MASSACHUSETTS WILDLIFE

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Carbon and Conservation,
Wild Edibles, Wood Thrush,
Eagle Scout Habitat Project

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MASSACHUSETTS WILDLIFE

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FEATURES

On the Cover: Legacy trees, like this black oak in Grafton, take time to grow. They are typically large, old, sturdy, full-crowned trees that provide abundant food and cover for wildlife. The total habitat lifespan of such trees can range from 400–700 years, including time as a snag and downed decaying log. Therefore, habitat biologists and foresters recognize and retain legacy trees for the many benefits they provide to wildlife and people. Photo by Troy Gipps/MassWildlife.

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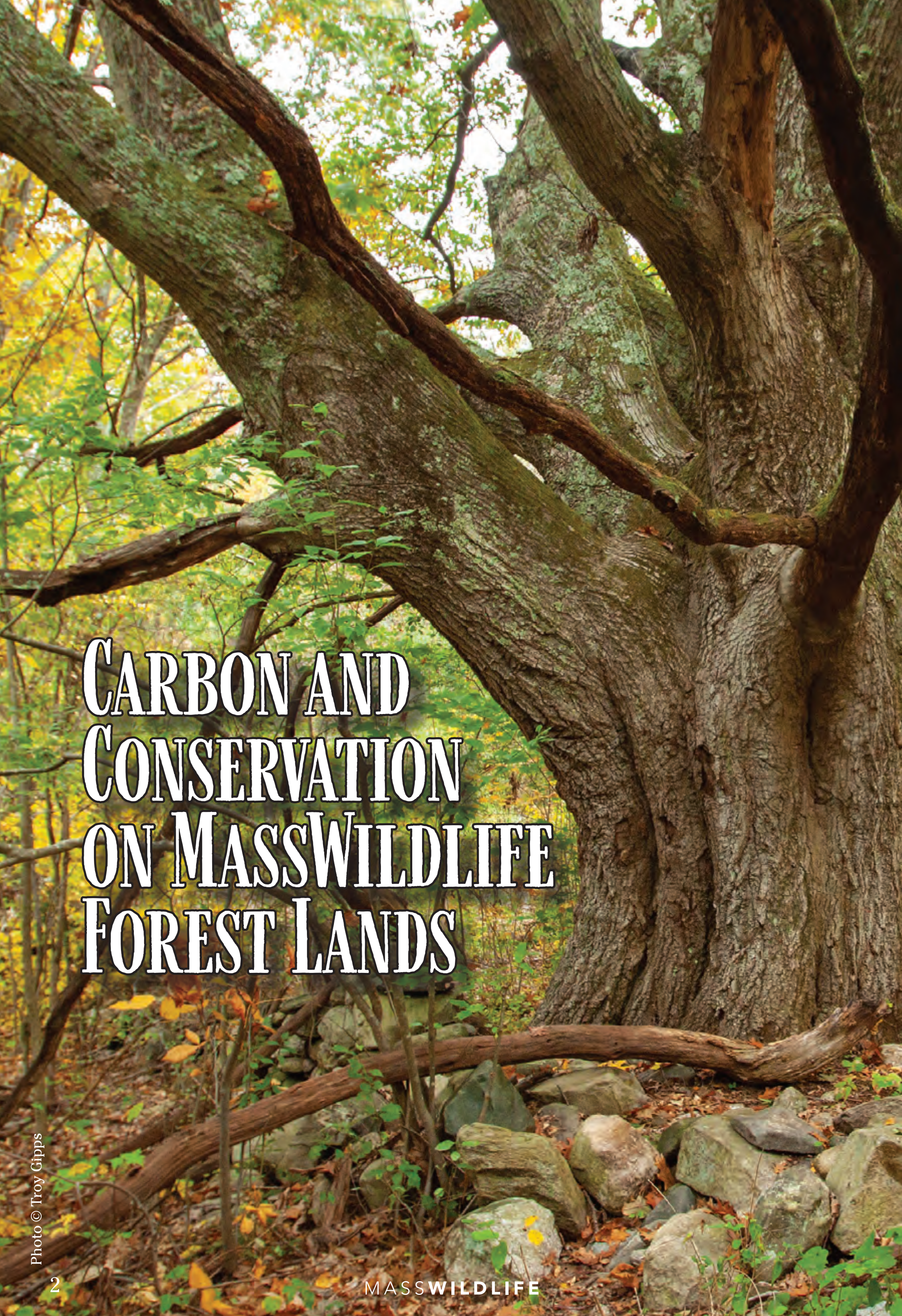


