MARYLAND'S

STRATEGIC FOREST LANDS ASSESSMENT

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Robert L. Ehrlich, Jr., Governor
Michael S. Steele, Lt. Governor

C. Ronald Franks, Secretary
W. P. Jensen, Deputy Secretary

This publication is a cooperative project of the Maryland Department of Natural Resources, Watershed Services and the Maryland Forest Service.

Significant funding for this project was provided by the USDA Forest Service, Northeastern Area State and Private Forestry grant # 00-DG-11244225-404.

Watershed Services

Frank Dawson, Director

Bill Jenkins, Director
Landscape and Watershed Analysis Division

John Wolf, Chief
Landscape Analysis

Greta Guzman, GIS Analyst

Anne Sloan, Natural Resources Planner

Fred Irani, Remote Sensing Specialist

Ted Weber, Landscape Ecologist

Christine Conn, Natural Resources Planner

Maryland Forest Service

Steven W. Koehn, Director
and Maryland State Forester

Don Van Hassent, Associate Director
Maryland Forest Service

Jeff Horan, Chief
Forest Ecosystem Planning and Analysis

Pat Patterson, GIS Analyst

Jack Perdue, Supervisor
Public Lands Stewardship

Layout, cover design and graphics
by Lisa Gutierrez, Waterway and Greenways Div.

CONTENTS

Introduction 1

- Current Conditions and Trends 3

Using GIS to Identify Strategic Forest Lands 4

- The Modeling Approach 5

Maryland's Forest Resource Land Base - Threats and Opportunities 6

- Ecological Values - Map: Ecological Ranking of Forest Lands 5
- Forest Ownership and Parcelization - Maps: Parcelization in Catoctin Mountain Area 8
- Forest Fragmentation - Map: Large Forest Blocks 10
- Economic Values - Map: Economic Ranking of Forest Lands 12
- Forest Lands at Risk - Map: Vulnerability Ranking of Forest Lands 14
- Strategic Forest Lands Assessment and Local Government Planning - Maps: County Examples of Ecological, Economic, and Vulnerability Models 16
- Maryland's Urban Forest Resources - IKONOS Imagery of Urban Forest Cover 18

Current Conditions – Criteria and Indicators of Forest Sustainability 20

- Conservation of Biological Diversity - Map: Dominant Forest Community Types 22
- Maintenance of Productive Capacity of Forest Ecosystems - Map: Average Site Index of Forest Soils 24
- Maintenance of Forest Ecosystem Health and Vitality - Map: Wildland-Urban Interface - Fire Threat Potential 26
- Conservation and Maintenance of Soil and Water Resources - Map: Percent of Riparian Zones Unforested 28
- Maintenance of Forest Contribution to Global Carbon Cycles - Map: Net Primary Productivity 30
- Maintenance and Enhancement of Long Term Multiple Socioeconomic Benefits - Map: Probability of Commercial Timber Management 32
- Legal, Institutional, and Economic Framework - Map: Projected Watershed Character - Year 2020 34

Forest Sustainability and Strategic Forests – A Look to the Future 36

- Forest Lands of High Ecologial and High Economic Value 37

INTRODUCTION

Maryland is a rapidly urbanizing state. Inventories by the USDA Forest Service have shown that over the last 50 years Maryland has lost an average of 7,200 acres of forest per year, primarily because of land development for urban uses.

Maryland faces many challenges in sustaining healthy, ecologically functional and economically viable forests in the face of rapid urban development. Once, more than 90% of Maryland was forested. Today 41% of Maryland's land is covered by forest. Maryland is the nation's fifth most densely populated state, with more than 5.3 million people. The constantly growing population has more than doubled since 1950.

Maryland's Strategic Forest Lands Assessment (SFLA) grows from the recognition that the state faces significant loss of the ecological, social and economic benefits of forests due to this rapid urban development. A compounding problem is that remaining forests are being fragmented from large, contiguous blocks of forest into many smaller, isolated patches. Smaller patches are less effective as wildlife habitat. They are more difficult to manage to protect soil, air and water quality. They are also less likely to support the $2.2 billion forestry and wood products industry, the fifth largest industry in the State.

PHOTO: LISA GUTIERREZ

Sustainable use of our forest resources, for the multiple benefits they provide, requires planned management in such a way that the needs of today are met without hurting the ability of future generations to meet their needs. This implies a stewardship of the environment, and living within some limits. Maryland's Strategic Forest Lands Assessment provides a baseline of information about where we are now, and criteria and indicators that can also be used to measure change, as a first step in working toward sustainability for Maryland's forests.

PHOTO: R. HARRISON WIEGAND

PHOTO: TED WEBER

PHOTO: BRODERBUND

Current Conditions and Trends

This document describes the current condition of Maryland's forests, including the results of three computer-based models that can be used to assess their ecological and economic value and their vulnerability to loss. The maps and models presented here are meant to be used for future planning and determination of trends, not for management decisions on individual parcels. Together the models discussed in the first part of this report help to identify "strategic forest lands", or those areas that might be most important for focusing management and protection efforts. The remainder of the report lays out internationally accepted criteria of sustainability for forests, with Maryland-specific example indicators for each. The indicators are useful for monitoring the health and vitality of our forests into the future. Data reflected in these indicators are among those used to build the three models.

The maps are shown in one of two ways: surface maps showing 30-meter grid cells or data aggregated by subwatershed. Each method of data presentation paints a slightly different picture of the forest resources of Maryland.

Trends in Forest Land Area

(thousands of acres at each inventory)

INVENTORY DATA

	1950	1964	1976	1986	1999
Total forest land	2,920	2,963	2,653.2	2,645.3	2,565.8
Percent forested	46.2%	46.9%	41.9%	42.3%	41.0%
Estimated total land area*	6,324	6,319	6,330.2	6,255.8	6,255.8

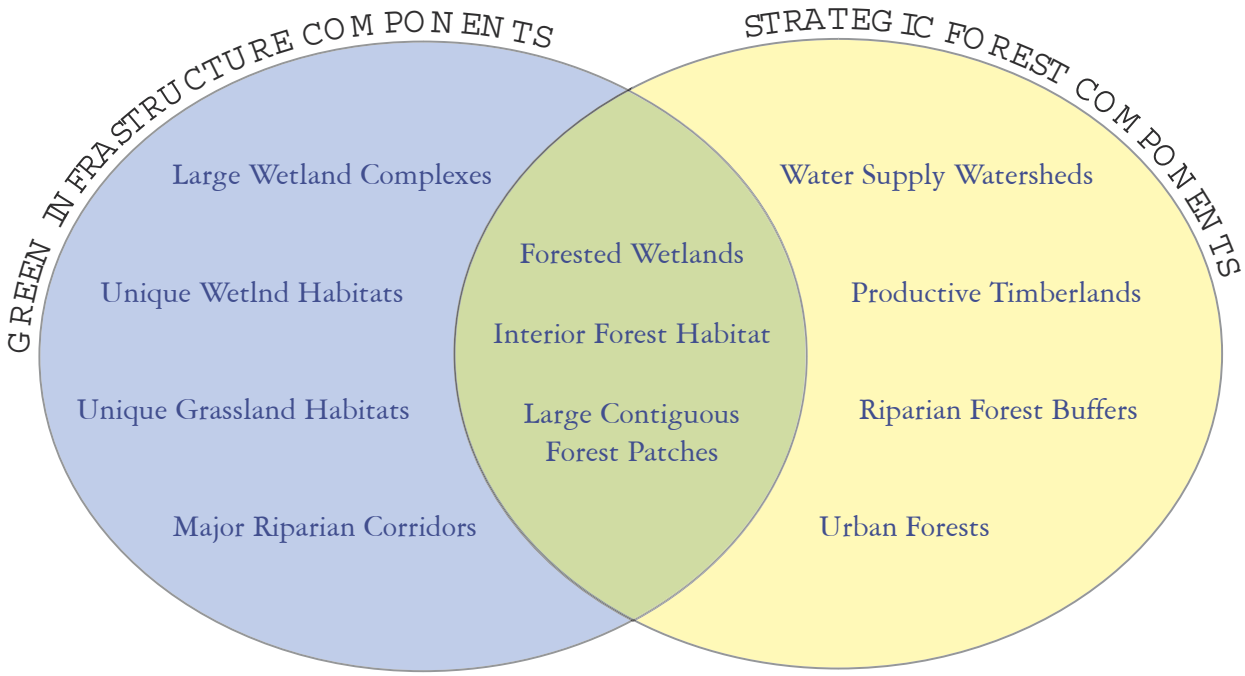
* Estimates of the total land area have changed because of new measurement techniques and refinements in the classifications of small bodies of water.

USING GIS TO IDENTIFY STRATEGIC FOREST LANDS

The Maryland Department of Natural Resources has, over the course of several years, compiled the best available data to identify a network of ecologically important natural resource lands – known as the Green Infrastructure. This has been accomplished through a combination of Geographic Information System (GIS) approaches - computer or desktop assessment techniques - and the knowledge of Department of Natural Resources scientists, foresters, biologists, ecologists, and planners, aided by local government planning and zoning and parks and recreation staff. The Strategic Forest Lands Assessment grows out of this Green Infrastructure Assessment (GIA), completed in 2000, which evaluated Maryland's sensitive natural resources, focusing on forests and wetlands, for their contribution to the network.

The SFLA expands on the analysis of the earlier assessment to take a more comprehensive look at forests, by (1) examining all forest lands of the State, not just those within the identified Green Infrastructure network, and (2) assessing these lands for their long-term economic potential as well as ecological value.

Green Infrastructure and Strategic Forests



The Modeling Approach

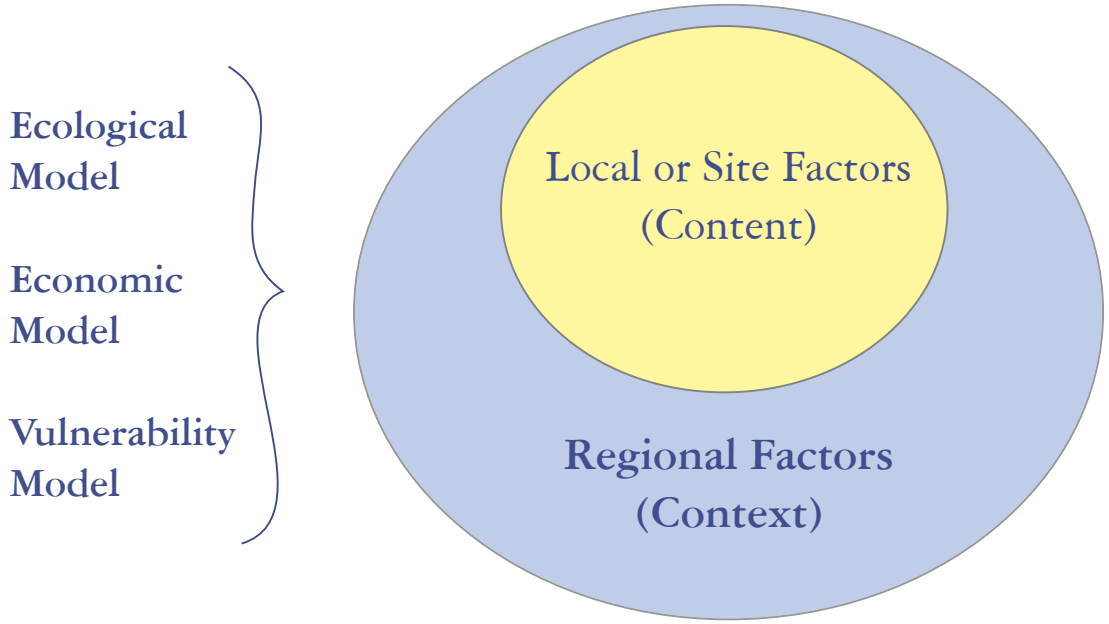
Through the Strategic Forest Lands and Green Infrastructure Assessments, DNR has developed a number of data sets that allow us to quantify the ecological and economic values of forestland areas, and correspondingly compare and rank these values. Evaluations are typically conducted at two different geographic scales: "regional" and "local".

Regional or landscape scale factors generally relate to the "context" of a given area of forest relative to one or more ecological factors or socioeconomic influences. For example, a one-acre woodlot surrounded by agricultural land provides different ecological services than one acre of forest embedded in a much larger forested patch.

Local or site factors generally relate to the "content" of a given forested area, or more specifically, the characteristics present at that particular place on the landscape.

For each of the composite GIS models developed to support the Strategic Forest Lands Assessment, both regional and local factors have been considered to evaluate the importance and vulnerability of Maryland's forestlands.

Strategic Forests Multi-Scale Modeling Approach



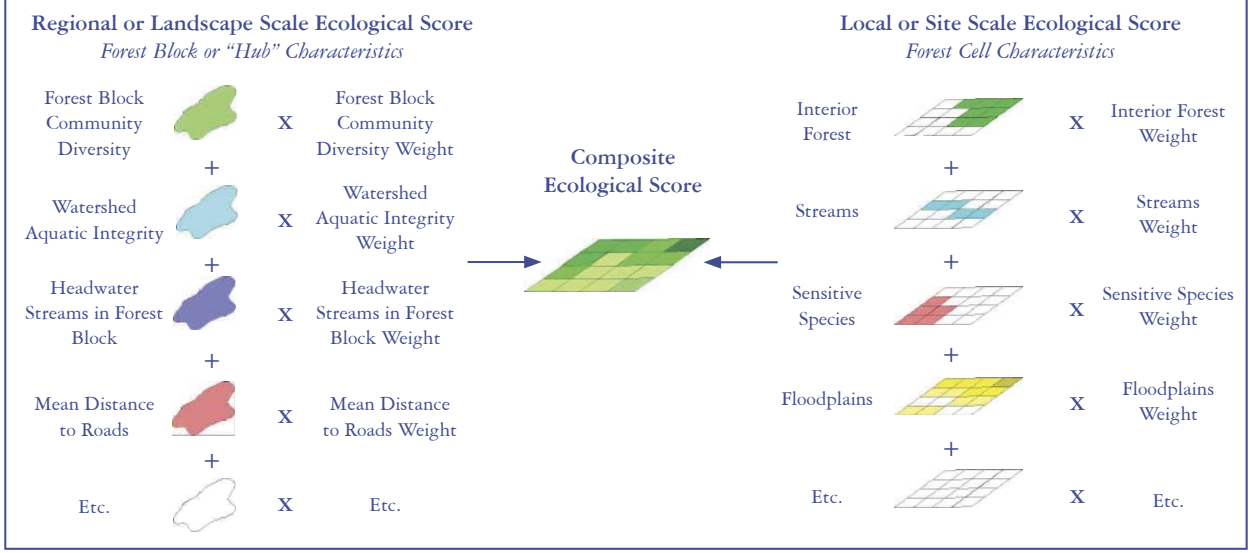
MARYLAND'S FOREST RESOURCE LAND BASE THREATS AND OPPORTUNITIES

Ecological Values

To determine forest areas of high ecological value, a GIS-based computer model was developed that considers both the regional and local ecological significance of the forest. The regional evaluation looks at the ecological importance of large forest patches relative to other forest patches within the same physiographic region. Variables relevant at local scales help to identify conservation values at or in close proximity to a specific parcel.

