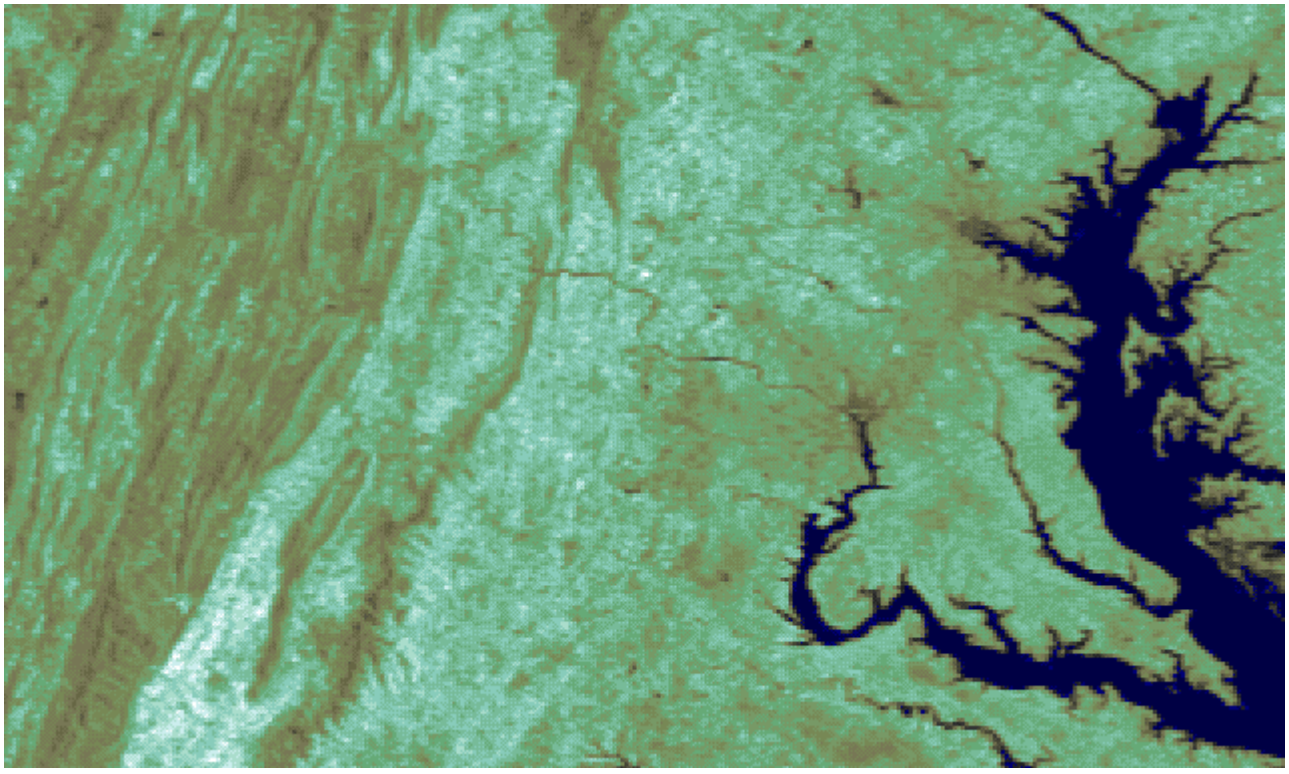
United States
Department of
Agriculture

Forest Service

**Northeastern
Area**

NA-TP-03-96

Conserving the Forests of the Chesapeake: The Status, Trends, and Importance of Forests For the Bay's Sustainable Future



INTERNET EDITION

This publication is a subset of the original version. It contains the complete text, all tables, maps and other pertinent technical data. However, many decorative graphics have been omitted in favor of reducing network download time. Please refer to the contacts listed in the Acknowledgements section of this report or complete the form at http://www.chesapeakebay.net/bayprogram/facts/forests/pubform.htm to request copies of the original.

ACKNOWLEDGEMENTS

This report was prepared by Richard A. Cooksey and Albert H. Todd, USDA Forest Service, Northeastern Area, State and Private Forestry, Chesapeake Bay Forestry Project Team. We gratefully acknowledge and extend out thanks to Steve Koehn, Maryland DNR Forest Service, Dave Gregg and Robert Merrill, Pennsylvania Bureau of Forestry, J. Michael Foreman, Virginia Department of Forestry, Dr. John C. Barber, Chair, and the other members of the Chesapeake Bay Program Forestry Work Group for providing continuous support, and critical input and review of the document. Thanks to Alex Gagnon for her faithful support in graphics and layout.

For additional information regarding this report, please contact:

USDA Forest Service at:

Richard Cooksey or Albert Todd
USDA Forest Service, Northeastern Area
State and Private Forestry
Chesapeake Bay Program
410 Severn Ave., Suite 109
Annapolis, MD 21403
1-800-968-7229, ext. 706, 705

Or your State Forestry Agency Representative:

Pennsylvania Bureau of Forestry
P.O. Box 8552
Harrisburg, PA 17105
717-787-2106

Maryland Department of Natural Resources Forest Service
Tawes State Office Building, E-1
580 Taylor Avenue
Annapolis, MD 21401
410-974-3776

Virginia Department of Forestry
P.O. Box 3758
Charlottesville, VA 22903
804-977-6555

Title Page

Table of Contents

Title Page

Forests around the Bay

The tall and established old-growth forests that once blanketed the shores of the Chesapeake Bay and its tributaries are gone. Today, younger forests cover large tracts of land in this region. These forests are critical to the water quality of the Bay and the health of the animals and plants that depend on the Bay for their survival. Without the forests, large amounts of sediment would flush into the streams and tributaries, vast quantities of nutrients would wash into the Bay setting up a chain reaction of detrimental consequences, and many of the more visible species, such as the bald eagle and osprey, would be left without habitat. Large areas of healthy forest are essential in the Bay restoration effort to reach nutrient and sediment reduction goals, achieve consistently low levels of nutrient input, protect the habitats of the Bay and its tributaries, and manage the growth and development of surrounding lands.

Historically, the demand for raw materials (e.g., wood and land for development and agriculture) has conflicted with the protection and conservation of natural resources (e.g., water, recreation areas, and wildlife habitat). With more and more people inhabiting the land surrounding the Chesapeake Bay, these opposing needs will continue to compete as more and more land falls to development. To satisfy both needs, we must strike a balance between forest utilization and conservation. The challenge in the Bay watershed, as elsewhere, is to satisfy diverse human needs on a sustainable basis without sacrificing the ecological integrity of our ecosystems.

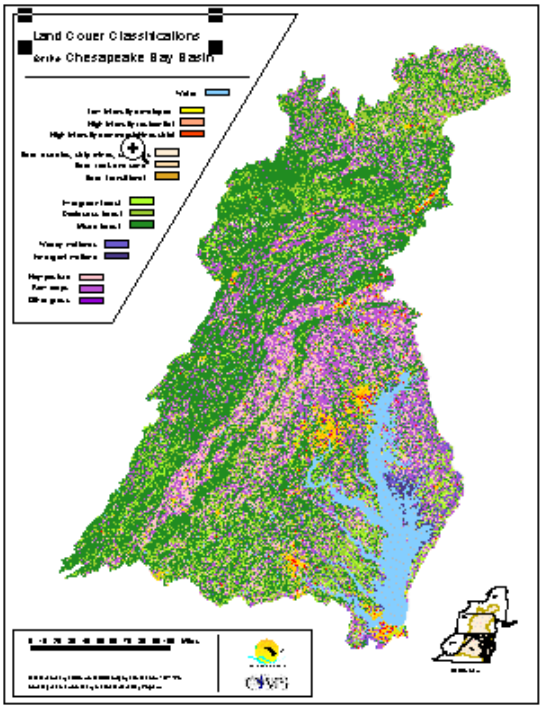


Figure 1. The original document included a detailed land use map similar to the one above. A reduced copy has been substituted here to decrease the overall file size of this version. The original map may be downloaded in PostScript format in its original resolution at - *http://www.chesapeake.net/bayprogram/data/gis/gallery.htm*

Retaining large areas of managed woodland is an important goal for resource use and development planning. Forest land retention is one means to protect our environment, maintain our quality of life, and use and enjoy our landscape in a sustainable way. Conserving forests as growth and development take place allows us to benefit from our forests today while still granting the option for future generations to use them tomorrow.

This report reviews the most current data on the status and trends of forests in the states of the Chesapeake Bay watershed. The report begins with an historical perspective of land use changes in the basin from the time of European settlement to today. It then proceeds with the status of the forests in the Bay watershed in 1996 and trends of forest change from the mid 1970's to early 1990's. This information is examined in light of its importance to the Bay. Finally, we present recommendations for an effective forest conservation program for the Chesapeake Bay region.

Title Page

Historical Background

The Chesapeake Bay stretches nearly 200 miles from the mouth of the Susquehanna River south to the Atlantic Ocean. Its watershed extends from Cooperstown, New York in the north to Cape Henry in the south and from the Appalachian Mountains in the west to the Delmarva Peninsula in the east. Its 8,700 miles of shoreline, 50 islands, and over 40 tributary rivers are home to 2,700 species of plants and animals.

About 45,000 Native Americans already lived in the Chesapeake Bay area when European settlers first arrived in 1607. By 1990, an estimated 14 million people inhabited the watershed's 64,000 square miles. Each person uses resources and produces wastes that ultimately affect the welfare of the Bay. Scientists and managers are only beginning to understand the consequences of such population demands on the Bay's ecology. Archival research, archeological exploration, and careful analysis of sediment layers and the remains of organisms in core samples taken in and around the Bay provide scientists with the tools to sketch the historical landscape of the Bay. A thorough understanding of the Bay of several centuries ago points the way for current and future restoration efforts.

