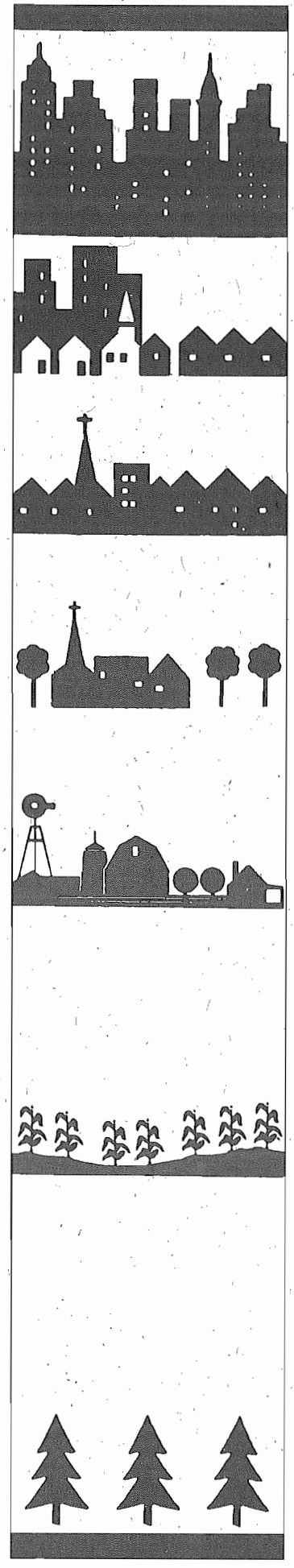

Managing Maryland's Growth

Models and Guidelines

Sensitive Areas, Volume II

- Tidal Wetlands
- Submerged Aquatic Vegetation
- Oysters, Clams, Crabs and Benthic Habitat
- Waterfowl Areas
- Colonial Waterbird Nesting Sites
- Eroding Shorelines
- Tidal Floodplains
- Nontidal Wetlands
- Verna Pools
- Bogs
- Trout Stream Watersheds
- Anadromous Fish Spawning Areas
- Groundwater
- Wellhead Protection Areas
- Springs and Seeps
- Caves
- Mineral Resources
- Wildlife Corridors
- Agricultural Land
- Scenic Vistas and Geologic Features

This document may not reflect current law and practice and may be inconsistent with current regulations.

The Maryland Economic Growth,
Resource Protection, and Planning Act of 1992

The Maryland Department of Natural Resources
The Maryland Office of Planning

State of Maryland
Parris N. Glendening, *Governor*

The Maryland Department of Natural Resources
John R. Griffin, *Secretary*

Maryland Office of Planning
Ronald M. Kreitner, *Director*

February, 1998

MARYLAND *Office of Planning*

APPALACHIAN REGIONAL COMMISSION

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Managing Maryland's Growth
Models and Guidelines

Sensitive Areas, Volume II

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The Maryland Department of Natural Resources
The Maryland Office of Planning

TABLE OF CONTENTS Page

INTRODUCTION

Sensitive Areas, Volume II is a cooperative effort between the Maryland Office of Planning and the Maryland Department of Natural Resources. It is one of a continuing series of *Models and Guidelines* prepared by the State to assist local governments in achieving the goals of the Economic Growth, Resource Protection, and Planning Act of 1992 (the Growth Act).

This publication is a supplement to volume I, *Preparing A Sensitive Areas Element For The Comprehensive Plan.* Volume I defines and describes protection strategies for four general categories of sensitive areas which are specified in the Growth Act: streams and their buffers, 100-year floodplains, habitats of threatened and endangered species, and steep slopes.

The Growth Act, in addition to providing protection to these four general categories of sensitive areas, encourages local governments to identify and protect the specific sensitive areas that occur in their jurisdiction. This document, which contains descriptions of twenty additional general categories, encourages this broader and more comprehensive approach.

This selection of sensitive areas is not a comprehensive list. There are many categories of sensitive areas in Maryland, many of which are provided some protection by local governments. A complete list would include areas such as the watersheds of drinking water reservoirs, historic sites, large forested tracts, and many more categories of wildlife habitat and wetlands.

Why Protect Additional Categories of Sensitive Areas?

The protection of a broad array of sensitive area categories will enhance the environmental quality of Maryland's counties and municipalities. The benefits which thus accrue to the State's water quality and natural habitats will improve and reinforce the quality of life for all citizens. Protection of a wide array of sensitive areas will protect landscapes and resources that attract new jobs and economic growth. The sustainability of Maryland's economy will depend, in part, on maintaining a natural environment which provides residents with passive and active recreational opportunities and environmental experiences, and which attracts corporations and businesses seeking new locations, while retaining existing employers.

Broadly-based protection efforts will produce a multiplicity of reasons for protecting networks of resource lands and waters. This means that a local policy for protecting an important natural stream valley or habitat network will have a stronger foundation or justification for regulatory protection, as opposed to a narrower approach that meets only the minimum requirements of the Growth Act. For example, protection of streams or habitat can be reinforced by local policies and land use controls that also seek to protect fish spawning areas, submerged aquatic vegetation, animal feeding and breeding areas, stream headwaters, and other specific components of these ecosystems.

Some of the protection objectives promoted in this publication have benefits that will be more readily appreciated by environmental technicians; protection of springs and seep areas is one example. In large measure, however, the various protection objectives will have advantages that are readily understood by the lay person. This includes, for example, protection of natural trout

streams for sport fishing; protection of wellheads and surface water supplies for maintaining sources of potable water; protection of unique natural features, vistas, and historic places for promoting tourism and other economic ventures; protection of valuable mineral deposits for building materials and household products; and protection of prime farmland for maintaining rural economies and minimizing costly rural residential sprawl.

The ultimate benefit of protecting a large number of sensitive area types will be the maintenance and enhancement of Maryland's ecosystems. An ecosystem is "an interconnected community of living things, including humans, and the physical environment within which they interact." (US Department of Commerce, 1995). "Ecosystem-based management is the management of the landscape for the primary purpose of maintaining healthy and sustainable ecosystem function, using the landscape and taking goods and services from the natural system only at a level consistent with this primary purpose" (MD DNR, 1996).

How Should This Information Be Used?

The information in this publication has several purposes. First, it can be used to prepare written materials needed to expand the Sensitive Areas Element of the Comprehensive Plan. It can then be used to prepare land use regulations that will minimize the adverse environmental effects of development on Sensitive Areas. Volume I (Maryland Office of Planning, Maryland Department of Natural Resources, 1993a), should be consulted for more information about comprehensive plans and State regulations.

Information provided in Volume II can also be used to structure educational programs for schools; to guide mitigation, and enhancement efforts; and to promote a broad-based stewardship ethic that guides day-to-day individual actions.

Some of the information will have direct relevance to local government promotional efforts for economic activities. This might include creation of tourism programs that take advantage of unique natural, scenic, and historic sites; recreational programs for hikers and bikers; and attractions for vacationers in Maryland.

Finally, this publication is intended to stimulate ideas, discussion, and creative approaches about maintaining Maryland's diverse natural heritage so that future residents can enjoy the numerous assets and resources that make the State a desirable place to live and work.

Organization of Information

The sensitive areas included in this report have been divided into four broad categories that reflect local, state, and federal resource protection programs and partnerships: Tidal Wetlands and Associated Resource Protection Areas; Nontidal Wetlands and Waterways; Groundwater and Mineral Resources; Landscape Conservation.

The following chart indicates the kinds of information that are provided in this publication for each category of Sensitive Area.

Definition	Each category of Sensitive Area is defined so that planners and appointed and elected officials have a clear understanding of the nature and significance of each category.
Why Protect	The justification for protection of each category is explained so that the Comprehensive Plan's policies and the implementing land use regulations can be gauged and tailored to meet the constitutional tests of "rational nexus" and "rough proportionality."
Protective Measures	Protection techniques are presented in two ways. Chapter one describes techniques that have broad utility for steering development away from sensitive areas. Specific techniques, standards, or guidelines accompany the discussion of each category of sensitive area in Chapter Two.
Mapping	Sources and techniques for mapping each category of area are included. Mapping resources can be integrated into the local planning and zoning program by the local government, or can be provided by the developer and private consultants as part of the development review process. The addresses and telephone numbers of sources for maps, charts, and resource data are included in the appendix.
Agency Contacts	Accompanying the discussion of each sensitive area are the names of units within State government that can provide technical information, assistance, and other resources. Agency addresses and telephone numbers are included in the appendix.

