2020
Forest Action Plan

Part I: Forest Resource Assessment

The Mission of the Maryland Department of Natural Resources

The mission of the Maryland Department of Natural Resources (DNR) is to lead Maryland in securing a sustainable future for our environment, society, and economy by preserving, protecting, restoring, and enhancing the state's natural resources. DNR is the state agency responsible for providing natural and living resources-related services to citizens and visitors. DNR manages more than 467,000 acres of public lands and 17,000 miles of waterways, along with Maryland's forests, fisheries, and wildlife for maximum environmental, economic and quality of life benefits.
A national leader in land conservation, DNR-managed parks and natural, historic, and cultural resources attract 14.5 million visitors annually. DNR is the lead agency in Maryland's effort to restore the Chesapeake Bay, the state's number one environmental priority.
Learn more at www.dnr.maryland.gov.

The Mission of the Maryland Department of Natural Resources Forest Service

The Forest Service mission is to restore, manage, and protect Maryland's trees, forests and forested ecosystems to sustain our natural resources and connect people to the land.

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Executive Summary

1. Maryland has 39% forest cover and a continued trend of slow loss of forest land. When all tree canopy is considered, including patches smaller than an acre, tree canopy covers almost 50% of the state. Trends correlate with the pace of development, constrained but not stopped by existing laws, policies, and programs.

2. In a year, Maryland's forests absorb 4.3 million metric tons of carbon dioxide equivalent (MMtCO2e) emissions. Urban trees and forests also contribute to carbon sequestration and store an additional 2.2 MMtCO2e per year.

3. Maryland is well-positioned to provide mature forests, which now make up 78% of Maryland's forest cover; 40% of forests are over 80 years old. The benefits of more mature forests for recreation, timber supply, interior forest habitat, and sustained carbon storage also come with the trend of slower annual net growth rates and increasing natural mortality. The related decrease in young forests has reduced early successional habitats needed for a variety of species now in decline, and increased the potential for future high carbon sequestration rates. .

4. A quarter of Maryland's forests are publicly owned, and over 41% of that forest is considered reserved from forest harvesting, about 10% of the forest area. Renewable resource-based industries, important for stable rural economies and watersheds, source more wood from private lands.

5. 16.9 million trees have been planted through ten planting programs in the last 14 years. The Backyard Buffer program has expanded to 20 counties, the Marylanders Plant Trees coupons continue to be available, and state funding for residential plantings in priority areas has increased. Pine seedling planting has decreased, while hardwood seedling planting has increased.

6. Planting and maintaining forested riparian buffers is an integral strategy for protecting water quality. Since 1996, over 1,400 acres of riparian buffers have been planted in Maryland. 57% of Maryland's streams are fully buffered, and another 27% are partially buffered.

7. Forest health concerns are expanding as many forests age, combined with continued new introductions of invasive, exotic pests, such as the emerald ash borer and spotted lantern fly. Gypsy moth (exotic) and southern pine beetle (native) continue to pose significant risks of interacting with seasonal weather, biocontrol organisms, and drought stress.

8. The area of sustainably certified forests has expanded since 2010. Over 800,000 acres are certified and audited, including private lands certified though the American Tree Farm System, dual certified State Forests, and other Sustainable Forestry Initiative certified private forests.The sustainable forestry certification on State Forest Lands includes protection of old-growth systems and plans for managing significant additional areas as Old-Growth Ecosystem Management Areas, where old-growth characteristics can develop over time.

9. Wildfire acres burned has declined, which is correlated with trends in increased rainfall and increased use of prescribed fire to restore fire-adapted ecosystems and manage wildfire risk.

10. Markets for locally sourced forest products are decreasing due to several factors including the loss of the fumigation capability at the Port of Baltimore, decline of log truck driving capacity, and closure of saw and paper mills. The Luke Paper Mill, Maryland's last remaining paper mill, located on the Potomac River in Allegany County, closed in 2019. Before its closure, it was capable of producing 450,000 tons of freesheet paper products annually.

11. Declining markets have impacted forestry's contribution to the economy. From 2005 to 2015, the economic impact of forestry in Maryland declined from $4.7 billion to $3.5 billion. Investing in existing markets, like poultry bedding, and new markets, like woody biomass for thermal and electrical energy, could help revitalize the forest products industry, and provide income to landowners and sustainable management of forests.

12. Forest harvest best management practices (BMPs) are widely used and are properly implemented at a rate of 88% during forest harvest, with 97% implementation on public lands. The natural land cover in Maryland is predominantly forest, and with wide use of good BMPs, forests are the most protective land use for water quality and watershed function.

13. Most Maryland forest types, dominated by oaks and yellow-poplar, are considered to have moderate to high adaptive capacity in the face of climate change, but red spruce habitats are more at risk. Faster growth has been documented for many tree species and is expected to continue with the higher carbon dioxide levels (needed for photosynthesis), and observed trends of warmer, wetter conditions, especially in winter and spring. However, all forest types, regardless of climate change adaptive capacity, require climate informed management to address threats that may be exacerbated by climate change.

14. Coastal maritime forests, where saltwater intrusion is a particular concern, are at risk. Maritime forests face increasing levels of saltwater, and a 2016 survey by MDA found that 50,406 acres had been affected by saltwater intrusion. This was an increase from 18,117 acres of forest in 2013.

Purpose

The Forest Action Plan is meant to be a roadmap for investing federal, state, local, and private resources where they can be most effective in achieving national conservation goals. States submit their Forest Action Plans to the United State Department of Agriculture Forest Service. Federal Farm Bills have required that states develop Forest Action Plans since 2008 to access federal funding.

The Forest Action Plan is made up of two parts, an assessment of forest conditions in the state, and a strategy that identifies major goals and actions to reach them. It also includes, by referencing the planning document for the Forest Legacy Program, a national land conservation program for working forests; the Assessment of Need is a state-specific plan that guides applications for the federal Forest Legacy Program, a third section of the Forest Action Plan.

Part I of Maryland's Forest Action Plan, the Forest Assessment, is required to:

- Describe forest conditions on all ownerships in the state
- Identify forest-related benefits and services
- Highlight issues and trends of concern as well as opportunities for positive action
- Delineate high priority forest landscapes to be addressed
- Outline broad strategies for addressing the national priorities along with critical issues and landscapes identified through the assessment

Maryland's Forest Assessment also identifies critical information gaps so that this information can be acquired as opportunities arise and to better coordinate with other natural resource plans. The assessment addresses all public and private ownerships in Maryland, spans the urban to rural continuum, and is built around sustainable forestry criteria and indicators.

Historic Conditions

The amount of Maryland's forests has changed considerably since Fred Besley's first survey was completed in 1916. There is actually more forest today than when he crisscrossed the state surveying forest patches, and his maps of forest cover are still available to be referenced today.

Maryland was once covered by forest broken only by rivers, marshes, and mountain meadows; this expansive, primeval forest stretched from the wet soils of the Atlantic coastal plain to the hills, plateaus, and valleys of the Appalachians. The inhabitants, Native Americans who settled along the Chesapeake Bay and its tributaries, were the first users of the forest, clearing and burning for farming, berry production, and managing game. In large part, the great forest of countless millions of oak, tulip-poplar, eastern hemlock, beech, loblolly pine, white pine and American chestnut was left to grow and die and change with the rhythms of the land and sky.

In 1634, this picture began to change. A group of settlers arrived on an island in the Potomac and brought with them a new set of values and aspirations regarding the land.

They saw a wilderness, full of untapped resources, which were rare in Europe at that time. They saw in the forest a rich source of lumber and fuel. In a few generations, tobacco, corn, and wheat instead of oaks and pines competed for the sun's energy. Industrious (and successful) farmers cut and cleared forests to feed a young economy based on cash crops. As the settlers spread westward, houses, fences, fuel, and crops demanded more and more forest clearing. Left behind were some unanticipated consequences. The rivers and streams threading through fields collected any unprotected soil as it ran off and filled the deep-water harbors of the Chesapeake Bay leaving a landscape of shifting shorelines and port communities with limited water access. Mill dams powering early settlements also changed the character of streams. The impacts of early settlement unfolded over one hundred years and slowly resulted in massive land use change; the next alterations were faster and larger.

While settlers acted individually and often in isolation, industrialization moved forward with an efficient coordination of people and resources.

The production of iron required more "input" than the production of tobacco or corn. It required more raw materials, specialized skills, and a controlled source of energy. Throughout much of the 1700's and 1800's, the controllable energy source was charcoal. The character of the forest changed from an obstacle to farming to a vast reservoir of fuel. To encourage the industry, the Maryland General Assembly in 1719 offered 100 acres of land to anyone who built an iron furnace. A single operation, the Principio Furnace in Cecil County, consumed 10,000 acres of woodland during its 100 years of production. Forest clearing reached its peak in the mid-1800's. In the decades after the Civil War, thousands of acres of local farmland were abandoned for better land in the Midwest and West or a more secure occupation in the booming cities. More land was released by better farming techniques that increased crop yields so that fewer acres were needed to produce the same amount. Still more land was made available by over 200 years of logging which had thinned the forest of its high quality trees. Set by natural causes and sparks from steam engines, fire completed the job by raging over land made vulnerable by indiscriminate logging. The Great Depression produced even more abandoned land as the cities and the West attracted desperate people. The forest now had new opportunities and moved in to fill the space. The abandoned agricultural, cut-over, or burned lands were first covered by grasses and brambles, then shrubs and small trees, and today's forest was established. Whitetail deer had been hunted to extinction, so

trees grew with little pressure from deer damage. These forests grew in a relatively short time and are now even-aged forests between 70 and 120 years old. The tree species found in these “new” forests are similar to those of the 1600’s, but the broad composition of the forest has changed dramatically. The American chestnut, a once dominant species in Maryland, is now mostly gone from today’s forests due to chestnut blight. The original forests were primarily composed of hardwoods; today, conifers are more abundant than they once were due to planting programs, natural succession, and scientific forest management. Scientific forest management meant that the forest, for the first time, had some help when it tried to reestablish itself. By the late 1800’s, a national conservation movement led by such notables as Theodore Roosevelt, Gifford Pinchot, and John Muir began to focus attention on wholesale timber harvesting and the lack of regard for forest regeneration. The movement saw the formation of the National Park and National Forest systems, conservation organizations, and many state forestry agencies. The passage of the 1911 Weeks Act provided money to states for fire protection and allowed for the purchase of land across the country for National Forests. In the early 1900’s, forestry schools were formed around the nation and supported research on how forests could be managed to provide adequate regeneration and meet other land use objectives. As the schools developed, so did the science of forest management.

The Maryland State Board of Forestry was organized in 1906 to take possession of and manage a gift of land in Garrett County, as well as control forest fires. Fred Besley, Maryland’s first state forester, inventoried every 5-acre woodlot in Maryland and produced the first forest inventory, printed in 1916. The first state forest nursery was established in 1914 to supply seedlings for reforestation. In the 1940’s, the Maryland Forest Division began to offer woodland owners professional forestry assistance, as well as seedlings, to ensure forest regeneration. Over the past 30 years, understanding of the forest’s functioning has grown in unexpected ways and unexpected places. In the late 1970’s, scientists began an extensive study of the Chesapeake Bay to determine the specific reasons for its decline. Three major problems were identified: excess nutrients from wastewater, agricultural land, and developed land; sediment runoff from farms, construction sites, and other lands, and elevated levels of toxic chemicals. We have since learned that nutrient pollution, much of it caused by human activity on the land bordering streams and even hundreds of miles upstream in the watershed, has driven a fundamental biological, chemical, and physical change in the Bay.

The Maryland forest we see today echoes human migration, the needs of agriculture, the lumber industry, iron and charcoal, wildfires, the first attempts at management, and, ultimately, the resiliency of nature. We will continue to influence the forest. Our charge is to do so responsibly and sustainably, meeting today’s needs and creating healthy forests for future generations.

Maryland is fortunate to have a large quantity of data available to assess the current condition and trends of its forest land. The Chesapeake Bay watershed has been at the forefront of the region’s environmental studies and recovery efforts, and 95% of Maryland is within the watershed. This being the case, land cover—impervious surface, forests, development, and agriculture— have been calculated, studied and estimated in great detail for more than 30 years, and measurements of other aspects affecting water quality have been quantified and digitized, where elsewhere they may not have been. As a result, many spatial data layers have been developed for the Chesapeake Bay watershed and its constituent states which are unavailable at a similar size and scale to other states, or simply unavailable at all. This wealth of data is used to provide a snapshot of Maryland’s current forest resources and provide some insight into where Maryland’s forests have been and where they will be in the near future.

Maryland's Forest Assessment is framed around the seven criteria for sustainable forestry established by the Montreal Process, which was originally developed by an international working group in 1994 as a guideline for policy makers in assessing forest trends and progress towards sustainable forest management.

1. Conservation of biological diversity
2. Maintenance of productive capacity of forest ecosystems
3. Maintenance of forest ecosystem health and vitality
4. Conservation and maintenance of soil and water resources
5. Maintenance of forest contributions to global carbon cycles
6. Maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of societies
7. Legal, institutional, and economic framework for forest conservation and sustainable management

Conservation of Biological Diversity

Increasing demands placed on Maryland's forests present a challenge to the conservation of biological diversity in the state. Taking measures to conserve biodiversity can ensure protection of the functions and values of our forests. Therefore, a better understanding of the biodiversity of Maryland's forests can aid in effectively managing and addressing issues such as old growth and endangered and threatened species. Biological diversity is about variety—in the number and kinds of life forms, in their genetic makeup, and in the habitats where they live. Generally, greater diversity means a greater potential to adapt to changes. To preserve biological diversity, animal and plant species must be able to freely interact with one another and with their environment. There must be food, water, and shelter in sufficient amounts spread across the landscape.

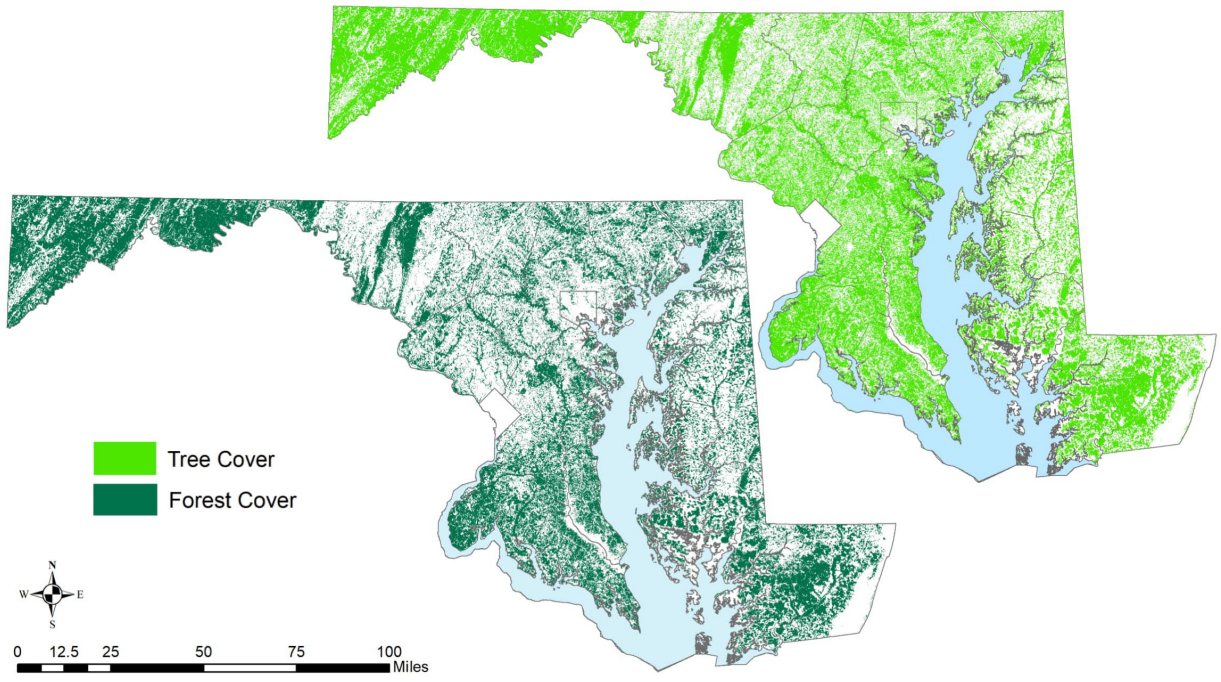


Figure 1 Maryland's tree canopy cover (top) and forest cover (bottom) form the Chesapeake Conservancy 2013 high resolution land cover project

Area of Total Land, Forest Land, and Reserved Forest Land

In 2019, the U.S. Census Bureau estimated Maryland's population at 6.05 million, a 5% increase over the 2010 population of 5.8 million. Total land area is estimated at 9,707.24 square miles, or 6,212,634 acres in 2019 (Census Bureau Quick Facts, 2019). There are estimated to be 595 persons per square mile in Maryland; a 9% increase since the last assessment was completed in 2010. This makes Maryland the 5th most densely populated state in the nation. Since 1990, the population density has increased 21%, and will likely continue to increase for the foreseeable future.

The land type we call "forest" is very precisely defined by the U.S. Forest Service and makes clear exactly what is and is not forest. The definition states that any area of trees with at least 10% tree cover, at least 120 feet wide, and 1 acre in size measured from stem-to-stem from the out-most edges, is a forest (figure 1). Forest land in the state has been decreasing since the 1970s, mostly due to development. Forests covered 41% of Maryland, or 2.6 million acres in 1999 (Frieswyk, 2001). This amount of forest cover is remarkable in a state that has seen tremendous population growth and economic development in recent years. Forest is defined with different metrics for other purposes, such as the Forest Conservation Act, where forest is defined as areas that have at least 100 trees per acre with at least 50% of those trees having a 2 inch or greater diameter at 4.5 feet above the ground and larger and areas that have been cut but not cleared.

"Since 2012, there has been little change in the estimated forest land area, however long-term data show decreases in forest land since the 1963 FIA inventory"

US FOREST SERVICE
FORESTS OF MARYLAND
2017

Today the U.S. Forest Service estimates forest cover in Maryland to be approximately 2.44 million acres or about 39% of the total land area, providing approximately 0.40 acres of forest per person (figures 1 and 2). Total forest area is virtually unchanged from the previous assessment in 2010, and may indicate a tapering-off of forest loss in Maryland. It may also be due to the slowing of the housing market since 2005,

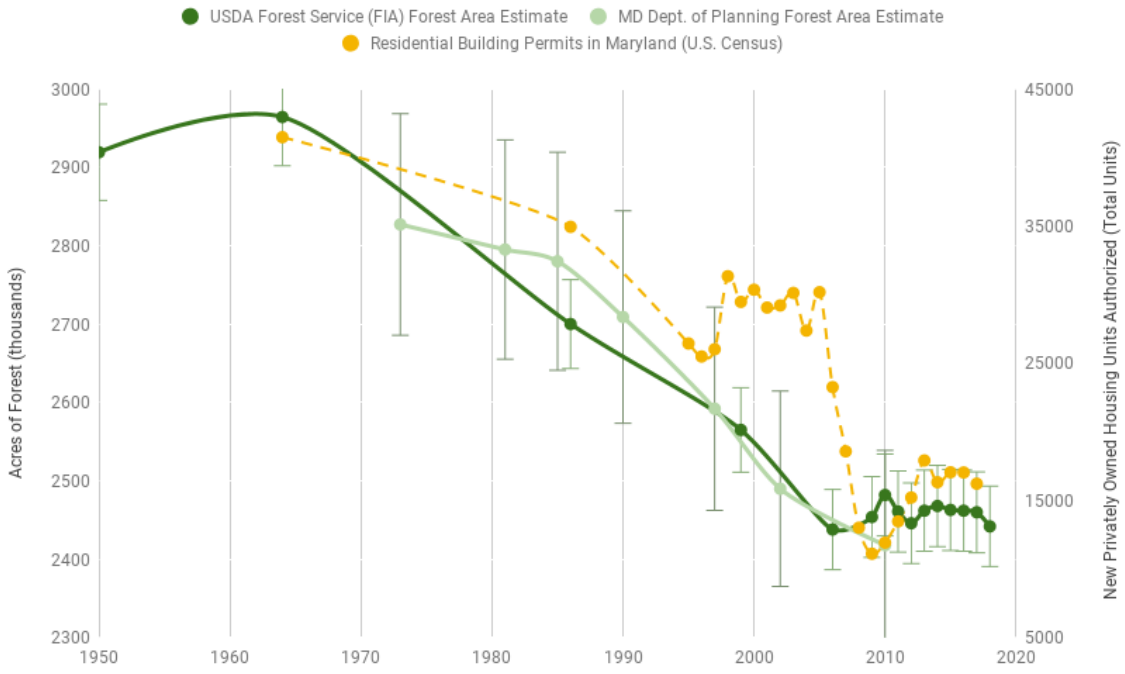


Figure 2 Forest cover in Maryland in acres compared with issued private housing building permits by year

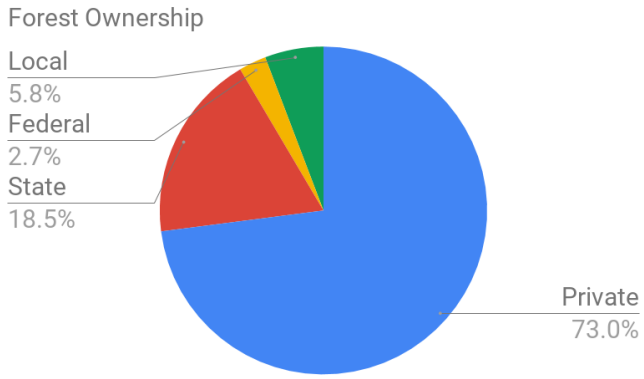


Figure 5 Forest Ownership in Maryland from 2019 FIA data

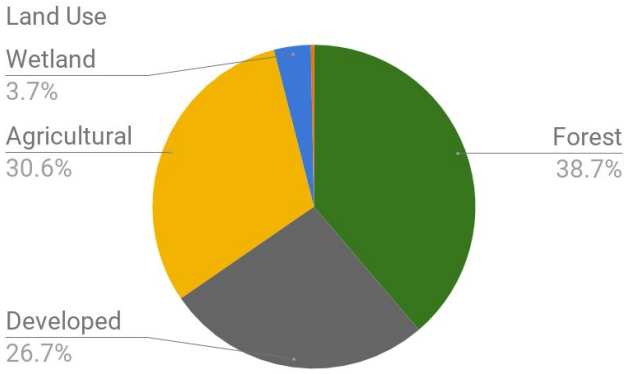


Figure 4 Land Use in Maryland from 2010 MDP data

reaching a low-point in 2009, and having nearly level growth in 2018 (figure 2).

According to 2019 U.S. Forest Service estimates from FIA, of the 2.44 million acres of forests, 73% are private, 18.5% are state, 2.7% are federal, and 5.8% are local (figure 3). In 2010 the Maryland Department of Planning, which has different estimates for forest cover, estimated Maryland's land cover to be 26.7% developed (residential, industrial, commercial, institutional, transportation), 30.6% agricultural land, 3.7% wetland, and less than 1% barren (figure 4).

Forests on reserved land (forestland that is withdrawn from timber harvesting through statute or administrative designation) in Maryland amounted to 284,000 acres in 2018, according to U.S. Forest Service estimates (figure 5). This makes up 41.9% of all public land in the state and includes all National Park and U.S. Fish and Wildlife Service land and one third of all state land. Of state land, 66,000 acres, or roughly 14% of state-owned land, are part of the Maryland Wildlands Preservation System. These areas are protected indefinitely by an act of the state legislature as wild, where motorized vehicle access is restricted, and tree harvesting is prohibited. Wildlands make up nearly 3% of Maryland's total forest cover. Most of Maryland's known old-growth forest is located in these areas. Old-growth characteristics such as the presence of large trees, large snags and downed wood, canopy gaps, and pit-and-mound topography from windthrown trees, should develop over time in wildlands and other areas being managed for older forests.

While private forestland and 58.1% of public forestland is not officially reserved from timber harvest, on average for the last three years, only 0.8% of private forestland and 0.5% of State Forests have permits for forest harvests each year. Additionally, a portion of that permitted area will likely not be harvested due to Best Management Practices (BMPs) of not harvesting in stream buffers and other sensitive areas and operational limitations like extremely steep slopes.

Forest Type, Size Class, Age Class, and Successional Stage

In Maryland, forest stands in which most of the stocking is in large trees have increased in acreage since the early 1970's. The U.S. Forest Service estimates that 78% of the state's forests are in the Mature/Large forest class, nearly 40% of forest is over 80 years of age (figure 6), and

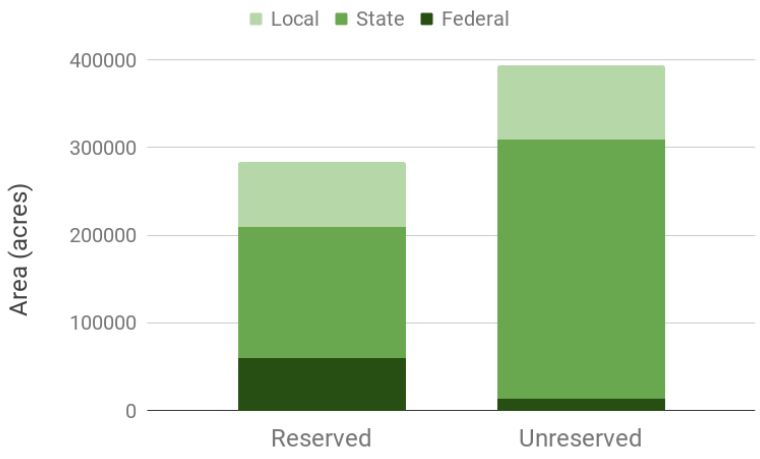


Figure 3 Area of public land in Maryland by reserve from timber harvest status and ownership

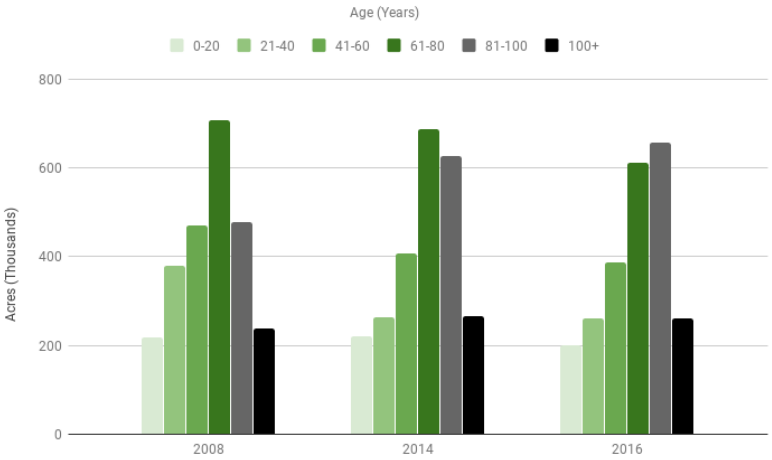


Figure 6 Forest age class by survey period

nearly all of which is in the oak/hickory forest type (Lister, 2018). This is indicative of a slowing of the forest products industry in Maryland over the last 40 years. Furthermore, the U.S. Forest Service reports that 10% of Maryland's timberland is at least 100 years old

By contrast, only 8% of the state's timberland is younger than 20 years (figure 6). To maintain a diversity of wildlife habitat types, a diversity of stand ages is needed. Older stands have many attributes that benefit wildlife: multiple layers with different vegetation that provide food and cover, bole cavities and bark flaps for nesting and feeding sites, respectively, and large dead trees, both standing and on the forest floor. People enjoy activities such as hiking and camping in stands dominated by large trees because they find them attractive and aesthetically pleasing. Forests that regrow after fire, windthrow, or cutting grow denser ground and shrub cover with high production of insects and fruits. Some species, like golden-winged warbler and cerulean warblers, depend on having both habitats in their habitat range (Hamel et. al., 2005).

Maryland's forests are composed largely of oak and hickory, with loblolly pine and other hardwoods making up the majority of other forest types. According to the US Forest Service in2017, oak and hickory forests made up 59 percent of Maryland's forest area, and Loblolly pine was about 16 percent. Maple, beech, and gum species make up the majority of the rest.

Extent of Forest Land Conversion

Perhaps the greatest threat to biological diversity in Maryland is development. The area between Boston, Massachusetts and Richmond, Virginia is perhaps the most densely populated and developed areas in the continental United States and the heart of Maryland lies within this region. According to the Maryland Department of Planning, between 1973 and 2010 the amount of developed land in Maryland more than doubled, while forest land has decreased by more than 300,000 acres.

In 1999 the U.S. Forest Service Northeastern Research Station completed the fifth statewide inventory of Maryland's forest resources. They found that Maryland was about 41% forested, with approximately 2.6 million acres of forest. Despite the rapid population growth over the previous years, the report indicated that much of the development in the 1990's had been contained within central Maryland, allowing the state to maintain a relatively high level of forest cover. There are three reasons for this high percentage of forested land. First, most of the population has been concentrated in and around Baltimore and Washington D.C. and a few other cities, leaving much of the state fairly rural. Second, there has been a sizable decrease in the amount of land used for farming. Land in farms is now half of what it was in 1950, a loss of 2.1 million acres. Although much of the lost farmland has been developed, some of it has been abandoned and has reverted to forest land through natural regeneration and tree planting. These new forests have offset much of the

losses in forest land due to development. Third, Maryland forests have been conserved and protected by various public programs such as Program Open Space, the Forest Conservation Act (FCA), the Forest Conservation and Management Agreement Program (FCMA), and the Smart Growth and Rural Legacy Programs. These programs allow and encourage sustainable forest management. Finally, the report found that Maryland had lost approximately 79,500 acres of forest in the period between 1986 and 1999.

The 2004 to 2008 estimate of Maryland's forest cover completed by the Forest Inventory and Analysis (FIA) unit of the U.S. Forest Service suggested that since 1999 Maryland had lost another 72,000 acres of forest. The last ten years, however, has seen little change in the area of Maryland forest lands, with the area remaining around 2.6 million acres. Over that period, the FIA data has consistently shown a trend of very slow forest loss, which is due in no small part to the economic down-turn the nation experienced in 2008, and the subsequent decline in the demand for housing (figure 2) (Ince and Nepal, 2012). **As the economy improves and the demand for housing increases, forest loss and fragmentation may increase some, despite being tempered by an array of policies, laws, and programs.**

Fragmentation and Parcelization

Fragmentation of forests is an increasing problem for wildlife. Wildlife biologists find that breaks made in the forest for roads, buildings, and other uses negatively impacts wildlife, especially birds. According to the National Woodland Owner Survey, the amount of forest landowners with less than 10 acres has increased from 72,400 in 1989, to 134,000 in 2006, signaling an increase in fragmentation brought on by parcelization (subdividing) of larger blocks of land from one landowner to many.

The most recent survey, conducted in 2018 (this survey did not include parcels under 10 acres), found that of forest landowners who responded to the survey and owned more than 10 acres of land, roughly 15% had sold or given away forest/woodland and 7% had their land subdivided..

Forest Communities and Associated Species of Concern

Old growth ecosystems are distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development which typically differ from earlier stages in a variety of characteristics that may include tree size, accumulations of large dead woody material, number of canopy layers, species composition, and ecosystem function. The age at which old growth develops and the specific structural attributes that characterize old growth will vary widely according to forest type, climate, site conditions and disturbance regime. Old growth forests support many of Species of Greatest Conservation Needs (SGCN) in Maryland.

The Maryland DNR uses the following definition for identifying old growth forests: An old growth forest is a minimum of 2 ha (5 acres) in size with a preponderance of old trees, of which the oldest trees exceed at least half of the projected maximum attainable age for that species and that exhibits most of the following characteristics:

1. Shade tolerant species are present in all age/size classes.
2. There are randomly distributed canopy gaps.
3. There is a high degree of structural diversity characterized by multiple growth layers (canopy, understory trees, shrub, herbaceous, ground layers) that reflect a broad spectrum of ages.
4. There is an accumulation of dead wood of varying sizes and stages of decomposition, standing and down, accompanied by decadence in live dominant trees.
5. Pit and mound topography can be observed, if the soil conditions permit it (MD DNR, 2007).

This definition does not require that an old growth forest has never been altered or harvested by humans. In general, most old growth forests in Maryland exceed 250 years in age.

Although old growth forest was once a dominant feature throughout most of the Maryland landscape, only about 40 small,

scattered remnants remain (MD DNR, unpublished data). The Maryland DNR has identified 2,399 acres of old growth forests on State Forest land (Table 1 This habitat is fragmented into small patches ranging in size from about 3 to 390 acres. Only five areas exceed 100 acres each. Most are considerably smaller (3-50 acres) and confined to isolated steep slopes, sheltered ravines or otherwise difficult to access areas where they were spared from indiscriminate logging and/or deforestation associated with agriculture. However, their isolation and limited acreage, along with increasing degradation of the surrounding landscape (e.g., via fragmentation) has compromised their ability to support old growth flora and fauna and function as intact ecosystems. Many areas are also threatened by invasive plant species, introduced insect pests and pathogens, and disruption of natural disturbance processes.

Approximately 95% of all remaining old growth forest that has been documented during the past decade is located on state lands. The remainder is either on federal (0.4%) or private lands (4.7%). Some of the best remaining examples occur on Savage River State Forest and Potomac-Garrett State Forest in Garrett County.). The sustainable forestry certification required on our State Forest lands includes protection of mapped old-growth systems and plans for managing significant additional areas as Old-Growth Ecosystem Management Areas which connect patches of existing old growth and forest where old-growth characteristics can develop over time. There are approximately 31,000 acres of Old-Growth Ecosystem Management Areas and an additional 7,600 acres of candidate Old-Growth Ecosystem Management Areas within Maryland's State Forests (Table 1). No logging of any kind is allowed in the identified old growth areas and the Old-Growth Ecosystem Management Areas only allow forest management activities that enhance their old growth conservation value.