Many believe that prior to European contact, America was dominated by impenetrable, relatively uniform ancient forests that cloaked the landscape in a long-term, stable balance with the environment. The reality is much different. Pre-settlement forests were exceedingly dynamic, shaped by many natural and human influences, disturbances, and catastrophic events that profoundly affected both the age and species mix of plants and animals (MacCleery, 1992). In the Chesapeake's forests, Native Americans lived in villages and practiced a maize-based agriculture. Domesticated crops accounted for much of their diet with the remainder provided by wild berries, nuts, fruits, and wild game harvested from the adjacent forests. Fire was the main forest management technique and was used to clear trees for crops. Additionally, thousands of acres around each village were burned periodically to improve game habitat, facilitate travel, reduce insect pests, remove cover for potential enemies, promote the growth of berries, and drive game for hunting. In some areas, native peoples burned the understory of the woods twice a year—in the spring and the fall (MacCleery, 1992). Although the entire forest may not have been virgin, as some believe, it was immense and able to sustain human demands easily while remaining healthy and productive.

When the first colonists arrived on the shores of the Chesapeake, the vast old-growth forest covered close to 95% of the watershed (Kraft and Brush, 1981). Along the Chesapeake and the rivers that fed it, the newcomers found a seemingly infinite variety of trees that were astonishing in their "bulk and antiquity." In comparison with Europe which had (and has) only about 25 prominent timber tree species, North America has some 525, many of which grow along the shores of the Bay (Illick, 1924). The forests in the region were composed of upland hardwood, principally oak and hickory; pines dominated areas with poor and sandy soils (Silver, 1995). Lumber was one of the first exports from the New World; the first ship that sailed back to England from the new colony had this prized cargo aboard. A Maryland visitor wrote in 1635 that "the timber of these parts is very good, and in abundance" (Hall, 1910).

The early colonists quickly recognized the potential of the region. In their view, the land needed to be tamed and improved—and ultimately made to turn a profit. The colonies'

forests soon became a source of the white pine ship masts, oak planking, and cedar timbers upon which the English navy depended. By the middle of the 1600's, the colonists had established a booming business in ship masts and timber. They also cleared the land for agriculture—primarily tobacco and corn—and for their chief fuel source—firewood. Initially, white settlers sought abandoned Indian fields, which required less labor to clear than mature forest. As labor was scarce, the colonists adopted Native American agriculture practices of slash and burn or "girdling" trees to suppress leaf production and allow light to reach the forest floor. Later, the settlers began to completely clear and then plow the land. By the mid 1700's, they had stripped 20 to 30% of the land to accommodate the growing population and its cash crop—tobacco.

By the mid-1800's, land use had changed dramatically. Settlers removed trees from 40 to 50% of the land for small grain and tobacco farms (Brush, 1995). Around this time, about two-thirds of the wood (by volume) removed from the forest was used for energy. A single household could consume 20 to 40 cords of wood annually. The wood was used for domestic heating and cooking and to produce iron and other metals critical to the economy. The effects on the local forests used to supply these smelting operations were significant. A 1,000-ton iron works production, for example, required between 20,000 and 30,000 acres of forest. Although it had taken 150 years for the colonies to reach a population of 3 million people, in the 65 years between 1785 and 1850 the US population multiplied more than seven times reaching 23.3 million. With an average of three acres of cropland required to support each person, cropland acreage grew at the same rate as the population. From 1800 to 1850, the total cropland grew from about 20 million acres to 76 million acres. Another 152 million acres of forests were cleared for pasture and hay (MacCleery, 1992).

By the start of the 20th century, only 30 to 40% of the watershed's forest cover remained. Local wood shortages were not uncommon (Walsh, 1992). Many wildlife species had been hunted close to extinction. Rivers had become so filled with sediment from eroded farmland that some navigable waterways were permanently closed. The choked and degraded streams had a deleterious effect on the fish and other aquatic animals. As people became aware of human impact, an ironic truth emerged: the very forests that had been perceived as a threat to civilized society now had to be protected from it (Silver, 1995).

Forest cover has rebounded, in part, from its historic lows at the beginning of the century. From the 1920's to the 1940's, agriculture again expanded, this time through the drainage of wetlands rather than forest clearing. Some old fields reverted to forest (Brush, personal communication). A great deal of reforestation and strip mine reclamation took place in the 1930's and also resulted in an increase of forests. By 1970, forest cover had jumped to 62% of the Chesapeake watershed. Since then, however, forests have been subject to urban expansion and lost to suburbanization at a rate of 100 acres per day (Environmental Protection Agency, 1994). Land consumption has become an important issue in development and is currently running at 180% the rate of new residents immigrating to the region. A total of 1.7 million new housing units are projected to be constructed between 1990 and 2020 to meet this influx. Development of these houses could consume more than 636 thousand acres through the conversion of forests and farmland (The Year 2020 Panel to the Chesapeake Executive Council, 1988).

Importance of the Forests

Environmental Significance of Forests

Acre for acre, forests are the most beneficial land use in terms of water quality. Acting as a living filter, forests capture rainfall, regulate stormwater and streamflow, filter nutrients and sediment, and stabilize soils. When streams are buffered by surrounding forests, the amount of nitrogen in runoff washing into the streams is reduced by 2.5 to 4 times while phosphorus drops by 1.5 to 3 times. The Maryland Tributary Strategy Overview states, "Any loss of forest or wetland represents an increase in nutrients entering the Bay."

Forests typically retain 70 to 80% of atmospherically deposited nitrogen. The Bay airshed is three times larger than the basin and the air is contributing an increasing proportion of nitrogen loads to the Bay. Loss of forest, therefore, results in more nitrogen entering the Bay. Forests in urban areas can exert significant control over the local and regional climates while improving air quality. Cities with adequate urban forest can save 4% on heating costs and an additional 10% on cooling. Trees absorb carbon dioxide; one acre of trees can remove 40 tons of carbon annually (Figure 2). This same acre produces enough oxygen to sustain over 1,000 people during the year.

Forest habitats are essential for much of the watershed's animal, bird, and plant life. Riparian forests along streams, rivers, and shorelines provide critical habitat for over half the terrestrial wildlife species. They also influence the quality of the adjacent water, buffering the inflow of nutrients, supplying organic detritus, and providing shade. Forests serve human values—people enjoy wooded areas for their aesthetic qualities and recreational opportunities—but they also serve human needs for food, building materials, and sustaining the environmental integrity of a region.

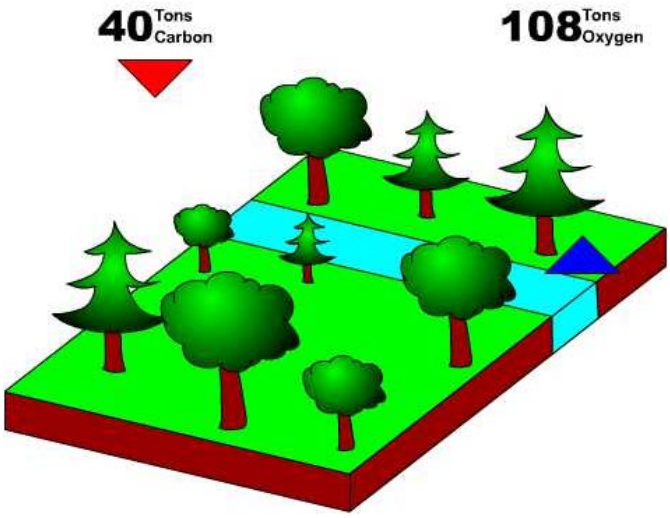


Figure 2. Annually, one acre of trees can remove 40 tons of carbon from the air and produce 108 tons of oxygen.

Resilience is a measure of an ecosystem's ability both to sustain itself over the long term and to return to the norm when pushed out of balance. An illustrative analogy is when a healthy, resilient person is exposed to the flu, that person may contract a mild case of the disease and recover rapidly. The same flu pathogen, however, may kill a weak or unhealthy person. On a watershed scale, the concept of resilience is important yet not commonly understood or quantified. Elements of the natural ecosystem—such as forests, wetlands, submerged aquatic vegetation (SAV), and oysters—strengthen the Chesapeake's ability to withstand the stresses of human impacts or natural events such as storms, hurricanes, or climate change. We don't know how much forest can be lost without seriously impairing the ability of a watershed to sustain its health over the long term. Studies of carrying capacity, environmental thresholds, land capability, and cumulative effects suggest

potential but highly controversial means of measuring the impacts of growth on an area.

Economic Importance of the Chesapeake Bay's Forests

Estimating the total value of forests to society is a difficult task. Timber sales and the number of hunting and fishing licenses sold provide a clue to the forests' tangible worth but estimating the value of non-consumptive forest uses, the worth of a scenic vista, or the future value of an important medicine or food found in the forest is more complex. In a gross sense, we know that the economic returns directly attributable to the Chesapeake's forests are large. Although data do not exist for all activities related to forest use, we can get a glimpse of the economic importance of forests from figures available for the signatory states in the basin.

In Virginia, the forest products industry provides a vital source of jobs for many rural areas and smaller cities. Harvesting, processing, and marketing of wood products adds $9.8 billion annually to the state economy. It is the second largest industry in the state, accounting for over 228,370 jobs. The recreation value of the state's forest exceeds $1.7 billion—nearly two-thirds of which is derived from wildlife-related recreation (Virginia DOF, 1995).

In Maryland, the forest products industry ranks fifth, employing over 41,000 people in the wood manufacturing industry and accounting for over $1 million in the annual payroll. Marylanders also profit from the recreational value of the state's forests. The Maryland Department of Natural Resources reports that hunters spent over $133 million on hunting-related expenses during the 1991/1992 season. These expenditures translate into a total economic contribution of $302 million. According to U.S. Fish and Wildlife Service reports, Marylanders spent $270 million observing, feeding, and photographing wildlife in 1991.

Pennsylvania's forest products industry is also vital to the commonwealth's economy. Pennsylvania is the largest producer of hardwood in the nation with over one billion board feet per year of quality black cherry, oak, and maple. As the commonwealth's fourth largest industry, forest products exceed $4.5 billion in annual sales. This industry provides more than 100,000 jobs, employing 10% of all state residents with a total payroll over $2 billion. Pennsylvania has more than two million acres of state forest; hundreds of thousands of visitors use the forest for hunting, fishing, and general outdoor recreation. (Penn State, 1995)

Economic Viability and Socioeconomic Impacts

The forests of the Bay region yield jobs, food, fiber and recreation to its residents, as well as a link to our ancestors' culture. Yet, as we have developed the land for places to live and work, our total forest area has declined. This reduction in forest land has resulted not only in fewer acres of trees but also in fragmentation of the forest. Where large swaths of forest once spread over the land, a patchwork of forest, houses, fields, cities, and suburbs now exists. This carving of the forest into small isolated patches could affect both the ecological and economic long-term sustainability of the forest ecosystem.

