# 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**

The Massachusetts Department of Conservation and Recreation (DCR), an agency of the Executive Office of Energy and Environmental Affairs (EEA), oversees 450,000 acres of parks and forests, beaches, bike trails, watersheds, dams, and parkways. The agency's mission is to protect, promote, and enhance our common wealth of natural, cultural, and recreational resources. To learn more about the DCR, our facilities, and our programs please visit us www.mass.gov/dcr. Contact us at mass.parks@state.ma.us.

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

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## ACKNOWLEDGEMENTS

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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. Having a current Forest Action Plan is a requirement for states to receive funding from the USDA 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 consists 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 also includes 10 goals related to forests and trees and strategies that may be undertaken to work toward achieving those goals. This plan is a tool to help guide activities 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 for 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

The plan includes four challenges and threats that encompass the greatest issues our forests face. These four issues were also part of the 2010 assessment.

- Climate Change
- Forest Conversion
- Invasive Pests & Plants
- Local Wood Production & Consumption

The plan also contains priority areas, entirely within Massachusetts and those that cross state lines, where activities utilizing federal funding will be emphasized. Some are existing geographical program areas while others were identified using geospatial analysis.

- Priority Urban Forests
- Greening the Gateway Cities
- High Elevations
- Forest Vulnerability to Conversion

Spatial analyses related to the three national themes:

- Conserve Working Forest Landscapes
- Protect Forests from Threats
- Enhance Public Benefits from Trees and Forests

Multi-State Priority Areas:

- Connecticut River Watershed
- Berkshire-Taconic Regional Conservation Partnership
- Last Green Valley
- Quabbin-to-Cardigan Partnership

## FORESTS OF MASSACHUSETTS

Massachusetts is the third most densely populated state in the country. It is also the 11$^{th}$ 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, and commercially owned working forests. Each provides a multitude of essential benefits to the Commonwealth and its residents.

More than 2.1 million acres of the forestland in Massachusetts is owned by private landowners. These lands are owned and managed for a variety of reasons ranging from aesthetic to economic. The Commonwealth owns 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 by Conservation Restrictions.

*Springtime in New England, photo by Jennifer Fish*

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 1998a).

The forests and trees of Massachusetts collectively provide cascading benefits, including clean air and water, recreation, wildlife habitat, climate resiliency, and forest products. While these ecosystem services, in many cases, cannot be replaced, economic benefits should 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 the Commonwealth and our forests. Current projections show that Massachusetts should

expect increases in precipitation, sea level, and average annual temperature (MSHMCAP 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 on 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 can 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/acre (U.S. Forest Service FIA 2018). 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. The bulk of carbon accumulation is occurring in Massachusetts forests between 70 and 100 years old.

Silvicultural activities have been recognized by international agreements as a means to sequester carbon dioxide (Birdsey et al. 2006). Annually, forests in the Northeast sequester 12 to 20% of the carbon emissions from the region; this percentage could be increased through improved application of sustainable forest management practices (Perschel et al. 2007), although 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 in Massachusetts include forest land protection, afforestation, lowering 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 (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, 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.

In 2018, Massachusetts adopted the 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' forest 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 and west from Boston to the Worcester metropolitan area have also 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). Zoning reform 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 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 can enroll in Chapter 61B and receive similar tax benefits.

Programs are also available to help fund the protection of forest land. The Community Preservation Act has helped communities protect their open space through a small property tax surcharge and state

matching funds. Conservation grant programs managed by the Executive Office of Energy and Environmental Affairs and the USDA Forest Service have also helped to 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 of acres of mature trees. Exotic insect pests and diseases have threated Massachusetts forests since the 19th century, causing extensive damage in many instances. The gypsy moth, accidentally introduced in 1869, continues to cause periodic defoliation. 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 more 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 1,780,000 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 trees have been cut and chipped.

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 as a consequence, 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 ahead for pests that pose a potential threat. The internet makes it possible to quickly warn large numbers of people against actions that may help to 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, fighting 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: DECLINING LOCAL WOOD PRODUCTION AND CONSUMPTION

Almost 90% of Massachusetts forestland is classified as timberland, based on the U.S. Forest Service definition, and 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, as well as 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 $0.5 billion 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 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 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 of us to implement it, utilize it, learn from it, 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 forests 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;
- **ENHANCE** public benefits from trees and forests.

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

- An analysis of conditions and trends of the forest resources of Massachusetts;
- Threats to our forest land 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 document. 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 to consider 5 Desired Future Conditions:

- 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.

***Goals and Strategies***

The plan also discusses drivers, issues, and threats that influence the character and condition of our forests. Introduced non-native plants and pests, as well as a changing climate, threaten the health and vitality of our forests. This plan outlines the strategies that the Department of Conservation and Recreation, as well as other state agencies and partners including municipalities, land trusts, private landowners, and the federal government, will 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 Desired Future Condition it best applies to, but it may apply to other Desired Future Conditions 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
- 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 for 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 Forest Resource Assessment and Strategies 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 & Pests; 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 our stakeholders a second time. Stakeholders were invited to review the draft plan in early 2020 and 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.

Army Corps of Engineers
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 Arborist Association
Massachusetts Audubon Society
Mass Maple Producers Association
Mass Tree Farm
Mass Tree Wardens
Massachusetts Army National Guard
Massachusetts Association of Conservation Commissions

Massachusetts Association of Conservation Districts
Massachusetts Department of Agriculture
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New England International Society of Arboriculture
New England Society of American Foresters, Mass Chapter
North Eastern 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 Fish and Wildlife Service
United States Forest Service
United States Geological Survey, Northern Climate Science Adaptation Center
Westover Air Force Base

# KEY MASSACHUSETTS FOREST FACTS

| Forest Facts | |
|---|---|
| **Total Land Area** | 5,175,349 acres |
| **Forested Area** | 3,242,113 acres |
| **Timberland Area** | 2,874,000 acres |
| **Old Growth Forest** | 1,119 acres |
| **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** | 2,193,496 acres (67.7% of Massachusetts forestland) |
| **Average Number of Cutting Plans Filed each year** | 513 |
| **Growth to Harvest Removal Ratio** | 4.8:1 |
| **Trees Planted by the Urban and Community Forest Program** | 44,176 |
| **Annual Gross Output of Massachusetts' Forest Products Industry** | $3 Billion |
| **Forest Products Industry Employs** | 17,000 people |
| **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-DSPR forests in soil and standing live and dead trees** | 21.5 million tons |

# State and Private Forestry National Priorities: Highlights and Accomplishments

Many programs managed by the 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 5 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 Forest Service, U.S. Department of Agriculture.

## 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:

- forest land 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 February 2020, 14 of the 21 had municipalities opted

in, allowing for the formation of the MTWP Board. The board shall coordinate the development and implementation of programs and activities and will pursue Federal legislation based on the State legislation (mohawktrailwoodlandspartnership.org) 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 USDA 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 (Q2W) Forest Legacy Project conserved 3,105 acres of forest land. This project weaved together 29 properties in 6 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 3 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 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 last assessment.

*FOREST STEWARDSHIP PROGRAM*

DCR's Forest Stewardship Program, a core component of the state's Working Forest Initiative (WFI), 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 has awarded $2.7 million in support of Forest Stewardship planning, which has supported the sustainable stewardship for an additional:

- 160,000 acres of forestland

- >1,700 landowners
- 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, the essential arm of 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 Mt. Grace Land Conservation Trust and DCR Service Forestry 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 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. Through work with conservation partners, the conservation-based estate planning message effectively reaches thousands more landowners as well. Detailed outreach publications also provide expert, yet accessible, summaries of weighty issues that loom large in estate planning, reaching thousands of people with a need to know (e.g. over 17,000 copies of "Protecting Your Legacy" have been distributed). Seventy percent (70%) of landowners evaluated following their participation 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 the past 11 years, the WFI has 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 has been available for such upgrades through the WFI since FY2009, but the program was ended in

2020. Throughout that time, the program certified over 52,000 acres across 315 parcels and 144 unique landowners, having become 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, DCR Service Forestry entered into 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 Assessments.

## 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 6 trees on the grounds of Boston's Faulkner Hospital. After about 3 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 6 in 2019. As of January 1, 2020, just over 24,000 ALB infested trees have been removed and over 9 million trees have been surveyed by the program.

The task of eradicating ALB from Worcester has been taken up by The Asian Longhorned Beetle Cooperative Eradication Program which consists of the Department of Conservation and Recreation, the USDA, the Massachusetts Department of Agriculture, and many local municipalities. Teams from the Asian Longhorned Beetle 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 1" 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 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 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 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, and active restoration is already underway on over 500 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 complete Assessment of Need is found in Appendix D.

### *Greening the Gateway Cities*

The Massachusetts Greening the Gateway Cities Program (GGCP) 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 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 & Community Forestry crews hired from within the local communities during two seasons: April to June and September to November. GGCP 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.

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.

GGCP is a partnership between the DCR Urban & Community Forestry Program, EOEEA, 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 GGCP is funded by the Executive Office of Energy and Environmental Affairs (EOEEA) and the Department of Energy Resources' (DOER) Alternative Compliance Payment program. GGCP is administered by the DCR Bureau of Forestry, Urban and Community Forestry Program.

*Arbor Day 2019 Greening the Gateway Cities planting event in Chelsea, photo by Matt Cahill*

***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 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 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 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 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 100$^{th}$ 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.

*Harold Parker State Forest*

# STRATEGIES MATRIX

**DFG** = Dept. of Fish and Game; **DWSP** = Water Supply Forestry; **EEA** = Energy & Environmental Affairs; **FA** = Forestry Administration; **FC** = Fire Control; **FH** = Forest Health; **FL** = Forest Legacy; **MF** = Management Forestry; **MFA** = Massachusetts Forest Alliance; **MU**=Markets and Utilization; **NEFF** = New England Forestry Foundation; **NRCS** = Natural Resources Conservation Service; **SF** = Service Forestry; **TNC** = The Nature Conservancy; **UCF** = Urban & Community Forestry; **USDA** = U.S. Department of Agriculture; **USFS** = U.S. Forest Service

| # | Strategy | Resources Available | Associated Programs | National Priorities | Ch. |
|---|---|---|---|---|---|
| **GOAL: 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<br>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<br>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 - State Hazard Mitigation Climate Adaptation Plan | State, Federal, Municipal | FH, UCF, MF, FC, SF | Protect forests from threats<br>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<br>Protect forests from threats<br>Enhance public benefits | 4 |
| **GOAL: 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<br>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<br>Protect forests from threats<br>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, FL, SF, EEA, FA | Conserve forest landscapes<br>Enhance public benefits | 3 |

| # | Strategy | Resources Available | Associated Programs | National Priorities | Ch. |
|---|---|---|---|---|---|
| 13 | Encourage private landowners and municipalities to develop forest stewardship and management plans | State, Federal, Municipal, NGO, Private | SF, UCF, FH, FC, FL, EEA, DFG | Conserve forest landscapes<br>Enhance public benefits | 3 |
| 14 | Work with partners such as Mass Audubon, MFA, NEFF, NRCS, and TNC to encourage landowners to implement forest management practices | State, Federal, Municipal, NGO, Private | SF, FL | Conserve forest landscapes<br>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<br>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<br>Enhance public benefits | 1 |
| 18 | Protect rare species habitats within the context of a resilient landscape | State, Federal | FH, UCF, MF, FC, FL, 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: Support and enhance forest economy** | | | | | |
| 20 | Promote firewood as a local resource and economy | State, Municipal | SF, MF, MU | Conserve forest landscapes<br>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, FL, 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 | SF, FL, DFG | Enhance public benefits | 4 |
| 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, MFA, and Tree Farm | State, Municipal, NGO, Private | SF | Conserve forest landscapes<br>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, FL, 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<br>Enhance public benefits | 4 |
| **GOAL: Maintain and increase urban tree canopy cover** | | | | | |

| # | Strategy | Resources Available | Associated Programs | National Priorities | Ch. |
|---|---|---|---|---|---|
| 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<br>Enhance public benefits | 1 |
| 30 | Drive innovative state-level programs that plant trees in urban areas, such as Greening the Gateway Cities | State, Federal | UCF, EEA | Enhance public benefits | 4 |
| 31 | Support 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<br>Enhance public benefits | 1 |
| 32 | Implement grants to maintain, protect, enhance, and measure urban tree canopy | State, Federal | UCF, EEA | Protect forests from threats<br>Enhance public benefits | 5 |
| **GOAL: 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 DCR Arbor Day Poster Contest, the Massachusetts Envirothon, and Project Learning Tree | State, Federal | IS, FA, UCF, SF | Enhance public benefits | 5 |
| 34 | Provide leadership for public programs, such as Firewise, Tree Campus USA, Tree City USA, and Tree Line USA | State | UCF | Enhance public benefits | 5 |
| 35 | Coordinate and participate in annual Town Forest events | State, Federal | SF, UCF, FH | Conserve forest landscapes<br>Protect forests from threats<br>Enhance public benefits | 4 |
| 36 | Create and support dynamic multimedia approaches to communicate information with stakeholders and the public | State | FH, UCF, MF, FC, FL, SF | Conserve forest landscapes<br>Protect forests from threats<br>Enhance public benefits | 4 |
| 37 | Provide grants and support for developing and maintaining community wood banks | State, Federal | MU | 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 |
| 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, FL, SF | Conserve forest landscapes<br>Protect forests from threats<br>Enhance public benefits | 2 |
| **GOAL: 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 | FL | Conserve forest landscapes<br>Protect forests from threats<br>Enhance public benefits | 1 |
| 41 | Support 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<br>Protect forests from threats<br>Enhance public benefits | 1 |

| # | Strategy | Resources Available | Associated Programs | National Priorities | Ch. |
|---|---|---|---|---|---|
| 42 | Engage with Regional Conservation Partnerships | State | MF, FL, SF | Protect forests from threats<br>Enhance public benefits | 1 |
| 43 | Propose and support 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 NRCS's Regional Conservation Partnership Program | State, Municipal, NGO | FL | Protect forests from threats<br>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, FL, SF | Conserve forest landscapes<br>Protect forests from threats<br>Enhance public benefits | 1 |
| **GOAL: Advocate for a legal and institutional framework pertinent for the conservation and management of trees and forests** | | | | | |
| 45 | Advocate for appropriate forestry and fire management related positions within Environmental Agencies | State, Federal | FH, UCF, MF, FC, FL, SF, MU, DFG | Enhance public benefits | 5 |
| 46 | Support 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, FL, SF, DFG | Enhance public benefits | 5 |
| 47 | Improve compliance with the Forest Cutting Practices Act | State, Federal | SF | Conserve forest landscapes<br>Enhance public benefits | 5 |
| 48 | 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, FL, SF, MU | Conserve forest landscapes<br>Protect forests from threats<br>Enhance public benefits | 5 |
| 49 | Increase communication and collaboration with other state agencies through shared stewardship | State | FH, UCF, MF, FC, FL, SF, MU, DFG | Enhance public benefits | 5 |
| 50 | 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 |
| 51 | Ensure forestry Best Management Practices reflect the latest research and standards | State | SF | Protect forests from threats<br>Enhance public benefits | 5 |
| 52 | Promote forest activities and associated programs relative to carbon storage | State, Federal | FH, UCF, MF, FL, SF, DFG | Protect forests from threats<br>Enhance public benefits | 2 |
| 53 | Advocate for programs and incentives that promote clean energy options and discourage forest conversion | State, Federal, NGO | UCF, MF, FL, SF, MU | Conserve forest landscapes<br>Protect forests from threats<br>Enhance public benefits | 5 |
| 54 | Support the goals of the Northeast Region Cohesive Wildland Fire Management Strategy: 1) Restoring Resilient Landscapes, 2) Creating Fire Adapted Communities, 3) Safe and Effective Wildfire Response | State, Federal | FC, DFG | Conserve forest landscapes<br>Protect forests from threats | 5 |
| 55 | 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<br>Protect forests from threats | 5 |
| **GOAL: Maintain and enhance soil, water, and air resources** | | | | | |
| 56 | Engage with conservation partners to promote understanding of forestry BMPs | State, NGO | SF | Enhance public benefits | 2 |

| # | Strategy | Resources Available | Associated Programs | National Priorities | Ch. |
|---|---|---|---|---|---|
| 57 | Develop and support projects and practices to retain tree canopy in urban and suburban areas | State, Federal | UCF | Enhance public benefits | 2 |
| 58 | 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<br>Enhance public benefits | 2 |
| 59 | Promote land conservation in important drinking water supply areas | State, Federal, Municipal, NGO | FL, SF | Conserve forest landscapes<br>Protect forests from threats<br>Enhance public benefits | 2 |
| 60 | 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<br>Enhance public benefits | 2 |
| **GOAL: Support the role and use of prescribed fire in the landscape** | | | | | |
| 61 | 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<br>Enhance public benefits | 1 |
| 62 | 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<br>Enhance public benefits | 1 |
| 63 | 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<br>Enhance public benefits | 1 |
| 64 | 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<br>Enhance public benefits | 1 |
| 65 | 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<br>Protect forests from threats<br>Enhance public benefits | 1 |
| **GOAL: Cultivate and support partnerships with forestry and conservation stakeholders** | | | | | |
| 66 | Expand financial and technical support of programs that further state forest priorities | State | FH, UCF, MF, FC, FL, SF, MU | Enhance public benefits | 5 |
| 67 | Seek multi-level funding opportunities that are tied to the state forest priorities | State | FH, UCF, MF, FC, FL, SF, MU | Enhance public benefits | 5 |
| 68 | Engage with local, regional, and national partners in on-going activities and projects | State, Federal, Municipal, NGO | FH, UCF, MF, FC, FL, SF, MU | Conserve forest landscapes<br>Protect forests from threats<br>Enhance public benefits | 5 |
| 69 | Maintain presence at regular meetings of stakeholders to stay abreast of interests, activities, and concerns | State, Municipal, NGO | FH, UCF, MF, FC, FL, SF, MU | Enhance public benefits | 5 |
| 70 | Improve coordination with government agencies on implementation of projects across jurisdictions | State, Federal, Municipal | FH, UCF, MF, FC, FL, SF, MU | Enhance public benefits | 5 |
| 71 | Actively participate in forest fire control and forest health compacts as well as the urban tree strike team to share resources for national response opportunities | State, Federal, Municipal | FH, UCF, FC | Protect forests from threats<br>Enhance public benefits | 5 |

# Chapter 1 – FOREST ECOSYSTEM HEALTH & BIODIVERSITY

*Massachusetts has a wide range of forest ecosystems that provide habitat for plant and animal species. Numerous invasive plants and pests, as well as diseases and a changing climate, threaten to alter our natural ecosystems. Geospatial technology and endangered species records have allowed us to identify the most important areas for biodiversity and resilience to climate change. Protection of these areas through legal prohibition of development, as well as 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 eleventh 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 nineteenth century. Near the end of that century, the number of agricultural fields declined, 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. Currently, land conservation rates have increased to a rate of 54.8 acres a day (Ricci et al. 2020) and many organizations are recommending and pursing dramatically increasing the rate of land protection 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 also are the 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).

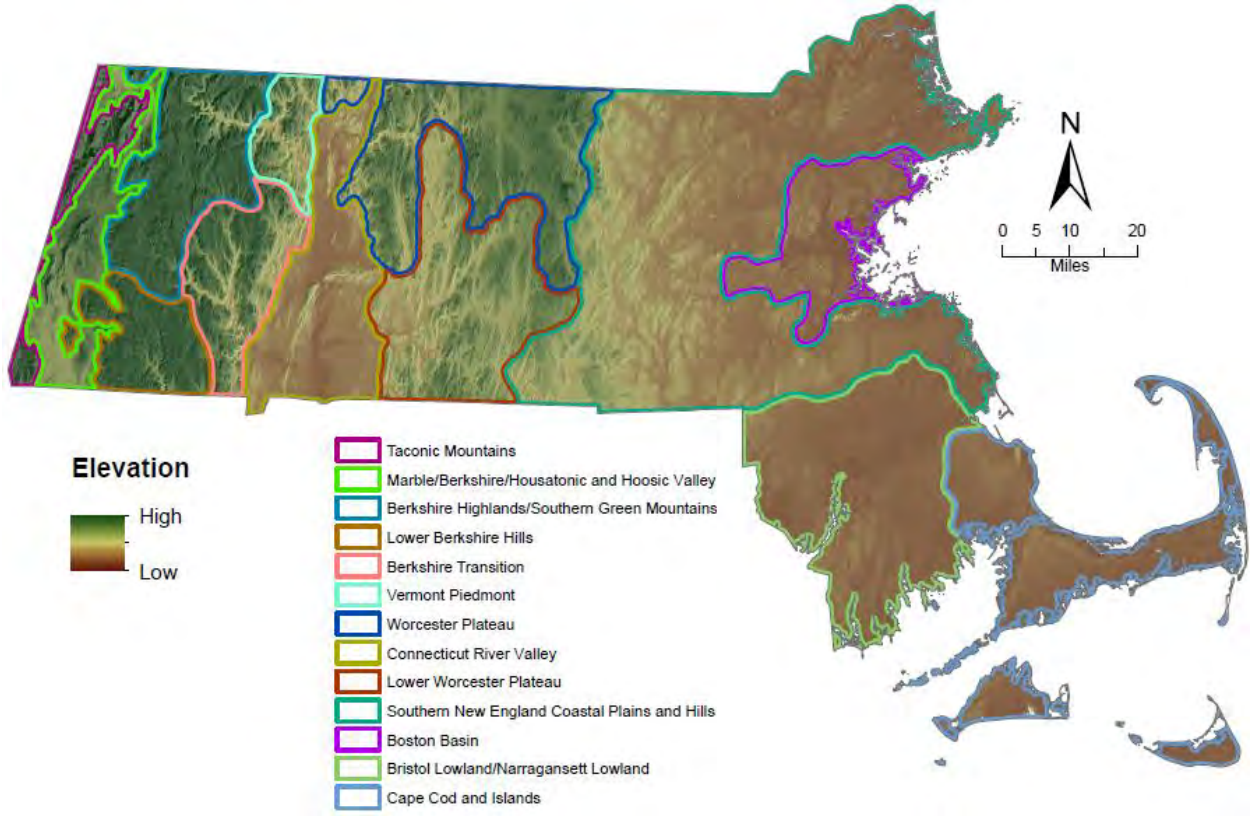



*Figure 1.1. Topography, Ecoregions (MassGIS).*

Soils in Massachusetts formed from surficial deposits left during repeated episodes of glaciation. Mountains of ice advanced from the north, scraping away existing material and retreated, leaving behind massive amounts of debris. The most recent glacial retreat occurred between 21,000 and 12,000 years ago. The Massachusetts uplands were left 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 (hurricanes and tropical storms), ice and snowstorms, 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 19$^{th}$ century was a period of widespread forest clearing for agriculture and harvesting for forest products. The height of clearing 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 1998a,b, 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 and the forest regrew. Large-scale clear-cutting occurred in the early 1900s 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).

During the twentieth century, agricultural fields were abandoned leading to natural reversion of open land to forest. 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.

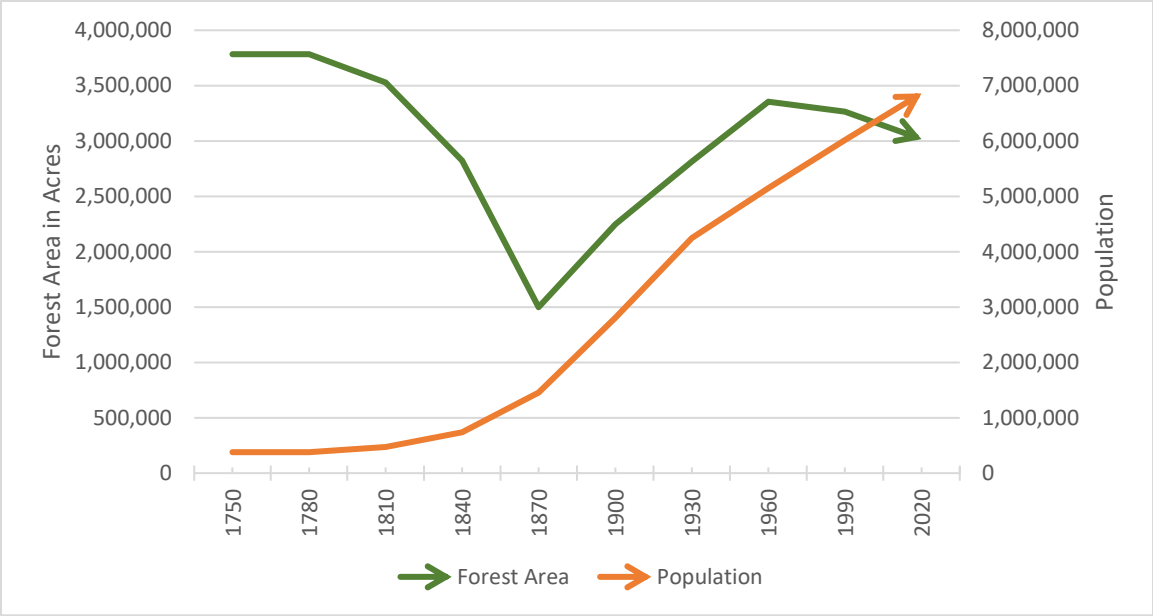



*Figure 1.2. The trend of Massachusetts forest area (acres, left axis) and population (right axis) over time (Foster 2003, U.S.F.S. FIA, US Census).*

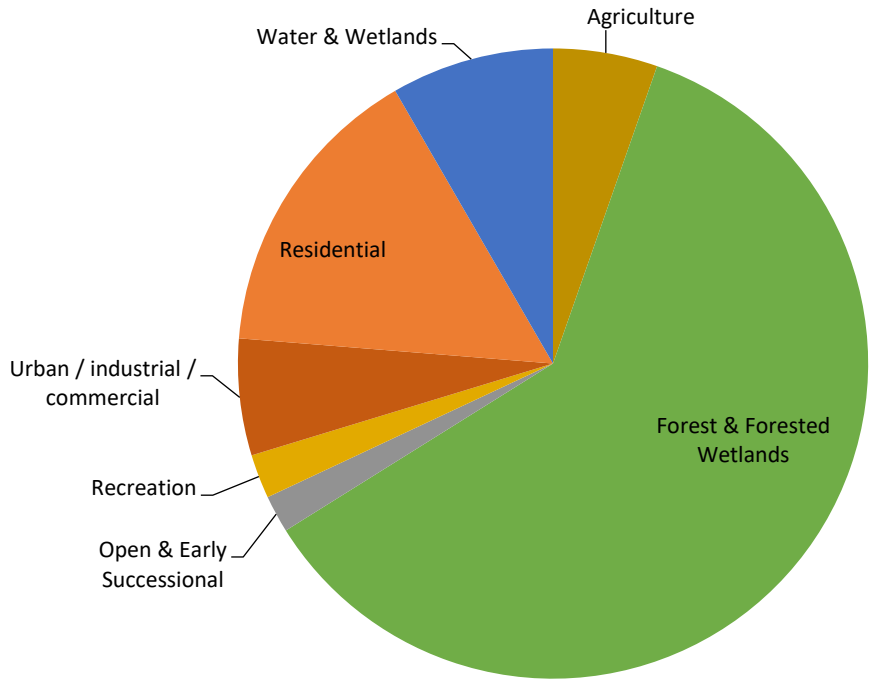



*Figure 1.3. Land use of Massachusetts. Pie chart with relative land cover (MassGIS).*

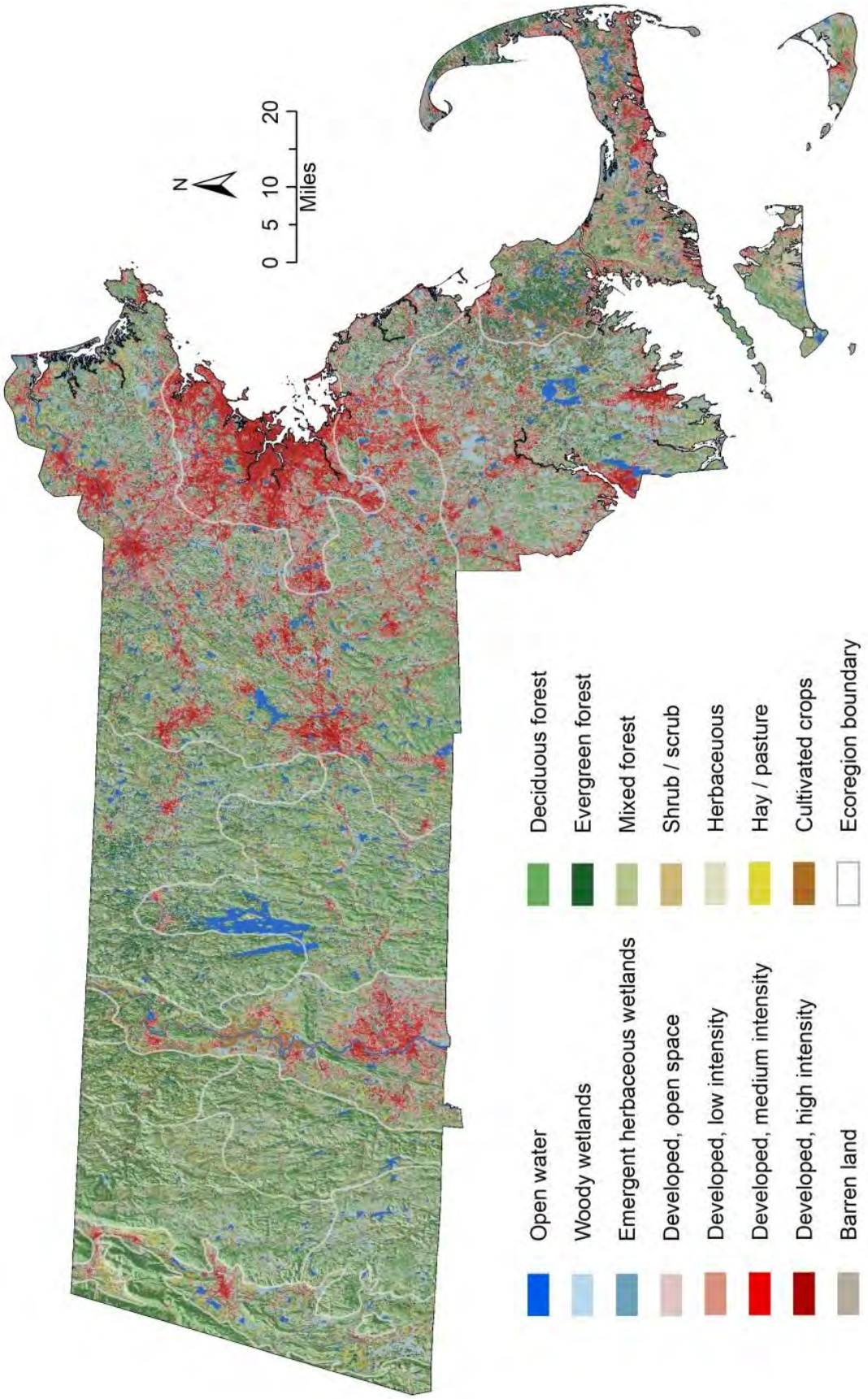



*Figure 1.4. Land use map showing the distribution of land uses across the state (NLCD 2016).*

## 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 Population Estimates Program 2018).

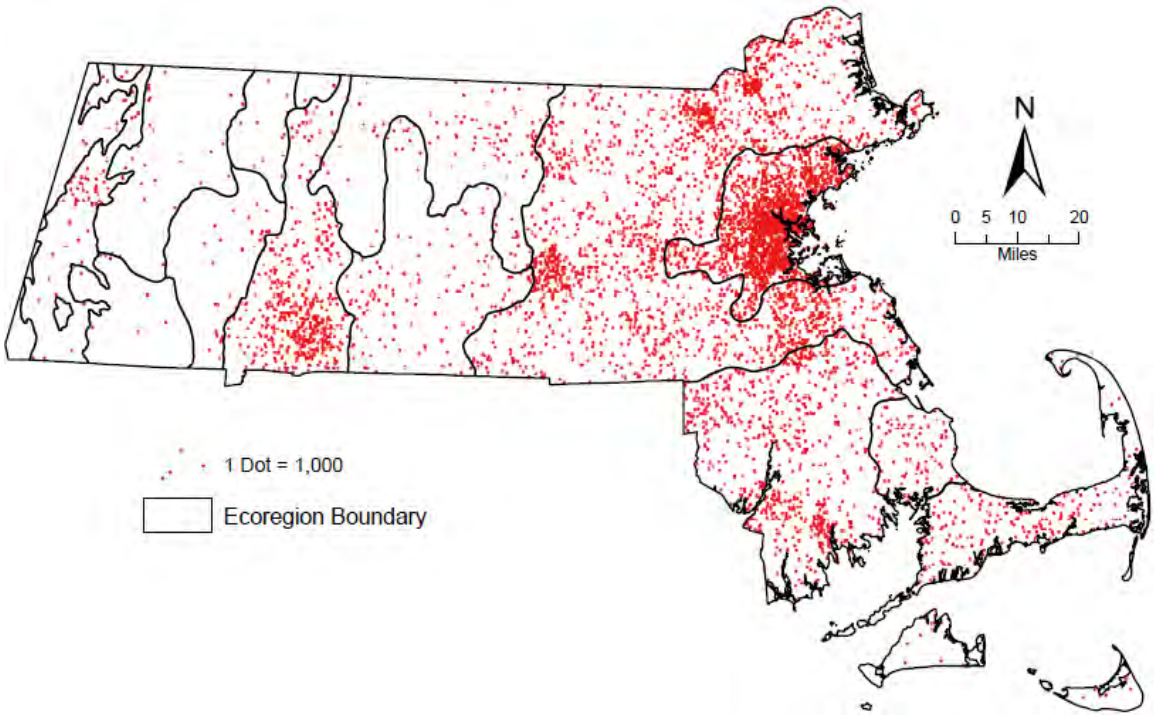



*Figure 1.5. Population density (derived from MassGIS CENSUS2010TOWNS_POLY.SHP).*

## 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 in private ownership. While NGOs own and manage a significant portion of private land, the remainder is owned by over 200,000 private landowners across the state. The majority of these ownerships are very small, 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

forestland (SFFI 2020). These family forest landowners, also known as non-industrial private forestland (NIPF) 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 have made 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). Details of this analysis are available in Appendix X, 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, sometimes, by the 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, if an Agricultural Preservation Restriction has been placed on it, 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 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 the 11 flood risk management reservoirs and the Cape Cod Canal managed by the U.S. Army Corps of Engineers.

| 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 & DFG | 5,136 |
| ***Subtotal: DCR & 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 (MassGIS XXX, NLCD 2016; See methodology in Appendix X).*

*[1]Includes lands of the US Department of the Interior (National Park Service, US Fish and Wildlife Service), US Army Corps of Engineers, and Department 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 MDAR).*

*[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,*

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 (Mass. Exec. Order No. 126). The Mashpee Wampanoag Tribe is involved in a partnership with federal and state agencies and private conservation groups to preserve and protect natural resources of the Mashpee National Wildlife Refuge.