Table 1 Area of old growth forests and Old Growth Ecosystem Management Areas (OGEMA) in Maryland's State Forests

Region	State Forest	Acres of Old Growth	Acres of OGEMA	Total SF Area
Western	Potomac-Garrett	438	2,011	18,632
Western	Green Ridge	198	15,535	47,560
Western	Savage River	1,758	13,199	55,281
Eastern	Chesapeake Forest Lands	0	1,502*	73,723
Eastern	Pocomoke	5	249+ 6,126*	18,198
	TOTAL	**2,399**	**30,994+7,628***	**213,394**

*Candidate Old Growth Ecosystem Management Areas in SF and nearby State/County lands

Successional Forest

Early Successional Forest, also referred to as "young forest habitat", from a forestry standpoint, is defined as trees younger than 20 years in age, and have not reached canopy closure. The historical extent of early successional forest in Maryland is uncertain, but today occupies 3% of forestland. Maryland has a variety of declining species that depend on early successional habitat, including woodcocks and golden-winged warblers. Certainly the origin, distribution and characteristics of today's forms of early successional forest are, in many cases, quite different. Prior to widespread European colonization, fires set by Native Americans and settlers and, to a lesser degree, lightning strikes, played a major role in creating and sometimes perpetuating forest conditions dominated by shrubs and small trees. Herbivores (e.g., beaver, bison, and elk), topography, soil conditions, and storm-related events (e.g., floods, ice storms, and tropical storms) also played significant roles. Together, these

agents of change maintained a shifting mosaic of early successional habitat embedded within a landscape that was likely dominated by old growth forest and a variety of grassland, shrubland and wetland habitats. The degree to which these factors affected the landscape varied by region and with local conditions (e.g., soil type, forest type, slope, and aspect).

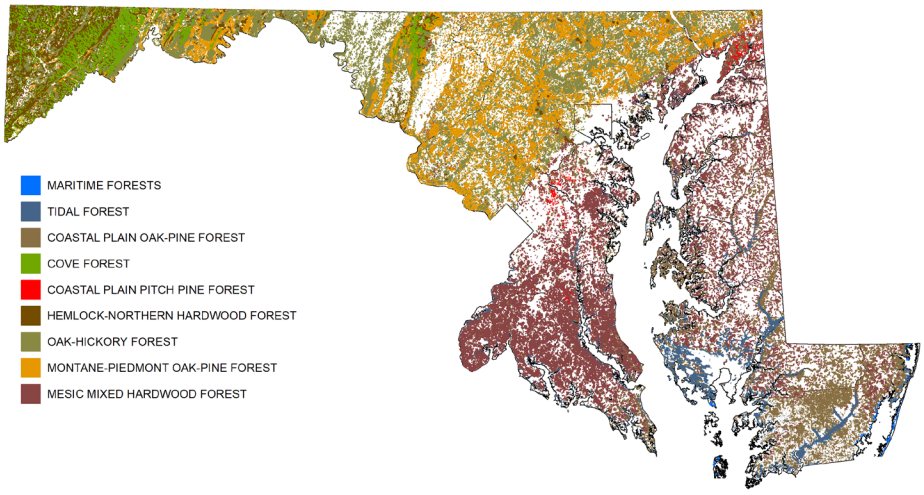


Figure 7 Map of Maryland's forest types

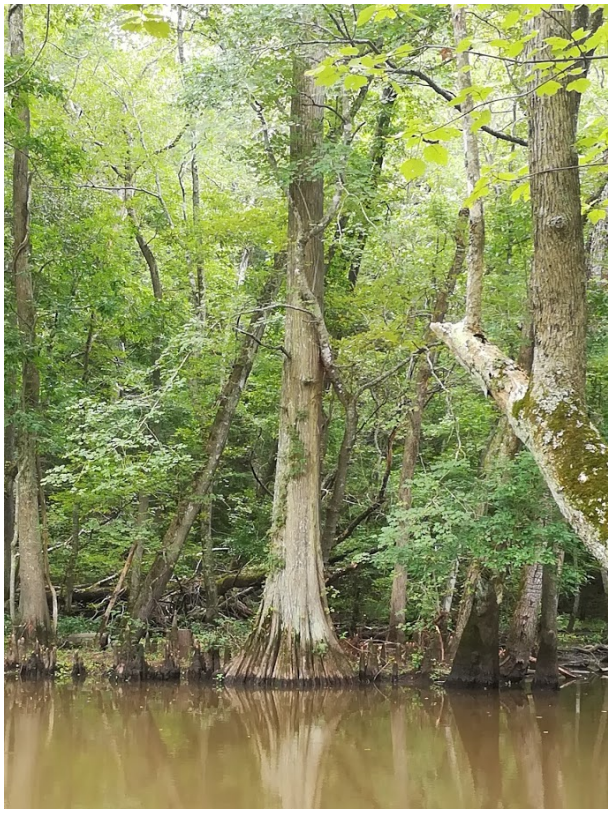
Today, the amount of Successional Forest is largely driven by three processes: logging, succeeding non-forest land, and forest edges. In logged areas, early successional forest begins to develop within one year of a timber harvest and may persist for 10-20 years or more depending, in part, on pre-harvest forest conditions, soil type, the size and type of silviculture, post-harvest silvicultural treatments, and the degree to which deer herbivory and invasive plant species impede native plant establishment and growth. Old cropland, pasture, or reclaimed strip mines are areas that were converted to agriculture or some other non-forested condition and have been recently allowed to "succeed" back to forest, or are otherwise managed in a way that has led to the development of early successional forest. Forest edges are usually abrupt, narrow (usually 3-30 ft wide), linear ecotones between a forested and non-forested habitat (e.g., cropland, road, transmission line right-of-way, backyard) or between two dissimilar forest age classes.

According to the U.S. Forest Service, there are approximately 177,100 acres of small diameter forest lands in Maryland as of 2018. The small diameter size class can be defined as live trees 1.0 to 4.9 inches (2.5 – 12.5 cm) in diameter and includes early successional forest. Examples of species with the greatest conservation need are the big brown bat, bobcat, golden-winged warbler, red-headed woodpecker, eastern box turtle, and Indian skipper, to name a few. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).

Tidal Forest

The Tidal Forest includes a variety of tidally-flooded forests that border the upper reaches of Maryland's Coastal Plain Rivers and tributaries. These habitats are species rich and structurally complex with open canopies and floristically diverse lower strata. In much of our region, these freshwater habitats are dominated by mixtures of hardwoods such as ash, gum, and maple. The Pocomoke River watershed is especially unique in that bald-cypress is co-dominant with ash, gum, and maple. Atlantic white-cedar is also present in the Nanticoke and Pocomoke River watersheds as small stands or scattered individuals. These communities often develop in narrow ecotones between regularly tidally flooded areas and the upland interface. Both Atlantic white-cedar (*Chamaecyparis thyoides*) and bald-cypress (*Taxodium distichum*) swamps are considered rare in Maryland because of widespread logging that occurred in the early 1900s. Examples of species with the greatest conservation need are Delmarva fox squirrel, scarlet tanager, Chermock's mulberry wing, eastern red bat, Acadian flycatcher, common ribbonsnake, taper-tailed darner, American redstart, eastern box turtle, and Chesapeake ambersnail. More information can be found in the 2015 to 2025 Maryland State

Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).



Bald-cypress trees at Pocomoke State Forest- Intyre McKee/Maryland Forest Service

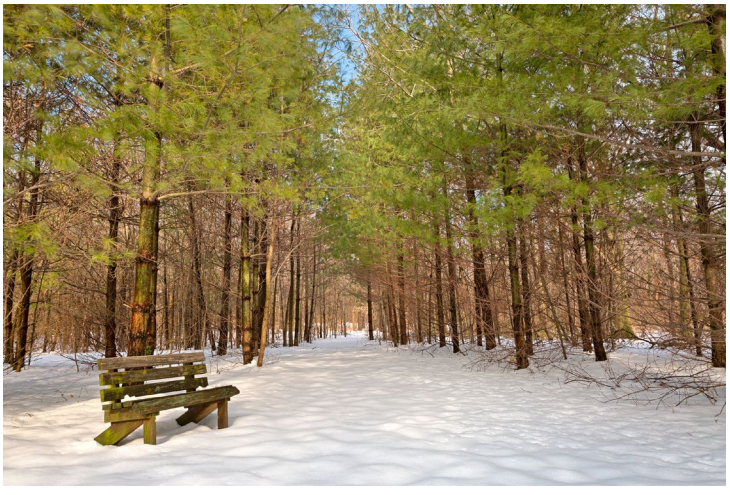
Maritime Forest and Shrubland

Maritime forests and shrublands structure and composition are influenced by proximity to marine environments. In Maryland, they are best developed in sheltered dune systems and flats of barrier islands of the Atlantic Coast and islands of the lower Chesapeake Bay. The distribution and vegetation of these habitats is largely controlled by marine influences such as salt spray and deep sand deposits. Forests that develop are primarily dominated by loblolly pine (*Pinus taeda*) with mixtures of black cherry (*Prunus serotina*), sassafras (*Sassafras albidum*), southern red oak (*Quercus falcata*), willow oak (*Quercus phellos*), red maple (*Acer rubrum*), American holly (*Ilex opaca* var. *opaca*), and bayberry (*Morella* spp.). While marine influences are the primary contributing factor in vegetation structure and distribution, soil moisture and drainage also play a critical role in shaping these habitats. Open woodlands of stunted loblolly pine may develop on rapidly drained back dunes, away from the primary dune, where the effects of salt spray are minimized.

These habitats are threatened by coastal development and by natural and anthropogenic disturbances that destroy the protective primary dune system. Because these habitats have a restricted geographic range (Delaware to North Carolina) and narrow habitat requirements, all natural communities within Maritime Forests and Shrublands are considered globally uncommon to rare. Examples of species with the greatest conservation need are Delmarva fox squirrel, bald eagle, northern bobwhite, eastern red bat, black-crowned night-heron, northern saw-whet owl, hoary bat, boat-tailed grackle, and ovenbird. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).

Managed Montane Conifer Forest

These forests consist of pure or nearly pure conifer stands that have been planted, usually as monocultures. Many contain non-native conifers (e.g., Norway spruce [*Picea abies*], black spruce [*Picea glauca*], Scotch pine [*Pinus sylvestris*]), but some include native species such as eastern white pine (*Pinus strobus*). Numerous conifer forest stands in western Maryland were established during the 1930s by Civilian Conservation Corps work crews. Today, these plantings can still be found on DNR lands (e.g., Savage River State Forest,



A white pine stand- Nicolas Raymond

New Germany State Park) and elsewhere as dense, heavily shaded, mature conifer stands. In a region where most natural forests dominated by northern conifers were eliminated by 19th and early 20th century logging, conifer plantations provide surrogate nesting habitat for some sub-boreal and boreal bird species of conservation need.

Examples of species with the greatest conservation need are Blackburnian warbler, black-throated green warbler, golden-crowned kinglet, and long-eared owl. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).

Montane-Piedmont Oak-Pine Forest

Montane-Piedmont Oak-Pine Forests consist of dry oak and oak-pine dominated forests of low (< 2,500 feet) mountain slopes, ridge crests, and rolling piedmont hills. These rocky forests commonly include chestnut oak (*Quercus montana*), white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*), bear oak (*Quercus ilicifolia*), black oak (*Quercus velutina*), black gum (*Nyssa sylvatica*), and eastern white pine (*Pinus strobus*) in variable mixtures. Some stands may be entirely dominated by chestnut oak whereas others may support abundant eastern white pine. The presence of Virginia pine (*Pinus virginiana*) and successional hardwoods such as red maple (*Acer rubrum*) in this key wildlife habitat indicates disturbance. Tall shrubs of mountain-laurel (*Kalmia latifolia*), wild azalea (*Rhododendron periclymenoides*), and maple-leaf viburnum (*Viburnum acerifolium*) are typical as are dense patches of low heaths such as early lowbush blueberry (*Vaccinium pallidum*), black huckleberry (*Gaylussacia baccata*), and deerberry (*Vaccinium stamineum*). The herbaceous layer of these forests is generally sparse but may include poverty-oat grass (*Danthonia spicata*), wavy hairgrass (*Deschampsia flexuosa* var. *flexuosa*), and Pennsylvania sedge (*Carex pensylvanica*). In 2007, the Maryland Department of Natural Resources (DNR) identified approximately 734 acres of Montane-Piedmont Oak-Pine Forest as old growth forests on state lands.

A montane Piedmont oak pine stand- Julie Conway/ Maryland Forest Service

Examples of species with the greatest conservation need in Montane-Piedmont Oak-Pine Forests are Allegheny woodrat, golden eagle, cow path tiger beetle, American mink, golden-winged warbler, Northern Barrens tiger beetle, least weasel, worm-eating warbler, cobweb skipper, and two species of bumble bee. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).

Oak-Hickory Forest

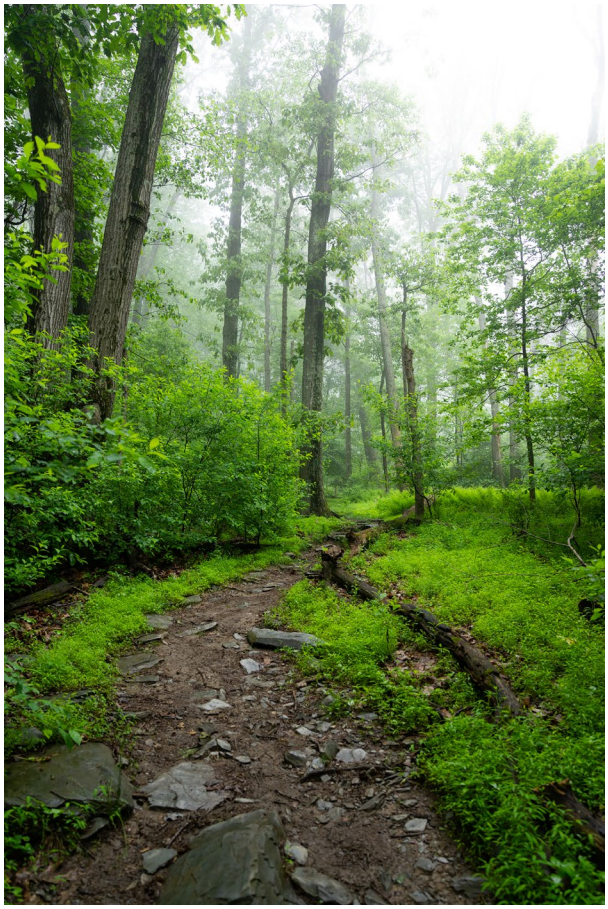
By far, the most common type of forest in Maryland, and the northeastern U.S. is the Oak-Hickory forest. These forests historically covered thousands of acres throughout the rolling Piedmont and mountains of the Ridge and Valley, Blue Ridge, and Appalachian Plateau. They occupy a wide variety of low- to mid-elevation upland settings of intermediate soil moisture and fertility. Soils are predominantly acidic, however, localized areas of basic substrates such as mafic igneous and metamorphic rocks (e.g., metabasalt, amphibolite, and gabbro) support a higher diversity of plants and are considered rare natural communities in the state.

Characteristics of these forests are a well developed, closed canopy of oaks such as white oak (*Quercus alba*), northern red oak (*Quercus rubra*), scarlet oak (*Quercus coccinea*), black oak (*Quercus velutina*), and occasionally

chestnut oak (*Quercus montana*). American chestnut (*Castanea dentata*) was likely prominent in the canopy of oak-hickory forests prior to the chestnut blight of the 1940s. Hickories are diagnostic and often abundant as understory trees but may also reach into the canopy. Hickory species commonly encountered include pignut hickory (*Carya glabra*), mockernut hickory (*Carya alba*), shagbark hickory (*Carya ovata*), and bitternut hickory (*Carya cordiformis*). White ash (*Fraxinus americana*), eastern hop hornbeam (*Ostrya virginiana*), common hackberry (*Celtis occidentalis*), and eastern redbud (*Cercis canadensis*) are characteristic of stands over basic substrates. With a long history of human habitation, logging, and agricultural conversion, many stands today are early to mid-successional and may be dominated or co-dominated by tulip-poplar (*Liriodendron tulipifera*), sugar maple (*Acer saccharum*), eastern white pine (*Pinus strobus*), and Virginia pine (*Pinus virginiana*). Only 104 acres of Oak-Hickory Forest have been identified by the DNR as old growth on state lands.

The shrub layer of Oak-Hickory Forests frequently includes dense patches of deciduous ericads such as early lowbush blueberry (*Vaccinium pallidum*) and deerberry (*Vaccinium stamineum*), and scattered individuals of maple-leaf viburnum (*Viburnum acerifolium*), witch-hazel (*Hamamelis virginiana*), and flowering dogwood (*Cornus florida*). Historically, flowering dogwood was probably much more abundant, but today's stands are vulnerable to dogwood anthracnose (*Discula destructiva*), a fungal pathogen responsible for high mortality in dogwoods. The herbaceous layer of Oak-Hickory Forests is generally patchy with the highest species diversity in stands over basic substrates. Unfortunately, excessive deer damage in these habitats has resulted in poor tree regeneration, and in some cases favored invasion of non-native weeds such as garlic mustard (*Alliaria petiolata*), Japanese stiltgrass (*Microstegium vimineum*), Japanese honeysuckle (*Lonicera japonica*), and flat-stemmed bluegrass (*Poa compressa*).

Examples of species with the greatest conservation need in Oak-Hickory forests are: big brown bat, American woodcock, eastern kingsnake, bobcat, bald eagle, red cornsnake, Jefferson salamander, and six-banded longhorn beetle. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).



An oak stand at Gambrill State Park- David Scotto

Basic Mesic Forest

Basic Mesic Forests are typically found on north and east facing slopes, in ravines, or occasionally upon high floodplain terraces that are well-drained. They are rich, moist forests of the Coastal Plain, Piedmont, and low mountain regions that develop over calcareous substrates or mafic bedrock that when weathered produce basic soils high in calcium and magnesium. On the Coastal Plain, these forests are associated with tertiary-aged shell deposits common in ravines and slopes bordering streams and rivers. In the Piedmont, Basic Mesic Forests are associated with mafic substrates such as amphibolite or diabase, while in the mountains they tend to be derived from limestone, calcareous shales, or greenstone material. While these forests may differ in the substrate from

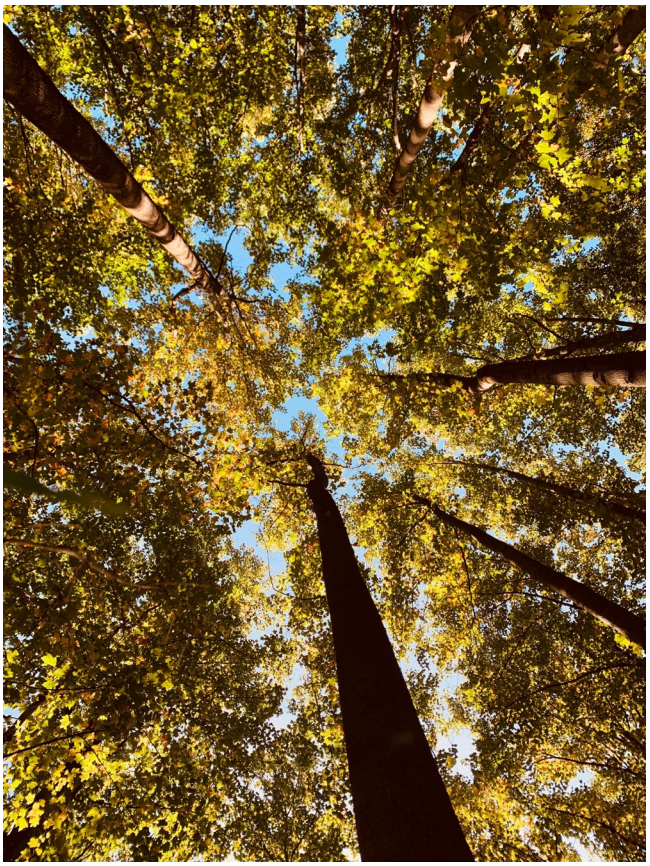
which they develop, they share a number of similar species.

Mesic forest stands commonly include tulip poplar (*Liriodendron tulipifera*), American beech (*Fagus grandifolia*), black walnut (*Juglans nigra*), northern red oak (*Quercus rubra*), chinkapin oak (*Quercus muehlenbergii*), bitternut hickory (*Carya cordiformis*), white ash (*Fraxinus americana*), eastern redbud (*Cercis canadensis* var. *canadensis*), eastern hop hornbeam (*Ostrya virginiana*), and sugar maple (*Acer saccharum*) in the mountains. The shrub and herbaceous layers are typically lush and dense with numerous species of ferns and leafy forbs such as may-apple (*Podophyllum peltatum*), black cohosh (*Caulophyllum thalictroides*), and twinleaf (*Jeffersonia diphylla*). Basic Mesic Forests are similar to Cove Forests, but they are differentiated by the number of species restricted to lower elevations in Maryland. There is not enough existing data to create meaningful distribution maps for Basic Mesic Forests.

Examples of species with the greatest conservation need include eastern small-footed myotis, northern parula, six-banded longhorn beetle, evening bat, ovenbird, Carolina satyr, silver-haired bat, wood thrush, giant swallowtail, bog turtle, cherrystone drop, tricolored bat, coastal plain milksnake, and Maryland glyph. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP), including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).

Mesic Mixed Hardwood Forest

The Mesic Mixed Hardwood Forest key wildlife habitat develops over acidic, nutrient poor soils of the Coastal Plain and Piedmont in a variety of moist landscape settings including ravines, lower slopes, undulating uplands, and flatwoods. These forests are characterized by mixed canopies of tulip-poplar (*Liriodendron tulipifera*), American beech (*Fagus grandifolia*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), mockernut hickory (*Carya alba*), pignut hickory (*Carya glabra*) and understories of flowering dogwood (*Cornus florida*), pawpaw (*Asimina triloba*), American strawberry-bush (*Duchesnea indica*), and American hop-hornbeam (*Ostrya virginiana*). Many of the oaks



Tulip poplars- Julie Conway/Maryland Forest Service

and other associated trees of these forests vary by region. For example, loblolly pine (*Pinus taeda*) and American holly *(Ilex opaca* var. *opaca*) are occasionally prominent in Coastal Plain Mesic Mixed Hardwood Forests, but are absent in Piedmont stands.

The infertile soils of these forests rarely support lush layers of herbaceous vegetation like those in basic mesic forests, however, ferns such as Christmas fern (*Polystichum acrostichoides*) and New York fern (*Thelypteris noveboracensis*) may be locally abundant in patches. Other plants common to this key wildlife habitat include pink lady's-slipper (*Cypripedium acaule*), false Solomon's-seal, perfoliate bellwort (*Uvularia perfoliata*), Indian cucumber-root (*Medeola virginiana*), cranefly orchid, and spotted wintergreen (*Chimaphila maculata*). Although Mesic Mixed Hardwood Forests are widespread throughout the Coastal Plain and Piedmont of Maryland, their size and condition have been much reduced by logging, agriculture, and development. Only 14 acres have been identified by DNR as old growth on state lands.

Examples of species with the greatest conservation need include hoary bat, broad-

winged hawk, northern scarlet snake, Indiana myotis, brown creeper, spotted turtle, and eastern narrow-mouthed toad. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).

A coastal oak-pine forest in Wicomico County- Maryland Environmental Trust

Coastal Plain Oak-Pine Forest

Coastal Plain Oak-Pine Forest key wildlife habitat is generally characterized by dry, fire-prone forests and woodlands that develop over sandy and gravelly soils of the Coastal Plain. Several different natural communities are represented in this key wildlife habitat and are largely differentiated by landscape setting, substrate, and soil moisture, which can range from extremely dry to dry-mesic. The landscape settings vary from steep ravine slopes, north-facing bluffs, terraces, ancient inland dunes and ridges to calcareous river-fronting bluffs.

Oaks are dominant and widespread throughout this key wildlife habitat, but may vary in cover as the landscape settings change and other species integrate into the tree canopy. Signature canopy oaks include white oak (*Quercus alba*), southern red oak (*Quercus falcata*), northern red oak (*Quercus rubra*), and chestnut oak (*Quercus montana*). Other canopy species may include black oak (*Quercus velutina*), scarlet oak (*Quercus coccinea*), sassafras (*Sassafras albidum*), and black gum (*Nyssa sylvatica*). Red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), Virginia pine (*Pinus virginiana*) and loblolly pine (*Pinus taeda*) are also frequent in the canopy and may be locally abundant, but they usually indicate past disturbance and fire suppression. American beech (*Fagus grandifolia*) is prominent on submesic sites such as steep ravine slopes or north-facing bluffs. Hickories are typically a component of the understory as are dense shrub colonies of heaths such as huckleberries (*Gaylussacia* spp.) and blueberries (*Vaccinium* spp.). Herbaceous plants are generally not well-developed and usually sparse throughout the deeply leaf- littered forest floor.

Two rare natural communities associated with this key wildlife habitat are ancient Inland Sand Dune and Ridge Woodland and Coastal Plain Dry Calcareous Forest and Woodland. Inland sand dunes and ridges developed during the late Pleistocene when strong northwest prevailing winds transported sands across the Coastal Plain, eventually mounding up into prominent dunes and ridges flanking the east sides of rivers such as the Choptank, Nanticoke, Wicomico, and Pocomoke. These areas now support dry oak-pine forests and woodlands of southern red oak (*Quercus falcata*), white oak (*Quercus alba*), blackjack oak (*Quercus marilandica*), post oak (*Quercus stellata*), shortleaf pine (Pinus echinata), pitch pine (*Pinus rigida*), sassafras (*Sassafras albidum*), sand hickory (*Carya pallida*), and flowering dogwood (*Cornus florida*).

Though numerous, inland dunes and ridges are considered rare natural communities in Maryland because they exhibit a unique flora adapted to these harsh and dry environments. In addition, many historical stands have been replaced or degraded by development, agriculture and commercial forestlands. Another rare natural community type within the Coastal Plain Oak-Pine Forest key wildlife habitat is the Coastal Plain Dry Calcareous Forest and Woodland. These extremely rare, natural communities exist as small wooded patches of river-fronting bluffs and slopes on the Coastal Plain that have developed over either tertiary-aged shell deposits or Native American oyster shell middens. They exhibit a unique flora, rich in species uncommon to the Coastal Plain due to a combination of dry sandy soil and abundant

calcium. Typically dry calcareous forests and woodlands contain chinkapin oak (*Quercus muehlenbergii*), white ash (*Fraxinus americana*), hackberry (*Celtis occidentalis*), eastern hop hornbeam (*Ostrya virginiana*), and eastern redbud (*Cercis canadensis* var. *canadensis*).

Examples of species with the greatest conservation need include: American mink, chuck-will's-widow, carpenter frog, big brown bat, common nighthawk, eastern narrow-mouthed toad, Acadian flycatcher, eastern six-lined racerunner, frosted elfin, American woodcock, mole kingsnake, and Leonard's skipper. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).

Coastal Plain Pitch Pine Forest

These forests are characterized by dry, mixed forests and woodlands of Maryland's inner coastal plain, extending from Cecil County south to Prince George's County. This key wildlife habitat is best developed over flat to gently rolling uplands with deep, sandy loams and sandy clay-loams of the Patuxent Formation. These soils are very acidic with exceedingly low base cation and base saturation levels, indicating extreme infertility.

In Maryland, these forests are considered as a southern extension of the New Jersey Pine Barrens, where pitch pine (*Pinus rigida*) is a dominant and characteristic species. Because pitch pine has numerous fire adaptations, allowing it to regenerate in burned areas, it is considered a fire-dependent ecosystem by many. It supports vegetation capable of various fire-adaptation strategies allowing for natural regeneration while persisting in settings susceptible to ignition, combustion, and fire spread. Though mean fire return intervals in portions of the New Jersey Pine Barrens occurred at much higher frequencies because of drier fuels and higher evaporation rates, it is likely that fire intervals in Maryland's pitch pine forest occurred every 40-60 years. It is believed by many that this fire return interval would allow pitch pine to persist, while also allowing for continued oak regeneration. Many aspects of Maryland's flora found in this region of Maryland also suggest

A pitch pine on Assateague Island- Bill Hubrick/Maryland Biodiversity Project

a phytogeographical relationship to natural communities of the New Jersey Pine Barrens. The tree canopies of Coastal Plain Pitch Pine Forests are mixed with pitch pine and several other species such as scarlet oak (*Quercus coccinea*), southern red oak (*Quercus falcata*), white oak (*Quercus alba*), black oak (*Quercus velutina*), blackjack oak (*Quercus marilandica*), dwarf chestnut oak (*Quercus montana*), black gum (*Nyssa sylvatica*), and sassafras (*Sassafras albidum*). Virginia pine (*Pinus virginiana*), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*) are successional in this key wildlife habitat and often indicate disturbance such as logging or agricultural conversion.

Examples of species with the greatest conservation need include: bobcat, American woodcock, eastern box turtle, eastern harvest mouse, Bicknell's thrush, eastern kingsnake, red-headed woodpecker, festive tiger beetle, scarlet tanager, and Northern Barrens tiger beetle. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).

High Elevation Ridge Forest

These Forests have developed on Maryland's highest mountain ridges at or above 2,500 feet, such as those found on Backbone, Big Savage, Negro, Meadow, and Dans Mountains. These areas are some of the most inhospitable habitats in Maryland because they are situated on very exposed sites that are frequently subjected to high winds throughout the year and ice storms during the winter months. Trees are often stunted, have wind-pruned branches, and generally have a much different appearance than trees downslope at lower elevations. Overall species diversity is low with chestnut oak (*Quercus montana*) most prominent in the canopy. Other canopy species may include northern red oak (*Quercus rubra*), white oak (*Quercus alba*), bear oak (*Quercus ilicifolia*), yellow birch (*Betula alleghaniensis*), black cherry (*Prunus serotina*), sugar maple (*Acer saccharum*), and occasionally red spruce (*Picea rubens*). Shrubs may include thickets of young bear oak, mountain-laurel (*Kalmia latifolia*), and huckleberries (*Gaylussacia* spp.). These forests are prone to gypsy moth infestations which can cause significant tree mortality, particularly in oak-dominated forests. Prior to the chestnut blight of the 1940s, American chestnut (*Castanea dentata*) was a major component of these forests. In 2007, DNR identified approximately 226 acres of High Elevation Ridge Forests, on state land, as old growth forest.

Examples of species with the greatest conservation need include: Allegheny woodrat, Acadian flycatcher, eastern box turtle, Appalachian cottontail, black-and-white warbler, timber rattlesnake, least weasel, golden eagle, and Sanderson's bumble bee. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).

Cove Forest

The Cove Forest key wildlife habitat is characterized by diverse, mesic forests of mountain slopes occupying sheltered landforms such as coves, ravines, and concave lower slopes. These landforms provide shade, protection from high winds, and lend to very moist soil conditions. Both rich and acidic Cove Forests are represented in this key wildlife habitat and are differentiated by soil fertility, species richness, and species composition. Rich Cove Forests contain deep, fertile soils weathered from a variety of substrates that have high levels of calcium, magnesium, and manganese. Soils are typically moderately alkaline and support very diverse and lush herbaceous layers. Unfortunately, this also makes rich cove forests highly susceptible to invasion of non-native plant species.

Dan's Mountain Wildlife Management Area- Maryland Wildlife and Heritage Service

Rich Cove Forests contain some of the highest diversity of plant species in the state. Stands are commonly dominated by sugar maple (*Acer saccharum*), basswood (*Tilia americana*), white ash (*Fraxinus americana*), white oak (*Quercus alba*), and northern red oak (*Quercus rubra*). Other characteristic tree species include cucumber magnolia (*Magnolia acuminata*), shagbark hickory (*Carya ovata*), butternut (*Juglans cinerea*), tulip-poplar (*Liriodendron tulipifera*), black locust (*Robinia pseudoacacia*), witch-hazel (*Hamamelis virginiana*), eastern hop-hornbeam (*Ostrya virginiana*), striped maple (*Acer pensylvanicum*), and sweet birch (*Betula lenta*).

Acidic Cove Forests occur on substrates underlain by acidic bedrock such as sandstone or quartzite. A mixture of eastern hemlock, white pine (*Pinus strobus*), and hardwoods such as

yellow birch, northern red oak (*Quercus rubra*), white oak (*Quercus alba*) and dense patches of great laurel (*Rhododendron maximum*) or mountain-laurel (*Kalmia latifolia*) differentiate these forests from rich Cove Forests. Other characteristic woody species include witch-hazel (*Hamamelis virginiana*), spicebush (*Lindera benzoin*), wild hydrangea (*Hydrangea arborescens*), and maple-leaf viburnum (*Viburnum acerifolium*).

Examples of species with the greatest conservation need include: eastern red bat, black-throated blue warbler, Jefferson salamander, eastern small-footed myotis, black-throated green warbler, mountain chorus frog, Sanderson's bumble bee, Appalachian blue, and Kentucky warbler. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).

Hemlock-Northern Hardwood Forest

The Hemlock – Northern Hardwood Forest is characterized by cool, mesic forests of low mountain slopes and valleys in Maryland. This key wildlife habitat is most abundant at higher elevations on the Appalachian Plateau but also occurs in pockets along north-facing mountain slopes of the Ridge and Valley and Blue Ridge. The composition of Hemlock – Northern Hardwood Forests in Maryland -- varies with site conditions and was heavily influenced by destructive fires and extensive logging of eastern hemlock (*Tsuga canadensis*), red spruce (*Picea rubens*), white pine (*Pinus strobus*), and hardwoods in the early 1900s. Currently, there are only 413 acres of Hemlock – Northern Hardwood Forests considered as old growth forest on state lands in western Maryland. Today's stands are typically dominated by northern hardwoods such as sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), black cherry (*Prunus serotina*), and yellow birch (*Betula alleghaniensis*) with mixtures of eastern hemlock. Other tree associates may include northern red oak (*Quercus rubra*), white oak (*Quercus alba*), white pine, sweet birch (*Betula lenta*), red spruce, white ash (*Fraxinus americana*), basswood (*Tilia americana*), and red maple (*Acer rubrum*). The understory of Hemlock-Northern Hardwood Forests may include species such as striped maple (*Acer pensylvanicum*), witch-hazel (*Hamamelis virginiana*), maple-leaf viburnum (*Viburnum acerifolium*), and dense patches of great laurel (*Rhododendron maximum*) and mountain-laurel (*Kalmia latifolia*). It is not uncommon to discover the herbaceous layers in some stands entirely dominated by patches of hay-scented fern (*Dennstaedtia punctilobula*) or New York fern (*Thelypteris noveboracensis*). These forests are related in part to small outlying stands of eastern hemlock that occur along north-facing river bluffs and ravines in the Piedmont and Coastal Plain. Although these communities are dominated by eastern hemlock, they lack a number of species restricted to higher elevations in Maryland.