Large areas of forest sold into many small parcels can impact both the local economy and the positive contributions the forest makes to a Gross State Product (GSP). As residential development sprawls into rural areas, many landowners take over where only a few once existed. Poorly planned development can reduce the utility of a forested area for timber management. Timber harvesting is often prohibited or severely limited in forests that border housing developments and roadsides. Similar restrictions, based on preservationist public attitude and misconceptions about forest management, are frequently applied to

other areas near these developments, resulting in a loss of forest area several times the actual acres used to accommodate housing. Logging costs also rise as forests are divided into smaller tracts since management and logging costs per acre become more expensive.

With a shrinking forest land base due to fragmentation and parcelization, additional ordinances are often enacted to protect the remaining forest. Many of these ordinances discourage landowners from selling products and industry from buying, increasing the cost of doing business and affecting the viability of an active forest industry. As our region relies increasingly on private timber resources to meet its needs for wood and paper, the loss of availability to this resource results in diminished economic returns.

The opportunities for outdoor recreation also diminish when larger tracts of forest become fragmented. As developments sprawl and roads crisscross rural areas, homeowners often post their land which decreases access and reduces opportunities for hunting, fishing, and hiking. These important recreational activities help maintain the rural character of a region and increase the quality of life for many people. In addition, forest fragmentation may result in permanent forest loss as impervious cover, such as buildings, pavements, and roads, becomes increasingly more common in a region. Ultimately, maintaining viable units of healthy, productive forest is not only important to the economy but means that there will be forests for the future.

Title Page

Status of the Bay's Forests

Method of Analysis

The USDA Forest Service used data from the Chesapeake Bay Program's watershed model to assess the status of forest land in the watershed (Neumiller et al., 1995). The information was generated by a geographic information system (GIS) that utilizes a combination of EPA's Environmental Monitoring and Assessment Program (EMAP), NOAA's Costal Change Assessment Program (C-CAP) and USGS's Geographic Information Retrieval and Analysis System (GIRAS) land use data sets. The EMAP data base is the primary source of land use data.

Data from the watershed model were converted into a format that reflects land use in acres and were adjusted from raster-based model segment to the county level for ease of analysis. The Chesapeake Bay Program Land Use Model (CBPLU) uses nine land use classifications; four were used here to simplify the presentation of forest status information.

Urban = CBPLU High Int. Urban + CBPLU Low Int. Urban + CBPLU Herbaceous Urban

Agriculture = CBPLU Herbaceous

Forest = CBPLU Woody + CBPLU Woody Urban

Wetlands = CBPLU Herbaceous Wetlands

Classifications for Water and Exposed Land were not shown in the analysis, but were included in GIS mapping.

Status of Forests in the Watershed

The Bay watershed encompasses over 41 million acres of land within its boundaries. As of 1990, forests accounted for 58.5% of this land area—an estimated 24.1 million acres. Of the other land uses in the basin, agriculture is the second highest encompassing 13.5 million acres which represent 32.6% of the land area. Urban development absorbs 2.8 million acres of the landscape—an estimated 6.7%. Emergent wetlands cover approximately 327 thousand acres along the Bay's shoreline and represent less than 1% of the total land area. Table 1 and Figure 3 depict the aggregate land uses for the Chesapeake Bay watershed.

Status of Forests in the Bay States

West Virginia (69.2%), Pennsylvania (63.2%), New York (59.7%), and Virginia (58.8%) have the highest percentages of forest while Delaware (40.1%) and Maryland (42.9%) have lower percentages Washington DC (12.6%) has the smallest percentage of forested land (Table 2).

The District of Columbia has a total land area of 39.7 thousand acres, all of which is in the Chesapeake watershed. Most of Washington DC (84.4%) is urbanized (Figure 4). In the district, forests account for approximately five thousand acres (12.6%) and are represented by city parks, national parks and parkways, buffers for highways, and streetscapes.

Table 1

Land Use in Bay Watershed for 1990					
	Total Acres in Basin	Urban	Agriculture	Wetland	**Forest**
Total Acres (thousands)	41,244.5	2,754.1	13,462.2	327.6	**24,114.2**
Total Acres (percent)	100.00	6.68	32.64	0.79	**58.47**

Source: Chesapeake Bay Program's Phase III Watershed Model, Appendix E: Land Use and Selected Parameter Values, 1994. CBPLU (includes EPA's EMAP, NOAA's C-CAP, and USGS's GIRIS)

Table 2

Percentage Land Use by State in Chesapeake Bay Basin for 1990								
	Watershed	Wash. DC	Delaware	Maryland	New York	Pennsylvania	Virginia	West Virginia
Total Acres in basin (thousands)	41,244.5	39.77	459.04	5,940.57	4,030.31	14,466.26	14,013.33	2,295.31
Percent of State in Basin	N/A	100.0	37.1	95.0	13.3	50.6	55.5	14.9
Percent Urban	6.7	84.4	3.3	12.8	4.8	4.0	8.0	2.1
Percent Agriculture	32.6	1.6	55.9	38.9	34.7	31.1	31.1	27.9
Percent Wetlands	0.8	0.0	0.4	3.5	0.0	0.0	0.9	0.0
PERCENT FOREST	58.5	12.6	40.1	42.9	59.7	63.2	58.8	69.2

Source: Chesapeake Bay Program's Phase III Watershed Model, Appendix E: Land Use and Selected Parameter Values, 1994. CBPLU (derivative of EMAP-EPA, 1992)

Maryland has 5.9 million acres in the Chesapeake Bay basin which represent 95% of the state's land (Figure 5). Forests cover 2.5 million of these acres or nearly 43% of the state land within the basin. Garrett and Allegany counties have the highest percentages of forest cover (82.2% and 78.4%, respectively) while Kent, Talbot, and Queen Annes counties have the lowest (22.2%, 25.0%, and 25.7%, respectively). Agriculture is a significant land use in the state and occupies an estimated 2.3 million acres or 39% of the state land in the basin. Urban growth and suburbanization cover 12.8% of the land base. Maryland has the most

emergent wetland area in the watershed with over 204 thousand acres, equivalent to 3.5% of the land area.

Pennsylvania has 50.6% of its land within the basin—an estimated 14.5 million acres Figure 6). This state has the largest portion (9.1 million acres) of the basin's total forest. These forests account for 63.2% of Pennsylvania's land in the basin but are not distributed evenly around the state. For example, the most forested areas of the state (in basin) are McKean (97%) and Cameron (93.5%) counties in the western part of the state. Counties in the Lower Susquahanna River basin, on the other hand, have much lower percentages of forest such as Lancaster with 21.7% and York with 34.8%. Agriculture dominates much of the landscape and constitutes 31.1% of the land in the basin or about 4.5 million acres. The percentage of urban land is lower than other signatory states at 4%.

Virginia has 14 million acres in the Chesapeake Bay watershed, representing 55.5% of the state's land (Figure 7). The forests of Virginia cover 8.2 million acres—nearly 58.8% of the state land within the basin. Giles and Montgomery counties have the highest percentage of forest cover (99.2% and 96.6%, respectively) and Suffolk, Chesapeake, and Fairfax counties are the lowest (33.2%, 23.5%, and 39.6%, respectively), excluding the cities. Agricultural land uses encompass 31% of the land area, covering 4.4 million acres while urban development occupies 8% of the state within the Bay basin, representing over one million acres of land. Virginia has 120 thousand acres of wetlands along its shores—about 1% of the total.

Table 3 shows land use acres for each state in the Chesapeake Bay basin for 1990.

Table 3

Acres of Land Use by State In Chesapeake Bay Basin for 1990

	Watershed	Wash. DC	Delaware	Maryland	New York	Pennsylvania	Virginia	West Virginia
Total Acres in Basin (in thousands)	41,244.50	39.77	459.04	5,940.57	4,030.31	14,466.26	14,013.33	2,295.31
Percent State in Basin	N/A	100.00	37.10	95.00	13.30	50.60	55.50	14.90
Urban Acres	2,754.10	33.50	15.10	760.80	193.10	579.80	1,122.70	49.20
Agriculture Acres	13,462.20	.63	256.70	2,309.30	1,399.30	4,499.10	4,355.20	642.20
Wetland Acres	327.60	.05	1.99	204.94	0.00	.30	120.34	.02
FOREST ACRES	**24,114.70**	**4.99**	**183.67**	**2,548.90**	**2,406.70**	**9,145.10**	**8,237.60**	**1,587.20**

Source: Phase III Watershed Model, Appendix E: Land Use and Selected Parameter Values, 1994. CBPLU (derivative of EMAP-EPA, 1992)

