gypsy Moth	349,866	Black Oak Gall Wasp	6,503	White Pine Needle Damage	3,623
2017	939,051	Gypsy Moth	923,186	White Pine Needle Damage	8,638	Fire Damage	1,950
2018	194,000	Gypsy Moth	159,705	Oak Mortality	23,602	Red Pine Scale	2,476

Table 1.6. Annual canopy damage from top three agents in Massachusetts by acreage for 2009-2018.

Gypsy Moth

Gypsy moth has been present in Massachusetts for more than 150 years. This pest causes tree defoliation in spring when caterpillars are feeding. Populations are generally cyclical in Massachusetts, based on weather and natural systems. Massachusetts recently experienced a gypsy moth population outbreak event. Populations of gypsy moth increased through 2015 and 2016 and led to over 923,000 acres of defoliation in 2017. Drought conditions in preceding years had limited the effectiveness of a soil borne fungus, *Entomophaga maimaiga*, which has helped keep gypsy moth populations in check since the last large outbreaks of the 1980s. Conditions improved in 2017 when there was high gypsy moth caterpillar mortality from the *E. maimaiga* fungus and the Nuclear Polyhedrosis Virus led to reduced feeding pressure in 2018, which in turn caused a decreased impact, reducing defoliation to 159,705 acres statewide. There was very little caterpillar mortality in 2018 and moth reproductive success was high, but 2019 weather conditions were perfect for reducing the numbers of caterpillars. Early that spring when the caterpillars first emerged, temperatures were very cool, preventing the newly hatched caterpillars from climbing into the canopy and feeding, leading to a massive starvation event. The cool and moist weather in June provided ideal conditions for *E. maimaiga*, which further decreased the population. Compared to previous years, minimal defoliation and few egg masses were seen in 2019. However, due to multiple years of gypsy moth defoliation, the added stress of the drought in 2016, and the attack of secondary invaders, there has been a significant increase in oak mortality across the state. 2018 marked the first time in years that oak mortality was recorded from aerial survey (23,602 acres).

Asian Longhorned Beetle

Asian longhorned beetles (ALB) are wood boring beetles that prefer to feed on live, healthy trees in 12 different genera: ash, birch, golden raintree, katsura, maple, mountain ash, willow, elm, horsechestnut/buckeye, London planetree/sycamore, mimosa, and poplar. ALB was first discovered in the United States in Brooklyn, New York in 1996 and has since been found in Illinois (1998), New Jersey (2002), Massachusetts (2008), and Ohio (2011). ALB most likely made its way to the U.S. inside wood packaging material from Asia where it is a serious pest of hardwood trees.

Two separate infestations have been found in Massachusetts, the first in Worcester in 2008 and the second in Boston in 2010. After about three years of survey surrounding the Boston infestation site, no other signs of ALB were found. Boston was declared eradicated in May 2014. The Worcester infestation is ongoing, however fewer infested trees are being found as time goes by and progress is being made toward eradication (Figure 1.14).

As of 2019, 110 square miles are regulated for ALB in Worcester County including all of Worcester, West Boylston, Boylston, and Shrewsbury, as well as parts of Holden and Auburn. Currently, the only effective means to eliminate ALB is to remove the infested trees and destroy them by chipping to one inch in two dimensions. The material is then considered to be deregulated and can leave the regulated area.

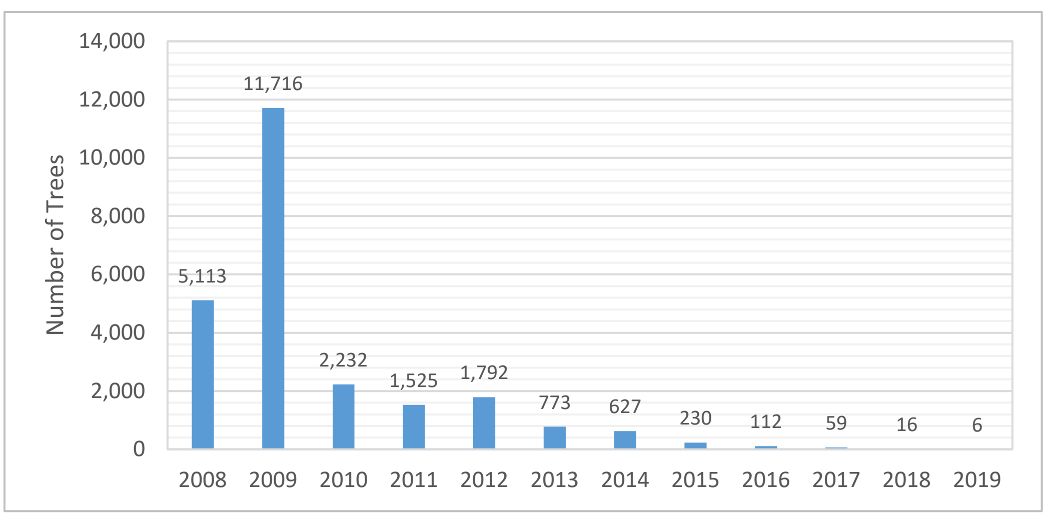


Figure 1.14. Number of ALB-infested trees identified in the regulated area in Worcester County, by year.

Emerald Ash Borer

The emerald ash borer (EAB) was first discovered in the United States in the Detroit area in 2002 and has steadily spread. The larvae of this metallic green beetle bore through the wood and phloem of a tree, disrupting the tree's ability to transport water and nutrients. EAB affects all ash species and can kill a tree in four to eight years.

In 2012, EAB was detected in Massachusetts in the Berkshire County town of Dalton. By July 2020, the DCR Forest Health Program has confirmed the presence of EAB in 11 of Massachusetts' 14 counties: Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, and Worcester (Figure 1.15). All of Massachusetts is currently part of the national quarantine zone, limiting the movement of all hardwood firewood, green wood products, nursery stock, and any plant materials from any ash species in an effort to slow the spread of the beetle.

The DCR Forest Health Program has implemented a trapping program to continue to detect emerald ash borer in the state. The trapping program allows state foresters to find new infestations, map the progression and spread of known populations, and determine sites suitable for biocontrol releases. The Forest Health Program is also working in partnership with the U.S. Department of Agriculture (USDA)

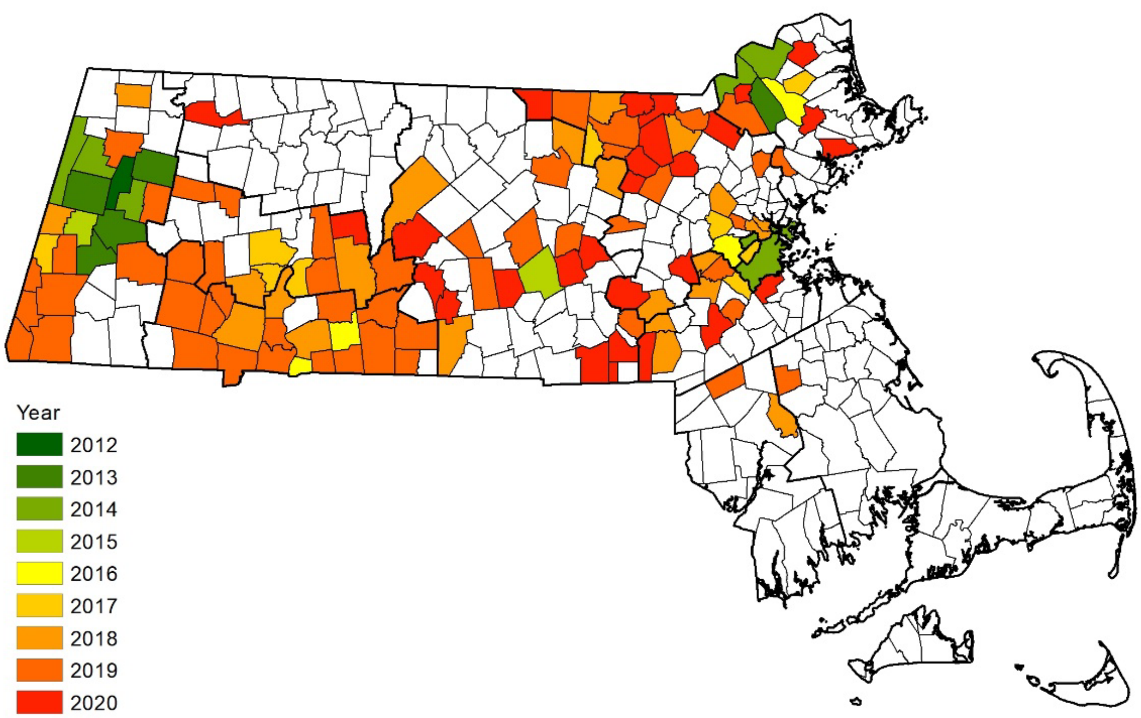


Figure 1.15. New Emerald ash borer detections in Massachusetts, by year (N. Keleher 7/27/2020).

Animal and Plant Health Inspection Service and U.S. Forest Service to establish biocontrol species to help minimize the impact of the emerald ash borer and to protect our ash trees. The goal of the biocontrol release program is to establish populations of host-specific parasitic wasps from EAB's native range;

these wasps will regulate EAB population growth. All biocontrol species are thoroughly studied prior to introduction into the ecosystem to avoid negative impacts.

Winter Moth

Native to Europe, winter moth's larval stage is a leaf-feeding inchworm caterpillar. It was identified in eastern Massachusetts in 2003 and caused widespread defoliation of forest and shade trees throughout the region. Caterpillars of winter moth feed on many kinds of deciduous trees with oaks, maples, and apples being their favorite. They also fed on blueberry; damage to blueberry and apple crops can be especially severe because the reproductive parts responsible for fruit can be destroyed before the buds are fully open.

Researchers at UMass Amherst initiated a winter moth biocontrol program in New England in 2005. Over the following decade they obtained tachinid flies, a parasitic insect originally from Europe, by collecting winter moth caterpillars infested with immature flies from Vancouver Island. The adult fly lays its eggs on leaves and the caterpillar consumes them as it eats the leaf. The eggs then hatch inside the caterpillar and feed on the caterpillar from the inside. The collected tachinid flies were reared over the winter and released the following spring. Monitoring efforts in the following years showed that the fly had successfully established, resulting in the near elimination of winter moth defoliation in eastern Massachusetts (Elkinton et al. 2017).

White Pine Needle Disease

Since 2010, eastern white pine has been experiencing needle browning and canopy dieback, also known as White Pine Needle Disease (WPND). In the spring of 2016, there was a dramatic decline of white pine observed throughout most of southern New England. The cause of the decline is not fully understood, but recent studies have identified four needle blight fungi that are associated with WPND, *Lecanosticta acicola, Lophophacidium dooksii, Bifusella linearis, and Septorioides strobi.* These pathogens favor warm wet weather in the spring when the pines are flushing new growth, followed by a dry summer. The changing climate has been shown to contribute to the problem as increasing temperatures and more frequent rainfall events in the spring create ideal conditions for the pathogens.

Symptoms of WPND vary depending on the pathogen responsible, though one common symptom is premature needle shedding. Older needles on mature trees become discolored, ranging from yellow to brown while the current season's needles appear healthy. Needle blights rarely kill the trees, but the annual infection and subsequent loss of older needles creates a chronic stress that weakens trees and exhausts stored resources leaving the tree vulnerable to secondary infections and insect attacks.

Caliciopsis canker and white pine bast scale (WPBS) also pose a threat to eastern white pine. Caliciopsis is a well-known fungus that has been observed in New England forests since the 1800s. Pole-sized trees in dense forest stands or trees in dense groves or screens in the landscaped environment are the most susceptible to the canker. Recently, it has been discovered that Caliciopsis attacks trees that are stressed and weakened due to feeding by the white pine bast scale. WPBS is a native insect that has piercing-sucking mouthparts and feeds on white pine saplings, pole-sized, and mature trees. By itself, the bast scale does little to no damage to the pines but combined with Caliciopsis, white pines face a greater threat. Active management to reduce the severity of the disease issues facing white pine include thinning to reduce stand density. Thinning improves air flow, promotes crown vigor, and enhances radial growth rates (Brazee 2019).

Hemlock Woolly Adelgid and Elongate Hemlock Scale


Hemlock tree infested with hemlock woolly adelgid, photo by DCR

Hemlock woolly adelgid (HWA) was introduced into Massachusetts in 1988 and attacks both Carolina and eastern hemlocks. Closely resembling an aphid, the hemlock woolly adelgid is a tiny insect covered with a woolly mass and looks like small white cotton balls at the base of the needles. It inserts its piercing-sucking mouthpart at the base of hemlock needles and can severely weaken and kill the hemlocks it feeds on. However, the cold, fluctuating winter temperatures we experience in Massachusetts cause significant levels of HWA mortality that reduces the persistent feeding pressure and the number of hemlocks that succumb solely to HWA.

Research reveals that hemlocks infested with both the HWA and the elongate hemlock scale (EHS) exhibit a more dramatic decline in tree health. The EHS is a non-native armored scale insect with piercing-sucking mouthparts and typically feeds on the undersides of hemlock needles. This can cause chlorosis (discoloration), premature needle loss, branch and limb dieback, and, in combination with the HWA, tree mortality.

Two biocontrol species have been released in Massachusetts to aid in decreasing the impact of HWA. *Sasajiscymnus tsugae* and *Laricobius nigrinus* are predatory beetles that feed on HWA. Since the late 1990s, HWA biocontrol beetles have been released in nine Massachusetts counties: Berkshire, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Suffolk, and Worcester. However, there has been limited success in significant population establishment or natural spread. Due to the high winter mortality of HWA in New England and the subsequent dramatic variability in HWA density, it is challenging to maintain the biocontrol populations, but the DCR continues to use biocontrol species as a tool against HWA. DCR releases *L. nigrinus* when conditions are suitable, and beetles are available from the U.S. Forest Service and partner rearing facilities.

Red Pine Scale

Red pine scale is a small invasive insect, originally from Japan, which attacks red pine. The scale uses its piercing-sucking mouthparts to feed on the tree. The most obvious symptom of red pine scale infestation is a slow shift in foliage color from light green to yellow and then to red. At first the color changes are on individual branches in the lower part of the crown, but soon spread to the entire canopy. The scale has two generations per year and prefers to feed beneath bark flakes. Control with insecticides has not been successful and natural enemies are ineffective in reducing the population of red pine scale.

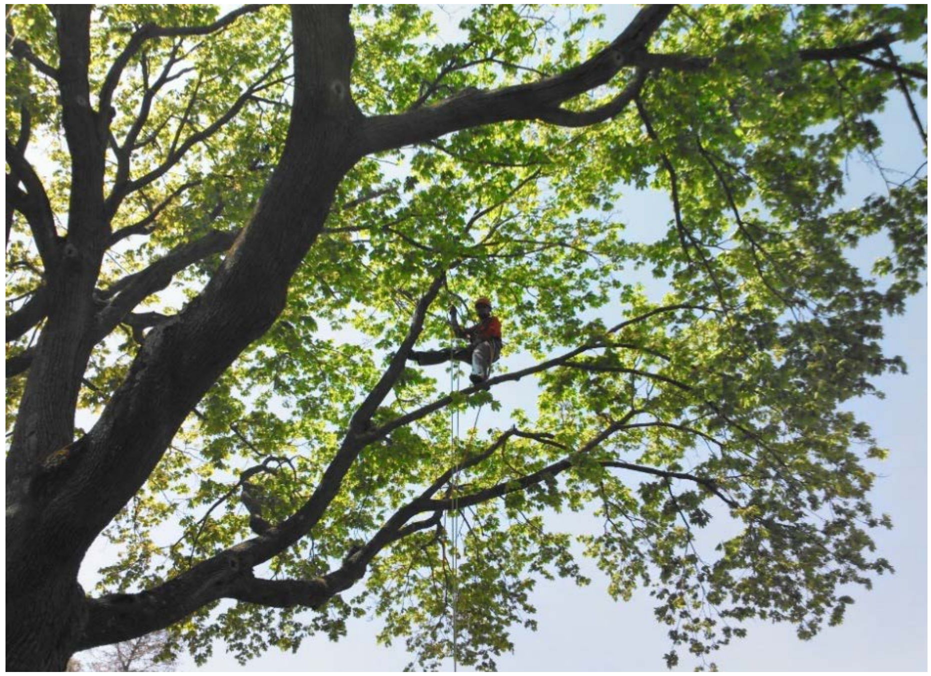
BOX 1.1. THREATS ON THE HORIZON

Oak Wilt is not currently known to be present in Massachusetts, but due to the close vicinity of an outbreak in Glenville, New York, just over the Massachusetts border, it has become a fungus to watch out for. The oak wilt fungus stops the flow of water and nutrients from a tree's roots to the crown, causing the leaves to wilt and fall off and even killing the tree in the midst of summer. Oak wilt can spread from one tree to another through the roots or through the activities of sap and bark beetles. The fungus develops spore mats just under the bark of the tree, which crack open and wound the bark as they grow. Sap and bark beetles are attracted to the sweet smell of the fungal spore mat. Oak wilt symptoms include green leaves suddenly turning brown, starting at the outer edge of the leaf and progressing inward; leaves may fall in the summer while there is still a little green on them. Branch dieback progresses downward from the top of the tree and dying branches exhibit split bark from the expanding spore mats beneath. Currently there is no effective treatment to save infected oaks. Diseased trees need to be removed and properly disposed of to limit the threat of spread.

Spotted Lanternfly (SLF) is also not known to be present in Massachusetts at this time. Though it looks like a moth and is called a 'fly', it is actually a planthopper native to China, India, and Vietnam. It was first detected in Pennsylvania in 2014 and has the potential to greatly impact agricultural crops and reduce the quality of life for farmers and people living in heavily infested areas. This insect has piercing-sucking mouthparts and feeds on the sap of a variety of economically important hosts including grapes, hops, apple and other fruit trees, as well as the invasive tree of heaven. As it feeds, it excretes a sugary liquid known as honeydew which may cover the host plant and drip onto anything beneath – cars, patios, swing sets, etc. – becoming a nuisance. The sugary coating will support the growth of a sooty mold which is harmless to people but serves as a good indicator of an infestation. No population of SLF has been found in Massachusetts, though a single dead adult was discovered on imported nursery stock in February 2019.

Southern Pine Beetle

Southern pine beetle (SPB) is an insect native to the southern and southeastern United States and has been expanding its range up the East Coast. As of 2020, no infested trees have been found in Massachusetts, but traps have been picking up low numbers of beetles in Barnstable, Dukes, Nantucket, and Plymouth counties since 2015. SPB feeds on two and three needled pine trees; in Massachusetts, their primary host tree is pitch pine. Females find a suitable host tree and excavate feeding and nursery galleries in the cambium layer while releasing pheromones to attract other SPB to the same tree. The tree's defense is to exude pine pitch into the holes and tunnels and force the beetles out. A heavily infested tree will appear covered with multiple popcorn-sized pitch clumps on its trunk. Both larvae and adults feed under the bark, and when enough beetles attack the tree, they overcome the pitching defense and the tree soon dies. Current management of SPB focuses on maintaining pitch pine health and vigor by thinning stands.



Tree climber looking for signs of Asian longhorned beetle, photo by Ben Gardner

Monitoring for Pest and Disease

While monitoring and managing current pest populations, forest managers must also be vigilant in guarding against new pest invaders. People play a large role in moving pests from one place to another through transporting firewood and plants or wooden shipping materials. Addressing pest pathways like firewood, nursery stock, and wooden shipping containers is an important step in stopping new introductions. It is also essential to be proactive and prepare for new invasions by working with partners to develop tools to detect, identify, evaluate, and manage any anticipated new pests before they arrive.

One of the most important methods of monitoring for forest pest and disease is outreach and community awareness. Many forest health threats are first noticed and reported by the public. In fact, Asian longhorned beetle was first reported in Worcester by a curious member of the public. The longer a threat goes unreported, the more time the population has to establish and spread. Educating the community on threats to the trees and forest increases the number of eyes looking for the threat and can lead to earlier detection. Outreach empowers the public, informs them what forest threats the Forest Health Program is watching, and gives the public the ability to recognize and report potential threats.

NATURAL DISTURBANCES

Human infrastructure and development have substantially restricted natural disturbance processes that historically provided diverse open habitats for wildlife. In particular, flooding and fire are greatly constrained across the landscape today. While control of flooding and fire is essential to protect human life and property, it also creates an obligation on our part to provide the dynamic habitats for wildlife that were previously created by natural processes.

Wind events can have positive effects on our forestland by creating openings, coarse woody debris, snags, and other features that increase structural diversity of forest habitat which is an important part of the natural succession process. However, some intense disturbances have profound negative impacts on a forest. Climate change is increasing the frequency of intense storms, floods, and droughts.

Flooding

Spring flooding and associated ice-scouring along rivers and major streams historically replenished vibrant open habitats for wildlife, but construction of more than 1,000 dams throughout Massachusetts has dramatically limited this natural process. Similarly, beaver flooding formerly replenished ephemeral open habitats that resulted after flowages were abandoned, dams decayed, and beaver ponds drained. These former beaver impoundments became thriving open habitats for wildlife until forests regrew and they were eventually re-occupied by beavers. While beaver flooding occurs in Massachusetts today, many areas of the state on moderate slopes adjacent to low gradient streams (the type of area beavers prefer) have been developed for urban and residential uses, and beaver activity either no longer occurs or is greatly constrained.

Windstorms

New England is affected by Atlantic hurricanes that form over tropical ocean waters and track north along the coast or east into the Atlantic. Hurricanes generally lose strength before reaching the Northeast, but periodically, strong storms travel northward along the Gulf Stream and pass directly over New England causing substantial changes to the landscape. The most recent category three hurricane (1938) had a lasting effect on forest structure and species composition.

In Massachusetts, tornados occur more frequently than the national average. There were 178 tornados in Massachusetts between 1950 and 2018. Of these, 138 were classified as F1 or above on the Fujita damage scale (F1 = trees blown down) and 13 qualified as F3 or F4 tornados (NOAA 2019). An F4 tornado in Worcester County in 1953 killed 94 people and injured 1,228 (The Tornado Project 2015). On May 29, 1995, an F3-4 tornado caused four deaths and left a continuous damage path 165 to 3,280 feet wide and 30 miles long in Great Barrington in the southwestern corner of Massachusetts. The area sustained severe forest and infrastructure damage (Bosart et al. 2006). Most recently on June 1, 2011 an F3 tornado up to 0.5 miles wide travelled 39 miles from Westfield to Charlton, the second longest on record in Massachusetts. The tornado path included parts of Springfield, the largest city in western Massachusetts. Three people were killed (Thompson Jr. et al. 2011).

Severe windstorms can blow down extensive areas of trees and create new even-aged forests, while more frequent, smaller, and less-severe storms create a patchy pattern of disturbance. Storms result in individual tree gaps, crown damage, broken branches, and leaf stripping. This adds snags and down deadwood, both important habitat features, to the forest environment. Because the most damaging hurricane winds normally come from the southeast, some valleys and leeward hillsides can be protected from damaging winds over long periods of time (Foster and Boose 1992, Boose et al. 2001). Over the long-term, and absent the effects of human land use, windstorms create the uneven-aged, multi-species forest typical of remnant old-growth stands in Massachusetts (D'Amato and Orwig 2008).

Microbursts are intense winds that are often, but not always, associated with thunderstorms. They descend from rainclouds, hit the ground, and fan out horizontally affecting small areas often with substantial impacts. A combination of thunderstorms, microbursts, and tornados caused extensive damage to Massachusetts forests from the Connecticut River Valley to the Central Uplands on July 11, 2006. Damage was especially severe in Wendell State Forest where a combination of a microburst and a tornado uprooted trees as large as 3 feet in diameter (NOAA 2020).

Ice Storms

Ice storms cause periodic, widespread damage to Massachusetts forests. Notable ice storms occurred in 1942, 1958, 1996, and 1997 (Rivers 1998) with the most recent in December of 2008. The 2008 storm damaged countless trees and caused widespread, extended power outages throughout the Central Uplands and the Berkshire Uplands. Forest damage was extensive and severe in both rural and urban areas, with aerial surveys estimating 9,000 acres of damage (DCR Forest Health Program 2010). Ice storms can cause significant crown damage to dominant and codominant forest trees, and even when trees survive and appear to have recovered, they remain vulnerable to pathogens and structurally compromised for many years. Effects of the 2008 ice storm were seen for several years as trees succumbed to stressors introduced or amplified by that singular event.

Wildfires

Fire has played a role in shaping the landscape. To date, over 95% of wildfire occurrence in Massachusetts is human caused, consistent with the national average. During the early 1900s it was not uncommon to see wildfire occurrence total over 10,000 acres in a year and the average size of single wildfire in Massachusetts was a little over 30 acres through the 1960s. Numerous large notable fires occurred during this period. Among them was a 7,000-acre fire in Erving and Wendell in 1927, a 16,000-acre fire in Townsend which burned into New Hampshire in 1927, a 50,000-acre fire on Cape Cod in 1946, and a fire of unknown total size that destroyed the village of Lake Pleasant (130 structures) in Montague in 1907. Weather pattern changes, increased training, and suppression and detection technology improvements have helped decrease the average size of wildfires. Since 2010, the average number wildfires per year is 1,595 with 1,365 acres burned on average (Figure 1.16).

The diversity of forest cover and fuel types in Massachusetts results in varying degrees of fire susceptibility and fire behavior. The dominant hardwood forest type across much of the interior portions of the state influence fire through the associated leaf litter fuel type. This fuel type exhibits low to moderate fire behavior during growing season conditions and periods of average precipitation, however, can present moderate to dangerous fire behavior during periods of drought or during spring dormancy under low humidity, low fire fuel moisture conditions. Drought-induced fire conditions in hardwood leaf litter often burn 12"-24" into the organic duff layer, leading to challenging suppression conditions and overstory mortality.

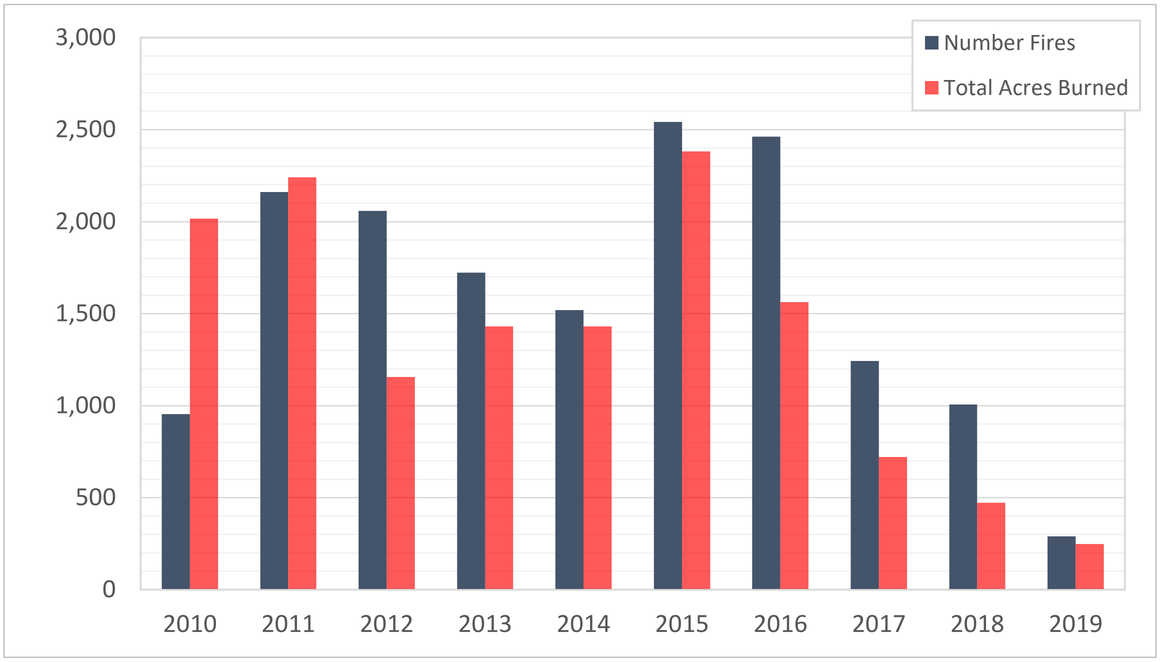


Figure 1.16. Massachusetts wildland fire occurrence, 2010-2019 (data: U.S. Forest Service Fire and Aviation, NASF State Wildfire Reporting Database).

In transition and central hardwood forests dominated by oak species, fire risk is slightly higher although still low compared to many forest types. Oak leaves are thicker and tend to curl leaving spaces in the leaf litter. This allows oxygen to mix with the litter and increases fire risk. Fire risk is greatest in hardwood forest types during the spring, after snowmelt but before leaf-out, and in the autumn after leaf fall because fuel on the forest floor is exposed to wind and sun (Kelty et al. 2008).

Massachusetts has many fire-influenced natural forest communities, including pitch pine-scrub oak, black oak-scarlet oak, hickory-hophornbeam, oak-hickory, and mixed oak forest types. In addition, fire-influenced grassland, shrubland, and wetland communities provide important habitats for biological diversity. Pitch pine-scrub oak is the most fire-adapted forest type in Massachusetts. These forests are found growing on sandy soils primarily on the southeastern coastal plain (Cape Cod and the Islands), but also on patches of outwash soils in the interior of the state. Pitch pine-scrub oak forests are susceptible to fire because: 1) pine needles do not decompose as quickly as hardwood leaves, leading to a build-up of fuel on the forest floor; 2) dead branches persist on the lower trunks of trees creating ladder fuels; and 3) the moisture content of the needles is low and the needles can become so dry that fire can spread through the forest canopy (Kelty et al. 2008).

In Massachusetts, there are few natural forest fires as lightning is almost always accompanied by rain. Fires occur primarily as a result of human activity; thus, the risk of forest fire increases in forest areas that are close to development and open to public use. A working group led by the U.S. Forest Service developed the Northeast Wildfire Risk Assessment model (Figure 1.17) (Northeast Wildfire Risk Assessment Geospatial Work Group 2009). The assessment is comprised of three components: 1) fuels (Scott and Burgan 2005), 2) wildland-urban interface (Radeloff et al. 2005) (Figure 1.18), and 3) topography (slope and aspect). These three characteristics are combined to identify wildfire prone areas

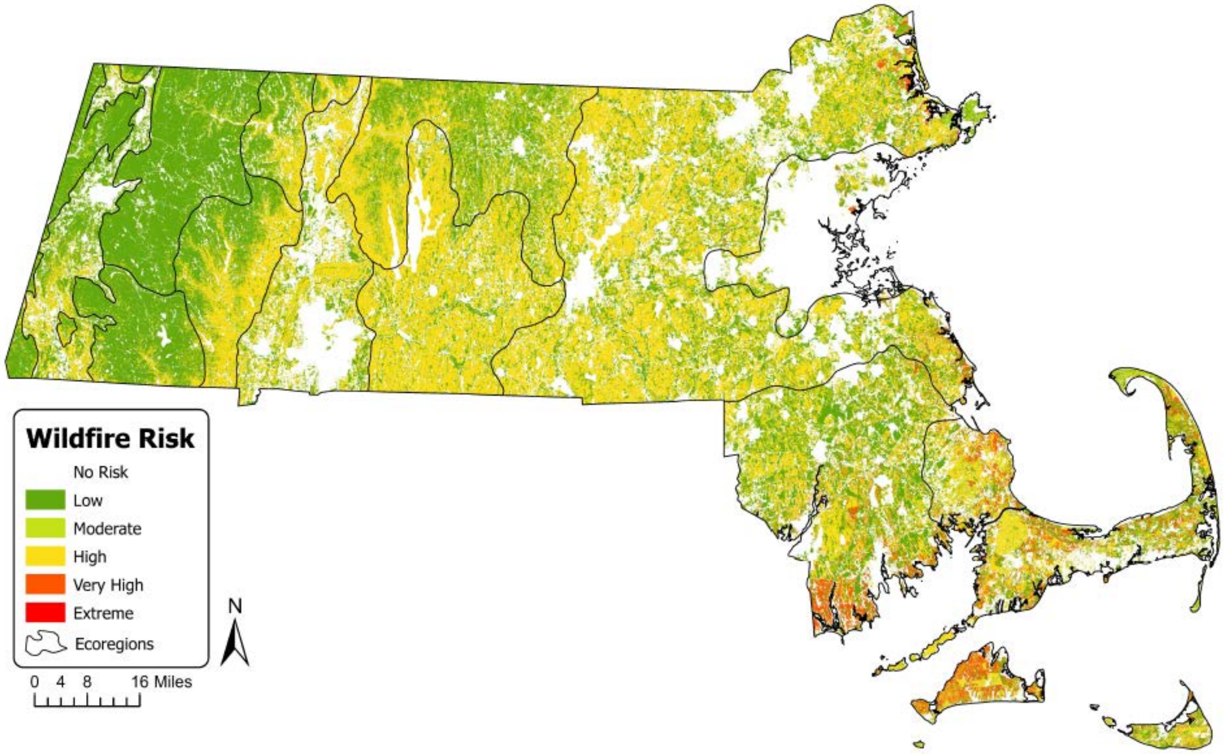


Figure 1.17. Wildfire risk in Massachusetts (data: Northeast Wildfire Risk Assessment Geospatial Working Group 2009).

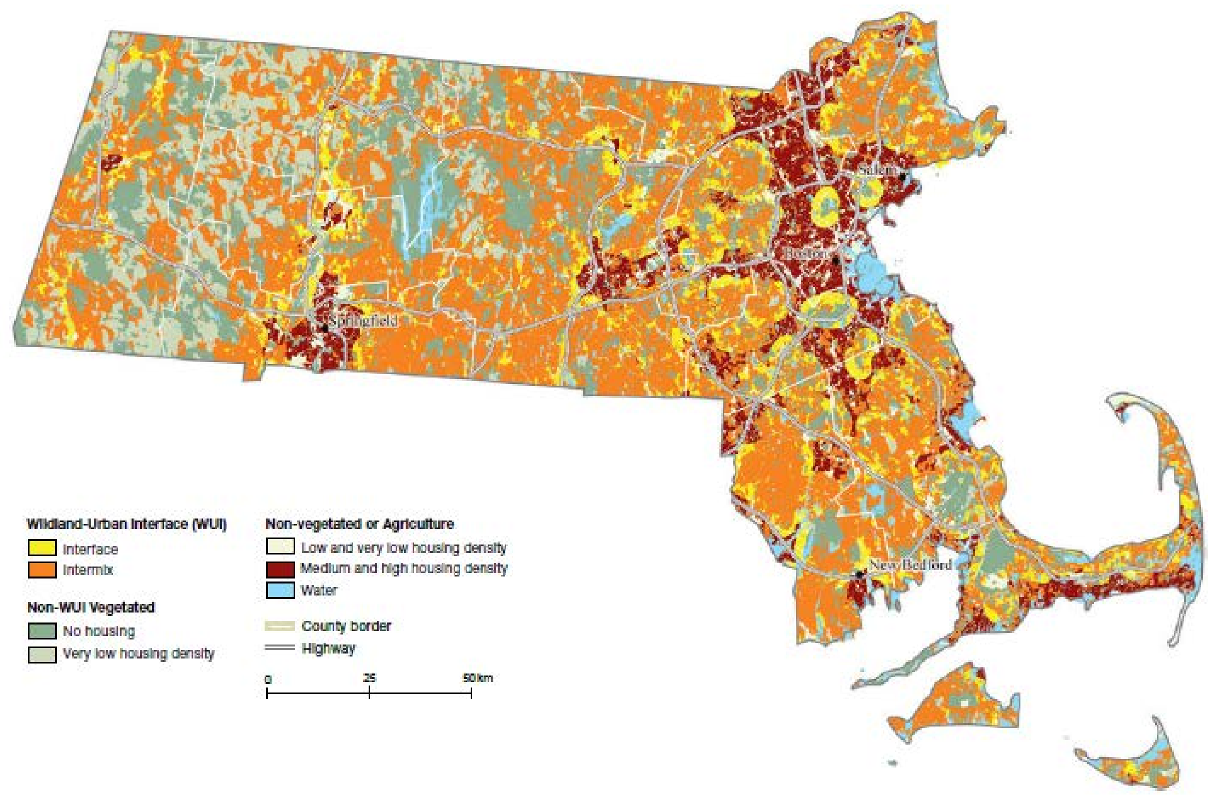


Figure 1.18. Wildland-urban interface 2010 (Martinuzzi et al. 2015). "The wildland-urban interface is the area where houses meet or intermingle with undeveloped wildland vegetation (Radeloff et al. 2005)."

where hazard mitigation practices would be most effective. The Wildfire Risk Assessment also identifies and prioritizes communities most at risk from wildfire. This allows state agencies to focus resources in areas of greatest need. High and very high-risk areas have fire prone forest types (pitch pine-scrub oak and oak) and significant forest-human interaction.

The state forests in southeastern Massachusetts (Myles Standish, Manuel Correllus, Nantucket, and Freetown-Fall River) are at particularly high risk of fire. The fire adapted pitch pine-scrub oak forests are well used and surrounded by populated areas. In May 1957, a fire in Myles Standish State Forest burned approximately 15,000 acres, stopping only when it reached the shores of Cape Cod Bay. The fire, known as the crown fire, was reported to have burned at a rate of 18 acres per minute with flame lengths exceeding 150 feet. The last major fire in Myles Standish State Forest occurred in 1964, burning 5,500 acres and destroying 26 structures (Mass Moments n.d.).

FOREST MANAGEMENT FOR ECOSYSTEM HEALTH AND BIODIVERSITY

Rare species, which are formally protected by the Massachusetts Endangered Species Act (MESA, MGL c.131A; 321 CMR 10), are an essential component to the Commonwealth's biodiversity, and several measures are in place to ensure their protection during forest management activities. Most importantly, all forest cutting plans filed in accordance with the Forest Cutting Practices Act and its ensuing regulations (MGL c.132, §§ 44 to 46; 302 CMR 16.00) are reviewed for overlap between the proposed project area and maps of Priority Habitat and Estimated Habitat for rare species, as published by MassWildlife NHESP. Projects that overlap with these habitat maps are then sent for further review by a NHESP review biologist, which may include a site visit in conjunction with the DCR Service Forestry Program to review conditions on the ground. Following review, the NHESP biologist issues a letter of determination that identifies potential threats or impacts to rare species, if any, and details any measures or modifications to the plan that are required to prevent such impacts. For the 10-year period from 2010 through 2019, NHESP reviewed 1,085 forest cutting plans, which is about 20% (ranging from 16-30% annually) of all forest cutting plans submitted to the DCR Service Forestry Program during that time. Of the plans reviewed by NHESP, 481 (44%) required additional conditions or changes to the cutting plan to prevent "take" of a rare species (Figure 1.19).

NHESP, in conjunction with DCR and other partners, has also developed a series of Forest Conservation Management Practices (CMPs) specific to a subset of rare species that occur more frequently in areas where forest management activities are planned. CMPs are specific, science-based guidelines for conservation of rare species during forest harvesting that help landowners and foresters plan more effectively for forest management activities in habitats of state-listed rare species. Following CMPs makes the outcomes of NHESP reviews more predictable and, when they are incorporated into Forest Cutting Plans prior to submission, expedites the review process. Five CMP documents have been published by NHESP. They address the following seven state-listed species: mole salamanders (including blue-spotted salamander, Jefferson salamander, and marbled salamander), Blanding's turtle, eastern box turtle, wood turtle, and common loon (NHESP 2019).

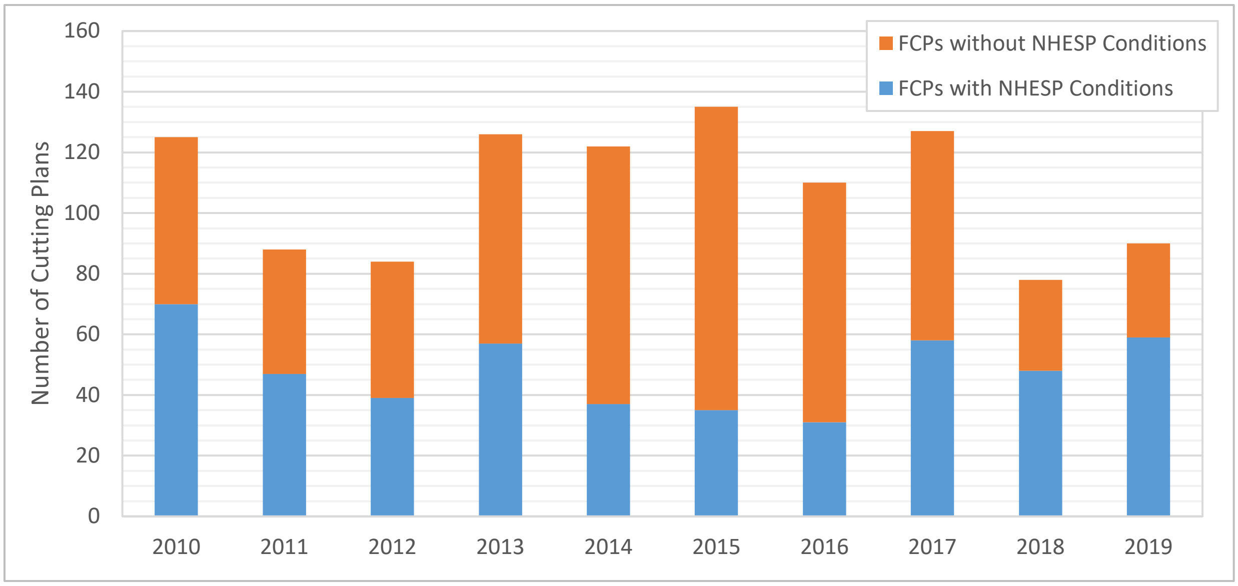


Figure 1.19. Summary of Forest Cutting Plans reviewed by the Department of Fish and Game, Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program from calendar year 2010 through 2019 (data: NHESP).

Private Forestland

Since private landowners are responsible for approximately 68% of the forestland in Massachusetts, biodiversity outcomes of management on private lands are important to the Commonwealth, whether implicitly or explicitly the aim of the management activity. The Forest Stewardship Program emphasizes natural resource values, including biodiversity of plant communities and faunal associations, in tandem with other assets and objectives for a property. DCR Service Foresters and consulting foresters provide landowners with technical advice to help landowners achieve their objectives for their land, while respecting or enhancing other natural resource values that support biodiversity in both the local and state-wide landscape.

A special case of forest management on private forestland with the main objective of promoting biodiversity is DCR's Foresters for the Birds Program (FFTB), run in partnership with Mass Audubon and modeled after the program pioneered by Audubon Vermont. In FFTB, forest landowners may elect to have a "bird-certified" consulting forester, who, in coordination with a Mass Audubon biologist, prepares a Bird Habitat Assessment for their property. The assessment contains the elements of a traditional Forest Stewardship Plan, but with emphasis on habitat elements for forest-breeding birds, and, in particular, a subset of Priority Birds that are either rare or declining in Massachusetts due to habitat loss and degradation. Management activities may then be planned to explicitly create habitats on the property that may be lacking in the landscape or to improve the quality of existing habitat to enhance breeding bird success.

A variety of cost-share programs are also in place with the aim of creating and maintaining wildlife habitat that supports rare and declining species. The most prevalent of these is the USDA Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP), which offers a


Pittsfield State Forest, photo by Kevin Hatcher

diverse array of cost-shared practices to effect habitat creation within degraded forested stands that lack commercial viability. Creating young forest habitat, which is scarce in southern New England and which supports the declining New England Cottontail as well as a suite of rare and declining migratory songbirds, has been a particular success of the EQIP funding. Additionally, since 2015, MassWildlife has offered the MassWildlife Habitat Management Grant Program (MHMPG) providing funding for projects that directly support the priorities outlined in the 2015 SWAP. Likewise, the DCR Service Forestry Program, through the Working Forest Initiative, offers a competitive matching grant program in support of municipal projects that are detailed in a community's Forest Management Plan, the majority of which have been centered on wildlife habitat creation, including restoration of rare habitats and invasive species control.

State Owned Forestland

Three state divisions own the majority of state forestland: the DCR Division of State Parks and Recreation, the DCR Division of Water Supply Protection, and MassWildlife.

DCR Division of State Parks and Recreation (DSPR)

The DCR adopted a land use designation system for their lands, based on primary land use characteristics and suitability. The landscape designation process, which stemmed from the Forest Futures Visioning Process, is described in Chapter Five. Through this process, all DSPR lands are designated as either reserves, parklands, or woodlands. The process focused on the premise that DCR lands should be managed for the provision of ecosystem services such as carbon sequestration, soil, air, and water quality, biological and ecosystem diversity, nutrient cycling, culture, history, spiritual values, public recreation, and renewable wood products. Each designation has its own set of ecosystem services and management priorities.

- **Reserves** – The dominant ecosystem service objectives of land designated as a Reserve are biodiversity maintenance, nutrient cycling and soil formation, and long-term carbon sequestration. Forest management generally consists of letting natural processes take their course, although under specific circumstances, more active management might be permitted under guidance of the Forest Reserve Science Advisory Committee.

- **Parklands –** Lands designated as Parklands are unique natural and cultural resource areas focusing on the provision of recreation. Management approaches range from areas where natural processes dominate to highly modified environments where use is intensively managed. Some vegetation management to support and ensure recreational use, public safety, or ecological integrity, may take place.
- **Woodlands –** Woodlands provide a range of ecosystem services, including production of high-quality, local, renewable wood products, protection of water quality, carbon sequestration, and both mature forest structures, and in focused areas, young forest stages to promote habitat diversity. Forest management plays a role in the ecological restoration of areas that have been significantly altered by past management practices, such as plantations of non-native species and high-grade harvests.

The *Landscape Designations for DCR Parks and Forests: Selection Criteria and Management Guidelines* provide a clear, scientifically based foundation for appropriate management practices on state land. Commercial timber harvesting will only occur in designated woodlands. It is important that policies and practices represent the most current and appropriate silviculture goals and objectives, as well as an active public dialogue. To achieve this, the guidelines are periodically reviewed with the next review scheduled to take place in 2022.

DCR DIVISION OF WATER SUPPLY PROTECTION (DWSP)

The primary goal of the DWSP is to provide high quality drinking water to over three million residents of Massachusetts. Protecting the source of this water – the Quabbin, Ware River, and Wachusett Reservoir watersheds – is accomplished through a variety of approaches. DWSP owns and manages large percentages of watershed lands; it continues to acquire land and deeded conservation restrictions on private land; and DWSP staff monitor and regulate potentially harmful activities throughout these watersheds.

DWSP incorporates principles from current scientific knowledge of watershed and natural resource management to develop policies, goals, and methods for managing its lands. Through its forest management activities, the agency works to develop and maintain a vigorously growing forest cover, diverse in species and age, with deliberately patterned vertical and horizontal structure intended to distribute risk and minimize impact from a variety of potential threats. Recognizing that water quality is of primary importance, DWSP implements a suite of measures to protect and monitor surface waters when planning and conducting forestry activities.

The benefits that follow from this management approach include the production of sustainably harvested wood products, carbon sequestration and long-term carbon storage, enhanced biodiversity, and maintenance of watershed forest resilience in the face of threats from agents such as insects, disease, large-scale wind events, and fire, as well as the predicted amplification of these threats due to climate change. Additionally, the forest and non-forest cover that has been developed and maintained through DWSP management provides habitat for a wide range of common and uncommon plant and wildlife species that collectively require a diversity of conditions, including grasslands, oak-pitch pine barrens, shrublands, wetlands, young forests, and interior unmanaged forest.

DFG DIVISION OF FISHERIES AND WILDLIFE (MASSWILDLIFE)

MassWildlife works to conserve a variety of wildlife and plants including rare and declining wildlife species identified in the *Massachusetts State Wildlife Action Plan*, as well as game animals and more common species. MassWildlife uses active management to provide a range of grassland, shrubland, and forested habitats to help support both common and declining species. Forestry practices, along with mowing, prescribed burning, and invasive plant control are used to manage sites.

One of the primary management strategies for protection of biodiversity is the protection of large blocks of forestland and smaller rare habitats. Public and private land protection programs and the establishment of Forest Reserves are a key part of this management strategy.

Prescribed Fire

Fire occurrence on portions of the landscape has long been a factor in certain ecosystems within Massachusetts (e.g., pitch pine and scrub oak barrens). Accordingly, fire is an important ecological process for sustaining biodiversity. Over time, human landscape influences have disrupted the natural process of fire on these systems. Prescribed fire has become an essential tool for effective conservation on portions of the landscape, providing the ability to maintain habitats and biodiversity in fire dependent natural communities as well as reduce the risk of increased fuel loads where fire has been absent over long periods of time.

Our understanding of the value and need for prescribed fire has increased dramatically over the past several decades. Because of this, land managers, conservationists, and government officials are increasingly turning to prescribed fire for wildlife habitat management and landscape restoration and maintenance. Fire is a necessary ecological process in certain natural communities and habitat types, and prescribed fire is a critical tool for restoring and sustaining the Commonwealth's diversity of animals, plants, and natural communities.

Additionally, Massachusetts has the potential for large and damaging wildland fires. Thoughtful use of prescribed fire to reduce fuels can decrease threats to life and property posed by wildfire. Using prescribed fire as a land management tool can reduce the number of firebrands as well as the range that the fire can throw embers (which can damage property and put other values at risk) by taking away heavy fuels available for wildland fire. It can also change the structure of the forest by reducing ladder fuels and by thermally thinning stands which will reduce the chances of crown fire. Creating areas of reduced fuels in our forests also give firefighters safer areas from which to suppress fires.

Beginning in the 1980s, UMass Amherst, along with partners from The Nature Conservancy, MassWildlife, the National Park Service, and the DCR began developing prescribed burn programs in areas where pitch pine-scrub oak forests are prevalent. Since that time, prescribed burning as a management tool has been increasing in Massachusetts on federal, state, municipal, and private non-profit lands.

To achieve prescribed fire program goals, the DCR relies on assistance from cooperating partners to facilitate prescribed burning on agency lands. Periodically, staff from MassWildlife, the U.S. Fish and Wildlife Service, the U.S. Forest Service, and the National Park Service participate in prescribed burns on DCR land. Reciprocally, DCR Forest Fire Control staff may participate in prescribed burns on lands not managed or owned by the DCR, including on land owned by federal, other state or municipal governments, and private land (e.g., land trusts). This assistance is referred to as “cooperative burning.”

Sharing prescribed burn equipment and staff through cooperative burning provides mutual benefits to partnering organizations. It is particularly important for more complex burns where large, multi-agency crews are the norm and where most organizations would otherwise lack the capacity to carry out such burns. In 2019, prescribed burns were completed on 2,185.56 acres in Massachusetts (Figure 1.20). From 2010 to 2019, DSPR conducted over 1,500 acres of prescribed burns in southeastern Massachusetts.

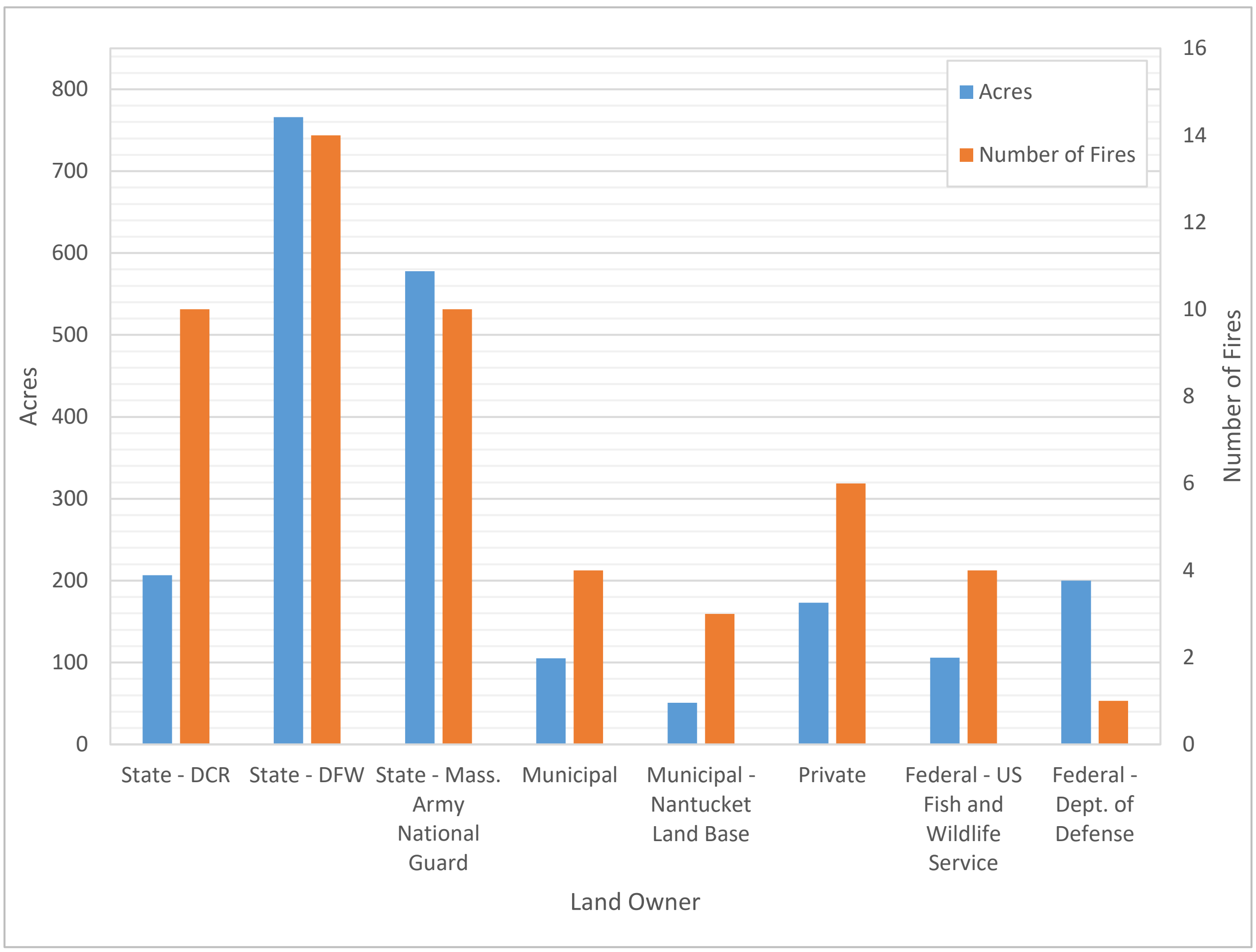


Figure 1.20. Acres burned by prescribed fire and total number of prescribed fires in Massachusetts in 2019, by ownership.

MONITORING FOREST ECOSYSTEMS

Continuous Forest Inventory

The Continuous Forest Inventory (CFI) on state lands in Massachusetts identifies state-wide patterns in our forests and is one of the oldest CFI systems in the nation. The first CFI plots were established in the state forests in 1959 by the Massachusetts Department of Natural Resources. New plots have been

established over the last 50 years as the state has purchased land. There are now nearly 1,900 plots on State Forests, Parks, and Reservations throughout the state. The DWSP initiated a similar CFI at Quabbin in 1960, which now includes nearly 500 plots on water supply lands in the Quabbin and Ware River watersheds.

The CFI plots are 0.2-acre circular, permanent plots laid out on a 0.5-mile square grid. Sampling at each plot consists of site descriptors (canopy disturbance, stand age and structure, topography) and measurements of overstory trees five inches diameter at breast height (DBH) and greater. Recorded measurements on overstory trees include DBH, species, pulpwood stem height, merchantable sawtimber stem height, and stem quality. New trees are added to the plot as they reach the minimum DBH of five inches.

The purpose of CFI sampling has evolved over time. Early sampling was focused on timber management and measurements were primarily to assess timber resource stocks. In 2000, additional ecological goals were added to CFI. New provisions for tree regeneration assessment and attributes to determine the extent of understory shrub and ground cover interference with the growth of tree seedlings and saplings were added. In 2010, coarse woody debris transects and an extensive grass, forb, and shrub species list were incorporated. In 2013, CFI plot measurement shifted to a 10% annual measurement and in 2018 many improvements in the standards for data collection were added to the protocol (Hill and VanDoren 2018). Potential research topics using CFI data include forest succession and carbon cycle dynamics.

The U.S. Forest Service also has continuous research plots in Massachusetts through its Forest Inventory and Analysis Program, however there are many more CFI plots than FIA plots (596) in Massachusetts. CFI sampling provides data with a relatively high level of statistical reliability for forest planning and determining sustainable harvest levels.

Aerial Survey

Every year the DCR Forest Health Program performs a state-wide aerial survey of forest disturbance to provide state foresters a broad view of the major insects and diseases impacting Massachusetts forests. This is the Forest Health Program’s largest annual survey and is done by flying over the entire state in a fixed-wing aircraft and mapping any disturbances that are seen, such as hardwood defoliation or conifer discoloration. Those disturbances are then visited on the ground by forest health staff to determine the cause of the damage. The results are reported to the other DCR forestry programs and to the public.

Monitoring the Effect of Tree Planting on Air Temperature


Fall colors at Savoy Mountain State Forest, photo by Peg Rennow

The DCR Urban and Community Forestry Program, in partnership with the UMass Amherst and Clark University, is monitoring the effects of the Greening the Gateway Cities program tree planting program (see Chapter Five for more information) on ambient air temperature in Chelsea, Fall River, and Holyoke. DCR Urban Foresters place and maintain temperature sensors in these cities and submit the data to university partners for analysis. Trees and vegetation are known to reduce air temperatures, thus reducing the "urban heat island" effect with subsequent effects on energy use, air quality, stormwater, and quality of life. This monitoring will quantify the effect of tree planting on air temperatures in these cities over time.

Other Monitoring Methods

Along with aerial survey, the DCR Forest Health Program uses various traps and visual surveys to detect different types of forest health threats. The type of trap or visual survey depends on the pest and their host trees. GIS analysis of such variables as previous infestation extent, known estimated adjacent host locations, and potential rates of spread is utilized to determine where the traps will be placed.

The DCR Service Forestry Program's Foresters for the Birds Program, offered in partnership with Mass Audubon, is conducting a two-year monitoring project of forest management activities on private forestland. Through an approved Bird Habitat Forest Management Plan, property owners have implemented bird-friendly practices and created habitat for rare or declining bird species. To document the effectiveness of these practices, biologists with Mass Audubon monitor bird habitat projects including both a survey of breeding birds utilizing the habitat and a survey of vegetation attributes of the habitat as they have changed since management began. This monitoring can be used to fine tune recommended practices, inform subsequent management or maintenance of habitats, and demonstrate the effectiveness of forest management as a habitat management tool.

There are a variety of efforts underway on DWSP lands to document the effectiveness of natural resources management in protecting the water supply, meeting management plan objectives for forest, wildlife, and biological diversity, and advancing the applied science of watershed forest management. In addition to long-term CFI, foresters routinely survey tree regeneration before and after harvesting activities to assess stem density and diversity as well as invasive plant and browse issues. With deer and moose impacts being of such high concern, DWSP wildlife biologists have estimated populations and impacts using a variety of techniques over the years, including browse surveys, pellet counts, fenced exclosure studies, and hunter surveys. Biologists also survey small mammals, reptiles, amphibians, breeding birds, and bats on several long-term permanent sample plots, to track population changes and responses to forest management. DWSP also monitors known rare plant populations and rare communities on water supply lands in consultation with NHESP and locates and verifies the functioning of all vernal pools that may be impacted by proposed forest management activities. Lastly, DWSP has initiated a long-term research effort to directly monitor the water quality and quantity effects of both natural and deliberate disturbances on both Quabbin and Wachusett watersheds.

The National Ecological Observation Network (NEON) continuously collects long-term observations of forest health, water quality, and air quality parameters at locations on the Quabbin Reservoir watershed and at Harvard Forest in Petersham.

CHALLENGES AND THREATS

Loss of Native Plant Species and the Spread of Invasive Species

It is estimated that one third of the 2,263 plant species in Massachusetts are non-native or naturalized (established newcomers introduced directly or indirectly by humans). Of those 2,263 known plant species, 69 have been identified by the Massachusetts Invasive Plant Advisory Group as current or potentially invasive (Mass.gov 2019c). Increases in non-native species have been accompanied by declines in native plant populations in many areas (Somers 2005).

A 2009 study in Concord, Massachusetts (Primack et al. 2009) surveyed plant species over a five-year period and compared the results of this survey to five historic plant surveys conducted by botanists, including Henry David Thoreau, over the last 170 years. They demonstrated that native plant species are declining, and rare native species are being lost; orchid species, for example, have shown severe losses and declines. Most of these losses occurred after 1970. At the same time, the percentage and, in some cases, abundance of non-native species in the Concord study sites increased from 20% between 1823 and 1837 to 39% in 2007. Dr. Robert Bertin of the College of the Holy Cross in Worcester has reported a 17% loss in the native flora of Worcester. “The non-native species are mainly agricultural weeds, plants of disturbed habitats, and escaped garden ornamentals.” Invasive non-native species present since 1974 include garlic mustard, black swallowwort, glossy buckthorn, and Morrow’s honeysuckle (Somers 2005).

Invasive species are also a concern for urban areas where many invasive plants thrive under conditions that native species cannot tolerate. Vines like oriental bittersweet and hardy kiwi strangle trees. Some invasive plants alter soil chemistry, preventing other plants from growing. In many parts of Massachusetts, the exotic invasive Norway maple dominates; on the Cape, the exotic invasive, sycamore maple has seeded into many areas. Non-native, invasive species like tree of heaven, glossy buckthorn, and common buckthorn can often be found in forest patches in urban and suburban areas. These species either spread from areas where they were originally planted or, as in the case with buckthorn, where birds spread seeds.

Over-Browsing

Browsing from ungulates, white-tailed deer and moose, continues to pose a threat to forests of Massachusetts. When deer densities rise above 20 deer per square mile, the density and diversity of trees and shrubs declines notably (cited in Faison et al. 2016). As moose have recolonized Massachusetts in the last few decades, researchers have examined the impacts browsing by moose has on forests, as well as the combined effects of moose and deer browsing. Browsing refers to "eating woody and non-woody dicotyledonous plants" (trees, shrubs, and forbs), while grazing refers to feeding on grasses (Janis 2008). While both moose and deer are herbivores, they are not functionally redundant; moose are much larger than deer and are 90% browsers, while white-tailed deer are 60% browsers and 40% grazers (Faison et al. 2016).

Faison et al. (2016) found that low densities of deer and moose in sites in Massachusetts had a large effect on forest composition and structure in disturbed patches. Moose alone did not have a greater impact on species richness than deer. In Massachusetts, deer densities vary regionally. In the northwestern part of the state, densities range from 10 to 15 per square mile. In the east, densities surpass 80 deer per square mile (Mass.gov 2019b). Ungulate over-browsing affects regeneration and recruitment of desirable tree species and will impact future timber resource availability. Red maple and oak species are preferred food for white-tailed deer and are also among the top five harvested species by volume in Massachusetts. Heavy browsing impacts will also affect birds and other wildlife that rely on native plant diversity and a robust understory for food and cover.

Forest Conversion and Fragmentation

Mass Audubon has documented the threat to biodiversity from habitat loss and fragmentation, primarily due to development and suburban sprawl, in their series of reports entitled Losing Ground. During the latter half of the 20^{th} century, the ratio of developed to undeveloped land in Massachusetts rose steadily. Between 1972 and 1996, the amount of developed land increased by 59% while the population increase was only 6% (Steel 1999). Most recent numbers show that 27% of land is permanently protected, while 21% is developed, leaving 52% of our lands vulnerable to development and conversion (Ricci et al. 2020).

Development has been concentrated in specific areas (Figure 1.21), some of which are particularly noted for their biodiversity and rare species habitat. These include southeastern portions of the state, and the

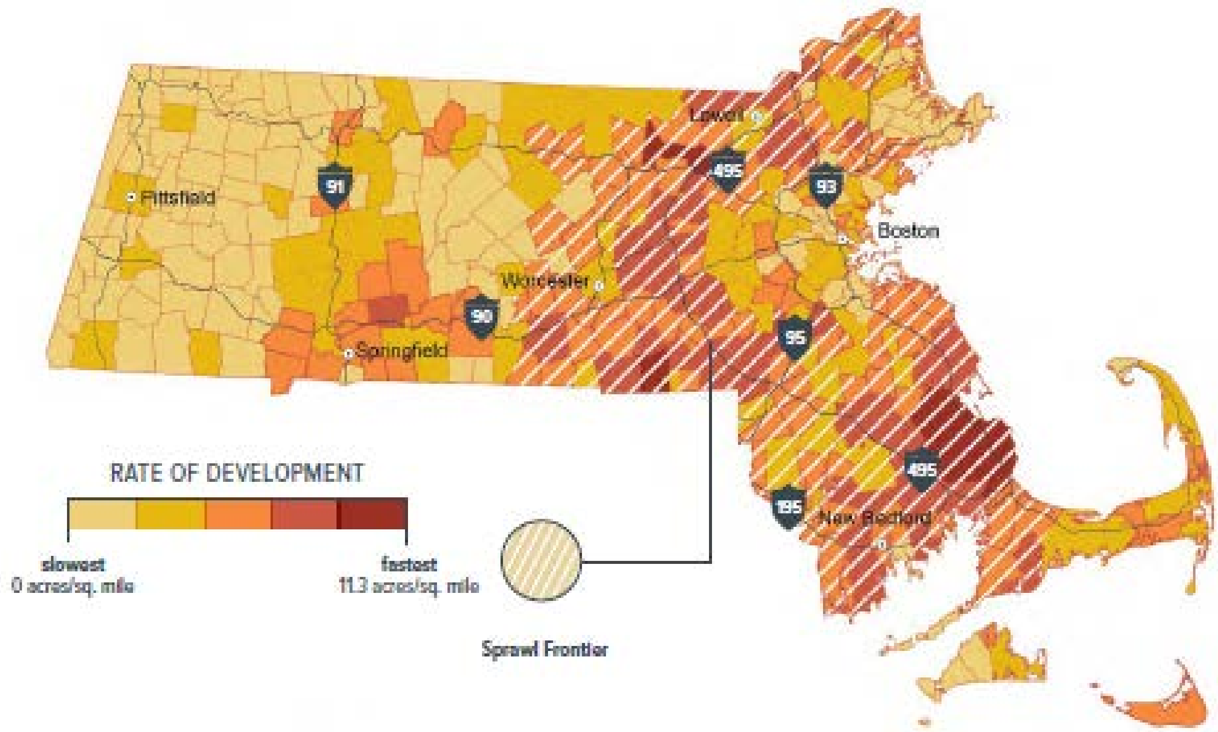


Figure 1.21. Recent land development trends (Ricci et al. 2020).

southern Connecticut River Valley. Areas north and south of Boston and west from Boston to the Worcester metropolitan area have also had higher rates of land conversion than other areas of the state.

The most recent Losing Ground report (Ricci et al. 2020) showed that development rates have decreased from the numbers seen in the late 1980s and 90s (Table 1.7). Between 2012 and 2017, 13.5 acres a day, totaling 24,700 acres, were lost to development, down from an average of 40 acres a day during the period between 1985 and 1999. Approximately one-quarter of all development during this period was a new form of development – large scale ground mounted solar arrays. During that time, conservation agencies and organizations protected 100,000 acres of land (55 acres/day); more than four times the area of the land that was developed between 2012 and 2017 and a 37% increase in the land protection rate. Nonetheless, more than half of BioMap2 core habitat remains unprotected. Mass Audubon recommends conservation efforts be focused on the Green Infrastructure Network (GIN) which totals about 2.9 million acres and includes BioMap2 Core Habitat and Critical Natural Landscape, TNC Resilient

Year	Pace of Development
1985 – 1999	40 acres per day
1999 – 2005	20 acres per day
2005 – 2013	13 acres per day
2012 – 2017	13.5 acres per day

Table 1.7. Acres developed in Massachusetts (data: Ricci et al. 2020).

Land, riparian buffers, and areas vulnerable to sea level rise. During the 2012-2017 period, 9,300 acres of the GIN were developed and 82,000 were permanently conserved. Mass Audubon recommends conserving 50% of the land in Massachusetts by 2050. To do this the recent land conservation rate must be doubled from around 50 acres a day to 100 acres per day.

While conversion has an immediate effect of removing habitat and disrupting ecological processes, the effects of forest fragmentation are often less visible. Forest fragmentation occurs when road construction, utility corridors, or housing development separate large forest blocks. The remaining habitat in these disconnected forests experiences loss of biodiversity, declines in forest health, and increases in invasive species. When fragmentation becomes extensive and forests become isolated islands, plants and animals are unable to migrate and reproduce leading to population decline. Additionally, the adjacent land use determines the environment within the forest, changing the temperature, moisture, light, and wind conditions and therefore forest growing conditions (Snyder 2014).

Areas of interior forest are an indication of the extent of forest fragmentation in the state. The interior forest map (Figure 1.22) shows forests (forest and forested wetland land use categories) that are 100 to 1,000 meters (328 – 3,280 feet) from a road, based on road type, and 300 meters (985 feet) from developed and open land uses. There is very little interior forest left east of the Central Uplands region. In western Massachusetts, the largest interior forest tracts are found in the Berkshire Uplands and Taconic Mountains.

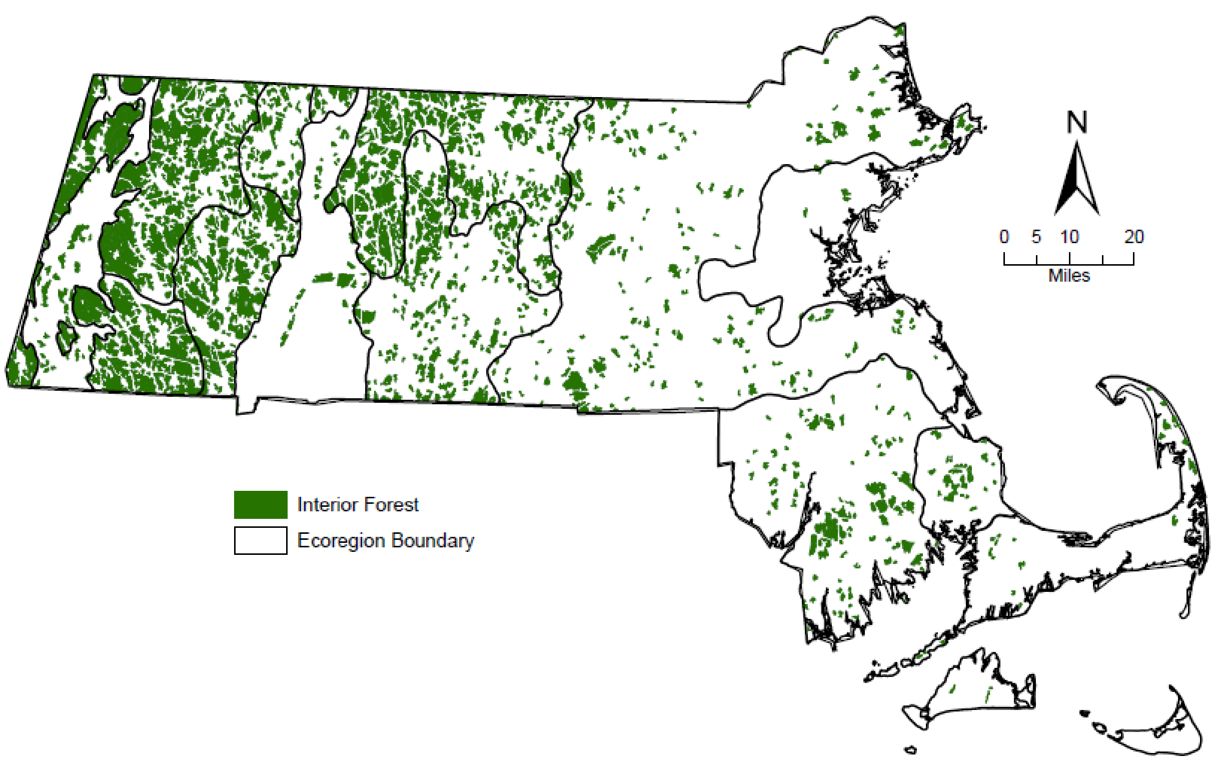


Figure 1.22. Massachusetts Interior Forest. Interior forest is 328-3,280 feet from a road, based on road type and 985 feet from developed and open land uses (data: MassGIS).

Land use conversion and development reduces the ecological integrity of the affected areas. The adverse impacts of development are seen not just in the immediate footprint (the direct impact) but in surrounding areas as well (indirect impacts). Ecological integrity as measured by the IEI falls to zero for cells that have been converted from a forested or other natural land use to a home or commercial industrial area. In addition, the IEI for surrounding areas is reduced as result of their proximity to new development as fragmentation and other impacts of development increase.

Climate Change

Climate change will play a key role in forest ecosystem health and vitality. Massachusetts forests will see an increase in temperatures in all seasons, an increase in precipitation in winter, and an increase in frequency of intense precipitation events during the spring. Winters will continue to become shorter and soils will be frozen for a shorter time while a larger portion of winter precipitation will fall as rain rather than snow (Janowiak et al. 2018).

The impacts that climate change will have on the forests will vary depending on the type of forest. One of those impacts is a shift in forest dynamics. Massachusetts forest species that are at the southern end of their range will start to decline as temperatures increase while forest species that are in the northern end of their range may increase in numbers. Forests and trees will also experience increasing damage from more frequent and severe storm events. Damage from forest pests and pathogens will also likely increase as a longer warm season will allow populations to grow to outbreak densities. Trees that have survived increasing temperatures, storm events, or outbreaks of diseases and insects will be stressed, leaving them more susceptible to secondary attack from pests or diseases that are native and not normally a forest health issue.

STRATEGIES

The strategies below focus on Forest Ecosystem Health and Biodiversity but may apply to other Chapters. The complete list of goals and strategies can be found in the Strategy Matrix on page 15.

GOAL 1: **INCREASE RESISTANCE AND RESILIENCE OF TREES AND FORESTS TO MITIGATE AND ADAPT TO THE EFFECTS OF CLIMATE CHANGE**

Strategy 1: Encourage forest management that promotes resiliency in future climatic scenarios

Strategy 2: Research feasibility of augmenting forests via assisted migration

Strategy 6: Increase community participation in fire adapted community programs in high-risk areas

Strategy 7: Encourage preparation for severe storms and the recovery of damaged or deteriorated landscapes – Massachusetts State Hazard Mitigation and Climate Adaptation Plan

GOAL 2: MANAGE FOREST ECOSYSTEM HEALTH AND BIODIVERSITY

Strategy 9: Monitor forest cover and health conditions using aerial and ground survey methods

Strategy 10: Implement programs to mitigate forest threats

Strategy 14: Work with partners such as Mass Audubon, Massachusetts Forest Alliance, New England Forestry Foundation, Natural Resources Conservation Service, and The Nature Conservancy to encourage landowners to implement forest management practices

Strategy 15: Collaborate with UMass, USDA, USFS and other institutions in the management of forest pests and disease and research related to management

Strategy 16: Conduct ecological restoration of degraded land through various methods including timber harvesting, invasive species management and prescribed fire

Strategy 17: Maintain, enhance, and expand forestry programs that support specific wildlife habitat and biodiversity goals

Strategy 18: Protect rare species habitats within the context of a resilient landscape

Strategy 19: Maintain a strong fire tower detection program, providing suppression ground resources and facilitating helicopter operations, providing sound fire weather and fuels intelligence data, and assisting fire officers with wildfire management tactics

GOAL 4: MAINTAIN AND INCREASE URBAN TREE CANOPY COVER

Strategy 28: Encourage municipalities to adopt ordinances that protect urban tree canopy

Strategy 29: Enhance monitoring of tree canopy levels in the state

Strategy 31: Encourage the use of emerging technology and practices to plant and monitor trees in urban areas, such as i-Tree, i-Naturalist, and storm water tree pits

GOAL 6: INCREASE LAND BASE OF CONSERVED FORESTS (KEEP FORESTS AS FORESTS)

Strategy 40: Protect private forest from development using diverse mechanisms, including state acquisition of lands, permanent protection by conservation restriction, temporary restrictions such as conservation covenants or easements, and municipal policies like Natural Resource Zoning

Strategy 41: Provide innovative programs such as estate planning, current use tax programs, buy local, Forest Stewardship, and neighbor-to-neighbor networks which provide landowners options, tools, and guidance for conservation

Strategy 42: Engage with Regional Conservation Partnerships

Strategy 43: Propose landscape-scale projects composed of multiple tracts of lands needing protection utilizing programs such as the Forest Legacy Program and EEA's Landscape Partnership, Conservation Partnership, Conservation Land Tax Credit, and LAND grants, and Natural Resources Conservation Service's Regional Conservation Partnership Program

Strategy 44: Support the Mohawk Trail Woodlands Partnership and forest conservation in Northern Berkshire and Western Franklin counties

Strategy 45: Support conservation commissions and non-profit land conservation groups in their work to conserve trees and forestland

GOAL 9: SUPPORT THE ROLE AND USE OF PRESCRIBED FIRE IN THE LANDSCAPE

Strategy 62: Support municipal fire agencies across the state with quality assistance in the form of detection, suppression, prevention, intelligence sharing, and grants

Strategy 63: Work with federal and state agencies, tribal entities, and partners to promote training programs and qualification opportunities for wildland fire resources in Massachusetts

Strategy 64: Promote public understanding of the benefits of prescribed fire relative to conservation and risk mitigation

Strategy 65: Provide a strong prescribed fire program that supports both hazard fuels mitigation, while at the same time providing a tool for ecosystem restoration in fire dependent ecosystems

Strategy 66: Utilize and support the use of prescribed fire as a tool in forest management on state and private land

Chapter 2 – Ecosystem Services: Soil and Water Resources and Carbon Storage

Massachusetts forests provide a range of important ecosystem services, including air and water quality protection, wildlife habitat, and carbon storage and sequestration. The continuance of these services is fundamental to the health and welfare of Commonwealth residents. Actions to promote forest protection, ecosystem sensitive management, and public appreciation of the need for conservation, will ensure that our forests are there to keep us healthy into the future.

SOIL	o Massachusetts contains nearly 2.2 million acres of Prime Forestland, only about 34% of which is permanently protected.
WATER	o The Massachusetts population is approximately 6.8 million, an increase of 4% since 2010, 6.2 million of whom are served by public water supplies. o Public water supplies in Massachusetts provide approximately 648 million gallons of water every day. That is equal to a cube of water measuring 442 feet on a side, which is equal to 1.5 football fields. Fifty-three percent of this water is delivered to households for domestic use. o The U.S. Geological Survey (USGS) estimates Massachusetts household water usage in 2015 at 57 gallons per person per day, down over 12% from 2010 (USGS Water Use Data).
CARBON	o The average forested acre in Massachusetts is storing approximately 89 tons of carbon. 51% of that carbon is stored in living plants and trees, 34% in the soil, and 15% in wood debris and leaf litter.
CLIMATE	o Future rainfall amounts are expected to rise, with more rain falling in more intense events. o Sea level rise may displace coastal residents, adding to the increasing development pressures on open lands in eastern Massachusetts.

Table 2.1. Ecosystem services forest facts.

Introduction

The services forests provide to both humans and wildlife are boundless (Table 2.1). Forests create, protect, and are supported by the soils upon which they grow. In Massachusetts, soils are the product of glacial and human impacts. Forests are solar-powered living water filters that absorb nutrients, promote infiltration, minimize soil erosion, and limit sediment delivery to streams, wetlands, rivers, lakes, reservoirs, and estuaries. Organic matter from forest vegetation covers and protects forest soil. Tree roots stabilize slopes and stream banks. Trees in riparian zones provide coarse woody debris to stream channels that dissipates the energy of flowing water and provides essential habitat for fish and aquatic macroinvertebrates. Access to clean drinking water for nearly 6.5 million people in Massachusetts is dependent on forests. Forests also accumulate and store carbon in the leaves, branches, stems, and roots of their trees as well as in the organic portions of forest soils, reducing carbon dioxide concentrations in the atmosphere. Thoughtful regulation and careful management of both private and public Massachusetts forests plays an important part in a regional response to climate change.

SOILS AND MASSACHUSETTS FORESTS

The current soils in Massachusetts formed during and after the melting of the most recent glacial ice sheet. The advancing ice contained vast amounts of rock fragments ranging in size from clay to boulders, plucked and scoured from the underlying bedrock and ground smoother and finer within the moving ice. As the ice melted, much of this material remained in place as a thick, poorly sorted deposit called glacial till. Till soils cover much of the uplands of Massachusetts today and can range from well to poorly drained depending on slope and permeability.

Glacial meltwaters gathered into fast flowing, high energy streams carrying sediments of many sizes. As these streams meandered or entered glacial lakes, they slowed and that energy was reduced. Particles were deposited and sorted by size according to the energy needed to move them. Sands and gravels accumulated along the bottoms of streams flowing in cracks in the ice, leaving deep ribbons of material called eskers standing proud on the landscape after the surrounding ice melted away. Large outwash deltas formed as sands and larger materials were deposited where streams entered glacial lakes (formed from meltwaters with no outlet) or the sea. The finest particles settled out on those lake bottoms, forming dense clay soils.

Post-glacial soil development has been influenced by abiotic factors such as climate, precipitation, topography, and chemical weathering of bedrock. Biotic factors, such as floral and faunal effects have influenced organic material accumulation and chemical cycling. More recently, human agriculture, industry, transportation, and housing have influence soil development.