Examples of species with the greatest conservation need include: eastern red bat, Blackburnian warbler, green salamander, eastern small-footed myotis, black-throated blue warbler, Jefferson salamander, timber rattlesnake, and Sanderson's bumble bee. More information can be found in the 2015 to 2025 Maryland State Wildlife Action Plan (SWAP) including a complete list of species (chapter 4) and conservation status for species of concern (chapter 3).

Hemlock Forest- Angela Genito

Maintenance of Productive Capacity of Forest Ecosystems

Area of Timberland

Not all forests are available for harvesting and multiple-use land management. Timberland is defined by the U.S. Forest Service as forest land that is producing or capable of producing crops of industrial wood (more than 20 cubic feet per acre per year) and not withdrawn from commercial uses. It was once referred to as "commercial forest land" (Frieswyk and DiGiovanni, 1988).

According to U.S. Forest Service data, the area of timberland decreased 6% from its 1976 estimated size of 2.52 million acres to 2.37 million acres in 2008. By 2018, timberland had further decreased to 2.153 million acres, roughly 17% from 1976 (figure 8). Stands classified as sapling, seedling, and non-stocked decreased from 20% of timberland in 1976 to 12% in 1999. In 2008, that number is estimated to have declined further to roughly 9% of timberland. Typically found in such stands are early successional, pioneer tree species as well as a variety of herbaceous and shrub plants that need full sunlight to survive. These stands provide unique nesting and feeding opportunities for wildlife, such as golden-winged warbler.

Besides offering diverse habitat for wildlife and providing a steady flow of wood products, forests that contain all stand-size classes might

A harvester in Western Maryland- Rob Feldt/Maryland Forest Service

be more resistant to devastating outbreaks of insects and diseases. Sawtimber stands however continue a slow upward trend as older trees make up more and more of the state's forests (figure 6). In 1976 timberland consisted of 55% sawtimber stands. In 2004 that number had increased to 76% of all timberland. A 2017 U.S. Forest Service report explained that "large diameter stands" accounted for nearly 80% of all timberland, and that the overall trend of decreasing small and medium diameter stands continues (Lister, 2018).

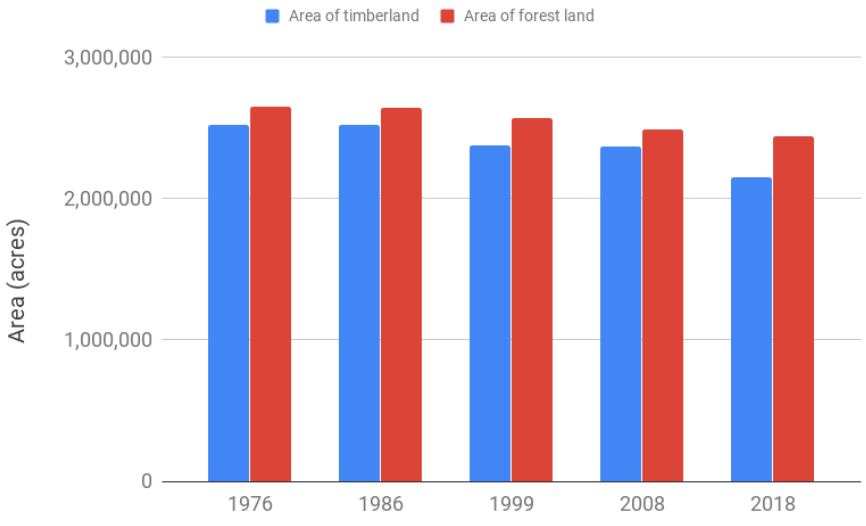


Figure 8 Area of timberland and forest land over time

Annual Removal of Merchantable Wood Volume Compared with Net Growth

The average annual net growth of wood on timberland in Maryland has been declining over the past decade. According to FIA data, in 2008 the annual net growth of merchantable bole volume for growing stock trees was 178.8 million cubic feet. This decreased to 127.4 million cubic feet in 2013, and 109.9 million cubic feet in 2018 (figure 9). This could be because the average age of Maryland's forests has been increasing overtime, and older trees grow slower than younger ones.

Removals for harvest stayed consistent from 2008 to 2013 at around 55 million cubic feet. However, this sharply declined to 27.8 million cubic feet in 2018. Mortality on timberland has stayed fairly consistent between 2008 and 2018.

Forest land experienced similar patterns with annual growth rate and harvesting, but there was a noticeable increase in mortality rates in the last decade, going from 57 million cubic feet in 2008 to 73.1 million cubic feet in 2018 (figure 10).

Of the growing stock trees harvested on forest land 2018, 40.1% were yellow-poplar, 15.8% were loblolly and shortleaf pine, 9.4% were white oak species, and 8.9% were red oak species.

Maryland produces over 2 million seedlings per year at the John S. Ayton State Nursery, sold at cost for conservation plantings. Pine planting and replanting after harvest have declined substantially over the past two decades, so the Nursery produces fewer pine seedlings (figure 11). Production of hardwood seedlings has expanded in number and species, including those beneficial for pollinators.

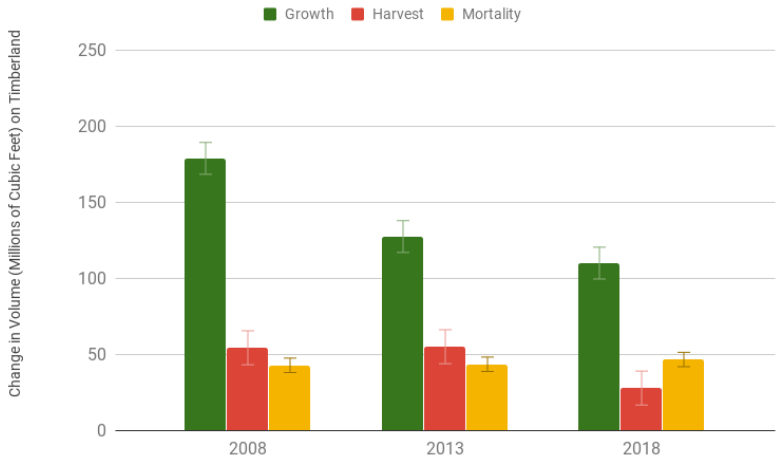


Figure 9 Annual growth rate, harvest, and mortality over time on timberland

Figure 10 Annual growth rate, harvest, and mortality over time on forest land

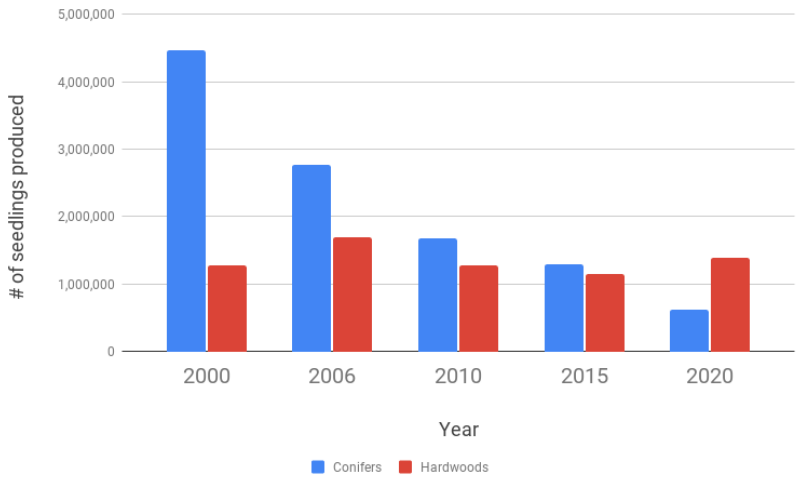


Figure 11 Annual seedling production of conifers and hardwoods at the state nursery

Conservation and Maintenance of Soil and Water Resources

Soil Quality of Forest Land

Soils provide the necessary nutrients, minerals, and water to the forest community. In turn, forests protect soils, allow for slow water uptake, and contribute organic material to the soil. While a well-managed and implemented timber harvest exposes bare soil on about 10% or less of a harvest site, compaction and runoff caused by improperly conducted timber harvesting or other human activities affect both the quantity and quality of soil resources. It is important to use best management practices in harvesting timber and during the land development process in order to minimize these negative effects.

Site index is defined as the average height of dominant trees, usually at 50 years of age. Tree height growth has been found to be closely correlated with tree volume growth and therefore site productivity. The average site index helps to determine the influence of soil related growth conditions on tree productivity for a particular site. Areas with high average site indices might be selected for the most intensive management, if producing timber were the primary objective for maintaining and managing the forest. From an ecological perspective, high site index areas may also, in some cases, support large numbers and multiple types of flora and fauna, although high site index values are also found in some areas in plantations where biological diversity is relatively low, but carbon sequestration is high.

In Maryland, the site index can be between the low 50's to over 100 in some rare cases. The USDA Natural Resources Conservation Service (NRCS) produces maps and tables of soil quality and type at the county level for all states in the US. This information is available as a soil survey, and includes information on site index for most soils. This information was used to estimate site productivity for forests in the state.

On Maryland's Eastern Shore, the site index will likely be measured on loblolly pine. There the soil quality is relatively high, as the trees are adapted to the region's sandy soils and high water tables. Site indices vary widely here with wetter soils and very low site indices in the 50's, to more moderate and upland sites ranging in the 70's to the 90's. In the vast central piedmont region of Maryland, one can find tulip poplar or northern red oak on rolling hills and stream valleys with average site indices generally in the 70's. In Western Maryland, steep slopes can carry thin soils with relatively low site indices only to give way to deeper, richer soils in the valleys. Here, site index can be measured on black cherry and red oak; tree species which have been important to the region's forest industries.

Area of Forest Land Adjacent to Surface Water, and Forest Land by Watershed

Planting and maintaining forest buffers is a cost-effective way of improving water quality and stream health for Chesapeake Bay and Coastal Bays restoration to local streams with water quality impairments. Research has consistently shown nitrogen removal rates of 60 to 90% in forest buffers over 100 feet wide. The shading and natural inputs from the forest support healthy streams and aquatic communities that further cleanse the water. Benefits of forest buffers also extend to wildlife habitat, clean air, and recreation. As average temperatures increase, streamside shade becomes more important for keeping water cool and riparian areas sheltered.

Stream systems across the state have been impacted by changes in land use and land cover. The reduction in forest cover and increase in impervious surfaces through development can be seen in eroding banks, deepening channels, and finer sediments in the stream bed. All of these changes affect both the function and the aesthetic qualities of the stream and all are directly related to the land use activities taking place within the watershed.

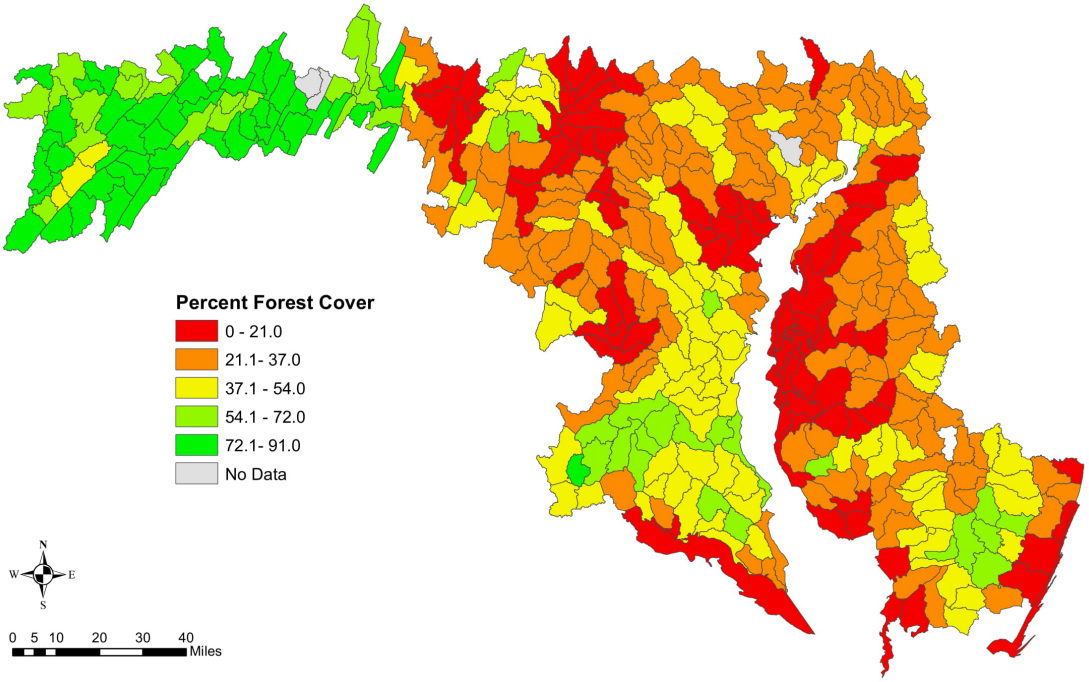


Figure 12 Percent forest cover of Maryland's HUC 12 watersheds

In Maryland, there are almost 17,000 miles of streams and 7,500 miles of shoreline. Of the 17,000 miles of streams, 57% are fully buffered (>80% tree canopy within a 100 foot buffer) and 27% are partially buffered (between 10-80% tree canopy within a 100 foot buffer). Over 1/3 of the inadequately buffered waterways are in developed areas, with the remainder in rural areas.

Watershed health can also be evaluated by forest cover, 57% of Maryland's HUC 12 watersheds (subwatersheds, usually between 10-40 acres) have less than 40% forest cover according to the U.S. Forest Service's Forest to Faucets data set (figure 12) (USDA Forest Service, 2019). These watersheds, along with the inadequately buffered streams present opportunities for reforestation.

Maryland has been working to increase riparian forest buffer cover over the past two decades. According to data from Chesapeake Progress[1], from 1996 to 2017, over 1,400 miles of riparian buffers have been planted with trees (figure 13). Over 85% have had survival and growth verified.

Water Quality in Forested Areas

Forests are the least polluting major land use, so keeping forests of any type on lands is the most important element for protecting water quality. Forests take up nutrients like nitrogen and phosphorus and capture them in stable organic forms that are not easily leached or eroded into water. The large trees are the backbone of the system, but forest functions also rely on forest soils, litter layers, shrubs, small trees, herbaceous plants, and all the insects and animals that keep them going. While keeping forest cover is a critical element, particular water quality functions depend on forest type, condition, and landscape position.

Maintaining forest land use is fundamental for protecting water quality over the watershed, so growing a forest that the landowner can afford to keep there is important. Rich and diverse forests offer varied responses to disturbances, and more options to recover functions quickly. Avoiding or minimizing disturbance in wetter and steeper areas also protects water quality.

[1] A website run by the Chesapeake Bay Program, which tracks progress made towards the Chesapeake Bay Agreement- https://www.chesapeakeprogress.com/

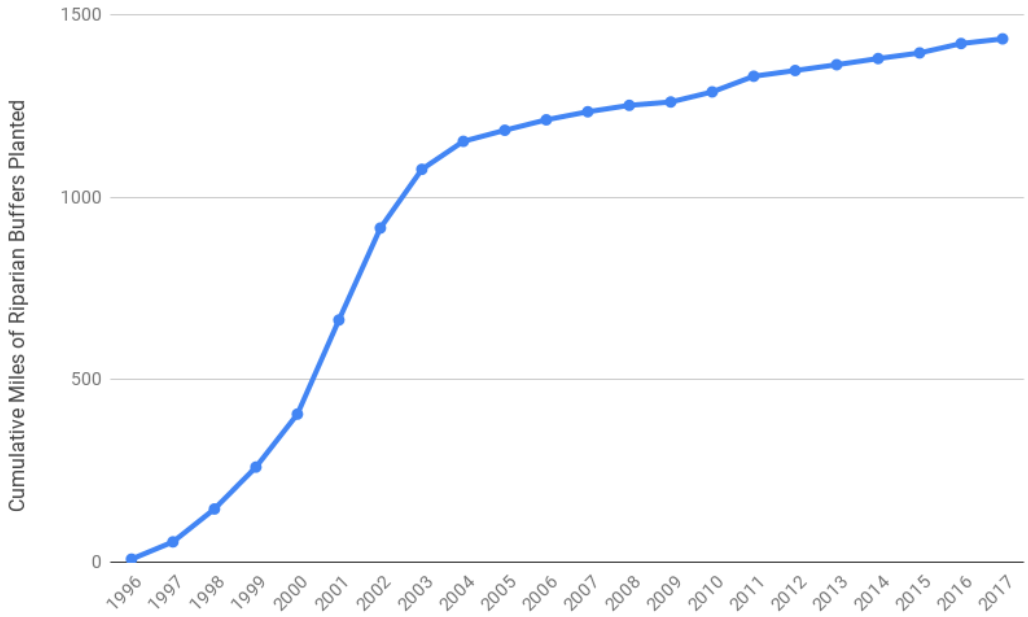


Figure 13 Cumulative miles of riparian buffers planted in Maryland

Maintaining highly forested watersheds on the landscape is critical to protecting aquatic biodiversity. Tier II waters have significantly better water quality than the minimum standards. In Maryland, they are designated based on biological community scores of benthic macroinvertebrates and fish, which are determined by sampling from the Maryland Biological Stream Survey. HUC 12 watersheds that contain Tier II waters, have on average 7% more forest cover than watersheds without Tier II waters.

For more information on water quality in Maryland, see Maryland's 2018 Integrated Report of Surface Water Quality on the Maryland Department of the Environment's website. The report details the status of impaired waters in the state.

Forest Protection of Drinking Water

Forests are the first line of defense for most of Maryland's supplies of drinking water. Outside of the Coastal Plain with its abundant groundwater, Marylanders rely primarily on surface water supplies, where the surrounding forests play critical roles in protecting water quality. Several large reservoirs supply water to the millions of residents in the Baltimore and Washington, D.C. metropolitan areas, which make up the majority of Maryland's population. Smaller reservoirs and watersheds supply water for even more communities like Frederick, Cumberland, and Frostburg. Much of the land adjacent to these reservoirs is publicly owned and kept in forest, relying on the buffering role and low nutrient outputs of forested systems. These areas are important because they can resist losses during disturbances like storms and pest outbreaks, and are resilient enough to regrow into healthy forests rapidly after a major disturbance.

The publicly owned forests around reservoirs occupy critical locations for protecting water quality, but generally comprise less than 20% of the forest in the watershed. The entire watershed that feeds the water supply reservoirs can affect water quality, so watershed-wide efforts to protect and responsibly manage forests are needed. Keeping forest cover, restoring forest buffers, and land use regulations that limit impacts from other land uses are all important mechanisms.

Much of the surface drinking water for Maryland comes from watersheds that have headwaters in Pennsylvania. In order to improve water quality and watershed health, the Maryland Forest Service has written several landscape scale plans for subwatersheds in Pennsylvania and Maryland that are important for maintaining

quality drinking water. These plans inform landowners about forest health and management, and list the available tools and programs in Pennsylvania and Maryland to help manage woodlands for clean water, wildlife, and wildfire resilience and identify potential areas for reforestation. To access the reports see the Maryland DNR's website.

Forest harvesting best management practices are required by law in Maryland and are an important safeguard to avoid damage to water quality. Forest lands yield excellent water quality, and produce raw materials that society and economies need, generation after generation.

A skid trail with tops used to protect soil, a commonly used BMP- Maryland Forest Service

Practices are designed to work with the site conditions and natural materials onsite as much as possible, and have been shown to protect water quality for sustainable forestry operations over several decades. Some common BMPS include:

- Harvest planning to avoid stream crossings, steep slopes and wetlands
- Locating roads and skid trails on low slopes (usually less than 15%)
- Timing harvest operations to avoid wet periods
- Diverting water off roads and skid trails to infiltrate into the forest floor using earthen berm water bars, broad-based dips or other diverters
- Stabilizing roads, landings and steep skid trails
- Using bridges, culverts or temporary corduroy logs for water crossings
- Crossing streams at right angles to minimize disturbance
- Leaving buffers to shade waterways, with at least 60 square feet of basal area, usually over half the canopy.

A recent study conducted by the Maryland Forest Service found that compliance with state-required best management practices was 88% in Maryland, and covered sites from the mountains to the coastal plain.

Maintenance of Forest Contribution of Global Carbon Cycles

Forest Ecosystem Biomass and Forest Carbon Pools

Maryland's tree biomass has been steadily increasing over the past decade. According to data from the Forest Inventory and Analysis (FIA), the dry weight of aboveground tree biomass over 1 inch on forest land was 176.3 million tons in 2008 and 190.1 million tons in 2018, an 8% increase. Aboveground biomass followed a similar pattern on timberland, increasing from 158.9 million dry tons in 2008 to 166.0 million dry tons in 2018, a 4% increase. Density of aboveground biomass on forest land increased from 70.4 dry tons per acre in 2008 to 77.8 dry tons per acre in 2018, a 10.5% increase (figure 14). Belowground biomass per acre of forest land showed a similar change, increasing 10% from 2008 to 2018.

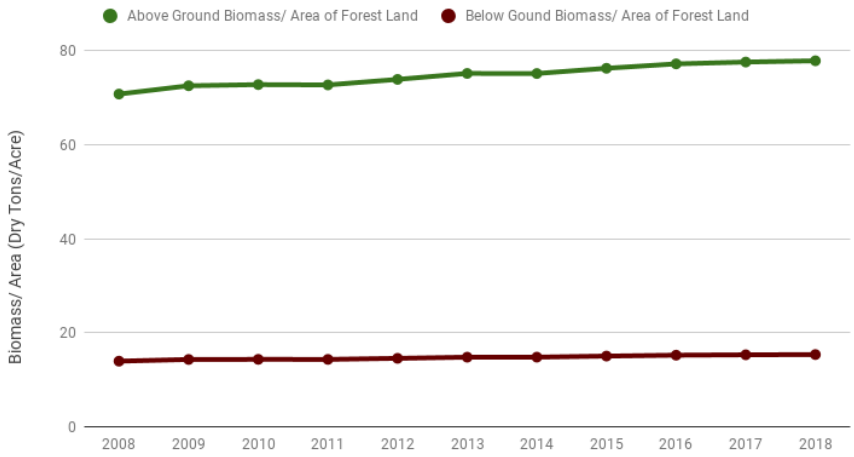


Figure 14 Above and below ground tree biomass per acre on forest land over time

Similar to biomass estimates, forest carbon pools in Maryland have slightly increased over the past decade. According to data from the FIA, in 2008 there were 204.0 million tons of carbon on forest land (figure 15). This includes 105.6 million tons of carbon in live trees larger than 1 inch, 70.4 million tons of carbon in soil organic matter, and 28.0 million tons of carbon in other pools (dead trees, seedlings, shrubs, stumps, coarse roots, coarse woody debris, and litter). In 2018 total carbon on forestland was 212.8 million tons, with 113.8 million tons in live trees, 69.7 million tons in soil organic carbon, and 29.2 million tons in other stocks. This is a 4% increase in total forest carbon from 2008.

While total biomass and carbon stocks have increased in the past decade, annual carbon sequestration of Maryland's trees has decreased according to greenhouse gas estimations from the U.S. Forest Service (figure 16) (Domke et. al., 2019; U.S. EPA, 2019). This is likely because the average age of Maryland's forest is getting older. While older forests store more carbon, their growth rate is slower than younger forests. Older forests are also a larger source of carbon emissions than younger forests as they have more mortality and respiration from the decomposition of dead organic material. In addition to this, the amount of carbon release by forest conversion to other land uses has increased over the last three decades (figure 17).

Maintaining and increasing carbon stocks are top priority as human carbon emission continues to rise, resulting in global climate change. Forests are incredibly important for offsetting climate change; globally they sequester 2.6 billion tons of carbon each year, which is equivalent to one third of annual carbon released

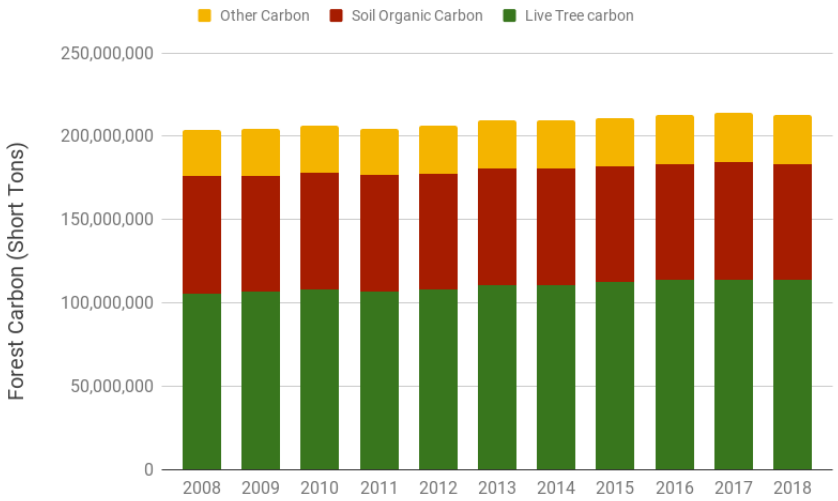


Figure 15 Stocks of live tree, soil organic, and other forest carbon over time

from burning fossil fuels (IUCN, 2017). Both active and passive forest management strategies can contribute to an effective climate mitigation strategy, best evaluated over lifecycles of trees and forest products and looking across landscapes, not just one stand (see Catanzaro and D'Amato 2019 and Favero et al. 2020) . Carbon storage is usually highest in older forests (e.g., 200 years) while carbon sequestration rates are higher in younger forests (e.g., 30-70 years); the mix of wood products affects carbon consequences, as does factoring in the carbon impact of products that would be substituted if wood isn't used, such as carbon-intensive steel or concrete. According to a study done by the U.S. Forest Service in Pennsylvania, extending harvest rotations and shifting commodity ratios to have more wood products that are longer lived (and thus store carbon longer) are two management actions that could decrease net carbon emissions for the state (Dugan et. al., 2018).

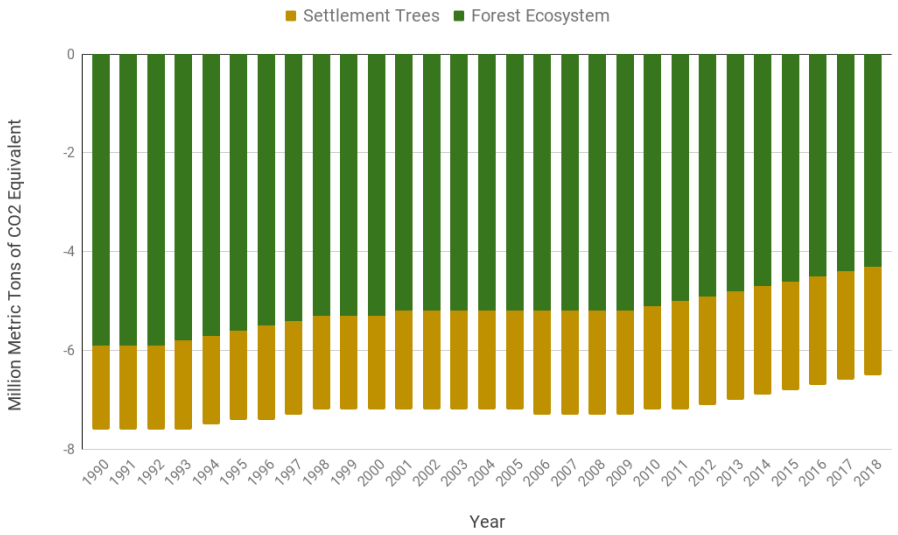


Figure 16 Carbon sequestered by Maryland's forest ecosystems and settlement trees (trees not a forests) from 1990 to 2018 in MMT of CO2 equivalent

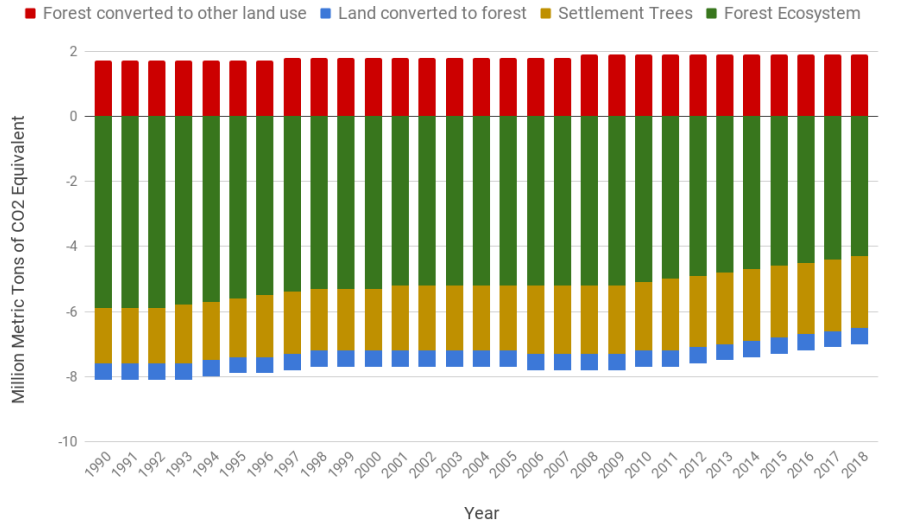


Figure 17 Annual carbon stock change of forest to nonforest, nonforest to forest, and forest to forest lands from 1990 to 2017. Positive values represent a release of carbon while negative values represent carbon sequestration

Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies

Wood and Wood Products Production, Consumption, and Trade

Maryland's forest products industry is one of the most economically important in parts of the state's economy. In 2015, the forestry industry was responsible for 15% of the total economic impact of all resource based industries in Maryland. The economic value of Maryland's forests is impressive, given the state's extent of urbanized area and relatively small size.

A study prepared by the Business, Economic, and Community Outreach Network (BEACON) at Salisbury University for the Maryland Agricultural and Resource Based Industry Development Corporation (MARBIDCO) looked at the overall economic impacts of the forestry sector in Maryland. They defined the forestry sector based on the North American Industry Classification System (NAICS) codes for forest commodity procedures (e.g. logging) and the immediate downstream processors, refiners, and manufactures (e.g. sawmills, wood furniture manufacturing, paper mills). Over 50 codes were referenced overall, and a complete list is available in Table 8 of the BEACON report.

A portable sawmill- Maryland DNR

The study found that forestry and the wood derivatives industries generated $3.5 billion of economic output in 2015. Forestry and wood derivatives generated over $2.5 billion in "direct" output in 2015. This includes the value of the industry's output along with the value of the supply chain needed to produce the products. From that, an additional $1 billion was generated by "indirect" and "induced" economic activities. Indirect impacts capture the second-order ripple effects of supply chain producers purchasing inputs along their supply chains. Induced impacts account for how employees of the affected industries spend their additional income.

The $3.5 billion of economic output in 2015 is a decrease from the estimates of the previous report. In 2005, BEACON estimated that forestry and the wood derivatives industry contributed $4.7 billion to Maryland's economy. Of that, $3 billion were from direct outputs and $1.7 billion were from indirect and induced impacts.

In 2008, the time of the most recent Timber Product Output (TPO) Report, Maryland produced 29.1 million cubic feet of industrial roundwood. Saw logs accounted for 49% of the industrial roundwood produced, and pulpwood accounted for 42% of the total. Loblolly/ shortleaf pine accounted for 34% of the total industrial roundwood productions. Other important species harvested were yellow-poplar, red oaks, and white oaks, soft maples, and black cherry.

In 2008, Maryland's commercial mills received a total of 47.9 million cubic feet of roundwood. Of that, 43% of the wood was from Maryland and 36% was from West Virginia. The remaining 21% came from Pennsylvania, Virginia, Delaware, and New York. Approximately 72% of industrial roundwood harvested in Maryland was retained for processing by primary wood-using mills in the State. A majority of exports70%) went to primary wood processors in Pennsylvania. The remainder of the exports went to West Virginia, Virginia, Delaware, and other countries.

Wood residues also play an important part in Maryland's forest product industry. In 2008, the time of Maryland's most recent TPO, Maryland's primary wood processing sector (i.e., sawmills) generated a combined 446,320

green tons of coarse wood residue (slabs, edgings, chips, etc.), fine wood residue (sawdust and shavings), and bark residue. Approximately 10% of these residues were used as fuel, with 5% of the total used almost entirely for industrial thermal needs (i.e., process heat). More than half of mill residues generated (54 percent) were put toward uses mainly consisting of paper manufacture and livestock bedding. Mulch consumed 20 percent of mill residues and fiber products consumed 16 percent. Only 0.3 percent of residues generated went unused. The wood chips typically made at sawmills, pallet manufacturers, molding companies currently sell for about $24/ton, oftentimes more. The revenue that wood chips generate only exists because they have a market. If these same wood chips were landfilled, they would cost companies $50/ton or more to dispose.

Unfortunately, since 2008, Maryland's wood and paper product industry's production of primary wood products and consumption of mill residues has nearly disappeared, which has created a need to expand current and emerging markets.

In addition to its timber products Maryland has a few, small non-timber forest products, like mushrooms, maple syrup, fruits, and ginseng. The production of these products has a negligible impact on the state's economy, but can be important in rural areas with limited employment options.

Outdoor Recreation Participation and Facilities

Maryland provides over 2,000 parks, open spaces and recreational properties covering 500,000 acres. While 90% of these sites are managed by counties and the City of Baltimore, the majority of the areas are managed by DNR (DNR, 2019). The overwhelming majority of the Maryland DNR's land consists of State Parks, State Forests, Wildlife Management Areas, Natural Resource Management Areas, and Natural Environmental Areas. In addition to the local and state recreational sites, Maryland is also home to 18 sites run by the National Park Service, which include National Scenic Trails, National Historic Parks, and National Seashores (Maryland DNR, 2019)

Fly fishing on the Gunpowder River- Maryland DNR

According to Maryland's 2019-2023 Land Preservation and Recreation Plan, in 2017, well over 20 million people visited public outdoor recreation sites in Maryland. This includes 14 million visitors to State Parks, 6.7 million visitors to National Parks, and millions of additional visitors to local jurisdictions. The exact number cannot be reported, as many sites are open for free, unstructured use, and unmonitored access (Maryland DNR, 2019).

There is no current estimate for visitors to all State Forests, but a study by Frostburg State University and DNR estimated 61,000 annual visitors to the three State Forests in Western Maryland in 2017, which account for half of the total State Forest acreage (Buta, 2019).

The visitation to Maryland's outdoor facilities has a sizable economic impact. According to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, people spent approximately $1.28 billion in Maryland while participating in wildlife related activities. This includes trip-related and

equipment expenses for fishing, hunting, and wildlife watching (U.S. Department of the Interior et. al., 2011). While not all of these activities took place in a forest (e.g. saltwater fishing, hunting in marshes or grasslands), it is likely a majority did, as much of Maryland's public lands are forested.