CHAPTER ONE: TECHNIQUES FOR PROTECTING SENSITIVE AREAS

A wide range of planning techniques, land acquisition programs, easement programs, zoning and subdivision regulations, and tax and funding incentives are used for the protection of sensitive natural resource areas. Brief summaries of some relevant techniques, programs, and incentives are presented below. Land use planning efforts are presented first, since local plans provide a framework for many aspects of natural resource conservation and management practices in Maryland.

Land Use Planning: Comprehensive planning provides the basis for determining the most appropriate level of natural resource protection. Contemporary comprehensive plans are becoming more sophisticated in the way that they prioritize various policies and recommendations to guide public and private sector development and to protect sensitive areas. Comprehensive planning may be the first step in developing watershed management plans, greenway planning maps, and a variety of flexible planning and zoning techniques.

Volume I (Maryland Office of Planning, Maryland Department of Natural Resources, 1993a) outlines methods for preparing the "Sensitive Areas" elements for the Comprehensive Plan and enacting a Sensitive Areas Protection Ordinance.

Watershed Management Plans - The watershed management approach is an integrated comprehensive strategy to protect and restore aquatic resources. This approach focuses on hydrologically defined drainage basins rather than on areas arbitrarily defined by political boundaries. For a given watershed, the approach encompasses not only the water resource, such as a stream, river, lake, estuary, or aquifer, but all the land from which water drains to the resource.

Tom Schueler's article "Crafting Better Urban Watershed Protection Plans" (Schueler, 1996) from the journal *Watershed Protection Techniques* critiques local watershed plans and presents a protocol for an effective local subwatershed management plan. In addition, the Tributary Strategies, Maryland Department of Natural Resources, can be contacted for information on approaches to reducing nutrient pollution in Bay watersheds.

Greenway Planning - Greenways are protected corridors of open space that allow for a multi-faceted approach to land conservation and park planning. A greenway can consist of a creek that is protected by a forested buffer, a forested corridor along a ridgeline, a stream valley park, or, in some cases, a converted railroad or utility right-of-way that is being managed for natural resource protection. Greenways can preserve landscapes important to a region's character while stimulating economic opportunities and tourism for individual communities.

The Maryland Greenways Atlas (Maryland Greenways Commission, 1996) contains a brief description of existing and potential greenways for each Maryland county and Baltimore City.

Acquisition and Easement Programs: Fee simple acquisition by a public agency or private non-profit conservation organization is the preferred technique for ensuring complete protection and development control, and should be applied when land areas are needed for clearly-identified preservation/recreation purposes. Other protection techniques range from acquisition methods that allow owners to continue to live on their land while slowly selling it off to a government agency; to easement acquisitions in which the owner sells or donates only those rights necessary to restrict the use of the property for the purpose of resource conservation. These methods include installment purchase; long-term lease with option to buy; purchase and lease-back; purchase and resale; land exchange; and purchase of easements.

A detailed list can be found in the *Maryland Land Preservation and Recreation Plan* (Maryland Office of Planning, 1993b) available from the Maryland Office of Planning. The following are a few examples of programs available in Maryland.

Program Open Space - Program Open Space (POS) provides funding for acquisition of park land, forests, wildlife habitat, greenways, and natural, scenic and cultural resources. POS guarantees the long-term future existence of public parks and natural lands because land that has been bought with the special funds cannot be converted to any use other than public open space and recreation unless an approved substitute is provided.

Agricultural Preservation Easements - Farmers can sell development rights on their land by establishing an agricultural preservation district and then selling an easement to the Agricultural Land Preservation Foundation. In some counties, local agricultural land preservation programs are offered as well. The state program requires a minimum lot size of 100 acres, but county programs often accept easements on smaller parcels.

Management Agreements - In some instances, a management agreement with a private property owner can be obtained that secures protection of a portion of land without reducing the rights of the private owner. This can be particularly helpful for wildlife management or preservation of habitat. Many utilities are managing corridors for wildlife in certain areas, allowing shrubs and small trees to grow instead of clear cutting under power lines.

Private Land Trusts - Land trusts are a very effective vehicle for conservation efforts. These groups operate through the purchase or acceptance of fee title, acquisition of conservation easements, and reconveyance to public agencies. Land trusts often operate as bridge organizations, temporarily acquiring land when public bodies or other private bodies do not have resources immediately available to save it. Once the resources are available, the land is reconveyed. Typically, restrictive covenants are placed on the land before reconveyance. At times, the least sensitive portion of the land may be developed or sold for development, to finance the protection of the remaining acreage.

Zoning and Regulations: Zoning in resource conservation areas often requires very low density of 1 dwelling per 20 acres. Subdivision regulations work in concert with zoning in the preservation of open space and scenic and natural features. Cluster zoning, overlay zoning, and flexible regulations are techniques that have also been employed to protect sensitive areas.

For further information on approaches to zoning for water quality protection, *Site Planning for Urban Stream Protection* (Schueler, 1995), is an excellent reference.

Transfer of Development Rights (TDR) - TDR programs identify areas which are to be preserved, as well as those which will receive additional development. Those portions of a county to be protected are identified as "sending" areas. Development rights originate in these districts; they can be transferred between property owners and used to increase the density in predetermined growth areas called "receiving" areas. The local government's decision to designate areas for receiving TDR is based upon adopted growth policies and the availability of services with adequate capacity to accommodate development. A TDR program creates a situation in which a landowner may sell the development rights and retain the land. Thus, the landowner receives compensation, the development occurs away from agricultural or natural resource areas, and the private sector bears the cost.

Purchase of Development Rights (PDR) - PDR is the technique used by the Maryland Agricultural Land Preservation Program. This concept consists of outright State or county purchase of agricultural easements on prime and productive farmland as a means of preserving viable agricultural land.

Tax Incentives and Funding for Environmental Programs: Taxes have a direct and indirect impact on land use. Taxes can create incentives or penalties for landowners and, to this extent, can affect the retention or conversion of agricultural lands, forest lands, and natural areas. There are many examples of tax incentive and penalty techniques as well as examples of communities that have found innovative sources of funding for environmental programs.

A detailed list of tax incentive programs can be found in the *Maryland Land Preservation Plan* (Maryland Office of Planning, 1993b) available from the Maryland Office of Planning. Another publication, *Financing Alternatives for Maryland's Tributary Strategies: Innovative Financing Ideas for Restoring the Chesapeake Bay* (Governor's Blue Ribbon Panel) may also be of value.

CHAPTER TWO: MARYLAND'S SENSITIVE AREAS

Section A Tidal Wetlands and Associated Resource Protection Areas

Tidal Wetlands

Definition: Tidal wetlands are classified as lands that are continuously or intermittently inundated by the rise and fall of the tide. To a large extent, Maryland's tidal wetlands are typified by emergent plants. These are so called "herbaceous plants" (non-woody) that are rooted in the soil, stand erect and extend through the water surface. The depth, duration of flooding, and chemistry of the water determine the types of plants found in a wetland. In turn these physical and biological characteristics determine the type of fish, mollusks, birds, crustaceans, and mammals that will utilize the tidal wetland.

Maryland's emergent tidal wetlands are classified into two major categories based on the frequency of flooding. These are high marsh and low marsh. High marshes are situated high on the tidal landscape and therefore flood on an irregular basis. Flooding occurs during storm surges and often during spring tides when the moon is in the full or new stage. Low marshes are situated low within the intertidal zone and therefore flood on a regular daily basis.

Other types of tidal wetlands include: shrub wetlands, forested wetlands, submerged aquatic vegetation, and the often overlooked tidal mud flats and gravel beaches. Shrub wetlands are dominated by woody vegetation less than 20 feet tall. Most of the shrub wetlands in Maryland fall within the high marsh category. Forested wetlands are characterized by woody vegetation greater than 20 feet. An example of tidal forested wetlands are the bald cypress swamps on the Pocomoke River. Submerged aquatic vegetation refers to the underwater plants that directly provide food and habitat for a variety of fish and waterfowl as well as enhance water quality. The intertidal flats compose a very important component of Maryland's tidal ecosystem. These are the areas often referred to as mud flats; they harbor a diversity of invertebrates including worms, clams, shrimp, and oysters.

Protection Benefits: Tidal wetlands are vital habitat for fish and wildlife. Many commercially and ecologically important species of fish are dependent on tidal wetlands during critical periods of their life cycles. Tidal wetlands provide essential resting, wintering, and nesting grounds for colonial water birds and many song birds. Tidal wetlands are important in maintenance of groundwater supplies and water purification. They provide natural shoreline protection and have the capacity to store floodwaters and reduce the severity of floods.