Carbon and Conservation on MassWildlife Forest Lands

Photo © Troy Gipps

BY
JOHN SCANLON AND BRIAN HAWTHORNE

With recently increased interest in carbon footprints and forest cutting, it's a good time to share some important findings on how MassWildlife's forest management activities contribute to wildlife conservation while mitigating the impacts of climate change.

One fine spring day during a habitat management planning site visit at a new wildlife management area, we found ourselves contemplating a huge 150+ year-old oak tree surrounded by a mix of other younger 60–80-year-old hardwood and softwood trees. Thick, horizontally branched limbs created a round and sturdy tree crown, and the forest floor was littered with acorns left over from the past year's nut crop. This sturdy old tree provides both food and cover for wildlife, and it will remain in place during any future forest management activities we plan for this area. We speculated on this venerable oak's probable life story, drawing on our knowledge of land use history and clues in the forest around us. We also found ourselves assessing the big tree in a way we would not have considered a decade or two ago. "Boy," we said. "That's a boatload of carbon!"

Forest carbon is a hot topic these days and with good reason. Trees remove carbon from the atmosphere, which helps mitigate the negative impacts of climate change. Some people suggest that the best use for a tree or a forest these days is carbon storage for climate change mitigation. We believe this is a misleading over simplification of a complex issue. Forest carbon and climate change need to be addressed within a framework of the multiple environmental benefits individual trees and entire forests provide. These include clean water, clean air, wildlife habitat, renewable wood products, aesthetics, and recreational opportunity—as well as carbon sequestration and storage. Let's consider the various benefits we derive from this huge 150+ year-old oak tree, and then expand our perspective to forests and forest management. Finally, we'll look at carbon storage and release on actively managed MassWildlife forest lands. You may be surprised at the numbers and how forest management offers a win-win for conservation and climate.

It may have been a forgetful gray squirrel that buried the acorn from which this oak sprouted. Then again, it may have been an absent-minded blue jay. Although we'll never know for sure, our bet is on the blue jay. Blue jays tend to pick up acorns on the ground, fly off and bury (plant) the nuts in the forest floor for a future winter meal beneath groves of large pines or other evergreen trees. If the blue jay remembers to return, digging for the acorn will be easier due to reduced snow depths.

