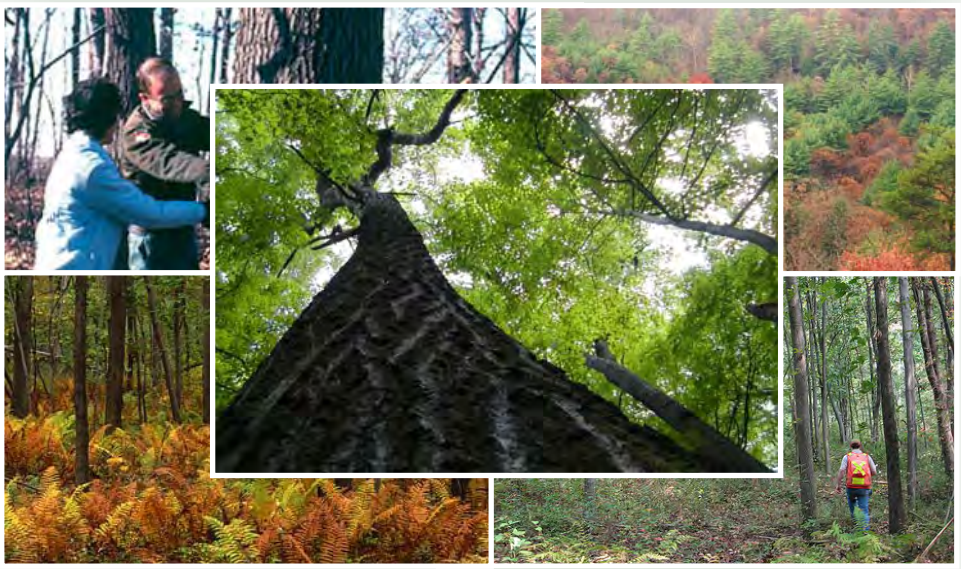
MARYLAND FOREST RESOURCE ASSESSMENT 2010



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MARYLAND
DEPARTMENT OF NATURAL RESOURCES
FOREST SERVICE

JUNE 18, 2010

The Mission of the Maryland Department of Natural Resources

The Maryland Department of Natural Resources (DNR) is the state agency responsible for providing natural and living resource-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 12 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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June, 2010

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LETTER FROM THE DIRECTOR

Dear Friend of Maryland's Forests

Most of us have an "intuitive" appreciation for the many benefits that we receive from trees and forests. We appreciate the beauty of trees in our neighborhoods and enjoy their shade. We understand that a wide variety of animals and plants live in the forest, and we want healthy forests to ensure they continue to thrive. We realize that we utilize an abundance of forest products in our homes and in our daily lives. We know that forest streams produce fresh clear water, and that tree leaves filter the air we breathe. However, it takes much more than a casual appreciation of our forests to ensure we will continue to enjoy these forest benefits into the future. It takes both knowledge of the current state of our forests, and a commitment to take the actions necessary to conserve our forests based on that knowledge.

The purpose of this document is to provide the basic knowledge on the state of our forests so that we can take the proper action steps to conserve, manage and protect our forests for the good of everyone in the state. This assessment takes a comprehensive look at the current state of Maryland's forests in 2010, using the best data sources and information available, so that we can better understand the factors that are shaping our forests into the future. With the factual knowledge provided by this assessment, we can begin to develop carefully thought out strategies to preserve the benefits our forests produce, and to confront the threats that our forests are facing.

Maryland's forest lands are very diverse, and different forests in different parts of the state contribute to the landscape in many different ways. Consequently, we need to give greater attention to certain facets of forest conservation in certain areas of the state. This assessment helps us to identify both critical forest conservation components, as well as where they are located from a priority perspective on the landscape.

Once you have finished reviewing this assessment please read the companion publication *Maryland Forest Resource Strategy 2010 to 2015.* The *Strategy* document utilizes the information contained in the assessment to lay out a broad suite of actions and approaches to forest conservation that will ensure we will continue to enjoy the many benefits our forests provide now and into the future.

Sincerely,

Steven W. Koehn

Steven W. Koehn
Director/State Forester
MD DNR Forest Service

Executive Summary

The Maryland Forest Assessment is intended to provide information on the current state of forests in Maryland, identify trends from past assessments, and locate areas of the state where forests provide critical services, such as clean air, clean water, plant and animal habitat, carbon sequestration, economic opportunities, and a high quality of life for Maryland's citizens. Forest priority areas for Maryland and at the national level were developed to determine where strategies to maintain, and even increase, forest cover, would be most effective.

Conservation of biological diversity reflects the potential for biodiversity—the number and type of plants and animals—on a landscape. The greatest threat to biodiversity in Maryland's forests has been, and continues to be land development. Maryland lost 151,500 acres of forest between 1986 and 2008, and the US Forest Service estimated in 2008 that 39% of Maryland is forested. Fragmentation of existing forests is exacerbated by development as roads, powerlines, and buildings replace forests, and forested corridors shrink and inhibit the movement of animals.

There is a predominance of older trees on the landscape, and about of all forests 63% are considered Oak-Hickory forests, which is well suited for wildlife. The forests continue to grow, and only 58% of average annual growth is harvested.

Development and fragmentation encroaching on existing forest land places greater pressure on forest health as invasive plants and insects like Emerald Ash Borer and Gypsy Moth change the composition of our forests. That composition is also threatened as deer populations increase, the ability of forests to retain its Oak –Hickory composition declines. Climate change is also expected to change the composition of Maryland's forests to more pine as sugar maple, beech, and hemlock are pushed further north. Wildfire is being controlled, particularly where rural areas meet urban areas.

Maryland's forests are protecting drinking water and preventing erosion. Most of the northern and western areas of the state, particularly the urban centers, are supplied with drinking water from surface sources like reservoirs. These areas must be protected and managed, and forest cover in watersheds expanded as water demand increases along with development. Fishable and swimmable streams are a goal, and increasing riparian forest buffers continues to be a priority to help clean up and restore our Chesapeake Bay.

Forests in Maryland are increasingly growing, and as they grow, they capture carbon. Larger tree volumes contribute to carbon sequestration as wood is left standing, but this could be increased with additional forest management. Carbon in biomass is estimated to have increased by 31% between 2004 and 2008.

The forests in Maryland provide multiple socioeconomic benefits to meet the needs of our society. The forest industry remains competitive and is a 4 billion dollar industry, providing paper products, lumber, and finished wood products. It is the fifth largest economic sector in the state. Other benefits include recreation, like hunting and wildlife viewing. Both of which are

estimated to contribute nearly $200 million each year to Maryland's economy, just on public lands alone.

It is estimated that 76% of the forest land in Maryland is privately owned and that more than 8 out of 10 private forest land owners in Maryland own fewer than 10 acres of forest. This means forests are increasingly bisected by property lines, reducing and complicating forest management opportunities. Government ownership of forests has generally been increasing over the past few years through purchases and easement donations.

Maryland has a robust suite of laws for protecting forests, from the Sustainable Forestry Act of 2009 to the Forest Conservation Act, Critical Area Law, Nontidal Wetlands Law, sediment and erosion control requirements, and local government comprehensive plan requirements. The state is committed to practicing sustainable forest management, and is working to have all state forests certified by third party organizations like the Forest Stewardship Council (FSC) and the Sustainable Forestry Initiative (SFI). Of paramount importance is Maryland's commitment to Chesapeake Bay restoration through increased riparian forest buffers, forest conversation in priority areas, and meeting urban tree canopy goals

Clearly Maryland's forests provide critical services that would otherwise have to be generated artificially and at great cost. As the amount of forest continues to decline in the state, awareness of the value of this resource is perhaps greater now than ever before, as alternative energy, sustainable living, climate change, and habitat protection are mainstream issues.

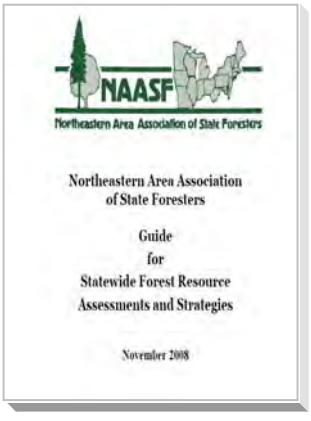
1. Introduction

FROM THE MOUNTAINS TO THE SEA, Maryland's forest has been measured to identify key forest-related issues and priorities to support development of the long-term Forest Resource Strategy. As a prerequisite, Maryland has completed its Forest Resource Assessment, designated Forest Priority Areas, and applied strategies to meet certain basic requirements. Since there is no required format for the assessment and strategies documents, Maryland's Forest Resource Assessment and Strategy is a unique undertaking unlike previous efforts like the Strategic Forest Land Assessment. Maryland's Forest Resource Assessment:

- Provides an analysis of present and future forest conditions and trends on all ownerships in the state, including analysis of market and non-market forces.
- Identifies threats to forest lands and resources in the state consistent with the USDA Forest Service Nation Priorities
- Identifies forest related benefits and services
- Delineates priority forest landscape areas in the state across themes and programs, ownerships, and the urban to rural continuum, to be addressed by the Resource Strategy
- Delineates any multi-State areas that are a regional priority

Forest-related issues of importance to Maryland are linked to the three Nation Priorities for managing the nation's forests as set forth in the 2008 Farm Bill: (1) Conserve Working Forest Landscapes, (2) Protect Forests from Harm, and (3) Enhance Public Benefits from Trees and Forests.

The Maryland DNR Forest Service conducted the assessment using a framework developed by the Forest Resource Planning Committee (FRPC) of the Northeastern Area Association of State Foresters (NAASF) with help from the USDA Forest Service's Northeastern Area State and Private Forestry staff. The framework was reviewed by all NAASF committees, which are composed of Forestry professionals from all of the states in the Northeastern United States. The *Guide for Statewide Forest Resource Assessments and Strategies* was completed in November of 2008 and can be reviewed on the NAASF website.



The Forest Resource Planning Committee of the NAASF was asked to provide a list of issues each state faced when planning for future forests, both threats and benefits. After the lists were compiled, 7 core issues were common across the Northeastern states. These issues are:

- Development Pressure
- Forest Fragmentation and Parcelization
- Wildfire Risk

- Risks to Forest Health
- Fish and Wildlife Habitat
- Water Quality and Supply
- Tree Cover in Urban Areas

Originally, the assessment was to include economic and green infrastructure issues, but it was determined that data was inadequate and inconsistent, so the issues were not recommended. On the other hand, the Maryland DNR Forest Service felt Forest Economic Viability was also an issue to be addressed in any assessment, and developed criteria based on data that was known to exist at a statewide level. A green infrastructure assessment had already been completed, and was currently undergoing a first update.

2. Forest Conditions and Trends

A Look Back

Maryland was once covered by forest broken only by rivers, marshes, and mountain meadows, this 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 small areas for farming and berry production. 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 that blocked agriculture, bred disease, and sheltered dangerous animals. They also 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, cleared, and burned the foreststo feed a young economy based on cash crops. As the settlers spread westward, houses, fences, fuel, and crops demanded more and more forest and it fell before them. Left behind were some unanticipated consequences. The rivers and streams threading through the treeless farms collected the unprotected soil as it ran off the fields and filled the deep-water harbors of the Chesapeake Bay leaving a landscape of shifting shorelines and port communities without water. The impacts of early settlement unfolded over one hundred years and slowly resulted in massive landuse 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 healthy and high quality trees. Set by natural causes and sparks from steam engines, fire completed the job by raging over land made vulnerable by unenlightened and 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. 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 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. Maryland's first State Forester, Fred Besley, single-handedly 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.

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 all but a small portion of Maryland is within the watershed. This being the case, landcover—impervious surface, forests, development, and agriculture — has 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 it's constitute 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.

In an effort to provide some level of consistency between Maryland and the other states of the Northeastern Area, the Maryland Forest Service conducted this assessment following the recommendations of the Northeastern Area Association of State Foresters *Suggested Framework for Statewide Forest Resource Assessments* produced in 2008. The framework recommends topics and issues to study to provide a meaningful forest assessment, and uses the seven nationally-monitored criteria and 18 measurable base indicators of forest sustainability. These come from the set of Criteria and Indicators (C&I) used at the national and international levels to monitor the sustainability of temperate and boreal forests. They are commonly referred to as the Montreal Process C&I. Figure 1 outlines the seven Indicators of Forest Sustainability.

Montreal Process Criterion and Indicators

- **Criterion 1: Conservation of Biological Diversity**
  - Area of Total Land, Forest Land, and Reserved Land
  - Forest Type, Size Class, Age Class, and Successional Stage
  - Extent of Forest Land Conservation, Fragmentation, and Parcelization
  - Status of Forest/Woodland Communities and Associated Species of Concern
- **Criterion 2: Maintenance of Productive Capacity of Forest Ecosystems**
  - Area of Timberland
  - Annual Removal of Merchantable Wood Volume Compared with Net Growth
- **Criterion 3: Maintenance of Forest Ecosystem Health and Vitality**
  - Area of Forest Land Affected by Potentially Damaging Agents
- **Criterion 4: Conservation and Maintenance of Soil and Water Resources**
  - Soil Quality on Forest Land
  - Area of Forest Land Adjacent to Surface Water, and Forest Land by Watershed
  - Water Quality in Forested Areas
- **Criterion 5: Maintenance of Forest Contribution to Global Carbon Cycles**
  - Forest Ecosystem Biomass and Forest Carbon Pools
- **Criterion 6: Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies.**
  - Wood and Wood Products Production, Consumption, and Trade
  - Outdoor Recreation and Participation Facilities
  - Investments in Forest Health, Management, Research, and Wood Processing
  - Forest Ownership, Land use, and Specially Designated Areas
  - Employment and Wages in Forest-Related Sectors
- **Criterion 7: Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management.**
  - Forest Management Standards and Guidelines
  - Forest-related Planning, Assessment, Policy, and Law

Figure 1: The Criteria and Indicators of Forest Sustainability

Criterion 1: 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.

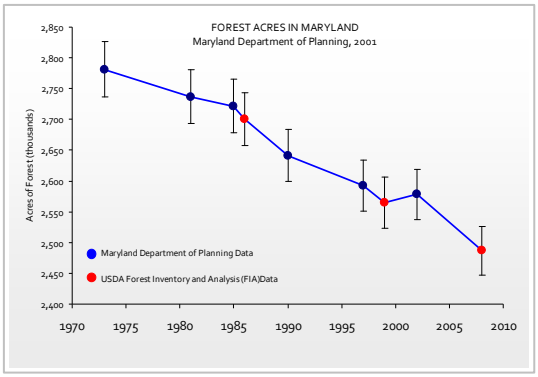
Area of Total Land, Forest Land, and Reserved Land

This Indicator assesses the percentage of the state that is forested. The US Census Bureau estimated Maryland's population at 5.63 million, a 6.4% increase over the 2000 population of 5.3 million. Total land area is estimated at 9,773.82 square miles, or 6,255,244.8 acres in 2008[1]. There are estimated to be 542 persons per square mile in Maryland making it the 5th most densely populated state in the nation.

Forestland in Maryland has generally been decreasing since the 1970s, mostly due to development. Forests covered 41 percent of Maryland, or 2.6 million acres in 1999. This amount of forest cover is remarkable in a state that has seen tremendous population growth and economic development in recent years. Today the US Forest Service estimates forest cover in Maryland to be approximately 2.46 million acres or about 39% of the total land area.

Forest cover varies from the two heavily forested (about 73%) counties of western Maryland to the less-forested (24 to 35%) urban, suburban, and agricultural counties of central Maryland and the Eastern Shore. Southern Maryland and the lower Eastern Shore also have a considerable amount of forest, 54 to 61% and 37 to 51% respectively.

Figure 2. The estimated acres of forest in Maryland, 1970 to 2008 from State and Federal sources.



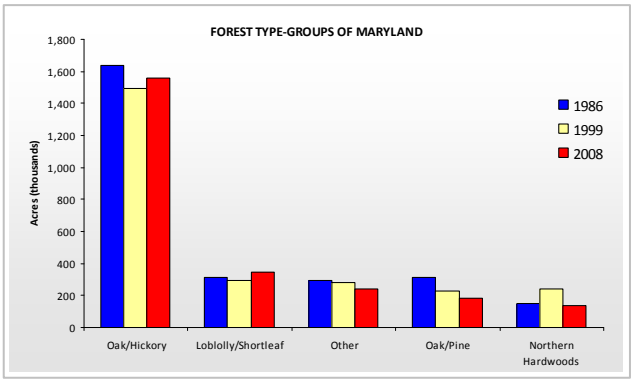
Forests on reserved land (forestland that is withdrawn from timber harvesting through statute or administrative designation) in Maryland amounted to 112,535 acres in 2008. A large portion of those acres are located in Maryland's Wildlands. The Maryland Department of Natural Resources currently manages 44,000 acres, or roughly 10% of state owned land, as Wildland. These areas are protected indefinitely by an act of the state legislature as wild, where motorized vehicle access is

restricted. Tree harvesting is prohibited in these areas and make up less than 2% of Maryland's total forest cover. A large portion of Maryland's known old growth forest is located in these areas, but total old growth forest is estimated at approximately 1,700 acres.

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

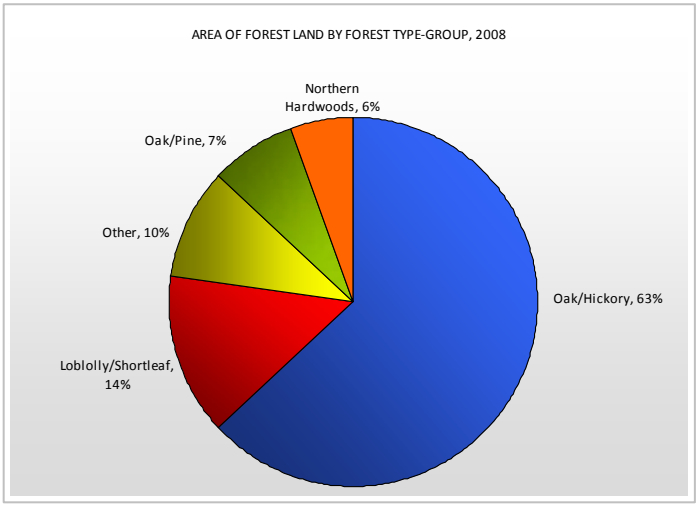
In Maryland, forest stands in which most of the stocking is in large trees suitable for sawlogs have increased in acreage since the last forest inventory (1999) of the state,. These stands, which today grow on two-thirds of the timberland, have many attributes that benefit wildlife: an understory with herbaceous plants and shrubs that provides 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. Also, people enjoy activities such as hiking and camping in stands dominated by large trees because they find them attractive and aesthetically pleasing.

Figure 3. Distribution of forest type-groups in Maryland from 1986 to 2008. Based on US Forest Service FIA data.



In Maryland, about 20 percent of the forest stands are of poletimber size (A tree of at least 5" in diameter that is not yet a sawtimber tree, but will be someday). Trees in these young stands are not sufficiently mature to produce large amounts of nuts and seeds, and often form dense overstories that inhibit the growth of understory vegetation.

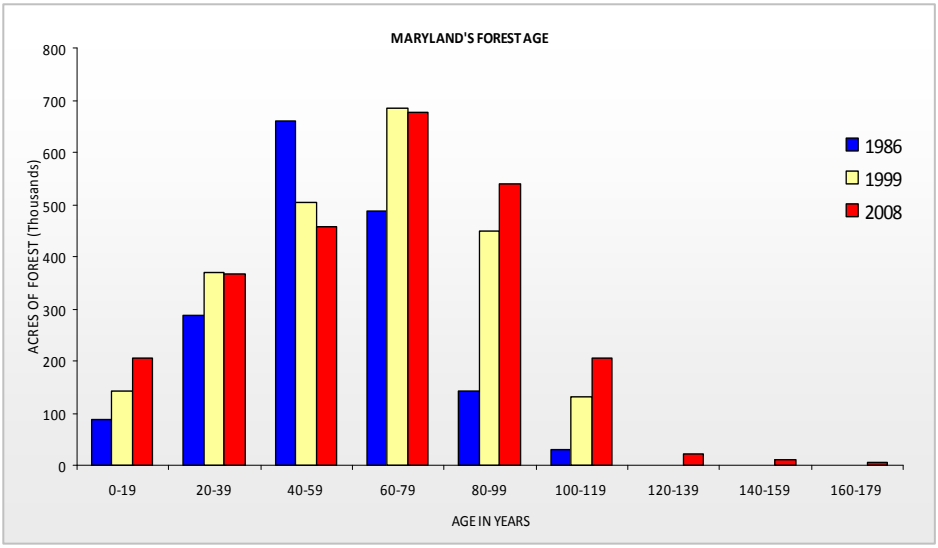
Figure 4. The percentage of Maryland's forests by Forest Type-Group from US Forest Service FIA data.



Maryland's forests now contain more large trees with increased volume. Average tree volume per acre more than doubled from 964 cubic feet in 1950 to 2,194 cubic feet in 1999. During the most recent inventory period (1999), growing-stock volume increased by 7 percent, with the portion suitable for sawlogs increasing by 14 percent to 16.2 billion board feet.

Maryland's forests are composed largely of Oak and Hickory, with Loblolly Pine and other hardwoods making up the majority of other forest types (figure 4) However, between 1986 and 2008 the number of Oak trees was estimated to have declined by 9% and Hickorys by 15%. By contrast, Red Maple increased by 16%, Swwetgum by 23%, and Beech by 80%. Traditionally, these species are less desirable from a forest product standpoint, and do not offer the same benefits to wildlife as a food source.

Figure 5. Acres of Maryland forest by Age-Class. Survey years from 1986 to 2008 are provided. Source: US Forest Service FIA data.

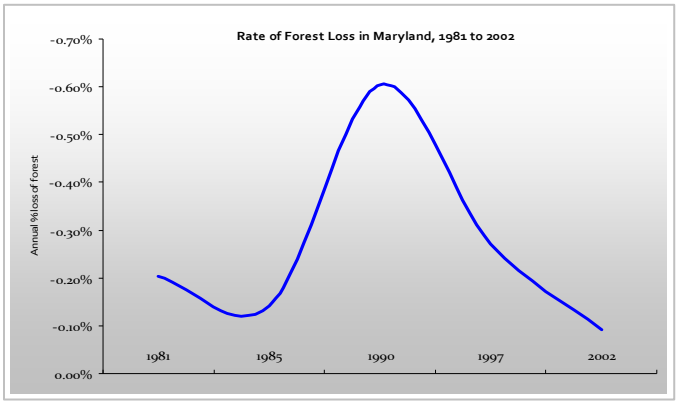


Extent of Forest Land Conversion, Fragmentation, and Parcelization

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. Between 1985 and 1990, low density residential land uses increased by 37% and the state saw development equivalent to the area of Howard County—roughly three times the size of Baltimore City—throughout the state. In that time, 11 counties averaged over 1,000 acres of new development a year. During this five year period alone, Maryland lost 71,000 acres of forest, mostly in the suburban central part of the state.[2]

In 1999 the US 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.

Figure 6. The estimated rate of forest loss, 1980 to 2002. Source: Maryland Department of Planning and DNR Forest Service.



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. Finally, the report found that Maryland had lost approximately 79,500 acres of forest in the period between 1986 and 1999[3].

The 2004 to 2008 estimate of Maryland's forest cover completed by the Forest Inventory and Analysis (FIA) unit of the US Forest Service suggests that since 1999 Maryland has lost another 72,000 acres of forest[4] (see figure 2).

Fragmentation of forests is an increasing problem. Wildlife biologists find that breaks made in the forest for roads, buildings, and other uses negatively impacts wildlife, especially birds. The US Forest Service found that in 1999 76% of forest land in the state was privately owned, and that between 1977 and 1989, the number of landowners owning less than 10 acres of forest increased 62%. In 2006, that number had climbed to 84% of privately owned forest, signaling an increase in fragmentation brought on by parcelization (subdividing) of larger blocks of land from one landowner to many.

As we look into the 21st Century, Maryland can expect to see additional development and increased population density. Areas of the state with large parcels such as western Howard County, large areas of Frederick County, eastern Carroll County, Northern Harford County, areas along the I-95 corridor in Cecil County, eastern Queen Anne's and Talbot Counties, eastern Charles County, central St. Mary's County and most of Calvert County can expected to see above normal growth between 2010 and 2030. Slow growth and even decreasing population densities will most likely occur in Allegany and Dorchester Counties, portions of Kent County, Baltimore City, and areas around the Washington DC suburbs.

Status of Forest/Woodland Communities and Associated Species of Concern

The Maryland DNR Wildlife and Heritage Service has developed a State Wildlife Action Plan otherwise known as Maryland's Wildlife Diversity Conservation Plan. This plan summarizes the current knowledge of the status of Maryland's wildlife, guides future efforts in Maryland's wildlife conservation, and is assembled by the DNR Natural Heritage Program with the assistance of other DNR units. This plan addresses eight elements, foremost of which are the needs of species in greatest need of conservation. The plan identifies eight forest community types as key wildlife habitat:

- Old Growth Forest

- Early Successional Forests
- Maritime Forests and Shrublands
- Loblolly Pine – Oak Forests
- Mesic Deciduous Forests
- Dry Oak – Pine Forests
- Northern Conifer – Hardwood Forests
- Floodplain Forests

A list of the species of Greatest Conservation Need (GCN) by each forest community as identified by the Maryland Wildlife Diversity Conservation Plan can be found in the Appendix.