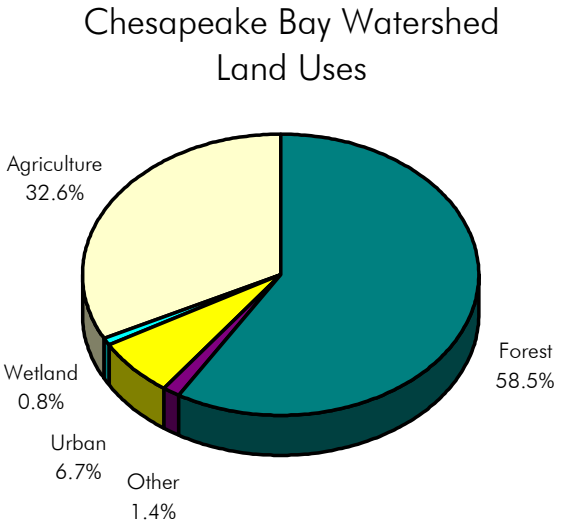


Figure 3

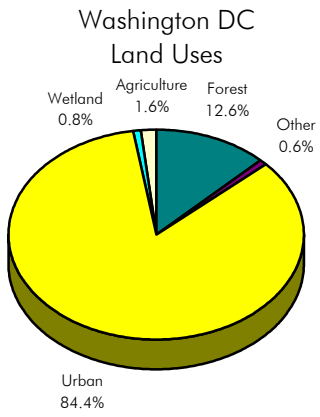


Figure 4

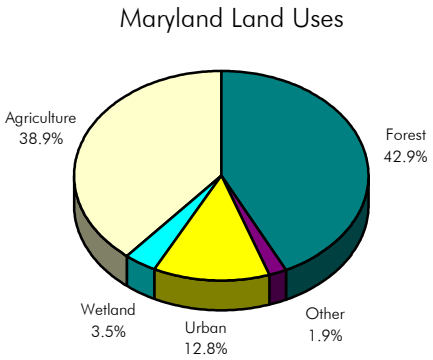


Figure 5

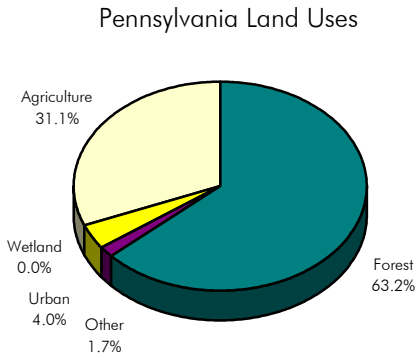


Figure 6

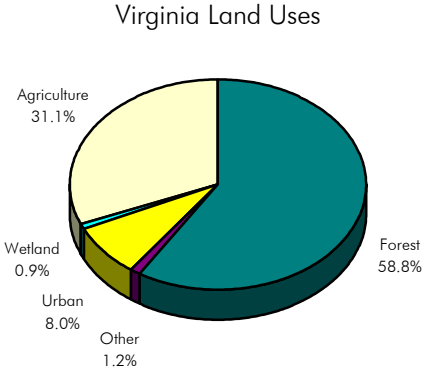


Figure 7

Trends in Forest Change

Because the Chesapeake Bay watershed is so vast, no consistent historic records, data sets, or tracking systems exist that provide land use information for trends across the watershed. Long-term uniform information on forests in each state is also nonexistent. Therefore, the USDA Forest Service developed an approach to track forest trends by assembling information from several sources and calling upon the professional judgement of forestry agencies in each state.

The results of trend analyses are presented using the Chesapeake Bay Program Phase II Watershed Model, the USDA Forest Service's Forest Inventory and Analysis, Natural Resource Conservation Service's National Resources Inventory within the Chesapeake Bay basin, and state-specific inventories done between approximately 1975 and 1995. Each inventory has been conducted using slightly different methodology and the results may not be directly comparable. For this reason, a conclusions statement is offered for each state that reflects the results of the data analysis and the input of state forestry agencies.

Sources and Methods

The trends analysis relied on three data sources: Chesapeake Bay Program Land Use Data for Phase II Watershed Model (Chesapeake Bay Program, 1992); The USDA Forest Service's Forest Inventory and Analysis (FIA) *Forest Statistics*; and the Natural Resources Conservation Service's (NRCS) *Summary Report 1992 National Resources Inventory* (NRI).

In the first data set, the Chesapeake Bay Program Phase II Watershed Model, CBP utilized information from the Census Bureau - Census of Agriculture, the USDA Forest Service's Forest Statistics, and the Natural Resources Conservation Service's NRI to develop a common data set for 1985 or "base case" of land uses which include-conventional till, conservation till, hay land, pasture, forest, pervious urban, herbaceous urban, impervious urban, and water. The state agriculture, forestry, and NRCS offices reviewed the 1985 information and made corrections to ensure the accuracy of the base case. The Bay Program signatory states then developed a year 2000 land use data set based on expected changes in the base case. This analysis uses interpolation between the base case and the year 2000 land use data sets to arrive at predicted changes to 1995.

The Chesapeake Bay Watershed Model forest land use was calculated by grouping herbaceous wetlands with forested land since the simulation of forest nutrient cycling is more closely related to wetlands than either developed or agricultural land. Although wetlands process nutrients differently than forests, the Watershed Model is a basinwide simulation and wetlands account for less than 1% of the total land area in the basin.

The USDA Forest Service Forest Inventory and Analysis (FIA) data were taken from the Resource Bulletin series of decennial forest surveys (*Forest Statistics)* for each state in the basin. At least two time periods were used to determine trends: Pennsylvania (1978 and 1989), Maryland (1976 and 1986), Virginia (1976, 1986 and 1992), Delaware (1972 and 1986), West Virginia (1975 and 1989), and New York (1968 and 1980).

The third source, Natural Resource Conservation Service (NRCS) - *Summary Report 1992 National Resources Inventory* (NRI) provides a review of land use change for the Bay states between 1982 and 1992. Scientists from the NRSC Annapolis office prepared the data. The

NRI data are statistically reliable for national, regional, and state analysis within a 95% confidence interval. At the county level, the data have a margin of error that may make them less reliable in some cases.

A state-specific inventory conducted by the Maryland Office of Planning, *Maryland's Land 1973-1990: A Changing Resource* , was used for comparison in Maryland. This document was the only state-specific inventory available.

Trends in Forest Land for the Watershed

Overall, the three data sets reflect a small negative to small positive change in total forest cover and primarily indicate a static trend in forest land within the watershed (figure 8). The inventory that shows the greatest change is the Chesapeake Bay Program's Land Use data set developed for the Phase II Watershed Model. Using a mathematical simulation, the model shows that the percentage of forest land in the watershed declined from approximately 59.8% to 58.6% or 1.2% of the total land base between 1985 and 1995. This change represents an estimated decline of almost 471 thousand acres or 1.93% loss of forest over the period. The U.S. Forest Service's FIA indicates a slight decline of forest—under 1%. Natural Resource Conservation Service's NRI shows a minute gain of 0.15%, indicating essentially no change. In most areas of the watershed, forest and agricultural land were converted to urban uses. Table 4 compares the three inventories.

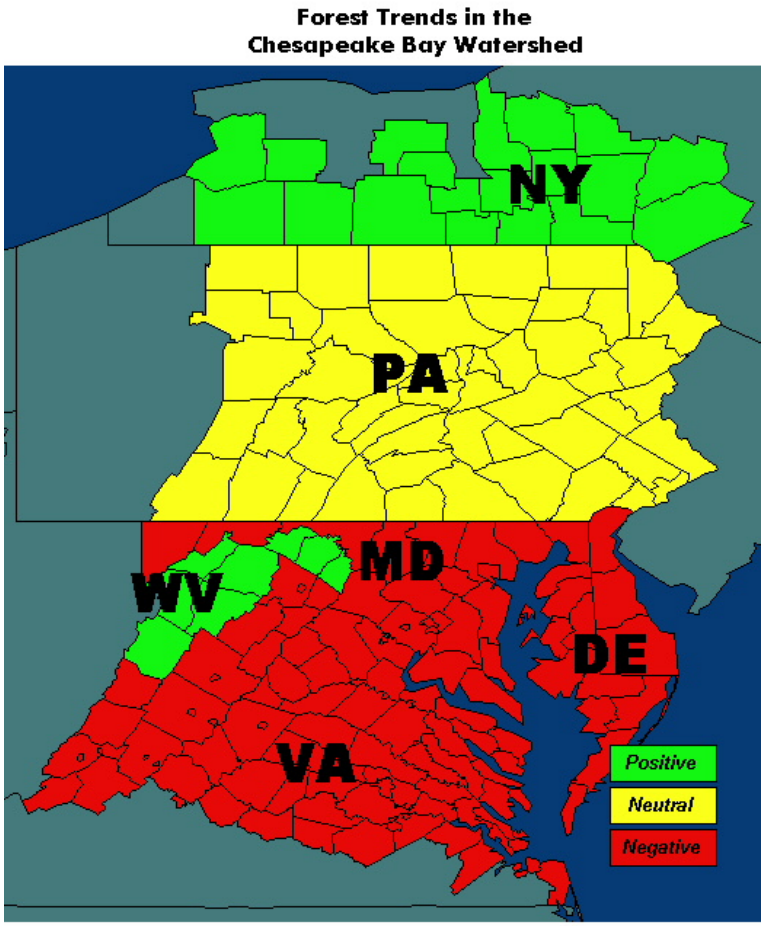


Figure 8

Trends in Forest for the Bay States

The Chesapeake Bay Program model data base indicates that many areas in the Bay region have experienced a net forest loss between 1985 and 1995. The most clear and consistent finding is that the counties closest to the Bay have experienced the greatest forest decline. In general, the Bay watershed model data show that the counties adjacent to the major rivers flowing into the Bay (the Susquehanna, Patuxent, Potomac, Rappahannock, York, and James) all experience greater forest loss than counties situated at the headwaters of these rivers. The NRI and FIA inventories for the Bay states indicate that forest loss may be low overall. In some cases, the inventories indicated slight increases.

The following discussion presents the results for each state based on the CBP data base, surveys conducted by the US Forest Service and the Natural Resource Conservation Service, as well as a state survey of Maryland for comparison.

Virginia

The Chesapeake Bay Program Watershed model data indicate that Virginia experienced a forest loss of 1.3% of the total land area. The total acres of forest declined from an estimated 8.7 million acres to about 8.5 million or a percentage drop from 60% to 58.6%. This loss translates into a decrease of almost 200,000 acres or 2.3% of its forest land between 1985 and 1995. According to the Bay Program data, urban growth and suburbanization were the greatest causes of conversion from forest and farm land.

Figures for total forest loss in the state give only a general sense of the overall change. A much more detailed picture of forest change and land use patterns emerges by examining trends in regions of the state. For example, with the sprawl of Washington DC into the lower Potomac River region of Loudoun, Fairfax, and Prince Williams counties in Virginia along with Montgomery and Prince Georges counties in Maryland, 7% of the forest—an estimated 7.1 thousand acres per year—were lost to urban development between 1985 and 1995. In contrast, the state totals for forest loss over the same period were 2.3% in Virginia (Figure 9) and 4.2% in Maryland. Also, this area of sprawl is only 32.5% forested versus the state (59%). Another example occurs in the area between Richmond and Hampton/Newport News. This region, bordered by the York and James rivers, includes York, Gloucester, New Kent, and King William counties and experienced more than a 7% decline of forest—almost 30 thousand acres—between 1985 and 1995. On the other hand, in the Shenandoah Valley region of Rockingham, Augusta, Page, Shenandoah and Warren counties, forest constitutes over 55% of the land area. The amount of forest has changed very little in this region; development has come from agricultural land.