The data that have been assembled for the ecological model were selected based on their utility in measuring ecological values important to land conservation programs. Specifically, principles of landscape ecology and conservation biology have been interpreted and represented by GIS data layers. Each data set was scored and weighted to represent the importance of that factor in assigning an overall ecological score.

Ecological Model Approach



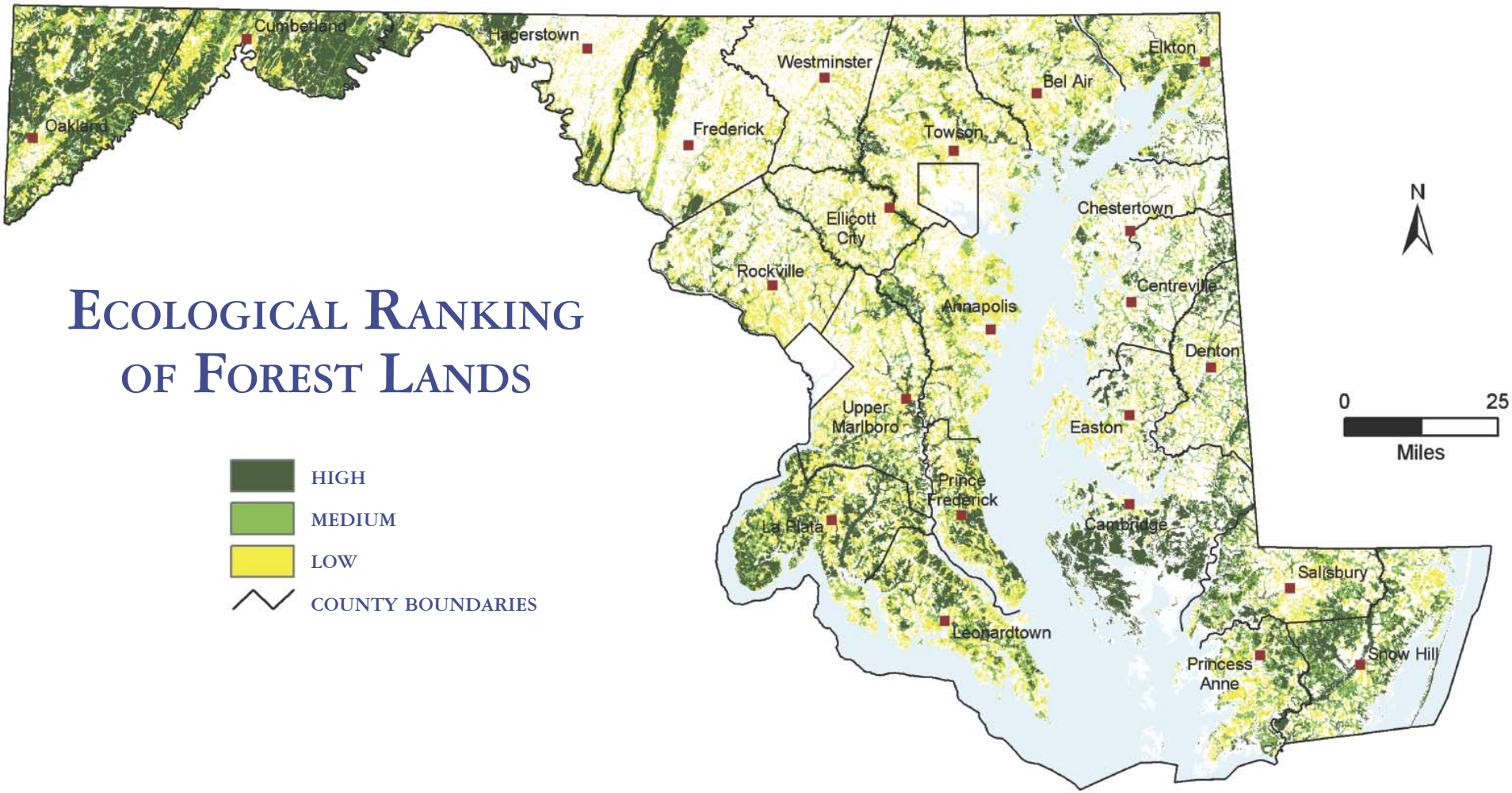
The ecological model gives priority or greater weight to large forest blocks, particularly:

- forest patches with a greater proportion of "interior" conditions
- intact blocks of forest (as opposed to patches containing substantial non-forest "gaps")
- patches with a diversity of habitat types
- patches that provide stream or erodible soils protection
- patches that are in close proximity to other forest blocks (as opposed to isolated patches with substantial inter-patch distance)

The ecological model also favors forested corridors that:

- are short as opposed to long
- are wide as opposed to narrow
- contain or have the potential to contain interior forest conditions
- are intact as opposed to fragmented
- link forest blocks ranking high as opposed to those that rank low
- link similar as opposed to dissimilar ecotypes
- have few or no road crossings
- protect and link riparian systems, and
- connect with large forest blocks

Ecological Ranking of Forest Lands



Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: Green Infrastructure Assessment
Maryland Department of Natural Resources

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

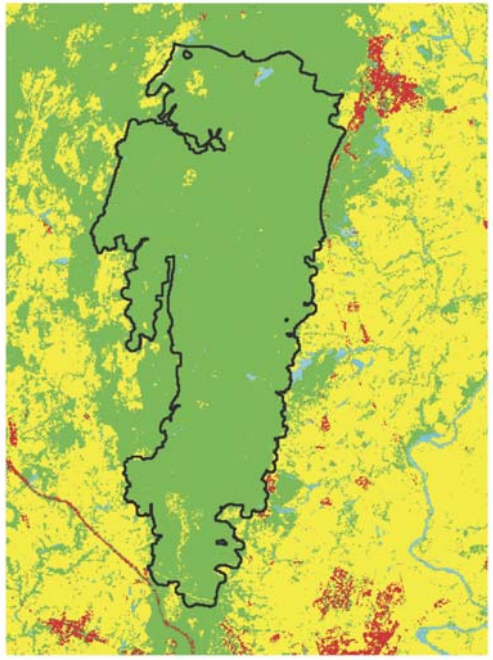
Forest Ownership and Parcelization

Far and away the majority, some 76%, of Maryland's 2.6 million acres of forestland is privately owned, by 130,600 individuals and corporations. But 75% of these owners control woodlots of fewer than 10 acres. Division of large tracts of forestland among multiple owners is referred to as parcelization, and it has major implications for the protection and management of forests. Increasingly forestland owners are among the older of the State's citizens—the 65+ age group is increasing dramatically—which suggests an increasing rate of parcelization may be anticipated in the future.

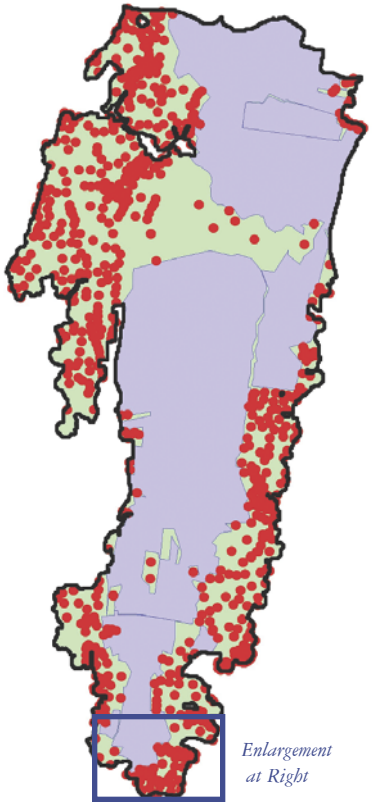
With parcelization into small ownerships, the reasons for forestland ownership are likely to shift away from management for forest products, wildlife and recreation. In the more urbanized parts of the State, where use of forest areas for residential settings is increasingly prevalent, it is less likely that trees will be harvested, and access to the forests for other products, for example mushrooms or berries, or activities like hiking or hunting, may be restricted. Coordination of multiple owners to deal with forest health issues, like invasive species of non-native plants or insects, is also complicated and may hold serious implications for long-term health and viability of the remaining forests.

Finally, ownership parcelization contributes to forest fragmentation, that has also become increasingly common in Maryland's landscape, with its associated impacts on wildlife habitat, biological diversity, water quality, and the viability of resource-based industry.

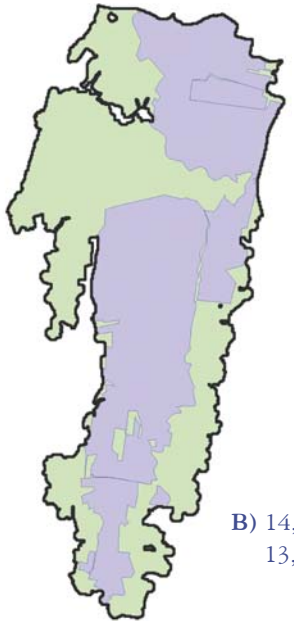
Parcelization in the Catoctin Mountain Area: As part of the Strategic Forest Lands and Green Infrastructure Assessments, a variety of statistics has been generated for large contiguous forest blocks throughout Maryland. The example at right shows one of these forest blocks or "hubs" in Frederick County. The boundaries of the forest block have been delineated based on land cover and road data (A). This forest block contains nearly 20,000 acres of forest interior habitat, over 40 miles of streams within interior forests and has 38 documented rare species occurrences. Approximately half of this forest block (shown in purple on the map) is in State or local government ownership (Cunningham Falls and Gambrill State Parks and the City of Frederick and Town of Thurmont watershed properties) (B). Although the forest extends beyond the public properties, ownership of the private forest is highly divided (C). Individual parcels are shown as red dots within the privately owned portion of the forest block (which is shown in green). The enlargements to the right show the actual parcel ownership configuration for a portion of the block.



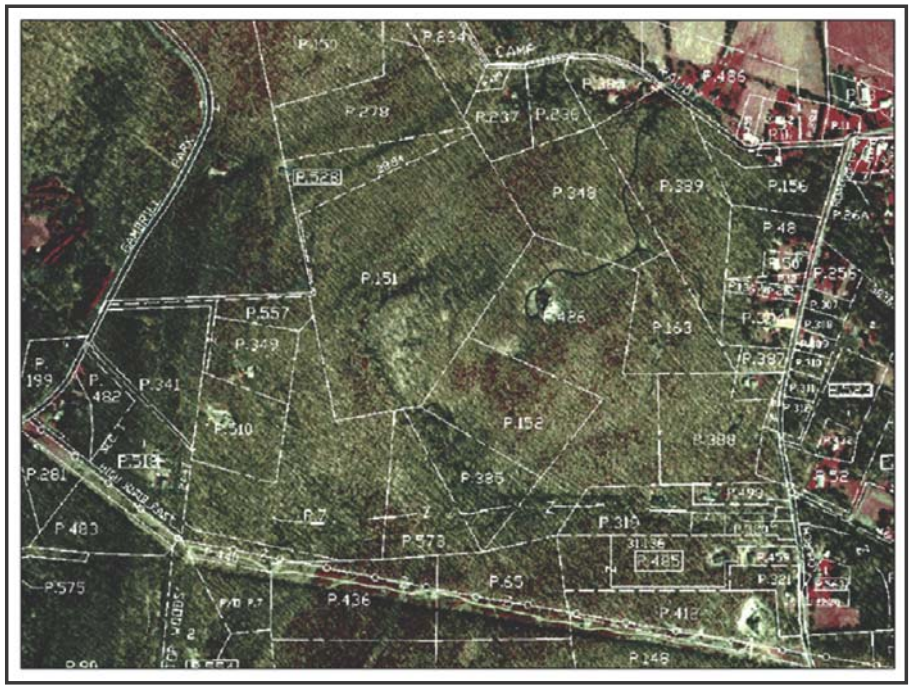
A) Land Cover Map - Catoctin Mountain (Frederick Co.)
Forest Block (27,000 acres) is outlined



C) Private Parcels = 798
Mean Parcel Size = 16 acres
Parcels > 25 acres = 105
Parcels > 50 acres = 33
Parcels > 100 acres = 9