Old Growth Forest

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 ongoing inventory for old growth forests on state lands has documented 1,679 acres of this important key wildlife habitat in western Maryland. 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.

Old Growth Forest Defined

Developed by the DNR Old Growth Committee (2002)

An old growth forest is a minimum of 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:

- Shade tolerant species are present in all age/size classes.
- There are randomly distributed canopy gaps.
- 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.
- There is an accumulation of dead wood of varying sizes and stages of decomposition, standing and down, accompanied by decadence in live dominant trees.
- Pit and mound topography can be observed, if the soil conditions permit it.

Note: A list of maximum attainable ages of Maryland trees has been developed. Exceptions to the definition above will be judged on an individual basis with appropriate justification.

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%). Most of the largest blocks of old growth forest are now being managed within much larger old growth forest management areas. Some of the best remaining examples occur on Savage River State Forest and Potomac-Garrett State Forest in Garrett County.

Early Successional Forests

The historical extent of early successional forest in Maryland is uncertain. It may be comparable to today's acreage (~5% of the land area)[5] but certainly the origin, distribution and characteristics of today's forms of this habitat 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, edaphic conditions and storm-related events (e.g., floods, ice storms, and tropical storms) also played a significant role. 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).

Today, the majority of Maryland's early successional forest is in the form of forest edges and recently harvested forests. The latter comprises approximately 291,000 acres or about 4.7% of the land area in Maryland[6]. This habitat is particularly common on the lower Eastern Shore with an estimated 81,000 acres (16.4% of forest land), followed by Allegany and Garrett Counties with 56,000 acres (12.2% of forest land). Information is lacking on the extent of some shrub-dominated natural communities and temporary natural forest openings but the acreage and benefit to early successional species is probably significant.

As Maryland's landscape becomes increasingly fragmented and converted to residential and commercial development, the amount of forest edge will increase, benefiting some of the more generalist early successional forest wildlife species. However, opportunities for creating or restoring (e.g., via prescribed burns, swelective thinning, natural succession) other forms of early successional forest will dwindle due to habitat loss, fragmentation and the related effects of parcelization. Maintaining natural shrubland communities, old fields, and other forms of early successional habitat is critical since forest edges support relatively few early successional habitat specialists including those that are area-sensitive or dependant on naturally occurring shrublands (e.g. Woodcock). Increases in forest edge frequently also come at the expense of species requiring large, unfragmented forests.

Maritime Forests and Shrubland

Maritime forests and shrublands are found within Coastal dune systems and flats along the Coastal regions and barrier islands in Maryland. The distribution and vegetation of these habitats is largely controlled by oceanic influences such as salt spray and deep sand deposits. Although oceanic influences are the primary contributing factors in vegetation structure and distribution, soil moisture and drainage also play a critical role in shaping these habitats.

Shrublands or "scrub" vegetation develops on inland edges of back dunes and leeward dune slopes where they are moderately protected from ocean salt spray. The vegetation is best characterized as "scrubby" in appearance typically including stunted trees and low growing, dwarfed shrub species such as beach heather, bayberry, and high- tide bush. Herbaceous species are sparse however; frequent canopy gaps support many species that are recruited from adjacent maritime grassland communities. These shrublands often occur in a mosaic with woodlands and forests dominated by Loblolly pine. Both occur on sheltered back dunes away from the primary dune where the effects of salt spray are minimal however, soil moisture is the major difference with woodlands typically restricted to rapidly drained, xeric dunes. Because these habitats have a restricted geographic range (Delaware to North Carolina) and narrow habitat requirements, they are considered globally uncommon to rare. Rangewide, these habitats are threatened by coastal development and by natural and anthropogenic disturbances that destroy the protective primary dune system. However, in Maryland nearly all remaining habitat occurs on federal and state lands.

The best remaining example of maritime forests and shrubland habitats are in Worcester County on Assateague Island. Habitats on Assateague Island represent the largest contiguous blocks of maritime forests and shrublands stretching for approximately 22 miles into Virginia. Historically, portions of Fenwick Island were scattered with maritime forests and shrublands; however, the development of Ocean City and surrounding areas have virtually destroyed all remaining habitats on Fenwick Island. There are currently about 1,600 acres of maritime forests and shrublands in Maryland, of which 92.5% is owned by the federal government, 6.3% is owned by the state, and 1.2% is owned privately

Loblolly Pine – Oak Forests

Natural loblolly pine-oak forests historically occurred throughout the lower portions of the Talbot formation reaching their northern limit in Kent and Queen Anne's Counties[7]. Before European settlement, the Eastern Shore of Maryland was predominately hardwood dominated, though increasingly mixed with pine south of the Choptank River[8]. Although large stands exist, many of today's loblolly pine-oak stands are considered second- growth, the result of extensive clearing at the turn of the twentieth century. In the nineteenth and early twentieth centuries loblolly pine became much more widespread, particularly south of the Choptank River largely due to economic factors. As an opportunistic species, loblolly pine was the first species to colonize abandoned farm fields[9]. In addition, recognizing the commercial value of loblolly pine, timber industries of the Eastern Shore accelerated the clearing of land and establishment of pines. Commercial logging industries also used steam locomotives to transport logs which were notorious for throwing sparks igniting widespread, intense fires during the late 1800s and early 1900s. Both the clearing of the forests by logging and the subsequent fires resulted in large areas of open, scarified land suitable for pine regeneration. By the middle of the twentieth century, loblolly pine was the dominant forest type in the lower counties of the Eastern Shore. Today's loblolly pine-oak stands are compositionally different than historical ones, most notably the hardwood component is not well-developed or absent altogether. Most of the natural loblolly pine-oak forests have been converted to pine plantations in recent years. Pine plantations are typically harvested on relatively short rotations and trees rarely exceed 40 to 60 years in age.

Species richness in plantations can be dramatically lower than that of natural stands with canopy associates often limited to red maple and sweetgum and sparse or absent shrub and herb layers.

Mesic Deciduous Forests

Mesic deciduous forests represent a broad group of forested habitats that are found throughout the Coastal Plain, Piedmont, and at low elevations in the Ridge and Valley and Appalachian Plateau physiographic provinces. These forests are widespread occurring throughout much of Maryland on moist low slopes, steep north- facing slopes, ravines, and well-drained uplands and occasionally in stream bottoms.

In Maryland, these forests are widely, but locally, distributed in small patches across the dissected Upper Coastal Plain, Lower Coastal Plain, and perhaps portions of the Piedmont near the fall line. In Maryland, forests that have developed over fertile basic substrates are found in the Coastal Plain, Piedmont, and major mountain valleys. Typical sites are deep ravines, sheltered north- or east-facing slopes subtending large streams and rivers, and occasionally well-drained floodplain terraces. Soils are usually weathered from carbonate or mafic bedrock, or from calcareous, shell-rich deposits in the Coastal Plain. Many of these forests are similar in species composition to rich cove forests but also usually contain species such as chinkapin oak, bitternut hickory, white ash, eastern redbud, and eastern hophornbeam. The moist and fertile soils of these forests often support a lush and diverse herbaceous layer.

Although their quality and extent were severely reduced by indescriminate logging in the past, mesic deciduous forests are widespread throughout Maryland. Areas spared from harvesting are few and mostly limited to steep slopes, sheltered ravines and coves. Many areas have been selectively cut many times and have increased the occurance of species such as American beech and other noncommercial hardwood species relative to oaks. Other disturbed habitats have increased amounts of pines and undesirable hardwoods such as red maple and sweetgum. Very few mesic deciduous forests are free of invasion by garlic mustard, Japanese stiltgrass, and other shade tolerant exotic weeds. Some of the oldest and best remaining examples of this habitat can be found under state and federal ownership such as Green Ridge State Forest, Belt Woods Natural Heritage Area, Chesapeake and Ohio Canal National Historical Park, and Fort Washington Historical Park.

Dry Oak – Pine Forests

Dry oak-pine forests are a broad group of dry upland forests and woodlands. They occur on highly droughty, infertile soils that range from strongly acidic or basic. Accumulations of thick duff and high biomass of inflammable shrubs in these forests make them susceptible to periodic fires, which in turn favors recruitment of oaks. In some cases, particularly in the mountains, these communities have replaced former mixed oak- American chestnut forests following the decimation of American chestnut canopy trees during the early 20th century by chestnut blight, an introduced fungus.

Dry-oak pine forests are a dominant habitat type on the mid- to upper slopes of many of the mountain ridges of western Maryland and hillsides in the Piedmont. However, their extent and condition have been greatly reduced by forest loss, fragmentation, fire suppression and invasive plant species. Because of the predominance of oak, this habitat is particularly vulnerable to Gypsy Moth damage, and salvage harvests are common.

On the Lower Coastal Plain, many of the largest remaining tracts occur along the leeward or eastern sides of the Pocomoke River, Nanticoke River and Marshyhope Creek and along some of their tributaries (e.g., Nassawango Creek). The condition of these "sand ridge" communities has been altered by fire suppression, and conversion to loblolly pine stands. In addition, large acreages have been converted to cropland, residential development, and sand and gravel mining operations. Calcareous variants of this habitat are rare to uncommon, and confined to small, scattered sites on the upper Eastern Shore and western Maryland.

Northern Conifer-Hardwood Forests

This habitat comprises two subboreal forest types, northern conifers and northern hardwoods. In Maryland, northern coniferhardwood forests grow primarily on the Allegheny Plateau, typically on mesic sites above 900 feet elevation, as forest ecotones bordering high elevation wetlands, along stream bottoms and north-facing slopes, and in deep ravines. In northern conifer forests, eastern hemlock, red spruce, and/or white pine is co-dominant or dominant, and often mixed with northern hardwoods.

Most of the state's remaining northern conifer- hardwood forests occur on the Allegheny Plateau followed by the Ridge and Valley where it is more local in distribution. The overall extent and quality of this habitat has been greatly diminished by indescriminate harvesting, conversion to agriculture, strip mining and residential development. During the late 19th and early 20th centuries, heavy cutting all but eliminated most remaining tracts of old growth condition of this forest. On the Allegheny Plateau, red spruce was nearly logged out. Most of the few remaining forests containing red spruce are now confined to high elevation bog wetland systems. The extent and dominance of white pine, a highly sought after and formerly much more common tree species, has also been greatly reduced. In recent years, eastern hemlock has been impacted by infestations of Hemlock Woolly Adelgid, an accidentally introduced insect pest. Hemlock stands in the Blue Ridge, Piedmont and Coastal Plain have been particularly hard hit. Widespread declines in hemlock could have severe ripple effects on other flora and fauna dependant on hemlock-dominated forests.

Floodplain Forests

Floodplain forests comprise a variety of nontidal and tidal forest habitats that occur along streams and rivers and their adjacent floodplains. Examples of floodplain forests can be found statewide but some of the largest tracts occur on the Upper and Lower Coastal Plain. In brackish river systems, small fringing tidal woodlands dominated by loblolly pine occur along portions of tidal rivers and creeks, in narrow ecotones between "high salt marshes" and adjacent uplands, and as islands within extensive salt marshes. Examples of tidal floodplain forests can be found in

the lower "tidewater" areas of Dorchester, Wicomico, Somerset, Worcester and St. Mary's counties. In the Piedmont and Ridge and Valley provinces, most large stream and river floodplains consist of temporarily to intermittently flooded bottomland forests, dominated by sycamore, silver maple, boxelder, and American elm.

Extensive tracts of floodplain forests remain along some of the streams and rivers of the Coastal Plain, especially in the Pocomoke, Nanticoke, Choptank and Patuxent drainages. However, many of these waterways, especially the smaller tributaries, have been ditched and channelized and the remaining floodplain forests areas have been drained and cleared for agriculture. From the Piedmont westward, many of the largest floodplain forests occur along the Potomac River and its major tributaries. However, much of this habitat has been converted to cropland or pasture, with concomitant decreases in stream water quality. Many floodplain forests also have been impacted by dams and rapidly expanding populations of invasive species. On the lower Eastern Shore, poor practices of the past have significantly reduced the extent of bald cypress and Atlantic white-cedar. Floodplain forests have also been impacted by changes in stream and river hydrology and declines in water quality due to reductions in forest cover, agriculture and increases in impervious surfaces in the surrounding watershed

Criterion 2: Maintenance of Productive Capacity of Forest Ecosystems

Area of Timberland

Timberland is defined by the US 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"[10]. According to US Forest Service data, the area of timberland has decreased 6% from its 1976 estimated size of 2.53 million acres to 2.37 million acres in 2008. Stands classified as sapling-seedling and nonstocked decreased from 20 percent of timberland in 1976 to 12 percent 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.

Besides offering diverse habitat for wildlife and providing a steady flow of wood products, forests that contain all stand-size classes might 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. In 1976 timberland consisted of 55% sawtimber stands. In 2004 that number had increased to 76% of all timberland.

Annual Removal of Merchantable Wood Volume Compared with Net Growth

Merchantable wood volume removal compared with net growth in Maryland has been on average 57% of the net annual average growth. Maryland has seen an average annual growth of 6.56 million cubic feet of merchantable (greater than or equal to 5 inch diameter at DBH) wood on its timberlands, with 3.77 million cubic feet of that wood being removed annually on average.

Figure 7: Percent of forest area by stand size in Maryland 1976 to 2008. US Forest Service FIA.

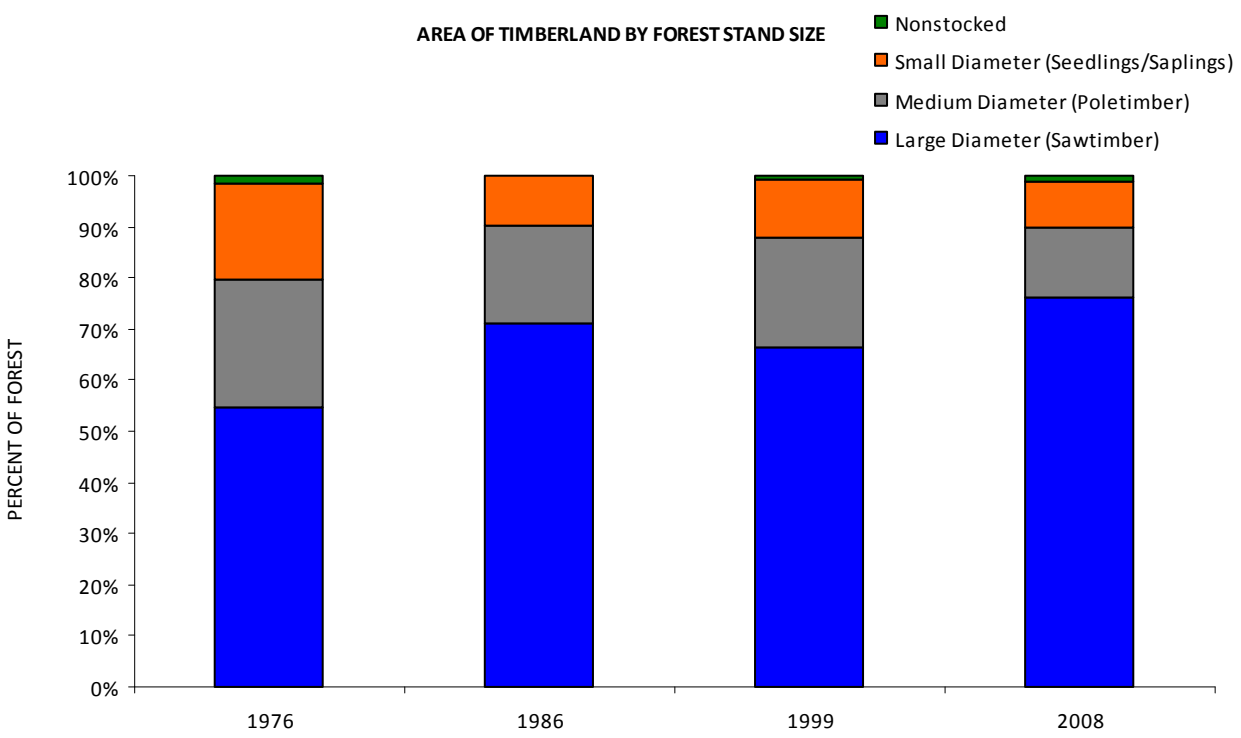


Figure 8. 2008 Net Growth compared with Average Annual Removals in cubic feet of timber on Timberlands in Maryland. Source: US Forest Service FIA.

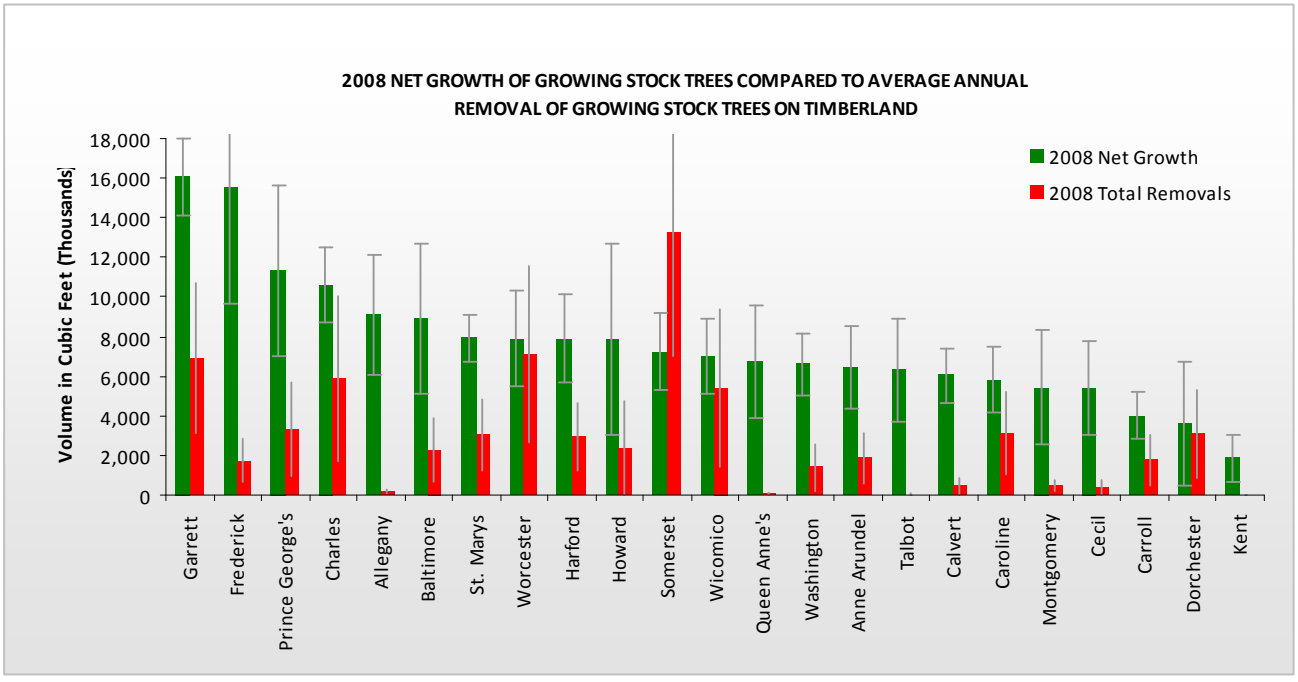
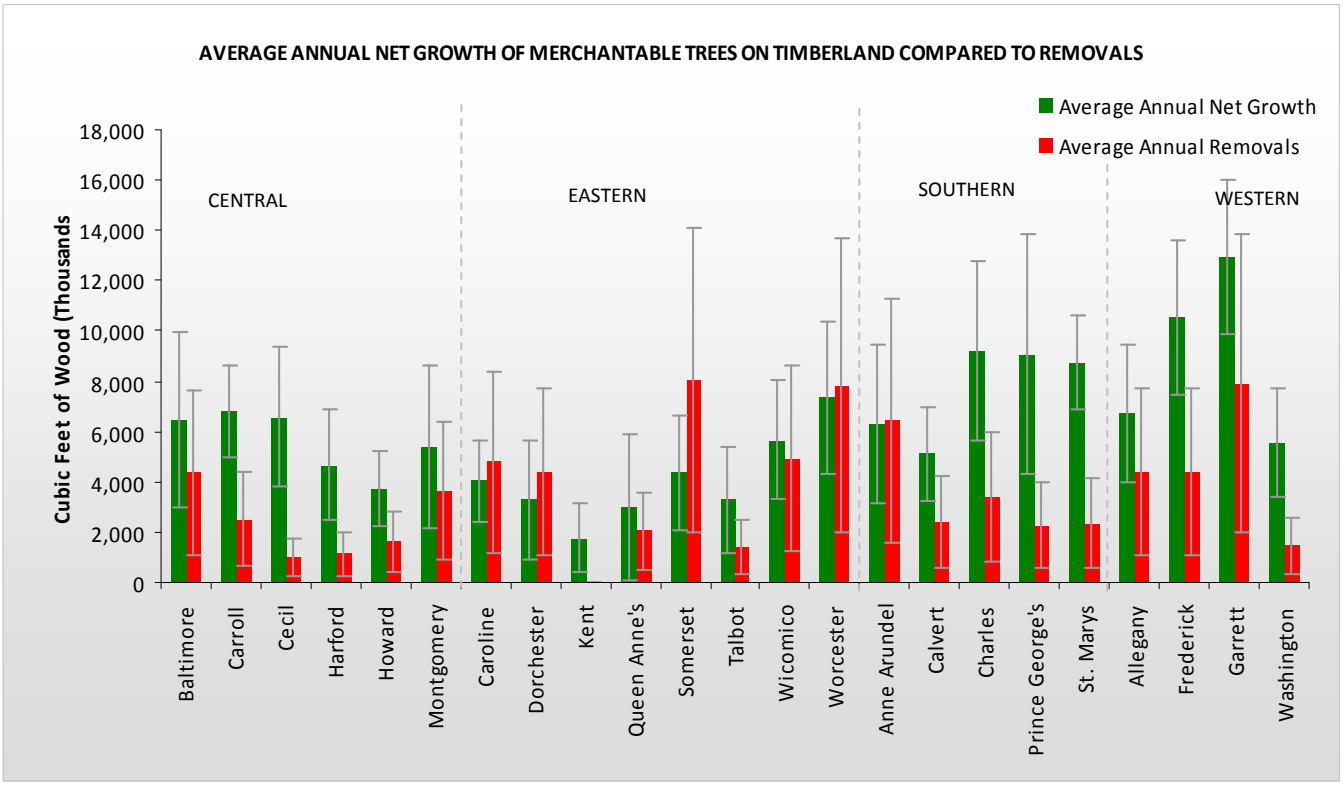


Figure 9. The Average Annual Net Growth of Trees on Timberland compared to Average Annual Removals on Timberland in Maryland by Region. Source: US Forest Service FIA data from 1986, 1999, and 2008.



The error rates of the FIA data are very high in Figures 8 and 9, however general trends and assumptions can still be made from it. Interestingly, the Central Region of Maryland has a much lower rate of removal than the rest of the state. This is most likely due to the high population density and large number of stands that are small and less attractive from a timber management perspective. Four counties in the Eastern Region (the Delmarva Peninsula) appear to experience greater removals than growth. However, the amount of error in the data suggests that this is not the case. These counties also contain the bulk of all state Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) certified sustainable forests. Queen Anne's and Talbot Counties are similar to counties in Central Region with higher population densities than the rest of Eastern Region. Removal data was not available for Kent County, however removals are expected to be fairly low in this county due to the high proportion of agricultural land use and traditionally low level of forest management.

Criterion 3: Maintenance of Forest Ecosystem Health and Vitality

Area of Forest Land Affected by Potentially Damaging Agents

Development Patterns

Projections by the Maryland Office of Planning estimate that between 1990 and 2015 the area dominated by urban development is likely to increase by 48% for a total of 1.5 million acres making Maryland 25% developed at that time. 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, an additional 274,000 acres of forests could be lost to development. Appropriate planning for land use and resource-specific controls such as Maryland's Forest Conservation Act may reduce this acreage.

Climate Change

Forests make up 39 percent of Maryland land cover. In 2000, they absorbed an estimated 11.5 million metric tons more of carbon dioxide equivalents ($MMTCO^2e$) than they emitted. Urban forests added an additional savings of 2.4 $MMTCO^2e$. Science tells us that forest carbon sequestration will become less effective if we do not reduce our green house gas (GHG) emissions generally, due to the increasing dominance of early successional conifers and more frequent forest fires in a warmer Maryland climate. The maple-beech-birch forest of Western Maryland is likely to fade away and pine dominant forest types are projected to become more dominant in Maryland forests.

Temperature, water, and solar radiation are the primary climatic factors that affect forest productivity. Increased precipitation, higher temperature, and a longer growing season will increase productivity where those factors are currently limiting. Consequently, a modest increase in forest yields and regrowth is likely. During the latter part of the century under a higher emissions scenario, however, heat stress, drought, and climate-related disturbances, are likely to force forest productivity to decline. Forests which grow more rapidly because of the CO^2 fertilization effect (plants require carbon dioxide for photosynthesis and an increase in atmospheric carbon dioxide can increase growth) may become increasingly fire-prone or subject to insect outbreaks.