The Frostburg State University Study, which looked specifically at recreation in forests in Western Maryland, also estimated economic impact. It estimated that in 2017, visitors to the State Forests in Western Maryland spent $6 million in western Maryland. This led to an additional $3 million of labor income and $8 million of total output, which included the purchasing of input goods and taxes on production and corporate profit (Buta, 2019).

Maryland's forests provide opportunities for diverse forms of recreation. These opportunities are subject to the limitations imposed by available land and fragile habitats, in response to increasing demand. More people than ever before are using Maryland's forests for a wide array of recreational activities, leading to increased conflicts among forest users. With the increase in popularity of motorized forms of recreation, such as off-highway vehicles (ATV's, snowmobiles, etc.), conflict with non-motorized forest uses increases, as do concerns over safety and environmental impacts. Careful planning will be critical to meet these diverse and often competing needs and to minimize conflicts with forests.

Investments in Forest Health, Management, Research, and Wood Processing

Ongoing surveys and assessments of forest insect and disease problems are a necessary part of forest management. Integrated Pest Management is the standard approach for forest health treatments; it includes evaluating roles, interactions, and timing for chemical, biological, mechanical, and cultural controls. Pest control treatments are usually applied only to "critical" areas and forests that are actively managed. Critical areas include forested areas where people live or play and where there are high numbers of susceptible tree species. Treatments are generally effective and damage is usually restricted to areas that are not treated. Treating entire areas that are affected by pests would be a massive project.

Forest management is practiced on both public and private lands to ensure the forestland base and associated benefits are maintained for current and future generations. Forest management practices are guided by the most current science and are applied based on the desire to maintain the full range of forest ecosystem values, including habitat for diverse species, water quality protection, clean air, carbon sequestration, temperature moderation, soil erosion control, recreational opportunities for all user groups, and scenic beauty.

Research in ecology, business, and social benefits applied to forestry remains an on-going need to refine the applied practices of the broad field of forest management. Understanding how changes to biotic and abiotic factors affect forests and forestry is the first step towards adapting methods to the care and treatment of forests. Applying the results generated by the rich resources of our multiple academic institutions enables our forest managers to implement the best tools and techniques in addressing the ever changing challenges and opportunities of our forests. Applied research is the primary focus of the role of forest research. Field trials and demonstrations are used to gain confidence in techniques and promote new concepts to practitioners and managers. Projects have been completed in the past in conjunction with the University of Maryland, College Park, and the University of Maryland, Eastern Shore.

Much of the funding for assessments, forest management, and research come from state and federal sources. In fiscal year 2019, the U.S. Forest Service Eastern Region State and Private Forestry invested $2.2 million in Maryland's forestry programs, including forest legacy, state fire assistance, and urban and community forestry. These funds went to a variety of state and private agencies. In 2018, the Maryland Forest Service had a total expenditure of $12.6 million.

Wood processing operations are found throughout Maryland and provide the basis for accomplishing much of our silvicultural goals through market outlets for products. Their role of importance to forestry is simply summarized by the statement "No markets, no management."

The profile of wood processing operations is fortunately diverse in terms of product utilization, size, and geographic location. General examples of processing operations include local firewood providers, logging businesses, sawmills, paper manufacturing, mulch producers, architectural millwork shops, cabinetry shops, custom furniture makers, corrugated box plants, and dozens of others, all of which ultimately derive their raw materials from forests, thus facilitating the economic resources needed to carry out needed silviculture. In 2016, wood and paper product manufacturers spent $13.4 million and $21.8 million, respectively, on capital expenditures (U.S. Census Bureau, 2017). This amount has not changed greatly for wood product manufacturing over the past decade; in 2007 their capital expenditures were $11.9 million. However, this is a large decline for paper product manufacturing, which spent $59.6 million on capital expenditures in 2007, almost three times as much as they did in 2016 (U.S. Census Bureau, 2010a). Investing technical resources in support of improving business efficiency, competitiveness, and market position all contributes toward retaining their contributions to our economies and sustaining our forests on our landscapes.

Forest Certification

Forest certification is a voluntary program that recognizes and certifies well-managed forests. The Maryland Forest Service is committed to managing its major State Forests in accordance with the internationally recognized standards for long term ecological, social and economic sustainability. Approximately 30% of all forest land in Maryland has a sustainable certification.

Currently, 211,000 acres of Maryland's State Forests (figure 18) are certified as well-managed according to the two major, independent, internationally recognized forest certification systems for public land, the Forest Stewardship Council® (FSC) and the Sustainable Forestry Initiative® (SFI. This certification covers 96% of State Forest land. There are an additional

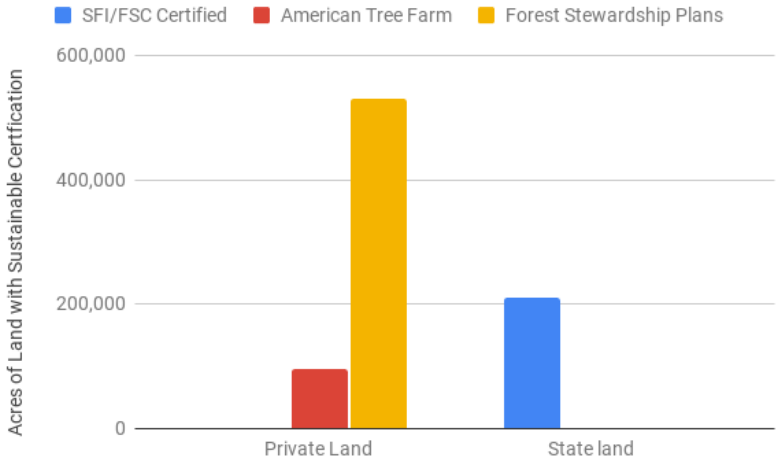


Figure 18 Sustainably managed lands in Maryland

2,000 acres of land held by private entities, like the Nature Conservancy, that are SFI certified.

Scientific Certification Systems registration SCS-FM/COC-00069P and NSF International Strategic Registrations certificate NSF-ISR/0Y301-FM1 indicates that timber from Savage River State Forest, Green Ridge State Forest, Potomac State Forest, Garrett State Forest, Pocomoke State Forest and Chesapeake Forest Lands come from a forest that is well-managed according to these strict principles and criteria approved by the FSC and SFI, respectively.

This recognition is a culmination of extensive audits, which include onsite verification, stakeholder meetings and consultation, and a comprehensive review of forest management and conservation practices. Certification standards are set and updated by the program's partners from environmental, social and economic sectors. As a result of the sustainable certification, each State Forest must write a sustainable forest management plan. These plans provide detail on the different management zones in the forest and the protections that go along with them. This includes Old Growth Ecosystem Management Areas, Ecologically Sensitive Areas, State Designated Wild Lands, and Forested Riparian Buffers which are all considered High Conservation Value Forests (HCVF). The concept of HCVF is to insure that existing fragile and unique ecosystems are managed to maintain their identified conservation attributes. The identification of unique values of each priority management/HCVF area along with the

Winner of Maryland's 2017 Tree Farm of the Year Award- Rob Prenger/Maryland Forest Service

prescriptive management protocols was a collaborative effort between DNR Forest Service and Wildlife and Heritage Service personnel. HCVF designation does not prohibit timber harvest activities, but instead utilizes forestry management operations to enhance the designated high conservation value. These Management Plans are available to the public and can be found on the Maryland DNR website.

The American Tree Farm System® (ATFS) is a national program of the American Forest Foundation. It is committed to sustaining forests, watershed, and healthy habitats through the power of private stewardship. The ATFS is the largest and oldest sustainable family woodland system in America, meeting strict third-party certification standards. There are currently 860 Certified Tree Farms covering 95,213 acres Maryland (figure 18).

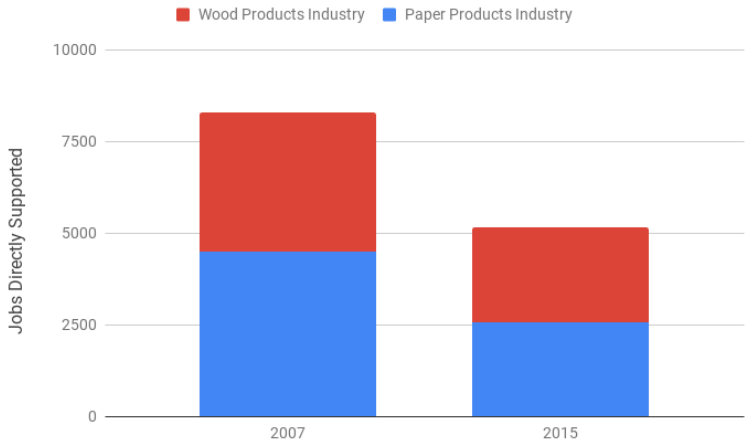


Figure 19 Jobs directly supported by the wood and paper products industry in Maryland in 2007 and 2015

Private landowners can practice certified sustainable management by creating a forest stewardship plan with a Maryland licensed forester. These plans manage the land to protect its resources for future generations. There are currently 531,000 acres of private lands with forest stewardship plans, some of which are also ATFS certified (figure 18).

Employment and Wages in Forest-Related Sectors

Maryland's forests are important in local, state, and global economies, supporting employment opportunities, investment in forest improvement practices, and venues for landowners. Forestry also plays a significant role in the ecological and social benefits derived from the existence of a healthy and diverse forest-based economy.

The BEACON report found that over 15,000 jobs were supported by the forestry sector. Of those jobs, 8,400 were directly produced by the forestry sector and the necessary supply chains. The Western Region of Maryland holds the largest amount of forestry employment, supporting 34.8% of the state's forested related jobs. The next highest region is the Eastern shore, with 23.1% of the state's forestry related jobs. It is followed closely by the Central and Southern Regions with 21.6% and 20.6% of the state's forestry related jobs, respectively. This is a sharp decline from the previous BEACON report, which estimated that the forestry sector supported 29,000 jobs in 2005.

Looking specifically at the wood and paper product manufacturing industries in 2015, they each directly employed approximately 2,600 people (figure 19). In 2015, the average annual payroll was $99 million for the wood product manufacturing industry and $152 million for the paper manufacturing industry. Production workers annual wages were $63 million and $124 million for the wood and paper product manufacturing industries, respectively (U.S. Census Bureau, 2017). This is a decrease from a decade ago. In 2007, wood product and paper manufacturers employed 3,800

and 4,500 people, respectively (figure 19). In 2007 wood product manufacturers had an average annual payroll of $128 million and paid $77 million in production worker wages. Paper product manufacturers had an average annual payroll of $190 million, and paid $137 million in production worker wages (U.S. Census Bureau, 2010a).

Outdoor recreation also supports broad economic activity and jobs. The Outdoor Industry Association estimated that $14 billion and 109,000 jobs were supported by outdoor recreation in Maryland in 2017. Some portion of that occured in forests including the same lands that are producing wood products. The 2019 Maryland Outdoor Recreation Economic Commission Final Report provides more details and makes recommendations about future opportunities.

As of 2018, the Maryland Forest Service has 86 permanent employees and dozens of contractual employees. $7.8 million of the state's budget went towards salaries, wages, and fringe benefits for the permanent employees.

Urban Tree Cover and Benefits

There is a growing body of evidence demonstrating the many benefits that urban trees provide to society, including improved human health and environmental services. People living in urban areas tend to be overstimulated by noise, movement, and visual complexity, which can lead to increased stress. This stress can lead to negative health impacts, as stress is one of the leading causes of premature death in developed nations. However, exposure to nearby nature, like urban trees and parks, has been shown to reduce stress levels and provide restorative experiences. In addition, participating in outdoor recreation and stewardship activities is correlated with physical activity, reduced depressive symptoms, and improved self-reported health outcomes. Trees can also increase property values up to 15%.

Urban trees across all site types from street tree pits to forest patches also provide important environmental services. They improve water quality by reducing runoff, which can cause erosion and carry pollutants into streams, and by uptake and filtering of drinking water pollutants. Urban trees also improve air quality by intercepting air pollution and providing shade, which reduces the heat island effect and cooling energy costs. All of these services can provide billions of dollars in value each year. More information on the benefits of urban trees can be found on the website "Green Cities: Good Health" which is run by the U.S. Forest Service Urban and Community Forestry Program and the University of Washington.

Over 87% of Marylanders live in census designated urban areas, which make up 20.8% of Maryland total area, according to data from the 2010 census (U.S. Census Bureau, 2010b). Maryland's urban areas have 48.1% tree cover, and 5.8% forest cover according to 2013 estimates from the Chesapeake Conservancy (figure 20) (forest is at least 1 acre in size and 120 feet wide). This provides 0.123 acres of tree cover and 0.015 acres of forest cover per person in these areas.

Pressures placed on these urban trees and forests increase as the state's population increases, highlighting the need to understand the extent of urban trees and forests in the state and, in turn, ensure their long-term health and viability. Invasive pests, pathogens and exotic species, the social and economic benefits of forests to communities, and the long-term

Tree planting on Arbor Day 2015- Anne Gilbert/Maryland Forest Service

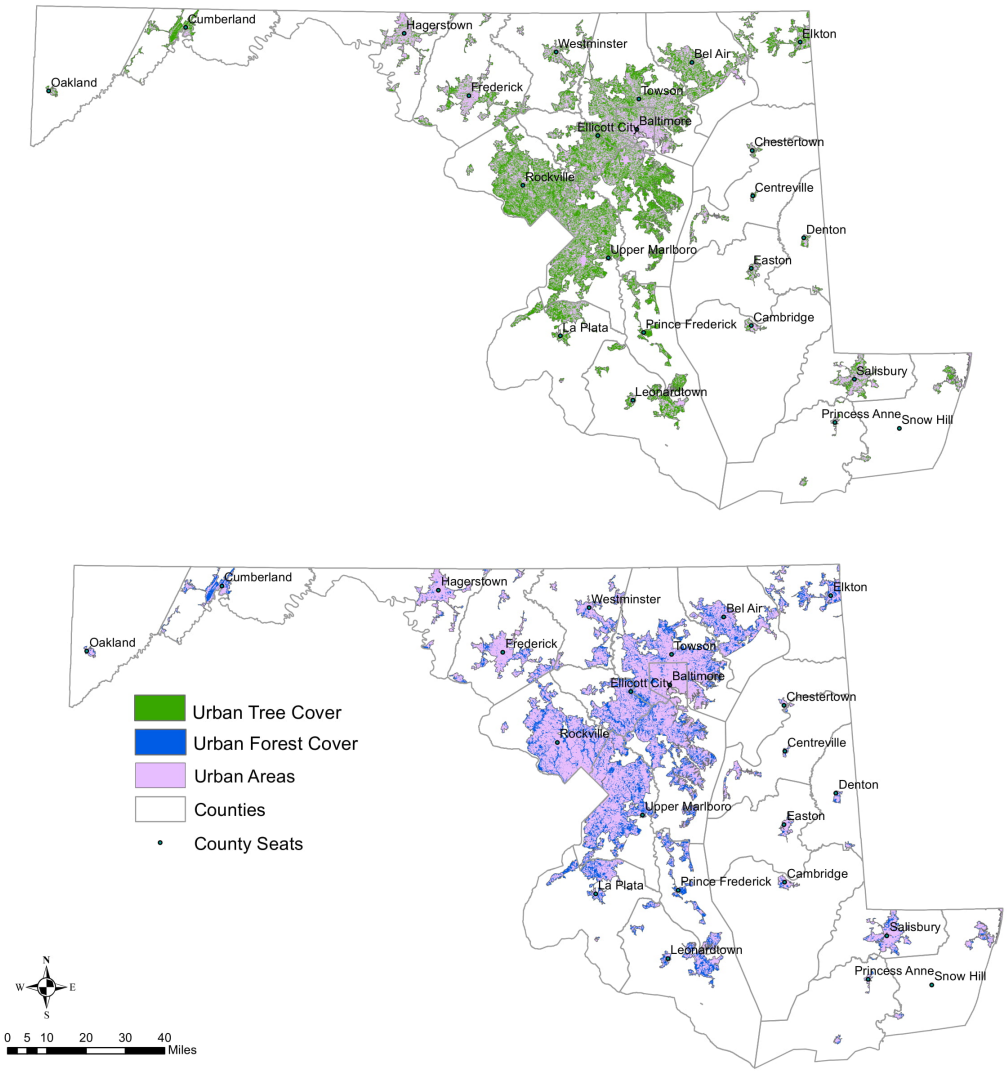


Figure 20 Urban tree cover (top) and forest cover (bottom) in Maryland

management of such forests are at the forefront of Maryland's urban forestry issues.

DNR hosts and participates in multiple programs to encourage tree planting and increasing tree cover in urban areas. Maryland's "Tree-Mendous" program provides resources to citizens wanting to plant trees on public land and in community space. Through partnerships with wholesale nurseries, Tree-Mendous helps provide native trees at a reduced cost to local government and communities. The "Marylanders Plant Trees" program provides coupons for $25 off a native tree at one of the 86 participating nurseries in the state. The Backyard Buffer programs assists homeowners who have a waterway on or adjacent to their property to create a streamside buffer of native trees and shrubs. It provides eligible homeowners with a free bag of 20-30 native tree seedlings to plant along their streamside and fact sheets with information on species, planting techniques, and proper maintenance. Since 2006, Tree-Mendous, Marylanders Plant Trees, and Backyard buffers have assisted with the planting over 300,000 trees in Maryland.

Maryland also participates in several Arbor Day Foundation programs. Seven colleges and universities in Maryland have earned a Tree Campus USA recognition, meaning they meet five standards that address tree care, benefits of trees on campus, and tree service learning projects. Over 4.6 million of Maryland's residents live in an Arbor Day Foundation Tree City, which meets standards associated with tree management, care, investment, and appreciation. In 2019, Maryland had one of the first sites recognized by Arbor Day's new

program, Tree Campus Health Care, at Perry Point VA Medical Center.

Baltimore City Urban Trees

Baltimore City has worked with multiple partners to monitor, protect, and utilize urban trees. The U.S Forest Service and the University of Vermont used high resolution land cover data to determine the changes in Baltimore's urban tree canopy (UTC). While most cities in the United States are experiencing UTC loss, Baltimore saw a 1% net increase in UTC from 2007 to 2015. This is a result of a mix of losses from human development and natural events and gains from plantings, regeneration, and growth (O'Neil-Dunne, 2017).

Baltimore was one of the first cities to participate in the U.S. Forest Service's Urban Forest Inventory and Analysis (FIA) program. This program utilizes forest inventory, landowner surveys, and timber product output surveys to better understand urban trees and their impacts in cities (USDA Forest Service, 2020). Data collection for urban forest inventory data for Baltimore will finish in 2021. The Urban National Landowner Survey is similar to the National Woodland Owner Survey, but focuses on private residential property owners with green space in census designated urban areas. The full report for Baltimore will come out later in 2020, but some initial results show that the primary landscaping activities performed in the last five years by Baltimore landowners are planting trees, shrubs, and flowers, pruning trees, removing whole trees, and eliminating invasive species. When asked who performed tree work on their property, the most common answers were tree care professionals, the homeowner, and landscaping professions. Landscaping and trees care professionals were also the most trusted source of information about caring for and planting trees, while state and local government employees were the least trusted (Locke, 2020). Baltimore's Timber Products Output report was finished in 2019. This report identified the amount of urban wood waste in Baltimore City and its generators and processors. It estimated that 78,000 tons of urban wood waste is produced in Baltimore annually and about 6-7% of that enters the urban wood waste steam (Galvin, 2019).

The Baltimore Wood Project is a program in partnership with the U.S. Forest Service and several local private agencies which salvages, processes, and repurposes wood from abandoned buildings in Baltimore. This project creates jobs for community members, reduces the amount of wood in waste facilities, and creates revenue from the repurposed products (Baltimore Wood Project, 2018). For more information, see the Baltimore Wood Project website.

Baltimore Green Space is a nonprofit that works with communities to preserve and maintain community gardens, parks, and forest patches in Baltimore City that are managed by city residents. Forest patches have a canopy area of at least 10,000 square feet. In 2013, 34% of Baltimore's tree canopy were forest patches, and 59% of the forest patches were outside of parks (Baltimore Green Space, 2019). Baltimore Green Space provides support for these forest patches through their Forest Stewardship Network. This network is made up of community residents and experts from the U.S. Forest Service, the Parks & People Foundation, Blue Water Baltimore, the Baltimore Ecosystem Study, and the Maryland Natural History Society. The network hosts meetings and workshops geared towards management and education (Baltimore Green Space, 2019). For more information on Baltimore Green Space and forest patches in Baltimore, see the Baltimore Green Space website.

Legal, Institutional, and Economic Framework for Forest Certification and Sustainable Management

Forest Management Standards/ Guidelines

The Maryland Forest Service is committed to working in partnership to protect and sustainably manage Maryland's public and private forest lands for the citizens of Maryland. Thousands of individual landowners can contribute to the future environmental quality and economic stability of Maryland by managing forest land according to a resource conservation plan. Private landowners are encouraged to practice forest stewardship and leave the land and its resources in better condition for future generations. Managing forest resources ensures the continuation of many forest benefits including improved water quality, wildlife species and habitat diversity, recreation, timber, aesthetics and air quality.

Maryland's public forests are managed in a sustainable way. The statewide forest planning process has been driven by a strong commitment to sustainable forestry. While individual definitions of sustainability differ slightly in their details, there is generally broad-based support that sustainable forestry focuses on meeting the needs of current generations, while protecting the ability of future generations to meet their own needs.

Forest harvesting best management practices (BMPs) are required by law in Maryland. BMPs protect water quality by limiting sedimentation into waterways and protecting forest buffers. Some common BMPs include planning the harvest to avoid stream crossings, utilizing roads with low slopes (less than 15%), and leaving forest buffers intact. Maryland and Delaware recently updated their BMP guidelines based on results from a 2017 study. The new practices will increase the presence of state staff to provide technical assistance in properly implementing BMPs.

Forest-Related Planning, Assessment, Policy, and Law

Successful forest conservation planning requires collaboration between professional foresters, planners, landscape architects, engineers, surveyors and developers, and various experts representing conservation organizations, the forest products industry, state technical assistance groups, financial incentive programs, and forestry related tax programs.

Statewide strategic plans include a common vision for Maryland's forests based on goals and assumptions for statewide sustainable forestry. Trends and issues address relevant ecological, economic, and social implications and provide a strategic objective. Periodic updates to assessments, planning, and implementation plans for sustainable forestry are long-standing traditions. Forest planning is undertaken with these goals in mind:

- Forests are conserved, healthy, protected from land use change and pathogens, and are managed according to sound stewardship practices.
- Forests provide a diverse range of native plant and animal species and habitats.
- Forests are productive, providing raw material for consumers and economic stability for local communities.
- Forests provide multiple recreational opportunities.
- Forestry educational outreach is the key to an informed public.

Assessments are made periodically, or when a significant amount of new data is collected and made available. DNR collects data on the state's forests in both tabular and spatial formats and utilizes that data to determine current conditions and trends. The U.S. Forest Service Forest Inventory and Analysis (FIA) unit collects data from permanent sample sites across the state, and provides that data in periodic technical reports. This FIA data provides a valuable "snapshot" of Maryland's forests, and is used to understand how the state's forests are changing and allows us to make recommendations of planning activities and policy changes.

Maryland has completed forest management plans and assessments in the past decade. The first Maryland State Forest Plan Assessment and Strategy came out in 2010, and an updated Strategy was published in 2015. All of Maryland's 11 State Forests have management plans with the major State Forests' plans being updated on a regular basis.

While Maryland does not have any national forests, it does have some federal land that is forested and requires management plans. The National Park Service (NPS) runs several sites in Maryland, like the C&O Canal National Historic Park and Catoctin Mountain Park. Both of these areas and other lands managed by NPS have management plans that can be found on the National Park Service's Website. Maryland is also home to five National Wildlife Refuges: Susquehanna, Patuxent, Eastern Neck, Blackwater, and Martin. Each of the National Wildlife Refuges has a Comprehensive Conservation Plan, which can be found on the U.S. Fish and Wildlife Service's website.

Many of Maryland's private woodland owners also have forest management plans. According to the 2018 National Woodland Owner Survey, about 37% of private woodland owners in Maryland have a management plan. This becomes more likely the more forested a property is. According to data from the 2013 NWOS , approximately 52% of private landowners whose property is more than 75% forested have a forest management plant, compared to only 17% of landowners whose property is less than 25% forested (figure 21).

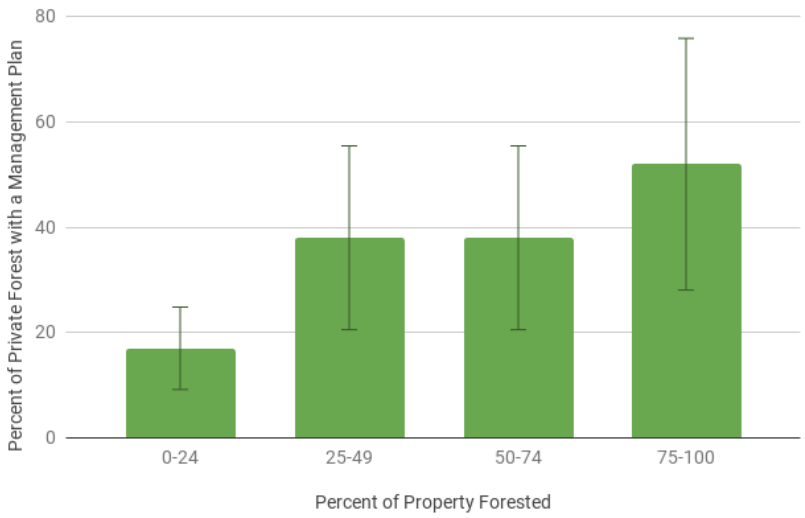


Figure 21 Percent of private forest acres in Maryland with a management plan from the 2013 National Woodland Owner Survey

Maryland has a robust suite of laws for protecting forests, including the 1991 Forest Conservation Act, the Sustainable Forestry Act of 2009, and the 2013 Forest Preservation Act. The Forest Conservation Act was adopted in 1991 to stem the loss of forest in the state and established standards for local authorities to enforce during development. It is a means to protect not only forest and trees in developing areas, but also any sensitive area identified during the local planning or comprehensive land use plan adoption process. Additionally House Bills 1141 and 2 both passed in 2006 and require all local government comprehensive plans to consider forests and forestry during the planning and land preservation process.

The Sustainable Forestry Act of 2009 formally recognized the need for retaining and expanding forests to meet the Chesapeake Bay restoration goals. The act also provided expanded funding of the Woodlands Incentive Fund (WIF) which is used to develop stewardship plans of private lands, establish a forest health contingency program, administer urban and community forestry programs, and promote production and marketing of wood products. Additionally, the act allows WIF funds to be used to expand forest mitigation banking, promote clean water credit trading, promote carbon trading and sequestration, and fund other environmental and renewable energy services.

The 2013 Forest Preservation Act works to encourage afforestation and sustainable forest management and reinforces a no-net-loss goal. It encourages retention of family-owned forests by doubling the income tax credit for forest management activities and expands the range of activities to include planting of riparian buffers, invasive species removal, and wildlife habitat improvement. It also allows for the State Reforestation Law to support tree planting and forest management and ensures that local fees collected by the Forest Conservation Act are used towards planting and conservation.

In addition to laws encouraging sustainable management, Maryland also has several forest advisory committees. The Sustainable Forestry Council (SFC) was formed to implement the 2009 Sustainable Forestry Act. The SFC uses current information to advise DNR on timely forest conservation issues and appropriate actions to help Maryland implement a no net loss of forest policy. Most State Forests have their own citizen advisory council and each Maryland district (the 23 countries plus Baltimore City) has a volunteer Forest Conservancy Board. The Forest Conservancy Boards work to ensure a sustainable supply of wood fiber, restore the Chesapeake Bay, improve the environment in urban and suburban areas, and educate the public on the benefits of forests and trees. For more information on these committees, see the Maryland DNR website.

Forest Conservation and Preservation Programs

Conserving large, intact, healthy forests assures that the many environmental, economic, and societal benefits they provide will persist well into the future. However, many forests are at risk of being converted into non-forests uses as populations grow and development expands. As 72% of Maryland's forest cover is privately owned, programs that work with private landowners are an integral part of maintaining forests.

The Maryland-specific conservation and preservation programs include Program Open Space, Rural Legacy Program, the Maryland Environmental Trust, the Maryland Agricultural Land Preservation Foundation, the Forest Conservation Act, the Forest Conservation and Management Agreement, and the Woodland Assessment Program. Maryland also participates in federal programs including the Land and Water Conservation Fund, the Forest Legacy Program, the Readiness and Environmental Protection Integration Program, the Sentinel Landscapes Partnership, the Farm and Ranch Lands Protection Program, the Conservation Reserve Enhancement Program, the North American Wetlands Conservation Act, the Coastal and Estuarine Land Conservation Program, and the Environmental Quality Incentive Program. These programs provide funding for land acquisition, conservation easements, and sustainable land management to protect and conserve forests. For more information on conservation and preservation programs in Maryland see the 2020 Maryland Forest Legacy Program Assessment of Need which can be found as an appendix on the SFAP Strategy.

In addition to the land protected through partnerships with private landowners, a vast majority of state and federal land in Maryland is protected from development (figure 22). This includes State Forests, State Parks, National Parks, and National Wildlife Refuges. There are approximately 1.66 million acres of land in Maryland that are protected from development through permanent easements or by federal, state, or local ownership; 52% of this protected land is forested. Included in the protected land is also 2,400 of old growth forest on State Forests.

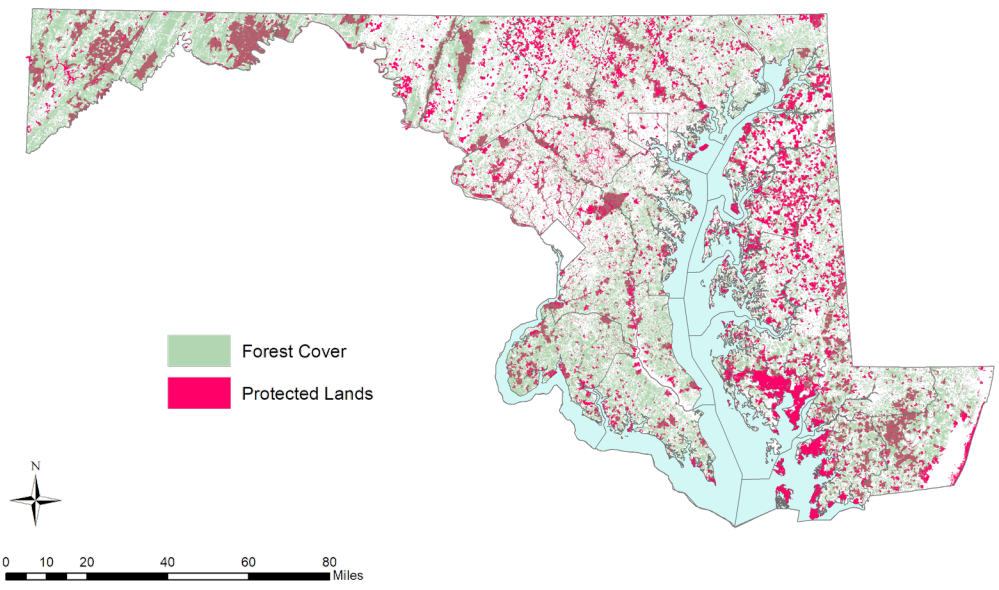


Figure 22 Map of protected lands and forest cover in Maryland

Existing and Emerging Benefits

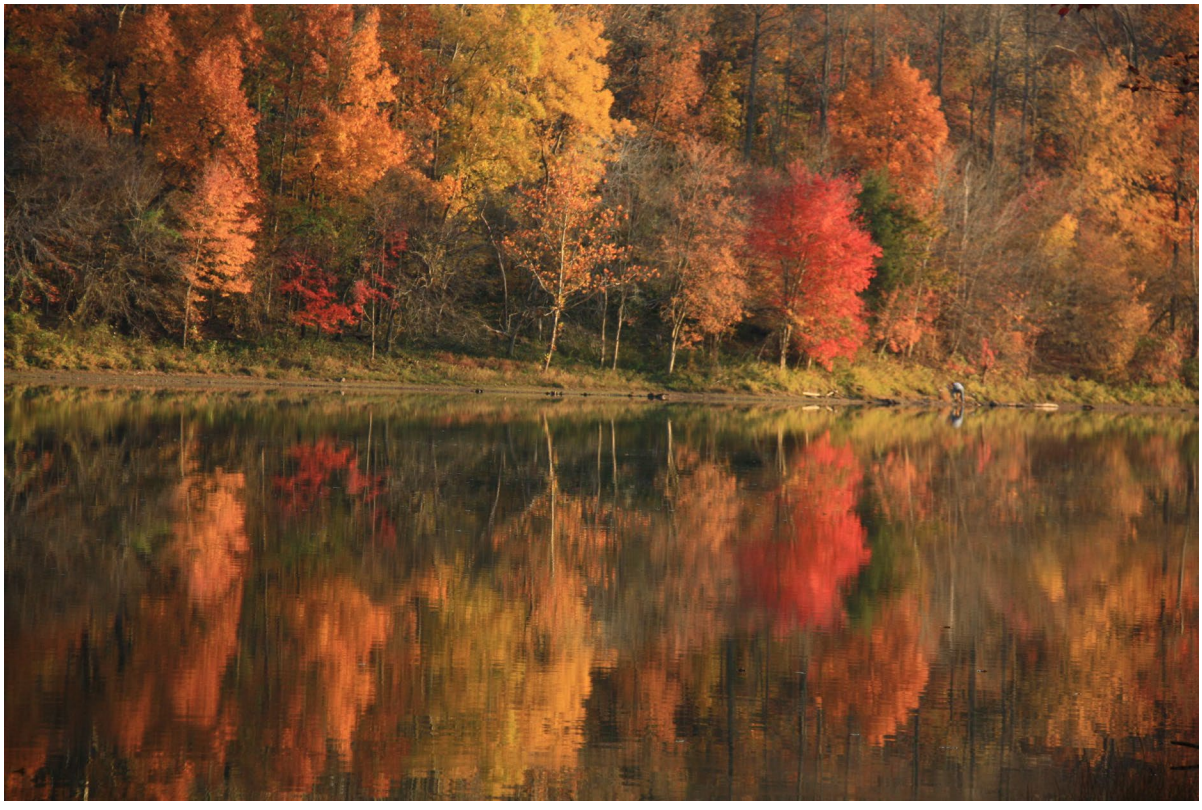
Forests are an integral part of Maryland's landscape, environment and economy. They are the single best land use for water quality protection and clean air, and provide wildlife habitat, aesthetic beauty and forest products – all important benefits too often taken for granted.