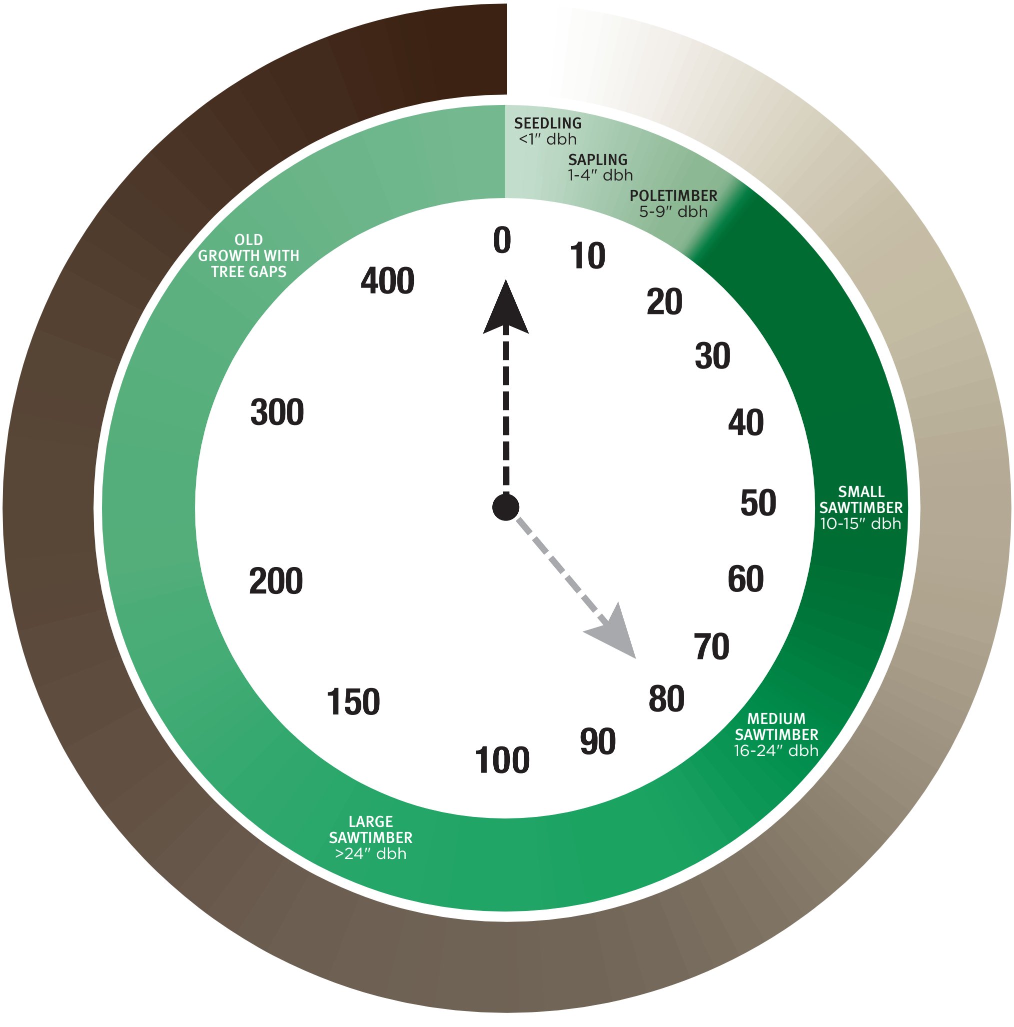
In this case, the blue jay didn't return, and we are free to imagine our oak germinated from that forgotten acorn in the spring of 1866, coinciding with the establishment of the Massachusetts Fisheries Commission. The Commission, one of the oldest government agencies in the state, grew into what is now the Division of Fisheries and Wildlife (MassWildlife). Over time, both the oak and MassWildlife have witnessed dramatic and not so visible changes to the wildlife and environment of the Commonwealth. Both the oak and MassWildlife have been and are continuing to make significant contributions, benefiting wildlife and their habitats, people, and the environment.

One Oak's Carbon Footprint

Biologically, our 150+year-old oak has just hit middle age. This tree could easily live another 150+ years, providing multiple environmental benefits or services along the way. As a young seedling and sapling, our oak grew rapidly. Its rapid growth rate drew carbon dioxide out of the air (carbon sequestration), and the process of photosynthesis broke apart the molecules of carbon dioxide (CO_2). The little oak used the carbon to grow and build wood (carbon storage) and released oxygen back into the air. While our sapling oak tree sequestered carbon at a high rate, its small size (sapling tree trunks are 1–5 inches in diameter) limited the total quantity or volume of carbon it could store as wood. However, as the oak grew and reached pole (5–11-inch trunk diameter) and saw timber (>12-inch trunk diameter) sizes, both the rate of carbon


Photo © Troy Gipps

FOREST CARBON CLOCK



LEGEND

0–400 Age of the forest in years

dbh **Trunk diameter at breast height** (4½' above ground)

Changes in carbon storage over time.
The darker the brown, the more carbon storage.

Changes in carbon sequestration over time.
The darker the green, the higher the rate of forest carbon sequestration.

Graphic courtesy of Catanzaro, P. and A. D'Amato. 2019. Forest Carbon: An essential natural solution for climate change. masswoods.org/carbon sequestration *and* the carbon storage volume increased greatly. Currently, this tree's annual rate of carbon sequestration has begun to decrease due to a slowing growth rate. However, the oak continues to add to its now relatively high total carbon storage volume and will continue storing carbon until it dies and begins to decay. *(See page 5)*

Carbon sequestration rates and carbon storage in a forest of trees differs from an individual tree. Not all trees within a forest grow at the same rate due to competition for sunlight, water, and other resources. Some trees may grow at a rapid or high rate, but many cannot and end up stunted or dead. In northeastern U.S. forests, peak carbon sequestration rates begin to slow after about 70 years of age. Slowing sequestration rates in older trees has led to the misconception that old growth forests don't store as much carbon as the predominantly middle-aged forests we see in Massachusetts today. However, recent research suggests that this is not the case. Studies show that as trees in the forest grow older, the amount of carbon stored in the forest floor increases due to root growth.