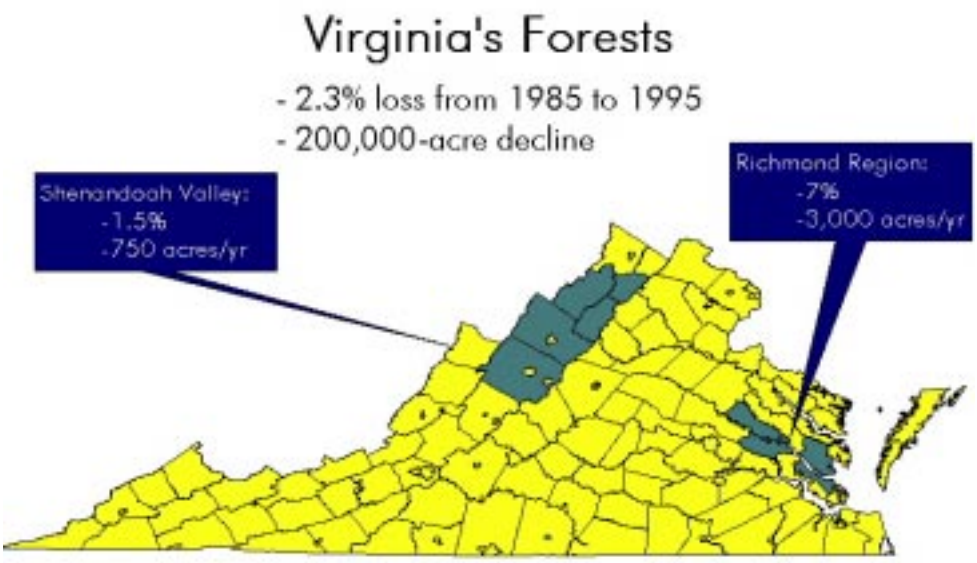


Figure 9

A U.S. Forest Service inventory of Virginia forests examined two time periods: 1976 to 1986 and 1976 to 1992. Virginia showed a loss of 4.1% or more than 437 thousand acres between 1976 and 1986, representing a decrease in total forest from 63.4% to 60.8%. Again, forest loss occurred most rapidly around the urbanizing areas—Fairfax (-19%), Newport News (-30%), and Virginia Beach (-21%). Between 1986 and 1992, however, forest loss slowed with some areas showing an increase. The Forest Service data showed that 31% of the counties gained forest between 1986 and 1992. The total change in forest over the eighteen years between 1976 and 1992 indicates a decline of 4% which represents approximately 430 thousand acres. This shift indicates a change of 2.6% of total land from forest to other uses.

The National Resources Inventory (NRI), on the other hand, suggests that forest land declined but at a slower pace with a loss of about 1.82% between 1982 and 1992. The inventory indicates that 75% of the counties within the basin remained unchanged or lost

forest within this time period.

On the whole, the three inventories indicate that Virginia is losing forest within the Chesapeake Bay basin. Differences in total acreage are likely due to statistical variation and methodological differences in data collection and analysis. The percentage changes from each inventory are very similar and concur in an overall trend of forest loss.

Pennsylvania

The data base analyses for Pennsylvania indicate that the state's 8.7 million acres of forest within the Bay basin are largely unchanged. The Chesapeake Bay Program data show essentially no change in forest, while the U.S. Forest Service data indicate a slight gain, and the NRI data also show no change in overall forest acreage for the state within the basin.

The Bay Program data showed Pennsylvania had virtually no change of total forest area, dropping from 60.7 to 60.1% from 1985 to 1995. Over the ten years, the change is under 1%, however this decline still represents an estimated loss of almost 85 thousand acres of forest in the Bay basin (Figure 10). These data also indicate that although the entire state within the basin saw little change, regional differences do show areas of forest loss. Patterns in forest change in some parts of the state vary substantially compared to the state as a whole. For example, the upper Susquehanna River area that includes Bradford, Susquehanna, Wyoming, and Lackawanna counties have gained in forest area. Down the Susquehanna River toward the Bay, a different situation appears. The urban sprawl associated with Harrisburg in Cumberland, Dauphin, and York counties caused forest losses of over 1100 acres per year—nearly 1.5% between 1985 and 1995. Differences also occur in the traditional agricultural region of the state, including Adams, Lancaster and York counties of the Lower Susquehanna River. Forests in these counties declined almost 5% from 1985 to 1995.

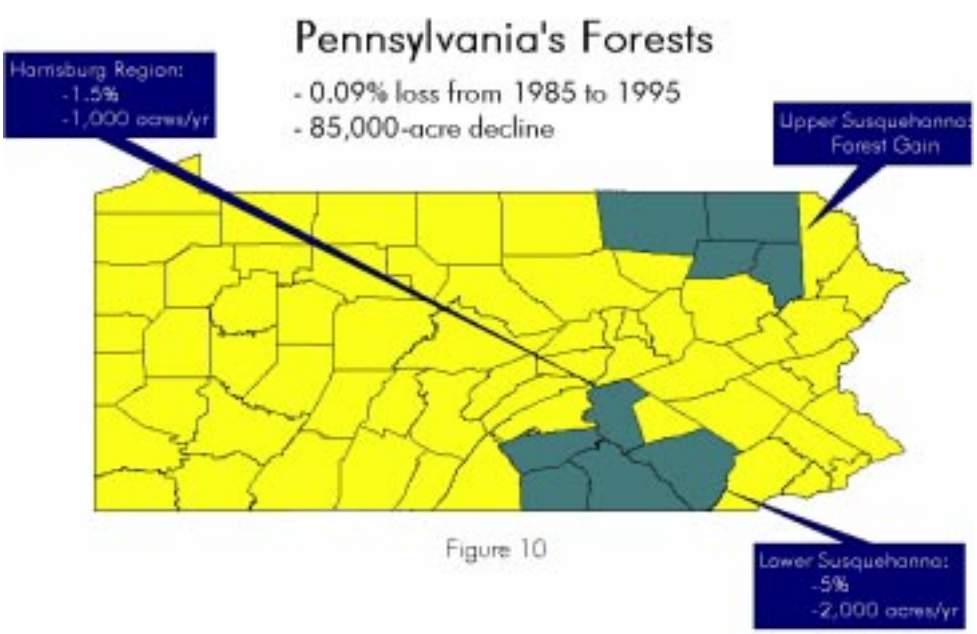


Figure 10

The U.S. Forest Service's Forest Statistics for Pennsylvania was used to examine the state's forest between 1978 and 1989. Over this period, the survey indicates that Pennsylvania's forests were essentially unchanged with a slight gain from 60.9% to 61.7%—an increase of about 142 thousand acres. These data also indicate that 30% of the counties of the state in the basin gained forest. Counties in the east central part of the state showed the greatest jumps—Bradford (13%), Columbia (13%), Montour and Northumberland (jointly, 23%) between 1978 and 1989. Similar to the Chesapeake Bay Program data, the FIA data also showed a decline in forest in the Lower Susquehanna region.

The Natural Resources Inventory data from 1982 to 1992 suggest an unchanging amount of forest for the state within the basin, showing an estimated 0.53% gain overall.

Although the results conflict, the general conclusion is that the state's forest in the basin are static. State bureau of forestry personnel were consulted for their professional judgement concerning the change in forest for the state in the basin and for various regions. Their assessment is that forest change in the state is static overall. The foresters believe that agricultural field abandonment and state reforestation efforts have yielded fruitful results over the past ten years. They suggest that the northeastern portion of the state is gaining forest at a significant pace, but the southern Susquehanna River region is likely losing forest to development in the Harrisburg and York areas.

Maryland

In Maryland, three of the four inventories used to examine forest trends indicate the state has lost forest. According to the Bay Program information, Maryland lost approximately 2% (from 45.8% to 43.9%) forest in total land area in the state. Forest acres dropped from over 2.7 million acres to 2.6 million—4.2% of the state's forest—between 1985 and 1995 which translates to a loss of almost 114 thousand acres or over 11 thousand acres of loss per year (Figure 11).

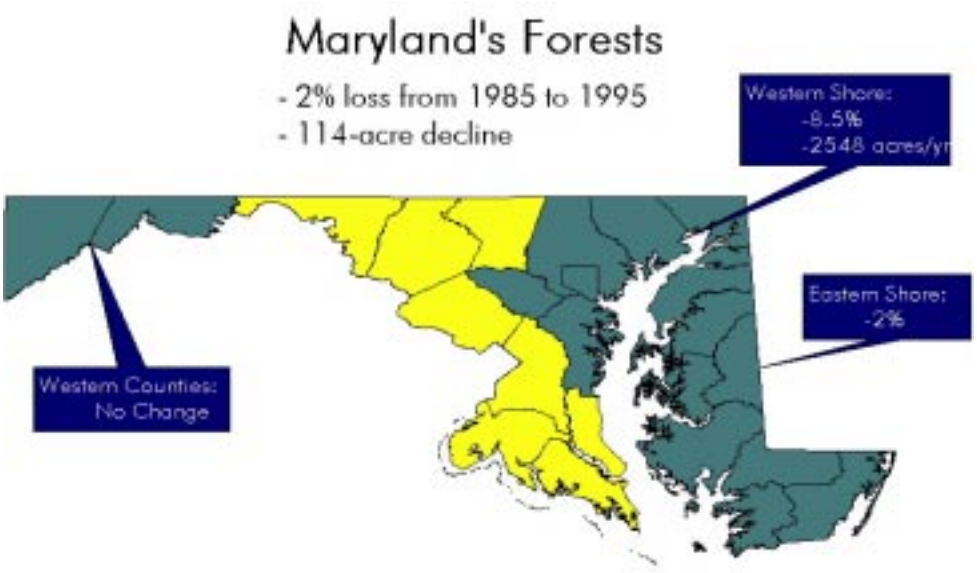


Figure 11

The Bay Program data indicate that land use change is also regional in Maryland. The trend in forest change for the western shore surrounding the city of Baltimore, including Cecil, Harford, Baltimore, Anne Arundel, and Howard counties, indicates a forest loss of 8.5%. This loss translate to an average decline of over 2548 acres per year between 1985 and 1995. The headwaters of the Potomac River, in the western portion of the state (Allegany and Garrett counties), show no change. The agricultural region of Maryland's Eastern Shore, however, experienced a mix of forest trends. The northern shore of Kent, Queen Annes, Talbot, and Caroline counties have lost forest at a rate of 2% between 1985 and 1995. Forests on the southern Shore—Dorchester, Wicomico, Worcester, and Somerset counties—remain practically unchanged. While the Eastern Shore of Maryland is 39% agriculture, 51% of its land is still cloaked in forest.