Forests can take decades to re-establish after disturbances are caused by fire, insect outbreaks, and wind or ice storms. These effects are likely to become more important than the direct effects of climate itself in shaping future forest ecosystem structure and functioning. Sea level rise will have a more dramatic effect as saltwater incursion into ground water kills salt-intolerant trees in coastal regions.

Sustainable forest and urban forest management is essential to healthy, productive forests and trees that maximize mitigation for GHGs and carbon sequestration. Additionally, these forests

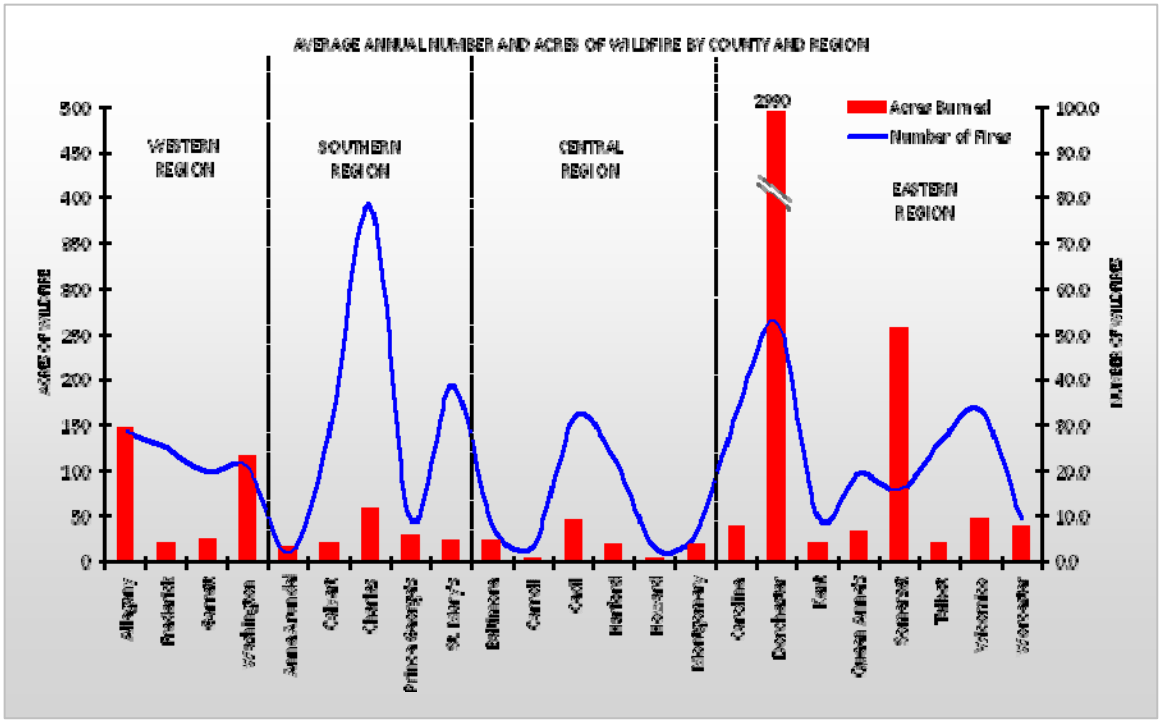
serve as the preferred land use for avoiding emissions. Increasing the amount and enhancing the condition of forests and trees is a critical component of mitigating climate change.

Every acre of forest in Maryland is potentially subject to alteration if climate change shifts species. Under a doubling of CO2 concentrations—likely to be experienced in the latter half of the century under the low-emissions scenario—the maple-beech-birch forests of Allegany and Garrett counties are likely to disappear, replaced by oak-hickory forests. Trees once found in Maryland—like Hemlock and Spruce—may become more scare as preferred habitat is pushed further north. The oak-hickory forest type that presently characterizes most of the Piedmont and Coastal Plain west of the Chesapeake is likely to transition to an oak-pine forest.

Wildland Fire

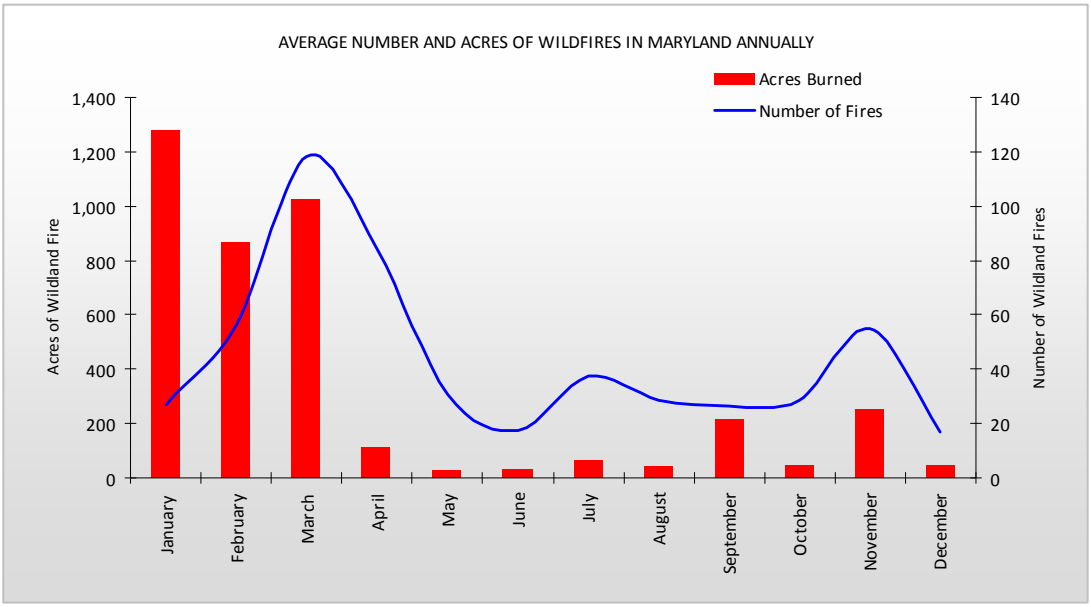
The MD DNR Forest Service is mandated by Natural Resources statute § 5-701 with the responsibility for forest fire suppression on all lands within Maryland. Annually the Forest Service responds to an average of 660 wildfires burning 3,600 acres throughout the state. In 2006, the Forest Service responded to 738 wildfires that burned 6,039 acres. In 2009, there was a decline to 4,853 acres of wildland fire on 408 separate incidents.

Figure 10. The average annual number of acres burned by wildfire, and the number of fires reported, by county and region in Maryland for the period 2000 to 2009. Source: MD DNR Forest Service.



The DNR Forest Service is the only state agency that maintains specialized heavy equipment for wildfire suppression. The Forest Service also relies on the volunteer and career fire service throughout the state for initial attack response for wildfires.

Figure 11. The average annual number of acres burned and the average annual number of fires reported by month for the period 2000 to 2009. Source: MD DNR Forest Service.



The Maryland Department of Natural Resources Forest Service assists fire companies in training, providing specialized equipment, investigating fire origins, and enforcing laws and regulations pertaining to wildland fires. The 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, chances of human-caused ignitions increases. In Maryland, arson is the leading cause of wildfires, accounting for 28%. Debris burning causes 26%, children playing with matches cause 11%, and the 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 DNR 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. Landowners and 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.

Insects and Diseases

A brief description of insects and diseases known to attack, damage, and kill trees and known to be present in Maryland or to soon be present follows, along with the acreages of forests at risk.

Orange Striped Oakworm–(Anisota senatoria (J. E. Smith)) Trees in forests, parks and cities can be defoliated. 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. A small outbreak was being monitored in 2009 and amounted to approximately 44 acres.

Variable Oakleak Caterpillar—(Heterocampa manteo (Dbldy.)) Variable Oakleaf Caterpillar was last recorded in Maryland in 2003 in two areas of the state; northern Caroline County/South Central Queen Anne's County and South Central St. Mary's County. 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. Parasites and predators, especially birds, often control populations. The Maryland Department of Agriculture Forest Pest Section monitors these periodic outbreaks and recommends treatment options. The outbreak in 2003 affected the forest on approximately 6,600 acres.

Cherry Scallop Shell Moth –(*Hydria prunivorata (Ferguson*) Cherry Scallop Shell Moth 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[11]. 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) Caterpillars of these two similar 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. Caterpillars of both species feed on oaks, maples and hickories.

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 tree may require insecticidal control[12]. According to the Maryland Department of Agriculture, 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.

Southern Pine Beetle—(*Dendroctonus frontalis (Zimmermann*)) Normally, southern pine beetles can be found at non-damaging levels in most pine stands on the Eastern Shore. They build up to damaging levels in overstocked, over mature or stressed stands. Healthy, vigorous trees are able to resist attack, however, trees that are weakened are susceptible to beetle attack. In 2005 this occurred in pine stands in southern and western Talbot County, and was the first record of extensive beetle activity in that county.

Southern pine beetles are 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 the areas affected amounted to approximately 100 acres, and were quickly contained. Activity is expected again in 2012 or 2013.

Hemlock Woolly Adelgid –(Adelges tsugae) The Hemlock Woolly Adelgid 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 20 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. The treatment of landscape hemlocks to control Hemlock Woolly Adelgid is much easier and more likely to succeed than the treatment of forests areas. In fact, there are few options available for controlling the adelgid in forests. Hemlocks in Maryland are usually found in inaccessible areas, such as along streams. Chemical control in these areas is often impractical or, due to the chance of chemical drift into the water, impossible. Tree injections with insecticides is a new alternative. Maryland Department of Agriculture also is investigating the use of biological control agents as a management tool.

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 July through October. Whatever treatment is used it is most important to get thorough coverage of all infested parts of the tree.[13] As of 2009, approximately 26,000 acres were thought to be at risk to Hemlock Woolly Adelgid in Maryland, and are currently being monitored or treated by the Maryland Department of Agriculture or the MD DNR Forest Service. Treatment options will follow the guidelines found

in the Hemlock Woolly Adelgid Strategy (Management and Suppression Plan) between 2010 and 2015.

Gypsy Moth—(A native of Europe, the 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 percent 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, the caterpillars were very active and the suppression spraying was conducted largely in those areas. 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 spring of 2000 – defoliating 22,824 acres – and again in 2001 – defoliating 46,183 acres. In 2000, the MDA's Gypsy Moth Suppression Program sprayed the trees on 16,971 acres. In 2001, the Suppression Program sprayed the trees on 48,588 acres.

In 2002, MDA sprayed 39,134 acres of trees statewide and only 112 acres of trees (untreated) were defoliated. As populations again began to collapse, spray acreage was reduced to 14,053 acres in 2003 and to 660 acres in 2004. There was no suppression spraying in 2005.

In 2006 and 2007, conditions seem to have been especially favorable for gypsy moth larvae. The large, healthy caterpillar populations fed voraciously on the oaks and other hardwoods in Maryland, defoliating the trees on 15,793 acres in the spring of 2006 and on 68,460 acres in the spring of 2007. In 2006, in response to population data gathered in the fall of 2005, the MDA's Gypsy Moth Suppression Program sprayed the trees on 25,456 acres statewide. In 2007, the Suppression Program sprayed the trees on 50,173 acres statewide.

Responding to the defoliation in 2007 and to population predictions from the 2007 fall egg mass survey program, MDA's Gypsy Moth Suppression Program sprayed the trees on 99,222 acres in the spring of 2008. Defoliation surveys conducted in July revealed that the trees on better than 97% of the areas sprayed were protected from severe leaf destruction. The trees on 2,803 sprayed acres showed moderate to heavy defoliation. Statewide in 2008, the caterpillars defoliated the trees on 19,279 acres. The majority of the defoliation occurred in Allegany (5,905), Garrett (1,793), Washington (1,855) and Frederick (8,204) counties[14].

Emerald Ash Borer— 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. Emerald ash borer (EAB) is a serious pest of quarantine significance. The Maryland Department of Agriculture issued a Quarantine Order in March, 2004. In August, 2006, larvae was detected in a sentinel ash tree placed in the original eradication area as part of follow up survey activities, and a girdled tree just outside of the eradication area, but still within the quarantined area, were confirmed as emerald ash borer by the USDA. The Maryland Department of Agriculture issued a revised Quarantine Order that prohibits anyone from moving ash (*Fraxinus* spp.) trees, products, or any hardwood firewood into or out of Prince Georges's County until further notice. The County was added to the federal emerald ash borer quarantine on June 1, 2007. In August 2008 emerald ash borer was discovered about 180 feet over the county line in Charles County. The state quarantine was revised at this time to encompass Charles County. The eradication zone (EZ) which previously encompassed 16,000 acres was increased to include areas in which purple prism traps baited with Manuka oil detected EAB. The new zone and buffer now encompass 18,000 acres, mostly in Prince George's County, with a small area in Charles County. In 2009 the final eradication zone encompassed 18.3 square miles, and the project area is nearly 45 square miles in size. Unfortunately, EAB outbreaks have been found in Northern Virginia and Pennsylvania, and it is considered only a matter of time until new outbreaks are detected in the region.

Control of the Emerald Ash Borer continues to be a joint effort between the Maryland Department of Natural Resources Forest Service and the Maryland Department of Agriculture. The DNR Forest Service maintained operational oversight of ground/harvest operations in wooded areas in the EZ, while the MDA continued ash inventory and eradication in residential areas of the EZ, and emerald ash borer delimitation survey in the ½ - mile delimiting buffer area. As the MDA contains the forest pest and disease expertise in Maryland, they will continue to monitor the Emerald Ash Borer intensely in the EZ and the surrounding areas, while also maintaining traps in all Maryland counties[15] Current operations are lower in intensity and focuses on survey, insecticide treatments, and monitoring.

Beech Bark—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. 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.

Imminent Threats

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 has found its way to North American in untreated crates and shipping products containing viable larvae. The wasp is not considered a threat to it's native pines in Europe and Asia..

There are no known reports of Sirex Wood Wasp 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[16].

Maryland's southern counties and Eastern shore is the northern-most 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 nation's pine lumber industry. Ironically, the main threat is not from the wasp itself, but from a fungus (*Amylostereum aveolatum*) the wasp inoculates the trees with when reproducing. This fungus is a nutritious food source for the wasp larvae, but 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.

Sudden Oak Death—(Phytophthora ramorum) known as Sudden Oak Death is a water-loving fungus that is most active during humid or wet conditions. It produces spores that can swim through water, and some species can spread spores by wind if conditions are not too hot and dry. It first appeared in California in the 1990s, and is not considered native to North America, and is spread mostly through infested nursery stock shipments. The concern is that large areas of the United States could provide the necessary host plants and suitable climate for the pathogen to become established and cause disease. This has happened with two other tree diseases, Dutch elm disease and chestnut blight.

In Maryland, through a national survey and "trace-forward" inspections of plant nurseries, three nurseries were found to have plants infected with *P. ramorum*. USDA protocols were followed in all instances, and P. ramorum was eradicated at those sites. *Phytophthora ramorum* has not been detected in the environment in Maryland.

Most of these species are considered "invasive exotics" or "noxious" To help combat these threats the Maryland Department of Natural Resources and Maryland Department of Agriculture developed *Maryland's Emergency Response Plan for Invasive Forest Pests* in 2005. The response plan is intended to identify agency roles and a plan of action for early detection, rapid response, control, and management. A team of multidisciplinary specialists, managers, and researchers developed this emergency response plan to organize for success—incorporating the themes of improving capacity, procedural streamlining, and funding flexibility with long-term commitment.

Although the plan organizes State efforts to combat environmental threats to forest health by invasive insects and diseases into a logical, systematic framework, it is not designed to serve as a comprehensive, all encompassing strategy.

A network of regulations, inspections and surveys is already in place to detect the introduction of an invasive species. The Maryland Department of Agriculture, Plant Protection and Weed Management Section conducts inspections of nursery stock entering the State, as well as systematic surveys through the Cooperative Agricultural Pest Survey program. The Maryland Department of Agriculture, Forest Pest Management Section conducts annual, systematic surveys in forested areas through the Cooperative Forest Health Program and the Forest Health Monitoring program. These programs work closely with the Maryland Department of Natural Resources, Maryland Forest Service and the public to recognize and report new forest pest problems in Maryland.

Deer

Animals may also affect 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. 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. These densities are high compared with the number of deer that most of Maryland can support. 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 browsed by deer, the diversity of plants is often significantly reduced and forested areas are difficult to regenerate when deer browsing pressure is high. Forests that survive repeated browsing develop slowly with widely-spaced trees of low vigor, poor form, and few species.

Exotic and Invasive Plants

Exotic and invasive plants established in Maryland are threatening forests and other native plant communities. Many of these 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 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 the single greatest threat to biodiversity worldwide, second only to habitat destruction by man. 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. An invaded area that becomes a mono-culture offers reduced habitat for animals. Since non-native species usually invade from "edges" they have caused 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.

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 exoctic and invasive plant species causing problems in Maryland are: Norway Maple (Acer platanoides L.), Lesser celadine (*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 Kudzu (*Pueraria montana var. lobata*), Garlic Mustard (*Alliaria petiolata*), Japanese Spiraea (*Spiraea japonica*), and Multiflora Rose (*Rosa multiflora)*.

Criterion 4: 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% 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 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 where monoculture (like a tree plantation) is practiced, and where biological diversity is relatively low.

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 have 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.

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

Planting and maintaining forest buffers is a cost-effective means of reducing amounts of pollutants entering waterways, including the Chesapeake Bay. In Maryland, there are almost 17,000 miles of streams and 7,500 miles of shorelines. Many of these areas have naturally vegetated buffers of 100 feet or more, but 36% lack this basic environmental protection. Over 1/3 of these inadequately buffered waterways are in developed areas, with the remainder in rural areas. Forest buffers are a cornerstone of strategies to improve water quality and stream health, from Chesapeake Bay and Coastal Bays restoration to local streams with water quality impairments. Research has consistently shown nitrogen removal rates of 60 to 90 percent in forest buffers over 100 feet wide. The shading and natural inputs from the forest support healthy stream and aquatic communities that further cleanse the water. Benefits of forest buffer also extend to wildlife habitat, clean air, and recreation.

Stream systems across the state have also 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. Recent estimates suggest that on average, approximately 76%, of the area within 100 feet of streams in Maryland has some form of forest cover. Table 2 in Appendix A shows the amount of forested streams and shorelines by county in the state.

Water Quality in Forested Areas

Forests are the least polluting major land use, so *keeping forests of any type on the land* 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 layer, shrubs, small trees, herbaceous plants, and all the insects and animals that keep it going. While keeping forest cover is the 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.

Maintaining large, highly forested watersheds on the landscape is critical to providing clean water to Maryland's native fish populations A report by the Maryland Biological Stream Survey found that population estimates for 9 species of fish had increased above 500 individuals, and that four of those nine instances had occurred in western Maryland, where the dominant land cover is forest[17].

Watersheds with a large number of forested wetlands are where particular care in forestry practices may be needed in order to maintain the ecological, public safety, and water quality benefits provided by forested wetlands. Because of the history of loss of these valuable land types, local land use decision-making may need to be particularly careful about potential impacts of urban types of development proposed in or near forested wetlands.

Forests and 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 3.6 million residents in the Baltimore and Washington, D.C. metropolitan areas, over 63% 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 most of the reservoirs is publicly owned and kept in forest, relying of the buffering role and low nutrient outputs of forested systems. These areas are important to keep in forests that 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.

Criterion 5: Maintenance of Forest Contribution to Global Carbon Cycles

Forest Ecosystem Biomass and Forest Carbon Pools

Forest ecosystem biomass measurements were begun for Maryland with the addition of the Biomass Statistics for Maryland for 1986, which was added to the fourth forest inventory for Maryland. The estimates recorded at that time placed biomass at 94.4 million dry tons of wood and bark in all above ground growing stock trees (5 inches D.B.H. and larger) on timberland. The average of the 2004 to 2008 biomass for the same category placed biomass at 124.1 million dry tons; a 31% increase on timberlands.

Forest carbon pools in Maryland were estimated by the US Forest Service, Northern Research Station in 1997 to be 92.8 million metric tons in biomass. The average of the 2004 to 2008 US Forest Service FIA estimates for above and below ground carbon was 96.3 million metric tons.

Criterion 6: Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies

Wood and Wood Products Production, Consumption, and Trade

Although Maryland accounts for only 0.3% of the nation's softwood production and 1.6% of its hardwood production, the forest products industry is economically important in parts of the State. The economic value of Maryland's forest s is impressive, given the state's extent of urbanized area and relatively small size. The forest industry is the fifth largest industry in the State, with more than 1,500 wood using companies support a $4 billion industry.

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 forestry sector in Maryland. They defined the forestry sector based on the North American Industry Classification System (NAICS) codes for logging, forest nurseries, forest products, timber, and agriculture and forestry support activities; code 322, paper manufacturing; and 377, furniture and related product manufacturing. This was done to encompass the "commodity producers", namely timber, nursery products, etc., and the immediate "down stream" processors and manufacturers. Over 50 codes were referenced overall, and a complete list is available in Table 27 of the BEACON report.

The study found that forestry and the wood derivatives industry generated $4.7 billion in 2005, and was second only to Crop and Nursery Agriculture in the resource based industry's contribution to the state's economy. Forestry and wood derivatives generated over $3 billion in "direct" output in 2005. From that an additional $1.7 billion was generated by "indirect" and "induced" economic activities. Induced activities were explained as "ripple effect" in the BEACON study. Another study describes induced economic activities as wages spent in the community by employees of direct or indirect forest industry activities[18]

Outdoor Recreation Participation and Facilities

More than 11 million people annually enjoy Maryland's 500,000 acres of public lands for a wide array of recreational and tourism activities. Maryland's forests provide opportunities for diverse forms of recreation. These opportunities are expanded, 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. Sample trends and issues related to this category include:

- Increased demand for forest-based recreation and associated services increases the complexity of managing conflict among forest users.
- Today's mix of forest uses demands the coordination of forest management and recreational activities.
- The amount of forestland open for public use is decreasing, impacting the future of public hunting, fishing, and other forms of recreation.
- Conflicting use of forests is a public debate.
- The increased popularity of motorized recreation in forested areas is leading to increased conflict among forest users.

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 and decisions for treatment are often made. 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 occurring 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.

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 and thus facilitating the economic resources needed to carry out needed Silviculture. 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 Ownership, Land use, and Specially Designated Areas

The U.S. Forest Service's National Woodland Owner Survey (www.fia.fs.fed.us/nwos) is conducted to improve our understanding of who owns the forests of the United States, why they own them, how they use them, and what they intend to do with them. This information is used by foresters, educators, and researchers to create programs, policies, and services that better meet the needs of forest owners and society. The family forest results below are a summary of the 78 owners from Maryland who participated between 2002 and 2006.

The National Woodland Owner Survey conducted in 2006 found that about 76% of Maryland's forests are privately owned and that 84% of those owners held 1-9 acres of forest[19]. The reasons why people owned those forests were for beauty/scenery, it was a part of their home, to protect nature, for privacy and to pass on to heirs. When asked what their immediate plans for their forest was, top responses were; Minimum activity, Leave it as is or no activity, Harvest firewood, Buy more forest land, and to Collect non-timber forest products.

The number and type of those ownerships are shifting as well. The US Forest Service FIA assessment of ownerships in Maryland reports the acres of forest in private ownership and federal ownership is decreasing, while state and local government ownership of forest increased. Private ownership decreased 17% over the same period, from 2.26 million acres to 1.87 million acres. State and local governments on the other hand, are gradually increasing ownership of forest by about 10% per year. This is probably attributed to donated easements and open space land acquisitions.

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 29,000 jobs were supported by the forestry sector, of which no less than

2,500 are estimated to be directly linked to timber produced by Maryland's forests. This was approximately 1% of Maryland's total employment in 2005[20]

The wood products industry is the largest employer in the Central Region, which accounts for 53% of all forestry and wood derivative activities. The Eastern shore, particularly the lower shore, accounted for 22% of the industry's total employment, followed closely by Western Region, with 21%. Southern Maryland followed the other regions with only about 3% of jobs directly and indirectly related to or induced by forestry and wood derived activities. Top employing localities were Baltimore City, Anne Arundel County, and Montgomery County respectively.[21]

Criterion 7: Legal, Institutional, and Economic Framework for Forest Conservation 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. The Maryland DNR Forest Service is working to have all State Forests certified as sustainable by a third party entity by 2012.

Forty percent of Maryland's urban areas are covered by Urban Tree Canopy (UTC) representing 11.1% of Maryland's total tree cover and forests in these urban settings strongly influence the local environment, quality of life and economy. Pressures placed on these urban forests increase as the state's population increases, highlighting the need to understand the extent of urban 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 management of such forests are at the forefront of Maryland's urban forestry issues

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. Electronic publishing allows the plan to be a dynamic and living document. 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. The 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 US 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 of recommendations to planning activities and setting or amending policies.

Maryland has been at the forefront of forestry law with the legislation enacting the Forest Conservation Act, which was adopted in 1991 to stem the loss of forest in the State, and established standards for local authorities to enforce during development (see Appendix F). 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, State House Bills 1141 and 2, both passed in 2006, required all comprehensive local government plans to consider forests and forestry during the planning and land preservation process.