B) 14,000 acres under 3 ownerships
13,000 acres under more than 700 ownerships



Forest Fragmentation

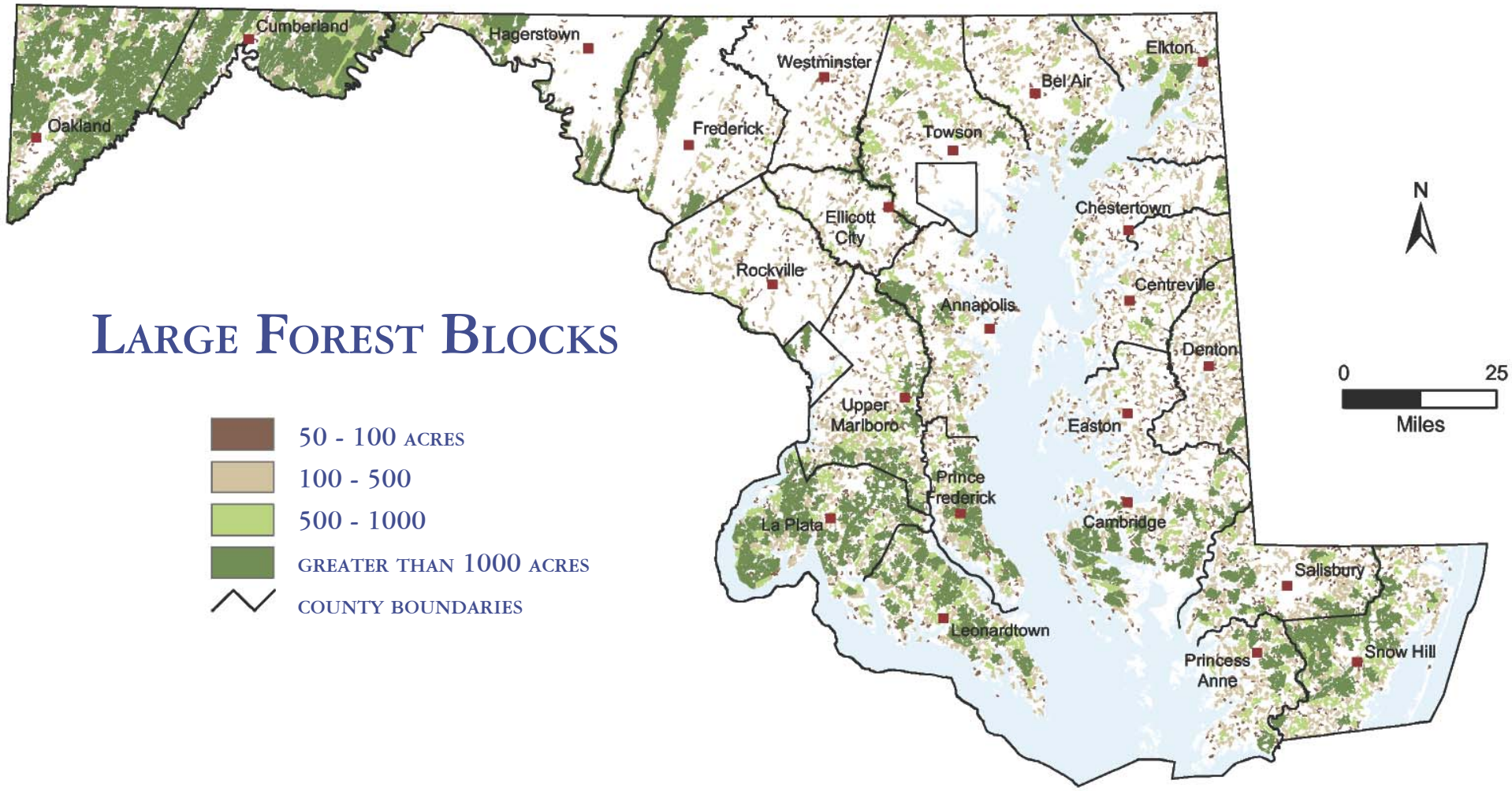
As residential and other development spreads across the landscape, the spatial configuration of the remaining forests changes, and in most cases the tendency is towards smaller and more isolated forested tracts, or "patches." This fragmentation of Maryland's forests is having an adverse effect on wildlife, on ecological function and economic viability. There are particularly important impacts on habitat available to species dependent upon larger forested tracts and the "interior" conditions these tracts often contain.

Much research has been done related to forest patch size and the connection with habitat. As forest patch size decreases, and as patches of habitat become more isolated, population sizes of species dependant upon contiguous blocks of forest may decrease below the threshold needed to maintain genetic variance, withstand natural population fluctuations and meet social requirements like breeding and migration. This is especially a problem for rare species, who often face declining habitat throughout their range.

In addition, to some extent the sustainability of the forest products industry is linked to the size of forested patches and tracts. For example, private forestry activities (both industrial and non-industrial) are more likely to be commercially viable in regions with an intact, relatively unfragmented resource base. This is due to numerous factors, including economies of scale, public perceptions and the regulatory environment.

This analysis justifies targeting particular areas with large forest patches to be the focus of land conservation initiatives aimed at maintaining the integrity of these patches, and protecting the connectivity of forest resources in the region. For those areas with smaller forest patches, opportunities may exist to increase habitat and habitat connectivity by examining gaps in forest cover within existing patches, as well as expanding forest cover along the external edges of existing patches.

Fragmentation and Parcelization



Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: National Land Cover Data (NLCD)

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

Economic Values

If managed properly, forests can continue to provide ecological services, water quality protection, and habitat, as well as a variety of forest products. The Economic Model for the Strategic Forest Lands Assessment uses GIS to help identify economically important forestlands, particularly those with the greatest potential to yield economic benefits associated with timber management activities. The model includes factors that relate not only to the short term potential economic return on a forest harvest operation, but also the long-term economic sustainability of forest land, considering local and regional influences.

At a local or site level, the economic model considers biophysical factors that influence what tree species can be grown in a given area. Also included are data layers that aim to approximate constraints on management of the forest resource.

Site-specific factors incorporated into the model include:

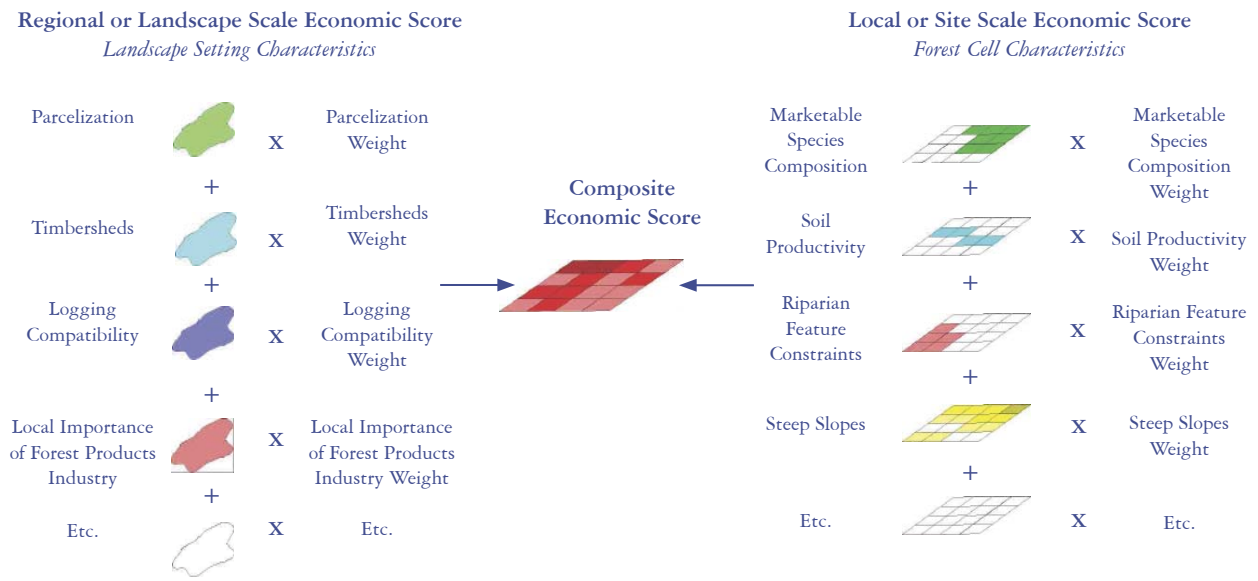
- species composition
- soil productivity
- slope
- microclimate
- riparian and wetland features
- presence of sensitive species habitats

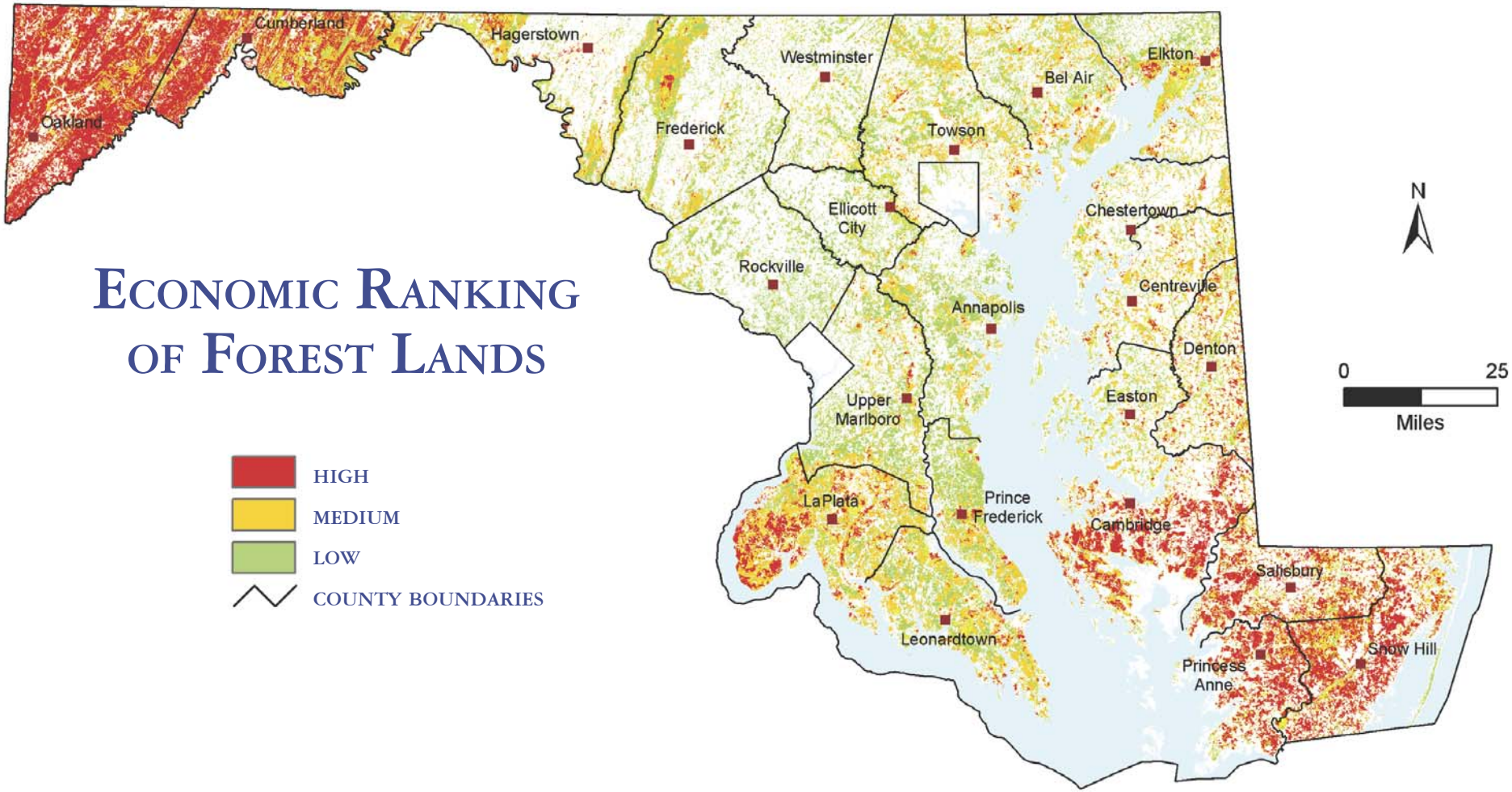
At regional or landscape scales, the economic model incorporates factors that affect the ability of the forest to support resource-based economies, including the importance of the timber management and wood products industry to local economies. Also included are data layers that attempt to capture the effects of State and local policy on forest land protection.

Regional or landscape scale socioeconomic and policy factors include:

- population density
- parcelization
- proximity of the forest resource to mills
- role of the forest products industry in the local economy
- existing or planned water and sewer service or other designations for urban growth
- existing working landscape protection initiatives (e.g. Rural Legacy and Forest Legacy Areas)
- existing public and private forest land protection.

Economic Model Approach





Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: SFLA Socioeconomic Assessment
Maryland Department of Natural Resources

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

Forest Lands at Risk

Threats to forestlands arise from multiple potential stressors. The most obvious threat is the conversion of forestland into some form of urban use–residential, commercial, industrial or institutional–with consequent loss of most of its natural resource values. Maryland's forest resources are also threatened by other forces, including biological pests (e.g., exotic species, overabundant deer, etc.) as well as abiotic factors (e.g., fire, acid deposition). For purposes of the Strategic Forest Lands Assessment, the vulnerability model that has been developed focuses on the threat of conversion of forestland to development. It only indirectly incorporates other biotic and abiotic stressors.

The model looks at regional and site specific factors that contribute to the vulnerability of a given acre of forest to development, as well as factors that make its conversion less likely. Examples of site specific data layers used to determine an area's vulnerability include:

- the current level of protection arising from public ownership, conservation or agricultural easements
- constraints on development as a result of physical limitations or regulations associated with environmentally sensitive features, including wetlands and riparian areas, steep slopes, and sensitive habitats.

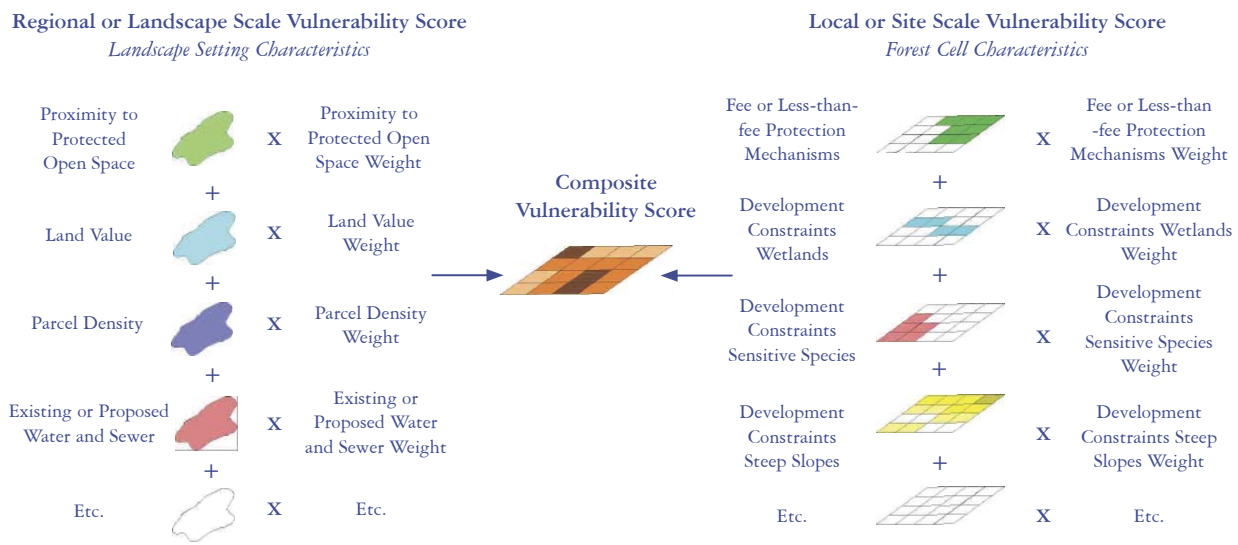
The vulnerability of forest land to development is also heavily influenced by the greater geographic setting. Market forces can drive the long term sustainability of forests as a preferred land use. The vulnerability model approximates these effects by including data layers to assess:

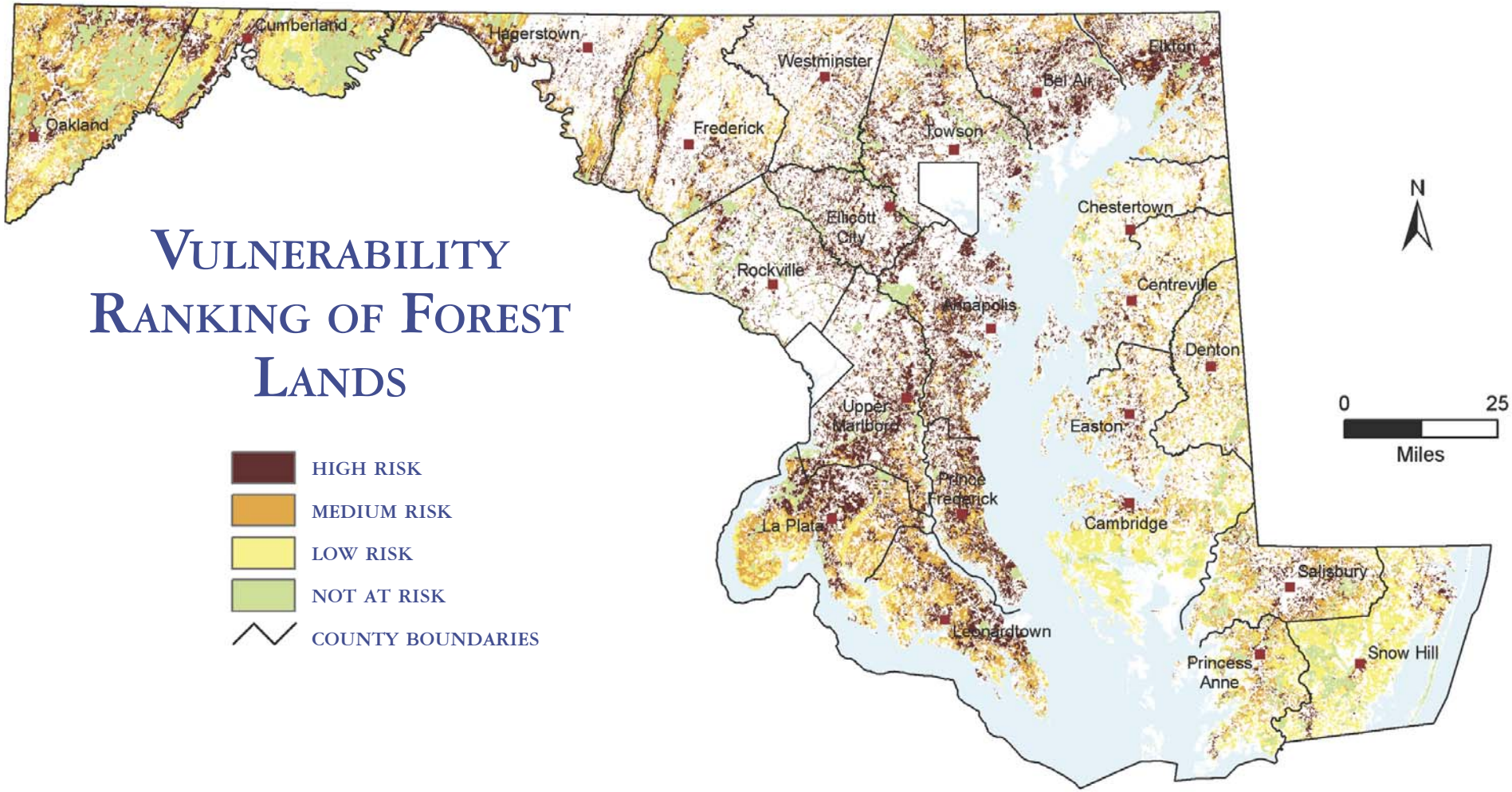
- proximity to population centers
- road access and density
- proximity to existing protected open space
- real estate values

Finally, public policy and investment can also be used to direct growth and, correspondingly, the conservation of forest resources. The model addresses these factors by including data layers for:

- existing water and sewer service areas
- Priority Funding Areas
- local zoning
- Chesapeake Bay Critical Area

Vulnerability Model Approach





Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: Green Infrastructure Assessment
Maryland Department of Natural Resources

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

Strategic Forest Lands Assessment and Local Government Planning

Most planning and land use decisions in Maryland—decisions that impact forests—are made by land owners and local governments (the 23 counties and Baltimore City). As they carry out comprehensive planning, local governments consider and seek to balance a wide variety of public needs in order to develop strategies for land preservation, resource protection, transportation, housing and economic development. As they review and update their comprehensive plans every six years, as required by law, Maryland's local governments have an opportunity to reconsider their goals and to integrate functional plans, for example for parks and open space or for water and sewer service, with their land use goals.

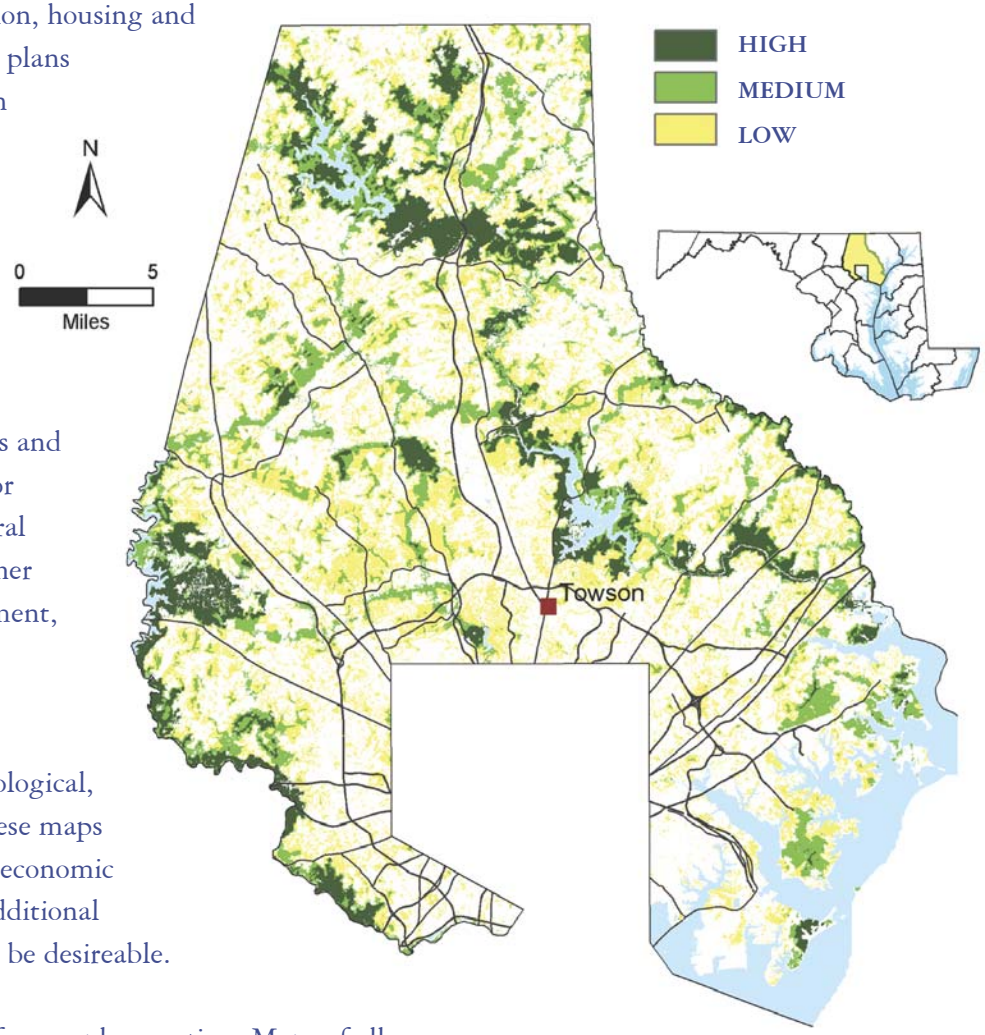
In Maryland, the sustainability of the forest resource base can be influenced by many facets of local planning. Land preservation and resource protection initiatives and strategies can direct growth away from rural areas, setting up a framework to protect important forestlands and farmlands in the process. Implementation mechanisms such as zoning, or programs such as Maryland's Rural Legacy, Forest Legacy and Agricultural preservation programs, can then be used to protect key forest lands. Other local planning efforts, such as transportation and infrastructure development, also have an impact on which forestlands are likely to remain viable for resource-based industry.

As part of the Strategic Forest Lands Assessment, county maps of the ecological, economic, and vulnerability rankings of forests have been produced. These maps can be used to assess the relationship between a county's land use plans, economic development goals and conservation interests, and may suggest where additional information should be gathered or where adjustments to local plans may be desireable.

The maps on these pages show examples of the three composite models for sample counties. Maps of all counties are viewable on the SFLA web site at www.dnr.state.md.us\forests\planning\sfla.

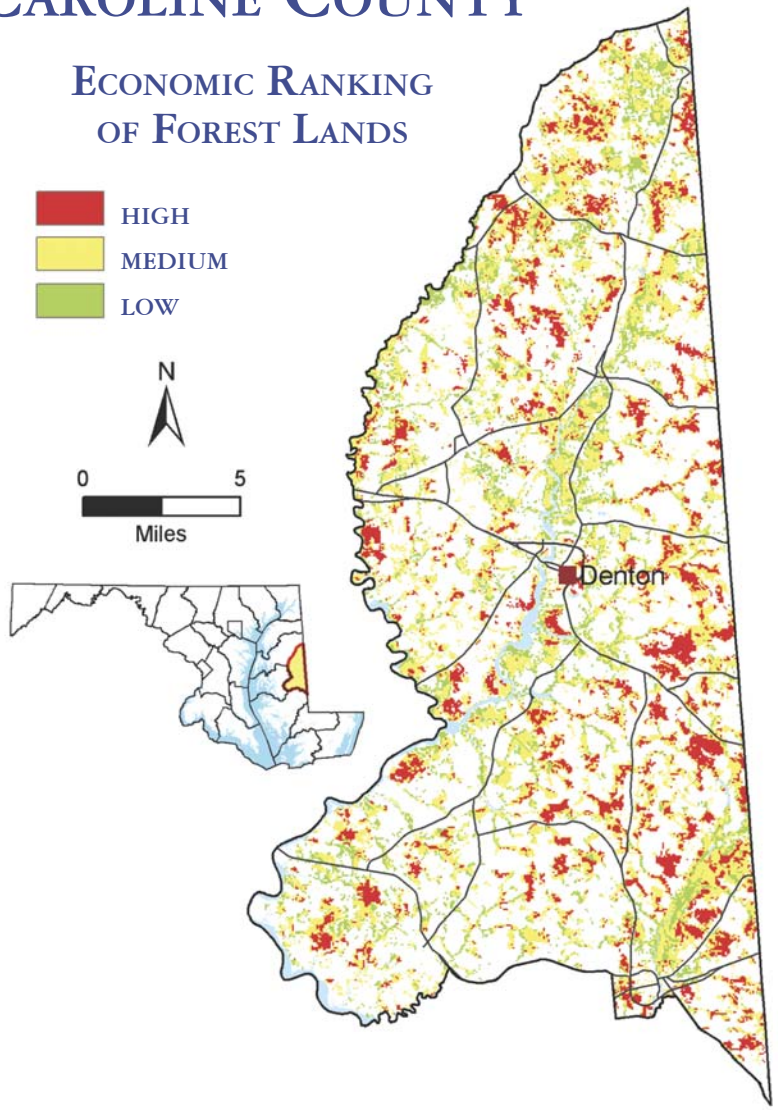
Baltimore County

Ecological Ranking of Forest Lands



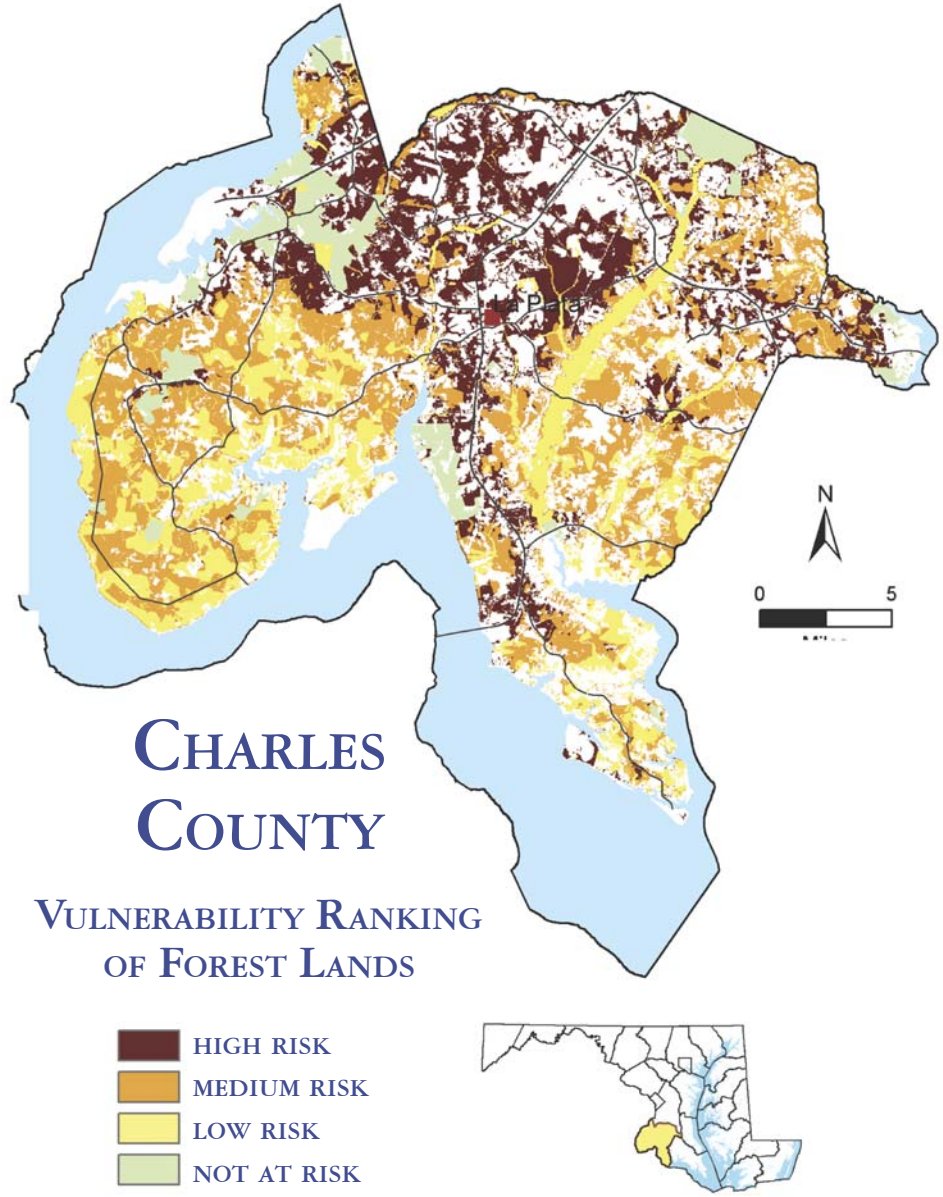
Caroline County

Economic Ranking of Forest Lands



Charles County

Vulnerability Ranking of Forest Lands



Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: Green Infrastructure Assessment\
SFLA Socioeconomic Assessment
Maryland Department of Natural Resources

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

Maryland's Urban Forest Resources

In Maryland the urban forest is particularly important. As the State becomes increasingly developed into urban uses, the character of the "urban forest" is substantially different from the character of the forest that existed previously. A recent study by the Maryland Department of Natural Resources of 74 communities in Maryland, with varying sizes and demographics, showed tree canopy cover ranging from less than 1% to over 75%.