Many recreational activities such as hunting, fishing, hiking, and boating take place in and around wetlands. In 1991, Maryland residents spent approximately $860 million in expenses related to hunting and fishing (U.S. Department of the Interior, 1993)(Table 56).

Protective Measures: Tidal wetlands loss can be due to direct human activity such as diking, draining, filling, and the placement of large structures such as piers and docks; or indirect impacts due to increased stormwater run off and sediment and nutrient pollution. To protect wetlands, local communities must regulate both the small wetland development activities that

cumulatively contribute to the loss of wetland areas, and the larger scale development that occurs throughout the watershed and which can contribute to erosion, sedimentation, hydrologic changes, stormwater runoff, and pollution.

Natural phenomena also play an important role in wetland loss. Coastal wetland areas are dynamic areas that are constantly changing due to sea level rise and the erosion and accretion of sediment. Tidal wetlands and forested buffers can provide some stabilization to shorelines and protect property from the full force of storms and wave erosion. However, planning in these areas must also provide for the natural changes that occur.

The Maryland Critical Area Act of 1984 created a partnership between State and local agencies for regulating land use in the 1,000 feet beyond the landward edge of tidal waters, tidal wetlands, and tributary streams up to the head of tide. Under the law, a Critical Area Commission was established that developed criteria for local jurisdictions to use in creating their own local Critical Area protection programs. Management techniques in the Critical Area Criteria include the establishment of performance standards for water quality; restriction of development within 100 feet of tidal waters and tidal wetlands; and the establishment of land management categories. These land management categories contain development criteria which protect water quality and sensitive habitat areas; they promote development in previously developed areas and conservation in natural resource utilization areas (Chesapeake Bay Critical Area Commission, 1988).

The following is a list of recommended program objectives and protection measures for tidal wetlands:

1. Develop protection programs including acquisition of critical wetland habitat and buffer areas, cooperative agreements with landowners, the use of conservation easements, and other tax incentives to promote conservation.

2. Extend stream and forest protection measures adopted by the local government Critical Area Program to the rest of the county outside of the 1000 foot wide Critical Area. Consider the use of overlay zoning districts that limit specific land uses, or require cluster development, and consider programs that allow development rights to be transferred to more appropriate areas.

3. Use the boundary line indicated on the 1971 Tidal Wetlands Inventory (TWI) Maps to define tidal wetlands and coordinate with federal and State permitting agencies to protect locally important, environmentally sensitive aquatic habitats. Coordination can help to avoid wasted time and misunderstandings with applicants for permits.

4. Base decisions regarding proposed activities, such as the development of new residential and recreation areas, on the impacts, both singly and cumulatively, of the activity on the functions and values of the affected aquatic habitat, and on other aquatic systems within the watershed and adjacent watersheds.

Mapping: Until recently, there have been two main types of paper maps available that locate and classify tidal wetlands in Maryland - *1971 Tidal Wetlands Inventory (TWI) Maps*, and U.S. Fish and Wildlife Service, *National Wetland Inventory (NWI) maps*. TWI maps provide the only official delineation upon which tidal wetlands regulatory decisions are made, and are available only as paper maps. The advantage of TWI maps is that they provide detailed site information at a large scale 1:2,400 (1 inch = 200 feet) and can be used for determining the boundaries of wetlands that are regulated by the State of Maryland Tidal Wetlands regulations. NWI maps provide a medium scale representation of the extent and location of tidal wetlands in Maryland 1:24,000 (1 inch = 2,000 feet) and are primarily used for general screening and planning purposes. The advantages of NWI maps are that they provide a regional view of wetlands and they are available in digital form.

Reproduction of TWI and NWI maps as blueline copies (paper maps) is available from the Maryland Geological Survey, Publications Office.

In recent years, the creation of digital data sets and the availability of affordable computer hardware and software products has made it possible for counties to develop county wide screening programs and customized paper maps. Since digital data sets can be used to create maps at a variety of scales with a choice of data layers, this type of mapping is an ideal tool for presenting the broad array of information necessary for watershed management planning. The Department of Natural Resources is in the process of developing the next generation of digital wetland maps (tidal and nontidal). The project will result in ortho-photo quarter quadrangles at a scale of 1:12,000 (1 inch = 1000 feet) and will depict newly photo-interpreted wetlands boundaries. Maps produced with *Department of Natural Resources Wetlands Data* will be used in the same way as NWI maps but will contain greater detail. However, TWI maps will continue to provide the only official delineation for tidal wetlands regulatory boundaries. Additional information on maps, charts, and data is listed in *Appendix A.*

Additional Reading: Two publications that provide detailed guidance on how local governments can protect wetlands are the Terrene Institute's guide, *Local Ordinances: A User's Guide* (Terrene Institute, 1995) and the Environmental Law Institute's publication, *Protecting Wetlands: Tools For Local Governments in the Chesapeake Bay* (Environmental Law Institute, 1997). Terrene Institute publications can be purchased by writing to 1717 K Street, NW, Suite 801 Washington DC 20006, or calling (202)833-8317. The Environmental Law Institute's publication is available from the Chesapeake Bay Program office of the Environmental Protection Agency by calling (800) 968-7229.

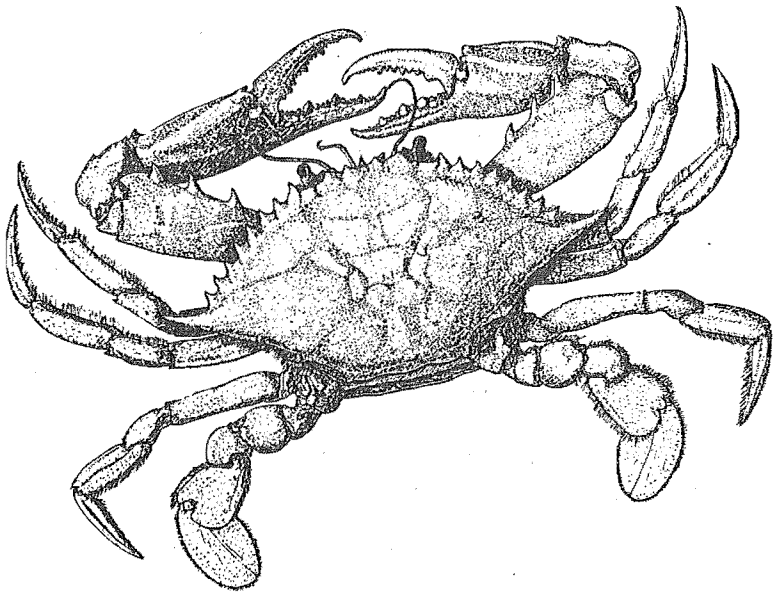
For further information on tidal wetlands in Maryland, *The Coastal Wetlands of Maryland* (McCormick and Somes, 1982) and *Wetlands of Maryland* (Tiner and Burke, 1995), are two very informative publications.

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers and web page addresses, see *Appendix B.*

- The Maryland Department of the Environment, Tidal Wetlands Division, provides information on wetland delineation, a copy of the publication "Shore Erosion Control Guidelines" (MD DNR) and the application necessary for a license, permit or approval from both the federal and state governments.

- The Critical Area Commission, Maryland Department of Natural Resources, can be contacted for a copy of the Critical Area Criteria (Chesapeake Bay Critical Area Commission, 1988). The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources can be contacted for information on the protection of wildlife habitat and specific threatened and endangered species that occur within tidal wetlands.

- The United States Environmental Protection Agency can provide extensive reference materials for local governments on protection techniques including management plans, zoning, and incentive programs. Information is available through a telephone hotline, various Internet webpages, and various publications.



Submerged Aquatic Vegetation (SAV) or 'Bay Grasses'

Definition: Submerged Aquatic Vegetation (SAV) is the term applied to flowering plants growing beneath the waters of the Chesapeake Bay and its tributaries. Also called "bay grasses" or "sea grasses," SAV is a type of wetland vegetation that can be found in shallow water on soft bottoms throughout the Chesapeake Bay. SAV can form dense beds where the water is clear and sediments contain sufficient nutrients.

Many species of SAV also occur in fresh water rivers and lakes above tidal influence throughout Maryland. General protection measures for many types of nontidal wetland habitat are listed under the section on nontidal wetlands.

Protection Benefits: SAV provides one of the most important habitat types within the Chesapeake Bay and its tidal tributaries. The root systems of these plants help stabilize bottom sediment. Plant leaves provide surface area for microorganisms to attach, and these small organisms in turn provide food for larger animals. When leaves die and decompose they also form an important food source for many species. Crabs and fish find food and cover within the SAV beds and many of these species utilize these areas for spawning. SAV is also an important source of food for many species of waterfowl, such as Redhead Duck, Canvasback Duck and Tundra Swan. The baywide decline in SAV distribution and abundance is considered to be a major cause for declines in the bay populations of these species.