The Sustainable Forestry Act of 2009 will help slow forest land conversion by encouraging local government planning and zoning to promote forests and forestry. The act also provides expanded funding of the Woodlands Incentive Fund (WIF) which will be 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 FCA and the Sustainable Forestry Act are examples of forestry laws that successfully reducing the amount of forest that would otherwise be lost to development, and prove that Maryland is at the forefront of innovative Forestry law and policy

3. Existing and Emerging Benefits and Services

Forests are an integral part of Maryland's landscape, our environment and our 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. These are normal physiological and biochemical processes of plant metabolism and growth. 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. Currently, all Marylanders live in areas that meet federal standards for carbon monoxide, sulfur dioxide, particulate matter, and nitrogen dioxide. Only 13% of Marylanders live in areas where standards for one-hour ozone are exceeded, this would likely be higher if there were fewer trees on the landscape to clean the air.

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, and environmental standards, 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

4. Issues, Threats, and Opportunities

Issues

- Forest landscapes must be sustained or restored
- Healthy and resilient forests are threatened by development and parcelization
- Clean and abundant water must be provided
- Jobs and sustainable communities are encouraged
- Landscapes must be more resilient to climate change
- Urban forests are protected and enhance public benefits
- Wildfire must be controlled or suppressed

Threats

- Landuse Change, Development, and loss of the resource
- Uncontrolled wildfire and wildlife in the Wildland Urban Interface
- Climate Change will raise sea levels and shift species.
- Forest Pests and Diseases must be mitigated.
- Invasive Species must be dealt with swiftly and effectively.
- Deer populations will inhibit forest regenerative capacity if unchecked.

Opportunities

- Continue to promote perpetual conservation easement programs such as Program Open Space (POS).
- Develop a private landowner enhancement incentive program to curb the conversion of the forest land and improve forest health.
- Encourage jurisdictions to develop and follow comprehensive plans that specifically address the long term protection and management of forested working landscapes.
- Continue to champion working forests as an important component of conservation landscapes in combination with protecting ecological function in core protected areas.
- Bolster Conservation Easement Acquisition Programs that are paramount in curbing the current decline of our forest land base.
- Work with state and local governments to enhance existing forest land tax reduction programs and develop new incentives for the expansion and retention of the forest land base.

- Propose legislation that would broaden the purpose and intent of existing land conservation programs by placing greater emphasis on the conservation of working landscapes.

5. Priority Landscape Areas

To provide priority areas for the 7 core forestry issues affecting Maryland and the three USFS Nation Priorities, a process was developed that was based on the recommendations of the GIS focus group that met in Colorado in November, 2009. Two Maryland DNR Forest Service employees attended the conference, one to represent the DNR Forest Service on the Strategy Committee and one for the Geospatial Analysis Committee. The Geospatial Committee had the following recommendations for completing the Assessment for all states:

- Use the best available data; only use federal, or national level data if a comparable data layer is not available from regional or state sources.
- Use a weight scheme to determine the importance of each data layer within each model.
- Have local experts review the data layers and associated weights
- Use a prioritization method that is spatially appropriate, i.e. "not too much and not too little"
- Priority areas that cover approximately 30% of a state are appropriate.
- Name priority areas. This will enhance management efforts and public recognition.
- Combine all priority areas into one, general statewide "Forest Priority Area" map.

Most of the recommendations were followed, with the exceptions being priority area size and creating a general statewide "Forest Priority Area" map. Priority areas may be much less than 30% of the state or much more, depending on the priority issue.

The process of selecting forest priority areas began with building models for each of the seven Forestry Core Issues. These models were constructed from data layers—or digital maps—of areas like Rare, Threatened, or Endangered Species Habitats, Population Density, Soil Types, and others depending on the issue. Experts from both within DNR and in other agencies and organizations were contacted to discuss the importance of a data layer or whether or not it should be included.

Some Forestry Core Issues have more data layers than others, but the number of data layers can represent how complex an issue is to manage, and the number of variables that land managers have to contend with. A Core Issue like Water Quality has many data layers, because it is important to the Chesapeake Bay restoration effort, and is a reflection of the amount of data generated by that effort. The Economic Core Issue has many data layers because it is a complex issue, whereas the Forest Health Issue has few data layers, because factors of forest health are mapped with great detail and are very specific.

With the data layers chosen, the process of scoring, weighting, and processing the individual models began. The data layers were scored based on the "value" of the areas they represent to

the overall Forestry Core Issue. For example, a data layer representing rainfall might have 5 classifications—or levels—that represent the value of the rainfall in any given area. These classifications were given a score of 1 to 5; 1 being a poor value, and 5 being the best value. The result is a map of cells that represent areas on the ground with each cell having a value between 1 and 5, depending on the value of the feature to represent. According to our example, an area with high average rainfall, which would be best for forest growth would get a 5, an area with less would get a 4, and so on. Other data layers may not represent "degrees" of value, but simply whether or not a given attribute is present on the landscape. These are known as Binary Data layers, because the feature they represent is either there or not. Data layers that are "binary" will have cells with either a score of 5—something of value or significance is present—or a value of 0—nothing of significance.

Once the data layers were assembled and scored, they were placed in a matrix and given weights. A "matrix" is a table of the data layers showing their scores and how they will be weighted. The weight of a data layer is a number between 1 and 10 or 1 and 15 that will act on the whole data layer—treating each cell the same. A weight of 10 or 15 is considered the best and a weight of 1 is considered less desirable.

Weights vary with each data layer, as the weight is a reflection of how important a feature is to a given issue. For example, drinking water watersheds—areas on the landscape that feed into reservoirs or wells—are very important to the Water Quality and Supply forestry Core Issue, so it will be given a weight of 10. All of the cells in that data layer—1 through 5, or 0 and 5 if binary—will be multiplied by 10, so a 10 x 10 meter cell with a score of 5 would be calculated as a 50 in the model, because of the high weight.

The weight is also a reflection of how much confidence the modeler has in the data layer. A data layer from the federal government that is 8 years old and has a coarse resolution—like 100 x 100 meter cells—might be given a lower weight than a data layer that is newer, with a higher resolution. It may be an old, imprecise data layer, but it may be the only one representing a particular feature. The weight may also be lower if a data layer was collected or created using data that was not peer reviewed or created internally by DNR, but this was rarely an issue. The maps of the model outputs—base models—can be viewed in Appendix B.

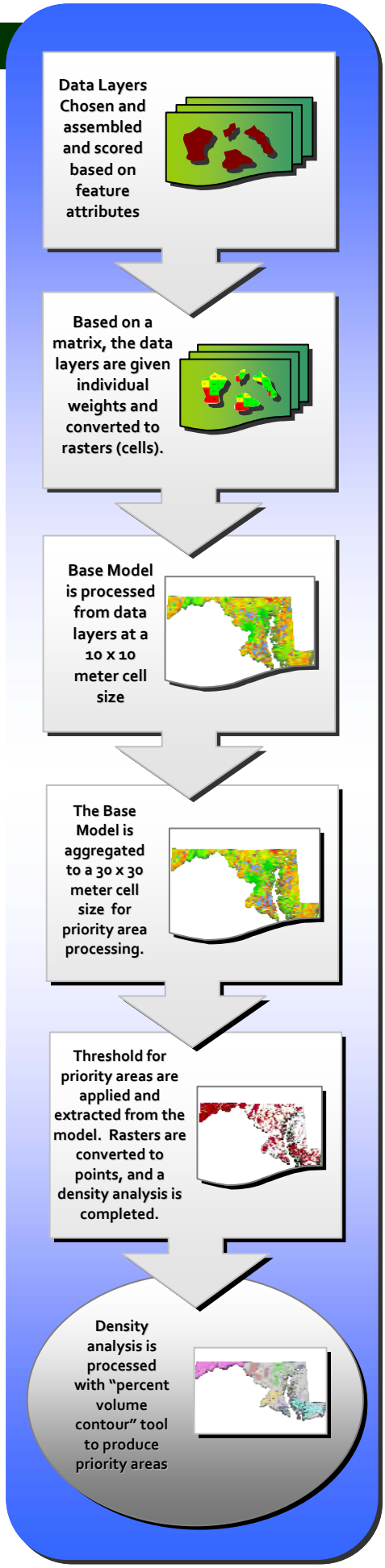
Using this method of scoring and modeling, the DNR Forest Service staff created models—often referred to as "base" models—that represented the "value" of the forests in Maryland to the various Forestry Core Issues across all ownerships and landscapes. Once completed, the base models were further refined to produce priority areas. This was done by aggregating the base model from a 10 meter resolution to a 30 meter resolution, which was then assessed using a nearest neighbor (or roving window) analysis. Each 30 meter cell in the aggregated model represents the average of nine 10 meter cells in the base model. The 30 meter resolution is an acceptable size for a statewide scale, as indicated by the NAASF *Suggested Framework for Statewide Forest Resource Assessments* and also facilitates further processing

The nearest neighbor (also known as a roving window) analysis makes generalizing areas to prioritize much easier by grouping cells together. In this case, a 1 kilometer circular window was chosen as the "neighborhood", the programthen takes the average of all the cells within that neighborhood and assigns the value to the center cell, represented by the red dot in figure 13. This has a smoothing effect on the data, making large areas with many small high value areas stand out. Once the nearest neighbor analysis was completed across all landscapes, a map with a 30 meter resolution was the result, and ready to facilitate the creation of priority areas within the state for each priority issue.

With the nearest neighbor analysis complete for the aggregated 30 meter model, the resulting areas were further refined to produce large blocks that would become the priority areas for the seven core issues. Some attempt was made at setting thresholds for each priority area, for example the Wildlife and Heritage Service requested that at least 80% of Sensitive Species Project Review Areas (SSPRA) be included in the Fish and Wildlife Priority Area. To do that, the top 70% of the Fish and Wildlife Model was included as a priority area. This encompassed at least 80% of the SSPRAs and the surrounding areas. Generally, the top 80% of a model's classification was used as the priority, and this was the case for the Economic, Development and Parcelization, and Water Supply and Demand models. The Wildfire, Forest Health, and Urban Tree Cover models used different thresholds, or non at all, and are explained below.

After the thresholds were set, the priority areas were extracted according to the threshold for a given issue model raster and the raster cells were converted to a point feature. A density function was then performed using the ESRI ArcView software with the Spatial Analyst extension. The Kernel method was utilized to produce the density raster, but the density tool options varied for each model, and output rasters were always 100 meters in size. After this process, the Percent Volume Contour tool in the Hawth's Tools extension (available from www.spatialecology.com) for ArcView was used to develop large blocks, based on the priority area thresholds, that were contiguous across the state. The resulting shapes were given names representative of the region in which they are located i.e. "Central" if found in Central Maryland or "Catoctin" if located along the South Mountain area in Frederick County

Figure 12. Diagram of the modeling process.



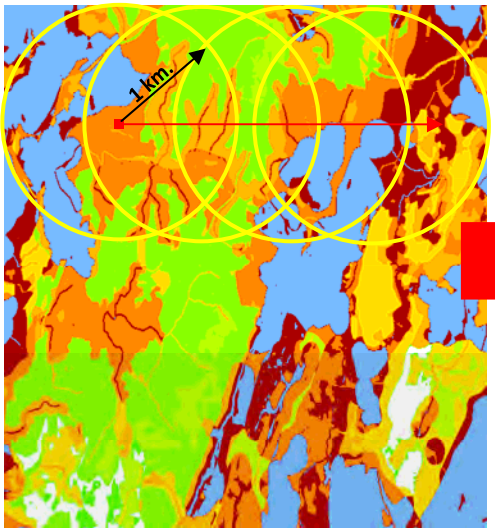


Figure 13. A portion of a 30 meter raster showing a 1 kilometer circular nearest neighbor (roving window) analysis process. Blue and red areas are higher values, green areas are lower values.

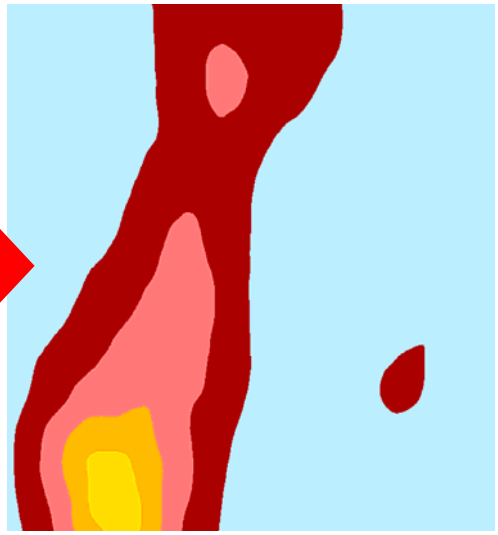


Figure 14. The same area from the left after the nearest neighbor analysis is complete. Blue areas now represent areas where high values may be present.

Development and Parcelization

Development and Parcelization is the leading cause of forest loss in Maryland today and has been since about 1970. Development spiked in the 1980's and is slowly declining[22], but remains the number one threat to forests in central Maryland. Legislation like the Forest Conservation Act has helped slow Maryland's rate of forest loss by requiring developers to retain forest on site, or replace cut forest with new plantings offsite. Still, land prices between Boston and Richmond are among the highest in the nation, making land use conversion an attractive option for those wishing to divest themselves of surplus or inherited land. Forests are cleared and replaced with buildings, parking lots, roads, sidewalks, and other impervious surfaces, thus changing the land use and land type. The forests that remain have many more owners, each with different ideas of how their forest patch should be managed, but more often the new owners do not even realize forest management is an option.

As stated, it was determined by the Maryland DNR Forest Service that a meaningful assessment would not only determine where fragmentation and parcelization is occurring in the state, but also find areas most at risk to development. So the Fragmentation and Parcelization issue was combined with the Threat of Development issue to produce a map that depicts areas with large forest blocks with few owners (low fragmentation and parcelization) in areas that are most at risk to development by 2030.

To produce the map to address both issues, two data layers were developed from data that was readily available at a statewide level: 1) data for housing density projections recommended for use by the NAASF Forest Resource Planning Committee, and 2) density of property ownership in the State of Maryland using Maryland Department of Planning (MDP) PropertyView data points.

The housing density data was downloaded from the University of Wisconsin Forest and Wildlife Ecology SILVIS Lab[23]. This data is based on the 2000 census blocks from the 2000 U.S. Census., and predicts housing density in units/sq. km. The data displays estimated housing densities in Maryland between 1940 and 2000 and predicts housing densities between 2000 and 2030. The MD DNR staff then subtracted the 2000 estimated density from the 2030 estimated density to determine what areas in the state are expected to rapidly grow in the next 20 years. This data was then placed in the ESRI Corp. ArcMap® mapping software (running version 9.1) to produce a 10 meter resolution raster map with a Quantile classification with 10 classifications; 1 representing a relatively low development rate, and 10 representing a relatively high development rate.

Knowing the number of landowners of a forest patch gives clues to how likely the entire patch can be easily managed, how susceptible it is to disease and insects, its wildlife suitability, and more. It is more desirable to have large, contiguous blocks of unfragmented forest, rather than large blocks with many landowners or smaller blocks. Data layers depicting individual parcels (cadastral layers) showing actual property lines, exist for only a few counties in Maryland at this time. To represent this, property ownership data produced from MDP MD PropertyView data from 2008, which was the most complete dataset at the time, was used as a basis for a density analysis. This data takes the form of centroids, essentially a point at the center of each property, and using the Kernel Density tool found in the Spatial Analyst extension of the ERSI Corp. ArcMap® software, produced a map showing points (properties) per square kilometer. This type of analysis indicates where property ownerships are clustered together and where they are not, thus giving an indication of parcel sizes, and where larger parcels are more likely to occur.

Having completed the Housing Density Prediction map and Property Ownership analysis, the two maps were combined to produce a model. To create the composite map model (see Appendix B, Map 1.1), the two data layers were given weights. The Housing Density Prediction map, having been peer reviewed, is considered more reliable and received a weight of ten (15) or about 66% of the influence of the model, whereas the Property Ownership analysis completed by the DNR has not been peer reviewed, and so was given a weight of five (10), or about 33% of the influence of the model. As the two maps exist in a raster, it is a simple task to add them together to find a composite value for each 10 x 10 meter cell for the entire state. This was done using the Raster Calculator tool found in the Spatial Analyst extension of the ERSI Corp. ArcMap® software. The Development and Parcelization Prioritization base map was then reviewed by DNR Forest Service staff for accuracy and to recommend a threshold from which to extract priority areas. The prioritization map was classified using a 10 class quantile classification scheme, and the top 2 classes were extracted as priority areas (figure 2).

Table 1. The Development and Parcelization Model Data Layer Matrix

Data Layer Name	Layer Weight (0-15)	Model Influence (%)
Univ. of Wisc. Housing density data	15	66%
Density of property ownership	10	33%

Wildfire

Wildfire is the oldest threat to forests and perhaps the most studied. The US Forest Service spends hundreds of millions of dollars a year in combating wildfire, and at least a portion of that is spent on predicting where fire will have the most impact to the forest and factors that cause fire to spread.

A few years ago a good deal of effort was expended on creating a fire atlas for Maryland. The atlas depicts areas in the state where fire start potential is greatest, where fuels are expected to be most abundant, and other important indicators of where uncontrolled wildfire would most affect Maryland's forests and Wildland-Urban Interface (WUI). These issues, and others, were combined to create a Composite Fire Map for Maryland.

Table 2. The Wildfire Model Data Layer Matrix

Data Layer Name	Layer Weight (0-10)	Model Influence (%)
Composite Wildfire Assessment	10	50%
Community Wildfire Protection Plan Areas (CWPP)	10	50%

The Composite Fire Assessment map serves as the basis for the Wildfire Core Forestry Issue. It identified areas of the state where wildfire is a significant concern and assists fire services in decision making for prevention and preparedness activities. It is also used in the positioning of suppression resources and specialized equipment. The composite assessment map was developed by first using the results of a Wildland Urban Interface analysis, and other assessments such as Fire Start, Fire Impact, and Fuel Hazard Potential models in conjunction with road access and topography information to develop four sub-models: WUI Analysis model, Firefighter Access model, Hazard Fuels model, and a socioeconomic model. The sub-models were analyzed and combined to create the Composite Wildfire Assessment map that displays the analysis using five classifications from "low" to "high".

Maryland DNR Forest Service Fire Staff also provided comments and a data layer of Community Wildfire Protection Plans (CWPP) for use as priority areas. Community Wildfire Protection Plans are developed for communities that face an above average risk of property damage from wildfire. DNR Forest Service Staff map these communities as part of the CWPP and prepare maps for use in fire suppression. These areas received the same score and weight as the Composite Wildfire Assessment, and placed into the model (See Table 2).

Creating the priority areas for wildfire for the Maryland Forest Assessment involved selecting areas from the Composite Wildfire Assessment and adding the CWPP mapped areas. It was determined the top two of the five classifications of the Composite Wildfire Assessment map would be areas of the state where fire would be severe or above average intensity, and it would be appropriate to include these areas as priorities. These top two classifications were combined

and together with the CWPP areas in the state produced the Wildfire Core Forestry Priority Areas map (Appendix B. Map 2.2).

Forest Health

The Forest Health Priority Areas were not developed from a modeling process, but produced from Maryland Department of Agriculture (MDA) data of forest insect pest and disease outbreak locations over the last ten years. These areas are mapped for management purposes, and is most useful to MDA for location and eradication of forest pests, and to track outbreaks over time. The MDA Forest Pest Management Section was contacted, and asked to provide the latest map data and historic trend map data. These areas were then buffered with a three mile buffer to provide adequately sized blocks for priority areas (Appendix B. Map 3.2).

Table 3. The Forest Health Model Data Layer Matrix

Data Layer Name	Layer Weight (0-10)	Model Influence (%)
Actual locations of known forest pest infestations and other damage	*N/A*	*N/A*

Water Quality and Supply

In Maryland, water quality is a much studied subject, due to the years of research and restoration efforts focused on restoring and protecting the Chesapeake Bay. Therefore lack of adequate geospatial data was not a problem, but rather selecting the right data layers, and keeping the model small was a challenge. Table 1 shows the matrix used to create the Water Quality and Supply model.

The NAASF *Guide for State Assessments* places an emphasis on drinking water and so Drinking Water Watersheds and Wellheads were given the highest weight Stronghold Watersheds were given the second highest weight as it represents rare, threatened, and endangered (RTE) species reliant on clean water supplied by heavily forested watersheds. Maryland Department of the Environment High Quality Water Watersheds are areas of high aquatic biodiversity, and represent the culmination of years of field surveys.

Nutrient uptake is a major theme in the model as the USGS SPARROW model and physiographic province nutrient uptake rates feature prominently. SPARROW or SPAtially Referenced Regressions On Watershed attributes, was produced by Preston and Brakebill to statistically model for predicting and relating upstream nutrient sources to downstream nutrient loading[24] The SPARROW Nitrogen model for Incremental Yield of Total Delivered Nitrogen was used to locate watersheds delivering high nitrogen loads for all point and non-point sources. Table 1 shows the scoring for these data layers and others.

Table 4. The Water Quality and Supply Model Data Layer Matrix

Data Layer Name	Layer Weight (0-15)	Model Influence (%)
Drinking Water Watersheds	15	13%
Stronghold Watersheds	12	10%
MDE High Quality Waters	12	10%
Watersheds with TMDL (Nutrients)	12	10%
Steep Slopes Over 15%	10	9%
SPARROW Total Nitrogen (watersheds)	10	9%
Nitrogen Removal Efficiency	10	9%
FEMA Flood Plains	8	7%
Wetlands	8	7%
Saturated Hydralic Conductivity	5	4%
Headwaters in Forest Interior	5	4%
Phosphorous Removal Efficiency (watersheds)	5	4%
Atmospheric Nitrogen Deposition	5	4%

The model was processed across all landscapes, but an average value was generated for each Maryland 12 digit watershed. This watershed level is the smallest level used at the state level and includes over 1,000 watersheds with an average size of 6,200 acres. Of those watersheds, 227 or 21% are forest priority areas for Water Quality and Supply (Appendix B, Map 4.2). This was one of the recommendations of the GIS focus group at the national meeting in Colorado; to make priority areas for Water Quality take the form of watersheds, since prioritizing small portions of adjacent watersheds is unlikely to significantly influence water quality.

Economic Viability

The Economic model is the Maryland DNR Forest Service's attempt to determine what areas on the landscape could theoretically continue to support traditional forest harvest operations. Table 3 shows how the various data layers were weighted. This matrix is based on a previous study done for Baltimore County, designed by Maryland DNR's Watershed Services unit

The economic issue is perhaps the most nebulous and therefore the most difficult to map spatially. Economic statistics can be graphed and calculated, but understanding the relationship the acreage and composition a forest has or its distance from

several competing mills, and other variables that impact its present and future economic value is difficult.

Other variables considered are population density; As the number of residences increase in an area, at what point will logging be seen as an unfavorable activity? Maryland's large population and large number of small forest patch landowners make traditional forestry operation less appealing, and forest patches lose value from a logging standpoint and gain in value for recreation and aesthetics.

The data layers chosen reflect intention, as much as actual, tangible objects on the ground. For example, Probability of Commercial Timber Management is based on research by the Virginia Department of Forestry that indicates a lower probability of timber management as population density nears 150 people/square mile. On the other hand Precipitation, Site Index, Slopes, Species Composition, Forest Patch Size and others are easily measured, and contribute directly to forest productivity.

The resulting Economic base model (Appendix B, Map 5.1) can represent two different economic assessments. The model was created to identify areas where traditional forestry operations are possible, or must be maintained, in order to continue to be the foundation of Maryland's Forestry economy. On the other hand, areas that are low for traditional forestry operations and management can be thought of as areas of opportunity for secondary forest products or urban forestry businesses.

Table 5. The Economic Viability Model Data Layer Matrix

Data Layer Name	Layer Weight (0-10)	Model Influence (%)
Species Composition (GAP)	10	14%
Public Land Management Activities	10	14%
Soil Productivity (Site Index)	8	11%
Areas off Steep Slopes (>50%)	7	10%
Probability of Commercial Timber Management	7	10%
Zoning	7	10%
Wetland Features	5	7%
Forest Patch Size	5	7%
Fragmentation Probability	5	7%
Rare, Threatened, and Endangered Species	4	5%
Distance to Processing	4	5%
Precipitation (1971 to 2001 Average)	2	3%

Fish and Wildlife

The Fish and Wildlife Forest Priority Issue model was developed with the guidance of the Maryland DNR Wildlife and Heritage (WHS) staff. The only requirement was for priority areas to encompass 80% or greater of the state's Group 1 and Group 2 Sensitive Species Project Review Areas (SSPRA), using the newly released version 3 of that dataset. A Group 1 SSPRA is any federally listed species and a Group 2 species are those listed by the state. To capture 80% of these groups, the SSPRA data layer was given a weight of 15, and after the model was run, the top 70% of the classification (using a Quantile classification scheme) was selected and run through the process developed for producing priority areas. This captured not quite 80% of Group 1 and Group 2 SSPRA acres in the state, however removing SSPRA areas on Smith Island and Assateague Island, brought the total to 80%. These two areas are predominantly tidal marsh and coastal dune.