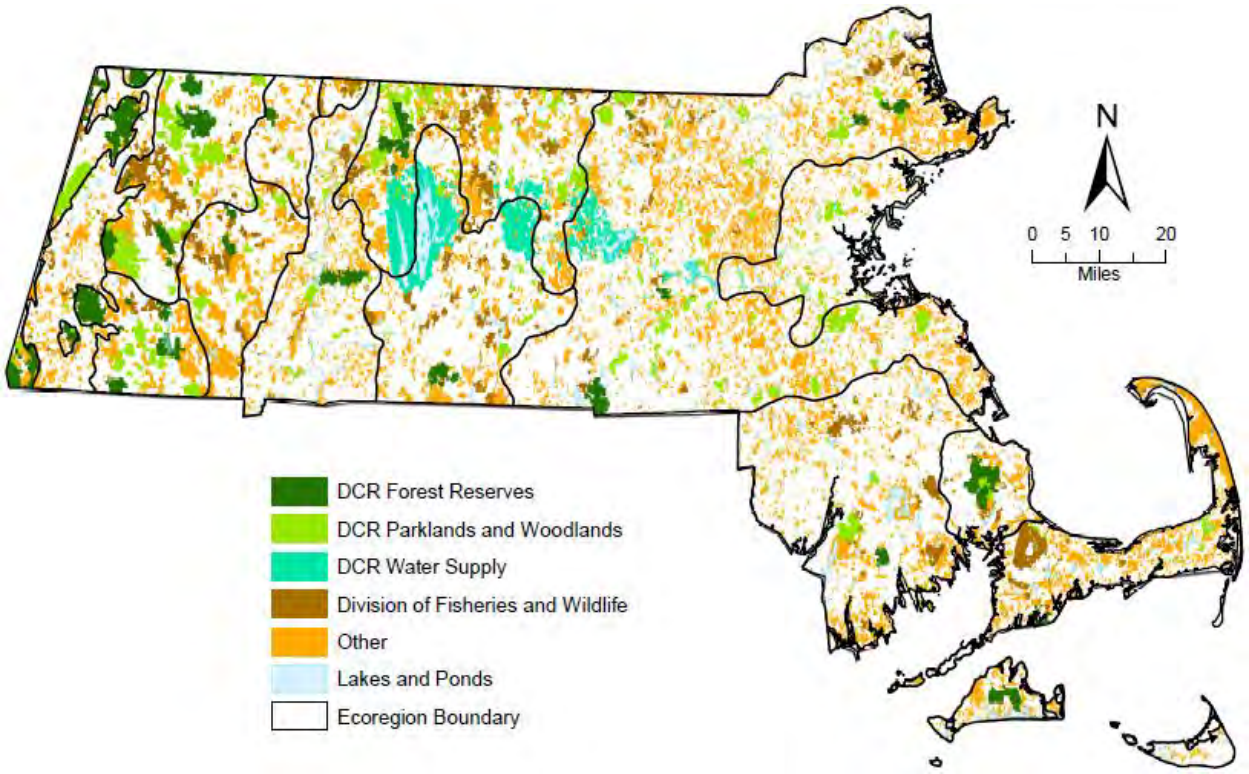



*Figure 1.6. Permanently protected forestland in Massachusetts (MassGIS).*

## 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 1998a, de la Cretaz and Kelty 2008).

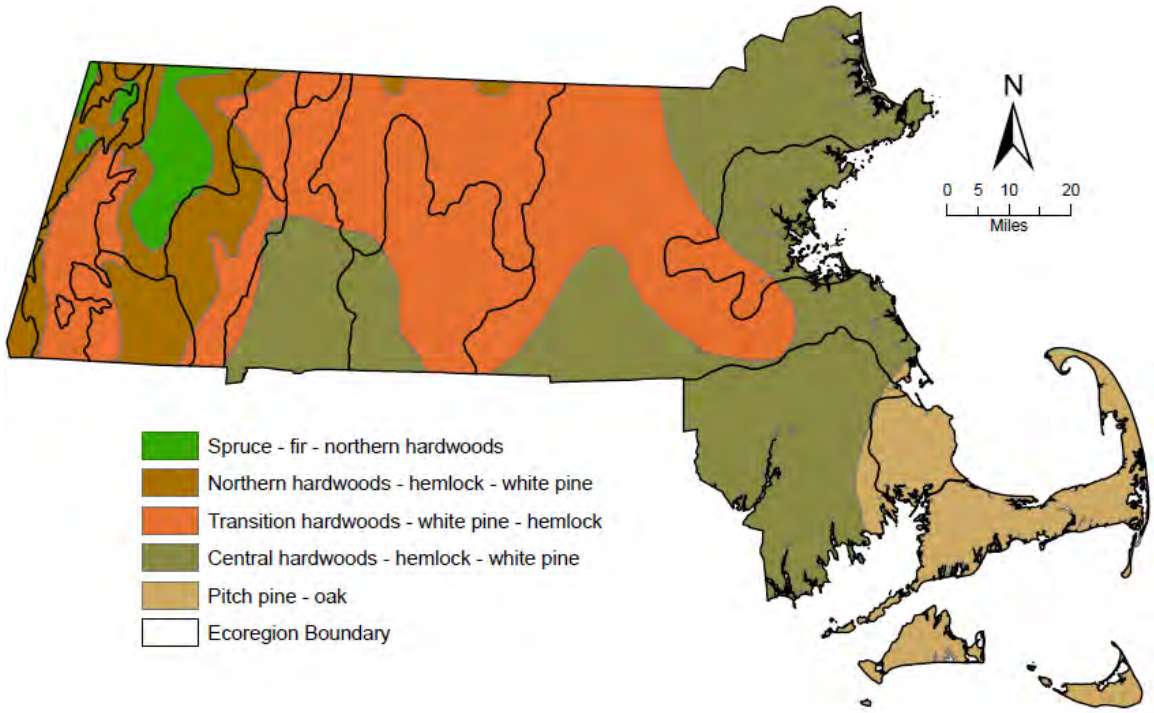



*Figure 1.7. Massachusetts forest types (modified from Westveld et al. 1956).*

## 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 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 forest 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, pit 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).

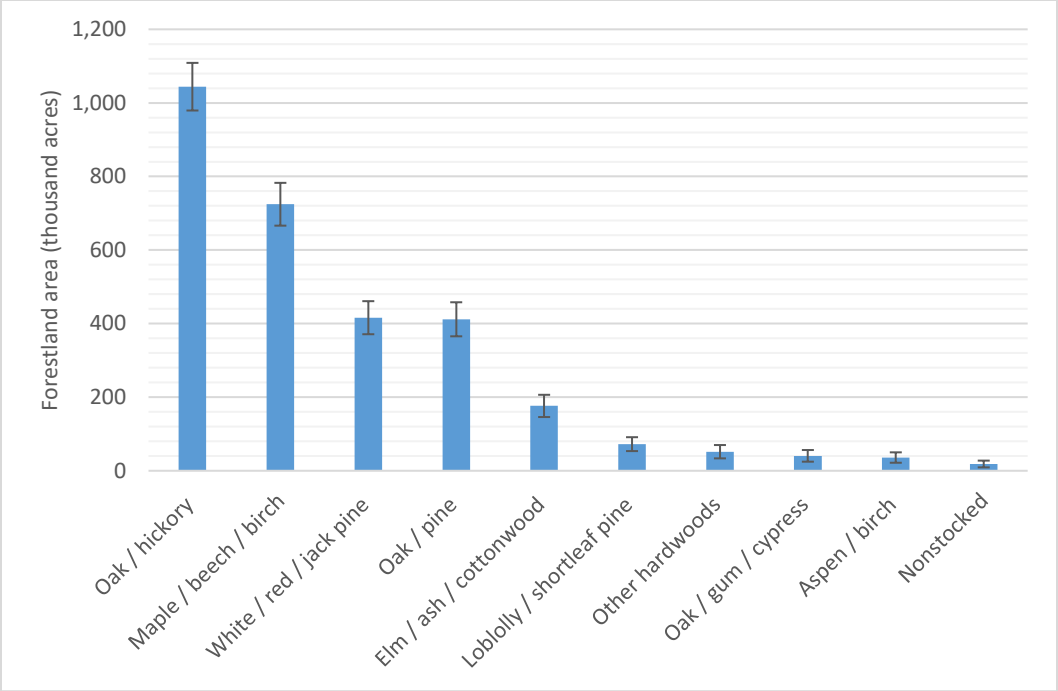



*Figure 1.8. Forestland area by forest type. Error bars represent one standard deviation (U.S. Forest Service FIA 2017).*

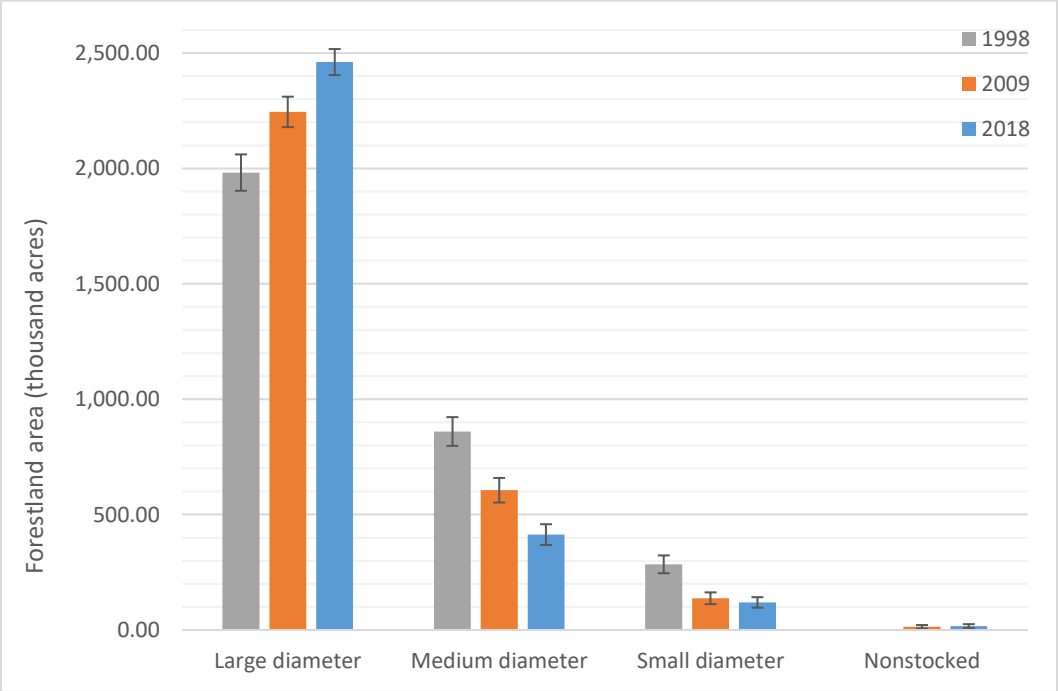



*Figure 1.9. Forestland area by size class. Size classes are determined by the dominant size class represented in each stand (greater than 50% stocking). The "large" class is defined as 11+ inch diameters for hardwood and 9+ inch diameters for softwood, the "medium" class is greater than 5 inches while "small: is less than 5 inches. Error bars represent one standard deviation (U.S. Forest Service FIADB 2017).*

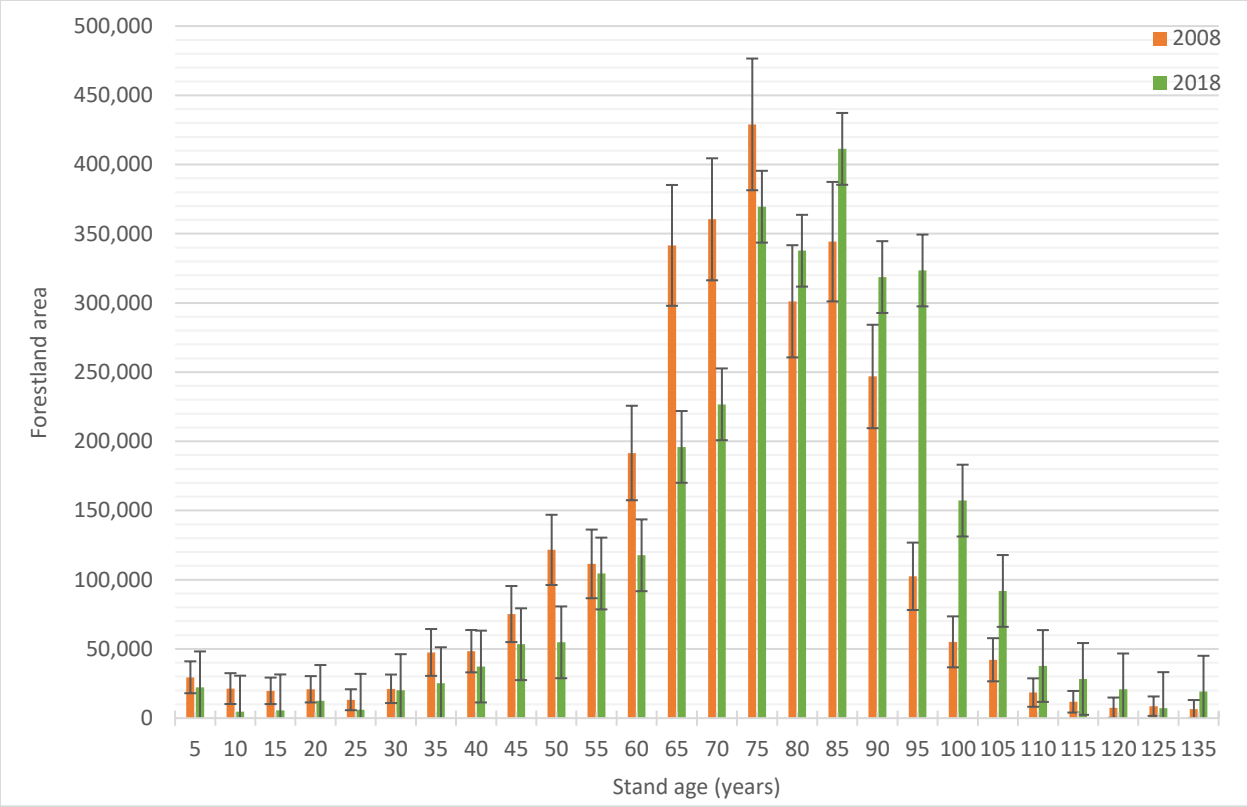



*Figure 1.10. Stand age distribution on forestland in Massachusetts. Note: each stand age refers to the 5-year class ending in the age shown. Error bars represent one standard deviation (U.S. Forest Service FIA 2019).*

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 moose in particular, have also increased and their ranges have expanded from northern New England. The bear population in Massachusetts was estimated at 975 to 1,175 in 1993. The current estimate of the population black bears in Massachusetts is 4,500 (Mass.gov 2019a). 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 (Massachusetts Audubon Society, 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 often consisting of both native and non-native trees purposefully planted and trees that have seeded in and been allowed to grow, often the case along some suburban and rural roadsides. One way of examining urban forests is to consider urban tree canopy, which varies greatly 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 most recently 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

*Charles River Esplanade, photo by Matt Heraifman*

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 most Massachusetts communities is available, although some municipalities have 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 it was 26%. In all of these studies, the most UTC is in residential areas. 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, as part of the DCR's Urban and Community Forest 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 one way to maintain UTC, the most important act that communities can do is to protect trees that they already have, 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 State Wildlife Action Plan*

In the 2015 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) which reflect 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 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 State Wildlife Action Plan.

| SWAP Habitats | | |
|---|---|---|
| **Large-scale habitats** | **Medium-scale habitats** | **Small-scale habitats** |
| • Connecticut and Merrimack Mainstems<br>• Large and Mid-sized Rivers<br>• Marine and Estuarine Habitats<br>• Upland Forest<br>  • Transition Hardwoods-White Pine[1]<br>  • Northern Hardwoods-Spruce-Fir[1]<br>  • Central Hardwoods-White Pine[1]<br>  • Pitch Pine-Oak[1]<br>• Large Unfragmented Landscape Mosaics[1] | • Small Streams<br>• Shrub Swamps[2]<br>• Forested Swamps[1]<br>• Lakes and Ponds<br>• Salt Marsh<br>• Coastal Dunes, Beaches, & Small Islands<br>• Grasslands<br>• Young Forests and Shrublands[1]<br>• Riparian Forest[1] | • Vernal Pools[2]<br>• Coastal Plain Ponds<br>• Springs, Caves, and Mines<br>• Peatlands and Associated Habitats<br>• Marshes and Wet Meadows[2]<br>• Rocky Coastlines<br>• Rock Cliffs, Ridgetops, Talus Slopes, and Similar Habitats |
| [1]Forested habitats. [2]Habitats likely to be surrounded by a forest.<br>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 State Wildlife Action Plan (DFG 2015).*

### *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, shown in Figure 1.11, include 943,000 acres of upland habitat and 233,000 acres of wetland and 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).

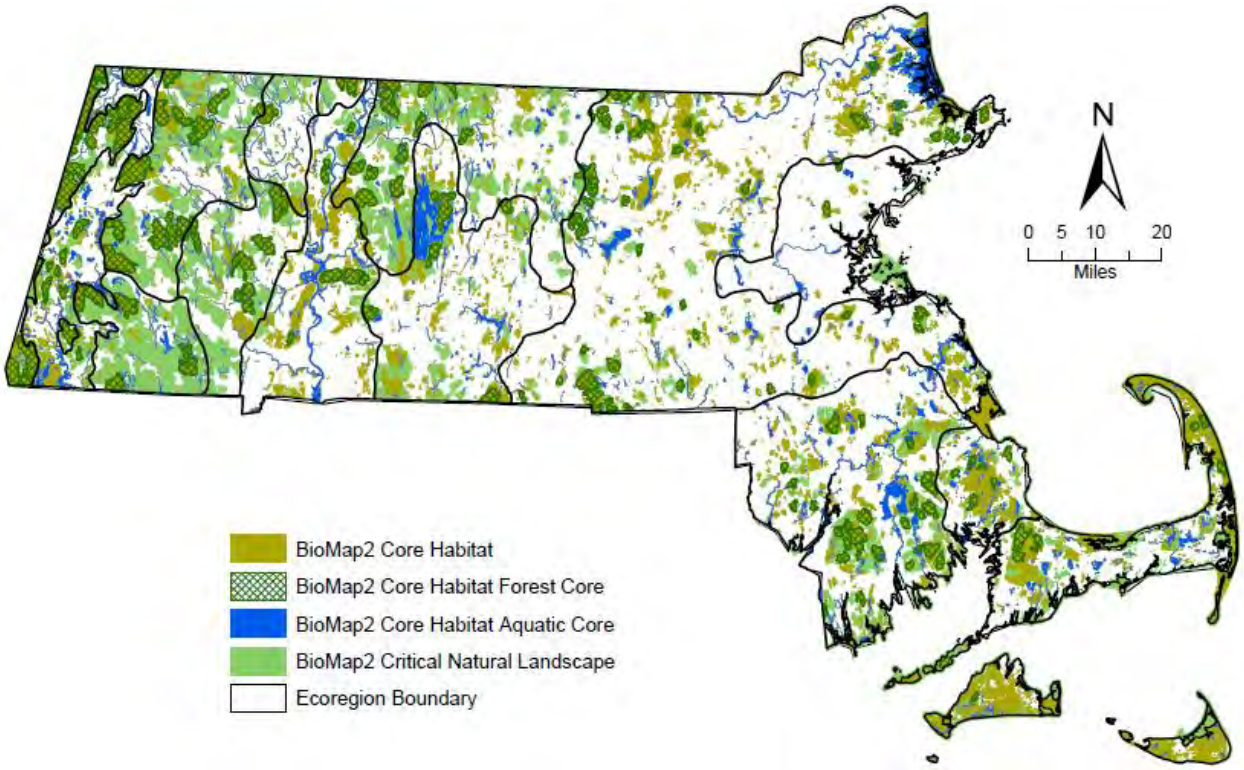



*Figure 1.11. Natural Heritage and Endangered Species Program (NHESP) and The Nature Conservancy (TNC) BioMap2 Core Habitats and Critical Natural Landscape (MassGIS 2010).*

"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 3 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 (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.

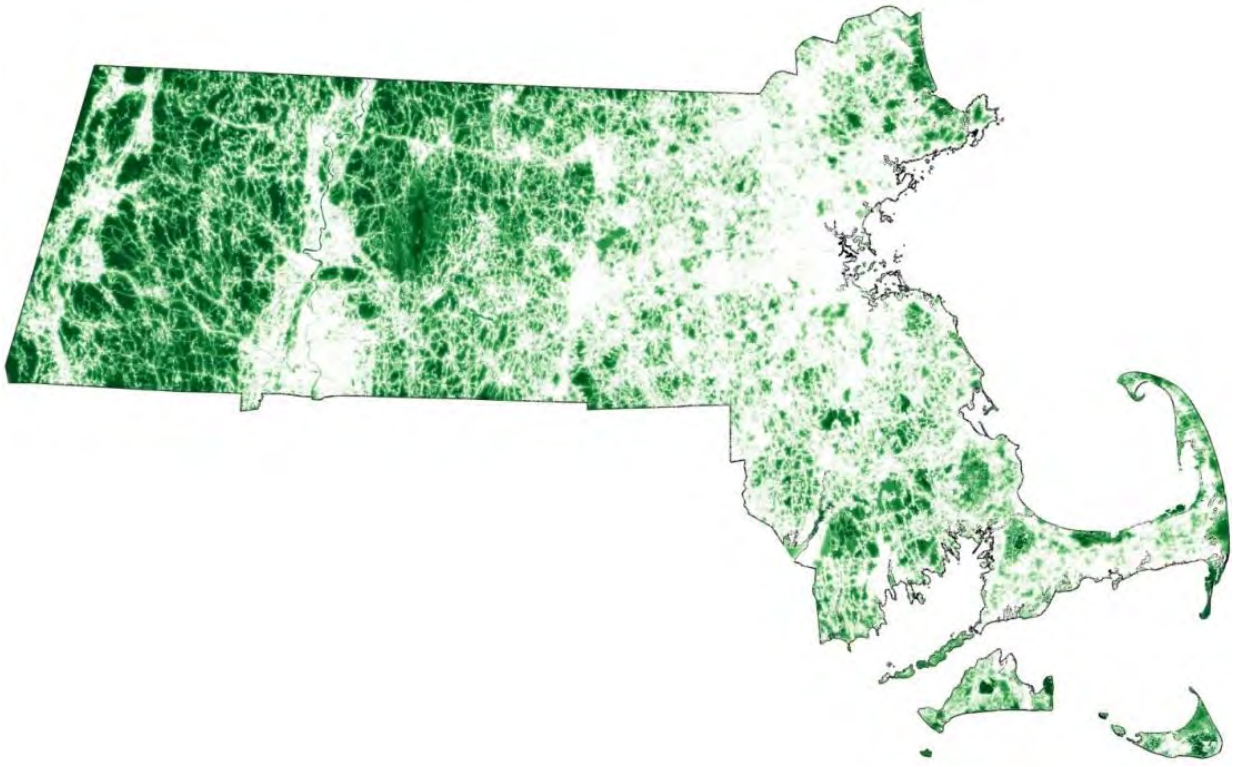


*Figure 1.12. Index of ecological integrity (IEI) for Massachusetts. Darker areas denote higher IEI values; white areas are developed land (umasscaps.org).*

***Resilient Sites for Conservation***

With a changing climate, many places may become degraded and lose species, but 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 are places where conservation action is most likely

to succeed in the long term. The Nature Conservancy has mapped places with these two characteristics to identify conservation sites that will stand the test of time, and support plant and animal species, and biodiversity (Figure 1.13). These 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 the conservation priorities. Permanent conservation of the resilient areas should be prioritized to ensure they can continue to provide habitat for species (Anderson et al. 2016).

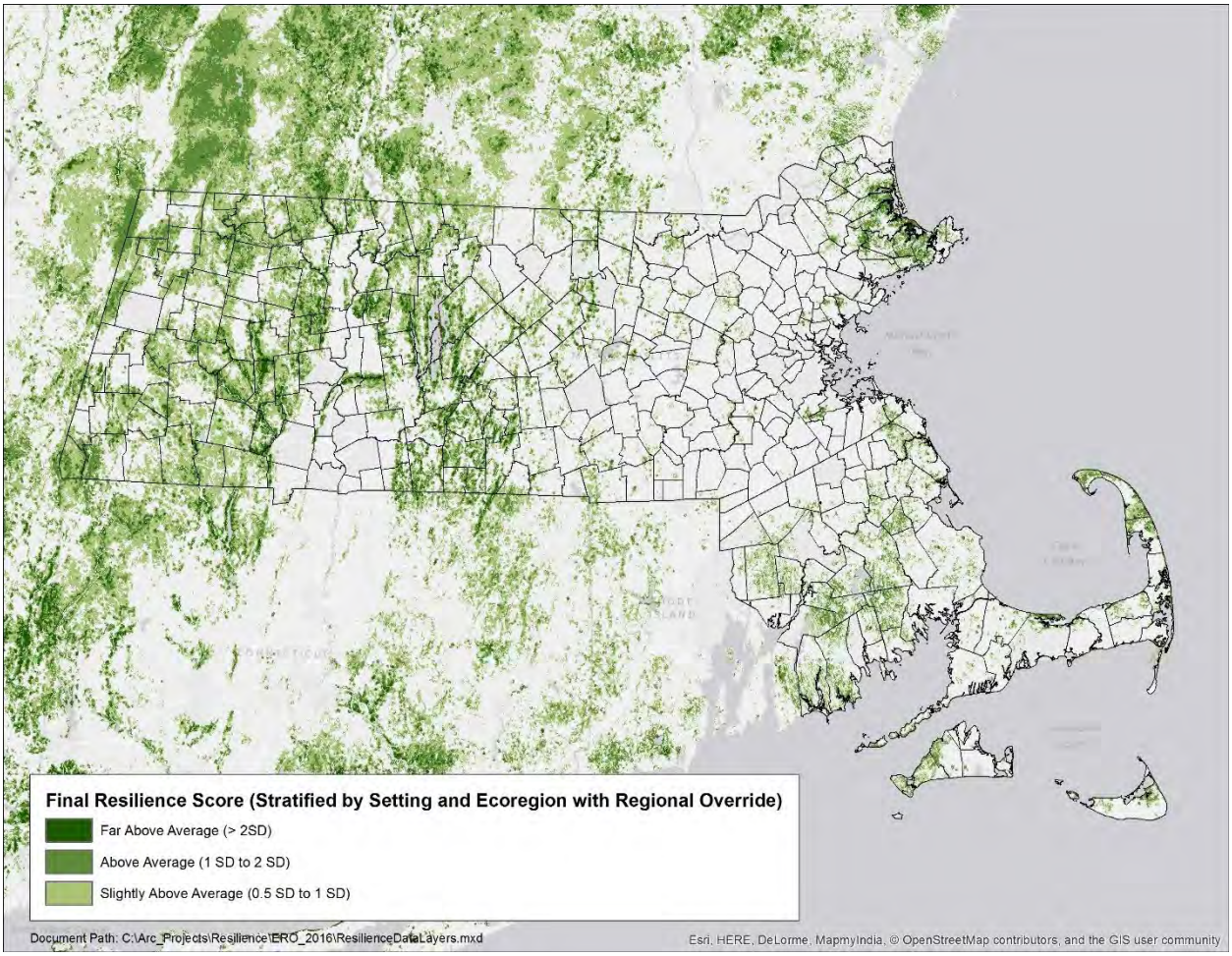



*Figure 1.13. The Nature Conservancy Resilient Sites for Conservation (Anderson et al. 2016).*

## 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 (MSHMCAP 2018). Projections for changes to Massachusetts' climate by the end of this century are found in Table 1.4.

| | |
|---|---|
| **PRECIPITATION** | • Increase up to 7.3 inches in annual precipitation;<br>• Increase up to 57% (+4 days) in days with rainfall accumulation greater than 1 inch;<br>• 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;<br>• Decrease up to 62 days with daily minimum temperatures below freezing;<br>• Increase up to 11.4° Fahrenheit in average minimum winter temperature;<br>• Increase up to 64 days with daily maximum temperatures over 90° Fahrenheit. |
| **EXTREME WEATHER** | • Increase in frequency and magnitude. |

*Table 1.4. Massachusetts climate projections (MSHMCAP 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 sp., and oak sp. 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;
- 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.

Table 1.5 is a climate change vulnerability assessment in suitable habitat for trees in Massachusetts with respect to two climate scenarios. “Low change” represents a cooler climate scenario, whereas the “High change” represents a warmer climate scenario. 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 | High change |
|---|---|---|
| Balsam fir | Large decrease | Large decrease |
| Black spruce | Large decrease | Large decrease |
| Northern White cedar | Large decrease | Large decrease |
| Paper birch | Large decrease | Large decrease |
| Tamarack | Large decrease | Large decrease |
| White spruce | Large decrease | Large decrease |
| | | |
| Black ash | small decrease | Large decrease |
| Eastern white pine | small decrease | Large decrease |
| Quaking aspen | small decrease | Large decrease |
| Striped maple | small decrease | Large decrease |
| | | |
| Red spruce | small decrease | small decrease |
| | | |
| Bigtooth aspen | No change | Large decrease |
| Eastern hemlock | No change | Large decrease |
| Red maple | No change | Large decrease |
| American beech | No change | small decrease |
| Eastern hophornbeam | No change | small decrease |
| Gray birch | No change | small decrease |
| Northern red oak | No change | small decrease |
| Yellow birch | No change | small decrease |
| | | |
| Black cherry | No change | No change |
| Scrub oak | No change | No change |
| Sugar maple | No change | No change |
| White ash | No change | No change |
| | | |
| American basswood | No change | large increase |
| | | |
| Black birch | small increase | small decrease |
| Pitch pine | small increase | No change |
| Black oak | small increase | small increase |
| Chestnut oak | small increase | small increase |
| Bitternut hickory | small increase | large increase |
| Pignut hickory | small increase | large increase |
| Shagbark hickory | small increase | large increase |
| White oak | small increase | large increase |
| | | |
| Black gum | large increase | large increase |
| Sassafras | large increase | large increase |

- *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*.

*Table 1.5. Vulnerability for potential changes in suitable habitat for trees in Southern New England under a low (temperature increase of 2.6 °F) and high (temperature increase of 7.6 °F) climate change scenario (U.S. Forest Service Climate Change Atlas).*

## 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 have been introduced to Massachusetts, either accidentally or through landscape plantings, out-compete or displace native species. They can alter soils, increase erosion, and reduce habitat value for native wildlife. Invasive plants often have biological traits that give them a competitive advantage as well as being free of the biological controls that manage their population in their native environment. Invasive species monopolization can have economic consequences and impact rare and endangered species. 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 are a diverse group representing research institutions, non-profit organizations, the green industry, and state and federal agencies (MIPAG n.d.). MIPAG's *Strategic Recommendations for Managing Invasive Plants in Massachusetts* identifies the essential components of a strategic response to invasive plant species and suggests a management framework to maximize control 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

Invasive 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 (WPND), 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 were Gypsy Moth (1,481,115 acres), Winter Moth (300,571 acres), and weather events such as snow, ice, wind, tornado, frost, 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*

Massachusetts experienced a gypsy moth population outbreak event that began in 2015. Drought conditions in previous 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. The current outbreak saw populations increasing through 2015 and 2016 and led to over 923,000 acres of defoliation in 2017. High gypsy moth caterpillar mortality in 2017 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, the temperature was very cool, preventing the newly hatched caterpillars from climbing into the canopy and feeding. This led to a massive starvation event for the caterpillars, but a portion of the population did survive into late stage caterpillars. The cool and moist weather in June provided ideal conditions for

*Entomophaga*, which further decreased the population down to low levels. Compared to previous years, minimal defoliation or 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 significant increase in oak mortality across the state. 2018 marked the first time in years that oak mortality was recorded (23,602 acres).

***Asian Longhorned Beetle***

The Asian longhorned beetle (ALB) was first discovered in the United States in Brooklyn, NY 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 and fewer infested trees are being found as time goes by and excellent progress is being made towards eradication (Figure 1.14). As of 2019, 110 square miles are regulated in Worcester County for ALB including all of Worcester, West Boylston, Boylston, and Shrewsbury, as well as parts of Holden and Auburn.

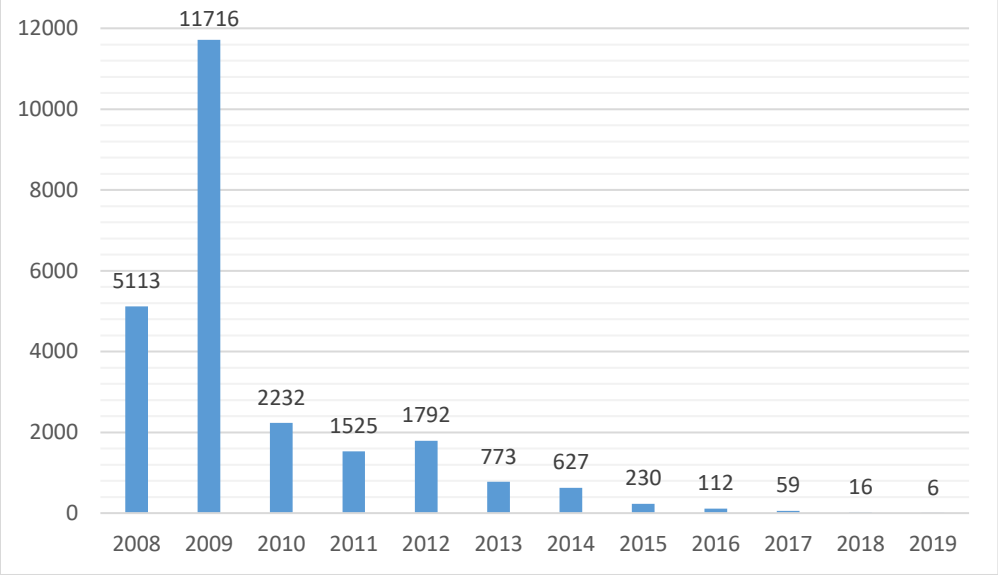



*Figure 1.14. Number of ALB infested trees identified in Worcester Quarantine area, by year.*

Asian longhorned beetle 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. 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.

***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 and expanded its range. 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, the invasive pest was detected in Massachusetts in the western town of Dalton. Since its initial find, EAB has been detected in 10 of Massachusetts' 14 counties: Berkshire, Bristol, Essex, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, and Worcester (Figure 1.15). The entire state 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.