Submerged aquatic vegetation is not only important as food and habitat but is also an important factor influencing water quality and the overall health of the bay. SAV helps regulate algae growth by taking up excess nutrients and by replenishing oxygen vital to the diversity of life in the bay. SAV plays an important role in removing suspended sediment from the water and in protecting shorelines from erosion. The roots of SAV bind the sediment, their leaves and stems reduce the energy of waves and currents, allowing the sediment in the water to drop to the bottom. SAV retards the introduction of sediment into the water by absorbing wave energy, thereby slowing the erosion of shorelines.

Protective Measures: Development impacts affecting the health of SAV and water quality include siltation from construction run-off and channel dredging that can block light from reaching SAV. Nutrient pollution from septic systems, sewage treatment plants and the application of fertilizers results in algae blooms that can also result in murky conditions. Dredging and bulkheading deepen shallow waters where SAV can no longer survive due to poor water quality.

Local efforts to avoid direct impacts to SAV include the sensitive siting of marinas, requirements for community piers which minimize the need for expensive dredging projects, and requirements for construction setbacks and forested buffers which protect the natural shoreline. Furthermore, protection of SAV can be indirectly accomplished through land use protection programs, such as forest preservation, sediment control, and stormwater quality management. The Tributary Strategies Program in Maryland has developed comprehensive approaches to reducing nutrient pollution in Bay watersheds. Each tributary has nutrient reduction goals which, when summed across all the tributaries, will allow Maryland to achieve its overall reduction goal. This regional

focus has brought state and local governments together with the public to build a locally-based framework to protect and restore the rivers and resources such as SAV habitat and oyster bars.

The following is a list of recommended program objectives and protection measures for the management and protection of SAV:

1. Develop habitat enhancement programs which could include protection of shallow water habitat, the establishment of forested buffer areas along tidal waters, cooperative agreements with landowners, the use of conservation easements, and other tax incentives to promote conservation.

2. Coordinate with federal and state permitting agencies to protect shallow water habitat and SAV areas. Coordination can help to avoid wasted time and expensive misunderstandings with applicants for permits.

3. Coordinate local government water quality protection efforts with the Tributary Strategies Program's nutrient pollution reduction efforts in order to reach the goals developed for tributaries in the County.

4. Extend the protection measures adopted by the local government Critical Area program to the rest of the county outside of the 1000 foot wide Critical Area. Consider the use of zoning measures that limit the amount of impervious surfaces and maximize forested land cover.

5. Base decisions regarding proposed dredging projects and other activities, such as the development of new residential and recreation areas, on the impacts, both singly and cumulatively, of the activity on the functions and values of local SAV areas and shallow water habitat.

Mapping: Due to fluctuations in populations of SAV, it is important to field check sites during the growing season to verify whether established SAV beds have increased in size or colonized new areas. A rake pulled across the bottom of shallow areas during the period May through October will verify whether SAV is growing in the area.

Survey reports for years since 1978 provide information on past SAV distribution and abundance, loss of habitat and recovery of habitat. Survey maps are developed using aerial photographs taken during the growing season and compiled with additional ground truth information in reports (Orth *et al.*, 1995). These Reports are available from Chesapeake Bay Program, Publications Office. SAV maps (scale 1:24,000 / 1 inch = 2,000 feet) are available as blueline copies from the Maryland Geological Survey at $4 per copy. Updated SAV data are available via the Virginia Institute of Marine Science Web Page and Bathymetric Soundings data are available from the Chesapeake Bay Program's Web page. For additional information on digital data and paper maps, see *Appendix A*.

Additional Reading: In 1989 the Chesapeake Bay Program's Executive Council established a Submerged Aquatic Vegetation Policy which was signed by Pennsylvania, Maryland, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission (Chesapeake Bay Program, 1989a). In this publication, the Chesapeake Bay Program recommends measures to control shoreline activities and protect tidal wetlands and shallow water habitat along shorelines. The Program has also set goals for reducing the amounts of nutrients entering the bay, which should increase water clarity thus promoting SAV survival. For a copy of these guidelines contact the Chesapeake Bay Program, Publications Office.

For further information on Submerged Aquatic Vegetation habitat in Maryland, *Habitat Requirements for Chesapeake Bay Living Resources* (Funderburk *et al.*, 1991) contains a detailed article by Linda M. Hurley on biology and conservation measures, and *Field Guide to the Submerged Aquatic Vegetation of the Chesapeake Bay* (Hurley, 1990) presents summaries and field identification information.

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B.*

- The Maryland Department of the Environment, Tidal Wetlands Division, provides information on tidal wetland delineation, a copy of the publication "Shore Erosion Control Guidelines" (MD DNR) and the application necessary for a license, permit or approval from both the federal and state governments.

- For information on the Chesapeake Bay Program and Tributary Strategies and for information on watershed planning programs in Maryland contact the Maryland Department of Natural Resources, Tributary Strategies Program. The Critical Area Commission can be contacted for a copy of the Critical Area Criteria (Chesapeake Bay Critical Area Commission, 1988).

- The United States Environmental Protection Agency can provide reference materials for local governments on protection techniques including management plans, zoning, and incentive programs. Information is available through a telephone hotline, various Internet webpages, and publications.

Oysters, Clams, Crabs and Benthic Habitat

Definition: Benthic, refers to the life associated with the bottom of the water. Benthic habitats include silty and sandy sediments on the bottom of the Bay and the surfaces of submerged objects such as rocks, woody debris, pilings, and old oyster shell. Oysters, clams and crabs are some of the more economically important of the organisms known as benthic invertebrates. Also important, although less visible, are many other benthic species including worms, snails, sponges and barnacles.

The oyster species found in the Chesapeake Bay is the eastern oyster (*Crassostrea virginica*). The clam species in the Chesapeake Bay that have the potential to be commercially valuable are the soft shell clam (*Mya arenia*), the hard shell clam or "cherrystone clam" (*Mercenaria mercenaria*), and the razor clam (*Tagelus plebeius*). In Maryland, the soft shell clam is the largest and most important commercial clam fishery. Hard clam populations are restricted to Pocomoke and Tangier Sounds and the razor clam fishery is used primarily for bait. The blue crab (*Callinectes sapidus*) is the largest of the crab species found in the Bay, and it is harvested by commercial and recreational crabbers by the millions.

Protection Benefits: In 1995 the commercial harvest in Maryland was estimated to have a dockside value of $3 million for oysters, $2 million for soft-clams, and $40 million for blue crab. The combined estimated total value of economic activity associated with these fisheries in 1995 was $135 million.

Benthic organisms play a significant role in energy flows throughout the bay food web. In addition to being the primary foods for many fish and birds, benthic organisms maintain water quality and are important for the many roles they play in the aquatic ecosystem.

Oysters and clams, as well as many other benthic organisms are members of a group of animals called filter feeders. They consume microscopic algae and are important for the role they play in filtering particles from the water. Oysters were once the primary filter feeders in the Bay. The earliest historical reports indicate that oyster reefs were once so massive that they were viewed as navigational hazards to the early settlers. It is hypothesized that the total population of oysters once was capable of filtering the Bay's entire water column in three to six days. Today, present stocks require an estimated 325 days and it has been proposed that this reduction in filtering capacity has resulted in major changes to the food webs in the Bay.

Oysters are also important because of their hard shell; oysters provide the greatest volume of hard substrate found in the bay. Young oysters (oyster spat) and other species including hooked mussels, tunicates, bryozoans, and barnacles all require hard substrate to attach to in order to survive. Other important components of benthic habitat include submerged aquatic vegetation or "Bay Grasses" and woody debris including whole trees and branches that wash out into the estuary in storms. Woody debris as well as bay grasses act as attachment areas for other species and cover for protection of molting crabs and small fish that are especially vulnerable to predation.

Protective Measures: Various factors associated with fluctuations in environmental parameters, not related to human actions, such as storm events, extremes in air temperature, and extremes in tides, affect populations of benthic organisms. In addition, many factors related to human actions, such as poor water quality, over-fishing, and disease have greatly impacted the oyster and clam fisheries. The crab fishery is still a thriving industry, although there is concern that they may be over-fished in the future.