The Forest Service data show different results. According to the FIA surveys, Maryland gained some forest (0.8%) between 1976 and 1986—approximately 50 thousand acres. Many of these new forest acres come from reversions of pasture to forest in Washington (8.5% gain in total forest area) along with reforestation in Anne Arundel and Howard (6%) counties. The Forest Service results show that 45% of the states counties gained forest between 1976 and 1989.

In contrast, the Natural Resource Conservation Service data indicate a decline in forest land of 2.5% between 1982 and 1992 for the Bay area.

According to the state Office of Planning, the mid-1980's were not the years of greatest land use change for Maryland; the early 1970's represented a time of expansive development for the state. Development increased 37.9% between 1973 and 1990 in Maryland. This expansion absorbed 129 thousand acres of farmland or 5.2% of the land base and over 126 thousand acres of forest or 4.5% (Maryland Department of Planning, 1991). The Office of Planning analysis was used to incorporate a state agency evaluation of land use change within the state. This analysis shows that forest loss occurred during two time periods: 1973 to 1985 and 1973 to 1990. During the first time period, forest declined about 1% of total land area—equivalent to 55 thousand acres. From 1973 to 1990, the state's forest loss was about 4.5% or 126 thousand acres. This decline represents over 2% loss of the total land area. Every county in the state experienced conversion of forest to other land uses.

The inventories suggest that Maryland may be losing forest at a moderate rate although the U.S. Forest Service data are not consistent with this conclusion. On a county level, the areas closest to the Bay are experiencing the most rapid growth and the greatest forest loss. Since these areas are more vulnerable to forest decline, the state-wide figure may be somewhat misleading with the regional assessments telling a more accurate story.

The Headwater States

New York, home to many of the streams and rivers that feed the Susquehanna River, has lost approximately 1.4% forest land (58.2% to 56.8%) from 1985 to 1995. This loss is attributed to growth in the developing areas around Binghamton and Elmira. In areas dominated by agriculture, slight increases may be a result of fallow and idle pasture land that had formerly been used for the dairy industry reverting to forest. Forest land declined from about 2.35 million to 2.30 million acres in New York's portion of the basin—a loss of 2.3%. The US Forest Service data show an estimated increase of 4.3% in forest land between 1968 and 1980. The Natural Resources Inventory indicates a remarkable and questionable gain in forest—6.1% for the area of the state within the basin between 1982 and 1992.

Delaware contains the important headwater streams to the Nanticoke, Choptank, and the Chester rivers that all empty into the Bay. Forest area has declined 1.7% with an estimated loss of 3500 forested acres (from 210 thousand to 206 thousand) of state land within the watershed. This decline represents a small 0.8% drop between 1985 and 1995 (45.7% to 44.9%). The Forest Service surveys confirm a small decline in forest area. These surveys show that Delaware lost 0.6% between 1972 and 1986. The National Resources Inventory suggests a 1.3% decline in forest between 1982 and 1992.

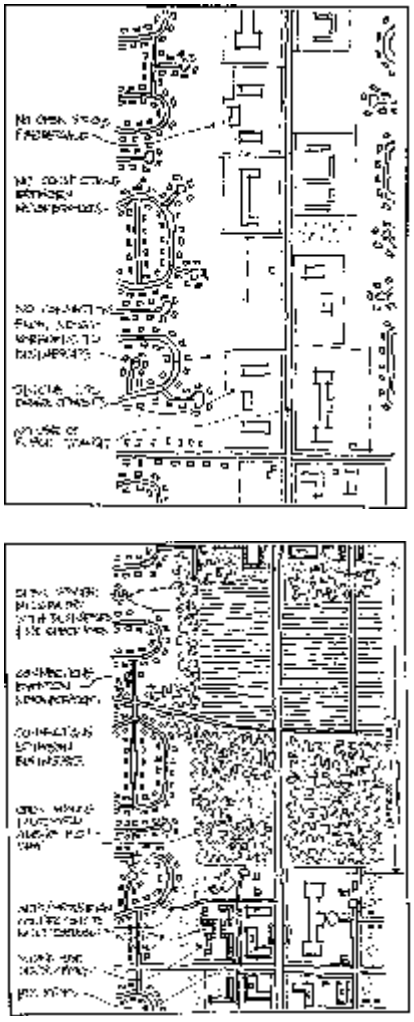


Figure 12. The idea that residential growth is cost-free is a myth. In fact, open space provides many times more tax dollars in income to municipalities compared to money paid out for community services in developed areas.

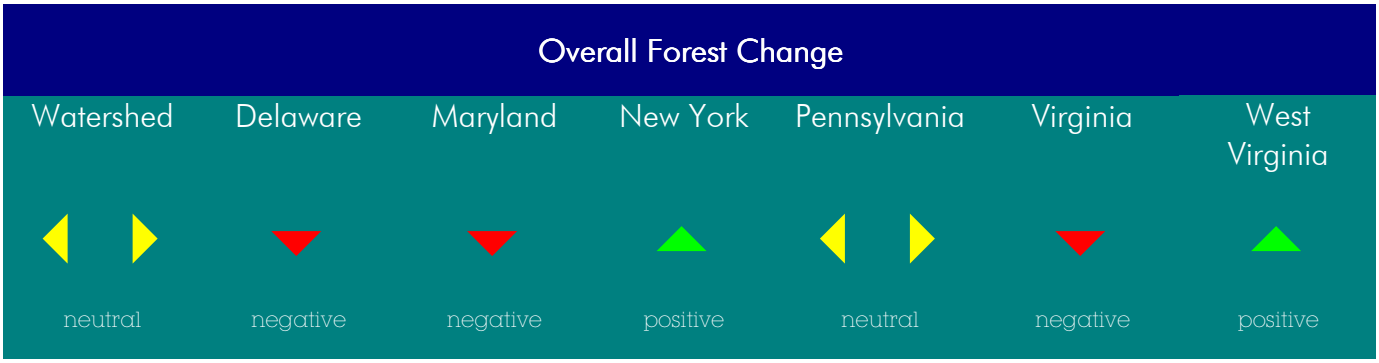
West Virginia is the most forested state in the watershed and feeds a maze of rivers and headwater streams that drain into the Potomac River. Although only 16% of West Virginia's land is in the Bay drainage basin, 68.5% of this area is forested. Between 1985 and 1995, the amount of forest declined 11 thousand acres (0.07%). The state, therefore, remained fairly stable with a slight decline in total land area in forest from 68.9% to 68.4 %. The Forest Service data showed a slightly different result with a 0.4% gain in forest between 1975 and 1989. The Natural Resource Inventory data indicate a 4.03% gain in forest for the state land within the basin. Table 4 shows the change for each state in the watershed.

Table 4

Chesapeake Bay Basin Forest Changes using Three Inventories

	Watershed	Delaware	Maryland	New York	Pennsylvania	Virginia	West Virginia
Total Acres in basin	41,244.50	459.04	5,940.57	4,030.31	14,466.26	14,013.33	2,295.31
Percent of State in Basin	N/A	37.10	95.00	13.30	50.60	55.50	14.90
Percent Forest (1990)	58.50	40.10	42.90	59.70	63.20	58.80	69.20
Forest Change (in percent) CB Model (1985 to 1995)	-1.93	-1.67	-4.19	-2.29	-0.09	-2.28	-0.07
Forest Change (in percent) USFS Inventory (varying dates)	-0.26	-0.59	1.90	2.80	1.24	-4.10	0.52
Forest Change (in percent) NRI – in Bay (1982 to 1992)	0.15	-1.30	-2.50	6.10	0.53	-1.82	4.03

Source: Chesapeake Bay Program. 1990. Land Use for Chesapeake Bay Program Watershed Model, USDA Forest Service Inventory and Analysis. Forest Statistics for each state, and USDA Natural Resources Conservation Service. Summary Report 1992: National Resources Inventory.


Overall Forest Change
Watershed
Delaware
Maryland
New York
Pennsylvania
Virginia
West Virginia
neutral
negative
negative
positive
neutral
negative
positive

Forest Conservation Issues

Land Consumption and Land Use Conversion

No clear boundaries separate land use, environmental quality, and economic well-being. A change in one area ultimately affects other areas. Land use is an important factor in the ecological health of the Bay. Land use and the health of the Bay, in turn, affect the economic vitality of the region. The report, *Population Growth and Development in the Chesapeake Bay Watershed to the Year 2020* (1988), projects that the population within Pennsylvania, Maryland, and Virginia will grow by nearly one million people (7%) by the year 2000 and by 2.6 million people (from 13.6 million in 1990 to 16.2 million—an increase of 19%) by the year 2020.

Such numbers clearly forecast that land consumption will continue to be a formidable issue. In the recent past, undeveloped areas have been converted to developed ones at a rate exceeding that of population growth. In Maryland, for example, the population increased 7.5% between 1970 and 1980 but developed acreage increased by 16.5% (Figure 13). The entire Chesapeake basin population grew almost 50% between 1950 and 1980 from 8.3 million to 12.4 million. During the same period, the amount of land used for residential and commercial purposes increased 180% from 1.5 million acres to 4.2 million acres (Year 2020 Panel, 1988) indicating that land for development has more than tripled on a per capita basis. Between 1990 and 2020, 1.7 million new housing units are projected—potentially consuming more than 636,000 acres (including an allowance for additional roads). If prior trends are a reliable indication, such development will take place at the expense of farms and forests.