Carbon in the Dirt

Not only is our oak sequestering and storing carbon above ground in the form of wood and leaves, it is also storing carbon below the ground in the tree roots and in the soil itself. How does this happen? Carbon storage occurs in the soil fungi growing on the tree roots, and the fungi in turn transfer carbon into the soil. When the old oak eventually falls and decays on the forest floor it will release some carbon into the air, but most of the carbon that built up in the soil while the tree was alive will remain stored.

Even after a few decades, the fallen tree is still present, blanketed with mosses and lichens on the outside while carpenter ants and wood-boring beetles devour the tree from within. The slow decomposition process by insects, fungi, bacteria, and lichens transfers carbon from the dead wood into other living organisms. Some carbon from the bodies of these organisms is released into the air through respiration when they die, but these creatures don't lose all their carbon. They'll be covered with fallen leaves and become part of the forest litter—the upper-most layer of forest soils. Continued decomposition locks more carbon into the forest soil's organic matter.

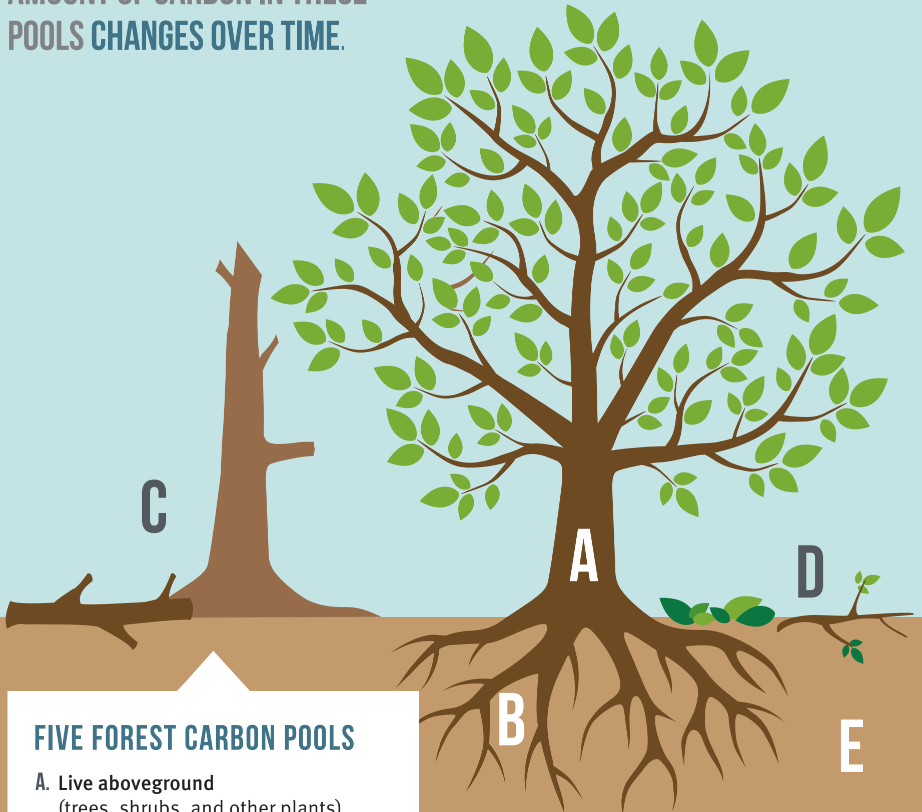
Seeing Forest Carbon Among The Trees

Stepping away from our single oak tree, let's expand our view to a forest composed of many trees. We've known that forests have always provided personal and public benefits such as clean water, forest products, wildlife habitat, and outdoor recreational opportunities. An added, more recently understood benefit is the forest's role in reducing the effects of climate change through carbon sequestration and storage. The carbon storage and sequestration process is similar to the lone oak, but on a far greater scale. Think of a forest as a place where carbon is stored, accumulated, or lost in "pools." The amount of carbon in those pools changes over time. Forest carbon pools can be categorized as live aboveground, live belowground, deadwood, litter, soil organic matter. *(See page 7)*