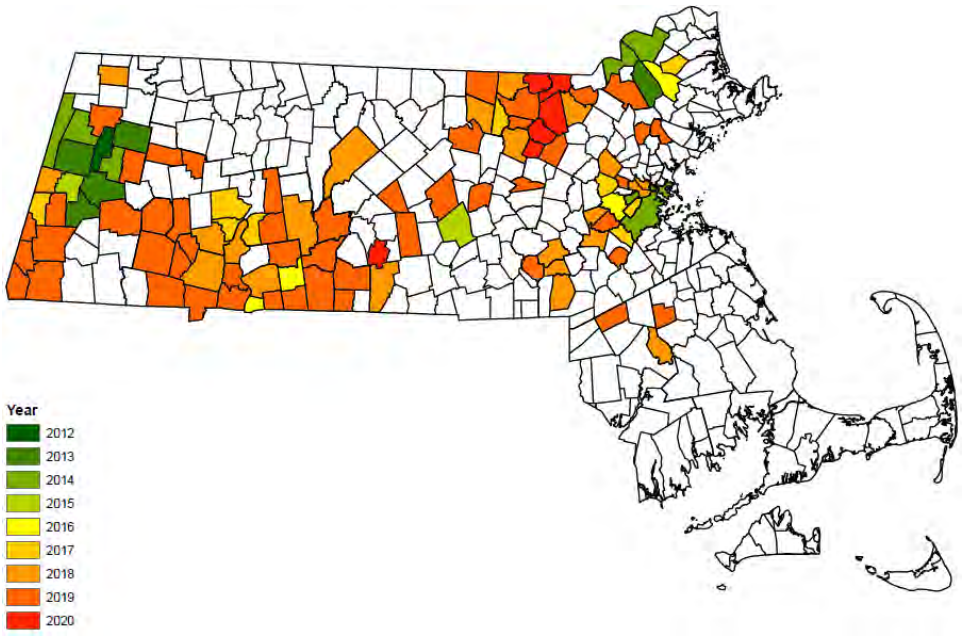



*Figure 1.15. New Emerald ash borer detections in Massachusetts, by year (E. Peterson 1/13/2020).*

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 working in partnership with the USDA 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 project 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 researched 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 started causing 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. 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 the University of Massachusetts 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, along with 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 a healthy population, resulting in the near elimination of winter moth defoliation in eastern Massachusetts (Elkinton et al. 2017).

***White Pine Needle Disease***

Eastern white pine has been experiencing needle browning and canopy dieback, also known as White Pine Needle Disease (WPND), since 2010. 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. An increase in temperatures and more frequent rain events between May and June create the ideal conditions for the pathogens to develop on the pines. 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 themselves, yet 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 attack.

Other problems facing Eastern white pine are Caliciopsis Canker and white pine bast scale (WPBS). Caliciopsis is a well-known fungus that has been observed in New England forests since the 1800s. Trees that are most susceptible to the canker are pole-sized trees in dense forest stands or trees in dense groves or screens in the landscaped environment. Recently, it has been discovered that Caliciopsis is attacking stressed and weakened trees in association with 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 there is now a well-documented link between the WPBS and Caliciopsis as the feeding sites of WPBS are readily colonized by Caliciopsis. Active management to reduce the severity of the disease issues facing white pine include thinning to reduce stand density, which improves air flow and promotes crown vigor, and enhances radial growth rates (Brazee 2019).

***Hemlock Woolly Adelgid and Elongate Hemlock Scale***

*Hemlock tree infested with Hemlock Woolly Adelgid*

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 mouthparts at the base of hemlock needles. HWA is capable of severely weakening and killing the hemlocks they feed on. However, the cold, fluctuating winter temperatures we experience in Massachusetts causes 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 1990's, HWA biocontrol beetles have been released in 9 counties: Berkshire, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Suffolk, and Worcester. However, we have had 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. The DCR continues to use biocontrol species as a tool against HWA. We release *L. nigrinus* when conditions are suitable and beetles are available from the U.S. Forest Service and partner rearing facilities.

**BOX 1.1. FUTURE CAUSES OF CONCERN**

**Oak Wilt** is not currently known 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 if the infected oak trees' roots are joined or grafted with another oak's 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 and can transfer oak wilt spores to other infected wounds in the same or other oak trees. 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), though it looks like a moth and is called a 'fly', is actually an invasive 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. 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, although a single dead adult was discovered on imported nursery stock in February 2019.

### *Red Pine Scale*

Red pine scale is a very small invasive insect originally from Japan that 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 will be on individual branches on the lower part of the crown but soon spread to encompass the entire canopy. The scale has two generations per year and prefers to feed beneath bark flakes. Control by use of insecticides has not been successful and natural enemies are ineffective in reducing the population of red pine scale.

### *Southern Pine Beetle*

Southern pine beetle (SPB) is an insect native to the southern portion of the United States and has been expanding its range up the East Coast. As of 2019, no infested trees have been found in Massachusetts, but traps have been picking up low numbers of SPB 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 pitch pine 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.

***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 shipping using wooden 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.

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

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 general 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 further. Educating the community on the threats to the trees and the 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 are watching, and gives the public the ability to recognize and report potential threats.

## WILDFIRES

Since European settlement, fire has played a role in shaping the landscape; the majority of fire occurrence is human caused and unintentional. To date, over 95% of wildfire occurrence in Massachusetts is human caused, consistent with the national average. During the early 1900's 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 1960's. 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, 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 technology improvements in suppression and detection have helped decrease the average size of wildfires. Since 2010, the average number wildfires per year is 1,595 with an average number of acres burned of 1,365 (Figure 1.16).

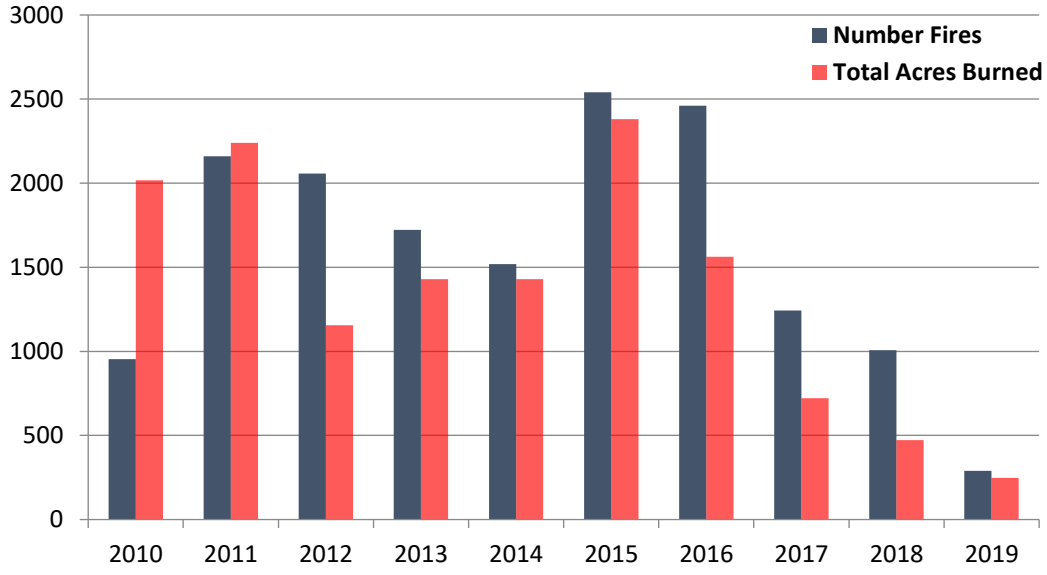



*Figure 1.16. Massachusetts Wildland Fire Occurrence, 2010-2019 (USFS Fire & Aviation, NASF State Wildfire Reporting Database).*

Wide diversity of forest cover types and fuel types result 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 fine 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.

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 up after they fall 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 the lack of overstory canopy exposes fuel on the forest floor to wind and sun (Kelty et al. 2008).

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

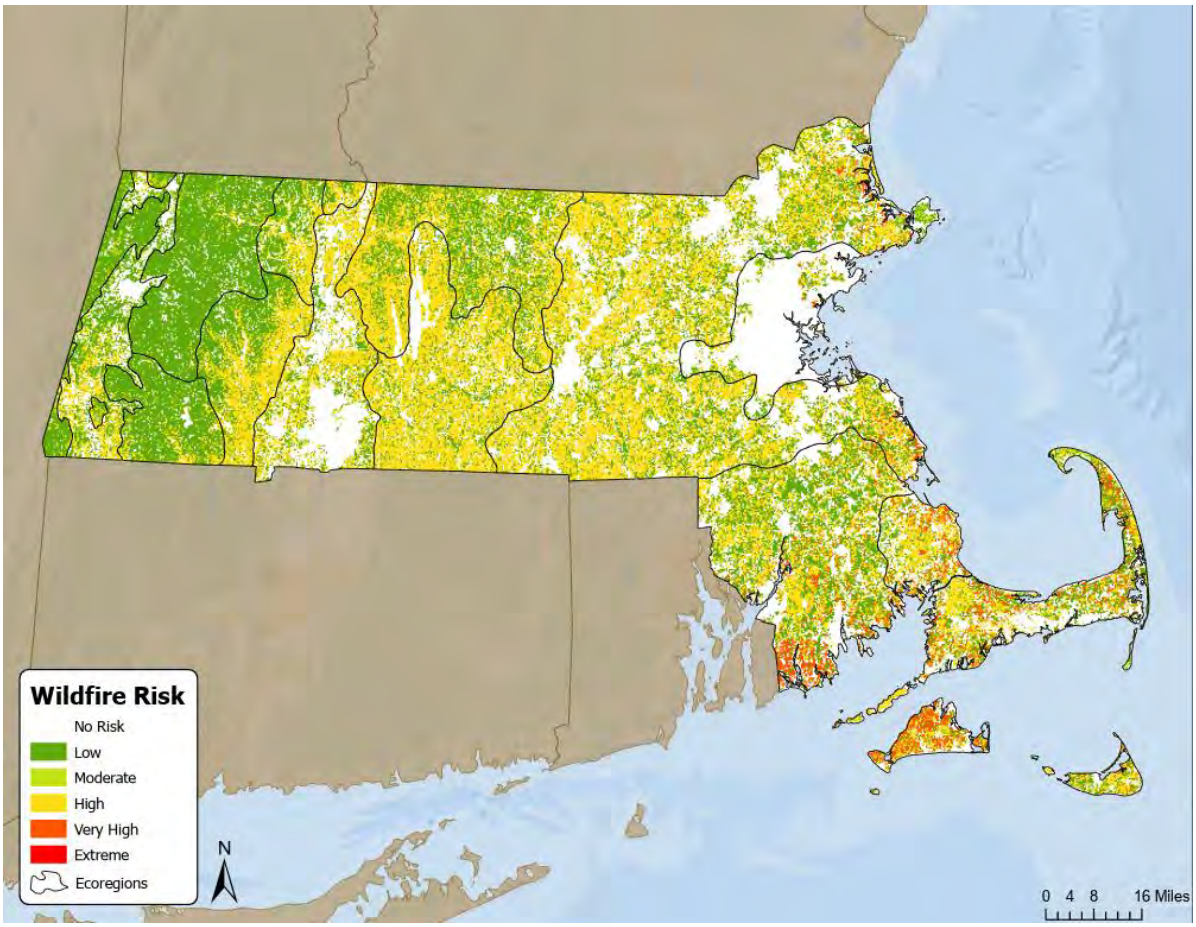



*Figure 1.17. Wildfire risk in Massachusetts and the Eastern Region (U.S. Forest Service 2009).*

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, lightning is almost always accompanied by rain; there are few natural forest fires. 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 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.

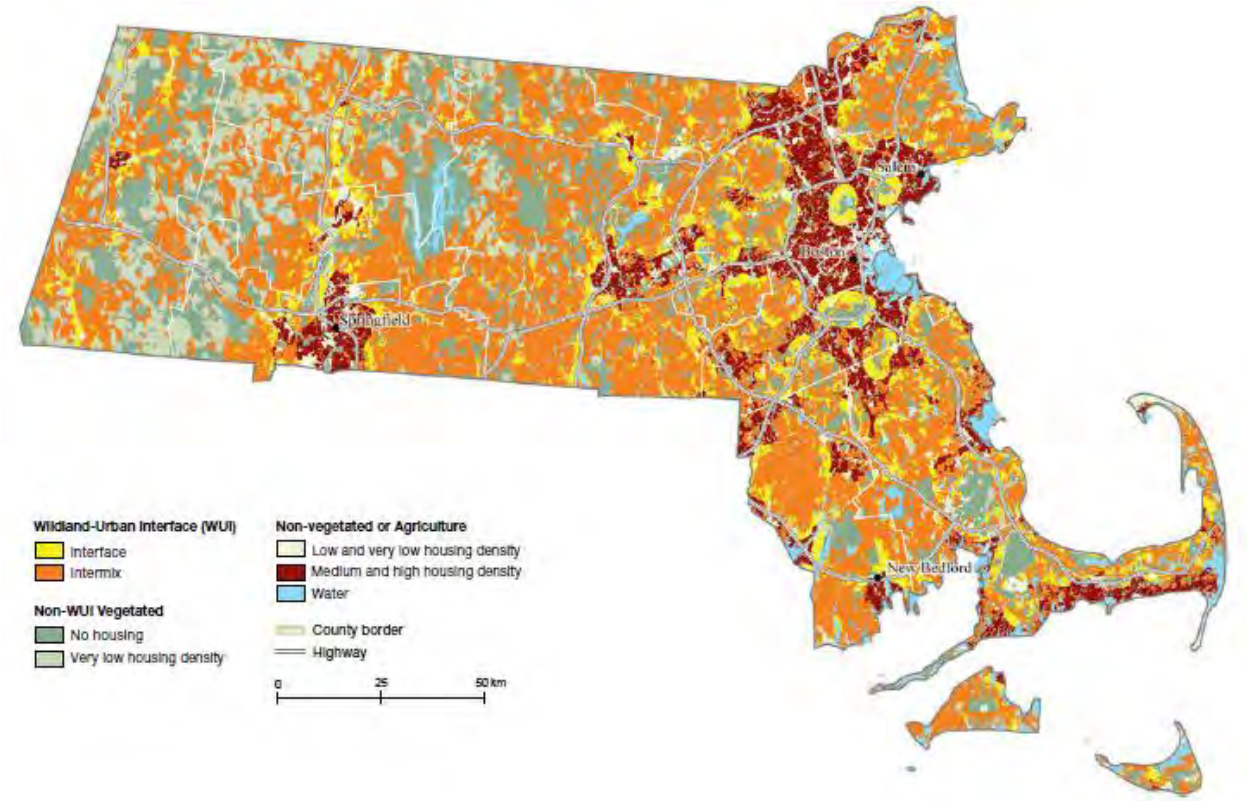



*Figure 1.18. Wildland-urban interface (WUI) 2010 (Martinuzzi et al. 2015). "The wildland-urban interface is the area where houses meet or intermingle with undeveloped wildland vegetation" (Radeloff et al. 2005).*

The state forests in southeastern Massachusetts (Myles Standish in Plymouth and Carver, Manuel Correllus on Martha's Vineyard, Nantucket on Nantucket Island, and Freetown-Fall River in Assonet) 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 2006).

## WEATHER RELATED NATURAL DISTURBANCES

Natural disturbances can have positive negative effects on our forest land. They create openings, coarse woody debris, snags, and other features that increase structural diversity of forest habitat and are a great 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.

***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 damage to the landscape. There have been 67 hurricanes recorded between 1620 and 1997. Of these, 11 caused no reported damage; four caused minor damage; 20 caused some tree blow downs; and, 24 caused extensive blow downs. Eight hurricanes (1635, 1788, 1804 1815, 1821, 1869 [two storms], and 1938), had winds of 107 to 139 mph (category 3) that blew down most of the trees in their path (Boose et al. 2001). The most recent category 3 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, a category 3-4 tornado caused 4 deaths and left a continuous damage path 165 to 3,280 ft. 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. Three people were killed (Thompson Jr. et al. 2011).

Severe windstorms can blow down extensive areas 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 (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).

***Thunderstorms and Microbursts***

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 ft. in diameter (Storm data and unusual weather phenomena July 2006).

***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 extensive 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. The effects of the 2008 ice storm lasted several years as trees succumbed to stressors introduced or amplified by that singular event.

## FOREST MANAGEMENT FOR ECOSYSTEM HEALTH AND BIODIVERSITY

Rare species, which are formally protected by the Massachusetts Endangered Species Act (MESA, MGL 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 132 ss. 44-46; 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 DCR Service Forestry to review conditions on the ground. Following review, a letter of determination is issued that identifies potential threats or impacts to rare species, if any, and details any measures or modifications to the plan that are required in order 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 DCR Service Forestry in that time period. 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. The aim of developing these CMPs was to help landowners and foresters plan more effectively for forest management activities that are likely to occur in habitats of state-listed rare species. CMPs are specific, science-based guidelines for conservation of rare species during forest harvesting. CMPs help make the outcomes of NHESP reviews more predictable and, when incorporated into Forest Cutting Plans prior to submission, help expedite 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).

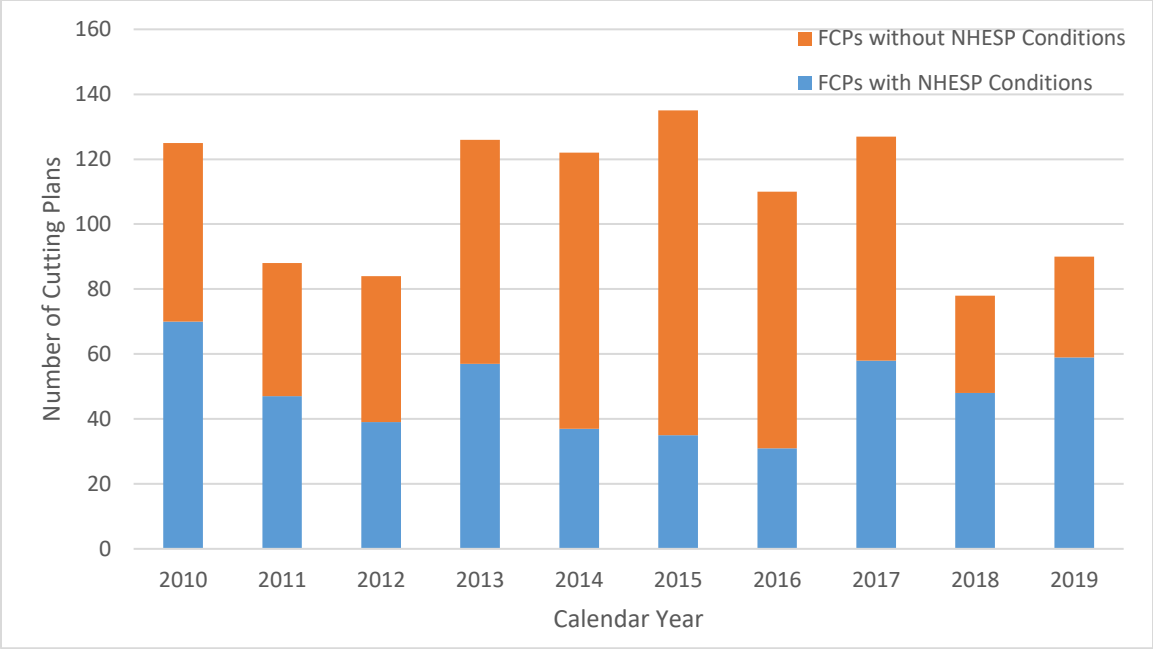



*Figure 1.19. Summary of Forest Cutting Plans (FCPs) reviewed by the Department of Fish & Game, Division of Fisheries & Wildlife, Natural Heritage & Endangered Species Program (NHESP) from calendar year 2010 through 2019 (NHESP, unpublished data).*

***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 contains and emphasizes natural resource values, including biodiversity of plant communities and faunal associations, in tandem with other assets and objectives for a property. Technical advice provided by DCR Service Foresters, and by consulting foresters with diverse knowledge gained through continuing education opportunities, provide landowners with sound technical guidance and proactive management opportunities that can achieve landowner objectives 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, in coordination with a Mass Audubon biologist, prepare a Bird Habitat Assessment for their property. The assessment contains the elements of a traditional Forest Stewardship Plan but with the special 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 improve the quality of existing habitat to enhance breeding bird success.

*Pittsfield State Forest, photo by Kevin Hatcher*

A variety of cost-share programs are also in place with the explicit 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 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 (state fiscal year 2016), 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, DCR's 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 & Recreation (DSPR); the DCR Division of Water Supply Protection (DWSP); and MassWildlife.

#### *DCR DIVISION OF STATE PARKS & RECREATION*

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. DCR DSPR lands are designated as either reserves, parklands, or woodlands. 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 and will be guided by the Forest Reserve Science Advisory Committee.

- **Parklands –** Lands designated as Parklands are of 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 recreational use, or to ensure 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 Designation guidelines provide 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. Due to the scale and complexity of the data analysis, as well as the significant public process, the guidelines are periodically reviewed with the next scheduled review in 2022.

*DCR DIVISION OF WATER SUPPLY PROTECTION*

The Land Management program of the DWSP incorporates principles from the current scientific knowledge of watershed and natural resource management to develop and implement policies, goals, and methods for managing DWSP lands. Forest cover provides the best protection for drinking water quality. An important goal of DWSP forest management is to deliberately create and maintain a vigorously growing, multi-aged, multi-species forest, which will provide the best resistance to and resilience following a variety of known and unknown threats. The diverse forest and non-forest cover that has resulted from DWSP management also provides habitat for a wide range of wildlife species that require a diversity of conditions including grasslands, oak-pitch pine barrens, shrublands, young forests, and interior unmanaged forest.

*DFG DIVISION OF FISHERIES AND WILDLIFE*

MassWildlife works to conserve a variety of wildlife and plants including rare and declining wildlife species identified in the 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. MassWildlife habitat goals include the establishment of forest reserves.

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.

### Natural Disturbance Processes

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 these natural processes formerly did.

### Flooding

Spring flooding and associated ice-scouring along rivers and major streams historically replenished vibrant open habitats for wildlife, but construction of >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 beaver. While beaver flooding occurs in Massachusetts today, many areas of the state on moderate slopes adjacent to low gradient streams (the type of area preferred by beaver) have been developed for urban and residential uses, and beaver activity either no longer occurs or is greatly constrained.

***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 manage habitats 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 and is supported by sound academic research and management (source). 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 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 fall on homes and 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, the University of Massachusetts Amherst, along with partners from The Nature Conservancy, MassWildlife, the National Park Service, and the DCR began development of prescribed burn programs in areas where pitch pine-scrub oak forests are prevalent. Since this inception, prescribed burning as a management tool has been on the increase in Massachusetts on federal, state, municipal, and private non-profit partnership lands.

In order 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 & Wildlife Service, U.S. Forest Service, or the National Park Service may participate in prescribed burns on the DCR lands. Reciprocally, the DCR prescribed fire staff may participate in prescribed burns on lands not managed or owned by the DCR, including prescribed burns 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.

## 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 DCR 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.

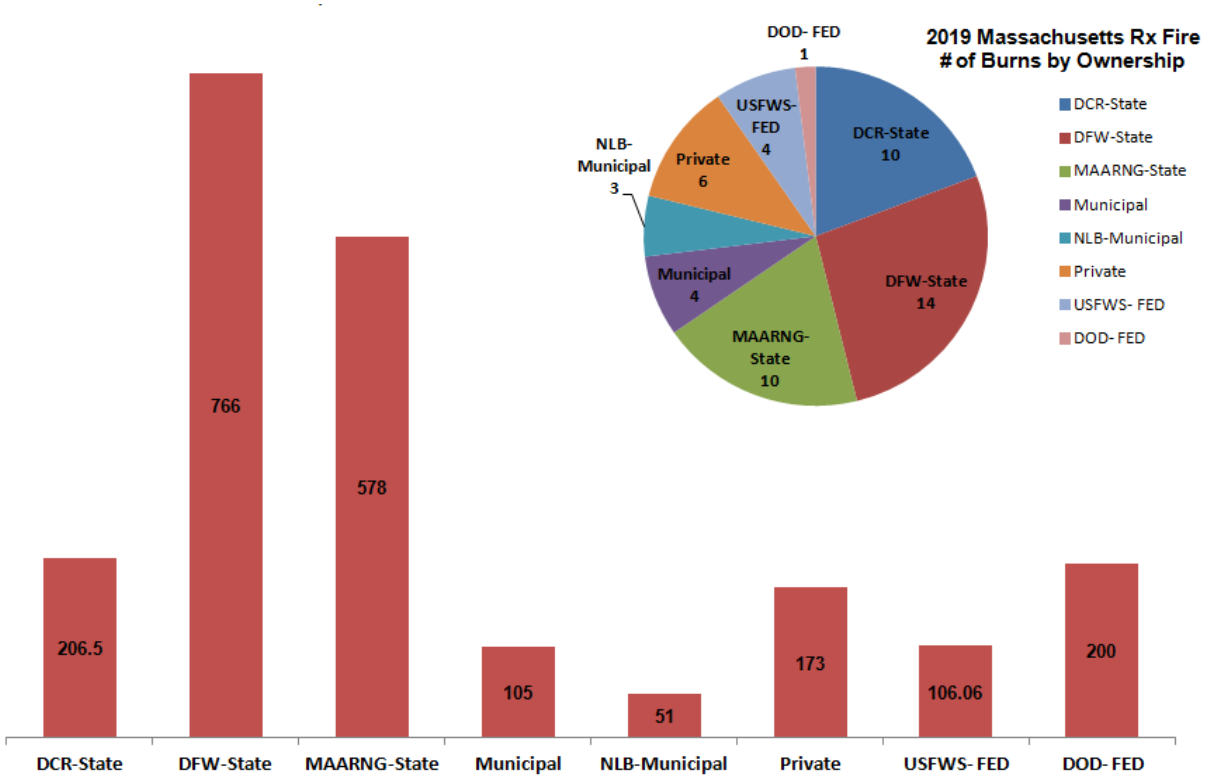



*Figure 1.20. Massachusetts 2019 Prescribed Fire Burned Acres by Ownership.*

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). 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 size 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 were added to tree regeneration assessment and attributes were also added to determine the extent to which understory shrubs and ground cover interfere with the growth of tree seedlings and saplings. In 2010, more additions were made to CFI to include coarse woody debris transects and an extensive grass, forb, and shrub species list. In 2013, the 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 the 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***

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

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***

The DCR Urban and Community Forestry Program, in partnership with the University of Massachusetts Amherst and Clark University, is monitoring the effects of the Greening the Gateway Cities (GGC) 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. Placement of these traps utilizes a GIS analysis of such variables as previous infestation extent, known estimated adjacent host locations, and potential rates of spread.

DCR Service Forestry's Foresters for the Birds Program, offered in partnership with Mass Audubon, is conducting a two year monitoring project of forest management projects on private forestland that have implemented bird-friendly practices and created habitat for rare or declining bird species. To document the effectiveness of these practices, Mass Audubon biologists conduct monitoring of bird habitat projects implemented under approved Bird Habitat Forest Management Plans, including both a survey of breeding birds utilizing the habitat and 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 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, in order 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. Finally, 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 was 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 species 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. "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. Dr. Robert Bertin of College of the Holy Cross in Worcester has reported 17% loss in the native flora of Worcester (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. They 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).

A recent study (source) showed 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 20th 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% (Massachusetts Audubon Society 1999). Most recent numbers show 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 a few areas (Figure 1.21), some of which are particularly noted for their biodiversity and rare species habitat. These include south eastern portions of the state, and the 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.

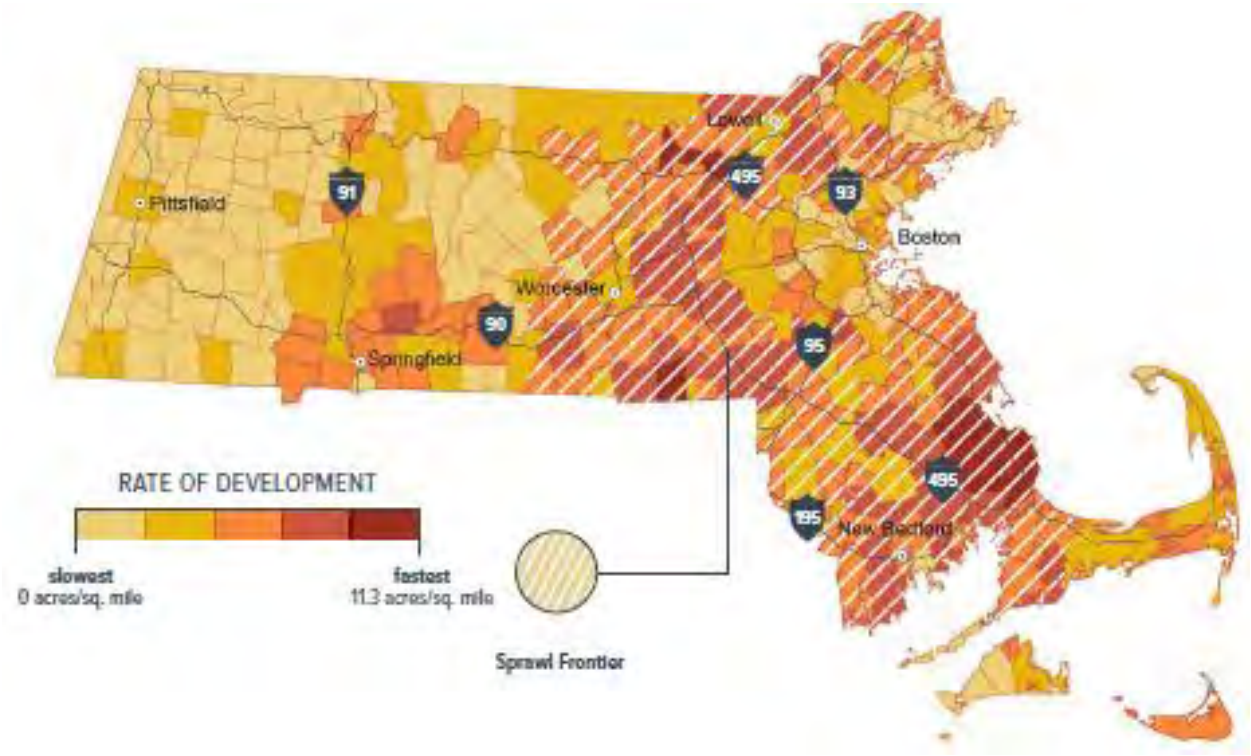



*Figure 1.21. Recent land development trends (Ricci et al. 2020).*

The most recent *Losing Ground* report (Ricci et al. 2020) showed that development rates have decreased from the numbers seen in the late 1980's and 90's (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. 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, a 37% increase in the land protection rate. Nonetheless, more than half of the BioMap2 core habitat and sub-component 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 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 by doubling the recent land conservation rate from around 50 acres a day to 100 acres per day.

| Year | Pace of Development |
|---|---|
| **1985 – 1999** | 40 acres/day |
| **1999 – 2005** | 20 acres/day |
| **2005 – 2013** | 13 acres/day |
| **2012 – 2017** | 13.5 acres/day |

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

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 sprawling housing development separates 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, forests become isolated islands and plants and animals are unable to migrate and reproduce, leading to population decline. Additionally, forest growing conditions are altered as the adjacent land use determines the environment of the forest, changing the temperature, moisture, light, and wind 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.

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.

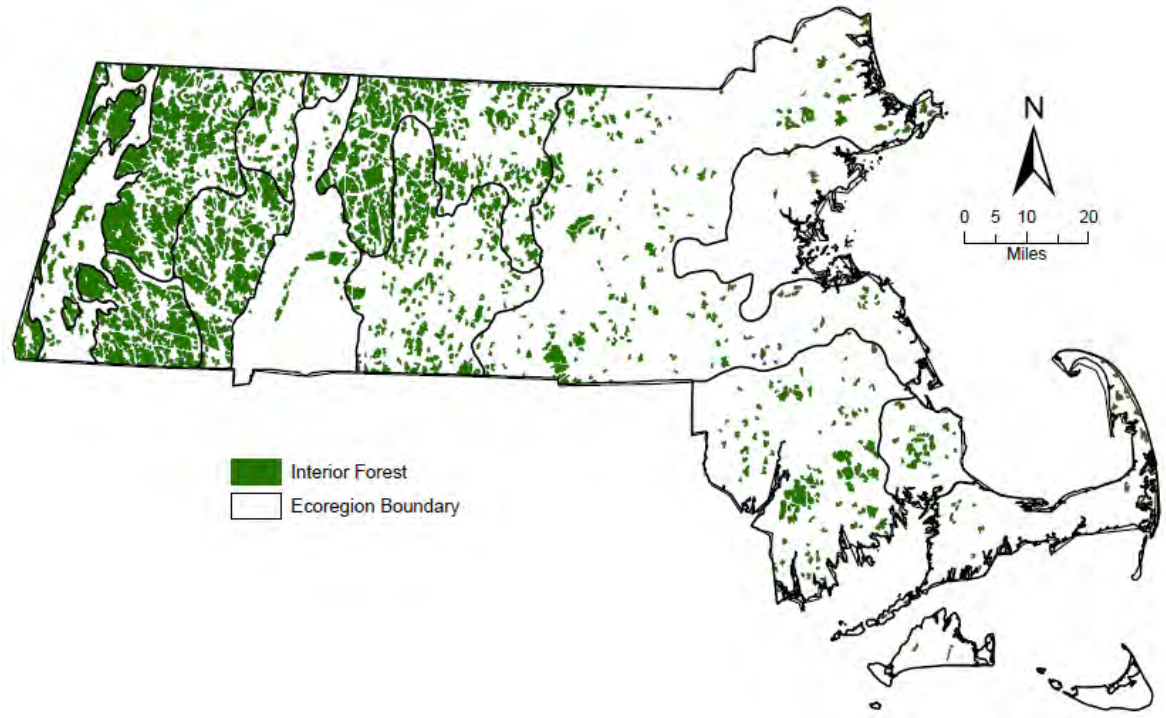



*Figure 1.22. Massachusetts Interior Forest (MassGIS).*

***Climate Change***

Climate change will play a key role in forest ecosystem health and vitality in the future. Massachusetts forests will see an increase in temperatures in all seasons, an increase in precipitation in winter, and increasing frequency of intense precipitation events during the spring. Winters will continue to become shorter and soils will be frozen for a shorter time while winter precipitation will fall mostly as rain instead of 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 the 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 will likely 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, outbreaks of diseases and insects will be stressed. Leaving them more susceptible to secondary attack from pests or disease 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 Desired Future Conditions. The complete list of goals and strategies can be found in the Strategy Matrix on page 26.