Forest vegetation is influenced by soil conditions such as permeability, water content/availability, and bedrock composition. Drier outwash soils with high infiltration rates support tree species such as pitch pine and scrub oak which are well-adapted to those conditions. Interior forests growing on till soils with higher water availability include a wide mix of hardwood species and conifers that vary across the state depending on climate and soil chemistry. Figure 2.1 shows the Prime Forestland coverage developed by the Department of Conservation and Recreation (DCR) and MassGIS in 2013. Shown on this map are Prime Forestland categories 1, 2, 3, and 3(wet), which are those acres supporting or potentially supporting forest cover with better than average growth rates for the species present. About 1.1 million acres of all Massachusetts forests are permanently protected (Table 2.2), but another 1.8 million forested acres remain vulnerable to conversion.

The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) is producing a *Healthy Soils Action Plan* for the Commonwealth in partnership with DCR, the Massachusetts Department of Agricultural Resources, the Department of Fish and Game Division of Fisheries and Wildlife (MassWildlife), Conservation Districts, and many municipal and NGO partners. This plan will be the first such state plan to include all land uses (lawns, institutions, urban soils, forests, farms, and wetlands)

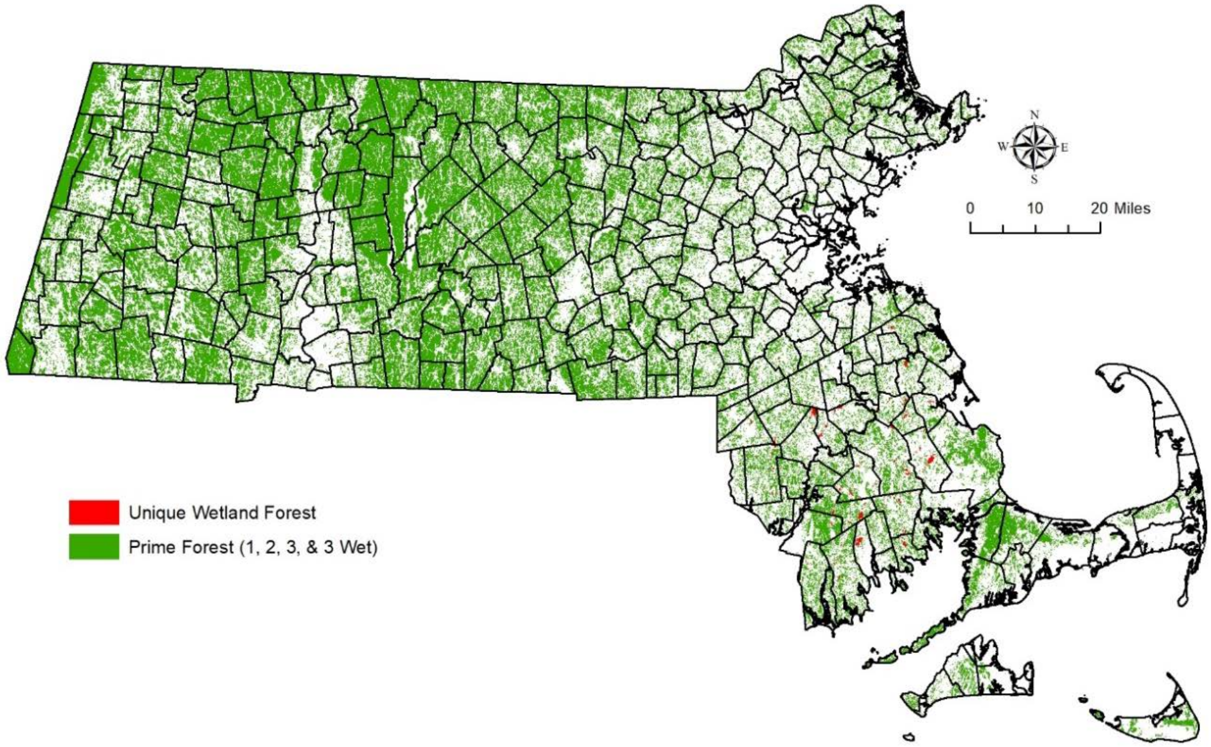


Figure 2.1. Prime forestland in Massachusetts (data: MassGIS).

Prime Forestland Category	Statewide Total	Total Permanently Protected Open Space	Permanently Protected Open Space Since 6/2010 (% gained)		Other Open Space Not Permanently Protected	Remaining Unprotected
Prime 1 – SI[1] >70 (WP[2]), >65 (RO[3])	354,371	102,008	7,485	7.9%	6,390	245,973
Prime 2 – SI[1] >60 (WP[2], RO[3])	840,648	281,135	20,044	7.7%	19,835	539,678
Prime 3 – SI[1] >50 (WP[2]), >55 (RO[3])	924,593	348,626	28,131	8.8%	19,334	556,634
Prime 3 – Wetland	66,028	20,440	1,639	8.7%	1,735	43,853
Total "Prime Forestland"	2,185,640	752,209	57,299	8.2%	47,294	1,386,138
Statewide Importance – SI[1] >45 (WP[2]), >50 (RO[3])	367,964	159,150	9,820	6.6%	8,156	200,658
Statewide Importance – Wetland	22,207	7,560	829	12.3%	633	14,015
Local Importance – SI[1] <45 (WP[2]), <50 (RO[3])	282,501	104,592	6,431	6.6%	7,158	170,752
Local Importance – Wetland	154,380	54,726	3,396	6.6%	3,935	95,719
Unique Wetland (AWC[4] wetlands)	8,790	4,239	129	3.1%	201	4,351
Total Other Forestland	835,842	330,267	20,605	6.7%	20,083	485,495
Non-forested (as of 1999)	2,161,442	258,723	18,111	7.5%	69,095	1,833,624

Table 2.2. Permanently protected lands and Other Open Space by Prime Forestland Category (data: MassGIS). Note about these acreages: this table includes acreages obtained from the Open Space datalayer maintained by MassGIS, June 2018. Accuracy of open space designated parcels is reliant upon town assessors voluntarily and routinely updating ownership status, and newer updates are likely under-reported in this datalayer. Data for properties owned by or with an interest held by EEA agencies is regularly updated and considered highly accurate. [1]Site index. [2]White pine. [3]Red oak. [4]Atlantic white cedar.

with input from stakeholders, including forest and forestry groups, analysis of best practices, and recommendations for each land use. At the time of this writing, the *Healthy Soils Action Plan* was under final review. It is expected to be completed in 2021.

WATER AND MASSACHUSETTS FORESTS

Massachusetts Climate

Precipitation is fairly uniform across the state (Figure 2.2), with an overall annual average of 46.1” (ranging from 31 to 59 inches), including water falling as snow or ice. Soil moisture and forest productivity are dependent on soil origin, slope, aspect, slope position, and, to a certain degree, on elevational gradients. Snowfall amounts average 24” to 94”, with the higher averages generally falling in the higher elevations in the northern and western portions of the state. The deeper snowpack and cooler temperatures in those areas contribute to increased soil moisture that supports species typical of more northern regions.

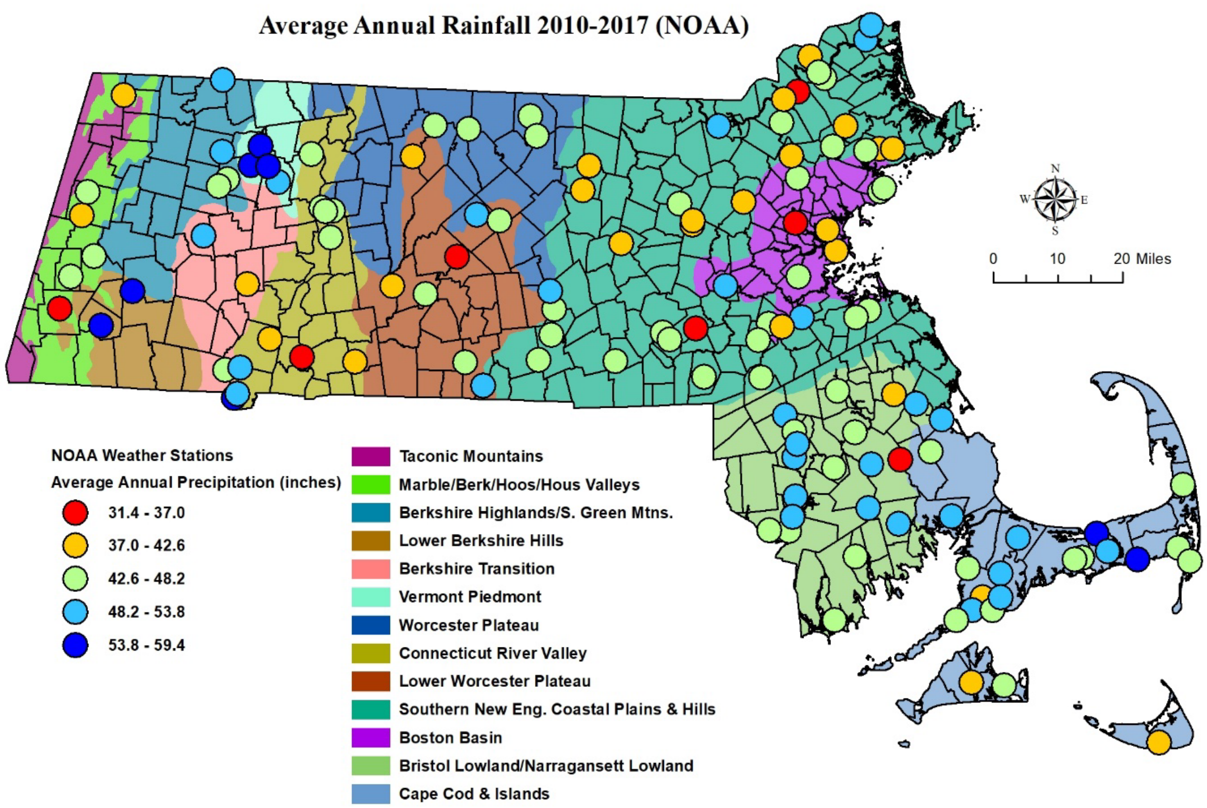


Figure 2.2. Average annual precipitation (inches) from available stations across Massachusetts, 2010-2017 (data: NOAA, MassGIS).

In contrast to precipitation, temperature shows a clear pattern across the state (Figure 2.3). Warm ocean currents help to moderate temperatures on lands close to the coast, resulting in fewer days annually with freezing temperatures. Western and Central Massachusetts, and especially the higher elevations in Berkshire and north-central Worcester counties, can see up to two months of temperatures below 32°F. Forest cover types and ecoregion boundaries generally align along these same gradients.

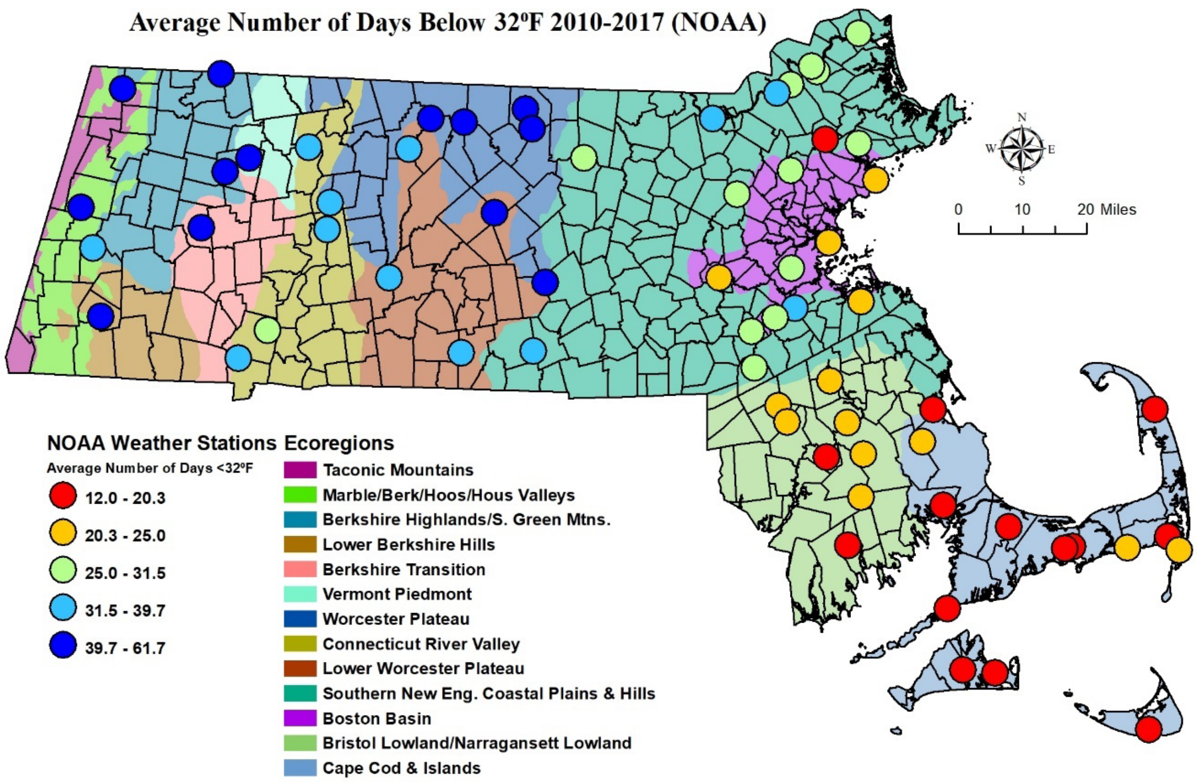


Figure 2.3. Average number of days with a maximum temperature below 32°F, 2010-2017 (data: NOAA, MassGIS).

Forest Hydrology

In forest ecosystems, most rain and snowmelt enters and moves through the soil rather than over its surface. The forest canopy intercepts precipitation, reducing the force of raindrops striking the forest floor. Leaves, needles, dead branches, and tree trunks form a protective organic layer complex that enhances infiltration of rain and snowmelt, moderates soil temperature, reduces evaporation of soil moisture, and gradually supplies nutrients as the organic matter decomposes. A substantial amount of water is taken up by roots and stored in forest vegetation. In addition, trees and forest soil bacteria take up, store, and recycle nitrogen, phosphorus, and other mineral nutrients from subsurface water before it reaches streams and wetlands (de la Crétaz and Barten 2007).

The quantity, timing, and quality of streamflow from watersheds, large and small, throughout Massachusetts are strongly influenced by the relative proportion of upland forest cover, riparian forest cover, and impervious area (i.e., roads, roofs, parking lots, etc.). The forest's ability to delay stormwater and meltwater inputs to streams helps to modulate variations in streamflow, protecting stream channel stability and ensuring high water quality (Verry et al. 2000). Riparian forests are especially important for water quality protection. Trees on streambanks and in the floodplain help to shade streams, stabilize stream temperatures, protect wetland soils, reduce nonpoint source pollutant loading, and provide coarse woody debris.

It follows that the loss of watershed forest and riparian forest cover can be deleterious to water quality, aquatic ecosystems, and drinking water supplies. The primary impact will be increased water output due to a reduction in evapotranspiration (*transpiration* or water use by plants, plus interception of water that later *evaporates* off the forest canopy). In general, reductions in forest area or live forest biomass of at least 20 to 30% will produce measurable increases in streamflow from a watershed (large or small), with additional increases rising proportionally to the amount of tree cover removed. The increased water yield typically increases the outflow of nutrients (e.g., nitrogen and phosphorus) and minerals (e.g., calcium) – in solution or suspension (adsorbed to sediment or organic matter) – from the watershed.

If the loss of forest cover is temporary, for instance due to timber removal from part of a managed forested watershed, any changes in water yield and sediment/nutrient loading in streams typically return to baseline levels after three to five growing seasons. While the cleared portion of the forest regenerates, the residual surrounding canopy trees are using much of the additional available water, light, and nutrients; this is a primary objective of thinning and other partial cuts since growth of these residual trees is enhanced. However, soil erosion and stream sediment loading can develop and persist if Best Management Practices (BMPs) are not effectively planned and implemented, and if impact-reducing measures such as bridged stream crossings, ditches, and water bars are not well-built and maintained.

In contrast, when forests are permanently converted to other land uses, yield increases will persist and concentrations of nitrate and phosphorus in receiving waters will increase by varying amounts depending on the nutrient loading associated with the new land use. Agricultural, residential, and urban lands have much higher rates of nitrogen and phosphorus export than forestland. Nitrogen and phosphorus in stream water can cause algal blooms and oxygen depletion (eutrophication) in downstream waters. Studies in areas of coastal New England have shown stream ecosystems are degraded and aquatic species populations are reduced (relative to a fully forested watershed) when as little as 3% of the land cover in a watershed is urbanized and population density is approximately 300 people per square mile (Robinson et al. 2004). Protection of forests and forested riparian areas through permanent land protection, low impact development, improved stormwater management, and urban and community forest management can help maintain or emulate natural systems in order to substantially reduce adverse impacts while providing a host of other benefits and values (e.g., air quality enhancement, wildlife habitat, moderating microclimate, and carbon sequestration).

Forests and Public Water Supply in Massachusetts

Massachusetts is fortunate in having a relatively high (>60%) proportion of forested land despite being relatively small and densely populated. The importance of forest protection is amplified by the role the forest plays in providing clean water (Figure 2.4). Most people in Massachusetts rely on forests for clean water, but the majority of our forest is privately owned and is not protected from land use conversion. In the 2010 *An Assessment of Forest Resources of Massachusetts*, information was presented that demonstrated the importance of Massachusetts watersheds relative to other Eastern Region forested watersheds in the protection of drinking water resources (Gregory and Barten 2008, Barnes et al. 2009). The U.S. Forest Service continues to provide leadership and information related to the importance of forests nationwide to drinking water supplies through its Forests to Faucets Initiative. To help local and regional planners make targeted land conservation decisions, a similar analysis was conducted for Massachusetts. The map represents unprotected forest cover in public water supply source areas at a 30-meter pixel scale (see also Figure 2.10).

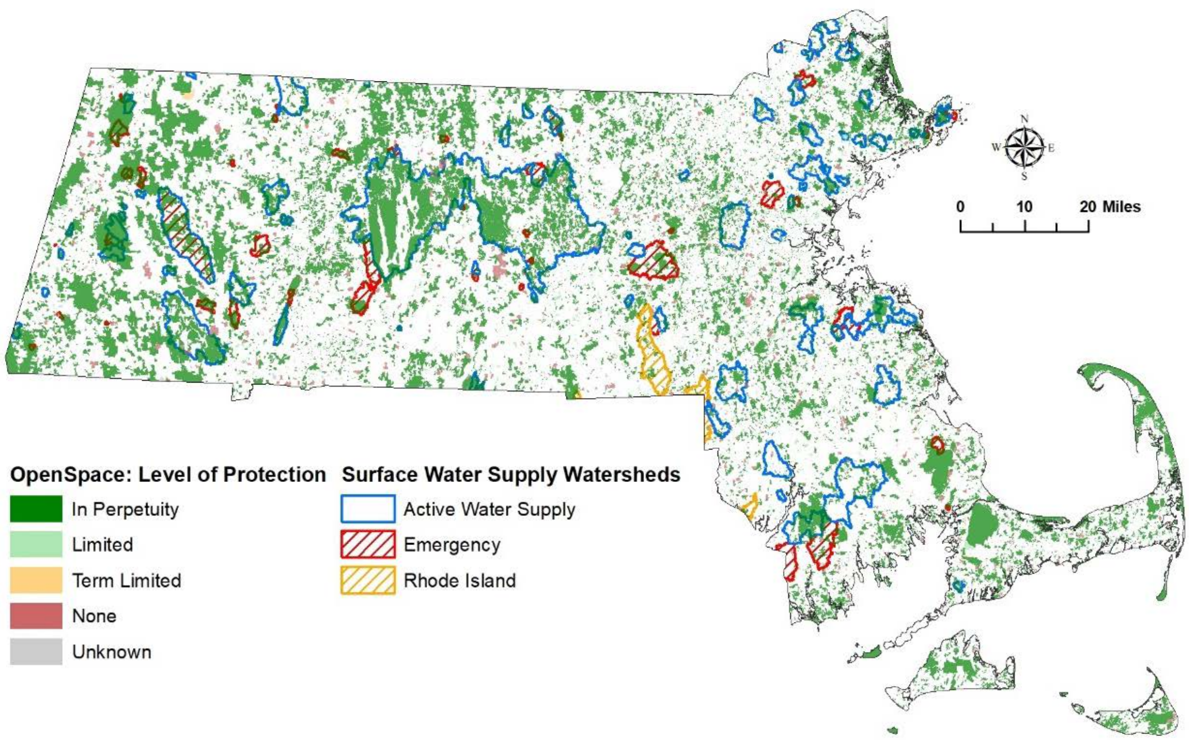


Figure 2.4. Surface drinking water supply watersheds and land protection in Massachusetts (data: MassGIS).

Surface Drinking Water

The DCR Division of Water Supply Protection (DWSP) owns and manages the largest acreage of public water supply land in Massachusetts, with the goal of protecting high quality source water for approximately three million residents in the greater metro Boston and Chicopee areas. A Watershed Protection Plan guides all activities and programs that enhance source water protection. The DWSP has actively worked to protect additional land since the creation of the system and maintains an active forest management program on most of its watershed land holdings. DWSP fee-owned acreage has grown by 1.3% since June 2010, while the amount of private acreage protected by deeded watershed preservation restrictions has grown by 63%. Forest management on DWSP lands was reviewed by a Science and Technical Advisory Committee shortly after the publication of the 2010 *An Assessment of Forest Resources of Massachusetts*. The committee supported the watershed forestry program and supported a stronger system of public engagement along with enhanced monitoring of forestry and stream water quality. DWSP committed to these programs and detailed them in its 2017 Land Management Plan (see Box C4.1 on page 76 of *An Assessment of Forest Resources of Massachusetts* for a complete discussion of forest management history around the Quabbin Reservoir).

Other major public water suppliers have also developed protection plans and engage in active forest management. The city of Worcester manages land that protects a system of 10 drinking water reservoirs and provides water to about 250,000 users. The city owns and conducts forest management activities on over 6,300 acres around these water supplies, treating about 150 acres a year. The city also holds conservation restrictions on an additional 716 acres. Overall land protection levels have grown by 12% since 2010 (Kevin Scherer, Worcester DPW Watershed forester, personal communication, 2019).

The city of Fall River delivers water to about 100,000 users from two protected sources – North Watuppa Pond and the Copicut Reservoir. The city owns these water bodies and 8,500 acres of restricted watershed land surrounding them.

The city of Northampton relies on three drinking water reservoirs to supply the needs of over 28,700 users who each use about 48 gallons per day. Their planning is guided by a Watershed Resource Protection Plan, much like the Watershed Protection Plan of DWSP. The Plan discusses land protection and acquisition goals, as well as forest management goals and practices. Over 150 acres have been acquired for watershed protection since 2011. Management activities on the 3,200 acres around the

Sunset at Wachusett Reservoir, one of the DCR-managed surface drinking water supplies, photo by Kelley Freda reservoirs are detailed in Forest Stewardship Plans. Like the DCR, the city has undergone its own challenges from public critics of forest management on watershed lands. Support resulting in the continuation of active forest management was generated by city water department engineers through a series of public presentations and field tours for city councilors and the mayor (Johanna Stacy and Mike Mauri, personal communication, 2019).

At an even smaller scale, the town of Upton's Land Stewardship Committee developed a comprehensive stewardship plan for 800 acres of conservation land they own and manage. This speaks to the awareness of the whole range of issues that are affecting conservation lands at this time, from local pressures to develop and extract resources, to global issues of sustainability, carbon storage, biodiversity, and invasive species. While this particular set of properties is not managed specifically for watershed protection, the goals and practices are very much in line with other forest management programs that focus on water quality protection.

Groundwater

Groundwater is an important source of both public and private drinking water in many areas. Public wells are well-documented and receive statewide regulatory protections. Wellhead protection areas have been established by the Department of Environmental Protection (DEP) to protect recharge areas around public water supply wells (Figure 2.5). Wellhead protection areas are defined as "that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation)" (310 CMR 22.02, DEP), and include a Zone I minimum radius (100 – 400 feet, depending on yield) which must be owned or controlled by the water supplier (310 CMR 22.21(1), DEP). Land uses prohibited within wellhead protection areas (Zone II) include landfills and open dumps; automobile salvage yards; sludge and septage monofils; disposal or stockpiling of chemically treated snow and ice that have been removed from areas outside the zone; petroleum, fuel oil and heating bulk oil stations and terminals; facilities for the treatment or disposal of non-sanitary wastewater; facilities that generate, treat, store, or dispose of hazardous waste; unprotected storage of sludge, septage, road salts, fertilizers, animal manure, and other hazardous materials; and land uses that result in impervious cover of more than 15% of any lot or parcel (310 CMR 22.21(2), DEP).

Private and domestic well registration and regulation in Massachusetts is the responsibility of local Boards of Health and statewide data is not readily available. However, the U.S. Geological Survey (USGS) maintains an interactive web map showing estimated densities of households utilizing groundwater wells across the United States. Their model suggests that 5-10% of Massachusetts residents rely on domestic wells. As shown in their map, areas most dependent on groundwater resources are haloes of suburban development around the major cities with a higher density of homes but without a public water supply. Such development involves significant increases in impervious cover at the expense of natural forest cover, along with a higher likelihood of contamination of groundwater from septic systems and residential chemical use. This problem is particularly apparent on Cape Cod. The Cape Cod aquifer lies in deep, sandy outwash deposits. These highly permeable soils transport groundwater pollutants easily. While the establishment of wellhead protection areas and clean-up efforts has reduced contamination and improved groundwater quality on much of the Cape, nitrate contamination from residential septic systems remains a problem for both drinking water and coastal freshwater and marine ecosystems. Nitrogen loading has been shown to vary by a factor of 30 to 50 times when forested land is compared to residential and suburban land uses. Nitrate increase has led to severe algal blooms and the reduction of important seagrass habitat in areas around Cape Cod Bay.

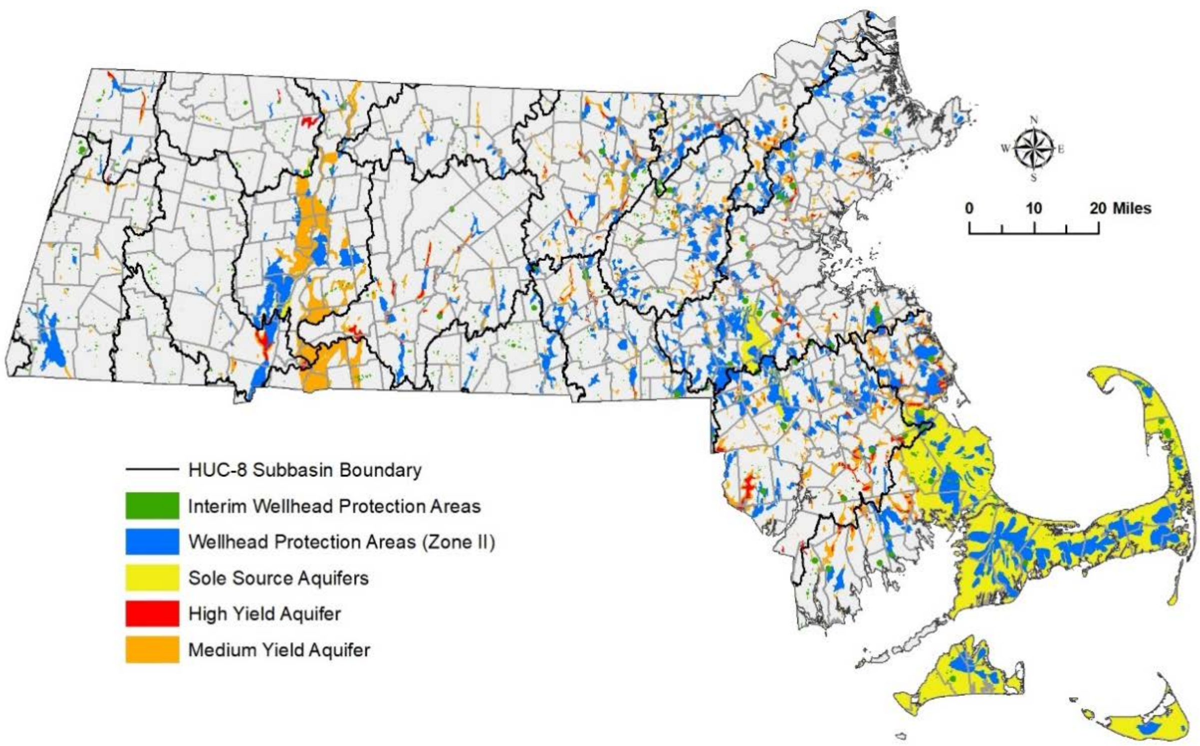


Figure 2.5. Groundwater recharge and wellhead protection areas (data: MassGIS).

FORESTS AND CARBON STORAGE

Global climate change is one of the greatest challenges facing the world today. The primary cause is the emission of carbon dioxide and other greenhouse gases from the burning of fossil fuels. Massachusetts forests accumulate and store carbon, thereby removing carbon dioxide emissions from the atmosphere. Scientific research related to climate change and the role of forests and forest management in carbon sequestration can inform thoughtful regulation and careful management of both private and public forests as part of a regional response to mitigate climate change.

Forest Carbon

Forests are both a source and a sink for carbon. Through photosynthesis, forests remove carbon dioxide from the atmosphere and fix, or sequester, carbon into usable energy-storing and structural materials. Carbon dioxide is released through metabolic cell processes (respiration) and ultimately through the process of decomposition. Sequestered carbon is stored in a variety of forest carbon pools: living biomass (vegetation), dead woody biomass, and organic matter in the forest floor and soil.

Forest carbon was essentially in balance in the United States prior to European settlement (Birdsey et al. 2006). During the 19th century widespread land clearing in Massachusetts, and in much of the United States, led to a large increase in carbon emissions (Birdsey et al. 2006). Forests in Massachusetts have been regrowing since the early-1900s and currently act as a carbon sink, sequestering more carbon annually than is lost to mortality, harvest, decay, and – for the moment – land conversion (Figure 2.6).

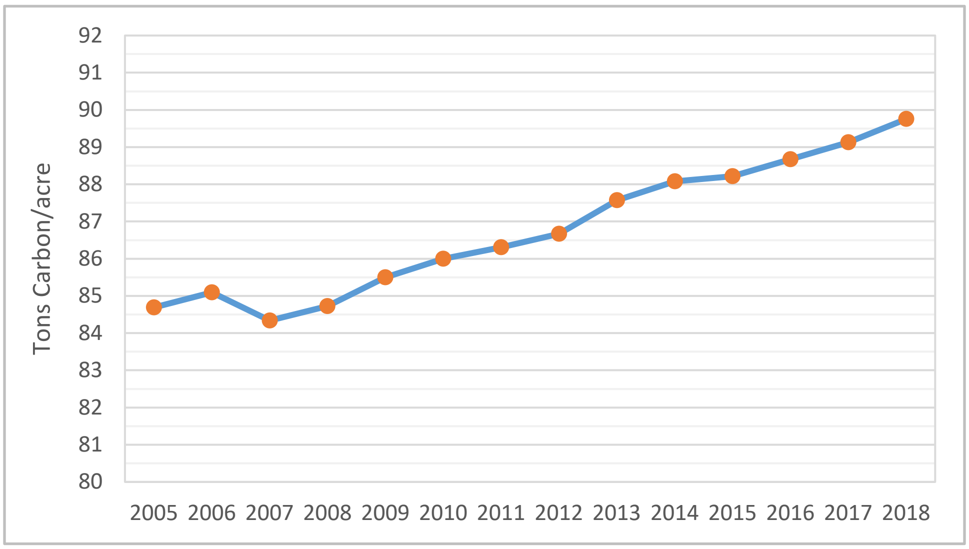


Figure 2.6. Per acre carbon storage in Massachusetts forestlands, 2005-2018 (data: FIA EVALIDator 2018).

The quantity of carbon sequestered by a given forest is dependent on a variety of factors, including but not limited to forest age and type, management history, and ecological site conditions. Due to landscape-scale patterns of abandonment of agricultural lands and subsequent regrowth of stands, the landscape-scale stand-replacing disturbance associated with the 1938 hurricane, and relatively little disturbance over the past 100 years, tree growth and carbon sequestration rates are slowing as forests mature (Hoover et al. 2012). Work is being done to increase awareness of practices that increase forest carbon density and rates of sequestration, relative to business-as-usual practices, on managed forestland in Massachusetts (e.g., Birdsey et al. 2006, Perschel et al. 2007, Catanzaro and D'Amato 2019).

Forest Carbon Pools

Massachusetts forestlands have the potential to sequester carbon and biomass across multiple forest ecosystem pools. Different pools sequester carbon at varying rates and differ in potential carbon storage capacity (Woodbury et al. 2007). In Massachusetts, based on readily accessible and pre-generated queries in the U.S. Forest Service Forest Inventory and Analysis (FIA) database, forest carbon is primarily stored in the wood of tree boles, but also in bark, branches, foliage, root systems, standing and down dead wood, understory vegetation, forest floor litter and duff, and soil. The Intergovernmental Panel on

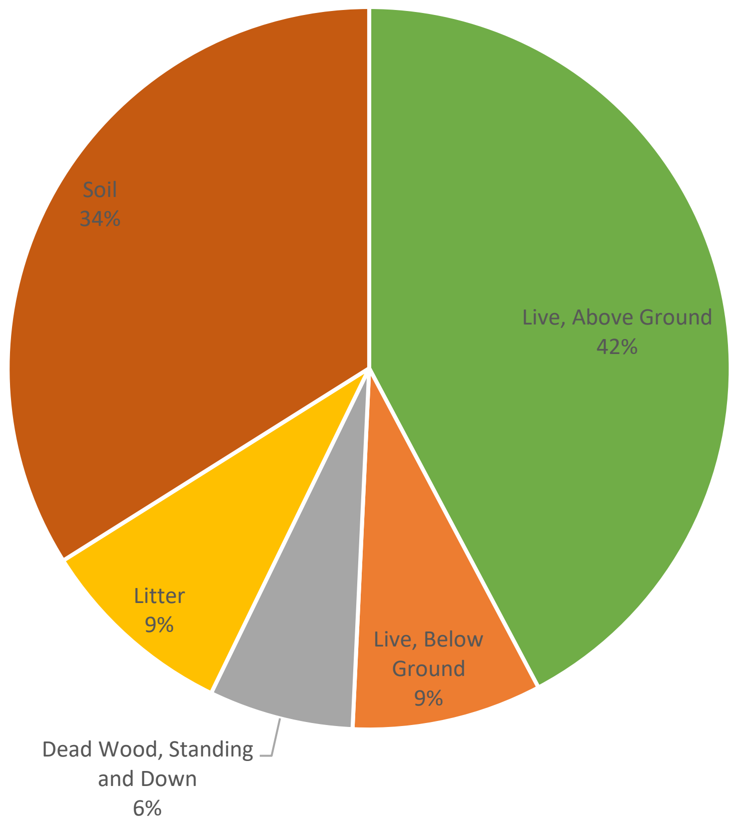


Figure 2.7. Proportion of carbon storage in Massachusetts forest lands in the five Intergovernmental Panel on Climate Change pools (FIA EVALIDator 2018).

Climate Change (IPCC) defines forest carbon in five pools (Figure 2.7). Based on these pre-generated queries summarizing those IPCC pools in the FIA database, half of carbon stored in Massachusetts forests is in the live vegetation (51%), both the above and below ground (including coarse roots) pools. The next largest carbon pool in Massachusetts forests is in the upper one meter of organic soil layers (34%), followed by the litter layer (9%), and dead wood (6%) pools. However, both FIA's Phase 3 data (O'Neill et al. 2005, Domke et al. 2017) and the samples collected and models developed as part of the NRCS's Rapid Carbon Assessment (Soil Survey Staff 2013) which are utilized in support of the Massachusetts Healthy Soils Action Plan, show that the magnitude of the soil organic carbon pool is likely larger than estimated by the default IPCC queries and condition-level estimates in the FIA database. As would be expected, the proportion of forest ecosystem carbon stored in different pools varies based on many factors, including forest type, stand age and structure, and others as discussed in the following sections. When all these pools are combined, the current total forest carbon estimate for Massachusetts is about 270 million oven-dry tons of carbon, or an average estimate of about 89 tons per acre on forestland (U.S. Forest Service 2018a).

The carbon balance of old-growth forests was thought to be a system of dynamic equilibrium, sequestering and releasing carbon at equal rates over time. This hypothesis is now being reconsidered since more recent research suggests that the forest soil and belowground carbon cycle may sequester carbon into a more stable long-term pool (Pregitzer and Euskirchen 2004, Zhou et al. 2006). It is possible that harvesting in older forests may have little to no effect on soil carbon (and nitrogen) stores, depending on the type and disturbance extent of the harvest. An analysis of the scientific literature pertaining to forest management effects on soil carbon and nitrogen showed that, while whole-tree harvests caused decreases in soil carbon and nitrogen (6% loss from the A horizon) from the removal of residues, overall sawtimber harvests had no significant soil loss. Study results ranged from slight losses to moderate gains in soil carbon, with variations attributed to residue management, forest type, and site differences (Johnson and Curtis 2001). Changes in soil carbon are slow and difficult to measure; this area of forest carbon science has been identified as a key area for additional research (Birdsey et al. 2006).

Carbon by Forest Type

Forest type influences both the rate at which carbon is sequestered and the overall magnitude of carbon stocks on forest land. The current distribution of carbon by forest type in the state is generally linked to the relative area, age, stocking, and volume of each forest type. Figure 2.8 shows carbon stocks on a per-acre basis as well as cumulative carbon stocks for all Massachusetts forestlands for various groups of forest types. For example, although northern hardwood stands in Massachusetts are storing more carbon per acre than oak-dominated forest types (light green bars), the oak types are storing more carbon overall (dark green bars) due to their greater acreage across the state (see also Figure 1.8). Additional studies are needed to understand how different variables such as site history and ecological site characteristics influence the rate and extent to which a given forest type will sequester carbon.

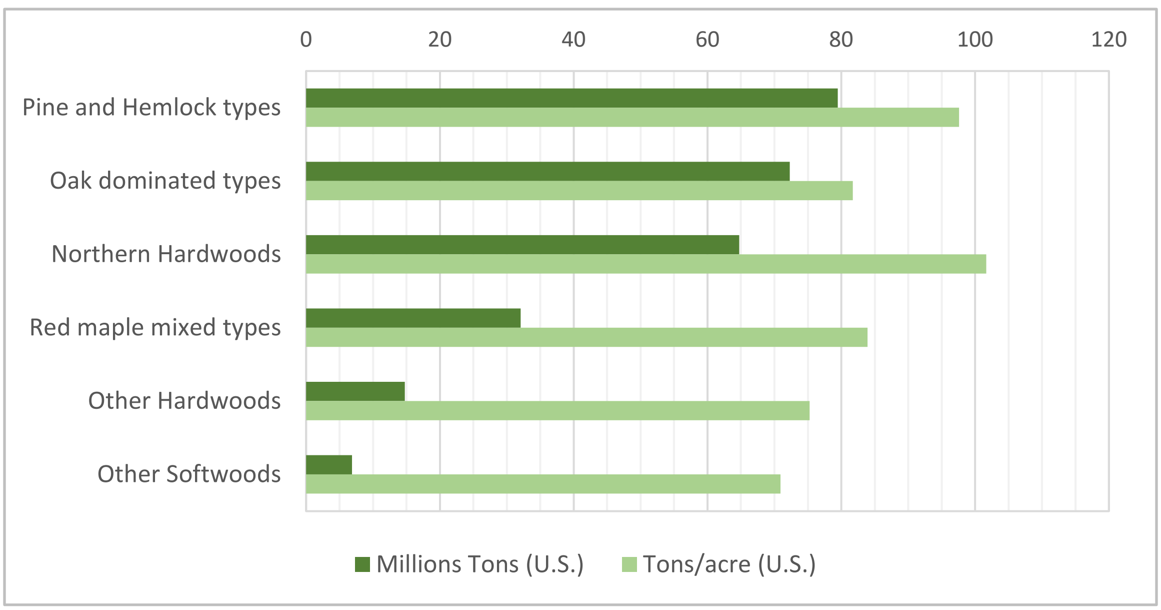


Figure 2.8. Carbon storage by forest type in Massachusetts forestlands (data: FIA EVALIDator 2018).

Carbon by Forest Age

Recent FIA estimates reveal that Massachusetts forestlands are steadily accumulating carbon stores (Figure 2.6). However, the sequestration rate and total store of carbon in a forest are closely linked to the age of the forest. A meta-analysis of worldwide carbon studies (Pregitzer and Euskirchen 2004) found that, "with notable exceptions, carbon pool sizes increased with age in all biomes, including soil carbon." The researchers also synthesized published carbon sequestration rates. They found that in the first 10 years after a disturbance, the forest was a source of carbon to the atmosphere, intermediate aged forests had the fastest sequestration rates, and older forests continued to sequester carbon, albeit at a slower rate.

Figure 2.9 shows total carbon stocking by stand age and demonstrates that the bulk of carbon storage is occurring in Massachusetts forests between 70 and 100 years old. Total carbon storage is linked with overall acreage of forests in these age classes in the state. This suggests that our relatively young Massachusetts forests have considerable potential to sequester additional carbon as they age, mostly in the living biomass and dead wood pools (Pregitzer and Euskirchen 2004). Changes to forest floor and soil organic carbon stocks tend to happen more slowly, have more spatial variability, and are more difficult and expensive to measure than other pools. However, these pools are an area of considerable current research and our knowledge continues to evolve on this topic (Domke et al. 2016, Domke et al. 2017, Cao et al. 2019).

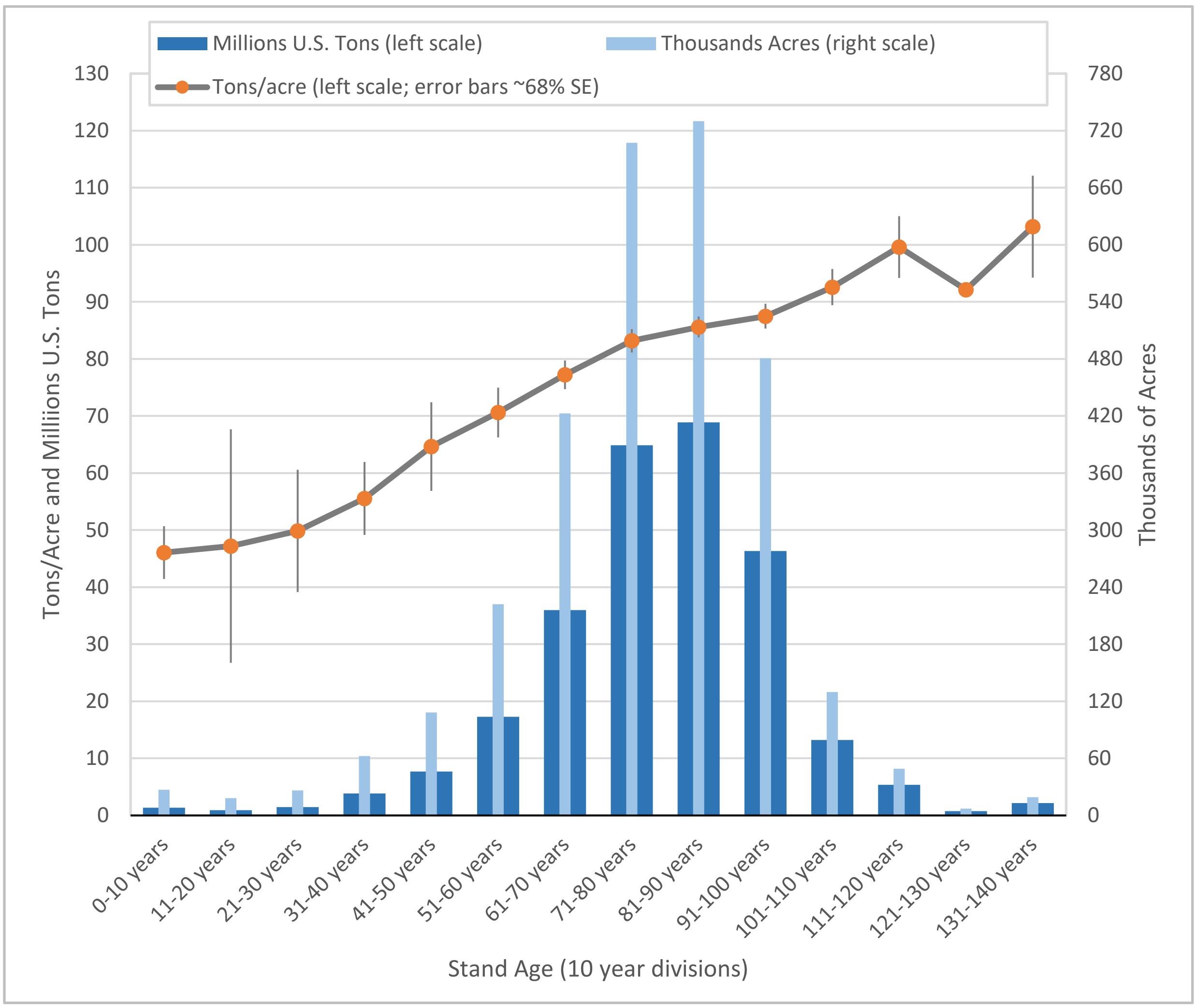
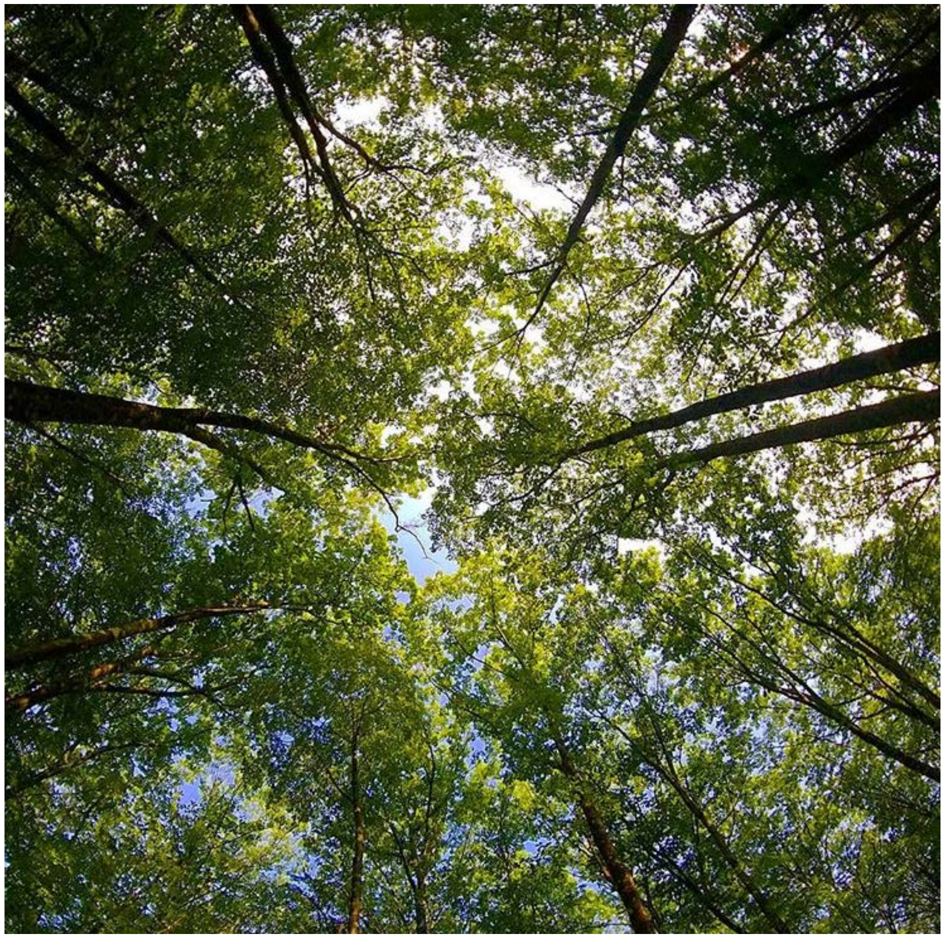


Figure 2.9. Carbon storage by age class in Massachusetts forestlands (data: FIA EVALIDator 2018).

Carbon in Old-Growth Stands



Pittsfield State Forest, photo by Kevin Hatcher

Massachusetts forests are relatively young, regenerating from a long history of forest clearing (Kelty et al. 2008). As noted earlier, until recently it was thought that old-growth forests were in a state of dynamic equilibrium. Gray (2015) for instance found net carbon change to be essentially zero in old stands on federal lands in the Pacific Northwest. Other studies suggest that old-growth forests may continue to accumulate carbon over time (Schulze et al. 2000, Suchanek et al. 2004, Pregitzer and Euskirchen 2004, Zhou et al. 2006). Multiple long-term studies of temperate North American forest types common to Massachusetts have found that older forests (i.e., >= 150 years old) continue to at least tightly manage carbon, if not be carbon sinks (Curtis and Gough 2018). Consistent with classical models of ecosystem development (Bormann and Likens 1979), both stock- and flux-based approaches document that biomass rapidly accrues following stand-replacing disturbances. Accrual slows gradually over many years and the importance of the standing and down dead wood, forest floor, and forest soil carbon pools increases. These same studies indicate significant variability in the rates of accrual and maxima over time. Old- growth carbon dynamics vary based on ecoregion, species composition, stand structure, hydrology, and weather and water patterns. The vast majority of all old-growth forest stands identified on public lands in Massachusetts (D'Amato et al. 2006) are protected by small patch reserves or large reserves.

Researchers at the University of Massachusetts Amherst and Harvard Forest mapped and studied the remaining old-growth stands on public land in Massachusetts (D'Amato et al. 2006, D'Amato and Orwig 2008, D'Amato et al. 2008). They compared old-growth hemlock stands to similar second growth stands across many structural characteristics. D'Amato found old-growth live tree carbon pools to average 64.4 ± 11.4 tons per acre, while the second growth stands averaged 51.8 ± 9.6 tons per acre (D'Amato unpublished data). McGarvey et al. (2015) found the volume of coarse woody debris and snags to be significantly higher in Mid-Atlantic old-growth stands compared to the surrounding second growth forests. These stands are similar to those in Massachusetts, where a history of forest clearing has depleted the live and dead wood carbon pools. Hoover et al. (2012) collected benchmark measurements of carbon in old-growth stands across northern New England and found that mature (about 80- to 120-year-old) hardwood stands had lower overall carbon stocks, but those differences were not statistically significant. This suggests the potential for the increased storage of carbon in all carbon pools, but particularly in the live tree, snag, and coarse woody debris pools as the younger second growth stands in the state gain in physical and biological complexity as they age, and as management practices are implemented that reduce differences with old-growth carbon stocks. The designation of DCR Division of State Parks and Recreation (DSPR) lands into actively managed woodlands (40%) and reserves and recreational parklands (60%) should result in the development over time of nearly 200,000 acres of old forest with emergent features and functions of old-growth, including carbon storage.

Carbon in the Urban Landscape

The urban forest canopy covers a much smaller footprint in Massachusetts than its woodlands, but its contributions to environmental resiliency, carbon storage, and other co-benefits such as aesthetics and urban cooling, are important. Nationwide, urban forests account for 3.2% of carbon storage in all forestlands. Nowak et al. (2013) estimate that urban forests in Massachusetts are storing 35.9 million metric tons of carbon and sequestering (net) about 0.9 million metric tons each year.

Carbon cycling and carbon pools in urban forests are quite different than in woodlands and old-growth reserves. The practicalities of urban living preclude the accumulation of leaves and woody debris from city streets and parks, so soil and dead wood pools naturally suffer. Individual tree growth for some species may be significantly greater in urban settings due to crown exposure and low density; forest grown trees grow on average 2.29 times slower than urban street trees (Nowak et al. 2013). Additional research in the Boston region has shown that fragmented forests, which contain more edges than large forests and are common in urban and suburban landscapes, can sequester carbon faster than traditional forests due to an increased growth rate at the forest edge (Reinmann and Hutyra 2016, Briber et al. 2015). While these edge trees may be growing faster and sequestering carbon at a higher rate than their interior forest counterparts, these trees may also be more vulnerable to heat stress and suffer greater declines in growth as the climate warms (Reinmann and Hutyra 2016).

The urban tree canopy provides a host of co-benefits that are described in Chapter One. Through transpiration and changes in albedo, trees can help cool buildings, reducing fossil fuel use in air conditioning. Trees in urban areas, particularly those planted along streets, typically do not live as long as their forested counterparts, but field studies in urban tree mortality are lacking (Roman 2014), though some are underway in Massachusetts. Planting trees and maintaining existing trees in urban areas can multiply these benefits that trees provide. Increasing the urban tree canopy through tree planting and preservation and expansion of urban parks may be an important strategy to maintain and increase urban forest carbon pools.

FOREST MANAGEMENT FOR INCREASED CARBON SEQUESTRATION

In the face of predicted climate changes due to increased carbon dioxide in the atmosphere, the ability of our forests to sequester carbon is more important than ever. Silvicultural activities have been recognized by international agreements as a means to increase carbon dioxide sequestration (Birdsey et al. 2006). The 2019 IPCC *Special Report on Climate Change and Land* states that "sustainable forest management aimed at providing timber, fibre, biomass, non-timber resources and other ecosystem functions and services, can lower greenhouse gas emissions and can contribute to adaptation...Sustainable forest management can maintain or enhance forest carbon stocks and can maintain forest carbon sinks, including by transferring carbon to wood products, thus addressing the issue of sink saturation. Where wood carbon is transferred to harvested wood products, these can store carbon over the long-term and can substitute for emissions-intensive materials reducing emissions in other sectors" (IPCC 2019).

Forests in the Northeast sequester 12 to 20% of the annual carbon emissions from the region. Land use affects forest carbon storage and sequestration rates. The most important consideration in maintaining the ability of forest land to continue to sequester and store carbon is to keep forestland as forestland and avoid conversion to developed land uses. Carbon sequestration of forestland could be increased through improved application of sustainable forest management practices and landscape scale management. Both active and passive forest management strategies should be considered in terms of their trade-offs in net forest carbon storage. "Though active forest management would temporarily reduce the amount of carbon stored in the forest, it may help prevent an even larger reduction in carbon storage by avoiding losses due to a large-scale disturbance (Catanzaro and D'Amato 2019)." Of equal importance to the management for carbon by including or excluding harvesting is that the other ecosystem services provided by the forest not be overlooked, as the maximization of live aboveground carbon stocks "…may come at the expense of forest health concerns such as fire hazards, individual tree resistance to pests, and loss of wildlife habitat (Woodall et al. 2011)."

Strategies that could increase forest carbon sequestration in Massachusetts forests include protecting forestland, afforestation, lowering harvest intensity, increasing forest growth rates, thinning to reduce fuel accumulation, increasing urban forest canopy levels, substituting wood and biomass for fossil fuels, and storing carbon in long-lived forest products (Ryan et al. 2010). To increase carbon sequestration, the Forest Stewards Guild recommends a suite of forest management practices such as thinning to increase the growth rates of the residual stands (Box 2.1) (Perschel et al. 2007). Incentivizing the use of such strategies is becoming increasingly available in the form of carbon credits described in Chapter Four.

The Northern Institute of Applied Climate Science (NIACS) has developed tools to help forest managers integrate climate considerations into natural resource management planning and activities (Swanson et al. 2016). A menu of broad adaptation strategies and more specific approaches for forest carbon management has been published (Ontl et al. 2020), based on a review of over 200 peer-reviewed papers and reports. Forest managers can use this menu (real-world examples are provided in the paper) along with the Adaptation Workbook (Swanston et al. 2016) to help guide decisions for implementation of on-the-ground tactics.

The DCR has engaged Mass Audubon and the New England Forestry Foundation to help develop a forest carbon and resilience program for private and municipal landowners. DCR is working with The Nature Conservancy (TNC) and NIACS through private foundation grants to develop a specific set of practices that can be validated to add carbon or resilience to forests. This approach expands the work of the Family Forest Carbon Program that TNC has piloted in Pennsylvania and California. Through state and federal sources, EEA hopes to fund payments to landowners for adopting practices from this menu.

BOX 2.1. FOREST MANAGEMENT FOR CARBON

The Forest Stewards Guild recommends the following forest management practices for increasing carbon storage on managed forestlands (Perschel et al. 2007):

- Use forest management plans and the supervision of professional foresters to guide harvests.
- Grow trees longer and extend the time between harvests to promote carbon storage and ecological values.
- Manage forests for structural complexity by growing trees of varying sizes and ages and leaving snags and coarse woody debris after harvests.
- Retain trees as biological legacies after harvests by allowing some trees to continue to grow after their companions have been harvested.
- Use low-impact logging practices — smaller scale, better adapted equipment and better planned harvest strategies — to protect soil and site productivity.
- Choose appropriate thinning techniques to concentrate growth on fewer, larger trees.
- Restore under-stocked stands to full stocking to take full advantage of the site’s productive capacity and potential to sequester carbon.
- Avoid harvesting practices that degrade ecosystem health (high grading, whole tree harvesting on nutrient-sensitive sites, liquidation cutting, and repeated short-term rotations).
- Maintain forest reserves for carbon sequestration, genetic diversity, and habitat refuges.
- Consider carbon storage potential as an additional benefit when evaluating the creation of future reserves.
- Consider introducing forest management to accelerate carbon accumulation in reserves now in unhealthy or undesirable conditions.

CHALLENGES AND THREATS

Climate Change and Water Supply

The predicted effects in Massachusetts of current climate change trends are stressed repeatedly throughout this Forest Action Plan. Some of those effects will directly impact drinking water supply. Van der Linden et al. (2018) conclude that future warming will lead to increased streamflow inputs to temperate zone water supply reservoirs, resulting in increased amounts of nutrients in surface runoff. Their models also indicate changes to annual temperature stratification in reservoirs, leading to extended periods of low oxygen which could result in greater nutrient releases from bottom sediments.

Other climate change impacts could indirectly impact drinking water, mainly through changes to watershed forest cover and health. Changes in precipitation may lead to increased seasonal drought conditions, which could impact tree seedling survival. Increased storm intensity and frequency may lead to greater levels of canopy disturbance, altering forest water demand and potentially providing footholds for the spread of terrestrial invasive plants, again impacting seedling survival and ultimately the functioning and resiliency of watershed forests.

Climate Change and Carbon Storage

The climate of the northeastern United States is predicted to change rapidly during this century due to human-induced greenhouse gas emissions. Average temperatures in Massachusetts have been increasing and temperatures are predicted to increase an average of 2°F in the summer, and 4°F in the winter by 2050. More rain and heavier snowstorms are predicted, as well as more frequent droughts as the timing of precipitation throughout the year becomes more erratic. These climatic changes may exacerbate current forest stressors such as invasive plant species, pests, and disease. The ranges of tree species will shift. It is unclear exactly how climate change will influence forested environments; increased levels of carbon dioxide and longer growing seasons may increase growth rates, while increased stressors may increase mortality. Monitoring forest resources is, therefore, crucial to adaptive management of changing forest environments.

Researchers at Harvard Forest measured the net uptake of carbon dioxide over five years in a deciduous forest in central Massachusetts in the 1990s. The uptake varied over the time period from 0.62 to 1.25 (tons per acre) per year. The amount of carbon dioxide sequestered annually was distinctly sensitive to four aspects of the climate: 1) the length of the growing season, 2) summer cloud cover, 3) snow depth and thus soil temperature, and 4) drought in the summer (Goulden et al. 1996).

Increases in natural and human disturbances often result in the release of stored carbon from forests through increased mortality. The release of carbon from forest ecosystems occurs through the decay and decomposition of biomass by microbial organisms. Natural disturbances, such as hurricanes, tropical storms, ice damage, or wildfires influence the rate of decomposition. However, human conversion of forests to developed uses in Massachusetts, currently occurring at a rate of 13.5 acres per day, is reducing forest carbon stores and potential future statewide sequestration rates and total storage. A recent study in northern New England showed net gains of forest carbon in all states, however land conversion and deforestation for development reduced carbon gains (Zheng et al. 2008). FIA estimates show net biomass gains from 2012 to 2017 in New England (Butler 2018a,b,c,d, Morin 2018a,b). There may be a threshold, a “tipping point” of forest loss, where the carbon released by deforestation exceeds the carbon sequestered by forestlands in Massachusetts. Forest conservation is, therefore, the critical first step to reducing the loss of carbon from forests in Massachusetts.

Forest Conversion and Fragmentation – Water Supply and Water Quality

Forests in Massachusetts provide and protect much of the surface and groundwater resources that sustain public drinking water supplies. However, many of these forests are vulnerable to development

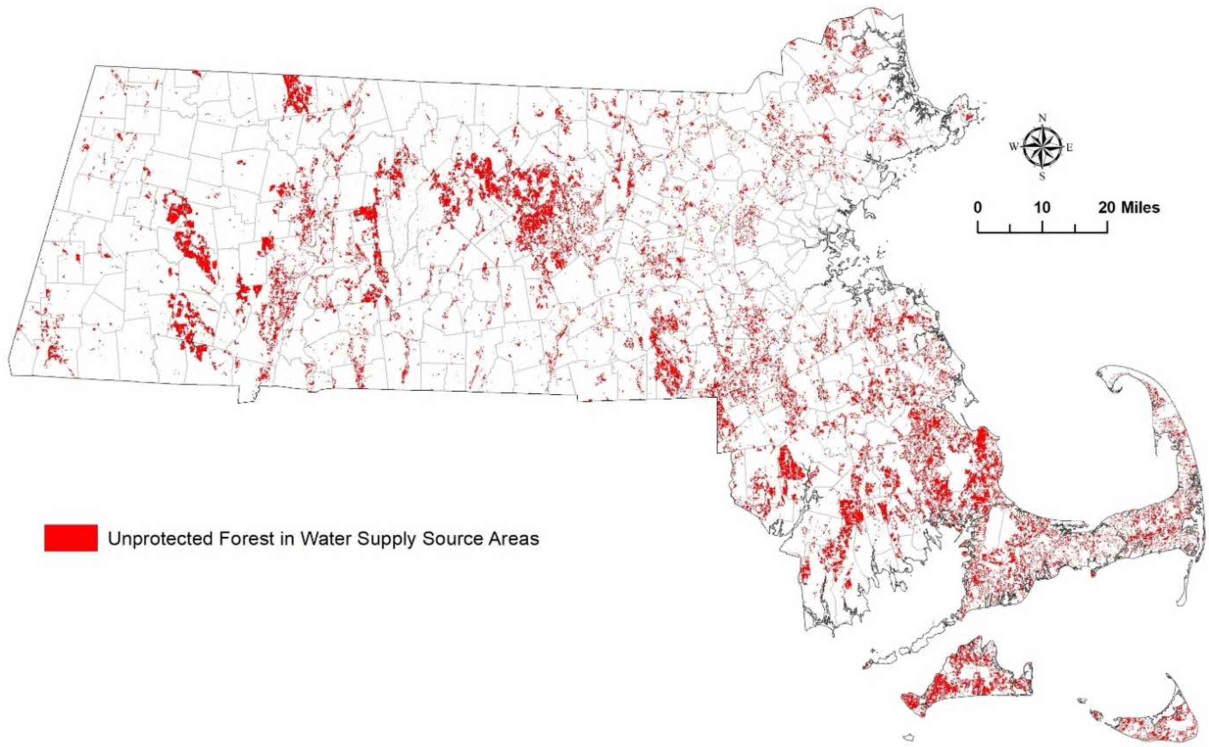


Figure 2.10. Unprotected forest cover in public water supply source areas (data: MassGIS).

(Figure 2.10). As more acres are converted each day to residential, commercial, and industrial uses, critical areas of watersheds that were once protected by the forest become threatened. Potential threats come from septic systems, lawn care practices, stormwater discharges, snow and ice melting products, and hazardous material storage. The threats to non-drinking water supply resources are equally serious, as these waters sustain critical aquatic ecosystems, rare plant and wildlife habitat, and recreational, cultural, and aesthetic benefits.

Forests are the ecological and hydrological counterweight to development. As forest conversion to residential, commercial, and industrial land uses leads to the construction of more impervious surfaces, excessive compaction of soils, and the introduction of new pollutants, streamflow and ambient water quality are likely to change in undesirable and expensive ways. The watersheds of Massachusetts are poised at the brink of major changes if population growth leads to more development of the type and character of recent years. In the face of these daunting challenges, it is imperative to commit financial and human resources to build upon innovations and successes, strengthen and extend land protection policies and programs, and encourage alternative development methods, at scales ranging from single parcels to entire regions.

Forest Conversion and Fragmentation – Carbon Storage

The most prominent threat to the ability of Massachusetts forests to sequester carbon is the conversion of forestland to developed uses. Forest conversion is detrimental in two ways: (1) by initially releasing large quantities of carbon and (2) by reducing the potential sequestration rate and total storage in

Massachusetts into the future. FIA estimates show that Massachusetts has lost 0.4% forestland from 2012 to 2017. Rhode Island and Connecticut actually show modest gains in forestland (1.3 and 3.1% respectively), while Maine, Vermont, and New Hampshire show losses (0.3%, 2.2%, and 1.9%) (Butler 2018a,b,c,d, Morin 2018a,b). Strategies to keep forestland both intact and productive will be necessary if Massachusetts continues to rely on these resources to mitigate greenhouse gas emissions.

STRATEGIES

The strategies below focus on Ecosystem Services but may apply to other Chapters. The complete list of goals and strategies can be found in the Strategy Matrix on page 15.

GOAL 1: INCREASE RESISTANCE AND RESILIENCE OF TREES AND FORESTS TO MITIGATE AND ADAPT TO THE EFFECTS OF CLIMATE CHANGE

Strategy 3: Support programs that assess, maintain, and enhance tree canopy in urban areas to reduce urban heat island effect, manage storm water, and provide other benefits

Strategy 4: Use long term monitoring to assess carbon storage trends in Massachusetts

Strategy 5: Develop initiatives that showcase science-based forest management as a viable carbon storage tool

GOAL 5: ENHANCE THE CONNECTION BETWEEN FORESTS AND PEOPLE

Strategy 39: Partner with nonprofit organizations, public lands forest management entities, land trusts, and municipalities to demonstrate the connection between sustainable forest management and ecosystem services, such as clean water and clean air

GOAL 7: ADVOCATE FOR LEGAL AND INSTITUTIONAL FRAMEWORK PERTINENT TO THE CONSERVATION AND MANAGEMENT OF TREES AND FORESTS

Strategy 53: Promote forest activities and associated programs relative to carbon storage

GOAL 8: MAINTAIN AND ENHANCE SOIL, WATER, AND AIR RESOURCES

Strategy 57: Engage with conservation partners to promote understanding of forestry BMPs

Strategy 58: Develop and support projects and practices to retain tree canopy in urban and suburban areas

Strategy 59: Support green infrastructure and low-impact development to reduce the impact of stormwater and air pollution

Strategy 60: Promote land conservation in important drinking water supply areas

Strategy 61: Promote ecological restoration and stream connectivity to enhance stream stability for wildlife passage and habitat and protection of infrastructure

Chapter 3 – Productive Capacity of the Forest

In addition to the immeasurable environmental benefits forests provide to the people of Massachusetts, our forests produce timber and other resources necessary to our way of life. Forest products provide a sustainable and more climate friendly alternative to steel and concrete building products which require more energy to produce, while at the same time providing jobs in rural parts of the Commonwealth.

Introduction

Productive capacity refers to the ability of forest ecosystems to produce timber as well as other non-timber products, such as maple syrup and ecosystem services. Ecosystem services include clean water, soil retention, wildlife habitat, carbon sequestration, recreation, and aesthetics and are covered in other chapters. Non-timber forest products ae discussed in Chapter Four. This chapter will focus primarily on the ability of forests to produce timber.

Much of the data for this chapter come from the Forest Inventory and Analysis (FIA) program of the U.S. Forest Service in Massachusetts. FIA provides information on status and trends in forests, including species, size, condition, growth, and mortality, as well as other characteristics. Additional data were also retrieved from the forest cutting plan database maintained by the Department of Conservation and Recreation (DCR) Service Forestry Program.

Productive Capacity Forest Facts	2012	2017	Change since 2012
Timberland Area (million acres)	2.875	2.874	+ 0.001
Sawtimber volume (million board-feet International ¼-inch rule)	25,265	27,390	+ 2,215
Growth-to-Harvest Removal on Timberland	4.7:1	6.8:1	+ 45%
Top four species harvested (by merchantable bole volume of trees at least 5 in. diameter at breast height)	red maple northern red oak Norway spruce black cherry	red maple northern red oak eastern white pine eastern hemlock	

Table 3.1. Productive capacity forest facts (data: FIA EVALIDator 2018).

Approximately 63% of land area in Massachusetts is forested, with 3,242,113 acres of forestland in the Commonwealth. Estimates of forestland can vary based on how forestland is defined and mapped. The U.S. Forest Service defines forestland as “land at least 1.0 acre in size and 120 feet wide that has at least 10% crown cover by live tally trees of any size or has had at least 10% canopy cover of live tally species in the past, based on the presence of stumps, snags, or other evidence.” Timberland is a subset of forestland, which the U.S. Forest Service defines as “forest land that is producing or is capable of producing crops of industrial wood over 20 cubic feet per acre, per year, and not withdrawn from timber utilization by statute or administrative regulation" (U.S. Forest Service 2016). Approximately 89% of forestland (2,874,000 acres) in Massachusetts is classified as timberland (Table 3.1).

Not all land classified as timberland may be available for harvesting due to diverse factors such as age, species composition, timber quality, accessibility, landowner objectives, regulatory restrictions (e.g., rare species or wetlands), and other complex social factors. In a 2010 paper, Butler et al. explored the concept of social versus biophysical availability of wood in the northern United States and found that actual availability of a large portion of timber is constrained by social factors, particularly landowner attitudes, much more so than by biophysical factors, such as slope. They estimate that in Massachusetts, at any given point in time, social constraints reduce the availability of timber by 67.7%, while biophysical constraints reduce availability by 5.8% (the constraints are not additive, total reduction in Massachusetts is 68.2%). Out of the 20 northeastern states in the study, Massachusetts had the sixth highest reduction in availability of wood due to social constraints (Butler et al. 2010). However, over time, the majority of forest landowners subvert social constraints as opportunities or the impetus to harvest arises, as evidenced by an analysis of 30 years of forest cutting plan data (Kittredge et al. 2017). In this study, in noted contrast with Butler et al. (2010), harvest activity was a frequent and widespread occurrence, and the principal social factor affecting the probability of harvest was distance to urban centers, with forests nearer to the Boston metro region exhibiting a negative correlation with harvest activity.

FORESTLAND RESOURCES

Forest Ownership

The Commonwealth of Massachusetts owns and manages 525,377 acres of forestland. Municipalities, the federal government, conservation organizations, and land trusts own an additional 652,354 acres. Yet, even with such large acreages under the purview of agencies and conservation organizations, private landowners own the bulk of forestland in Massachusetts: 2,064,382 acres. See Table 1.2 for more information.

Forest History

From the beginning of the abandonment of farmland in Massachusetts in the mid-1800s, forestland increased through the 1960s, as abandoned fields aggraded to pioneer forest communities (Kelty and D'Amato 2005). Some major disturbances of the past 100 years include the category 3-equivalent hurricane of 1938, the ice storm of December 2008, and in 2011, a tornado in June, Tropical Storm Irene in August, and a snowstorm in October which greatly affected trees in urban and suburban areas. The most severe damage to forestland from the 1938 hurricane was in central Massachusetts, as well as in neighboring central and western New Hampshire (Foster 1988). Old-field white pine trees, more common prior to the hurricane, were particularly susceptible to windthrow. The loss of these trees accelerated the conversion from pine to even-aged hardwoods in Massachusetts forests (Berlik et al. 2002). Rural, suburban, and urban forests have also been significantly altered by exotic insects and diseases. Chestnut blight, white pine blister rust, gypsy moth, hemlock woolly adelgid, elongate hemlock scale, emerald ash border, Dutch elm disease, Asian longhorned beetle, and winter moth are just some of the insects and pathogens that have changed our forestland (Lovett et al. 2016).

TIMBER HARVESTING TRENDS

All commercial timber harvesting activities that remove more than 25,000 board feet (25 MBF) or 50 cords, or the combined equivalent of either of those values, are required to file a Forest Cutting Plan (FCP) for review and approval by the DCR Service Forestry Program. Exempted from this requirement are smaller harvests and other tree-cutting activities like agricultural clearing and utility corridor maintenance. Valuable information about commercial harvesting in the Commonwealth is gained from these requisite cutting plans. Patterns and trends in harvest volume and products (sawlogs, cordwood, chips, and pulp), acreage, landowner motivation and intent, involvement with a licensed forester, and enrollment in a current use program are all documented. It should, however, be noted that there are limitations to utilizing information provided on FCPs, as they represent *proposed* work that may take place up to four years in the future or may not occur at all. Additionally, reported harvest volumes are not independently verified.

In addition to the estimates being for proposed work that may or may not happen, estimates of the volume of wood harvested are based on log scaling, which may be approached in different ways by the many foresters who prepare forest cutting plans in Massachusetts. It is assumed that differences in estimates even out when aggregating volumes.

On FCPs, products are estimated in different units: sawlogs (MBF), cordwood (Cds), softwood pulp (tons), hardwood pulp (tons), and chips (tons). To access total volume, these different units must be converted to a common unit of measurement, introducing additional room for inaccuracy. Despite these changes, we can look at total volume to assess general trends in harvesting and products, but these volumes are estimates. In this chapter, we present most volumes in cubic feet (ft^3) to facilitate comparison to other sources of timber data, but some are presented in board feet, and some are presented in both. For cubic feet, each original unit has been converted using U.S. Forest Service and industry conversion factors.

Over the last 10 years (with the exception of 2011), there has been a trend of increasing volume planned for harvest. Between 2010 and 2017 an average of 15,547,000 ft^3 was proposed for harvest in Massachusetts (Figure 3.1), larger than the average for 2003-2009.

Cutting plan data from 2003-2017 also shows changes in products generated from timber harvesting (Figure 3.2). The most noticeable trend is the rise in chips and pulp. In 2003, chips and pulp made up approximately 10% of total volume harvested, but by 2013, chips and pulp made up 39% of the total volume harvested. That proportion has continued to increase, reaching 44% in 2016. Sawlog production was at its highest before the 2009 financial crisis and has not returned to pre-crisis levels. Figure 3.2 also shows a spike in cordwood in 2006 and 2007, potentially a reflection of the rising cost of home heating oil in the preceding years. (In October 2003, home heating oil was $1.25/gal and by 2005, that had risen to $2.60/gal. Mass.gov 2020b)

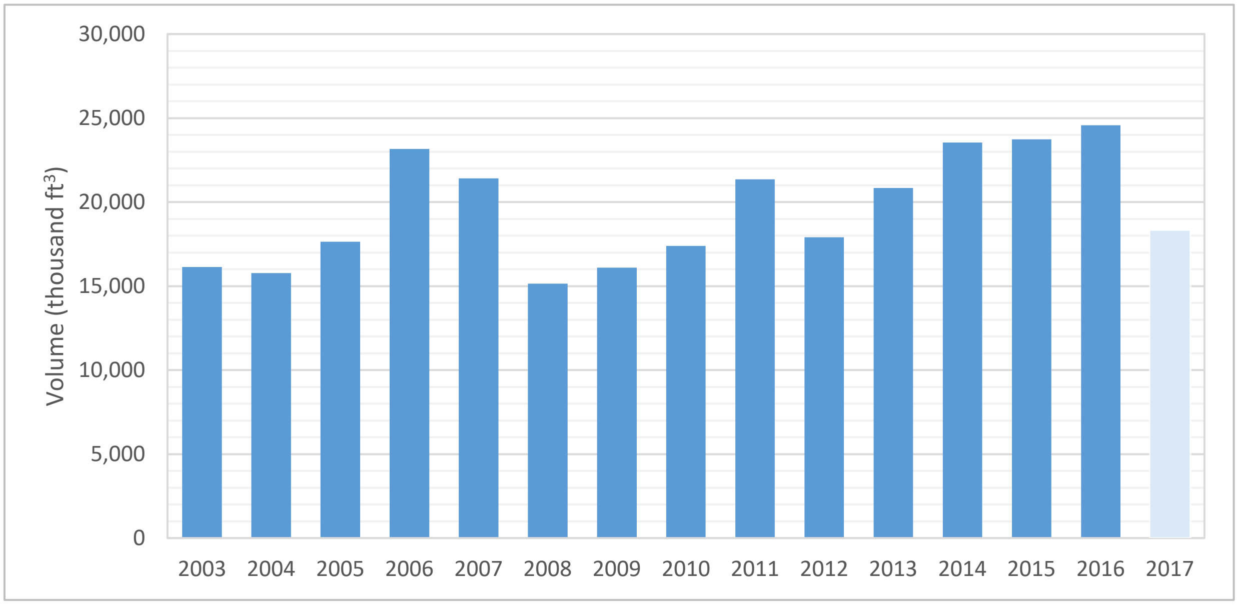


Figure 3.1. Volume proposed for harvest 2003-2017. 2017 values reflect only 10 months of data (data: DCR Bureau of Forest Fire Control and Forestry).

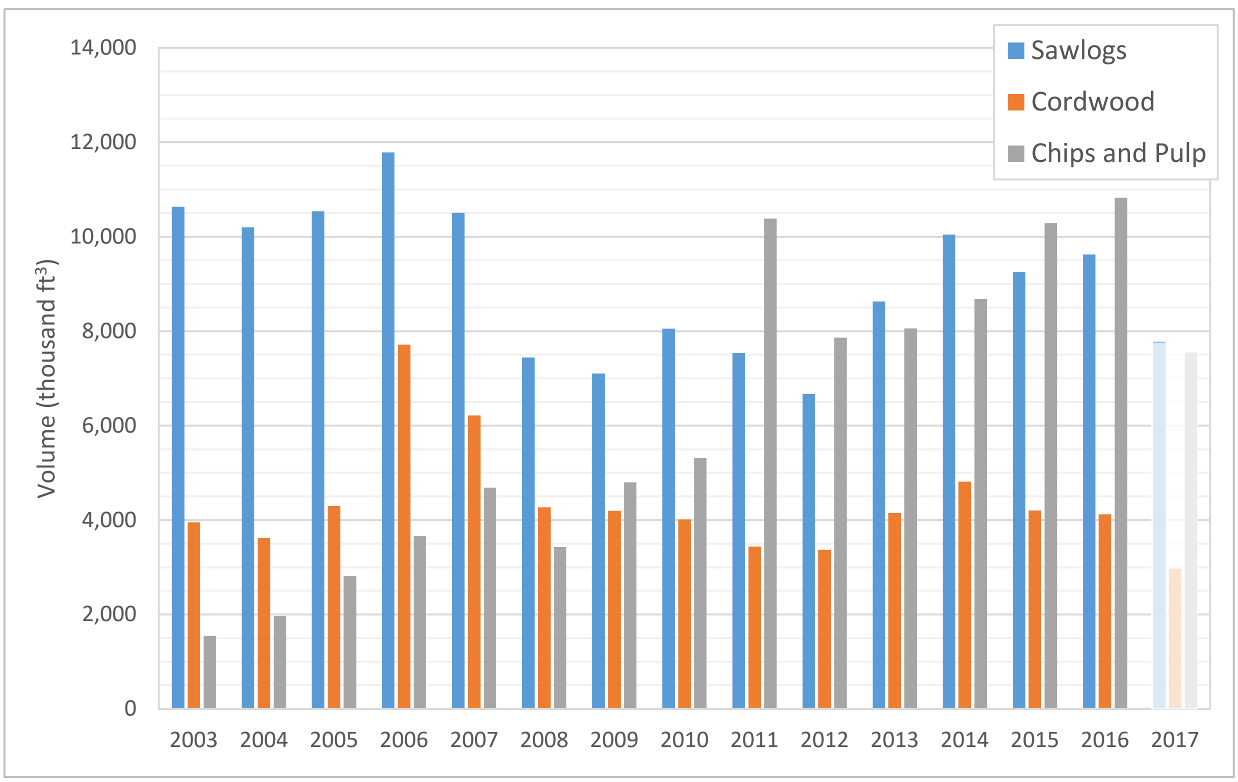


Figure 3.2. Volume of sawlogs, cordwood, and chips and pulp proposed for harvest, 2003-2017. 2017 values reflect only 10 months of data (data: DCR Bureau of Forest Fire Control and Forestry).

An important positive trend in recent years is the increase in the proportion of timber harvesting conducted under the guidance of a long-term forest management plan (FMP). The role of an FMP in guiding landowner harvesting is crucial because it indicates that a licensed forester is helping the landowner make sound long-term decisions about their forestland, which generally has positive outcomes for the productivity and quality of timber stands being managed. Thanks to incentive programs like the Forest Stewardship Program, within DCR's Working Forest Initiative, there have been significant increases in private landowners procuring the services of professional foresters, creating long-term plans for their property, and carrying out forest management activities based on this guidance (Figures 3.3, 3.4, and 3.5). Notably, 2016 was a tipping point in which the volumes of proposed timber harvest on private lands with and without management plans in place was approximately equal (Figure 3.3).

Harvest volumes and area have held rather steady, with the exception of the 2009 economic crisis, with roughly 80 MMBF harvested annually across over 20,000 acres state-wide (Figures 3.3 and 3.4). Interestingly, the total number of FCPs (Figure 3.5) has not rebounded since 2009, which may indicate that smaller acreages are no longer viable for commercial timber harvest, but operators are still harvesting comparable volumes on the remaining larger ownerships. This is consistent with trends in harvest intensity (Figure 3.6), which shows a sustained pattern of greater harvest volumes per acre, averaging 4.9 MBF/ac between 2013-2017, in comparison to the pre-2009 average intensity of 4.0 MBF/ac).