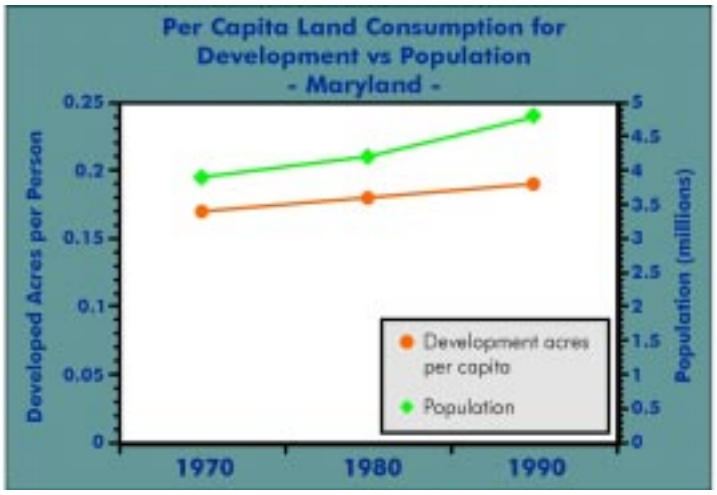


Figure 13. The amount of developed land per person is increasing at a significantly greater rate than the population. While population increased 23% from 1970 to 1990, total development has increased by 36%.

Quality versus Distribution

Forests are unevenly distributed throughout the Bay basin. By observing changes on a broad scale, ecosystem shifts and interactions that may not fall within jurisdictional boundaries become apparent. Using only forest statistics for large geographic areas, however, may mislead us about the potential impacts of forest loss and the rate of deforestation in a region. We also need to examine smaller unit areas such as sub-watersheds and counties. As an example, the total forest acreage of the Chesapeake Bay watershed has remained essentially unchanged over the last 15 years. Development in the areas closest to the Bay, however, show more rapid declines in forested open space and greater increases in population. Conversely, the gains in forest have occurred primarily in the headwater regions, far removed from the Bay.

The quality of a forest matters as much, or perhaps more, than the total forest area. Forest

fragmentation affects fish and wildlife populations and the biological health and diversity of the forest itself. If many small habitat losses occur over time, the cumulative effect will be similar to a few dramatic changes. Forest fragmentation disrupts animal travel corridors, increases the invasion of exotic vegetation, exposes forest interiors (which is detrimental to interior-dwelling and nesting birds), and places people in direct conflict with the animals that live and feed in these forests. Habitat loss results in the reduction of many wildlife population numbers and the total elimination of some species.

To protect the quality of our water, retaining and restoring riparian forests is a high priority because these forests provide an exceptionally wide range of environmental benefits. Forests along rivers and streams and in coastal zones and wetlands have significant benefits on water quality and may be uniquely important to mimic the effects of a larger forest area.

The distribution of forest area varies considerable across the regions of the Bay watershed. Some counties have lost over 85% of their original forest cover while others have become almost completely reforested due largely to agricultural abandonment. From 1973 to 1990, for example, the total portion of Maryland in the Bay basin lost approximately 2% forest while Maryland's Anne Arundel county lost nearly 10% forest and increased low density development by 48%. Calvert County experienced losses of 9% in forest and had more than a 153% increase in low density development during the same period (Maryland Office of Planning, 1991). In Virginia, counties in Northern Virginia and along the Virginia coast experienced decreases as much as three times the decline for the total state.

Significant regional differences exist as well. The lower Susquehanna River region of Adams, York, and Lancaster counties experienced sizable forest loss between the late 1970s and the late 1980s, while areas in the east central portion of the state showed forest gains. As a result, Pennsylvania as a whole remained unchanged. In the Washington DC/Baltimore corridor of Prince George's, Montgomery, and Baltimore counties, the mature and highly valuable forests that were cleared in the 1980's have been largely replaced with street trees and ornamental plants. Species composition and location of the trees make an important difference in the quality and function of a forest. A few trees and ornamental bushes planted in a suburban area cannot perform the same environmental functions as a forest with a multi-layered overstory, native trees, a diverse understory, and ground cover.

Integration of Forest Retention with Land Use Planning and Development

There is a long-held misconception that undeveloped land only carries its weight in the local tax base after it has been developed. More and more studies, however, are showing that conserving open space does not require an either/or choice between environment and economics (Figures 14-16). Forest conservation can be a sound investment. Studies comparing the fiscal impact of development to conserved open space have found that open space protection has a more positive impact on a community's economy than suburban sprawl-style development. For example, researchers for the Piedmont Environmental Council in Virginia found that ". . . for every dollar collected from farms, forests, and open space, 19 cents is spent on services." The benefits come from lower costs of community services, increased property values resulting in higher tax rates, greater recreation opportunities, more tourism dollars, and free natural water quality control. Development is not the sure-fire economic boon it was once thought to be.

Alternately, forest retention or open space protection should not exclude the housing, schools, roads, businesses, and services needed to maintain a dynamic community. To

provide affordable housing and infrastructure (such as sewer, water, and schools), land should be used appropriately with development concentrated where it is best served by existing infrastructure while conserving as much forest as possible.

Good planning and access to information are the key elements in wise land use planning. Comprehensive planning efforts at both broad (state or regional) and local levels are needed to assess where and how development should occur. Localities need information and technical assistance to assist them in retaining important natural, scenic, and historic assets. These tools help lead to better decisions about how and where investments in roads, water supplies, stormwater treatment, and sewers are made. Planning our "green infrastructure" to accommodate recreation, aesthetics, and areas for natural water quality maintenance can save money and increase the character of our growing communities.

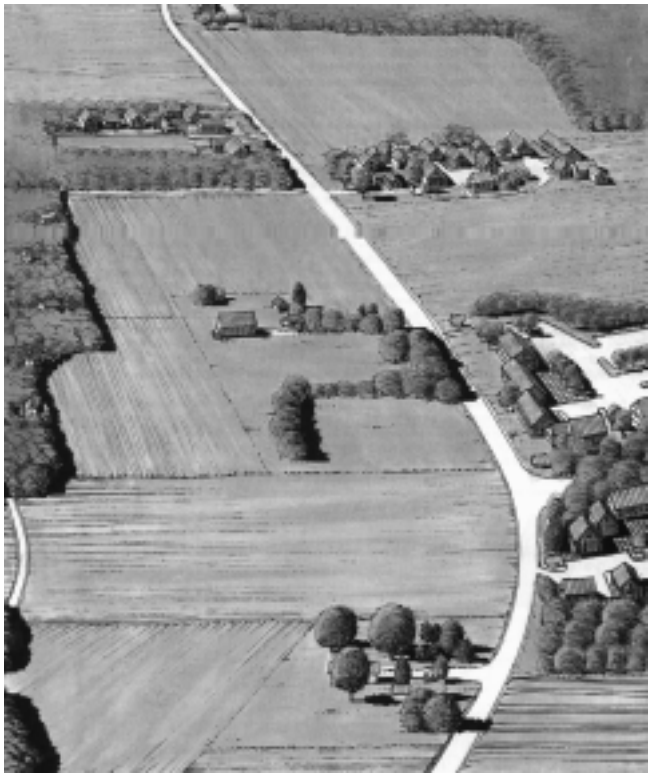


Figure 14. Before development: rural community within a working landscape.

Retaining the Bay's Forests

The Bay states have taken several actions to retain their forests. Both Maryland and Virginia recognize that the coastal areas of the Bay are particularly important and sensitive. The Chesapeake Bay Critical Area Act in Maryland and the Chesapeake Bay Preservation Act in Virginia include provisions for the retention of forests in those areas nearest the Bay. In Maryland, the Forest Conservation Act requires the consideration of forests in the development process, restricts some forest clearing, and in some cases mandates the planting of trees in unforested areas as mitigation. Growth legislation in both Maryland and Virginia has initiated planning for sensitive areas such as forests and riparian areas. In Maryland, the Economic Growth, Resource Protection, and Planning Act encourages forest cover protection and riparian forests as part of each county's requirement to develop a "sensitive areas element" in its comprehensive planning. This legislation, however, permits the local government to define each sensitive area and its level of protection.

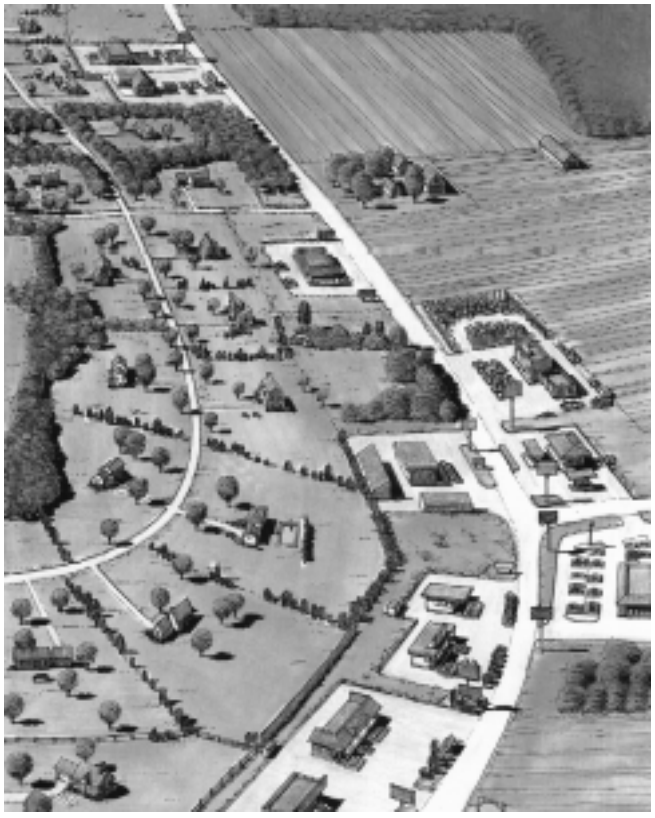


Figure 15. Conventional development: inefficient, unattractive, and fragmented.

Some local governments have taken additional steps to protect trees and forests specifically. Prince George's and Baltimore counties in Maryland, Fairfax County in Virginia, and Lancaster County in Pennsylvania each have ordinances and guidelines that address planning for forest and open space retention where development occurs. Increasing educational opportunities and making information accessible have increased the level of awareness of local planners, engineers, and regulators on the importance of retaining forest cover and the benefit of forests in their communities.