Forests help clean air by removing carbon dioxide and pollutants and releasing oxygen. Along with carbon dioxide, trees remove nitrogen dioxide, carbon monoxide, sulfur dioxide, ozone, and particulate matter from the air. They also reduce and moderate local temperatures, reducing energy demand for artificial cooling (and its accompanying pollution) during peak temperature periods.

Forests are efficient filters, cleaning sediments and other pollutants from water. Forest buffers, strips of forests along bodies of water, are essential to maintain clean water. Tree roots protect waterways by stabilizing stream banks and shorelines and reducing erosion. Shade from trees lowers water temperatures in the summer and increases amounts of oxygen dissolved in the water. Forests increase large woody debris and organic matter in waterways, thereby improving living conditions for cold-water fish and spawning conditions for warm-water fish.

Maryland's emerging issues, including forest certification, sustainable energy, environmental standards, and forest markets need attention to maintain healthy communities. Strategies to maintain Maryland's forest-based economy will be required as the globalization of the economy increases. Sample trends and issues related to this theme include:

- Global demand for forest products requires timber companies to make decisions within the context of a worldwide market
- Sustainable management certification is emerging, and the global market for sustainable forest products may give certified Maryland forests a strategic competitive advantage
- Wood biomass has the potential to serve as an energy source for Maryland
- Water Quality Trading Credits
- Forest Mitigation Banking
- Carbon Trading
- Temperature Mitigation



Maryland DNR

Forest Issues, Threats, & Opportunities

Forest Ecosystem Health and Vitality Issues

Maryland forests face many challenges to their health and resilience. Some, like the continued loss of forest to development, gypsy moth defoliation, and wildfire have been concerns for decades. More recently, emerald ash borer and other insect invaders are having noticeable effects on our forests. Particularly in urban settings, where ash was extensively planted for its tolerance of poorer sites and rapid growth rate. These trees now face an uncertain future as emerald ash borer spreads across the state.

bugwood.ne
bugwood.net

Fred Besley saw four major threats to the forest's health in 1915: *"Injudicious Cutting"* as he called it, known today as *"high grading"* or the process of removing the best, usually most genetically superior trees and leaving the worst. This predisposes the future forest to genetically inferior trees and undesirable (from a timber perspective) tree species.

Fire was the larger, more direct threat to the forest in 1915, with much of the state having poor roads and few local fire companies to battle fires. That year Besley estimated the damage from forest fires to be $108,966 (roughly $2.7 million in 2019 dollars) just to the timber and trees alone.

Deliberately set fires, Besley estimated, also contributed to the third major problem he saw to forest health: grazing. Fires were set to "promote a growth of grass" for grazing livestock. This was particularly problematic in the Piedmont and western portions of the state. He also found soil compacted by grazing animals affected forest regeneration.

The final threats to the forests of Maryland in Fred Besley's eyes were tree diseases and destructive insects. He found locust borer, locust leaf miner, two lined chestnut borer, and pine bark beetle to "have not done a very great amount of damage," but could "at any time increase to an alarming extent under favorable conditions."

Today these insects are less of a threat to Maryland's forests, with the exception of pine bark beetles. There are occasional outbreaks of these beetles that require management, usually on the Eastern Shore or Southern Maryland. According to the Maryland Department of Agriculture (MDA) Forest Pest Section, there are several forest pests, present and on the horizon, that pose a significant threat to Maryland's forest resources. These pests are monitored through the **Cooperative Forest Health Program** involving the U.S. Forest Service, MD Department of Agriculture and MD Department of Natural Resources. Currently MDA is monitoring for pests such as southern pine beetle, sirex wood wasp and walnut twig beetle, the vector of thousand canker disease in walnut trees.

Above all stands climate change. The impacts of a changing climate will increase the damaging effects of other forest health threats. Warmer winters will likely increase the spread of invasive insects, and allow insect activity to continue that would otherwise be held in check by cold temperatures. Housing density will likely increase as people migrate to escape floods and severe weather. Fire activity is expected to increase, forests on the Eastern Shore will be inundated by rising waters, and invasive plants like kudzu, will spread further into the state.

Development Patterns

Maryland's population is expected to increase by over 11%, between 2020 and 2040 to nearly 6.75 million people (Maryland Department of Planning, 2020). It is currently the fifth most densely populated state in the nation. Projections by the Maryland Department of Planning estimated that between 1973 and 2010, Maryland's developed area increased from 10% of land cover to 27% of land cover, a 1 million

acre increase. Past studies clearly show that the absence of a comprehensive forest retention and reforestation program has compromised the distribution of forests throughout the state. **Without changes in land use planning at the local level, thousands of additional acres of forests could be lost to development. Appropriate planning for land use and resource-specific controls such as Maryland's Forest Conservation Act (FCA) may reduce this acreage.**

The Maryland Sustainable Growth Commission, which is tasked with assessing the progress of state, local, and regional planning efforts, found a shift in the demand for multifamily housing, and that from 2011 through 2015, 39% of new housing units were apartments and condos, compared to 23% in the three years before the recession. The commission also found that between 2008 and 2018, 75% of residential development occurred in Priority Funding Areas (PFA), and that over the last five years, 70% of Maryland's population growth has occurred in the inner suburban counties of Anne Arundel, Baltimore, Montgomery, and Prince George's and in Baltimore City. The commission believes this is a result of an increased desire for more compact, walkable communities, and that there is well-documented movement back to towns, older suburbs, and cities. A trend which may have spared, or at least postponed, many forest acres from development.

The Sustainable Growth Commission recognizes the state's need to conserve the "finite land, [and] irreplaceable natural resources" of the state, and recommends focusing new development in PFAs, of which it indicates 37% currently exist in low-density or undeveloped land uses. To facilitate sustainable growth, the commission provides a tool kit for land use planning to help focus future development on the principles of in-fill, redevelopment, and revitalization, and a shift from "greenfield" development (Maryland Department of Planning, 2018). The tool kit offers numerous examples of successful projects utilizing myriad funding sources and partners in urban, suburban, and rural locations

The Environmental Protection Agency (EPA) has completed several growth analyses for U.S. states, and combines the predicted growth with the four Intergovernmental Panel on Climate Change (IPCC) emissions scenarios in the Integrated Climate and Land-Use Scenarios (ICLUS) Model. The social, economic, and demographic storylines from the IPCC SRES, adapted for the U.S., were used to create population projections. The model results (figure 23) simulate housing density and impervious surface change from the

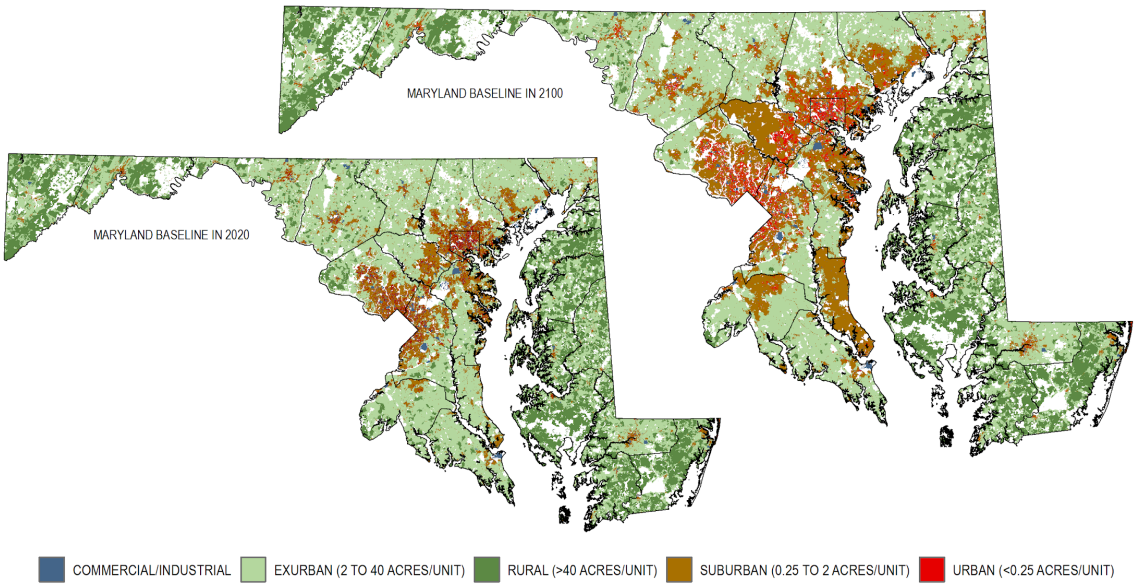


Figure 23 Map of Maryland's commercial, exurban, rural, suburban, and urban land in 2020 and 2100 (predicted)

assumptions made about population change, for each decade, until the end of the century. In Maryland, areas defined as a "rural" housing density (properties >40 acre in size with one housing unit) are expected to decline (figure 24) to about 1 million acres by 2100, under the A2 scenario, a scenario which implies greater global emissions from the baseline. The more favorable emissions scenarios have Maryland losing approximately 100,000 acres by mid-century, and holding at about that amount. This would slow the amount of forest cleared, and focus development into "brown-field" areas, and more concentrated zoning schemes. Under most of these scenarios, Maryland should expect greater urbanization in eastern Howard County, central Montgomery County, and areas east of Baltimore within the Baltimore County URDL (Urban-Rural Demarcation Line). Calvert, Howard, Harford, Charles, and Anne Arundel can expect to see significant gains in suburban housing density. Howard and Calvert in particular, are projected to grow significantly over the rest of the century.

Climate Change

As the climate changes, Marylanders can expect an increased risk for extreme events such as drought, storms, flooding, and forest fires; more heat-related stress; the spread of vector-borne diseases, particularly from ticks and mosquitoes, and increased erosion and inundation of low-lying areas along the state's shoreline and coast (Maryland Department of the Environment, 2015). Large departures from typical conditions and extreme events, such as late frosts, drought, and wind storms, can damage or kill trees. The occurrence and severity of such extreme events associated with climate change are projected to increase. These indirect effects of climate on factors such as wildfires and insect outbreaks are likely to negatively impact forest production (Boesch, 2008).

Forests makeup 39% of Maryland land cover. Trees and forests serve as a carbon "sink", collecting and storing carbon from the air, and roughly half of a tree's mass is composed of carbon. In a year, they absorb 4.3 million metric tons of carbon dioxide equivalent (MMtCO2e) emissions. Carbon sequestration can continue with harvested wood products, particularly durable categories such as lumber, flooring and paneling, cabinets, furniture, and others, contributions that can be captured with life-cycle carbon analysis. Urban trees and forests also contribute, and store an additional 2.2 MMtCO2e per year. Unfortunately, this is not enough to

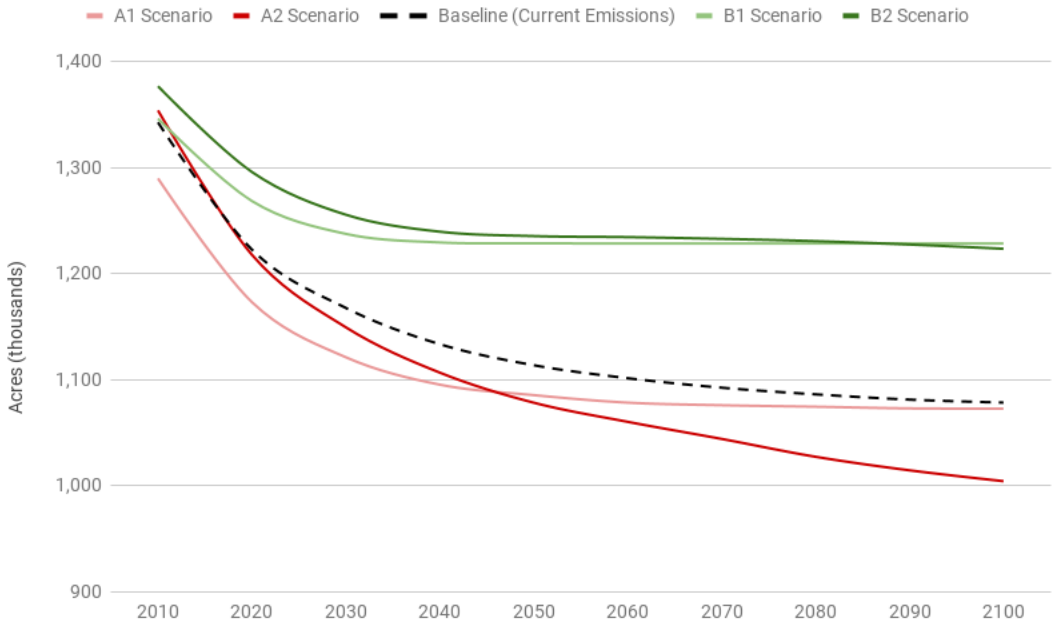


Figure 24 Available rural land in Maryland (40 acres/unit) from estimated housing density 2010 to 2100, under IPCC emission scenarios

equal Maryland's emissions, which were 78.49 MMtCO2e in 2017. Planting forests in Maryland is one of ten "key strategies" under the state's updated Greenhouse Gas Reduction Act (GGRA) plan. It was estimated that planting roughly 43,000 acres of trees through afforestation and reforestation would reduce emissions by approximately 1.79 MMtCO2e from 2006 to 2020. The plan projects tree plantings to increase the forest carbon sink by 300,000 metric tons of CO2e per year by 2030. So far, Maryland programs, such as the Forest Conservation Act (FCA), 5-103 Reforestation law, Marylanders Plant Trees coupon program, and riparian buffer planting initiatives have been successful in planting over 36,000 acres of trees.

There is a large volume of research and guidance available to forest planners and managers to assist them with adaptation or mitigation plans. Resources like the Northern Institute of Applied Climate Science or the U.S. Forest Service Climate Change Resource Center can provide forest managers with targeted, region-specific guidance.

The Mid-Atlantic Forest Ecosystem Vulnerability Assessment and Synthesis report, in particular, identifies impacts and vulnerabilities of forests to climate change in Maryland, and surrounding states. According to the assessment, Maryland's forests can expect to see:

- a change in the timing and amount of precipitation,
- an increase in the frequency of intense precipitation events,
- a change in soil moisture patterns,
- increased drought and wildfire risk,
- continued sea level rise.

Forest productivity is expected to increase, so long as stressors are low or few, but pests, pathogens, and invasive plants are expected to increase. Major findings included: expansion of southern tree species into the region, namely post oak, scarlet oak, and southern red oak as habitat becomes more suitable for those species. Reduction of suitable growing conditions for other species will occur, changing forest composition. Finally, loss of regeneration potential by other species, like high-elevation species will be unable to "migrate," as habitat requirements may be more narrow than others. Tree species with high tolerance to disturbance will be less affected by a changing climate.

The assessment evaluated the potential impacts, adaptive capacity, and vulnerability of major forest systems in the region, and found that maritime forests, lowland conifer forests, and montane spruce-fir forests were highly vulnerable to climate impacts. Maritime forests face increasing levels of saltwater, and a 2016 survey by MDA found that 50,406 acres had been affected by saltwater intrusion. This was an increase from 18,117 acres in 2013 (USDA 2017).

The montane spruce-fir was also rated as "low" for adaptive capacity, which could lead to potential negative impacts. This forest type is perhaps the most at-risk type in the region, and will make current efforts to restore red spruce stands in Appalachia more difficult. On the other hand, oak-pine systems, glades, and barrens may experience moderate to positive impacts from climate change. These forests are the dominant types in Maryland, and benefit from a diversity of species and tolerances for a wide range of temperatures and water. However, all forest types, regardless of climate change adaptive capacity, require climate informed management to address threats that will be exacerbated by climate change.

Insects and Diseases

Emerald Ash Borer (EAB)

On Aug. 28, 2003 a Maryland Department of Agriculture (MDA) inspector found emerald ash borer-infested ash trees at a single Prince George's County nursery. The U.S. Department of Agriculture (USDA) Systematic Entomology Laboratory in Beltsville, MD confirmed the identification of the emerald ash borer (EAB). EAB is a serious pest of quarantine significance. MDA issued a Quarantine Order in March, 2004 and an eradication program began in the infested area. EAB continued to expand beyond the boundaries of the quarantine zone, however, and successive areas were added to the quarantine and eradication area. By 2009, eradication became no longer feasible, and the focus switched to containment, using quarantines and citizen outreach to limit the spread of EAB. In 2015, EAB was found on the Eastern Shore in

Queen Anne's, Talbot, and Dorchester Counties. The state removed its quarantine that prohibited movement of untreated ash products and hardwood firewood outside of infested counties. The entire state of Maryland entered into the federal EAB quarantine, prohibiting movement of these articles across state lines to non-infested states.

Control of emerald ash borer continues to be a joint effort between MDA and the Maryland Forest Service. MDA continues to monitor for EAB in uninfested counties, conducts biocontrol releases, and assists with chemical treatments on state lands. Maryland Forest Service works with county and local governments, state highways, and other landowners to develop and implement ash tree inventories and management plans.

Many communities are implementing treatment and removal programs for their street and park trees, to protect environmental benefits and limit safety hazards from dying ash trees. In protected lands, treatments are under way to protect specimen trees, riparian stands, and rare ash species. Seed source protection treatments are being implemented to aid repopulation following EAB, particularly in vast tidal hardwood ash stands on the Eastern Shore. Biocontrol shows promise for controlling EAB populations, following the initial wave of invasion, but requires several years of releases to begin establishing significant populations.

Damage from emerald ash borer- Stephen Badger/ Maryland DNR

Beech Bark Disease

Beech bark disease, as it is known, is the mortality resulting when the beech tree (*Fagus grandifolia*) is attacked by the beech scale, *Cryptococcus fagisuga Lind.*, followed by attack by the fungus *Nectria coccinea* var. *faginata* Lohman, Watson, and Ayers. The fungus enters the tree through the injuries caused by the scale and causes the bark to swell, eventually girdling the tree. The disease in Maryland was detected in southern Garrett County and positively identified in June, 2003. The disease is known to be the cause of beech decline in West Virginia, just to the south of the detection site in Garrett County. The MDA Forest Pest Management Section is monitoring the infestation and reported in 2009 that the scale had advanced north to an area around Savage River Reservoir, and was found for the first time in Allegany County in Dan's Mountain State Park in 2017 The disease has affected or has the potential to affect the forest on approximately 150,000 acres of Garrett County; about 36% of the county.

Beech dark disease- Linda Haugen/USDA Forest Service

Thousand Canker Disease (TCD)

TCD is native to the western United States, and primarily affects black walnut (*Juglans nigra*) trees. Damage is caused by the fungus *Geosmithia morbida* that is introduced to the host tree by the walnut twig beetle (*Pityophthorus juglandis*) (Thousand Canker

Disease, 2020). The disease causes many small branch and stem cankers to form, which can kill an infected tree. The disease was largely contained to western states, until 2010, when it was detected in Tennessee, within the native range of black walnut trees. TCD has now also been found in Maryland, Pennsylvania, Virginia, and North Carolina, and the presence of walnut twig beetle has been confirmed in Ohio. TCD was first found in Cecil County at Fair Hill Natural Resource Management Area in 2013. A quarantine was put in place surrounding the northeast corner of Cecil County. Several new positive sites have since been found within the original quarantine area. In 2018, walnut twig beetles were found in the City of Baltimore, and an additional quarantine area was put in place encompassing the city and eastern half of Baltimore County.

No signs of tree decline have been seen at any TCD-positive sites in Maryland, however, severe decline was seen in Tennessee. According to the U.S. Forest Service, TCD is "an example of a native forest health condition where the biotic agents (beetle and fungus) have expanded their geographic ranges and switched to new host species with no coevolved resistance," and is likely to act like a non-native disease in populations of walnut outside of the diseased native range (USDA Forest Service Research and Development, 2014).

Southern Pine Beetle

Normally, southern pine beetles (*Dendroctonus frontalis (Zimmermann))* can be found at non-damaging levels in most pine stands on the Eastern Shore. They build up to damaging levels in overstocked, overmature or stressed stands. Healthy, vigorous trees are able to resist attack, however, trees that are weakened are susceptible to beetle attack. SPB is native to the eastern United States and can be found from Texas to southern New Jersey. In Maryland, previous infestations have been seen in Dorchester, Worcester, Wicomico, and Somerset counties. Outbreaks typically develop every seven to eight years.

Since the beetle is near the northern edge of its range in Maryland, area-wide outbreaks are often controlled by cold winter temperatures. Mild winters and hot, dry springs and summers lead to beetle population buildups, and outbreaks. In 2005, SPB was found for the first time in Talbot County. Populations have also begun further north, outside the historical range of SPB, including Cecil County, Nottingham PA, and Long Island NY.

In Dorchester County, in particular, saltwater intrusion from large storm events has stressed many low-lying pine forests. Over 300 acres of mortality occurred in the Andrews and Crapo area of the county. Similar spikes in mortality may be expected following future storm surge events.

Hemlock Woolly Adelgid

The hemlock woolly adelgid (*Adelges tsugae)* is a pest of both ornamental and forest hemlocks. This aphid-like insect is native to eastern Asia, and has been in the United States since the 1920s and in Maryland for at least 30 years. The hemlock woolly adelgid has been found in most Maryland counties where hemlocks are planted or grow naturally. Landscape hemlocks, as well as natural forested stands, have become infested with adelgids, however, hemlocks under stress are more likely to decline and die. Some stands in Maryland have shown signs of decline, especially in those areas affected by drought.

Treating for hemlock woolly adelgid- Stephen Badger/ Maryland DNR

An important part of hemlock woolly adelgid management is early detection; control will be more successful if done before adelgid populations reach damaging levels. Chemical control is often the best option for controlling adelgids in the landscape. Dormant oils can be used from November to March, and insecticides or insecticidal soap can be used from March through October. Systemic insecticides use tree respiration to spread throughout the treated tree, but other treatments require thorough coverage of all infested parts of the tree.

While large-scale treatments are cost-prohibitive, the Maryland Department of Agriculture and the Maryland Forest Service carry out a cooperative effort to protect important hemlock stands across the state. Systemic insecticides are used, with stem injections in sensitive habitats and riparian areas. Biocontrol populations have become established in several sites in Western MD. However, our most successful biocontrol species, *Laricobius nigrinus*, only provides control during cooler months. Federal, state, and university partners are continuing research to find biocontrols that will provide effective control during summer months

Gypsy Moth

A native of Europe, gypsy moth (*Lymantria dispar*) was accidentally released in Massachusetts in 1869. Infestations of the pest have gradually spread, leaving behind millions of acres of defoliated trees. Since 1980, the gypsy moth has defoliated more than one million acres in Maryland. During this period, the Gypsy Moth Cooperative Suppression Program sprayed the trees with carefully selected insecticides on another 1.8 million acres statewide. The suppression spray program has protected the trees from severe leaf loss on an average of over 97% of the acreage treated each year. From the early 1980s to the early 1990's, severe infestations of gypsy moth caterpillars and the resultant defoliation occurred primarily in Allegany, Anne Arundel, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Kent, Montgomery, Prince George's, and Washington counties. Most of the Maryland Department of Agriculture's (MDA) gypsy moth suppression activities were conducted in these counties. By 1994, the northern infestations had collapsed, but on the Eastern Shore and in Southern Maryland, where the suppression spraying was largely conducted, the caterpillars were very active. Although gypsy moth caterpillar populations were low between 1996 and 1999, MDA's annual fall survey program detected several increasing populations throughout the state. Gypsy moth caterpillar populations rebounded significantly in the early 2000's and the MDA Suppression Program responded with spraying, treating over 48,000 acres in 2001. Populations began to collapse, then expand again in the second half of the decade. In spring 2008, over 99,000 acres were sprayed, with 19,279 acres of defoliation, mostly in Western MD from Frederick to Garrett County.

Since 2015, populations have been growing in the mountains of VA and PA. However, several years of very wet springs in MD fostered the growth of the Entomophaga *maimaiga* fungus, which kills gypsy moth caterpillars. While populations are currently low, they can be expected to grow as seasonal weather conditions allow.

Gypsy Moth- NPS

Oak Decline/Disease Complexes

Oak species in Maryland are periodically attacked by a number of diseases. Bacterial leaf scorch is a disease caused by the bacteria *Xylella fastidiosa* which can reduce growth and eventually kill trees in severe infections. Oak wilt is a fungal pathogen which primarily targets red oaks, and can spread across large stands. Unconfirmed records of oak wilt in Maryland date back to the 1950's, but 2 confirmed sites in Allegany County have been monitored for over a decade without outbreaks. In 2017, oak wilt was

confirmed on a chestnut oak in Carroll County. This is the first record so far east in the state, and on chestnut oak, and monitoring is ongoing to determine if Maryland faces any increased threat.

Oak decline is a general term for a complex of insects, diseases, and environmental conditions which are leading to widespread oak dieoff. Many oaks are becoming stressed due to age, poor soil and site conditions, and changing seasonal and weather patterns. These stressed trees are attacked by secondary agents such as red oak borers, two-lined chestnut borers, or armillaria root rot. In 2019, there was widespread die-off of oaks in urban areas. While the exact causes are not known, it appears that several years of extremely wet weather followed by a drought event has led to root damage, water stress, and secondary attacks from a suite of agents. These issues may become more common as more extreme weather events occur.

Other pests

Orange striped oakworm *Anisota senatoria* (J. E. Smith) can defoliate trees in forests, parks, and cities. Red and white oaks are potential hosts, but in Maryland, species in the red oak group seem to be favored. Adults lay eggs on the undersides of leaves from June to July. Caterpillars feed for 5 to 6 weeks in July to September. After feeding is complete, mature larvae pupate in the soil where they over winter. There is one generation per year. Severe outbreaks rarely last more than two years due to natural enemies. Control is usually not warranted, except to control caterpillar nuisance and to protect weakened or high value trees.

Variable oakleaf caterpillar (*Heterocampa manteo* (Doubleday.)) hosts include several hardwoods, including all species of oak, with white oak the preferred species. Female moths deposit single eggs on leaves in May. Larval feeding occurs through August. Winter is spent in cocoons in the soil. There is one generation per year. Although severe widespread defoliation can occur, outbreaks rarely last more than two years. The most recent outbreak occurred in St. Mary's County, with heavy defoliation in 2017. Parasites and predators, especially birds, often control populations. The Maryland Department of Agriculture Forest Pest Section monitors these periodic outbreaks and recommends treatment options.

Cherry scallop shell moth (*Hydria prunivorata* (Ferguson) is a defoliator of black cherry trees in North America. The damage is caused by the moth larvae caterpillar which hatches from eggs laid on the underside of cherry leaves. The larvae construct a nest and feed vigorously on cherry tree leaves. When a leaf is defoliated they will move to another and continue the process. Other stresses like drought, frost or other insect attack can cause mortality (Omer and Allen-Reid, 2018). Approximately 60 acres of forest in Northern Baltimore County are known to be at threat.

Fall and spring cankerworm (*Alsophila pometaria* (Harris) and *Paleacrita vernata* (Peck), respectively) feed on oaks, maples and hickories. Both species reach one inch long; color varies from light green to dark brown with yellow stripes on their sides. Fall cankerworm caterpillars have three pairs of abdominal legs; spring cankerworms have two. Both species hatch in the spring. While young larvae only make holes in leaves, older caterpillars consume most of the leaf. After feeding for about six weeks, caterpillars burrow into the soil to pupate. Fall cankerworm adults emerge and lay eggs in the fall, spring cankerworms overwinter in the soil and adults emerge in the early spring. Natural enemies usually limit outbreaks to 1-2 years with little tree mortality. Sticky bands placed around tree trunks can trap females as they ascend trees to lay eggs. High use areas or high value trees may require insecticidal control (Maryland Department of Agriculture, 2013).

According to MDA, over the years approximately 6,500 acres of forest have been at risk to this pest. Most of the activity occurred in Central Maryland, particularly Frederick, Carroll, and Montgomery Counties, with spot occurrences in Allegany, Cecil, Anne Arundel, Prince George's, Howard, and Washington Counties

Deer

Deer have also had a large impact on forest diversity. Populations of white-tail deer have risen dramatically in response to a lack of natural predators, an abundance of favorable habitat, and protective game laws. The Maryland Deer Management Plan states, "although white-tailed deer represent the preeminent example of

bringing a species back from the brink of extinction, their abundance now poses threats to natural forest ecosystems and to other wildlife species." So much so, the Maryland Wildlife and Heritage Service considers them to be a "problematic native species" to many conservation efforts. Severe damage from high deer densities can alter forest tree species composition and thus the wildlife species that depend on that forest (Alverson and Waller, 1997). A National Park Service study reached the same conclusion and found that deer damage particularly altered the composition of bird species in forest stands, while altering the stands themselves. Hickory and oak species were severely diminished, along with red maple and tulip poplar, while hackberry, black cherry, and ash species composition was unchanged. The study concluded that if unchecked, excessive, preferential deer damage would alter oak-hickory and bottomland forest types by directing successional regeneration toward cherry/ask/hackberry dominated stands (Gorsira et. al., 2005).

Deer browse in on stand (right) and regeneration in a fenced area (left) in Baltimore County- Baltimore County Department of Environmental Protection and Sustainability

Maryland white-tailed deer habitat includes most of the state except for open water and intensely developed urban areas (e.g. downtown Baltimore). Deer thrive in landscapes with wooded/brush sections and open areas such as cropland, pasture or landscaped yards. Deer use the wooded areas for food and cover, and open areas provide food. Landscapes with an abundance of edge habitat (areas where forested and open habitat meet) support prime deer habitats. Because of this, suburban sprawl creates ideal habitat conditions for white-tailed deer. When forested areas are converted into housing developments, portions are cleared for roads and home sites, while other sections remain forested (Maryland Department of Natural Resource, White-tailed Deer Biology).

In the early 1990's, Maryland's deer population was estimated at 160,000 animals. The density ranged from approximately 25 deer per square mile in the rural regions of the state, to 15 per square mile in the suburban areas. More recent population estimates are around 200,000. These densities are high compared with the number of deer that most of Maryland can support. The typical, annual average home range for white-tailed deer is considered about one square mile (640 acres). However, the sex and age of the deer and habitat types will influence varying size home ranges. Yearling males will move many miles while adult females usually have smaller annual home ranges. Deer in good quality habitat will need to travel less than deer in poor quality habitat. During the 2018/2019 hunting season, approximately 77,000 deer were harvested by hunters.

When there are too many animals for the land to support, the competition for food becomes intense. Nutritious foods become sparse, and without adequate diets, deer are small and unhealthy. In areas heavily trafficked by deer, the diversity of plants is often significantly reduced and forested areas are difficult to regenerate when deer damage is high. Forests that survive repeated deer damage develop slowly with widely-spaced trees of low vigor, poor form, and few species.

Wildland Fire

The Maryland Forest Service is mandated by Natural Resources statute § 5-701 with the responsibility for forest fire suppression on all lands within Maryland. During the period between 2009 and 2018, the Maryland Forest

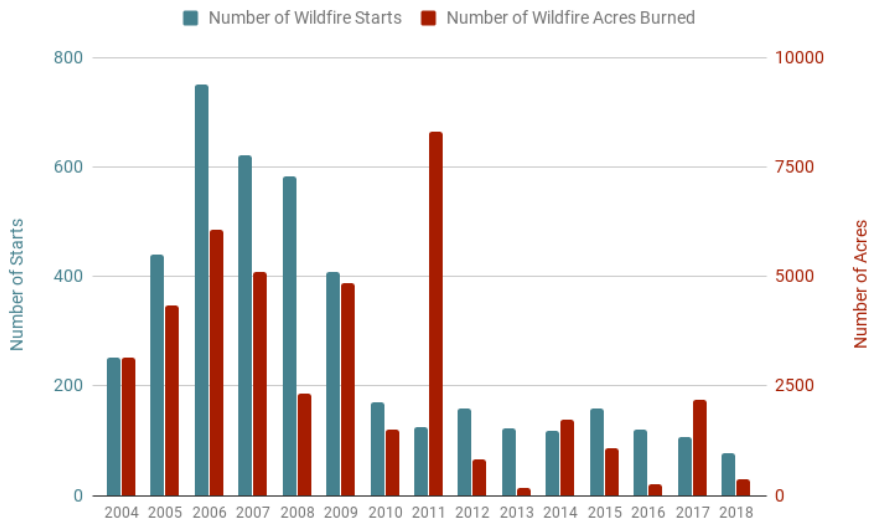


Figure 25 Wildfire starts and acres burned from 2004 to 2018 in Maryland

Service responded to an average of 156 wildfire starts which burned 2,100 acres annually throughout the state (figure 25). In 2018, the Maryland Forest Service responded to 77 wildfires that burned 359 acres. The annual area burned during wildfires peaked in 2011, when 8,310 acres burned during 125 separate incidents. The Maryland Forest Service is the only state agency that maintains specialized heavy equipment for wildfire suppression, but relies heavily on the volunteer and career fire companies throughout the state, for initial attack response for wildfires. To that end, the Maryland Forest Service issues Volunteer Fire Assistance Grants to help departments purchase wildland firefighting equipment, which is funded through the U.S. Forest Service Cooperative Forestry program. In 2018, $104,099 of Volunteer Fire Assistance grants were awarded to 49 departments, in 17 counties throughout the state.

The Maryland Forest Service assists fire companies in training, providing specialized equipment, investigating fire origins, and enforcing laws and regulations pertaining to wildland fires. The Maryland Forest Service concentrates its fire prevention and suppression efforts in the rural and suburban areas. As the suburban fringe increases and people move into forested areas, the complexity of suppressing fires involving both natural vegetation and structures increases. In addition, the chance for human-caused ignitions increases. In Maryland, debris burning is the leading cause of wildfires, accounting for 29%, followed by arson at 23% (figure 26). Remaining fires are caused by lightning strikes, campfires, smoking, equipment use, and railroad operations.

Eastern Shore counties usually have a high number of acres burned annually. The majority of these acres are typically in Dorchester County, where marsh fires are illegally set to aid muskrat and nutria trapping and from a tradition of simply burning the marsh. These fires are monitored and suppressed when they approach structures or forest, and the Maryland Forest Service has had success in reducing and legalizing many of these fires by encouraging landowners to develop a controlled burn plan.