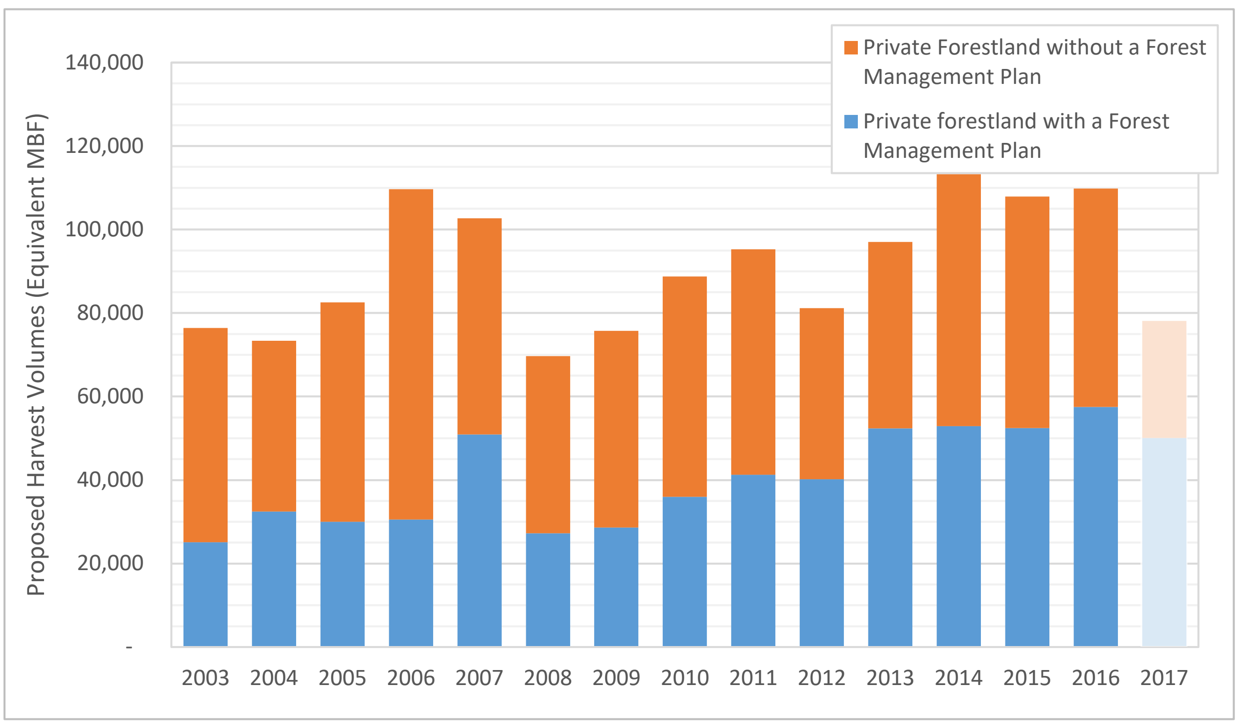


Figure 3.3. Proposed harvest volumes (MBF) on private forestland over time, separated by harvest with and without a forest management plan in place. Forest management plans include Forest Stewardship Plans and Chapter 61/61A/61B plans written by a Massachusetts licensed forester. 2017 values reflect only 10 months of data (data: DCR Bureau of Forest Fire Control and Forestry).

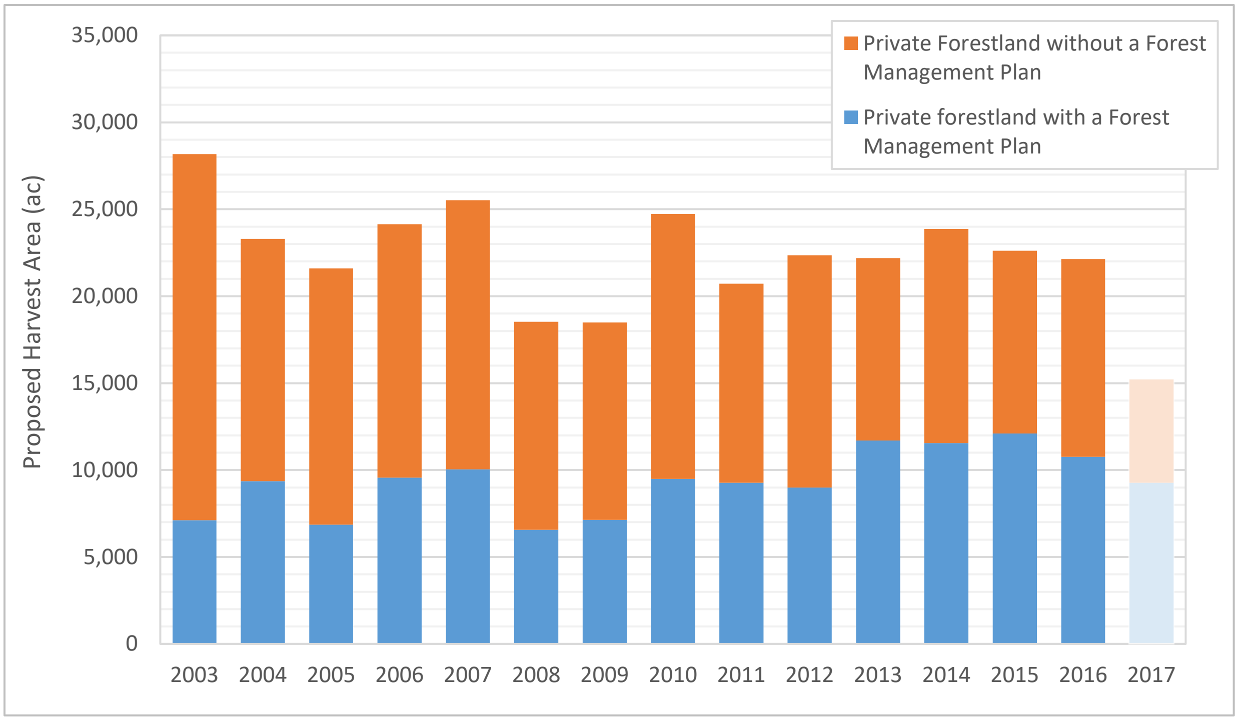


Figure 3.4. Area of proposed timber harvest in acres on private forestland over time, separated by harvest with and without a forest management plan in place. Forest management plans include Forest Stewardship Plans and Chapter 61/61A/61B plans written by a Massachusetts licensed forester. 2017 values reflect only 10 months of data (data: DCR Bureau of Forest Fire Control and Forestry).

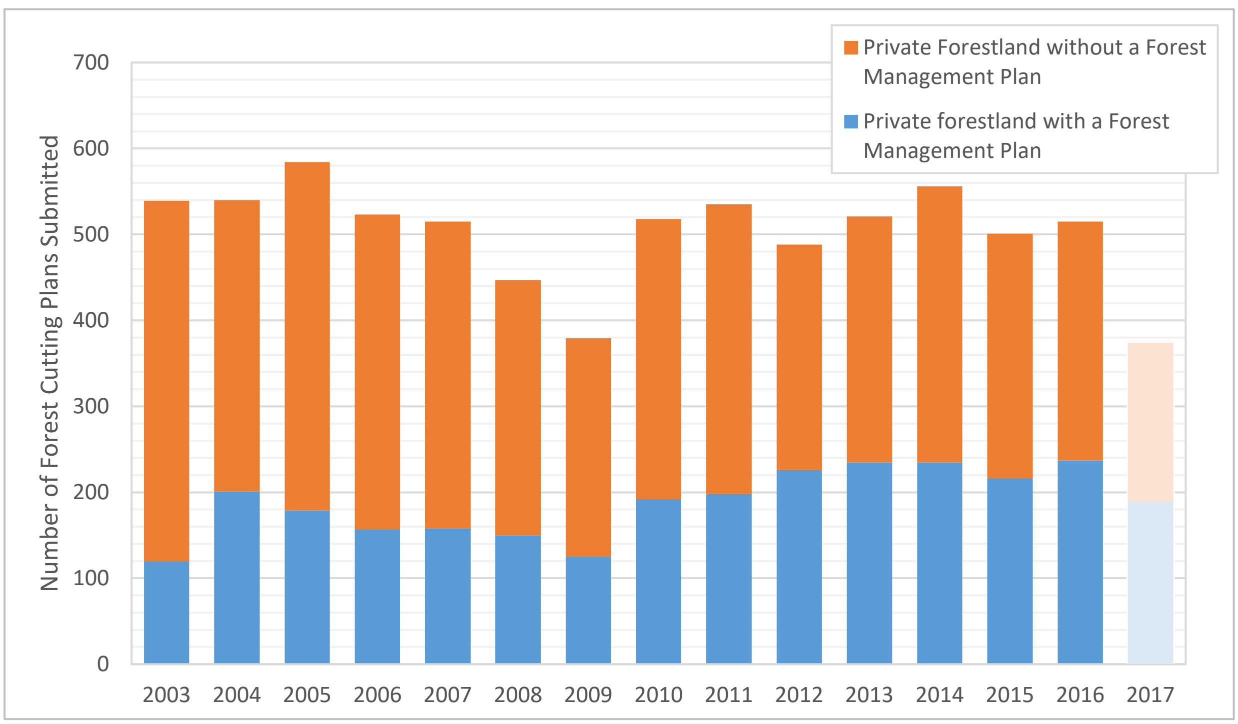


Figure 3.5. Number of forest cutting plans submitted for proposed timber harvest on private forestland over time, separated by harvest with and without a forest management plan in place. Forest management plans include Forest Stewardship Plans and Chapter 61/61A/61B plans written by a Massachusetts licensed forester. 2017 values reflect only 10 months of data (data: Bureau of Forest Fire Control and Forestry).

Although the majority of timber harvesting, both in terms of volume harvested and acres subject to harvest, occurs on privately owned forestland, trends in state and municipal timber harvest are also important components to the overall timber production activity in the Commonwealth (Figures 3.7, 3.8, and 3.9). State lands managed by the DCR and the Department of Fish and Game Division of Fisheries and Wildlife (MassWildlife) are subject to long-term forest management planning, and most municipal forestlands are managed according to a long-term forest management document. This segment of timber harvesting generally represents long-term, sustainable forestry practices and forms a baseline of broad-scale activity in Massachusetts. The lull in state timber harvests from 2009 to ca. 2013 corresponds to the Forest Futures Visioning Process, when a moratorium on cutting was enacted (see Chapter Five). Following the Visioning Process, harvest activity resumed at a markedly reduced level, reflecting the designation of substantial acreage of previously managed forestland as Reserves or Parklands.

Timber Harvesting on State Public Lands

Forest management on the DCR Division of State Parks and Recreation (DSPR) lands is guided by the direction of the *Landscape Designations for DCR Parks and Forests: Selection Criteria and Management Guidelines* (see Chapter Five). State Public Lands Forestry (also known as the Management Forestry Program) uses the principles of ecosystem management to meet the responsibilities and the public's

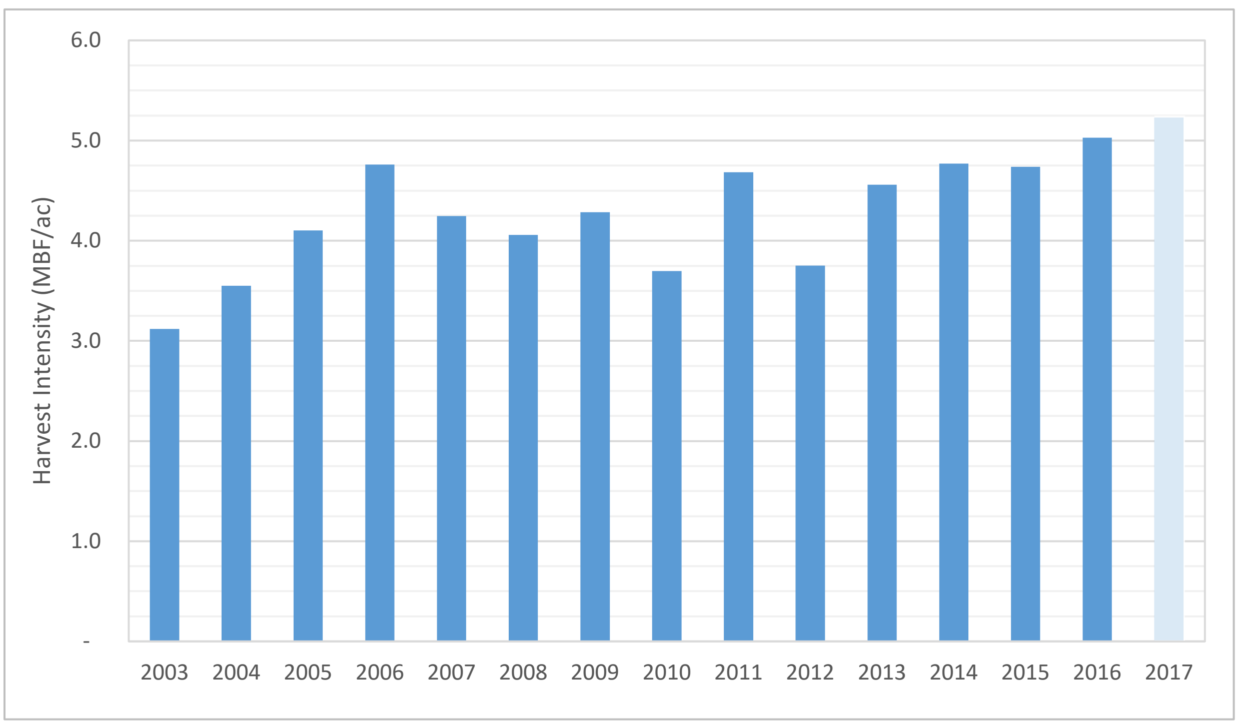


Figure 3.6. Harvesting activity as the number of board feet proposed for harvester per acre of harvest area indicated in a forest cutting plan. 2017 values reflect only 10 months of data (data: DCR Bureau of Forest Fire Control and Forestry).

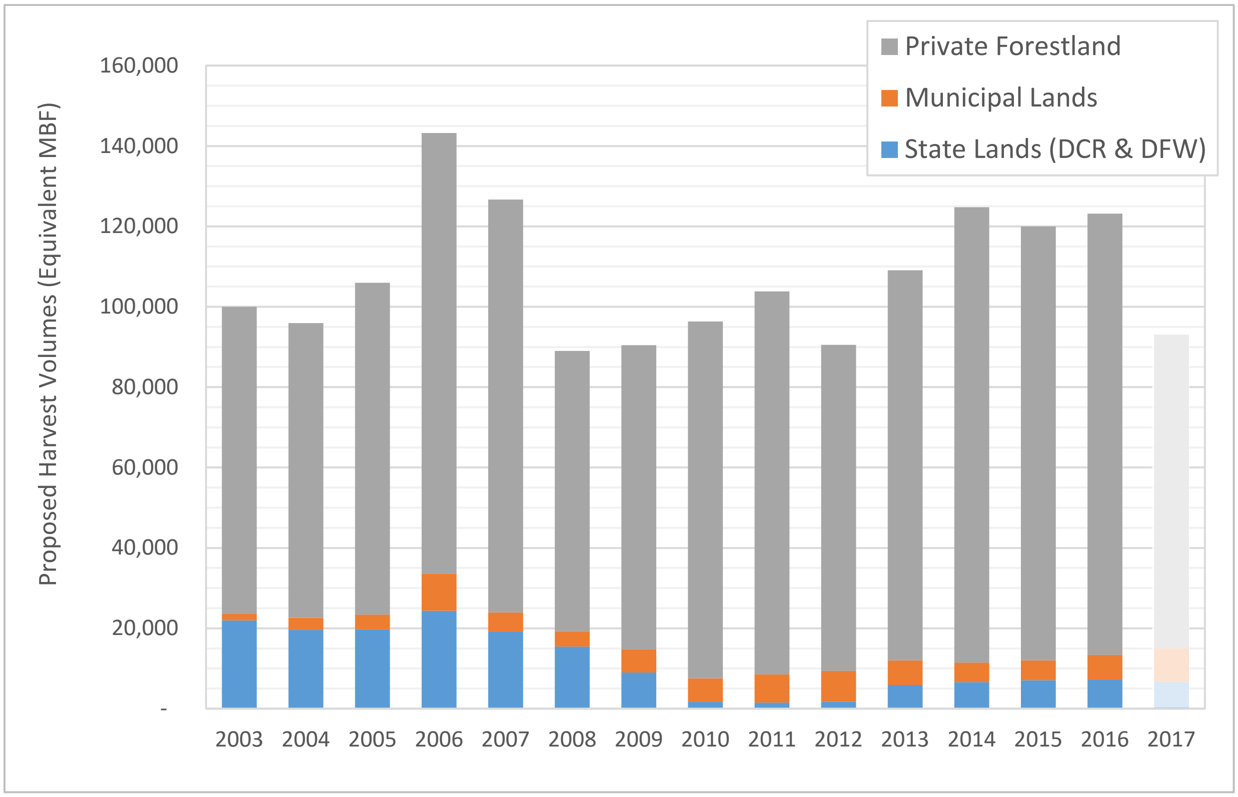


Figure 3.7. Equivalent volume of proposed timber harvests in MBF (thousand board feet) by ownership type over time. 2017 values reflect only 10 months of data (data: DCR Bureau of Forest Fire Control and Forestry).

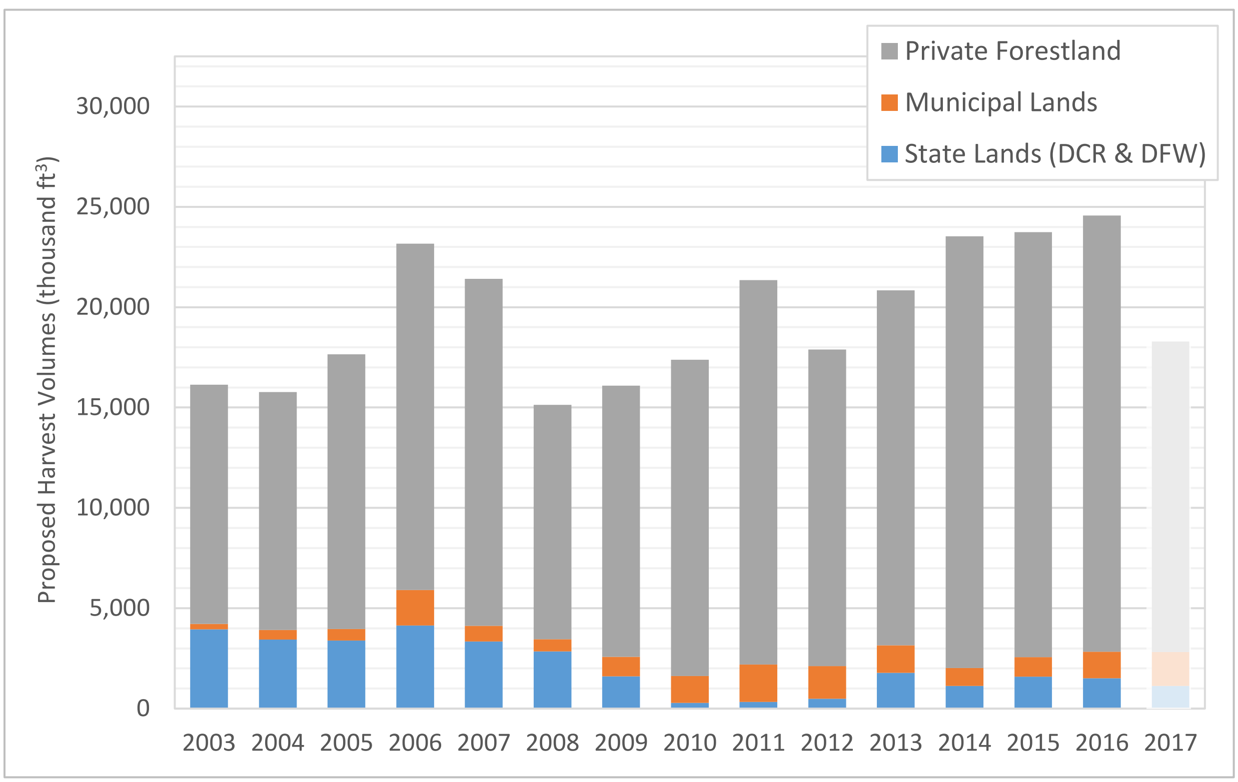


Figure 3.8. Volume of proposed timber harvests in thousand cubic feet by ownership type over time. 2017 values reflect only 10 months of data (data: DCR Bureau of Forest Fire Control and Forestry).

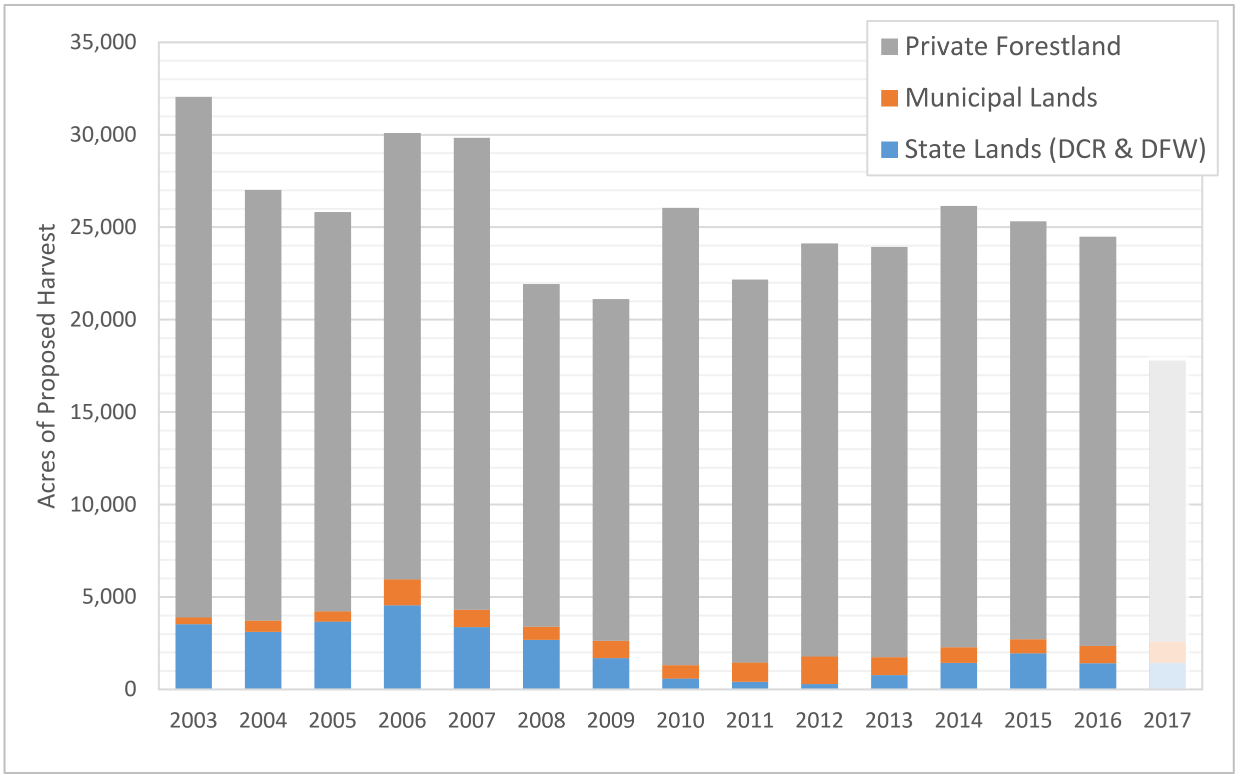


Figure 3.9. Area of proposed timber harvest in acres by ownership type over time. 2017 values reflect only 10 months of data (data: DCR Bureau of Forest Fire Control and Forestry).

expectations under MGL Chapter 132, which states "the public welfare requires the rehabilitation, maintenance, and protection of forest lands for the purpose of conserving water, preventing floods and soil erosion, improving the conditions for wildlife and recreation, protecting and improving air and water quality, and providing a continuing and increasing supply of forest products for public consumption, farm use and for the wood-using industries of the commonwealth."

To achieve its mission of balancing social needs with ecosystem health, State Public Lands Forestry uses silviculture and other management tools to create a range of desired forest and non-forest conditions. These conditions and the management guidelines to achieve them are defined in the planning process. The program produces Forest Resource Management Plans (FRMP) that are designed to provide a 100-year strategy that is condensed into an initial 10-year implementation schedule. Goals in FRMPs are intended to balance competing interests and values including providing direction for the sustainable and integrated management of natural and cultural resources, restoring and maintaining native forests to have greater vegetative diversity of size and age classes, improving wildlife habitat, increasing resilience to disturbances, balancing recreational use and aesthetics with sustainable forest management, managing for ecosystem services such as water filtration and flow and carbon sequestration, providing habitat for rare species, helping to supply locally produced wood products and energy, providing educational opportunities, and reducing wildfire risk.

Land managed by the DCR Division of Water Supply Protection (DWSP) and MassWildlife was not subject to the Forest Futures Visioning process, but each had their own separate reviews during that time. The

DWSP has the long-term objective to diversify the mostly even-aged forest into a multi-aged forest. The DWSP is determined to do this while conserving biodiversity using sustainable forestry practices. Timber is a byproduct of managing for water quality. DWSP Foresters design timber harvests that will regenerate about 1% of the managed forest every year so that gradually, over time, the managed forest will include a much broader range of age classes than is currently present. Simultaneously, large unmanaged stands of trees are left to grow to biological maturities ranging from 100 to 400 or more years of age. The overall purpose of this management is to restore the forest to more balanced proportions of young, mid-aged, and older trees comprised of the greatest possible variety of native species. DWSP's working hypothesis is that the new makeup of the forest will help ease the damage caused by inevitable future severe weather events, outbreaks of disease, and insect infestations.

DCR portable saw mill in use at Haverhill Town Forest Event, photo by Jennifer Fish

MassWildlife manages its land to meet habitat goals for wildlife and plant conservation. Through its Habitat Programs, the agency works to conserve a variety of wildlife and plants including rare and declining wildlife species identified in the *Massachusetts State Wildlife Action Plan*, as well as game animals and more common species. In many cases, this happens through restoration and management of grassland, shrubland, and young forest habitats on public and private lands across Massachusetts. Like the DWSP, any timber produced is a byproduct of working to achieve habitat goals.

CURRENT CONDITION OF TIMBER

Looking at the volume of trees, standing and harvested, is one method of estimating productivity of timberland. According to FIA data, aboveground biomass of live trees has increased since 2012, along with net merchantable bole volume, though net growth has decreased (Table 3.2). Because of the error rates associated with some FIA data, it is not possible to assess whether annual mortality or average annual harvest removals have changed since 2012, but those may be numbers to watch in the future.

Most of the forest stands on timberlands in Massachusetts are between 61 and 95 years old (Figure 3.10). The total volume of growing stock on all timberlands is 7.4 billion ft^3 (± 2.7% 68% confidence level). Sawtimber volume makes up 6.0 billion ft^3 (± 3.18, 68% confidence level) or 81% of the growing stock (Figure 3.11). The U.S. Forest Service defines sawtimber as “a live tree of commercial species containing at least a 12-foot sawlog or two noncontiguous saw logs eight feet or longer and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0 inches DBH (diameter at breast height outside the bark). Hardwoods must be at least 11.0 inches diameter outside bark.” (USDA FS 2016). Since 1985, the volume of poletimber-sized trees (trees at least 5.0 in. DBH and smaller than sawtimber-sized trees) has decreased, while volume of sawtimber has increased, an indication that Massachusetts forests are aging and that the state is losing younger forests and not replacing them. The majority of sawtimber volume in Massachusetts is in trees between 11 and 18.9 inches DBH (Figure 3.12). The total volume of growing stock has been increasing since at least 1985 (Figure 3.11). Growing stock includes all live trees 5.0 inches DBH or larger that currently or are expected to meet regional merchantability requirements in terms of sawlog length, grade, and cull deductions. It excludes rough and rotten cull trees. Similar to 2008, the composition of growing stock on timberlands is 39% conifers and 61% hardwoods, measured by net merchantable bole volume of growing-stock trees (at least five inches DBH), in cubic feet, on timberland (FIA EVALIDator 2017). The most common species of growing stock tree is red maple, followed by eastern white pine and eastern hemlock (Figure 3.13).

Timberland productivity estimates	2012	2017
Above-ground biomass live trees (thousand dry short tons)	203,360 (±2.5%)	213,576 (±2.3%)
Net merchantable bole volume live trees (million cubic feet)	7,864 (±2.8%)	8,282 (±2.5%)
Average annual net growth of growing stock (thousand cubic feet)	144,014 (±6.4%)	121,349 (±6.6%)
Average annual mortality of merchantable bole volume of growing stock (cubic feet)	44,922,691 (±9.7%)	51,946,228 (±9.4%)
Average annual harvest removals (merchantable bole volume of growing-stock trees (at least 5 inches DBH), in cubic feet)	27,832,467 (±25.0%)	21,407,149 (±24.8%)

Table 3.2. Timberland productivity estimates (data: Butler 2018c, FIA EVALIDator 2018).

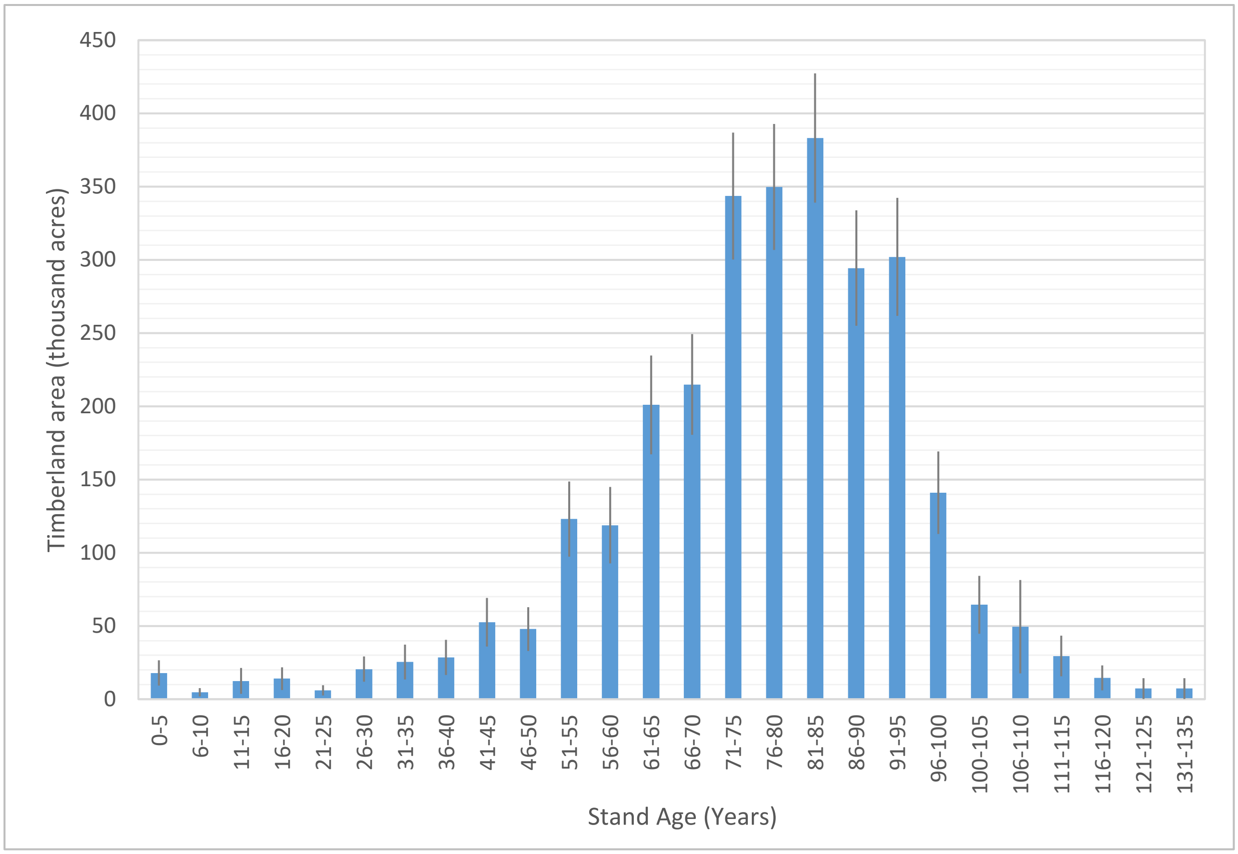


Figure 3.10. Stand age of forest stands on timberland in Massachusetts, 2017. Error bars represent one standard deviation (data: FIA EVALIDator 2018).

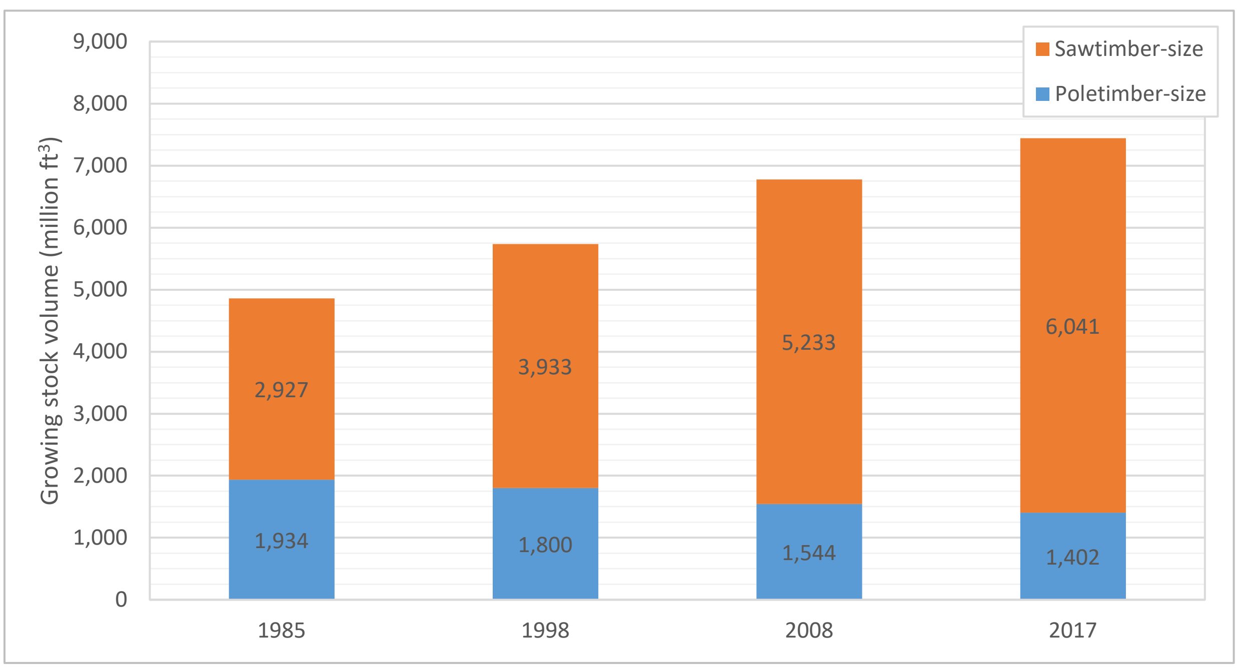


Figure 3.11. Volume of growing stock on timberland, 2017. Poletimber size: 5.0 inches diameter at breast height (DBH) to sawtimber; sawtimber: softwoods 9.0+ inches DBH, hardwoods 11.0 inches DBH. Percent sampling error for all subcategories is less than 6% (data: FIA EVALIDator 2017).

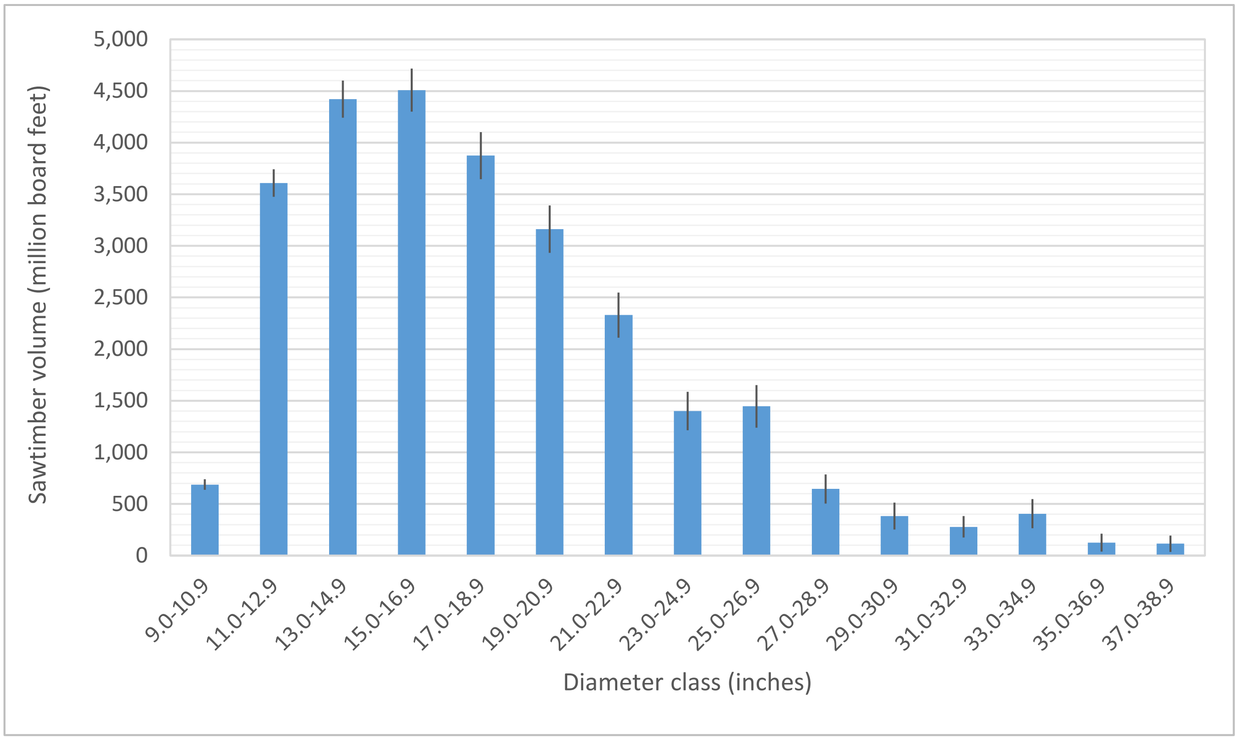


Figure 3.12. Sawtimber volume by diameter class on timberland. The minimum diameter at breast height for sawtimber is 9 inches for softwood and 11 inches for hardwood. Error bars represent one standard deviation (data: FIA EVALIDator 2017).

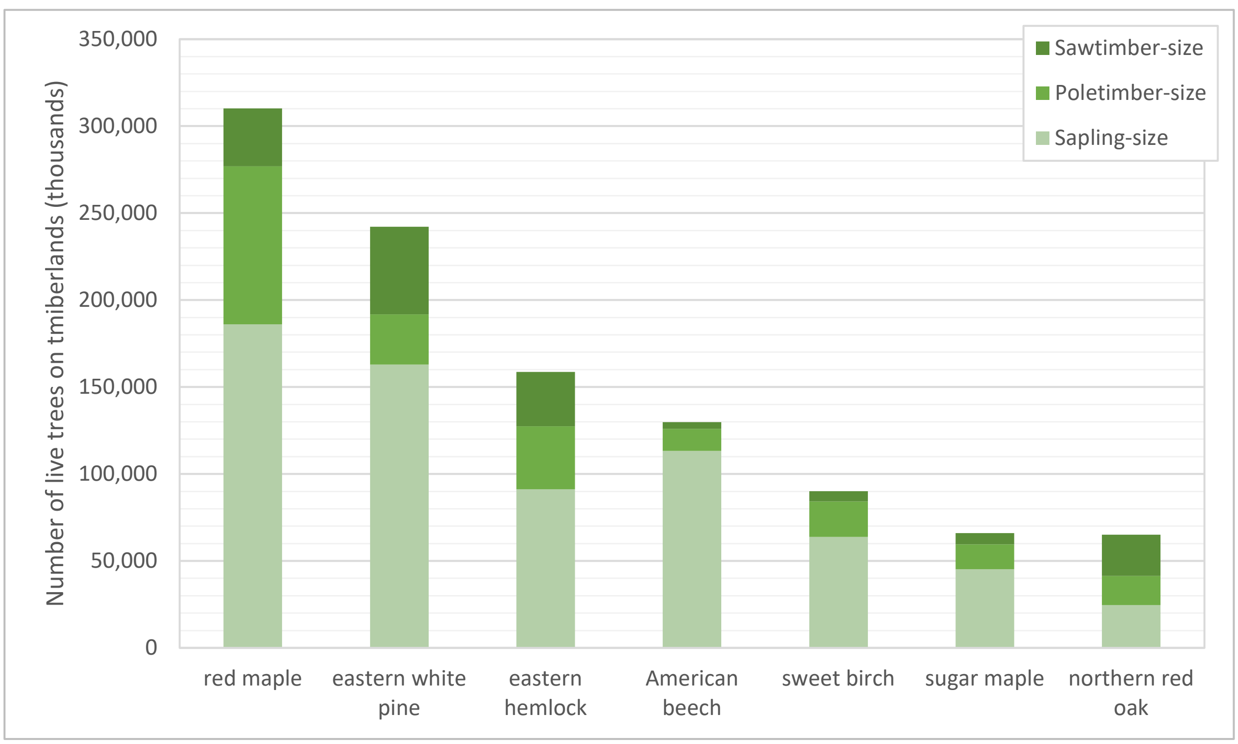


Figure 3.13. Live growing stock trees on timberland (saplings 1.0 to 4.9 inches DBH; poletimber 5.0 inches to sawtimber; sawtimber: softwoods 9.0+ inches DBH, hardwoods 11.0 inches DBH; percent sampling error for all subcategories is less than 19%), 2017 (data: FIA EVALIDator 2017).

Tree Grading

FIA data show that the average net board foot volume per live, sawlog-sized, growing stock tree on forestland has increased since 2007 from approximately 134 to 149 net board foot volume. This is potentially an indicator of an aging forest without an adequate cohort of younger, and thus, smaller, trees, as suggested above. Tree grading is a way to evaluate the quality and value of standing timber and FIA includes tree grade in its data collection. Examining average net board foot volume per live, sawlog-sized, growing stock tree on forestland by grade, the percent of each sawlog in each grade has remained fairly flat since 2005, varying by 5% at most. For recent years, the percent of total sawlog volume for grade one and two has been around 20%, while percent volume for grade three has been increasing and in 2017 was 36%. Volume of the lowest grade, grade five, has been between 10 and 12% since 2008 (Figure 3.14).

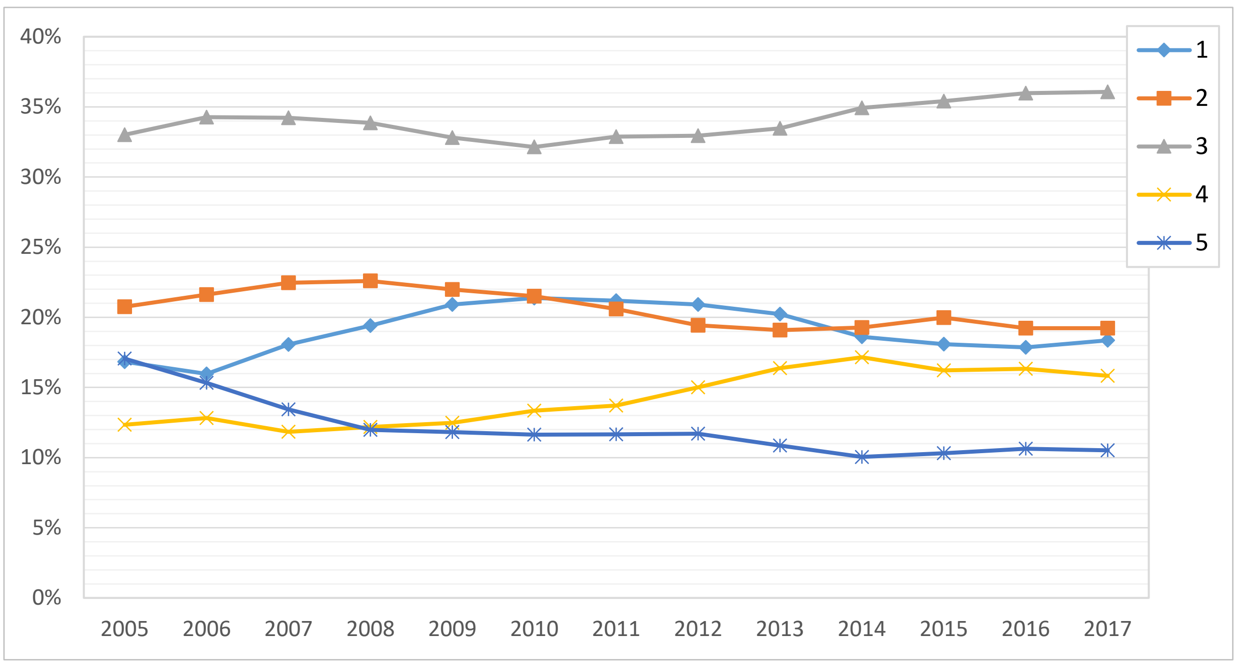


Figure 3.14. Average board foot volume per live, sawlog-sized, growing stock tree on forestland by tree grade (1 (highest) – 5 (lowest)) and year (data: FIA EVALIDator 2018).

Timber Harvesting

The majority of timber harvesting occurs in the central and western parts of the state (Figures 3.15, 3.16, 3.17, and 3.18, based on Forest Cutting Plan data from state fiscal year 2011-2017). Worcester County has the largest land area (approx. 1,500 sq. mi.) and likewise sees the greatest amount of harvesting activity, by both acres and volume harvested. The four western counties, covering the Berkshires and the Connecticut River Valley, also see significant harvesting activity. When normalized to number of harvest acres per square mile of county area, these five counties stand out with an average of between 30 and 50 acres of harvest per square mile of county area (Figure 3.18). FIA estimates that between 2013 and 2017, average annual harvesting on private lands exceeds harvesting on public lands in Massachusetts by a factor of approximately four (FIA EVALIDator 2018).

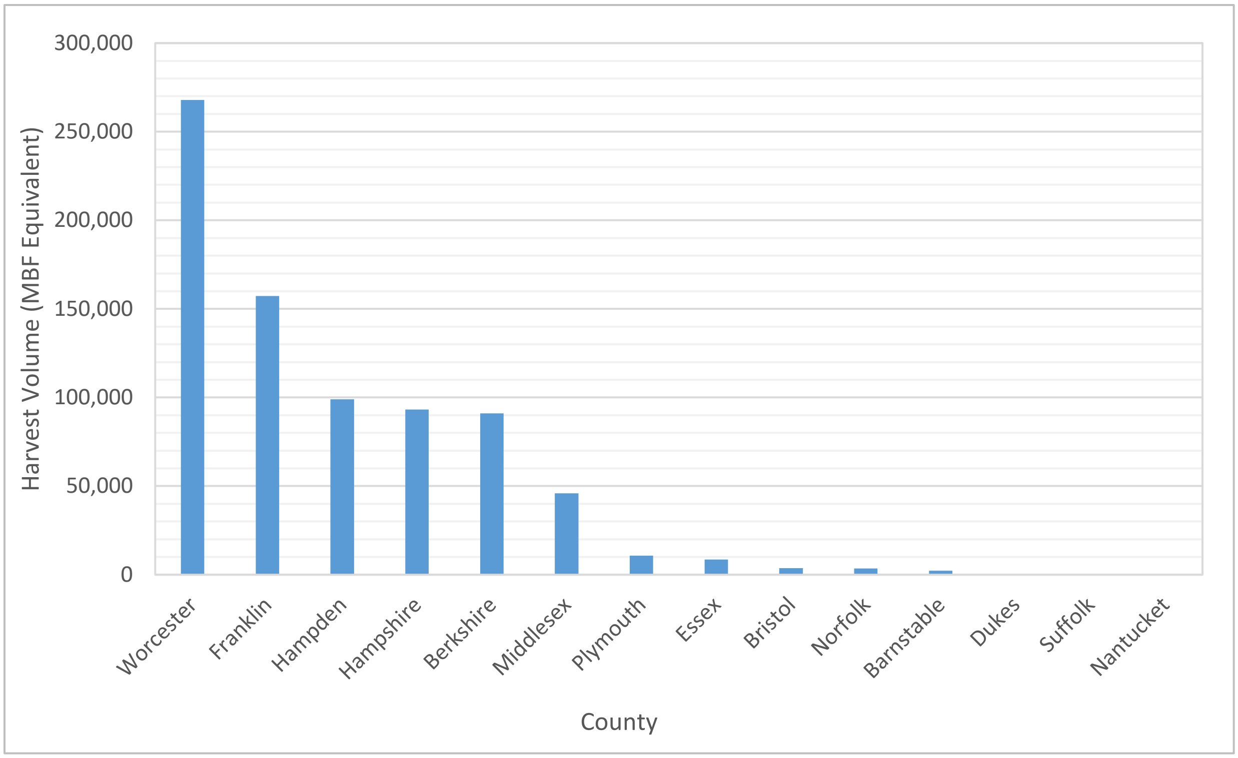


Figure 3.15. Harvest volume in MBF (thousand board feet), by county, from cutting plan data from state fiscal year 2011-2017 (data: DCR Bureau of Forest Fire Control and Forestry).

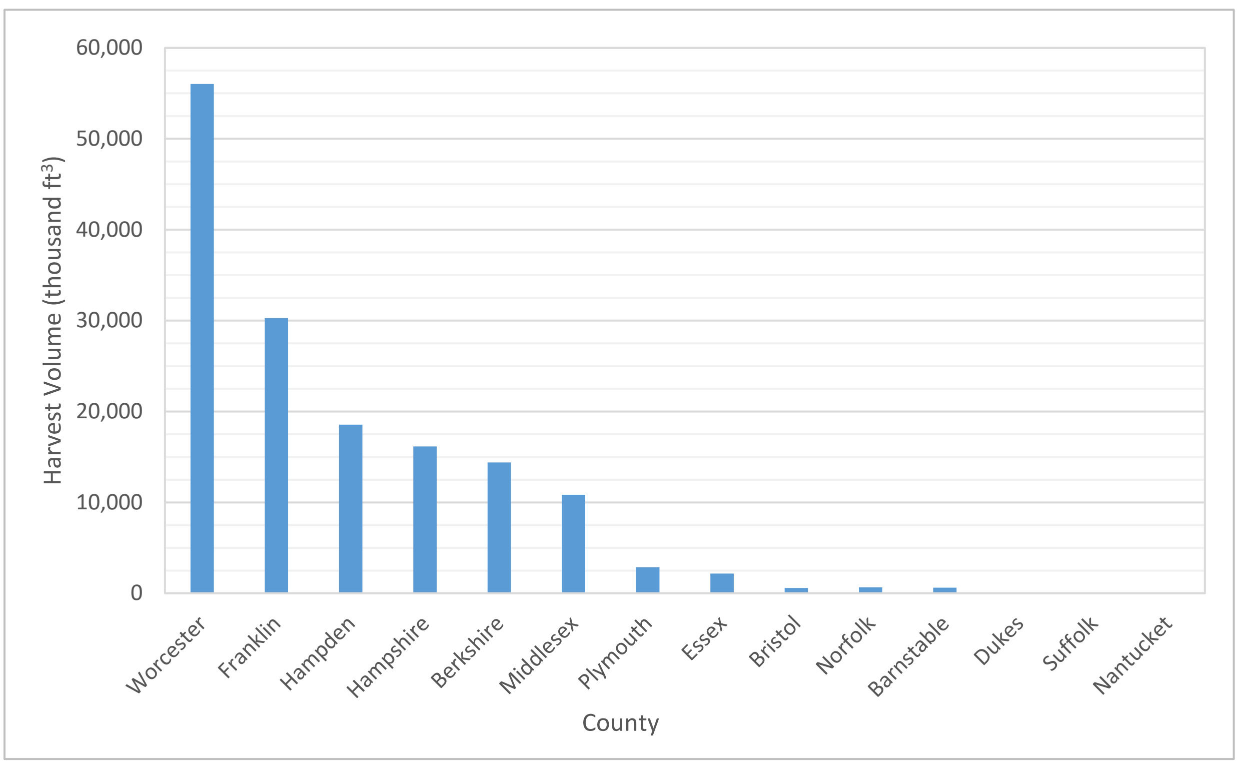


Figure 3.16. Harvest volume in thousand cubic feet, by county, from cutting plan data from state fiscal year 2011-2017 (data: DCR Bureau of Forest Fire Control and Forestry).

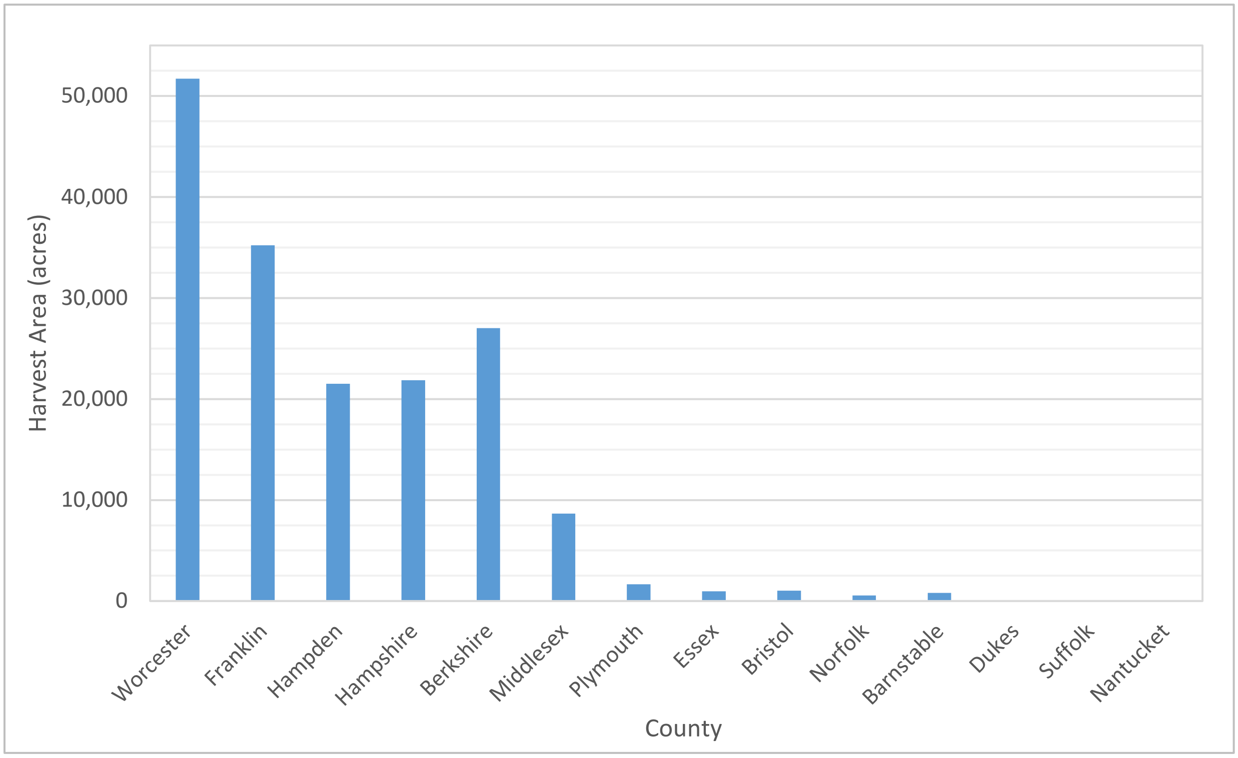


Figure 3.17. Harvest area in acres, by county, from cutting plan data from state fiscal year 2011-2017 (data: DCR Bureau of Forest Fire Control and Forestry).

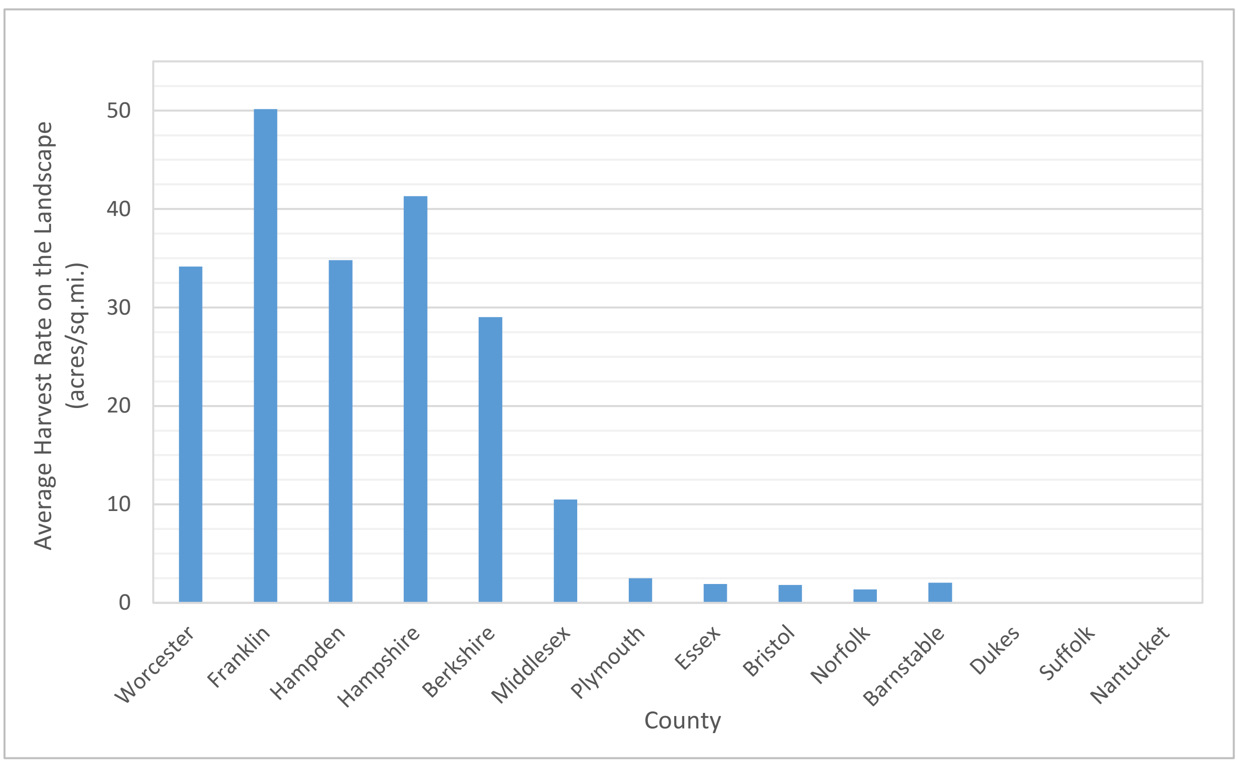


Figure 3.18. Average harvest rate (acres/mi^2), by county, from cutting plan data from state fiscal year 2011-2017 (data: DCR Bureau of Forest Fire Control and Forestry).

In Massachusetts, every person, firm, or corporation harvesting wood products for hire or profit on a timber harvesting operation that falls under the Forest Cutting Practices Act (MGL Chapter 132) must hold a timber harvester license to assure that those harvesting timber in Massachusetts are familiar with the laws governing commercial timber harvesting. Over the last 10 years, the number of licensed timber harvesters has fluctuated between 471 and 630 (Figure 3.19). Since 2009, there has been a general decline in the number of licensed timber harvesters. The steepest decline followed the economic crash of 2008, though initially the number of licensed timber harvesters increased in 2009, by 27 licenses (Table 3.3).

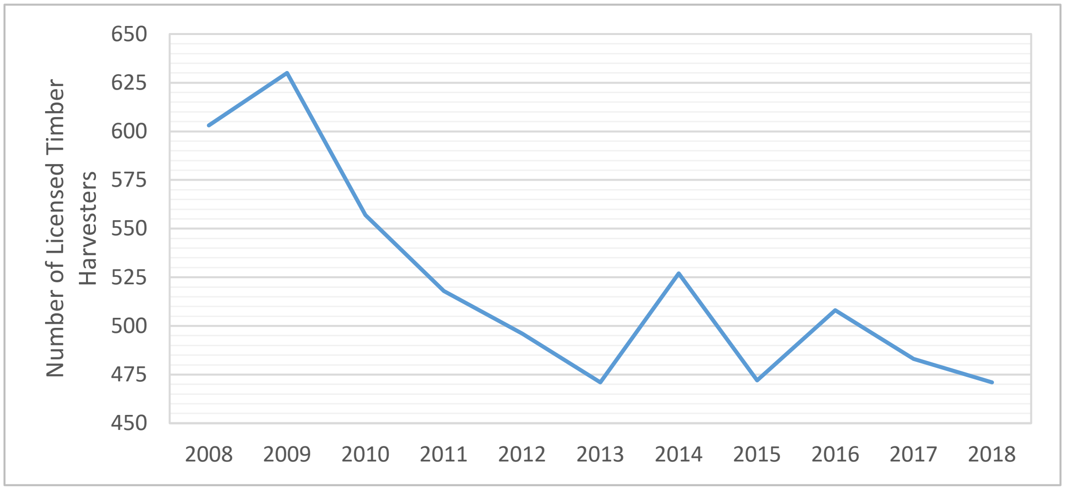


Figure 3.19. Number of timber harvesters licensed in Massachusetts by fiscal year (data: DCR Timber Harvester License database).

	Change (%)	Change (n)
1999-2018	-19.53%	-92
2008-2018	-18.24	-86

Table 3.3. Change in number of timber harvesters licensed in Massachusetts, 1999-2018 (data: DCR Timber Harvester License database).

The annual DCR Timber Harvester License Survey (2017) shows that timber harvesters use a variety of equipment in their operations, particularly in skidding methods, with most respondents reporting that they use a skidder, followed by forwarder, crawler, farm tractor, and animal.

As in *An Assessment of Forest Resources of Massachusetts*, published in 2010, the annual net growth of forests in Massachusetts exceeds annual harvest removals on timberland and forestland. In 2017, the growth to harvest removals ratio on timberland was 6.8:1. When land that was converted to other uses is included, that is, it didn't remain as timberland ("other removals"), in 2017 this ratio is 5.2:1. Red maple, northern red oak, eastern white pine, and eastern hemlock are the top four species of growing-stock trees harvested by merchantable bole volume (Figure 3.20) and have remained major components of timber harvesting over the last 10 years (Figure 3.21).

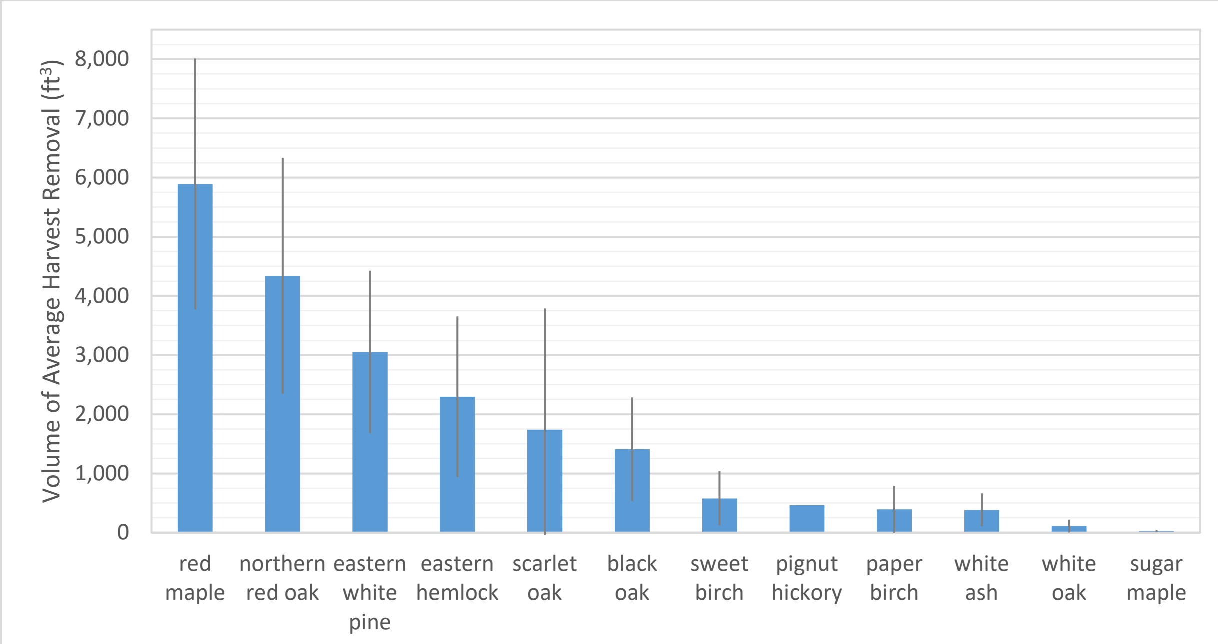


Figure 3.20. Average annual harvest removals of merchantable bole volume of growing stock trees (trees over 5.0-inch DBH) in cubic feet on timberland, 2017 (data: FIA EVALIDator 2017).

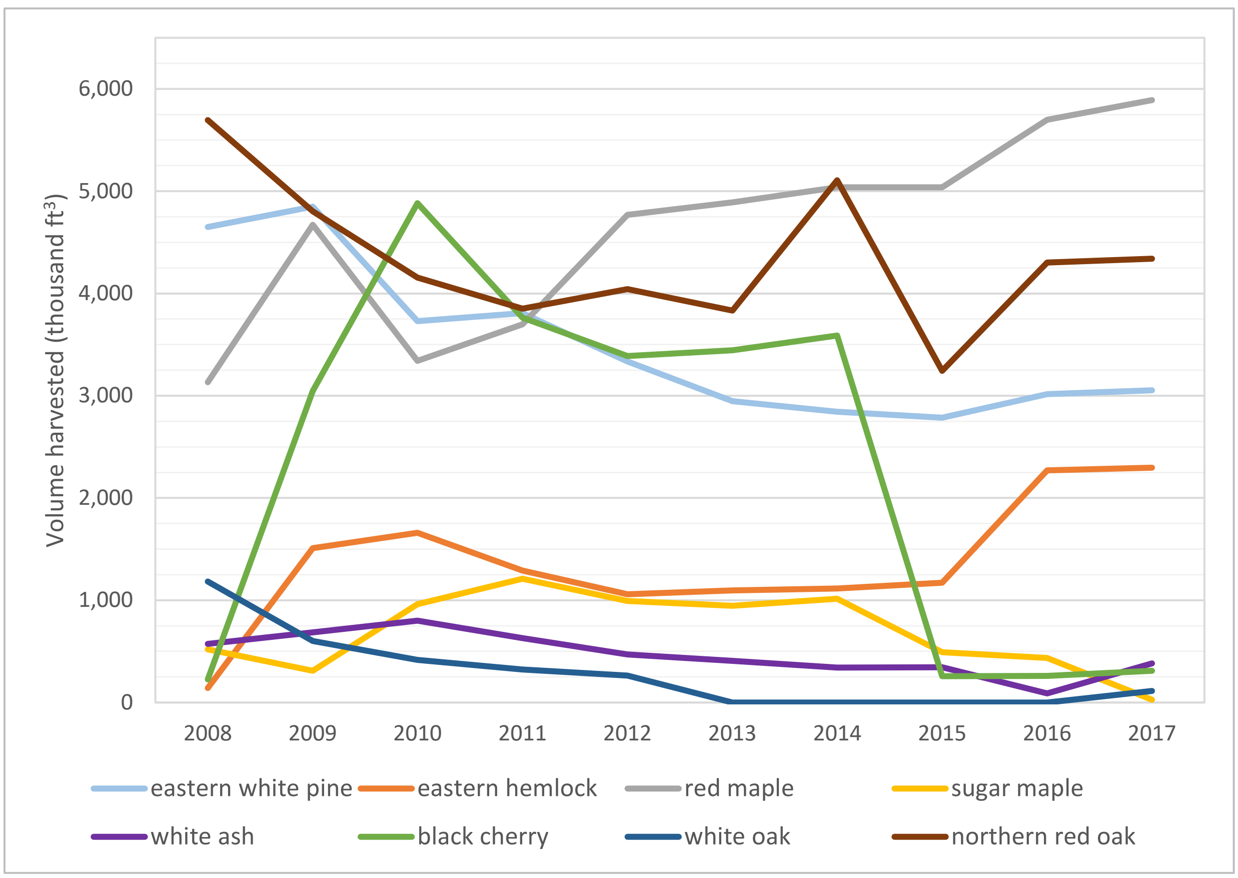


Figure 3.21. Species by estimated average annual harvest removals of merchantable bole volume of growing-stock trees (at least 5 inches DBH), in cubic feet on timberland from 2008 to 2017 (data: FIA EVALIDator 2017).

Timber Processing

Most timber leaves Massachusetts for processing by larger sawmills (>15MMBF/year) in the surrounding states and Quebec. In addition, Massachusetts logs are containerized and sold in the international timber market. Market access to these more distant buyers is made possible by a low-cost shipping method known as backhauling. Shippers with empty trucks and containers returning home after offloading higher value cargo in Boston or New York are eager to optimize logistics and will often carry a load of logs on a return to capture additional profit and maximize energy efficiency. This opportunity for forest landowners and timber harvesters provides additional product markets and price competition for harvested trees. Local mills primarily manufacture products for local users and compete well on niche high value products and volume production of bulky products such as industrial sawn wood, firewood, and mulch.

Bioenergy firms also represent important buyers for Massachusetts forest landowners. There is one 17-megawatt biomass electric plant and a growing number of thermal energy installations who purchase both mill and bole chips (NEFA 2015). Regional pellet manufacturing facilities in New Hampshire and Connecticut also purchase products from timber harvesters in Massachusetts.

Pulpwood is known to be sold to three remaining pulping facilities in New York and Maine on a limited basis due to long trucking distances and market forces.

The existing buyer/seller relationship structure is able to clear the market with little call for restructuring by landowners or their agents except when faced with sudden drops in value caused by extreme weather (e.g., tornado), insect outbreak (e.g., gypsy moth), or national economic issue (e.g., tariffs/recession).

NON-TIMBER FOREST PRODUCTS

Forests and trees in Massachusetts are the source of several non-timber forest products. These include maple syrup, medicinals, boughs and plants, and a number of wild edibles including fiddleheads, wild leeks (ramps), mushrooms, nuts, and berries. The economic impact of these non-timber forest products will be explored in Chapter Four.

URBAN FOREST PRODUCTS

In Massachusetts, 38% of the land area is considered urban[2] (U.S. Census Bureau 2012). These areas also contain trees, and though not classified as timberland, trees in these areas can provide products. Upon removal, some wood from trees in urban areas enters local markets and often is purchased by artisans

[2] For the 2010 Census, the Census Bureau classified as urban all territory, population, and housing units located within urbanized areas (UAs) and urban clusters (UCs), both defined using the same criteria

or hobbyist woodworkers. This specialized market is not well tracked and there is potential to develop this market as demand for local wood continues to increase.

EEA has hired the Pioneer Valley Commission to track the fate of local wood from storm clean up, urban wood removal, and right of way clearing to determine if there are ways to better utilize this wood for local higher value uses such as wood banks, heating local buildings, and animal bedding.

CHALLENGES AND THREATS

The main threats to the productive capacity of forests are the same as those for Massachusetts forests in general: development/conversion of forest to non-forest, including forest clearing to build ground-mounted solar arrays, climate change, fire and natural disasters, herbivore browsing, pests and disease, and economic factors.

Development/Conversion

The major threat to forestland in Massachusetts, as well as globally, is conversion of forestland to developed uses (Thompson et al. 2017). When forests are permanently lost, all the benefits and ecosystem services that go along with them are lost as well. Most forestland in Massachusetts is privately owned and these owners face many challenges. In parts of Massachusetts, revenue from periodic timber harvesting is not enough to cover local property taxes. As a result, property owners may be open to converting their forestland to other uses. To ease financial burden, property owners can enroll in tax-reducing programs or yield development rights through a conservation restriction (D'Amato et al. 2010).

A recent study of forest loss in New England found that 'distance to nearest developed land' was the greatest predictor of forest conversion to low-density development, followed by 'distance to roads'. In Massachusetts, population density was also an important factor in conversion to low- and high-density development (Thompson et al. 2017). As suburbanization increases in Massachusetts, parcels at the suburban-rural interface may be most vulnerable to conversion. Additionally, in Massachusetts, the average parcel size for nonindustrial private forestland is less than 20 acres (Kittredge et al. 2008) and as parcel size decreases, so does the likelihood of timber harvesting. Social factors for landowners, as well as minimum sizes for profitability for loggers contribute to this trend (Kittredge et al. 2017).

At the time of writing, there is concern about the specific conversion of forestland to fields for ground-mounted solar arrays. The state incentivizes installation of solar panel fields as a means to increase clean, renewable energy options. The latest results show that 24% of installations were placed on previously forested lands. Since 2012, 6,000 acres of previously undeveloped land were converted to large-scale ground-mounted solar arrays (Ricci et al. 2020). The intent of the state incentive program was not to promote forest conversion, but rather better utilize gray space. However, if current trends continue, as much as 150,000 acres of land could be lost to solar development (Ricci et al. 2020). In the

Spring of 2020, new regulations were announced to adjust the program to balance these two important priorities.

A report from Harvard Forest suggests that under trends from 1999-2005, if the 'business as usual' scenario of development continues, developed area in Massachusetts will increase from 0.98 million acres to 1.35 million acres, with a corresponding loss of forests from 3.2 million acres to 2.85 million acres by 2060 (Blumstein et al. 2014).

Climate Change

Massachusetts continues to experience a changing climate, though there is uncertainty on how that will affect productivity of northeastern forests. With a longer growing season and more carbon dioxide in the atmosphere, productivity of biomass may increase, but drought, changes in suitable habitat, changes in pests and diseases, and continued air pollution and acid rain may negatively affect productivity (Rustad et al. 2012, Janowiak et al. 2018).

Projections for Massachusetts from the National Climate Assessment suggest that the state will continue to experience warming temperatures, including more days above 90°F and nights above 70°F. Precipitation in winter and spring is projected to increase, with more precipitation falling as rain and an increase in extreme precipitation events (days with over two inches of rain). Warmer temperatures will increase evaporation and with changes in the timing and intensity of rainfall, natural droughts may be exacerbated (Runkel and Kunkel 2014).

Warmer temperatures, as well as increased precipitation falling as rain in winter, will likely pose challenges for logging operations and cause a decrease in harvest productivity. The Natural Heritage and Endangered Species Program imposes some restrictions on timber harvesting, including only allowing harvesting in some areas during winter, when the ground is frozen, to protect endangered species. If harvesters do operate in rain or wet ground conditions, it can damage roads, soils, and waterways. It is possible that there will be fewer days with optimal, or even adequate, conditions for timber harvesting under a changing climate, and that substantial acreage may become effectively inaccessible without suitable ground conditions, which effectively shrinks the total availability of timberland for management. Trade publications, such as *The Northern Logger*, are discussing the new climate change-related challenges to timber harvesting and predict that these challenges will increase the cost of operating (Berry et al. 2019). Through the Working Forest Initiative, Massachusetts is beginning a program to evaluate the effects of climate change on timber harvesters in the state.

Economic Factors

Along with the challenges for timber harvesters related to climate change, the decline in the number of licensed timber harvesters in the state threatens the ability of landowners to manage their land through timber harvesting. Additionally, the distance to pulpwood processors adds costs and other challenges to processing low-grade wood.

Goats assisting with vegetation control at the Middlesex Fells Reservation, photo by DCR

Insect Pests, Disease, and Invasive Plants

There are many insect pests, diseases, and invasive plants present in forests in Massachusetts and these will continue to pose challenges. The impact of climate change on pests and disease is another factor to consider. Research suggests that invasive plant growth may increase under changing climate conditions (Dukes et al. 2009, Janowiak et al. 2018).

Consequences for invasive species under climate change may be wide-ranging, with changes brought about by altered movement of invasive species, as well as changes in species' ability to survive, establish, and spread (Hellman et al. 2008). While it may be hard to predict how climate change will specifically alter pest and disease regimes, it is known that insect activity—consumption, development, and movement—increases as temperature increases (Bale et al. 2002). As the climate warms, we may expect to see increases in insect activity, both from our native insects, as well as exotic, invasive imports. Insects such as southern pine beetle, native to the southeastern United States, will continue to expand northward under a warming climate (Weed et al. 2013). Insects whose survival was previously limited by cold winter temperatures, such as the exotic, invasive hemlock woolly adelgid, will likely increase their ability to survive as winter temperatures warm (Paradis et al. 2008). Increased insect activity, in combination with other stressors related to climate change, such as drought, may increase the vulnerability of our forests to secondary insects and diseases that historically have been of little concern on the landscape scale, such as the root and butt rot pathogen *Armillaria* and the two-line chestnut borer (Dukes et al. 2009).

Fire and Natural Disasters

Massachusetts averages around 1,595 small-scale wildland fires annually. Fire and natural disasters, including hurricanes, drought, tornados, ice storms, wildland fires, and insect and disease outbreaks have the potential to not only damage standing timber on the production side, but also to affect the price for timber and wood products when damage is widespread. The risk to the resource and to the market are not independent. Prestemon et al. (2001) explore this relationship and implications for landowner decision-making in depth.

STRATEGIES

The strategies below focus on Productive Capacity of the Forest but may apply to other Chapters. The complete list of goals and strategies can be found in the Strategy Matrix on page 15.

Goal 2: **Manage Forest Ecosystem Health and Biodiversity**

Strategy 11: Continue to develop and implement forest resource management plans on state land

Strategy 12: Advocate for balanced, long-term sustainable forest management on public and private land

Strategy 13: Encourage private landowners and municipalities to develop forest stewardship and management plans

Chapter 4 - Socioeconomic Benefits

Forests impact the social and economic well-being of the Commonwealth's citizens in numerous ways. From jobs in the forestry and wood processing industries, to recreation and tourism, to funding for wildlife habitat management, forests are inextricably linked to the values held by society and are shaped by the economic pressures and opportunities borne out by those values.

The forest products industry employs over 17,000 workers, while another 9,000 are employed in the sectors that include and support the greater forest-based recreation economy.
Secondary wood processing represents the bulk of the forest products industry in Massachusetts with an estimated $2.5 billion in gross state output and 13,100 jobs (NEFA 2015). This sector represents 76% of the total forest-based manufacturing jobs located in the Commonwealth.
Over 43,800 homes in Massachusetts use wood or wood pellets as their primary heat source.
From FY2010 through FY2019, DCR administered $2.7 million to over 1,700 landowners who collectively steward 159,650 acres of forestland.
Since its inception, DCR has awarded $226,000 to more than 200 landowners, enrolling more than 27,000 acres in the Foresters for the Birds Program.
There are 168 active licensed foresters and 468 active licensed timber harvesters in Massachusetts.
The Greening the Gateway Cities program has planted 26,000 trees to date.
It is estimated that recreation and tourism activity generate $2.2 billion in economic activity throughout the state.

Table 4.1. Socioeconomic forest facts.

Introduction

The forests and trees of Massachusetts collectively provide a multitude of essential and cascading benefits, ranging from products as tangible as firewood for heating homes to values as intangible as the aesthetic beauty of the forested landscape (Table 4.1). Thousands of people are employed or engaged in innumerable ways to deliver diverse benefits to the people of Massachusetts, and, as our population continues to increase, the work of delivering these benefits also increases.

The socioeconomic benefits of properly stewarding our collective forest resources include: 1) direct employment in forest-based and forest products-based sectors, 2) economic value of products generated, including value added, and 3) the enhanced well-being of the citizenry. Additionally, funding opportunities to implement proactive wildlife habitat or forest stand improvement projects generate economic activity in support of elements valued by society on lands that lack the commercial value to generate more traditional types of forest-based economic activity. More complex are the issues surrounding forest conservation and the taxable land base of communities, where conservation is at risk of being viewed as undesirable due to budgetary constraints, especially in our smallest towns.

A 2015 synthesis of Massachusetts' forest-based industries reported that the total annual gross state output of Massachusetts' forest products industry totals nearly $3.0 billion, with an additional $2.2 billion generated by the forest-based recreation economy. Correspondingly, the forest products industry employed over 17,000 workers, including the maple sugar and Christmas tree sectors, while the equivalent of another 9,000 jobs were found in the sectors that include and support the greater forest-based recreation economy. Additionally, over $4.5 million in cost-share payments have been administered in the past decade by the Commonwealth in support of sustainable forestry and wildlife habitat projects, mostly paid directly to individual private forestland owners.

FORESTRY AND TIMBER HARVESTING

Employment

Traditionally, timber harvesting and wood processing were the predominant employers in the forest sector. Despite the continued closure of small, local sawmills, and timber markets becoming increasingly distant from southern New England, timber harvesting remains a common activity. At the close of 2018, there were 468 active licensed timber harvesters in Massachusetts, the majority of whom operate as sole proprietors.

With private forestland comprising over two million acres of Massachusetts' land base, consulting foresters are a small, but integral component of the forest-based workforce. Since its inception in the early 2000s, the Massachusetts forester licensing system has issued licenses to nearly 450 individuals. Of these, 168 were active in 2018, with 36 of these employed by the Commonwealth. The remaining 132 private consulting foresters are variously engaged in writing long-term forest management plans, orchestrating and overseeing timber harvesting operations, conducting boundary line maintenance, controlling invasive species, or otherwise informing or advocating on behalf of their clients.

Urban forestry extends the workforce even further. As of December 2019, the International Society of Arborists (ISA) note there are 565 certified arborists in Massachusetts. The Massachusetts Arborists Association certifies 817 arborists. It is not known how many individuals are certified by both organizations. Additionally, there are 99 Qualified Massachusetts Tree Wardens.