### GOAL: 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 – State Hazard Mitigation Climate Adaptation Plan

### GOAL: 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, MFA, NEFF, NRCS, and TNC 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: 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:** Support 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: 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:** Support 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 and support landscape-scale projects composed of multiple tracts of lands needing protection utilizing programs such as the Forest Legacy Program and EEA's Landscapre Partnership, Conservation Partnership, Conservation Land Tax Credit, and LAND grants, and NRCS's Regional Conservation Partnership Program

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

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

**Strategy 61:** Support municipal fire agencies across the state with quality assistance in the form of detection, suppression, prevention, intelligence sharing, and grants

**Strategy 62:** Work with federal and state agencies, tribal entities, and partners to promote training programs and qualification opportunities for wildland fire resources in Massachusetts

**Strategy 63:** Promote public understanding of the benefits of prescribed fire relative to conservation and risk mitigation

**Strategy 64:** 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 65:** 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 MA population is approximately 6.8 million, an increase of 4% since 2010, 6.2 million of whom are served by public water supplies.<br>o Public water supplies in MA provide approximately 648 million gallons of water every day. That is equal to a cube of water measuring 442 feet on a side, that is equal to 1.5 football fields! Fifty-three percent of this water is delivered to households for domestic use.<br>o USGS estimates Massachusetts household water usage in 2015 at 57 gallons/person/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 itself, and 15% in dead wood debris and leaf litter. |
| **CLIMATE** | o Future rainfall amounts are expected to rise, with more rain falling in more intense events.<br>o Sea level rise may displace coastal residents, adding to the increasing development pressures on eastern Massachusetts open lands. |

*Table 2.1. Ecosystem Services Forest Facts.*

## INTRODUCTION

Forests create, protect, and are supported by the soils upon which they grow, which in Massachusetts are the product of both 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. Riparian zone trees provide coarse woody debris to stream channels that dissipates the energy of flowing water and provides essential habitat for fish and aquatic macroinvertebrates. Nearly 6.5 million people in Massachusetts depend on forests for clean water. 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 are playing an important part in a regional response to mitigate 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, and 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; floral and faunal effects on organic material accumulation and chemical cycling; and more recently human agriculture, industry, transportation, and housing.

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 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 MA forests are permanently protected (Table 2.2), but another 1.8 million forested acres remain vulnerable to conversion.

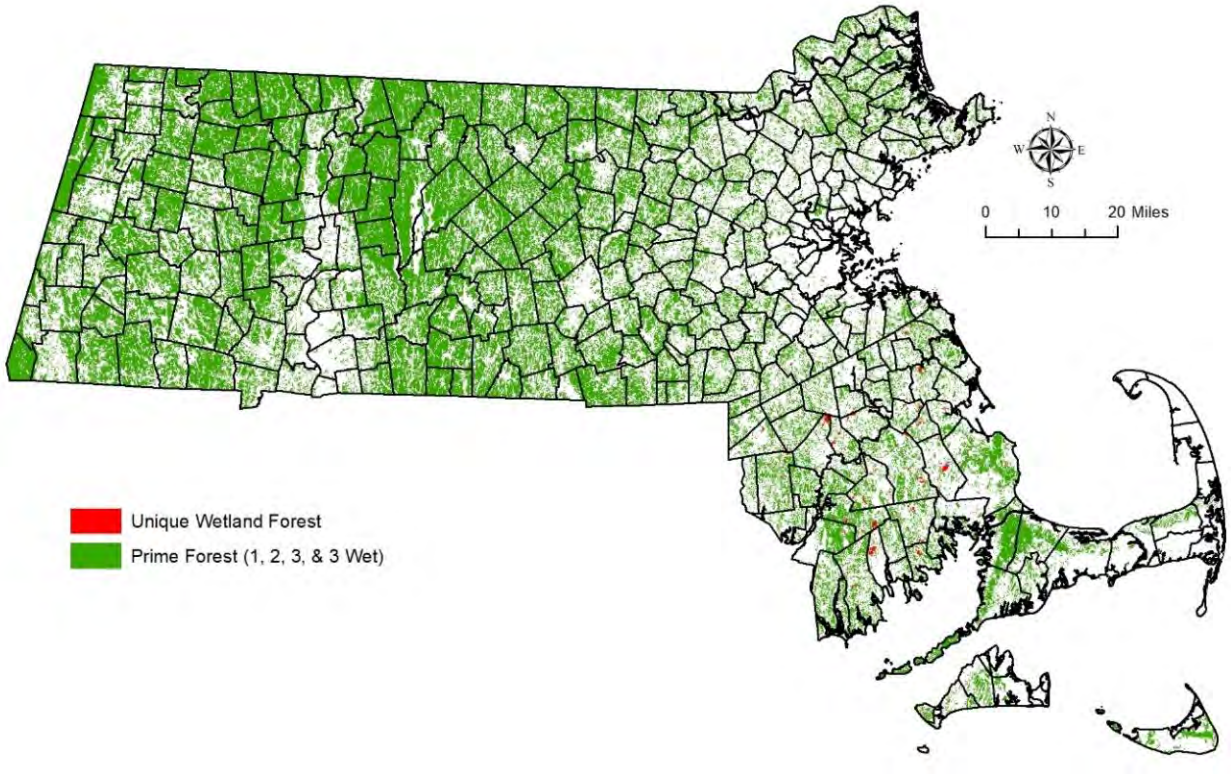



*Figure 2.1. Prime Forest in Massachusetts (MassGIS).*

| 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 >70 (WP), >65 (RO) | 354,371 | 102,008 | 7,485 | 7.9% | 6,390 | 245,973 |
| Prime 2 – SI >60 (WP, RO) | 840,648 | 281,135 | 20,044 | 7.7% | 19,835 | 539,678 |
| Prime 3 – SI >50 (WP), >55 (RO) | 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 >45 (WP), >50 (RO) | 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 <45 (WP), <50 (RO) | 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 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 (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.*

The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) is producing a Healthy Soils Action Plan for the Commonwealth in partnership with DCR, MDAR, 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) with input from stakeholders, analysis of best practices, and recommendations for each land use. The plan includes a group of forest and forestry stakeholders and should be completed during the summer of 2020.

## 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; this includes water falling as snow/ice) in recent years. 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. These deeper snowpacks and cooler temperatures contribute to increased soil moisture that supports species typical of more northern regions.

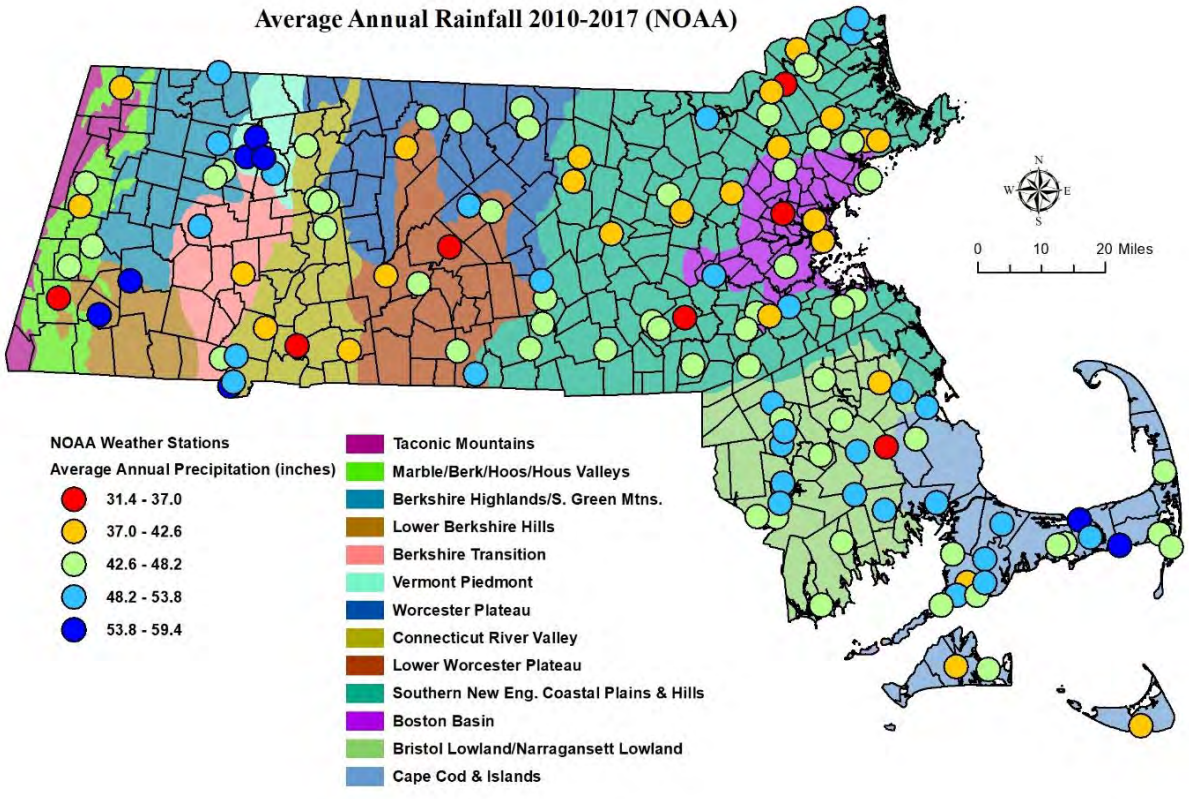



*Figure 2.2. Average annual precipitation (inches) records from available stations across Massachusetts between January 2010 and December 2017 (NOAA MassGIS).*

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.

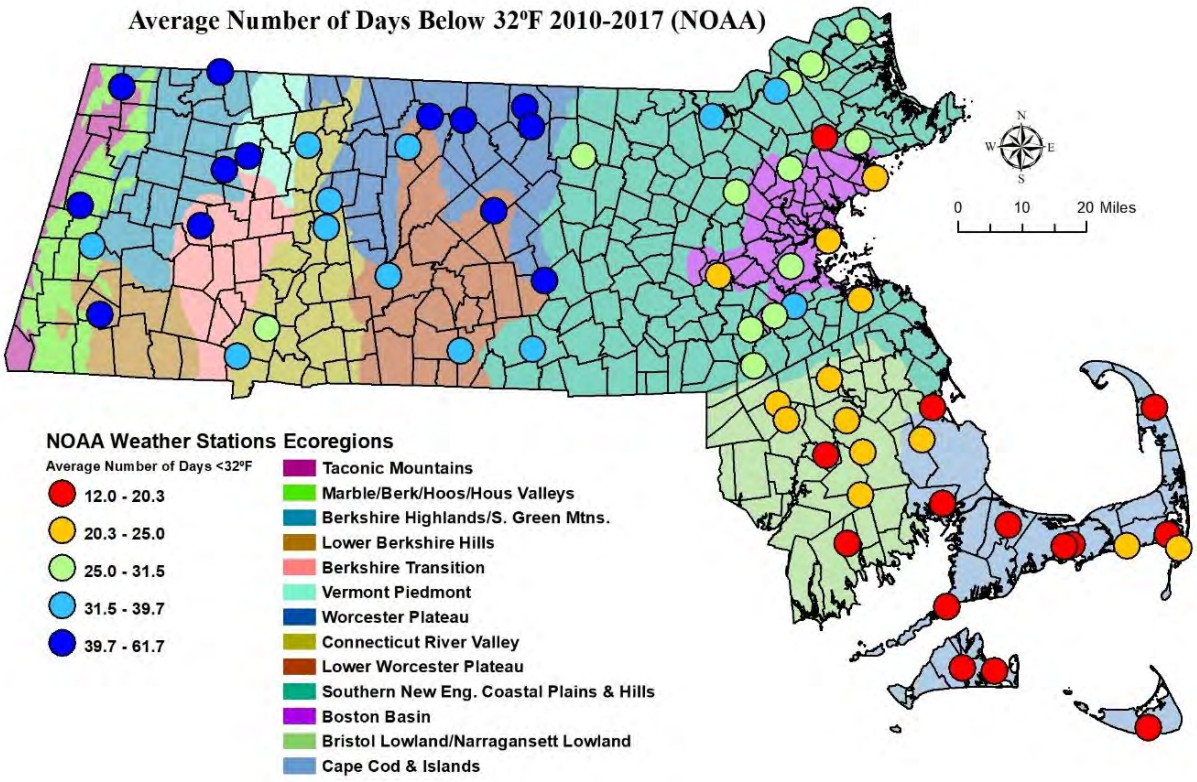



*Figure 2.3. 2010-2017 average number of days with a maximum temperature below 32 °F (NOAA, MassGIS).*

### *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 have deleterious impacts 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 BMPs (Best Management Practices) 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 forests. 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 not protected from land use conversion. In the 2010 Assessment of Forest Resources of Massachusetts, information was presented that demonstrated the importance of Massachusetts watersheds relative to other Eastern Region forested watersheds in 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 as a layer in the web map accompanying this assessment (see also Figure 2.10).

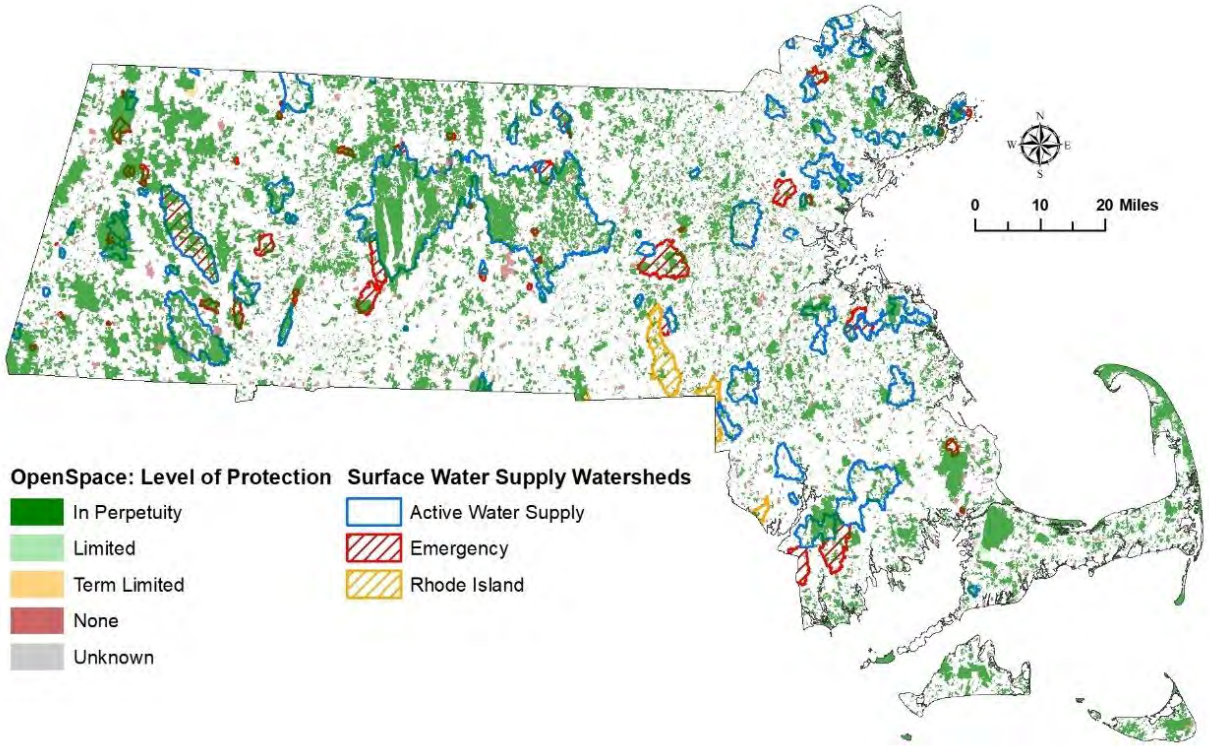



*Figure 2.4. Surface Drinking Water Supply Watersheds and Land protection in MA.*

***Surface Drinking Water***

The DCR's 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 3 million residents in the greater metro 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. 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 Forest Action Plan. The reviewers 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 the 2010 Assessment 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

*Sunset at Wachusett Reservoir, one of the DCR-managed surface drinking water supplies, photo by Kelley Freda*

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 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 155-page 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 drinking water in many areas. Unfortunately, those areas most dependent on groundwater resources are also the most susceptible to groundwater contamination. 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 multiple protections, including the establishment of wellhead protection areas and clean-up efforts, have 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.

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).

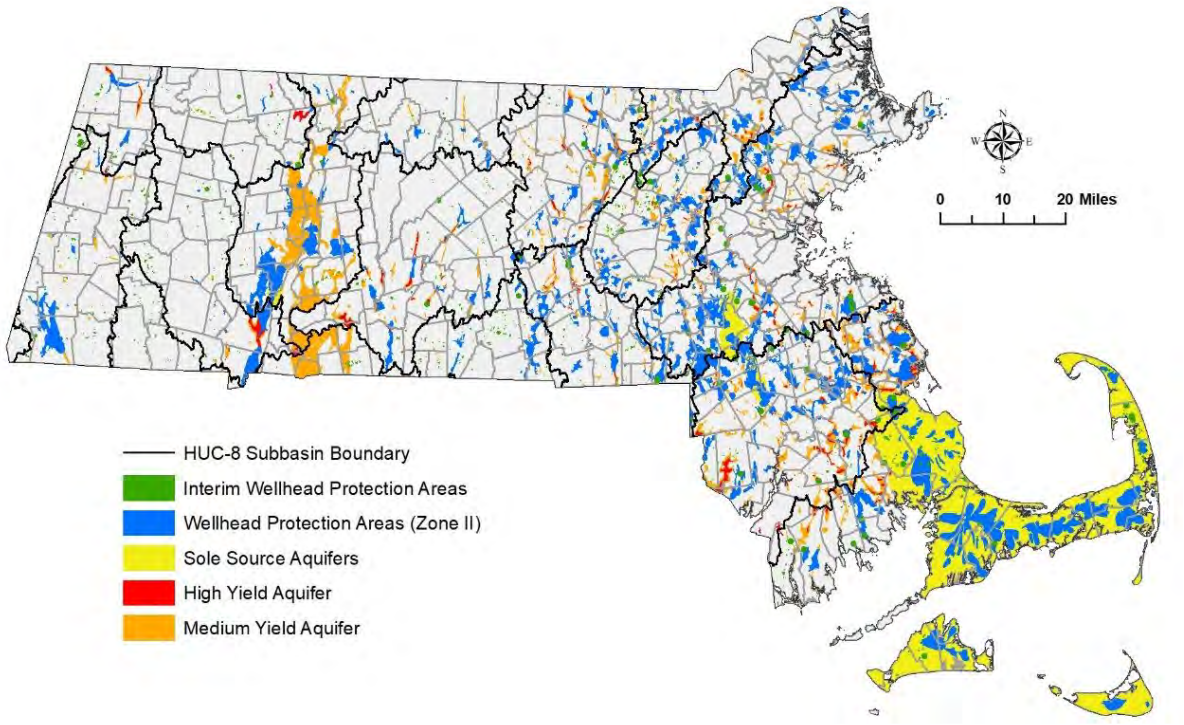



*Figure 2.5. Groundwater Recharge and Wellhead Protection Areas.*

## 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.

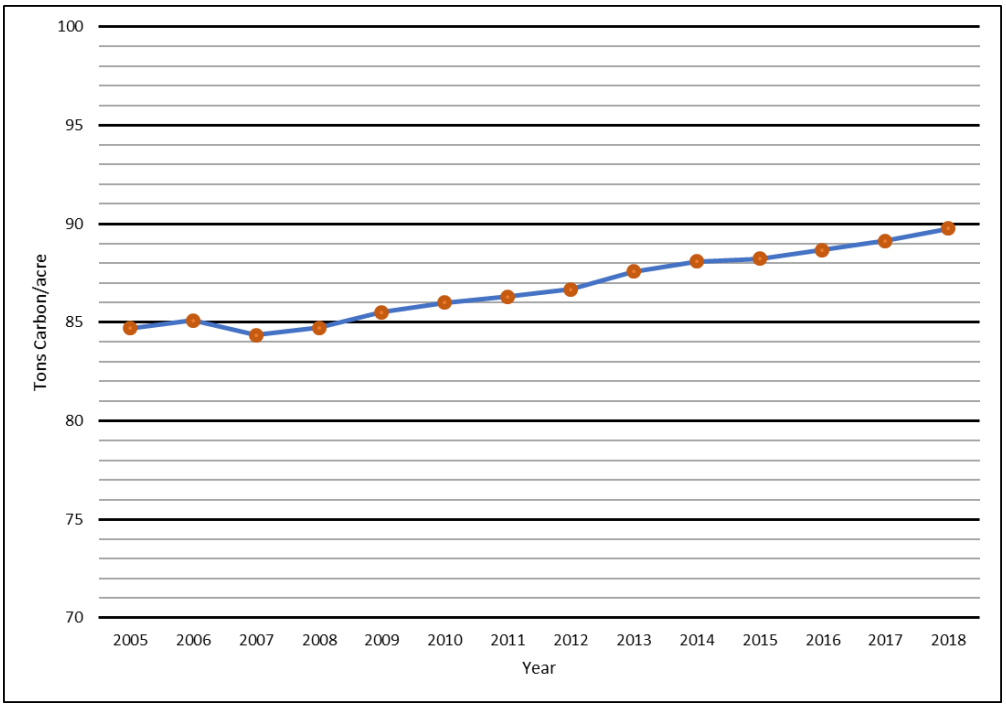
### *Forest Carbon*

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 again 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 19$^{th}$ century widespread land clearing in Massachusetts, and 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 MA forestlands, 2005-2018 (FIA 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. Given the largely




unimodal age class distribution and low overall harvest and disturbance rates realized over the past 100 years, in the absence of dramatic changes, the rate of sequestration is likely to diminish and carbon density is likely to increase asymptotically, as forest structure complexity increases (e.g., greater amounts of standing dead and forest floor carbon, e.g., Hoover et al. (2012)). Work is being done to increase awareness of practices that increase forest carbon density and rates of sequestration in managed forests, relative to business-as-usual practices, on managed forest land 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, carbon is primarily sequestered 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 (Figure 2.7). The majority of carbon stored in Massachusetts forests is in the live vegetation (~50%), both above and below ground (including coarse roots). 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. 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/acre on forestland (U.S. Forest Service FIA 2018).

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).

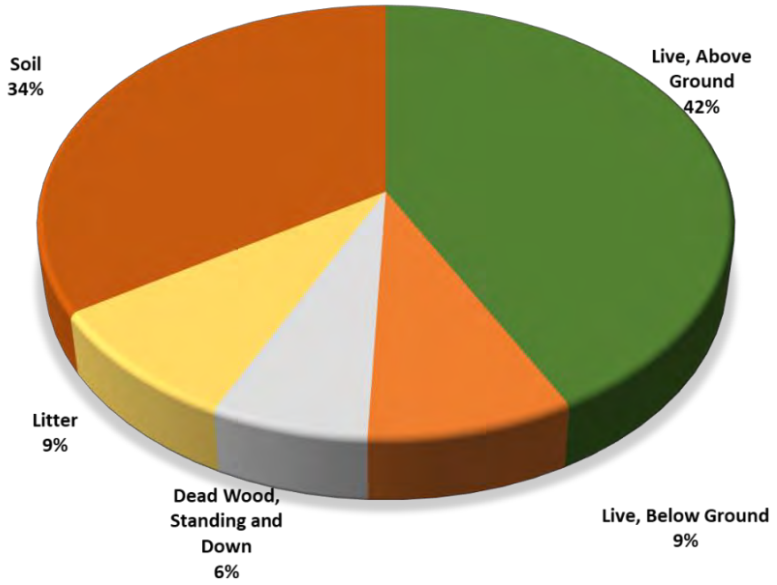



*Figure 2.7. Proportion of carbon storage in Massachusetts forest lands in the five Intergovernmental Panel on Climate Change (IPCC) pools (FIA 2018).*

***Carbon by Forest Type***

Forest type is a variable that 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.

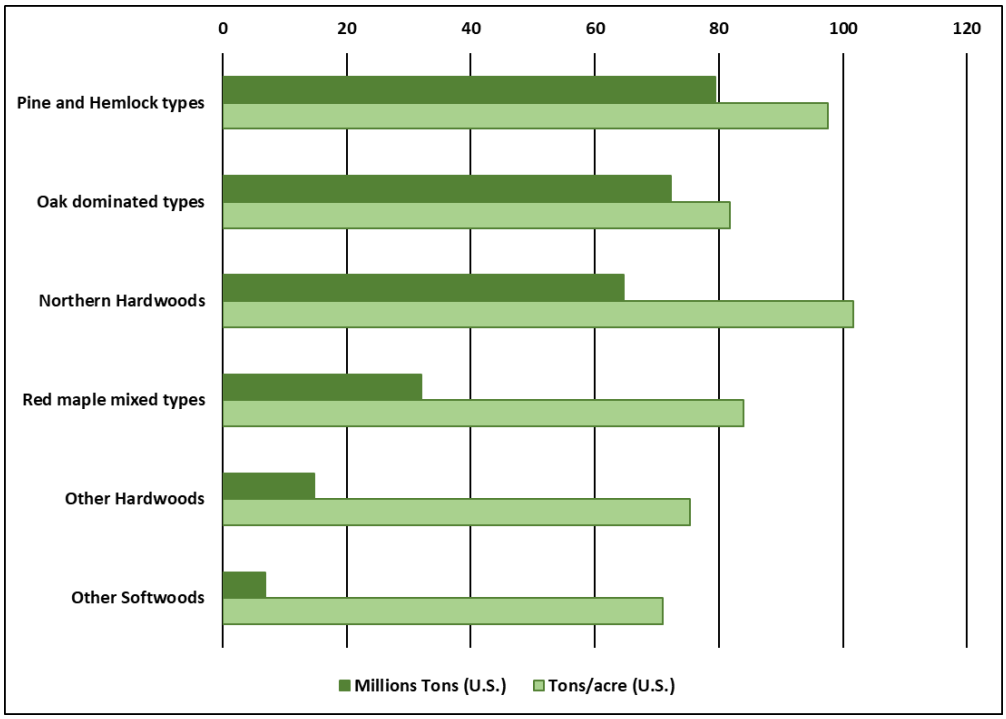



*Figure 2.8. Carbon storage by forest type in MA forestlands (FIA 2018).*

***Carbon by Forest Age***

Recent U.S. Forest Service Forest Inventory and Analysis (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; referring back to Figure 1.10 this graph should be unsurprising as together the two clearly show that total carbon storage is linked with overall acreage of forests in these age classes. 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).

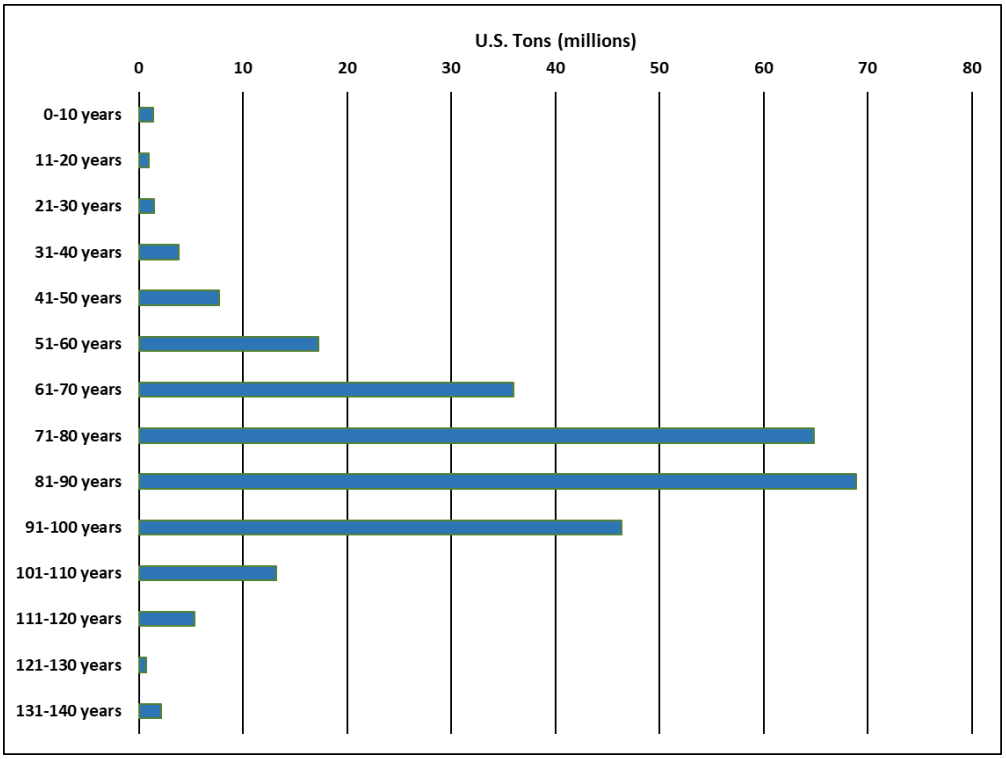



*Figure 2.9. Carbon storage by age class in MA forestlands (FIA 2018).*

***Carbon in Old Growth Stands***

Massachusetts forests are relatively young, regenerating from a long history of forest clearing, which peaked in the early-1900s (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, with accrual slowing - gradually over many years - and the importance of standing and down dead, forest floor, and forest soil carbon pools increasing in importance. These same studies indicate significant variability about 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.

*Pittsfield State Forest, photo by Kevin Hatcher*

Researchers at the University of Massachusetts Amherst and Harvard Forest (D'Amato et al. 2008) 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/acre, while the second growth stands averaged 51.8 ± 9.6 tons/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 mitigate 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, should not be disregarded. 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 an increased 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).

Urban trees can alter carbon emissions in urban environments. Through transpiration and changes in albedo, trees can help cool buildings, offsetting fossil fuel used in air conditioning. The urban tree canopy provides a host of co-benefits described in Chapter One. 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 increase 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

Silvicultural activities have been recognized by international agreements as a means to sequester carbon dioxide (Birdsey et al. 2006). The 2019 Intergovernmental Panel on Climate Change (IPCC) Special Report Climate Change and Land states “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; this percentage could be increased through improved application of sustainable forest management practices (Perschel et al. 2007), although 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 in Massachusetts forests include forest land protection, afforestation, lowering 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 (Ryan et al. 2010). To increase carbon sequestration, the Forest 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).

**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.

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. 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.

DCR has hired 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 the Northern Institute of Applied Climate Science (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. EEA hopes to fund (via state and federal payments) payments to landowners for adopting practices from this menu.

## CHALLENGES AND THREATS

### *Climate Change and Water Supply*

The predicted effects in Massachusetts of current climate change trends are stressed repeatedly throughout this 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*

*"It was a cord of maple, cut and split*
*And piled—and measured, four by four by eight.*
*…I thought that only*
*Someone who lived in turning to fresh tasks*
*Could so forget his handiwork on which*
*He spent himself, the labor of his ax,*
*And leave it there far from a useful fireplace*
*To warm the frozen swamp as best it could*
*With the slow smokeless burning of decay."*
*– Robert Frost, "The Wood-Pile*

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. Tree species' ranges 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/acre)/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 (13.5 acres/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 States (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 in Massachusetts. However, many of these forests are vulnerable to development (Figure 2.10), and more acres are converted each day. Forest conversion to residential, commercial, and industrial uses threatens critical areas of watersheds that were once protected by forests. Potential threats come from septic systems, lawn care practices, stormwater discharges, 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 a host 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.

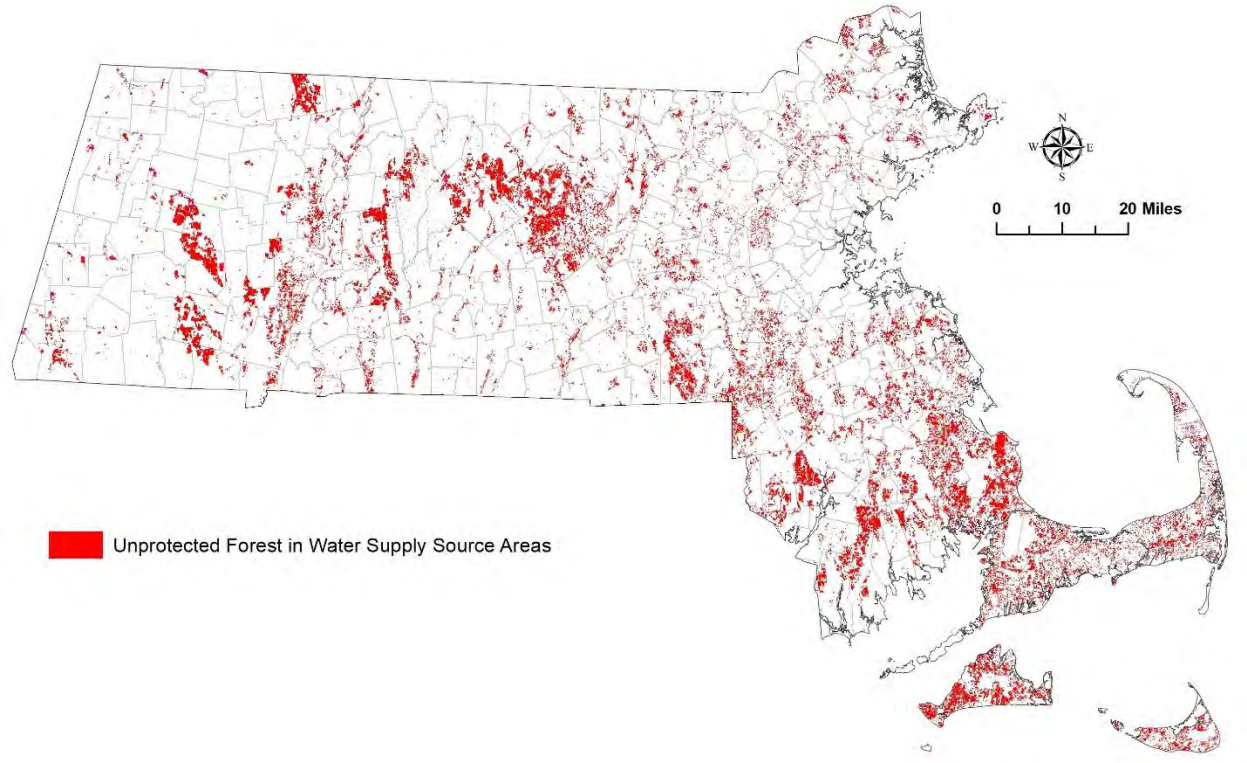



*Figure 2.10. Forest cover threatened by conversion in public water supply source areas (MassGIS).*

***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 store in Massachusetts into the future. FIA estimates show that Massachusetts has lost 0.4% forest land from 2012 to 2017. Rhode Island and Connecticut actually show modest gains in forest land (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 Desired Future Conditions. The complete list of goals and strategies can be found in the Strategy Matrix on page 26.