Additional data layers used in the Fish and Wildlife model were developed by Maryland State agencies and the Nature Conservancy. The State's Stronghold watershed layer, Old Growth Forest, High Quality Waters layer, Green Infrastructure assessment, and wetlands layers were also used. Potential Habitat for Forest Interior Dwelling Species (FIDS) was used to provide a forest interior component, even though the data layer is over a decade old.

The Maryland Biological Stream Survey (MBSS) data on streams were used to created the "Special Streams" data layer. The layer consists of Coldwater Streams, Limestone Streams, and Blackwater Streams and their watersheds. Brook Trout, Maryland's only native trout species are found in Coldwater streams; Limestone streams are biologically unique and the average condition of these streams is considered poor; and Blackwater streams, need instream wood and cover, and are slowly disappearing from the landscape due to a lack of carbon input from deforestation in the watershed.

Table 6. The Fish and Wildlife Model Data Layer Matrix

Data Layer Name	Layer Weight (0-15)	Model Influence (%)
Sensitive Species Project Review Areas (SSPRA)	*15*	*21%*
Old Growth Forest	*15*	*21%*
Stronghold Watersheds	*11*	*15%*
Green Infrastructure	*8*	*11%*
Potential FIDS Habitats	*6*	*8%*
MDE High Quality Waters	*6*	*8%*
TNC Forest Matrix Blocks	*4*	*5%*
Wetlands	*4*	*5%*
Special Streams	*4*	*5%*

Forest Matrix blocks developed by the Nature Conservancy were also used, and represent "large contiguous areas whose size and natural condition allow for the maintenance of ecological processes, viable occurrences of matrix forest communities, embedded large and small patch communities, and embedded species populations."[25] The Fish and Wildlife Base Model and Core Forestry Priority Areas can be viewed in Appendix B, Maps 6.1 and 6.2)

Urban Tree Cover

The Urban Forestry Priority Areas were developed using a separate process from the production of the other priority areas. The other priority areas were created using modeling of readily available data layers, but this was not the case with the Urban Priority Areas. A few cities, including Baltimore and Annapolis, have completed an Urban Tree Cover (UTC) assessment, and developed goals for creating or maintaining tree cover. UTC assessments have been completed for a handful of municipalities across the state and at the county level for some counties, and assessments are being completed or contracted for the near future. This being the case, the Maryland DNR Forest Service leadership decided to focus priorities on the counties most likely to be affected by urban forests in the Interstate-95 corridor, and other major routes that can serve as corridors for urban expansion. Municipalities were also included where they fell outside of the I-95 corridor (See Appendix B, Map 7.1).

Table 7. The Fish and Wildlife Model Data Layer Matrix

Data Layer Name	Layer Weight (0-10)	Model Influence (%)
I-95 Corridor Counties	N/A	50%
Other municipalities	N/A	50%

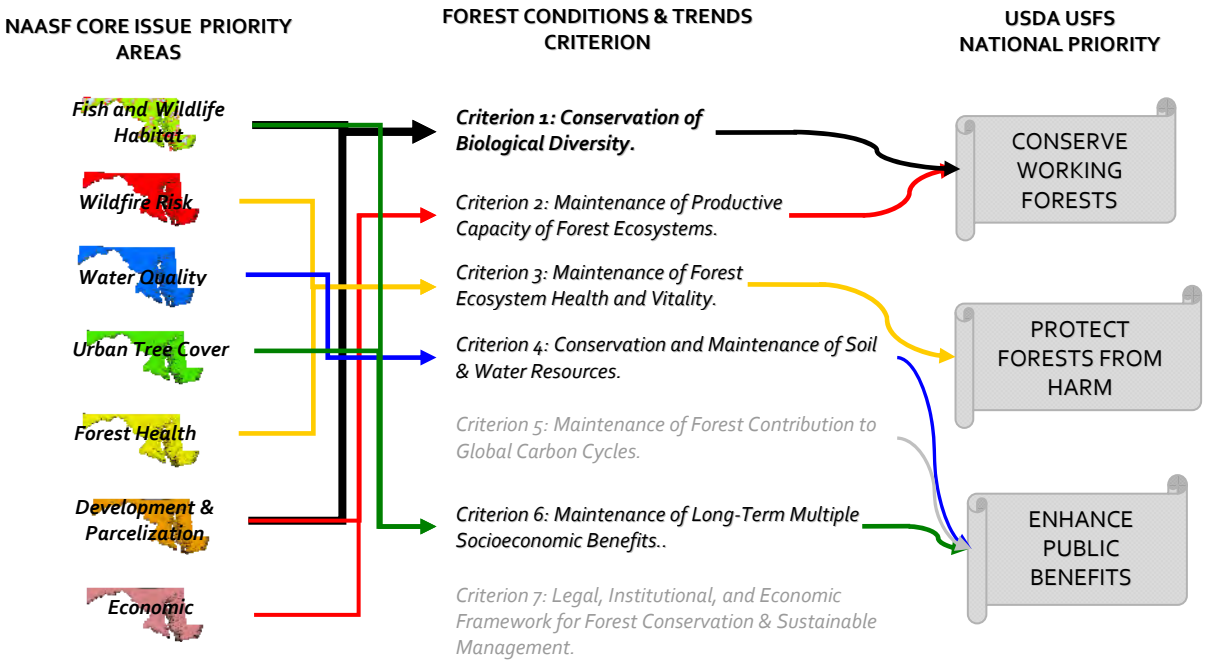
Maryland Priorities

Maryland Priority Areas were assembled from Core Forestry Issue priority areas. Each priority area from each Core Issue was simply combined with the other priority areas from other issues to produce a Maryland Priority Area. The same process used to define the final priority areas for the Core Forestry Issues was used to define the areas of Maryland Priorities. After the priority areas were combined into one raster file, the rasters were given a cell value of one if inside a priority area, and zero if outside. These were converted to points and a density function was then performed using the ESRI ArcView software with the Spatial Analyst extension. The Kernel method was utilized to produce the density raster, the same density tool options were used for each model, and output rasters were always 100 meters in size. After this process, the Percent Volume Contour tool in the Hawth's Tools extension (available from www.spatialecology.com) for ArcView was used to develop large blocks, based on the priority area thresholds, that were contiguous across the state. In some cases, areas that are Core Forest Issue priorities were not included as a Maryland Priority. This is a result of the grouping process to create the National Priority Areas, where certain areas were isolated or did not overlap other Core Forestry Issue priority areas. The resulting shapes were given names representative of the region they were located.

The Protect Forests from Harm priority area was composed of the priority areas from the Core Issues of Wildfire and Forest Health (figure 16). These Core Issues were used to define areas most at risk to the natural threats of insects, disease, and fire.

The Conserve Working Forests Prioity (figure 17) combined the Core Forestry Issues of Development and Parcelization Risk, Water Quality, Economic Viability, and Forest Health Risk. It was felt these issues, when viewed as a whole, depicted areas where forest is important to Maryland's economy and must be maintained to provide the socioeconomic and ecosystem benefits, which otherwise would be lost or produced artificially.

Figure 15. Diagram of how Core Forestry Issues relate to the Forest Criterion and Indicators for Sustainability and the USDA USFS Nation Priorities. Criterion 5 and 7 are difficult to display spatially.



The Enhance Pubic Benefits of Forest priority areas (figure 18) encompass Urban Tree Canopy, Water Quality, and Fish and Wildlife Habitat Core Issue priority areas. These issues are essential to maintaining a high quality of life in Maryland. These Core Forestry Issues provide clean and abundant water, reduce air pollution, and provide habitat for wildlife in addition to aesthetic benefits.

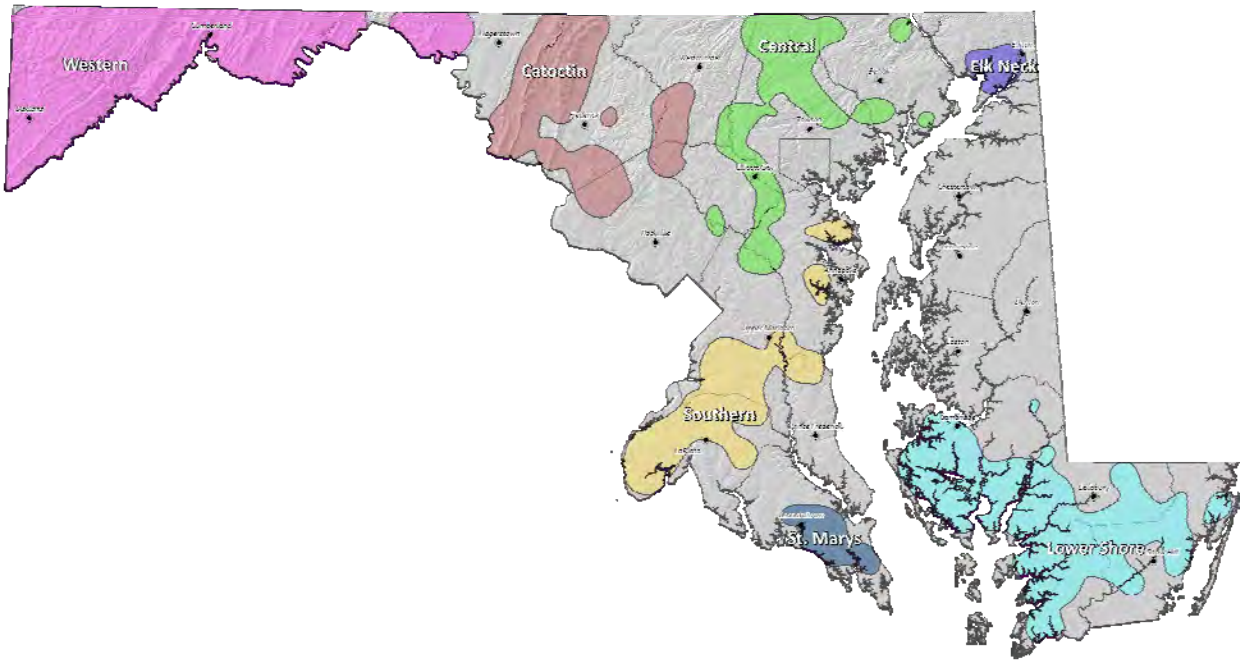


Figure 16. Maryland priority areas of the USDA Forest Service Nation Priority *Protect Forests from Harm*

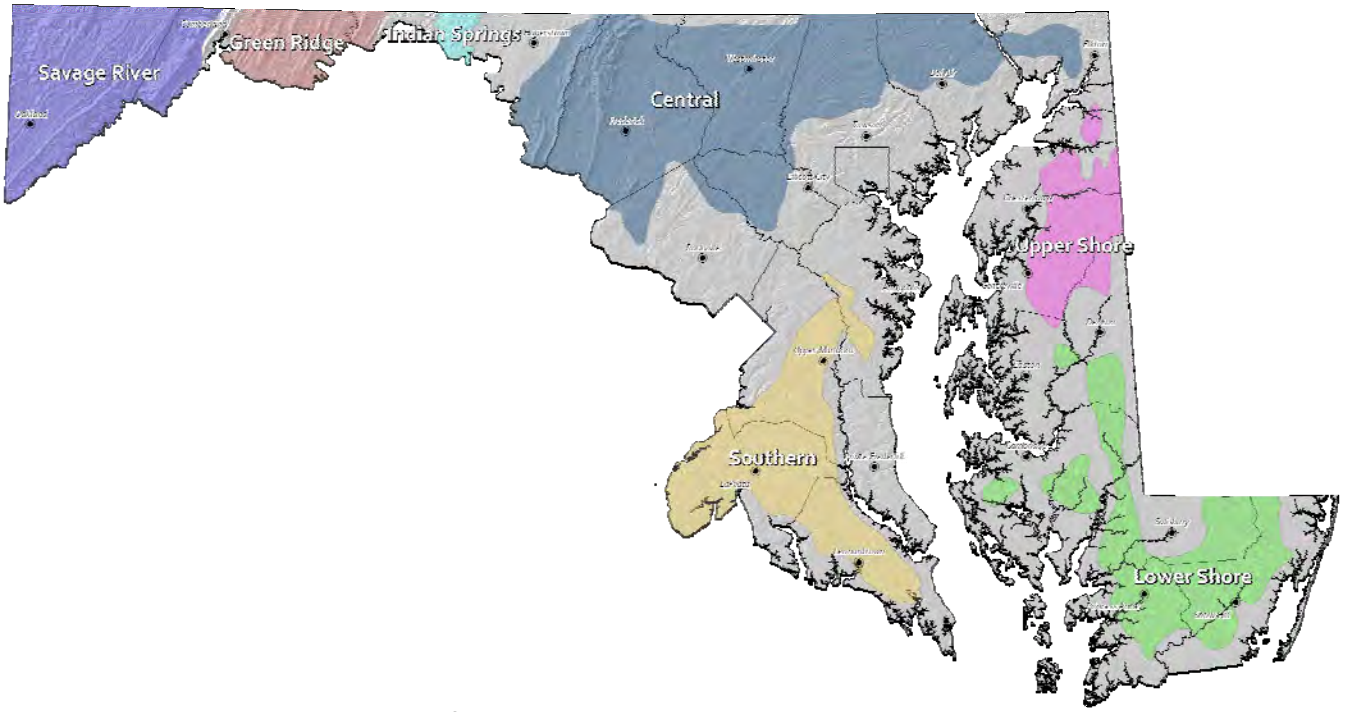


Figure 17. Maryland priority areas of the USDA Forest Service Nation Priority *Conserve Working Forests.*

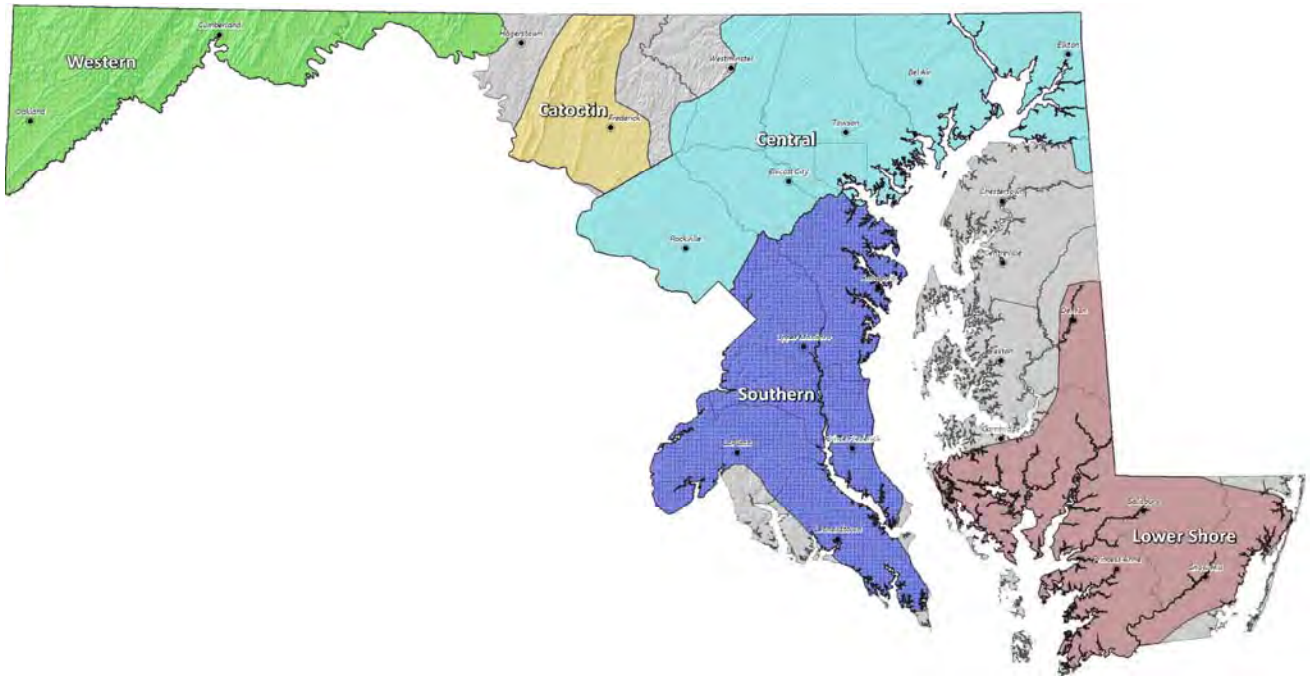


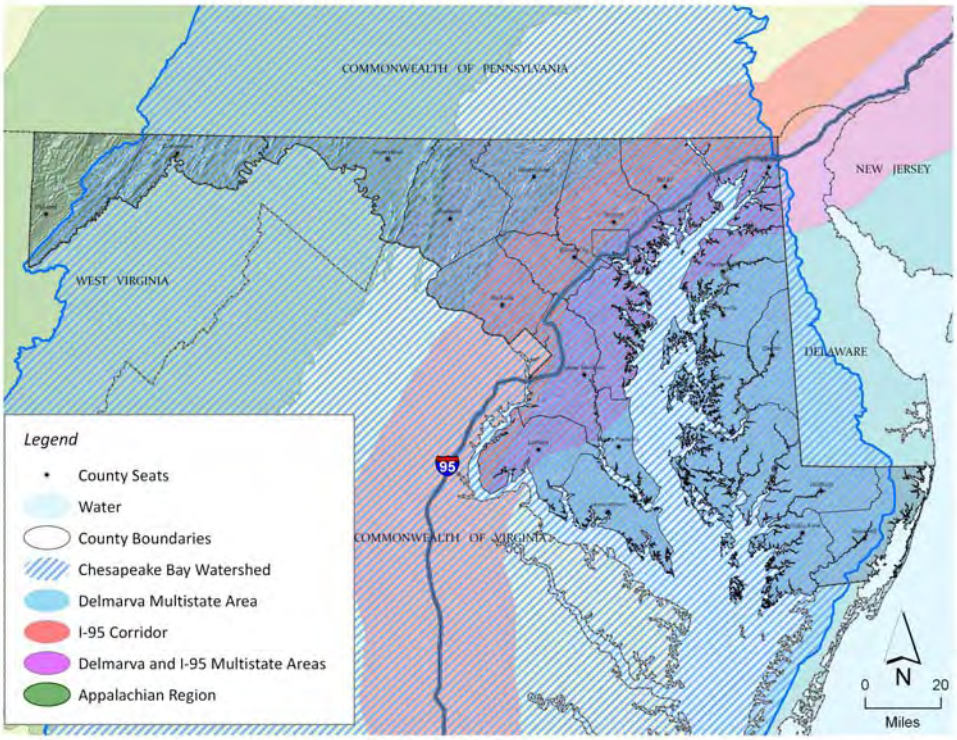
Figure 18. Maryland priority areas of the USDA Forest Service Nation Priority *Enhance Public Benefits of Forests.*

Multistate Opportunities

The largest and most obvious multistate opportunity for Maryland has been, and continuous to be the restoration of the Chesapeake Bay estuary. The Bay watershed is vast, and opportunities exist with all of Maryland's immediate neighbor states to coordinate restoration of forests and riparian forest buffers in targeted areas. The Maryland DNR Forest Service has represented Maryland's forestry issues on the Chesapeake Bay Program's Forestry Work Group for many years and coordinates with other states located within the Chesapeake watershed. The DNR Forest Service is a key player for technical support and leadership for the Forestry Work Group.

Another potential multistate opportunity is the Interstate 95 corridor. This highway corridor transects the most densely populated area in the country, and is a driving force for development, and consequently forest loss. Urban and traditional forestry opportunities exist in this corridor, and planning and coordination can enhance existing forests and mitigate the loss of additional acres

Figure 19. Potential multistate priority areas.



The Appalachian Region has also been proposed as a multistate opportunity. This region spans from Maine to Alabama, and Maryland's three westernmost counties lie within it. This area is viewed as having unique vegetation, with some of the highest plant and animal biodiversity in the United States. Preservation of its rural character in the face of ever expanding urban areas is constant challenge. A major component of this area is the Appalachian Trail, which is one of the longest foot-paths in the United States, and is traveled by thousands of people each year.

The Delmarva Multistate Area is another potential multistate project opportunity for Maryland forestry projects. This area extends from Long Island, NY, across New Jersey and Delaware, to Maryland's eastern shore and portions of Virginia. It is comprised primarily of the Coastal Plain provinces of these states and is bounded by the Piedmont province to the west. The Delmarva Multistate area is considered unique because of its rural character despite the proximity to heavily developed areas like Philadelphia and Wilmington, and its patches of unusual assemblages of forest.

6. Conclusion

Over the last decade, Maryland's forests acres have continued to diminish. There is still an unarrested downward trend in Maryland's forest cover, which is approximately 40% of the landcover of the state. Development still represents the number one threat to maintaining healthy, productive, and biodiverse forests on the landscape. Maryland is expected to continue growing its population, and land prices are some of the highest in the nation, making preservation of larger forest blocks difficult. These forests more often than not have many owners, complicating management and making the conservation of large forest blocks challenging.

In addition to development Maryland's forests must contend with numerous and periodic health issues. Gypsy Moth annually damages more forest land than other forest pests, and Emerald Ash Borer may continue to destroy the native ash, if it escapes containment. Other threats are not yet as widespread, but are reduced through proper forest management and mitigation methods. Protecting Maryland's forests from harm will require rapid response and research of new and emerging threats, in addition to continuing to promote forest management and maintain an experienced cadre of professional foresters and other natural resource experts.

The Maryland Forest Service, with the help of local volunteer fire companies, will continue to respond to wildfires, provide initial attack, provide incident investigation, and plan for protection of the Wildland Urban Interface (WUI) in Maryland This is especially critical in the rural Eastern and Western Regions where incidents of fire are most prevalent. An average of 3,600 acres burn annually, but can be as high as 5,000 to 6,000 acres. This may increase if climate change makes Maryland hotter and drier.

Maryland's forests continue to be a mainstay of Maryland's economy. Forestry and the manufacturing of forest products remains a billion dollar industry. Forestry and wood derivatives generated over $3 billion in "direct" output in 2005. From that an additional $1.7 billion was generated by "indirect" and "induced". Forestry and wood products economic activities provided thousands of jobs through logging and processing timber in the rural parts of the state, to furniture and cabinet production in the urban and suburban areas. The jobs and services necessary to support that industry are significant contributors to Maryland's overall economy as well. At least 29,000 jobs are derived from forestry and wood derivatives, accounting for roughly 1% of all jobs in Maryland.

The forests of Maryland provide recreational opportunities and vital habitat. Thousands of visitors enjoy Maryland's forests each year by hiking, camping, fishing, shooting, hunting, and horseback riding. These forests, particularly the public forests, enhance the public wellbeing and keep nature within reach through the state forest and parks system.

A number of rare, threatened, and endangered species call Maryland forests home and depend on those forests to remain healthy and diverse. Though it is unclear how many of those truly forest dependant the Maryland DNR Wildlife and Heritage Service monitors over 1,100 native plants and animals, of which, 9 plants and 29 animals are federally listed species, and 455 plants and 152 animals are state listed species recognized in the Code of Maryland. DNR estimates that nearly 135 plants and animals (forest and non-forest dependant) are either extinct or no longer found in Maryland.

Appendix A: Forest Statistics for Maryland

Table 1: County Statistics

County	Total Land Area (U.S. Census Bureau)	Forest Cover (USFS FIA)				National Priority Area (All Land Uses)			Protected Lands**
	(acres)	1986 (acres)	1999 (acres)	2008†† (acres)	2008 (percent)	CONSERVE WORKING FORESTS	PROTECT FORESTS FROM HARM	ENHANCE PUBLIC BENEFITS OF FOREST	2010 (acres)
Allegany	272,269	212,381	211,396	193,565	71%	249,993	272,269	272,269	74,504
Anne Arundel	266,202	126,451	85,475	69,373	26%	29,379	86,693	266,202	31,172
Baltimore City	51,712	*	1,830	1,379	3%	0	0	51,712	4,966
Baltimore	383,098	145,269	115,249	122,975	32%	183,796	199,585	383,098	84,693
Calvert	137,709	74,694	75,856	64,402	47%	0	15,895	132,025	14,757
Caroline	204,890	59,790	49,352	82,854	40%	61,459	0	107,817	38,354
Carroll	287,443	72,785	63,344	53,031	18%	263,609	59,749	183,286	56,401
Cecil	222,803	82,335	73,797	70,742	32%	62,751	41,752	222,803	38,149
Charles	295,040	176,524	196,619	177,946	60%	253,270	176,297	241,292	39,737
Dorchester	356,826	144,826	137,588	172,313	48%	88,744	195,389	307,232	101,290
Frederick	424,243	136,734	127,286	92,830	22%	417,152	226,248	302,884	62,372
Garrett	414,694	306,281	297,537	255,472	62%	414,694	414,694	414,694	103,319
Harford	281,824	107,427	102,163	94,066	33%	162,388	43,068	281,824	27,917
Howard	161,306	63,289	56,806	37,677	23%	98,125	58,577	161,306	14,846
Kent	178,836	40,941	53,722	50,235	28%	52,620	0	12,538	38,181
Montgomery	317,133	100,310	97,881	136,886	43%	54,565	50,651	317,133	61,679
Prince George's	310,675	127,749	136,902	160,079	52%	150,196	115,165	310,675	51,276
Queen Anne's	238,214	72,919	47,801	45,148	19%	154,783	0	0	46,555
Somerset	209,414	87,251	87,757	106,522	51%	102,185	144,532	195,399	57,733
St. Mary's	231,200	130,207	108,468	101,996	44%	132,537	80,655	193,735	22,732
Talbot	172,250	41,938	57,856	41,572	24%	11,967	0	0	24,657
Washington	293,210	128,373	107,736	117,167	40%	160,749	174,753	185,701	54,431
Wicomico	241,389	104,696	115,339	116,136	48%	131,125	149,783	239,033	34,946
Worcester	302,874	157,150	156,971	139,867	46%	158,497	125,631	243,784	68,322
State Total	**6,255,251**	**2,700,320**	**2,564,731**	**2,504,231**	**39%**	**3,394,584**	**2,631,386**	**5,026,442**	**1,152,988**

* No data available.