Maryland has large areas of wildland urban interface (WUI) or areas where homes and forest are intermingled. This increases the threat of loss of property even with small wildfires. Need and complexity of wildfire suppression also increases in the WUI. Landowners and

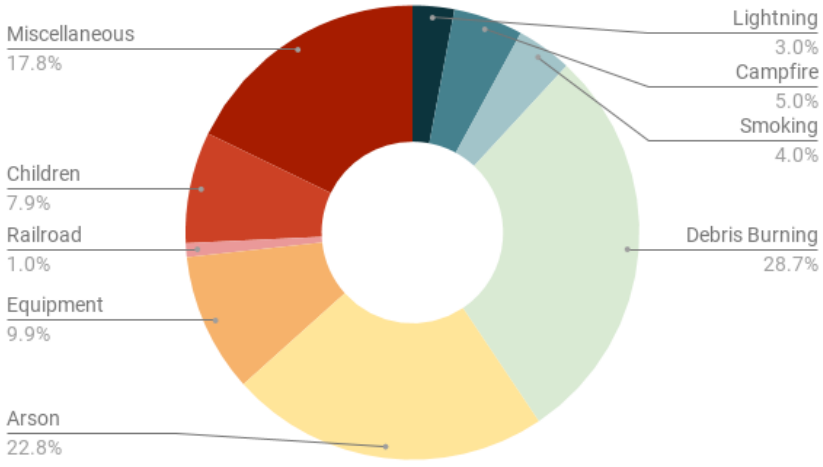


Figure 26 Causes of wildfires in Maryland from 2009 to 2018

homeowners must be aware of the dangers of wildfires and develop and use “Firewise” building and landscaping practices to help reduce the risk to their properties. Keeping forests healthy and thinned can help manage risk across the landscape. High fuel density can result in more severe fires that are harder to control and cause greater ecological damage. Many of Maryland’s forests are adapted to handle low intensity understory fires, but unnaturally high fuel loading and fire intensity can kill even large fire resistant trees.

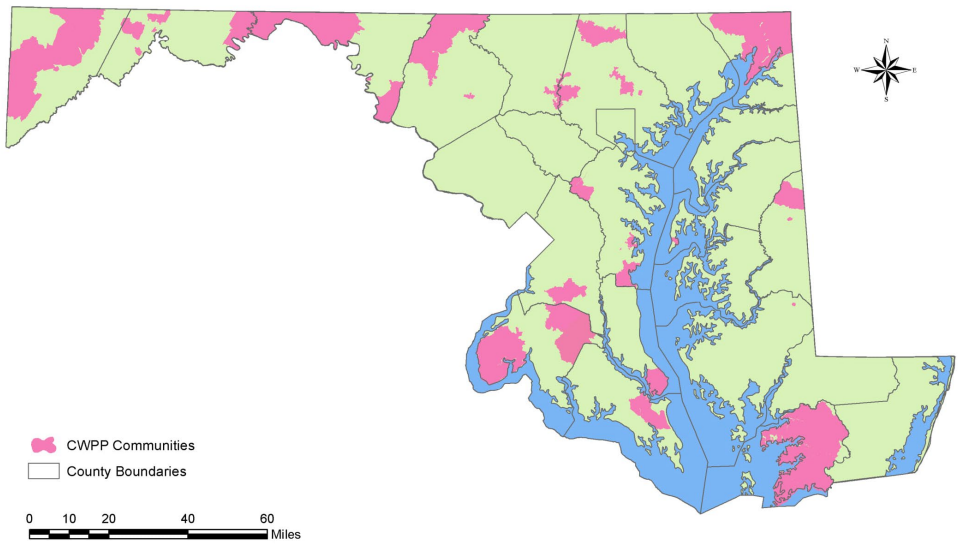


Figure 27 Areas in Maryland with Community Wildfire Protection Plans

Community Wildfire Protection Plans

As wildland urban interface areas continue to increase throughout Maryland, the risk that lives and property will be lost to wildfires is also increasing. The most effective way to reduce this risk is through proactive planning. For this reason, the Maryland Forest Service offers community wildfire protection planning services to qualifying WUI Communities.

A Community Wildfire Protection Plan (CWPP) analyzes the wildfire risk in a community, and helps guide the efforts of the community residents, homeowners association, developers, and the local fire department in mitigating their wildfire risk. This plan is an important step in raising awareness and coordinating community efforts. There are currently 81 CWPPs covering 1180 rural communities, communities located in the Wildland Urban Interface, and government properties across the state (figure 27). These plans have been focused in areas identified in the Maryland Wildland Fire Assessment Atlas as having elevated fire risk.

Dry fire hydrants are non-pressurized pipe systems permanently installed into a water source that permits the withdrawal of water by drafting to provide an available water source for fire suppression via all weather access. They serve as an important tool in fire fighting. As of 2008, Maryland has 419 installed dry hydrants (Table 2)

Table 2 Number of dry hydrants in each Maryland County as of 2008

County	# of Dry Hydrants	County	# of Dry Hydrants	County	# of Dry Hydrants
Allegany	12	Dorchester	23	Queen Anne's	22
Anne Arundel	2	Frederick	36	St. Mary's	22
Baltimore	26	Garrett	30	Somerset	1
Calvert	5	Harford	17	Talbot	4
Caroline	4	Howard	17	Washington	17
Carroll	45	Kent	6	Wicomico	8
Cecil	49	Montgomery	31	Worcester	21
Charles	15	Prince George's	6		

Threats

Imminent Insect Threats

Spotted Lanternfly (*Lycorma delicatula*)

According to the Maryland Extension, on October 25, 2018 the Maryland Department of Agriculture (MDA) confirmed the first sighting of a single adult spotted lanternfly found on a trap in Cecil County. By early 2019, the spotted lanternfly had been detected in multiple additional Mid-Atlantic States (University of Maryland Extension, 2019). First detected in Berks County, Pennsylvania in 2014, the insect is a native planthopper of China, India, and Vietnam, and has spread to 14 other countries, as of 2019. Its preferred host is tree-of-heaven (*Ailanthus altissima*), but it is known to feed on a wide range of plants.

Spotted lanternfly causes damage to plants in two different ways. The nymphs and adults feed on plants using their piercing mouthparts to suck fluids from the stems or leaves. This has been shown to cause stunted growth, localized damage, reduced yields, and, in extreme cases, even death of the plant. Additionally, as the spotted lanternfly feeds, it excretes a sugary substance called honeydew. This honeydew, in addition to being attractive to ants, wasps, and other insects, is readily colonized by sooty mold, which can cause parts of the plants to become blackened, reducing photosynthesis and affecting the quality of the plants.

Forest and orchard trees known to be damaged by spotted lanternfly include almond, apple, apricot, cherry, hickory, maple, oak, peach, pine plum sycamore, walnut, and willow. Additionally, crop plants are vulnerable, including grapes, basil, blueberry, cucumber, horseradish, hops, and potentially others (Maryland Department of Agriculture, 2018).

Spotted lanternfly quarantines are in Cecil and Harford Counties in 2020. It has been found in multiple other counties and is expected to spread throughout the state. I, A nearby infestation in Virginia has the potential to cross West Virginia, and invade Allegany and Washington counties (Cornell College of Agriculture and Life Sciences, 2020). Control efforts include removing the most common host tree, the non-native invasive Ailanthus, leaving male Ailanthus tree with insecticides as trap trees, sticky bands, and direct spray with insecticide, soap, or vinegar. Biocontrol organisms are under study.

Sirex Wood Wasp (*Sirex noctilio*)

The sirex wood wasp was discovered in the Fulton, New York woods in February, 2005 by Dr. Richard Hoebeke in a forest survey trap sample. Since 1985, only eight other wasps had been detected and successfully intercepted by U.S. Customs officials. Sirex is native to Europe and Asia and found its way to North American in untreated crates and shipping products containing viable larvae. The wasp is not considered a threat to its native pines in Europe and Asia, but is considered one of the top 10 most serious forest insect pests worldwide. There are no known reports of sirex wood wasps in Maryland, however the insect has been slowly migrating south from the initial infestation zone around Fulton, NY. The last reported positive identification occurred in Pennsylvania in Potter County in July 2008 (PA DCNR, 2008).

Maryland‘s southern counties and Eastern shore are the northernmost extent of southern pine forest communities. The wasp tends to favor loblolly pine, a tree that makes up a significant amount of the forest in southern and eastern Maryland. The loblolly is a fast growing tree and has been a mainstay of the lumber industry for decades. It is often grown in plantations, planted by hand or naturally regenerated. Therefore the wasp represents a grave concern to the state’s (and nation’s) pine lumber industry. The main threat is not from the wasp itself, but from a fungus (*Amylostereum areolatum*) the wasp inoculates the trees with when reproducing. While this fungus is a nutritious food source for the wasp larvae, it will rapidly kill the tree. Trees planted in plantations often experience 80% mortality. The wasp is capable of traveling up to 100 miles and the infestation appears to be spreading further south at a rate of 5 to 15 miles annually.

Exotic and Invasive Plants

Exotic and invasive plants established in Maryland are threatening forests and other native plant communities, and are widespread, particularly in Central Maryland. Many of these

Removal of invasive species at Patapsco State Park- Stephen Badger/Maryland DNR

plant species were introduced prior to the initiation of federal plant quarantines in 1919 and others have been introduced more recently for landscaping, wildlife habitat, or erosion control. Favorable climate and soil conditions and the absence of competitors to keep them in check are allowing these introduced species to spread to menacing proportions. These invasions alter the structure and composition of the local ecosystem and lead to a reduction in biodiversity and a breakdown of regional distinctiveness.

Many experts feel the proliferation of non-native species is one of the greatest threats to biodiversity worldwide. Once invasive plants gain a foothold they may degrade areas subject to erosion by replacing native grasses with plants that are much less effective at anchoring soil. Invaded areas have increased nutrient leaching, affecting water quality functions. Invaded areas that become a monoculture offer reduced habitat for animals. Since non-native species usually invade from “edges” they cause a major shift of resources to eradication programs in areas with high infestations, typically parks and urban green spaces. Control is often difficult and expensive, and site preparation to remove non-natives is now an initial step in most reforestation and habitat restoration programs in some areas.

While not as obvious or dramatic as the damage caused by insects and diseases, introduced species can dominate forested areas and old fields or other openings, preventing tree regeneration, inhibiting native herbaceous plants, changing visual quality, and reducing recreational use. Some of the introduced exotic and invasive plant species causing problems in Maryland are:

- Norway maple (*Acer platanoides* L.),
- lesser celandine (*Ranunculus ficaria*),
- winged euonymus or burning bush (*Euonymus* spp.),
- porcelain berry (*Ampelopsis brevipedunculata* (Maxim.),
- Asiatic bittersweet (*Celastrus orbiculatus* Thunb.),
- tree-of-heaven (*Ailanthus altissima* (Mill.) Swingle),
- Japanese honeysuckle (*Lonicera japonica*),
- English ivy (*Hedera helix* L.)
- mile-a-minute weed (*Persicaria perfoliata*),
- privet (*Ligustrum obtusifolium),*
- kudzu *(Pueraria montana* var. *lobata*),
- garlic mustard (*Alliaria petiolata*),
- Japanese spiraea (*Spiraea japonica*),
- Japanese knotweed (*Fallopia japonica*)
- multiflora rose (*Rosa multiflora*)

Forest Market Threats

Decline of regional forest product markets is concerning to most stakeholders. In a world economy where the demand for paper continues to decrease, large forest product industries find themselves under increasing pressure to compete.

The paper mill in Luke, Maryland, most recently owned by the Verso Company, and in operation for 131 years, was closed in 2019. This mill had an annual output of 450,000 tons of coated freesheet paper per year (Verso Corporation, 2019), and had provided the region with over 600 jobs. The mill had also provided electricity and waste water treatment for the town (Dance, 2019). The loss of this paper mill also leaves Maryland without a major market for its mill residues and pulpwood. When paper production in Maryland was a thriving industry, a large portion of residues were utilized by paper mills. Without the utilization of mill residues, many of them will end up in landfills at a disposal cost to the mills, instead of being an additional source of income.

Skilled logging operators are a critical part of the labor force and supply chain. They are

A timber harvest- Maryland DNR

an important link between good forestry and careful application in the woods. According to recent surveys, Maryland has regulatory barriers that are deterring business, such as a patchwork of permitting rules that cause confusion.

Loss of log truck labor threatens the ability to manage forests. There is a national decline in the number of people driving log trucks, and the average age of current drivers is increasing. Since trucking is needed in one way or another by most industries, drivers are often attracted to other sectors that offer higher wages. Insurance costs have been identified as a barrier to filling log truck driver needs, as premiums are higher for younger, less experienced drivers. Additionally, the hours driven by truck drivers are more closely (and in some cases electronically) monitored, which is decreasing trips to a given mill in a day (Wilent, 2019).

Other issues of concern for forest industry owners were identified by a 2015 survey conducted by the University of Maryland. Owners indicated that fuel costs were a major barrier, and a reason why many felt their business was worse off now, than five years prior. Distances to markets from production centers only contributed to this feeling by surveyed owners (Tjaden et. al., 2015).

The survey also uncovered supply concerns by many business owners. Chief among them was the ability to secure raw materials long-term. Namely higher fuel costs of suppliers, low availability of raw materials, costly regulations, and costs of production exceeding market prices (Tjaden et. al., 2015).

The Port of Baltimore serves the region by supplying ready access to global trade, but regional forest products are being shut out of that market. The port recently ceased log fumigation operations, affecting the ability to export some products and increasing the supply chain complexity to locate off-site fumigation (MARAMA, 2019). The Port is also the largest importer of raw wood pulp on the east coast, and both import and exports of wood products have increased in recent years (USITC), but the Mid-Atlantic region is seemingly being left out of the benefits of increased exports.

Opportunities

Forest Market Opportunities

Maryland has recently seen a decline in markets for forest products, which in turn has impacted the ability of landowners to sustainably manage their woods. Mill closures around the state in the last 20 years have led to a limited market or no market at all for many timber products. For example, there is currently no reliable market for pine on the Mid-Shore, an area that used to have a thriving pine market. This lack of markets leads to a lack of management, as markets are what make management of woods profitable. It is a very rare landowner that will bear the high costs of forest management out of pocket, and will instead look to and rely upon the value of the products to recover (or profit) from management actions. Without the industry, the work will not happen, and the economy will lose billions of dollars annually. Active markets that support sustainable forest management can also prevent forest conversion to developed land by providing a financial incentive to keep areas forested, thus ensuring that the benefits of forests, like clean air, clean water, and wildlife habitat remain for generations to come. Many landowners would like to keep their land in forest use and sustainable forest management with good markets helps them do that.

There are several opportunities to expand current markets and explore new ones to encourage sustainable forest management. Maryland currently has 74 sawmills, but only 12 of them are of significant size. Maryland could open more sawmills, specifically on the Eastern

Shore and Western Maryland as those regions have an abundance of timber without strong markets. This will likely require supporting access to capital for start-up, as even small mills require around $5 million to start up. Due to the Port of Baltimore ceasing log fumigation operations, there is now an opportunity to find or create a new facility for log fumigation. Typically, in order for logs to be exported internationally they need to be fumigated, so reopening this industry will allow Maryland and other Mid-Atlantic States to participate in more timber exports. This will likely also require supporting access to capital, as the necessary machinery is expensive.

There are also opportunities to increase Maryland's forest product output to support other major industries in the state. Maryland's poultry industry is incredibly important for the economy. The industry relies on the forest product industry and vice versa; the forest products industry provides sawdust and wood shavings for animal bedding, and the poultry industry provides a market for timber products. The horse industry is another important economic sector that relies on animal bedding made from forest products as well. There are opportunities to open more wood shaving facilities in central Maryland and the upper shore to maintain these industry relationships and expand the utilization of Maryland's timber products.

Expanding forest products used in the energy sector will help fill a gap left by declining markets and utilize underutilized wood products. Maryland's only paper mill closed in June 2019, and the paper pulp market in the state is not likely to rebound in the near future (Dance, 2019). This leaves a gap in the demand for pulpwood, which could potentially be filled with biomass for heat and power. Other sources of wood for biomass energy include forest residues, products of thinnings, low quality wood, and urban tree waste; expanding utilization of these products will make the forest and tree management that produces them more profitable. In addition to expanding forest product markets, wood energy is renewable and can help reduce reliance on fossil fuels. While burning wood releases carbon, that carbon is quickly reabsorbed as new trees grow in place of the removed ones (compared to fossil fuel reveres, which take millennia to replenish). Given the price of other energy sources and Maryland's current fuel supply, it is unlikely that any large scale, electrical biomass facilities will be feasible. However, small to moderate scale thermal and combined heat and thermal (CHP) projects in residential, commercial, and institutional locations could provide a market for low quality wood.

Wood pellets

Utilizing biomass for thermal energy can also help small landowners accomplish their silvicultural goals. Many landowners can utilize the wood produced from timber stand improvement to heat their homes. While this does not participate in larger markets, it provides incentives to sustainably manage forests and will lower heating energy costs. Incentives are available for fuel-efficient, clean-burning wood stoves that take advantage of renewable energy and limit pollution concerns with older technology.

Some sites that utilize thermal wood energy use wood pellets instead of wood chips. Wood pellets are usually made from sawdust, a common residue at timber processing facilities, and are more energy dense and provide more consistent heat than wood chips. Currently there are no wood pellet facilities in Maryland; most of the sawdust produced here is used for animal bedding or sent to out of state wood pellet facilities. Opening wood pellet facilities in Maryland would help keep energy dollars in the state and increase the market for sawdust.

The use of woody biomass for energy and heat could also be expanded by increasing use of combined heat and power (CHP) operations in commercial and institutional locations. CHP systems can function by either combusting fuel for electricity or thermal needs, then using the leftover heat for the other function.

It is more efficient than using energy from the grid and producing thermal energy separately, and can reduce energy operating costs. CHP can be fueled by biomass, coal, natural gas, or waste, with natural gas as the current most common source. A 2016 technical study by the U.S. Department of Energy identified 4,920 sites in Maryland with the potential to utilize CHP, including 585 industrial sites and 4,330 commercial sites (e.g. schools, commercial office buildings, hospitals, etc.) These numbers represent potential for CHP fueled by any source, not just biomass, and therefore do not take into account Maryland's supply and markets for biomass. However, they do demonstrate that there is high potential for technology than can efficiently utilize woody biomass.

Many of the current and future wood product opportunities rely on utilization of residues. In addition to their utility, residues are significant sources of revenues, and in the case of sawmills the residues are very often the only sources of profits. Regardless, each of the wood manufacturing enterprises, no matter what product they make, are all selling their various forms of residues. If their respective residues are excluded from markets, they incur great additional costs and will be forced to dispose of their residues in landfills. Strategies and policies that advocate the use of wood residues will help encourage sustainability of forest practices by producing less waste, and will stimulate growth in important sectors like renewable energy.

Tree Planting Opportunities

Since 2006, the state of Maryland has planted 16.9 million trees though several different programs (figure 28). There are opportunities to expand tree planting efforts in Maryland. Of the 17,000 miles of stream in the state, only 56% are considered fully buffered. Maryland has a goal of 70% of streams being fully buffered, so the unbuffered and partially buffered streams provide opportunities for more tree planting. There is potential for a state or Bay-wide program, particularly to complement the major cost share program led by the Conservation Reserve Enhancement Program (CREP).

Private lawns are another opportunity for tree planting and the Maryland DNR has programs to assist landowners with this. Healthy Forests, Healthy Waters Project, which is funded by the State Chesapeake Coastal Bays Trust Fund, and Maryland's Lawn to Woodland program both aid private landowners with planting trees. Tree planting can also be used to strategically reduce forest fragmentation by identifying forest patches that are close to each other with suitable land for trees between them. Planting trees in these areas will combine the adjacent forest patches, reducing forest fragmentation.

Urban Forestry Opportunities

Maryland is also looking to expand its urban tree cover and recognition. Programs like Tree-Mendous, Marylanders Plant Trees, and Backyard Buffers all provide resources to help local governments, communities, and individuals plant trees. Expanding these programs will help continue to provide Marylanders with urban tree benefits like improved air and water quality and reduced heat island effect. The Arbor Day Foundation's new program, Tree Campus Healthcare, recognizes healthcare facilities that

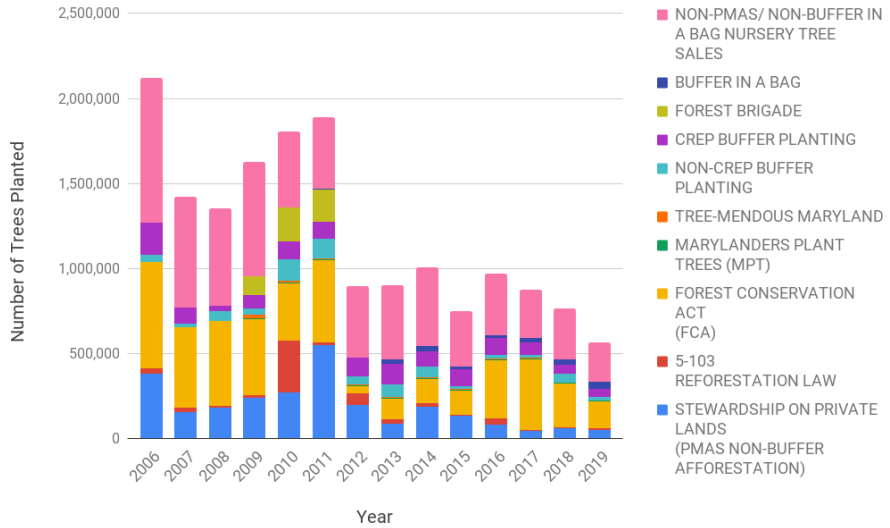


Figure 28 Trees planted in Maryland annually from 2006-2019 by the various state programs

impact community wellness through tree education, investment, and community engagement. There is currently one veterans' hospital recognized as a Tree Campus Healthcare facility in Maryland. There are opportunities to get more healthcare facilities recognized by the Arbor Day Foundation, while taking advantage of improved healthcare outcomes people experience in forests and greenspaces.

There are also opportunities to utilize biochar and incorporate it into the urban wood waste stream. Biochar is a carbon rich substance that is created through the process of pyrolysis or gasification, where organic material is heated in the total or partial absence of oxygen. It can be sourced from different kinds of organic materials such as poultry litter, leaves, and wood. When added to the soil it can provide many benefits including increased nutrient retention, water infiltration, and further climate stability through being greenhouse gas (GHG) neutral and potentially GHG negative (International Biochar Initiative, 2018).

In Baltimore, the U.S. Forest Service field station is supporting exploration of a biochar soil amendment as part of vacant lot greening. Researchers at the University of Maryland's Environmental Finance Center (UMD EFC) and the U.S. Forest Service are working on a literature review and basic cost benefit summary of using biochar generated from wood waste. The U.S. Forest Service is looking into potential sources of wood waste in Baltimore, such as fresh cut or businesses that produce wood waste. The UMD EFC has multiple projects, current and past, that look at waste management systems that have potential to supply marketable products like biochar.

Utilizing biochar sourced from urban wood waste prevents that waste from entering landfills and also provides a useful material. One of the potential uses of biochar is reducing stormwater runoff, as biochar improves water infiltration in soil. This could lead the Maryland Department of the Environment or the Chesapeake Bay Program to credit practices that use biochar as increasing reductions in stormwater or addressing total maximum daily loads (TMDLs) .

While this project is currently focused in Baltimore, there are potential opportunities to utilize biochar sourced from wood waste throughout Maryland and the Chesapeake Bay Watershed as a tool to reduce stormwater and nutrient runoff. However the uses of biochar are limited by approved crediting from the Chesapeake Bay Program. The Bay Program has not yet evaluated or approved biochar under the Bay Program's expert panel process and it is not currently eligible for credit in the Woodland Incentive Program (WIP). However, Maryland has supported research into the use of many soil amendments and medias, including biochar (MDE, 2019)

Another emerging resource being developed by the UMD EFC aims to standardize the return on investment in urban and community forestry resources. The project will provide an assessment methodology to inform investment decisions by private, public and nonprofit urban forestry stakeholders. A universally accepted accounting framework to holistically measure the benefits and costs of urban and community forest resources does not exist. The design principles of this project emphasize standardization, replicability and transparency to develop an accounting system via asset management with potential to align benefits for a return on investment.

Prescribed Fire

There are also opportunities to continue increasing the use of prescribed fire in many of Maryland's ecosystems. Prescribed fire is an important tool to help restore landscapes that historically experience frequent fires. It reduces fuel loads and improves seedbed conditions, which can encourage germination and growth of fire dependent plants, and aid in nutrient cycling, all under controlled conditions. From the period of 2009-2019, Maryland averaged 55 prescribed burns on 1214 acres annually (figure 29). This includes burns completed by the Maryland Forest Service, partner agencies and other cooperators (TNC, contractors, private landowners).

These numbers have been relatively consistent over this time period, but in 2019 the area burned with prescribed fire was 2,332 acres, almost double the average from 2009 to 2019. This could partly be due to having favorable weather this past spring and fall to get more burns completed, but also in part to more partners

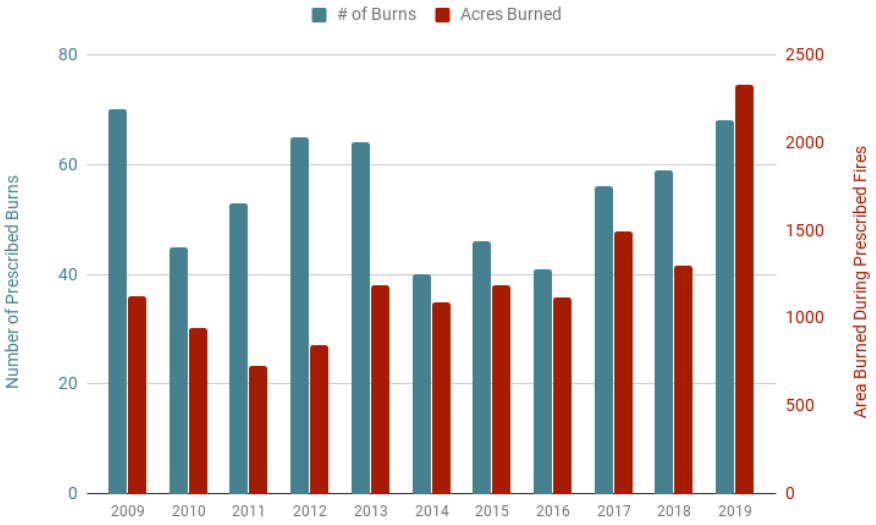


Figure 29 Number of and area burned with prescribed fire in Maryland from 2009 to 2019

starting to see the benefits of prescribed fire as a land/habitat management tool.

Conservation Opportunities- Forest Legacy Program

Conserving large, intact, healthy forests assures that the many environmental, economic, and societal benefits they provide will persist well into the future. However, many forests are at risk of being converted into non-forests uses as populations grow and development expands. As 72% of Maryland's forest cover is privately owned, conservation easements are an integral part of maintaining forests.

The Forest Legacy Program (FLP) protects working forests on private land. It is a voluntary program administered by the U.S. Forest Service in partnership with states to protect important forested areas that are threatened for conversion to non-forest uses. FLP provides funds for conservation easements or fee simple purchases of forest lands at fair market value to interested landowners who meet the program requirements. Maryland, where FLP is administered by the Maryland Forest Service, has acquired easements for 2,014 acres of forests as of 2019.

In order for a landowner to participate in the FLP, their land needs to be in a state designated Forest Legacy Area (FLA). FLA's are forests in the state which have high economic, environmental, and societal importance and are threatened by conversion to non-forest use or fragmentation. FLA's are identified in the FLP Assessment of Need (AON) through GIS analysis which can be found as an appendix on the SFAP Strategy. The 2020 AON identified 2,337,413 acres of land in Maryland as Forest Legacy Areas, a 3% increase from the 2013 report (figure 30). These areas present future opportunities to expand conservation of Maryland's private forests. The Forest Legacy Program coordinates with Maryland's other land conservation programs, including Program Open Space, the Rural Legacy Program, and the Maryland Agricultural Land Preservation Foundation, all of which include forest land.

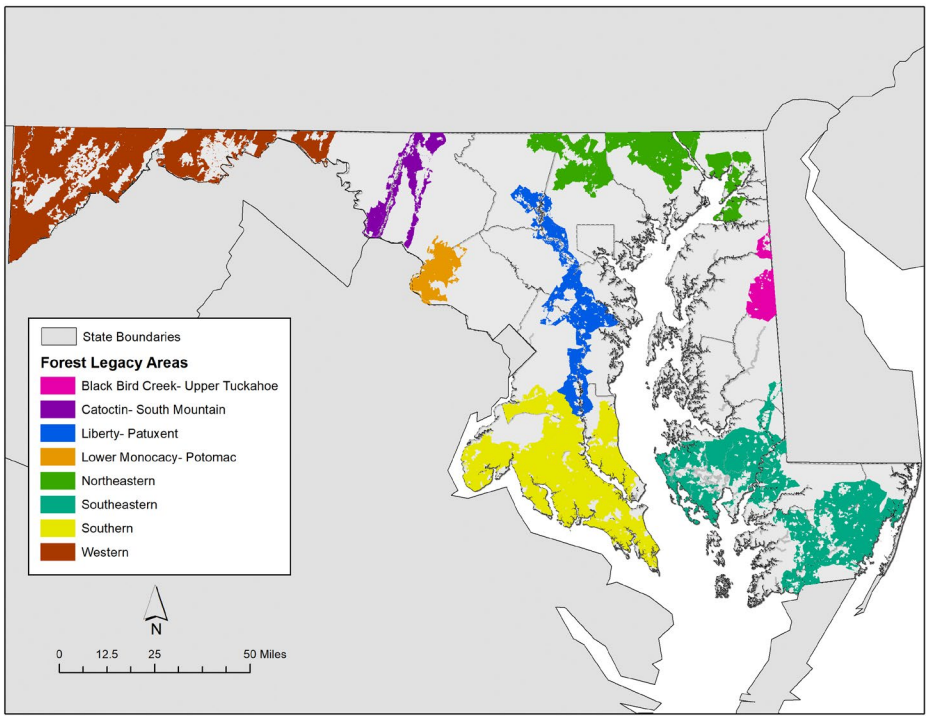


Figure 30 FLA areas

Priority Landscape Areas in the State

Protecting Forests from Harm: Wildfire

The Protect Forest From Harm (PFFH) Wildfire Priority Map is designed to highlight areas of the state where wildfire is historically prevalent, has the potential to cause great harm to people and property, and where fuels and other conditions can increase the likelihood and intensity of wildfire. This priority area was identified by creating a weighted sum model that combines the data sources:

- Maryland Forest Service Wildfire Response Locations for 2005 to 2018.
- University of Wisconsin SILVIS Lab Wildland Urban Interface model results for "intermix" and "interface" areas of Maryland.
- Wildfire Hazard Potential Model (2018 version) created by the U.S. Forest Service, Rocky Mountain Research Station.

The resulting PFFH: Wildfire map (figure 31) shows the top 60% of the weight sum of the above data.

The Maryland Forest Service responds to wildfires across the state as the primary responder, or to assist local fire agencies to provide assistance. These activities are recorded and the location plotted to show areas with the greatest activity.

The University of Wisconsin SILVIS Lab published a study of areas known as Wildland Urban Interface for every state. Using US Census data for the number of households in a given area and the type of vegetation, the SILVIS Lab can locate areas where uncontrolled wildfire would be devastating to communities. For instance, the 2018 Camp Fire in California, which destroyed thousands of homes and killed dozens of people in the city of Paradise, is located in a wildland-urban interface (WUI) area. Knowing where these fires can occur and have the most impact to communities is a critical part of prevention.

It is also critical to know the types of fuels that exist in an area that can carry and sustain wildfires, and affect the intensity. The U.S. Forest Service Rocky Mountain Research Station created a nationwide map of these areas where it would be difficult for suppression resources to contain fires. The Wildland Hazard Potential map that resulted is classified into low to high values of fuels; the highest values represent a higher

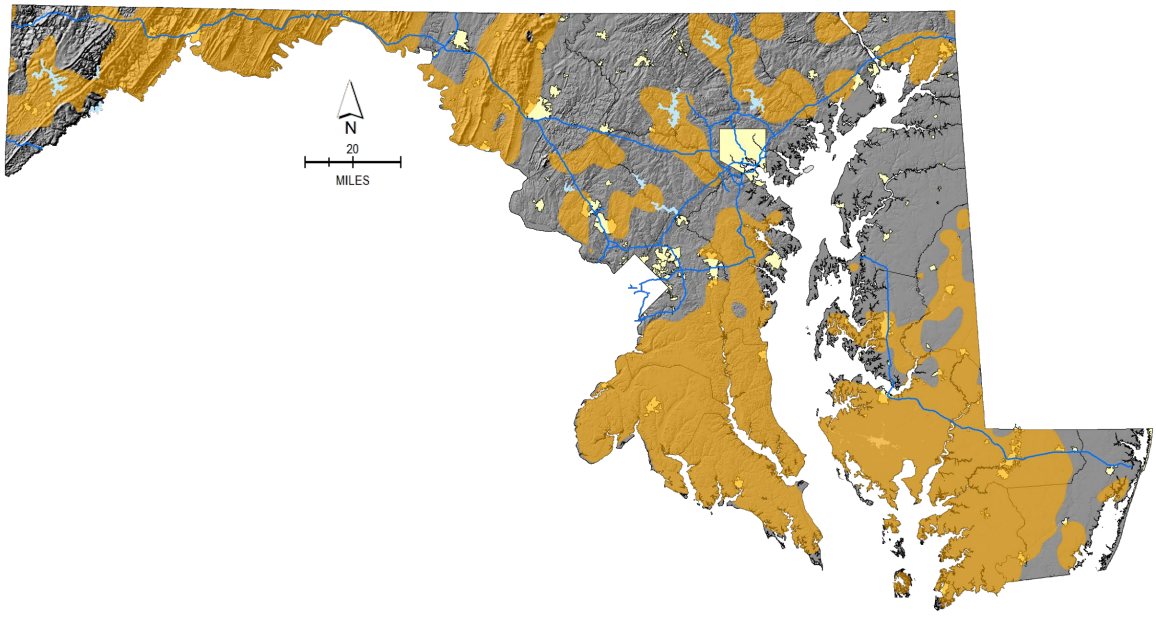


Figure 31 The Protect Forest From Harm (PFFH) Wildfire Priority Map

probability of torching, crowning, and other extreme fire behavior under conducive weather conditions.