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

**Strategy 52:** Promote forest activities and associated programs relative to carbon storage

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

**Strategy 56:** Engage with conservation partners to promote understanding of forestry BMPs

**Strategy 57:** Develop and support projects and practices to retain tree canopy in urban and suburban areas

**Strategy 58:** Support green infrastructure and low-impact development to reduce the impact of storm water and air pollution

**Strategy 59:** Promote land conservation in important drinking water supply areas

**Strategy 60:** 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. This chapter will focus primarily on timber.

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, mortality, and other characteristics. Data also come from the forest cutting plan database maintained by the Department of Conservation and Recreation (DCR) Service Forestry Program.

| Productive Capacity Forest Fact | 2008 | 2017 | Change since 2008 |
|---|---|---|---|
| **Timberland Area (million acres)** | 2.844 | 2.874 | + 0.03 |
| **Sawtimber volume (million board-feet International ¼-inch rule)** | 23,190 | 27,390 | + 4,200 |
| **Growth-to-Harvest Removal** | 2.4:1 (2007) | 4.8:1 | + 100% |
| **Top four species harvested (by merchantable bole volume of trees at least 5 in. diameter at breast height)** | northern red oak<br>eastern white pine<br>black oak<br>red maple | red maple<br>northern red oak<br>eastern white pine<br>eastern hemlock | |

*Table 3.1. Productive capacity forest facts (FIA Evalidator 1.8.0.00).*

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" (US Forest Service 2016). Approximately 2,874,000 acres of forestland in Massachusetts are classified as timberland.

Not all timberland may be available for timber 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 reduced availability by 5.8% (the constraints are not additive, so total reduction in Massachusetts is 68.2%). Out of the twenty 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 585,725 acres. Yet, even with such large acreages under the purview of agencies and conservation organizations, private landowners own the bulk of forestland in Massachusetts, 2,193,496 acres (NLCD 2016). See Table 1.2 for more information.

### *Forest History*

From the beginning of the abandonment of farmland in Massachusetts in the mid-1800s, forest land 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). All of our forests (rural, suburban, and urban) have also been significantly altered by exotic insects and diseases. Chestnut blight, white pine blister rust, gypsy moth, hemlock woolly adelgid and 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 these values, are required to file a Forest Cutting Plan (FCP) for review and approval by DCR's 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 two 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 different foresters or other individuals preparing forest cutting plans. It is assumed that differences in estimates even out to a large extent 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 have to 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 US Forest Service and industry conversion factors (see appendix).

Over the last ten 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 $ft^3$ has been proposed for harvest in Massachusetts, larger than the average for 2003-2009 (Figure 3.1).

Cutting plan data from 2003-20017 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 2020).

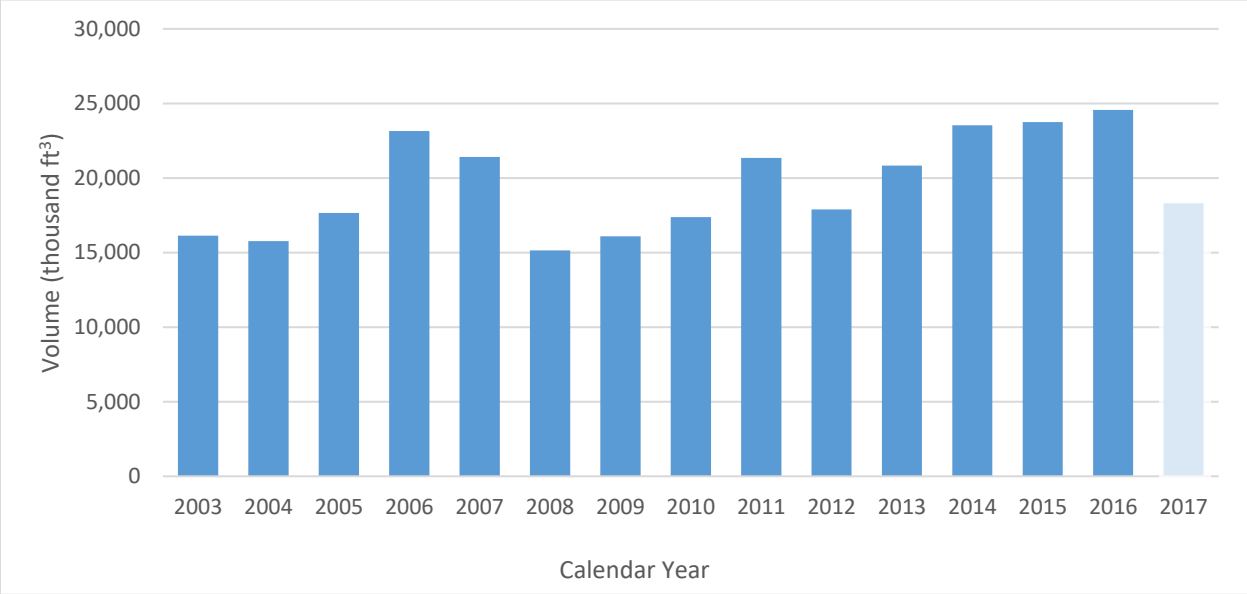



*Figure 3.1. Volume proposed for harvest 2003-2017. Note that 2017 data reflect a partial calendar year (approx. 10 months) (DCR Bureau of Forest Fire Control and Forestry).*

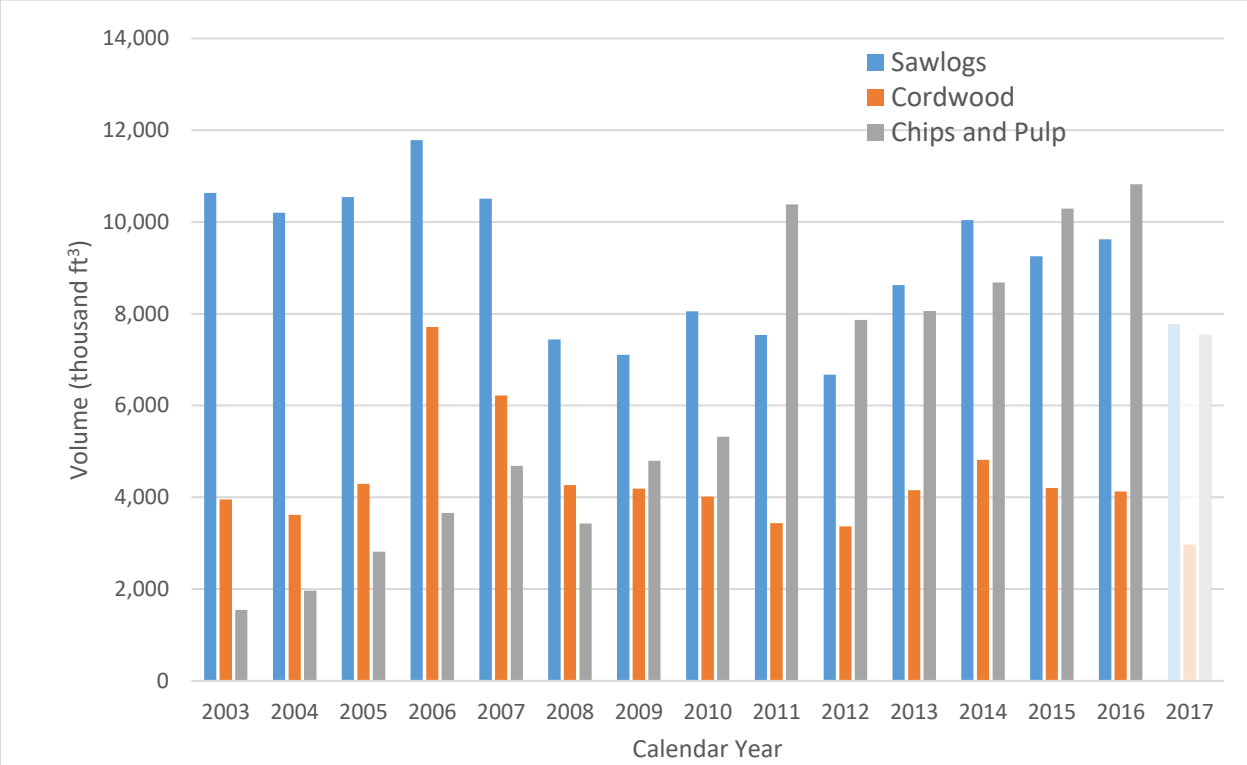



*Figure 3.2. Volume of sawlogs, cordwood, and chips and pulps proposed for harvest, 2003-2017. Note that 2017 data reflect a partial calendar year (approx. 10 months) (DCR Bureau of Forest Fire Control and Forestry).*

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 incentivized 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).

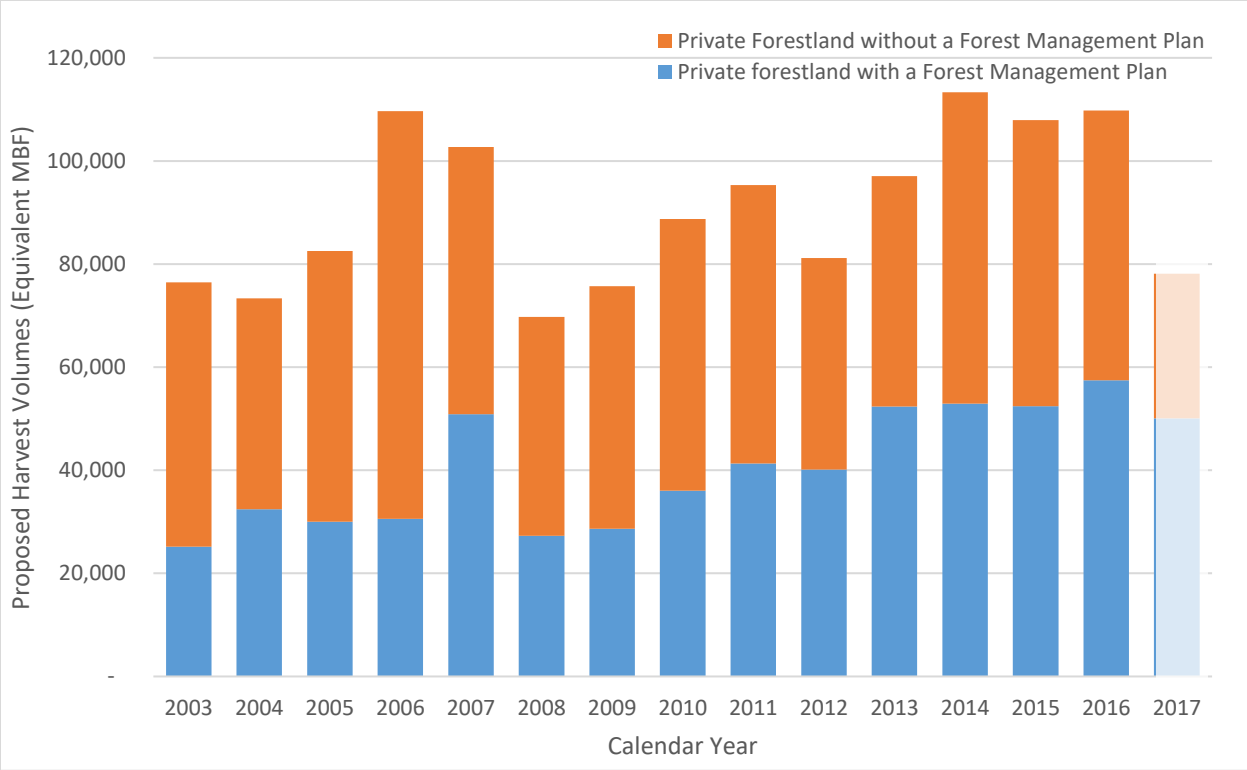



*Figure 3.3. Proposed harvest volumes (MBF) on private forestland over time, separated by harvest with and without a forest management plan in place. Forest management plans include Forest Stewardship Plans and Chapter 61/61A/61B plans written by a Massachusetts licensed forester. Note that 2017 data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

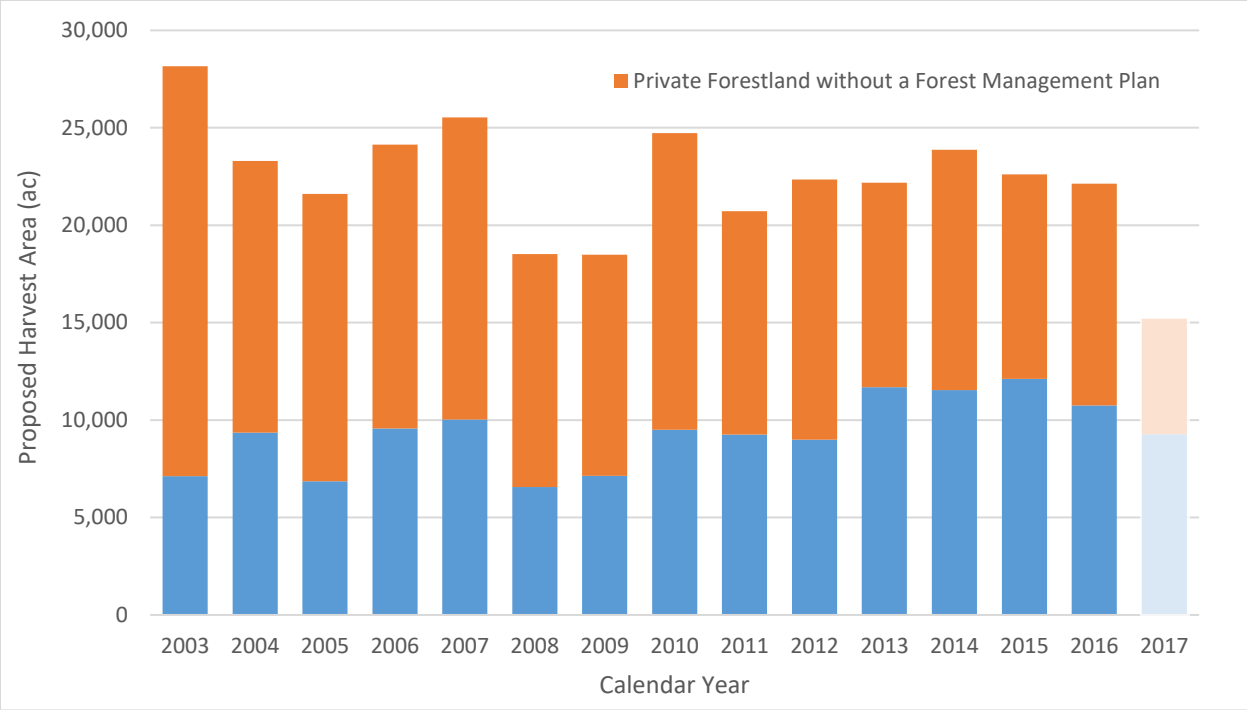



*Figure 3.4. Area of proposed timber harvest in acres on private forestland over time, separated by harvest with and without a forest management plan in place. Forest management plans include Forest Stewardship Plans and Chapter 61/61A/61B plans written by a Massachusetts licensed forester. Note that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

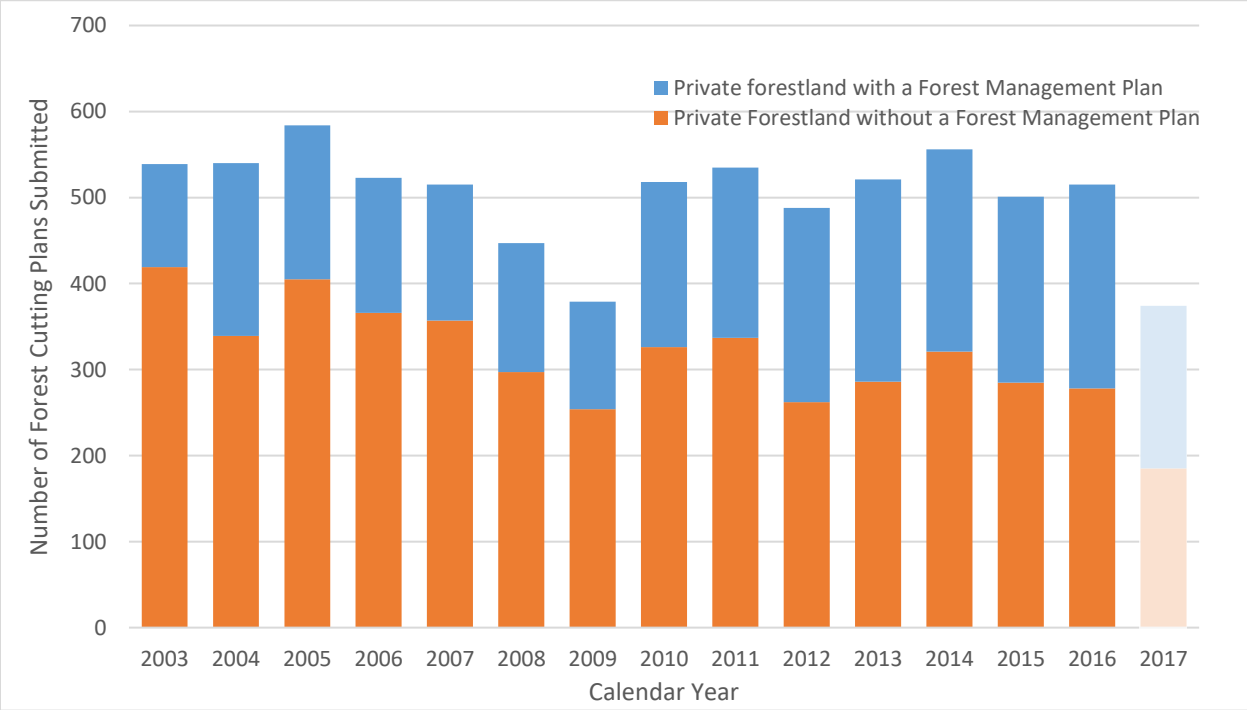



*Figure 3.5. Number of forest cutting plans submitted for proposed timber harvest on private forestland over time, separated by harvest with and without a forest management plan in place. Forest management plans include Forest Stewardship Plans and Chapter 61/61A/61B plans written by a Massachusetts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

Harvest volumes and area have held rather steady, with the exception of the 2009 economic crisis, with roughly 100 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).

Although the vast 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 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 of some fashion. 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, discussed in 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.

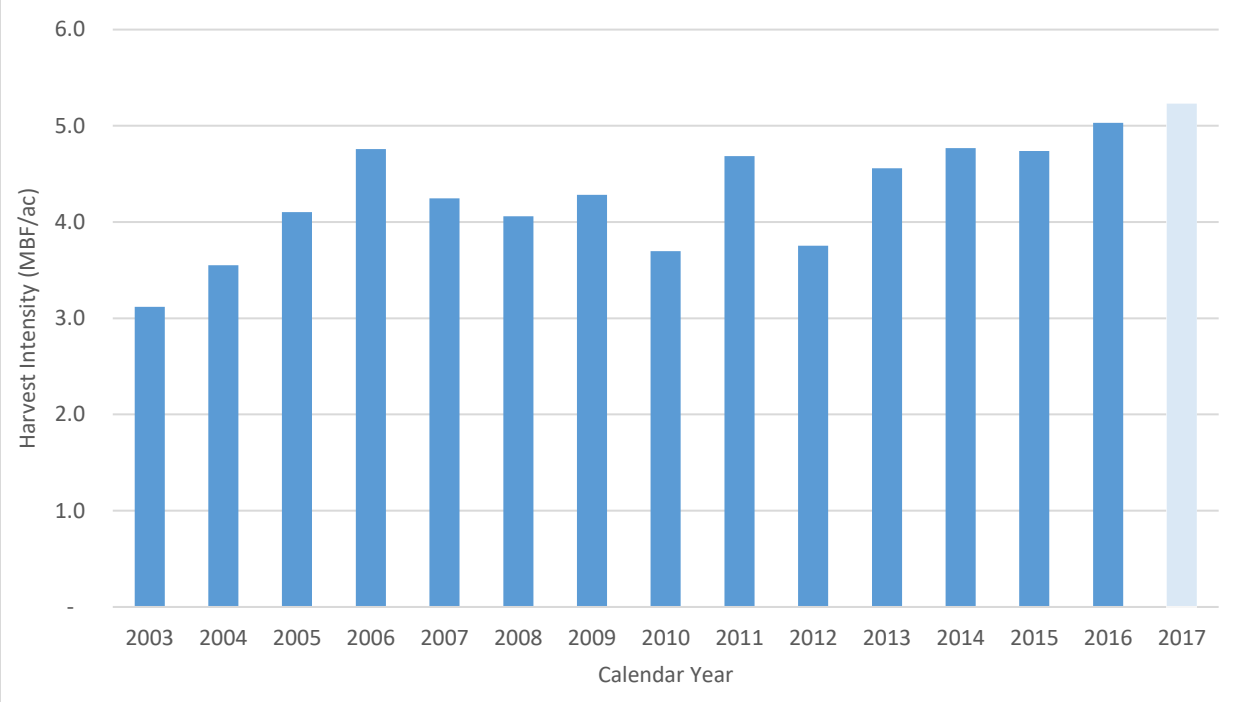



*Figure 3.6. Harvesting activity as the number of board feet harvester per acre. Note that 2017 data reflect a partial calendar year (approx. 10 months) (DCR Bureau of Forest Fire Control and Forestry).*

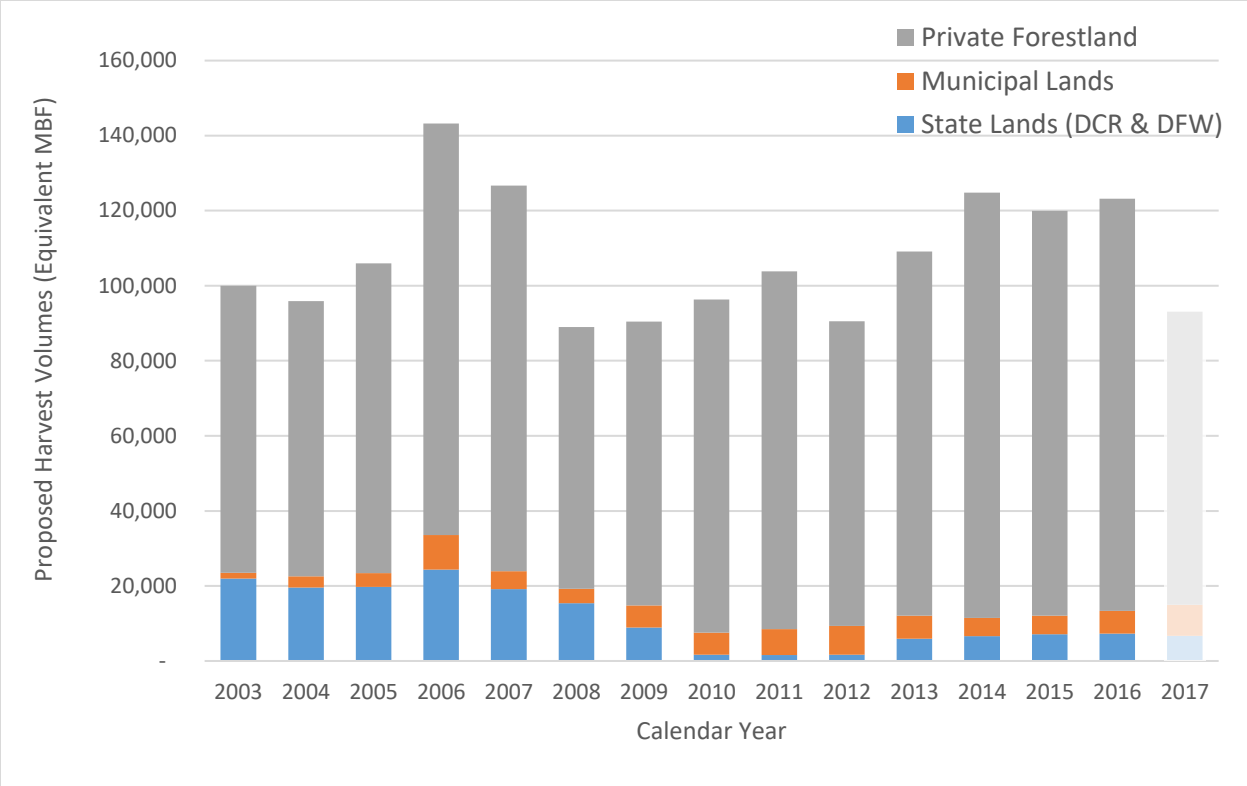



*Figure 3.7. Equivalent volume of proposed timber harvests in MBF by ownership type over time. Note that 2017 data reflect a partial calendar year (approx. 10 months) (DCR Bureau of Forest Fire Control and Forestry).*

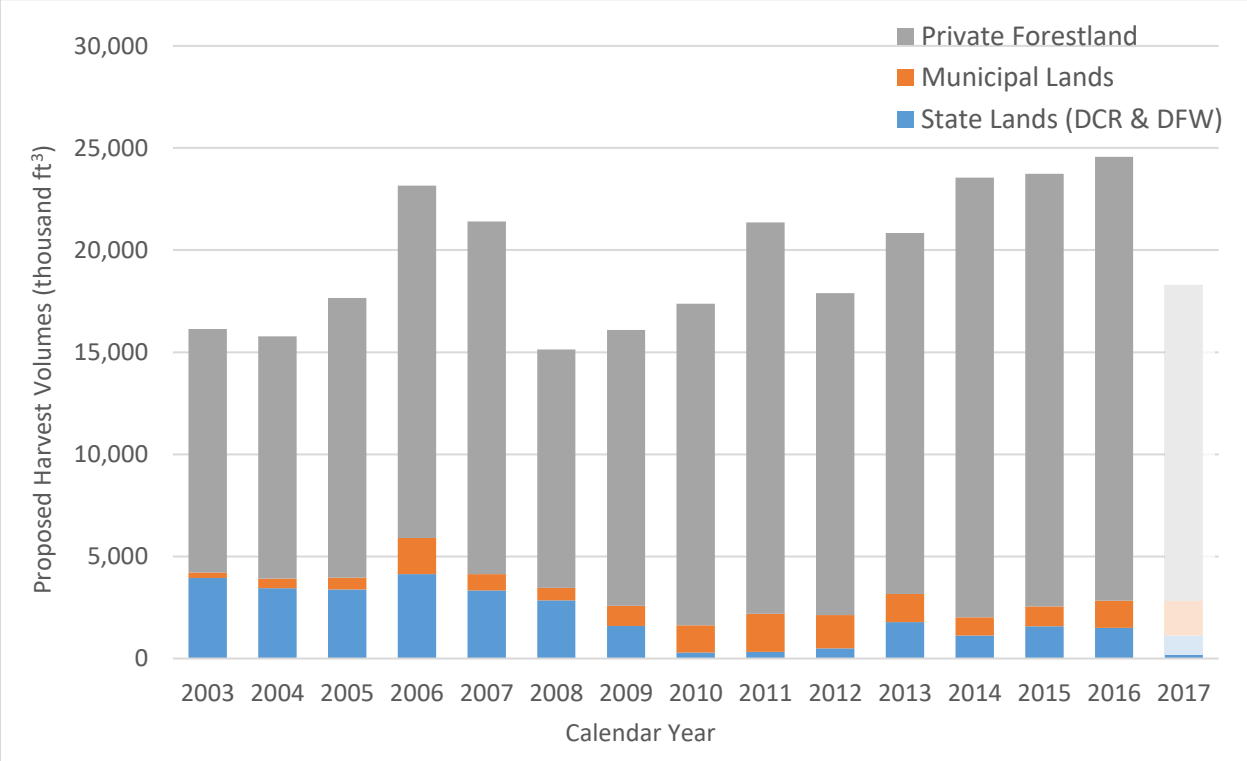



*Figure 3.8. Volume of proposed timber harvests in thousand cubic feet by ownership type over time. Note that 2017 data reflect a partial calendar year (approx. 10 months.) (DCR Bureau of Forest Fire Control and Forestry).*

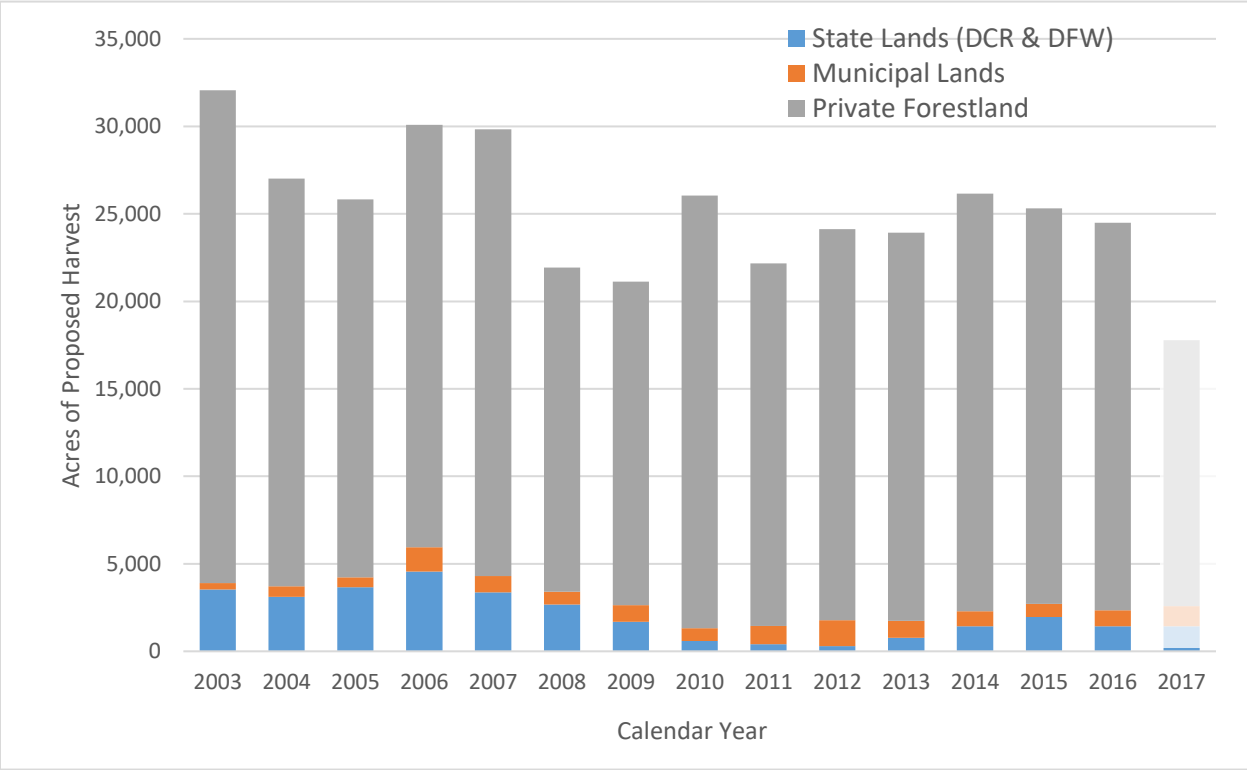



*Figure 3.9. Area of proposed timber harvest in acres by ownership type over time Note that 2017 data reflect a partial calendar year (approx. 10 months) (DCR Bureau of Forest Fire Control and Forestry).*

***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 One). 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 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 (but not limited to), 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, improved wildlife habitat, and

increased 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.


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

Land managed by the DCR Division of Water Supply Protection (DWSP) and MassWildlife were not subject to the Forest Futures Visioning process, but had their own separate reviews occurring 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.

MassWildlife manages its land to meet habitat goals for wildlife and plant conservation. Through its Habitat Programs, DFG works to conserve a variety of wildlife and plants including rare and declining wildlife species identified in the 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.

| 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 (USDA FS, Forests of Massachusetts 2018 and FIA Evalidator 1.8.0.00).*

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 8 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 5 inches DBH), in cubic feet, on timberland (FIA Evalidator 1.7.2.00 2017). The most common species of growing stock tree is red maple, followed by eastern white pine and eastern hemlock (Figure 3.13).