** Protected lands include: Agriculture easements, land protected by counties, DNR lands, Maryland Environmental Trust (MET) easements, non-military federal lands, Forest Legacy (FLA) easements, Rural Legacy (RLA) easements, and private conservation lands (TNC, etc.).

†† Represents that average of 2004 to 2008 estimates.

Appendix A: Forest Statistics for Maryland

Table 2: Amount of Forest in Stream and Shoreline Buffers

Forested 100 Foot Stream and Shoreline Buffers

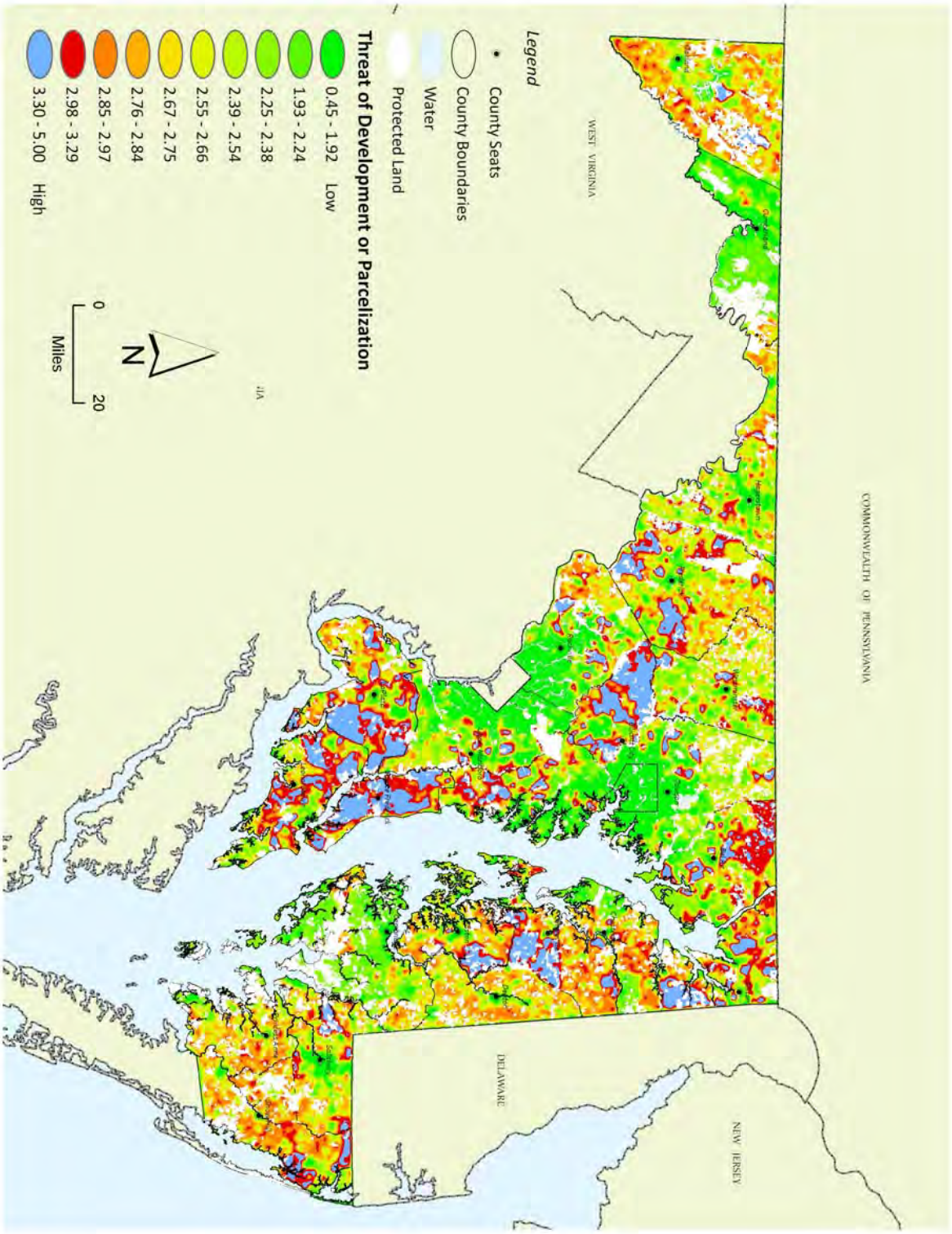
(based on 2007 NAIP Imagery analysis by CCBC - Catonsville)

	Streams (NHD Plus)				**Shoreline** (MD SHA)			
County	Unforested (acres)	Forested (acres)	Total (acres)	% Forested	Unforested (acres)	Forested (acres)	Total (acres)	% Forested
Allegany	1,956	12,836	14,792	86.8%	240	1,126	1,366	82.5%
Anne Arundel	1,513	8,994	10,507	85.6%	3,491	2,307	5,798	39.8%
Baltimore City	455	748	1,203	62.2%	619	57	676	8.5%
Baltimore	3,762	13,615	17,377	78.4%	1,681	962	2,643	36.4%
Calvert	550	5,233	5,783	90.5%	1,427	784	2,211	35.5%
Caroline	2,803	6,466	9,269	69.8%	533	1,019	1,552	65.7%
Carroll	4,565	9,349	13,914	67.2%	0	0	0	0%
Cecil	1,188	6,090	7,278	83.7%	1,612	1,197	2,810	42.6%
Charles	994	11,821	12,816	92.2%	2,040	974	3,014	32.3%
Dorchester	3,929	4,665	8,595	54.3%	11,610	3,097	14,707	21.1%
Frederick	7,409	15,934	23,343	68.3%	102	472	574	82.3%
Garrett	3,438	14,306	17,744	80.6%	13	94	107	88.2%
Harford **(see note)**	2,028	8,627	10,655	81.0%	258	364	622	58.5%
Howard	2,192	6,199	8,391	73.9%	0	0	0	0%
Kent	2,109	2,893	5,003	57.8%	2,650	1,225	3,875	31.6%
Montgomery	4,123	11,883	16,006	74.2%	796	685	1,482	46.3%
Prince George's	2,162	11,923	14,085	84.7%	520	495	1,015	48.7%
Queen Anne's	2,232	4,938	7,170	68.9%	3,533	1,265	4,798	26.4%
Somerset	1,148	2,352	3,500	67.2%	10,044	922	10,966	8.4%
St. Mary's	1,942	7,079	9,021	78.5%	4,039	1,470	5,509	26.7%
Talbot	1,103	2,732	3,836	71.2%	5,712	1,460	7,173	20.4%
Washington	5,310	8,542	13,852	61.7%	493	984	1,477	66.6%
Wicomico	1,414	4,174	5,588	74.7%	2,736	756	3,492	21.6%
Worcester	1,528	5,462	6,990	78.1%	6,584	1,880	8,465	22.2%
Total	**59,854**	**186,863**	**246,717**	**75.7%**	**60,732**	**23,599**	**84,331**	**28.0%**

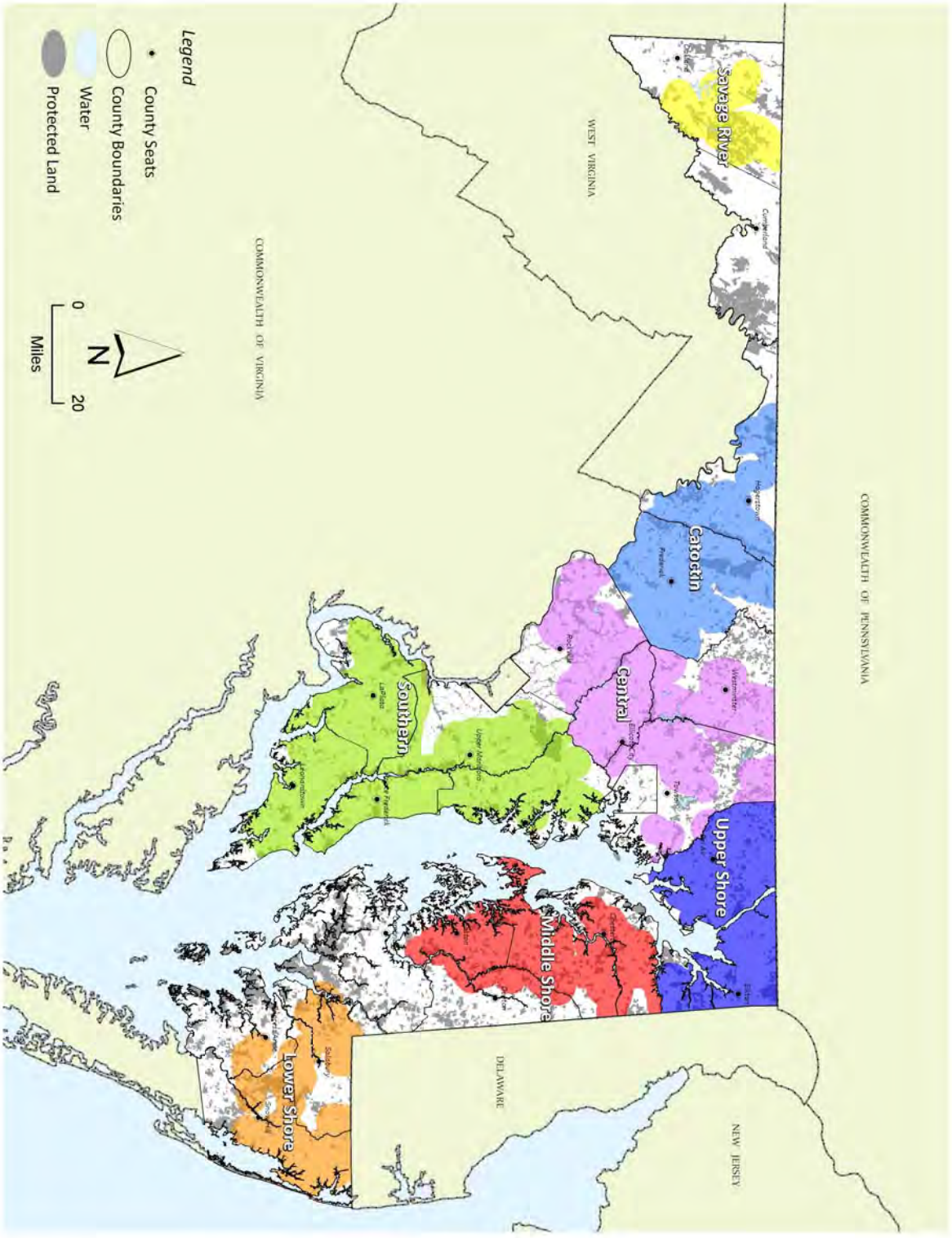
Note: There is an additional 2,290 acres within 100 feet of the shoreline and 1,400 acres within 100 feet of streams that is not included in this analysis for Harford County since it is in the Aberdeen Proving Ground area where imagery was not available to perform the tree cover anlaysis.

Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 1.1: Development and Parcelization Base Model

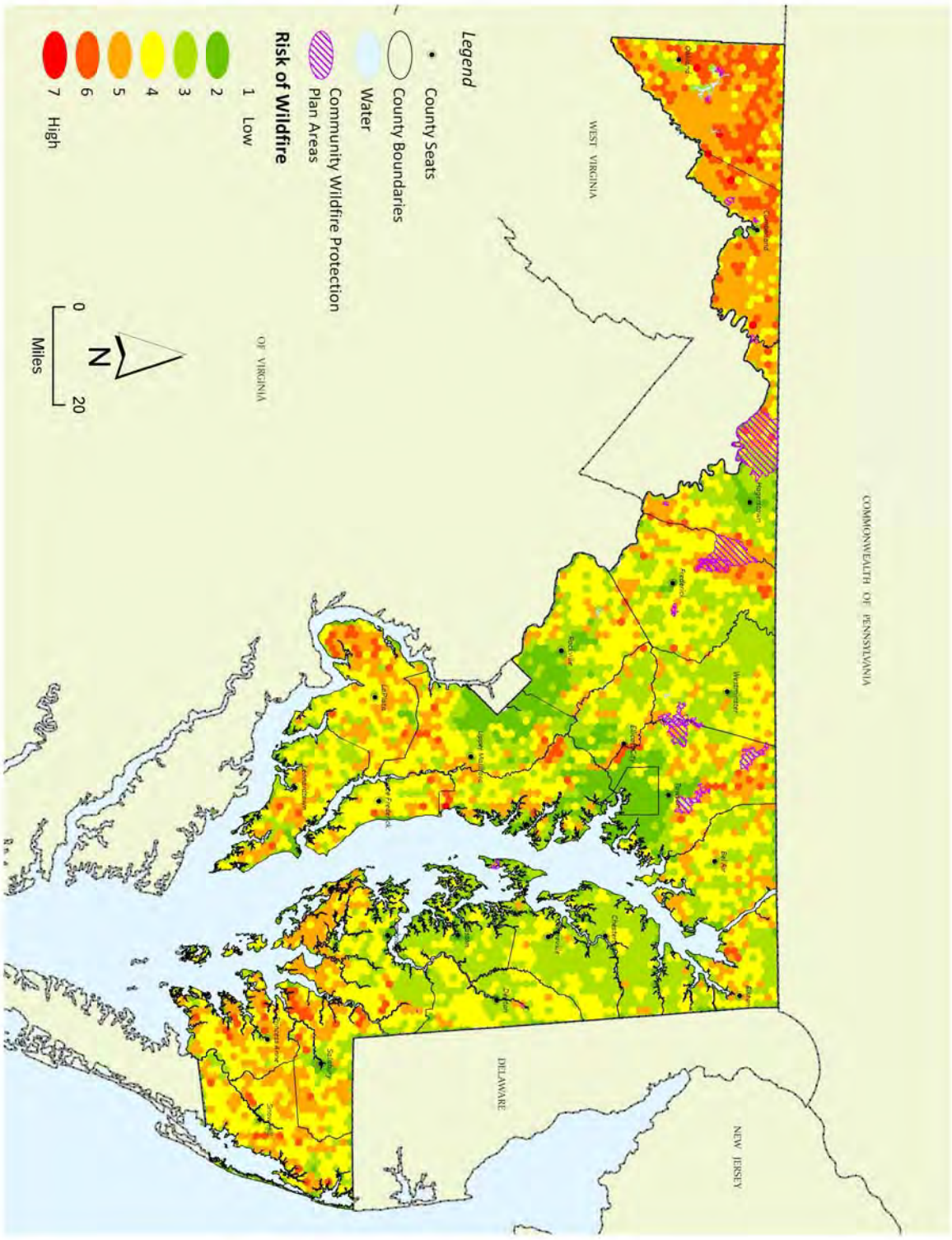


Map 1.2: Development and Parcelization Core Forestry Priority Areas



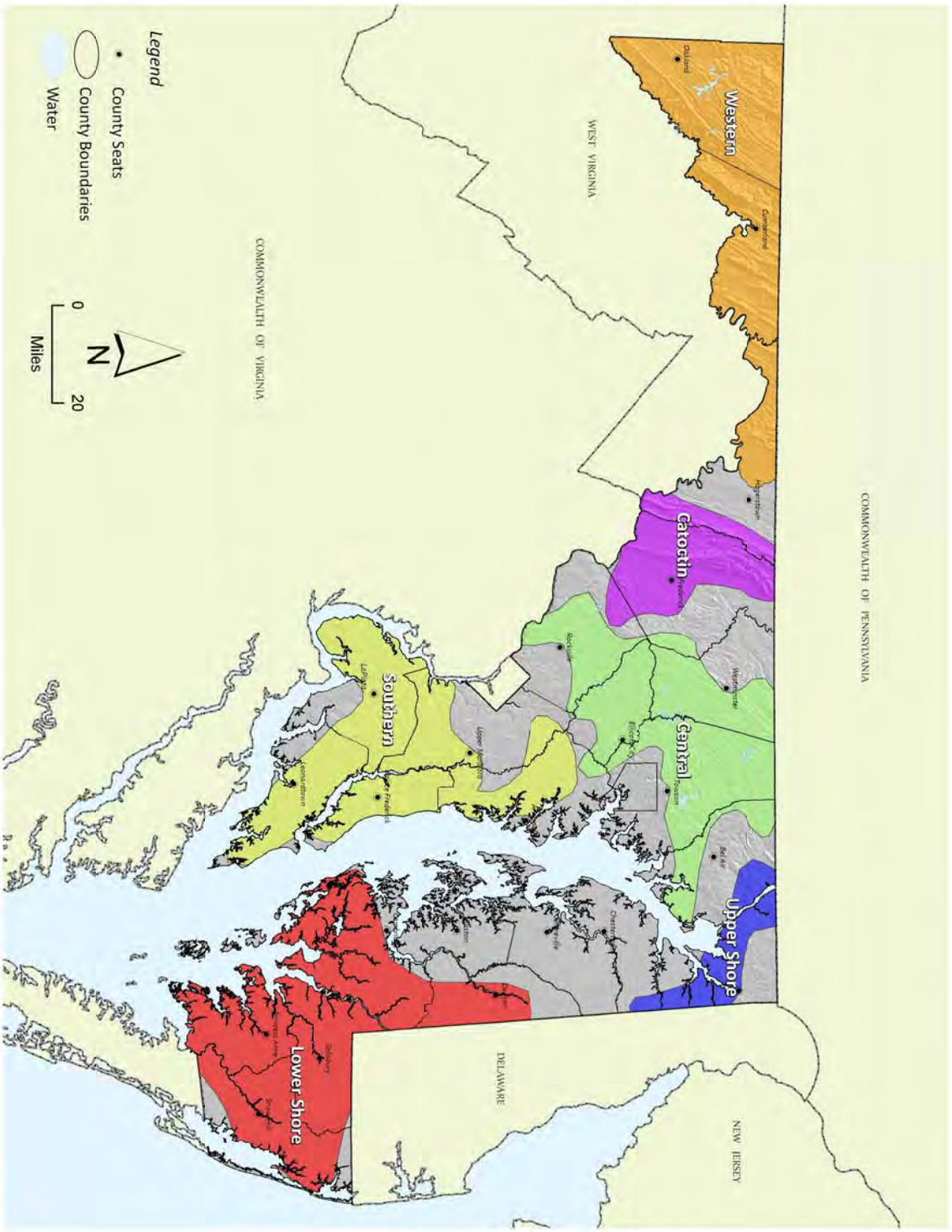
Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 2.1: Wildfire High Priority Areas



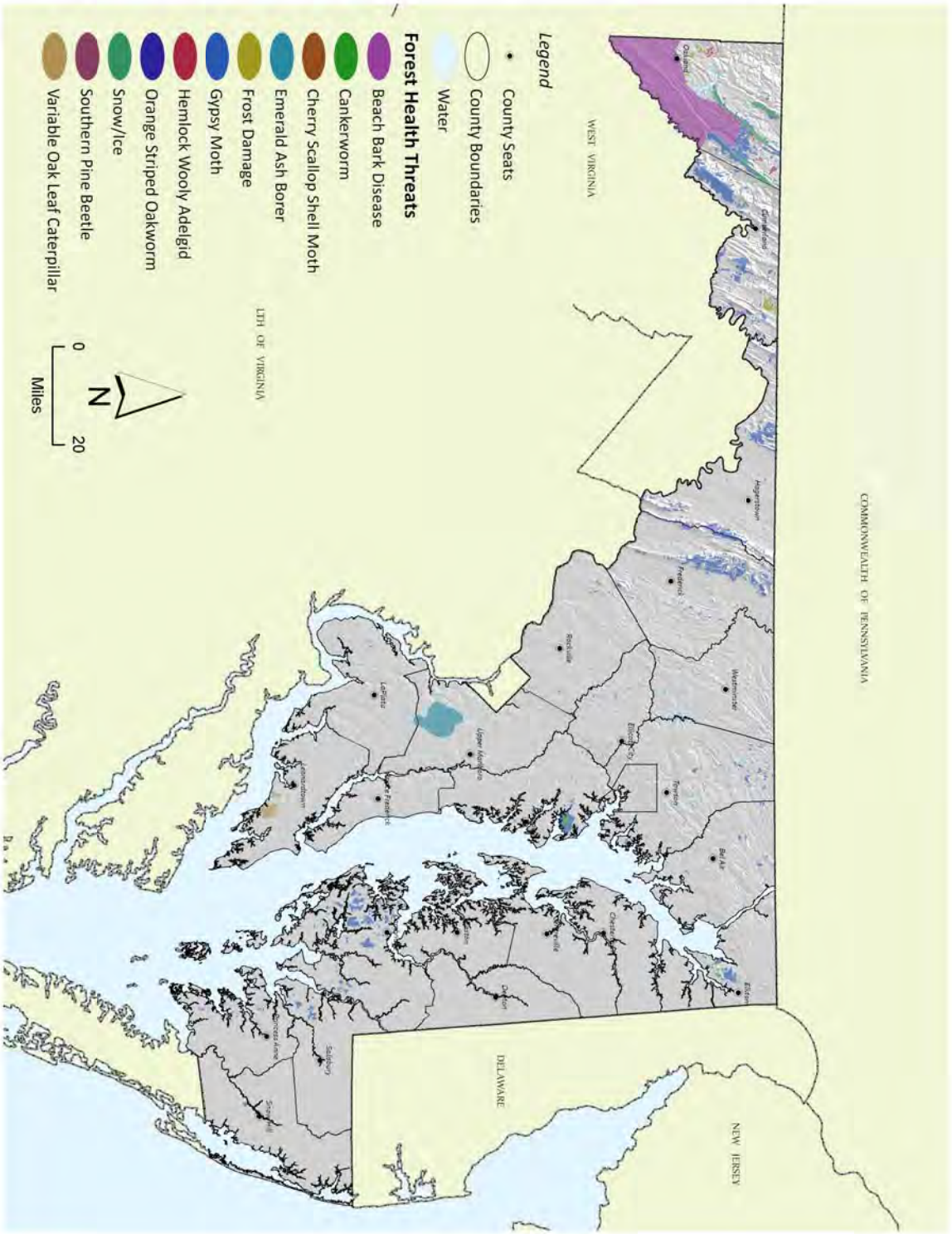
Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 2.2: Wildfire Core Forestry Priority Areas



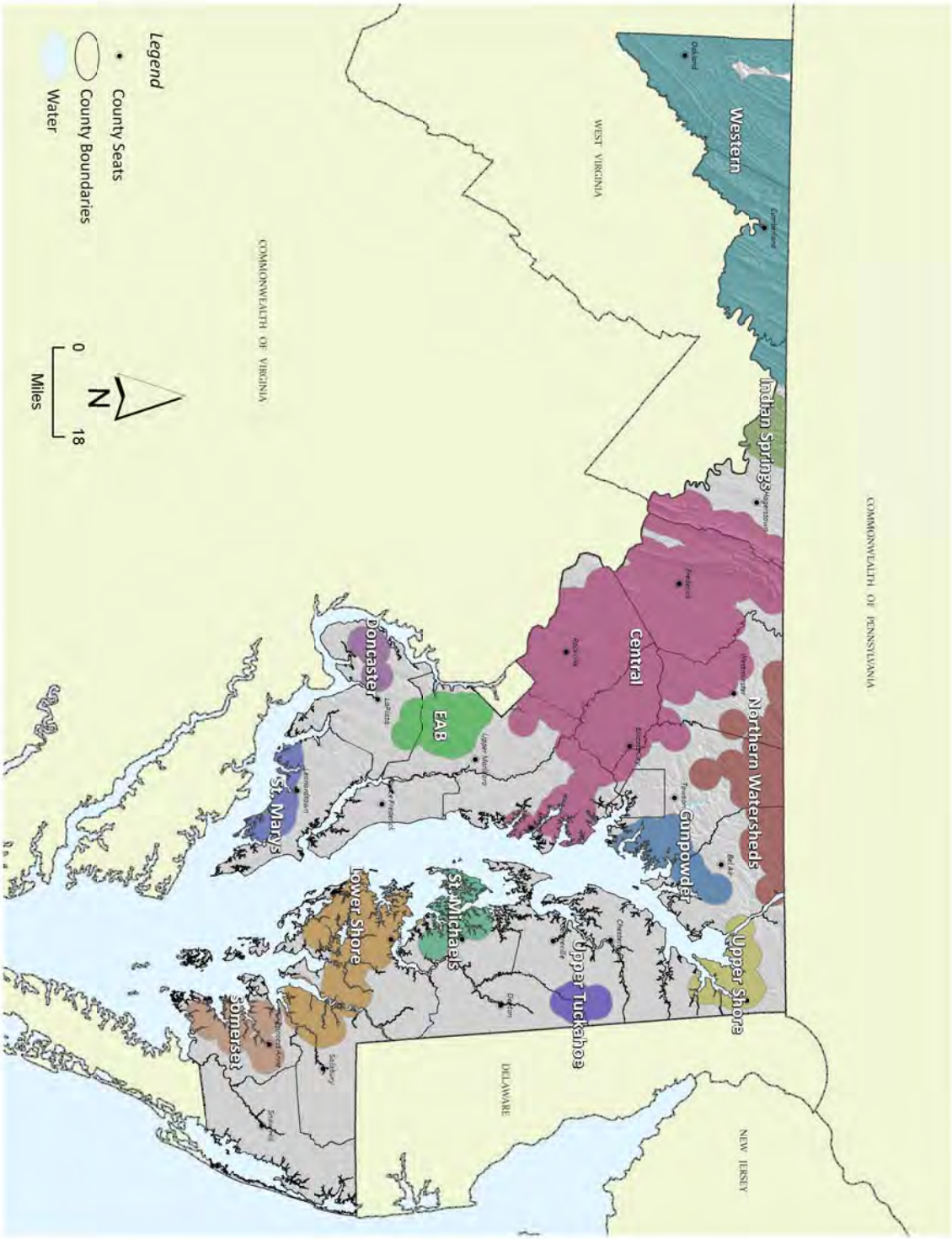
Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 3.1: Mapped Forest Health Issues