Urban forest cover is largely in the form of street and lawn trees, and landscaped parks, commercial/industrial sites, and public grounds. These trees still provide multiple ecological, economic, and aesthetic benefits such as energy savings; air, soil, and water quality improvement; carbon storage; storm water management; and real estate value. Maryland has a history of caring about urban trees, with a law that has protected trees in the public right of way since 1914 and the first and only statewide Forest Conservation Act, passed in 1991. In the first nine years of implementation, Maryland's Forest Conservation Act has been responsible for the retention of 63% of the more than 73,000 acres of forest under review for development. A third of the acreage was cleared, and 8,702 acres were planted, resulting in post-development forest that represents 75% of the amount present prior to development.

A recent study by the USDA-Forest Service Northeast Research Station determined that Baltimore's tree canopy, estimated as covering approximately 25% of the City, benefits the City in several ways:

- Trees reduce building energy use, for a net energy saving of $3.3 million per year.
- Carbon emissions from power plants are lowered due to building energy conservation, saving an estimated 9,300 metric tons of carbon emission per year.
- The City's trees store approximately 527,300 metric tons of carbon, at an estimated total value of $10.7 million.
- Baltimore's trees also remove about 10,800 metric tons of carbon per year, at a value of $219,000 annually.
- They remove about 700 metric tons of air pollution per year, at a value of $3.8 million annually.

The report also estimates that 25,000 new trees will need to be established annually to sustain current tree cover and maintain existing benefits 30 years from now.

A 2001 study of roadside trees in the Baltimore-Washington corridor found that more than 390,000 trees line roadsides there, and that they are in good condition. Unfortunately, it also found that only about 14% of the sites appropriate for trees had trees on them, suggesting much still needs to be done to promote and protect a sustainable urban forest.

The images of part of Baltimore shown here are derived from IKONOS satellite imagery, one of them enhanced to emphasize vegetative cover and the other further processed to distinguish tree canopy (shown in green) from other vegetation (shown in yellow). Areas of vegetative cover without trees may present opportunities for reforestation.

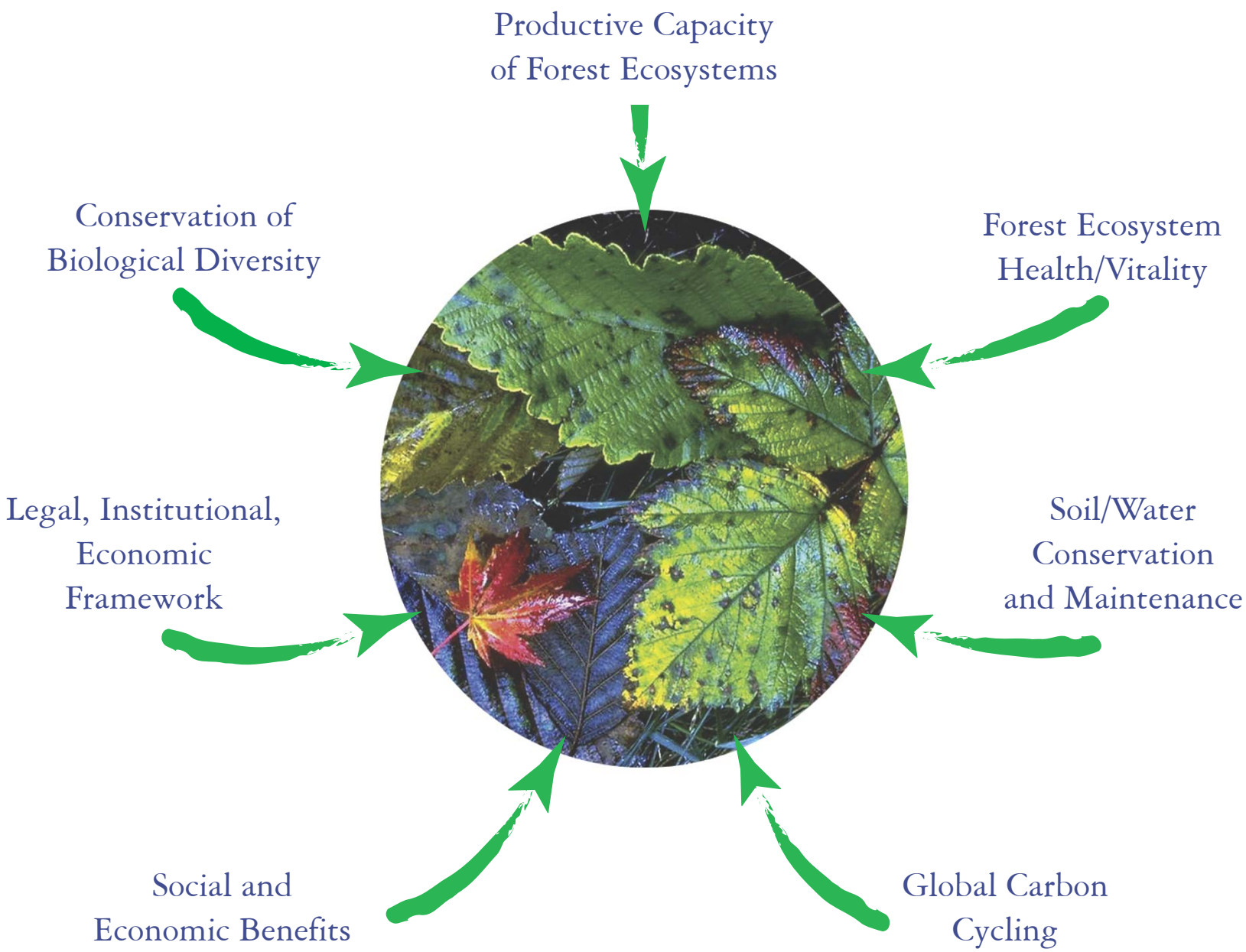
CURRENT CONDITION - CRITERIA AND INDICATORS OF SUSTAINABILITY

The 1992 United Nations Conference on Environment and Development in Rio de Janeiro, or "Earth Summit", produced a Statement of Forest Principles and a plan of action for the 21st century, *Agenda 21*, which called upon the international community to ensure the sustainable development and management of all types of forests. In response, the Montréal Process, an ad hoc committee, was formed in 1994 to develop Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests. Member countries represent about 90 percent of the world's temperate and boreal forest in both northern and southern hemispheres. The Santiago Declaration, signed in 1995 by member countries, formally presents the results of the Montréal Process. The Criteria and Indicators are intended to provide a common understanding of what is meant by sustainable forest management and a means for evaluating a country's progress in meeting this goal.

A criterion represents a category of conditions or processes by which sustainable forest management may be assessed. It is accompanied by a set of related indicators that can be monitored periodically to assess change. Maryland's Strategic Forest Lands Assessment has been used to assist with the development of indicators which address the seven criteria of the Santiago Declaration. The criteria and indicators offer a means for policy and decision-makers, and managers on the ground, to make more informed decisions regarding their actions that might have an impact on forest resources.

A more complete suite of indicators addressing each criterion may be found on the SFLA web site at www.dnr.state.md.us\forests\planning\sfla.

PHOTO: BRODERBUND



Forest conservation and sustainability indicators based on Seven Criteria developed during the Montreal Process

Conservation of Biological Diversity

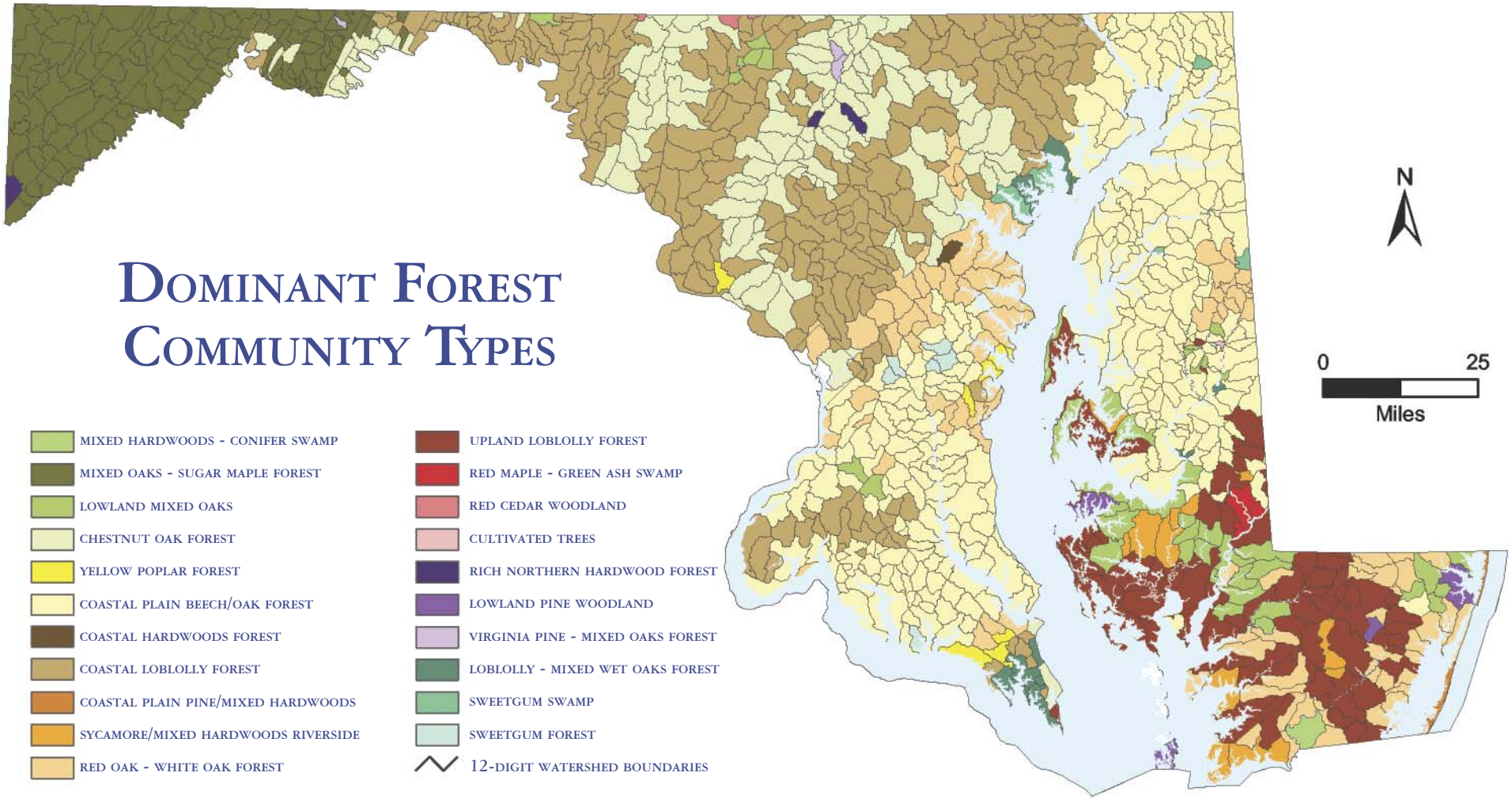
Biological diversity (biodiversity) is a term used to denote variability among living organisms, including ecosystem diversity, species diversity, and genetic diversity. Ecosystem diversity is the variety of different ecosystems, which are classified by the types of plants and animals and the physical environment found in each. Species diversity is the number and range of different species located within a given area. Genetic diversity refers to the range of genetic characteristics found within a species.

Biodiversity is critical for the sustainability of forests because it enables ecosystems to respond to external influences, to recover from disturbances, and support important ecological processes. Forest ecosystems are particularly important to biodiversity in Maryland, where forests originally occupied over 90% of the land area. All components of a given ecosystem are tied together within an intricate web, and alterations can have dramatic impacts on the entire system. By conserving biological diversity, forests should have the ability to function, reproduce, and remain productive.

PHOTO: R. HARRISON WIEGAND

- *Approximately 1,012,000 acres of Maryland's forests contain "interior" conditions that may be favored by certain wildlife species.*
- *Of the 317,342 acres of forest on DNR lands, 38,355 are currently protected as designated units of the State Wildlands Preservation System.*

Sample Indicator: Forest community types, as mapped for this indicator, are at the "alliance" level of the National Vegetation Classification System (NVCS). An alliance is a group of plant associations that share a similar architecture and one or more diagnostic species, which are generally the dominants in the forest canopy. Each type, such as Coastal Plain Beech/Oak Forest or Upland Loblolly Forest, is characterized by certain plant and animal species that depend on the particular habitat provided by that forest type.



Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: Mid-Atlantic Gap Analysis Project
(MID-A GAP); Maryland DNR

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

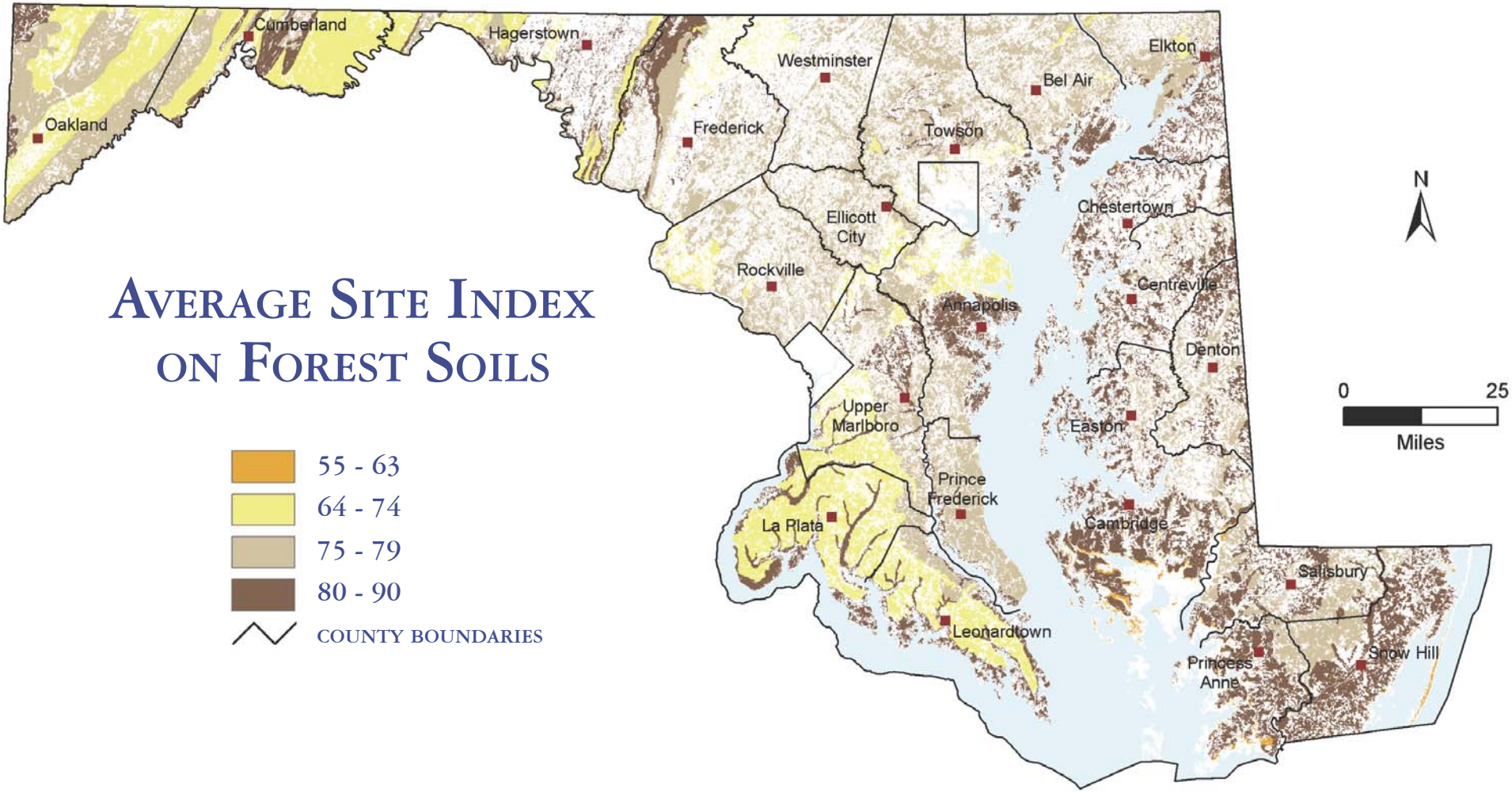
Maintenance of Productive Capacity of Forest Ecosystems

Forest ecosystems are important natural systems that provide a wide range of goods and services to humans. Historically, one of the most important goods they provide is timber, but they also provide many other non-timber resources as well. These non-timber goods include game, furbearers, syrup, mushrooms, berries, medicinal plants, vines, novelties like mistletoe, and other products. Forests also provide many valuable ecosystem services, such as carbon and nutrient uptake, soil conservation, water supply, recreation, and habitat for wildlife. The ability of a forest to provide these goods and services sustainably is linked to its productive capacity. The productive capacity of a forest is a good indicator of its overall health. Declines in capacity may indicate poor forest management practices, over harvesting, or other problems, such as acid rain, insects, and disease. These factors will negatively impact the level of goods and services provided. To manage a forest sustainably, annual forest growth (in-growth) should at least meet, or preferably exceed, the amount harvested (drain). This approach can be applied to both timber and non-timber resources. Losses in productivity can be bellwether of systemic problems in the forest. Therefore, it is very important that the productivity of Maryland's forests be determined, monitored, and compared with historic productivity levels to ensure that over harvesting or other environmental problems do not arise.

- *The average timber volume per acre has increased from 2274 board feet in 1950 to 6814 board feet in 1999.*

PHOTO: R. HARRISON WIEGAND

<u>Sample Indicator</u>: One measure of the productive capacity of a forest is the site index of the dominant tree species in the area. On Maryland's Eastern Shore, the site index will likely be measured on loblolly pine; in Central Maryland, tulip poplar or northern red oak; and in Western Maryland on black cherry and red oak. This forest site quality measurement is an estimate of the capacity of particular sites to grow trees. It is similar to various measures of the productivity of land for growing agricultural crops. For Eastern forest species, the 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.



Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: Statsgo Soils Data
U.S. Department of Agriculture
Forest Cover - NLCD

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

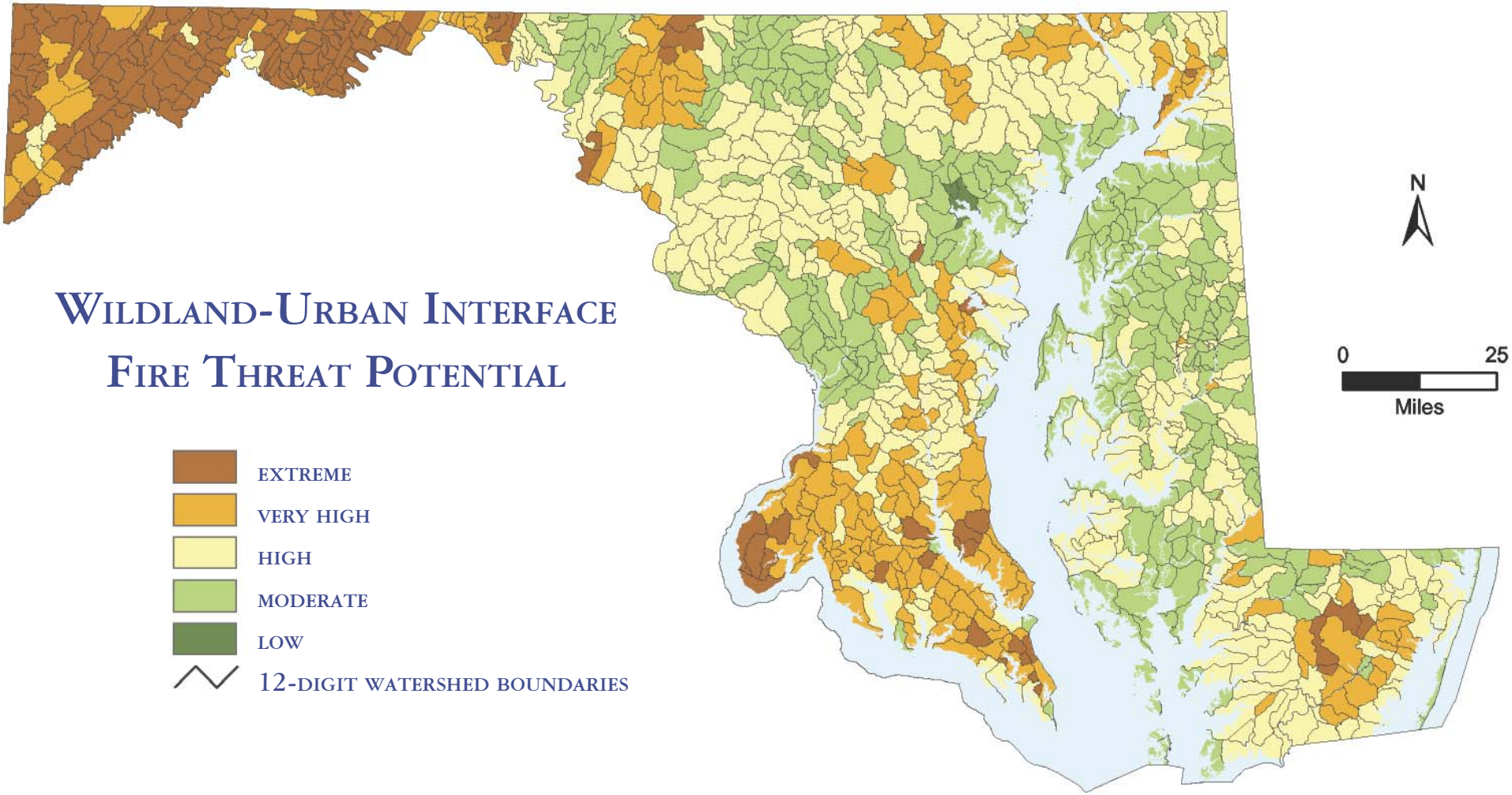
Maintenance of Forest Ecosystem Health and Vitality

Health and vitality provide the essential backbone for the sustainable management of forested lands. Health is the overall condition of the forest, whereas vitality is the ability of the forest to perpetuate itself while providing genetic diversity to sustain viable populations in the future. Both natural and human factors affect the health and vitality of forests. Many species of trees are reliant on specific pollinators or different types of disturbances, such as fire, in order to reproduce. Foraging stress from herbivores, such as deer, can play a large role in lowering the vitality of a forest. Humans can also greatly damage forests by altering natural processes, introducing non-native plant or animal species, and polluting the environment. It is critical to monitor healthy forests to ensure that these lands remain healthy and vital for many generations to come.

PHOTO: R. HARRISON WIEGAND

- *Examples of forest insect pests impacting Maryland include gypsy moth, hemlock woolly adelgid, southern pine bark beetle, and beech scale—newly found in 2003.*
- *Common non-native and exotic plant species impacting Maryland's forest ecosystems include Norway maple, tree of heaven, Japanese stilt grass, and vines like tear-thumb and Japanese honeysuckle.*
- *Deer, by using forests for winter cover and forage, are having severe negative impacts on forests' ability to regenerate themselves.*

Sample Indicator: One major factor impacting forest health and vitality is fire. As portrayed in this indicator, fire threat is modeled to reflect six important variables: Fuel hazard is based upon the amount and type of vegetation within a subwatershed; risk of fire relates both to the dryness of the vegetative fuel and to presence of human activities that could ignite a fire. Aspect is based on the direction faced by slopes, with south- and west-facing slopes tending to be much drier than north- or east-facing slopes; slope itself affects the rate at which a fire spreads due to the chimney effect of steep slopes. Sensitivity is a measure of public perception of losses that would be caused by a fire; fire protection resources reflect road accessibility in a watershed and the location and availability of fire-fighting personnel and equipment.



Wildland-Urban Interface Fire Threat Potential

- EXTREME
- VERY HIGH
- HIGH
- MODERATE
- LOW
- 12-DIGIT WATERSHED BOUNDARIES

Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: Maryland Forest Service
Maryland Department of Natural Resources

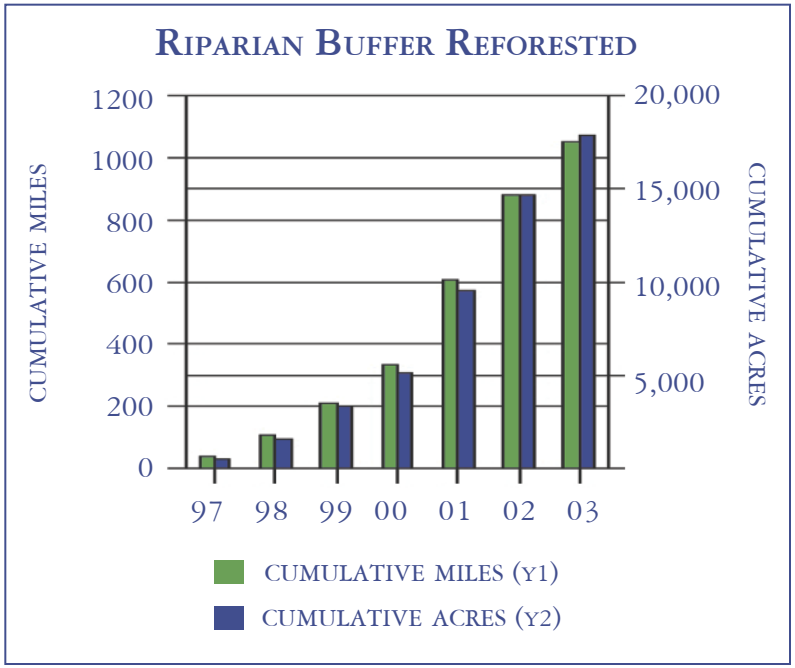
Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

Conservation and Maintenance of Soil and Water Resources

Forests are extremely important in the Chesapeake Bay region for the protection of water quality. Forests are by far the most protective land use adjacent to streams, around our reservoirs and throughout our watersheds. Water resources, such as streams, ponds, and lakes are also good indicators of forest health because the water that runs off forest lands drains into them. Physical, chemical and biological properties of the receiving waters can easily be measured and need to be evaluated against a healthy baseline range. Monitoring these resources can provide evidence of change in the forest ecosystem and makes it possible to implement adaptive management strategies.