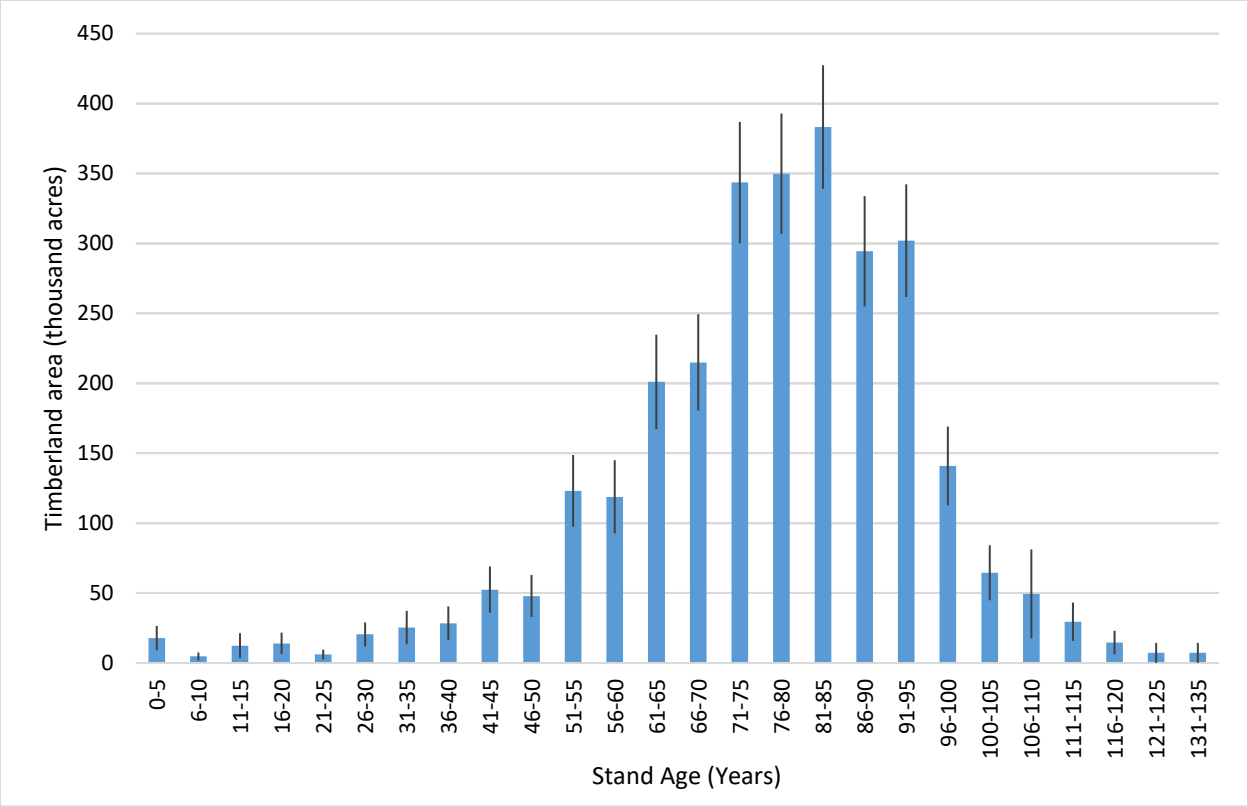



*Figure 3.10. Stand age of forest stands on timberland in Massachusetts. Error bars represent one standard deviation, 2017 (FIA Evalidator 1.8.0.00).*

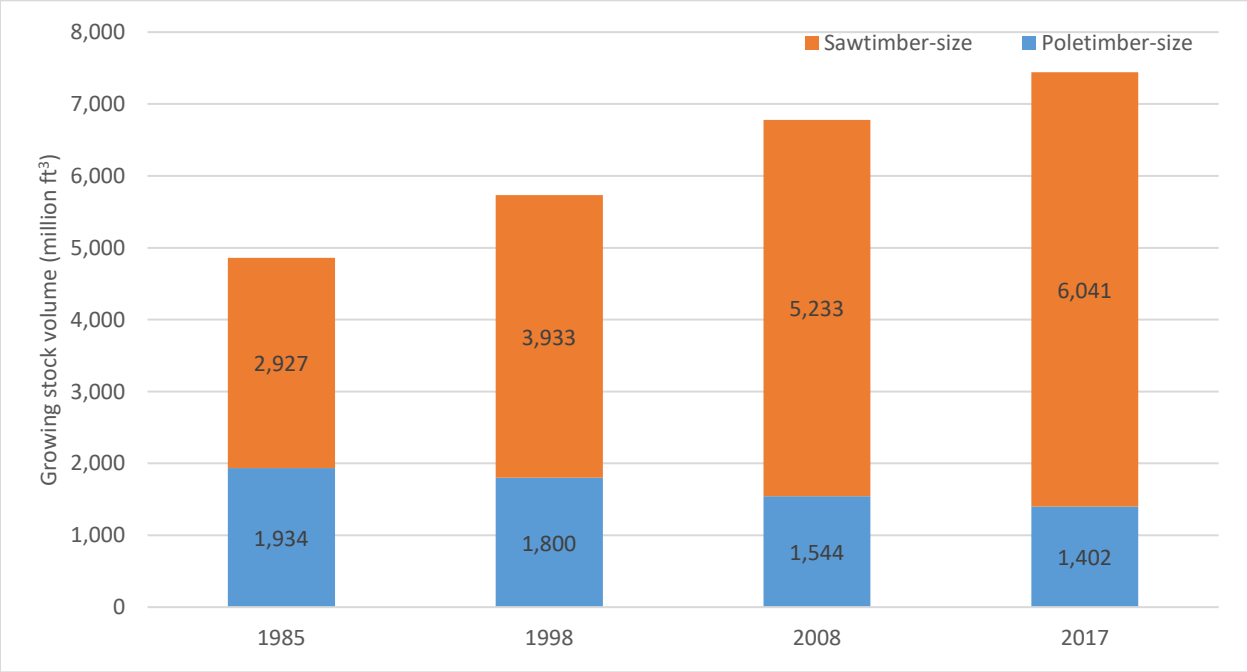



*Figure 3.11. Volume of growing stock on timberland. Percent sampling error for all subcategories is less than 6%, 2017 (FIA Evalidator 1.7.2.00).*

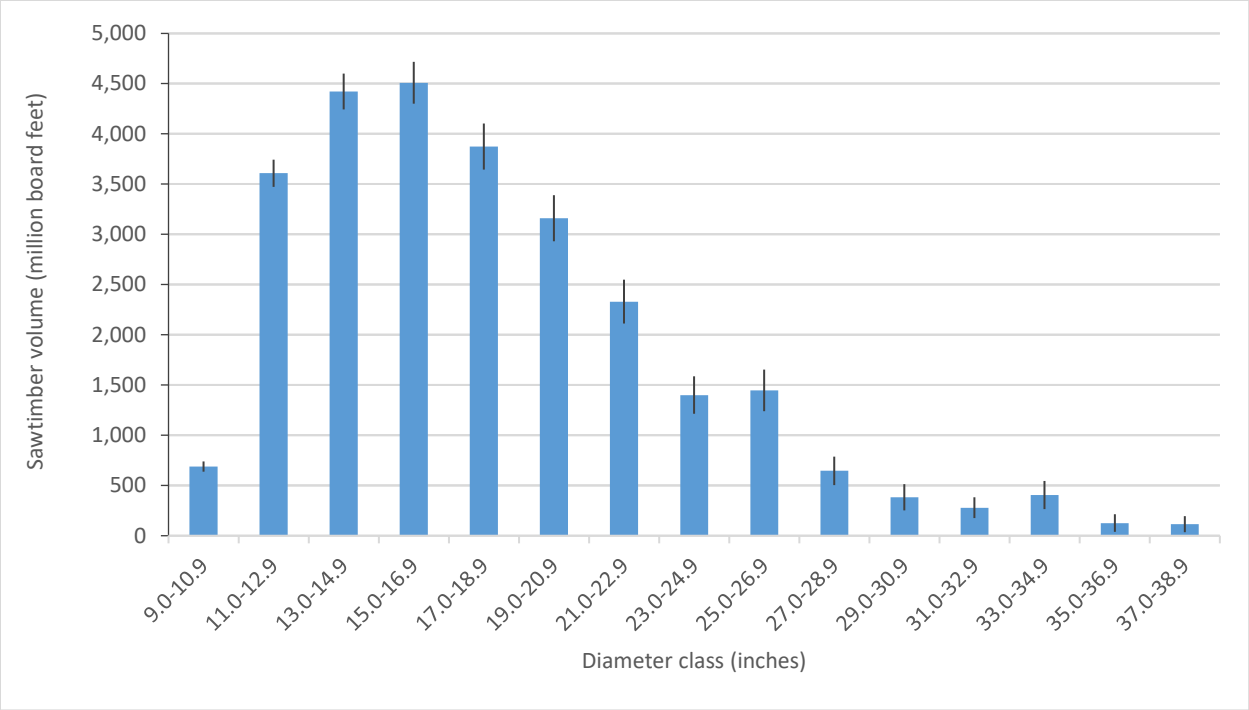



*Figure 3.12. Sawtimber volume by diameter class on timberland. The minimum diameter (at breast height [DBH] for sawtimber is 9 inches for softwood and 11 inches for hardwood. Error bars represent one standard deviation (FIA Evalidator 1.7.2.00, 2017).*

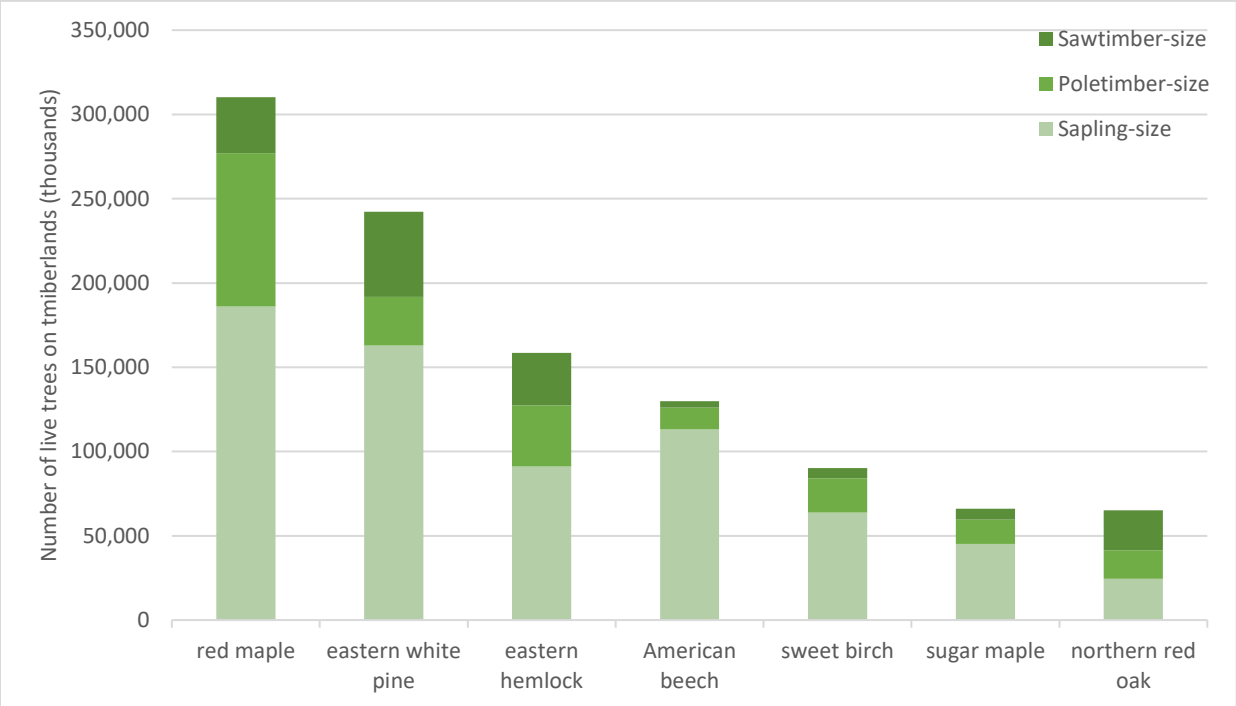



*Figure 3.13. Live growing stock trees on timberland (saplings 1.0 to 4.9 inches DBH; poletimber 5.0 inches to sawtimber; sawtimber: softwoods 9.0+ inches DBH, hardwoods 11.0 inches DBH; percent sampling error for all subcategories is less than 19%, 2017 (FIA Evalidator 1.7.2.00, 2017).*

### *Tree Grading*

FIA data show that the average net board-foot volume per live, sawlog-sized, growing stock tree on forest land 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 3 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).

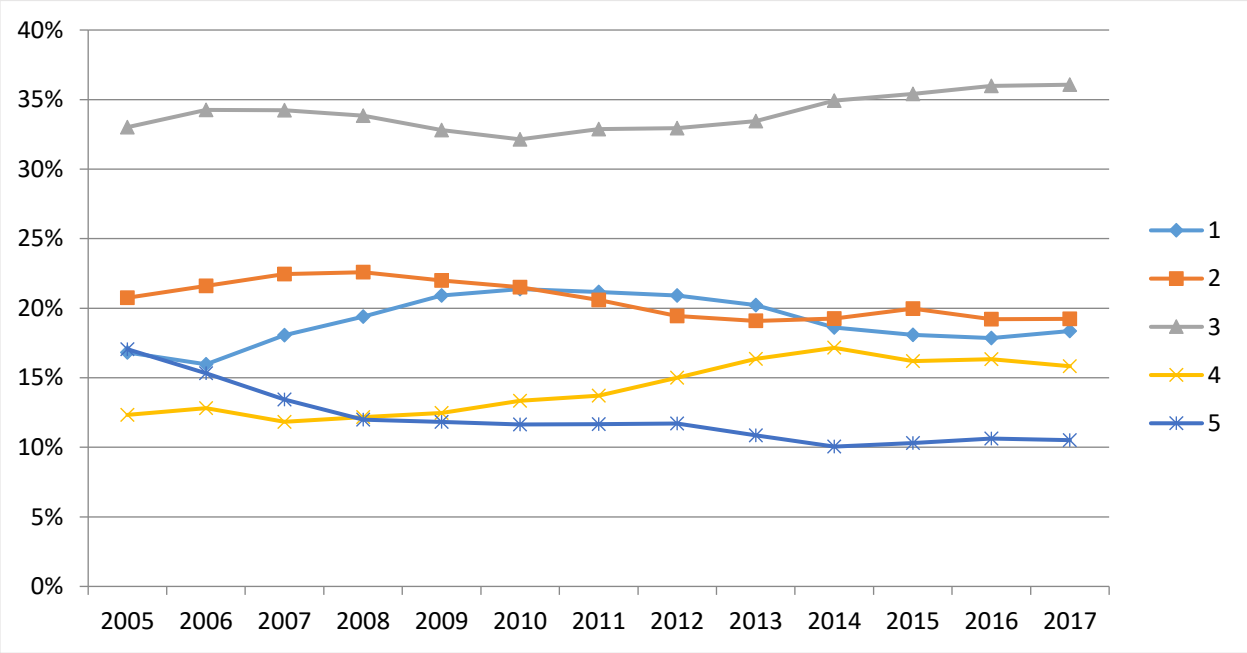



*Figure 3.14. Average board-foot volume per live, sawlog-sized, growing stock tree on forest land by tree grade (1 (highest) – 5 (lowest)) and year (FIA 2018).*

### *Timber Harvesting*

The vast 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 Pioneer 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 4 (FIA Evalidator 1.8.0.01).

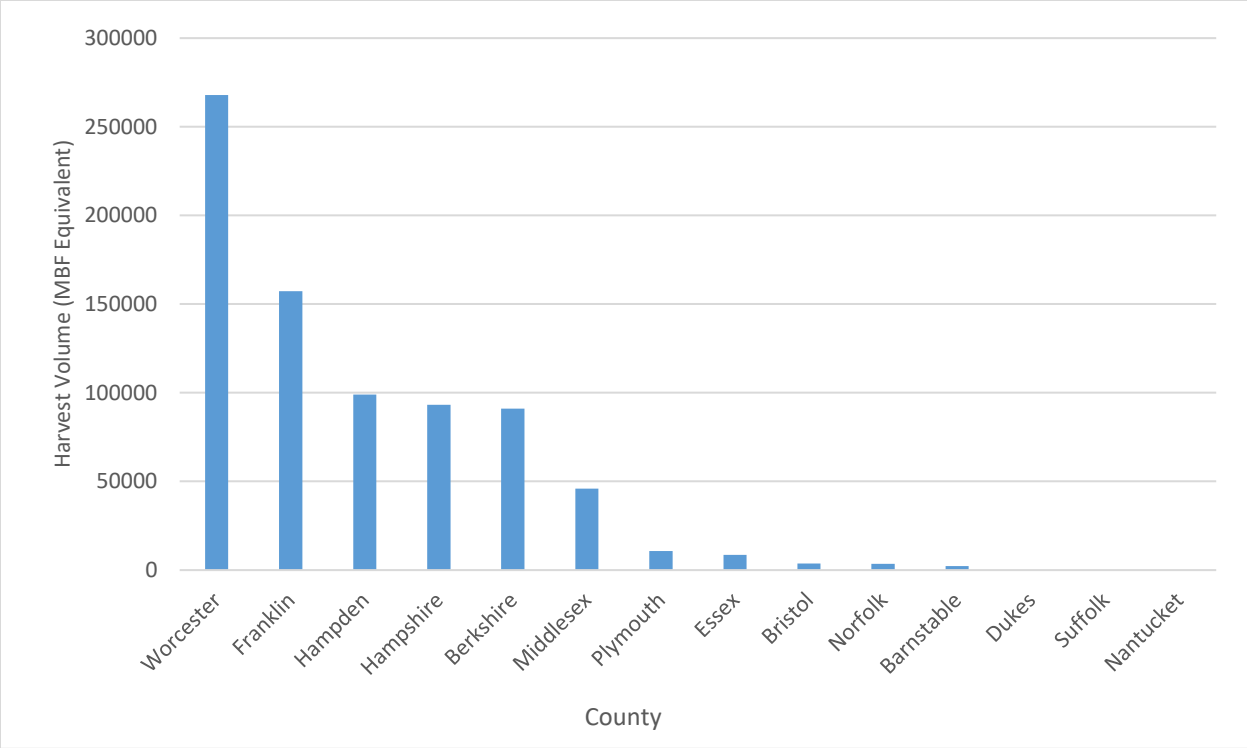



*Figure 3.15. Harvest volume in MBF, by county, from Cutting Plan data from state fiscal year 2011-2017 (DCR Bureau of Forest Fire Control and Forestry).*

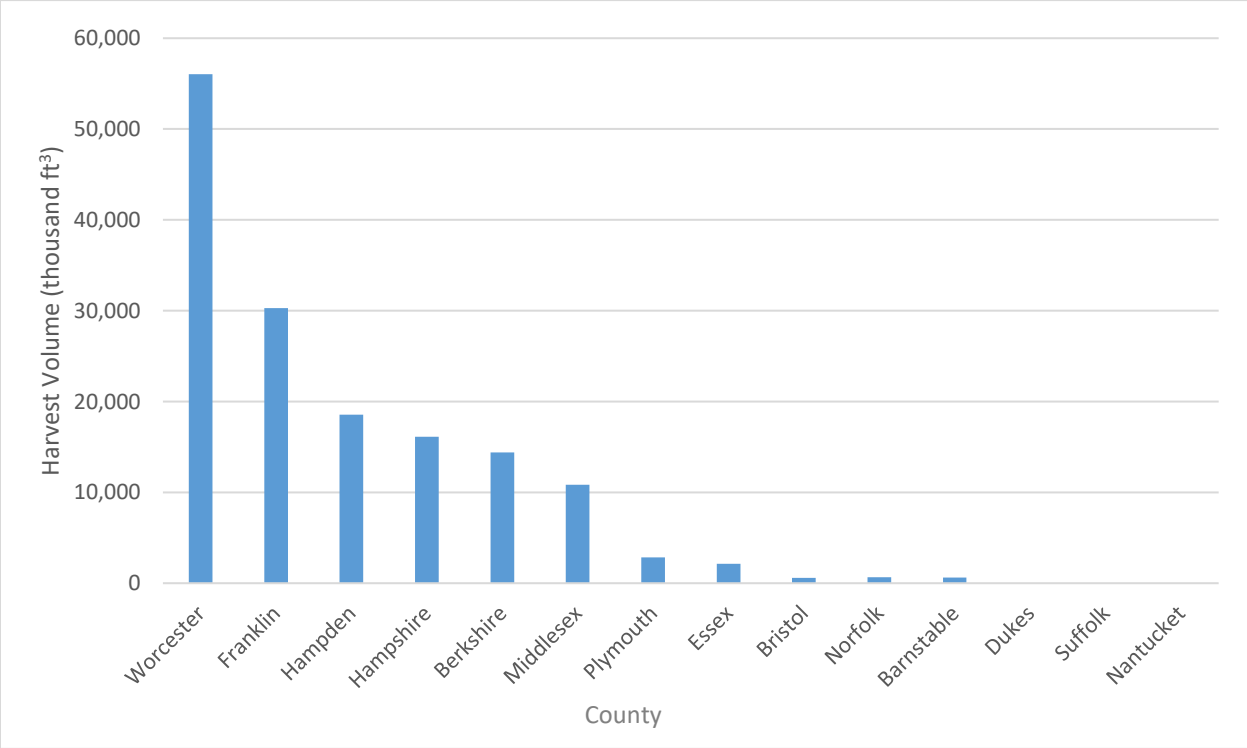



*Figure 3.16. Harvest volume in thousand cubic feet, by county, from Cutting Plan data from state fiscal year 2011-2017 (DCR Bureau of Forest Fire Control and Forestry).*

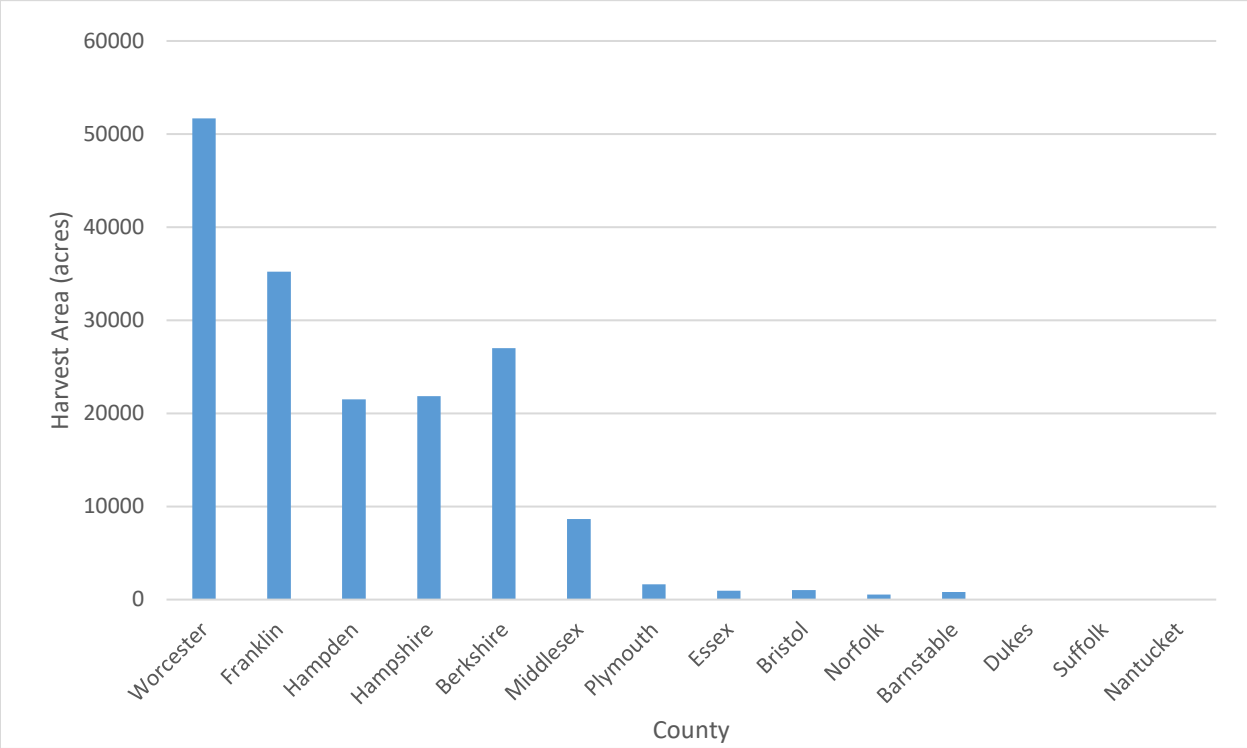



*Figure 3.17. Harvest area in acres, by county, from Cutting Plan data from state fiscal year 2011-2017 (DCR Bureau of Forest Fire Control and Forestry).*

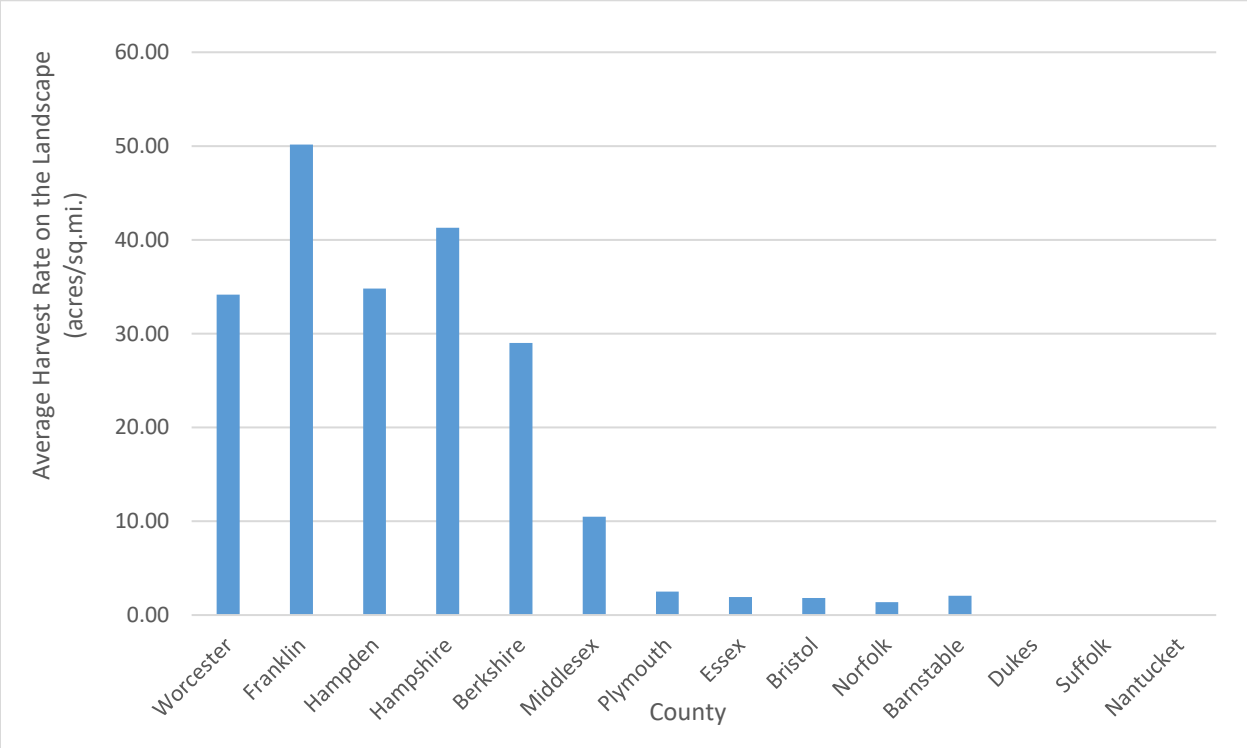



*Figure 3.18. Average Harvest rate (acres/mi$^2$), by county, from Cutting Plan data from state fiscal year 2011-2017 (DCR Bureau of Forest Fire Control and Forestry).*

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 Ch132) must hold a timber harvester license. The purpose is 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 went up in 2009, by 27 licenses (Table 3.3).

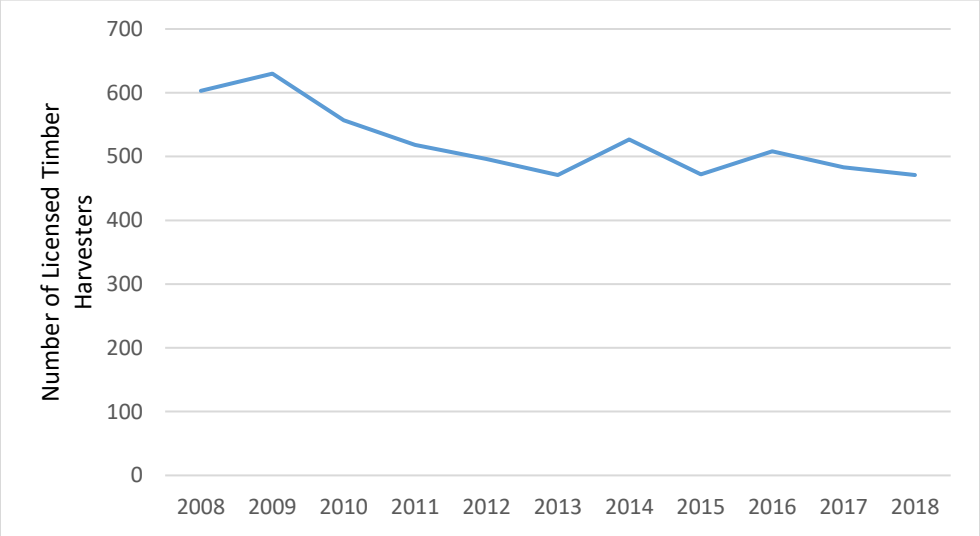



*Figure 3.19. Number of timber harvesters licensed in Massachusetts by fiscal year (DCR Timber Harvester License database).*

| | 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 (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 the previous forest assessment, annual net growth of forests in Massachusetts exceeds annual harvest removals on timberland and forestland. In 2016, the growth to removals ratio was 4.8:1. 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).

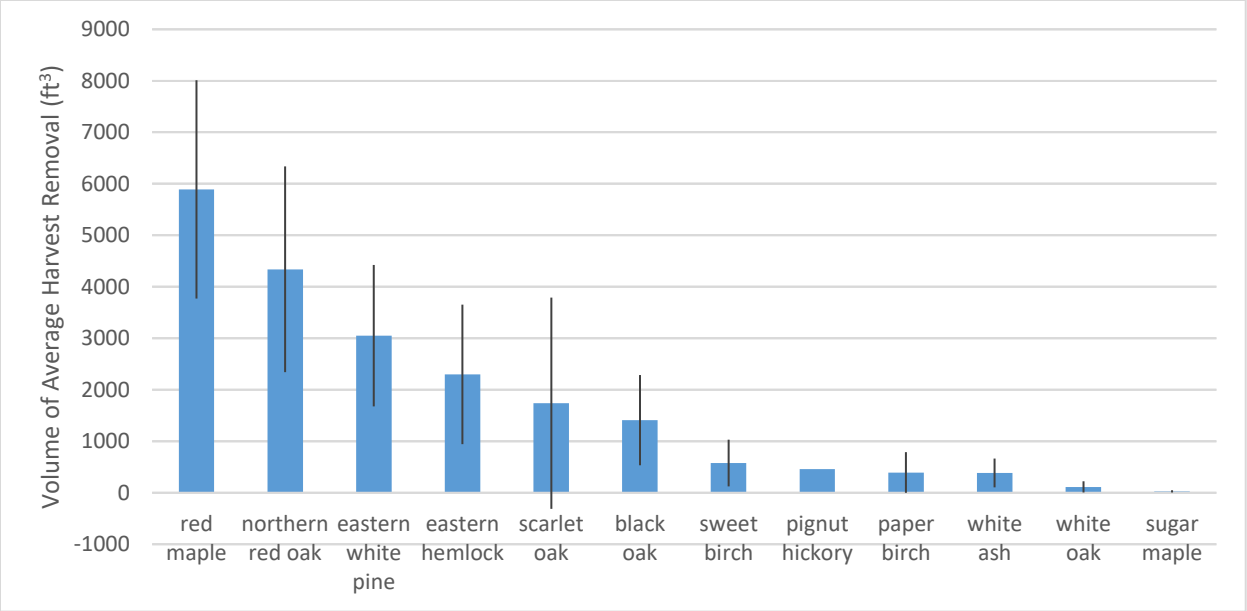



*Figure 3.20. Average annual harvest removals of merchantable bole volume of growing stock trees (trees over 5.0 inch DBH) in cubic feet on timberland, 2017 (FIA Evalidator 1.7.2.00).*

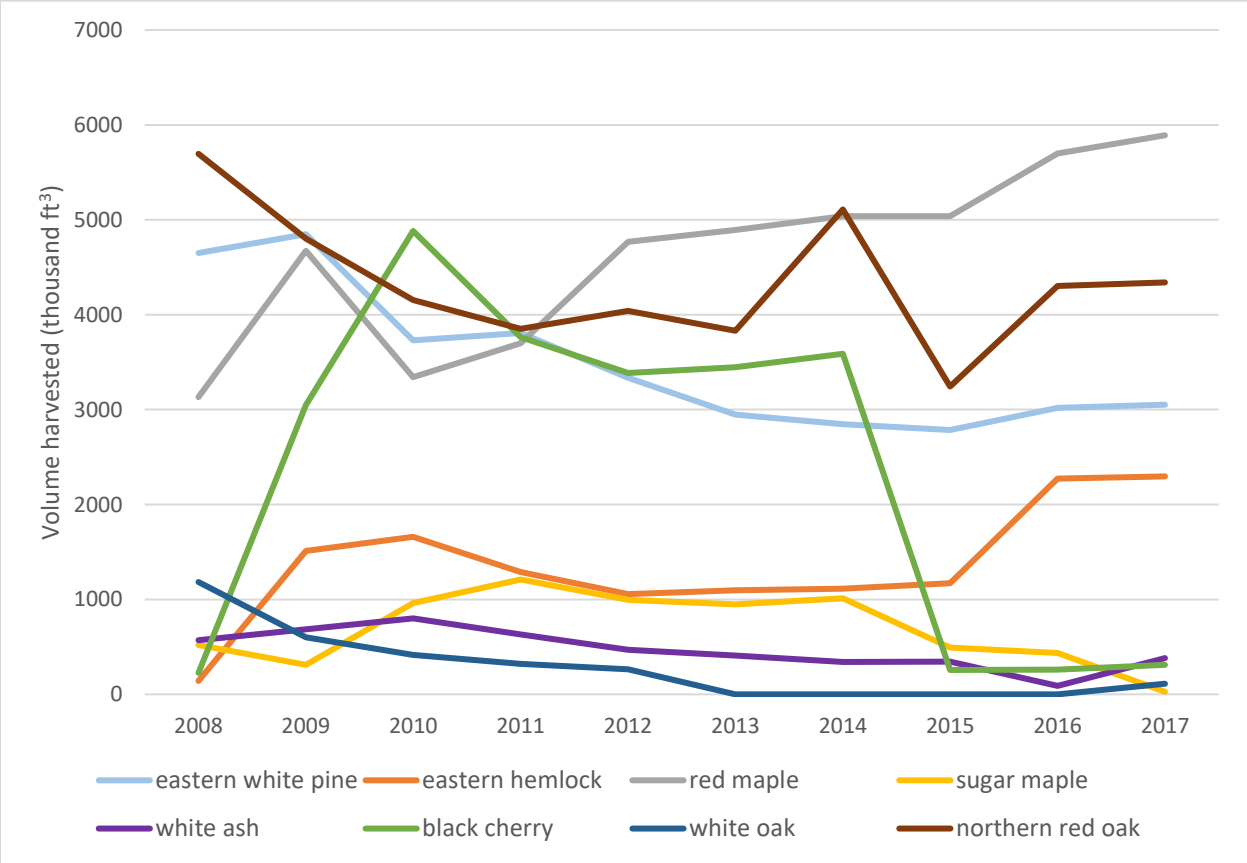



*Figure 3.21. Species by estimated average annual harvest removals of merchantable bole volume of growing-stock trees (at least 5 inches d.b.h.), in cubic feet on timberland from 2008 to 2017 (FIA Evalidator 1.7.2.00).*

***Timber Processing***

The majority of timber leaves Massachusetts for processing by larger sawmills (>15MMBF/year) located 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 MW 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 enter local markets and often is purchased by artisans or

[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

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 see 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).

Another 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 for ground-mounted solar arrays. Currently, 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 done 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 incentive was higher to convert the land than the incentive to keep the forestland. A recent analysis by Clark University of land use around solar arrays shows that, in 2005, the most common land use around solar fields was forest (66%). By 2015, that had dropped to 31% forest, with residential land increasing to 28%. The intent of the state incentive

program was not to promote forest conversion, but rather better utilize gray space (Himmelberger et al. 2019. However, if current trends continue, 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 the 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 2.85 million acres to 3.2 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 $CO_2$ 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).

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, as well as cause equipment to get stuck. 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.

*A goat performing vegetation control at the Middlesex Fells Reservation*

***Pests, Disease, and Invasive Plants***

There are many invasive plants, insect pests, and diseases present in forests in Massachusetts and these will continue to pose challenges for our forests. 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, though a lot is unknown (Dukes et al. 2009, Janowiak et al. 2018).

While it may be hard to predict how climate change will 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. 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, wildfire, 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 Desired Future Conditions. The complete list of goals and strategies can be found in the Strategy Matrix on page 26.