Logs

Forest landowners derive income from harvesting timber, and the value of a timber harvest lies principally in the stumpage prices paid for the standing timber. Stumpage values slumped in the mid- to late-2000's, coinciding with the nationwide economic downturn. Although these prices have rebounded considerably, they have not returned to pre-downturn levels (Figure 4.1). While individual species can

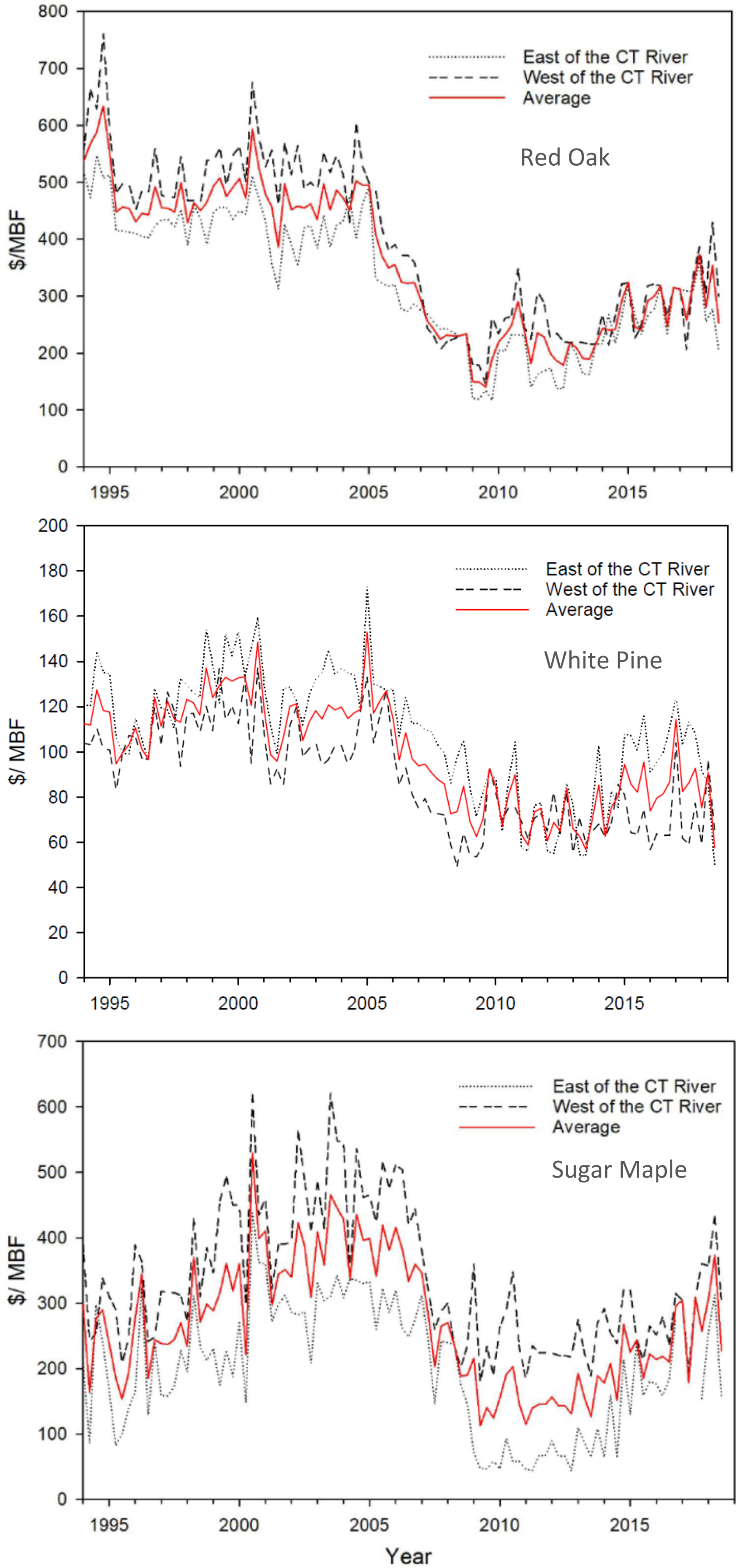


Figure 4.1. Stumpage trends for red oak, white pine, and sugar maple, the most representative principle components of timber harvesting operations in Massachusetts. Prices have been adjusted for inflation and are shown in 2018 dollar values ([*MassWoods Stumpage Trends*]()*).*

fetch very high values, overall trends in harvest activity, including number of forest cutting plans filed and total volumes harvested, are driven by our most prevalent species, especially red oak (Kittredge and Thompson 2016) which continues to experience its own price volatility. International markets have also been increasingly important; present volatility surrounding international commerce has led to abrupt declines in log prices across the region.

Lumber

Local sawmills declined significantly in the latter half of the 20th century and several mills have closed since 2010. However, a variety of milling operations remain, ranging from traditional stationary sawmills to small-scale portable mill operators. The most current available data indicate a total of 154 active milling operations. Stationary mills comprise more than one quarter of these at 43. The remainder consist of 40 portable sawmills and an additional 71 operations of unknown status.

The declining number of active sawmills is a challenge in Massachusetts. The 1956 report *The Timber Resource in Massachusetts* documented 365 active sawmills in the state; two-thirds of which were stationary mills. By 1971, that number declined to 130, 94 in 1993, 88 in 1996, and a 2005 survey showed 32 sawmills and 12 portable band mills. Massachusetts does not require registration of mills, but anecdotally, there is a trend toward current operators entering the market as a second career and operating mills largely to break even. As was true at the time of the 2010 *An Assessment of Forest Resources of Massachusetts*, most timber harvested in Massachusetts leaves the state for processing. Barriers to in-state processing include high energy and transportation costs, smaller lot sizes, and the diverse forest types making economies of scale with single species difficult (Sean Mahoney, DCR, personal communication, May 2019). Other challenges include the aging population and declining number of licensed timber harvesters in the state (Egan, 2011; Kittredge et al., 2017).

WOOD HEAT

Firewood continues to be a widely utilized product derived from forest management. Particularly in more rural communities west of the I-495 corridor, as well as on the South Shore and Cape Cod, wood stoves are a common appliance in homes. Many homes heat exclusively with wood, even when other fossil fuel-burning centralized heating systems are present. A 2012 survey by the U.S. Census Bureau's American Community Survey, found that over 43,800 homes in Massachusetts use wood or wood pellets as their *primary* heat source (Figure 4.2). This represents about 2% of households in the state.

The harvesting, processing, and transport of firewood to the end user represents, to this day, one of the very few truly localized economies, with the entire span of the supply chain, from resource to consumer, occupying a very small geographic area. Dollars spent on firewood also largely stay within the community from which the trees were harvested.

Thirteen thousand rural households in Massachusetts struggle with energy insecurity (U.S. EIA 2009). This often leads to vulnerable people being forced to make a difficult decision between paying for

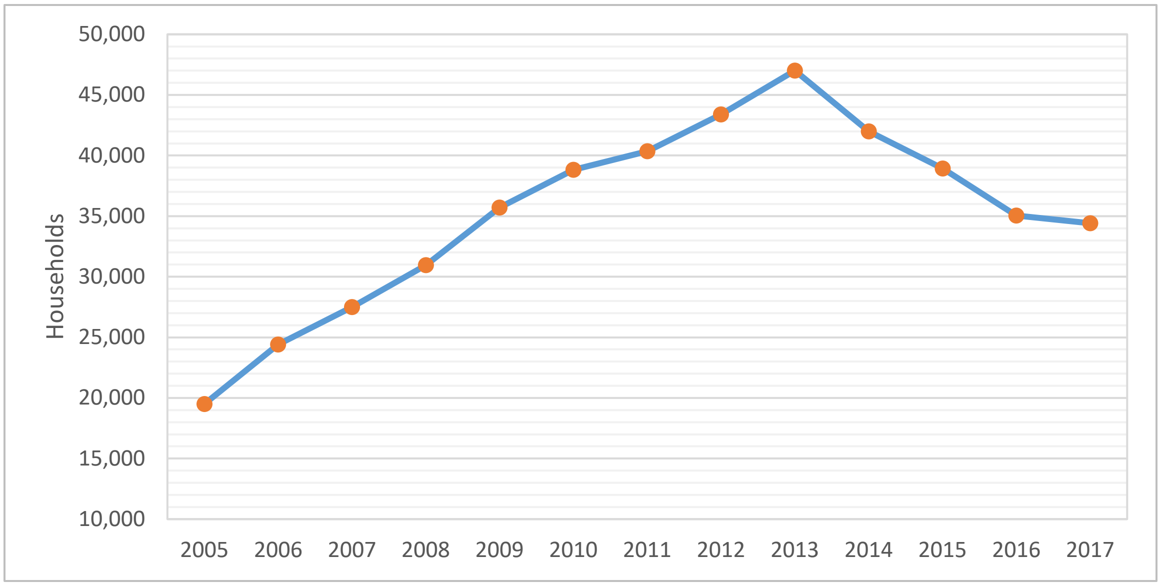


Figure 4.2. Massachusetts households using wood for primary heat, 2005-2017 (data: U.S. Census Bureau American Community Survey).

heating fuel or other essential household expenditures such as food and medication. Forgoing heat may allow families to address more pressing needs, but it is at the expense of maintaining healthy indoor air temperatures (WHO 2018). People struggling with energy insecurity may also be forced to burn green wood which has serious community health impacts due to exponentially higher particulate emissions (EPA 2013).

The Community Wood Bank Program, founded in 2015 with the support of a U.S. Forest Service Landscape Restoration Grant, works to empower municipalities to improve the utilization of surplus trees. A wood bank works as a cooperative project between local and state governments. Municipal Tree Wardens facilitate the delivery of logs to a central processing yard where the state wood utilization team safely converts logs into rounds or split firewood. Processing is then completed by volunteers who split and stack wood for drying. Distribution of dry firewood is handled through existing social aid organizations and the community. Currently the program operates in three municipalities and provides 45 cords per year to 73 households.

Wood pellet fuel has become well-established in households throughout Massachusetts as well. Free-standing stoves are a frequent fixture in many homes, functioning at least as a secondary heat source, and oftentimes the primary heat source. Centralized systems for combined heat and hot water have also become more common, and such installations generate a consistent and predictable demand for wood pellets on a yearly basis.

Although not yet present in Massachusetts, wood pellet-producing facilities are as close by as southern New Hampshire (New England Wood Pellet, Jaffrey, NH). North-central Massachusetts is within the procurement area for this plant, and timber harvests in that area routinely supply roundwood for pellet production.

More broadly, wood heat at the institutional scale, capable of heating a complex of buildings or other large structures, is gaining a foothold. With funding from the U.S. Forest Service Wood Innovation Grants, the Massachusetts Statewide Wood Energy Team, coordinated by the Massachusetts Forest Alliance, is working to promote renewable, modern wood heating initiatives for residential, municipal, and commercial heating projects. Dozens of systems burning wood pellets, energy-grade “clean” wood chips and even cordwood have been installed throughout Massachusetts (MFA 2019) in settings ranging from churches and schools to municipal buildings and even Mass MoCA in North Adams.

In 2019, there were over 40 known commercial/institutional-scale heating systems in place relying solely on wood chips or wood pellets, and a number of projects were in the planning stages. Pellet-fired heat and hot water systems continue to matriculate as institutions upgrade their aging fossil-fuel-fired systems, and concerns about local, renewable resources become more pressing and pertinent.

Wood chip fuel, like firewood, represents a necessarily local, minimally processed, direct-to-consumer product. Chips are currently being produced in green and dry form. Dried chips burn more cleanly and efficiently, and they are eligible for renewable energy incentives, but the market for dried vs. green chips is still evolving.

Wood Energy

Throughout the northeast, tree material in rough chipped form (differentiated from “clean” chips), colloquially known as "biomass" fuel, has become increasingly utilized for the generation of electricity, and for cogeneration of heat and electricity, in both industrial power supply plants and in smaller institutional-scale settings. Although expansion of this sector remains controversial, there are presently industrial-scale markets within transport distance to portions of Massachusetts that represent an important component of the forest products sector. Consequently, this represents a significant market for wood harvested from Massachusetts forests, principally in the north-central part of the state.

Within the Commonwealth, Pinetree Power in Fitchburg and Westminster is the lone commercial biomass power plant in operation, with the capacity to generate 17 megawatts of energy using tree-derived fuel. Similar plants exist in southern New Hampshire, acquiring a portion of their feedstock from Massachusetts.

There is uncertainty about the future of existing industrial biomass power generation. Although few, the loss of these markets would be significant, adversely impacting specialized operators, timber sale revenue for private landowners, and silvicultural options available to foresters and landowners.

SECONDARY WOOD PROCESSING

Secondary wood processing represents the bulk of the forest products industry in Massachusetts with an estimated $2.5 billion in gross state output and 13,100 jobs (NEFA 2015). This sector represents 76% of the total forest-based manufacturing jobs located in the Commonwealth. While at one time the businesses in this sector used local forest products to meet their needs, historical exploitation of local forests and the economic realities of forest commodities traded in a global market has shifted these businesses to source most raw materials from outside Massachusetts.

The largest source of economic contribution comes from paper manufacturing. Massachusetts paper manufacturers primarily produce packaging materials including wrapping tissue and corrugated boxes to serve consumer markets. For tissue products, recycled paper bales and new pulp is purchased from the global market. Box plants operating in Massachusetts purchase paper off the open market and convert it into corrugated products for boxes and point of purchase displays. There are also a few specialty paper coating facilities operating to serve niche markets. As we have seen from the past few years of pulp and paper consolidation in the region, making paper in the northeast with older small-scale facilities is a risky proposition, but the remaining paper mills have had a long history of product adaptation to remain viable in an ever-changing market. A bright spot for paper manufacturing in the Commonwealth is the growth of the box market as more consumer goods continue to be bought online and shipped to homes.

Wood working industries are also an important component of the forest products economy in Massachusetts making up 17% of the total workforce. Architectural millwork, flooring, limited furniture manufacturing, and artisans make up most businesses within the sector. While historically a large consumer of local forest products, due to consumer preference and strong global competition these businesses primarily source material not grown in Massachusetts but remain an important component of the regional and national forest-based economy. Some material grown in Massachusetts is still used by secondary manufacturers in the Commonwealth, but currently there is little understanding of this material flow.

Still there are important components of the industry that largely depend upon, or routinely utilize, locally produced lumber. Agricultural outbuildings are still routinely built of locally sourced, rough-sawn timbers, and they are typically sheathed with white pine boards grown, harvested, and sawn within a few dozen miles of where they are used. Older farm buildings, some of them 100-200 years old themselves, have been repaired and re-sheathed in this fashion throughout their existence.

Timber framers in general are more inclined to work with local sawmills to procure their materials, striving to match the age-old craft from the landscape to the finished structure. With its roots in western Massachusetts, the Timber Framers Guild has long promulgated a resource-based land ethic involving sustainable forestry practices and partnerships with local sawmills. The modern result is a robust contingency of local practitioners with deep ties to the landscape and the people who steward the forests that furnish their fundamental materials.

Although a small percentage of the total consumer portrait, a multitude of finish-grade wood products are produced within the state using local wood. This includes wood flooring and millwork as well as various artisan-made furniture and crafts.

Artisans often begin with rough-sawn wood, which requires kiln-drying. There are several kiln-drying operations active within the state, including some not directly tied to a sawmill, which are providing these essential secondary-processing services.

Whenever possible, the beauty and utility of our local wood products, and the stories of their ties to the landscape, should be shared and celebrated.

COST-SHARE OPPORTUNITIES FOR FOREST LANDOWNERS

A range of cost-sharing programs have evolved in the interest of facilitating the planning and implementation of sound forestry practices and effecting positive changes on the landscape to the benefit of the forest ecosystems of the Commonwealth. Such programs fall into two broad categories: 1) providing technical assistance for forest management planning, and 2) assistance for implementation of forest management practices, especially for the creation of wildlife habitat.

Landowner Technical Assistance

Long-term planning is critical to sound forest management, and the 10-year forest management plan is the traditional tool used to guide landowners. The Working Forest Initiative (WFI), through its Forest Stewardship Program, is the principal cost-share program in Massachusetts, providing up to 100% funding to hire a licensed forester to compose a 10-year Forest Stewardship Plan. For the most recent 10-year period of funding, including state fiscal year 2010 (FY2010) through FY2019, the Department of Conservation and Recreation (DCR) has administered $2.7 million to over 1,700 landowners who

DCR Service Forester Chris Capone speaks with landowners, photo by DCR collectively steward 159,650 acres of forestland. This includes nearly 50,000 acres of municipal lands covered by more than 200 Forest Stewardship Plans. The proportion of Forest Stewardship Plans that are also used to enroll in one of the state’s current use programs (Chapter 61, 61A, and 61B) has steadily risen to nearly 90% in recent years. Additionally, in 2019 funding became available for landowners who renew the Forest Stewardship Plan on their conservation restriction, watershed preservation restriction, or agricultural preservation restriction.

Under the WFI, the Forest Stewardship Program continues to operate with an annual budget between $200-300,000, which helps 100-200 landowners each year. Alternatively, forest landowners may also be funded for the same plan writing work under the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP).

Additional planning tools have also evolved based on specific priorities. "Green certification," which is a third party-verified forest sustainability program, was provided for 11 years through a group certificate held by DCR with the Forest Stewardship Council (FSC). This certification was available to interested forest landowners at no cost simply by updating and enhancing the content of their forest management plans and committing to the principles set forth by the FSC. Cost-share funding was available for such upgrades through the WFI beginning in FY2009, and the program awarded over $60,000 to 144 landowners across 315 parcels, bringing over 52,000 acres of forestland into the Green Certification program. The group certificate program ended in April 2020.

The Foresters for the Birds Program was initiated as part of the WFI in FY2015, in partnership with Mass Audubon, building off the successful program created by Audubon Vermont. The Massachusetts version initially focused on the northern hardwood forest, but it has expanded to encompass all the forest types of the Commonwealth and the rare and declining birds that depend on their judicious management. The program trains licensed foresters to understand and incorporate elements of bird habitat into their forest management planning and it provides funding to landowners to hire a “bird-certified forester” to write a Forest Stewardship Plan specific to forest birds of Massachusetts. As of March 2020, 49 foresters had been trained. DCR has awarded $226,000 – in addition to other Forest Stewardship funding – to more than 200 landowners who have voluntarily sought out the program, enrolling more than 27,000 acres in the Foresters for the Birds version of the Forest Stewardship Plan to date.

In 2010, the WFI offered a pilot Forest Carbon Offset and Trading Program to properties enrolled in the Forest Stewardship Program, but this was short-lived due to changes in the Chicago Climate Exchange that proved unfavorable for the smaller landowner holdings typical in Massachusetts. However, 2020 brings a new incarnation of carbon credit opportunities with the addition of a “Climate Forestry” offering to the WFI portfolio. In partnership with Mass Audubon and the New England Forestry Foundation, the DCR will explore emerging opportunities for private and municipal landowners to engage with carbon markets. This will build off recent successes by some municipalities which have enrolled significant acreage – Green certified under DCR’s group FSC certificate – into a carbon exchange market. Additionally, the possibility of offering new incentives to landowners in support of sound, science-backed “forest resilience” practices will be initiated.

The WFI also includes the essential arm of Community-Based Estate Planning Outreach. Recognizing that our forested landscape is predominantly in private ownership, and that the vast majority of landowners are over 55 years old, this partnership between University of Massachusetts Amherst (UMass Amherst) Extension Forestry, the Mount Grace Land Conservation Trust and the DCR Service Forestry Program delivers outreach programming and publications to landowners, communities, land trusts and other conservation professionals across the Commonwealth to help all parties navigate the complex – yet critically important – process of land protection and conservation. To date, the partners have directly reached over 1,500 landowners with more than 60,000 acres of land, and through training of conservation partners have effectively reached thousands more. Detailed outreach publications also provide expert, yet accessible, summaries of weighty issues that loom large in estate planning, reaching thousands of people (e.g., over 17,000 copies of "Protecting Your Legacy" have been distributed). Seventy percent (70%) of landowners surveyed following their participation indicated that they subsequently took action to prepare for the future of their land, and nearly half described sharing information with another landowner. The sustained efforts of estate planning outreach remain essential as family forest landowners continually arrive at critical moments in planning for the future of their land.

Cost-Share Programs for Wildlife Habitat

Building off the shared objective of creating critical wildlife habitats and applying silvicultural treatments to degraded stands of timber, several cost-share opportunities available to private and municipal landowners have gained in prevalence. Most notably, NRCS administered EQIP (Environmental Quality Incentives Program), which provides a diverse range of cost-sharing opportunities to create specific wildlife habitats that support species in need. A multitude of projects creating young forest habitat have been implemented specifically to benefit the New England cottontail rabbit and an important suite of declining neotropical migrant songbirds that require this habitat for breeding.

Similar in scope, the Department of Fish and Game Division of Fisheries and Wildlife (MassWildlife) Habitat Management Grant Program (MHMPG) was created in 2015 (state fiscal year 2016) to provide funding for projects that directly support the priorities outlined in the 2015 *Massachusetts State Wildlife Action Plan* (SWAP). In the five years since its inception, MassWildlife has awarded nearly $1.8 million to facilitate 68 projects across the Commonwealth, awarding over $300,000 annually in a very competitive field of high-quality proposals.

Through the WFI, DCR has also administered the Community Forest Stewardship Implementation Grant program since FY2011. This program, available to any municipality with a current Forest Stewardship Plan on town-owned land, provides 75% reimbursement of costs for the implementation of actions identified in the Forest Stewardship Plan. The remaining 25% is met through matching funds or in-kind services furnished by the town. (For FY2017 and earlier, the program was administered at the 50-50 ratio). Although not explicitly a wildlife habitat grant program, the vast majority of projects have contributed directly to habitat improvement work, spanning diverse projects such as Blanding's turtle habitat improvement, invasive species control, and ecological restoration of pitch pine barrens using prescribed fire. Through FY2019, 23 projects have been funded involving more than 7,600 acres.

Funding provided by DCR totaled $261,350, which, including match contributions from municipalities, corresponds to a combined value of $335,770 for all completed projects. The success of this program has ensured its continued place among the WFI's annual offerings.

CONSERVATION IN COMMUNITIES

Cities and towns with substantial forested acreage face the unique challenge of meeting the needs of their communities while also maintaining forests for the benefit of society. This is especially challenging in Massachusetts where the majority of forestland is owned by private citizens and is therefore a source of tax revenue to the municipality. With municipal budgets experiencing continuously increasing demands, conservation-based programs that reduce property taxes or remove land from the tax base may come to be viewed unfavorably and, in some instances, may turn the community into an adversary rather than an ally in support of forest conservation. The various factors affecting how forestland is valuable to a community are discussed here to lend context to the importance of forests and draw attention to factors that ultimately lead to municipal involvement in the fate of forestland.

Inter-generational Land Transfer

Our forested landscape is predominantly in private ownership, and most landowners are over 55 years old. This presents a unique challenge in that a significant amount of forestland will change hands in the coming decades. Forest is at a great risk of being lost to conversion as a result of a change in ownership, especially if an unexpected burden or expense, such as estate taxes, makes keeping forest as forest untenable for the new owners or heirs. Planning for this transfer is imperative at the individual, community, and state levels. The WFI continues to make gains in educating family forest landowners and others engaged in community conservation about the elements of planning for the process of transferring land to the next generation, but there is limitless work to do in this arena. It is just as vital to engage with the new cohort of landowners and cultivate a stewardship ethic early on in their ownership so that they can make informed, sustainable decisions about their forestland for decades to come. Within any given community, the decisions of the individual landowners will ultimately shape the broader community. As such, helping conservation-minded landowners navigate the future of their land must be given as much emphasis as is typically given to the rules and regulations designed to restrict conversion.

Cost of Community Services

In general, a given acre of forestland brings in significantly lower tax revenues than an equivalent acre in a residential use. However, there is a strong disparity in terms of the cost of providing services to the community for each of these acres. Road improvements, winter maintenance, schools, and other town services are budget-intensive items required principally in proportion to the amount of residential development within the community. Studies focused on the cost of community services, including in Massachusetts explicitly (Kotchen and Schulte 2009, Murray and Catanzaro 2019), have shown consistently that residential properties typically incur greater expenses – or at best they break even –

compared to the tax revenue they generate. Conversely, open space (including forestland) consistently generates more revenue than it incurs – as much as threefold more. At face value, allowing or promoting the conversion of forestland to residential use may be appealing based on the immediate gains in tax revenue, but the disproportionate increase in the cost incurred to the town based on that conversion must be taken into account.

Smart Growth Issues: Open Space Planning, Natural Resources Zoning, Community Preservation Act, and Right of First Refusal

Recognizing the cost of community services disparity described above, and the compounded ecological and public health detriments caused by fragmentation and conversion (sprawl), municipalities can be proactive in guiding and promoting conservation and responsible development using a variety of tools and policies. Open Space Planning can be used to identify natural resource and open space elements that are valued by the community and which may be threatened by conversion. Although non-binding, such comprehensive planning can streamline prioritization of conservation activities, including outreach and use of conservation funds.

Acknowledging that development is inevitable in any community, specific statutes can be devised to put open space planning into action. One such concept that has been implemented in Massachusetts is known as Open Space Design/Natural Resource Protection Zoning (OSD/NPRZ), which is designed to strike a balance between development and conservation/protection of natural resources and open spaces that are identified as important for the community (EEA 2020). Implemented as a municipal bylaw, OSD/NRPZ typically incentivizes conservation-oriented development by alleviating permitting requirements in exchange for incorporating natural resource or conservation elements into a project. The resulting project tends to concentrate development, preserving open space as an intact block and resulting in less fragmentation. This approach preserves the natural and ecological function of the open space.

Many towns also own conservation properties, and there are mechanisms that can help assist the town in making important acquisitions to conserve properties of ecological or recreational value. The Community Preservation Act (CPA) is one such tool. The CPA funding is generated using a small increase in property taxes which is dedicated strictly to CPA uses, one of which is the purchase of land for conservation purposes. Towns are also eligible for disbursements from the statewide Community Preservation Trust Fund. Since it was passed into law in 2000, CPA has been used to conserve over 30,000 acres of open space across the Commonwealth (Community Preservation Coalition 2020).

Lands enrolled in one of the state's current use programs (see below) are subject to a right of first refusal (ROFR) process if the land is converted, or sold for conversion, to an ineligible use. In such cases, towns are granted the right – on a strict timeline – to purchase the property for conservation purposes for the same value as a bona fide offer. Importantly, CPA funds function as "cash on hand" to use towards ROFR offers in such moments. Local land trusts and state conservation programs can also collaborate and provide funds to enable the town to act on an ROFR acquisition. Funding, coordination between municipal departments, and the ability to respond in a timely manner are critical, so planning for such scenarios in advance is imperative to making the most of the ROFR contingencies in the current use laws.

Current Use Taxation and Conservation Restrictions

By default, forestland is taxed based on its “highest and best use,” but these taxes may be reduced in several ways. Forestland may be enrolled in one the state’s current use programs (Chapter 61, 61A or 61B), which reestablish the value of the land based on its use as forestland (61 and 61A) or open space (61B). Forestland values are set annually using timber harvesting data specific to Massachusetts, the resulting land value reflects the value of timber in the state, as opposed to a property’s potential for development. Chapter 61B reduces the property tax of open space by a flat 75%. Each of these programs involve a temporary commitment by the landowner to keep the land from being converted. Both penalties (e.g., back-taxes) and a right-of-first-refusal mechanism are built into the laws to enable towns to recuperate lost tax revenue, discourage conversion, or act to acquire a property for conservation purposes, should the landowner convert or sell with the intention to convert to an ineligible use.

When a property is permanently protected through a legal mechanism such as a conservation restriction (CR), the former development potential is no longer reflective of the highest and best use of the land. Many such properties are enrolled in a current use program prior to a CR being put in place and the impact of the CR on property tax revenue is moot, but for properties not enrolled in current use, the recording of a CR may have an effect on tax value comparable to current use enrollment.

State-Owned Land: Payment in Lieu of Taxes (PILOT) Payments

For most state-owned land, as well as some municipal lands (e.g., municipal watershed lands in towns other than the community they serve), payments are made to towns under a Payment in Lieu of Taxes (PILOT) program. The amount paid for a given parcel varies based on the ownership entity. For state-owned lands, a fixed amount of funding is distributed annually using a recently devised formula which accounts for local property values.

State-Owned Land: Forest Products Trust Fund Payments

A percentage of revenue generated by timber harvests occurring on land managed by DCR Division of State Parks and Recreation is deposited in a Forest Products Trust Fund, which is then disbursed to municipalities in which the harvests occur. This percentage differs depending on when the land was acquired by DCR, with 50% of revenue going into the trust fund for lands acquired on or after June 1, 1987, as opposed to 8% for lands acquired prior to that date. Within the past 10 fiscal years (FY 2010-2019) – which included a multi-year moratorium on state timber harvests during the Forest Futures Visioning and Landscape Designation Processes – a total of $171,065 was distributed to 41 municipalities, with the largest payment over $18,000.

INCREASING URBAN CANOPIES

Increasing tree cover in urban and other highly developed areas is known to improve air quality and increase the aesthetic value of a neighborhood. Shade trees also have a range of benefits relating to microclimatic effects. A minimum level of tree cover in cities can lower ambient air temperatures and mitigate wind events, resulting in improved quality of life and energy savings. It is estimated that every 1% increase in tree canopy above a minimum 10% canopy cover brings a 1.9% reduction in energy needs for cooling and up to a 1.1% reduction in energy for heating. These are costs that would otherwise be incurred upon residents and property owners. To this end, DCR's Urban and Community Forestry Program's Greening the Gateway Cities program has already planted over 26,000 trees across 14 communities, with a goal of planting 2,400 trees in each of 26 Gateway City communities across the Commonwealth in order to affect these positive environmental and energy-saving effects and promote beauty and sense of community in underprivileged urban neighborhoods (See "Wellness" section below).

Home to nearly 700,000 people and the most populous city in Massachusetts, Boston is not a Gateway City, but has been a target of tree planting initiatives in the past. In 2007, the mayor announced a 'Grow Boston Greener' initiative, with a goal of increasing the city's tree canopy cover from 29% to 35% by planting 100,000 trees by 2020. Due to funding shortfalls and political transitions, the planting goal was never reached. Additionally, in 2014, a major non-profit figure in urban forestry in Boston, the Boston Natural Areas Network (BNAN), was subsumed into the Trustees of Reservations. The Trustees initially hoped to continue the urban forestry work of BNAN, but it has not been able to continue to the same extent. This has left an urban forest advocacy void in Boston, which has recently been filled by the organization Speak for the Trees, Boston. Urban and community forestry non-profit organizations represent an important ally for urban canopy and for city residents. In recent years, the City of Boston has transitioned to a new campaign called Greenovate, which seeks to empower residents to carry out actions in their communities to support Boston's climate goals and help to carry out the City's Climate Action Plan in neighborhoods and communities.

Many cities and towns in the Boston metropolitan area have advocacy groups or municipal tree committees working at the local level. These groups engage residents in advocacy as well as in tree planting, events and recognition programs like Tree City USA, writing tree ordinances, and even in collecting tree inventory data and monitoring for pests and diseases. Many work closely with municipal urban forestry programs and are important community assets.

RECREATION AND TOURISM

Although different from the forest products sector, the recreation and tourism sector is what most people associate with the forested landscape. In contrast to the forest products sector, which is engaged in providing raw materials and consumer goods, the recreation and tourism sector is principally delivering an experience-based product. Although difficult to quantify, it is estimated that recreation and tourism activity effectively generate $2.2 billion in economic activity throughout the state. As such,

Hikers on Mount Greylock, photo by DCR

forest-based employment in the recreation and tourism sector is quite broad, including not just the outfitters, guides, and sporting goods vendors, but also the full suite of support services, such as dining and lodging. These services facilitate and promote the enjoyment of the greater experience of engaging in forest-based recreation. Fall foliage viewing, camping, hiking, and snowmobiling are examples of exceedingly popular activities that hinge upon the greater forested landscape, but also require a host of support services to make them successful. Other noteworthy forest-based recreational activities include cross-country skiing, mountain biking, wildlife tracking, and birdwatching. A 2015 report estimated that about 9,000 people are employed in the diverse industries that support this sector, with a total annual payroll equivalent of $293 million.

Hunting and fishing are the quintessential outdoor recreation activities associated with forests and remain vitally important in the state. Nearly 60,000 hunting licenses and 150,000-175,000 freshwater fishing licenses are issued annually (U.S. Fish & Wildlife Service 2019), predominantly to Massachusetts residents. License revenue in Massachusetts directly funds diverse projects, including trout and pheasant stocking, wildlife habitat management and land protection through acquisition of lands and conservation restrictions on private forestland. The majority of Massachusetts game species rely on a landscape dominated by forests of diverse structure and age classes. Our fisheries also depend on forests to filter runoff for clean water and provide critical shade to cold headwater streams required by species like the iconic brook trout. Through the sale of sporting licenses, hunting and fishing represent perhaps the only recreational sector that directly supports conservation of forestland.

Numbers of users in outdoor recreation is known to be strongly correlated with population (Cordell et al. 2012), so as population in Massachusetts and the entire Northeastern region continues to increase, demands on our forests for recreational and outdoor experiences, as well as the infrastructure to support them, will increase as well. A growing workforce to perform maintenance of facilities, trails, and infrastructure will be required to protect the sensitive or vulnerable components of our forested landscape from the known detriments of over-use. Similarly, increasing the total acreage available for recreation can help accommodate increases in population and the corresponding increase in demand for recreational opportunities.

NON-TIMBER FOREST PRODUCTS

Carbon Credits

Although the pilot carbon offset program detailed in the 2010 *An Assessment of Forest Resources of Massachusetts* was ultimately short-lived, recent developments have brought the prospect of carbon markets back into the mix for Massachusetts forests. In 2019, the cities of West Springfield, Holyoke, and Westfield initiated the Tri-City Carbon Sequestration program, enrolling approximately 6,500 acres of forestland covering their municipal watersheds into a carbon credit program where developers and polluters can purchase their carbon credits to mitigate impacts elsewhere. The project will sequester approximately 122,000 metric tons of carbon dioxide per year and the cities will earn carbon credits expected to be worth about $2 million over the course of the ensuing decade. This revenue will be used to clean up illegal dumping, enhance passive recreation, and enhance forest wildlife corridors.

The DCR will be initiating a new forest carbon credit pilot program to investigate the broader involvement of smaller municipalities and other private landowners who are interested in committing their forestland to a carbon market. The lands involved in the Tri-City Carbon Sequestration program are all Forest Stewardship Council (FSC)-certified under DCR's group certificate, relying on Forest Stewardship Plans written with funding from the WFI.

Maple Syrup

Maple syrup is perhaps the best-known non-timber forest product. The annual tapping of sugar maples in late winter is a welcome harbinger of spring and many instances of cabin fever are cured over pancakes and syrup. Although sap buckets on roadside trees are the most visible, there are actually thousands of acres of forestland being used in the production of maple syrup in Massachusetts (Table 4.2). Maple production has been consistently on the rise in the state due to increasing acreage in

Maple Syrup in Massachusetts
• **Jobs:** Employs over 1,000 farm workers • **Rural Economy:** Over 300 syrup producers in Massachusetts, with 80% of these west of I-91 • **Local Economy:** Predominantly sold and/or consumed in-state • **Product Value:** Average annual production of 60,000 gallons, valued at approximately $5 million • **Ecotourism:** Over 60,000 visitors spend more than $2 million during syrup boiling season • **Open Space:** Over 15,000 acres of farm and forestland engaged in production

Table 4.2. Maple syrup in Massachusetts statistics (Massachusetts Maple Producers Association 2019).

production and more efficient extraction technology being employed by a greater number of producers. Importantly, most of the maple syrup produced in the Commonwealth is sold and consumed within the state, representing a truly localized economy, with short physical and economic distances between the resource and the consumer.

Coincident with the writing of this report, a new partnership between Mass Audubon and the Massachusetts Maple Producers Association aims to certify and celebrate “bird-friendly syrup.” This program will complement DCR’s Foresters for the Birds Program. Run in partnership with Mass Audubon as part of DCR’s WFI, it will promote maple production practices that support the forest-breeding birds that utilize sugarbushes as part of their breeding habitats.

Christmas Trees

Planting of various evergreen species for the production of Christmas trees has long been a popular way to put small open spaces into production that are not necessarily suitable for other agricultural uses. Popularity of live, fresh-cut Christmas trees varies by year and local production has direct competition from wholesale bulk imports of Canadian trees, as well as inexpensive artificial trees.

Christmas tree data available from the national agricultural census conducted by the USDA show the trend shows that about 50,000 trees are harvested annually for a total value of roughly $1.5 - 2.5 million (Table 4.3). Many growers also furnish other Christmas greenery products, as well as value-added eco-tourism activities like wagon rides and concessions, which contribute an unknown additional amount to the net effect of the greater Christmas tree industry.

	2002	2007	2009	2012	2014
Trees Harvested	72,522	75,914	46,528	52,188	63,672
Tree Sales	-	-	$1.9 million	$1.4 million	$2.8 million

Table 4.3. Christmas tree sales in Massachusetts over time (data: Census of Agriculture, USDA, National Agricultural Statistics Service 2017).

Christmas trees occupy an estimated 30,000 acres of open space in Massachusetts. Plantations of five acres or greater are eligible for preferential taxation under the agricultural current use program, Chapter 61A, and plantations that are part of a forest management plan are also eligible for taxation under the forestry current use law, Chapter 61. These tax programs enable landowners to reduce their tax burden and commit to maintaining their Christmas tree farms as open space for the greater benefit of the citizens of the Commonwealth.

Wild Edibles

Other non-timber forest products that were typically relegated to hobbyists, like wild mushrooms, fiddleheads, wild leeks, etc., have risen to the level of niche markets in recent years. Wild-harvested foods can be found at farmers' markets and natural food stores, answering to society's demand for eating local, in-season foods.

CAREERS IN CONSERVATION

Employment associated with managing, protecting, and engaging with our forest resources encompasses a diverse range of natural resource professionals, including foresters, arborists, wildlife biologists, land conservation specialists, wetland scientists, ecologists, naturalists, interpreters, and timber harvesters. The importance of the expertise and guidance of these professionals will only grow as climate change causes stress on our landscape, the need for science-based decision-making becomes imperative, and a growing population engages with the forest land base with increasing frequency. Technical training for this work force is more important than ever, and our local educational institutions will continue to play a vital role in preparing people to do this essential work, especially Massachusetts citizens who will continue to serve their home state.

At the high school level, several vocational programs include forestry and arboriculture in their curricula. Schools that train future foresters, arborists, and urban foresters include Norfolk County Agricultural and Technical High School, Essex North Shore Agricultural and Technical School, and Smith Vocational and Agricultural High School.

The flagship campus of the University of Massachusetts, UMass Amherst, provides a suite of academic tracks, from the broadly applicable sciences and humanities to very specific programs directly pertinent to care and stewardship of trees, forests, and forested ecosystems. A variety of two- and four-year degrees, as well as graduate degrees are offered (described further in Chapter Five), principally through the Stockbridge School of Agriculture and the Department of Environmental Conservation (ECO). The Forest Ecology and Conservation concentration under the Natural Resources Conservation degree is an official forestry curriculum with national third-party accreditation from the Society of American Foresters (SAF).

ECO also produces students with a variety of graduate degrees, including thesis and non-thesis M.S. tracks, as well as PhD candidates. Graduate student research projects span diverse natural resource interests that are both cosmopolitan and locally pertinent to the Commonwealth, including studies focused on family forest landowners, wildlife ecology and habitat management, novel urban forest planting programs, and ecology of invasive species.

WELLNESS

I think that I cannot preserve my health and spirits, unless I spend four hours a day at least—and it is commonly more than that—sauntering through the woods and over the hills and fields, absolutely free from all worldly engagements.

– Henry David Thoreau, from "Walking"

Trees and forests, or more generally any green spaces adorned with plants, are widely regarded as positive, and even requisite, components of our landscape. Such suppositions are at the heart of urban reforestation efforts presently underway and this principle manifests in the real estate realm where

Hikers on a property protected by a Conservation Restriction, photo by Sasha Auer

residences in "well-treed" neighborhoods, or with access to walking trails and parks, are more desirable. In addition, decades of multi-disciplinary research have yielded scientific evidence that green spaces have direct, positive effects on our physical and mental well-being (U.S. Forest Service 2018b).

It is difficult to quantify the effects of trees and forests on the well-being of individuals, yet the self-evident value of natural spaces has driven major conservation efforts – from John Muir's crusade to protect Yosemite to the daily grass-roots land protection activities of our dozens of local land trusts.

Exposure to sunlight and fresh air, the complexity of natural ecosystems and the physical activity associated with even a casual walk, are all known to induce positive effects on an individual's physical and emotional health. Encouragingly, "walking for pleasure" has been documented as the most popular outdoor activity in the U.S. Forest Service's North Region and nature viewing, and photography are increasing in popularity (Cordell et al. 2012). The increasing role of exposure to nature on well-being and public health is further demonstrated by the establishment of programs such as Park Rx, where doctors and other health care professionals can provide patients with prescriptions to spend time in a park engaged in a park program or other activity for a given time. In 2019, Massachusetts had three active park prescription programs around the state. The 2017 *Massachusetts Statewide Comprehensive Outdoor Recreation Plan* identified walking or jogging on trails and greenways and hiking as two of the top recreation activities residents enjoy (EEA 2017).

A new trend in outdoor recreation is "forest bathing," also known by the Japanese name *Shinrin-yoku*. This mindfulness-based, passive experiential approach to engaging with the forest was first developed in Japan, and it has recently been gaining in popularity due to the positive physical and mental health effects reported by its many proponents. A recent synthesis of extant research on forest bathing has corroborated the positive effects purported in numerous independent studies (Wen et al. 2019), which include improvements related to blood pressure, glucose levels, mental disorders, respiratory diseases, and immunity.

The uncertainty and heightened anxiety brought on by the COVID-19 pandemic in the spring of 2020 highlighted the imperative need for forests as outlets for society during stressful times. Time spent in nature became a self-prescribed therapy for countless Massachusetts residents. Visitation at state parks and forests was at record levels as people took to the woods for solace, health, and a sense of normalcy. Given the demonstrated positive mental health effects of forest bathing, it is not an overstatement to say that at least some of the collective anxiety and stress incurred by the pandemic was assuaged by the simple act of people spending time in our forests.

STRATEGIES

The strategies below focus on Socioeconomic Benefits but may apply to other Chapters. The complete list of goals and strategies can be found in the Strategy Matrix on page 15.

GOAL 1: INCREASE RESISTANCE AND RESILIENCE OF TREES AND FORESTS TO MITIGATE AND ADAPT TO THE EFFECTS OF CLIMATE CHANGE

Strategy 8: Provide leadership to increase landowner knowledge on how sustainable forest management can increase forest resistance, resilience, mitigation, and adaptation to climate change while meeting social and economic goals of communities

GOAL 3: SUPPORT AND ENHANCE FOREST ECONOMY

Strategy 20: Promote firewood as a local resource and economy

Strategy 21: Build and strengthen connections between Massachusetts forestland, timber harvesting, wood processing, and utilization of local wood products

Strategy 22: Create and support recreational opportunities in forests (e.g., birdwatching, camping, fishing, hunting, hiking, biking, snowmobiling, foliage viewing, forest bathing, geocaching, etc.)

Strategy 24: Support forest-based rural economies through forest producer organizations such as the Massachusetts Maple Producers Association, Massachusetts Forest Alliance, and Tree Farm

Strategy 26: Provide leadership in the use of local wood in construction and support efforts to market local wood and local wood products

GOAL 4: MAINTAIN AND INCREASE URBAN TREE CANOPY COVER

Strategy 27: Support programs and activities that plant and retain trees in urban areas

Strategy 30: Drive innovative state-level programs that plant trees in priority urban areas, such as Greening the Gateway Cities

GOAL 5: ENHANCE THE CONNECTION BETWEEN FORESTS AND PEOPLE

Strategy 35: Coordinate and participate in annual Town Forest events

Strategy 36: Create and support dynamic multimedia approaches to communicate information with stakeholders and the public

Support 38: Support programs that engage underserved communities and increase diversity, equity, and accessibility in forestry and urban forestry

Chapter 5 – LEGAL, POLICY & INSTITUTIONAL FRAMEWORK

The Massachusetts Legislature began working to protect forests at the beginning of the 20th century and that respect for conservation and stewardship continued with the passage of numerous laws. The Forest Cutting Practices Act, created to ensure the long-term public benefits that forests provide, and the immensely important Article 97 of the Articles of Amendment to the Constitution of the Commonwealth, which mandates that citizens have a right to the quality of life that open space can provide, are just two examples.

INTRODUCTION

Massachusetts has more than three million acres of public and private forested lands, 63% of the lands in the Commonwealth. Built upon the rich history of conservation and stewardship in Massachusetts, the current legislative and policy framework as well as institutional practices continue to support efforts to conserve, protect, and enhance the unique and important ecosystems within the Commonwealth. This chapter covers the Massachusetts General Laws relating to forests, forestry, and our natural resources, the policies the Department of Conservation and Recreation (DCR) administers to enhance and conserve our forests lands, the multiple programs within the DCR Bureau of Forest Fire Control and Forestry, and the vital roles of non-governmental forest advisory groups and educational institutions.

HISTORY OF LEGISLATIVE FRAMEWORK

Efforts to conserve and replenish Massachusetts forestland began in earnest in the 1890s, following widespread forest clearing for agriculture and logging. The Massachusetts Legislature established the Trustees of (Public) Reservations in 1891. In 1897, a group of private citizens formed the Massachusetts Forestry Association and used both state funding and private donations to acquire the summit of Mount Greylock, presented to the state as its first forest reserve in 1898. In 1904, the Massachusetts Legislature created the Office of State Forester. The Department of Conservation, including a Division of Forestry, was formed later in 1919. The first attempt to regulate forest cutting came in 1922 when a fire-prevention law was passed requiring that "operators of portable sawmills and others engaged in lumbering activities" notify the state fire warden of the harvest site location and be subject to inspection. Demand for wood products increased at the advent of World War II and the possibility arose that the federal government would impose regulations of forest harvesting practices. In 1941, state legislation was passed to:

1. Create regional state forestry committees to develop standards leading to the elimination of destructive cutting practices,
2. Tax forestland at a reduced valuation…[and] create a method of deferring taxes on timber until harvest (current use), and
3. Provide free demonstrations of forestry practices to owners of woodlands.

Shortly after they were formed, the regional forestry committees were joined into one state committee that developed minimum standards for forest cutting. The first Massachusetts Forest Cutting Practices Act was approved on May 15, 1944. The 1944 Cutting Practices Act required that seed trees of desirable species be left following harvesting and that a minimum number of seedlings (1,000 per acre) of desirable species be established prior to clear cutting. The Forest Cutting Practices Act and associated regulations have been amended regularly since that time. In the 1950s the Department of Natural Resources Division of Forests and Parks was granted the ability to regulate operations by cities, towns, and individuals to suppress a wide variety of forest pests, including: gypsy moth, brown tail moth, tent caterpillars, saddled prominent caterpillar, pine looper, the beetles that spread Dutch elm disease and, most recently, Asian longhorned beetle, emerald ash borer, and oak wilt.

The Bureau of Forest Fire Control provides assistance to cities and towns in the prevention, detection, and suppression of wildland fires throughout Massachusetts. The Weeks Law, enacted on March 1, 1911, allowed the Federal Government to cooperate with states in forest fire control programs. This marked the beginning of the fire tower system and fire suppression assistance to cities and towns. Massachusetts was one of 11 original states to enter into an agreement with the Federal Government to cooperate in forest fire control. The Massachusetts fire tower program is the oldest in the nation. There are currently 42 fire towers of which 22 can be staffed during times of high fire risk, given current staffing levels. The Clark-McNary Act of 1924 gave further authority for Federal assistance and grants to states for fire control. In 1978, section two of the Clark-McNary Act was superseded by section seven of the Cooperative Forestry Assistance Act, now known as the Rural Fire Prevention and Control Program.

CURRENT LEGISLATIVE FRAMEWORK

The Commonwealth of Massachusetts began legislative support of land and forest protection starting in 1904. Table 5.1 highlights the active General Laws that assign and mandate a state-wide organizational structure to protect, maintain, and enhance various natural resources. It also highlights the regulations that guide the practice of managing and preserving forests and open spaces.

	Description	Mass. General Law	Commonwealth of Mass. Regulations
Organizational Structure			
DCR Divisions of State Parks and Recreation and Water Supply Protection	DCR is comprised of two operational divisions: the division of state parks and recreation and the division of water supply protection.	MGL c.21, §1; c.92A½, §2	302 CMR 12: Parks and Recreation Rules; 313 CMR 11.00: Watershed Protection
	"The division of state parks and recreation shall have control over the state parks, forests, parkways, waterways, rinks, pools, beaches and other recreational lands and facilities outside of the watershed systems..."	MGL c.21, §1; c.92, §33; and c.132A, §3	304 CMR 7.00: Management plans and Massachusetts wildlands

	"The director of the division…shall promote the perpetuation, extension and proper management of the public and private forest lands of the commonwealth… and shall perform such other duties as may be imposed upon him by the governor."	MGL c.132, §1	304 CMR 7.00: Management Plans and Massachusetts Wildlands; 302 CMR 12.00: Parks and Recreation Rules
DCR Bureaus of Forest Fire Control, Forestry, and Recreation	Within the division of state parks and recreation are three bureaus: forest fire control, forestry, and recreation.	MGL c.132A, §1C	
	The bureau of forestry, with the commissioner's approval, is charged with performing such duties concerning forest management practices, reforestation, development of forest or wooded areas under DCR's control, making them in perpetuity income producing and improving such wooded areas.	MGL c.132A, §1F	
	The bureau of forestry is also responsible for shade tree management, arboricultural service, and insect suppression of public nuisances.	MGL c.132, §11; c.132A, §1F (See also MGL c.132, §1A)	
	The bureau of forestry, subject to the commissioner's approval, may promulgate rules and regulations to carry out its pest and nuisance control duties and powers.	MGL c.132, §11; c.132A, §1F	
DCR Mission			
Core Agency Duties	It shall be the duty of the Department of Conservation and Recreation to "exercise general care and oversight of the natural resources of the commonwealth and of its adjacent waters; to make investigations and to carry on research relative thereto; and to propose and carry out measures for the protection, conservation, control, use, increase, and development thereof. The words "natural resources'', as used herein, shall be held to include ocean, shellfish and inland fisheries; wild birds, including song and insectivorous birds; wild mammals and game; sea and freshwater fish of every description; forests and all uncultivated flora, together with public shade and ornamental trees and shrubs; land, soil and soil resources, lakes, ponds, streams, coastal, underground and surface waters; minerals and natural deposits. The department shall also be concerned with the development of public recreation as related to such natural resources; and shall have control and supervision of such parks, forests, and areas of recreational, scenic, or historic significance as may be from time to time committed to it."	*MGL c.21, §1*	
Forest Cutting Practices Act; Declaration of Policy	"It is hereby declared that the public welfare requires the rehabilitation, maintenance, and protection of forest lands for the purpose of conserving water, preventing floods and soil erosion, improving the conditions for wildlife and recreation, protecting and improving air and water quality, and providing a continuing and increasing supply of forest products for public consumption, farm use, and for the wood-using industries of the commonwealth."	*MGL c.132, §40*	302 CMR 14: Forester Licensing; 302 CMR 16: Forest Cutting Practices

Article 97 of the Amendments to the Constitution of the Commonwealth of Massachusetts	"The people shall have the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment; and the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is hereby declared to be a public purpose." No land or interest in land acquired and held by DCR can be conveyed out or put to an inconsistent use unless the Legislature authorizes such conveyance or change in use by two-thirds roll-call vote.		
Development of Resource Management Plans	1. "The director of the division of state parks and recreation shall work in cooperation with the director of the division of fisheries and wildlife within the department of fish and game to establish coordinated management guidelines for sustainable forestry practices on public forest lands within the [DCR] and on private forestlands. Said guidelines for public forest lands shall include agreements on equipment, personnel transfers, operational costs, and assignment of specific management responsibilities. The [DCR] shall submit management plans to the stewardship council for the council's adoption with respect to all reservations, parks, and forests under the management of the department… Said management plans shall include guidelines for the operation and land stewardship of the aforementioned reservations, parks and forests, shall provide for the protection and stewardship of natural and cultural resources, and shall ensure consistency between recreation, resource protection, and sustainable forest management." […] "The [DCR] shall be responsible for implementing said management plans, with due regard for the above requirement."	*MGL c.21, §2F*	304 CMR 7.00: Management plans and Massachusetts wildlands
	2. For land in the division of water supply protection, the commissioner shall adopt watershed management plans prepared with the participation of a professionally qualified forester and the appropriate watershed advisory committee. Watershed management plans shall provide for, but need not be limited to, forestry, water yield enhancement and recreational activities.	MGL c.92A½, §16. All forestry activities shall be subject to the Forest Cutting Practices Act (MGL c.132, §§40 to 46). MGL c.92A½.	302 CMR 16: Forest Cutting Practices
Required Compliance			
Licenses of foresters	The director of the division state parks and recreation shall promulgate rules and regulations hereunder and shall issue licenses to persons to engage in the practice of forestry in accordance with such rules and regulations. Said director may revoke or suspend such license, if after hearing, the director determines that any licensed forester has engaged in fraud, negligence, incompetence or misconduct in the practice of forestry.	MGL c.132, §§46 to 50	302 CMR 14.00: Forester Licensing; 302 CMR 16.00: Forest Cutting Practices

Public Shade Tree Management	Cities and towns shall have a tree warden who has care and control of all public shade trees, shrubs, and growths in the town except those within a state highway, and those in public parks or open places under the jurisdiction of the park commissioners, and shall have care and control of the latter, if so requested in writing by the park commissioners.	MGL c.41, §1; MGL c.87, §2	
Public Shade Tree Law	"All trees within a public way or on the boundaries thereof including trees planted in accordance with the provisions of section 7 shall be public shade trees…" Public shade trees may not be trimmed without approval of the tree warden or the deputy of the tree warden. With some exceptions, removal of public shade trees may take place only after a public hearing unless a tree has been deemed to "obstruct, endanger, hinder or incommode persons travelling [on a public way]". Utilities may be required to submit vegetation management and hazard tree removal plans.	MGL c.87, §§1 to 14	
Slash Law	"Every owner, lessee, tenant or occupant of lands, or their agents or employees, or any such person or entity holding rights or interest in said lands or the timber thereon, or of any rights or interests therein, except electric, telephone and telegraph companies, who cuts or permits the cutting of brush, wood or timber on lands which border upon the woodland of another, or upon a highway or railroad location, shall dispose of the slash caused by such cutting in such a manner that the same will not remain on the ground within forty feet of any woodland of another, or of any railroad location, or within one hundred feet from the center of any highway, and all slash resulting from such cutting operations shall be cut and scattered in such a manner as to minimize the danger from fire. Wherever multiple highway systems exist adjacent to cuttings, no slash shall be permitted within one hundred feet from the outer edge of the highway. No slash shall be permitted within twenty-five feet of any brook, stream, pond, river or water supply."	MGL c.48, §§16, 16A	
Wetlands Protection Act	The Wetlands Protection Act (WPA) regulates activities that either occur within a wetland resource area and its buffer zone (100 feet) or causes an impact to the resource area. The WPA requires the filing of a notice of intent with the local Conservation Commission before undertaking any activity within a wetland or its buffer zone.	MGL c.131, §40	310 CMR 10.00
The Massachusetts Endangered Species Act	The Massachusetts Endangered Species Act prohibits the taking of any state-listed rare plant or animal species. The sate list is managed by the Division of Fisheries and Wildlife Natural Heritage and Endangered Species Program (NHESP).	MGL c.131A	321 CMR 10.00
Forest Lands Assessment Act	"Except as otherwise herein provided, all forest land, parcels of not less than 10 contiguous acres in area, used for forest production shall be classified by the assessors as forest land upon written application sufficient for identification and certification by the state forester. Such application shall be accompanied by a forest management plan. The state forester will have sole responsibility for review and certification with regard to forest land and forest production."	MGL c.61, §§1 to 8	302 CMR 15: Ch 61, Forest Classification

Forest Products Trust	Fifty percent of all revenue received by the removal of forest products on land acquired by the commonwealth on or after June 1, 1987 shall be deposited in the Forest Products Trust Fund. Such funds shall be dispersed to those municipalities within whose boundaries the removal of forest products occurs. Eight percent of all revenue received by the removal of forest products on land acquired by the commonwealth before June 1, 1987 shall be deposited in the Forest Products Trust Fund. Such funds shall be dispersed to those municipalities within whose boundaries the removal of forest products occurs.	MGL c. 58, §17C	
Forest Wardens	"The mayor in cities, subject to charter provisions, and, except as provided in section forty-three (MGL c. 48, §43), the selectmen in towns, shall annually, in June, appoint a forest warden, and forthwith give notice thereof to the commissioner of conservation and recreation, in this chapter called the forester."	MGL c.48, §8	
Scenic Road Designations	"Upon recommendation or request of the planning board, conservation commission or historical commission of any city or town, such city or town may designate any road in said city or town, other than a numbered route or state highway as a scenic road; provided, however, that a numbered route may be designated by a city or town as a scenic road if its entire length is contained within the boundaries of said city or town and no part of said route is owned or maintained by the commonwealth. After a road has been designated as a scenic road any repair, maintenance, reconstruction, or paving work done with respect thereto shall not involve or include the cutting or removal of trees, or the tearing down or destruction of stone walls, or portions thereof, except with the prior written consent of the planning board, or if there is no planning board, the select board."	MGL c.40, §15C	
Other			
Environmental Bond Bill	"An Act promoting climate change adaptation, environmental and natural resource protection, and investment in recreational assets and opportunity."		
Native Lumber Program	Under the State Board of Building Regulations and Standards, this provision shall govern the licensing of native lumber producers.		780 CMR 110.R4

Sale of Cordwood; dimensions; standards units of measure defined	"Cordwood sold or offered or exposed for sale shall be four feet in length. The term ''firewood'' shall be construed to mean and include wood cut to any lengths of less than four feet and more than eight inches. Cordwood and firewood shall be advertised, offered for sale and sold only in terms of cubic feet or cubic meters which will be construed as indicating the closely stacked cubic foot or cubic meter content to be delivered to the purchaser. The terms ''cord'', ''face cord'', ''pile'', ''truckload'' or terms of similar import shall not be used in the advertising and sale of cordwood or firewood. The term ''kindling wood'' shall be construed to mean and include all split wood, edgings, clippings or other waste wood averaging eight inches in length. Except as provided by sections two hundred and forty-three and two hundred and forty-seven, the standard unit of measure for kindling wood shall be the bushel of two thousand one hundred and fifty and forty-two hundredths cubic inches."	MGL c.94, §298	

Table 5.1. Summary of Massachusetts General Laws that assign and mandate a state-wide organizational structure to protect, maintain, and enhance various natural resources.

CURRENT POLICY FRAMEWORK

Along with the General Laws and Regulations, DCR, as the lead state agency of forestry practices and policy, administers and adheres to policies and best management practices also designed to protect, enhance, and conserve the state forest lands.

Climate Adaptation Executive Order

In September 2016, Governor Charlie Baker signed Executive Order 569, directing the Executive Office of Energy and Environmental Affairs (EEA) to work with all state agencies to plan and prepare for the ongoing impacts of climate change.

In September 2018, the Commonwealth released the *Massachusetts State Hazard Mitigation and Climate Adaptation Plan* (SHMCAP), a comprehensive integrated climate change plan that outlines adaptation strategies with hazard mitigation planning. Natural resources and the environment is one of five critical sectors of focus, with active forest management, forest fire control, urban tree planting, and invasive species control identified as core initiatives within that sector. In 2018 the legislature passed, and Governor Baker signed, the Environmental Bond Bill, allotting $2.4 billion in capital investment for the protection of environmental and natural resources, infrastructure, and assets against climate change and the associated threats and codifying the SHMCAP into law.

Landscape Designation

Starting in 2009, the DCR began a three-year initiative called the Forest Futures Visioning Process (FFVP) to designate all land owned by the DCR Division of State Parks and Recreation into three categories – parklands, reserves, or woodlands. The designations were based on a complex assessment of tree species and cover, land usage, soil types, and other critical factors. A technical working group of industry experts from public, private, and academic realms was convened to provide guidance and oversight to the process. The 11-member Technical Steering Committee (TSC) was composed of individuals with a high level of expertise on issues, trends, and best practices in climate change, forest conservation and ecology, invasive species, landscape ecology, natural resource economics and law, recreation, silviculture, social policy, visual/aesthetics, watersheds, and wildlife habitat (Vernegaard et al. 2010). They were guided by a 23-person Advisory Group of Stakeholders and conducted five public forums that were attended by over 500 individuals. Over 1,000 comments were received.

The ultimate goal of the Forest Futures Visioning Process was to ensure that the DCR practiced consistent, transparent, and professional forestry practices on its public lands. Published in 2012, the *Landscape Designations for DCR Parks and Forests: Selection Criteria and Management Guidelines* concluded that the DCR would produce Forest Resource Management Plans for areas where timber harvesting would be practiced, as well as implement a robust, transparent, and consistent public process to allow all constituents the opportunity to provide comment prior to timber harvesting on any public lands. The report states:

> *"In its final recommendations report, the TSC encouraged the DCR to embrace a "land management paradigm shift … moving the Department's forest management towards a vision based on a more comprehensive suite of ecosystem services." The concept of ecosystem services, as developed through the 2005 Millennium Ecosystem Assessment, relates to the benefits provided to humans and the environment by ecosystem resources and processes. These services can be broken into four broad categories:* ***provisioning, regulating, supporting, and cultural****. The TSC focused on the premise that the DCR lands should be managed for the provision of ecosystem services to the public that are not consistently delivered by private lands. These services include: carbon sequestration, soil, air and water quality, biological and ecosystem diversity, nutrient cycling, culture, history, spiritual values, public recreation, and renewable wood products." (DCR 2012)*

Best Management Practices

The *Massachusetts Forestry Best Management Practices* manual outlines critical forest management practices for anyone harvesting timber in Massachusetts as well as highlighting key components of sections 40-46 of Chapter 132 of the General Laws, also called the Forest Cutting Practices Act, and section 40 of Chapter 131 of the General Laws known as the Wetlands Protection Act (Catanzaro et al. 2013). The DCR created, follows, and regulates by all guidelines in this manual.

Old-Growth Forests

The DCR Bureau of Forest Fire Control and Forestry established a policy in 1998 for the management of old-growth forest on DCR land. Under this policy, it is the role of the Bureau to 1) provide a definition of old-growth forests, 2) preserve and maintain the integrity of existing old-growth forests, 3) "restore" old-growth where appropriate and utilize these areas as buffers, 4) prepare site-specific management plans, and 5) create old-growth attributes in selected, previously managed stands. Practices to create old-growth attributes during forest management activities include retaining live “cull” and standing dead trees (snags), retaining downed coarse woody debris, and leaving some trees unharvested.

CURRENT PRACTICES

Public Safety

The DCR Bureau of Forest Fire Control and Forestry oversees several programs designed to ensure state lands are secure for public use. Working to maintain healthy forests is a crucial component of public safety. Forest pest and disease monitoring and trapping programs are used across the Commonwealth to detect, track, and manage various pests. In some instances, the detection of forest pests and disease may lead to the removal of stressed, compromised, and dead trees. The DCR also supports active arboriculture practices on major parkways, in a manner consistent with Historic Parkway Preservation Treatment Guidelines (DCR 2007), in an effort to provide both safe and aesthetically pleasing historic roadways.

The Bureau of Forest Fire Control carries out pre-suppression activities designed to control and reduce potential fire hazards. These include the construction and maintenance of access fire roads, brush cut-back on state forest roads linking remote areas to state forests, fire tower maintenance, equipment upgrades and maintenance, and fuel reduction (prescribed burning). In addition, the Bureau of Forest Fire Control works with communities to develop Community Wildfire Protection Plans (CWPP). A CWPP allows a community to specify how the risk of wildfire will be reduced. The plan identifies sites and methods for fuel reduction projects. Fire risk reduction projects identified in a CWPP may be eligible for federal funding through the U.S. Forest Service and Bureau of Land Management under the Healthy Forest Restoration Act. There are 16 complete CWPPs in Massachusetts. Another four are in the process of being completed, including one on

Hazardous trees removed from Purgatory Chasm State Park, photo by Mary Cardwell

Nantucket where U.S. Forest Service Wildfire Risk Reduction grant funds will be used to fund a town-wide Community Wildfire Protection Plan. All CWPPs are for areas in southeast Massachusetts, Cape Cod, and the Islands.

Tree Canopy in Urban Communities

In 2009, the Asian longhorned beetle was discovered in Worcester, and subsequently required the removal of more than 10,000 trees in established, urban neighborhoods. The loss of the urban canopy raised much concern about the impact of trees relative to heating and cooling in private residences. Associated research confirmed the importance of trees to energy efficiencies in urban areas. That concern was the catalyst for a comprehensive urban canopy replacement program within the Worcester area. The program served as a model for additional urban tree planting programs in Massachusetts. The programs are supported through funding from the Department of Energy Resources and EEA and are currently working on support from the very successful MassSave energy efficiency programs. As part of the Greening the Gateway Cities Program (GGC), launched in 2017, Governor Baker announced through increased partnerships with non-profits, industry, and municipalities, the initiative to plant 10,000 urban trees in Massachusetts. In April 2019, the Commonwealth celebrated the planting of the 20,000th tree under this program.

Forest Management on Public Lands

The DCR is responsible for the care and stewardship of State Forests, Parks, Reservations, Beaches, and Recreational facilities across the Commonwealth. The DCR carefully manages the public's land and natural resources for many purposes and uses that are outlined in legislation establishing the agency's responsibilities. The State Lands Management Program uses the principles of ecosystem management to further the policy of the Commonwealth in section 40 of Chapter 132 of the General Laws which states in part that:

> *"the public welfare requires the rehabilitation, maintenance, and protection of forest lands for the purpose of conserving water, preventing floods and soil erosion, improving the conditions for wildlife and recreation, protecting and improving air and water quality, and providing a continuing and increasing supply of forest products for public consumption, farm use and for the wood using industries of the commonwealth".*

To achieve its mission of balancing social needs with ecosystem health, the program uses silviculture and other management tools, such as prescribed fire, to create a range of desired forest and non-forest conditions across large, landscape-scale areas designed to provide these benefits for multiple future generations.

The DCR Division of Water Supply Protection (DWSP) owns and manages the largest acreage of public water supply land in Massachusetts, with the goal of protecting high quality source water for approximately three million residents in the greater metropolitan Boston and Chicopee areas. A Watershed Protection Plan guides all activities and programs that enhance source water protection. DWSP has actively worked to protect additional land since the creation of the system and maintains an active forest management program on most of its watershed land holdings. Forest management on DWSP lands is detailed in its latest Land Management Plan, with primary goals of promoting healthy, resilient forests while protecting water quality and other ecological functions.

Forest cover provides unparalleled water quality. DWSP has determined that the most resilient land cover for watershed and water quality protection comes from a vigorous, species-diverse, many-aged forest. The Division's long-term objective is to diversify the current mostly even-aged mature forest into a multi-aged forest while conserving and enhancing biodiversity. Implementation of this objective is achieved by deliberately regenerating up to one percent of the managed portion of the forest annually through carefully overseen harvesting operations. Simultaneously, large unmanaged portions of the forest as well as small groups and individual legacy trees are left to grow to biological maturities ranging well beyond 100 years of age.

The Department of Fish and Game Division of Fisheries and Wildlife (MassWildlife) supports a Biodiversity Initiative (BDI) that includes active habitat management projects that directly benefit rare and declining wildlife species and plant communities. Biodiversity refers to the variety of life and the natural processes that sustain life, such as water, nutrient, and energy cycling. BDI brings together Restoration Ecologists, Wildlife Biologists, and Foresters to conduct active habitat management projects to conserve biodiversity that directly benefit wildlife species and plant communities of greatest conservation need identified in the *Massachusetts State Wildlife Action Plan* (SWAP).

There is an annual financial commitment from the Executive Office of Energy and Environmental Affairs for deferred land maintenance, also referred to as land stewardship. This capital funding investment provides approximately $2 million annually for the DCR, Department of Fish and Game, and Department of Agricultural Resources to steward lands owned or managed by the state to maintain the ecological value of those parcels. Funds have contributed to the completion of baseline document reports on protected lands, boundary maintenance and survey work to minimize encroachments, and invasive species management.

Reduction of Forest Fragmentation

Forests provide critical carbon storage and sequestration that is essential for mitigation of risks associated with climate change. By reducing the fragmentation of forests, those benefits can be obtained at a higher level of capacity and efficiency. The DCR, in conjunction with and under the guidance of EEA, offers programs designed to help keep forests as forests. Among them are the Conservation Land Tax Credit, Conservation Partnership grants, and capital funding for state land protection. The Landscape Partnership Grant Program seeks to protect large blocks of conservation land. Local, state, and federal government agencies and non-profit groups can use this grant to work together to protect at least 500 acres of land.

The Forest Legacy Program, managed in cooperation with the U.S. Forest Service, provides federal grant funding to protect environmentally important forestland from conversion to non-forest uses. In this voluntary program, landowners who wish to protect their land with the program may sell or donate the

Forest Legacy Program protected property in Northfield, Massachusetts, photo by Benjamin Engel

property in fee simple, or if they wish to retain ownership of the property, sell or donate a conservation restriction. This legally binding agreement prohibits certain uses, such as development, but allows the property to be managed for forestry, recreation, and other conservation values. As of 2020, the Massachusetts Forest Legacy Program has protected more than 17,000 acres of forestland on more than 100 properties. The Massachusetts Forest Legacy Program Assessment of Need is found in Appendix D.

The Community Forest Program also provides federal grant funding to protect private forestlands that are threatened by conversion to non-forest uses. Under this program, private forestland can be purchased by a municipal government, federally recognized tribal entity, or a qualified non-profit organization that has a land conservation purpose to create a community forest. The community forest must provide community benefits such as economic, environmental, educational, and recreational benefits. Massachusetts has had three community forest projects funded under the program, located in Holland, Pelham, and Sturbridge, totaling 648 acres.

Conservation restrictions (CRs) are legal agreements that prohibit certain acts and uses, while allowing others, on private or municipally owned property to permanently protect conservation values present on the land. The Conservation Restriction Review Program reviews CRs in order for the Secretary of Energy and Environmental Affairs to approve of privately or municipally-held CRs in the public interest pursuant to the Massachusetts General Laws (MGL c.184, §§ 31 to 32). Massachusetts state law requires that all CRs in the state, unless held by a state agency, be reviewed by the CR Review Program, and approved by the Secretary of Energy and Environmental Affairs prior to being recorded.

Massachusetts current use tax programs (MGL Chapter 61, 61A, and 61B) provide tax incentives to landowners who maintain and/or manage their property in accordance with forestry, agricultural or open space guidelines. Chapter 61 was designed explicitly for private forestland owners, whereas Chapter 61A was more broadly designed for agricultural ownerships that may also include forestland. Chapter 61B is intended for recreational or open space properties that may include forestland that is either actively or passively managed. Forestland certified under an approved Forest Management Plan that is then enrolled in Chapter 61 or Chapter 61A is taxed at the forestland rate set by the Farmland Valuation Advisory Committee, the values for which are calculated based on the productive potential of the property for growing trees, rather than on the fair market or development value of the land. Chapter 61B land is taxed at a flat reduced rate of 25% of full valuation. The Chapter 61 programs are designed to help private landowners with the cost of maintaining farms, natural areas, and working forests.

Environmental Education

The Commonwealth of Massachusetts strongly supports various environmental education programs designed to inform both youth and adults about the values of healthy forests and land conservation. The Department of Conservation and Recreation sponsors Project Learning Tree (PLT) in Massachusetts with support from the Massachusetts Forest Alliance. In-person workshops led by trained facilitators are available for classroom teachers, home school parents, youth group leaders, nature center staff, and those who work with young people. Workshops focus on trees, forests, forest ecology, and their place in the human culture.

The Massachusetts Environmental Education Society (MEES) is dedicated to the promotion, preservation, and improvement of environmental education in the state and region. The annual MEES Conference brings together environmental educators and professionals from all regions of Massachusetts and from a variety of industries including K – 12 schools, nature centers, urban environmental programs, and museums. MEES also acts as a state liaison with the North American Association of Environmental Educators and provides guidance for environmental educational excellence.

For nearly three decades, the Massachusetts Envirothon has engaged young people in hands-on exploration of soil, water, wildlife, and forest resources, and investigation of the important environmental issues affecting themselves, their families, and their communities. Teams representing communities across Massachusetts prepare throughout the school year, then come together in May at the annual Massachusetts Envirothon competition to demonstrate what they've learned about the environment and environmental issues.

The DCR Division of Water Supply Protection provides specialized educational programs focused on the connection from land protection and watershed management to the production of clean drinking water. Programs and educational materials for a general audience are available at the Quabbin Visitor Center in Belchertown and at Stillwater Farm in Sterling, while educational staff also provide a range of age-appropriate classroom workshops at local schools in watershed towns.

Citizen science is a process where the public can participate and collaborate in scientific research. Citizen scientists participate through sharing observations, conducting monitoring, and undertaking other activities. Citizen science is not only a way to collect data, but also is a way to engage children and adults with the natural world. There are many ways citizen science takes place in Massachusetts and there are endless opportunities for additional citizen science projects. Examples of citizen science include the development of the Outsmart Invasive Species app by the University of Massachusetts Amherst (UMass Amherst), the DCR, and the Center for Invasive Species and Ecosystem Health at the University of Georgia. Through this app, users submit observations of invasive species to aid in monitoring and detection. iNaturalist is another application that offers the opportunity to participate in data collection. State and local governments and non-profit organizations in Massachusetts have a variety of citizen science initiatives ongoing throughout the year.

INSTITUTIONAL FRAMEWORK

State Agencies

Within the Department of Conservation and Recreation's Division of State Parks and Recreation, the Bureau of Forest Fire Control and Forestry provides oversight on all forestry related regulations and works closely with other DCR divisions and EEA agencies regarding resource protection and resource management. The Bureau of Forest Fire Control and Forestry serves state, municipal, and private landowners and the trees and forests they care for through the programs listed below.

- The **Forest Health Program** monitors and assesses factors that influence the health of Massachusetts' forests and provides oversight to forest pest regulatory programs. A sample of programs managed by the Forest Health Program include:
    - Asian Longhorned Beetle Cooperative Eradication Program,
    - Aerial Forest Surveys, and
    - Hazardous Tree Crews.
- The **Forest Legacy Program** is a partnership between the DCR and the U.S. Forest Service to identify and fund protection of environmentally important forests from conversion to non-forest uses through competitive grant awards.
- The **Urban and Community Forestry Program** offers technical assistance and grants to communities to build long-term support for the protection and management of public trees and forests. A sample of programs managed by the Urban and Community Forestry Program include:

  - Greening the Gateway Cities program,
  - The Citizen Forester Newsletter, and
  - Tree Steward Training.

- The **State Public Lands/Management Forestry Program** is responsible for the planning and implementation of forest management activities within the forest and parks system. A sample of programs managed by the Management Forestry Program include:
  - Forest Resource Management planning,
  - Silviculture prescriptions on state lands, and
  - Forest data collection and analysis including carbon management.

- The **Private Lands/Service Forestry Program** provides technical and financial assistance to private landowners and municipalities in forest resource planning, forest management, and forest protection. They also provide regulatory oversight for all timber harvest activities. A sample of programs managed by the Service Forestry Program include:
  - Working Forest Initiative, including Foresters for the Birds,
  - Oversight of Chapter 132 cutting plans and regulatory authority, and
  - Town Forest Celebrations.

- The **Utilization and Markets Program** assists landowners, foresters, timber harvesters, sawmills, and manufacturers in the promotion and expansion of the forest products industry in the Commonwealth. A sample of programs managed by the Utilization and Markets Program include:
  - Community Wood Bank Program,
  - Improving the resiliency of MA timber industry, and
  - Supporting fair and transparent markets.

- The **Forest Fire Control Program** provides aid, assistance, and advice throughout the Commonwealth. They are also responsible for the state's Prescribed Fire Program in which they reduce fuel loads in at risk natural communities as well as execute controlled burns for land and habitat restoration where appropriate. The DCR Forest Fire Control Program works closely with MassWildlife on state lands. A sample of programs managed by the Forest Fire Control Program include:
  - Volunteer Fire Assistance Grants,
  - Prescribed fires, and
  - Wildfire prevention and education programs.

The DCR Division of Water Supply Protection actively manages its own forest lands to promote health and resiliency and regulates development on private lands under the Watershed Protection Act (MGL c.92A½, §§1, 5; 313 CMR 11.00) to ensure the highest protection of source water quality.

Beyond the Bureau of Forest Fire Control and Forestry and Division of Water Supply Protection, the Commonwealth's environmental agencies work in coordination under the guidance EEA to ensure the spirit of Article 97 of the Amendments to the Massachusetts Constitution remains in the forefront of environment and natural resource programs and decisions:

> *"The people shall have the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment; and the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is hereby declared to be a public purpose."*

Some of the programs that fall under this description are the EEA Land Protection and Acquisition Programs within the DCR, DWSP, MassWildlife, and the Department of Agricultural Resources. Programs range from purchasing land in fee acquisitions to conservation restrictions for water supply protection, agriculture protection, or land conservation. MassWildlife also oversees the Natural Heritage and Endangered Species Program to ensure all endangered and / or at-risk plants and animals are protected.

Federal Partners and Cooperative Programs

Both DCR and MassWildlife work closely with many federal partners to ensure that federal priorities and state priorities align for the most robust and cost-efficient programs. Shared stewardship includes coordinated efforts that result in common goals that conserve and manage working forests, protect forests from threats, and enhance public benefits from these lands. The U.S. Department of Agriculture's (USDA) Forest Service and Animal Plant Health and Inspection Services are long-standing partners and have a consistent and active presence within the Commonwealth of Massachusetts.

NATURAL RESOURCES CONSERVATION SERVICE

The Natural Resources Conservation Service (NRCS) works directly with farmers – including owners of forestland – and in partnership with the DCR Service Forestry Program and MassWildlife to achieve mutual objectives of sustainable forestry and wildlife habitat management. NRCS administers the Environmental Quality Incentives Program (EQIP), which provides cost-share funding for numerous wildlife habitat and forestry practices, particularly when timber quality or markets preclude the opportunity to achieve desired outcomes. NRCS soil conservationists meet with landowners and conduct on-site visits to bring projects to fruition.

Congress created the Land and Water Conservation Fund (LWCF) in 1964 to support protection of federal public lands in our national parks, forests, and wildlife refuges, and provide grants for state and local parks and recreation projects. The Great American Outdoors Act, passed in August 2020, permanently and fully funds the LWCF. Under this act, $900 million in offshore oil and gas royalties will be allocated towards conservation projects including land acquisition and deferred maintenance and repairs in national parks. Several programs are funded through LWCF including the Forest Legacy Program, LWCF State Grants program which provide matching grants to States and local governments for acquisition and development of public outdoor recreation areas, and the Cooperative Endangered Species Conservation Fund which provides grants for conservation projects for endangered species.

National Cohesive Wildland Fire Management Strategy

In 2009, Congress passed the Federal Land Assistance, Management, and Enhancement (FLAME) Act. In the FLAME Act, building on earlier reports from the Government Accountability Office, Congress directed the USDA and the Department of the Interior (DOI) to develop a national cohesive wildland fire management strategy. The National Action Plan is the result of a collaborative effort by federal, state, local, territorial, and tribal governments, non-governmental partners, and public stakeholders. It is a companion to the National Strategy and supports its implementation.

The purpose of the National Action Plan is to provide a framework for implementation actions and tasks necessary at various scales. The actions identified were developed collaboratively by and for stakeholders, as a proactive, collaborative approach to implementing the National Strategy. Scientific data analysis underpins all aspects of the National Action Plan. Using science and data analysis to support implementation planning and decision-making must continue. Coordinated engagement and action on the part of all stakeholders provides the best opportunity to restore and maintain landscapes, protect communities from wildfire, and effectively respond to wildfires when they occur. National actions are significant in the context of this national commitment and the plan describes the commitment made by the Wildland Fire Leadership Council, the nation's highest collaborative wildland fire group, to implement the National Strategy.

In 2012, the Wildland Fire Leadership Council adopted a vision for the next century: "To safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and as a Nation, live with wildland fire." There are three primary, national goals identified as necessary to achieve the vision:

- Restore and maintain landscapes: Landscapes across all jurisdictions are resilient to fire-related disturbances in accordance with management objectives,
- Fire-adapted communities: Human populations and infrastructure can withstand a wildfire without loss of life and property, and
- Wildfire response: All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions.

Forests and Rangelands Northeast Regional Strategy Committee

Forests and Rangelands is an active, cooperative effort between the DOI, the USDA, their land management agencies, and the DCR. A Memorandum of Understanding was signed in 2016 by the Secretaries of the DOI, USDA, and the U.S. Department of Homeland Security affirming the departments' commitment to the Wildland Fire Leadership Council to support the implementation and coordination of Federal Wildland Fire Management Policy. To coordinate the regional assessments, the Wildland Fire Executive Council chartered three Regional Strategy Committees, one for each region delineated in the Cohesive Strategy. The goal of the Northeast Regional Strategy Committee is to provide a forum for Northeast and Midwest wildland fire management partners to establish common objectives, overcome barriers, and to provide tools and resources to professionals and the public.