About 80% of the forest land in the Chesapeake Bay region is privately owned and most land use decisions are made at the local level. Both the funding and capability of state forestry agencies to provide technical assistance to localities in land use planning and managing for open space are limited and should be supported. Conservation of natural resources requires partnerships that seek creative and innovative ways to assist local governments in responsible long-term planning.

Figure 16. Creative Development: allows growth, preserves natural resources, and is aesthetically pleasing.

Local governments are at the forefront of efforts to protect both the Bay and the forests in developing areas. Watershed plans, forest protection ordinances, greenways, and other programs currently supplement traditional planning and zoning. Such efforts focus, more than ever before, on environmental values and protection of water quality. Although initiatives demonstrate that local governments have a great capacity for innovation, the range of issues these governments face today and will face tomorrow continues to broaden. Gary Allen, Mayor of Bowie, Maryland and chair of the Chesapeake Bay Program's Local Government Advisory Council, said recently, "Local government is the appropriate agent for accomplishing these objectives, but local governments need the information and technical assistance provided by state and federal agencies, concerning how their efforts can support Bay restoration objectives."

**Figures 14, 15, 16. Courtesy of Center for Rural Massachusetts, University of Massachusetts, Amherst.*

Recommendations

Forest land area is approximately stable for the entire Bay watershed. Substantial regional forest loss, however, has occurred in urban and suburban areas and in those counties closest to the Bay. Counties removed from the Bay (in the headwater areas) have experienced forest gains. In the regions that have suffered forest decline, there are potential impacts on the quality of the environment (air, water, soil). The economic value and ecological importance of forest cover for protecting water quality, providing essential habitat for wildlife and fish, and yielding an array of forest products and recreation cannot be underestimated. It is, therefore, essential to integrate practical forest retention techniques into land management and development planning.

With agreement on these findings, the U.S. Forest Service and the Forestry Work Group of the Nutrient Subcommittee make the following recommendations.

General Recommendation

Forest retention should be actively promoted basinwide as a key element in residential and commercial land use planning and development. Local land use planning that includes forest conservation, reduces forest fragmentation, and integrates forest management and open space recreation use should be supported and assisted. Forest retention and management should be integrated with our water quality goals. Forested riparian buffers, therefore, should be promoted as an essential prescription in farm planning and urban stormwater management planning—as a cost-effective means to protect water quality, prevent pollution, and provide important living resource habitat.

Working Toward Livable Solutions

The following actions would greatly enhance the implementation of an effective forest conservation program for the Chesapeake Bay region. The objective of such a program is to support comprehensive planning techniques and provide the information necessary for the Bay states and its local governments to make informed land use decisions. A federal/state/local partnership is appropriate for these activities and should be directed, ultimately, by the desired future condition of the local community and the landscape.

1. Develop a data base and sources of information to track the status and trends of the forest and its relationship to other land uses for states in the Bay basin.
2. Conduct a survey of local governments throughout the watershed to determine how local forest conservation issues are addressed, to assess local attitudes and values about forest conservation, and to define the citizens' visions of their local forest and its use 50 years from today.
3. Prepare a compendium of successful case studies and model guidelines in developing forest conservation and management approaches, ordinances, or public participation processes in local planning efforts.
4. Assess the benefits, costs, and impacts of voluntary versus regulatory approaches to forest conservation used during development in the Bay states. Identify and evaluate existing and proposed innovative financial and tax incentive means to retain forest land.

5. Identify demonstration sites that illustrate land use planning techniques which integrate forest and open space retention and consider natural functions in design. Establish a recognition program for developers and builders.
6. Promote and foster regional, local , and grassroots efforts to develop incentive-based approaches to conserving forest land, such as forest conservation easement programs and forest use tax incentives.
7. Develop practical information and educational tools that promote forest conservation through manage-ment and illustrate the value of forests and the products and services they provide. The intended audiences for these products would be local land-use planners, conservation boards, waterfront homeowners, and others.
8. Conduct an economic evaluation of the benefits of conserving forest in urban areas and as economically viable forest units (EVU) in rural areas. The study would seek to illustrate the value of forest conservation and management, and the potential long-term cost savings these approaches provide to local communities. After being shown various forest conservation and management options—including economic use of the forest—, landowners may be inclined to retain their forests as open space.
9. Conduct studies that focus on alternative development pattern and build-out (the maximum amount of development) scenarios for several selected communities or sub-watersheds in the Bay basin. These studies would assess the cost of community services and impacts on the infrastructure capacities of new development.
10. Develop GIS-based resource and information tools to educate local land use planners on the impacts of land use change and build-outs for their localities. The objective of the outreach program is to reach local planners on their home field and assist them in visualizing development alternatives and the impacts of land use decisions.

References

Alerich, C.L. 1992. *Forest Statistics for Pennsylvania - 1978 and 1989*. USDA Forest Service. Resource Bulletin NE-126. Radnor, PA.

Brown, M.J. 1987. *Forest Statistics for Virginia, 1986*. USDA Forest Service. Resources Bulletin SE-84. Asheville, NC.

Brush, Grace. 1995. *History and Impact of Human Activities on the Chesapeake Bay*. The Renewable Natural Resources Foundation. Baltimore, MD.

Considine, T.J. and T.S. Frieswyk. 1982. *Forest Statistics for New York, 1980*. USDA Forest Service. Resource Bulletin NE-71. Broomall, PA.

DiGiovanni, D.M. 1990. *Forest Statistics for West Virginia - 1975 and 1989*. USDA Forest Service. Resource Bulletin NE-114. Radnor, PA.

Frieswyk, T.S. and D.M. DiGiovanni. 1988. *Forest Statistics for Maryland - 1976 and 1986*. USDA Forest Service. Resource Bulletin NE-107. Radnor, PA.

Frieswyk, T.S. and D.M. DiGiovanni. 1988. *Forest Statistics for Delaware - 1972 and 1986*. USDA Forest Service. Resource Bulletin NE-109. Radnor, PA.

Hall, C.C. 1910. "Narratives of Early Maryland." In J.F. Jameson (Ed.) *Original Narratives of Early American History*. New York: Scribner's.

Horton, T. and W.M. Eichbaum. 1991. *Turning the Tide: Saving the Chesapeake Bay*. Washington, DC: Chesapeake Bay Foundation and Island Press.

Illick, J. 1924. The Story of the American Lumbering Industry. In Kaempffert (Ed.) *A Popular History of American Invention*. New York: Scribner's.

Jones, Hugh. 1956. *The Present State of Virginia*. Richard L. Morton (Ed.) Chapel Hill: University of North Carolina Press.

Johnson, T.G. 1992. *Forest Statistics for Virginia, 1992*. USDA Forest Service. Resources Bulletin SE-131. Asheville, NC.

Kraft, J.C. and G.S. Brush. *A Geological-Paleoenvironmental Analysis of the Sediments in St. Johns Pond and the Nearshore Zone near Howard's Wharf at St. Mary's City, Maryland*. Unpublished manuscript, 1981. Baltimore, MD.

MacCleery, Douglas. 1992. *American Forests: A History of Resiliency and Recovery*. USDA Forest Service, FS-540 in cooperation with the Forest History Society, Durham, NC.

Maryland Department of Natural Resources. 1995. *Maryland Game Program Annual Report 1994*. Annapolis, MD.

Maryland Office of Planning. 1991. *Maryland's Land 1973 - 1990: A Changing Resource*. Baltimore, MD.

Natural Resources Conservation Service. 1994. "Summary Report 1992 National Resources

Inventory." Information adapted to Chesapeake Bay Watershed by Maryland State Conservationist's Office. Annapolis, MD.

Neumiller K.S., L. Linker, J.E. Hannawald, A.S Donigian, B.R. Bicknell. In Revies. Phase III Watershed Model Application to Calculate Bay Nutrient Loadings: Final Findings and Recommendations - Appendix E: Land Use and Selected Parameter Values. AquaTerra Consultants and Chesapeake Bay Program. Annapolis, MD.

Papenfuse, Edward. 1993. "Colonial Encounters in the Chesapeake: The Natural World of Native Americans, Europeans and Africans, 1585-1800." Text of an exhibit by the Milton S. Eisenhower Library of the Johns Hopkins University, with support of the Maryland State Archives. Baltimore, MD.

Powell D.S., J.L. Faulkner, D.R. Darr, Z. Zhu, D.W. MacCleery. 1993. *Forest Resources of the United States, 1992*. USDA Forest Service. General Technical Report RM-234. Fort Collins, CO.

Silver, Timothy. *Arcadia Made Useful: European Colonists as Biotic Factors in Chesapeake Forests*. Unpublished manuscript, 1995. Appalachian State University, ND.

Southern New England Forest Consortium, Inc. 1995. "Cost of Community Services in Southern New England." Conducted by Commonwealth Research Group, Inc. September, 1995.

Stachey. W. 1953. *The History of Travel into Virginia Brittania*. L.B. Writght and V. Freund (Eds.) London: The Hakluyt Society.

Thorne. S.G. 1994. "Unfinished Business: Creating the Future Forests of Pennsylvania." Distinguished Lecture Series II. The Pennsylvania State University. College Park, PA.

The Year 2020 Panel. 1988. "Population Growth and Development in the Chesapeake Bay Watershed to the Year 2020." Chesapeake Executive Council. Annapolis. MD.

US Environmental Protection Agency Chesapeake Bay Program. 1993. *Cost of Providing Government Services to Alternative Residential Patterns*. Annapolis, MD.

Virginia Department of Forestry. 1995. *Virginia's Forests - Our Common Wealth: The Economic Importance of Virginia's Forest Resource*. Charlottesville, VA.

Walsh, L.S. In press. "Land Use, Settlement Patterns, and the Impact of European Agriculture, 1620-1820." A manuscript for The Colonial Williamsburg Foundation. Williamsburg, VA.

Widmann, R.H. 1993. "The Pennsylvania Forest Inventory: Documenting a Decade of Change." In J. Finley and S. Jones (Eds.) Proceedings of the 1993 Penn State Forest Resources Issues Conference - Penn's Woods - Change and Challenge. State College, PA.

Yaro, R.D., R.G. Arendt, H.L. Dodson, and E.A. Brabec. 1988. "Dealing with Change in the Conneticut River Valley: A Design Manual for Conservation and Development." Center for Rural Conservation. Amherst, MA.