Development impacts affecting the survival of shellfish and the quality of benthic habitat include siltation from stormwater run-off and from channel dredging. Silt can smother adult oysters and clams and foul attachment surfaces needed by setting oyster larvae and other organisms. Industrial discharges that introduce toxic chemicals can pollute edible clams and oysters and kill larvae or prevent them from setting. Sewage treatment discharges cause a variety of problems for shellfish. Bacterial pollution from discharges causes the closure of harvest areas. Chlorine used to disinfect the effluent may kill shellfish larvae or prevent setting. Nutrient enrichment from the application of fertilizers and leaking septic systems results in anoxic (oxygen deficient) conditions in bottom waters which can kill shellfish.

Major restoration efforts are underway to restore oyster populations in the Chesapeake Bay. Maryland State efforts include the development of the *Chesapeake Bay 1994 Oyster Fishery Management Plan* (Chesapeake Bay Program, 1994) and the Maryland Oyster Roundtable Action Plan (MD DNR, 1993). These plans provide descriptions of resources available for rebuilding oyster habitat and oyster populations. The goals of these plans are to maximize the economic and ecological value of Chesapeake Bay oysters.

Local efforts to protect and restore oyster bars and other benthic habitat should emphasize the control of sediment pollution. Land use protection programs that help to control sediment runoff include forest conservation programs, run-off control programs, and local Critical Area protection programs. Local efforts should also include efforts to minimize impacts to benthic habitats such as the careful siting of navigation channels, marinas, and wastewater outfall pipes.

The following is a list of recommended policies and techniques for the management and protection of shellfish resources and benthic habitats:

1. Develop habitat enhancement programs which could include the protection of shallow water habitat, the establishment of forested buffer areas along tidal waters, cooperative agreements with landowners, the use of conservation easements, and other tax incentives to promote conservation.

2. Coordinate local government water quality protection programs with the Tributary Strategies Program's nutrient pollution reduction efforts. The Tributary Strategies Program has developed nutrient reduction goals for tributaries which, when summed across all the tributaries, will allow Maryland to achieve its overall nutrient reduction goal. This regional focus has brought state and local governments together with the public to build a locally-based framework to protect and restore water quality and important resources including clam and oyster populations and submerged aquatic vegetation.

4. Extend the protection measures adopted by the local government Critical Area program to the rest of the county outside of the 1000-foot wide Critical Area (Chesapeake Bay Critical Area Commission, 1988). Consider the use of zoning measures that limit the amount of impervious surface within sensitive watersheds and maximizes forested land cover.

3. Coordinate with federal and state resource agencies in the siting of navigation channels, marinas, and outfall pipes to protect shellfish habitat areas. Coordination can protect valuable resources while avoiding wasted time and expensive misunderstandings with applicants for permits.

Mapping: Natural oyster bar (NOB) charts delineate Maryland's natural oyster bars as defined by the Bay Bottom Survey completed by the Maryland Department of Natural Resources in the early 1980s. There are 41 charts for Maryland with a scale of 1:20,000. Also available are charts of privately leased oyster bottom in Maryland. For copies of maps, please contact the Natural Resources Police, Maryland Department of Natural Resources.

The majority of the soft shell clam harvest comes from the Chester River, the upper main Bay and the Bay shore of Anne Arundel County. Some harvest occurs in the Patuxent River, the Choptank River and in the Maryland tributaries to the Potomac River. In areas that allow clamming, clamming can occur in only those areas that are not charted as NOB. There are no plans to map individual clam bars; however, large geographic areas populated by clams, oysters, crabs, and other benthic organisms are mapped in the atlas publications by Lippson which are listed in the Bibliography.

Survey information pertaining to the Chesapeake Bay populations of macoma clam - a very important food species for Canvasback Ducks and other wintering waterfowl - is available from the United States Fish and Wildlife Service. For additional information on digital data and paper maps, see *Appendix A.*

Additional Reading: For further information on habitat requirements and resource protection measures for the eastern oyster, blue crab, and hard and soft shell clams, in Maryland, *Habitat Requirements for Chesapeake Bay Living Resources* (Funderburk *et al.*, 1991) contains detailed articles. *The Eastern Oyster* published by Maryland Sea Grant College (Kennedy *et al.*, 1996) presents the most recent scientific findings. Alice Jane Lippson's atlas books and general book on life in the Bay provide a great deal of general information on the biology and distribution of these species. (Lippson and Lippson, 1984) (Lippson *et al.*, 1981) (Lippson, 1973).

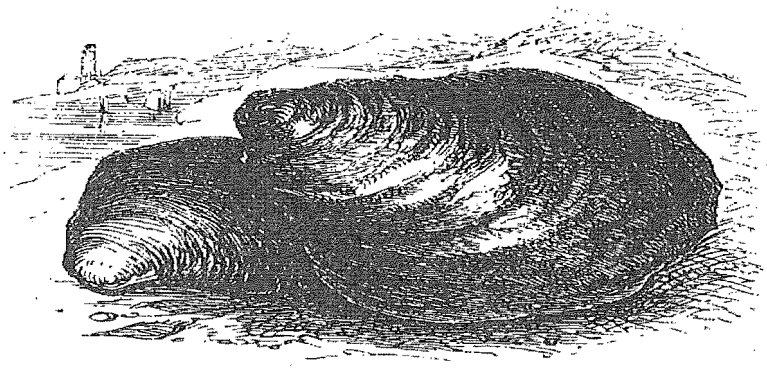
Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B.*

- The Environmental Review Unit, Maryland Department of Natural Resources, can provide information on the location of oyster bars, clam bars, and other sensitive natural resources. The Fisheries Service can provide information on the oyster sanctuary program, copies of the *Oyster Round Table Plan* (MD DNR, 1993), and information on issues pertaining to the protection of fishery resources.

- The Shellfish Harvest Water Quality Certification program of the Maryland Department of the Environment can provide information on environmental monitoring and the protection of shellfish harvest waters from contamination.

- The Critical Area Commission can be contacted for a copy of the Critical Area Criteria (Chesapeake Bay Critical Area Commission, 1988). The Tributary Strategies program, Maryland Department of Natural Resources, can provide information on nutrient reduction strategies and watershed planning programs in Maryland.

- The Chesapeake Bay Program, Publications Office, U.S. Environmental Protection Agency, can provide information on federal programs and copies of fishery management plans.



Waterfowl Areas

Definition: Waterfowl are a family of birds (Anatidae) that include swans, geese and ducks. Twenty-nine species of waterfowl depend on the Chesapeake Bay for migration and wintering habitat; and/or for breeding habitat; and/or for staging areas before and after migratory flight. Programs for the protection of these species should identify and protect the following habitat areas:

Staging Areas - those areas which serve as stopover sites or arrival or departure areas for large numbers of migrating waterfowl. While some species are widely dispersed before and after migratory flights, many species of waterfowl will concentrate or gather in a general area to begin or end migratory flights.

Concentration Areas - those areas which, due to a variety of environmental factors, regularly attract groups of wintering waterfowl. Generally these habitats offer food, and/or protection from severe weather, predators, and disturbances of all kinds.

Breeding Areas - habitats which serve as breeding and brood rearing areas for waterfowl. These habitats are as varied as the life requirements of the different waterfowl species which may breed in Maryland. Examples of waterfowl species which breed in Maryland include Mallard, Black Duck, Blue-winged Teal, Gadwall, Wood Duck, and Canada Goose. Inland shallow freshwater marshes, shrub swamps, and uplands adjacent to estuarine marshes and islands offer the most commonly utilized breeding habitats in Maryland.

Feeding Areas - include all aquatic habitats in Maryland, from submerged aquatic vegetation (SAV) beds, freshwater, estuarine, and saltwater emergent marshes, to open water areas which offer macro-invertebrate food sources to certain diving duck species. In recent years, wintering Canada Geese, Snow Geese, and Tundra Swan have utilized waste grain in agricultural croplands.

Protection Benefits: Waterfowl are among the most visible and well known of the Chesapeake Bay's wildlife. The abundance of waterfowl serves as an indicator of the Bay's health and a link to the Bay's history and tradition. Tourism and hunting associated with waterfowl populations are a major industry for the Chesapeake Bay Region. The Chesapeake Bay is a premier wintering area for Canada Geese, Greater Snow Geese, Canvasbacks, and Black Ducks. Farmers having waterfront property can supplement incomes by renting agricultural fields for hunting in the winter months. The Chesapeake Bay and its tributaries have historically provided a diversity of critical habitats for waterfowl. The loss or degradation of these habitats would have a disastrous effect on waterfowl populations and the recreational, economic, and aesthetic values associated with them.

Protective Measures: Loss of habitat, such as islands, wetlands, and SAV has reduced the number of many of the Bay's breeding and wintering waterfowl species.