Carbon storage varies depending on forest type, and the location and climate in which it is growing. In New England, on average, studies show live, aboveground carbon storage across four different forest types ranges from 21%–48% of total forest carbon. Live belowground tree roots typically account for about 5%–9% of the total forest carbon pool. Dead, decomposing trees lying on the ground add some carbon storage and accounts for about 5% of the forest carbon pool. The litter layer of fallen and decaying leaves accounts for the 5%–15% of all forest carbon, and the deep soil organic pool beneath the litter is typically the largest carbon component, accounting for 30%–50% of the total forest carbon pool.

WHERE IS CARBON STORED IN A FOREST?

A FOREST **STORES CARBON** IN **DIFFERENT POOLS,** AND THE AMOUNT OF CARBON IN THESE POOLS **CHANGES OVER TIME**.



FIVE FOREST CARBON POOLS

A. Live aboveground
(trees, shrubs, and other plants)

B. Live belowground
(roots)

C. Deadwood
(standing dead trees [snags] and downed logs)

D. Litter
(leaves, needles, and small branches)

E. Soil organic matter
(organic material in the soil, such as dead and decayed biomass [e.g., plant material and insects])

Factors that influence the amount and proportion of carbon in each of these pools:

- the age of the forest
- the species of trees making up the forest
- natural and human disturbances
- soil characteristics (e.g., texture and drainage)
- past agricultural land-use history

Graphic courtesy of Catanzaro, P and A. D'Amato. 2019. Forest Carbon: An essential natural solution for climate change. masswoods.org/carbon

Without question, the most important action to take relative to forests and climate change is to keep forest land in forest use. Converting forest lands into residential and industrial developments results in immediate and substantial carbon release levels with little or no future ability to re-sequester and re-store carbon. According to Mass Audubon's *Losing Ground* report, we are losing 13 acres of forestland to development in Massachusetts *each day*. MassWildlife and its conservation partners are doing their part by acquiring thousands of acres of additional forest each year, permanently protecting those forests from conversion to house lots or industrial sites. These actions ensure that those forests will continue to sequester and store more carbon every year.

Cutting for Conservation

What about the needs of wildlife and wildlife habitat? Land protection benefits wildlife but land protection alone is not enough for long-term wildlife and habitat conservation. We cannot ignore the fact that human land use change has fundamentally and permanently altered natural disturbance processes like flooding and fire that historically created a diversity of wildlife and vibrant open habitats. Some of these habitats, such as shrublands, grasslands, young forests, and barrens, are now uncommon and even rare in Massachusetts due to development or forest maturation. Similarly, some wildlife species and rare plants whose existence depends on these open habitats are uncommon, are dwindling in population or range, and in some cases, are now endangered. Examples include ruffed grouse, American woodcock, New England cottontail, buck moth, wood turtle, and green snake. Common wildlife such as white-tailed deer, wild turkeys, and a wide variety of songbirds also rely on the food and cover offered by these uncommon habitats. *(See page 9)*

Continued on page 11

Photo by Bill Byrne/MassWildlife

Photos © Bill Byrne (white-tailed deer); Mike Nelson (buck moth); Mike Jones (wood turtle); Anne Stengle (green snake); Troy Gipps (wild turkey poult)

Carbon in your Home and Community

Climate change is driven by increased concentrations of greenhouse gases, mainly carbon dioxide that human activities release into the atmosphere. Keep in mind that carbon itself is *not* the enemy. After all, life as we know it cannot exist without carbon. The "enemy" is the dramatic and increasing human-driven rate of change in the geochemical state of carbon within Earth's ecosystem. In a nutshell (or acorn shell), humans have removed massive amounts of ancient carbon from the earth in the form of coal, oil, and natural gas over the past two centuries. The carbon in these fossil fuels has been released back into the atmosphere in such high quantities that the forests that sequester and store carbon cannot keep up. On a planetary scale, it's estimated that the earth's forests currently absorb less than 30% of annual human-caused carbon release. Furthermore, the amount of forest land on Earth is declining annually due to human development and agricultural practices.