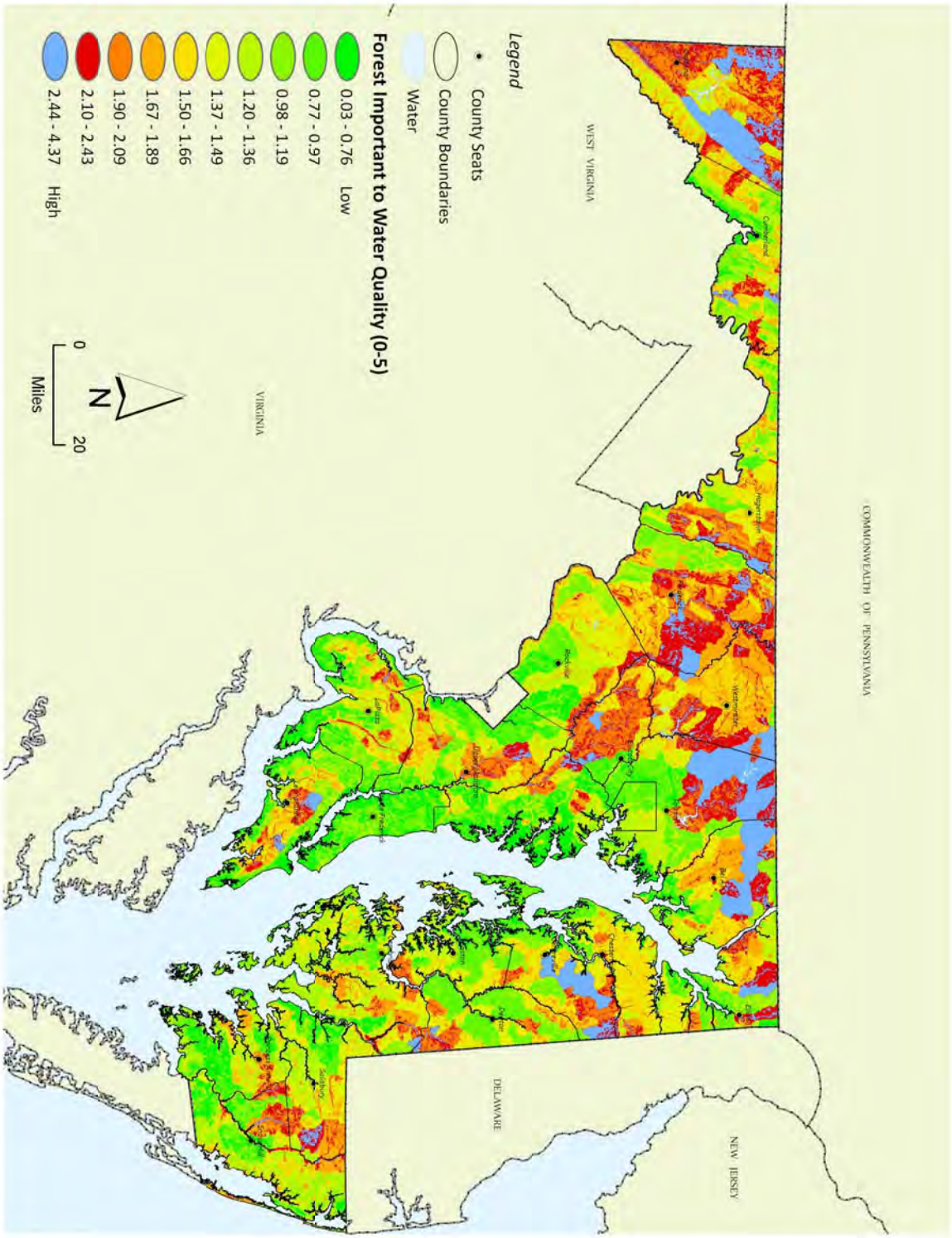
Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 3.2: Forest Health Core Forestry Priority Areas



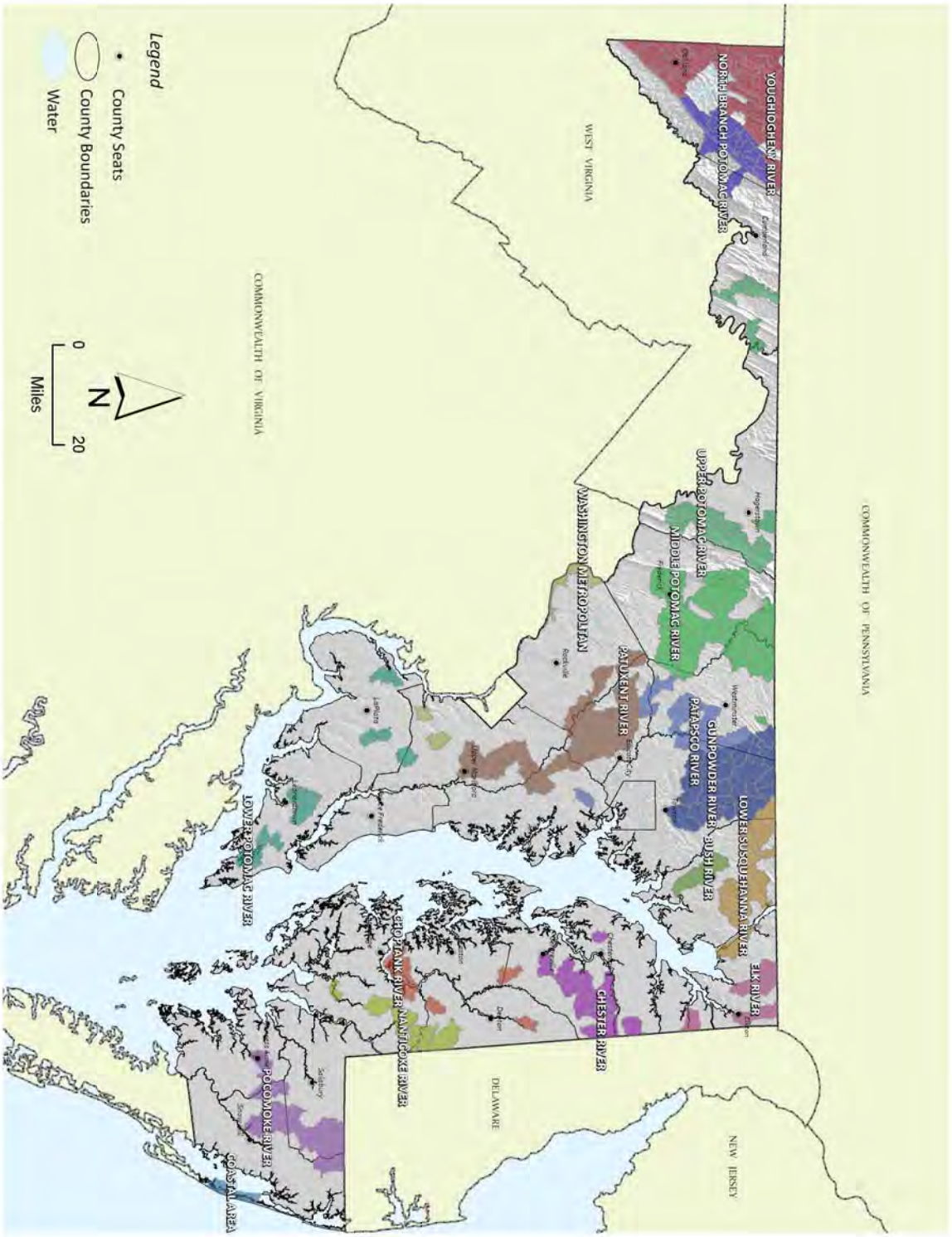
Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 4.1: Water Quality Base Model



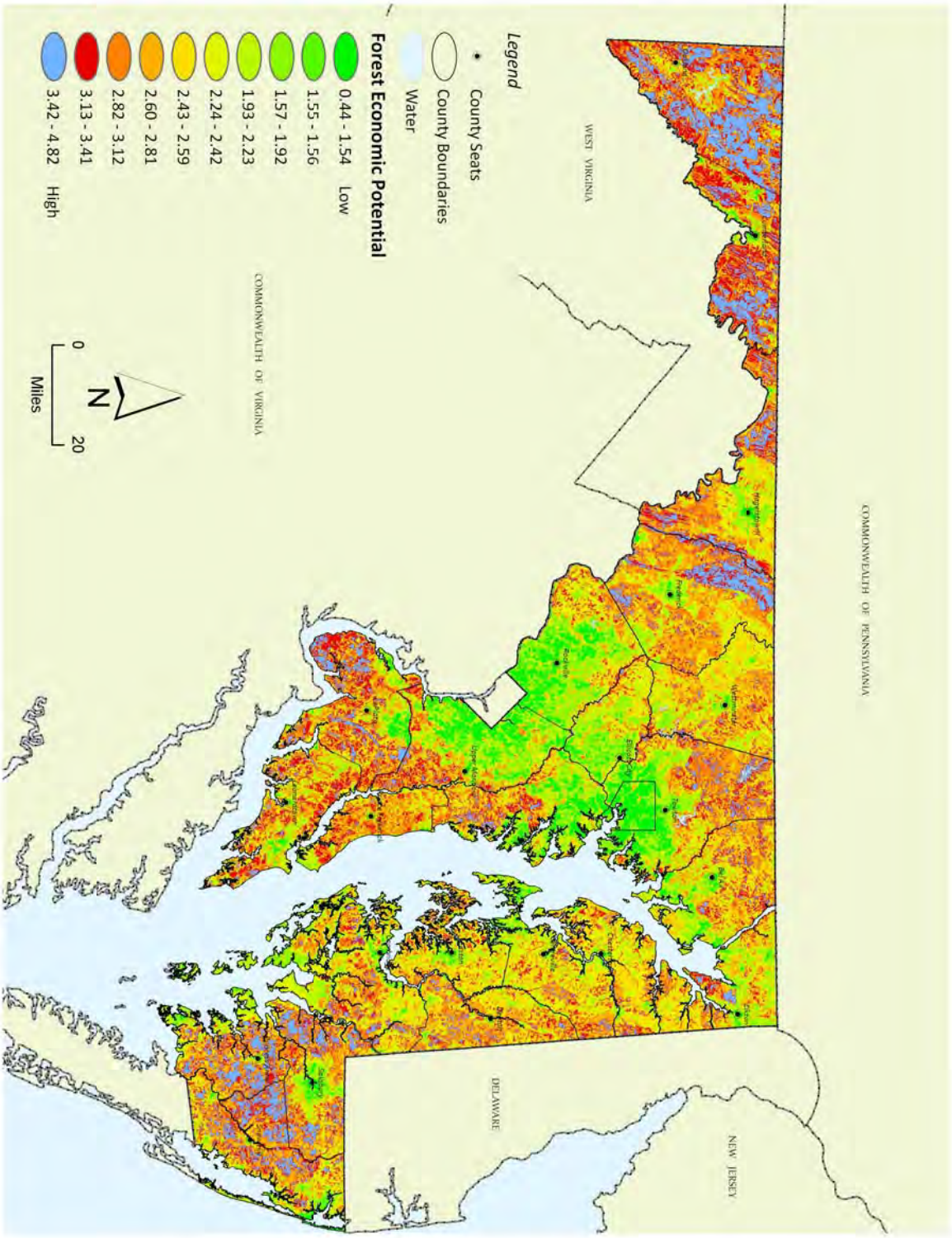
Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 4.2: Water Quality Core Forestry Priority Watersheds



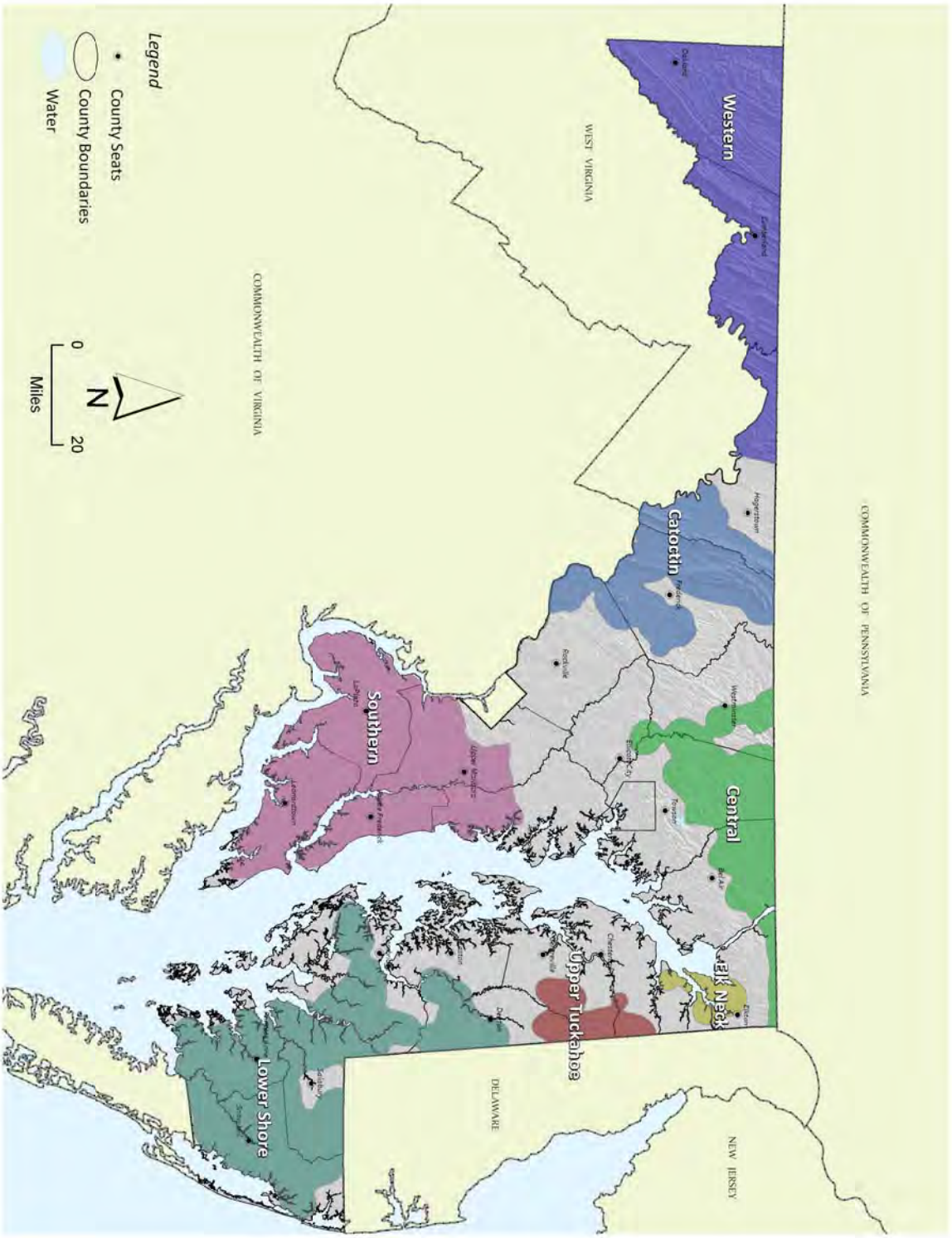
Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 5.1: Forest Economic Viability Base Model



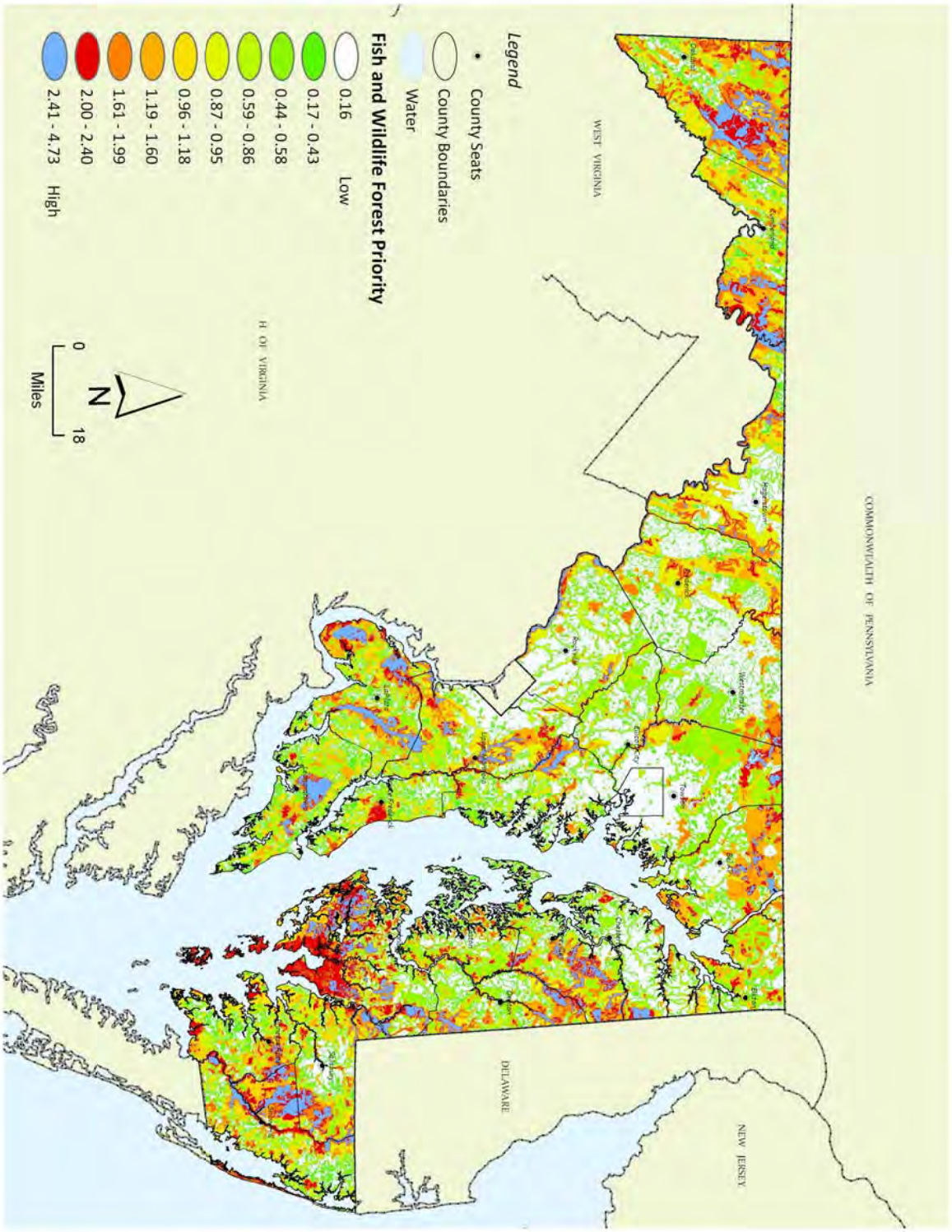
Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 5.2: Forest Economic Viability Core Forestry Priority Areas



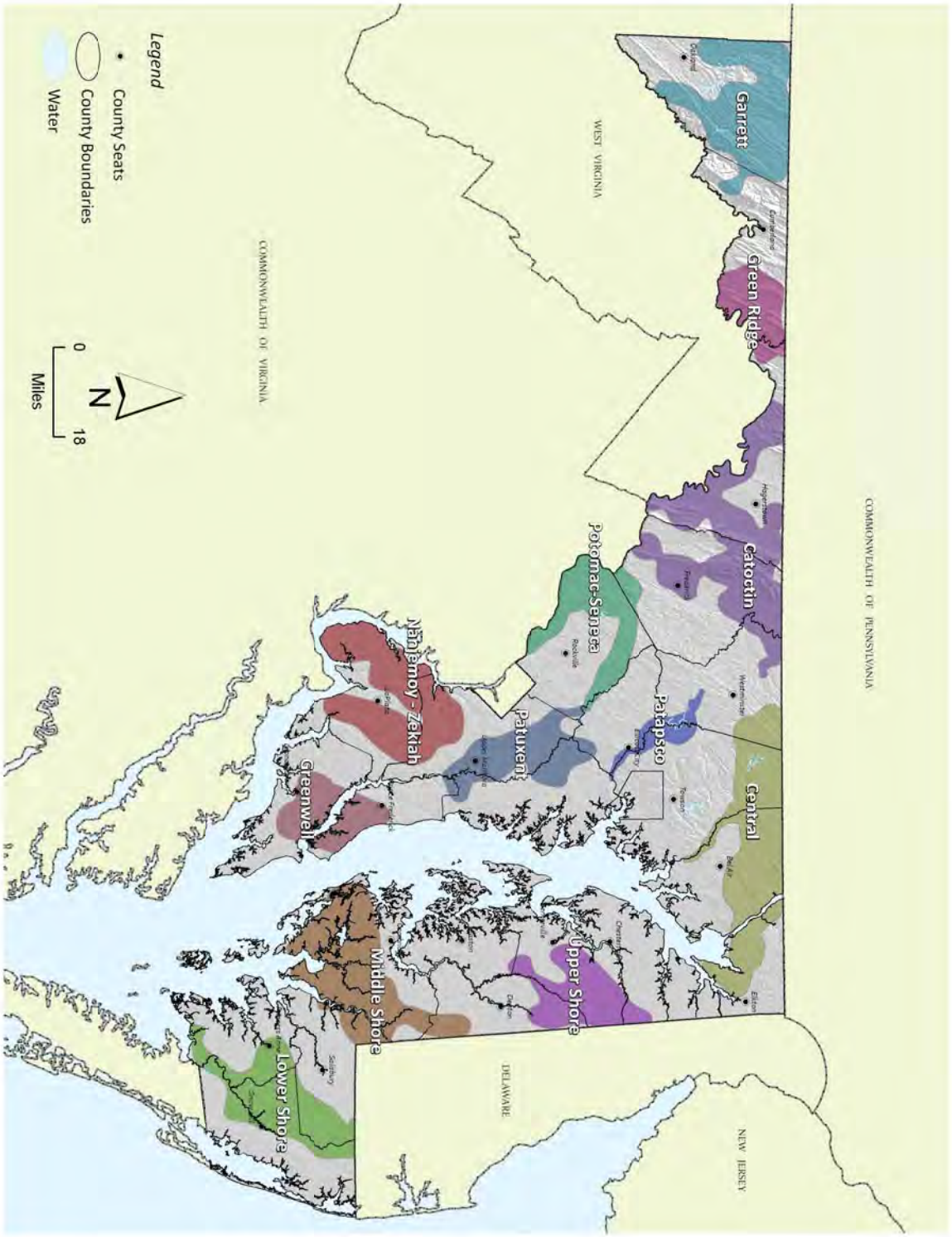
Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 6.1: Fish and Wildlife Base Model



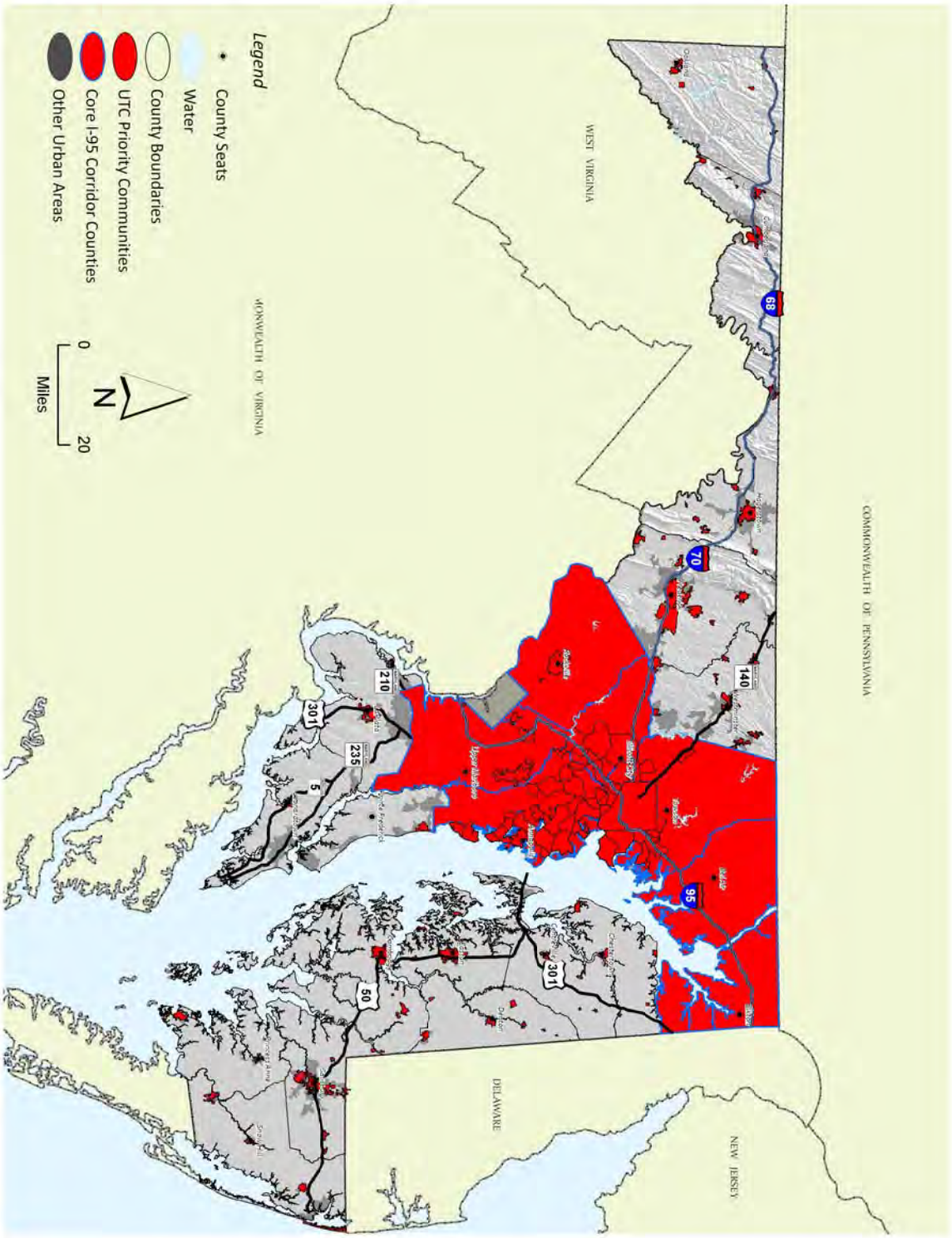
Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 6.2: Fish and Wildlife Core Forestry Priority Areas



Appendix B: Base Model Maps and Forestry Core Issue Priority Areas

Map 7.1: Urban Forestry Core Forestry Priority Areas



Appendix C: Summary of Priority Areas

The Number of Spatial Analysis Project (SAP) Stewardship Potential Acres in Maryland by US Forest Service Nation Priority.