Management techniques in the Critical Area Criteria provide for the protection of waterfowl staging and concentration areas. Each local jurisdiction within the Critical Area is required to develop a plant and wildlife habitat protection program that includes the identification and protection of the habitats in historic waterfowl staging and concentration areas in tidal waters, tributary streams, or tidal and nontidal wetlands. In a cooperative program with local jurisdictions, buffer areas have been established for historic waterfowl staging and concentration areas. In addition, these areas are protected from disturbances related to the siting of certain new or expanded water-dependent facilities within the Chesapeake Bay Critical Area through provisions contained within the Critical Area Criteria (Chesapeake Bay Critical Area Commission, 1988).

Waterfowl breeding and feeding areas are directly and indirectly protected by provisions found within Maryland laws and regulations which protect habitat and water quality. These include the nontidal wetland law, tidal wetlands law, forest conservation act, water quality regulations, and hunting regulations. For example, the tidal wetland law directly protects beds of SAV which are a vital food source for Redheads and other waterfowl, while water quality regulations indirectly protect these same habitat areas through requirements for sediment control in upland areas.

The following is a list of recommended program objectives and protection measures for the management and protection of waterfowl breeding, staging, feeding, and concentration areas:

1. Coordinate with federal and state permitting agencies to protect waterfowl habitat areas. Coordination can help to avoid wasted time and expensive misunderstandings with applicants for permits.

2. Develop programs that reduce the amounts of nutrients entering the Bay. The restoration of water clarity, and populations of SAV, oysters, and clams is vital to healthy waterfowl populations.

3. Develop habitat enhancement programs which could include cooperative agreements with landowners, the use of conservation easements, and other tax incentives to promote conservation. Since each species of waterfowl has varied life requirements, a protection program would need to specifically identify the species present, and a management strategy should focus on specific needs. Specific measures might include the protection of bottomland forests for wood duck habitat or a program that encourages the conservation of agricultural land for wintering geese.

Mapping: The Department of Natural Resources can provide copies of maps and digital data indicating waterfowl staging and concentration areas and other sensitive tidal wetland features. Data on these locations have been combined with other data and called Sensitive Species Project Review Areas. Maps are available through the Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources. Digital data are available from the Geographic Information Services Division, Maryland Department of Natural Resources.

The North American Waterfowl Management Plan (U.S. Department of the Interior, 1986) contains a set of goals for the management of waterfowl populations and habitat preservation in the United States and Canada that was developed cooperatively by Federal, State, Provincial, and private agencies. Focus areas in Maryland include the following areas: Sinepuxent and Chincoteague Bay marshes (Worcester County), Blackwater and Nanticoke River marshes (Dorchester and Wicomico Counties), Dickenson Bay (Talbot County), and the Patuxent River marshes (Prince George's, Anne Arundel, St. Mary's and Calvert Counties). Digital maps have not been generated for the North American Waterfowl Management Plan focus areas but may be available eventually.

In addition, the National Oceanic and Atmospheric Administration (NOAA) has identified environmentally sensitive areas of the Chesapeake Bay. These areas are not regulated but protected through other means. Some detailed information about the species commonly found in specific river systems is available on maps prepared by NOAA which show environmentally sensitive areas of the Chesapeake Bay. Certain federal and state research data are available and may be of some benefit in identifying these areas. For further information and a copy of the North American Waterfowl Management Progress Report contact the U.S. Fish and Wildlife Service. For additional information on digital data and paper maps, see *Appendix A.*

Additional Reading: For further information on habitat requirements and resource protection measures for waterfowl areas in Maryland, *Habitat Requirements for Chesapeake Bay Living Resources* (Funderburk *et al.*, 1991) contains detailed articles on Wood Duck, American Black Duck, Canvasback, and Redhead. Alice Jane Lippson's atlas books and general book on life in the Bay provide a great deal of general information on the biology and distribution of these species. (Lippson and Lippson, 1984) (Lippson *et al.,* 1981).

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B.*

- The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources, can provide information on waterfowl staging and concentration areas, and other sensitive tidal wetland features.

- The Critical Area Commission can be contacted for a copy of the *Critical Area Criteria* (Chesapeake Bay Critical Area Commission, 1988).

- The Tidal Wetlands Program of the Maryland Department of Environment considers the location of important waterfowl habitat in the permit review process. Staff can be contacted for further information and a copy of the program regulations.

- The Fish and Wildlife Service, Documents Center, can provide publications concerning Federal efforts to restore and protect waterfowl populations in the United States.

Colonial Waterbird Nesting Sites

Definition: Nineteen species of birds including species of herons, egrets, terns, ibises, gulls, pelicans, cormorants, and skimmers make up Maryland's breeding colonial waterbird population. When nesting, these birds congregate, or "colonize," in relatively few sites, at which time the regional populations of these species are highly susceptible to local disturbances. Colonial waterbird nesting sites include beaches where Black Skimmers and Least Terns nest, bottomland forests where herons and egrets nest, and islands in the Chesapeake Bay. In recent years, flat gravel and tar rooftops have been increasingly chosen as nest sites by Least Terns, which are a species that has been seriously declining in Maryland for many years due to the loss of nesting habitat. Colonial waterbird nesting sites are found within all of the coastal and Chesapeake Bay counties and also in Montgomery County, where there are three colonies of nesting Great Blue Herons.

Colonial Waterbird Buffer Areas - Designated buffer areas are designed to protect nesting sites from adverse impacts associated with human disturbance including development activities. Buffer areas act to protect nesting areas from disturbance throughout the year. However, the protection they provide is critical during the breeding season. In Maryland, colonial waterbird nesting sites that occur within 1000 feet of tidal waters are provided protection through the Critical Area Act.

Protection Benefits: Colonial water birds are some of the most easily observed wildlife in Maryland. Throughout the year thousands of visitors come to the Chesapeake Bay region to view wildlife. In 1985, there were almost 2.2 million Maryland residents who took an active interest in wildlife around their homes by participating in activities including: observing, photographing, or feeding wildlife; visiting public parks; maintaining natural areas; or maintaining food or cover plants to benefit wildlife (U.S. Department of the Interior, 1993).

Protective Measures: Management techniques in the Critical Area Criteria guide development and recreation activities away from waterbird nesting colonies and provide for site specific protection of colonies in cooperation with local jurisdictions. Disturbances to nesting sites include any activities that destroy historic nesting areas or any activities that disturb nesting areas during the breeding season. The Critical Area Criteria require that local governments develop a plant and wildlife habitat protection program as an element of their Critical Area Program and require that colonial waterbird nesting sites be identified and provided protection. Since outside of the Critical Area there are no assurances of protection, it is recommended that the Critical Area guidelines be used as a model by local governments to provide protection of colonial waterbird nesting sites throughout the coastal regions of the State (Chesapeake Bay Critical Area Commission, 1988).

The following is a list of recommended program objectives and protection measures for the management and protection of colonial waterbird sites:

1. Establish buffer areas for colonial waterbird nesting sites so that these sites are protected from the adverse impacts of development activities and from disturbance during the breeding season. Since the widths of buffers and the need for restricting activities within buffers

varies greatly with different nesting colonies, it is recommended that a wildlife expert be consulted when colonial waterbird buffer areas are established. Generally, local governments that participate in the Critical Area habitat protection program update their nesting area information on a regular basis, using information provided by the Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources.

2. Develop habitat enhancement and protection programs which could include cooperative agreements with landowners, the acquisition of critical nesting habitat and buffer area for public conservation land, the use of conservation easements, and other tax incentives to promote conservation. The use of rooftops by Least Terns is of special concern and can be a nuisance to building managers who are required to access air-conditioning units and provide maintenance on rooftops during the period when birds are nesting and can be easily disturbed. The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources can help resolve these conflicts by providing technical assistance and developing cooperative agreements with land owners and building managers.

3. Consider the use of overlay zoning districts that limit specific land uses, or require cluster development, and consider programs that allow development rights to be transferred to more appropriate areas.

4. Develop education opportunities that encourage the protection of tidal wetlands and water quality and the posting of critical nesting areas against entry.

5. Coordinate with federal and state permitting agencies to protect colonial waterbird nesting sites while reducing time and avoiding expensive misunderstandings with applicants for permits. For information on coordination and streamlining contact the Maryland Department of Environment, Permit Service Center, and Tidal Wetlands Program.

Mapping: The general locations of colonial waterbird nesting sites have been mapped statewide. These data have been combined with other data and called Sensitive Species Project Review Areas. Atlases containing detailed data on colonial waterbird colonies located on the Atlantic Coast for the years 1975-1977 and 1985-1988, have been published by the Fish and Wildlife Service. More recently, the Maryland Department of Natural Resources, Colonial Waterbird Project has been publishing Annual Reports (Brinker *et al.*, 1993). For information on published data, and the SSPRA maps, contact the Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources.