Climate change is an overwhelming subject. How can we make a difference and maintain some kind of balance? Here are a few ideas to consider. We know that trees and other forest plants help reduce greenhouse gases by storing large amounts of carbon in wood, root systems, and soils.

Protecting forest lands is an important action as it prevents large scale carbon release associated with residential and industrial development. Get involved with efforts to protect land in your community or consider placing your property in some form of conservation protection program. If you qualify, there could be a tax benefit to you. Consider managing your forest for wildlife and support efforts to manage habitat on municipal and conservation lands.

Promote local wood products! Forest lands provide renewable and locally sourced wood products. Tree harvesting for wood product purposes keeps forest land in forest use and the resulting products benefit people. Processing of locally sourced, renewable wood products does release some carbon, but the carbon budget numbers demonstrate there is very little carbon released compared to overall storage. Additionally, long-lived wood products continue to moderate climate change over their life or "use" term; a substantial amount of carbon is still stored in your own home in the form of lumber, furniture, flooring, and handrails. More recently, cross-laminated timber is being produced and used in commercial building construction. These long-term products store carbon from the felled trees for decades or even centuries. In addition, using renewable wood products for building construction has the benefit of a substantially lower carbon footprint compared to buildings constructed of non-renewable products such as concrete and steel.

Resources: Carbon and Forest Management

UMass/Amherst, masswoods.org

- Forest Carbon
- Landowner Programs
- Find a Professional

MassWildlife, mass.gov/masswildlife

- Guidance for Private and Municipal Landowners
- Habitat Management Grants
- Natural Resources Conservation Service programs

Food and Agriculture Organization of the United Nations, fao.org

- Managing Forests for Climate Change
- Forests and Climate Change

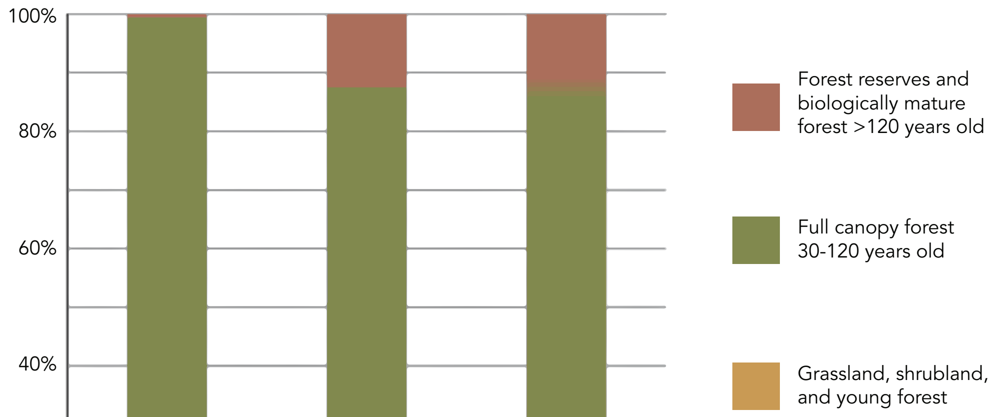
Continued from page 8

These habitats need direct management intervention to restore and maintain them or to remove invasive plants. Without habitat restoration and management, we would lose a number of native wildlife, tree, and plant communities and diminish the Commonwealth's natural heritage and wildlife diversity. In fact, *over 40%* of the 427 plants and animals currently listed under the Massachusetts Endangered Species Act depend on habitats *needing active management* during at least part of their life cycle. Forest management for wildlife maintains the benefits of clean air and water and provides people with a variety of outdoor and nature-based recreational opportunities. Active management of open habitats and forests also increases the resiliency of the landscape to the impacts of climate change.