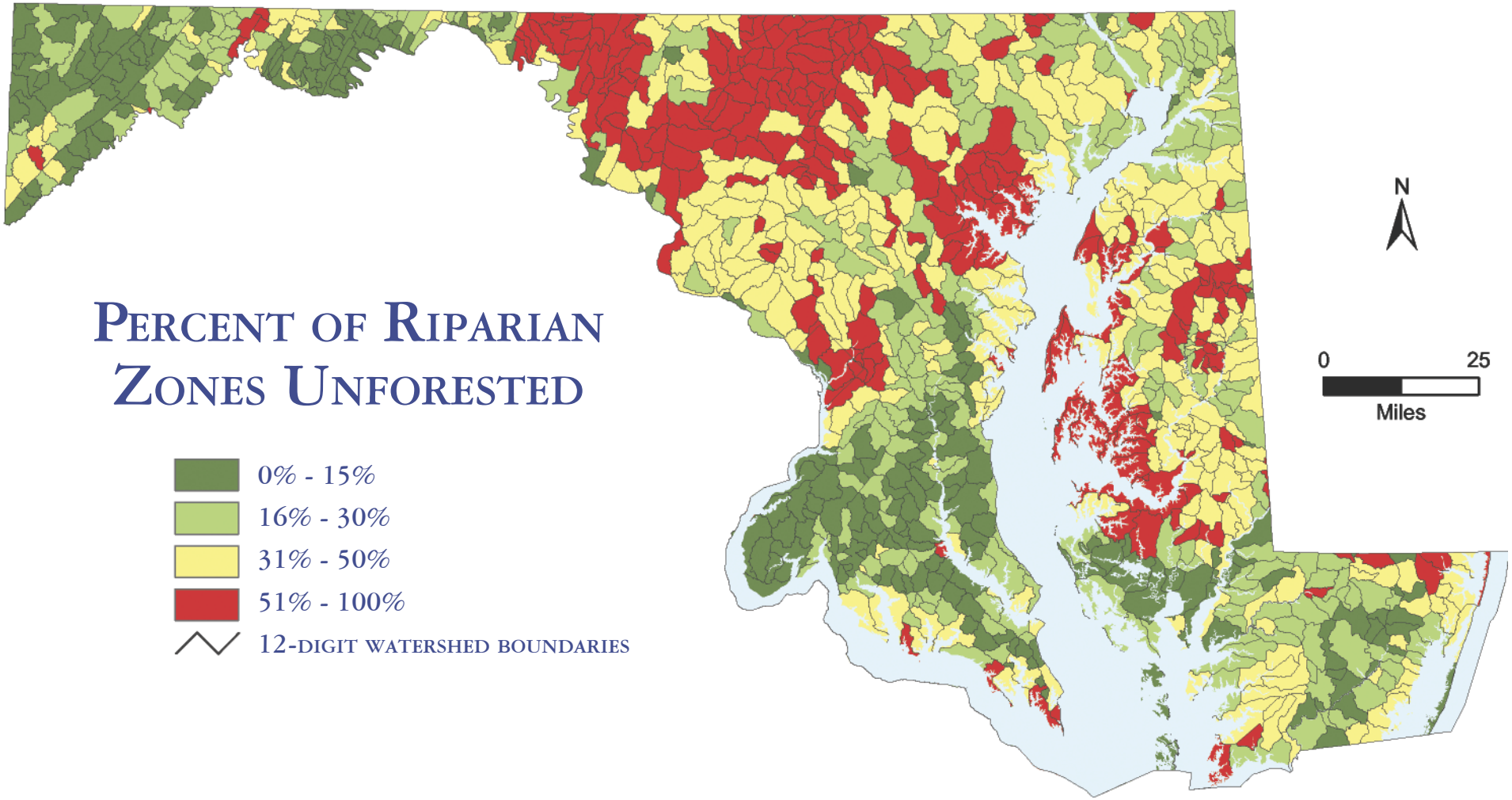
Soils provide the necessary nutrients, minerals, and water to the forest community. In turn, forests protect soils, allow for slow water uptake, and contribute organic material to the soil. While a well-managed and implemented timber harvest exposes bare soil on about 10% of a harvest site, compaction 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.

Restoring forests can provide significant benefits to unbuffered streams, particularly headwater streams, to highly erodible lands and to prior-converted wetlands. Maryland has focused on restoring these sensitive lands and over the last six years has been successful in planting forest riparian buffers on over 1000 miles of streams through our Stream ReLeaf and Conservation Reserve Enhancement Program (CREP).



- *There are about 326,000 acres of forested or "woody" wetlands remaining in Maryland.*
- *Forest cover within a watershed is an important factor in determining water quality. Watershed forest cover in Maryland ranges from just under 11% to nearly 93%.*

Sample Indicator: The presence of unforested riparian areas is an indicator of aquatic and terrestrial system stress within a watershed. Many ecological benefits are associated with maintaining forest along streams–riparian forest. These include taking up nutrients in ground and surface water, as a buffer between streams and adjacent land uses; stabilizing stream banks; shading the water and maintaining its temperature; and providing food for aquatic and terrestrial animals. Approximately 35% of Maryland's streams lack a riparian forest buffer 100 feet or more wide.



Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: Maryland Department of Planning's
1997 Land Use Land Cover and Hydrography

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

Maintenance of Forest's Contribution to the Global Carbon Cycle

Forests are an important component in the global carbon cycle and provide both a source and sink for this basic element on which all life depends. Carbon dioxide (CO_2) is the most prevalent greenhouse gas in the world today and is the leading contributor to the increasing problem of global warming. Forests are a source of carbon by releasing this gas into the atmosphere during decomposition and wild fires. They also act as an important sink by locking up carbon into biomass through photosynthesis, and later contributing it to soils as organic matter. Approximately a seventh of total atmospheric carbon dioxide is passed into vegetation annually.

Although the carbon cycle is a natural phenomenon, humans can dramatically alter its balance by altering the natural forest processes that regulate carbon storage and emission. For example, the way in which timber is processed and used plays an important role. By burning wood for residential and commercial use, carbon emission rates are increased, particularly if forests are not replaced. Alternatively, if forests are properly managed, and if the timber is used for long-term products, such as buildings, forest harvesting could result in a net reduction of atmospheric carbon.

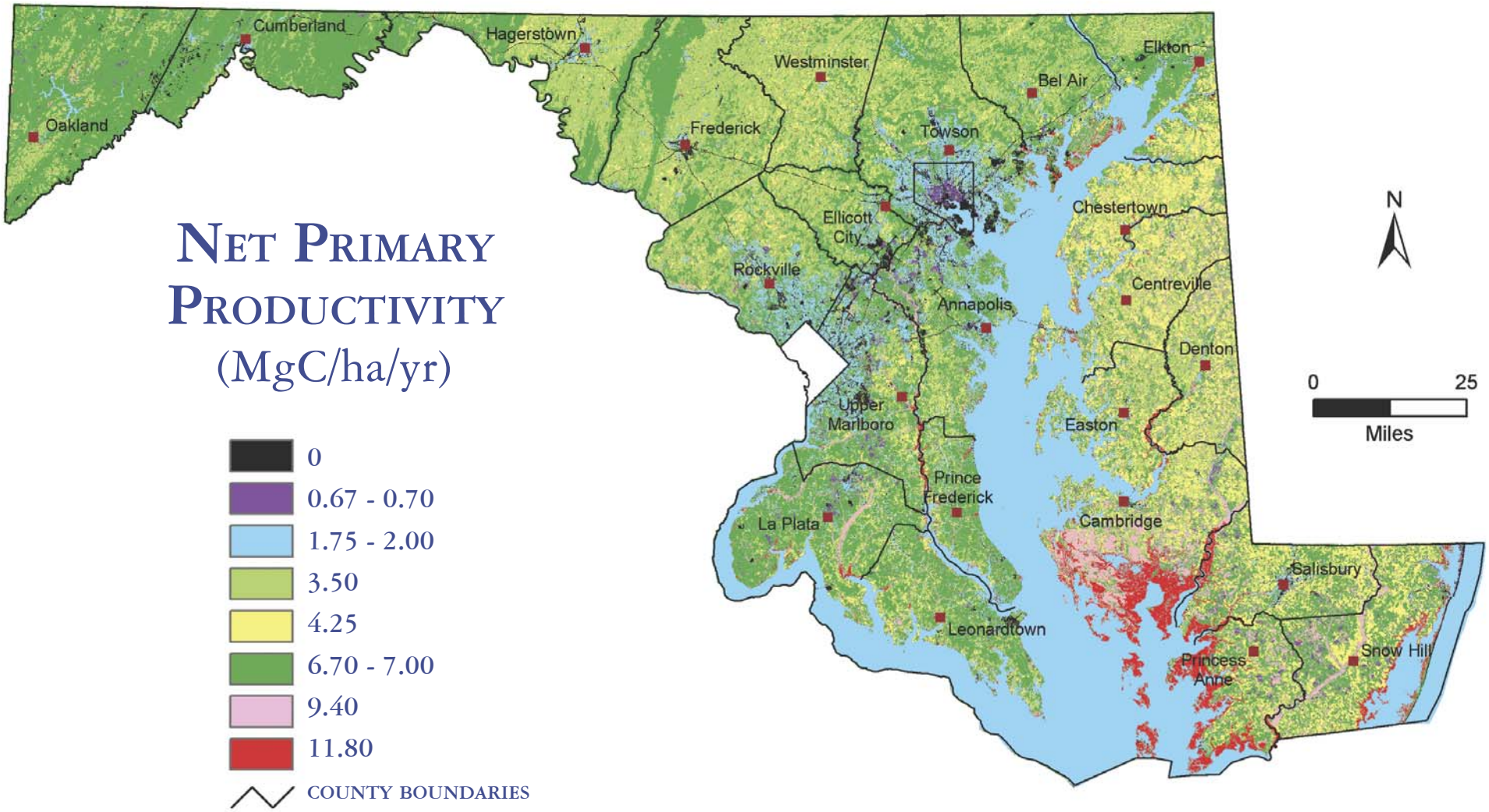
Other natural disturbances such as insects, diseases, storms and wildfires can also cause large shifts in the global carbon cycle and must be taken into account.

Although the carbon cycle is complex and very difficult to monitor, a better understanding is necessary to manage forests in a way that supports reducing the increase of CO_2 levels in the atmosphere.

PHOTO: R. HARRISON WIEGAND

- *There are more than 204 million dry tons of biomass in all live trees on forest land in Maryland. 65 percent of the weight is in growing stock trees, 19 percent is in stumps and roots, and 16 percent is distributed among branches, foliage and cull trees.*

Sample Indicator: Net Primary Productivity is the rate at which plants incorporate atmospheric carbon through photosynthesis–forests account for almost 48% of Maryland's carbon fixation. This is one component, combining with a modeled sequestration rate, in determining how much carbon is stored in biomass and therefore does not contribute to atmospheric carbon levels. This indicator points toward land management opportunities to offset CO_2 emissions from burning fossil fuels.



Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: Carbon Sequestration Potential in Maryland
June, 2002 Versar, Inc.

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

Maintenance and Enhancement of Long Term Multiple Socioeconomic Benefits

Forests are not only important ecologically, but they are also invaluable economically and socially. In Maryland the timber products industry is the fifth largest in the State, generating over two billion dollars and providing over 14,000 jobs annually. There are also many non-timber products that are economically important, such as foods and medicines. Forests also provide revenue to the State's economy through tourism, hunting, fishing and other recreation-related expenditures. Maintaining resource-based industries like the forest products industry is very challenging in a rapidly urbanizing state like Maryland.

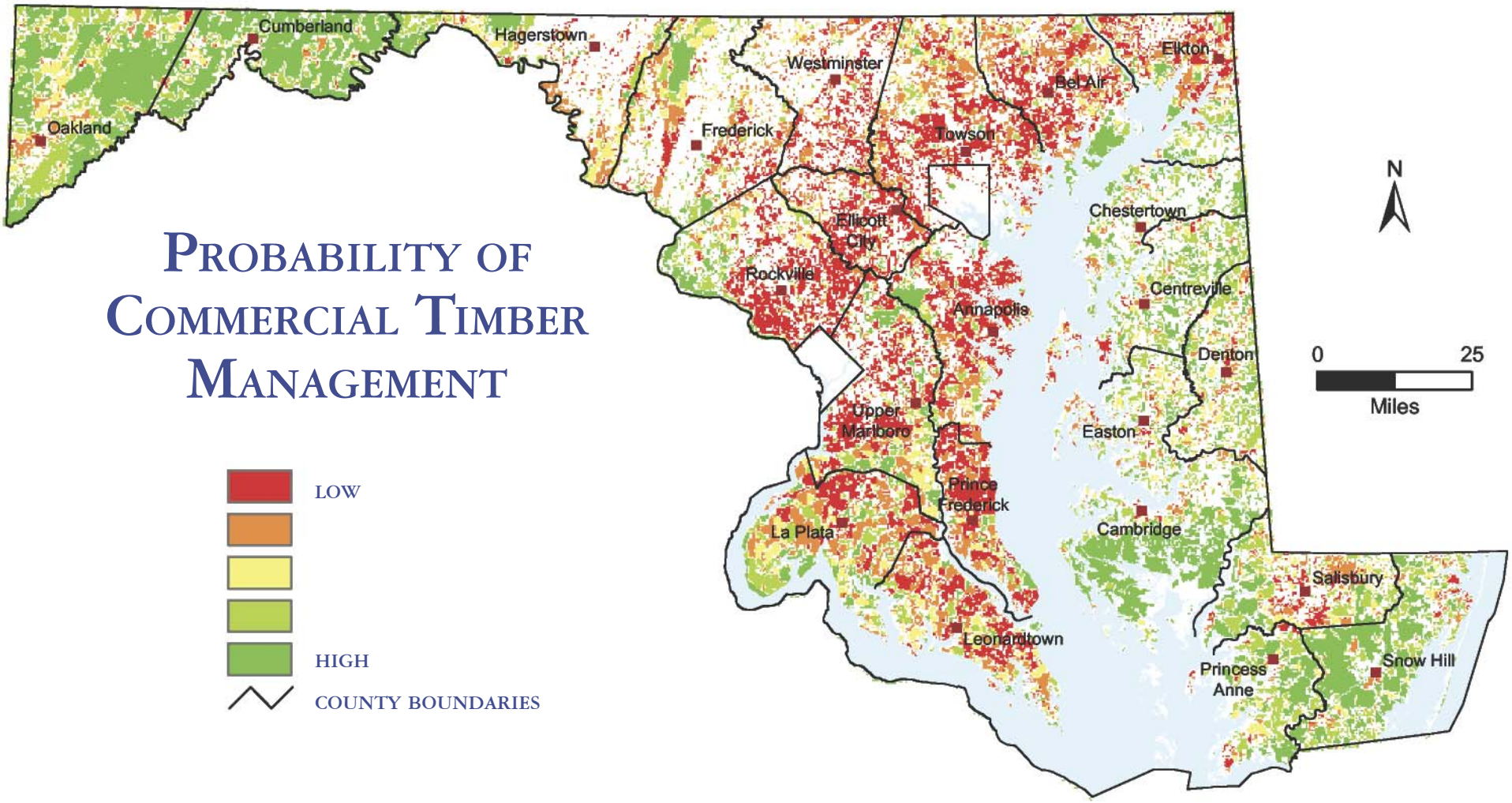
Humans receive many social and cultural benefits from forested lands as well. The natural beauty of a forested landscape, areas of special historic or religious significance, and the cultural and spiritual connections many people have to forests are a few of these benefits.