### Goal: **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 jobs 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. Thousands of people are employed or engaged in a multitude of ways to deliver these 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 2 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 2000's, the Massachusetts forest licensing system has issued licenses to nearly 450 individuals. Of these, there were 168 active in 2018, with 36 of these employed by the Commonwealth. The remaining 132 private consultants 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. 817 arborists are certified by the Massachusetts Arborists Association. 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). Although individual species can 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

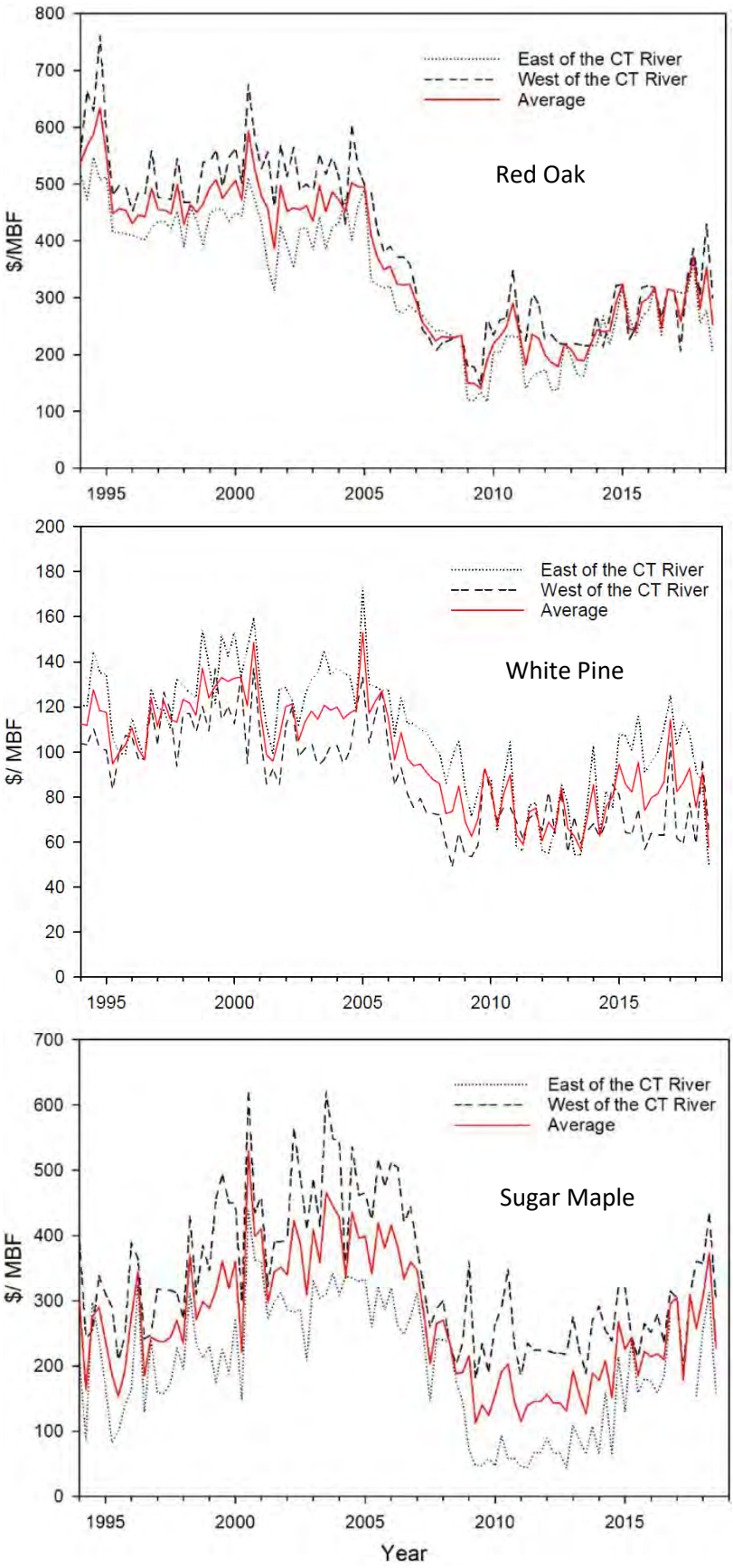



*Figure 4.1. Stumpage trends for red oak, white pine and sugar maple, the most representative principle components of timber harvesting operations in Massachusetts. Prices have been adjusted for inflation and are shown in 2018 dollar values (MassWoods Stumpage Trends).*

(Kittredge and Thompson 2016) which continues to experience its own price volatility. International markets have also been increasingly important, and 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 the 2010 assessment. 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 operate mills largely to break even. As was true at the time of the last assessment, 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).

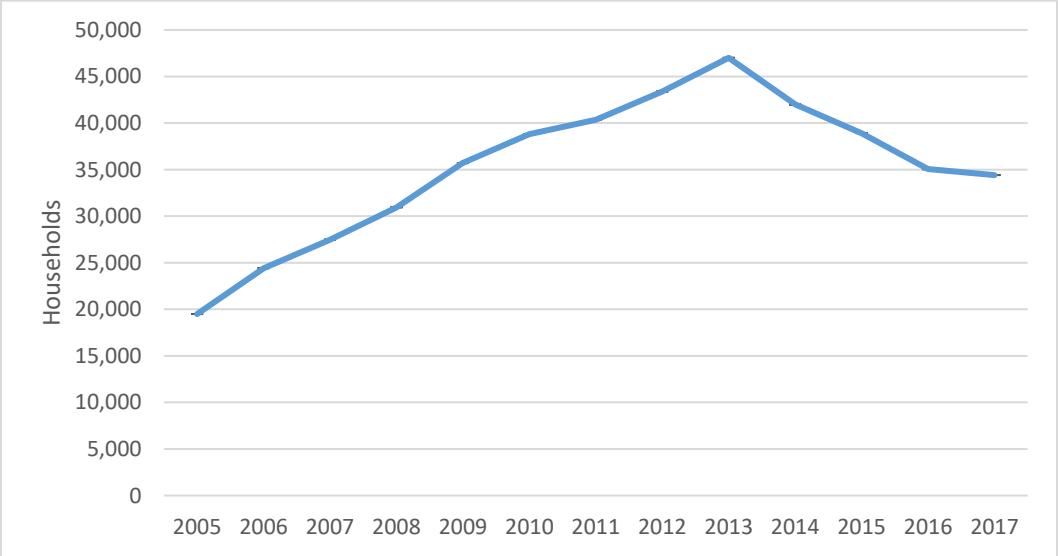



*Figure 4.2. Massachusetts Households Using Wood for Primary Heat, 2005-2017 (U.S. Census Bureau American Community Survey).*

## 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 most 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.

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 MW of energy using tree-derived fuel. Similar plants exist in southern New Hampshire, acquiring a portion of their feedstock from Massachusetts.

There is presently 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 always 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.

Yet 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 principle 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, DCR has administered $2.7 million to over 1,700 landowners who collectively steward 159,650 acres of forestland. This includes nearly 50,000 acres of municipal lands covered by more than 200 Forest Stewardship Plans. Additionally, 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.

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 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, is provided through a group certificate held by DCR with the Forest Stewardship Council (FSC). This certification is 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 has been available for such upgrades through the WFI since FY2009, and the program has awarded over $60,000 to 315 landowners, bringing over 52,000 acres of forestland into the Green Cert program since that time.

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. Since its inception, 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. As of March 2020, 49 foresters had been trained.

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 with it 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, 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.

*Bald Eagles at Wachusett Reservoir, photo by Jamie Carr*

In cooperation with the Forestry Extension Program staff at the University of Massachusetts Amherst, the WFI also provides resources to conduct estate planning outreach and education to forest landowners, including the production of outreach documents and hosting of free workshops for landowners.

***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 administers EQIP, 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 is available to any municipality with a current Forest Stewardship Plan on town-owned land, providing 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.

## 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, the Department of Conservation and Recreation's Urban and Community Forestry Program's Greening the Gateway Cities Program has already planted over 20,000 trees across a dozen communities, with a goal of planting 2,400 trees in each of 26 Gateway City communities across the Commonwealth in order to effect these positive environmental and energy-saving effects, and to promote beauty and sense of community in underprivileged urban neighborhoods (See "Wellness" section below).

## RECREATION AND TOURISM

Although quite different from the forest products sector, the recreation and tourism sector is what most people will associate with the forested landscape. In contrast with the forest products sector, which is engaged in providing raw materials and consumer goods, the recreation and tourism sector is principally delivering an

*Hikers on Mount Greylock*

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, 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, which 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 classic, quintessential outdoor recreation activities associated with forests, and these remain vitally important in the state. Nearly 60,000 hunting licenses and 150,000-175,000 freshwater fishing licenses are issued annually (USFWS 2019a,b), 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 fee-owned 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 Assessment of Forest Resources 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.

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. Thus, continuing to build off DCR's robust and active Forest Stewardship & Green Certification programs represents a promising next phase in 2020.

### *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 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.

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

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 Working Forests Initiative (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, are not precise, but overall 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 (Census of Agriculture, USDA, National Agricultural Statistics Service 2017).*

Christmas trees occupy an estimated 30,000 acres of open space in Massachusetts. Plantations of 5 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.

## FOREST ECOLOGY AND CONSERVATION

Employment associated with managing, protecting and engaging with our forest resources encompasses a diverse range of natural resource professionals, including foresters, biologists, land conservation specialists, wetland scientists, ecologists, naturalists, interpreters, and timber harvesters. The importance of biological professionals will only increase as our natural landscapes experience increasing stress due to climate change, and the need for science-based decision-making becomes imperative.

## 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 those aggregations of trees known as 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 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 (USDA FS 2018).

It is difficult, perhaps impossible, 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 to well-being and public health is further demonstrated by the establishment of programs such as Park Rx (www.parkrx.org), 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 (SCORP 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. Visitorship at state

parks and forests were 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 acts of people spending time in our forests.

## STRATEGIES

The strategies below focus on Socioeconomic Benefits but may apply to other Desired Future Conditions. The complete list of goals and strategies can be found in the Strategy Matrix on page 26.

### GOAL: 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, and adaptation to climate change while meeting social and economic goals of communities

### GOAL: SUPPORT AND ENHANCE FOREST ECONOMY

**Strategy 20:** Promote firewood as a local resource 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, MFA, 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: 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 urban areas, such as Greening the Gateway Cities

## GOAL: ENHANCE THE CONNECTION BETWEEN FORESTS AND PEOPLE

**Strategy 35:** Coordinate and participate in annual Town Forest events

**Strategy 28:** 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 reverence to 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 or forests lands, the multiple programs within the DCR Bureau of Forestry and Fire Control, and the vital roles of non-governmental forest advisory groups and educational intuitions.

## 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 1918. 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)
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 State Forestry Department 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 caterpillar, saddled prominent caterpillar, pine looper, the beetles which spread Dutch Elm disease and most currently Asian longhorned beetle and emerald ash borer.

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 2 of the Clark-McNary Act was superseded by section 7 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 protections 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 regulate the practice of managing and preserving forests and open spaces.

| | Description | MA General Law | Commonwealth of Mass. Regulations |
|---|---|---|---|
| ***Organizational Structure*** | | | |
| ***DCR Divisions of State Parks 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 has control over the state parks, forests, parkways, waterways, rinks, pools, beaches and other recreational lands and facilities that are not within DCR's division of water supply protection. | 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 of state parks and recreation shall promote the perpetuation, extension and proper management of the public and private forest lands of the commonwealth, and perform such other duties as may be imposed upon him or her 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 fresh water 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 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. 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. 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 |

| | | | |
|---|---|---|---|
| ***Shade Tree Management*** | 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; and when it appears in any proceeding in which the ownership of or rights in a tree are material to the issue, that, from length of time or otherwise, the boundaries of the highway cannot be made certain by records or monuments, and that for that reason it is doubtful whether the tree is within the highway, it shall be taken to be within the highway and to be public property until the contrary is shown. | MGL c.87, §1 | |
| ***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. State list is managed by 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 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, the Department of Conservation and Recreation (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 of Massachusetts released the nation's first 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 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 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[3], invasive species, landscape ecology, natural resource economics and law, recreation, silviculture, social policy, visual/aesthetics, watersheds, and wildlife habitat. 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 during the course of the FFVP.

The ultimate goal of the Forest Futures Visioning Process was to ensure that the DCR practiced consistent, transparent, and professional forestry practices on public lands. Published in 2012, the Landscape Designation report 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,

[3] *Final Report - Forest Futures Visioning Process Recommendations of the Technical Steering Committee*. April 21, 2010, p. 6.

and consistent public process to allow all constituents the opportunity to provide comment prior to timber harvesting on any public lands. From the Landscape Designation report:

> "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."

### *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. 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 for the management of old growth forest on the DCR land that was adopted in 1998. 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's 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 the various pests. In some instances, the detection of

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

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 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 CWPPs completed in Massachusetts. Another four are in the process of being completed, including one on 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 located 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 Worcester County. The program served as a model for additional urban tree planting programs in Massachusetts. The programs are supported through funding from Commonwealth energy programs such as the Department of Energy Resources, the Executive Office of Energy and Environmental Affairs and are currently working on support from the very successful MassSave energy efficiency programs. As part of

the Greening the Gateway Cities program 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:

> *"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's 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 3 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.

DWSP is determined to protect our water resources for future generations. Forest cover provides unparalleled water quality. DWSP has determined that the most stable land cover comes from a vigorous, species-diverse, many-aged forest. The Division's long-term objective is to diversify today's mostly even-aged forest into a multi-aged forest while conserving biodiversity using sustainable forestry practices.

DWSP timber harvests are designed to regenerate about 1% of the managed forest every year so that 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.

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 Commonwealth's State Wildlife Action Plan (SWAP).

***Reduction of Forest Fragmentation***

Forests provide critical carbon storage and sequestration that are 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 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 Forest Legacy Program, 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 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 forest land 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 in order 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 (MGLC, 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 (M.G.L. 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 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.

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.

*Forest Legacy Protected Property in Northfield, Massachusetts, photo by Benjamin Engel*

### *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 from all regions of Massachusetts, and from a variety of industries including K – 12 schools, nature centers, urban environmental programs, museums and environmental professionals. 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 from Boston to the Berkshires 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.

## 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 sister agencies regarding resource protection and resource management. The Bureau of Forest Fire Control and Forestry serves state, municipal and private landowners and the 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.

- The **Forest Legacy Program** is a partnership between the DCR and the U.S. Forest Service to identify and help protect environmentally important forests from conversion to non-forest uses.

- 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.

- The **State Public Lands/Management Forestry Program** is responsible for the planning and implementation of forest management activities within the forest and parks system.

- 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.

- 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.

- 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's Forest Fire Control Program works closely with the Division of Fisheries and Wildlife (MassWildlife) on state lands.

The DCR's Division of Water Supply Protection (DWSP) manages and protects the forested watersheds that supply drinking water for over 3 million residents of Massachusetts. DWSP actively manages its own forest lands to promote health and resiliency and regulates development on private lands under the Watershed Protection Act (MGL Chapter 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 of the Executive Office of Energy and Environmental Affairs (EEA) to ensure the spirit of Article 97 of the Amendments to the Massachusetts Constitution remains in the forefront of all 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 Agriculture 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***

The Department of Conservation and Recreation, as well as the Department of Fish and Game's Division of Fisheries and Wildlife, 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 United States Department of Agriculture's divisions of U.S. Forest Service and Animal Plant Health and Inspection Services (APHIS) are long-standing partners and have a consistent and active presence within the Commonwealth of Massachusetts.

Congress created the Land and Water Conservation Fund (LWCF) in 1964 to support protection of federal public lands and waters and voluntary conservation of private land. Permanently reauthorized in 2019, the legislation allocates up to $900 million in offshore oil and gas royalties towards conservation projects. 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.

*Freetown State Forest prescribed burn, photo by David Celino*

*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 U.S. Department of Agriculture (USDA) and the Department of the Interior 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 the following 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.*

The three primary, national goals identified as necessary to achieving the vision are:

- 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.
- Wildfire response: All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions.

*FORESTS AND RANGELAND'S NORTHEAST REGIONAL STRATEGY COMMITTEE*

Forests and Rangelands is an active, cooperative effort between the United States Department of the Interior, the United States Department of Agriculture (USDA), their land management agencies, and the DCR. A Memorandum of Understanding was signed in 2016 by the Secretaries of the U.S. Department of the Interior, U.S. Department of Agriculture, 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's 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, more 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. By coordinating at the state level to prioritize, it 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 state and federal wildlands.

***Educational Institutions***

Harvard University's first program related to forests and trees began in 1872, when they acquired the Bussey Farm in the 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 general public and professionals and supports research around the world (Harvard College 2010).

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).

The University of Massachusetts 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). The University 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, University of Massachusetts Amherst 2010). 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.

The University of Massachusetts 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)
- 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.)
- 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, there are six concentrations:

- Environmental Conservation
- Fisheries Ecology and Conservation
- Forest Ecology and Conservation
- Urban Forestry and Arboriculture (B.S.)
- Water Resources
- Wildlife Ecology and Conservation

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

The University 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
- 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.

***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 (TTOR), Mass Audubon, New England Forestry Foundation, and the Massachusetts Chapter of The Nature Conservancy (TNC) 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.

*Harold Parker State Forest, photo by Lindsay Nystrom*

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.

There is also the New England Forestry Foundation who, through the application of expertise in conserving forestland and advancing exemplary forestry, help 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.

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 national organization The Trust for Public Lands. At the Trust for Public Land, they work to save land for people to enjoy, from neighborhood parks to national parks since 1972. 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: "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." 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*

#### *MASSACHUSETTS FORESTRY LICENSING BOARD*

The DCR's Director of State Parks and Recreation appoints as his or her 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 M.G.L. c. 132, §§ 47 through 50 and 302 CMR 14.00. In order 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
- 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 agreed to 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
- 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 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. For the full statement, see 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 Parks 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. FEMC supports the collaborative network by providing data retrieval, archive, management, sharing, analysis and/or synthesis coordination.

## 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 state's hazard mitigation plan, state funding and resources are increasingly available for forestry-related initiatives. Currently the DCR employs 105 staff within the Bureaus of Forest Fire Control and Forestry and 14 at the Division of Water Supply Protection 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. Staff numbers are broken down by program are in Table 5.2.

| Program | # of full time Forestry-related 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) | 14 |
| Urban Forestry | 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, on average $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, 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 (APHIS) 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 forester. Reimbursement is also available to landowners with current Forest Stewardship and Chapter 61 management plans who wish to upgrade those plans to meet requirements for the Forest Stewardship Council (FSC) 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 the University of Massachusetts 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, Massachusetts Audubon Society, the Appalachian Mountain Club, and The Trustees of Reservations employ scientists and resource managers who conduct research and collaborate with the University of Massachusetts Amherst and Harvard Forest. Faculty members and graduate students at other colleges and universities in Massachusetts conduct research that relates to

*DCR Management Forester Keith DiNardo*

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 (LTER) 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 (AmeriFlux Network Management Project), US Environmental Protection Agency, US National Science Foundation (Long Term Ecological Research Network, National ecological Observatory Network, Research Experience for Teachers, and Research Experience for Undergraduates), U.S. Forest Service, National Institute of Food and Agriculture, Smithsonian Institution, as well as the Commonwealth of Massachusetts (EEA and the DCR), Harvard University – Faculty of Arts and Sciences, and other universities and private foundations (Harvard Forest 2020).

Sources of funding for research at the University of Massachusetts 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, and the Department of Environmental Protection, the National Urban and Community Forestry Advisory Council.

## WEAKNESSES OF THE CURRENT LEGAL, POLICY AND INSTITUTIONAL FRAMEWORK

### *Massachusetts General Laws*

While created to protect critical ecosystem services to 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 from happening. As an example, the fine for moving regulated material outside of the Asian longhorned beetle 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 them from 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 fields and wind farms, 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 priorities 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 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, the flagship Amherst campus of the University of Massachusetts 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 the last assessment, 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 in the DCR.

## STRATEGIES

The strategies below focus on Legal / Policy and Institutional Framework but may apply to other Desired Future Conditions. The complete list of goals and strategies can be found in the Strategy Matrix on page 26.

### GOAL: 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: MAINTAIN AND INCREASE URBAN TREE CANOPY COVER

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

### GOAL: 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 Project Learning Tree, DCR Arbor Day Poster Contest, and the Massachusetts Envirothon

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

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

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

**Strategy 45:** Advocate for appropriate forestry and fire management related positions within Environmental Agencies

**Strategy 46:** Support training and development opportunities for state forestry and forest fire control staff to ensure competency with current standards and practices

**Strategy 47:** Improve compliance with the Forest cutting Practices Act

**Strategy 48:** Identify forestry-related laws and regulations – for example, the Public Shade Tree Law - that require clarification, modernization, or strengthening and work to remediate.

**Strategy 49:** Increase communication and collaboration with other state agencies through shared stewardship

**Strategy 50:** Ensure state agencies have the appropriate structures to allow for participation in national and international emergency responses

**Strategy 51:** Ensure forestry Best Management Practices reflect the latest research and standards

**Strategy 53:** Advocate for programs and incentives that promote clean energy options and discourage forest conversion

**Strategy 54:** Support the goals of the Northeast Region Cohesive Wildland Fire Management Strategy: 1) Restoring Resilient Landscapes, 2) Creating Fire Adapted Communities, 3) Safe and Effective Wildfire Response

**Strategy 55:** 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: CULTIVATE AND SUPPORT PARTNERSHIPS WITH FORESTRY AND CONSERVATION STAKEHOLDERS

**Strategy 66:** Expand financial and technical support of programs that further state forest priorities

**Strategy 67:** Seek multi-level funding opportunities that are tied to the state forest priorities

**Strategy 68:** Engage with local, regional, and national partners in on-going activities and projects

**Strategy 69:** Maintain presence at regular meetings of stakeholders to stay abreast of interests, activities, and concerns

**Strategy 70:** Improve coordination with government agencies on implementation of projects across jurisdictions

**Strategy 71:** Actively participate in forest fire control and forest health compacts as well as the urban tree 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 area has a different focus, including urban forests, high elevation ecosystems, forests vulnerable to development, and small-rural or economically disadvantaged communities. Geospatial analysis was also done 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, 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.

## PRIORITY URBAN FORESTS

The priority landscapes for Urban and Community Forestry analysis (Figure 6.1), incorporates and ranks several GIS layers (in descending order): “Maryland Method (a layer that incorporates additional GIS layers),” 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 (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, the North Shore, and 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).

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). Currently, about 34% of land is classified as urban. 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

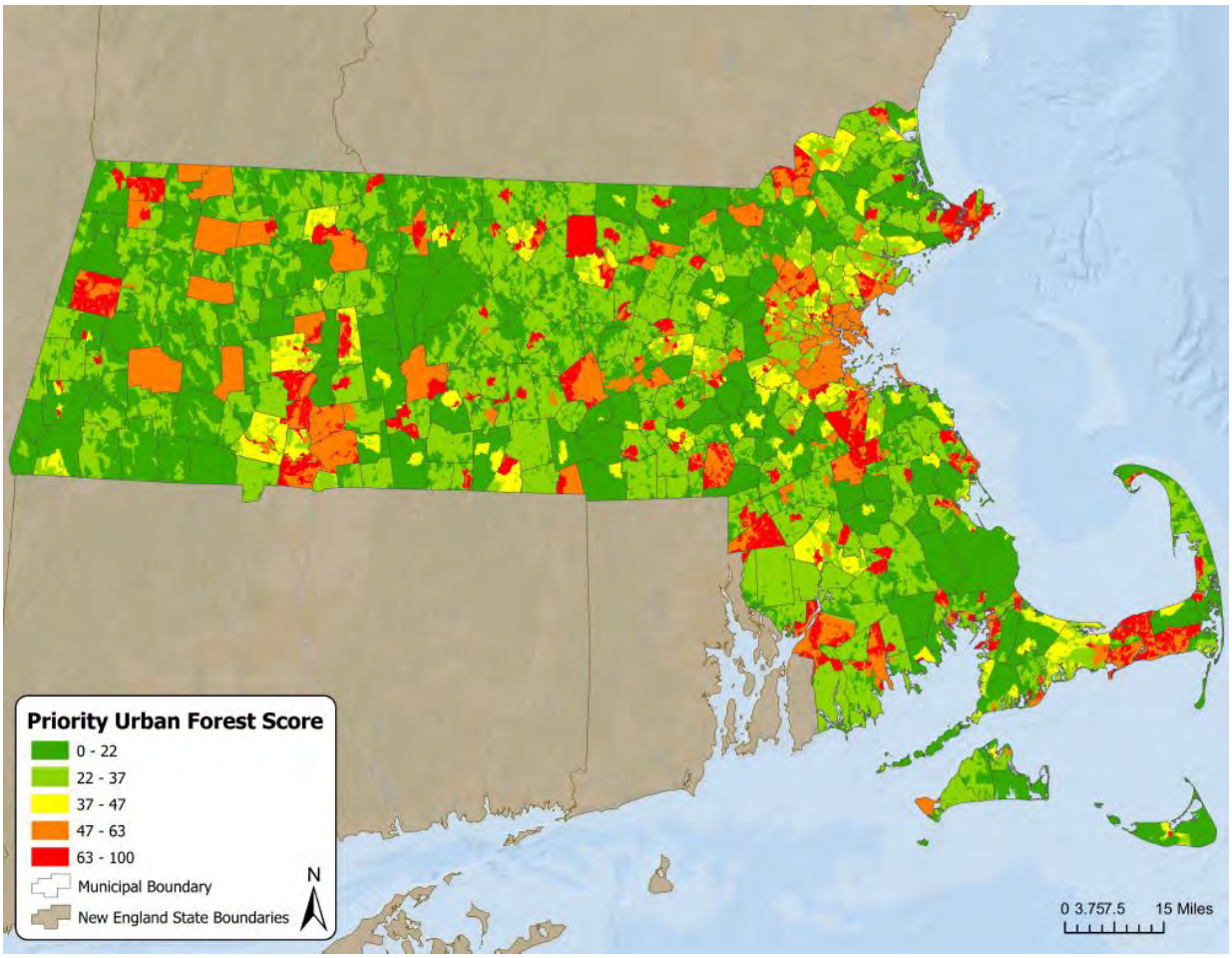



*Figure 6.1. Urban Forests shown by priority urban forest score. Green represents areas that have a lower urban forest priority score; red represents communities with the highest priority urban forest score.*

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 all of the trees from their small 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 and every town was

required to have a tree warden. 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 Wardens 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. 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.

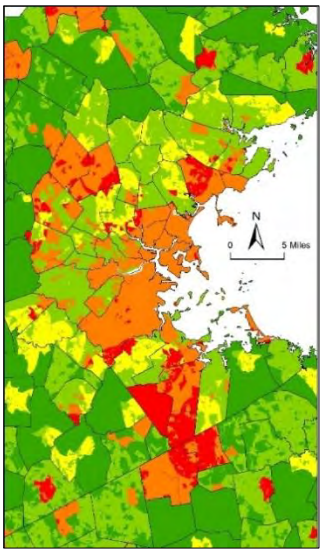
The major findings of the Assessment of urban forest resources for the state of Massachusetts are:

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.

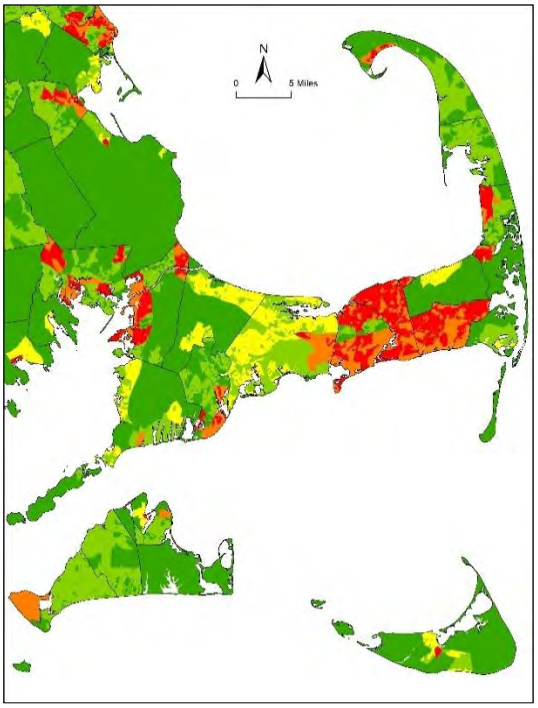
Many areas identified in the 2010 analysis also appear in the 2020 analysis. This is not surprising given that the variables measured in this analysis generally change slowly over time. The priority level for

many communities increased, particularly in Berkshire County, and we suspect this is due to the effect of the recession on the 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.

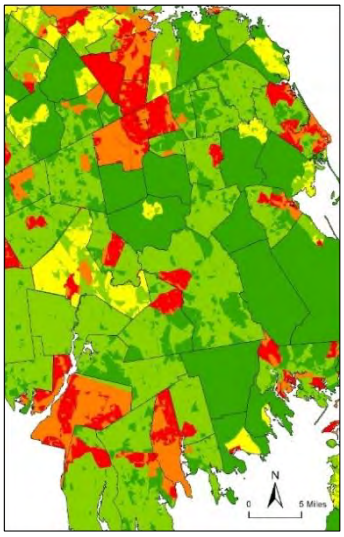
From the composite GIS Urban Forestry Layer generated by this analysis, DCR has identified the following areas of the state as priority urban and community Forests. The communities within the regions identified in this analysis will be the priority target areas of the DCR U&CF program and its partners.

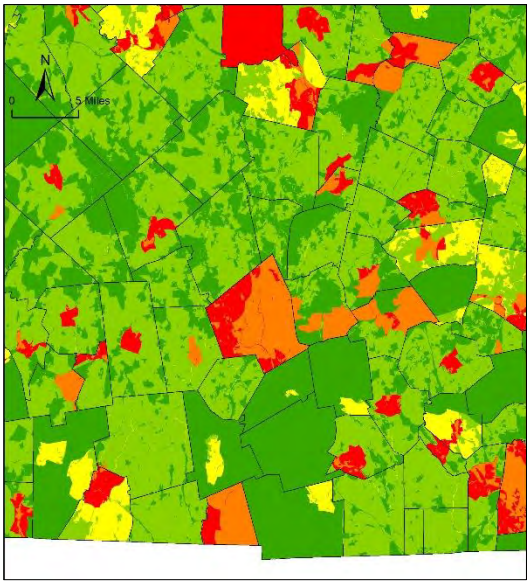



**Greater Boston Area Sub-region (right)**: The Greater Boston area is the oldest and most heavily developed area of the state. Communities in this region are largely "built out" such that redevelopment of already disturbed sites may be more prevalent here than in other areas of the state. Forestry programs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

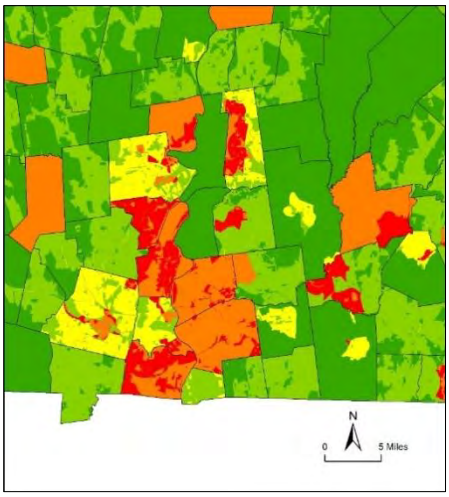



**Cape Cod and the Islands (left) and Interior Southeast – Greater Franklin, Greater Fall River / New Bedford Sub-regions (below, right):** The southeastern area of Massachusetts is the fastest developing area of the state with large parcels of forest land being developed into housing and commercial 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.

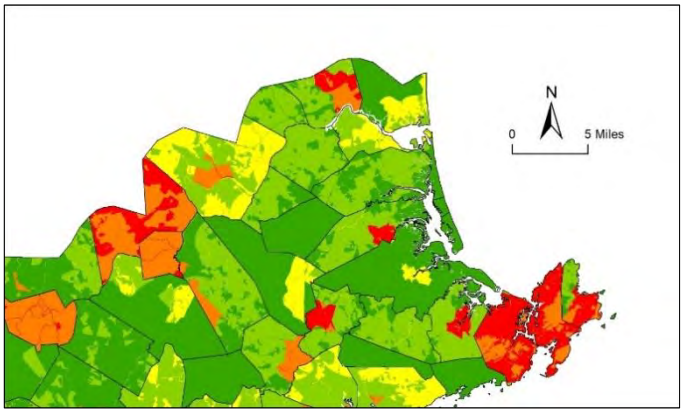




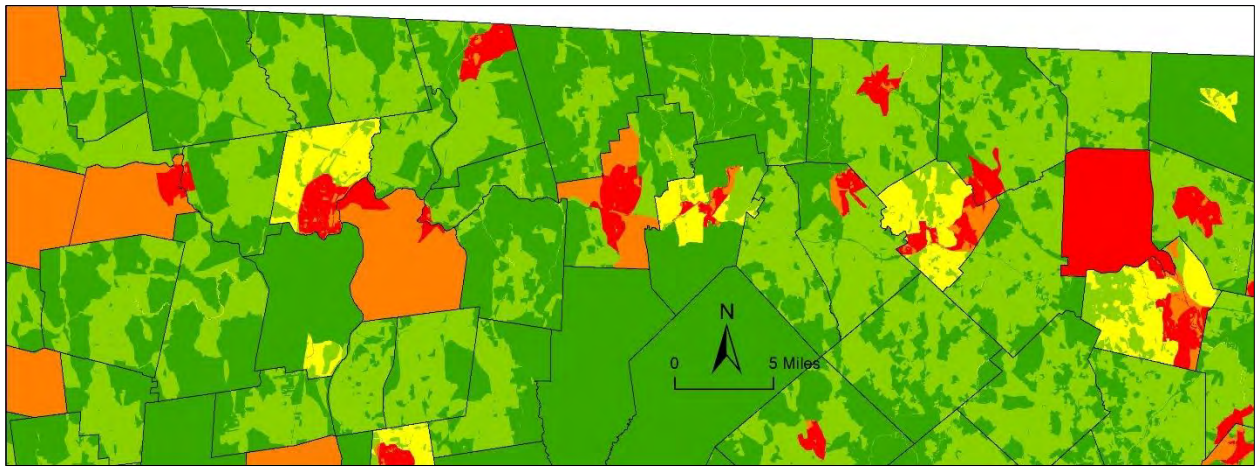

**Greater Worcester Sub-region (left):** The Greater Worcester Area is comprised of the densely developed City of Worcester and surrounding suburban towns. This area of the state is becoming increasingly developed as commuters who work in the Greater Boston area move here to find slightly reduced real 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.



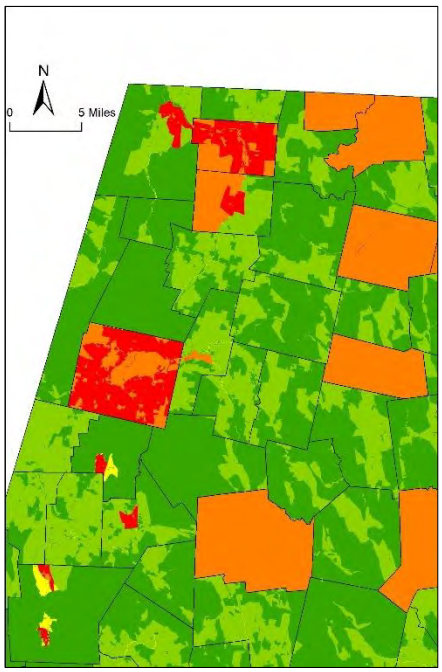

**Greater Springfield Sub-region (right):** The Greater Springfield Area is comprised of the densely developed cities of Springfield and Holyoke and surrounding sub-urban towns. Communities in the area are characterized by older infrastructure and pockets of diverse, lower income populations. For the 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 Industrial Cities Area Sub-region (left):** The Northeast Industrial Cities 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 Manufacturing Corridor Cities Sub-region (above):** The Route 2 Manufacturing Corridor is comprised of the older mill 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 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. 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 Area 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) data 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 north-western 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 implementing the goals of the partnership.