SHARED STEWARDSHIP

Built on the same collaborative foundation as the National Cohesive Wildland Fire Management Strategy and authorities created or expanded in the 2018 Omnibus Bill and the 2018 Farm Bill, such as Good Neighbor Authority, the U.S. Forest Service's Shared Stewardship Strategy is designed to address urgent challenges, among them catastrophic wildfires, increased public demand, degraded watersheds, and epidemics of forest insects and disease by working collaboratively to identify priorities for landscape-scale treatments.

Through Shared Stewardship, a variety of partners will work together to do the right work in the right place and at the right scale. Coordinating at the state level to prioritize will increase the scope and scale of critical forest treatments that support communities and improve forest conditions. Such approaches are essential to achieve common benefits, such as protecting life and property in the wildland urban interface, where homes and businesses intermingle with wildlands.

In August 2018, the State Environmental Bond Bill established the Mohawk Trail Woodlands Partnership (MTWP) in the 21-town Mohawk Trail region of northwestern Massachusetts. On November 21, 2019, the Commonwealth and the U.S. Forest Service signed a Shared Stewardship Agreement. Through this agreement, they will partner with communities to advance the goals of the MTWP to conserve forests and enhance economic development in the region. This is the first Shared Stewardship Agreement in the U.S. Forest Service Eastern Region and the first in the 10 states that do not have a National Forest.

Educational Institutions

Harvard University's first program related to forests and trees began in 1872, when they acquired the Bussey Farm in Boston's Jamaica Plain neighborhood. This property became the Arnold Arboretum, now an internationally recognized center for research and education in the fields of botany, ecology, and landscape design. The Arboretum conducts educational programs for the public and professionals and supports research around the world (Harvard College 2010).

Freetown State Forest prescribed burn, photo by David Celino

In 1907, Harvard University acquired the now 4,000-acre Harvard Forest in Petersham to "serve as a forest demonstration area, a research station, and a teaching and field laboratory for students" (Bond 1998). The transition hardwood-hemlock-white pine forest is located about 70 miles west of Boston. Since that time, the forest and associated research facilities, including the well-known Fisher Museum, have been a center for scientists, students, and collaborators to explore topics ranging from conservation and environmental change to land-use history and the ways in which physical, biological and human systems interact to change our earth (Harvard Forest 2010).

UMass Amherst is a land grant institution established in 1863 as the Massachusetts Agricultural College. The forestry program began in 1909 with the hiring of one faculty member in the department of horticulture. Forestry research and graduate studies programs developed in the 1950s, following the designation of the school as the University of Massachusetts (1948). UMass Amherst owns five forests, which are used for research and management demonstration projects. The largest of these are the 755-acre Mount Toby experimental forest, acquired in 1916, and the 1,200-acre Cadwell Memorial Forest acquired in 1951-52 (Bond 1998, UMass 2020). Mount Toby and Cadwell Forests were permanently dedicated for "the purposes and uses of forest and open space protection, management, and conservation, environmental education, environmental research, and public access for passive recreation and enjoyment" via Chapter 499, Acts of 2002.

UMass Amherst offers two-year, four-year, and graduate degrees in fields related to trees and forests. Through the Stockbridge School of Agriculture, the University offers two-year degrees:

- Arboriculture and Community Forest Management (A.S), and
- Sustainable Horticulture (A.S.).

The Department of Environmental Conservation (ECO) consists of three undergraduate programs:

- Building and Construction Technology (B.S.),
- Natural Resources Conservation (B.S.), and
- Environmental Science (B.S.).

The Building Construction and Technology program addresses virtually every area of building technology including construction and project management, sustainable design, green building and energy conservation, wood design and building as well as sales and marketing of building materials. Within the Natural Resources Conservation degree (B.S.), there are six concentrations:

- Environmental Conservation,
- Fisheries Ecology and Conservation,
- Forest Ecology and Conservation,
- Urban Forestry and Arboriculture,
- Water Resources, and
- Wildlife Ecology and Conservation.

The Forest Ecology and Conservation concentration is nationally accredited by the Society of American Foresters.

UMass Amherst also offers graduate degrees (M.S. and PhD) in Environmental Conservation, with five concentrations:

- Sustainable Building Systems,
- Environmental Policy and Human Dimensions,

- Forest Resources and Arboriculture,
- Water, Wetlands, and Watersheds, and
- Wildlife, Fish, and Conservation Biology.

Other colleges and universities in Massachusetts have programs in forestry-related fields or have encouraged student research into trees and forests, including Williams College, Smith College, Clark University, UMass Dartmouth, Boston University, and Westfield State University.

At the high school level, some vocational programs include forestry and arboriculture in their curricula. Schools that train future foresters, arborists, and urban foresters include Norfolk County Agricultural and Technical High School, Essex North Shore Agricultural and Technical School, and Smith Vocational and Agricultural High School.

UMASS PARTNERSHIPS

UMass Amherst has long been an important partner with DCR, training professionals to enter the workforce at the technical, professional, and academic levels, and providing critical collaborations with research and outreach that serve the scientific community as well as the citizens of the Commonwealth and the nation.

The UMass Department of Environmental Conservation houses a breadth of scientists engaged in research on such diverse topics as forestry, arboriculture, forest health, wildlife biology, landscape ecology, family forest ownership dynamics, and wood building technology. These researchers routinely partner with DCR forestry programs to utilize their unique and intimate knowledge of the forests and landowners of Massachusetts, probing scientific questions such as the effects of invasive species on our forests, forest carbon dynamics, the effects of climate change on trees and forests, how trees in urban areas are managed, wood utilization opportunities, and intergenerational land transfer challenges.

Extension forestry is embedded organically within ECO, so the results and findings of cutting-edge research are made available to professionals and the public, with immediate practical benefits to practitioners and the forests they interact with. Numerous publications and outreach events are produced each year, with extension forestry serving other vital roles, from gathering data and publishing a quarterly stumpage report for the region to hosting an annual Keystone training workshop to educate and empower local conservationists to effect change in their communities.

UMass Extension's Landscape, Nursery and Urban Forestry Program also provides invaluable, cutting-edge, science-based information for professionals and the public. The program provides continuing education opportunities and best management practice guidelines for licensed pesticide applicators and for other practitioners; produces fact sheets on tree and landscape pests, diseases, and other topics; provides laboratory services to diagnose insect, disease, and other problems on trees and shrubs, as well as testing for pinewood nematode (a requirement in some cases for exporting pine and hemlock); and publishes a weekly to monthly "Landscape Notes" newsletter on pests and seasonal phenology, in addition to other periodical publications.

Other cooperative federal institutions are housed wholly or in-part at UMass that partner with DCR and produce important research and other science-based products relevant for trees and forests include the Northeast Climate Adaptation Science Center (USGS), the Urban Natural Resources Institute (U.S. Forest Service), and the Massachusetts Cooperative Fish and Wildlife Research Unit (USGS). The Family Forest Research Center, a partnership between the U.S. Forest Service and UMass, researches family forest landowner attitudes and dynamics and provides outreach strategies and materials to guide landowner engagement in Massachusetts and beyond.

Conservation Organizations, Non-Profits, and Land Trusts

There is a long tradition of private citizen involvement in conservation issues in Massachusetts. Henry David Thoreau, citizen of Concord, Massachusetts, is considered by many to be the first conservationist. In 1876, a group of prominent Bostonians founded the Appalachian Mountain Club (AMC). The club soon became involved in forest preservation. Charles Eliot, a landscape architect and early member, was instrumental in the founding of The Trustees of (Public) Reservations. The AMC was also actively involved in preserving forestland in other New England states and is now a regional organization. The Trustees of Reservations, Mass Audubon, New England Forestry Foundation, and the Massachusetts Chapter of The Nature Conservancy are four major statewide organizations. In addition to owning and managing nature reserves and holding conservation easements on private lands, these organizations conduct a wide array of educational, research, and public outreach activities and are actively involved in the political process.

There also are numerous regional and local conservation organizations and land trusts. The Massachusetts Land Trust Coalition lists 131 land trusts in Massachusetts. These are located in all regions of the state from Cape Cod to the Berkshires.

Beyond land trusts, there are many vital non-profit organizations designed to protect forests, preserve our unique and varied natural resources, and promote responsible sustainable environmental practices throughout the state. The Massachusetts Forest Alliance (MFA) was formed in 2012, consolidating disparate groups with similar interests in sustainable forest management and conservation. These groups previously included the Massachusetts Wood Producers Association, the Massachusetts Association of Professional Foresters, and the Massachusetts Forest Landowners Association, which operated independently on a volunteer basis. The MFA now provides a unified voice representing the shared values of landowners, foresters, sawmill owners, and others that support a strong, sustainable forest economy, utilizing a full-time executive director to carry out the work in support of the association's vision. The main activities of the MFA center on advocating for sensible laws and regulations pertaining to the forest economy, providing continuing education opportunities to parties involved in sustaining the forest economy, and promoting a greater understanding of forest management and forest policy issues to the general public.

The New England Forestry Foundation, through the application of expertise in conserving forestland and advancing exemplary forestry, helps the people of New England to sustain their way of life, protect forest wildlife habitat and ecosystem services, and mitigate and adapt to climate change.

Harold Parker State Forest, photo by Lindsay Nystrom

The Massachusetts Tree Wardens' and Foresters' Association was founded in 1913 as a forum for municipal tree managers to share their concerns and to promote the preservation of public shade trees. Since that time, the mission has expanded to encompass preservation of the entire urban and community forest. Members include tree wardens, city foresters, utility representatives, commercial arborists and companies, education professionals, and citizen tree advocates.

Also operating in Massachusetts is The Trust for Public Land, a national organization founded in 1972. The Trust for Public Land works to save land for people to enjoy, from neighborhood parks to national parks. Their mission is to create parks and protect land for people, ensuring healthy, livable communities for generations to come.

Massachusetts has an extensive network of friends groups and partners across the Commonwealth that volunteer their time, efforts and expertise to support the key mission of Article 97 of the Articles of Amendment to the Constitution of the Commonwealth of Massachusetts. Currently the DCR works with approximately 95 different friends' groups and associations that support environmentally sound practices and protect our valuable nature resources across the Commonwealth.

Forestry Advisory Groups and Oversight Committees

STEWARDSHIP COUNCIL

As identified in MGL Chapter 21, the Department of Conservation and Recreation works under the guidance of a Stewardship Council. Committee members on this 13-person committee are appointed by the Governor and participate in a seven-year term:

> *The governor shall appoint 11 members of the stewardship council with due regard to geographical distribution, provided that five members shall reside within the urban parks district defined in section 33 of chapter 92, at least one of whom shall be a resident of the city of Boston,*

and one of whom shall be a resident of Berkshire county. Of these members, no more than one may come from the same county except as provided herein.

The commissioner shall request each of the boards of trustees or directors of the Massachusetts Audubon Society, the Massachusetts Chapter of the Sierra Club, the Massachusetts Chapter of the Appalachian Mountain Club, the Trust for Public Land, the Environmental League of Massachusetts, and the Trustees of Reservations to nominate six candidates for the remaining two members of the council. From the nominations received from the several boards of such organizations, the commissioner shall select six candidates whom he shall recommend to the governor. The governor shall appoint the remaining two members of the council from among the candidates recommended by the commissioner.

MASSACHUSETTS FORESTRY LICENSING BOARD

The DCR Director of State Parks and Recreation appoints, as agent, a five-member Forester Licensing Board (FLB) for the purposes of assisting and advising on the administration of the licensing of foresters pursuant to MGL c.132, §§ 47 through 50 and 302 CMR 14.00. To ensure all practices and standards span the broadest scope of responsible forestry, the board is made of a cross-section of various forestry interests. The board is comprised of one individual per each related field:

- employee of a federal, state, or a municipal government agency,
- licensed forester employed in the private sector,
- faculty member of a college or university in a forest resources or natural resources management program,
- private landowner of classified forest land, and
- representative of an environmental organization, a land trust, or a consumer group.

Four of the members must have the qualifications necessary to obtain a license to practice forestry in Massachusetts, two of whom must be Licensed Foresters.

THE MASSACHUSETTS FOREST FORUM

The Forest Forum, founded in 2006, was created to “improve the viability of Massachusetts’ forests, forestry, and forest products industry by using sustainable practices.” The Forum adopted five goals that benefit our forests and over 20 environmental, landowner, industry, and educational organizations:

- Protect a sustainable base of forestland to ensure the ecological integrity of Massachusetts’ forests and support fundamental public values, uses, and ecosystem services,
- Ensure the economic viability and sustainability of working forests, the forest products industry, and local rural economies in Massachusetts,
- Create a balanced, comprehensive matrix of sustainable working forests and forest reserves to ensure the ecological and economic integrity of Massachusetts forests,
- Pursue priority in-state actions to minimize the threats to forest ecosystems, and
- Increase understanding of and connections to our forests.

The Forest Forum is committed to discussing current issues from new perspectives to find innovative solutions that benefit our forests, forestry, and the forest economy. In August 2019, participants in the Forest Forum called for a science-based approach to optimize the climate benefits derived by the forests of Massachusetts while also ensuring that our forests continue to deliver the ecosystem services that benefit society. The full statement is found in Appendix C.

Forest Reserves Scientific Advisory Committee

One of the results of the Forest Futures Vision Process and subsequent Landscape Designation process was the development of the Forest Reserves Scientific Advisory Committee (FRSAC). FRSAC is comprised of local experts in forestry and fire control practices, research, and policy who review proposals of forestry and restoration projects within the state's public reserves to ensure the objectives of the Forest Futures Visioning Process are met. The current FRSAC committee includes representatives from The Nature Conservancy, Harvard Forest, UMass Amherst, National Park Service, U.S. Forest Service, as well as key industry sectors.

Forest Ecosystem Monitoring Cooperative

The mission of the Forest Ecosystem Monitoring Cooperative (FEMC) is to serve the northeast temperate forest region through improved understanding of long-term trends, annual conditions, and interdisciplinary relationships of the physical, chemical, and biological components of forested ecosystems. The FEMC also promotes the efficient coordination of multi-disciplinary environmental monitoring and research activities among federal, state, university, and private-sector agencies with common interests in the long-term health, management, and protection of forested ecosystems.

FEMC works towards its mission and goals with a professional staff, web-based Project Library and Database, education and outreach programs, and continuing efforts to support and coordinate the region's forest ecosystem interests.

The Forest Ecosystem Monitoring Cooperative is a partnership of northeastern state agencies, the University of Vermont, and the U.S. Forest Service. The FEMC maintains a long-standing, diverse repository of monitoring and research data relevant to forest ecosystem structure, health, and function. The repository includes datasets unique to the archive, region-specific extracts of data maintained by other organizations, and links to datasets hosted elsewhere. Web access to this searchable database provides linkages between datasets, documents, people, organizations, news, and events used in management, decision-making, research, and student training.

FUNDING

State Commitment and Spending

Under the Executive Office of Energy and Environmental Affairs, the support and commitment to forestry in Massachusetts is on the rise. With the lift of the limitations on timber harvesting on state lands in 2012, a heightened public awareness of the health benefits of trees, and climate change being addressed in the *Massachusetts State Hazard Mitigation and Climate Adaptation Plan*, state funding and resources are increasingly available for forestry-related initiatives. Currently the DCR employs 105 staff within the Bureau of Forest Fire Control and Forestry and 14 at the Division of Water Supply Protection (Table 5.2) that work on issues regarding the health and management of our forests. The Department of Fish and Game has six staff members who have forestry-related responsibilities.

Program	# of Full Time Forestry Staff
Division of Water Supply Protection	14
Forest Fire Control	20
Forest Health (includes federally funded ALB staff)	35
Forest Legacy	1
Management Forestry (Public Lands)	10
Service Forestry (Private Lands) (includes one federally funded position)	14
Urban and Community Forestry (includes one federally funded position)	24
Utilization and Markets Forestry	1
Department of Fish and Game	6

Table 5.2. Full time forestry staff in the Department of Conservation and Recreation and the Department of Fish and Game.

The Commonwealth has also made significant capital investments in programs such as Service Forestry's Working Forest Initiative (see below), and Urban and Community Forestry's Greening the Gateway Cities program, averaging about $4 million annually. Another capital investment in our forests includes the Land Stewardship Deferred Maintenance program which allots nearly $1 million annually for items such as boundary maintenance, markings, and surveys.

Federally Funded Programs

The U.S. Forest Service Eastern Region State and Private Forestry Program provides funding for the forest health, fire management, urban and community forestry, Forest Stewardship, and Forest Legacy Programs. In 2018, the DCR received approximately $7,750,000 for those programs. Additionally, the DCR received $3,800,000 from the USDA Animal Plant and Health Inspection Services for the ongoing Asian Longhorned Beetle Cooperative Eradication Program.

The Working Forest Initiative

The Working Forest Initiative (WFI), funded under the 2008 Massachusetts Environmental Bond Bill, has helped to increase enrollment in Forest Stewardship and all Chapter 61 programs. Under the Working Forest Initiative, landowners not currently enrolled in Forest Stewardship or Chapter 61 programs can be reimbursed for the development of a new Forest Stewardship Plan by a Massachusetts licensed

DCR Management Forester Keith DiNardo, photo by DCR

forester. From 2011-2020, reimbursement was available to landowners with current Forest Stewardship and Chapter 61 management plans who wished to upgrade those plans to meet requirements for the Forest Stewardship Council Group Certification Program. From July 2009 through June 2019, The Working Forest Initiative has assisted 1,843 forest landowners on 166,585 acres across the Commonwealth to achieve a sustainable forest plan at a financial commitment of approximately $2,837,000.

Forest Research

There are two major forest research institutions in Massachusetts: Harvard Forest and UMass Amherst. A third, Clark University, has undertaken significant research in urban forests through its Human-Environment Regional Observatory. Other organizations such as The Nature Conservancy, the Massachusetts Audubon Society, the Appalachian Mountain Club, and The Trustees of Reservations employ scientists and resource managers who conduct research and collaborate with UMass Amherst and Harvard Forest. Faculty members and graduate students at other colleges and universities in Massachusetts conduct research that relates to forests and society. There are no publicly accessible information sources where these funding data and information can be obtained. Harvard Forest, located in Petersham, MA, has been a Long Term Ecological Research site for more than 30 years. Total research funding is generally between $1.5 and $2 million annually.

Harvard Forest receives funding from a wide variety of sources including the following: the US Department of Energy, U.S. Environmental Protection Agency, U.S. National Science Foundation, U.S. Forest Service, National Institute of Food and Agriculture, Smithsonian Institution, as well as the Commonwealth of Massachusetts (EEA and DCR), Harvard University – Faculty of Arts and Sciences, and other universities and private foundations (Harvard Forest 2020).

Sources of funding for research at UMass Amherst include the National Science Foundation, U.S. Forest Service, USDA National Institute of Food and Agriculture, the USDA Cooperative State Research Education and Extension Service, The Nature Conservancy, The TREE Fund Foundation, EEA, the DCR, the

Department of Environmental Protection, and the National Urban and Community Forestry Advisory Council.

In-Lieu Fee

The Department of Fish and Game (DFG) sponsors and administers the In-Lieu Fee (ILF) Program for the Commonwealth of Massachusetts. This state-wide program was established in May 2014 upon approval by the U.S. Army Corps of Engineers ("Corps"). The ILF Program provides a mechanism for Corps permittees to make a payment to DFG as compensation for impacts to federally regulated aquatic resources (payments are "in-lieu of" on-site permittee responsible mitigation). DFG aggregates the ILF payments and distributes them through a request for proposals process in order to implement larger-scale mitigation projects. State agencies, municipalities, and non-governmental organizations may apply for ILF funding to support aquatic resource preservation and/or enhancement projects. The first ILF project began in 2017 and five new projects were approved in 2019 for a total of $1,118,377 in ILF funding to date. ILF Program funds are prioritized by geographic Service Areas and resource type (e.g., wetlands, stream, fresh, or tidal) depending on the locations and type of impacts for which ILF payments were made.

WEAKNESSES OF THE CURRENT LEGAL, POLICY, AND INSTITUTIONAL FRAMEWORK

Massachusetts General Laws

While created to protect critical ecosystem services for the residents and visitors of the Commonwealth, the fine structures for violations under Massachusetts General Laws do not reflect current market values and thus fall short of a value that adequately deters violations. As an example, the fine for moving regulated material outside of the Asian longhorned beetle regulated area is now $25,000, increased from the original fine of $25. Similar fines for violations of the Forest Cutting Practices Act and Chapter 87 Shade Tree Management laws remain well below acceptable standards. Beyond fine structures, some environmentally focused laws contain text that do not reflect modern technologies or practices. One of the most glaring examples comes from Chapter 87, section 12: "Whoever wantonly injures, defaces or destroys a shrub, plant or tree, or fixture of ornament or utility, in a public way or place or in any public enclosure, or negligently or willfully suffers an animal driven by or for him or belonging to him to injure, deface or destroy such shrub…". In our current times, more damage is caused from vehicles than from horses. More importantly, other proposed changes to modernize the language include the creation of standardized regulations to provide a mechanism that can change with time and needs.

Similarly, encroachment on protected state-owned/restricted lands by private landowners is curtailed when a structure exists that can properly reduce or mitigate the problem. Development of laws, regulations, and a sufficiently disincentivizing fine structure would allow state agencies to pursue egregious and/or repeat violators in a swift and appropriate manner, dissuade future violations, and thus benefit all residents through improved conservation of critical natural resources.

The first iteration of the Forest Cutting Practices Act was approved in 1944. Although some areas of the original text have been updated, the time has come for a significant update. Current regulatory oversight programs are challenged by the current language of the Massachusetts General Laws. In some instances, there can be conflict between following the law as outlined in the text and the onsite, real-world violations that reside in the loopholes of the text.

Programs

The Executive Office of Energy and Environmental Affairs has the dual role of identifying and growing energy-related industries, including solar and wind, and protecting and stewarding lands of critical importance to the natural and cultural resources of the state. There is the potential that incentivizing one program may come at the cost of undervaluing another. It is important that open, constructive conversations continue within state government to ensure appropriate compromises can be identified and implemented. Currently, the state incentivizes installation of solar panel fields to increase clean, renewable energy options. Latest results show 24% of installations were built on previously forested lands because the incentive was higher to convert the land than the incentive to keep forests as forests. The intent of the program was not to promote forest conversion, but rather better utilize gray space. In the Spring of 2020, new regulations were announced to adjust the program to balance the two important priorities.

Resources

Funding will always be of the highest priority to properly manage, protect, and steward the vast natural and cultural resources in Massachusetts. The instability of federal funding for environmental programs directly impacts state-level funding. While states, non-profits, and even private landowners try to allocate decreasing resources and budgets to accomplish more with less, the cost of management and stewardship continues to rise.

Funding for programs like Urban and Community Forestry (UCF) has increased at the state level due to the Greening the Gateway Cities program and its connecting energy costs with urban canopy. However, the general national trend is for federal UCF funding to decrease, resulting in a nearly non-gain, level funding landscape. For FY2020, the federal allocation for the Massachusetts UCF program increased, but this has not been a regular trend and cannot be relied upon in the future. The UCF program depends on this federal allocation for one staff position and for most of the grant funding the program distributes. Forest Health is another area that is grossly underfunded. The threat of forest pests and diseases is on a steady incline due to the impacts of climate change, and again state and federal funding for that program remain flat at best and potentially have declined.

Overall rates of enrollment in forestry education programs nationwide have remained flat but can vary widely from year to year. The general trend in natural resource education has been for students to enroll more frequently in environmental conservation programs, rather than traditional management-based programs such as forestry. Some factors that are discouraging students from seeking forest management degrees include changing societal values toward forests and forestry, the desire for a more diversified forestry degree, inflexible curriculum due to accreditation standards, a perception of low wages or lack of available jobs, and limited appeal for women and minorities (Sharik et al. 2015). In Massachusetts, UMass Amherst offers a major in Natural Resources Conservation with a concentration either in Forest Ecology and Conservation or Urban Forestry and Arboriculture (alongside other non-forestry-related concentrations). Since *An Assessment of Forest Resources of Massachusetts* was published in 2010, these programs have continued to see low enrollment, resulting in fewer locally trained professional foresters entering the field. Compounding the problem even further, the workforce is aging. In the DCR alone, the average age of employees is 55 years old, and with limited entry-level professional jobs available, the challenge to replace retiring staff with qualified, experienced individuals is being felt throughout the various bureaus within the DCR.

STRATEGIES

The strategies below focus on Legal / Policy and Institutional Framework but may apply to other Chapters. The complete list of goals and strategies can be found in the Strategy Matrix on page 15.

GOAL 3: SUPPORT AND ENHANCE FOREST ECONOMY

Strategy 23: Support training and development opportunities for licensed foresters, timber harvesters, arborists, and urban foresters in the state

Strategy 25: Advocate for and provide educational opportunities for students interested in forestry and related disciplines

GOAL 4: MAINTAIN AND INCREASE URBAN TREE CANOPY COVER

Strategy 32: Implement grants to maintain, protect, enhance, and measure urban tree canopy

GOAL 5: ENHANCE THE CONNECTION BETWEEN FORESTS AND PEOPLE

Strategy 33: Support environmental education to teach children and young adults the value of trees and forests using programs, such as the Massachusetts Envirothon, Project Learning Tree, and through Arbor Day and Earth Day events

Strategy 34: Provide leadership for public programs, such as Firewise USA, Tree Campus USA, Tree City USA, and Tree Line USA

Strategy 37: Provide grants and support for developing and maintain community wood banks

GOAL 7: ADVOCATE FOR A LEGAL AND INSTITUTIONAL FRAMEWORK PERTINENT TO THE CONSERVATION AND MANAGEMENT OF TREES AND FORESTS

Strategy 46: Advocate for appropriate forestry and fire management related positions within Environmental Agencies

Strategy 47: Participate in training and development opportunities for state forestry and forest fire control staff to ensure competency with current standards and practices

Strategy 48: Improve compliance with the Forest cutting Practices Act

Strategy 49: Identify forestry-related laws and regulations – for example, the Public Shade Tree Law - that require clarification, modernization, or strengthening and work to remediate

Strategy 50: Increase communication and collaboration with other state agencies through shared stewardship

Strategy 51: Ensure state agencies have the appropriate structures to allow for participation in national and international emergency responses

Strategy 52: Ensure forestry Best Management Practices reflect the latest research and standards

Strategy 54: Advocate for programs and incentives that promote clean energy options and discourage forest conversion

Strategy 55: Support the goals of the Northeast Region Cohesive Wildland Fire Management Strategy: 1) Restoring Resilient Landscapes, 2) Creating Fire Adapted Communities, and 3) Safe and Effective Wildfire Response

Strategy 56: Encourage municipalities to adopt ordinances and bylaws such as Low Impact Development, Natural Resource Zoning, and Open Space that reduce the loss of trees and forests

GOAL 10: CULTIVATE AND SUPPORT PARTNERSHIPS WITH FORESTRY AND CONSERVATION STAKEHOLDERS

Strategy 67: Expand financial and technical support of programs that further state forest priorities

Strategy 68: Seek multi-level funding opportunities that are tied to the state forest priorities

Strategy 69: Engage with local, regional, and national partners in on-going activities and projects

Strategy 70: Maintain presence at regular meetings of stakeholders to stay abreast of interests, activities, and concerns

Strategy 71: Improve coordination with government agencies on implementation of projects across jurisdictions

Strategy 72: Actively participate in forest fire control and forest health compacts as well as the urban forest strike team to share resources for national response opportunities

Chapter 6 - Priority Landscape Areas

The following pages identify priority landscape areas across the Commonwealth where federally funded cooperative forestry outreach will be emphasized. Each priority landscape area has a different focus such as urban forests, high elevation ecosystems, forests vulnerable to development, or small-rural or economically disadvantaged communities. Geospatial analysis was also used to create overlays of the priority areas of the state based on each of the three national priorities: Conserve and manage working forest landscapes for multiple values and uses, Protect forests from threats, and Enhance public benefits from trees and forests. Existing conservation and environmental focus areas important to Massachusetts that cross state boundaries are also identified as multi-state priority areas. Order of presentation does not signify a ranking of these priorities. More information about the geospatial analyses can be found in a separately published appendix.

Priority Urban Forests

The priority landscapes for Urban and Community Forestry analysis (Figure 6.1), incorporates and ranks several GIS layers (in descending order): a layer that prioritizes communities for urban forestry resource targeting (“Maryland Method”), Massachusetts Sustainable Community Forestry Score, Percent of population below poverty level, wildland urban interface, and 303d (Clean Water Act) list of impaired waters. The methodology was developed by an urban forestry advisory group comprised of key partners to the DCR Urban and Community Forestry Program (UCF) and DCR staff for the 2010 assessment.

Results of the geographic analysis using these recent data show some changes from the 2010 assessment, likely due to the use of data from the 2010 census for this analysis. Several communities had their priority ranking increase, particularly communities in Berkshire County, Greater Springfield, Greater Boston, on the North Shore, and on Cape Cod.

Urban and community forests, comprised of street trees, trees in open spaces, parks, forested patches, and transportation zones lined with trees, constitute a critical part of a community’s infrastructure and define the character of each town or city in the Commonwealth. Between 1990 and 2010, Massachusetts experienced one of the highest rates of urban development with a 5% growth in urbanized land, most of which occurred in open forested land (Nowak et al. 2005). Between 2000 and 2010, Massachusetts had a 3.8% increase in urban land to 38% of all land, the third highest percentage of urban land in the continental United States (Nowak and Greenfield 2018).

Urban areas, with their associated impervious surfaces, and constrained spaces for trees, face increased threats from climate change: increased temperatures, inland urban flooding, and potential tree loss due to extreme weather. Additionally, many of these areas are home to Environmental Justice communities. In Massachusetts, a community is identified as an Environmental Justice community if it meets any of three conditions: a census block group whose annual median household income is equal to or less than

65% of the statewide median; 25% or more of the residents identify as a race other than white; or 25% or more of households have no one over the age of 14 who speaks English only or who speaks English very well (Mass.gov 2020a).

Although Massachusetts remains the eleventh most forested state (Oswalt et al. 2019) with approximately 63% of its land area considered to be forested, by 2060 it is projected that 60% of land in Massachusetts may be classified as urban, according to the U.S. Census definition of urban (Nowak and Greenfield 2018). This combination of population density, increasing urbanization, and forest cover suggests that the pressure between urban vegetation and people in Massachusetts is particularly intense. It is the third most densely populated state in the nation, which makes the management of its forest resources, particularly community forest resources, vital to the quality of life of the states' residents.

The citizens of Massachusetts have long recognized and valued the forests and trees that comprise the community forest. As early as 1646, the citizens of Boston Neck (the area now known as Beacon Hill and Boston Common) recognized that they had made a mistake in removing the trees from their small

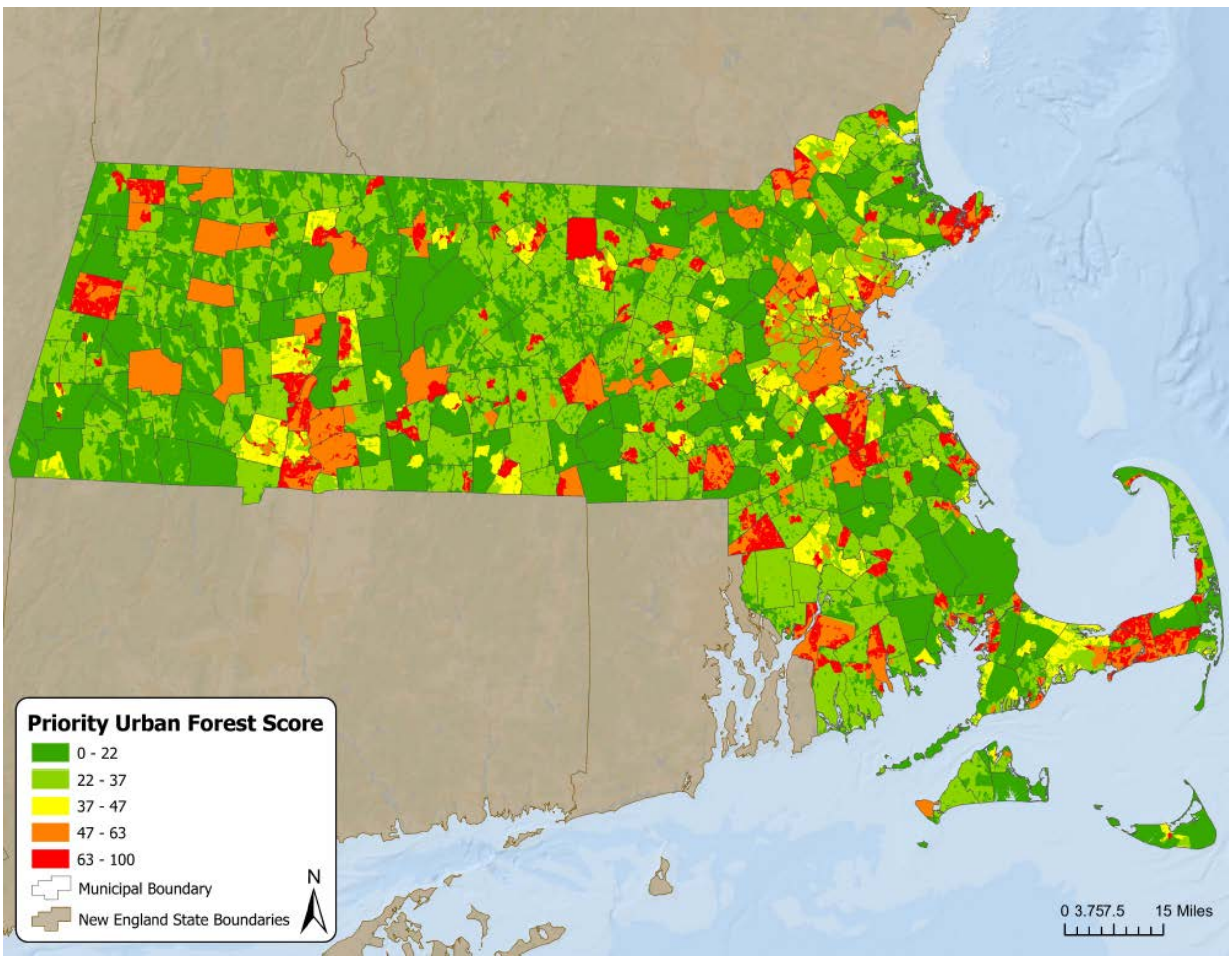


Figure 6.1. Urban Forests shown by priority urban forest score. Green represents areas that have a lower urban forest priority score; red represents communities with the highest priority urban forest score (data: U.S. Forest Service, MassGIS, U.S. Census Bureau).

community. Their actions resulted in a shortage of fuel wood and increased exposure to the fierce winds that swept off of the ocean. They took legal action to remedy the situation. These early Bostonians voted to raise public funds for the planting of trees and enacted strict penalties for the unlawful removal of these trees. Interestingly, many of the trees that the colonists planted were American elms, one of which would become the celebrated Liberty Tree of the American Revolutionary period which stood near the Boston Common until the occupying British troops spitefully cut it down in 1775.

In 1896, the state legislature passed a law authorizing towns to elect tree wardens, as well as to provide for the preservation of public shade trees (An Act to Provide for the Preservation of Public Shade Trees, and to Authorize Towns to Elect Tree Wardens, Chapter 190 of the Acts of 1896). In 1899, the legislature passed a law changing the position of tree warden from optional to required for every town. An 1899 law mandating tree wardens (An Act to Codify and Amend the Laws Relative to the Preservation of Trees (Chapter 330 of the Acts of 1899) has evolved into Massachusetts General Law Chapter 87 (MGL Chapter 87) known as the "Shade Tree Act." This law became, perhaps, the first statute in the nation to offer protection for community trees by designating trees planted and growing along the "public right of way" to be presumed public property. The law also created the novel position of the Tree Warden and empowered this municipal representative with authority to plant, maintain, and remove public shade trees and to act as the convener of public tree hearings to settle disputes related to public trees. Every municipality in the state was mandated to designate a Tree Warden and to ensure that the statutory protections enacted through the mandated processes of the law were followed. In 1913, the Tree Wardens gathered together to form the Massachusetts Tree Warden's and Forester's Association to "provide a forum for professional tree managers to share their concerns for a common cause ... the shade trees growing in our communities." The association was the first tree organization in the United States and engaged in activities that were the first examples of urban and community forestry work in the nation. Today, the Association continues as an important and vibrant player in the protection and management of the state's community forest resources.

Many other conservation groups are active players in the management of community forestry resources in Massachusetts. It was on March 5, 1890 that Boston landscape architect Charles Eliot proposed the formation of the first non-profit land trust in the country, The Trustees of Reservations. Other conservation organizations were quick to follow, leading to the formation of a strong network of advocates for the protection of local natural resources. This list of organizations includes The Nature Conservancy of Massachusetts, The Massachusetts Audubon Society, the Trust for Public Land, the Massachusetts Association of Conservation Commissions, and numerous local tree committees and neighborhood and regional associations. Underpinning these groups is an interest in the protection and proper management of local natural resources that pervades the citizenry of the state. A "green" cultural awareness is one of the hallmarks of the general public of the state of Massachusetts.

With this long and rich history of conservation firsts and a widespread recognition of the importance of local natural resource protection, Massachusetts offers a unique set of opportunities and challenges for urban and community forestry. The Department of Conservation and Recreation (DCR) and its partners seek to capitalize upon the support for local forestry efforts so evident in the populace of the state while also meeting the high expectations and standards of these concerned citizens.

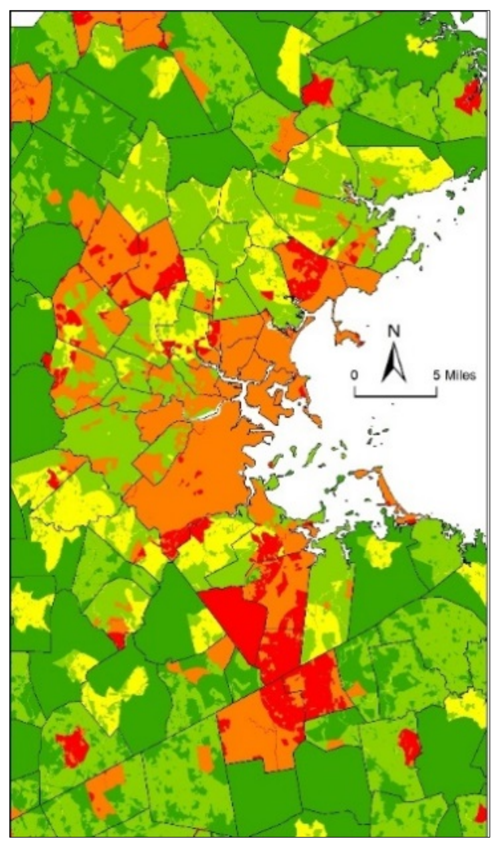
The major findings of the assessment of urban forest resources for Massachusetts are:

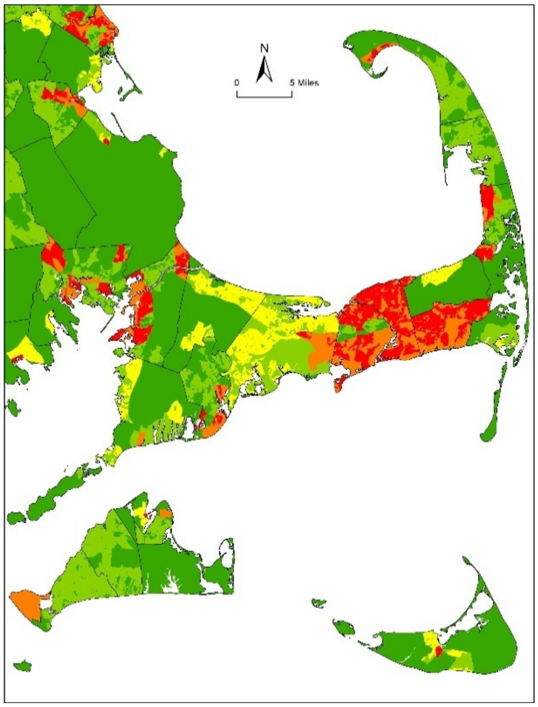
1. The highest priority urban forest areas are the major urban centers and surrounding communities.
2. Moving west from the Boston/coastline area, priority areas roughly follow US Route 2 and I-90, with some exceptions.

Many areas identified in the 2010 analysis also appear in the 2020 analysis. This is not surprising given that the variables measured in this analysis generally change slowly over time. The priority level for many communities increased, particularly in Berkshire County, and we suspect this is due to the effect of the recession on income that was captured in the American Community Survey (2006-2010) data used in this analysis. The third-ranked layer in our analysis is the percent of population below the poverty level, which increased to over 10% for many communities, the threshold for inclusion in this assessment.

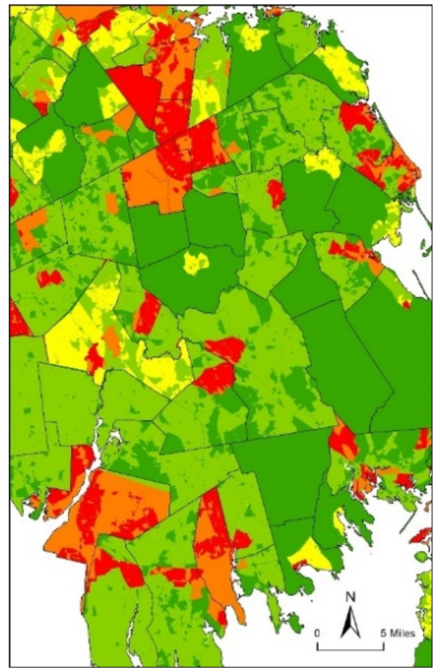
From the composite GIS Urban Forestry Layer generated by this analysis, DCR has identified the following areas of the state as priority urban and community forests. The communities within the regions identified in this analysis will be the priority target areas of the DCR UCF program and its partners.

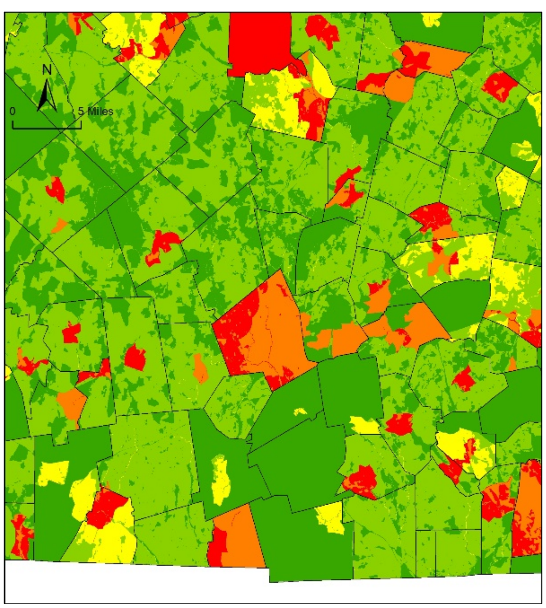
Greater Boston Area Sub-Region (right): The Greater Boston Sub-Region is the oldest and most heavily developed area of the state. Communities in this region are largely "built out" such that redevelopment of already disturbed sites may be more prevalent here than in other areas of the state. Forestry programs in this region are primarily concerned with maintaining current canopy and re-building forest canopy within the dense matrix of human development.





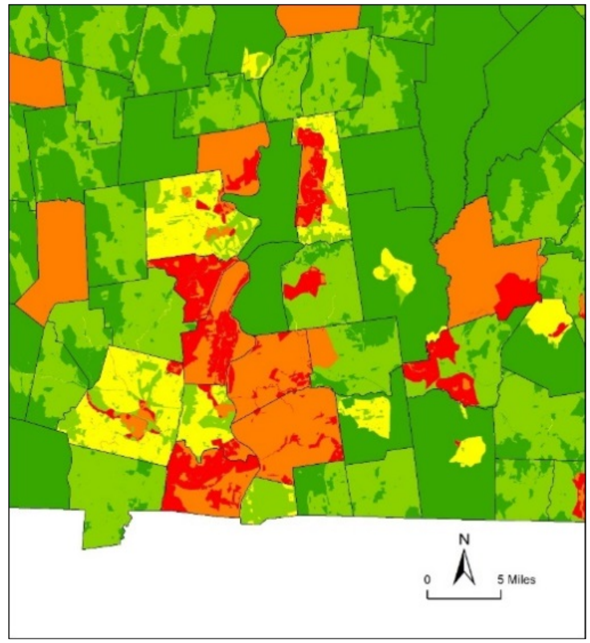
Cape Cod and the Islands (left) and Interior Southeast – Greater Franklin, Greater Fall River / New Bedford Sub-Regions (right): The southeastern area of Massachusetts is the fastest developing area of the state with large parcels of forestland being developed into housing and commercial use sites. Also within this area, are a number of older, densely settled cities. Urban forestry programs in this area need to address the effects of urban sprawl and also work to re-build tree canopies within the urban core communities.

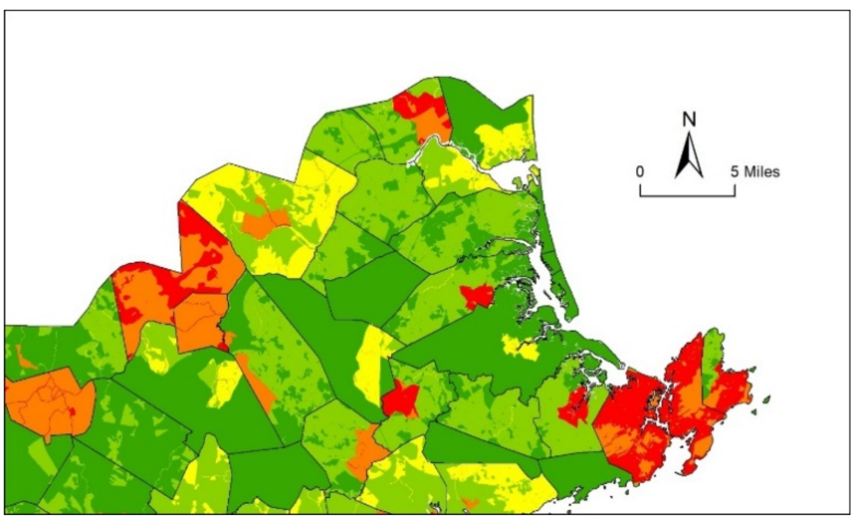




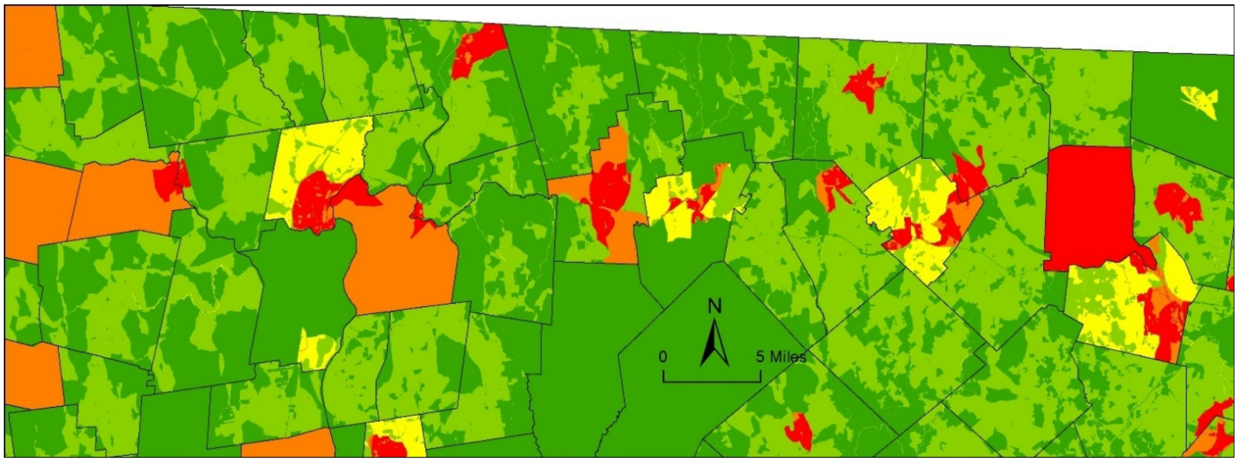
Greater Worcester Sub-Region (left): The Greater Worcester Sub-Region is comprised of the densely developed City of Worcester and surrounding suburban towns. This area of the state is becoming increasingly developed as commuters who work in the Greater Boston area move here to find slightly reduced real estate prices. Urban forestry programs in this area need to address the increasing effects of urban sprawl and also work to re-build the forest canopies within the urban core.

Greater Springfield Sub-Region (right): The Greater Springfield Sub-Region is comprised of the densely developed cities of Springfield and Holyoke and surrounding sub-urban towns. Communities in the area are characterized by older infrastructure and pockets of diverse, lower income populations. In the 2020 assessment, this area has expanded to include Ware and Palmer. Forestry programs in this area face the challenge of limited budgets and lack of staff while working mostly to protect and re-build existing tree canopy.

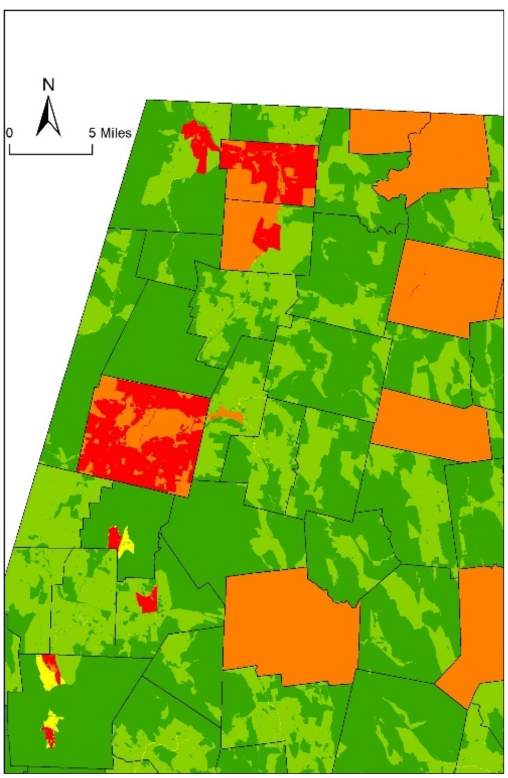




Northeast Area Sub-Region (left): The Northeast area is comprised of the older mill cities of Lowell, Lawrence, Methuen, and Haverhill and a number of smaller communities surrounding these urban centers. In this analysis, Gloucester and Rockport also are priority areas. This area is characterized by a wide discrepancy in relative community affluence with West Newbury being one of the 25 wealthiest communities in the state, while Lawrence is one of the poorest communities (as measured by median household income from the 2013-2017 American Communities Survey). Forestry programs in this region work to protect the existing tree canopy in the suburban and rural communities, while rebuilding tree canopy is the goal in the densely settled cities.



Route 2 Central Corridor Sub-Region (above): The Route 2 Central Corridor is comprised of the older mill towns and cities of Fitchburg, Athol, Orange, Montague, and Greenfield and a small number of suburban towns. West of Greenfield, also along the Route 2 corridor, but without industrial histories of the communities above, are Buckland, Hawley, and parts of Shelburne, which all increased in priority from 2010. Development pressure in this region of the state has been historically lower than in other regions to the east and south, but the most recent Losing Ground report (Ricci et al. 2020), shows rates of development similar to the Greater Springfield area, with Greenfield and Orange having the highest rate in this region. Forestry programs in this area face the challenge of limited budgets and lack of staff while working mostly to protect and re-build existing tree canopy.



Greater Pittsfield Sub-Region (left): The Greater Pittsfield Sub-Region is comprised of the older mill cities of Pittsfield and North Adams and a small number of suburban towns. Changes in poverty captured by the American Community Survey (2006-2010) resulted in several communities with low population (e.g., Hawley, pop. 337, Monroe, pop. 121, Rowe, pop. 388) being bumped to a higher priority. Development pressure in this region of the state has been historically lower than in other regions to the east. Forestry programs in this area face the challenge of limited budgets and lack of staff while working mostly to protect and rebuild existing tree canopy.

MOHAWK TRAIL WOODLANDS PARTNERSHIP

The Mohawk Trail Woodlands Partnership (MTWP) in the 21-town Mohawk Trail region of northwestern Massachusetts (Figure 6.2) was designated to bring financial and technical resources to the region. The Mohawk Trail region has great biological diversity due to the convergence of different forest types. Through a Shared Stewardship Agreement with the U.S. Forest Service, new sources of funding and assistance to landowners, communities, and local businesses will be brought to this area. MTWP is one of the first state designations of its kind to support small communities through sustainable forestry through the passage of the Acts of 2018 Chapter 209. A regional board of local towns and conservation and economic development NGOs has been created to oversee implementation of the goals of the partnership.

Five programmatic priorities were chosen: forestland conservation, municipal financial sustainability, sustainable forestry practices, forest-based economic development, and natural resource-based tourism. The Partnership will work to 1) Increase sustainable economic development related to forestry and natural resource-based tourism, 2) Support forest conservation on private lands and use of sustainable forestry practices, and 3) Improve fiscal stability and sustainability of the municipalities.

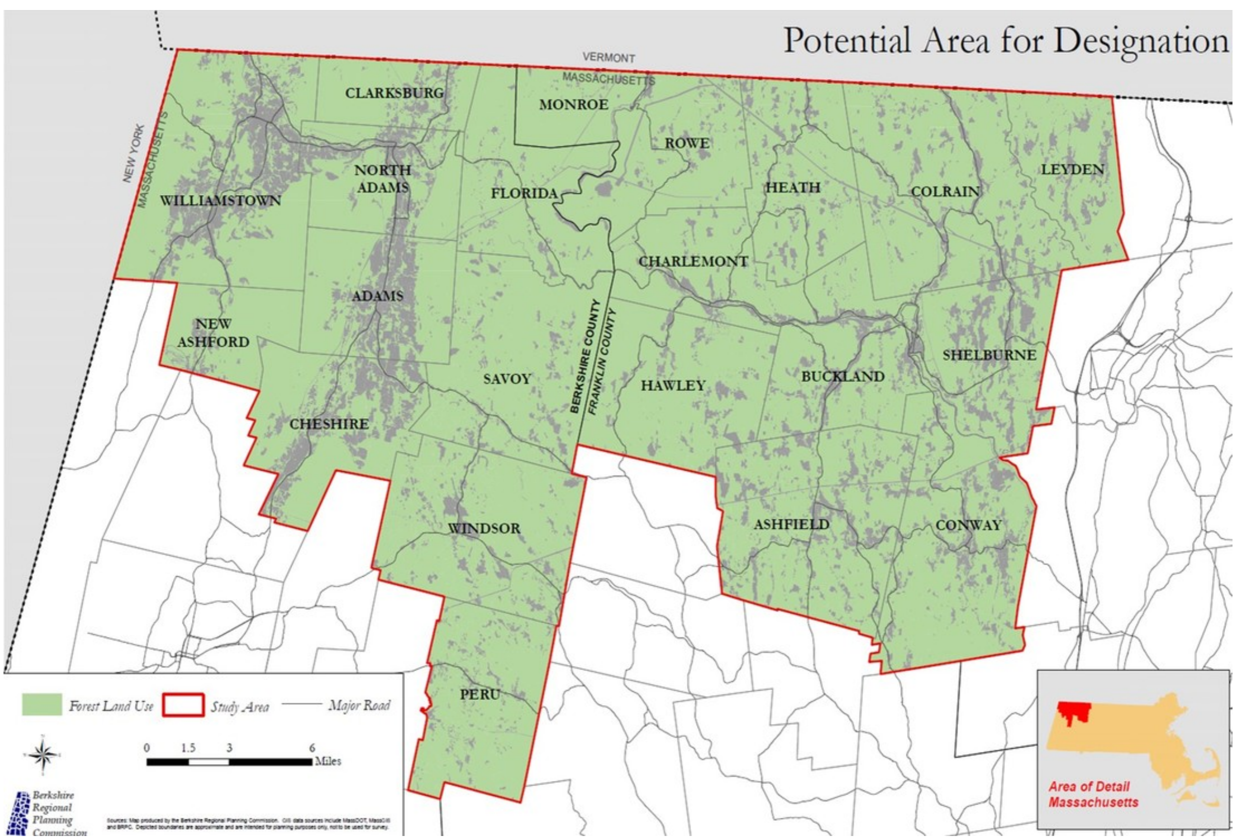


Figure 6.2. Mohawk Trail Woodlands Partnership area. The 21 towns in the study area are outlined in red. (mohawktrailwoodlandspartnership.org).

GREENING THE GATEWAY CITIES PROGRAM

The Massachusetts Greening the Gateway Cities program (GGC) is an environmental and energy efficiency program designed to reduce household heating and cooling energy use by increasing tree canopy cover in urban residential areas in the state's Gateway Cities. Under Massachusetts Law, there are 26 cities with the designation of Gateway City (Figure 6.3). All have a population between 35,000 and 250,000, with an average household income and educational attainment rate below the state average. These areas overlap with the areas identified in the Priority Urban Forests but are highlighted here as well.

The program aims to plant 2,400 trees in each city. The program targets the parts of Gateway Cities that have lower tree canopy, older housing stock, higher wind speeds, and a larger renter population. Concentrating tree plantings in target areas maximizes energy savings and provides the greatest benefits when established over an entire neighborhood. Planting this number of trees will increase canopy by an estimated 1% in eight years, and 5% in 30 years.

As of 2019, the Greening the Gateway Cities program is currently planting in the following locations:

Brockton	Fall River	Lawrence	New Bedford	Revere
Chelsea	Haverhill	Leominster	Quincy	Springfield
Chicopee	Holyoke	Lynn	Pittsfield	

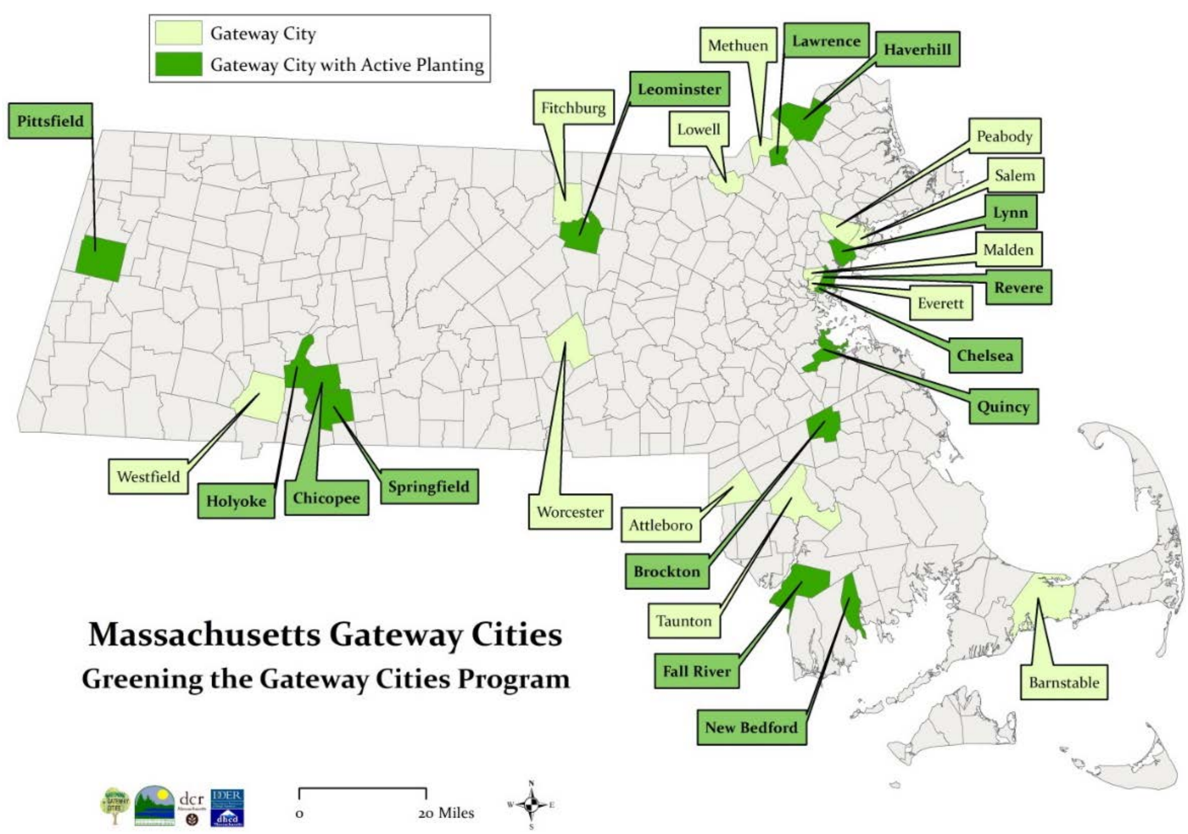


Figure 6.3. Municipalities that are part of the Massachusetts Greening the Gateway Cities program.

HIGH ELEVATION FORESTS

At the opposite end of the ecological spectrum from coastal maritime forests of the Cape and Islands are the forests at the highest elevations of central and western Massachusetts (Figures 6.4 and 6.5). These forests represent an uncommon and important component to our landscape, containing species assemblages that are more common to our north and as such, represent the most southern ranges for important forest species within New England. Not surprisingly, climate change is expected to have adverse effects on these obligate species of cooler, high-elevation habitats. Heat stress, drought, erratic winter temperatures, and more volatile winter precipitation patterns are some of the challenges that these forests face. It is important to anticipate how these forests will be affected by such stresses, to inform protection and active management to improve resistance and resilience of these vulnerable habitats.

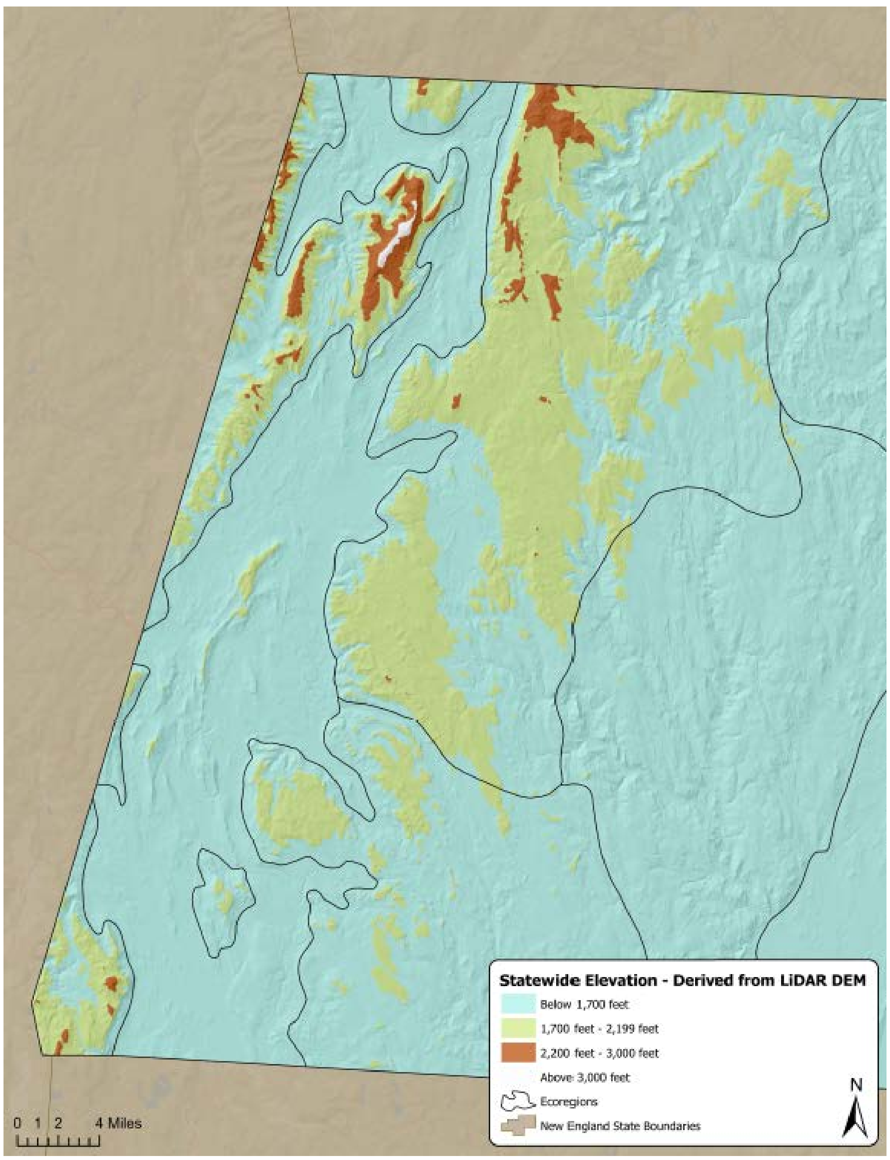


Figure 6.4. High elevations of Western Massachusetts (data: MassGIS).

High elevation habitats are concentrated in the northwestern corner of the state where the Berkshire Plateau rises to its highest points in the towns of Florida and Monroe, as well as on the somewhat isolated ridges and peaks of Mt. Greylock, the highest point in southern New England (3,491 feet) (Figure 6.4). Beginning roughly at 1,700 feet elevation, red spruce – a characteristic species of more northern climates – begins to enter the mixture of forest trees, becoming a regular component and even becoming locally dominant at higher elevations. Balsam fir, a boreal species, also becomes more common at these elevations. Even in pure northern hardwoods forests, red spruce is typically recruiting in the understory, gradually attaining the canopy and transitioning the landscape to a mixed-woods forest. Red oak is often absent, except on south-facing slopes where it can be dominant to elevations up to and above 2,000 feet. The core area containing such habitats was identified as the "Savoy Zone" by Egler (1940), which extends roughly from October Mountain State Forest in Washington and Becket, northward through the towns of Peru, Hinsdale, Windsor, Savoy, Florida, and Monroe where it meets the Green Mountain National Forest at the Vermont border.

The elevation zone beginning at 2,200 feet appears to represent a subtle, but important, habitat threshold for more northern forest types. Both on the Greylock massif and at the northwestern corner of the Berkshire Plateau, occurrences of large-leaved goldenrod, a state species of Special Concern, begin to appear consistently at this elevation and become more frequent with increasing elevation. Other rare plant species, also listed in the *Massachusetts State Wildlife Action Plan* (SWAP), that are directly associated within microsites at higher elevations include woodland millet (Threatened), hairy wood-mint (Endangered) and Braun's holly-fern (Endangered).

Young forest habitat within this higher-elevation "spruce zone" has been identified as critical for supporting a suite of breeding birds that are rare or in decline, including the mourning warbler (Special Concern) and the characteristic songbird of the north, the white-throated sparrow. Creating and maintaining such habitats requires intensive, active forest management practices, and several cost-share programs are in place to encourage this work.

At the extreme are the upper elevations, particularly above 3,000 feet, of the Mount Greylock massif in northern Berkshire County, which represent the only true subalpine climate in southern New England. Although geologically related to the Taconic Mountains to the west, the summit vegetation shares many features with the Berkshire Plateau. Stunted forests dominated by balsam fir, red spruce, yellow birch, and American beech bear testament to harsh winter conditions (ice, snow, and extreme cold). The uncommon heart-leaf paper birch (Watch List species) is more common in this zone, although recruitment is seemingly negligible, and the southernmost occurrences of showy mountain-ash (Endangered) occur on the top of Mount Greylock. Several rare herbaceous plants and breeding birds identified in the SWAP also occur exclusively in this zone. Although similar habitats occur not far north in the southern Green Mountains of Vermont, the isolated nature of Mt. Greylock effectively makes it an "island" of subalpine habitat for species that cannot physically migrate (i.e., plants). Although climate will have its effect, other factors limiting the perseverance of such species, including forest succession and recreational use, are within our control and management may help bolster these vulnerable populations.

Additional, isolated high-elevation outposts at Mount Wachusett (2,006 feet) in Worcester County (Figure 6.5) and Mount Everett (2,607 feet) in extreme southern Berkshire County also offer their own unique contributions to the high-elevation forest communities of Massachusetts. Mount Wachusett features northern hardwoods with red spruce and mountain ash towards the summit, which is quite similar to Berkshire habitats. Conversely, Mount Everett is known for its novel dwarf pitch pine forest, reflecting a more southerly ecotype, which has been well-studied (Motzkin et al. 2002).

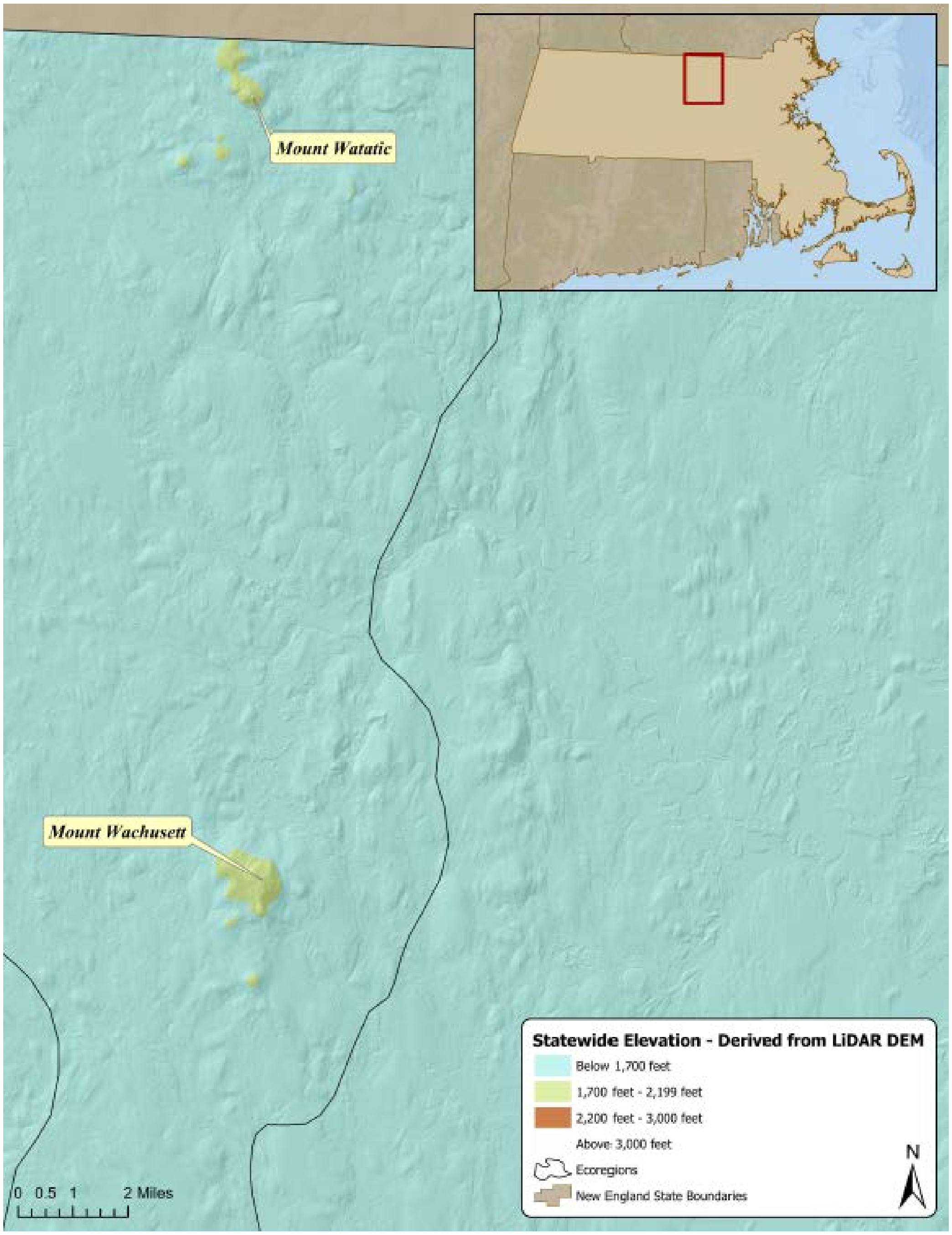


Figure 6.5. High elevations of Central Massachusetts (data: MassGIS).

The Taconic Mountains (excluding Mount Greylock) are notably dissimilar from the Berkshire Plateau, largely lacking a red spruce component and with greater frequency of more southern associates like red oak and black birch. Rich-mesic forest also covers a greater percentage of the area in this range. As such, the high elevation forests of the Taconics are serving equally important, but notably different, habitat functions in comparison to the Berkshire Plateau. This distinction is not well-documented, and further study is needed to better inform forest management.

Our priorities in these high elevation areas are to 1) promote and retain red spruce, taking advantage of its capacity for longevity and tolerance, 2) create and maintain young forest habitats above 1,700 feet elevation to benefit rare and declining breeding birds, and 3) identify and investigate limiting factors for rare species and habitats in the subalpine zone of Mt. Greylock, including forest succession and recreational use.

FOREST VULNERABILITY TO CONVERSION

Figure 6.6 represents areas where forestland is vulnerable to development pressure which leads to forest conversion. This analysis uses data on increasing housing density, forest cutting plans and stewardship plans, non-reserve state land, and non-protected private forest to represent an area's development pressure. Forest conversion is a great threat in Massachusetts as urban areas grow. Loss of forests to build housing, commercial areas, and solar installations results not only in loss of wildlife habitat, but in loss of ecosystem services that are vital to the health and emotional wellness of citizens. Forest development also results in fragmented areas which have high exposure to human activity and, consequently, higher risk of wildfire and decline in forest health due to introduction of pests. Priority forest areas (high and very high categories) indicate forests that are threatened by conversion due to development pressure. Due to data aggregation at the town level, areas that are currently protected may be represented as having high vulnerability. Permanently protected open space is overlayed to distinguish these areas.

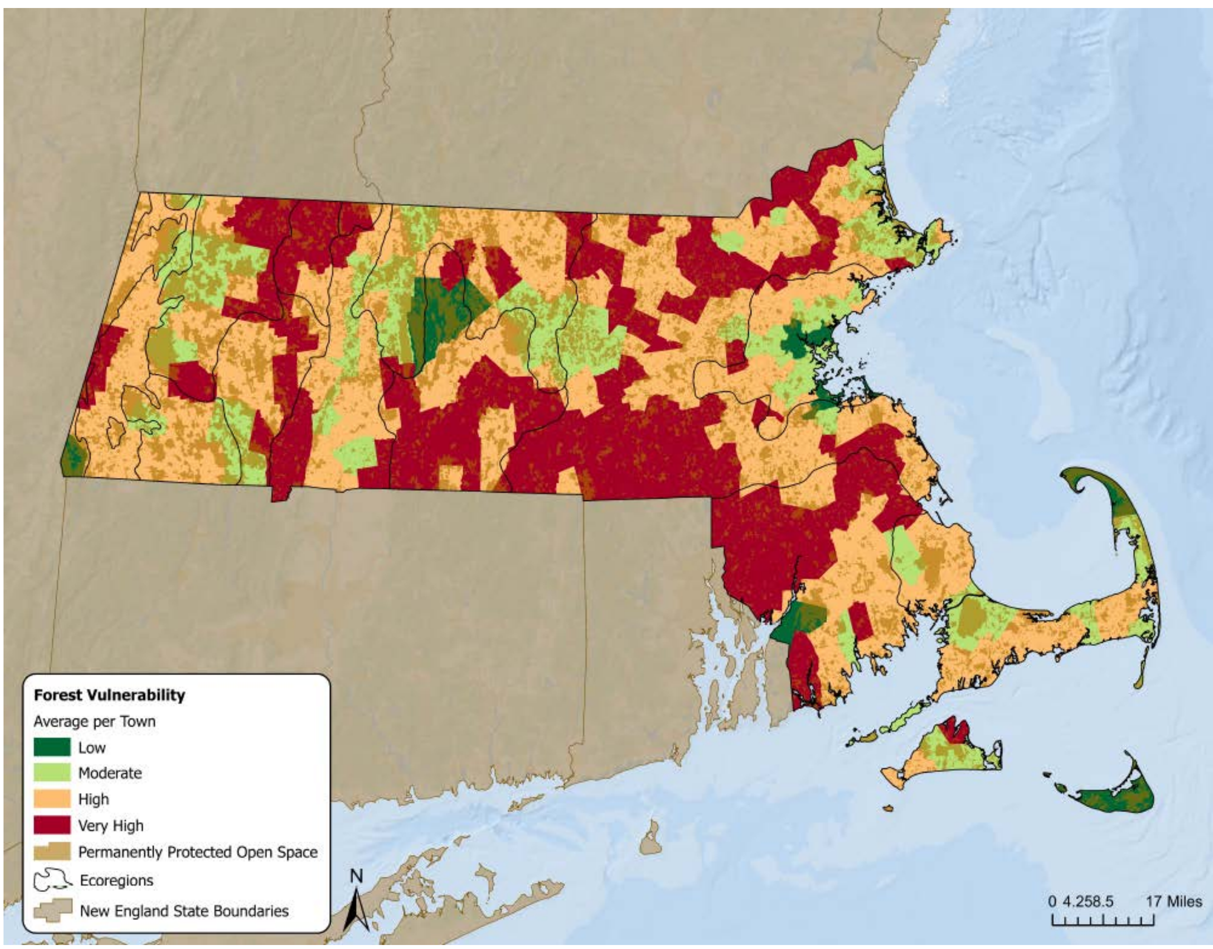


Figure 6.6. Forest Vulnerability overlay map. High and very high categories (red and orange areas) represent forests that are at risk of conversion to developed uses (data: MassGIS, NLCD 2010 and 2016).

CONSERVE AND MANAGE WORKING FOREST LANDSCAPES

Figure 6.7 emphasizes forestland that is actively and sustainably managed and plays a vital role in providing ecosystem services (e.g., water quality protection, soil erosion prevention, and clean air). The geospatial analysis used data layers including non-protected private forests, a measure of development pressure based on increasing housing density, forest cutting plans and stewardship plans, and non-reserve state land. Priority forest areas (high and very high categories) are identified as being in the Berkshire Uplands and Central Uplands. These areas would benefit from programs that seek to protect forestland from development and maintain sustainably managed working forests, such as the landowner incentive programs discussed previously that provide financial and planning assistance to forest landowners and land conservation grant programs.

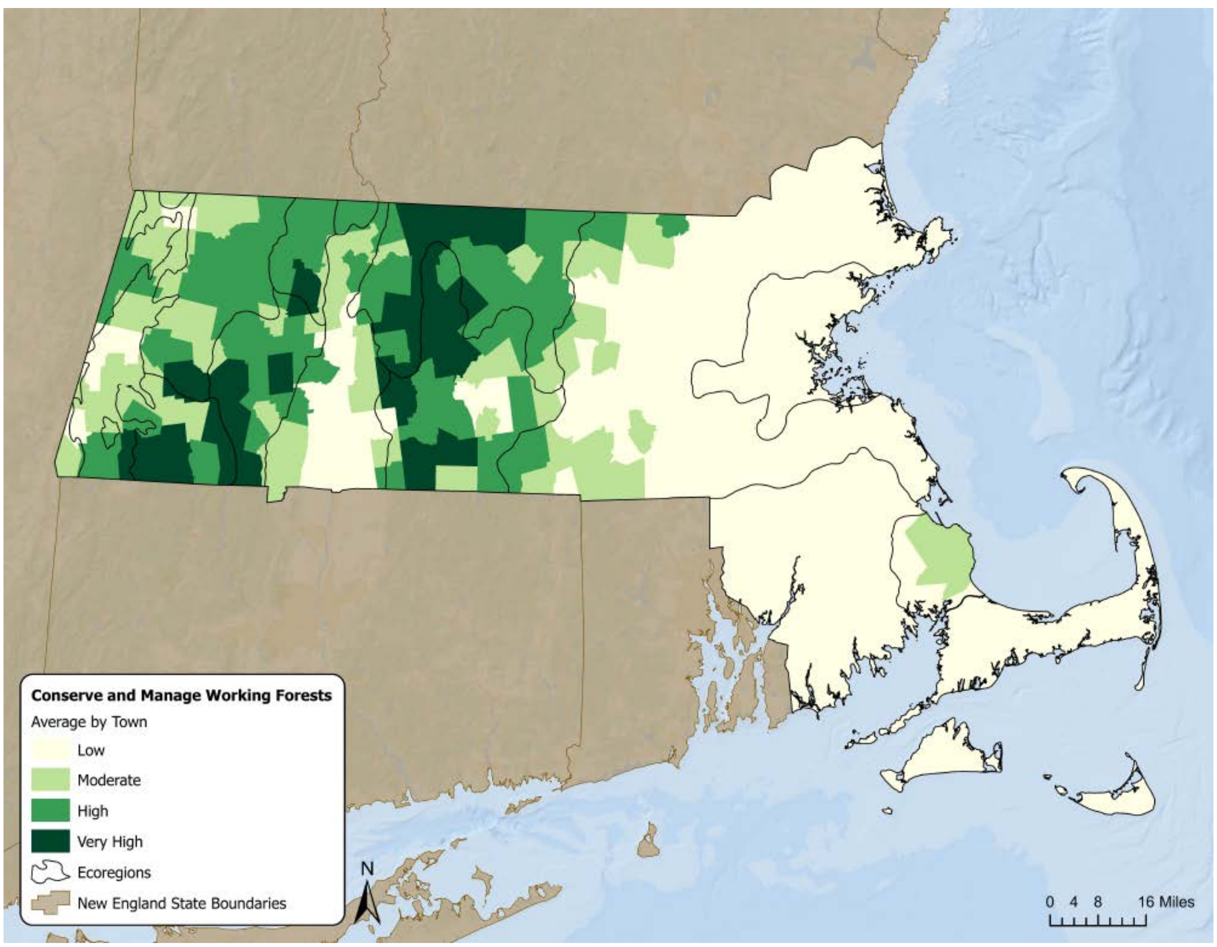


Figure 6.7. Conserve and Manage Working Forest Landscapes overlay map. High and very high categories (darker green areas) represent forestland that is actively and sustainably managed and plays a vital role in providing ecosystem services (data: MassGIS, NLCD 2010 and 2016).