Although forests are a renewable resource, they can be lost to development, over harvested and mismanaged. Forest management practices, for both economic and social objectives, can be implemented to ensure sustainable use of forest goods and services for current and future generations.

PHOTO: BRODERBUND

- *As of 1999, the average annual removal of timber stock volume was 82,655 thousand cubic feet.*
- *Important non-wood forest products in Maryland include maple syrup, mushrooms, and botanicals*

Sample Indicator: Increasing population density can affect timber supply by a shift in forest management objectives as well as by direct conversion of forested land to developed areas. For example, management for timber production may shift to a focus on forests as residential or park settings when population density increases. Land clearing accompanies this transition and may provide timber products, but only in the form of a one time cutting called a terminal harvest. More land-use conflicts over timber management in remaining woodlots accompany this trend, adding to the difficulties for forest management created by smaller tract size and decreasing forest contiguity. This indicator, based on population density, highlights forested areas that are more likely to support sustainable commercial timber activities and those areas that are more suited for other forest-based uses, such as soil and water conservation/protection, wildlife habitat, recreation, etc. The accompanying map paints a bleak picture for timber avilability for Maryland's forest products industry. Only the Eastern Shore and Western Maryland are likely to have significant amounts of timber available for commercial management.



Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: TIGER Census 2000
USGS National Land Cover Dataset

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

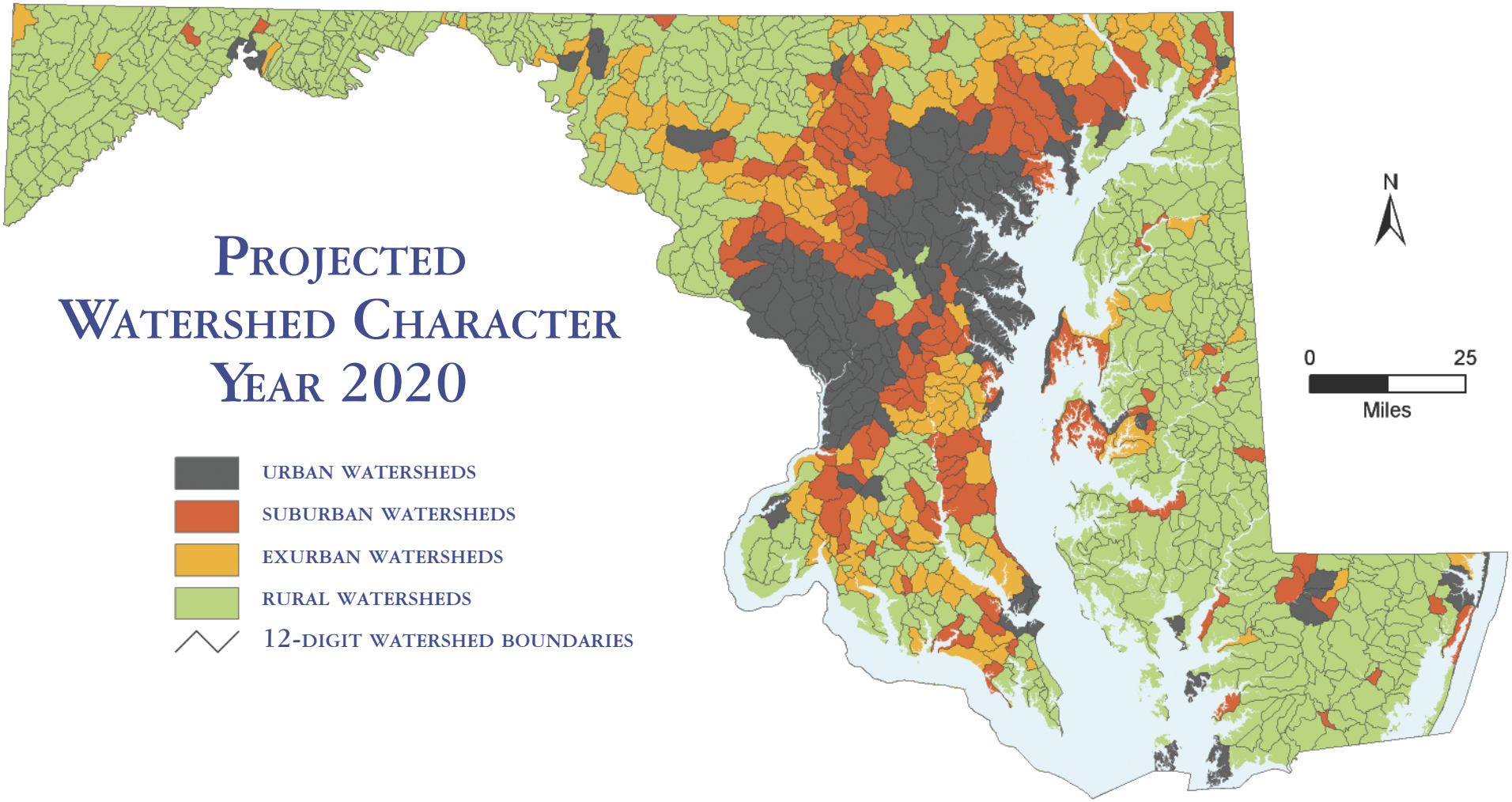
Legal, Institutional, and Economic Framework

A forest is a forest not only by virtue of its trees, but also by virtue of the views and values society holds. Ultimately, it is these factors that support the conservation and sustainable management of Maryland's forests.

Conditions and processes beyond forest boundaries have a key role to play in the conservation and sustainable management of Maryland's forests. The market for forest products is now clearly global. Investment, taxation and trade policies for forest products and forestland ownership, determined at the national level, can both support and constrain conservation and sustainability initiatives. The overall policy framework that exists within the State can facilitate efforts to conserve, maintain or enhance any of the forest related attributes described in the preceding criteria. Legislative processes at multiple levels of government establish the regulations, policy decisions, and means of enforcement that determine much about how forests are managed and conserved. Programs, both public and private, developed to encourage public involvement and stewardship activities promote awareness and public investment in sustainable forest management. Evaluation of these policy and institutional frameworks that impact forest management and conservation is a necessary component for the assessment of forest sustainability. Greater support and recognition can be given to those processes and policies that have a positive impact on sustainable forest management. Areas in which policy and institutional frameworks are weak or absent can be identified and strengthened.

PHOTO: R. HARRISON WIEGAND

Sample Indicator: Human population growth, and how it is accommodated in the landscape, is the dominant local influence on the future of forests and forestry in Maryland. The primary institutional framework determining how and where development will be accommodated is local government, operating through zoning and subdivision regulation and the programming of infrastructure like roads, water lines and sewers. Watershed classifications mapped in this indicator are based on the proportion of urban and rural land uses as defined by the Maryland Department of Planning's 1997 and projected 2020 land use estimates. The exurban areas represent the greatest shift from predominantly rural to more developed use between 1997 and 2020. From a forest management perspective, these areas are more likely to experience wholesale one-time land clearing cuts rather than continued forest production.



Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

Data Source: Maryland Department of Planning's
Growth Simulation Model, Maryland DNR

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

Forest Sustainability and Strategic Forests
A Look to the Future

The identification of Strategic Forest Lands based on resource significance, and their subsequent evaluation based on potential vulnerability to development and other stressors, is critical to establishing forest conservation priorities. Such a "place-based" approach allows us to geographically align our conservation strategies with high ecological and economic resource values and high or moderate vulnerability to development. The result is a more efficient application of the tools and limited resources we have to influence forest conservation and management. Some of the projected uses of SFLA include :

- **Coordinated focus for DNR's forest conservation programs** – SFLA can provide the geographic context for integrating multiple conservation programs.

- **Geographic tracking protocol for forest resource management actions** – through geocoding of management actions, the Department will be able to better monitor resource management successes and failures.

- **An information base for evaluating Forest Legacy and Rural Legacy Proposals** – SFLA can provide an ecological and socioeconomic rationale for state investments in landscape conservation efforts.

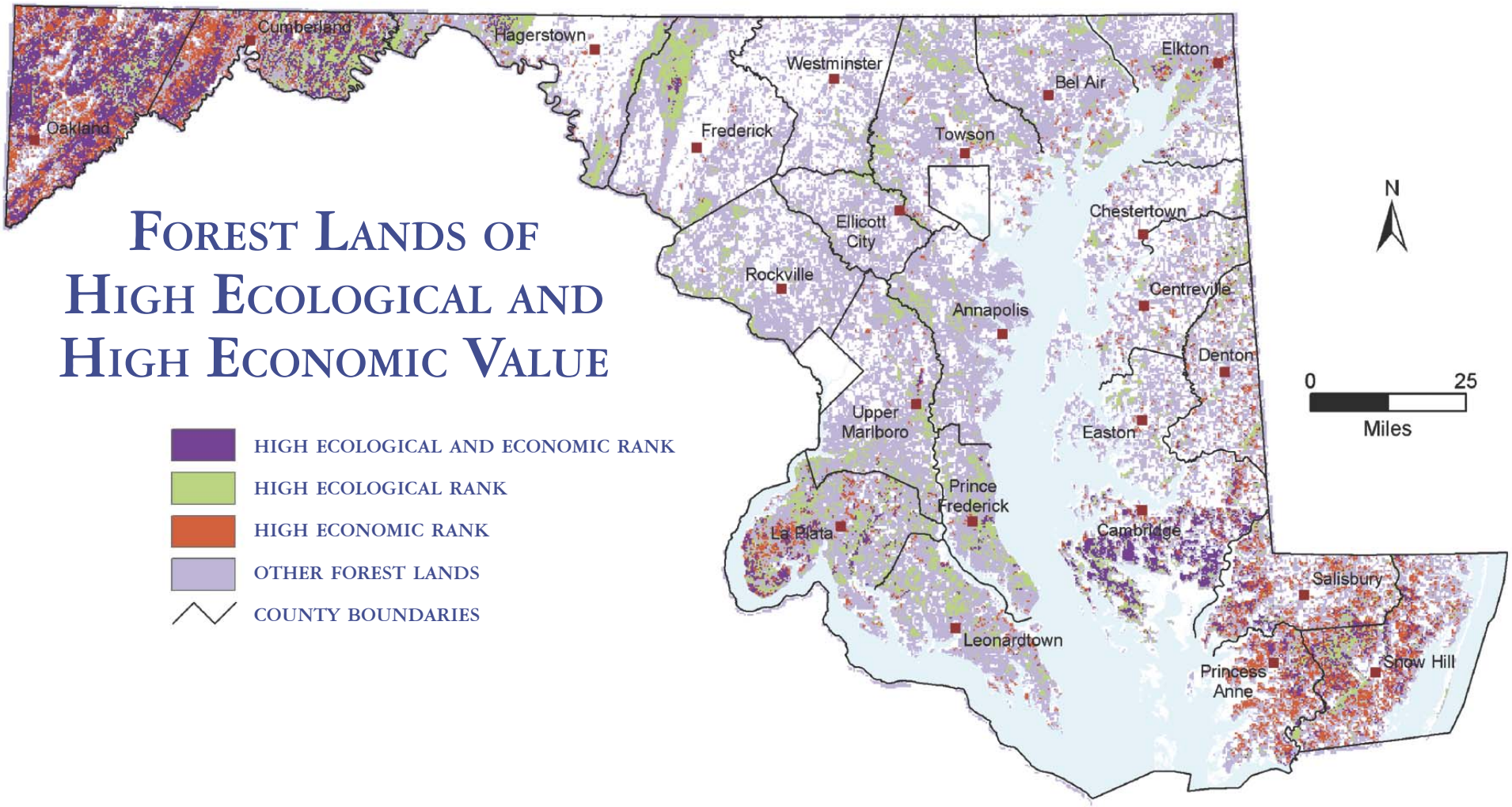
- **A framework for evaluating land acquisition and protection proposals** – as Program Open Space, the Maryland Environmental Trust, and others are presented with land conservation opportunities, SFLA can provide the regional context for evaluating a parcel's ecological and economic significance.

- **Expanding the Green Infrastructure Assessment to incorporate socioeconomic issues** – SFLA augments the Green Infrastructure landscape ecological focus with other important attributes of Maryland's forests.

- **A forum for state and local government recognition of resource-based industry** – SFLA can provide other government agencies with valuable information to consider in a variety of state and local planning efforts.

- **Identification and tracking of forest restoration activities** – as additional resources are dedicated to restoring forests throughout the state, SFLA can provide the landscape context to ensure these efforts contribute to a sustainable forest resource base.

- **Public lands planning** – SFLA can provide the landscape context for developing long-range resource management plans for land units within DNR's public lands system.



Maryland's Strategic Forest Lands Assessment

Watershed Services Unit
Landscape and Watershed Analysis Division

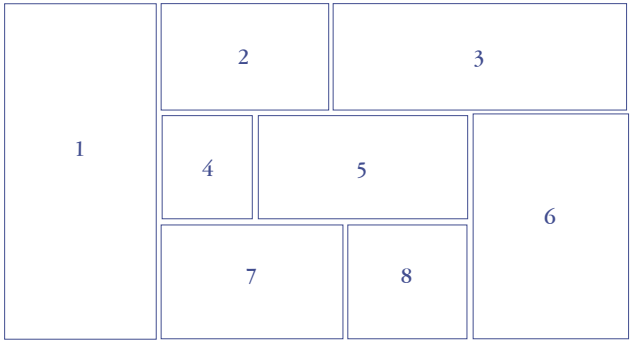
Data Source: Green Infrastructure Assessment
SFLA Socioeconomic Assessment; Maryland DNR

Funding for this project was provided in part
by the USDA Forest Service Northeastern Area

1st Printing October 2003

Cover photo credits:

1. R. Harrison Wiegand
2. Broderbund
3. Lisa Gutierrez
4. Lisa Gutierrez
5. R. Harrison Wiegand
6. Metaphotos
7. R. Harrison Wiegand
8. Broderbund



The facilities and services of the Maryland Department of Natural Resources are available to all without regard to race, color, religion, sex, sexual orientation, age, national origin or physical or mental disability.
Call toll free in Maryland, 1-877-620-8DNR ext. 8780. Outside of Maryland dial 410-260-8794.
TTY users call via the Maryland Relay. For more information visit www.dnr.state.md.us.

printed on recycled paper