Maryland SAP Statistics		
Maryland	Statewide SAP	
Total Acres (Land Area)	SAP Stewardship Potential	SAP Acres
6,255,245	Low	1,637,163
	Medium	2,075,980
	High	349,032

Conserve Working Forests			
CWF as a percent of state	SAP Stewardship Potential	CWF Acres in SAP	Percent of Statewide SAP
54%	Low	868,469	53%
	Medium	1,204,061	58%
	High	223,554	64%

Protect Forests From Harm			
PFFH as a percent of state	SAP Stewardship Potential	PFFH Acres in SAP	Percent of Statewide SAP
42%	Low	445,303	27%
	Medium	1,006,342	48%
	High	219,740	63%

Enhance Public Benefits of Forest			
EPBF as a percent of state	SAP Stewardship Potential	EPBF Acres in SAP	Percent of Statewide SAP
81%	Low	1,141,050	70%
	Medium	1,738,396	84%
	High	303,251	87%

Appendix D: Species of Greatest Conservation Need by Forest Type

OLD GROWTH FOREST

Mammals
Allegheny woodrat
American marten
Bobcat
Delmarva fox squirrel
Eastern red bat
Eastern small-footed myotis
Eastern spotted skunk
Hoary bat
Indiana bat
Least weasel
Long-tailed shrew
New England cottontail
North American Porcupine
Northern flying squirrel
Rafinesque's big-eared bat
Silver-haired bat
Smoky shrew
Southeastern myotis
Southeastern shrew
Southeastern star-nosed mole
Southern bog lemming
Southern pygmy shrew
Southern rock vole
Southern water shrew

Birds
Acadian flycatcher
American redstart
Bald eagle
Barred owl
Bicknell's thrush
Black-and-white warbler
Black-billed cuckoo
Blackburnian warbler
Black-throated blue warbler
Black-throated green warbler
Blue-headed vireo
Broad-winged hawk
Brown creeper
Brown-headed nuthatch
Canada warbler
Cerulean warbler
Chuck-will's-widow
Common raven
Dark-eyed junco
Eastern towhee
Golden-crowned kinglet
Hairy woodpecker
Hermit thrush
Hooded warbler
Kentucky warbler
Louisiana waterthrush
Magnolia warbler
Northern goshawk
Northern parula
Northern saw -whet owl
Northern waterthrush
Olive-sided flycatcher
Ovenbird
Pileated woodpecker
Prairie warbler
Prothonotary warbler
Red-breasted nuthatch
Red-cockaded woodpecker
Red-eyed vireo
Red-headed woodpecker
Red-shouldered hawk
Scarlet tanager
Summer tanager
Swainson's thrush
Swainson's warbler
Veery
Wayne's black-throated green warbler
Whip-poor-will
Winter wren
Wood thrush
Worm-eating warbler
Yellow -bellied sapsucker
Yellow -throated vireo

Reptiles
Broad-headed skink
Cornsnake
Eastern box turtle
Eastern hog-nosed snake
Northern pinesnake
Northern scarletsnake
Timber rattlesnake
Wood turtle

Amphibians
Allegheny Mountain dusky salamander
Barking treefrog
Eastern mud salamander
Eastern narrow -mouthed toad
Eastern spadefoot
Eastern tiger salamander
Green salamander
Jefferson salamander
Long-tailed salamander
New Jersey chorus frog
Northern red salamander
Seal salamander
Wehrle's salamander

Inverts: Dragonflies & Damselflies
Arrowhead spiketail
Brown spiketail
Delta-spotted spiketail
Gray petaltail
Harlequin darner
Northern pygmy clubtail
Southern pygmy clubtail
Taper-tailed darner
Tiger spiketail

Inverts: Butterflies & Moths
A noctuid moth
American chestnut nepticulid moth
Appalachian blue
Carolina satyr
Chermock's mulberry wing
Chestnut clearwing moth
Compton tortoiseshell
Cypress sphinx moth
Dusky azure
Early hairstreak
Giant swallowtail
Golden-banded skipper
Gray comma
Great purple hairstreak
Hessel's hairstreak
Hickory hairstreak
King's hairstreak
Marbled underwing
Northern crescent
Palamedes swallowtail
Pepper and salt skipper
Phleophagan chestnut nepticulid moth
Pine barrens zanclognatha
Precious underwing
The buckmoth
Three-horned moth
West virginia white

Inverts: Beetles
Giant stag beetle
Six-banded longhorn beetle

Inverts: Spiders
Red-legged purse-web spider

Inverts: Land Snails
Angular disc
Bear creek slitmouth
Cherrydrop snail
Cylindrically-ornate wood snail
Rader's snail
Spruce knob threetooth
Striped whitelip

Rare Natural Communities
****This is considered the highest quality condition/stage of any forested community and is therefore rare from that standpoint****

Appendix D: Species of Greatest Conservation Need by Forest Type

EARLY SUCCESSIONAL FOREST

Mammals
Bobcat
Eastern red bat
Least shrew
North American Porcupine
Snowshoe hare
Southeastern shrew
Southern bog lemming

Birds
American woodcock
Bachman's sparrow
Bewick's wren
Blue-winged warbler
Brown thrasher
Chestnut-sided warbler
Common raven
Eastern towhee
Field sparrow
Golden-winged warbler
Least flycatcher
Mourning warbler
Nashville warbler
Northern bobwhite
Prairie warbler
Willow flycatcher

Reptiles
Eastern hog-nosed snake
Timber rattlesnake

Amphibians
Eastern spadefoot
New Jersey chorus frog

Inverts: Butterflies & Moths
Indian skipper

Rare Natural Communities
Unknown

Appendix D: Species of Greatest Conservation Need by Forest Type

MARITIME FORESTS AND SHRUBLAND

Mammals
Least shrew

Birds
American woodcock
Bicknell's thrush
Boat-tailed grackle
Brown thrasher
Brown-headed nuthatch
Chuck-will's-widow
Common nighthawk
Eastern towhee
Field sparrow
Hairy woodpecker
Northern bobwhite
Prairie warbler
Red-cockaded woodpecker
Red-headed woodpecker
Summer tanager

Reptiles
Broad-headed skink
Eastern hog-nosed snake

Inverts: Beetles
American burying beetle

Rare Natural Communities
Maritime Dune Loblolly Pine Forests
Maritime Dune Scrub
Maritime Dune Woodlands

Appendix D: Species of Greatest Conservation Need by Forest Type

LOBLOLLY PINE – OAK FORESTS

Mammals
Delmarva fox squirrel
Eastern red bat
Southeastern shrew
Southern bog lemming
Southern pygmy shrew

Birds
Acadian flycatcher
American redstart
American woodcock
Bald eagle
Barred owl
Bicknell's thrush
Black-and-white warbler
Black-billed cuckoo
Brown-headed nuthatch
Chuck-will's-widow
Common nighthawk
Eastern towhee
Great blue heron
Great egret
Hairy woodpecker
Hooded warbler
Northern bobwhite
OvenbirdPileated woodpecker
Red-cockaded woodpecker
Red-eyed vireo
Red-headed woodpecker
Red-shouldered hawk
Scarlet tanager
Snowy egret
Summer tanager
Whip-poor-will
Wood thrush
Worm-eating warbler
Yellow -throated vireo

Reptiles
Broad-headed skink
Cornsnake
Eastern box turtle
Eastern hog-nosed snake
Northern pinesnake
Northern scarletsnake

Amphibians
Barking treefrog
Eastern narrow -mouthed toad
Eastern tiger salamander
New Jersey chorus frog

Rare Natural Communities
Unknown

Appendix D: Species of Greatest Conservation Need by Forest Type

MESIC DECIDUOUS FORESTS

Mammals
Allegheny woodrat
Bobcat
Delmarva fox squirrel
Eastern red bat
Eastern small-footed myotis
Eastern spotted skunk
Hoary bat
Indiana bat
Least weasel
Long-tailed shrew
New England cottontail
North American Porcupine
Silver-haired bat
Smoky shrew
Southeastern shrew
Southern bog lemming
Southern pygmy shrew
Southern water shrew

Birds
Acadian flycatcher
American redstart
Bald eagle
Barred owl
Bicknell's thrush
Black-and-white warbler
Black-billed cuckoo
Black-throated blue warbler
Black-throated green warbler
Broad-winged hawk
Brown creeper
Canada warbler
Cerulean warbler
Common raven
Dark-eyed junco
Eastern towhee
Great blue heron
Hairy woodpecker
Hooded warbler
Kentucky warbler
Least flycatcher
Northern parula
Ovenbird
Pileated woodpecker
Red-eyed vireo
Red-headed woodpecker
Red-shouldered hawk
Scarlet tanager
Sharp-shinned hawk
Veery
Whip-poor-will
Wood thrush
Worm-eating warbler
Yellow -throated vireo

Reptiles
Broad-headed skink
Cornsnake
Eastern box turtle
Eastern hog-nosed snake
Northern pinesnake
Northern scarletsnake
Timber rattlesnake
Wood turtle

Amphibians
Barking treefrog
Eastern narrow -mouthed toad
Eastern spadefoot
Eastern tiger salamander
Green salamander
Jefferson salamander
New Jersey chorus frog
Wehrle's salamander

Inverts: Butterflies & Moths
A noctuid moth
American chestnut nepticulid moth
Appalachian blue
Carolina satyr
Chestnut clearwing moth
Compton tortoiseshell
Dusky azure
Early hairstreak
Giant swallowtail
Golden-banded skipper
Gray comma
Hickory hairstreak
Marbled underwing
Northern crescent
Phleophagan chestnut nepticulid moth
Three-horned moth
West virginia white

Inverts: Beetles
A coccinellid beetle
American burying beetle
Giant stag beetle
Six-banded longhorn beetle

Inverts: Spiders
Red-legged purse-web spider

Inverts: Land Snails
Angular disc
Bear creek slitmouth
Cherrydrop snail
Cylindrically-ornate wood snail
Rader's snail

Rare Natural Communities
Rich Cove and Slope Forests
Basic Oak-Hickory Forests
Dry-Mesic Calcareous Forests
Low-Elevation BoulderfieldForests and Woodlands
Piedmont/Mountain Basic Woodland

Appendix D: Species of Greatest Conservation Need by Forest Type

DRY OAK - PINE FORESTS

Mammals
Allegheny woodrat
Bobcat
Eastern harvest mouse
Eastern red bat
Eastern small-footed myotis
Eastern spotted skunk
Indiana bat
Least weasel
New England cottontail
North American Porcupine
Silver-haired bat

Birds
Acadian flycatcher
Bachman's sparrow
Bicknell's thrush
Black-and-white warbler
Black-billed cuckoo
Broad-winged hawk
Chuck-will's-widow
Common raven
Eastern towhee
Hairy woodpecker
Northern bobwhite
Ovenbird
Pileated woodpecker
Red-eyed vireo
Red-headed woodpecker
Scarlet tanager
Summer tanager
Whip-poor-will
Wood thrush
Worm-eating warbler
Yellow -throated vireo

Reptiles
Broad-headed skink
Cornsnake
Eastern box turtle
Eastern hog-nosed snake
Northern pinesnake
Northern scarletsnake
Timber rattlesnake

Amphibians
Eastern narrow -mouthed toad
Eastern spadefoot

Inverts: Butterflies & Moths
A noctuid moth
American chestnut nepticulid moth
Chestnut clearwing moth
Cobweb skipper
Dotted skipper
Edwards' hairstreak
Frosted elfin
Giant swallowtail
Hoary elfin
Mottled duskywing
Northern metalmark
Persius duskywing
Phleophagan chestnut nepticulid
Pine barrens zanclognatha
Silvery blue
Tawny crescent
The buckmoth

Inverts: Beetles
American burying beetle
Big sand tiger beetle
Cow Path Tiger Beetle
Eastern pinebarrens tiger beetle
Festive Tiger Beetle
Northern Barrens Tiger Beetle
One-spotted Tiger Beetle
Splendid Tiger Beetle

Inverts: Spiders
Red-legged purse-web spider

Rare Natural Communities
Coastal Plain Dry Calcareous Forests and Woodlands
Montane Acidic Woodlands
Montane Dry Calcareous Forests and Woodlands
Pine-Oak/Heath Forests and Woodlands
Sand Ridge/Inland Dune Woodlands

Appendix D: Species of Greatest Conservation Need by Forest Type

NORTHERN CONIFER-HARDWOOD FOREST

Mammals
Allegheny woodrat
American marten
Bobcat
Eastern red bat
Eastern small-footed myotis
Eastern spotted skunk
Hoary bat
Indiana bat
Least weasel
Long-tailed shrew
New England cottontail
North American Porcupine
Northern flying squirrel
Silver-haired bat
Smoky shrew
Snowshoe hare
Southern bog lemming
Southern pygmy shrew
Southern rock vole
Southern water shrew

Birds
Acadian flycatcher
American redstart
Barred owl
Bicknell's thrush
Black-and-white warbler
Black-billed cuckoo
Blackburnian warbler
Black-throated blue warbler
Black-throated green warbler
Blue-headed vireo
Broad-winged hawk
Brown creeper
Canada warbler
Common raven
Dark-eyed junco
Golden-crowned kinglet
Hairy woodpecker
Hermit thrush
Hooded warbler
Least flycatcher
Long-eared owl
Magnolia warbler
Nashville warbler
Northern goshawk
Northern parula
Northern saw -whet owl
Ovenbird
Pileated woodpecker
Red-breasted nuthatch
Red-eyed vireo
Scarlet tanager
Sharp-shinned hawk
Swainson's thrush
Veery
Whip-poor-will
Winter wren
Wood thrush
Worm-eating warbler
Yellow -bellied sapsucker
Yellow -throated vireo

Reptiles
Eastern box turtle
Timber rattlesnake

Amphibians
Green salamander
Jefferson salamander
Wehrle's salamander

Inverts: Butterflies & Moths
Appalachian blue
Compton tortoiseshell
Dusky azure
Early hairstreak
Gray comma
Olympia marble
Three-horned moth
West virginia white

Inverts: Land Snails
Angular disc
Bear creek slitmouth
Spruce knob threetooth

Rare Natural Communities
Central Appalachian Northern Hardwood Forests
Central Appalachian Red Spruce Forests
Acidic Cove Forests
Eastern Hemlock Forests
Eastern White Pine-Hardwood Forests

Appendix D: Species of Greatest Conservation Need by Forest Type

FLOODPLAIN FORESTS

Mammals
Bobcat
Delmarva fox squirrel
Eastern red bat
Hoary bat
Indiana bat
Least weasel
Rafinesque's big-eared bat
Silver-haired bat
Southeastern myotis
Southeastern shrew
Southeastern star-nosed mole
Southern pygmy shrew
Southern water shrew

Birds
Acadian flycatcher
American black duck
American redstart
American woodcock
Bald eagle
Bank swallow
Barred owl
Bicknell's thrush
Black-and-white warbler
Black-billed cuckoo
Blackburnian warbler
Black-crowned night-heron
Black-throated blue warbler
Black-throated green warbler
Blue-headed vireo
Broad-winged hawk
Brown creeper
Brown-headed nuthatch
Canada warbler
Cerulean warbler
Golden-crowned kinglet
Great blue heron
Great egret
Hairy woodpecker
Hermit thrush
Hooded warbler
Kentucky warbler
Louisiana waterthrush
Magnolia warbler
Northern parula
Ovenbird
Pileated woodpecker
Prothonotary warbler
Red-eyed vireo
Red-headed woodpecker
Red-shouldered hawk
Scarlet tanager
Solitary sandpiper
Swainson's warbler
Veery
Wayne's black-throated green warbler
Wood thrush
Worm-eating warbler
Yellow -crowned night-heron
Yellow -throated vireo

Reptiles
Bog turtle
Broad-headed skink
Common ribbonsnake
Eastern box turtle
Eastern spiny softshell
Northern map turtle
Northern red-bellied turtle
Queen snake
Rainbow snake
Red-bellied watersnake
Spotted turtle
Timber rattlesnake
Wood turtle

Amphibians
Carpenter frog
Eastern mud salamander
Eastern narrow -mouthed toad
Eastern spadefoot
Jefferson salamander
New Jersey chorus frog

Inverts: Dragonflies & Damselflies
Aurora damsel
Blue-faced meadowhawk
Cyrano darner
Fine-lined emerald
Harlequin darner
Robust baskettail
Taper-tailed darner
White-faced meadowhawk

Inverts: Butterflies & Moths
Baltimore checkerspot
Carolina satyr
Chermock's mulberry wing
Cypress sphinx moth
Dion skipper
Giant swallowtail
Golden-banded skipper
Great purple hairstreak
Hessel's hairstreak
King's hairstreak
Long dash
Marbled underwing
Northern crescent
Palamedes swallowtail
Pepper and salt skipper
Precious underwing
West virginia white

Inverts: Dipterans
Pitcher-plant mosquito

Inverts: Beetles
Appalachian Tiger Beetle
Giant stag beetle

Inverts: Freshwater Crustaceans
An entocytherid ostracod
An entocytherid ostracod

Rare Natural Communities
Riverside Outcrop Barrens
Floodplain Ponds and Pools
Piedmont/Mountain Swamp Forests
River-Scour Woodlands
Riverside Prairies
Atlantic White Cedar Wetlands
Estuarine Fringe Loblolly Pine Forests
Tidal Bald Cypress Woodlands/Forest

Appendix E: Gaps in Assessment Data

1) Accurate and timely geospatial assessment of forest cover is produced on a regular basis to aid in future assessments and to provide trend data. This will involve:

- Collection of Color Infrared (CIR) imagery with National Agricultural Imagery Program Imagery on a statewide basis.
- A contractor capable of producing a GIS compatible data layer of all forest cover in the state from the CIR data.
- Time for data analysis and to work around unforeseen problems with the CIR imagery. It is recommended that this process begin 3 years prior to delivery of the state's 5 year assessment to the US Forest Service.

2) A Zoning geodata layer that is updated on an annual basis and delivered to the DNR that captures changes to county zoning and is generalized across the state. The current data layer is many years old.

3) A statewide property line geodata layer that depicts individual properties that is compiled for an approximate time period is needed. Similar data layers exist for about half of all Maryland counties. This will enhance estimates of forest fragmentation and parcelization

4) Economic study or data on "non-traditional" forest products, such as mushrooms, medicinals, such as ginseng and ginko, holiday ornamental greenery, and others.

Appendix F: Maryland Forest Service Laws And Regulations

Forest Service Statute:
http://michie.lexisnexis.com/maryland/lpext.dll/mdcode/1b123/1b124?f=templates&fn=document-frame.htm&2.0

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.*

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.* and
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

References

1 U.S. Census Bureau QuickFacts. 2008.

2 Maryland's Land 1973 – 1990: A Changing Resource. Maryland Office of Planning. 1991.

3 Maryland's Forests. USDA Forest Service, Northeastern Research Station. 2002.

4 USDA Forest Service, Forest Inventory and Analysis (FIA) Data. 2010.

5 Frieswyk, T. S. 2001. Forest statistics for Maryland: 1986 and 1999. Resources Bulletin NE-154. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station.

6 Ibid.

7 Shreve, F., M. A. Chrysler, F. H. Bodgett, and F. W. Besley. 1910. The plant life of Maryland. The Johns Hopkins Press, Baltimore, Maryland. Special Publications Vol. III.

8 Rountree, H. C., and T. E. Davidson. 1997. Eastern Shore Indians of Virginia and Maryland. University Press of Virginia, Charlottesville, Virginia.

9 Shreve, F., M. A. Chrysler, F. H. Bodgett, and F. W. Besley. 1910. The plant life of Maryland. The Johns Hopkins Press, Baltimore, Maryland. Special Publications Vol. III.

10 Frieswyk, T. S. 2001. Forest statistics for Maryland: 1986 and 1999. Resources Bulletin NE-154. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station.

11 Pest Alert: Cherry Scallop Shell Moth. Northeastern Area, Southern Region. USDA Forest Service. NA-PR-01-96.

12 Maryland Department of Agriculture. 2010.

13 Forest Pest Leaflet: Hemlock Woolly Adelgid. Maryland Department of Agriculture. MDA 14-005-05. Adapted from McClure, M 1995. Managing Hemlock Woolly Adelgid in Ornamental Landscapes. Conn Agr. Exp. Sta. Bulletin 925.

14 Gypsy Moth in Maryland. Maryland Department of Agriculture. MDA 14-006-08. 2009.

15 Annual Accomplishment Report Maryland Emerald Ash Borer Eradication Project 08-8224-0408-CA. The Maryland Department of Agriculture. 2008

16 Pennsylvania Annual Pest Conditions Report. PA Department of Conservation and Natural Resources Bureau of Forestry, Division of Forest Pest Management. 2008.

17 Maryland Biological Stream Survey 2000-2004, Volume 9: Aquatic Biodiversity. Maryland Department of Natural Resources, Chesapeake Bay and Watershed, Monitoring and Non-tidal Assessment Program. CBWP-MANTA-EA-05-6. July, 2005.

18 The Economic Impact of Privately-Owned Forests. Forest2Market Inc.. 2009

19 Forest Ownership in Maryland, 2006. Adapted from Family "Forest Owners of the United States, 2006" General Technical Report NRS-27. 2006.

20 Maryland Department of Labor, Licensing, and Regulation. Average Employment for 2005. 2010.

21 MARBIDCO Resource Based Industry Report. Salisbury University. 2008

22 "Maryland's Land 1973-1990 A Changing Resource". Maryland Office of Planning. October, 1991.

23 Roger B. Hammer, Susan I. Stewart, Richelle L. Winkler, Volker C. Radeloff, Paul R. Voss. "Characterizing dynamic spatial and temporal residential density patterns from 1940–1990 across the North Central United States". Landscape and Urban Planning 69 (2004) 183–199.

24 Stephen D. Preston and John W. Brakebill. US Geological Survey Report WRIR 99-4054. 2005.

25 Metadata for Forest Matrix Blocks. The Nature Conservancy (TNC) Eastern Conservation Science. 2005. Available online: http://www.2c1forest.org/atlas/metadata/matrix_metadata.htm. Accessed May 6, 2010.

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