PROTECT FORESTS FROM THREATS

Figure 6.8 identifies areas where a combination of stressors, including wildfire risk, forest health risk from insect and disease threats, percent tree canopy cover, and deer browse threaten forest ecosystems. Priority areas (high, very high, and extreme categories) are regions where hazard mitigation practices would be most effective in reducing tree damage from these stressors and are found covering most of the state. The southeast region is oak and pine forests with areas of fire-adapted pitch pine-scrub oak. These ecosystems are most likely to benefit from targeted planning and management to address the high risk of wildfire. Large areas of forest in the Central Uplands near the Quabbin Reservoir and farther to the west on the Berkshire Uplands, Marble Valley, and Taconic Mountains area are also highlighted. Forests in the Central Uplands have a relatively high fire risk, primarily because the forest is fragmented by development (Radeloff et al. 2005). In addition, these areas have experienced repeated insect infestations. Forests in western Massachusetts are vulnerable to a variety of insect infestations. Data used in the forest health overlays were from aerial photos that detect defoliation. Hemlock woolly adelgid, Asian longhorned beetle, and emerald ash borer infestations are not visible in aerial survey; however, they are known to be present in many areas of the state, particularly at lower elevations.

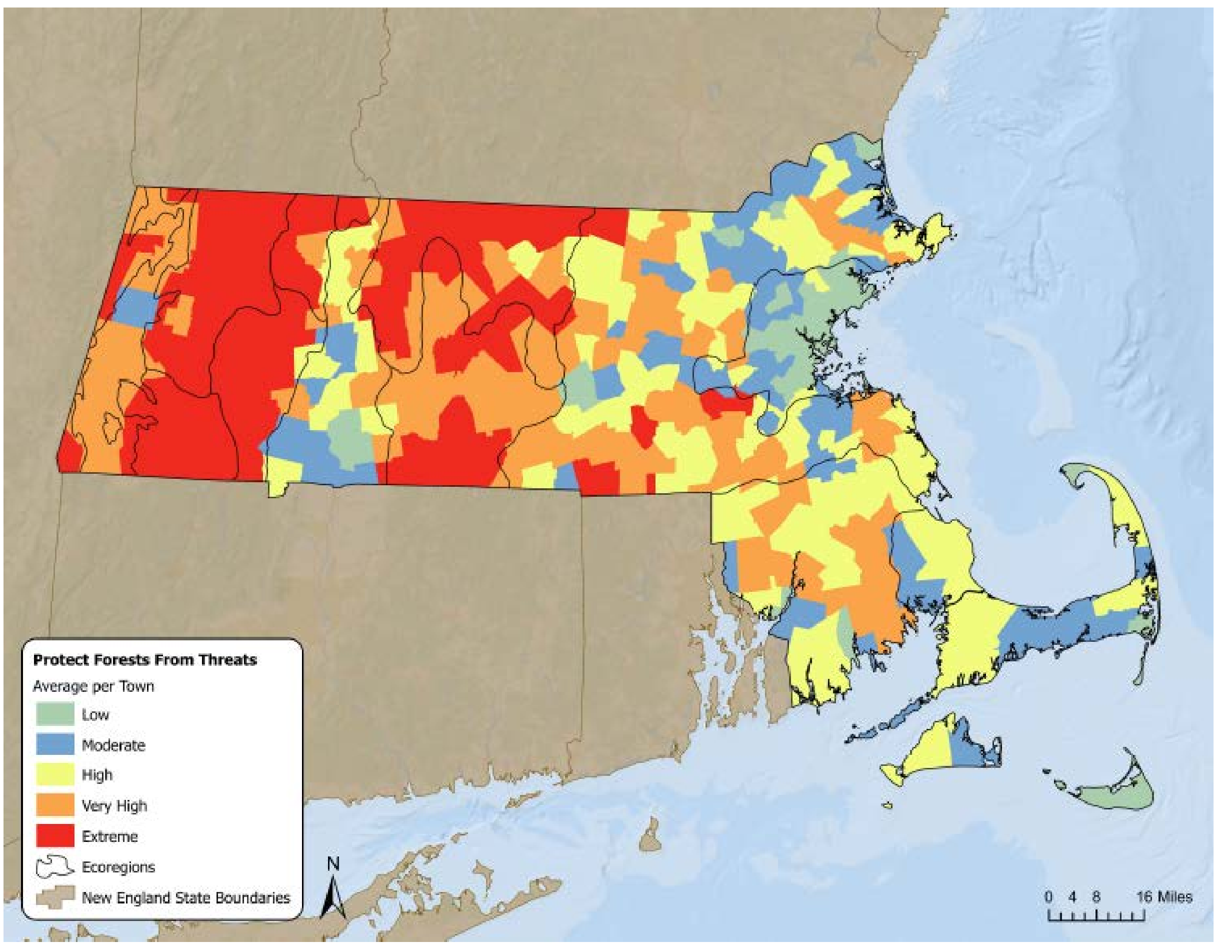


Figure 6.8. Protect Forests from Threats overlay map. High, very high, and extreme categories (yellow, orange, and red areas) represent forestland where stressors threaten forest ecosystems and where hazard mitigation practices would be most effective (data: Northeast Wildfire Risk Assessment Geospatial Workgroup 2009, U.S. Forest Service Forest Health Aerial Survey Damage, NLCD, Massachusetts Deer Browse Impact Survey).

ENHANCE PUBLIC BENEFITS FROM TREES AND FORESTS

Figure 6.9 illustrates the locations of the forested watersheds that play a major role in providing ecosystem services for our citizens and wildlife habitat. Priority forestland (high and very high categories) is located in southeastern Massachusetts, the Central Uplands, the Berkshire Uplands, and Taconic Mountains/Marble Valley. Millions of people in Massachusetts depend on the highest priority forested watersheds for public drinking water supplies. Forested watersheds also provide critical habitat for rare species. Data layers used in this analysis include Zone II and interim wellhead protection areas, BioMap2 and Living Waters core habitats, and tree canopy percentage.

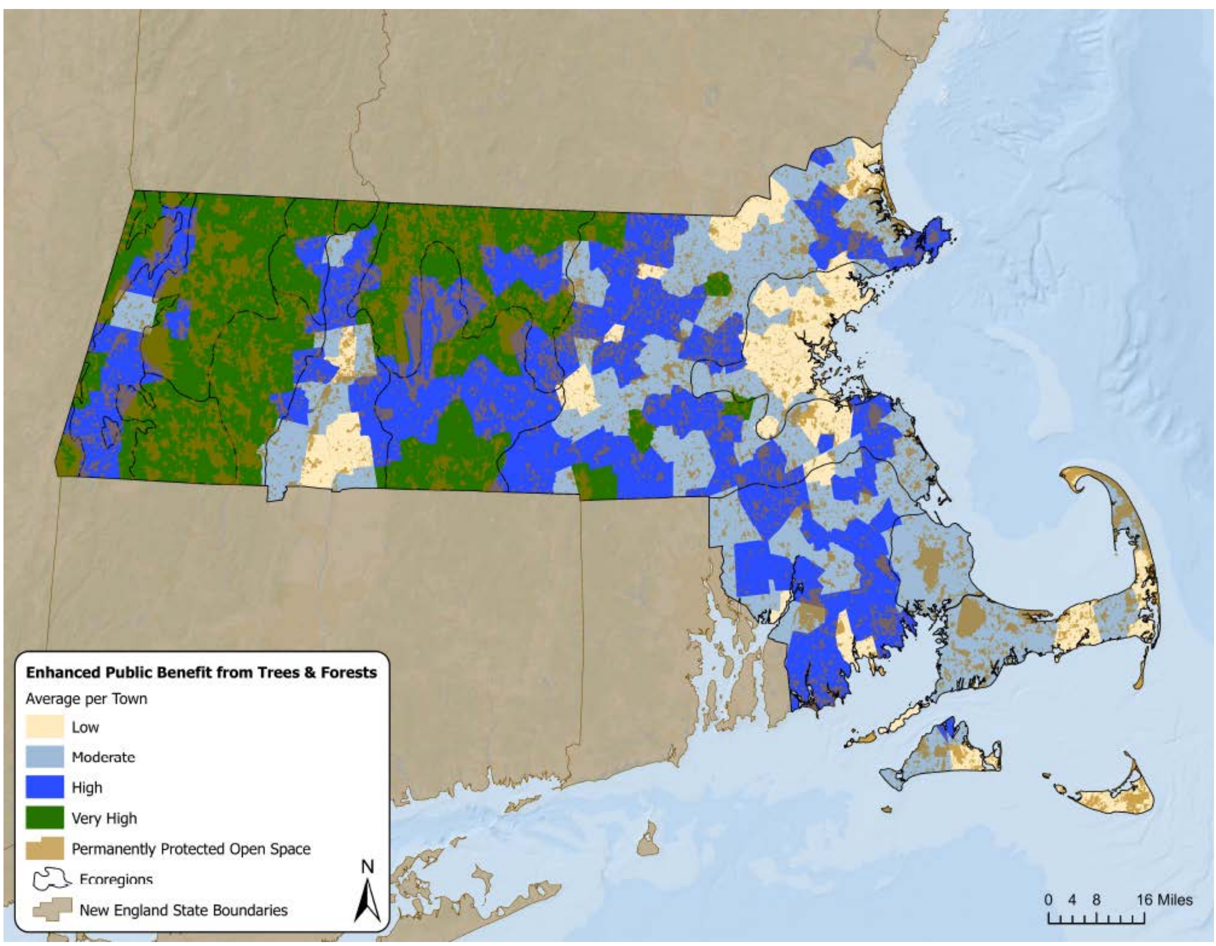


Figure 6.9. Enhance Public Benefits from Trees and Forests overlay map. High and very high categories (dark blue and green areas) represent forests that play an important role in providing ecosystem services (data: MassGIS, NLCD 2011).

MULTI-STATE PRIORITY AREAS

Within the New England region there is a growing recognition that land conservation planning across state boundaries and public and private ownerships is essential to preserving the New England landscape (NEG 2009, Foster et al. 2010). The 2017 Wildlands and Woodlands report noted that "keeping forests intact and managing them well is one of New England's greatest options in combating global change" (Foster et al. 2017). Conservation and management organizations have formed several partnerships and focus areas to target specific landscapes important to the New England region. Some of these are organized into Regional Conservation Partnerships (RCP). RCPs are "informal yet organized networks of people representing private and public organizations and agencies who work together to develop and implement a shared, long-term conservation vision across town and sometimes state and international boundaries." In 2020, there were 43 RCPs in New England, some of which stretched into New York. Those multi-state areas important for Massachusetts forests are described here and depicted in Figure 6.10.

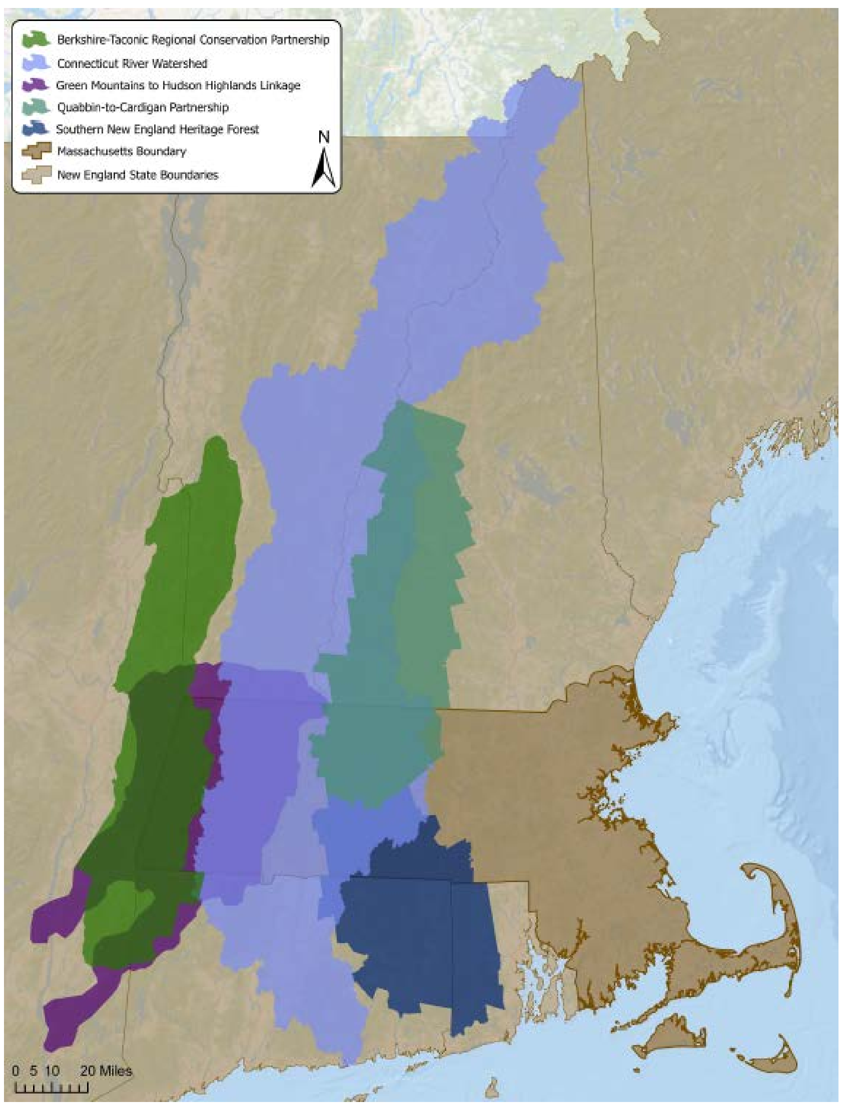


Figure 6.10. Multi-state priority areas for the 2020 Forest Action Plan.

Berkshire-Taconic Regional Conservation Partnership

This region is centered on the Taconic Mountains ridgeline that runs along the border of New York, Vermont, Massachusetts, and Connecticut. The Marble/Limestone valley borders the Taconic Mountains to the east. Marble and limestone bedrock deposits are common at various sites higher up in the mountains as well. This calcium-rich bedrock has created a variety of unusual habitats, calcareous wetlands, and rich mesic forests that support a high level of biodiversity. Nearly 100,000 acres within the 2.1-million-acre region are mapped as rare species habitat. The 2,000-acre Taconic Trail State Forest and 8,000-acre Mount Washington Forest Reserve are located within the Taconic Region in Massachusetts. The 5,000-acre Taconic State Park in New York abuts the Mount Washington Forest Reserve to the west. The state governments of New York and Massachusetts, The Nature Conservancy, and the Forest Legacy Program have all directed conservation efforts towards this area, where only 15.7% of the land is protected. The Berkshire Taconic Regional Conservation Partnership, made up of 15 non-profit partners, works together on conservation across boundaries.

Connecticut River Watershed

The Connecticut River Watershed is approximately 11,000 square miles and is the largest river ecosystem in New England. It spans New Hampshire, Vermont, Massachusetts, and Connecticut. “The Connecticut River was designated as a National Heritage River in 1998, and it is now a National Blueway and priority landscape of national significance for the America’s Great Outdoors Initiative. This is one of the most at-risk areas of New England for forest fragmentation” (DeSenze 2016). The U.S. Fish and Wildlife Service’s Conte National Wildlife Refuge (about 40,000 acres of the 7.2-million-acre watershed) developed a Comprehensive Conservation Plan (CPC) in 2016 that will guide the refuge’s management for 15 years. The CPC outlines goals, objectives, and strategies for four management activities: wildlife and habitat conservation; environmental education, outreach and interpretation; recreation; and partnerships (U.S. Fish & Wildlife Service 2020).

In 2005, an RCP for the Connecticut River Watershed formed, the Friends of the Silvio O. Conte National Fish and Wildlife Refuge. In 2020, this partnership comprised over 70 public and private entities in the four-state watershed. These organizations work together to achieve four goals: “Conserve, restore, and steward our lands and waters; ensure access and recreation; engage and inspire the watershed community; and promote a resilient and adaptive watershed.”

Green Mountains to Hudson Highlands Linkage (Berkshire Wildlife Linkage)

The Green Mountains to Hudson Highlands Linkage, also called the Berkshire Wildlife Linkage, covers western Massachusetts, southern Vermont, eastern New York, and northern Connecticut, roughly 2.4 million, predominantly forested, acres. This area is part of the bi-national Staying Connected Initiative, focused on protecting and connecting wildlife habitat across the Northeast U.S. and eastern Canada. The core of the linkage is a 742,000-acre north-south structural pathway through the middle of the area that allows movement of native species, including porcupine, foxes, bear, and bobcat. Efforts to maintain and restore connectivity are focused here. Two major roadways, I-90 and Route 2, bisect the area.

Community groups are working to ensure wildlife can cross these highways and create a continuous path of connected land from the northern to southern border of Massachusetts (Staying Connected Initiative 2020).

The Nature Conservancy and partners "envision a landscape stretching from the Green Mountains in Vermont to the Hudson Highlands in New York and beyond, where core habitats are protected as well as corridors between them. People and wildlife of all types, from bears to beetles, move freely and safely: people move along roads, and wildlife and water move under roads. Foxes, otters, salamanders, and other moderately mobile wildlife are our measuring stick. If we are successful, these animals can always reach their next home through a landscape that provides for their needs as well as for ours" (Marx n.d.). They have three methods to achieve this vision: 1) Fill in the gaps to create a continuous path of protected land in natural cover across western Massachusetts, 2) Maintain or increase the ability of animals to cross all major roads within this path, and 3) Encourage land stewardship that allows for wildlife movement and maintains the ability of land to produce drinking water and remove greenhouse gases from the air (Marx n.d.).

Southern New England Heritage Forest (The Last Green Valley)

The Quinebaug and Shetucket River Valleys located in northeastern Connecticut, south-central Massachusetts, and western Rhode Island comprise a significant region that has been called "The Last Green Valley." To avoid confusion, in this assessment this area is referred to as the Southern New England Heritage Forest. "The Last Green Valley" also refers to a National Heritage Corridor within this area in Massachusetts and Connecticut (comprising 707,000 acres) as well as to the organization that manages the National Heritage Corridor in partnership with the National Park Service. The Southern New England Heritage Forest is the larger, more encompassing area and includes 68 towns in the tri-state area, versus 35 towns in The Last Green Valley corridor.

The 1.49 million-acre Southern New England Heritage Forest is the only area in the Boston-to-Washington metropolitan corridor that appears dark when viewed from above at night. In 2012, a new RCP formed around the Southern New England Heritage Forest, though prior to that, the area had been an important cooperative geography for the tri-state area. The area covered by this RCP is nearly 76% forest or farmland, yet is surrounded on nearly all sides by heavily urbanized land. Only 118,734 acres, or about 8% of the land, is protected (Last Green Valley 2020).

There are three lead partners for the RCP – MassConn Sustainable Forest Partnership, the Last Green Valley, and the Northern Rhode Island Conservation District – and they work with a variety of partners including a water supply a forest products company, educational institutions, state governments, and non-profit organizations. The goals of the RCP include landscape conservation, stewardship, and economic development in the region (SFFI n.d.). Since the formation of the new RCP, the partnership has been awarded grant funding through the Natural Resources Conservation Service – Regional Conservation Partnership Program.

Quabbin-to-Cardigan Partnership

The Quabbin to Cardigan Initiative (Q2C) “is a collaborative, landscape-scale effort to conserve the Monadnock Highlands of north-central Massachusetts and western New Hampshire.” The area spans from the Quabbin Reservoir in central Massachusetts to Mount Cardigan in New Hampshire, 100 miles north, and encompasses approximately 1.9 million acres. The mostly rural area sits on the edge of the spreading suburbanization of central New England. If current development and unsustainable timber harvesting trends continue, without an effort to protect large forest ownerships, the result will be “the irreversible fragmentation of the region’s forests, and degradation of its exceptional habitat, watershed, recreational, and economic values” (Q2C 2017).

The Quabbin-to-Cardigan Partnership is a collaboration of 31 private organizations and public agencies working to protect land within the Q2C Initiative area. In 2020, only 20% of land in the area was protected. “The Q2C partners share a vision of consolidating the permanent protection of the region’s most ecologically significant forest blocks, and key connections between them, for wildlife passage and human recreation.” The partners coordinate financing efforts and conservation planning to maximize their efforts in the region (Q2C 2017). Land protection efforts are focused in a 600,000-acre core conservation area representing the Q2C region’s most ecologically significant forest and 400,000 acres of supporting forest landscape that buffer and link the core forest.

Beartown State Forest sign in the snow, photo by Molly Hudlin

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Appendix A – Scientific Names of Species Referenced

Trees

American basswood (*Tilia americana*)

American beech (*Fagus grandifolia*)

American elm (*Ulmus americana*)

Balsam fir (*Abies balsamea*)

Bigtooth aspen (*Populus grandidentata*)

Bitternut hickory (*Carya cordiformis*)

Black ash (*Fraxinus nigra*)

Black birch (*Betula lenta*)

Black cherry (*Prunus serotina*)

Black gum (*Nyssa sylvatica*)

Black locust (*Robinia pseudoacacia*)

Black oak (*Quercus velutina*)

Black spruce (*Picea mariana*)

Callery pear (*Pyrus calleryana*)

Carolina Hemlock (*Tsuga caroliniana*)

Chestnut oak (*Quercus prinus*)

Common buckthorn (*Rhamnus cathartica*)

Eastern hemlock (*Tsuga canadensis*)

Eastern hophornbeam (*Ostrya virginiana*)

Eastern White Pine (*Pinus strobus*)

Glossy buckthorn (*Frangula alnus*)

Gray birch (*Betula populifolia*)

Heart-leaf paper birch (*Betula cordifolia*)

Mountain ash (*Sorbus americana*)

Norway maple (*Acer platanoides*)

Northern red oak (*Quercus rubra*)

Northern white cedar (*Thuja occidentalis*)

Paper birch (*Betula papyrifera*)

Pignut hickory (*Carya glabra*)

Pitch pine (*Pinus rigida*)

Quaking aspen (*Populus tremuloides*)

Red maple (*Acer rubrum*)

Red spruce (*Picea rubens*)

Sassafras (*Sassafras albidum*)

Scrub oak (*Quercus ilicifolia*)

Shagbark hickory (*Carya ovata*)

Showy mountain-ash (*Sorbus decora*)

Striped maple (*Acer pensylvanicum*)

Sugar maple (*Acer saccharum*)

Sycamore maple (*Acer pseudoplatanus)*

Tamarack (*Larix laricina*)

Tree of heaven (*Ailanthus altissima*)

Yellow birch (*Betula alleghaniensis*)

White ash (*Fraxinus americana*)

White oak (*Quercus alba*)

White spruce (*Picea glauca*)

Insects and Diseases

Asian longhorned beetle (*Anoplophora glabripennis*)

Black Oak Gall Wasp (*Zapatella davisae*)

Caliciopsis canker (*Caliciopsis pinea*)

Chestnut blight (*Cryphonectria parasitica*)

Crypt Gall Wasp (*Bassettia ceropteroides*)

Elongate hemlock scale (*Fiorinia externa)*

Emerald ash borer (*Agrilus planipennis*)

Gypsy moth (*Lymantria dispar dispar*)

Hemlock woolly adelgid (*Adelges tsugae*)

Oak wilt (*Ceratocystis fagacearum*)

Red pine scale (*Matsucoccus resinosae*)

Southern pine beetle (*Dendroctonus frontalis*)

Spotted lanternfly (*Lycorma delicatula*)

Tachinid fly (*Cyzenis albicans*)

Two-line chestnut borer (*Agrilus bilineatus*)

White pine bast scale (*Matsucoccus macrocicatrices*)

Winter moth (*Operophtera brumata*)

WILDLIFE

Black bear (*Ursus americanus*)

Black-throated green warbler (*Setophaga virens*)

Blanding's turtle (*Emydoidea blandingii*)

Blue-spotted salamander (*Ambystoma laterale*)

Common loon (*Gavia immer*)

Coyote (*Canis latrans*)

Eastern box turtle (*Terrapene carolina carolina*)

Jefferson salamander (*Ambystoma jeffersonianum*)

Marbled salamander (*Ambystoma opacum*)

Moose (*Alces alces*)

Mourning Warbler (*Geothlypis philadelphia*)

New England cottontail *(Sylvilagus transitionalis)*

Pileated woodpecker (*Dryocopus pileatus*)

White-tailed deer (*Odocoileus virginianus*)

White-throated Sparrow (*Zonotrichia albicollis*)

Wood turtle (*Glyptemys insculpta*)

PLANTS

Black swallow-wort (*Cynanchum louiseae*)

Braun's Holly-fern (*Polystichum braunii*)

Fiddlehead (*Matteuccia struthiopteris*)

Garlic mustard (*Alliaria petiolata*)

Hardy kiwi (*Actinidia arguta)*

Hairy Wood-mint (*Blephilia hirsuta*)

Large-leaved goldenrod (*Solidago macrophylla)*

Morrow's honeysuckle (*Lonicera morrowii*)

Oriental bittersweet (*Celastrus orbiculatus*)

Wild leek (*Allium tricoccum*)

Woodland Millet (*Milium effusum*)

Appendix B – Links to Referenced Documents

- DCR Watershed Protection Plan FY19 to FY23: https://www.mass.gov/files/documents/2018/10/16/dcr_watershed_protection_plan_fy19tofy23.pdf
- Environmental Justice Policy: http://www.mass.gov/eea/grants-and-tech-assistance/environmental-justice-policy.html
- Forest Inventory and Analysis Program: https://www.fia.fs.fed.us/
- Greening the Gateway Cities Program: https://www.mass.gov/service-details/greening-the-gateway-cities-program
- Landscape Designations for DCR Parks and Forests: Selection Criteria and Management Guidelines: https://www.mass.gov/files/documents/2016/08/qq/management-guidelines.pdf
- Massachusetts Forest Action Plan: https://www.mass.gov/service-details/massachusetts-forest-action-plan
- Massachusetts Forestry Best Management Practices (BMP) Manual: https://www.mass.gov/files/documents/2016/08/rk/ma-forestry-bmp-manual-rd.pdf
- Massachusetts State Wildlife Action Plan: https://www.mass.gov/dfw/swap
- MassWoods Stumpage Trends: https://masswoods.org/stumpage/trends
- Northampton Forest Stewardship Plan: http://northamptonma.gov/1822/Forest-Stewardship
- Northern Institute of Applied Climate Science Climate Change Response Framework: www.forestadaptation.org
- Park Rx: https://www.parkrx.org/
- Silvio O. Conte National Wildlife Refuge Comprehensive Conservation Plan: https://www.fws.gov/refuge/Silvio_O_Conte/what_we_do/finalccp.html
- Upton Stewardship Plan: https://www.uptonma.gov/sites/g/files/vyhlif5121/f/uploads/north_upton_open_space_land_stewardship_plan_may_2018.pdf
- U.S. Forest Service Climate Change Atlas: https://www.fs.fed.us/nrs/atlas/products/
- U.S. Forest Service Forests to Faucets Initiative: https://www.fs.fed.us/ecosystemservices/FS_Efforts/forests2faucets.shtml
- USGS Domestic Wells in the United States: https://ca.water.usgs.gov/projects/USGS-US-domestic-wells.html
- USGS Water Use Data: https://waterdata.usgs.gov/ma/nwis/wu

Appendix C – The Forest Forum Climate Statement

Valuing our Forests in a Changing Climate

Forests define the landscape of Massachusetts and are an important component to solving the climate crisis. The choices we make can have a huge impact on the communities and landscapes where forests surround us in Massachusetts.

Forests interact with climate in three key ways:

1. They store carbon in living trees, forest soils, and decaying leaves and branches. Every year Massachusetts forests draw carbon dioxide out of the atmosphere and convert it to wood. The amount of carbon dioxide removed by Massachusetts forests each year is equivalent to about 14% of all emissions in Massachusetts.
2. They produce sustainable, renewable products that can be used to meet societal needs. Wood, which is one half carbon by weight, represents a climate-friendly alternative to steel and concrete, which both take many times more energy to produce than wood.
3. Forests also support resilience and reduce our vulnerability to climate impacts by absorbing precipitation, filtering water, providing shade and windbreaks, providing community health benefits from cooler neighborhoods and cleaner air, and supporting a wide range of interconnected habitats for fish, wildlife and other organisms.

The participants in the Forest Forum call for a science-based approach to optimize the climate benefits derived from Massachusetts forests, while also ensuring that our forests continue to deliver these other ecosystem services that benefit society. To achieve this goal, we support initiatives that enhance and expand the long-term storage of carbon in trees, soil and wood products.

When thinking of the important role forests play**, the top priority must be conserving the forests that surround us and cover 60% of Massachusetts.** Forest conservation involves both supporting land protection efforts and reducing the pressure to build on our forests by using developed land more efficiently and creating value for the forests as forests. Supporting landowners, municipalities, and conservation organizations that strive to permanently conserve our forests must be our top priority. Instead of losing forest cover and the valuable functions it provides, we should aim to increase forest cover to enhance all the benefits that forests provide for communities and the environment.

An integrated approach to conserve, and where feasible, expand forest cover and judiciously build more with wood can be a critical component of Massachusetts' climate policy. We support the following steps as a balanced, pro-active approach to improving the climate resilience of our forests, increasing carbon storage of our forests and communities, and reducing the vulnerability of our communities to the impacts of climate change.

1. Expand tree cover, especially in our cities and towns where trees cool and filter the air to improve community health, reduce heat islands, reduce summer and winter energy use, reduce and filter storm runoff, create jobs and store carbon. Planting one million trees, in our neighborhoods lacking tree cover, would create the equivalent of 20,000 acres of new urban forest that would mature by the middle of the century, adding more than 10% to our urban tree cover and significantly improve the lives of tens of thousands of residents.

2. Support the thousands of thoughtful private forest owners to manage their woodlands to be more diverse and resilient to climate impacts and store more carbon over the next 100 years. Develop a balance of incentives to improve forest soil health; improve our forests' resilience to drought, wind, ice and flood damage and invasive outbreaks; continue to increase carbon storage; and restore and reinvigorate those of our forests that were poorly managed in the past.

3. Develop local and regional markets for harvested and storm- and insect-damaged trees that store wood in long-term products like cross-laminated timber and building insulation and wood for new buildings and repairs. Forest management policy needs a balanced approach to maintain adequate dead and downed wood in the forest for carbon storage, soil health, and habitat, while also using clean and efficient wood heat to help improve forest resilience through thoughtful silviculture and to help communities burdened with cleaning up dead and dying trees after increasing storms and invasive outbreaks. Local and regional markets reduce life cycle costs associated with wood products and fossil fuels brought in from other regions or countries, that we commonly now use.

4. Maintain wild forest reserves on diverse and productive sites where forests can continue to increase carbon storage, provide inspiration to communities and provide a living laboratory for researchers. Forest reserves develop structures and habitat types that are largely missing from our landscape except in a few small old-growth patches. A balance of working forests and reserves will provide the best combination of forest diversity and resilience for both people and wildlife in a changing climate.

The participants of the Forest Forum listed below support the above statement. As participants in the Forest Forum, we also work toward five shared goals: 1) Educate key groups about forest values; 2) conserve our forests; 3) sustain the economic viability of our forests; 4) strike a balance between working forests and forest reserves; and 5) protect the health of our forests. This consensus statement grew out of our regular meetings, and discussions and debates with each other about the value of forests and how we can best use forests to fight climate change. We all agree that our forests are an enormously valuable resource, worth protecting and using wisely.

This statement is supported by:

- Massachusetts Woodlands Institute
- The Nature Conservancy – MA Chapter

- Mass Audubon
- Mount Grace Land Conservation Trust
- Jack Lochhead, Forest Landowner
- Massachusetts Rivers Alliance
- MassConn
- New England Forestry Foundation
- T.S. Mann Lumber Co.
- Massachusetts Forest Alliance
- Mystic River Watershed Association
- Massachusetts College of Liberal Arts, Environmental Studies Department
- Neponset River Watershed Association
- River Merrimack
- Ocean River Institute
- Jones River Watershed Association
- Association to Preserve Cape Cod
- Hoosic River Watershed Association
- Muddy Water Initiative
- Lowell Parks and Conservation Trust
- Friends of the Ten Mile
- Merrimack River Watershed Council
- Groundwork Lawrence
- The Trustees of Reservations
- League of Women Voters of Massachusetts
- Kestrel Land Trust
- Friends of the Assabet River National Wildlife Refuge
- Massachusetts Association of Conservation Commissions
- Friends of the Malden River
- Conservation Law Foundation
- The Trust for Public Land

Appendix D – Forest Legacy Program Assessment of Need

Photo by Benjamin Engle

United States Department of Agriculture | Forest Service | Eastern Region Regional Office | 626 East Wisconsin Avenue
Suite 800
Milwaukee, WI 53202
414-297-3600

File Code: 3000; 3360
Date: July 20, 2020

Mr. Peter Church
State Forester
Department of Conservation and Recreation
Bureau of Forest Fire Control and Forestry
251 Causeway Street, Suite 600
Boston, MA 02114-2119
Peter.Church@state.ma.us

Dear Mr. Church:

I am writing in response to your letter dated January 29, 2020, requesting approval of the changes to the Massachusetts Forest Legacy Program (FLP) Assessment of Need (AON) dated January 2020. The updated AON captures local knowledge of private forest issues, major changes to the Forest Legacy Areas (FLA) and reflects regional landscape goals.

According to FLP Implementation Guidelines, these changes to the FLA are identified as "significant changes" necessitating approval from the Chief of the Forest Service, or designee (FLP Implementation Guidelines May 2017, Part 6: Forest Action Plans, page 21).

The Eastern Region State and Private Forestry review of the changes to the AON concluded that the request met all FLP requirements. I forwarded a memo to the United States Department of Agriculture Forest Service, Deputy Chief for State and Private Forestry recommending approval which is enclosed.

Congratulations! Enclosed is a copy of the letter from the United States Department of Agriculture Forest Service, Deputy Chief for State and Private Forestry approving the Massachusetts FLP updated AON dated January 2020.

Please contact Kirston Buczak kirston.buczak@usda.gov, FLP manager, at (414) 297-3609 if you have any questions.

Sincerely,

Robert Lueckel

ROBERT LUECKEL
Acting Regional Forester, Eastern Region

Enclosures

cc: Lindsay Nystrom (Lindsay.Nystrom@state.ma.us), Mark Buccowich, Kirston Buczak, Neal Bungard, Scott Stewart, Connie Carpenter

Forest Service Washington Office 1400 Independence Avenue, SW
Washington, D.C. 20250

File Code: 3360 **Date:** July 8, 2020
Route To:

Subject: Approval of Massachusetts Forest Legacy Program Assessment of Need Update

To: Gina Owens, Regional Forester, Eastern Region

This letter is in response to your letter of February 14, 2020, regarding the proposed update to the Massachusetts Forest Legacy Program Assessment of Need that includes significant updates to Forest Legacy Areas.

Our staff has reviewed the update, and I approve.

John Phipps

JOHN PHIPPS
Deputy Chief, State and Private Forestry

cc: Kirston Buczak, Mark Buccowich, Scott Stewart

Forest Service

Eastern Region
Regional Office

626 East Wisconsin Avenue
Suite 800
Milwaukee, WI 53202
414-297-3600

File Code: 3360 **Date:** FEB 14 2020
Route To:

Subject: Approval Request of Massachusetts Forest Legacy Assessment of Need Update

To: Chief

Attn: Associate Deputy Chief, State and Private Forestry

The Department of Conservation and Recreation of Massachusetts has submitted a major update to their Forest Legacy Program (FLP) Assessment of Need (AON). The proposed update that is enclosed captures local knowledge of private forest issues, includes major Forest Legacy Area (FLA) changes, and reflects regional landscape goals. The FLP Implementation Guidelines define a proposed FLA as a "significant amendment" necessitating approval from the Chief of the Forest Service or designee (FLP Implementation Guidelines May 2017, Part 6: Forest Action Plans, page 21).

The Eastern Region State and Private Forestry review of the update concluded the request met all FLP requirements. The update meets the requirements as set forth in Section 7 of the Cooperative Forestry Assistance Act (16 U.S.C. 2101 et seq.) as amended by Section 1217 of Title XII of the Food, Agriculture, Conservation and Trade Act of 1990 (P.L. 101-624:104 Stat. 3359), the Federal Agriculture and Reform Act of 1996 (P.L. 104-127:110 Stat. 888), and the Forest Legacy Program Implementation Guidelines, May 2017.

In addition, the Massachusetts Department of Conservation and Recreation and the State Forest Stewardship Coordinating Committee have endorsed the update. I recommend the proposed updated AON be approved.

Robert Lueckel
ROBERT LUECKEL
Acting Regional Forester, Eastern Region

Enclosure

cc: Michael Bohne, Peter Church (peter.church@state.ma.us), Lindsay Nystrom (lindsay.nystrom@state.ma.us), Gina Jorgensen, Mark Buccowich, Scott Stewart, Kirston Buczak, Constance Carpenter

FOREST LEGACY PROGRAM
ASSESSMENT OF NEED

MASSACHUSETTS DEPARTMENT OF CONSERVATION & RECREATION
BUREAU OF FOREST FIRE CONTROL AND FORESTRY

JANUARY 2020

PREFACE

Massachusetts forests are a major resource to the Commonwealth and constitute an inter-generational legacy. Today, despite being the fifth most densely populated state in the nation, sixty percent of Massachusetts remains forested. However, because of increasing population and demand for land for development, these forests have been divided up into smaller and smaller parcels and are threatened by conversion to non-forest uses.

The 2019 Forest Legacy Assessment of Need for Massachusetts provides a comprehensive, long range process to identify and protect privately-owned woodlands that are under threat of parcelization, fragmentation, and conversion to non-forest uses.

As appropriate, periodic review and revision to this assessment will be made to meet the future needs of the citizens of the Commonwealth of Massachusetts.

NON-DISCRIMINATION STATEMENT

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Funding for this publication was provided by the USDA Forest Service Forest Legacy Program.

Peter Church, Director of Forest Stewardship

Bureau of Forestry

Department of Conservation and Recreation

Commonwealth of Massachusetts

Date: June 30, 2019

TABLE OF CONTENTS

I. INTRODUCTION

The forests of Massachusetts are an invaluable resource providing benefits ranging from recreational opportunities and tourism to clean water and air, food, wood products, and wildlife habitat. As in 1993, when Massachusetts joined the Forest Legacy Program, our forests face many challenges. These include ensuring landowners have enough economic incentive to retain and manage forest land, the loss of forests due to development pressure, and maintaining a viable forest products industry. It remains in the best interests of the state of Massachusetts to continue to encourage the conservation and management of its forests.

The Forest Legacy Program (FLP) was established in 1990 through an amendment to the Cooperative Forestry Assistance Act (CFAA). The purpose of the FLP is to identify and protect environmentally important private forest land that is threatened by conversion to non-forest uses and to provide the opportunity for the continuation of traditional forest uses. The FLP uses both fee-simple land purchases and permanent conservation easements to protect important forest areas from development and fragmentation.

The original Forest Legacy Program Assessment of Need was written for Massachusetts in 1993. Over the next 25 years it was amended multiple times to designate additional areas for inclusion in the program. These amendments were completed in 2000 (Taconic Range Forest Legacy Area), 2001 (Nashua River Greenway Forest Legacy Area), 2004 (North Quabbin Corridor Forest Legacy Area), 2013 (Heritage Corridor) and 2016 (Western Massachusetts Forest Legacy Area). This document will merge all existing Forest Legacy Areas in Massachusetts as well as incorporate new towns into the area.

II. MASSACHUSETTS FORESTS:
PAST AND PRESENT

A. Massachusetts Forest History

When one walks in the woodlands of Massachusetts, it is easy to get the feeling that the forest around you has not changed for centuries. While it is true that forests change very slowly in relation to our lives, they are a dynamic and changing environment. The forests of Massachusetts have been altered by both natural disturbances and human influences for hundreds of years.

Destructive hurricanes have swept through the state, leaving a changed forest in their wake. Before English settlers arrived, Native American tribes manipulated the forest to meet their needs. They burned the forest floor to stimulate the brushy growth favored by game species, cleared land around major lakes and rivers for settlements and used wood for their primary cooking fuel. Because the native population was small, the forests of Massachusetts were largely unaffected by these practices.

1. The First Forest

When European settlers arrived, they found forests dominated by red oak, white pine and hemlock. Elk, caribou, mountain lion and timber wolves roamed the woodlands. Deer, quail, skunk, grouse and hare were largely confined to settlement areas or younger forests that had been affected by natural disturbances.

For the next 200 years the forests of Massachusetts were cut to establish farms and to harvest wood for houses, barns, forts, furniture, fuel, charcoal and potash. By the early 1800s only 20% of the land in Massachusetts was forested. Elk, caribou and mountain lion had disappeared. Hunting and trapping decimated wild turkey and beaver. The removal of the forest canopy encouraged small, brushy growth favored by deer, grouse and hare.

During the mid-1800s, reports of fertile farmland to the west, the opening of the Erie Canal, the California Gold Rush and the offer of free land to Civil War veterans were situations too tempting for the Massachusetts farmer to refuse. Many abandoned their farms and moved west.

2. The Second Forest

Trees that had seed capable of being established in grassy pastures, such as white pine and grey birch, began to form a forest on abandoned farmland in Massachusetts. By the early 1900s, the earliest farmland to be abandoned had grown into pine stands that were ready to be harvested. The opening of the Panama Canal and improved railroads expanded the marketplace from New England to the rest of the nation and the world. Containers were needed to ship commercial goods and the white pine forests of Massachusetts provided wood for the manufacture of shipping crates. The stage was set for the heaviest commercial exploitation of the Commonwealth's forests to date. In 1908 at the peak of the "boxboard boom", the sawmills of Massachusetts produced almost 400 million feet of lumber. For comparison in 2006, 47 million board feet of lumber was produced by Massachusetts sawmills (De Le Cretaz et al., 2010).

After the pine was removed, the young oaks and maples already established grew quickly to form the next forest. This was a great boon to deer, and in 1910 a century-long deer hunting ban was lifted. Populations of black bear, wild turkey, beaver and grouse were still in decline.

3. The Third Forest

During the turn of the century, as Massachusetts' second forest was undergoing extensive cutting, public concern over the fate of the Commonwealth's forest resources began to grow. The Trustees of Reservations (now known as "The Trustees") and the Massachusetts Forest and Park Association (now known as the "Environmental League of Massachusetts") were formed during this time. Public acquisitions of large parcels of land including Mt. Greylock, Middlesex Fells and the Blue Hills Reservation also began. In 1908 the legislature created the office of the State Forester. A State Forest Commission was established and in 1915 the first state forest, Otter River State Forest in Winchendon and Templeton, was purchased.

Insects, diseases and natural disasters played a large role in changing the composition of the forest at this time. A fungus imported from England introduced the chestnut blight and within 15 years American chestnut was virtually eliminated. This tree had been one of the primary components of the Massachusetts forest, providing durable lumber and food for both people and wildlife, especially wild turkeys, whose population declined afterwards. Dutch elm disease was also established in the early 1900s and has slowly killed most American elms, the state tree of Massachusetts. Gypsy moths reached epidemic proportions at this time, defoliating thousands of acres of red and white oak. The Great Hurricane of 1938 roared through Massachusetts and blew down 880,000,000 board feet of timber.

The wood products industry languished during the Depression. Mobilization for the war effort brought renewed activity for forest industries, but generally this was a period of low exploitation of Massachusetts' forests. The hardwood stands that were established after the white pine was cut were not yet mature and the abundance of natural gas and oil made cordwood less popular.

During this time social shifts in our population were taking place that would also affect the forest. During the 1940s and 1950s urban dwellers began leaving cities in large numbers. Suburban developments cut into forest land. As farming became less profitable many farmers sold their cropland and forests to developers and urban dwellers looking for a rural experience.

Forest land was chopped into smaller parcels, making management less practical. The new country dweller had different uses and priorities for forest land and woodlots became more important as sources of recreation than as income. The uses that landowners deem important for their forest land is significant, since as of the year 2013 private individuals owned 64% of the forest land in Massachusetts (Butler, et al., 2016).

The forests of Massachusetts have again reached maturity, providing us with quiet woodlands, scenic vistas, thriving wildlife populations, a timber resource for our wood industry, recreational opportunities and clean water and air. While the forests of Massachusetts provide us with these benefits, they still face many threats. From April 2005 to April 2013, approximately 38,000 acres of forest or other undeveloped land were converted to development in Massachusetts, translating to a pace of 13 acres per day (Lautzenheiser et al., 2014). Looking at a regional scale a recent report from Harvard Forest and Harvard University states that we are in a second wave of forest destruction and that at the current rate 1.2 million acres of farms and forestland will be lost in New England to development in the next 50 years (Foster et al., 2017).

B. The Forest Resource Base

1. Forest ownership

Although Massachusetts is often thought of as an urban state an estimated 60% of the land area, about 3 million acres, meets the U.S. Forest Service Forest Inventory and Analysis definition of forest land (Butler, 2017). The original assessment of need written in 1993 estimated 64% of the land or 3,225,200 acres was forested. However, the definition of forestland being used was changed between the two dates, so it is not possible to make a direct comparison of the acreages. According to a report by the US Forest Service, Northern Forest Research Station, *Future Forests of the Northern United States*, forest area in the northern US is projected to decrease between 3.5 and 6.4 percent over the next 50 years, with losses concentrated around existing urban and suburban areas (Shifley and Moser, 2016).

As of 2013, 64% of the forest land in Massachusetts is privately owned while the other 36% of forestland is under the ownership of the Commonwealth (19.5%), cities and towns (13.5%) and the federal government (2.7%). Seventy percent of the private forestland is family owned (Butler, et al., 2016). The amount of publicly owned land has grown since the original assessment of need was written in 1993. In 1993 the Department of Environmental Management (DEM), Division of Forests and Parks owned 263,485 acres and the Metropolitan District Commission (MDC) owned 85,000 acres. At that time the Massachusetts Division of Fisheries and Wildlife owned 64,182 acres. By 2010 the Department of Conservation and Recreation (formerly DEM and MDC) Division of State Parks and Recreation owned approximately 290,000 acres, the Division of Water Supply Protection (formerly MDC) owned 105,000 and the Massachusetts Department of Fisheries and Wildlife owned 160,00 acres (De Le Cretaz et al., 2010). In 1993, 16% of the forestland in the state was publicly owned while as of 2013 approximately 36% of forestland was publicly owned (Butler, 2017). Forestland under state ownership is protected through Article 97 of the Amendments to the Constitution of the Commonwealth of Massachusetts.

The Commonwealth has also sought to protect land through permanent conservation restrictions. Conservation restrictions are the most significant and fastest-growing means of protecting environmentally sensitive land and Massachusetts has been a leader in their development. Massachusetts was the first state in the nation to amend its statutes to recognize this new property right. While Massachusetts is 44th among states in terms of land area, it is ranked 10th in terms of acres preserved for conservation and has more land trusts than any other state except California (Conservation Restrictions and Real Property Taxation, 2018).

According to the MA Executive Office of Energy and Environmental Affairs (EEA), there are 135,200 acres of EOEEA agency conservation restrictions – about 45,000 under the Department of Fish and Game (DFG); 48,000 under the Department of Agricultural Resources (MDAR); 7,500 under the Department of Conservation and Recreation (DCR), Office of Watershed Management; 29,000 under DCR Bureau of Resource Protection; and 5,000 that are joint DCR/DFG. They also estimate that there are about 80,000 acres of land trust held CRs and an unknown acreage held by municipalities (correspondence with R. O'Connor, EEA, Division of Conservation Services, 1/22/18). DFG seeks to protect critical habitat, biological diversity and public hunting, fishing and trapping access. MDAR seeks to protect productive agricultural land through Agricultural Preservation Restrictions. The Office of Watershed Management seeks to protect land within the Quabbin, Ware, Wachusett and Sudbury watersheds, using Watershed Preservation Restrictions. The Bureau of Resource Protection is seeking to protect forest management, recreation, trails connectivity and public access for recreation.

At the time of the original Massachusetts Assessment of Need, the number of individual landowners in Massachusetts was increasing dramatically. In 1972 the US Forest Service estimated that there were 103,900 forest landowners in the Commonwealth. By 1984 that number had jumped to 235,200, greater than a two-fold increase. Most of these new landowners bought parcels ranging in size from 1 to 9 acres. During the same period 25% of the parcels ranging in size from 100-199 acres were sold. Thus, many of the larger forested tracts were being broken up into smaller parcels. Today it is estimated that there are over 212,000 owners of private forest land in the state (Massachusetts Forests, 2017) and a recent study found that the average forestland parcel in Massachusetts was 17.9 acres. Parcels between 3 and 9 acres represent 69% of the ownerships (Kittredge et al., 2008).

2. Forest Composition

Massachusetts' forests lie in the transition zone between the pure coniferous woodlands of the north and the mixed deciduous woodlands of the Mid-Atlantic States. A long growing season, well-distributed rainfall and fertile soils have resulted in forests that contain a rich mixture of many species. White pine, hemlock, oak, red maple, and hickory occur throughout the Commonwealth, while birch and sugar maple are concentrated in the fertile soils of western Massachusetts. There are pockets of red spruce at high elevations in the Berkshire Mountains and pitch pine grows with oaks on the dry, sandy soils of Cape Cod and the Islands.

The volume of growing stock on Massachusetts timberlands has increased steadily since 1953. In that time the estimated growing stock of softwoods has gone up 450% and there was a 750% increase for hardwoods. In 1993, growth of our forests exceeded removals by 3 to 1, as of 2010 growth on timberlands exceeded harvests 12.7 to 1. Harvest removals on timberlands account for 13,300,000 cubic feet per year. Currently we are losing more volume to terminal land clearing which was estimated at 23,000,000 cubic feet per year. It was found that forest clearing for development was more prevalent in the eastern part of the state while from the Central Uplands to the western border timber harvesting far exceeded forest cutting for development (De Le Cretaz et al., 2010).

According to the *Future Forest of the Northern United States,* forest area in the region is currently concentrated in the 40-to-80-year age class and is expected to increase in mean age over time, resulting in a paucity of early-successional habitats and low structural forest diversity. Closed-canopy habitat classes are expected to gain acreage at the expense of open-canopy habitat classes. The historical trend of steadily increasing live wood volume over time is projected to level off or decline under all scenarios, with little variation attributable to differing assumptions about future climate conditions. The area of the maple-beech-birch forest-type group is expected to increase relative to nearly all other groups. Projected forest removals resulting from land-use changes are likely to average about 13 percent of total removals, with the remainder resulting from harvesting; in some populous Eastern States, removals resulting from land-use changes could exceed 50 percent of all removals (Shifley, Moser, 2016).

3. Forest Wildlife

Most fluctuations in wildlife populations can be traced to habitat change. As the forests of the Commonwealth shifted to open farmland and to a forest containing all ages of trees, wildlife populations have changed with it. Due to the variety of coastal, inland, farm and woodland habitats and the rich mixture of woodland species, Massachusetts has a diverse array of wildlife.

Mass Audubon's Breeding Bird Atlas 2, for which surveys were completed from 2007 to 2011, recorded 222 species of birds in the state, many of which depend on forested lands. The northern hardwood forest provides an abundant and varied habitat for approximately 80-100 breeding bird species, while the pine and oak forests contain fewer species. Wooded wetlands also support diverse birdlife, especially if they contain water courses with brushy or marshy edges (Breeding Bird Atlas 2 Results. 2017).

The varied terrain of thickets, woods and abandoned fields in the Commonwealth provide an ideal habitat for mammals. More than 50 species of terrestrial mammals regularly occur in Massachusetts. Our largest resident mammal, the black bear, has been increasing in numbers and distribution since the 1970s. The statewide population of bears is estimated to be over 4,500 animals and is growing and expanding eastward, with breeding animals in northern Middlesex County (Learn About Black Bears., 2017). One of our medium sized predators, the eastern coyote, is now well established throughout the state, except on Martha's Vineyard and Nantucket (Learn About Coyotes., 2017). A popular game species, the white-tailed deer, is common throughout the state and is valuable for its regulated hunting season (Learn About Deer., 2017). All the above species as well as many species of amphibians, reptiles and fish are all affected by changes in the forests of Massachusetts.

In order to identify the most critical habitats in Massachusetts and to guide the stewardship of these areas, the Department of Fish and Game and the Nature Conservancy in 2010 developed BioMap2. BioMap2 identifies Core Habitat and Critical Natural Landscapes (Figure 1.) that are essential to safeguard the diversity of species and their habitats, intact ecosystems, and resilient natural landscapes across the state.

Core Habitat consists of 1,242,000 acres that are critical for the long-term persistence of rare species and other Species of Conservation Concern, as well as a wide diversity of natural communities and intact ecosystems across the Commonwealth. Core Habitat includes:

- Habitats for rare, vulnerable, or uncommon mammal, bird, reptile, amphibian, fish, invertebrate, and plant species;
- Priority Natural Communities;
- High-quality wetland, vernal pool, aquatic, and coastal habitats; and
- Intact forest ecosystems.

Critical Natural Landscape (CNL) consists of 1,783,000 acres complementing Core Habitat, including large natural Landscape Blocks that provide habitat for wide-ranging native species, support intact ecological processes, maintain connectivity among habitats, and enhance ecological resilience. It includes buffering uplands around coastal, wetland and aquatic Core Habitats to help ensure their long-term integrity. CNL, which may overlap with Core Habitat includes:

- The largest Landscape Blocks in each of 8 ecoregions; and
- Adjacent uplands that buffer wetland, aquatic, and coastal habitats.

	Total Acres	Percent of State	Acres Protected
Core Habitat	1,242,000	24%	559,000
Critical Natural Landscape	1,783.000	34%	778,000
BioMap2 Total (with overlap)	2,092,000	40%	861,000

Table 1. BioMap2 Total and Protected Acres in Core Habitat and Critical Natural Landscapes. (2010. BioMap 2. MA Department of Fish and Game and the Nature Conservancy)

4. Forested Wetlands

Forested wetlands occupy poorly drained areas that are subject to flooding during periods of high rainfall. These areas are often overlooked because they lack surface water for much of the year. Forested wetlands provide important functions such as flood and sediment control, ground and surface water purification and fish and wildlife habitat.

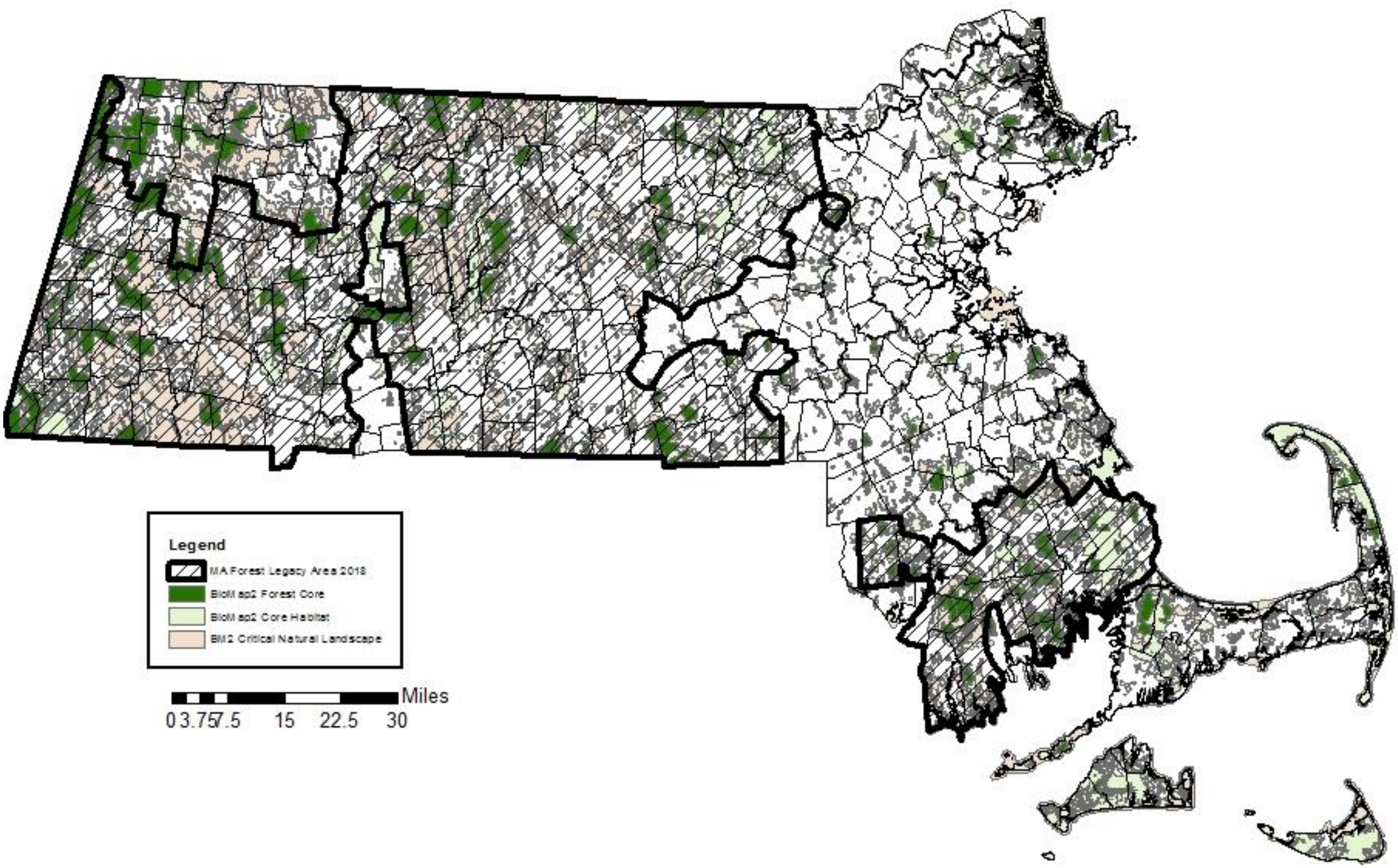

Figure 1. BioMap2 Map of Massachusetts

Red maple swamps are common throughout the state. Other types of forested wetlands in Massachusetts include floodplain forests found along major rivers and streams, black spruce bogs, Atlantic white-cedar swamps and vernal pools. Vernal pools are small, temporary bodies of freshwater, filled during wet spring and autumn months, and dry during the summer.

Wildlife that favor forested wetlands include the red-shouldered hawk, wood duck, spotted salamander, black bear, white-tailed deer and the beaver. Forested wetlands with a permanent source of water, such as a small brook or stream, provide ideal conditions for beavers who create an entire new habitat of dead trees and marshland. This habitat, in turn, will support a rich variety of wildlife.

5. Geology, topography and outstanding geologic features

The topography of Massachusetts was formed by glacial action that occurred 10 to 15 thousand years ago. As the glacier advanced and retreated it scraped away at existing land forms in some areas and deposited earth materials in others. Throughout Massachusetts there are numerous examples of landforms shaped by moving ice. Some features, such as drumlins and terminal and recessional moraines, were formed by glacial deposits. Other features such as lakes, swamps and waterfalls were formed by debris that clogged valleys and dammed streams as the glacier retreated.

The Taconic Mountains form a mountain border with New York State. Elevations range from 1200 to 2800 feet. Mount Greylock, the state's highest peak at 3,491 feet, is in the northeastern part of the Taconic Province. The Taconics, although classified as hills, comprise the state's only "mountainous" region.

The Berkshire Valley, a long, narrow, lowland running north and south between the Taconic Mountains and the Berkshire Hills, includes both the Hoosic and Housatonic River valleys. The area, underlain by less resistant rock than surrounding regions, has eroded to provide a striking contrast with the bordering hills.

The Western Highlands (Berkshire Hills) lie between the Berkshire and Connecticut valleys. The topography is rugged; elevations, which range from 700 to 2000 feet, are highest in the northwestern part of the province. The eastern section is dissected by major rivers which flow east and south to the Connecticut River.

The Connecticut Valley Lowland is a wedge-shaped area extending north and south from southern Vermont to the Connecticut border. The Lowland, about 20 miles wide at its greatest width, is in a large geologic fault bordered by an escarpment on either side of the Valley. The topography is generally flat to rolling, except for a few ridges, such as Mt. Holyoke and Mt. Tom, which rise above the valley and are notable landmarks. The Quabbin Reservoir, which serves as Boston's drinking water supply, is in this region. Much of the land around the Quabbin is protected to ensure the quality of the drinking water (Massachusetts Statewide Comprehensive Outdoor Recreation Plan 2017).

The Central Highlands are comprised of the eroded plateau east of the Connecticut Valley Lowland. The topography is generally rugged but more subdued than that of the Western Highlands. Elevations range from 700-1200 feet, except for single mountains, such as Mt. Wachusett at 2006 feet. The eastern part of the Highlands is bounded by an escarpment that slopes down to join the Coastal Hills. There are also two major drinking water supplies here in the Wachusett and Sudbury Reservoirs.

The Coastal Hills region is the largest physiographic province in the state. Its low-lying plateau (elevations 200 to 700 feet) surrounds the Boston and Narragansett basins and borders the Coastal Lowlands. Best known of the Coastal Hills are the Blue Hills which rise to the south of Boston and dominate the skyline for miles around.

The Boston Basin is a very distinct topographic feature of the Massachusetts coast. Its lowlands (up to 150 feet in elevation) are surrounded by hills which rise abruptly forming a ring around the entire basin. The major relief within the lowlands area is provided by a series of more than 50 drumlins.

The Narragansett Basin, similar to the Boston Basin, is a lowland (up to 200 feet in elevation) surrounded by the eastern uplands of the Coastal Hills.

The Coastal Lowlands include a narrow strip in the northeastern part of the state and all land south of the Narragansett Basin, Cape Cod, and the islands of Nantucket sound. The landscape is flat to rolling and elevations range from sea level to 200 feet. Much of Cape Cod is still in the process of change; wind and wave action change the shape of the present landscape.

6. Cultural Resources

Cultural resources include the remains of sites, structures or objects used by humans in the past. The Massachusetts Historical Commission (MHC) is charged with preserving this important heritage. According to the MHC, settlement has existed in Massachusetts for 11,000 years and patterns of use, abandonment, and reuse characterize the landscape.

Throughout all settlement periods, including prehistoric times, the most densely populated areas in the state have been the three lowland regions; the coastal lowlands, the Connecticut River Valley and the Housatonic Valley. The central and western uplands have consistently been less densely settled according to the MHC. While trade and industrial technology grew and flourished in the market centers and cities of the core lowland areas, agricultural activities dominated the upland areas. Settlers cleared the land for crops and pastures and depleted much of the forests across the state. Wood was valued for timber and fuel; white pine was especially prized for ship masts. By the early to mid-1800’s however, farming was no longer profitable, and a period of farm abandonment ensued. With the decline of farming and logging, the abandoned fields reverted to forests and enfolded the stone walls and homesteads that dotted the landscape and now form part of our cultural heritage and record.

Many cultural resource sites are fragile and subject to a variety of negative impacts from diverse sources. Particularly vulnerable are sub-surface cultural resource sites that can be destroyed or damaged by soil mixing, compaction or erosion. According to the Department of Conservation and Recreation's Cultural Resource Management Guidelines, without appropriate controls, forest management programs can be detrimental to archaeological resources, but the protection of cultural resources fits well with the Massachusetts Forest Cutting Practices Act and its associated Best Management Practices, which if properly applied, should result in minimal soil compaction and erosion.

C. Demands on the Forest

The citizens of Massachusetts place great demands on our forest resources. We expect the forest to supply recreational opportunities, clean water, benefits to human health and society, wildlife habitat, and a healthy forest industry. The key to good land management is to meet these diverse needs on a sustained basis without sacrificing the integrity and the productive capacity of the resource base. Much work has been done to gather information on the forest resources, to assess our impacts on them and to prioritize policies and actions for resource conservation. These efforts will guide future conservation efforts in the state.

1. Recreation

Recreation on private and public land is a dominant use of Massachusetts forest land. Many private landowners permit the use of their land for hiking, nature study, horseback riding, cross-country skiing, snowmobiling, fishing and hunting. The state is the largest owner of recreation and conservation land (SCORP., 2017). The Department of Conservation and Recreation and the Department of Fish and Game both manage forest areas that are used heavily for recreation. It is estimated that outdoor recreation generates $10 billion in annual consumer spending in Massachusetts and the tax revenue generated equals $739 million annually. In 2011, 2.2 million people spent 1.99 billion dollars on wildlife related recreation, including fishing, hunting and birdwatching (Oriel, Linda., 2013).

2. Clean Water

The forest land of Massachusetts protects our water resources. The purity of water reaching a stream, its total amount, and the regularity of flow are all affected by the conditions of the surrounding forest, the soils in that forest, and other plant cover. Because trees also take up water, available water from municipal watersheds in Massachusetts can be increased by decreasing the forest cover to a compatible balance of open and forested land. Harvesting timber from municipal watersheds also provides income to towns.

Massachusetts has 77 public water supply systems that have an active surface water source, serving a total population of 5,282,557. The Quabbin Reservoir, Ware River, and Wachusett Reservoir water supply system provides 250 to 300 million gallons of water per day and serves 2.36 million customers. This water is disinfected, but unfiltered. The federal Environmental Protection Agency's Surface Water Treatment Rules (SWTRs) were established for the purpose of reducing illnesses caused by pathogens in drinking water. The SWTRs require water systems to filter and disinfect surface water sources. However some water systems that meet criteria for water quality and watershed protection are allowed to use disinfection only (40 CFR Parts 9, 141, and 142, National Primary Drinking Water Regulations: Interim Enhanced Surface Water Treatment; Final Rule, Federal Register / Vol. 63, No. 241 / Wednesday, December 16, 1998 / Rules and Regulations). There are five surface water supplies in Massachusetts that have filtration waivers; Holyoke (serving 40,000 customers); East Northfield Water Company (700); Mass Water Resources Authority (2.36 million); Falmouth (77,500 (summer), 33,000 (winter)); and, Concord (16,000).

The state manages more than 100,000 acres of forest within these watersheds and about 75% are actively managed and growing at a rate of 10 million board feet of timber each year. Forests protect the water supply from threats such as residential lawn care and gardening, septic systems, residential fuel oil storage, storm water discharge, and state regulated underground storage tanks (De Le Cretaz et al., 2010).

3. Benefits to Human Health and Society

Climate change is one of the challenges that face all of us today. Fortunately, Massachusetts forests accumulate and store carbon, removing carbon dioxide emissions from the atmosphere. In New England our forests offset more than 20% of the region's carbon dioxide emissions. In addition, New England's forests remove over 760,000 tons of air pollution each year, which is worth an estimated $550 million in health benefits (Foster et al., 2017). Forests also help to protect people from flood damage as these forests store and slow runoff from storms. When forests are permanently cleared for development we lose this ability to store carbon, filter our air and water, and mitigate flooding.

4. Wildlife Habitat

Traditionally, wildlife managers have focused their attention on those species considered "consumptive", or those that are hunted or fished. Today in addition to focusing on game species an emphasis is placed on preserving biodiversity and protecting rare, threatened and endangered species and their habitat. Managing a forest to promote game species and wildlife biodiversity provides an economic benefit to the state, as noted above, $1.99 billion was spent on wildlife related recreation in 2011.

Wildlife populations are entirely dependent on their habitat, so the link between wildlife and forests is a crucial one. Forests can be managed to enhance a certain wildlife species, such as ruffed grouse or white-tailed deer, protect important habitat elements like forested wetlands, seeps and vernal pools, or generally improve habitat by providing a variety of food and cover. Planning a timber harvest with this diversity in mind can greatly enhance wildlife habitat.

5. Forest Industry

Our forests can provide a variety of products as well. Timber can be harvested for construction materials or value-added products like furniture, firewood and paper products or pellets. Besides wood products, food items such as maple syrup, nuts, fruits and mushrooms have traditionally been harvested from Massachusetts forests.

The forest industry is one of the oldest in Massachusetts, beginning with the first sawmills that were present in every village. It is an agricultural industry with roots in every small town, providing local jobs and often a source of native lumber. A healthy forest industry prevents the loss of rural character and agricultural heritage and helps to preserve the local rural economy.

A challenge for our state will be increasing the amount of locally harvested wood products that we use. Currently Massachusetts residents use more wood than is harvested in the state. Approximately 98% of the wood that residents use is imported (De Le Cretaz et al., 2010). The Timber Products Output program from the USDA Forest Service shows a 55% decrease in round wood products including saw logs, pulpwood, industrial wood and fuel wood between 2001 and 2006. There has also been a progressive decline in both the number of local sawmills and sawmill output. The number of sawmills in the state has decreased steadily from 130 in 1971 to 32 sawmills and 12 portable band mills reported from a survey in 2005, and there has been an 80% decline in the amount of lumber produced in that time (De Le Cretaz et al., 2010). As of 2006 there were 16,801 total people employed by the forestry, logging, wood products, and pulp and paper industries in the state (AF&P., 2006). This includes approximately 156 professional foresters and 298 timber harvesters licensed to practice in Massachusetts. For comparison the 1993 Assessment of Need stated that in 1983, 38,000 people in Massachusetts were employed by the forest products industry.

Despite a rather small primary manufacturing capacity, Massachusetts is home to a diverse array of secondary manufacturers. The North-East State Foresters Association (NEFA) 2015 report "*Forest Based Economy of Massachusetts*" identified 8,500 workers employed in paper manufacturing and an additional 4,600 workers employed in secondary wood products manufacturing in Massachusetts.

Forest industry growth has largely recovered from the economic downturn of 2008 with Massachusetts ranked 2nd in New England by NEFA for forest based Gross State Output. Forest based GSP was valued in 2015 at $5.2 billion.

6. Energy from Wood

The oil crisis during the 1970's generated much interest in fuelwood as a source of home heating. One million cords of wood were used in Massachusetts during the 1981-1982 season. Since 1982 home fuelwood burning has generally decreased, but it has fluctuated depending upon the price of oil and natural gas. Wood pellet stoves have provided a cleaner and easier option for homeowners and are gaining in popularity. There is one wood pellet manufacturer in the area with a plant in southern New Hampshire and another in the Albany, NY area.

There is one biomass electricity plant in Massachusetts and several in northern New England that utilize wood biomass from Massachusetts' forests. There are also many thermal biomass units in the state providing heat for public and private buildings, such as schools, colleges, hospitals and manufacturing plants, that utilize sawmill residues or forest biomass. The Massachusetts Renewable Energy Portfolio Standards requires retail electricity suppliers (both regulated distribution utilities and competitive suppliers) to obtain a percentage of the electricity they serve to their customers from qualifying renewable energy facilities. As of September 2017, the Massachusetts Department of Energy Resources (DOER) has granted Statements of Qualification for two generation units producing biomass power, Seaman Paper in Baldwinville, MA, and Cooley-Dickinson Hospital in Northampton, MA. To qualify for the standard, forest biomass must be sourced from Massachusetts forests covered by a forest cutting plan or from third-party certified woodlands if outside Massachusetts (MA DOER website, 2018, https://www.mass.gov/renewable-energy-portfolio-standard).

In December 2017, DOER published regulations creating the Alternative Energy Portfolio Standard (APS). APS recognizes thermal energy from wood when burned in a qualifying unit. They anticipate that the primary participants will be homeowners with qualifying wood pellet systems. They have already identified approximately 50 potentially qualified participants who had installed units through a program of the Mass. Clean Energy Center which covers up to 45% of the cost.

Energy suppliers in Massachusetts must have renewable energy credits covering at least 20 percent of their total supply by 2020. This creates a potential income source for businesses and families participating in the RPS and the APS, and therefore should create a greater demand for locally grown and harvested forest products. After converting BTUs to megawatts (3.412 million BTUs = 1 megawatt), one ton of wood pellets produces the equivalent of 4 megawatts of thermal energy. If a participating homeowner burns 8 tons of pellets a year and the credits are worth $20 per megawatt, they could earn $640.00.

7. Maple Syrup

In Massachusetts there are over 350 maple producers who make more than $2 million worth of syrup per year. This income is a vital source of farm income in the rural part of the Commonwealth. The maple industry also represents an important tourist attraction. It is estimated that these syrup producers bring in about 60,000 tourists to the state who spend over $1 million (De Le Cretaz et al., 2010), generating considerable economic spin-off benefits to rural communities.

8. Christmas Trees

There are over 400 Christmas tree growers in Massachusetts, most of whom are part-time producers. Over 50,000 Christmas trees are harvested in Massachusetts annually, with a retail value to the growers of over $1.5 million. Good markets exist for these trees in southern New England, on a retail and wholesale level. The potential exists to produce over one million trees annually in Massachusetts.

9. Enhancing Urban Areas

The trees, soil, water and wildlife in our communities make up the urban forest. City trees are intermingled with buildings, streets, sidewalks, overhead and underground utilities, parking lots, cars, parks and people. This unnatural environment makes growing conditions difficult for trees and other plants. Special care is needed to plan for and to maintain the urban forests of our towns and cities.

Proper management of street plantings provides communities with amenities such as reduced noise pollution, cleaner air, more moderate temperatures, windbreaks, habitats for wildlife, increased property values, and a more aesthetically pleasing environment. Eighty-eight communities in Massachusetts have been recognized as members of the "Tree City, USA" program, sponsored by the National Arbor Day Foundation. Tree City USA is an awards program that provides public attention and national recognition for local commitments to community trees and forests. In addition, two Tree Line USA Awards have been earned by local utility companies, and four Tree Campus USA Awards were given to colleges and universities for their dedication to urban forestry management.

10. Quality of Life

Forestland provides strong economic, ecological, and aesthetic benefits for citizens of the Commonwealth. The open space provided by our forests contributed to the economic boom Massachusetts experienced during the 1980s. Businesses assessing relocation consider the quality of life, including scenic surroundings, open land, and clean water, to be more important than factors such as taxes and land costs. Three hundred and thirty communities in Massachusetts (out of 351) associated the "quality of life" in their communities with the presence of natural areas, panoramic vistas, rural atmosphere, traditional town centers and historic buildings. Amenities such as these are vitally linked to the forest land and urban forests of the Commonwealth.

In 2014, 22.9 million domestic visitors and 2.235 million international visitors came to Massachusetts, generating $19.5 billion in direct spending and $1.2 billion in state and local taxes. The Massachusetts travel and tourism industry supports 132,000 jobs across the Commonwealth and $4.1 billion in paid wages. The "tourism industry", worth an estimated $2 billion annually to Massachusetts, is largely dependent on the maintenance of the existing character of the forest. Therefore, any activity, private or public, which may profoundly impact the landscape and affect the forested ambiance, directly affects the residents of the state as well its attractiveness for tourism.

Massachusetts is currently implementing an urban tree program called Greening the Gateway Cities Program (GGC). GGC is a partnership between the Executive Office of Energy and Environmental Affairs (EEA), the Department of Conservation and Recreation (DCR) Urban & Community Forestry Program, the Department of Energy Resources (DOER) and the Department of Housing and Community Development (DHCD), along with Gateway Cities and local grassroots organizations. GGC is an environmental and energy efficiency program designed to reduce household heating and cooling energy use by increasing tree canopy cover in urban residential areas in the state's Gateway Cities. The program plants trees (ranging from 6ft to 10ft tall) with a goal of covering 5-10% of the target neighborhoods in new tree canopy cover. Trees are planted by DCR Bureau of Forestry, Urban & Community Forestry crews hired from local communities.

11. Air quality

Forest cover affects air quality in many ways. The forest filters particulates from the air, shades and cools forest interiors through evapotranspiration, and reduces wind and consequent drying. It is also becoming widely recognized that forests may play an important part in helping to mitigate the effects of global warming through long-term sequestration of carbon.

The international consensus on climate released in 2007 by the Intergovernmental Panel on Climate Change (IPCC) found that the warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (*4th Assessment Report*, Intergovernmental Panel on Climate Change, 2007).

The 1990 report of the National Association of State Foresters Global Warming Committee suggests that, second to reducing our worldwide consumption of fossil fuel energy, increasing the sequestration of carbon in trees and wood products is of utmost importance in helping to mitigate the buildup of atmospheric carbon and the resultant greenhouse effect. Improved forest management and wood utilization can increase the amount of carbon absorbed by forest stands, as well as effectively delaying the release of carbon dioxide through long-term storage in wood products.

Forests are important for removing carbon dioxide, a greenhouse gas, from the atmosphere and storing it for long periods of time. Carbon dioxide is stored in the roots, stems, branches, and leaves of trees, and in the forest soil. It is estimated that 50 percent of carbon in a forest is stored in the forest soil, 36 percent is stored in living plants and trees, 8 percent is stored in deadwood, and 6 percent is stored in the leaf litter (Catanzaro, D'Amato, Increasing Forest Resiliency for an Uncertain Future, 2016). When forest soils are disturbed, and trees are removed for development, much of the stored carbon is returned to the atmosphere, and the carbon storage capacity of Massachusetts forestlands is reduced.

12. Mineral resources

There are a variety of mineral resources in Massachusetts, but relatively few are of commercial quantity or quality. Historically, many of the minerals listed below were commercially exploited, but now only sand, gravel, limestone, traprock and granite remain commercially significant. Non-metallic minerals present in Massachusetts include: alum, asbestos, barite, clay, coal, corundum, emery, cyanite, feldspar, garnet, graphite, lime, lithium compounds, mica, novaculite; precious stones of beryl, chiastolite, jasper, rhodonite, spinel and tourmaline; sand and gravel, silica; stone including granite, limestone and marble, sandstone, traprock, talc and sandstone. Metallic minerals include: copper, gold, iron, lead, manganese, molybdenum, nickel, silver, tin, and zinc.

Sand and gravel are ubiquitous in Massachusetts and resulted from glacial deposition. Especially prevalent in major river basins, these deposits serve as groundwater aquifers. Extensive outwash plains in Plymouth County, Cape Cod, Nantucket, and Martha's Vineyard are substantial areas of sand and gravel and constitute the stratum for water supply in those areas. Commercial exploitation of sand and gravel constitutes the greatest competitive use of the forest from the standpoint of mineral extraction. Limestone is confined to Berkshire County, in the western part of the state, and though prevalent is mined significantly in two quarries. Thus, in terms of area, limestone mining has little effect on the forest resource, except in a localized way. Traprock is mined as well with major quarries located in the Connecticut River Valley.

III. THE FUTURE OF THE FOREST RESOURCE: CRITICAL ISSUES

A. Forest Fragmentation

The overall acreage and species composition of the Massachusetts forest are becoming far less of a concern for forest planners than the pattern of forest ownership and the impacts that this pattern will have on community land use in the future. Of the 3 million acres of forests in Massachusetts, 64% is in the private ownership of individuals, corporations, farmers, and the forest industry. The remaining 36% is in public control of state, county, municipal, or federal government. Public land has increased greatly since 1993 when the split was 84% private land and 16% public.

The Harvard Forest Wildlands and Woodlands report published in 2017 stated that development in New England eliminated 24,000 acres of forest each year from 1990 to 2010. At that rate, another 1.2 million acres of farms and forestland will be lost to development in the region in the next 50 years. They stated that in 2010, after 150 years of increasing forestland acreage in New England, the trend reversed and forested acres in the region began declining (Harvard University, Harvard Forest, Wildlands and Woodlands, Farmlands and Communities, 2017). The increase had been fueled mainly by abandonment of farmland that reverted to forest. By the 21st century, there was little unused farmland left to be abandoned that could offset the continuing loss of forest to development.

The division and sale of large forested tracts in southern New England threatens the integral value of forest ecosystems. Parcelization of woodland in Massachusetts is corroborated by the results of the Forest Service's landowner surveys of 1972 and 1984. In 1972, there were 103,900 private forest owners who collectively owned 2,432,300 acres for an average of 23.4 acres per owner. Twelve years later (1984) the number of owners increased to 235,200, but the forest-base remained nearly the same. Today, 93% of forest ownerships are between 10 and 99 acres in size. (Butler, et al, 2016).

Small parcels usually are uneconomical to manage and may lead to forced sales to a developer with little intent to keep the property in its natural state. Though the tract may not be developed or subdivided immediately, its speculative ownership removes it from the roster of lands managed for future productivity and open space. With the shrinking acreage of contiguous ownership, management and productivity of forest lands will be increasingly difficult and less cost-effective. The future of the region's already weak forest products industry is at stake, while clean air and water, recreation, wildlife, and aesthetic values of the state's woodland are threatened.

Massachusetts' current use programs - Chapters 61 for forestlands, 61A for agriculture land, and 61B for recreation land - give preferential tax treatment to landowners who maintain their property as open space for timber production, agriculture or recreation. Chapters 61 and 61A allow substantial property tax deferment for woodland owners who follow an approved forest management plan. Though Chapter 61B also avails forest landowners tax relief, no management plan is required. The current use programs do not permanently protect land as properties can be withdrawn upon payment of penalties. The laws do, however, grant a transferable right of refusal to the town if classified land is to be sold for conversion to another use.

As of January, 2018, there are 492,801 acres of forestland and 13,574 landowners enrolled in Ch. 61 and Ch. 61A. That is 25% of the private forestland in the state. This is a significant increase from 1990 when 270,000 acres, or 10% of private forestland, were enrolled in the program.

B. Availability of Timber to the Wood Products Industry

Increasing fragmentation of the resource base, combined with a shorter tenure of ownership of forest land, has had a great impact on the timber industry in the Commonwealth. Loggers and sawmillers face difficulties in obtaining timber from smaller parcels of land. Escalating operating costs, expensive machinery, fuel and labor expenses, and a shrinking labor pool, have accompanied a rise in what the harvester must pay to buy standing timber.