Protecting Forest from Harm: Forest Health

The Forest Health Priority Map provides insight into how Maryland's forest threats are diverse and wide-ranging. These threats present a challenge to managers and landowners alike, and are exacerbated by climate change. Four current data sources from the Maryland Department of Agriculture (MDA) and the U.S. Forest Service were available to create a weighted sum model that combines data. These data inputs are:

- MDA Historic Gypsy Moth Treatment Areas.
- MDA Saltwater intrusion areas causing tree mortality.
- MDA Hemlock Treatment Stands
- U.S. Forest Service, Forest Inventory and Assessment (FIA) Estimated Basal Area Loss 2013 to 2027.

The resulting PFFH: Forest Health map (figure 32) shows the top 50% of the weight sum of the above data.

MDA Historic Gypsy Moth Treatment Areas depict areas in the state which are high-priority forests that have been defoliated by Gypsy moths or have had suppression activities completed on them for over three years, or both. Most of the priority areas in central and western regions of the state have had high Gypsy moth activity.

Saltwater intrusion areas began to take a toll on forests on the Eastern Shore over the last ten years. This is due to rising sea levels and land subsidence. MDA specialists conducting aerial forest health surveys began noticing ever increasing areas of forest mortality, and could not determine the cause until a closer inspection revealed elevated salt in the water table. These "ghost forests" are only expected to increase over time, but the data represented here is from 2010 to 2019.

Hemlock Wooly Adelgid is a small insect that feeds on the sap of the hemlock tree, and can often cause mortality. Sadly, many of Maryland's oldest trees are hemlock, and treating them for future generations has been a priority for several years. These treated stands account for much of the priority areas in central and western Maryland.

The U.S. Forest Service Percent Projected Forest Basal Area Loss dataset from the Forest Service, Forest Health Protection Program shows the projected percentage loss of

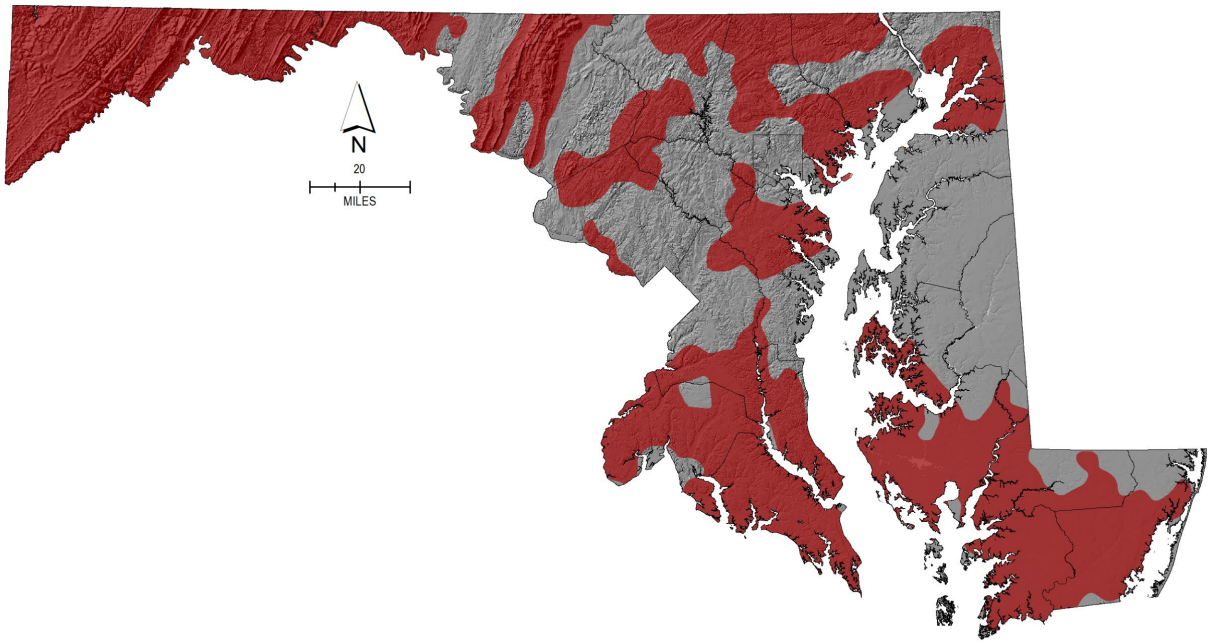


Figure 32 The Protect Forest From Harm (PFFH) Forest Health Priority Map

total basal area from all forest pests and pathogens, assuming no remediating management, over the 2013-2027 time frame. The highest loss is expected to occur in western Maryland.

Conserve Working Forests

The Conserve Working Forests Priority Areas highlights forested areas of Maryland that have sustained large forest patches, and the industries that utilize them, for decades. These areas are critical to maintaining a robust forest industry in the state, which even today provides thousands of jobs and millions of dollars in payroll and tax revenue. These areas face pressure from development, insect and disease invasion, and challenging regeneration from high deer populations.

To determine where these areas still exist in the state, the following two datasets were used to create a weighted sum model:

- Maryland Forest Service Density of Forest Stewardship Plans, 2003 to 2018.
- Density of Large Forest Patches.

The resulting CWF map (figure 33) shows the top 50% of the weight sum of the above data.

Maryland Forest Service foresters are writing management plans across the state and entering the information into a U.S. Forest Service database in a national effort to help determine how much stewardship is occurring in privately owned forests on the landscape. The locations of these plans and the size of the acres under stewardship were plotted to locate stewardship acres/square mile “hotspots” in the state—where is forest management occurring most frequently over time.

The size of forest patches is also an important consideration for conserving working forests, as more management is likely to occur in areas with large forest blocks. Forest cover was estimated from a high-resolution tree canopy layer from an analysis completed by the Chesapeake Conservancy for 2013. Forest was considered to be any tree canopy at least 1 acre in size, at least 120 wide and 343 feet long, and not within 30 feet of a structure in rural areas or 80 feet in urban areas. Finally, the blocks fifty acres or greater in size were plotted and a point density analysis was used to estimate the number of blocks/square mile.

The two density analysis data layers were combined to locate areas representing actual stewardship and potential stewardship. Working forests are likely to occur where high values were common to both layers.

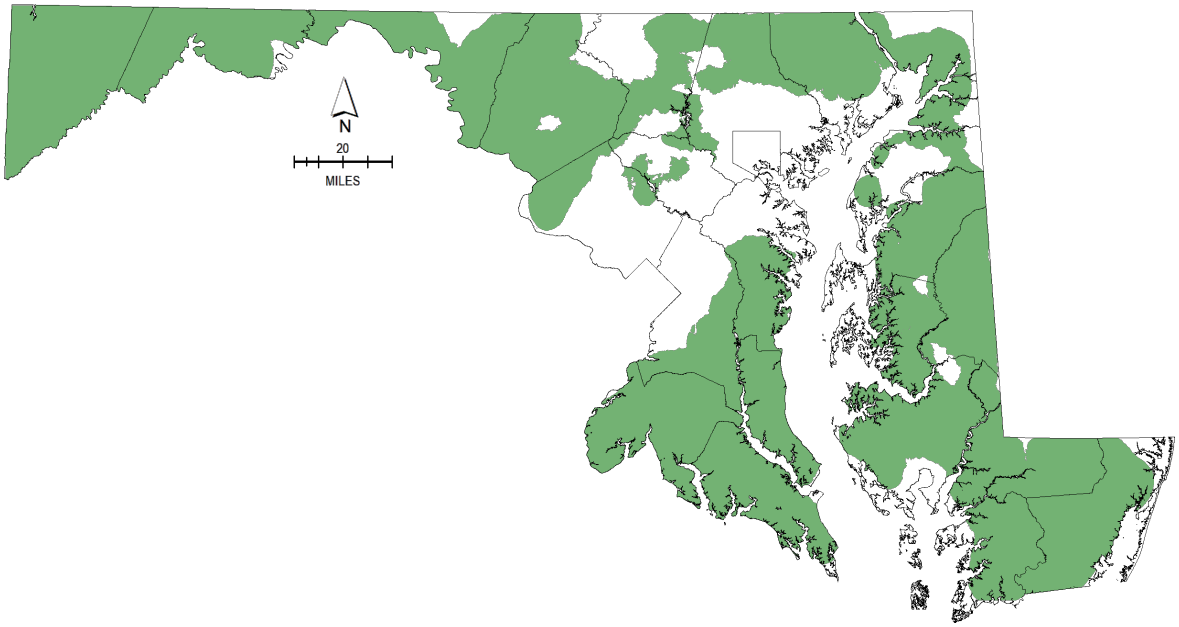


Figure 33 The Conserve Working Forests (CWF) Priority Map

Trees and Forests Providing Benefits to Society

Numerous studies have focused on the values trees provide to homeowners and urban areas. Everything from the reduction of crime, to the saving of building cooling costs, to water filtration, to lowered incidences of asthma; all have been linked to the number of trees in the area. Increasing the number of trees to benefit society is a primary goal of the Maryland Forest Service, and locating the best places to implement and focus tree planting efforts that directly benefit Marylanders is more difficult than one would think. In urban areas, there are houses, schools businesses, parking lots, roads, and other impervious surfaces that have pushed the natural tree canopy to the fringes. At the same time, these impervious surfaces are critical to supporting the large populations usually found in urban settings, thus complicating the process of locating places to increase tree canopy. Like the other priority areas, the Tree and Forests Providing Benefits to Society Priority Map shows the locations of the state where urban forestry is practiced, trees are planted singly or in small groups often by landowners, and natural forest patches are small, in need of conservation, and may have serious vine and invasive plant infestation. Programs such as the Lawn to Woodland or the Backyard Buffers programs have found success in urban and suburban neighborhoods. The priority areas are composed from four data layers merged together to create the priority areas, and no model or analysis was used. There layers are:

- Maryland Municipalities
- I-95 Corridor Counties
- Maryland Priority Funding Areas
- US Census Bureau Urban Areas, 2010

There are 157 municipalities in Maryland, all with some form of local government, and some have planning and zoning authority. Several have also undertaken urban tree inventories in an effort to understand where trees are located, what are the species of tree, and a rough estimate of tree health. In many municipalities, tree maintenance is occurring, and thought is being given to how tree canopy can be replaced or increased.

The I-95 corridor is one of the most densely populated areas in North America, and has been identified as a multi-state priority by several states in the U.S. Forest Service's Eastern Region, also making it a state priority. The counties in Maryland that contain I-95 were added to this layer, but also included Charles County, which has experienced rapid development in recent years.

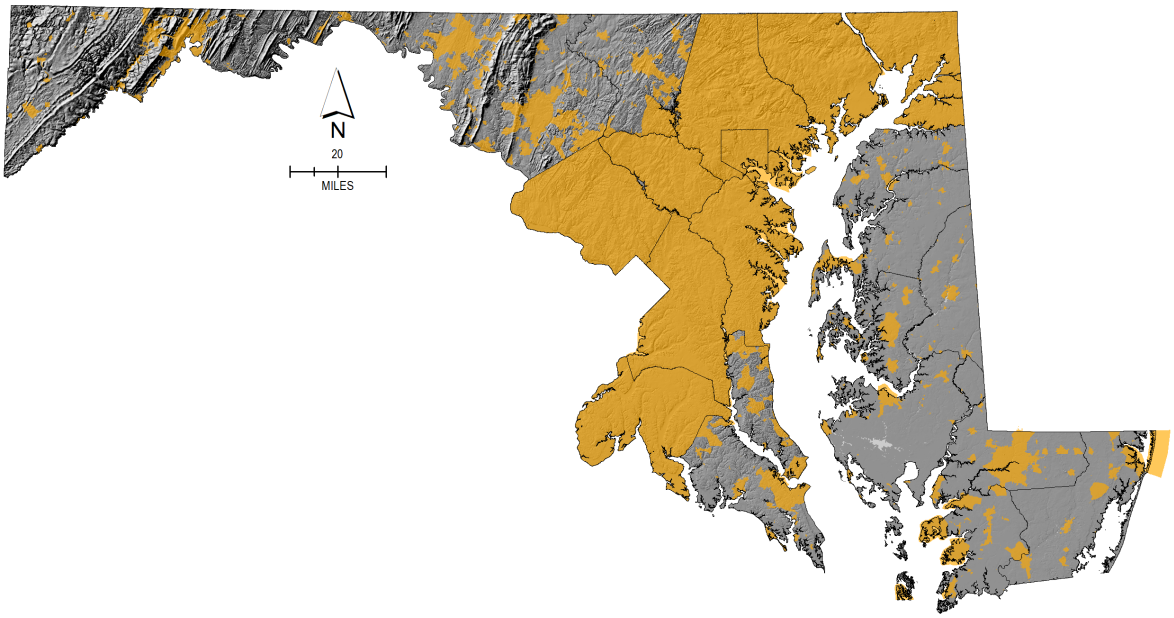


Figure 34 The Trees and Forests to Benefit Society Priority Map

Maryland Priority Funding Areas were included as they focus state funding for growth related infrastructure, providing a geographic focus for state investment in growth. Growth-related projects include most state programs that encourage development, such as highways, sewer and water construction, economic development assistance, and state leases or the construction of new office facilities.

US Census Bureau Urban Areas are based on populations from the decadal census which defines an urban area as any incorporated place or census designated place with a population of at least 2,500 and less than 50,000 people. These areas are geographically created from Census Blocks, one of the geographic designations that identifies where actual census data is collected from people.

Multistate Priority Areas

The Chesapeake Bay

Parts of New York, Pennsylvania, West Virginia, Delaware, Maryland, Virginia, and the entire District of Columbia make up the 64,000 square miles of land that drain into the Chesapeake Bay. The Chesapeake Bay watershed provides drinking water, natural resources, food, employment, and recreation for its 18.2 million residents and also serves as an important habitat for many plants and animals (Chesapeake Bay Program, 1995).

Some of the major issues affecting this watershed are forest loss, pollution, and sedimentation. Prior to European settlement, 95% of the watershed was forested (Chesapeake Bay Program, 2020). The forest surrounding the Bay, especially riparian buffers, captures rainfall, traps pollution in runoff, stabilizes soils, and improves air quality. Clearing land for agriculture and timber in the 19th century removed 40 to 50% of the forests in the watershed. While portions of the land became naturally reforested when farms were abandoned, these forests are more homogenous than pre-settlement forests. The watershed lost an additional 750,000 acres of forest in the last 20th century due to land development. As of 2006, the rate of forest loss to development is 70 acres a day. In addition to forest loss, 60% of the watershed's forests are fragmented, which makes them less resilient to disturbances (Chesapeake Bay Program, 2020). The loss and fragmentation of forests, in conjunction with other land uses practices (e.g. agriculture runoff), has led to an increase in sediment and nutrient pollution in the bay. The excess sediments and nutrients harm water quality and the organisms in and around the bay (Chesapeake Bay Program, 2020).

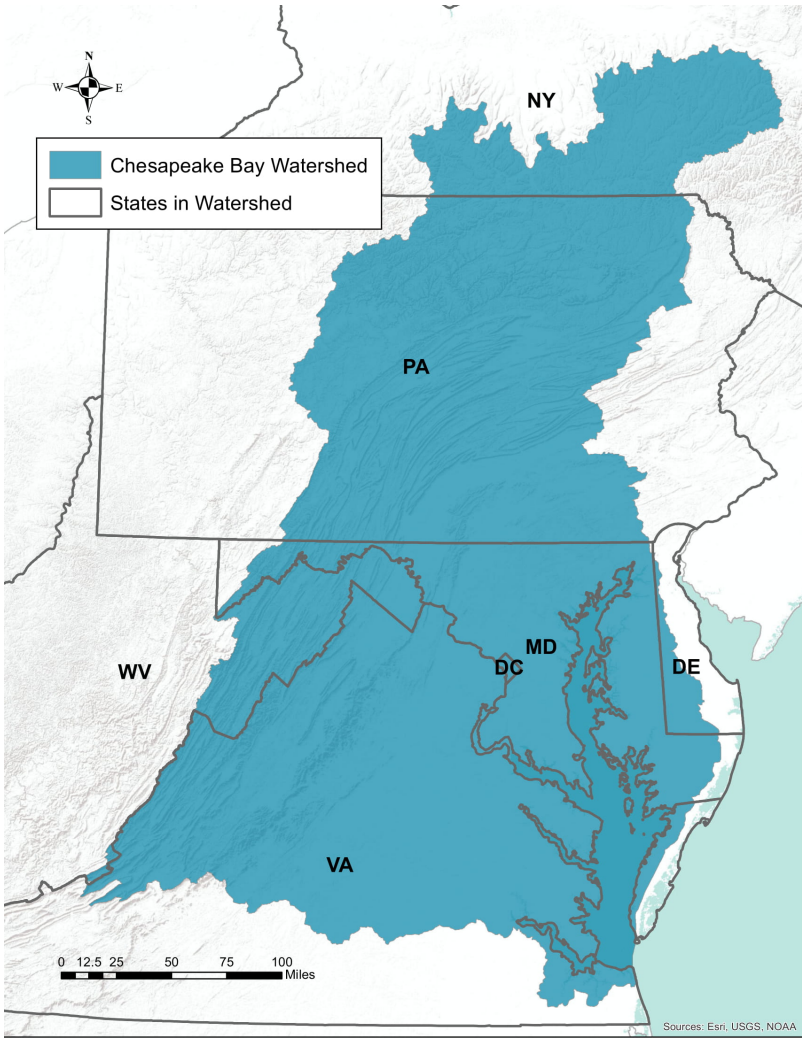


Figure 35 Map of the Chesapeake Bay multi-state priority area

There are many opportunities for multi-state collaboration to restore the Chesapeake Bay. The state of Maryland, along with all the other states and territories in the watershed and several federal agencies, academic institutions, NGO's, and local organizations from all over the watershed are partnered with the Chesapeake Bay Program, which has led and directed the restoration of the Chesapeake Bay since 1983 (Chesapeake Bay Program, 2020). One of the main restoration goals for the bay is to plant forest buffers, as they are one of the most effective ways to restore water quality and habitats. Approximately 69% of the 288,000 miles of stream bank and shoreline in the Chesapeake Bay watershed have forest or wetland buffers, and since 1996, 9,000 miles of forest buffer have been planted in the watershed (Chesapeake Progress, 2018).

There are continuing opportunities for reforestation as an additional 1.4 million acres of streamside land has been identified as potential sites for forest or wetland planting. The goals set forth by the Chesapeake Bay Management Strategy include a minimum of 70% of riparian areas with forest or wetland buffers and for 900 miles of buffer to be planted each

year. For more detailed information on reforestation goals and progress, see the "Riparian Forest Buffer Outcome Management Strategy for 2015-2025", published though the Chesapeake Bay Program.

Delmarva Peninsula and Mid-Atlantic Coastal Plain

The Mid-Atlantic Coastal Plain covers southern New Jersey, all of Delaware, Maryland's eastern and western shores, and the eastern shore of Virginia. It is bordered by the Atlantic Ocean to the East and the Piedmont to the West. This includes the Delmarva Peninsula, which sits between the Delaware Bay, the Atlantic Ocean, and the Chesapeake Bay. The Delmarva Peninsula is the home to the previously federally endangered (delisted in 2015) Delmarva fox squirrel. The peninsula is an extremely important migratory route in the fall for southbound birds. Over 10 million birds pass through the area each year, using it as a stopover to rest and eat (Audubon, 2013). It also provides important breeding habitat for wintering species. The Mid-Atlantic Coastal Plain houses nearly 1,000,000 hectares of wetlands which provide wildlife habitat, support unique plant communities, mitigate storm effects, and improve water quality. Some of the unique and important plant communities found in this region include Atlantic white-cedar forests and the Delmarva bays.

Land development and fragmentation poses a threat to much of the area's habitat. From 1996 to 2006, the Mid-Atlantic Coastal plain lost approximately 40,000 acres of wetlands, with conversion to agriculture accounting for 48% of that loss (U.S. EPA, 2015). Southern pine beetle (SBP) and spotted lantern fly are two pest threats facing the area. SPB has been found in southern Maryland and on the Eastern Shore, and its northernmost extent is in southern New Jersey. Spotted Lantern was found in Cecil County Maryland in 2018, and as of 2019 has been detected in multiple other Mid-Atlantic States (University of Maryland Extension, 2019). Climate change and its resulting sea level rise also pose threats to the area. It is predicted that the sea level will rise between 1.2 and 4.2 feet by 2100, depending on the amount of emissions reductions achieved (Boesch, 2018). Some of the effects of sea level rise include shoreline erosion, deterioration of tidal wetlands, saltwater intrusion, more frequent high-tide flooding, and tropical storm surges spreading further inland. Saltwater intrusion can kill trees, depending on their tolerance, and turn once productive agriculture land unfarmable.

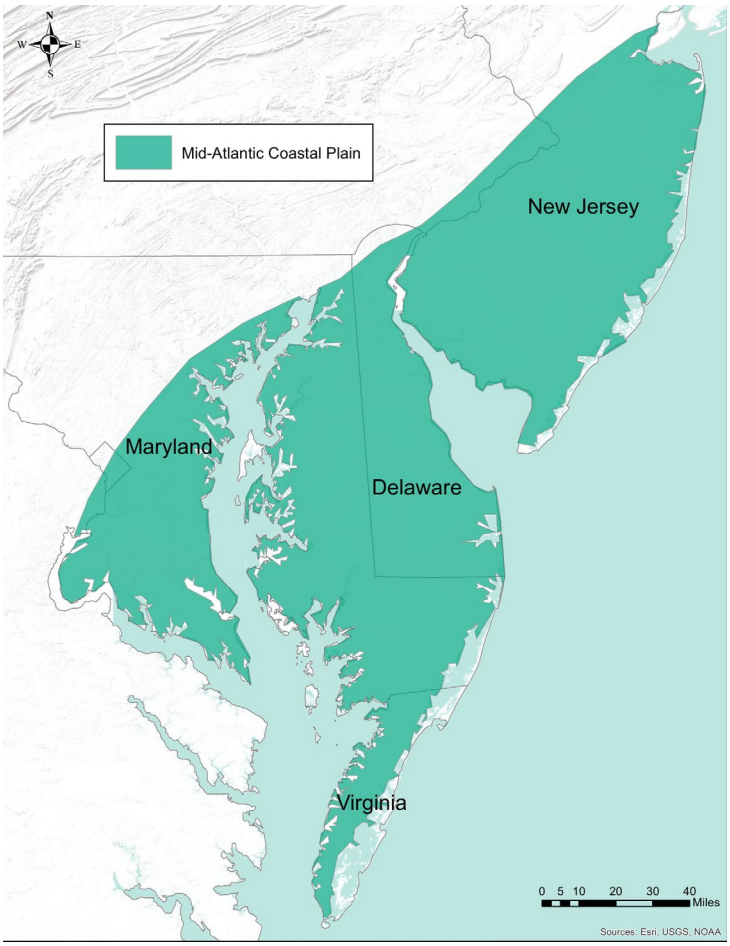


Figure 36 Map of the Delmarva Peninsula, Mid-Atlantic Coastal Plain multi-state priority area

Maryland will continue to partner with other states in the area through the Northeast-Midwest State Foresters Alliance and the Mid-Atlantic Cooperative Forest Health group to identify and plan for threats happening in the area.

I-95 Corridor

The I-95 corridor spans from Maine to Florida, encompassing 1,917 miles and passing through 15 states and the District of Columbia, including 109 miles in Maryland. I-95 connects

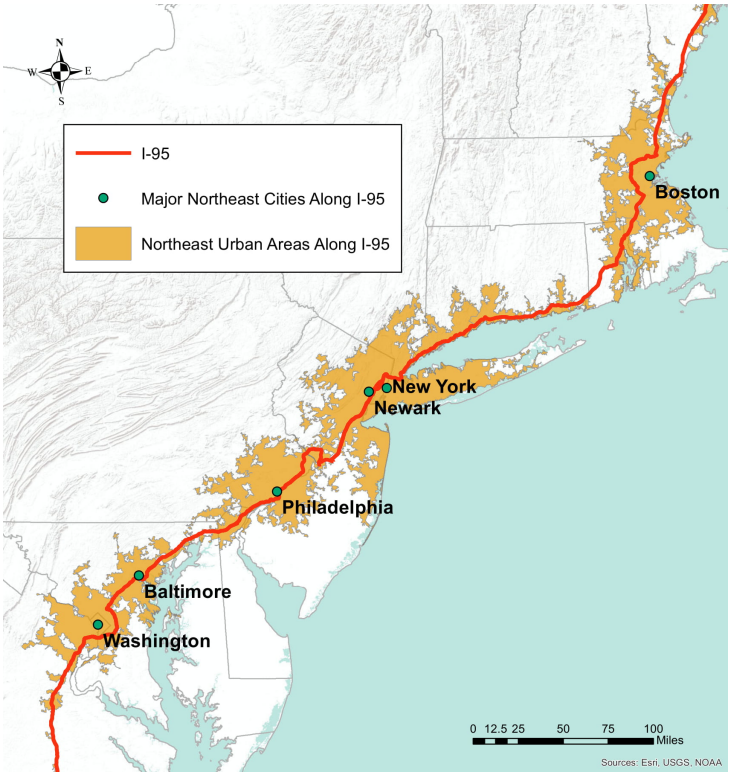


Figure 38 Map of the I-95 multi-state priority area

Boston, New York City, Philadelphia, Baltimore and Washington D.C. - densely populated, major metropolitan areas that make up the Northeast Megaregion.

Watersheds that intersect the corridor face threats from heavy use, dense population, and highway expansion. The heavy use and connectivity the corridor creates increases the potential to spread invasive plants and pathogens. The highway and the development that surrounds it have removed and fragmented forests. Fragmented forests are less effective at supporting wildlife populations and have reduced air, soil, and water quality benefits when compared to unfragmented forests.

There are opportunities for reforestation and promoting urban tree health along the I-95 corridor. The benefits from reforesting urban areas, like the many that I-95 passes through include improved air and water quality, a reduced "heat-island effect," reduced heating and cooling costs, and improved aesthetic value.

Appalachian Mountains

The Appalachian Mountains stretch from Alabama to Maine and include Maryland's three most western countries (Garrett, Allegheny, and Washington) in the Central Appalachian region. Central Appalachia includes the headwaters of the Potomac, which provides drinking water for the D.C. metro area. The region also has high biodiversity and provides habitat for 200 globally rare plants and animals.

One of the unique communities that provides habitat to several rare species are red spruce forests, which are at their southernmost extent in Central Appalachia. The Nature Conservancy in partnership with the Central Appalachian Spruce Restoration Initiative, and other organizations, including the Maryland Department of Natural Resource, have been working to restore Central Appalachian red spruce forests in western Maryland and West Virginia since 1996; as of August 2019, they have planted 99,000 red spruce seedlings (The Nature Conservancy, 2019). Some of the sites include Sharp's Knob, Cheat Mountain and Canaan Valley in West Virginia, Cranesville Swamp on the border between West Virginia

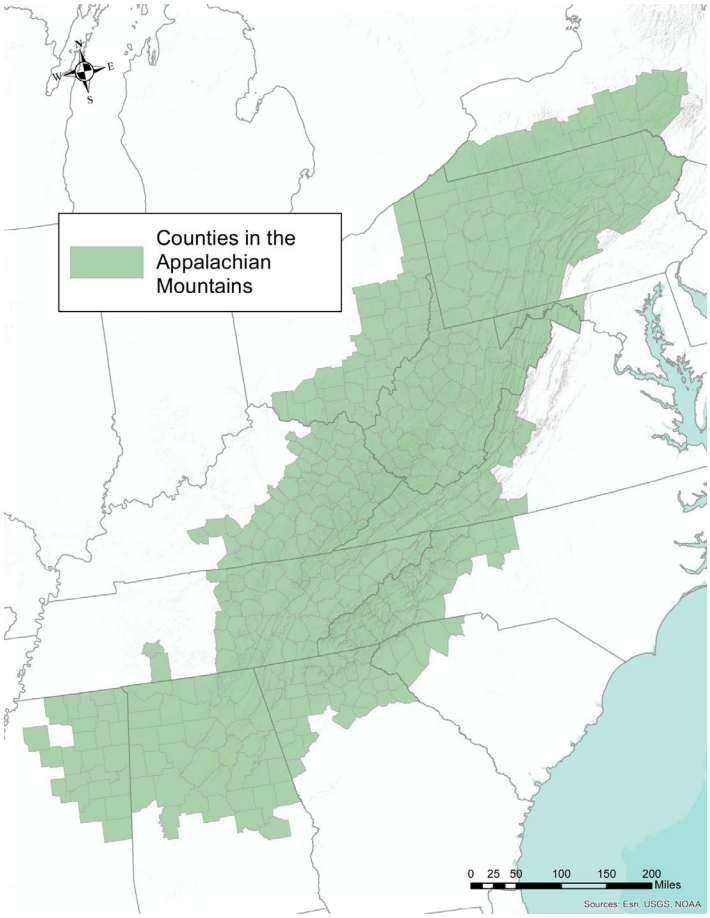


Figure 37 Map of the Appalachian Mountains multi-state priority area

and Maryland (Garrett County), and Finzel Swamp in Maryland (Garrett County).

Maryland is also involved with the Nature Conservancy's Central Appalachians Fire Learning Network, which partners with federal, state, and private managers to implement ecological fire management. Central Appalachia contains several fire dependent plants and ecosystems like Table Mountain pine, which relies on fires to open its cones and release its seeds, and shale barrens where fire prevents woody plant encroachment and improves biodiversity. The Central Appalachian Fire Learning Network's goals include collaborating with stakeholders on the scientific basis for landscape-scale fire management, facilitating ecological objective setting, stakeholder engagement, and funding of ecological fire management projects, and to identify and overcome barriers to restoring fire adapted systems. They have conducted prescribed burns on Sideling Hill in Washington County to encourage Table Mountain Pine and other native plant regeneration. There are opportunities to continue work with the Nature Conservancy (TNC) and other partners in the region to plant more red spruce and reintroduce fire back into the landscape. For more information on Maryland's partnerships with TNC see the Nature Conservancy's website (https://www.nature.org/en-us/about-us/where-we-work/united-states/maryland-dc/) .

Some other multistate partnerships in the Appalachian region include mine land restoration efforts with the Appalachian Regional Reforestation Initiative (ARRI) and the Appalachian Forest Natural Heritage Area (AFNHA). ARRI includes multiple state, federal, academia, and private partners who work to restore forests on mined lands in the Eastern United States. For more information on mineland reforestation in Central Appalachia see the ARRI website. AFNHA values working forest as an active force in the region's present and future, including making connections between the natural resources of the forest, people's livelihoods that are dependent on the forest, and the products from the forest that the whole country uses..

Maryland is also working with partners, including the USDA Natural Resource Conservation Service (NRCS) and the Indiana University of Pennsylvania Research Institute, to improve habitat for golden-winged and cerulean warblers. This includes creating early successional habitat for the golden-winged warbler and complex canopy structure in mature forests for the cerulean warbler. For more information on these projects see the golden-winged warbler 2018 progress report and the Cerulean Warbler Appalachian Forestland Enhancement Project on the NRCS website.

Important Surface Drinking Water Watersheds

Much of the drinking water for Maryland comes from watersheds which have headwaters in Pennsylvania. In order to improve water quality and watershed health, the Maryland Forest Service has written several landscape scale plans for subwatersheds in Pennsylvania and Maryland. These plans inform landowners about forest health and management. They also include available tools and programs in Pennsylvania and

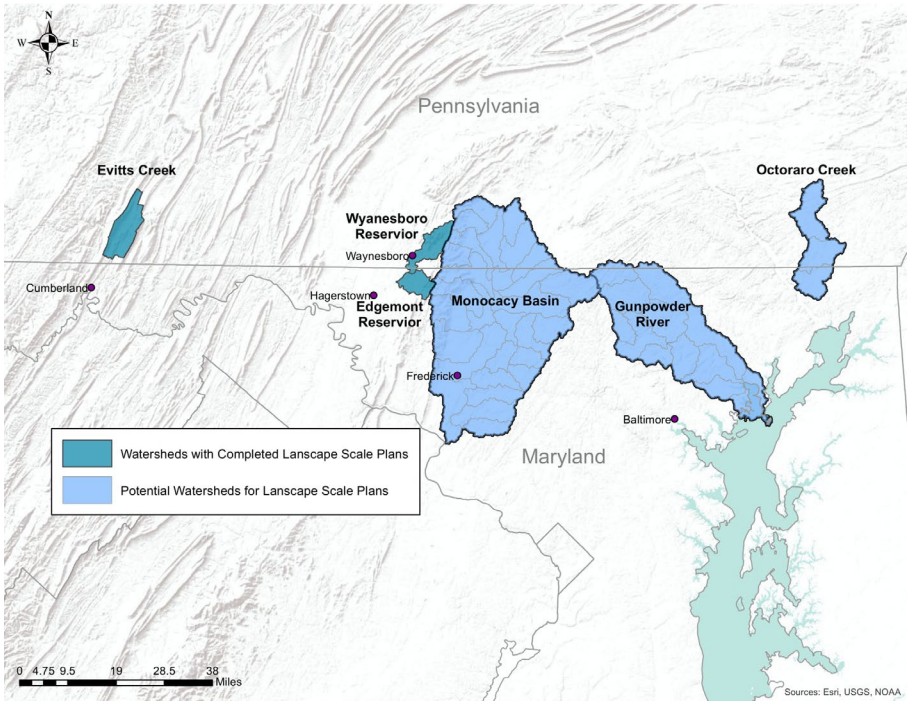


Figure 39 Map of the important surface drinking water watersheds multi-state priority area

Maryland to help manage woodlands for clean water, wildlife, and wildfire resilience and identify potential areas for reforestation.

Plans have been written for Evitts Creek watershed in Pennsylvania, which provides drinking water to southern Bedford County in Pennsylvania, central Allegany County in Maryland, and northern Mineral County in West Virginia; Edgemont Reservoir watershed in Maryland, which provides drinking water to municipalities in Washington County Maryland, and the Waynesboro Reservoir watershed, which provides drinking water to Waynesboro Pennsylvania.