The four colonial waterbird species protected by Maryland's endangered species law include the Royal Tern, Gull-billed Tern, Black Skimmer and Least Tern. The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources should be contacted for information on specific regulations and management programs associated with these species. For additional information on digital data and paper maps, see *Appendix A*.

Additional Reading: Since the locations of colonies changes over the years and protection practices change over time, federal and state agencies should be contacted for the most recent information on locations and protection practices. *Habitat Requirements for Chesapeake Bay*

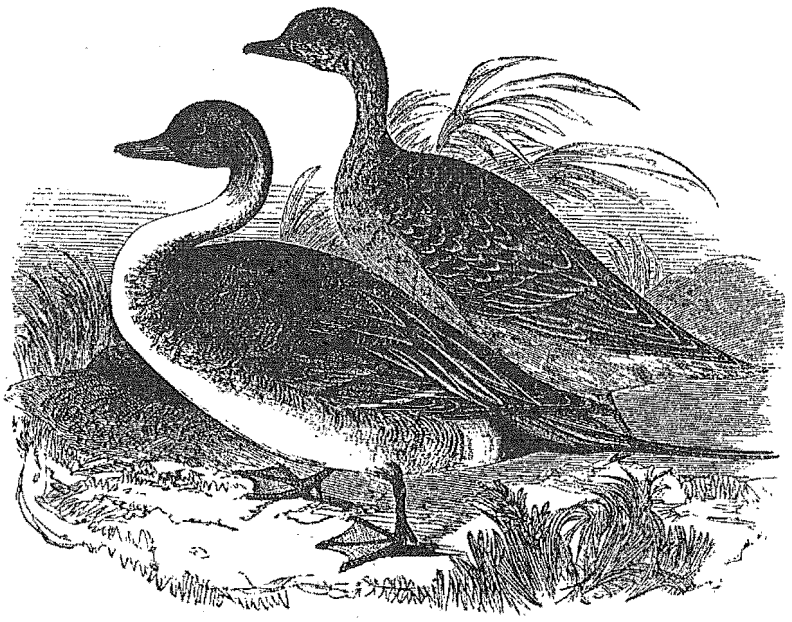
Living Resources (Funderburk *et al.,* 1991) contains a detailed article on the habitat requirements of herons and egrets. For more technical information, the journal publication, *Colonial Water Birds*, is a valuable reference. "Patterns of species co-occurrence of nesting colonial ciconiiformes in Atlantic coast estuarine areas," published in the 1989 journal may be a helpful article. (Spendelow *et al.*,1989).

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B*.

- Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources, can provide updated information on colonial waterbird nest sites.

- The Critical Area Commission can be contacted for a copy of the Critical Area Criteria (Chesapeake Bay Critical Area Commission, 1988).

- The Tidal Wetlands Program of the Maryland Department of Environment consider the location of important waterfowl habitat in the permit review process. Staff can be contacted for further information and a copy of the regulations.



Eroding Shorelines

Definition: A shoreline is the intersection of a specified plane of water with the adjacent land feature and may be represented by the mean high water line. Shoreline erosion may be defined as a net loss of land over a given reach of shoreline during a particular period of time. The principal types of shorelines subject to erosion are Coastal Plain sedimentary bluffs, barrier-type sandy beaches, and coastal wetlands, or any combination.

Coastal erosion is a complex physical process involving many natural and human-induced factors. The natural factors include such variables as the existence of sediment sources and sinks, changes in relative sea level, geological characteristics of the shore, and effects of waves, currents, and tides. Human intervention alters these processes through such actions as the dredging of tidal inlets or construction of shoreline structures. Erosion and deposition are due to naturally occurring processes such as waves, surface and groundwater flow, and freeze-thaw, or are human-induced by activities such as construction or modification of inlets, construction of shoreline structures, community development, and boat activity. The sediments introduced from an eroding shoreline may be deposited as a beach along the base of the shoreline, transported along the shore, or carried offshore away from the eroding shoreline.

Protection Benefits: There are many reasons why shorelines should not necessarily be protected from erosion. Eroding shorelines are an important part of the ecology of tidal areas and the conservation of naturally eroding shoreline areas is often necessary for the preservation of sensitive habitats as well as recreational and scenic areas. The sandy beaches, spits, and low marshy islands along our shorelines are a direct result of shoreline erosion of sandy banks and bluffs. Coarse-grained sediments provide the foundation for many unique habitats such as for hard and soft clams and oysters. Forested buffers provide complex shallow water habitat where fish can hide beneath fallen trees. Fresh exposures of bluffs provide habitats for certain endangered species of Tiger Beetles. Sandy beaches provide recreational benefits for people and provide a foundation for the continued growth of wetlands along the shore.

On the other hand, erosion of shorelines may pose serious economic and ecological problems. To the property owner, shoreline erosion puts valuable waterfront property and structures, homes, and businesses at risk to damage or loss by storm waves or flooding. Localized increase in sedimentation can often be attributed to shoreline erosion. Sediments derived from shoreline erosion are reworked by waves and tidal currents and transported to sections of the waterway. Fine-grained sediments fill channels and inlets, bury natural oyster bars and submerged aquatic vegetation (SAV), increase water turbidity, and introduce additional nutrients.

Protective Measures: There are two approaches to the management of eroding shorelines. The first approach is to protect shorelines from human disturbance. This approach protects eroding shorelines where wetlands and nearshore habitat are sustained by the natural cycles of erosion and sediment transport. Protection includes the conservation of natural vegetation along shorelines, the minimization of impervious surfaces such as roads, driveways, and rooftops, and where severe erosion occurs, provision for the removal of existing structures from erosion hazard areas. The advantages of this approach include the preservation of natural wetland functions and wildlife corridors and the reduction in the use of public funds, since expensive protective action is not needed.

The second approach to the management of eroding shorelines is to use human intervention to retard or stop erosion. This approach is often taken in combination with the shoreline protection approach. In areas where manmade structures, such as houses and businesses, are threatened by shoreline erosion, the reduction or elimination of shoreline erosion may be necessary, and can be accomplished by either structural or non-structural methods. The structural approach most often involves classic coastal engineering designs. Structures such as bulkheads, revetments, groins, or breakwaters are placed along the shoreline to prevent or retard continued erosion. Non-structural approaches use natural conditions such as fringe marsh planting, sand emplacement, or bank revegetation as methods to reduce shoreline erosion.

A non-structural approach to shore erosion control is often preferred. In some cases, however, decision making may require the consideration of other issues. For example, non-structural methods may not be successful due to a high energy environment, such as the main stem of the Chesapeake Bay. In this case, a revetment structure may be required. In another situation, the planting of fringe marsh may require the removal of forested shoreline buffers and associated woody debris habitat so that species of marsh plants, which require sunlight, can be established. In this case, other approaches to shore erosion control may be more successful in preserving shallow water habitat and the structural complexity provided by fallen trees.

The Critical Area Criteria are a national model for local government ordinances. The Criteria and Critical Area Law combine both the intervention and conservation approaches to eroding shoreline management. The Critical Area Criteria require restrictions on the clearing of shoreline vegetation; various stormwater run-off and water quality control techniques and regulations; wildlife protection regulations; and water-dependent facilities regulations. The Critical Area Criteria also encourage the protection of rapidly eroding portions of the shoreline in the Critical Area, and encourage the use of nonstructural shore erosion protection measures where they can effectively and practically be used (Chesapeake Bay Critical Area Commission, 1988). Tidal Wetland regulations and policy, administered by the Maryland Department of the Environment, restrict the use of structural erosion control measures to those areas where nonstructural measures would be impractical or ineffective.

Where eroding shorelines occur in tidal and nontidal floodplains, the adoption of the primarily safety oriented management techniques presented in the Maryland Model Floodplain Management Ordinance (MDE, 1995) can be of additional value. The floodplain ordinance requires setbacks for construction and directs development away from high hazard areas.

Mapping: Changes in shorelines, both erosion and accretion, have been determined by analysis of historical maps and aerial photographs. Average long-term erosion rates and gains can be calculated by dividing the amount of shoreline lost or gained by the number of years between the dates of the maps and/or aerial photographs. Such maps are available from the Maryland Geological Survey. These include paper maps (scale 1:24,000/ 1 inch = 2,000 feet) compiled in 1986 for 7.5-minute quadrangles covering the Chesapeake Bay, the Potomac River, and the Atlantic Coast. Another map series is currently in production with both digital and hard copy for quadrangles (scale of 1:24,000) around the Bay; 56 maps have been completed, primarily for the western shore of the Bay.