As the state agency responsible for the conservation of freshwater fish and wildlife, including endangered plants and animals, it is MassWildlife's core mission to address and mitigate the effects of human disturbance and development on wildlife and their habitats. MassWildlife has care and control of over 220,000 acres of conservation lands, which includes 170,000 acres of Wildlife Management Areas (WMA) and about 50,000 acres of Wildlife Conservation Easements (WCE). These lands are conserved for wildlife to thrive and for people to enjoy. Using information from scientific literature, biological monitoring, and private conservation organizations, MassWildlife biologists and foresters set wildlife habitat goals for MassWildlife lands that received approval from the Fisheries and Wildlife Board in 2000. The goals are designed to conserve a wide 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 keeping with the agency's science-based habitat goals, the majority of MassWildlife's forestlands will continue to be managed as forests. *(See graphic below)*

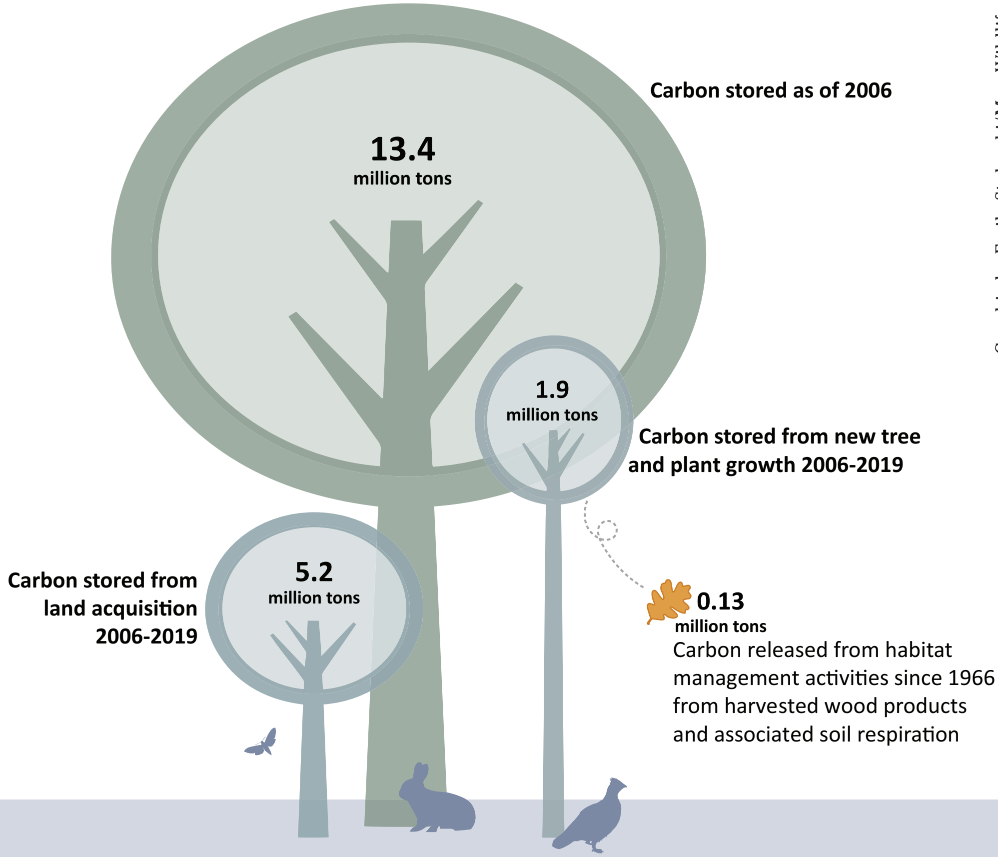
MassWildlife has established approximately 10% of its lands as forest reserves.

Habitat Composition and Goals for MassWildlife Lands



Graphic by Emily Stolarski/MassWildlife; Photo by John Scanlon/MassWildlife

This means no commercial harvesting will take place and natural disturbance processes such as wind storms and flood events will determine what these reserves will look like. The forests MassWildlife manages both in and out of reserves will continue to grow (and store carbon) into the future, perhaps even reaching or surpassing the age of our old oak. On the other end of the spectrum, the agency is striving to maintain, restore, or create 1%–2% grasslands, 8%–9% shrubland and 10%–15% young forest habitats on its lands. Forestry activities like tree cutting and tree mulching are useful tools used by foresters and habitat biologists to achieve wildlife and habitat goals. The wildlife services from forest management help create thriving young forest and barrens habitats, benefiting a variety of wildlife in need of special conservation efforts. The remaining 60%–70% of MassWildlife forest lands will be managed as full-canopy forest.