Five programmatic priorities were chosen: forest land 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.

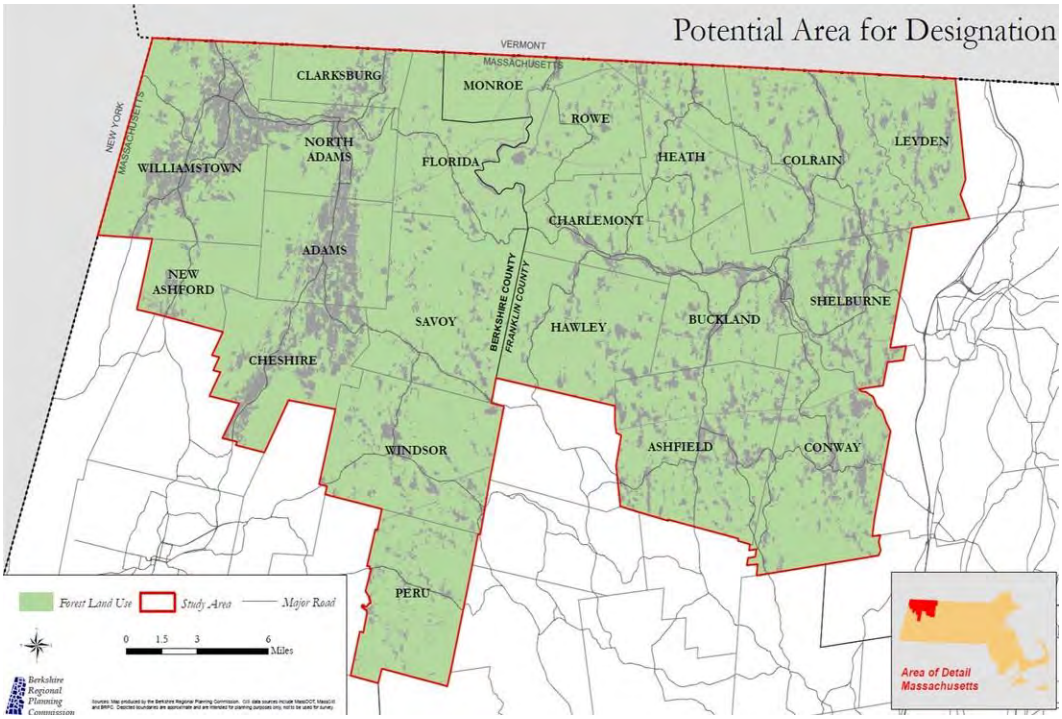



*Figure 6.2. Mohawk Trail Woodlands Partnership Area (mohawktrailwoodlandspartnership.org).*

## GREENING THE GATEWAY CITIES PROGRAM

The Massachusetts Greening the Gateway Cities Program (GGCP) 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.

The program plants trees with a goal of planting 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 | |

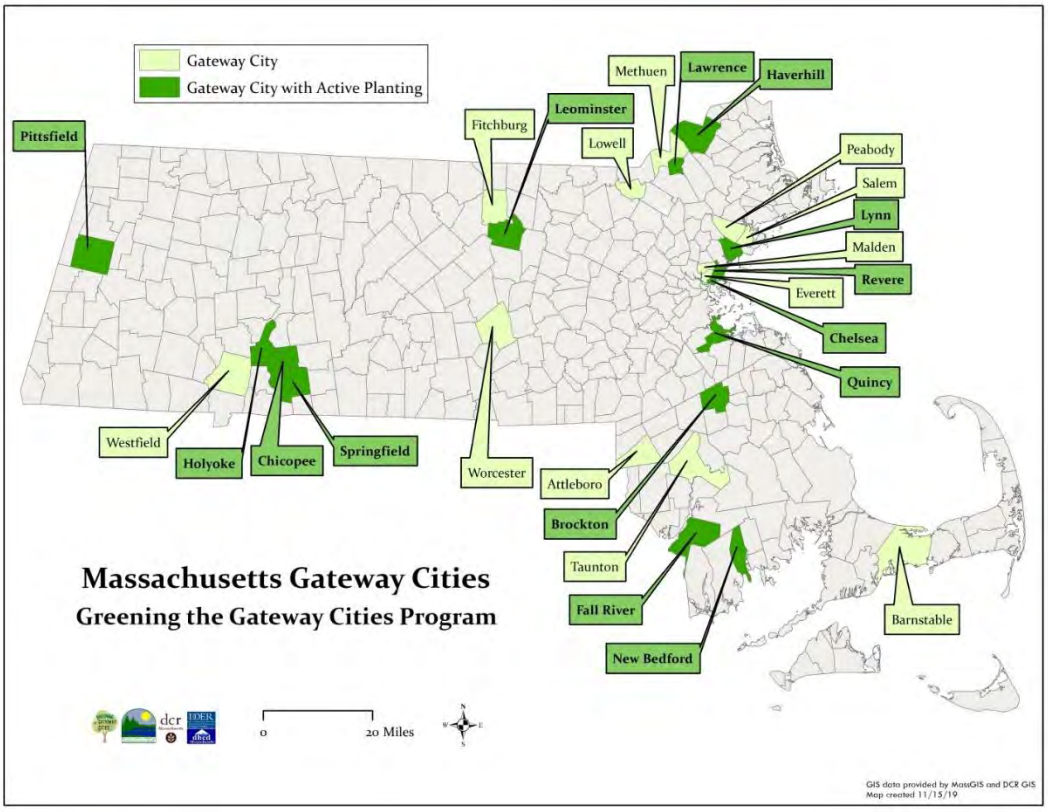



*Figure 6.3. Massachusetts Greening the Gateway Cities Program.*

## HIGH ELEVATIONS

At the opposite end of the ecological spectrum from coastal maritime forests of the Cape & Islands are the forests at the highest elevations of northwestern Massachusetts (Figure 6.4). 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 will be faced with. It is important to anticipate how these forests will be affected by such stresses, to inform protection and/or active management to improve resistance and/or resilience of these vulnerable habitats.

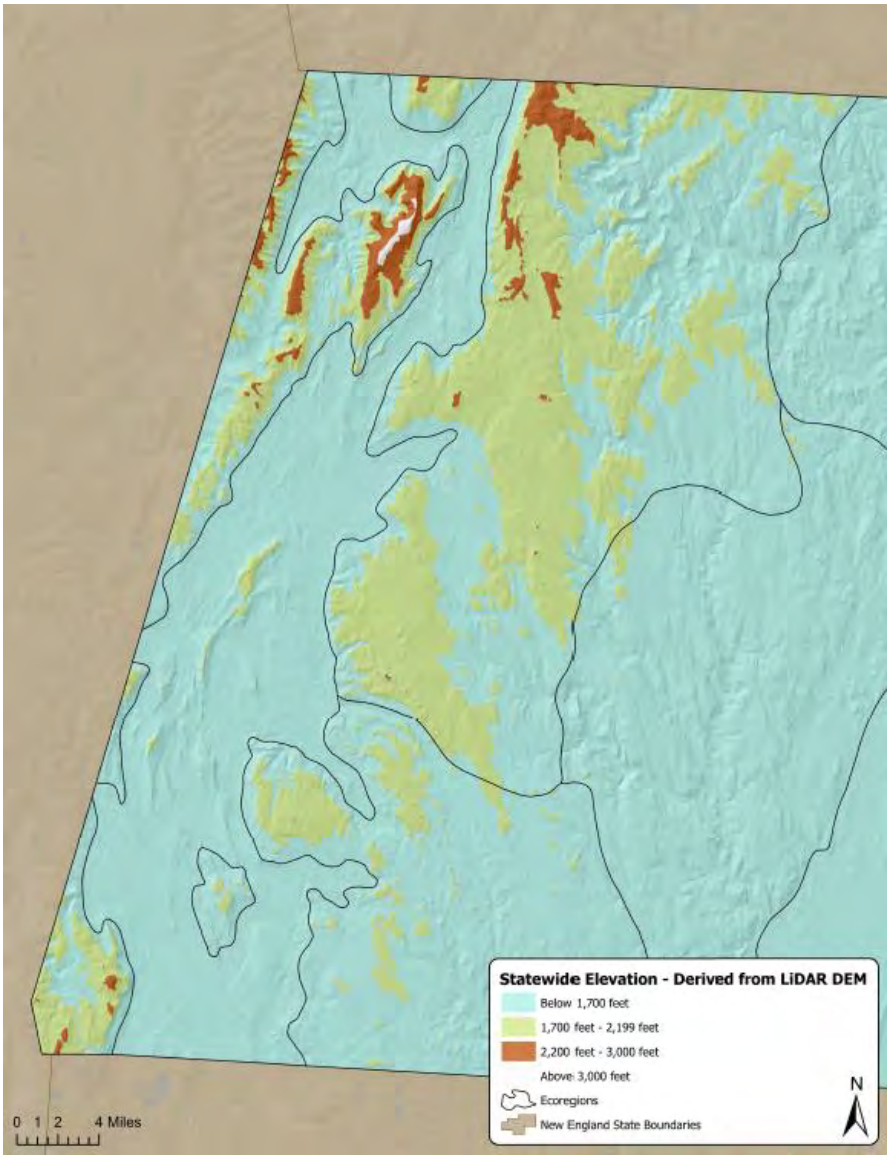



*Figure 6.4. High Elevations of Western Massachusetts.*

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') (Figure 6.4). Beginning roughly at 1,700' 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 on which it can be dominant to elevations up to and above 2,000'. 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' 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 specie of Special Concern, begin to appear consistently at this elevation, becoming more frequent with increasing elevation. Other rare plant species, also listed in the 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', 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') in Worcester County (Figure 6.5) and Mount Everett (2,607') in extreme southern Berkshire County also offer their own unique contributions to the high-elevation forest communities of Massachusetts. Mt. Wachusett features northern hardwoods with red spruce and mountain ash towards the summit, which is quite similar to Berkshire habitats. Conversely, Mt. Everett is known for its novel dwarf pitch pine forest, reflecting a more southerly ecotype, which has been well-studied (Motzkin et al. 2002).

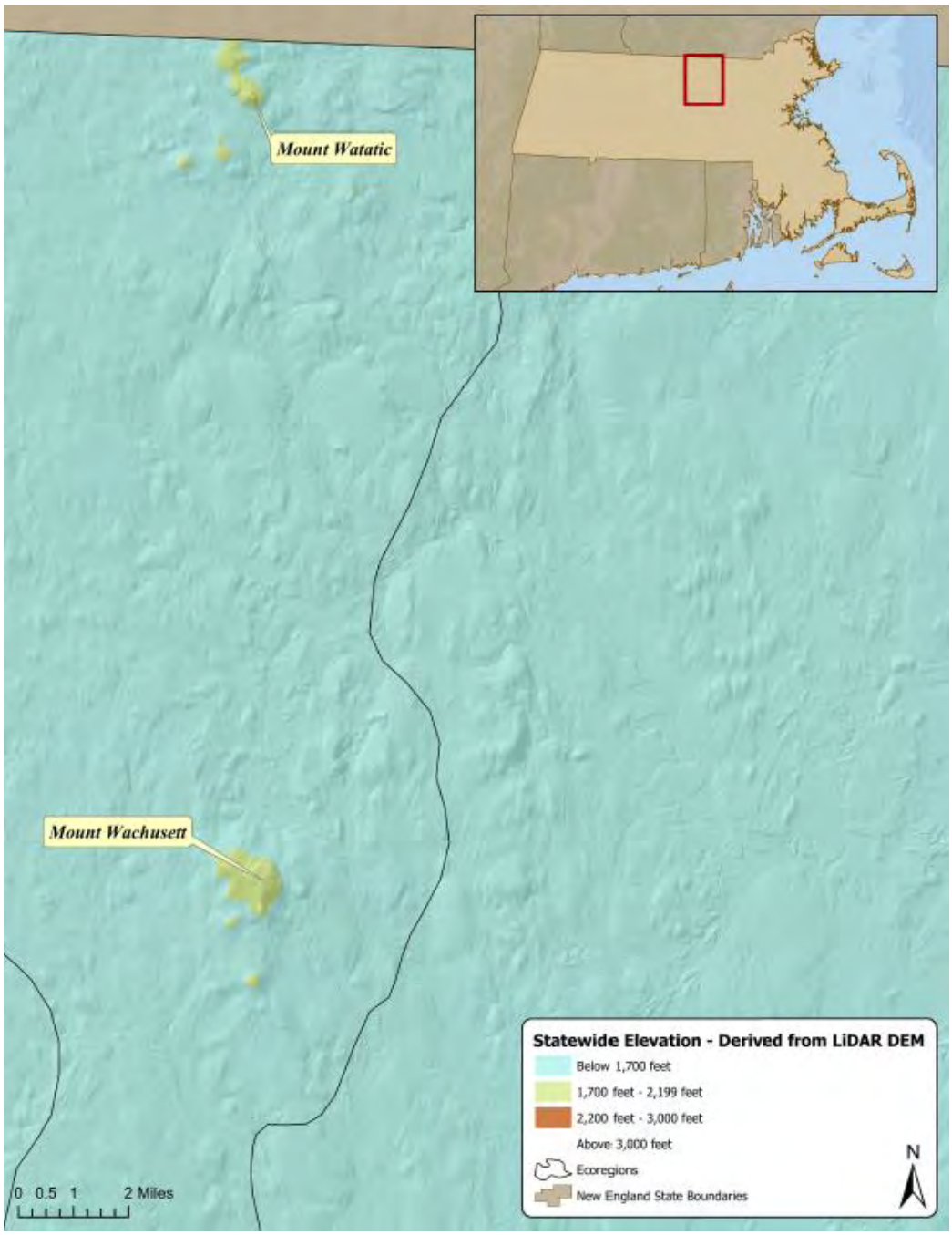



*Figure 6.5. High Elevations of Central Massachusetts.*

The Taconic Mountains (excluding Mt. 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 1700' 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 the associated higher wildfire and forest health damage risk. Priority forest areas (high and very high categories) indicate forests that are threatened by conversion due to development pressure. These areas are in need of restoration and protection through programs that help communities reduce current forest health threats and plan preventive strategies to protect against future ones. Due to data aggregation being done 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.

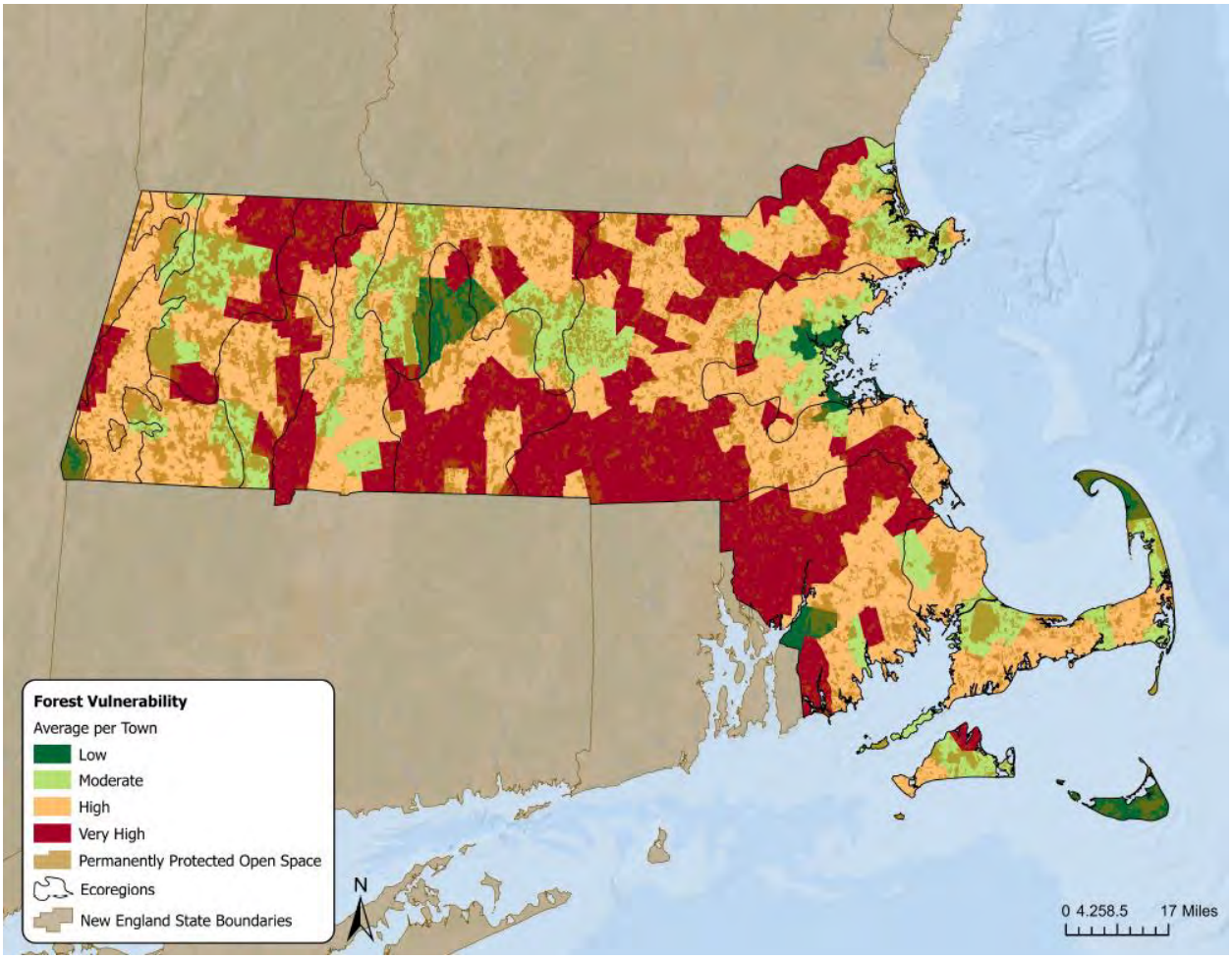



*Figure 6.6. Forest Vulnerability overlay map. High and very high categories represent forests that are at risk of conversion to developed uses.*

## 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, and 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.

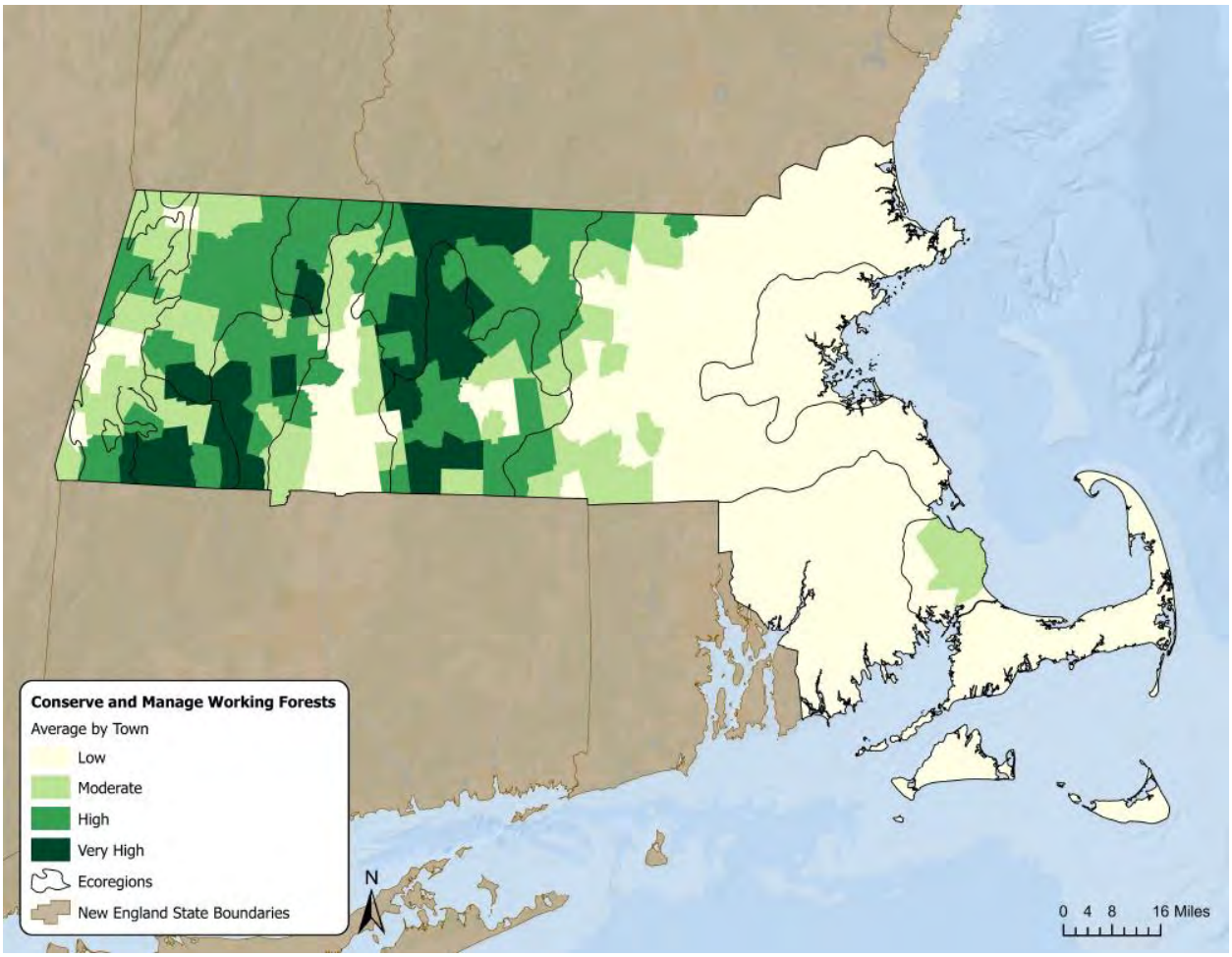



*Figure 6.7. Conserve Working Forest Landscapes overlay map. High and very high categories represent forestland that is actively and sustainably managed and plays a vital role in providing ecosystem services.*

## 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 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, are known to be present in many areas of the state, particularly at lower elevations.

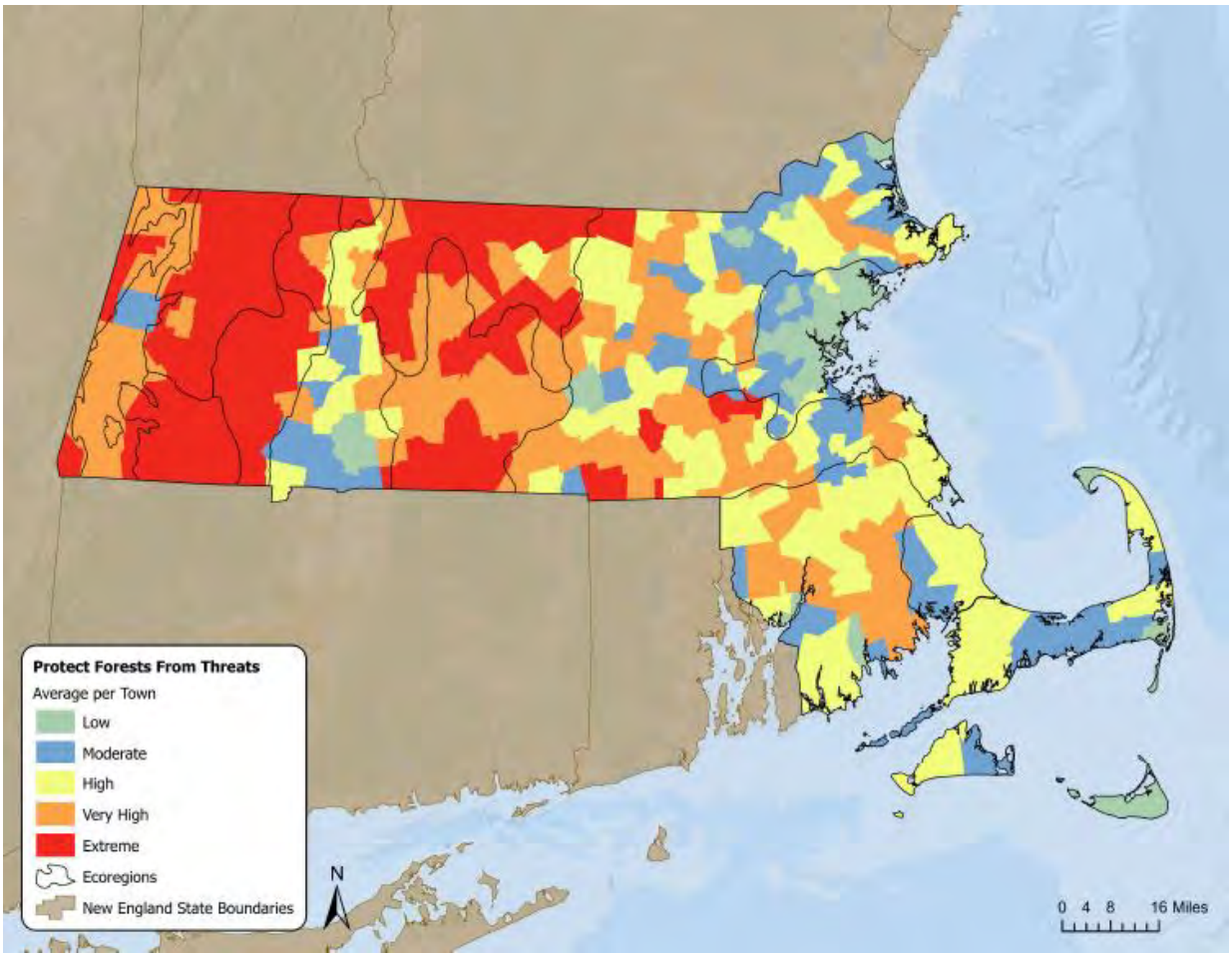



*Figure 6.8. Protect Forests from Threats overlay map. High, very high, and extreme categories represent forestland where stressors, such as wildfire risk, insect and disease, and deer browse threaten forest ecosystems and where hazard mitigation practices would be most effective.*

## 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.

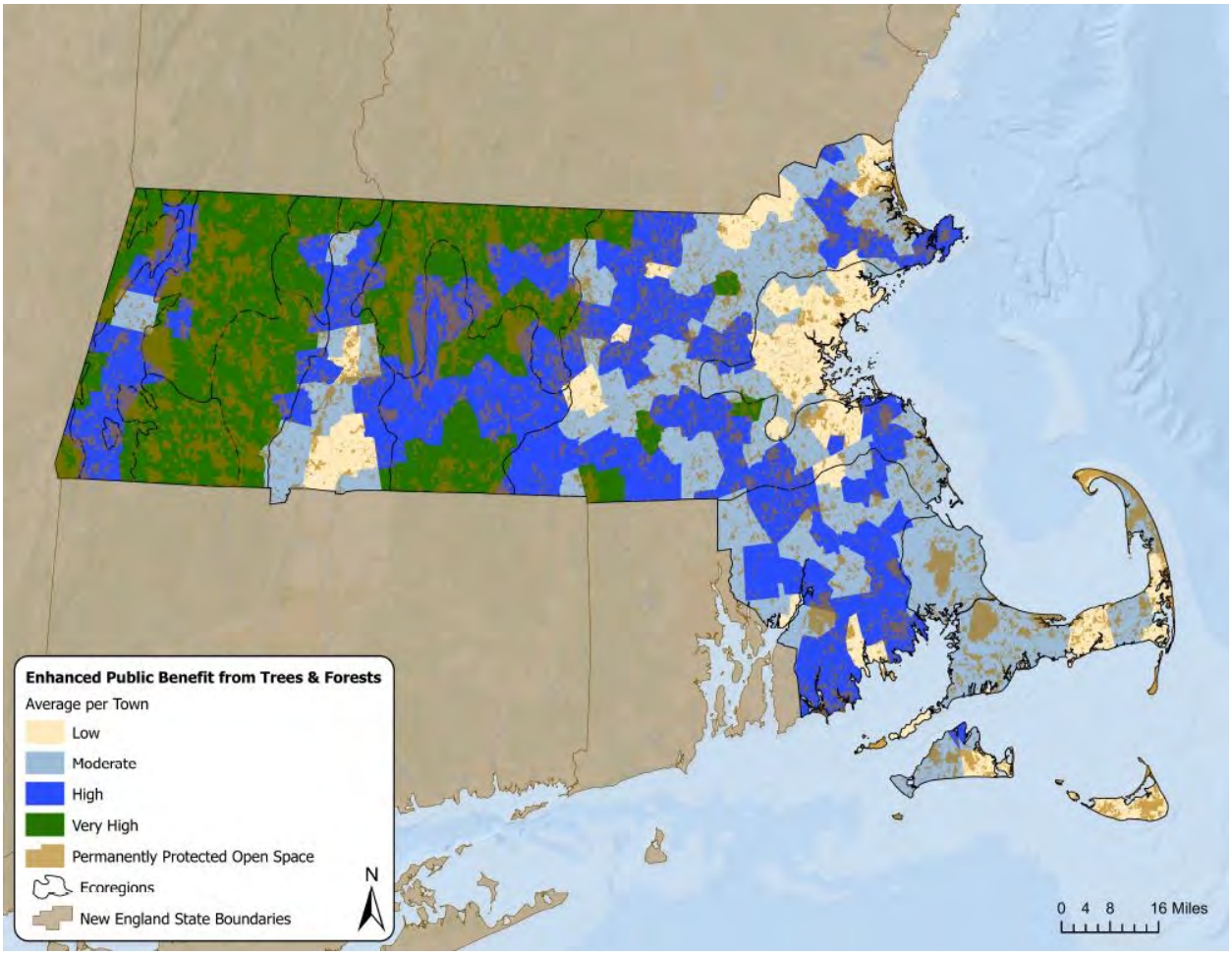



*Figure 6.9. Enhance Public Benefits from Trees and Forests overlay map. High and very high categories represent forests that play an important role in providing ecosystem services.*

## 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 & 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.

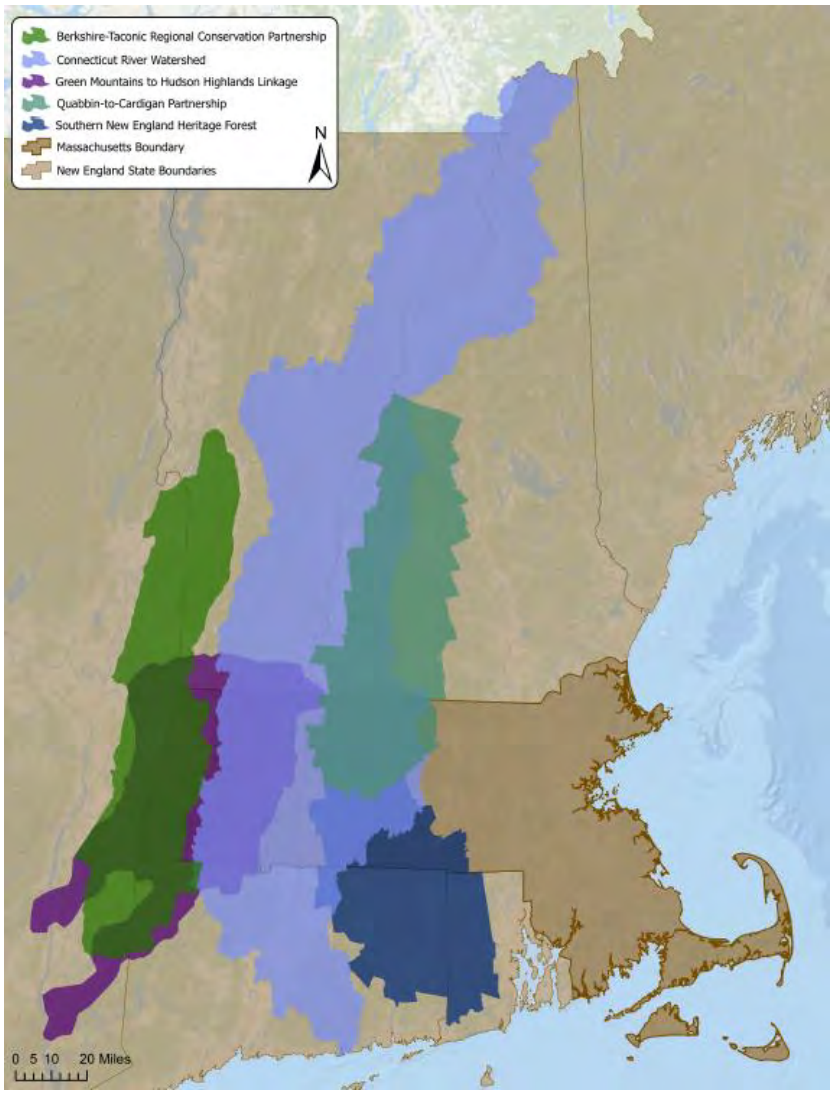



*Figure 6.10. Multi-state priority areas for the 2020 Forest Action Plan.*

***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 (USFWS 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 Quinnebaug 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 (TELE 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 balsamia*)

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 pseudoaccacia*)

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 american*)

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*)

## Pests and Diseases

Asian longhorned beetle (*Anoplophora glabripennis*)

Black Oak Gall Wasp (*Zapatella davisae*)

Caliciopsis canker (*Caliciopsis pinea*)

Chestnut blight (*Cryphonrctria parasitica*)

Crypt Gall Wasp (*Bassesttia ceropteroides*)

Elongate hemlock scale (*Fiorinia externa)*

Emerald ash borer (*Agrilus planipennis*)

Gypsy moth (*Lymantria dispar dispar*)

Hemlock woolly adelgid (*Adelges tsugae*)

Nuclear Polyhedrosis Virus (*Nuclear polyhedrosis virus*)

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 philadelpha*)

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*)

Hairy Wood-mint (*Blephilia hirsuta*)

Large-leaved goldenrod (*Solidago macrophylla)*

Morrow's honeysuckle (*Lonicera morrowii*)

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: http://www.mass.gov/hed/community/planning/gateway-cities-and-program-information.html

Massachusetts Forestry Best Management Practices (BMP) Manual: https://www.mass.gov/files/documents/2016/08/rk/ma-forestry-bmp-manual-rd.pdf

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

Silvio O. Conte National Wildlife Refuge Comprehensive Conservation Plan: https://www.fws.gov/refuge/Silvio_O_Conte/what_we_do/finalccp.html

State Wildlife Action Plan: https://www.mass.gov/dfw/swap

Upton Stewardship Plan: https://www.uptonma.gov/sites/uptonma/files/pages/north_upton_stewardship_final_report_and_appendices.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 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:

- 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.
- 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.
- 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
- Groundworks Lawrence
- The Trustee 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

(To be included in final version. The current Assessment of Need and its appendices can be found at https://www.mass.gov/service-details/forest-legacy-program)