Many landowners are not aware of the value of the timber on their woodlands and those that are may be reluctant to harvest timber. In a recent (2011-2013) forest landowner survey, respondents most commonly listed: to enjoy beauty or scenery, to protect nature or biological diversity, to protect water resources, privacy, and to protect or improve wildlife habitat as their most important reasons for owning forestland. Each of these was listed on over 64% of the responses. Firewood and timber production were listed on only 30% and 17% of the responses, respectively. Seventy-five percent of respondents have harvested firewood from their land and over 30% have harvested timber (Butler, et al, 2016).

The wood industry must do a better job of assuring landowners that a timber harvest can be completed without extensive damage to the remaining trees and how it can actually enhance the values they deem important, such as habitat, water protection and biodiversity.

C. Impacts on Wildlife

Although stable populations of much of our wildlife, including wild turkey, black bear and white-tailed deer have been reestablished, many species still need our protection. The variety, frequency, distribution and health of Massachusetts' wildlife depends directly on the size, species and distribution of forest trees, but contiguity and connectivity are also important ecosystem requirements. Wildlife biologists are questioning the utility of setting aside relatively small, unconnected preserves to protect wildlife. They are advocating a system of linkages or "corridors" between these preserves so they may continue as biologically diverse ecological systems in an increasingly fragmented and urbanized land base. Protecting existing riverside corridors, an infrastructure upon which wildlife is vitally dependent, is a beginning. The Massachusetts Riverways Project was initiated to achieve that goal.

The University of Massachusetts Amherst, in partnership with The Nature Conservancy and state agencies, developed the Conservation Assessment and Prioritization System (CAPS) computer program which mapped an Index of Ecological Integrity (IEI) for all communities in Massachusetts. The IEI delineates the relative wildlife habitat and biodiversity value of any point on the landscape based on landscape ecology principles and expert opinion.

Another tool used to assist with identifying priority areas for land protection is BioMap2. The Massachusetts Department of Fish & Game, through the Division of Fisheries and Wildlife's Natural Heritage & Endangered Species Program (NHESP), and The Nature Conservancy's Massachusetts Program developed BioMap2 to protect the state's biodiversity in the context of climate change. BioMap2 combines NHESP's 30 years of rigorously documented rare species and natural community data with spatial data identifying wildlife species and habitats that were the focus of the Division of Fisheries and Wildlife's 2005 State Wildlife Action Plan (SWAP). BioMap2 also integrates The Nature Conservancy's assessment of large, well-connected, and intact ecosystems and landscapes across the Commonwealth, incorporating concepts of ecosystem resilience to address anticipated climate change impacts.

D. Sustainable Forestry

Sustainable forestry focuses on the retention, conservation and health of forest land in the face of increasing development so that our forests continue to provide the multiple benefits that citizens of the Commonwealth expect. This includes maintaining a viable forest products industry, sufficient economic incentive for landowners to retain and manage forest land, and attention to the protection and management of Massachusetts wildlife. It also involves education of the private landowners who control the fate of our forests.

Cooperation between the diverse groups who use the forest resource is vitally important to the goal of sustainable forestry. These groups include the forest industry, passive recreation users, wildlife managers and observers, watershed managers, foresters, forest landowners, hunters, anglers, local land trusts, and any other group who has an interest in maintaining a viable, healthy and productive forest for all users.

Forest landowners need improved techniques for realizing timber, wildlife, and recreational benefits from the same piece of forest land. Charging hunting and recreation fees to users is an option that is popular elsewhere in the eastern United States. Favorable tax programs for landowners who practice wildlife management are another option.

The Massachusetts Working Forests Initiative, begun in 2009, is a suite of programs designed to aid landowners in sustainable forest management and long-term conservation, while providing local forest products to our economy, enhancing wildlife habitat for declining species and permanently protecting forest land. It includes a wide network of partners including MassAudubon, the Franklin Land Trust, Mount Grace Land Conservation Trust, and UMass Amherst. The program includes funding for forest stewardship planning and has aided in the significant increase of forestland under management plans and enrolled in the Chapter 61 programs. As a result, timber harvests on properties with forest stewardship plans has increased from 1% in 2003 to nearly 20% of the total state harvests in 2017 and the volume of timber harvested under a management plan increased from 10% to nearly 40% of all timber harvested in the state (MA DCR, 2018).

E. Conserving the Land Base

The problems caused by fragmentation of forest land must be addressed. Most forest landowners in Massachusetts retain ownership of their property for less than ten years and the goals of each successive landowner often differ. In monetary terms, the development potential of forest land in Massachusetts almost always exceeds its value for forestry uses. These factors make preservation of our forest land a difficult task. The Commonwealth uses two tools as an important part of the solution: conservation restrictions and the Chapter 61 programs (the current use property tax law). Figure 2 shows all land in Massachusetts that is permanently protected.

Land trusts are non-profit entities than can acquire property through a conservation restriction purchase or donation. In some cases, land trusts have assembled development packages for properties which include a lease to the original landowner for farming or timber production and a limited cluster development on a corner of the farm acreage so that the landowner can realize some income from the property. They also purchase lands on occasions when rare or unique features are at stake and the possibility of a gift of the land or an easement does not exist. Many will hold land for purchase by a governmental entity. Currently the Division of Conservation Services estimates that there are 80,000 acres in Massachusetts protected by conservation restrictions held by land trusts.

Generally, one of the ultimate stewardship goals of a land trust is the use and management of land for the public benefits to be derived from open space and natural area protection. The kinds of features of interest to land trusts include, but are not limited to, areas which contain unique wildlife, high quality wildlife habitat, rare plants or unusual plant communities, interesting or unusual geologic or archaeological features or particularly large open space areas unbroken by development. Size of the areas for consideration is usually less important than quality and defensibility against disturbance. One important aspect of land trusts is that they are community based and usually operate within a specific geographical area and so represent a local perspective on the value of land to the community.

Woodland owners enrolled in a Chapter 61 program have made a long-term commitment to managing their forest resources. All parcels that fall within lands classified under this legislation may be initially identified as potential willing sellers. Also, the management plans associated with those parcels are either already in the Stewardship Plan format or can be easily amended to include Stewardship goals as the Chapter 61 format was retained as the basis for the Stewardship Plans.

New and innovative approaches to keeping forest land in an undeveloped and productive state are gaining popularity in the Commonwealth. A healthy forest industry with profitable markets is a vital part of this picture.

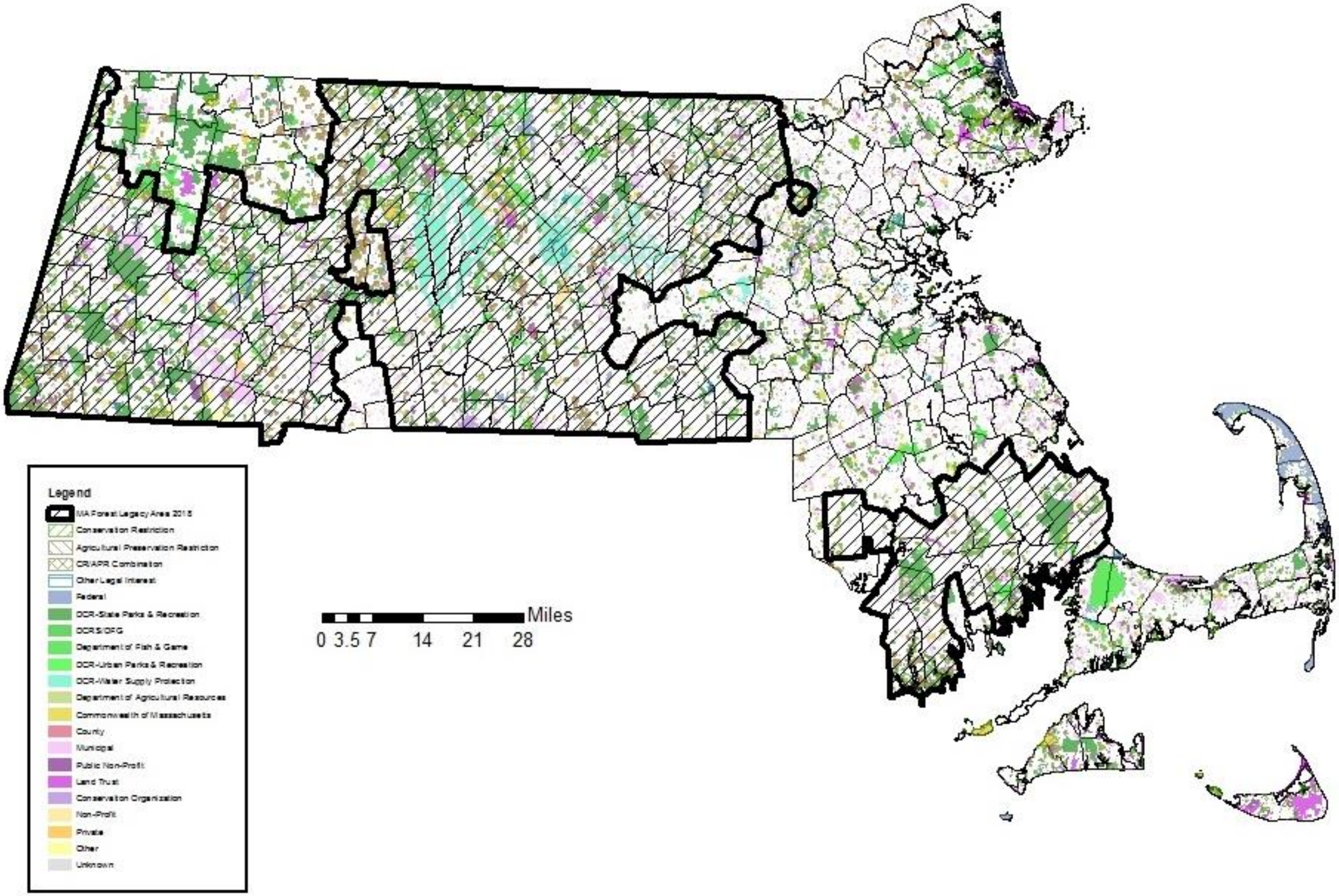

Figure 2. Massachusetts Protected Open Space Map

IV. THE FOREST LEGACY PROGRAM: ADDRESSING THE PROBLEM

A. Massachusetts Forest Legacy Program

The forests of Massachusetts contribute greatly to our economy and provide the ecological systems and visual landscapes essential to our quality of life. Historically, demands for raw materials (wood, land for development) have competed with the need to protect and conserve natural resources (water supply, recreation areas, wildlife). Meeting these diverse needs on a sustained basis without sacrificing the integrity and the productive capacity of the resource base is the challenge that we face in the Commonwealth.

Several social and economic trends have significantly affected the balance of natural resource utilization and protection in the Commonwealth. Increasing residential and commercial pressure has led to the development of substantial areas of forested land, raising questions of water supply protection and altering the visual landscape to which communities are accustomed. Development pressures are compounded by the fact that agricultural and wood products industries cannot match other economic incentives for land ownership.

Massachusetts is fortunate to have a strong network of land trusts and related conservation organizations, along with local, state, and federal government support for land conservation. Partnerships have developed from this network, which have demonstrated a sound record of land conservation state-wide. Through their collective efforts, these partnerships have cultivated a landowner public that is knowledgeable of, and receptive to, the concept and benefits of land conservation.

In the fall of 1991, a committee was convened to implement the Forest Legacy Program in Massachusetts, composed of state resource management professionals and private sector representatives of land trusts and other conservation related organizations, such as Watershed Associations. These organizations already had a constituency, had demonstrated their willingness, and could be counted on to develop public support and program accountability. The expertise of the land trusts, other conservation related organizations, and state land conservation agencies played a key role in the genesis, evolution, and success of the Forest Legacy Program in Massachusetts.

Since the beginning of the Forest Legacy Program in Massachusetts, a significant number of new and updated resources and tools have been developed. The most significant of these is the general availability of Geographic Information Systems (GIS) software and data. The Massachusetts Forest Action Plan includes detailed GIS analysis and discussion of relevant information about both public and private lands and addresses the issue of how best to maintain the integrity of forestlands for future generations in the Commonwealth of Massachusetts.

Additional resources and tools are now available to state agencies and all partners involved in the forest conservation community. These resources will enable state agencies and partners to identify new Forest Legacy Areas and prioritize projects in which to conduct landscape scale forest conservation. Additionally, outreach and education information has been developed with the intent to help woodland owners make informed decisions about the future of their land. Below is a partial list of these resources:

Losing Ground

"Over the past 40 years, the landscape of Massachusetts has been transformed by new residential and commercial development. Eastern and southeastern Massachusetts have undergone the most change, but virtually every community in the Commonwealth has experienced rapid growth driven by economic and demographic factors. Starting in 1991, Mass Audubon has analyzed these changes every five years using the most up-to-date technology and methods, providing conservationists, town planners, and agencies with information for planning and advocacy."

MAPPR 2.0

"Mapping and Prioritizing Parcels for Resilience (MAPPR) allows land conservationists to identify the parcels within an area of interest that are the highest priorities for protection based on habitat quality, climate change resilience, and other metrics such as parcel size and adjacency to existing protected parcels."

Resilient and Connected Landscapes

"The Nature Conservancy's Resilient and Connected Landscapes project is the first study to comprehensively map resilient lands and significant climate corridors across Eastern North America. Released in October 2016, the study took eight years to complete, involved 60 scientists, and developed innovative new techniques for mapping climate-driven movements."

Massachusetts Wildlife Action Plan (SWAP)

"This Plan presents the 570 Species of Greatest Conservation Need in the Commonwealth, the 24 types of habitat that support these species, and the actions necessary to conserve them."

Massachusetts Wildlife Climate Action Tool

"The Massachusetts Wildlife Climate Action Tool can be used by local decision-makers, conservation managers, land trusts, regional planners, landowners, and community leaders in Massachusetts who are interested in taking action in response to climate change. Users can access information on climate change impacts and the vulnerabilities of various fish and wildlife and their habitats. The tool also allows users to explore adaptation strategies and actions to help maintain healthy, resilient natural communities in the face of climate change."

BioMap2: Conserving the Biodiversity of Massachusetts in a Changing World

"BioMap2 is designed to guide strategic biodiversity conservation in Massachusetts by focusing land protection and stewardship on the areas that are most critical for ensuring the long-term persistence of rare and other native species and their habitats, exemplary natural communities, and a diversity of ecosystems."

The Critical Linkages Project

"The University of Massachusetts Amherst is working in partnership with The Nature Conservancy and state agencies to complete a comprehensive analysis of areas in Massachusetts where connections must be protected and restored to support the Commonwealth's wildlife and biodiversity resources. The Critical Linkages project is developing spatially explicit tools, including models, maps and scenario-testing software, for use in mitigating the impacts of roads and railroads on the environment."

Nature's Network

"Nature's Network is a collaborative effort facilitated by the U.S. Fish and Wildlife Service Science Applications program that brings together partners from 13 states, federal agencies, nongovernmental organizations, and universities to identify the best opportunities for conserving and connecting intact habitats and ecosystems and supporting imperiled species to help ensure the future of fish and wildlife across the Northeast region."

Your Land, Your Legacy: Deciding the Future of Your Land

"The goal of this publication is to help these landowners and their families make an informed decision about the future of their land."

In addition to these resources and the extensive analysis of Massachusetts' natural resources that has been done, new initiatives, programs, forums, and networks have developed that have impacted the direction of forest conservation in Massachusetts and the whole New England region. Some of these are listed below:

Wildlands and Woodlands

"Wildlands and Woodlands is a science-based conservation vision for the New England landscape. The project is led by the Harvard Forest and Highstead and is advanced by partnerships, organizations, agencies, and individuals across the region."

1. **Vision**

   "The Wildlands and Woodlands (W&W) vision calls for a 50-year effort to conserve 70 percent of New England as forest permanently free from development, plus at least 7 percent of New England as farmland. Through the leadership and commitment of landowners, these conserved lands will continue to power the region's traditional land-based economy and provide irreplaceable environmental and social benefits for current and future generations."

   "W&W recommends that voluntary, community-driven conservation result in approximately 90 percent of the forest conserved as woodlands sustainably managed for timber harvesting and other values, and 10 percent conserved as wildlands to protect biodiversity and wilderness. W&W further envisions an expanding amount of acreage devoted to local, sustainable agriculture, compact development, and local communities that adopt sustainable transportation, energy and land use policies."

2. **Voices from the Land**

   "Voices from the Land: Listening to New Englanders' Views of the Future, released in September 2018 by W&W lead partner Harvard Forest and the Science Policy Exchange, with support from W&W lead partner Highstead, provides a stakeholder-driven approach for addressing the important question: What does the future hold for the New England landscape?"

3. **Regional Conservation Partnerships**

   "People across the region are banding together in Regional Conservation Partnerships to increase the pace and scale of land protection. This is the exciting new face of conservation in New England, and beyond."

4. **Academics for Land Protection in New England** (ALPINE)

   "ALPINE is an emerging network that seeks to explore and expand the role that New England academic institutions play in conserving the natural heritage of the region. ALPINE helps academics connect, collaborate, and conserve through knowledge exchange and targeted activities that catalyze the pace and scale of conservation."

Massachusetts Land Conservation Conference (since 1990)

"The Massachusetts Land Conservation Conference provides an opportunity for staff and volunteers from land trusts; urban and rural community groups; colleagues from federal, state and local government agencies; students; and philanthropists to participate in a full day of workshops and discussions that focus on fostering a green future in our state through land conservation and greening strategies." See A Land Conservation Vision Summary for Massachusetts, from the "20 Year Land Conservation Vision Workshop Summary of 4 Work Group Reports at the Massachusetts Land Conservation Conference, March 27, 2010".

The Massachusetts Forest Forum (since 2004)

"The Forest Forum is a diverse group that includes: about 30 forest landowners, private and public foresters, timber harvesters, mill owners, land trusts and environmental organizations, and the Executive Office of Energy and Environmental Affairs. The Forum has met each spring and fall since 2004 and was created to improve the viability of Massachusetts' forests, forestry, and forest products industry by using sustainable practices."

Land Trust - State Agency Retreat (since 2002)

The first Land Trust – State Agency Retreat was convened to improve the partnership between the land trust and state agency communities and increase conservation in Massachusetts. One of the products of that retreat was a guide to all state agency land conservation programs and grants, so that land trusts could match the land project with the most appropriate program. Discussion topics are chosen that will help improve land conservation and stewardship and guest speakers are invited to present and discuss new innovative approaches to land conservation.

The above will undoubtedly influence future forest conservation efforts. Participation and involvement in these ongoing discussions provides innovative ideas and insight from many forest conservation stakeholders and is proving to be beneficial in the advancement of land conservation. Many local, regional, state-wide, and multi-state partnerships have evolved from these efforts and together they are focused on addressing the continued forest fragmentation, parcelization, and conversion threats to the Massachusetts and New England forest.

These initiatives provide new opportunities for the land conservation community to learn from one another. Local, regional, state-wide, and multi-state partnerships have also evolved from these efforts. These partnerships, along with all the GIS data, tools and resources now available, have transformed the once typical single tract project proposals submission for Forest Legacy Program funding consideration from Massachusetts. Massachusetts, with the foresight of its many partners, has evolved to submission of large landscape scale multi-tract / multi-landowner projects. Massachusetts and its partners recognized the need to focus on landscape-scale projects, not only to connect the fragmented resources among many landowners, but to also be competitive with other states that have the advantage to still have many large blocks of land under single ownerships.

These projects have been highly successful in increasing the pace of forest conservation here in Massachusetts; however they are also complex and require a significant amount of coordination and collaboration among many partners. What goes on behind the scenes in these highly complex projects is most often never quantified in terms of what these projects have done to leverage additional forest conservation outside of the Forest Legacy Program.

The purchase, by Fee or Conservation Restriction, of these environmentally important and threatened forested lands under the Forest Legacy Program from knowledgeable, willing owners will protect valuable woodland from conversion to non-forest uses in perpetuity. Moreover, since forest land acquired under the Forest Legacy Program in Massachusetts is required to be managed under a Forest Stewardship Plan that addresses traditional forest uses and environmentally important public values, privately-owned working forests would be insured, as well as the protection of these environmental values and their contribution toward rural economies.

B. Massachusetts Forest Legacy Program Goal

The goal of the Massachusetts Forest Legacy Program is to prevent the conversion of environmentally important forestland to non-forest uses, and to provide the opportunity for the continuation of traditional forest uses. The importance of large, landscape scale, collaborative projects with multiple Partners in achieving this goal cannot be emphasized strongly enough. Massachusetts has worked with Federal, State, and Municipal Governments; qualified non-profit organization such as land trusts and watershed associations; and other conservation organizations with great success. This includes collaborative projects that cross state boundaries.

These projects will also need to seek out and utilize multiple funding sources (Federal, State, and Municipal Governments; qualified non-profit organizations; conservation/environmental philanthropic organizations) for both acquisition and due diligence related expenses, as they contribute to the FLP cost-share requirements. The donation of acquisition and due diligence, related expenses toward the FLP required cost-share from willing sellers has to-date been exemplary.

There remains the need for long-term funding for the continued monitoring and enforcement of the conservation easements acquired with FLP funds or donated as an FLP cost-share.

C. Eligibility Criteria for a Forest Legacy Area

The history of the Massachusetts Forest Legacy Area is catalogued in Appendix A and represents a rich and varied assortment of forest lands. Many forest lands across Massachusetts meet the Forest Service eligibility criteria for the Forest Legacy Program. To determine the outstanding ones, each area, in addition to documentation of environmentally important public values within its boundaries, will be evaluated within its local, regional, state-wide and multi-state context. Floodplains, extensive wetlands, high elevation forests with characteristic vegetation, threatened and endangered species habitats, coastal plain aquifers, riverine and coastal shorelines all constitute distinctive, regionally occurring, natural resources in Massachusetts.

The Massachusetts Forest Action Plan (see: "*An Assessment of the Forest Resources of Massachusetts*" and "*Forest Resource Strategies of Massachusetts*"), provides analyses that aids Massachusetts in the identification of environmentally important forestlands threatened by conversion to non-forest use. Its data and analysis can be used in the development of project proposals that prioritize areas of the Commonwealth where environmentally important resources and threats occur and develop strategies and partnerships that incorporate all available programmatic and external land conservation tools and resources.

Ideally, future Forest Legacy Area proposals will embody multiple environmentally important public values; be acquirable and enjoy public support; be threatened with conversion to non-forest use; abut and/or plan to connect existing permanently protected public open space tracts, blocks, and corridors; be delineated by man-made (physical infrastructure) and/or natural boundaries (physiographic, geologic, hydrologic/riparian); and contribute to forest conservation at the local, regional, state-wide, and/or multi-state scale.

In early 1992, land trusts and other conservation organizations across the state were invited to submit potential Forest Legacy Areas that would meet Forest Service eligibility criteria. From those proposals, the committee selected five areas for recommendation to the US Forest Service. Since the approval of the original AON in 1993, two new areas and two area expansions have been proposed, submitted, and approved by the US Forest Service. At this time, these areas are consolidated into a single Forest Legacy Area.

Below is a list of the Massachusetts Forest Legacy Program eligibility criteria:

1. **Legacy area criteria**

   For inclusion in the Forest Legacy Program, lands must:

   a. Be threatened by present or future conversion to non-forest uses
   b. Contain one or more of the following environmentally important public values:
      i. Timber and other forest commodities;
      ii. Scenic resources;
      iii. Public recreation opportunities;
      iv. Riparian areas;
      v. Fish and wildlife habitat;
      vi. Known threatened and endangered species;
      vii. Known cultural resources; and
      viii. Other ecological values.
   c. Provide opportunities for continuation of traditional forest uses
   d. Reflect environmentally important public values at a landscape-sale (local, regional, state-wide, and/or multi-state)

2. **Evaluation factors**

   The nominator of a proposed Forest Legacy Area may quantify and qualify the information utilizing these evaluation factors and provide a persuasive argument for the nominated area. This list is provided as a guideline for future nominations.

a. Threat by conversion to non-forest uses:

   i. Type and level of threat

   ii. There are various kinds and degrees of threat to valuable forested areas, such as encroaching housing development, improved town roads, sewer line and power line extensions into undeveloped areas, and fragmentation of land ownership into smaller, less manageable parcels. In determining the threat to an area, factors to consider include the following:

      - Area is in danger of conversion to non-forest use within 5 years.
      - Area may remain wooded, but will become further fragmented.
      - Area is not under Ch. 61/A/B or other forest management program.
      - Area may remain wooded but, is in danger of being over-harvested.

b. Contain one or more important values:

   i. Forest commodities such as

      - Timber
      - Cordwood
      - Pulpwood
      - Biomass
      - Carbon Storage
      - Other Forest Products (i. e. – maple syrup, berries, mushrooms, bark, burls, cones, nuts, herbs, etc.)

   ii. Scenic Resources

   The scenic aspects of a natural resource area may often be subjective, but there are several means of measuring the special qualities that make a given area stand out. DCR's Scenic Landscape Inventory and the Massachusetts Scenic Roads Act provide a means of citing scenic qualities. In identifying scenic amenities of a Forest Legacy Area, these factors must be considered.

      - Area is listed in the Massachusetts Landscape Inventory Project, 1982 (see: MassGIS for shapefile). Area includes locally important panoramic views and / or exceptional short views.
      - Area is situated along a designated scenic road (see: MGL Ch. 40 Sec. 15C)

   iii. Public recreation opportunities

   Recreational use of a proposed Forest Legacy Area by the public is an important component. Documents such as the Massachusetts Statewide Comprehensive Recreation Plan (SCORP) will provide the proponent of a Forest Legacy Area needed information on the relative importance of the following factors:

- Water based recreation is present - boating, swimming, fishing, rafting, canoeing.
- Trail based and or day use recreational opportunities exist - hiking, picnicking, horseback riding, ice skating, cross country skiing.
- Natural resource recreational activities are available - camping, hunting, nature touring, etc.
- Adjacent land is protected.

iv. Riparian areas

In an urbanizing state such as Massachusetts, one of the most important forest "products" may be water. Proper management of forest lands through institution of a Forest Legacy Area can increase the quality and quantity of water for the residents of the Commonwealth. Factors to be included in determining the value of riparian areas:

- Area is situated on waters that are identified as Coldwater Fish Resources by the MA Division of Fisheries and Wildlife (see: MassGIS Data: Coldwater Fish Resources).
- Area has extensive (over 300') river or wetland shoreline.
- Area includes floodplain components (see: MassGIS: FEMA flood hazard maps).
- Area contains a minimum 80' strip of native trees and shrubs as a natural buffer and sediment filter, per USFS guidelines outlined in Riparian Forest Buffers.
- Area contributes to important public ground supply wellhead protection areas (see: MassGIS Data: MassDEP Wellhead Protection Areas) and / or surface water supply area (see: MassGIS: Surface Water Supply Watersheds).
- Area contains important wetlands; especially isolated wetlands and/or vernal pools (see: MassGIS Data: MassDEP Wetlands and NHESP Certified Vernal Pools).

v. Fish and wildlife habitat

Preventing the fragmentation of forest tracts into smaller units is crucial to maintaining viable populations of particular wildlife species. Factors to be considered include:

- Area contains outstanding habitat, as evaluated per the Massachusetts Forest Action Plan, Massachusetts Wildlife Action Plan and Mass Natural Heritage Endangered Species Program BioMap2,
- Area contains ecologically recognized habitat for one or more species that include:
  - ◊ Forest interior nesting birds

◊ Significant populations of resident species
◊ Neo-tropical migrant species
◊ Areas for resting and feeding of migratory species.

- Area exhibits connective habitats, corridors, habitat linkages and areas that reduce biological isolation.
- Known threatened and endangered species.

As urbanization and fragmentation of forest lands continues the need to give special attention to threatened species of fish, wildlife and plants increases. Areas nominated for the Forest Legacy Program should be inventoried for such natural habitats that may contain imperiled species, considering the following factors:

- Area contains plant or animal species on Massachusetts state list as Endangered, Threatened or of Special Concern (consult Massachusetts Natural Heritage Endangered Species Program at Mass. Division of Fisheries and Wildlife).

vi. Known cultural resources

Material evidence of the earlier human occupation in Massachusetts comprises a unique and irreplaceable resource, as do historic features and vernacular landscapes. Factors to consider:

- Area contains recorded archeological site; e.g. burial, midden, fire pit, or artifacts of Contact, Woodland or Archaic periods.
- Area includes historic features; e.g. charcoal kilns, church or village sites, battle sites, historic roads, paths or lookouts.

vii. Productive soils

Of the 3.2 million acres of forests in Massachusetts, nearly 67% are classified as "prime," based on the productive soils upon which they grow. This classification system is useful in determining the importance of individual tracts within a Forest Legacy Area:

- Area contains soils of Prime, or State or Local significance for agriculture (see: MassGIS Data: Prime Farmland Soils.
- Area contains soils of Prime, or State or Local significance for forestry (see: MassGIS Data: Prime Forest Land).

viii. Other ecological values

In addition to the characteristics already outlined, an area may exhibit additional or exceptional conditions that are important and add to the quality of the nominated Forest Legacy Area, such as:

- Area contains old growth forest.
- Area provides a mix of ecological communities.

- Area includes ecological communities which are dwindling in Massachusetts, such as vernal pools, mature riparian floodplain forest, and pine barrens.
- Area provides immediate watershed/water supply protection.

c. Provide opportunities for continuation of traditional forest uses.

Maintaining traditional forest uses is important in a Forest Legacy Area in that it permits owners to remain on the land without increasing demand for high-cost services such as schools, street clearing or repair by the town. Positive factors which reinforce this include:

i. Area will remain available for sugar bush operation, cordwood or timber management under a Forest Stewardship Plan.

ii. Area will continue to serve watershed and water filtration role.

iii. Area will continue to provide outdoor recreation opportunities.

d. Local, Regional, State-wide, Multi-state values

Through careful selection, Forest Legacy Areas should provide units that have not just local, but regional, state, and multi-state significance. The features and functions of these units should include:

i. Linkages for recreational values, such as trails, especially along river greenbelts, mountain ridges and parcels which connect existing publicly-owned lands.

ii. Public access to boating and swimming relative to the needs of local population centers and the effects of projected land use change.

iii. Public or private drinking water supply protection (ground or surface water).

iv. Scenic qualities having their basis in the traditional New England natural and cultural landscape.

v. Areas that can provide connectivity to conserve and protect important environmental values that will maintain environmental values and provide for mitigation and adaptation strategies.

3. Designation Requirements for Forest Legacy Areas

A Forest Legacy Area can be nominated for designation at any time by submitting a written proposal to the Massachusetts Forest Legacy Committee. Proposals for FLAs must include the following elements:

a. Location of geographic area on a map and a written description of the proposed FLA boundary;

b. Summary of the analysis used to identify the FLA and its consistency with the eligibility criteria;

c. Identification of important environmental values;

d. List of public benefits that will be derived from establishing FLA; and

e. Documentation of the public involvement process.

FLA boundaries must encompass forestlands with significant environmental and other resource-based values. Areas may also include non-forested areas, such as farms, if they are an integral part of the landscape and are within logical boundaries.

D. Massachusetts Forest Legacy Area

At this time, the original Massachusetts FLAs and subsequent Amendments/Expansions are combined into a single FLA. This will provide easier administration and greater opportunities for land protection. This update also provides the opportunity to add new areas to the state FLA. The proposed additions are areas with significant areas of forestland that provide critical benefits or are under significant threat from development or environmental factors.

The additions include three new regions; Northeast Massachusetts, Central Massachusetts, and Southeastern Massachusetts, and result in the inclusion of 157 cities and towns in the FLA. The Massachusetts Forest Legacy Area is shown in Figure 3. The Cities and Towns included within the boundary of the Massachusetts Forest Legacy Area, either the entire city/town or any portion of the city/town, are listed in Table 2 (towns added in 2019 are marked with an *).

1. Process for designating MA Forest Legacy Area

The 2010 Massachusetts Forest Action Plan analyzed the forest resources of Massachusetts through the lens of the Montreal Process that includes the following seven criteria:

Criterion 1: Conservation of Biological Diversity

Criterion 2: Maintenance of productive capacity of forest ecosystems

Criterion 3: Maintenance of forest ecosystem health and vitality

Criterion 4: Conservation and maintenance of soil and water resources

Criterion 5: Maintenance of forest contribution to global carbon cycles

Criterion 6: Maintenance and enhancement of long-term multiple socio- economic benefits to meet the needs of societies

Criterion 7: Legal, policy and institutional framework

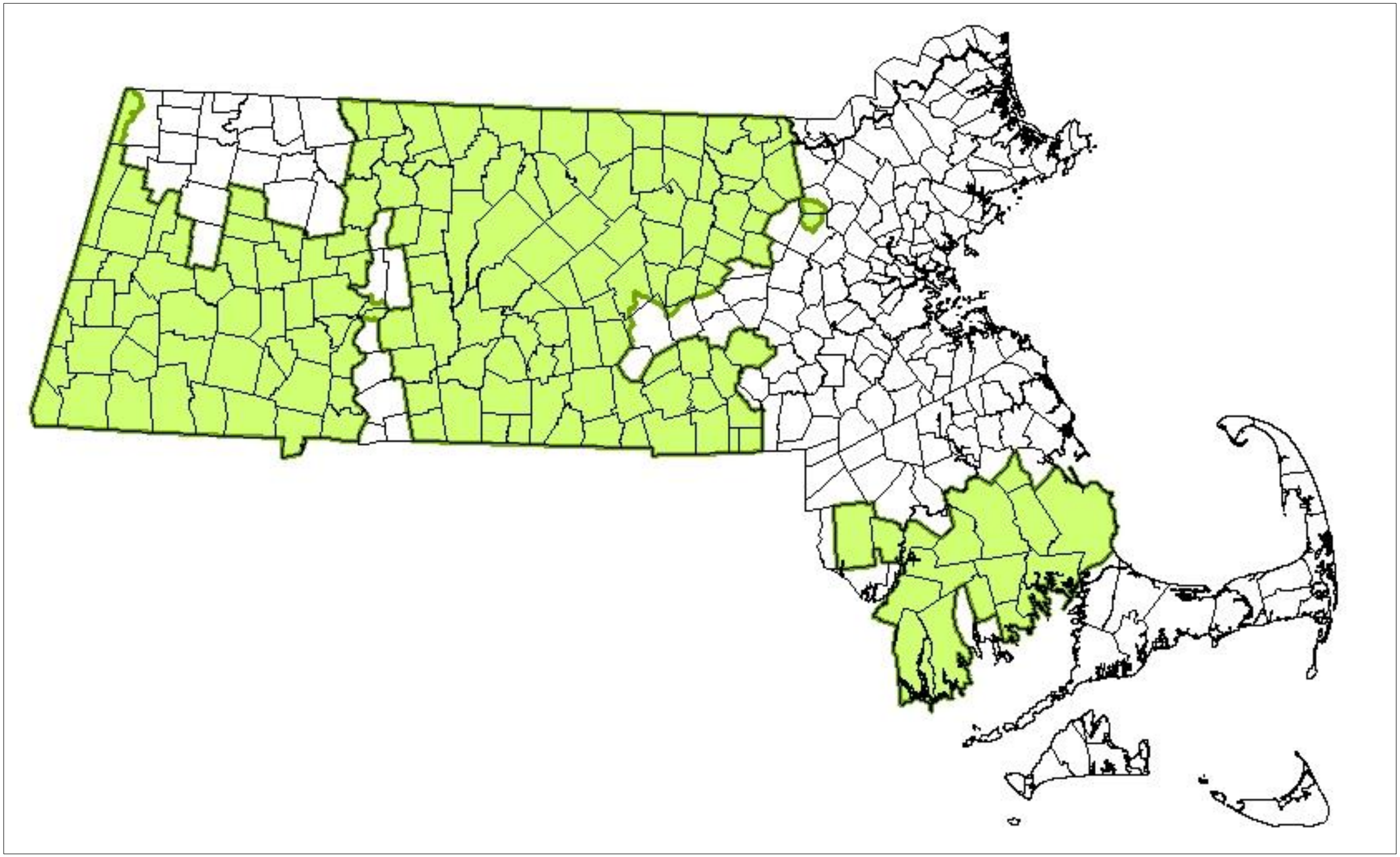

Figure 3. Massachusetts Forest Legacy Area Map

Acushnet*	Fall River*	Mendon*	Sandisfield
Agawam	Fitchburg	Middleborough*	Sheffield
Alford	Freetown*	Middlefield	Shirley
Ashburnham	Gardner	Millbury*	Shrewsbury
Ashby	Gill	Millville*	Shutesbury
Athol	Goshen	Monson	South Hadley
Ayer	Grafton*	Montague	Southampton
Barre	Granby	Monterey	Southbridge
Becket	Granville	Montgomery	Southwick
Belchertown	Great Barrington	Mount Washington	Spencer
Berkley*	Greenfield	New Braintree	Sterling
Berlin*	Groton*	New Marlborough	Stockbridge
Bernardston	Hadley	New Salem	Stow*
Blackstone*	Hampden	North Brookfield	Sturbridge
Blandford	Hancock	Northampton	Sutton*
Bolton*	Hardwick	Northborough	Templeton
Boxborough*	Harvard*	Northbridge*	Tolland
Boylston	Hatfield	Northfield	Townsend
Brimfield	Hinsdale	Oakham	Tyngsborough*
Brookfield	Holden	Orange	Tyringham
Carlisle	Holland	Otis	Upton*
Carver*	Holyoke	Oxford*	Uxbridge*
Charlton	Hopkinton*	Palmer	Wales
Chester	Hubbardston	Paxton	Ware
Chesterfield	Huntington	Pelham	Wareham*
Clinton	Lakeville*	Pepperell	Warren
Concord	Lancaster	Petersham	Warwick
Cummington	Lanesborough	Phillipston	Washington
Dalton	Lee	Pittsfield	Webster*
Dartmouth*	Leicester	Plainfield	Wendell
Deerfield	Lenox	Plymouth*	West Boylston
Dighton*	Leominster	Plympton*	West Brookfield
Douglas*	Leverett	Princeton	West Springfield
Dudley	Leyden	Rehoboth*	Westford*
Dunstable*	Littleton*	Richmond	Westminster
East Brookfield	Ludlow	Rochester*	Westport*
Easthampton	Lunenburg	Royalston	Wilbraham
Egremont	Marion*	Russell	Winchendon
Erving	Mattapoisett*	Rutland	Worcester

Table 2. Cities and towns in Massachusetts Forest Legacy Area

The Montreal Process criteria are linked to the three national priorities designated by the U.S. Forest Service State & Private Forestry (S&PF):

1. Conserve and Manage Working Forest Landscapes for Multiple Values and Uses
2. Protect Forests from Threats
3. Enhance Public Benefits from Trees and Forests

Using the combined parameters of the Montreal Process Criteria and the S&PF National Priorities, DCR and UMass DNR conducted a GIS analysis of the state to identify high priority forest resources. The data layers that were derived from this analysis include:

1. Conserve and Manage Working Forest Landscapes for Multiple Values and Uses Overlay (Figure 4)
2. Protect Forests from Threats Overlay (Figure 5)
3. Enhance Public Benefits from Trees and Forests Overlay
    a. Water Resources and Biological Diversity (Figure 6)
    b. Local Wood Production and Forest Sector Employment (Figure 7)
4. Synthesis Overlay
    a. Forest Functions, Benefits and Values (Figure 8)
    b. Forest Vulnerability (Figure 9)

These layers were then combined into one unified comprehensive overlay that identifies the highest priority forested landscapes of the state. Figures 4-9 show this analysis and eligibility criteria in relation to the Forest Legacy Area. Table 3 lists the resource statistics for all the towns in the Massachusetts FLA.

In addition to the consolidation of the original FLAs and subsequent Amendments/Expansions into a single FLA, the State Lead Agency, in consultation with the State Forest Stewardship Coordinating Committee, 40 new towns have been identified for inclusion in the Massachusetts Forest Legacy Area and are recommended to the Forest Service for designation. The Massachusetts Forest Legacy Area includes the five previously approved Forest Legacy Areas; Western Massachusetts FLA; Heritage Corridor FLA; North Quabbin Corridor FLA; Estabrook Woods FLA; and Nashua River Greenway FLA (see Appendix for original boundary descriptions), and three new regions in northeastern Massachusetts, central Massachusetts, and southeastern Massachusetts.

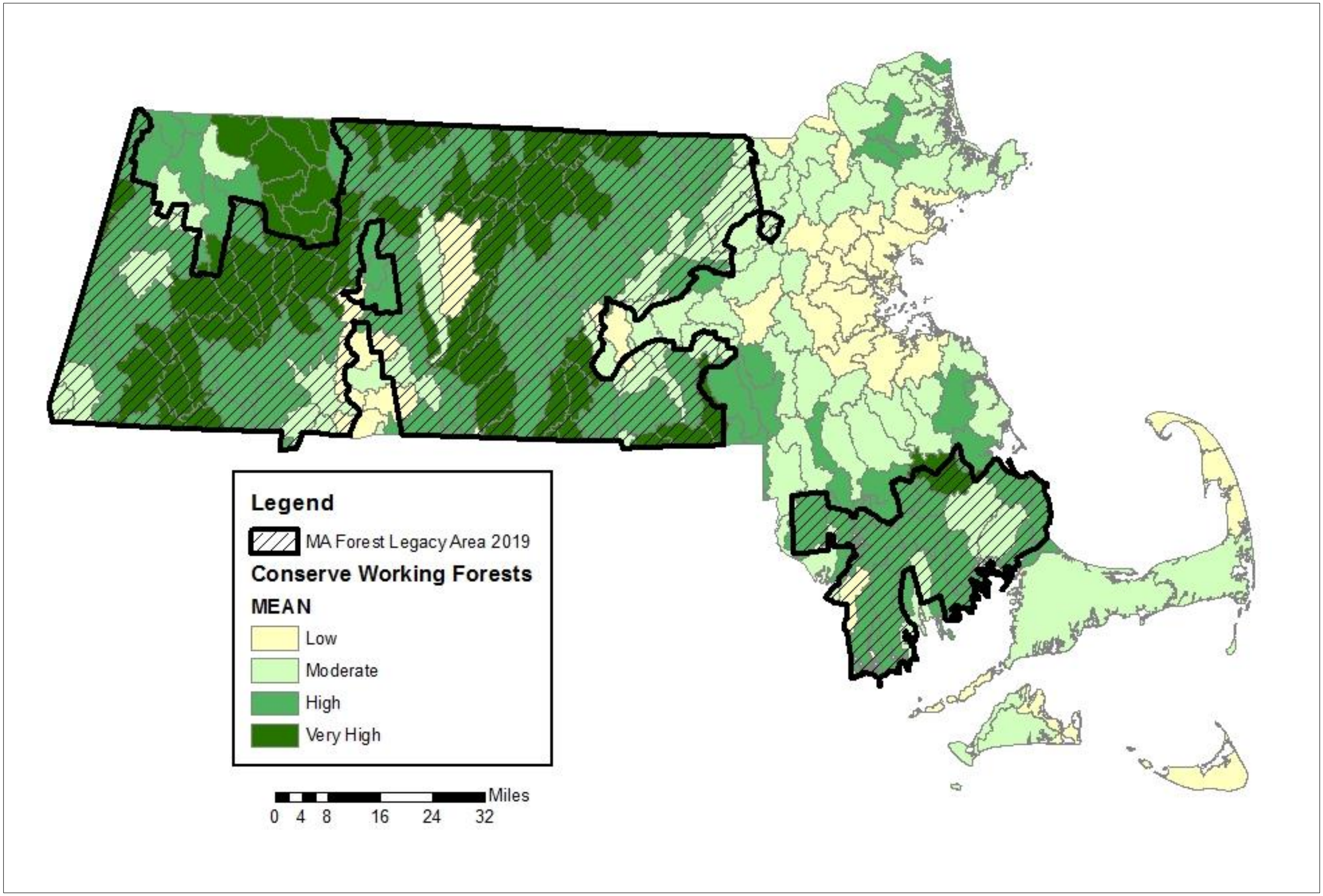

Figure 4. Conserve and Manage Working Forest Landscapes for Multiple Values and Uses

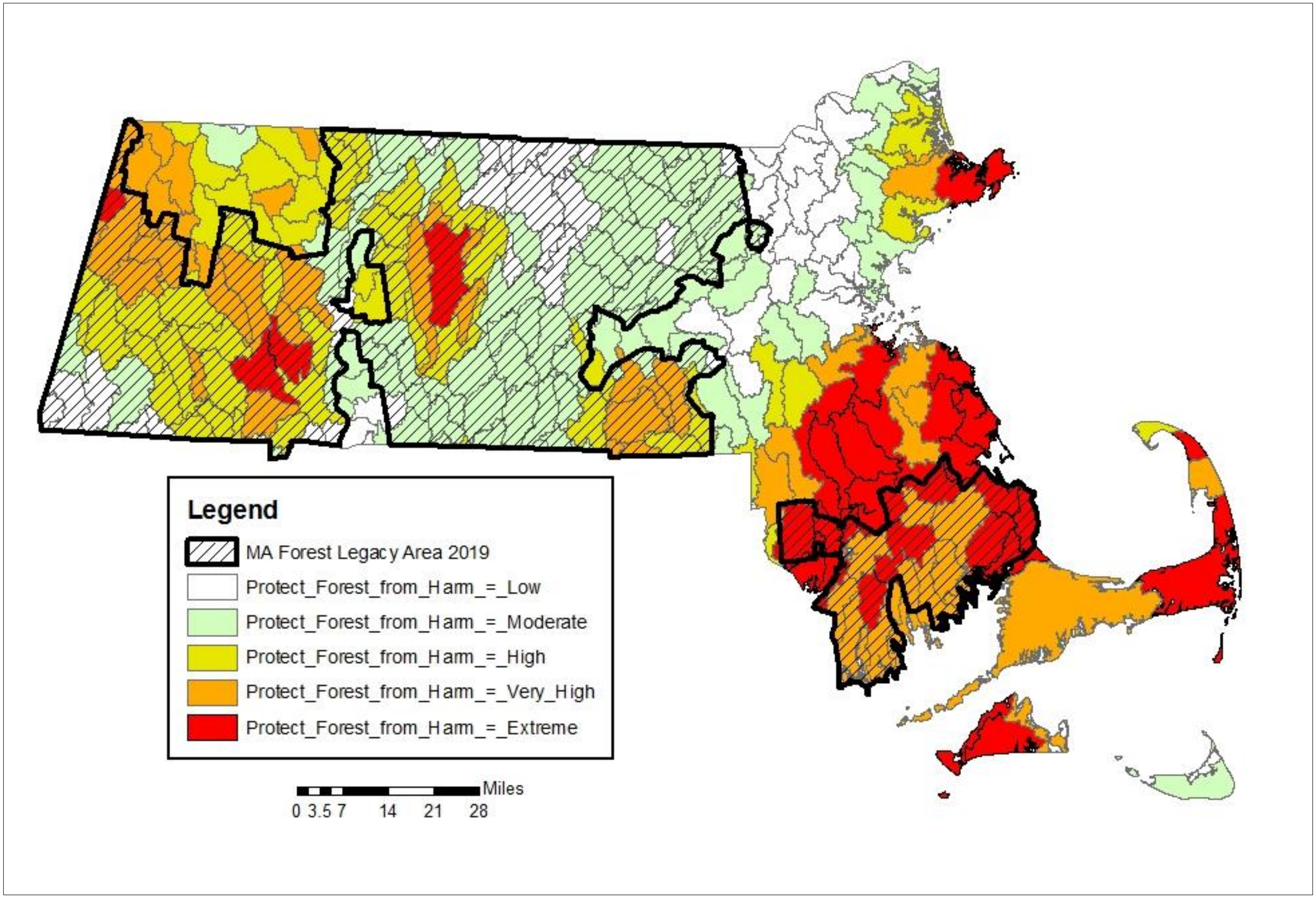

Figure 5. Protect Forests from Threats

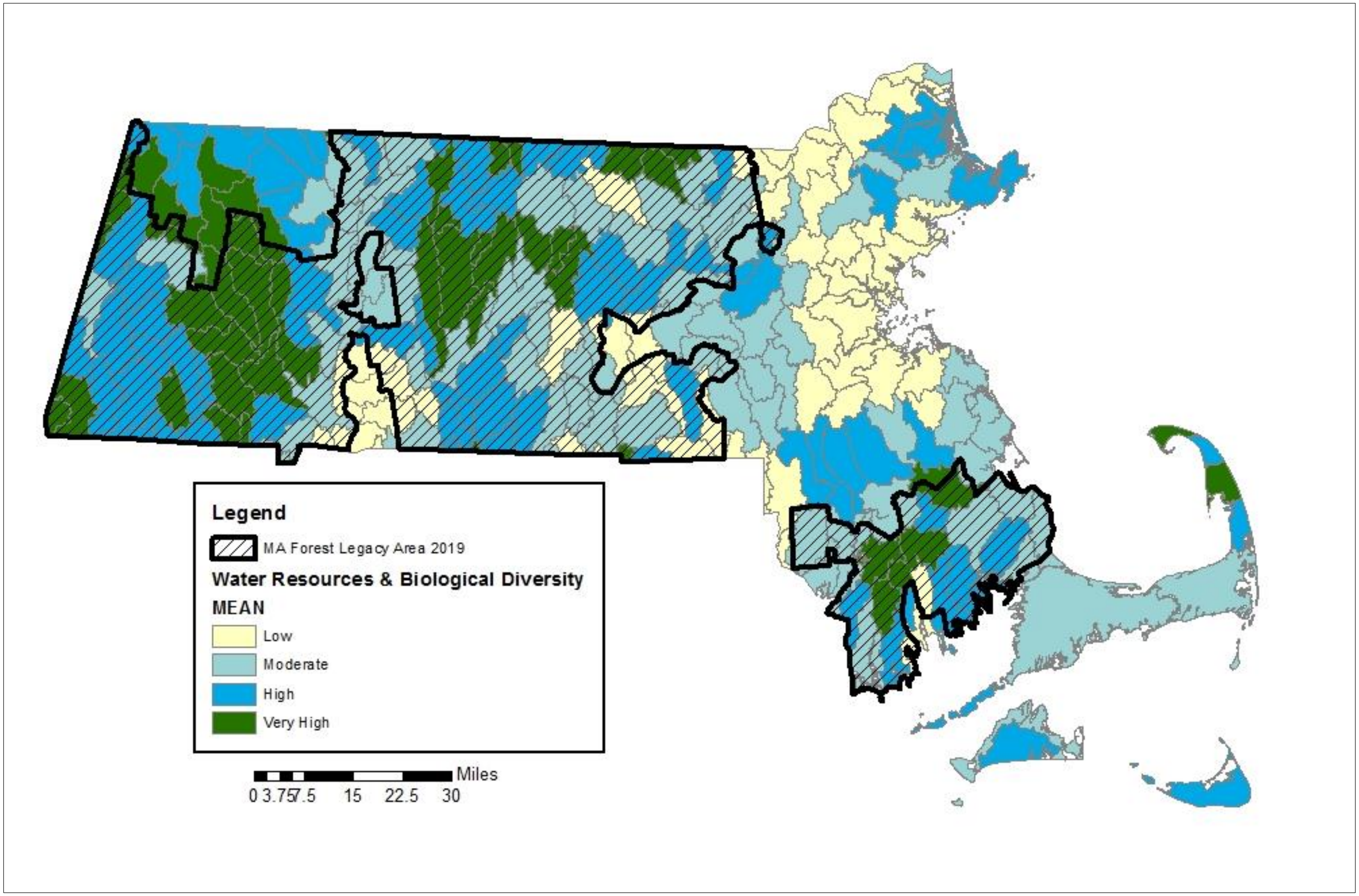

Figure 6. Water Resources and Biological Diversity

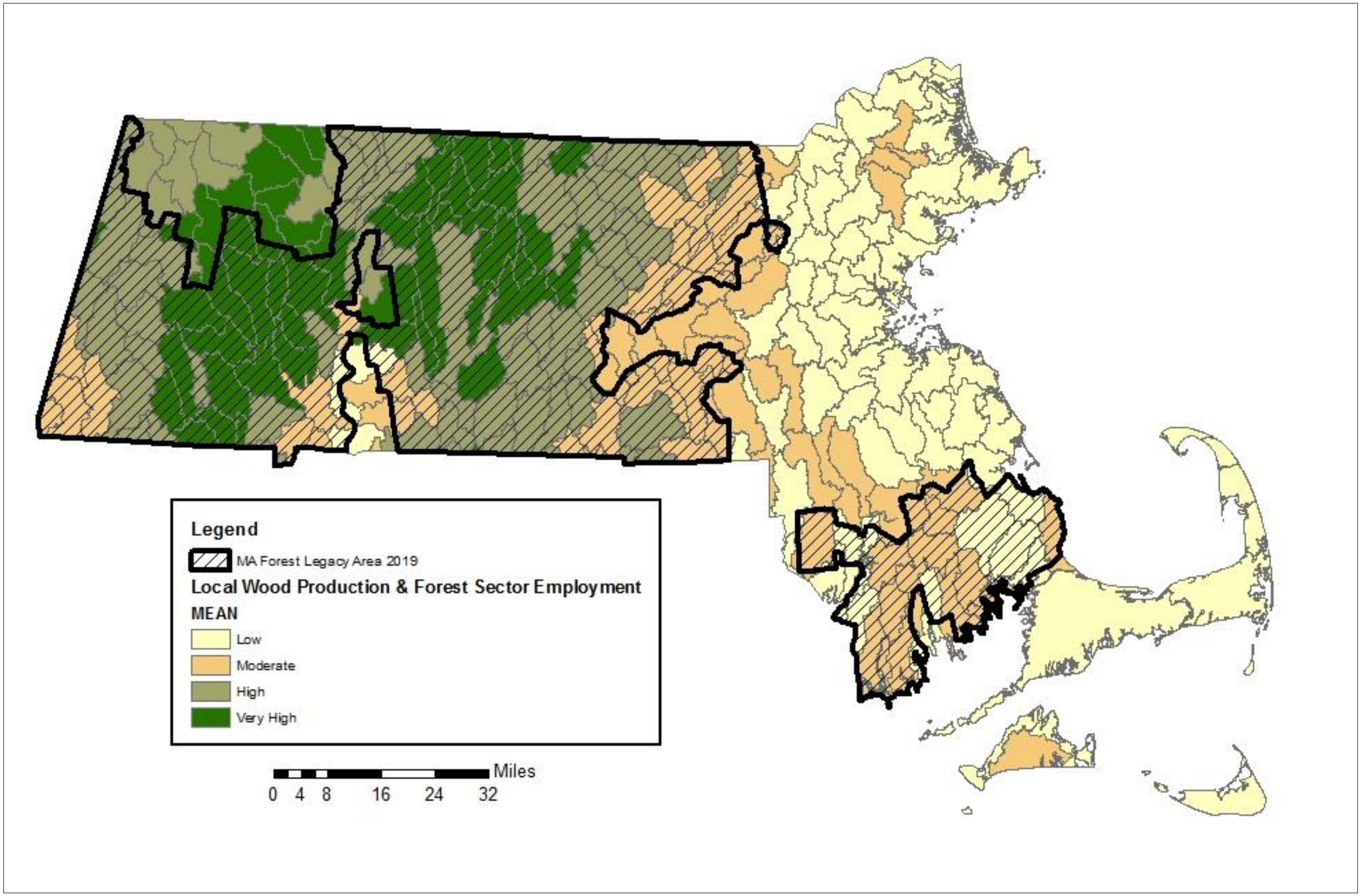

Figure 7. Local Wood Production and Forest Sector Employment

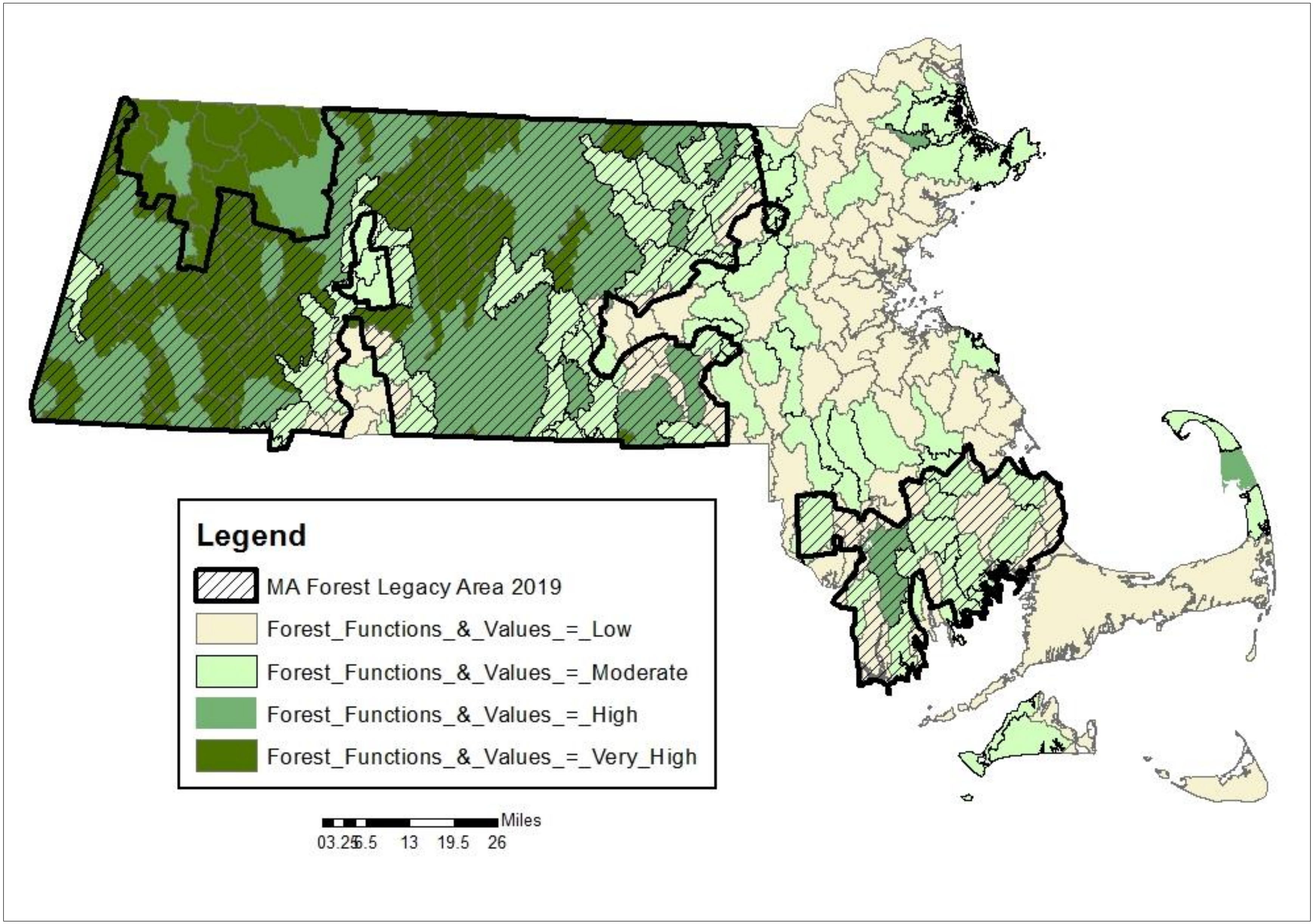

Figure 8. Forest Functions, Benefits and Values

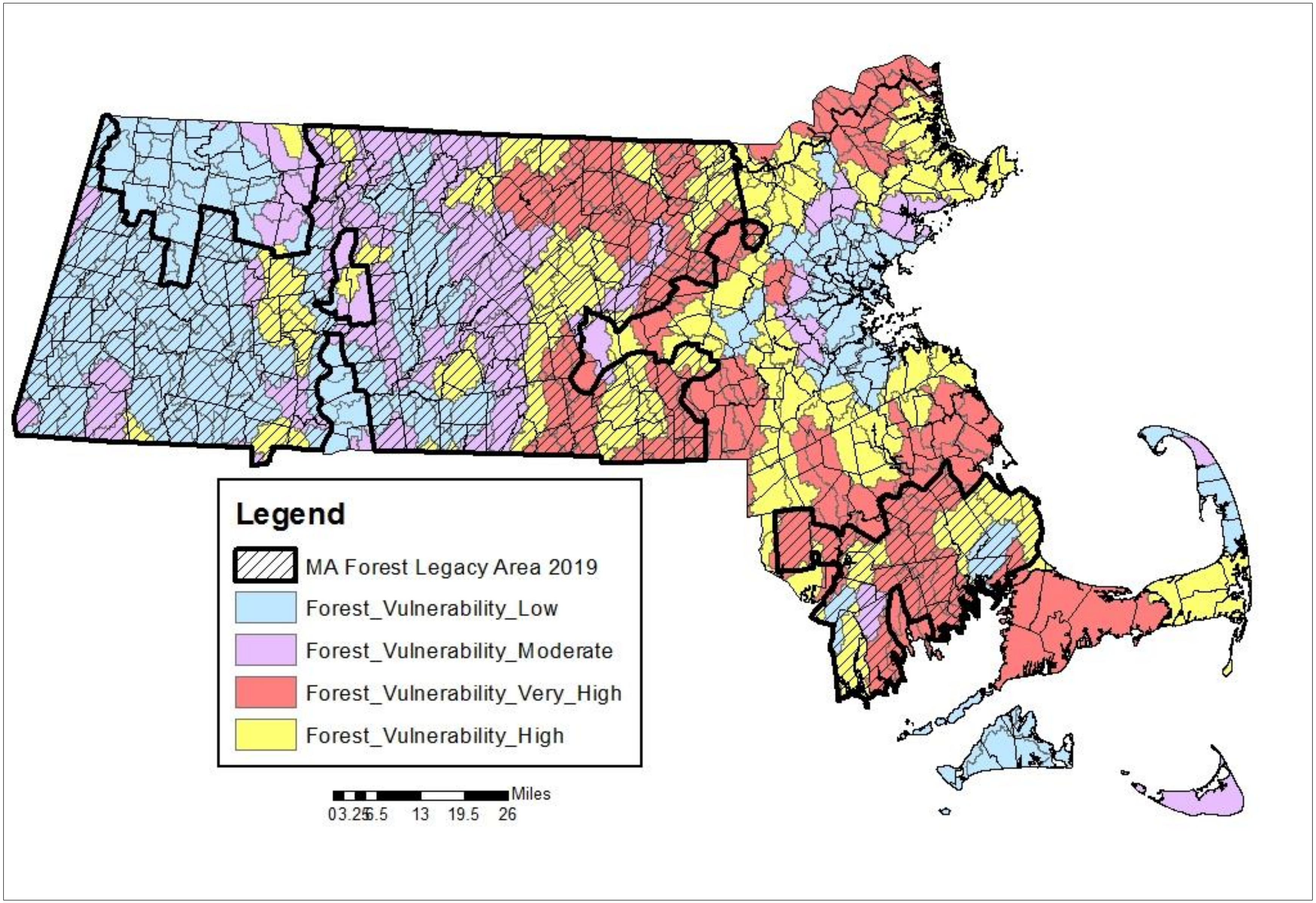

Figure 9. Forest Vulnerability

Town	Forest Acres	% Forest	Protected Open Space Acres	Core Habitat Acres	Core Habitat Protected Acres	Critical Natural Landscape Acres	CNL Protected Acres	# BioMap2 Forest Cores	# BioMap2 Landscape Blocks	Ch. 61 Acres
Acushnet*	6,685	55.4	1,144	1,373	300	4,906	676	3	2	1,205
Agawam	5,093	32.6	1,576	4,521	868	4,479	463	0	1	253
Alford	5,116	69.3	1,897	1,593	502	5,214	1,484	2	1	771
Ashburnham	19,718	75.1	6,084	4,051	1,818	11,180	4,729	0	5	7,436
Ashby	12,115	78.6	3,555	1,719	884	3,514	1,711	2	4	2,851
Athol	16,211	75.9	4,997	3,235	1,832	5,360	3,363	1	1	3,068
Ayer	2,593	42.6	755	2,597	598	539	58	1	1	442
Barre	20,784	72.8	10,809	3,469	2,528	5,245	4,525	1	3	2,850
Becket	25,383	83.0	5,082	2,143	1,334	16,678	4,183	2	5	3,041
Belchertown	23,131	65.3	7,363	5,024	2,414	8,966	4,104	2	5	6,805
Berkley*	6,532	61.9	638	2,399	239	1,067	116	0	0	346
Berlin*	5,384	63.9	2,096	603	247	755	313	1	1	720
Bernardston	11,201	74.8	2,920	2,256	1,479	7,006	2,030	2	3	4,580
Blackstone*	3,779	51.8	464	1,005	235	1,878	351	1	1	222
Blandford	29,428	86.0	16,610	1,650	774	23,564	14,340	1	3	7,549
Bolton*	8,539	66.3	2,166	2,914	1,089	547	438	0	0	650
Boxborough*	3,578	53.8	1,306	1,289	337	485	147	0	1	581
Boylston	7,567	59.8	5,930	3,367	2,824	5,077	4,244	0	2	543
Brimfield	17,789	78.8	3,862	1,567	860	6,277	2,843	0	2	8,419
Brookfield	6,750	63.6	3,339	3,380	1,660	3,018	1,564	0	2	1,069
Carlisle	5,709	57.6	3,160	3,171	1,558	913	621	1	1	692
Carver*	11,446	45.0	2,316	6,535	1,971	8,177	2,124	2	4	704
Charlton	18,146	64.4	1,304	1,648	83	1,598	108	0	1	2,518
Chester	21,448	90.2	7,831	2,870	1,534	16,342	6,912	0	2	10,328
Chesterfield	17,119	85.6	6,407	4,025	2,247	11,345	4,594	2	2	5,401
Clinton	1,402	30.1	1,483	1,208	999	996	992	0	1	58
Concord	6,431	39.0	4,879	5,403	2,339	3,738	2,053	1	1	620
Cummington	12,071	81.8	3,670	1,562	400	5,558	1,406	0	3	3,987
Dalton	10,542	748.2	7,163	5,491	4,817	7,139	5,664	2	2	1,854
Dartmouth*	22,358	56.4	9,156	10,501	4,333	20,323	7,061	4	5	2,927
Deerfield	12,372	58.0	4,083	5,377	1,452	6,686	1,896	2	2	4,525
Dighton*	9,431	66.6	400	2,725	146	5,473	176	1	3	556
Douglas*	19,096	78.0	5,707	10,427	5,098	14,124	5,662	6	3	3,491
Dudley	7,656	54.7	1,925	1,018	139	2,897	344	2	3	674
Dunstable*	6,828	63.6	1,682	5,332	715	5,006	851	1	3	2,407
East Brookfield	4,293	64.5	1,432	1,622	410	2,378	1,021	0	1	1,428

Table 3. Resource Data for MA Forest Legacy Area Towns

Town	Forest Acres	% Forest	Protected Open Space Acres	Core Habitat Acres	Core Habitat Protected Acres	Critical Natural Landscape Acres	CNL Protected Acres	# BioMap2 Forest Cores	# BioMap2 Landscape Blocks	Ch. 61 Acres
Easthampton	3,690	42.4	1,719	2,210	873	1,517	606	0	2	242
Egremont	7,379	61.1	3,185	5,095	2,527	3,546	2,146	1	3	929
Erving	7,515	81.7	3,089	820	264	4,882	1,427	0	2	361
Fall River*	12,031	48.7	10,082	9,658	6,754	14,018	988	6	1	423
Fitchburg	10,211	56.7	2,763	427	232	581	19	1	2	1,607
Freetown*	15,357	67.8	5,182	6,374	2,764	12,201	4,732	6	2	1,813
Gardner	8,828	59.9	3,706	463	205	2,153	1,391	0	2	1,188
Gill	5,558	58.6	1,722	2,492	544	6,208	1,316	1	1	2,479
Goshen	9,307	82.0	2,202	1,283	152	3,610	951	0	3	2,593
Grafton*	7,676	51.4	1,553	1,205	176	345	59	1	1	560
Granby	11,232	62.5	2,661	5,002	2,032	9,026	2,221	4	4	1,874
Granville	34,116	123.8	12,465	3,013	1,810	20,694	11,211	1	2	7,527
Great Barrington	19,721	67.3	10,511	11,174	6,279	17,057	8,448	5	4	1,730
Greenfield	6,721	47.9	1,856	1,670	300	1,587	243	0	1	1,499
Groton*	12,520	57.9	6,325	14,532	4,836	5,586	2,609	5	4	1,619
Hadley	4,525	28.7	4,533	7,270	2,539	3,727	1,328	1	1	205
Hampden	8,667	68.8	1,059	3,785	377	8,710	976	0	1	2,399
Hancock	19,874	86.9	8,666	13,951	6,963	18,716	7,885	4	3	2,252
Hardwick	19,172	73.3	9,605	6,389	4,310	10,501	7,028	1	1	2,961
Harvard*	10,297	59.3	4,445	4,876	2,304	2,834	1,401	0	1	1,295
Hatfield	4,721	43.9	881	4,581	315	2,566	79	0	1	827
Hinsdale	10,280	74.1	4,604	1,915	1,340	6,516	3,405	1	3	1,982
Holden	16,181	69.6	9,642	3,361	2,538	7,455	5,177	3	4	1,337
Holland	6,348	75.8	1,583	528	164	2,415	864	0	1	953
Holyoke	7,257	49.8	4,800	8,105	4,212	4,615	2,596	1	3	526
Hopkinton*	9,907	55.5	3,738	1,715	1,374	1,784	1,475	1	1	1,012
Hubbardston	21,474	80.0	11,169	3,869	2,793	10,155	6,390	1	5	3,017
Huntington	14,433	84.1	6,278	6,143	4,213	10,007	5,424	2	4	3,427
Lakeville*	11,433	49.5	3,188	8,593	1,624	10,435	2,072	1	4	835
Lancaster	10,651	59.5	1,849	7,822	1,456	2,684	867	1	1	400
Lanesborough	13,077	69.1	4,619	3,067	1,893	9,040	3,573	4	3	4,174
Lee	10,877	62.9	5,185	5,253	5,316	7,075	4,075	3	2	2,433
Leicester	9,946	63.1	2,071	1,051	316	618	60	0	0	1,289
Lenox	8,470	61.0	4,306	5,033	2,611	7,065	3,951	2	2	763
Leominster	9,707	51.1	5,129	5,015	3,202	6,148	3,833	3	1	1,057
Leverett	12,472	84.6	4,818	8,027	3,519	9,899	4,091	2	1	6,744

Table 3 cont. Resource Data for MA Forest Legacy Area Towns

Town	Forest Acres	% Forest	Protected Open Space Acres	Core Habitat Acres	Core Habitat Protected Acres	Critical Natural Landscape Acres	CNL Protected Acres	# BioMap2 Forest Cores	# BioMap2 Landscape Blocks	Ch. 61 Acres
Leyden	8,792	76.4	2,192	1,335	35	5,626	1,368	0	1	3,326
Littleton*	4,622	41.2	1,539	2,166	277	396	155	0	1	876
Ludlow	9,585	52.9	3,636	4,293	2,288	5,120	3,004	1	2	869
Lunenburg	9,729	54.7	2,888	3,599	1,409	3,620	1,212	4	3	1,290
Marion*	5,506	61.1	2,948	2,882	1,494	5,429	2,598	2	4	1,093
Mattapoisett*	7,507	67.6	2,826	4,793	2,143	6,629	2,464	2	3	854
Mendon*	7,259	62.9	745	2,456	371	4,509	553	1	2	856
Middleborough*	27,391	59.3	7,698	16,073	5,756	22,754	6,699	5	5	3,824
Middlefield	14,022	90.7	6,418	5,098	3,830	12,635	6,144	3	1	2,521
Millbury*	5,260	50.0	761	812	216	305	21	1	1	59
Millville*	1,950	61.4	140	26	0	576	0	0	1	237
Monson	21,331	74.5	3,843	6,624	839	11,843	2,174	0	3	5,587
Montague	14,084	70.0	7,375	8,289	3,859	10,365	5,390	2	2	3,326
Monterey	14,351	81.9	7,585	2,010	827	11,675	6,109	1	3	2,370
Montgomery	8,419	87.4	3,404	5,839	2,911	3,223	1,372	1	1	1,079
Mount Washington	13,432	93.8	10,593	12,564	10,238	13,040	10,390	2	1	299
New Braintree	8,415	62.8	2,139	1,242	12	1,149	165	0	1	2,114
New Marlborough	23,586	76.9	8,475	6,088	2,805	20,649	6,578	2	4	4,135
New Salem	26,075	69.4	31,458	14,850	13,722	28,056	26,472	2	2	2,016
North Brookfield	8,335	59.3	2,013	1,913	362	251	94	0	0	1,325
Northampton	11,237	49.2	4,930	6,479	1,902	3,653	1,370	1	1	2,332
Northborough	5,580	46.5	2,368	1,152	573	903	582	1	1	613
Northbridge*	6,361	55.0	1,291	1,035	263	770	436	0	1	345
Northfield	16,060	71.0	4,043	7,573	2,656	12,999	3,431	3	3	3,928
Oakham	10,832	79.5	4,138	1,492	706	1,329	360	0	2	1,637
Orange	16,723	72.6	6,871	4,941	1,868	8,434	4,093	2	4	9,147
Otis	19,412	79.7	6,283	5,115	1,614	15,535	4,833	1	5	2,072
Oxford*	1,460	42.2	1,299	2,489	784	3,074	658	3	3	2,459
Palmer	13,153	64.2	2,450	2,514	681	1,617	263	0	1	2,885
Paxton	6,405	64.7	3,026	0	0	677	376	0	2	1,391
Pelham	14,591	86.0	10,178	3,817	1,759	13,026	8,377	1	3	3,580
Pepperell	7,913	53.3	2,492	5,516	1,200	2,804	1,101	2	3	909
Petersham	31,110	71.3	29,082	18,860	16,387	30,739	25,386	1	2	6,560
Phillipston	13,329	84.5	5,152	2,062	1,206	6,904	3,546	1	2	2,844
Pittsfield	10,969	40.4	5,054	6,475	2,679	7,426	3,325	3	3	1,426
Plainfield	11,491	84.3	4,011	1,646	591	3,248	1,595	0	3	3,803

Table 3 cont. Resource Data for MA Forest Legacy Area Towns

Town	Forest Acres	% Forest	Protected Open Space Acres	Core Habitat Acres	Core Habitat Protected Acres	Critical Natural Landscape Acres	CNL Protected Acres	# BioMap2 Forest Cores	# BioMap2 Landscape Blocks	Ch. 61 Acres
Plymouth*	40,844	62.3	17,110	30,785	14,062	30,839	14,233	5	5	9,054
Plympton*	5,644	58.5	230	3,170	188	7,424	222	0	1	973
Princeton	18,652	81.3	9,938	3,435	2,102	10,944	6,063	4	6	3,914
Rehoboth*	19,123	63.1	1,176	7,848	508	8,901	590	3	5	1,654
Richmond	7,642	62.7	993	1,830	218	3,759	401	1	2	1,993
Rochester*	13,965	60.4	4,475	8,519	2,449	15,676	3,509	6	1	2,215
Royalston	23,614	86.7	11,005	5,228	2,645	23,168	10,201	2	3	9,331
Russell	10,123	88.4	3,436	1,327	869	4,764	2,206	0	2	3,569
Rutland	17,514	75.6	9,635	1,946	1,583	6,596	5,056	0	5	2,501
Sandisfield	30,124	88.9	11,169	3,281	1,435	29,488	10,994	1	5	7,389
Sheffield	18,752	60.3	5,831	17,092	6,162	19,587	6,850	3	3	6,747
Shirley	6,494	63.9	2,717	3,697	1,715	1,162	881	2	1	977
Shrewsbury	5,106	36.7	796	218	1	188	1	0	0	281
Shutesbury	15,664	90.3	8,246	3,993	3,018	13,904	7,223	3	3	5,829
South Hadley	5,688	48.1	2,952	4,651	2,280	4,113	2,085	1	2	215
Southampton	12,841	69.3	3,761	4,346	1,534	10,737	3,260	1	2	3,353
Southbridge	8,901	67.7	952	4,175	788	4,170	705	2	4	2,021
Southwick	10,708	52.9	1,823	2,101	440	2,108	106	0	2	1,698
Spencer	13,550	62.3	4,457	702	192	833	332	0	1	1,504
Sterling	11,332	56.0	6,932	3,689	2,837	5,758	4,037	4	4	2,116
Stockbridge	9,499	62.7	3,281	6,060	2,000	7,324	2,327	4	5	2,121
Stow*	6,067	52.6	3,097	876	830	1,318	1,162	0	1	569
Sturbridge	17,925	71.9	5,535	7,345	3,590	5,055	2,594	1	3	4,058
Sutton*	13,605	62.4	2,877	2,922	942	5,351	1,479	2	2	1,733
Templeton	14,402	69.4	4,435	1,988	902	1,924	807	0	2	1,373
Tolland	18,491	88.1	8,402	3,072	2,413	19,336	8,252	1	2	1,036
Townsend	16,052	75.9	7,027	9,838	5,443	11,582	5,830	9	5	2,137
Tyngsborough*	5,590	48.3	1,293	2,500	381	1,595	253	1	3	1,034
Tyringham	9,713	80.5	4,157	5,359	2,039	10,891	3,913	2	1	3,056
Upton*	9,841	70.5	2,830	2,552	527	3,328	887	1	2	527
Uxbridge*	10,909	56.9	1,263	2,055	183	2,528	292	1	4	2,614
Wales	8,738	85.4	4,393	1,291	978	6,136	3,587	0	3	923
Ware	15,789	61.7	9,277	6,294	4,677	7,892	6,802	1	2	2,587
Wareham*	11,597	48.9	2,759	6,238	1,284	7,246	1,408	1	3	821
Warren	13,212	74.7	783	1,291	41	938	168	0	1	4,369
Warwick	21,530	89.3	13,825	8,625	6,145	18,791	11,689	4	3	6,986

Table 3 cont. Resource Data for MA Forest Legacy Area Towns

Town	Forest Acres	% Forest	Protected Open Space Acres	Core Habitat Acres	Core Habitat Protected Acres	Critical Natural Landscape Acres	CNL Protected Acres	# BioMap2 Forest Cores	# BioMap2 Landscape Blocks	Ch. 61 Acres
Washington	22,390	90.2	16,173	8,415	6,943	20,895	16,063	3	2	1,219
Webster*	4,115	44.1	1,034	2,138	870	2,123	855	2	2	137
Wendell	18,727	90.8	11,668	4,378	2,577	11,270	7,005	3	2	3,090
West Boylston	4,572	51.7	3,621	1,287	1,058	1,401	1,171	1	2	417
West Brookfield	8,865	65.6	2,988	1,458	550	2,427	740	0	1	2,563
West Springfield	4,137	36.9	1,499	1,905	780	1,365	478	1	1	169
Westford*	9,562	47.7	3,199	5,643	1,311	934	263	1	1	1,113
Westminster	16,657	69.8	5,635	1,448	843	4,334	2,225	1	3	2,329
Westport*	18,470	55.8	5,315	4,642	1,375	12,028	2,874	2	6	2,567
Wilbraham	7,938	55.7	2,087	3,603	834	3,188	737	0	1	565
Winchendon	21,127	74.9	6,945	6,695	2,787	8,678	3,902	0	4	7,603
Worcester	5,230	21.3	2,022	1,481	552	16	0	0	0	121

Table 3 cont. Resource Data for MA Forest Legacy Area Towns

2. MA Forest Legacy Area Boundary Description

The boundary description of the Massachusetts Forest Legacy Area follows:

A. Beginning at the intersection of the Massachusetts/Connecticut state line at the town boundary between the Towns of Agawam and Longmeadow;

B. Thence westerly along the Massachusetts/Connecticut state line, along the southern border of the towns of Agawam, Southwick, Granville, Tolland, Sandisfield, New Marlborough, Sheffield, and Mount Washington, a distance of 40.3 miles;

C. Thence northerly along the Massachusetts/New York state line, along the western border of the towns of Mount Washington, Egremont, Alford, West Stockbridge, Richmond, Hancock, and Williamstown, a distance of 49.8 miles;

D. Thence easterly along the Massachusetts/Vermont state line along the northern boundaries of the towns of Williamstown, Clarksburg, Florida, Monroe, Rowe, Heath, Colrain, Leyden, Bernardston and Northfield, then along the Massachusetts/New Hampshire state line along the northern boundaries of the towns of Northfield, Warwick, Royalston, Winchendon, Ashburnham, Ashby, Townsend, Pepperell and Dunstable to the intersection of Hollis Street, a distance of 87.7 miles; Thence southerly along Hollis Street to the intersection with Route 113, a distance of 1.9 miles;

E. Thence westerly along Route 113 to Unkety Brook, a distance of 0.32 miles;

F. Thence southerly along Unkety Brook, to Groton Street, a distance of 1.0 miles,

G. Thence southerly along Groton Street to its intersection with Chicopee Row, at the town line of Dunstable and Groton, a distance of 1.2 miles;

H. Thence southerly along Chicopee Row to the intersection of Hollis Street, a distance of 4.0 miles;

I. Thence southerly along Hollis Street to Groton Center and the intersection of Route 119, a distance of 0.5 miles;

J. Thence southerly along Route 119 to Interstate 495 in Littleton, a distance of 11.0 miles;

K. Thence southerly along Interstate 495, to Interstate 290 in Marlborough, a distance of 5.6 miles;

L. Thence westerly along Interstate 290 to exit 21 in Worcester, a distance of 10.7 miles;

M. Thence northerly along Plantation Street to the intersection with Northeast Cutoff (route 70 intersection), a distance of 0.71 miles;

N. Thence northerly along Northeast Cutoff to East Mountain Street, a distance of 0.75 miles;

O. Thence westerly along East Mountain Street to the intersection of West Boylston Street (Route 12) and West Mountain Street, a distance of 1.49 miles;

P. Thence westerly along West Mountain Street to intersection with Doyle Road at the Worcester / Holden town line, a distance of 0.81 miles;

Q. Thence westerly along Doyle Road to Shrewsbury Street, a distance of 1.2 miles;

R. Thence westerly along Shrewsbury Street to Route 122A (Main Street), a distance of 0.9 miles;

S. Thence westerly along Route 122A to Salisbury Street, a distance of 0.8 miles;

T. Thence southerly along Salisbury Street to Fisher Road, a distance of 3.4 miles;

U. Thence southerly along Fisher Road / Stonehouse Hill Road to Reservoir Street, a distance of 1.8 miles;

V. Thence southerly along Reservoir Street to the intersection with Oleane Street at the Holden / Worcester town line, a distance of 0.2 miles;

W. Thence southerly along Oleane Street to the intersection with Cataract Street, a distance of 0.06 miles;

X. Thence southerly along Cataract Street to the intersection with Mower Street, a distance of 0.85 miles;

Y. Thence westerly along Mower Street to the intersection with Pleasant Street (Route 122), a distance of 0.23 miles;

Z. Thence westerly along Route 122 to Airport Drive, a distance of 0.37 miles;

AA. Thence southerly along Airport Drive, to Goddard Memorial Drive, a distance of 0.9 miles;

BB. Thence southerly along Goddard Memorial Drive to Route 9, a distance of 1.9 miles;

CC. Thence westerly along Route 9 to the Worcester/Leicester town line, a distance of 0.5 miles;

DD. Thence southerly along the boundary of the towns of Leicester, Charlton and Oxford to the Oxford/Millbury town line, a distance of 7.7 miles;

EE. Thence easterly along the boundaries of the towns of Millbury, Grafton, Upton and Hopkinton to the boundaries of the towns of Hopkinton, Ashland and Holliston, a distance of 27.1 miles;

FF. Thence southerly along the boundaries of the towns of Hopkinton, Upton, Mendon and Blackstone to the boundary of the state of Rhode Island, a distance of 21.8 miles;

GG. Thence westerly along the boundaries of the towns of Blackstone, Millville, Uxbridge and Douglas to the boundary of the state of Connecticut, a distance of 15.5 miles;

HH. Thence northerly along the boundary between the town of Douglas and the state of Connecticut, a distance of 1.1 miles;

II. Thence westerly along the boundaries of the towns of Douglas, Webster, Dudley, Southbridge, Sturbridge, Holland, Wales, Monson and Hampden to the boundary of the town of East Longmeadow, a distance of 33.7 miles;

JJ. Thence northerly along the western border of the towns of Hampden, Wilbraham, Ludlow and Granby to Rte. 116 at the boundary of the towns of Granby and South Hadley (north of the intersection of Amherst Rd. and Burnett St.) a distance of 20.2 miles;

KK. Thence southwesterly along Route 116 (Amherst Rd) to the intersection of Pearl St in South Hadley, a distance of 0.01 miles;

LL. Thence westerly along Pearl St to Route 47, a distance of 1.8 miles;

MM. Thence northerly along Route 47 to the boundary between the towns of Hadley and South Hadley, a distance of 0.7 miles;

NN. Thence westerly along the southern boundary of the town of Hadley to the center of the Connecticut River, the boundary of the city of Holyoke, a distance of 0.4 miles;

OO. Thence southerly along the center of the Connecticut River, the eastern boundary of Holyoke, West Springfield, and Agawam to the Connecticut/Massachusetts state line at the point of beginning, a distance of 21.5 miles

Excluding the towns of Amherst and Sunderland and portions of the town of Hadley as described as follows:

A. Beginning at the boundary of the towns of Sunderland, Montague and Deerfield in the center of the Connecticut River, thence southerly along the eastern boundary of Deerfield, Whately, Hatfield, and Northampton in the center of the Connecticut River to the confluence of the Fort River and the Connecticut River, a distance of 18.0 miles;

B. Thence easterly and northerly upstream along the Fort River to a point where it crosses Bay Rd in the town of Hadley, a distance of 0.8 miles;

C. Thence southerly along Bay Rd to Lawrence Plain Rd, a distance of 0.1 miles;

D. Thence southerly along Lawrence Plain Rd to Churma Road, a distance of 1.1 miles;

E. Thence easterly along Churma Rd to its end at a cul-de-sac, a distance of 1.3 miles;

F. Thence northerly along a line from the cul-de-sac to the intersection of South Maple St and Bay Rd, a distance of 0.4 miles;

G. Thence easterly along Bay Rd to the Hadley / Amherst town line, a distance of 0.15 miles;

H. Thence southerly along the Hadley / Amherst town line to the intersection of the Hadley / Amherst / South Hadley town line, a distance of 1.11 miles;

I. Thence southeasterly along the Amherst / South Hadley town line to the intersection with Route 116 (Amherst St) at the Amherst / South Hadley / Granby town line, a distance of 0.43 miles;

J. Thence southwesterly along Route 116 (Amherst St) to the intersection with the South Hadley / Granby town line, a distance of 0.24 miles;

K. Thence southwesterly along South Hadley / Granby town line (a portion of which follows along Route 116) to the Granby / South Hadley town line corner near the intersection at Route 116 (Amherst Rd) and Pearl St., a distance of 2.09 miles;

L. Thence easterly along the northern boundary of the town of Granby to the town of Belchertown, a distance of 3.8 miles;

M. Thence northerly along the western boundaries of the towns of Belchertown, Pelham and Shutesbury to the town of Leverett, a distance of 9.0 miles;

N. Thence westerly along the southern boundary of the town of Leverett to the town of Sunderland, a distance of 2.1 miles;

O. Thence northerly along the western boundary of the town of Leverett to the town of Montague, a distance of 5.7 miles;

P. Thence westerly along the southern boundary of the town of Montague, a distance of 1.8 miles, to the point of beginning.