There are opportunities to write similar plans for other drinking water watersheds that intersect Maryland and Pennsylvania. Some potential watersheds include the Gunpowder River watershed, which provides a large portion of the drinking water for Baltimore City and County, and the Octoraro Creek watershed, which is one of the greatest nitrogen polluters to the Chesapeake. The Monocacy Basin is another potential site, which includes areas in southern Pennsylvania and Fredrick, Carroll, and Montgomery counties in Maryland. The watershed provides drinking water for the city of Fredrick. For more information, see the Landscape Scale Stewardship Plans on the Maryland Forest Service's website.

Readiness and Environmental Protection Integration Program

The Readiness and Environmental Protection Integration Program (REPI) is a program developed by the U.S. Department of Defense. The program funds cost sharing for the partners to obtain conservation easements around military bases to avoid land use conflicts around military bases, which in turn protects wildlife habitat from development.

There are several REPI areas in Maryland and the surrounding states. The Naval District Washington region covers areas in Maryland, Delaware, and Virginia, and includes several Naval Air Stations and Naval Support Facilities. Some of that area overlaps with the Middle Chesapeake Sentinel Landscape Boundary. Sentinel Landscapes are areas around military installations that include natural and working lands. Within these areas, the Department of Defense partners with state and local governments, and conservation organizations to aid in sustainable management on the privately owned lands in the area. This is accomplished through voluntary state and federal assistance programs that provide tax reductions, agricultural loans, disaster relief, educational opportunities, technical aid, and funding for conservation easements.

Blackbird-Millington Corridor

The Blackbird-Millington Corridor is an important conservation corridor encompassing the eastern section of Kent County Maryland to southern New Castle County in Delaware. It includes the Millington Wildlife Management Area and the Blackbird State Forest in Delaware. This corridor includes multiple Coastal Plain ponds, which provide habitat for the eastern tiger

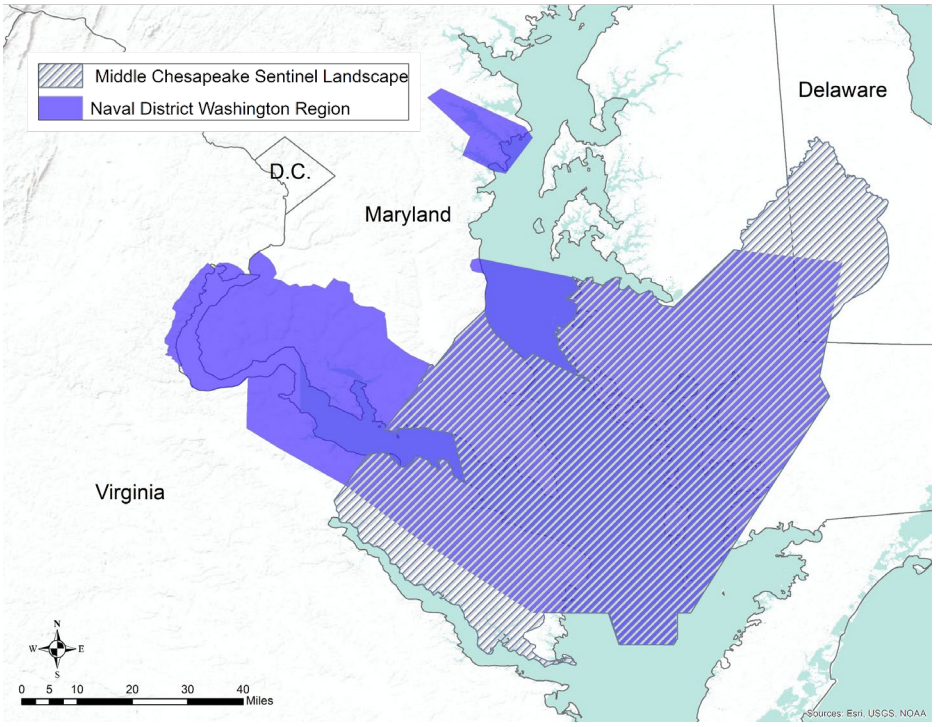


Figure 40 Map of the REPI multi-state priority area

salamander, which is listed as endangered in both Maryland and Delaware. The hardwood forests in the corridor provide habitat for migratory songbirds and nesting and hunting areas for raptors.

There are many opportunities to work with the Delaware Forest Service and their partners to enhance the ecological value of the Blackbird-Millington Corridor.

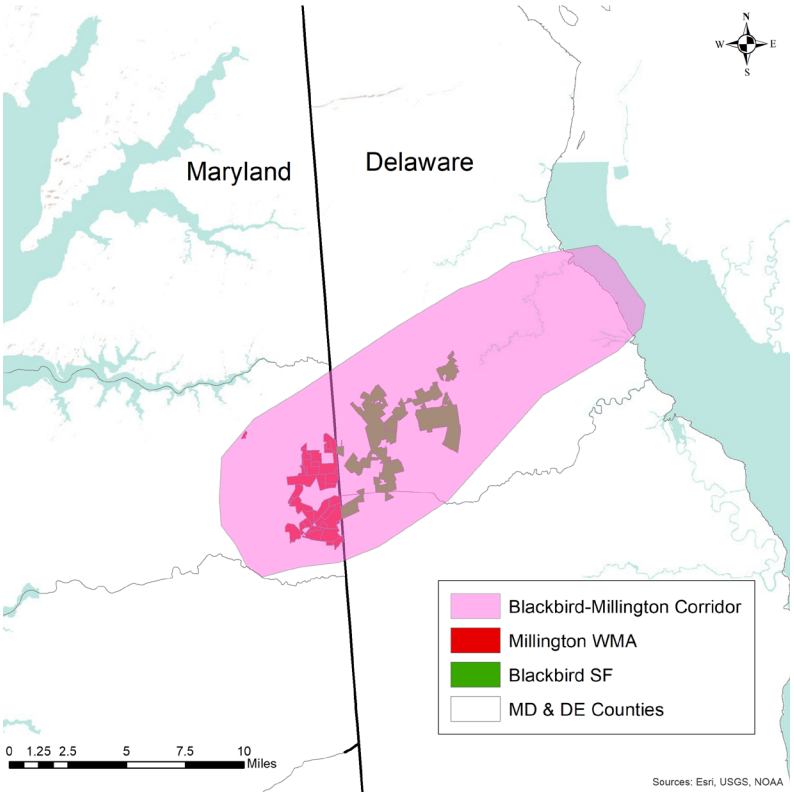


Figure 41 Map of the Blackbird-Millington Corridor multi-state priority area

Appendix A. Forest Statistics by County

		Acres of Forest *			
	County Acres	**1986**	**1999**	**2008**	**2018**
Allegany	272,269	212,381	211,396	185,561	212,084
Anne Arundel	266,202	126,451	85,475	69,523	46,333
Baltimore city	51,712	-	1,830	1,365	2,012
Baltimore	383,098	145,269	115,249	117,083	145,987
Calvert	137,709	74,694	75,856	71,772	62,073
Caroline	204,890	59,790	49,352	71,284	56,606
Carroll	287,443	72,785	63,344	53,572	44,658
Cecil	222,803	82,335	73,797	68,521	62,008
Charles	295,040	176,524	196,619	182,118	167,973
Dorchester	356,826	144,826	137,588	139,684	139,802
Frederick	424,243	136,734	127,286	131,402	135,804
Garrett	414,694	306,281	297,537	277,129	273,156
Harford	281,824	107,427	102,163	79,952	82,338
Howard	161,306	63,289	56,806	48,813	50,394
Kent	178,836	40,941	53,722	42,231	46,156
Montgomery	317,133	100,310	97,881	84,768	100,434
Prince George's	310,675	127,749	136,902	134,423	121,404
Queen Anne's	238,214	72,919	47,801	70,144	63,096
St. Mary's	231,200	130,207	108,468	120,175	105,779
Somerset	209,414	87,251	87,757	114,230	92,154
Talbot	172,250	41,938	57,856	43,944	50,948
Washington	293,210	128,373	107,736	136,037	131,329
Wicomico	241,389	104,696	115,339	108,229	114,937
Worcester	302,874	157,150	156,971	140,652	135,230
Statewide	**6,255,251**	**2,700,322**	**2,564,730**	**2,492,613**	**2,442,695**

*Data from U.S. Forest Service FIA

	Miles of 100 ft Buffer		
	Buffered (>80%forest)	**Partially Buffered**	**Unbuffered (<10%forest)**
Allegany	720	211	35
Anne Arundel	548	150	48
Baltimore	569	401	88
Baltimore City	32	38	10
Calvert	289	37	11
Caroline	362	225	265
Carroll	502	347	145
Cecil	400	141	57
Charles	757	123	33
Dorchester	253	192	302
Frederick	689	511	261
Garrett	638	257	83
Harford	412	228	88
Howard	363	182	78
Kent	198	112	122
Montgomery	744	297	58
Prince Georges	585	217	43
Queen Annes	311	136	136
Somerset	116	97	81
St. Mary's	561	111	39
Talbot	197	117	105
Washington	393	355	202
Wicomico	246	158	202
Worcester	576	292	493
Statewide	**10,462**	**4,936**	**2,985**

Appendix B. Summary of Priority Areas

	Conserve Working Forests			Protecting Forest from Harm: Forest Health			Trees Providing Benefits to Society			Protecting Forests from Harm: Wildfire		
County	**Total Acres**	**Forested Acres**	**Acres Available for Stewardship**	**Total Acres**	**Forested Acres**	**Acres Available for Stewardship**	**Total Acres**	**Forested Acres**	**Acres Available for Stewardship**	**Total Acres**	**Forested Acres**	**Acres Available for Stewardship**
Allegany	263,452	196,608	130,054	273,067	205,076	132,893	39,463	15,064	7,068	273,411	205,200	132,975
Anne Arundel	132,149	58,786	35,279	146,490	59,278	21,013	267,972	102,265	47,500	142,575	62,579	35,556
Baltimore City	0	0	0	0	0	0	52,407	3,630	526	0	0	0
Baltimore	158,351	68,286	37,055	244,454	86,435	38,336	389,368	127,745	55,376	185,064	76,491	29,660
Calvert	136,311	72,828	43,908	116,653	64,966	39,521	38,046	15,572	7,352	137,365	73,199	44,026
Caroline	200,935	61,203	47,876	0	0		10,834	1,815	1,033	116,645	39,547	29,761
Carroll	150,234	49,880	27,275	139,533	45,464	28,300	59,745	11,818	4,752	44,635	17,836	5,839
Cecil	148,914	66,276	46,014	144,229	59,879	41,353	223,873	85,634	60,672	80,229	43,231	28,128
Charles	292,445	178,353	120,561	250,452	160,401	108,141	294,099	178,954	120,692	293,464	178,944	120,721
Dorchester	295,165	104,151	74,503	287,439	93,281	64,964	14,901	2,144	1,256	340,754	106,655	76,278
Frederick	396,347	139,142	83,241	206,923	100,960	54,875	91,859	16,837	9,151	190,731	88,154	46,197
Garrett	418,453	281,496	174,828	419,758	282,302	175,521	10,772	3,010	1,456	192,794	117,784	72,790
Harford	215,714	76,084	50,229	168,856	62,550	40,666	282,109	96,984	54,515	86,231	35,756	23,875
Howard	35,112	14,349	5,759	40,000	13,057	4,957	161,252	48,572	16,699	50,448	18,800	4,579
Kent	73,323	19,858	17,061	160	53	30	12,299	2,588	1,491	0	0	0
Montgomery	98,543	37,421	21,298	97,857	36,347	14,910	323,513	93,896	32,347	103,646	33,433	9,430
Prince George's	148,537	78,045	40,047	136,729	75,147	33,860	310,914	120,952	48,224	161,224	82,177	40,900
Queen Anne's	191,592	56,202	49,572	0	0	0	15,625	2,591	1,449	0	0	0
St. Mary's	223,579	114,927	79,580	229,490	116,497	80,234	47,340	18,544	8,782	227,466	116,488	80,374
Somerset	160,250	80,980	55,594	190,881	85,312	57,511	18,774	5,537	2,006	189,235	85,393	57,542
Talbot	134,573	35,219	30,655	60,056	16,889	13,591	23,993	5,252	3,381	57,603	15,627	12,150
Washington	269,371	107,210	63,368	174,968	89,825	51,238	58,211	11,111	6,838	203,926	96,502	55,748
Wicomico	234,235	105,164	73,455	164,714	84,450	57,832	56,427	13,544	7,776	218,805	98,788	68,066
Worcester	265,955	149,024	99,627	230,155	130,407	83,786	23,563	4,539	2,907	126,476	79,674	45,516
Total	4,643,541	2,151,493	1,406,838	3,722,866	1,868,576	1,143,529	2,827,357	988,599	503,249	3,422,727	1,672,257	1,020,110

*Forest Cover data from the Chesapeake Conservancy

** Potential areas for stewardship are forested areas that lie in privately owned parcels larger than 10 acres

Appendix C. Species of Greatest Conservation Need by Forest Type

From the 2015-2025 Maryland State Wildlife Action Plan- Chapter 4

Successional Forest

Mammals	**Birds**	**Reptiles**
Big brown bat	American woodcock	Eastern box turtle
Bobcat	Blue-winged warbler	Northern pine snake
Eastern harvest mouse	Common nighthawk	Northern scarlet snake
Eastern red bat	Golden-winged warbler	Plain-bellied watersnake
Evening bat	Least flycatcher	Timber rattlesnake
Hoary bat	Mourning warbler	Smooth green snake
Indiana myotis	Northern bobwhite	**Insects (Butterflies & Moth)**
Least weasel	Prairie warbler	Indian skipper
Little brown myotis	Red-headed woodpecker	
North American porcupine	Willow flycatcher	
Northern long-eared bat	Yellow-breasted chat	
Seminole bat		
Silver-haired bat		
Southeastern myotis		
Southeastern shrew		
Southern bog lemming		
Tricolored bat		

Tidal Forest

Mammals	**Birds (cont.)**	**Insects (Butterflies & Moth)**
Big brown bat	Red-headed woodpecker	Bronze copper
Bobcat	Scarlet tanager	Carolina satyr
Delmarva fox squirrel	Swainson's warbler	Chermock's mulberry wing
Eastern red bat	Wayne's black-throated green warbler	Cypress sphinx moth
Hoary bat	Wood thrush	Dion skipper
Seminole bat	Worm-eating warbler	Great purple hairstreak
Silver-haired bat	Yellow-breasted chat	Hessel's hairstreak
Southeastern myotis	Yellow-throated vireo	Marbled underwing
Southeastern star-nosed mole	**Reptiles**	Palamedes swallowtail
Tricolored bat	Coastal Plain milk snake	**Insects (Dragonflies and Damselflies)**
Birds	Common ribbonsnake	Harlequin darner
Acadian flycatcher	Eastern box turtle	Taper-tailed darner
American restart	Eastern king snake	White-faced meadowhawk
American woodcock	Mole king snake	**Other Insects**
Bald eagle	Northern map turtle	Pitcher-plant mosquito
Black-and-white warbler	Plain-bellied watersnake	**Crustaceans**
Chuck-will's-widow	Rainbow snake	An amphipod (*Crangonyx stagnicolous*)
Great blue heron	Spotted turtle	**Invertebrates (Snails)**

Great egret	**Amphibians**	Chesapeake ambersnail
Hooded warbler	Atlantic Coast leopard frog	Coastal-plain ambersnail
Kentucky warbler	Carpenter frog	Snowhill ambersnail
Louisiana waterthrush	Eastern mud salamander	
Birds (cont.)	**Amphibians (cont.**	
Northern parula	Eastern narrow-mouthed toad	
Ovenbird		
Prairie warbler		
Prothonotary warbler		

Maritime Forest and Shrubland

Mammals	**Birds**	**Birds (cont.)**
Big brown bat	American woodcock	Long-eared owl
Delmarva fox squirrel	Bald eagle	Northern bobwhite
Eastern red bat	Black-crowned night-heron	Northern saw-whet owl
Hoary bat	Boat-tailed grackle	Ovenbird
Least shrew	Chuck-will's-widow	Prairie warbler
Seminole bat	Common nighthawk	Red-cockaded woodpecker
Silver-haired bat	Glossy ibis	Snowy egret
Southeastern myotis	Great blue heron	Tricolored heron
Tricolored bat	Great egret	Yellow-breasted chat
	Little blue heron	Yellow-crowned night-heron

Managed Montane Conifer

Birds
Blackbburnian warbler
Black-throated green warbler
Golden-crowned kinglet
Long-eared owl
Magnolia warbler
Northern goshawk
Pine siskin
Red-breasted nuthatch
Sharp-shinned hawk

Montane-Piedmont Oak-Pine

Mammals	**Birds (cont.)**	**Amphibians**
Allegheny woodrat	Golden eagle	Jefferson salamander
American mink	Golden-winged warbler	Mountain chorus frog
Appalachian cottontail	Northern bobwhite	Upland chorus frog
Big brown bat	Northern saw-whet owl	Valley and Ridge salamander
Bobcat	Ovenbird	**Insects (Beetles)**

Eastern red bat	Prairie warbler	Cow path tiger beetle
Eastern small-footed myotis	Red-headed woodpecker	Northern barrens tiger beetle
Eastern spotted skunk	Ruffed grouse	One-spotted tiger beetle
Evening bat	Scarlet tanager	Splendid tiger beetle
Hoary bat	Sharp-shinned hawk	**Insects (Bees, Wasps, & Ants)**
Indiana myotis	Wood thrush	Rusty patched bumble bee
Least weasel	Worm-eating warbler	Sanderson's bumble bee
Mammals (cont.)	**Birds (cont.)**	**Insects (Bees, Wasps, & Ants; cont.)**
Little brown myotis	Yellow-breasted chat	A mining bee (*Andrena braccata*)
North American porcupine	Yellow-throated vireo	A mining bee (*Andrena fulvipennis*)
Northern long-eared bat	**Reptiles**	**Insects (Butterflies & Moth)**
Seminole bat	Eastern box turtle	American chestnut nepticulid
Silver-haired bat	Eastern six-lined racerunner	Cobweb skipper
Tricolored bat	Northern coal skink	Edwards' hairstreak
Birds	Red cornsnake	Frosted elfin
Acadian flycatcher	Timber rattlesnake	Giant swallowtail
American woodcock	Smooth green snake	Leonard's skipper
Bald eagle	Wood turtle	Mottled duskywing
Black-and-white warbler		Northern metalmark
Broad-winged hawk		Olympia marble
Brown creeper		Phleophagan chestnut nepticulid moth
Eastern whip-poor-will		Silvery blue

Oak-Hickory

Mammals	**Birds (cont.)**	**Amphibians**
Allegheny woodrat	Brown creeper	Green salamander
American mink	Canada warbler	Jefferson salamander
Big brown bat	Cerulean warbler	Mountain chorus frog
Bobcat	Dark-eyed junco	Upland chorus frog
Eastern red bat	Eastern whip-poor-will	Valley and Ridge salamander
Eastern small-footed myotis	Golden eagle	**Insects (Beetles)**
Eastern spotted skunk	Golden-winged warbler	Six-banded longhorn beetle
Evening bat	Hooded warbler	**Insects (Bees, Wasps, & Ants)**
Hoary bat	Kentucky warbler	Rusty patched bumble bee
Indiana myotis	Least flycatcher	Sanderson's bumble bee
Least weasel	Mourning warbler	**Insects (Butterflies & Moth)**
Little brown myotis	Northern bobwhite	American chestnut nepticulid moth
Long-tailed shrew	Northern parula	Appalachian blue
North American porcupine	Ovenbird	Compton tortoiseshell
Northern long-eared bat	Prairie warbler	Early hairstreak
Seminole bat	Red-headed woodpecker	Gray comma
Silver-haired bat	Ruffed grouse	Hickory hairstreak

Smokey shrew	Scarlet tanager	Marbled underwing
Southeastern shrew	Sharp-shinned hawk	Northern crescent
Southern bog lemming	Veery	Northern metalmark
Southern pygmy shrew	Wood thrush	Pepper and salt skipper
Tricolored bat	Worm-eating warbler	Phleophagan chestnut nepticulid moth
Birds	Yellow-bellied sapsucker	Three-horned moth
Acadian flycatcher	Yellow-breasted chat	West Virginia white
American restart	Yellow-throated vireo	**Invertebrates (Snails)**
American woodcock	**Reptiles**	Bear creek slitmouth
Bald eagle	Bog turtle	Rust glyph
Birds (cont.)	**Reptiles (cont.)**	
Black-and-white warbler	Eastern box turtle	
Blackburnian warbler	Eastern king snake	
Black-throated blue warbler	Red cornsnake	
Black-throated green warbler	Smooth green snake	
Blue-winged warbler	Timber rattlesnake	
Broad-winged hawk	Wood turtle	

Basic Mesic

Mammals	**Birds (cont.)**	**Amphibians**
Allegheny woodrat	Brown creeper	Barking treefrog
American mink	Cerulean warbler	Eastern narrow-mouthed toad
Big brown bat	Eastern whip-poor-will	Eastern tiger salamander
Bobcat	Hooded warbler	Jefferson salamander
Delmarva fox squirrel	Kentucky warbler	Upland chorus frog
Eastern red bat	Northern bobwhite	**Insects (Beetles)**
Eastern small-footed myotis	Northern parula	Six-banded longhorn beetle
Evening bat	Ovenbird	**Insects (Bees, Wasps, & Ants)**
Hoary bat	Prairie warbler	Rusty patched bumble bee
Indiana myotis	Red-headed woodpecker	**Insects (Butterflies & Moth)**
Little brown myotis	Scarlet tanager	American chestnut nepticulid moth
Northern long-eared bat	Sharp-shinned hawk	Appalachian blue
Seminole bat	Veery	Carolina satyr
Silver-haired bat	Wood thrush	Giant swallowtail
Smoky shrew	Worm-eating warbler	Marbled underwing
Southeastern myotis	Yellow-breasted chat	Phleophagan chestnut nepticulid moth
Southeastern shrew	Yellow-throated vireo	A noctuid moth (*Hadena ectypa*)
Southern bog lemming	**Reptiles**	**Invertebrates (Snails)**
Southern pygmy shrew	Bog turtle	Cherrystone drop
Tricolored bat	Coastal Plain milk snake	Maryland glyph
Birds	Common ribbonsnake	Natural Bridge supercoil
Acadian flycatcher	Eastern box turtle	Rust glyph
American restart	Eastern kingsnake	

American woodcock	Mole kingsnake	
Bald eagle	Northern pine snake	
Bicknell's thrush	Northern scarlet snake	
Black-and-white warbler	Spotted turtle	
Blue-winged warbler	Timber rattlesnake	
Broad-winged hawk	Wood turtle	

Mesic Mixed Hardwood

Mammals	**Birds**	**Reptiles**
Allegheny woodrat	Acadian flycatcher	Bog turtle
American mink	American restart	Coastal Plain milk snake
Big brown bat	American woodcock	Common ribbonsnake
Bobcat	Bald eagle	Eastern box turtle
Delmarva fox squirrel	Bicknell's thrush	Eastern kingsnake
Eastern red bat	Black-and-white warbler	Mole kingsnake
Evening bat	Blue-winged warbler	Northern pine snake
Hoary bat	Broad-winged hawk	Northern scarlet snake
Indiana myotis	Brown creeper	Spotted turtle
Little brown myotis	Cerulean warbler	Timber rattlesnake
Northern long-eared bat	Eastern whip-poor-will	Wood turtle
Seminole bat	Great blue heron	**Amphibians**
Silver-haired bat	Great egret	Barking treefrog
Smoky shrew	Hooded warbler	Carpenter frog
Southeastern myotis	Kentucky warbler	Eastern narrow-mouthed toad
Southeastern shrew	Northern bobwhite	Eastern tiger salamander
Southern bog lemming	Northern parula	Jefferson salamander
Southern pygmy shrew	Ovenbird	Upland chorus frog
Tricolored bat	Prairie warbler	**Insects (Beetles)**
	Red-headed woodpecker	Six-banded longhorn beetle
	Scarlet tanager	**Insects (Butterflies & Moth)**
	Sharp-shinned hawk	American chestnut nepticulid moth
	Veery	Appalachian blue
	Wood thrush	Carolina satyr
	Worm-eating warbler	Marbled underwing
	Yellow-breasted chat	Pepper and salt skipper
	Yellow-throated vireo	Phleophagan chestnut nepticulid moth
		A noctuid moth (*Hadena ectypa*)

Coastal Plain Oak-Pine

Mammals	**Birds (cont.)**	**Amphibians**
American mink	Common nighthawk	Carpenter frog
Big brown bat	Eastern whip-poor-will	Eastern narrow-mouthed toad
Bobcat	Northern bobwhite	Eastern tiger salamander
Delmarva fox squirrel	Ovenbird	**Insects (Beetles)**
Eastern harvest mouse	Prairie warbler	Eastern pine barrens tiger beetle
Eastern red bat	Red-headed woodpecker	Festive tiger beetle
Evening bat	Scarlet tanager	Northern barrens tiger beetle
Hoary bat	Wood thrush	One-spotted tiger beetle
Least shrew	Worm-eating warbler	Splendid tiger beetle
Little brown myotis	Yellow-breasted chat	A tenebrionid beetle (*Helops cisteloides*)
Seminole bat	**Reptiles**	A tenebrionid beetle (*Schoenicus puberulus*)
Silver-haired bat	Coastal Plain milk snake	**Insects (Butterflies & Moths)**
Southeastern myotis	Eastern box turtle	Cobweb skipper
Mammals (cont.)	**Reptiles (cont.**	**Insects (Butterflies & Moths; cont.)**
Tricolored bat	Eastern kingsnake	Frosted elfin
Birds	Eastern six-lined racerunner	Leonard's skipper
Acadian flycatcher	Mole kingsnake	Pine barrens zanclognatha
American woodcock	Northern pine snake	A noctuid moth (*Hadena ectypa*)
Bicknell's thrush	Northern scarlet snake	
Black-and-white warbler	Red cornsnake	
Broad-winged hawk	Spotted turtle	
Chuck-will's-widow		

Coastal Plain Pitch Pine

Mammals	**Birds**	**Reptiles**
Big brown bat	Acadian flycatcher	Coastal Plain milk snake
Bobcat	American woodcock	Eastern box turtle
Eastern harvest mouse	Bicknell's thrush	Eastern kingsnake
Eastern red bat	Black-and-white warbler	Eastern six-lined racerunner
Evening bat	Broad-winged hawk	Mole kingsnake
Hoary bat	Chuck-will's-widow	Northern pine snake
Least shrew	Eastern whip-poor-will	Northern scarlet snake
Seminole bat	Northern bobwhite	Red cornsnake
Silver-haired bat	Ovenbird	**Insects (Beetles)**
Southeastern myotis	Prairie warbler	Cow path tiger beetle
Tricolored bat	Red-headed woodpecker	Festive tiger beetle
	Scarlet tanager	Northern barrens tiger beetle
	Sharp-shinned hawk	One-spotted tiger beetle
	Wood thrush	Splendid tiger beetle
	Worm-eating warbler	**Insects (Bees, Wasps, & Ants)**

	Yellow-breasted chat	Rusty patched bumble bee
		Insects (Butterflies & Moth)
		Cobweb skipper
		Frosted elfin
		Leonard’s skipper
		Pine barrens zanclognatha
		A noctuid moth (*Hadena ectypa*)

High Elevation Ridge Forest

Mammals	**Birds**	**Reptiles**
Allegheny woodrat	Acadian flycatcher	Eastern box turtle
Appalachian cottontail	Black-and-white warbler	Timber rattlesnake
Big brown bat	Black-throated green warbler	**Amphibians**
Bobcat	Broad-winged hawk	Jefferson salamander
Eastern red bat	Brown creeper	Wehrle's salamander
Eastern small-footed myotis	Canada warbler	**Insects (Beetles)**
Eastern spotted skunk	Dark-eyed junco	Cow path tiger beetle
Hoary bat	Eastern whip-poor-will	Northern barrens tiger beetle
Indiana myotis	Golden eagle	
Mammals (cont.)	**Birds (cont.)**	**Insects (Bees, Wasps, & Ants)**
Least weasel	Golden-winged warbler	Sanderson's bumble bee
Little brown bat	Magnolia warbler	**Insects (Butterflies & Moth)**
Long-tailed shrew	Mourning warbler	American chestnut nepticulid moth
North American porcupine	Ovenbird	Gray comma
Northern long-eared bat	Ruffed grouse	Phleophagan chestnut nepticulid moth
Silver-haired bat	Scarlet tanager	**Invertebrates (Snails)**
Smoky shrew	Winter wren	Angular disc
Tricolored bat	Wood thrush	Rust glyph
	Worm-eating warbler	
	Yellow-bellied sapsucker	

Cove Forest

Mammals	**Birds (cont.)**	**Amphibians**
Allegheny woodrat	Broad-winged hawk	Green salamander
American mink	Brown creeper	Jefferson salamander
Appalachian cottontail	Canada warbler	Mountain chorus frog
Big brown bat	Cerulean warbler	Upland chorus frog
Bobcat	Dark-eyed junco	Valley and Ridge salamander
Eastern red bat	Eastern whip-poor-will	Wehrle's salamander
Eastern small-footed myotis	Golden eagle	**Insects (Bees, Wasps, & Ants)**
Eastern spotted skunk	Golden-winged warbler	Sanderson's bumble bee
Hoary bat	Hooded warbler	**Insects (Butterflies & Moth)**

Indiana myotis	Kentucky warbler	American chestnut nepticulid moth
Least weasel	Least flycatcher	Appalachian blue
Little brown bat	Northern parula	Compton tortoiseshell
Long-tailed shrew	Northern saw-whet owl	Early hairstreak
North American porcupine	Ovenbird	Gray comma
Northern long-eared bat	Prairie warbler	Hickory hairstreak
Silver-haired bat	Ruffed grouse	Marbled underwing
Smoky shrew	Scarlet tanager	Phleophagan chestnut nepticulid moth
Southern bog lemming	Sharp-shinned hawk	Three-horned moth
Southern pygmy shrew	Veery	West Virginia white
Southern water shrew	Winter wren	**Invertebrates (Snails)**
Tricolored bat	Wood thrush	Bear creek slitmouth
Birds	Worm-eating warbler	Rust glyph
Acadian flycatcher	Yellow-bellied sapsucker	
American restart	Yellow-throated vireo	
American woodcock	**Reptiles**	
Black-and-white warbler	Eastern box turtle	
Blackburnian warbler	Timber rattlesnake	
Black-throated blue warbler	Smooth green snake	
Black-throated green warbler	Wood turtle	
Blue-winged warbler		

Hemlock northern hardwood

Mammals	**Birds (cont.**	**Reptiles**
Allegheny woodrat	Black-throated blue warbler	Eastern box turtle
American mink	Black-throated green warbler	Timber rattlesnake
Appalachian cottontail	Broad-winged hawk	Smooth green snake
Big brown bat	Brown creeper	Wood turtle
Bobcat	Canada warbler	**Amphibians**
Eastern red bat	Dark-eyed junco	Green salamander
Eastern small-footed myotis	Eastern whip-poor-will	Jefferson salamander
Eastern spotted skunk	Golden eagle	Mountain chorus frog
Hoary bat	Golden-crowned kinglet	Valley and Ridge salamander
Indiana myotis	Golden-winged warbler	Wehrle's salamander
Least weasel	Hooded warbler	**Insects (Bees, Wasps, & Ants)**
Little brown bat	Kentucky warbler	Sanderson's bumble bee
Long-tailed shrew	Least flycatcher	**Insects (Butterflies & Moth)**
North American porcupine	Magnolia warbler	Appalachian blue
Northern long-eared bat	Mourning warbler	Compton tortoiseshell
Silver-haired bat	Northern goshawk	Early hairstreak
Smokey shrew	Northern parula	Gray comma
Southern bog lemming	Northern saw-whet owl	Olympia marble

Southern pygmy shrew	Ovenbird	Pepper and salt skipper
Southern rock vole	Pine siskin	Three-horned moth
Southern water shrew	Red-breasted nuthatch	West Virginia white
Tricolored bat	Ruffed grouse	**Invertebrates (Snails)**
Virginia northern flying squirrel	Scarlet tanager	Angular disc
Birds	Sharp-shinned hawk	Bear creek slitmouth
Acadian flycatcher	Swainson's thrush	Rust glyph
American restart	Veery	Spruce knob three-tooth
American woodcock	Winter wren	
Bald eagle	Wood thrush	
Black-and-white warbler	Worm-eating warbler	
Blackburnian warbler	Yellow-bellied sapsucker	

Appendix F. Maryland Forest Service Laws And Regulations

Forest Service Regulation
http://www.dsd.state.md.us/comar/subtitle_chapters/08_Chapters.aspx

Roadside Tree Law
Natural Resources Article, Title 5, §401-411
http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=08.07.02.*

Licensed Tree Expert
Natural Resources Article, Title 5, §415-423
http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=08.07.07.*

Seed Tree Law
Natural Resources Article, Title 5, §501-509

Forest Conservation Act
Natural Resources Article, Title 5, §1601-1613
http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=08.19.01.*

Woodland Incentive Program
Natural Resources Article, Title 5, §301-307
http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=08.07.05.*

Forest Conservancy District Boards
Natural Resources Article, Title 5, §601-610

Forest Fire
Natural Resources Article, Title 5, §701-720
http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=08.07.04.*

Mid-Atlantic Fire Compact
Natural Resources Article 5-8

State Forests
Natural Resources Article, Title 5
http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=08.07.01.*

Critical Area Law
Natural Resources Article, Title 8, §1801-1817
http://www.dsd.state.md.us/comar/subtitle_chapters/27_Chapters.aspx

Reforestation Law
Natural Resources Article, Title 5, §103

Forest Product Operator
Natural Resources Article, Title 5, §608

Forest Conservation and Management Program
Tax Property Article, Title 8, §211
http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=08.07.03.*
http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=18.02.03.*

Wildlands Act
Natural Resources Article, Title 5, §1201-1222
http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=08.01.02.*

Urban and Community Forestry Law
Natural Resources Article, Title 5, §424-427

Forest Management
Natural Resources Article, 5-1

Tree Nursery
Natural Resources Article, 5-4

Required County Payments
Natural Resources Article, 5-212g

Forest Resources Plan
Natural Resources Article, 5-214

Sustainable Forestry Act of 2009
Natural Resources Article, 5 et al

Reduced Property Tax Assessments for FCMAs
TAX PROPERTY ARTICLE 8-211

State Highway Reforestation Law
Natural Resources Article, 5-103

Forest Preservation Act
NAT. RES. ARTICLE 5-104

Chesapeake and Coastal Bays Critical Area Law
NAT. RES. ARTICLE 8-18

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