Graphic by Emily Stolarski/MassWildlife

MASSWILDLIFE LANDS CURRENTLY STORE 20.37 MILLION TONS OF CARBON

In 2006, MassWildlife lands stored 13.4 million tons of carbon. Since 2006, 5.2 million tons of storage has been added thanks to new land purchases. An additional 1.9 million tons of carbon storage has been added by forest growth. Habitat management activities since 1966 released 0.13 million tons, amounting to less than 7% of the carbon storage gained through forest growth.

EXECUTIVE ORDER 569

In 2016, Governor Baker issued an Executive Order to establish an integrated climate change strategy for the Commonwealth to help meet the goals of the Global Warming Solutions Act. State agencies must develop "strategies that conserve and sustainably employ the natural resources of the Commonwealth to enhance climate adaptation, build resilience, and mitigate climate change." This order allows agencies to take a holistic approach, considering climate change concerns and options as they relate to an agency's realm of responsibilities. In fact, the Executive Order provides for MassWildlife to continue its mission of restoring, protecting, and managing land for wildlife to thrive and people to enjoy while contributing to climate change solutions.

Carbon's Bottom Line; The Budget Analysis

With so much discussion about climate change, carbon release, conservation, and cutting trees, it's time to look at the numbers. How much carbon is stored versus released across MassWildlife lands by its forest habitat management activities? MassWildlife habitat biologists recently completed a detailed accounting of carbon storage and carbon release on WMA and WCE forest lands. The results on both carbon storage and release are derived from formulas that utilize data from a 2006 forest inventory conducted on MassWildlife lands, information on the habitat management activities (tree cutting and tree mulching), and the types of wood products derived from those activities. The results also account for forest growth since 2006 and forest protection from additional land acquisition since 2006. Finally, information from habitat management activities on MassWildlife forest lands from 1966 to 2019 was also factored into the equation.

The final numbers are overwhelmingly positive. Currently, MassWildlife forest lands store 20.37 million tons of carbon. The volume of carbon released during forest habitat management practices (tree cutting and tree mulching) *since 1966* on all MassWildlife lands is a mere 0.13 million tons. The amount of carbon released during forestry activities for wildlife habitat management is a tiny fraction of carbon storage gained by tree and plant growth on agency lands. *(See page 12)*

Looking at it another way, the annual ratio of carbon storage additions to carbon release across MassWildlife lands stands at 17:1. This means that for every pound of carbon released through habitat restoration and management activities, 17 pounds is added to storage through tree growth on unmanaged forest lands. There is far more carbon stored on MassWildlife lands than there was at the end of the previous year *even after* accounting for carbon release from active forest management. The bottom line is that it is possible to actively manage forests to achieve wildlife habitat and forest conservation goals while positively addressing climate change concerns. To that end, MassWildlife will continue its wildlife conservation mission while incorporating climate considerations into forest and habitat planning for the next 150 years.

About the Authors

John J. Scanlon is the Habitat Program Supervisor at MassWildlife's Field Headquarters in Westborough and Brian Hawthorne, MassWildlife Habitat Program Coordinator, works out of the MassWildlife Western District office in Dalton. *The authors would like to thank Paul Catanzaro, Associate Extension Professor of Forestry at UMass/Amherst; Dr. Anthony D'Amato, Professor and Forestry Program Director at the University of Vermont in Burlington, VT; and graphic design professional Penny Michalak for use and modification of several forest carbon graphics. Thanks also to Marion Larson, Information and Education Chief, for editing assistance.*

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TRUE GREEN

Few sounds in the woods of New England are as iconic as a "drumming" ruffed grouse (*Bonasa umbellus*). Grouse are a fixture of northern forests across all of North America. In Massachusetts, grouse will utilize a variety of forested habitat, but thick, dense, regenerating young forest is critically important to provide ample food and cover from predators. These habitats are rare across southern New England. MassWildlife foresters and biologists are focusing their efforts to increase young forest habitat to benefit grouse and numerous other species that rely on these dense, brushy habitats. Photo by Bill Byrne/MassWildlife

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