And including, in southeastern Massachusetts, the following area:

A. Beginning at the northwest corner of the town of Rehoboth where it meets the towns of Seekonk and Attleboro, thence easterly along the boundaries of the towns of Rehoboth, Dighton, Berkley, Lakeville, Middleborough, Plympton, Carver and Plymouth to the Atlantic Ocean at the boundary of the towns of Plymouth and Kingston, a distance of 53.2 miles;

B. Thence southerly along the boundary of the town of Plymouth to the boundary of the town of Bourne, a distance of 19.9 miles;

C. Thence westerly along the boundaries of the towns of Plymouth, Wareham, Marion and Mattapoisett to the boundary of the town of Fairhaven, a distance of 43.5 miles;

D. Thence northerly along the boundary of the town of Mattapoisett to the town of Acushnet, a distance of 3.7 miles;

E. Thence westerly along the boundary of the town of Acushnet to the Acushnet River, a distance of 3.2 miles;

F. Thence northerly along the boundary of the town of Acushnet to the boundary of the town of Freetown and the city of New Bedford, a distance of 6.1 miles;

G. Thence westerly along the boundary of the town of Freetown to the boundary of the town of Dartmouth and the city of New Bedford, a distance of 1.4 miles;

H. Thence southerly along the boundary of the town of Dartmouth to the boundary of the town of Dartmouth and the city of New Bedford on Buzzard's Bay, a distance of 9.6 miles;

I. Thence westerly and northerly along the coast and the boundaries of the towns of Dartmouth and Westport to the boundary of the city of Fall River, a distance of 32.2 miles;

J. Thence northerly and westerly along the boundary of the city of Fall River to boundary of the states of Massachusetts and Rhode Island in Mount Hope Bay, a distance of 7.7 miles;

K. Thence northerly along the boundary of the city of Fall River and the towns of Freetown and Dighton, and the Taunton River to the boundary of the town of Dighton, a distance of 10.8 miles;

L. Thence westerly, northerly and westerly along the boundary of the town of Dighton to the town of Rehoboth, a distance of 6.3 miles;

M. Thence southerly, westerly and northerly along the boundary of the town of Rehoboth to the point of beginning, a distance of 16.7 miles.

E. Project Evaluation and Prioritization Process

Each year, the Massachusetts Forest Legacy Committee will solicit project applications from the land conservation community. Projects applications will be accepted until the second Monday in September. The Massachusetts Forest Legacy Program Coordinator will collect the applications and distribute them to the Massachusetts Forest Legacy Committee. Committee members will be given at least one week to read each project and score it based on the National Scoring Criteria. A scoring sheet similar to the example below (Figure 10) will be distributed to Committee members for this process.

Project proponents will be invited to attend a Forest Legacy Committee meeting held in late September where they will be asked to present their project to Committee members and answer any questions they may have. After the presentations are complete a vote will be held for each project, with a vote in favor indicating the project is ready to be submitted to the Forest Service for consideration for funding. A simple majority vote will move a project forward. After voting, projects will be ranked by the Committee. In the case that the number of projects submitted exceeds the number of projects the state is allowed to submit for federal consideration, or the total FLP grant request for all submitted projects exceeds the federally allowed maximum, the highest ranked projects will be submitted to the Forest Service.

Project Name	**National Criteria**				**Ranking**
	Importance (0-30)	**Threatened (0-20)**	**Strategic (0-30)**	**TOTAL POINTS**	
Project A					
Project B					
Project C					
Project D					

Figure 10. Example Massachusetts Forest Legacy Project Scoring Sheet

V. PUBLIC INVOLVEMENT

The responsibility for Forest Legacy Program implementation in Massachusetts is through the State Forest Stewardship Coordinating Committee. As of September 2019, the Forest Legacy Committee subcommittee was rejoined with the State Forest Stewardship Coordinating Committee. The committee was designed to provide land conservation acquisition expertise. Consultation with this committee, which broadly represents the many facets of the Massachusetts forestry community, constituted the initial phase of public participation when the program was first implemented.

The committee is tasked with developing the assessment which would make the case for the Forest Legacy Program in Massachusetts, representing its various constituencies. Further, the committee took nominations for Forest Legacy Areas and chose those areas to be eligible for initial funding.

All documents submitted to the Forest Legacy Committee supporting Forest Legacy Area nominations are public records and available through the Massachusetts Department of Conservation and Recreation, Bureau of Forest Fire Control & Forestry, Forest Legacy Program.

When a new Forest Legacy Area is being considered for recommendation for addition to the Massachusetts Forest Legacy Program public notification will entail:

- Review, comment and approval by the State Forest Stewardship Coordinating Committee which members diversely representing the forestry community.
- Notification and request for response of regional land trusts, community land trusts, watershed associations, and units of state and local government.

In regards to the proposed 2019 expansion of the Massachusetts Forest Legacy Area, letters were sent to 37 lands trusts and conservation organizations in the affected areas soliciting their comments. Responses are included in Appendix D.

VI. SUMMARY

The Forest Legacy Program will continue to enhance an existing network of governmental and private organizations working together, employing sophisticated techniques to protect the most special and most threatened resources in Massachusetts.

The Massachusetts Forest Legacy Committee believes this document clearly shows the vital need for the Forest Legacy Program in the Commonwealth and substantiates the ability and readiness of that committee to effectively deliver a successful program in a timely manner.

Authorization for conducting the Forest Legacy Program in Massachusetts was affected by Governor William F. Weld in a letter dated October 3, 1991 and is contained in Appendix B. Additionally, the State Stewardship Coordinating Committee minutes of August 27, 1991, authorizing the establishment of a Forest Legacy Program Subcommittee, are in Appendix C.

A summary of the historical Massachusetts Forest Legacy Areas can be found in Appendix A. Full copies of the AONs are on file and available by request from the Massachusetts Department of Conservation and Recreation, Bureau of Forest Fire Control & Forestry.

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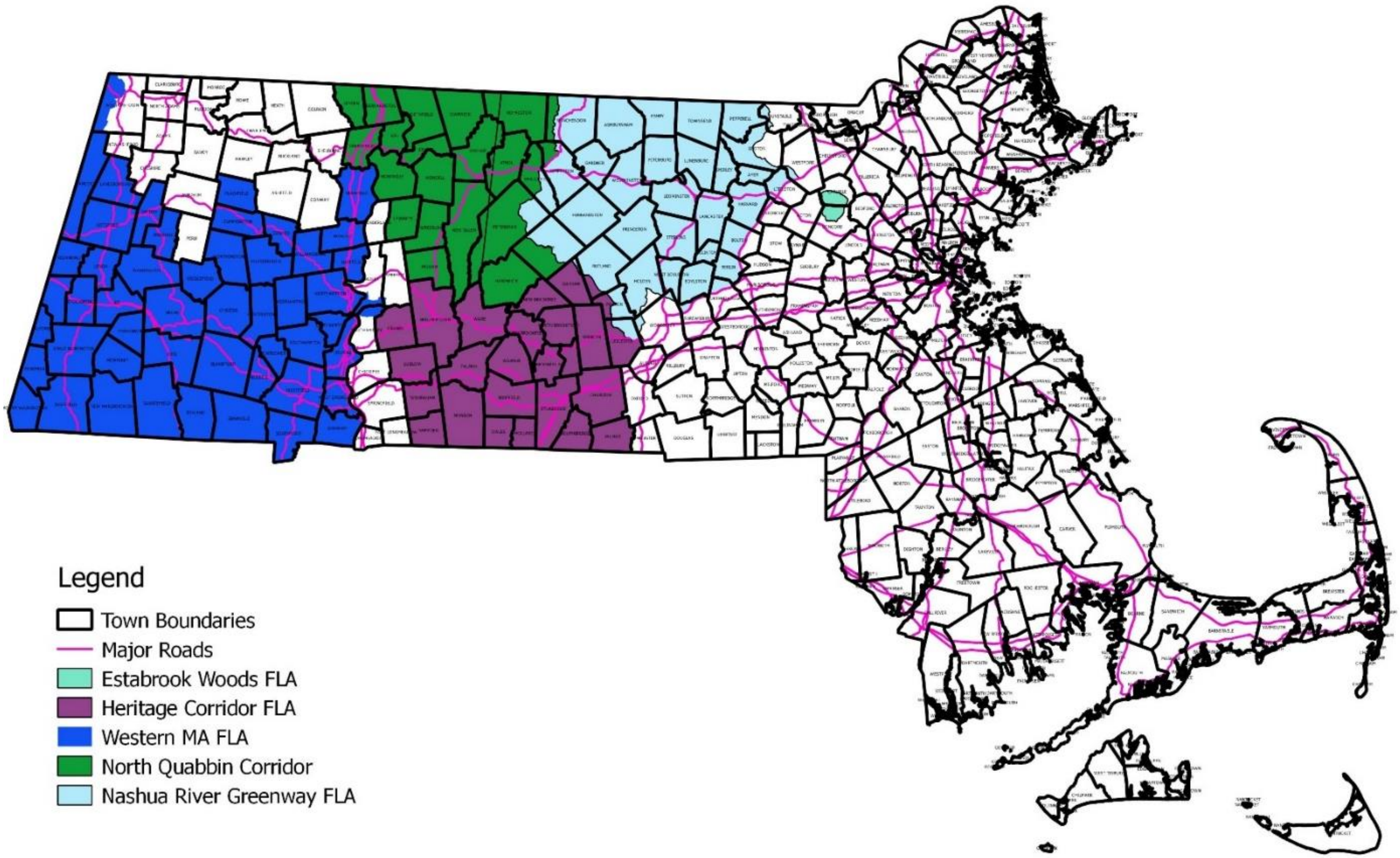
VIII. APPENDICIES

APPENDIX A.

Massachusetts Forest Legacy Area History

Maps and Descriptions



Massachusetts Forest Legacy Area Map, as of Western Mass Forest Legacy Area Amendment 2016

Estabrook Woods Forest Legacy Area

History

The Estabrook Woods Forest Legacy Area was established on August 5, 1993. This 2,000 acre forested area was a green island amidst a sea of development 20 miles outside of Boston. The area supports a diversity of rare and endangered plants and animals identified by the Massachusetts Natural Heritage Program and is entirely within the Concord River watershed.

Boundary Description

A. Beginning In the center of the town of Carlisle, Massachusetts, at the Intersection of Lowell Street and Route 225;

B. Thence, southeasterly along Route 225 to its junction with River Road, a distance of 1.6 miles;

C. Thence, southwesterly along River Road, crossing the town line between the towns of Carlisle and Concord and into the town of Concord, at which point it becomes Monument Street, to its junction with Liberty Street, a distance of 3.6 miles;

D. Thence, southwesterly along Liberty Street to its junction with Barnes Hill Road, a distance of 0.2 miles;

E. Thence, northwesterly along Barnes Hill Road to its junction with Barret's Mill Road .and - Lowell Street, a distance of 0.6 miles;

F. Thence, westerly along Barret's Mill Road to its junction With Strawberry HDI Road, a distance of 1.1 miles;

G. Thence, northwesterly along Strawberry Hill Road to its Intersection with the town line between the towns of Acton and Concord, a distance of 1.6 miles;

H. Thence, northeasterly along the town line to a comer and its intersection with Pope Road, a distance of 1.0 miles;

I. Thence, northerly along Pope Road to its intersection with West Street in the town of Carlisle, a distance of 0.1 miles;

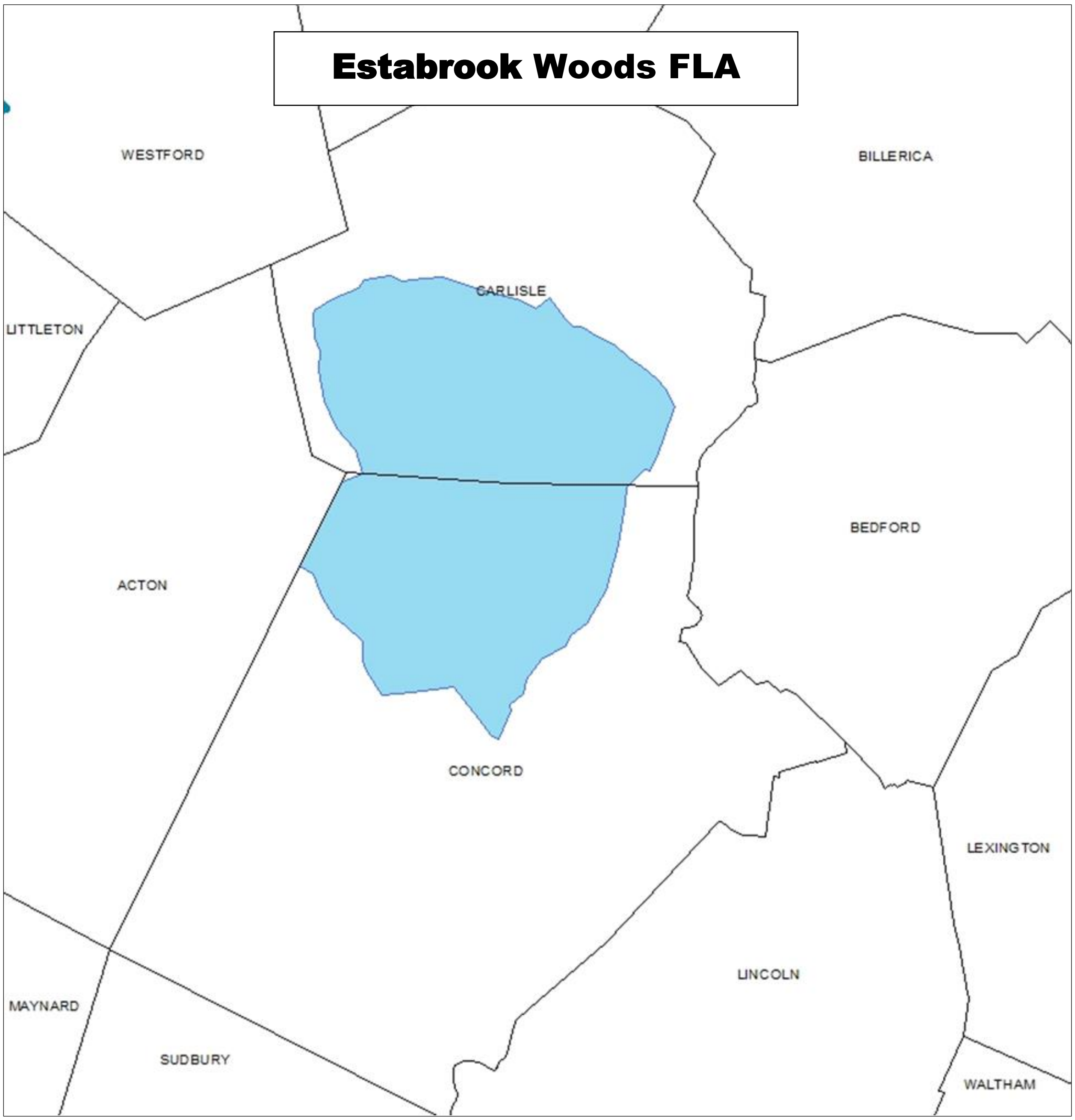
J. Thence northerly along West Street to its intersection with Acton Street, a distance. of 1.6 miles;

K. Thence, easterly along Acton Street to its intersection with Route 225, a distance of 0.8 miles;

L. Thence easterly along Route 225 to Carlisle center, its junction with Lowell Street and the point of beginning, a distance of 1.4 miles...

Towns Within or Partially Within the Estabrook Woods Forest Legacy Area

Carlisle	Concord



Estabrook Woods Forest Legacy Area Map

Heritage Corridor Forest Legacy Area

History

The Heritage Corridor Forest Legacy Areas was established on October 25, 2013. This area is ripe for becoming a new bedroom community for the cities of Worcester, Springfield, Hartford, and Boston. The FLA is 70% forested and contains 473 miles of major rivers and streams.

Boundary Description

A. Beginning at the intersection of the Massachusetts / Connecticut state line at the town boundary between the Towns of Dudley and Webster;

B. Thence, westerly along the Massachusetts / Connecticut state line, along the southern border of the towns of Dudley, Southbridge, Sturbridge, Holland, Wales, Monson and Hampden, a distance of 29.6 miles;

C. Thence, northerly along the western border of the towns of Hampden, Wilbraham, Ludlow and Granby to the northwest corner of the Town of Granby (north of the intersection of Amherst Rd. and Burnett St.), a distance of 20.22 miles;

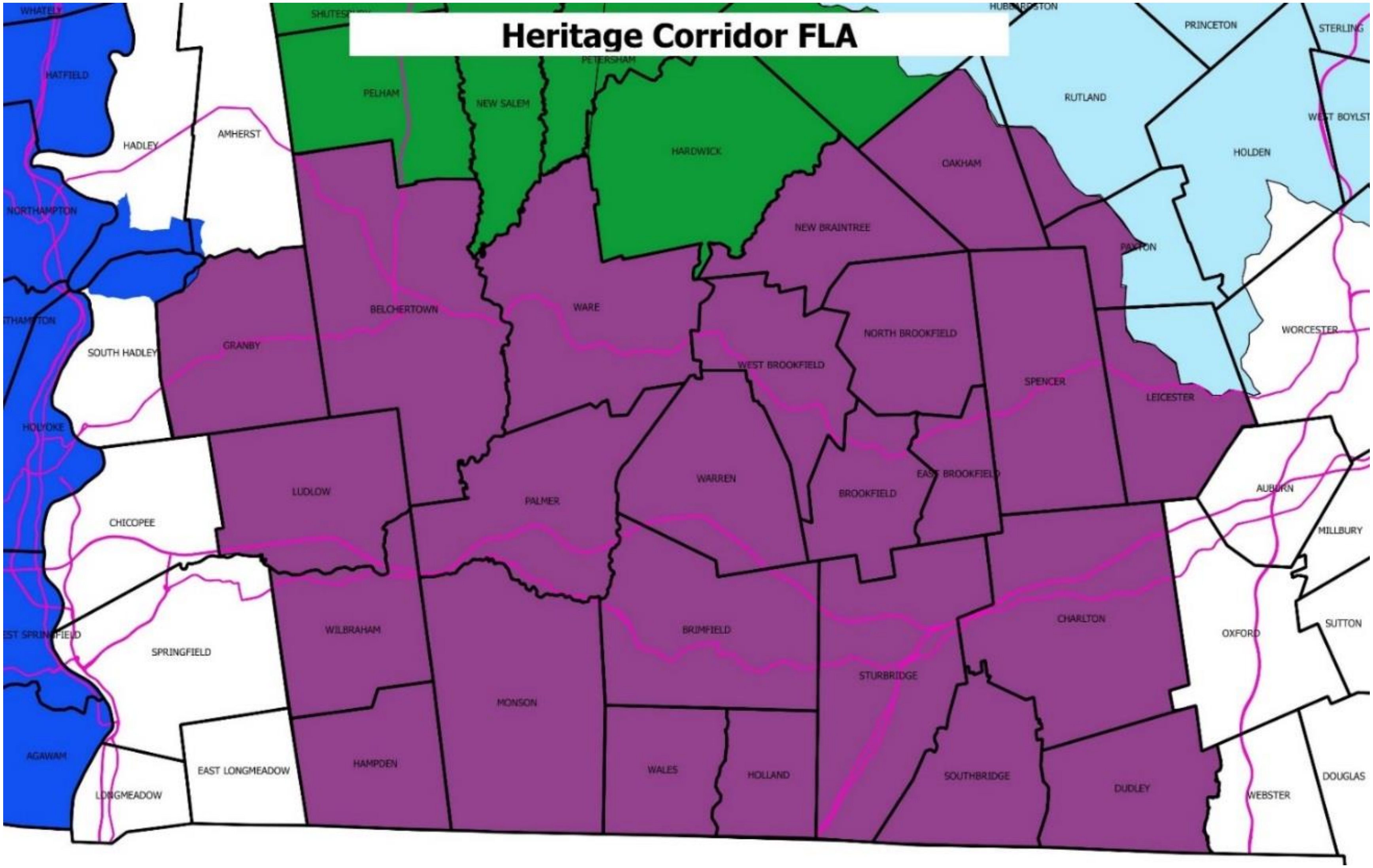
D. Thence, easterly along the northern border of the towns of Granby, Belchertown, Ware, New Braintree and Oakham to the point of intersection with the Nashua River Greenway FLA, a distance of 68.3 miles, which also runs along the southern boundary of the North Quabbin Corridor FLA;

E. Thence, southerly along the southern boundary of the Nashua River Watershed through the towns of Oakham, Rutland, Paxton and Leicester, a distance of 32.9 miles;

F. Thence, easterly and southerly along the boundary of the towns of Leicester, Charlton and Dudley to the point of beginning, a distance of 19.8 miles…

Towns Within or Partially Within the Heritage Corridor Forest Legacy Area

Belchertown	Hampden	Oakham	Wales
Brimfield	Holland	Palmer	Ware
Brookfield	Leicester	Paxton	Warren
Charlton	Ludlow	Rutland	West Brookfield
Dudley	Monson	Southbridge	Wilbraham
East Brookfield	New Braintree	Spencer	
Granby	North Brookfield	Sturbridge	



Heritage Corridor Forest Legacy Area Map

Nashua River Greenway Forest Legacy Area

History

The Nashua River Greenway was established on August 5, 1993. On June 1, 2001, an amendment to the Assessment of Need was approved which expanded the area significantly. Two-thirds of Massachusetts' population receives their drinking water from the central part of the state and this FLA's goal was to increase water supply area management and protection.

Boundary Description

A. Beginning at the intersection of the New Hampshire / Massachusetts state line and Tarbell Brook, in the town of Winchendon (the northeastern corner of the North Quabbin Corridor Forest Legacy Area);

B. Thence, easterly along the New Hampshire / Massachusetts state line, along the northern border of the towns of Winchendon, Ashburnham, Ashby, Townsend, Pepperell and Dunstable to the intersection of Hollis Street, a distance of 27.9 miles;

C. Thence, southerly along Hollis Street to the intersection with Route 113, a distance of 1.9 miles;

D. Thence, westerly along Route 113 to Unkety Brook, a distance of 0.32 miles;

E. Thence, southerly along Unkety Brook to Groton Street, a distance of 1.0 miles;

F. Thence, southerly along Groton Street to its intersection with Chicopee Row, at the town line of Dunstable and Groton, a distance of 1.2 miles;

G. Thence, southerly along Chicopee Row to the intersection of Hollis Street, a distance of 4.0 miles;

H. Thence, southerly along Hollis Street to Groton Center and the intersection of Route 119, a distance of 0.5 miles;

I. Thence, southerly along Route 119 to Interstate 495 in Littleton, a distance of 11.0 miles;

J. Thence, southerly along Interstate 495, to Interstate 290 in Marlborough, a distance of 5.6 miles;

K. Thence, westerly along Interstate 290 to exit 21 in Worcester, a distance of 10.7 miles;

L. Thence, northerly along Plantation Street to the intersection with Northeast Cutoff (route 70 intersection), a distance of 0.71 miles;

M. Thence, northerly along Northeast Cutoff to East Mountain Street, a distance of 0.75 miles;

N. Thence, westerly along East Mountain Street to the intersection of West Boylston Street (Route 12) and West Mountain Street, a distance of 1.49 miles;

O. Thence, westerly along West Mountain Street to intersection with Doyle Road at the Worcester / Holden town line, a distance of 0.81 miles;

P. Thence, westerly along Doyle Road to Shrewsbury Street, a distance of 1.2 miles;

Q. Thence, westerly along Shrewsbury Street to Route 122A (Main Street), a distance of 0.9 miles;

R. Thence, westerly along Route 122A to Salisbury Street, a distance of 0.8 miles;

S. Thence, southerly along Salisbury Street to Fisher Road, a distance of 3.4 miles;

T. Thence, southerly along Fisher Road / Stonehouse Hill Road to Reservoir Street, a distance of 1.8 miles;

U. Thence, southerly along Reservoir Street to the intersection with Oleane Street at the Holden / Worcester town line, a distance of 0.2 miles;

V. Thence, southerly along Oleane Street to the intersection with Cataract Street, a distance of 0.06 miles;

W. Thence, southerly along Cataract Street to the intersection with Mower Street, a distance of 0.85 miles;

X. Thence, westerly along Mower Street to the intersection with Pleasant Street (Route 122), a distance of 0.23 miles;

Y. Thence, westerly along Route 122 to Airport Drive, a distance of 0.37 miles;

Z. Thence, southerly along Airport Drive, to Goddard Memorial Drive, a distance of 0.9 miles;

AA. Thence, southerly along Goddard Memorial Drive to Route 9, a distance of 1.9 miles;

BB. Thence, westerly along Route 9 to Route 56 in Leicester, a distance of 2.9 miles;

CC. Thence, northerly along Route 56 to Whittemore Street, a distance of 0.6 miles;

DD. Thence, northerly along Whittemore Street to Hill Street at the Paxton town line, a distance of 2.7 miles;

EE. Thence, northerly along Hill Street to Marshall Street, a distance of 0.6 miles;

FF. Thence, westerly along Marshall Street to Suomi Street, a distance of 0.1 miles;

GG. Thence, northerly on Suomi Street to Route 31, a distance of 1.0 miles;

HH. Thence, easterly along Route 31 to Route 122 in Paxton Center, a distance of 0.9 miles;

II. Thence, northerly along Route 122 to Route 32, a distance of 12.7 miles;

JJ. Thence northerly on Route 122 / 32 to Petersham where Route 122 bears west and Route 32 bears north, a distance of 8.4 miles;

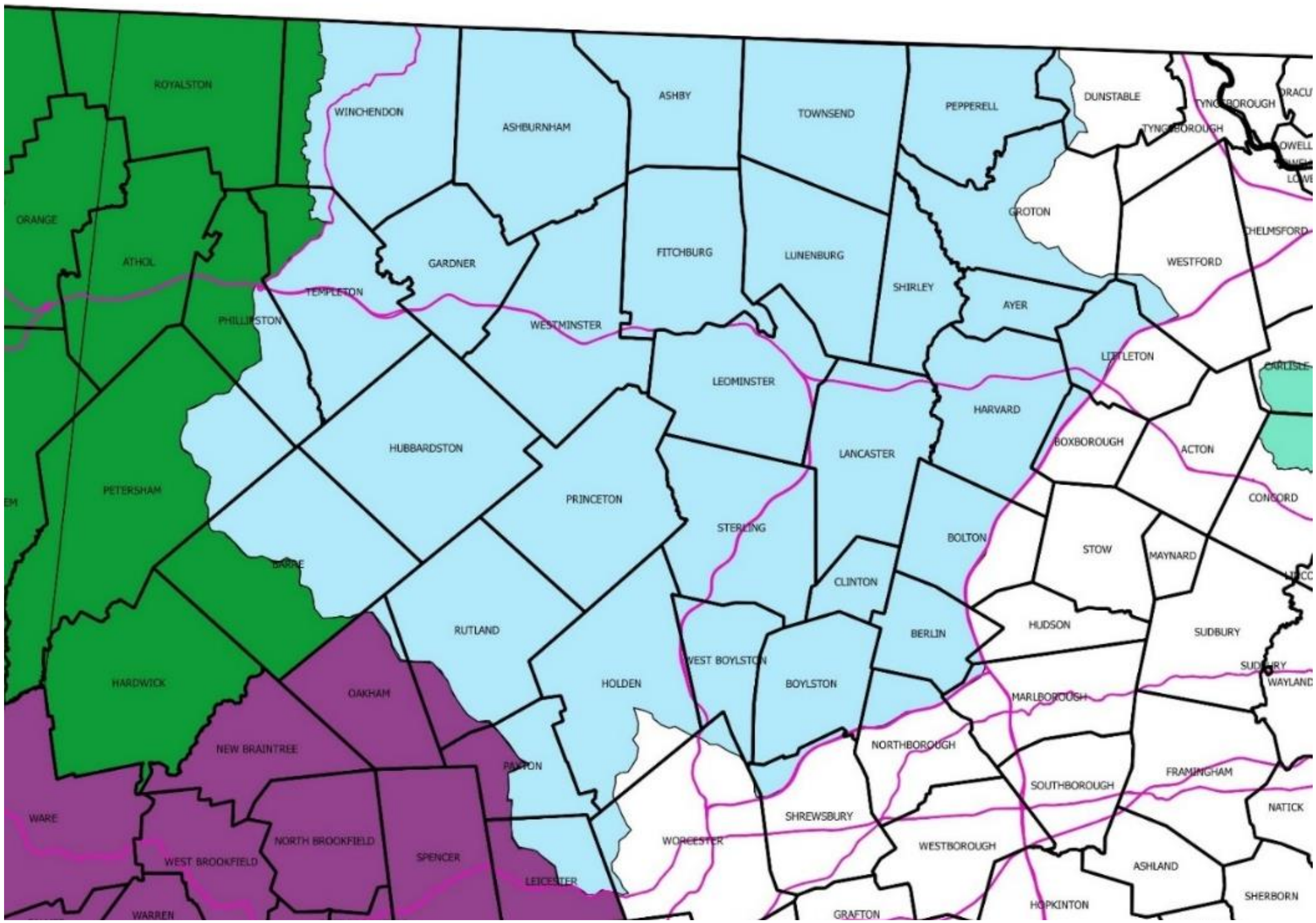
KK. Thence, northerly along Route 32 to West Street, a distance of 0.6 miles, where the Nashua River Greenway Forest Legacy Area intersects with the North Quabbin Corridor Legacy Area;

LL. Thence, northerly along the easterly edge of the North Quabbin Corridor Legacy Area boundary, heretofore described, to the Massachusetts / New Hampshire State line...

Towns Within or Partially Within the Nashua River Greenway Forest Legacy Area

Ashby	Gardner	Oakham	Sterling
Ashburnham	Groton	Paxton	Templeton
Ayer	Harvard	Pepperell	Townsend
Barre	Holden	Petersham	West Boylston
Berlin	Hubbardston	Phillipston	Westford
Bolton	Lancaster	Princeton	Westminster
Boylston	Leicester	Rutland	Winchendon
Clinton	Leominster	Northborough	Worcester
Dunstable	Littleton	Shirley	
Fitchburg	Lunenburg	Shrewsbury	

Nashua River Greenway FLA



Nashua River Greenway Forest Legacy Area Map

North Quabbin Corridor Forest Legacy Area

History

The North Quabbin Corridor Forest Legacy Area was established on August 5, 1993. On December 17, 2010, an amendment to the Assessment of Need was passed to expand the area. After the original area was established, development pressure in the area increased and advances in GIS technology revealed the ecological significance throughout the expansion area.

Boundary Description

A. Beginning at the intersection of the Tarbell Brook in the town of Winchendon and the New Hampshire / Massachusetts state line;

B. Thence, westerly along said New Hampshire / Massachusetts state line 29.69 miles to the intersection of the Town Line of Leyden and Colrain;

C. Thence, in a general southeasterly direction along the town boundary between Leyden and Colrain until the intersection with the Town line for Greenfield;

D. Thence, southwesterly along the town boundary between Greenfield and Colrain 0.69 miles until the intersection with the town line for Shelburne;

E. Thence, southerly along the town line between Greenfield and Shelburne 4.88 miles;

F. Thence, easterly along the town boundary between Greenfield and Shelburne 0.61 miles until the intersection with the Deerfield town line;

G. Thence, easterly along the irregular town boundary between the towns of Greenfield and Deerfield until the intersection with the town line for Montague;

H. Thence, along the irregular town boundary (center of the Connecticut River) between the towns of Montague and Deerfield southeasterly and southwesterly until the intersection with the town line for Sunderland;

I. Thence, along the town boundary between the towns of Montague and Sunderland easterly for 1.79 miles until the intersection with the town line for Leverett;

J. Thence, southerly along the town boundary between Leverett and Sunderland for 5.64 miles until the intersection with the town line for Amherst;

K. Thence, easterly for 2.13 miles along the town boundary between Amherst and Leverett until the intersection with the town boundary for Shutesbury;

L. Thence, southerly along the town boundary between Shutesbury and Amherst for 1.76 miles until intersecting the town line for Pelham;

M. Thence, southerly along the town boundary line between Pelham and Amherst for 3.85 miles until intersecting the town line for Belchertown;

N. Thence, easterly along the town boundary line between Pelham and Belchertown for 3.24 miles;

O. Thence, southerly along the town boundary line between Pelham and Belchertown for 1.60 miles;

P. Thence, easterly along the town boundary line between Pelham and Belchertown for 2.55 miles until the intersection with the town line for New Salem;

Q. Thence, southerly along the jagged town boundary between New Salem and Belchertown until the intersection with the town line for Ware;

R. Thence, north-easterly along the town boundary between New Salem and Ware until intersection with the town line for Petersham;

S. Thence, north-easterly along the town boundary between Petersham and Ware for 1.49 miles until intersection with the town line for Hardwick.

T. Thence, southerly along the town boundary between Hardwick and Ware for 3.9 miles;

U. Thence, easterly along the town boundary between Hardwick and Ware for 3.33 miles;

V. Thence, southerly along the town line between Hardwick and Ware for 1.27 miles:

W. Thence, easterly along the town boundary between Hardwick and Ware for 0.16 miles until the intersection with the town line for New Braintree;

X. Thence, north-easterly along the town boundary between Hardwick and New Braintree for 0.95 miles;

Y. Thence, north-westerly along the town boundary between Hardwick and New Braintree for 0.38 miles;

Z. Thence, easterly and northeasterly along the town boundary between Hardwick and New Braintree until the intersection with the town line for Barre;

AA. Thence, south-easterly along the town boundary between Barre and New Braintree for 0.69 miles until the intersection with the town line for Oakham;

BB. Thence, north-easterly along the town boundary between Barre and Oakham for 3.9 miles until the intersection with Route 122.

CC. Thence, north-westerly, generally, along Route 122 until the intersection with Route 32 in Barre;

DD. Thence, northwesterly, generally, along Routes 122 and 32 until the intersection of Routes 122 and 32 in Petersham;

EE. Thence, northerly, generally, along Route 32 until the intersection with Route 101, a distance of 1.53 miles;

FF. Thence, northeasterly along Route 101 to its intersection with Old Queen Lake Road, a distance of 3.41 miles;

GG. Thence, northeasterly along Old Queen Lake Road to its intersection with Searle Hill Road, a distance of 0.21 miles;

HH. Thence, northerly along Searle Hill Road to its intersection with Barre Road, a distance of 1.13 miles;

II. Thence, northerly along Barre Road to its intersection with Baldwinville Road in

Phillipston Center, a distance of 0.2 miles;

JJ. Thence, northerly along Baldwinville Road to its intersection with Route 2A, a distance of 1.4 miles;

KK. Thence, northeasterly along Route 2A to its intersection with Route 2 (junction at Four Corners in Phillipston) and Route 202, a distance of 0.2 miles;

LL. Thence, continuing northeasterly along Route 202 to its intersection with Otter River in Baldwinville, a distance of 3.7 miles;

MM. Thence, northerly along Otter River to its intersection with Millers River, a distance of 3.4 miles;

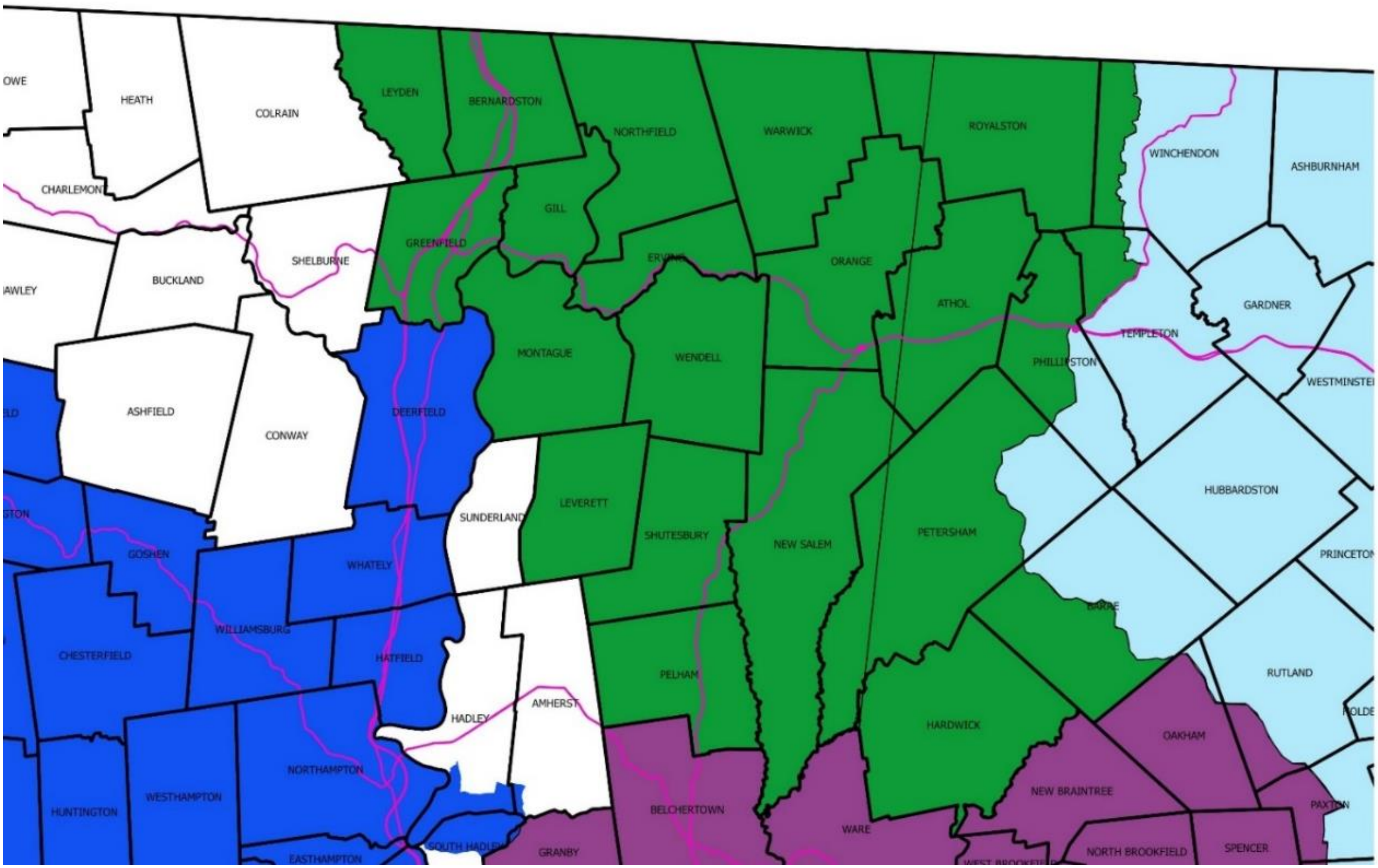
NN. Thence, northerly along Millers River to its intersection with Tarbell Brook in the Town of Winchendon, a distance of 5.2 miles;

OO. Thence, northerly along Tarbell Brook to its intersection with the New Hampshire / Massachusetts State line at the point of the beginning, a distance of 2.4 miles...

Towns Within or Partially Within the North Quabbin Corridor Forest Legacy Area

Athol	Hardwick	Orange	Templeton
Barre	Leverett	Pelham	Warwick
Bernardston	Lyden	Petersham	Wendell
Erving	Montague	Phillipston	Winchendon
Gill	New Salem	Roylston	
Greenfield	Northfield	Shutesbury	

North Quabbin Corridor FLA



North Quabbin Corridor Forest Legacy Area Map

Western Massachusetts Forest Legacy Area

History

The Western Massachusetts Forest Legacy Area was established on October 11, 2016. This amendment to the Assessment of Need incorporated 3 historical Forest Legacy Areas (Conncticut Valley, Stockbridge Yokun Ridge, and Taconic Range) into this area as well as adding many towns in Berkshire, Hampden, and Hampshire counties. This 1.25 million acre FLA contains some of the largest blocks of intact natural landscape in southern New England

Boundary Description

A. Beginning at the intersection of the Massachusetts / Connecticut state line at the town boundary between the Towns of Agawam and Longmeadow;

B. Thence, westerly along the Massachusetts / Connecticut state line, along the southern border of the towns of Agawam, Southwick, Granville, Tolland, Sandisfield, New Marlborough, Sheffield, and Mount Washington, a distance of 40.3 miles;

C. Thence, northerly along the Massachusetts / New York state line, along the western border of the towns of Mount Washington, Egremont, Alford, West Stockbridge, Richmond, Hancock, and Williamstown, a distance of 49.8 miles;

D. Thence, easterly along the Massachusetts / Vermont state line to Northwest Hill Rd in the town of Williamstown, a distance of 1.0 mile;

E. Thence, southerly along Northwest Hill Rd to Main St, a distance of 2.5 miles;

F. Thence, easterly along Main St. to Thornliebank Rd, a distance of 0.2 miles;

G. Thence, southerly along Thornliebank Rd to Cold Spring Rd, a distance of 0.4 miles;

H. Thence, westerly along Cold Spring Rd to Bee Hill Rd, a distance of 0.1 miles;

I. Thence, southerly along Bee Hill Rd to Torrey Woods Rd, a distance of 2.0 miles;

J. Thence, easterly on Torrey Woods Rd to Oblong Rd, a distance of 0.6 miles;

K. Thence, southerly on Oblong Rd to Route 43, a distance of 3.41 miles;

L. Thence, southerly on Route 43 to the boundary between the Towns of Williamstown and Hancock, a distance of 1.7 miles;

M. Thence, southerly and easterly along the north-eastern boundary of the towns of Hancock, Lanesborough, Dalton, and Hinsdale to the boundary of the town of Washington, a distance of 33.5 miles;

N. Thence, easterly along the northern boundary of the towns of Washington and Middlefield to the boundary of the town of Worthington, a distance of 5.2 miles;

O. Thence, northerly along the western boundary of the towns of Worthington, Cummington, and Plainfield to the boundary of the town of Hawley, a distance of 12.3 miles;

P. Thence, easterly and southerly along the northern boundary of the towns of Plainfield, Cummington, Goshen, Williamsburg, and Whately to the boundary of the town of Deerfield, a distance of 23.4 miles;

Q. Thence, northerly along the western boundary of Deerfield to the to the center of the Connecticut River, a distance of 6.9 miles;

R. Thence, southerly along the eastern boundary of Deerfield, Whately, Hatfield, and Northampton in the center of the Connecticut River to the confluence of the Fort River and the Connecticut River, a distance of 24.3 miles;

S. Thence, easterly and northerly upstream along the Fort River to a point where it crosses Bay Rd in the town of Hadley, a distance of 0.8 miles;

T. Thence, southerly along Bay Rd to Lawrence Plain Rd, a distance of 0.1 miles;

U. Thence, southerly along Lawrence Plain Rd to Churma Road, a distance of 1.1 miles;

V. Thence, easterly along Churma Rd to its end at a cul-de-sac, a distance of 1.3 miles;

W. Thence, northerly along a line from the cul-de-sac to the intersection of South Maple St and Bay Rd, a distance of 0.4 miles;

X. Thence, easterly along Bay Rd to the Hadley / Amherst town line, a distance of 0.15 miles;

Y. Thence, southerly along the Hadley / Amherst town line to the intersection of the Hadley / Amherst / South Hadley town line, a distance of 1.11 miles;

Z. Thence, southeasterly along the Amherst / South Hadley town line to the intersection with Route 116 (Amherst St) at the Amherst / South Hadley / Granby town line, a distance of 0.43 miles;

AA. Thence, southwesterly along Route 116 (Amherst St) to the intersection with the South Hadley / Granby town line, a distance of 0.24 miles;

BB. Thence, southwesterly along South Hadley / Granby town line (a portion of which follows along Route 116) to the Granby / South Hadley town line corner near the intersection at Route 116 (Amherst Rd) and Pearl St., a distance of 2.09 miles;

CC. Thence, southeasterly along the Granby/South Hadley town line to its intersection with Route 116 (Amherst Rd), a distance of 0.02 miles;

DD. Thence, southwesterly along Route 116 (Amherst Rd) to the intersection of Pearl St in South Hadley, a distance of 0.01 miles;

EE. Thence, westerly along Pearl St to Route 47, a distance of 1.8 miles;

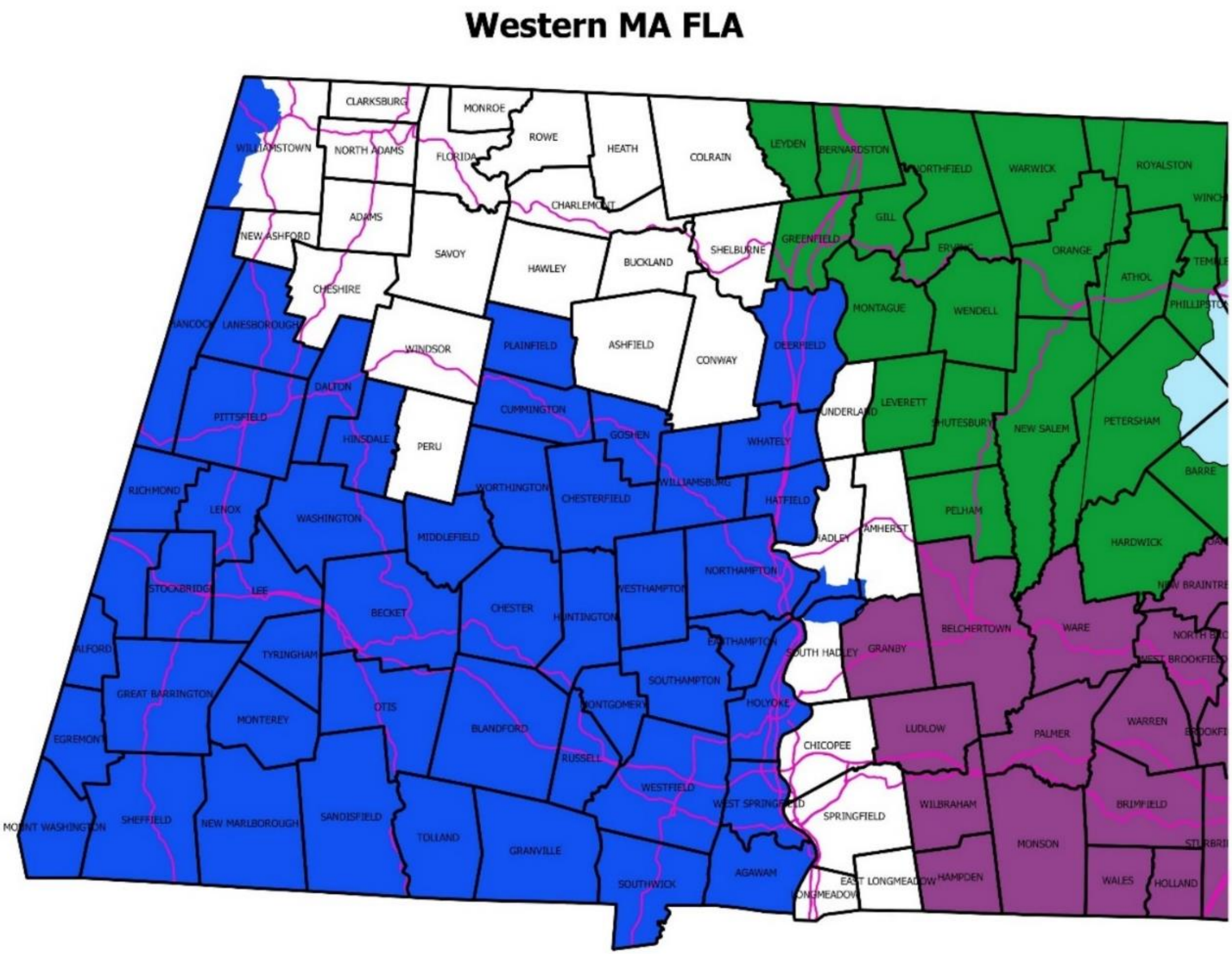
FF. Thence, northerly along Route 47 to the boundary between the towns of Hadley and South Hadley, a distance of 0.7 miles;

GG. Thence, westerly along the southern boundary of the town of Hadley to the center of the Connecticut River, the boundary of the city of Holyoke, a distance of 0.4 miles;

HH. Thence, southerly along the center of the Connecticut River, the eastern boundary of Holyoke, West Springfield, and Agawam to the Connecticut / Massachusetts state line at the point of beginning, a distance of 21.5 miles…

Towns Within or Partially Within the Western Massachusetts Forest Legacy Area

Agawam	Goshen	Lenox	Russell
Alford	Granville	Middlefield	Sandisfield
Becket	Great Barrington	Monterey	Sheffield
Blandford	Hadley	Montgomery	South Hadley
Chester	Hancock	Mount Washington	Southampton
Chesterfield	Hatfield	New Marlborough	Southwick
Cummington	Hinsdale	Northampton	Stockbridge
Dalton	Holyoke	Otis	Tolland
Deerfield	Huntington	Pittsfield	Tyringham
Easthampton	Lanesborough	Plainfield	Washington
Egremont	Lee	Richmond	West Springfield



Western Massachusetts Forest Legacy Area Map

APPENDIX B

Massachusetts Forest Legacy Program Authorization Letter

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE DEPARTMENT
STATE HOUSE • BOSTON 02133

WILLIAM F. WELD
GOVERNOR

ARGEO PAUL CELLUCCI
LIEUTENANT-GOVERNOR

October 3, 1991

Mr. Michael Rains, Director
Northeast Area State & Private Forestry
USDA Forest Service
5 Radnor Corporate Center
100 Matsonford Rd.
Radnor, PA 19087

Dear Mr. Rains,

I am writing in response to a request to name a lead agency to cooperate with the U.S.D.A. Forest Service on the Forest Legacy Program in Massachusetts.

I am designating the Department of Environmental Management's, Bureau of Forest Development as the lead agency for this project. The Bureau is headed by Chief Forester Warren Archey who will serve as the principal contact for the Legacy program in the Commonwealth.

I am excited about the potential of this program to provide new means for the protection of critical forest lands in the Commonwealth, and look forward to its successful implementation.

Sincerely,

Bill Weld

William F. Weld
Governor

cc: Peter Webber, Commissioner DEM
Warren Archey, Ghief Forester

APPENDIX C

State Stewardship Coordinating Committee minutes of August 27, 1991, authorizing the establishment of a Forest Legacy Program Subcommittee

Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Management

TO: Massachusetts Stewardship Committee

P. O. Box !55
Clinton
Massachusetts
01510
(508) 368-0126

Division of
Forests & Parks
Region 3

Enclosed please find minutes of August 27, 1991 Stewardship Coordinating Committee Meeting.

Next Stewardship Committee Meeting
September 26th, 1991 at Auburn Rink at 9:30

Other Meetings
5 Year Plan Revision Subcommittee Meeting
September 16th, 1991 at the Auburn Rink, 9:30 a. m.

Forest Legacy Program - overview of new Forest Service Program. Tom Quink, Forest Legacy Coordinator, Subcommittee will be established to propose "Legacy Areas" throughout Massachusetts. No money available to purchase "rights" from willing landowners for this current year.

Land Trust Association in Massachusetts will meet with T. Quink to discuss Forest Legacy Program.

SIP Report - Chairman Bob Lear explained that some of the SIP Practices for Massachusetts will be ready for full Stewardship Committee review by September 26th.

5 Year Plan - Chairperson S. Campbell handed out a progress report. The 5 Year Plan subcommittees' timeline for the next few months and next year were discussed along with the idea of training sessions for resource professionals.

Mike Fleming informed the committee of an upcoming Stewardship Video conference February 15th, 1992. One site for visiting will probably be at Univ. of Mssachusetts Amherst. Contact Dave Kittredge.

The idea of a Full Time Stewardship Coordinator position was discussed. Hugh Putnam suggested that Mike Fleming spend as much time as possible on the program. Mike explained that some of his workload will be reassigned to other Bureau of Forestry Personnel.

APPENDIX D

Letters of Support

buzzards BAY COALITION

June 11, 2018

Lindsay Nystrom
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01520

Re: Forest Legacy Area Expansion

Dear Lindsay:

Buzzards Bay Coalition strongly supports the Massachusetts Forest Legacy Program's proposed Forest Legacy Area, Southeastern Massachusetts Expansion.

Buzzards Bay Coalition (BBC) is a non-profit conservation organization and nationally accredited land trust supported by 8,500 members dedicated to the protection, restoration and sustainable use and enjoyment of Buzzards Bay and its 432 square mile watershed. BBC pursues its mission through specific programs aimed at protecting and improving Bay health. These programs include water quality monitoring, research and education programs as well as an active Watershed Protection Program which supports the conservation of and restoration of bay watershed lands. BBC was selected from more than 1,700 land trust as the recipient of the first ever National Land Trust Excellence Award from the Land Trust Alliance for its work in preserving lands vital to the protection of Buzzards Bay, its rivers and its water resources. Since launching its land program, BBC has successfully accelerated land protection in the watershed in the face of strong development pressure, has successfully garnered federal, state and local funds as well as private funds and has protected more than 8,000 acres of watershed land.

The Buzzards Bay watershed overlaps with 12 of the 16 towns within the proposed expansion. Much of this area is privately owned woodlands that are currently under threat of land use conversion and fragmentation. BBC supports landowners, municipalities and conservation agencies and organizations in all of these towns and successful conservation outcomes are often limited by lack of funding. Expansion of the Forest Legacy Program Area to include these towns in Southeastern Massachusetts would have great benefits to the continuation of traditional forest uses and the variety of valuable natural resources that are supported by these forest lands.

Sincerely,

Brendan Annett
Vice President, Watershed Protection

www.savebuzzardsbay.org
114 Front Street, New Bedford, Massachusetts 02740 | Tel: 508-999-6363 Fax: 508-984-7913
21 Luscombe Avenue, Woods Hole, Massachusetts 02543 | Tel: 508-540-6222
100% Post Consumer Paper

Town of Dighton
Office of the Town Administrator
979 Somerset Avenue
Dighton, MA 02715
Tel: (508) 669-6431
Fax: (508) 669-5667

December 3, 2019

Lindsay Nystrom
Massachusetts Forest Legacy Program Coordinator
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01510

Re: Inclusion of the Town of Dighton as a Forest Legacy Area

Dear Ms. Nystrom,

Thank you for your correspondence dated October 8, 2019, explaining the Forest Legacy Program and the need to protect privately-owned forest lands.

Please consider this a letter of support for the Forest Legacy Program as well as a request to include the Town of Dighton, as a designated Forest Legacy Area. I understand that this designation would allow access to possible future funding sources for potential forest conservation projects.

Our community is very much interested in such preservation projects as we experience seemingly endless population growth. The new developments are built and oftentimes named after the very trees they just cut down to do so. We are happy to take steps to preserve our local forestry assets and enhance our natural environment.

Thank you for your kind attention and consideration.

Sincerely,

Mallory Aronstein, MCCPO
Town Administrator
Town of Dighton

OFFICE OF THE
CONSERVATION COMMISSION
TOWN HALL, 511 MAIN STREET
DUNSTABLE, MA 01827-1313
(978) 649-4514 FAX (978) 649-8893
mailto:conscom@dunstable-ma.gov

November 5, 2019

Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01510

Attn: Lindsay Nystrom

Ms. Nystrom,

The Dunstable Conservation Commission met on Monday, November 4, 2019 and discussed your letter regarding the Forest Legacy Program (FLP).

Members are in full support of expanding the program into our town, which would allow residents access to another funding source for forest conservation projects. We have many private landowners that have shown interest in protecting their forestlands from conversion to non-forest uses.

Dunstable residents have traditionally supported protection of important woodlands and critical wildlife habitat that makes up the rural character of our town. Adding Dunstable to the program would be another step in our quest to protect our important forests.

Respectfully,
The Dunstable Conservation Commission

FREETOWN
CONSERVATION COMMISSION

TOWN HALL **P.O. BOX 438**

ASSONET, MASSACHUSETTS 02702

December 9, 2019

Mass. Dept. of Conservation & Recreation
Attn: Lindsay Nystrom
355 West Boylston Street
Clinton, Mass. 01510

Dear Ms. Nystrom:

The Freetown Conservation Commission has reviewed your letter of October 8th regarding the Forest Legacy Program. We are in support of the expansion of this program, and of the inclusion of Freetown in the expanded area.

Should you have any questions or concerns, or require any further information, please contact us by e-mail at conservation@freetownma.gov or by telephone at (508) 644-2201.

Sincerely,

Keven V. Desmarais, Chairman
Freetown Conservation Commission

conservation@freetownma.gov

TOWN OF GROTON
173 Main Street
Groton, Massachusetts 01450-1237
Tel: (978) 448-1111
Fax: (978) 448-1115

Town Manager
Mark W. Haddad

Select Board

Alison S. Manugian, *Chair*
Joshua A. Degen, *Vice Chair*
John F. Reilly, *Clerk*
John R. Giger, *Member*
Rebecca H. Pine, *Member*

November 25, 2019

Lindsay Nystrom
Massachusetts Forest Legacy Program Coordinator
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01510

RE: Massachusetts Forest Legacy Area Designation

Dear Ms. Nystrom:

The Groton Select Board supports the proposed designation of a Forest Legacy Areas in central and south eastern Massachusetts. The remaining forest blocks in these areas of Massachusetts are highly threatened by development and urban sprawl as the population of Boston grows. These areas provide wildlife habitat, timber and other forest products, clean drinking water, and many exceptional recreational opportunities. Funding for the conservation of working forests and forest preserves is also consistent with the town's goal to promote agriculturally based economic opportunities, which includes the growing and harvesting of forest products.

For some regional context, over 50 % of the town's 32 square miles are forested. There are approximately 713 acres of private- and institutionally-owned forested land that have been protected with Conservation Restrictions. Additionally, approximately 608 acres in Groton are classified as Chapter 61 Forest Lands and are under a minimum ten-year management plan certified by the State Forester. On the public side, the Town has permanently protected numerous acres of (largely forested) open space. These properties are primarily managed by the Groton Conservation Commission (2,009 acres), the Town Forest Committee (516 acres), and the Groton Water Department (including the West Groton Water Supply District) (385 acres).

We believe the Forest Legacy Program is consistent with both the regional context of the Town of Groton as well as our goal to promote agricultural opportunities. Furthermore, we believe the Forest Legacy Program could be an important tool in conserving the region's forest resources while maintaining private ownership, and we strongly support the expansion of Massachusetts' Forest Legacy Areas.

Sincerely,

Groton Select Board

Alison S Manugian

Alison S. Manugian, Chair

ASM/mwh
cc: Select Board

OFFICE OF THE
CONSERVATION COMMISSION

13 AYER ROAD HARVARD, MA 01451 978-456-4100 EXT.321 www.harvard.ma.us

November 19, 2019

Lindsay Nystrom
Department of Conservation & Recreation
355 West Boylston Street
Clinton, MA 01510

RE: Forest Legacy Program

Dear Ms. Nystrom,

The Harvard Conservation Commission (ConCom) vote unanimously at its November 7, 2019 meeting to support the efforts of the Massachusetts Department of Conservation and Recreation Forest Legacy Program (FLP) by expanding the Massachusetts Forest Legacy Area to include the Town of Harvard. The protection of important forest areas from development and fragmentation is one of the goals of the 2016 Open Space and Recreation Plan by protecting historic landscapes. The values of FLP go hand and hand with those of the Harvard ConCom by ensuring conservation of important public benefits that forested areas provide, including wildlife habitat, watershed function, water quality and quality recreational opportunities.

Thank you for this opportunity to be part of this program.

On behalf of the Commission,

Don Ritchie

Don Ritchie, Chair

Cc: File

TOWN OF HOPKINTON
TOWN MANAGER'S OFFICE

December 2, 2019

Lindsay Nystrom
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01510

Re: **Forest Legacy Program**

Dear Ms. Nystrom,

The Town of Hopkinton supports its inclusion in the Massachusetts Forest Legacy Area. For several years, Hopkinton has seen rapid residential growth. While the Town has been successful in preserving open space and forest land during this period, the Town has also seen a significant amount of forest converted to development and it has seen its forests fragmented. There are property owners in Hopkinton who are stewards of the forest land they own, and Hopkinton's inclusion in the Forest Legacy Program would provide them more opportunities and tools to undertake conservation projects.

Hopkinton's Master Plan (2017) includes the following goals:

- Preserve and enhance large tracts of privately owned open land in agricultural, recreational, or undeveloped use.
- Link public, private and semi-public open spaces together to form corridors for wetlands, wildlife and recreational uses and preserve wildlife corridors.

The Master Plan includes the following Action Plan item:

- Provide incentives for owners of large parcels to maintain their land as open space.
- Create open space links and corridors, using tools such as OSLPD, land trusts, donations of land, and conservation easements.

Inclusion within the Massachusetts Forest Legacy Area would help the property owners and further the Town's goals. It would also link Hopkinton's forest preservation goals with aligned regional and statewide goals.

18 Main Street, Hopkinton, MA 01748 | 508-497-9700 | elainel@hopkintonma.gov

Thank you, and please contact me if you have any questions or if you need additional information.

Sincerely,

Elaine Lazarus
Assistant Town Manager

TOWN OF HOPKINTON
OFFICE OF THE
PLANNING BOARD
18 Main Street, Hopkinton MA 01748
(508) 497-9745

January 14, 2020

Lindsay Nystrom
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01510

Re: Forest Legacy Program

Dear Ms. Nystrom,

The members of the Hopking Planning Board would like to express their collective support of the inclusion of Hopkinton in the Massachusetts Forest Legacy Area. As stated in the letter by Elaine Lazarus, Assistant Town Manager, the Town has undergone significant residential growth in recent years, which has had an adverse impact on the forest resources within Town.

Hopkinton has and continues to make an effort to conserve forest resources in Town, and we hope that the inclusion of Hopkinton in DCR's Massachusetts Forest Legacy Area will help in this ongoing effort.

Sincerely,

John Gelcich, AICP
Principal Planner

:own of Lakeville

PLANNING BOARD
346 Bedford Street
Lakeville, MA 02347
508-946-3473

Brian Hoeg, Chairman
Sylvester Zienkiewicz, Vice Chairman
Peter Conroy
Barbara Mancovsky
Mark Knox

December 18, 2019

Ms. Lindsay Nystrom
Massachusetts Forest Legacy Program Coordinator
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01510

Dear Ms. Nystrom,

This is in response to your October 8, 2019, letter regarding the proposed expansion of the Forest Legacy Area. This proposal would allow grant funding from The Forest Legacy Program (FLP) to be available for the conservation of additional forest areas in the state of Massachusetts. The Lakeville Planning Board reviewed your correspondence at their November 14, 2019, meeting. It was voted by the Board to forward you their unanimous support for this initiative.

At this meeting, one Board member also commented upon an individual they were acquainted with who owns a large forested property. That individual found the knowledge gained from participating in this type of program invaluable. It was not only beneficial to them and their business but also to the environment and the community. As developable land becomes progressively scarce in the Commonwealth, alternative economic options such as The Forest Legacy Program will become instrumental to land owners whose desire is to preserve their land but may find it unfeasible because of varying financial situations.

The Planning Board recognizes the importance of maintaining forested areas, not only within the State, but also within the Town of Lakeville. Responsible management of a forest provides a variety of benefits including employment opportunities, protection for watersheds, and preventing soil erosion. Forests are also home to a diverse population of wildlife and plant species. The loss of a forest is the loss of an entire ecosystem. As this program is voluntary and imposes no regulatory constraints on the landowner, the Planning Board feels it is a program they can whole heartedly endorse. They look forward to receiving additional information when these changes are implemented.

Sincerely yours,

Brian Hoeg, Chairman
Lakeville Planning Board

TOWN OF MARION
CONSERVATION COMMISSION
2 SPRING STREET
MARION, MASSACHUSETTS 02738
Telephone (508) 748-3515

November 20, 2019

Lindsay Nystrom
Massachusetts Forest Legacy Program Coordinator
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01510

RE: Massachusetts Forest Legacy Area Designation

Dear Ms. Nystrom:

The Marion Conservation Commission supports the proposed designation of a Forest Legacy Areas in south central and south eastern Massachusetts, provided that there is no additional regulatory burden, or required action by public or private landowners. The remaining forest blocks in these areas of Massachusetts are highly threatened by development and urban sprawl as the population of Boston grows. These areas provide wildlife habitat, timber and other forest products, clean drinking water, and many exceptional recreational opportunities. Funding for the conservation of working forests and forest preserves is needed to help our organization pursue key projects within the region.

We believe the Forest Legacy Program could be an important tool in conserving the region's forest resources while maintaining private ownership, and we strongly support the expansion of Massachusetts' Forest Legacy Areas.

Sincerely,

Jeffrey Doubrava, Chair
Marion Conservation Commission

Town of Mendon
Land Use Committee
20 Main Street, Mendon, MA 01756
www.mendonma.gov

December 17, 2019

Lindsay Nystrom
Massachusetts Forest Legacy Program Coordinator
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01510

Dear Lindsay Nystrom,

The Mendon Land Use Committee fully supports Mendon becoming a Forest Legacy Area.

Mendon still has large areas of undeveloped contiguous forests and natural vegetation. According to the MA BioMap2, Mendon has sizeable portions of the town that fall under Core Habitat and Critical Natural Landscapes. However, they are under threat by development. The towns from Boston right up to Mendon are built-out putting heavy pressure on Mendon for sprawling development.

Mendon also has a successful record of preserving land through using CPA funds and state grant programs. Mendon would find the Forest Legacy Program to be an asset to support the protection of forestland.

Thank you for your efforts to include Mendon in the Forest Legacy Program.

Sincerely,

Anne S Mazar

Anne Mazar
Mendon Land Use Committee Chair
508.280.8826

cc: Mendon Conservation Commission

METACOMET
LAND • TRUST
P.O. Box 231
Franklin, MA 02038

January 9, 2020

Lindsay Nystrom
Massachusetts Forest Legacy Program Coordinator
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01510

Dear Lindsay,

At its December 19, 2019, meeting the Metacomet Land Trust Board of Directors voted to strongly support the proposed expansion of the Massachusetts Forest Legacy Program service area into south central Massachusetts. The trust works in 15 communities throughout southern Worcester and Norfolk Counties and the expansion of the Legacy program would be greatly beneficial to those we regularly engage with including landowners, municipalities and the Commonwealth.

Should you have any questions please contact me and we look forward to working with you in the event that the Legacy program successfully expands to include our service area.

In conservation,

Lisa Mosczynski

Lisa Mosczynski
President
508-341-4876

Metacomet Land Trust is a charitable organization recognized as a 501 c 3 tax exempt organization by the Internal Revenue Service (EIN 04-3020897) and the Commonwealth of Massachusetts. Donations are tax-deductible to the extent allowed by law.

www.metacometlandtrust.org

Mattapoisett Land Trust, Inc.

June 13, 2018

Ms. Lindsay Nystrom
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01520

Subject: Letter of Support – Expansion of Forest Legacy Area into Southeastern Massachusetts.

Dear Ms. Nystrom:

On behalf of the Mattapoisett Land Trust, Inc. (MLT) I write to strongly support the proposal by Massachusetts DCR to expand the Forest Legacy Area to include 16 new communities in southeastern Massachusetts, including our town of Mattapoisett. MLT is an all-volunteer, nonprofit organization of 300 members presently conserving over 700 acres of land in Mattapoisett and Rochester.

MLT has worked hard for over forty years to permanently protect sensitive land and create large areas for wildlife habitat, public passive use, and beautiful scenic vistas. The work in Mattapoisett is by no means over, and we would welcome further involvement, support and funding from DCR. The expansion of the FLP will bring more federal dollars to state agencies, and those agencies in turn can utilize additional funds for land protection in Mattapoisett and surrounding towns. In our view, this fills an important need and is an excellent use of public money.

Please contact me if I can provide further information, and thank you for your work to expand the FLP areas.

Sincerely,

Mike Huguenin
President

Post Office Box 31
Mattapoisett, Massachusetts 02739
www.mattlandtrust.org

We preserve land in order to enrich the quality of life for present and future generations of Mattapoisett residents and visitors.

Plympton Conservation Commission

5 Palmer Road

Plympton, Ma 02367

Lindsay Nystrom

Massachusetts Forest Legacy Program Coordinator

Department of Conservation and Recreation

355 West Boylston St

Clinton MA 01510

Dear Ms Nystrom

The Town of Plympton, located in Southeastern Massachusetts, has many forests that are primarily in private ownership. In fact, only 4% of the town's land is permanently protected. About one- third of the town's parcels are registered in Chapter 61 for forestry or related uses. Plympton is a small town with a population of 2800, with a residential tax base, and a modest town operating budget.

The Massachusetts Heritage program rates almost 2/3 of the Town's land as either critical or core habitat. 12 Endangered species have been recorded, as well as other Threatened and vulnerable species. Plympton relies solely on private wells and septic systems, and has no designated community well sites for future contingencies- a problem we are working to remedy through acquisition of key sites. In sum, we are a town rich in natural resources but poor in our ability to help landowners protect them for the future.

Through town-wide surveys, Plympton residents rate "maintaining our rural character" and "protecting our water quantity and quality" as their top priorities.

The expansion of the Forest Legacy Areas program would provide our private landowners with another option for preserving their forested lands. We hope very much that the program can be expanded.

Please contact me if you would like further information.

Sincerely,

Richard Burnet/C

Richard Burnet, Chair

Rochester Conservation Commission & Town Forest Committee
Town Hall Annex, 37 Marion Road, Rochester MA 02770
Phone: 508-763-5421 Fax: 508-763-5379

November 25, 2019

Lindsay Nystrom
Massachusetts Forest Legacy Program Coordinator
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01510

RE: ROCHESTER – Letter of Support for inclusion of the Town of Rochester In the Massachusetts Forest Legacy Area

Dear Ms. Nystrom;

The Rochester Conservation Commission & Town Forest Committee voted unanimously at its November 19, 2019 meeting to wholeheartedly support Massachusetts DCR's proposal to include the Town of Rochester in its expanded the Forest Legacy Area eligible for FLP funding. The Town of Rochester has a number of large privately-owned woodlands that are under threat of fragmentation and conversion to non-forest uses. We support DCR's efforts to provide our Town another funding source to protect these vital properties.

Please feel free to contact me at lfarinon@townofrochester.com or 508-763-5421 extension 206 with any questions or comments.

Very truly yours,

Laurell J. Farinon

Laurell J. Farinon, P.W.S.
Conservation Agent

Sudbury Valley Trustees

Conservation, Collaboration, and Community since 1953

June 5, 2018

Lindsay Nystrom
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01520

Dear Ms. Nystrom,

On behalf of Sudbury Valley Trustees, I'm writing to enthusiastically support the expansion of Forest Legacy areas in east-central Massachusetts.

Sudbury Valley Trustees (SVT), founded in 1953, is a regional land trust that conserves land and protects wildlife habitat in the Concord, Assabet, and Sudbury river basin for the benefit of present and future generations. We care for some of this region's most important forests, wetlands, and grasslands—natural areas that support wildlife habitat, working farms, and recreational trails. As of 2018, SVT cares for more than 4800 acres on 89 reservations and 77 Conservation Restrictions and maintains 55 miles of trails. We collaborate with numerous partner organizations, and our work is supported by 2800 members and 200 volunteers.

This proposed Forest Legacy expansion promises to bring needed attention to a region of the Commonwealth where expansive forests, copious drinking water resources, and diverse wildlife habitats have been increasingly threatened by development pressure – the sprawl frontier. Since many of these resources remain privately owned, expanding the Forest Legacy Program's reach in the region will have a strong positive impact on conservation. Not only does this represent an important opportunity for protecting large tracks of ecologically significant land, but also for protecting the character of communities and the quality of life in the region.

The proposed expansion will cover much of the western portion of SVT's focus area. This contains large blocks of unprotected lands that we have identified in a recent prioritization exercise as being of high value for conservation because of their roles in protecting wildlife habitat, water quality, and ability to adapt to climate change, in addition to other qualities. Most of these areas are densely forested.

Sudbury Valley Trustees shares the Forest Legacy Program's commitment to working in close collaboration with landowners, businesses, local conservation commissions and government agencies to protect land. We believe the Forest Legacy Program will be well served by the proposed expansion of Forest Legacy areas in central-eastern Massachusetts.

Sincerely,

L Vernegaard

Lisa Vernegaard
Executive Director

cc: Joe Smith

Printed with 100% wind power.
Printed on 100% post-consumer recycled paper.

18 Wolbach Road • Sudbury, MA 01776-2429 • tel 978-443-5588 • fax 978-443-2333 • www.svtweb.org

ROCHESTER LAND TRUST, INC.

Please consider this a letter of support for the proposed expansion of Massachusetts' Forest Legacy Program Assessment of Need. The expansion of the Forest Legacy Area to include towns in Southeastern Massachusetts is critical in helping groups like the Rochester Land Trust aid local residents. Land-rich owners may find themselves torn between retaining the scenic and natural lands they've grown to love and cherish and very real financial needs that could push them to sell, potentially losing natural land for the foreseeable future. A program such as this could go a long way towards helping us provide them a better alternative.

The area of SE MA may seem to be all suburbia, but the 36.4 square miles that make up Rochester put it in the top largest Massachusetts town in land area. With a population just over 5000, the density per square mile is as low as many of the towns already in the program in the western part of the state. We are lucky that we have large tracts of White Pine, Beech and Pine Barren forests. Loss of these forested areas poses an increasing threat to the integrity of our town's natural resources. As these areas are fragmented and disappear, so do the benefits such as habitat for wildlife, drinking watershed, forest products and outdoor activity opportunities that they provide. We truly need help protecting these "working forests"

We urge the Massachusetts Department of Conservation and Recreation to update its Forest Legacy Program and to include areas in SE Massachusetts to help identify and protect privately owned woodlands that are under threat in this part of the state.

Thank you for your consideration of our needs.

Laurene Gerrior

Laurene Gerrior
Board of Directors
Rochester Land Trust

Post Office Box 337, Rochester, Massachusetts 02770

TOWN OF UPTON, MASSACHUSETTS

Conservation Commission

January 8, 2020

Lindsay Nystrom
Massachusetts Forest Legacy Program Coordinator
Department of Conservation and Recreation
355 West Boylston Street Clinton, MA 01510

Dear Lindsay,

The Upton Conservation Commission strongly supports the proposed expansion of the Forest Legacy Program service area into southcentral Massachusetts, including the Town of Upton.

Upton has an exceptional amount of protected open space and thousands of acres of unprotected developable land. There remain many opportunities to expand and link contiguous areas of protected open space and we would welcome support the Forest Legacy Program could provide.

Sincerely,

Christine Scott

Chair Upton Conservation Commission

cc: Upton Town Manager

One Main Street • Suite 9 • Upton, MA 01568
T: 508.529.6286 • F: 508.529.1010

P.O. Box 718
219 Main Street, Suite E
Wareham, MA 02571
May 23, 2018

Lindsay Nystrom
Massachusetts Forest Legacy Program Coordinator
Department of Conservation and Recreation
355 West Boylston Street
Clinton, MA 01510

RE: Massachusetts Forest Legacy Area Designation

Dear Ms. Nystrom:

The Wareham Land Trust, Inc. (WLT) supports the proposed designation of a Forest Legacy Areas in south central and south eastern Massachusetts. The remaining forest blocks in these areas of Massachusetts are highly threatened by development and urban sprawl as the population of Boston grows. These areas provide wildlife habitat, timber and other forest products, clean drinking water, and many exceptional recreational opportunities. Funding for the conservation of working forests and forest preserves is needed to help our organization pursue key projects within the region.

There are significant forested areas along and near the Weweantic and Agawam Rivers in Wareham that WLT has set as acquisition goals. In addition, there are wooded areas remaining along Stoney Run and other small tributaries to Buzzards Bay that still need conserving. We would hope that the Forest Legacy Program may be of help in our conservation plans.

We believe the Forest Legacy Program will be an important tool in conserving the region's forest resources while maintaining private ownership, and we strongly support the expansion of Massachusetts' Forest Legacy Areas.

Sincerely,

John H. Browning
Vice President Land Protection