Chesapeake Bay Program Data - Digital shoreline data based on NOAA's nautical charts are available via the Chesapeake Bay Program's Web page (http://www.epa.gov/r3chespk). Bathymetric Soundings data are also available from the Bay program. Bathymetric, water depth data are updated annually. For additional information on digital data and paper maps, see *Appendix A*.

Additional Reading: The Terrene Institute publication, *Local Ordinances: A User's Guide*, gives a good overview of shore erosion control measures and offers recommendations for local government programs (Terrene Institute, 1995). This publication can be purchased by writing to 1717 K Street, NW, Suite 801 Washington DC 20006. 202-833-8317.

A number of books provide a good overview of the subject. These include *Beaches and Coasts* (King, 1972) and *Managing Coastal Erosion* (National Research Council, 1990). In addition, three journal articles that address local issues are included in the bibliography: "Cliff stability along western Chesapeake Bay, Maryland" (Leatherman, 1986), "Summary of beach replenishment experience on U.S. East Coast barrier islands" (Pilkey and Clayton, 1989), "Effects of erosion control structures along a portion of the northern Chesapeake Bay shoreline" (Zabawa *et al.*, 1981).

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B*.

- The Tidal Wetlands Program of the Maryland Department of Environment can provide information on regulatory programs and a copy of "shore erosion control guidelines" (MD DNR). The Natural Hazard Mitigation Planning Division can provide information on tidal floodplain hazard areas in Maryland and a copy of the Maryland Model Floodplain Ordinance (MDE, 1995).

- The Critical Area Commission can be contacted for a copy of the Critical Area Criteria (Chesapeake Bay Critical Area Commission, 1988).

- Contact the Shore Erosion Control Office, Maryland Department of Natural Resources, for technical assistance and potential financial assistance. The Maryland Geological Survey, Coastal and Estuarine Geology Program can also be contacted for technical assistance.

- The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources, can provide maps, digital data, and management guidance for the protection of rare, threatened and endangered species of aquatic organisms. These data are important to consider when decisions about shoreline protection and management are being made.

Tidal Floodplains

Definition: Tidal floodplains are normally dry lands that are subject to flooding by coastal waters under tidal influences such as unusually high tides, hurricanes, tropical storms, nor'easters, and prolonged on-shore winds. Areas that are predicted to flood by an event with a 1% chance of being equaled or exceeded in any year are called the "100-year floodplain." Along shorelines that are exposed to high velocity wind and wave action, areas referred to as "coastal high hazard areas" may be identified. Many of these reaches of shoreline are subject to high rates of erosion.

Protection Benefits: Floodplain management focuses on public safety and property protection in two ways: guiding development away from high risk areas; and, in shallow floodplains where development may be deemed appropriate, requiring compliance with specific construction standards. Lowlying land immediately adjacent to bodies of water typically is subject to frequent flooding. This area tends to experience the greatest water depth and the most severe flood damage during infrequent but large events, and may provide important water quality and wildlife habitat values.

Some areas subject to tidal flooding are extensive, reaching several miles inland from the Chesapeake Bay. By themselves, tidal floodplains do not necessarily represent a particularly sensitive environmental area. However, multiple benefits can be achieved by acknowledging that areas subject to frequent and/or severe tidal flooding are inappropriate for most development activities.

Protective Measures: Management techniques in the *Maryland Model Floodplain Management Ordinance* (MDE, 1995) recognize the value of guiding development away from the lands adjacent to tidal bodies of water. The Model Ordinance recommends adoption of a minimum 100' flood protection setback designed to limit development in the highest risk area. A deeper setback may be appropriate as a function of concurrent damage-related variables such as depth of flooding, wave energies, active erosion, subsidence, or unstable soils. Environmental variables also may suggest a deeper setback in order to maximize water quality and habitat protection benefits of preserving a buffer strip along the water. The Model Ordinance requires new development proposed for tidal floodplain areas to be sited on the highest available ground to minimize flood damage potential, as well as impacts on lowlying areas that are likely to be wetlands.

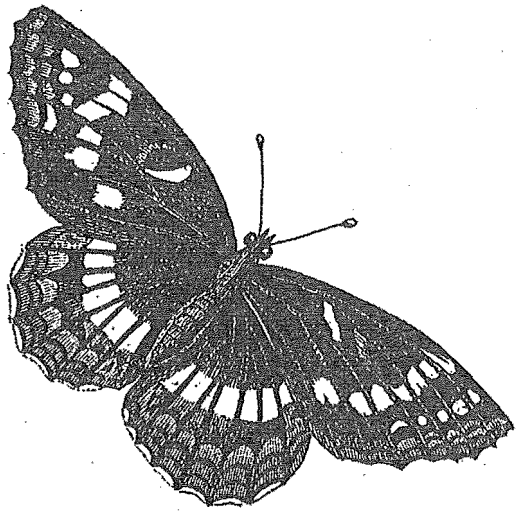
Mapping: Maryland's tidal floodplains are mapped by the Federal Emergency Management Agency (FEMA), National Flood Insurance Program (NFIP) and are based on studies performed by the Virginia Institute of Marine Sciences. Additional wave height studies have been conducted to delineate coastal high hazard areas and these are included on the NFIP maps. However, shorelines that are significant specifically because they are subject to erosion, have not been included on these maps. For updated information on mapping in Maryland, consult the updated Maryland Geographic Information Systems Resource Guide (Maryland Office of Planning, 1997) and Maryland Geological Survey List of Publications (MGS, 1997).

The Maryland Department of the Environment, in partnership with FEMA and the Maryland Department of Natural Resources, anticipates completion of digitized floodplain mapping by 1999. For information on digital data that are currently available, contact the Maryland Department of Natural Resources, Geographic Information Services Division. Additional information on maps, charts, and data is listed in *Appendix A*.

Additional Reading: For guidance on protection measures, contact the Maryland Department of the Environment, National Flood Insurance Program State Coordinating Office for the *Maryland Model Floodplain Management Ordinance* (MDE, 1995). In addition, *Chesapeake Bay Tidal Flooding Study* (U.S. Army Corps of Engineers, 1984), and *A Storm Surge Model Study* (VIMS, 1978), are important references.

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B*.

- The primary contact regarding Maryland's National Flood Insurance Program is the Maryland Department of the Environment. Personnel of the Natural Hazard Mitigation Planning Division can provide extensive information on tidal floodplain hazard areas in Maryland as well as copies of the *Maryland Model Floodplain Ordinance* (MDE, 1995).



Section B Nontidal Wetlands and Waterways

Nontidal Wetlands

Definition: Nontidal wetlands are the transition zones between open water or aquatic environments and uplands. They are inland, freshwater areas not subject to tidal influence. They are typically areas where the water table is at or near the surface, or the land is covered by shallow water. These areas contain distinct biological and chemical characteristics due to their wetness. The term "nontidal wetlands" encompasses a variety of environments such as marshes and swamps, bottomland hardwood forests, wet meadows, vernal pools, inland bogs, and the shallow areas of lakes and ponds.

Nontidal Wetlands of Special State Concern: Nontidal Wetlands of Special State Concern are the best examples of Maryland's nontidal wetland habitats and are designated for special protection under the State's nontidal wetlands regulations. Many of these special wetlands contain the last remaining populations of native plants and animals that are now rare and threatened with extinction in the State.

Protection Benefits: The health of the Chesapeake Bay ecosystem is inextricably linked to the abundance and condition of the wetlands, both tidal and nontidal, in the bay watershed. Many species of wildlife, particularly amphibians, reptiles, and many species of birds use nontidal wetlands for breeding, wintering, and migrating. Valuable fur bearers such as muskrats and beavers also inhabit nontidal wetlands. Species dependent on wetlands include a large number of Maryland's endangered species. When critical reproductive areas are filled for development or choked by pollution and excessive nutrients, the populations of these species will decline.

The aquatic food chain is dependent upon wetlands to provide nourishment for the many fish, shellfish, and smaller organisms that spend periods of their lives in the wetland habitat. Organic material, or food, is produced in the water by the breakdown of wetland plant leaves and stems. Wetland plants are very effective in reducing or eliminating stream bank erosion. Because they have extensive and complex root systems, these plants are especially efficient at holding soil in place and thus reducing sedimentation. Sedimentation in streams and estuaries severely impacts reproduction and survival of aquatic life.

The special characteristics of nontidal wetlands make them particularly important for the following reasons:

- Upland runoff water that passes through nontidal wetlands is filtered. This improvement in water quality comes from the nontidal wetland's ability (1) to intercept and retain excess nutrients such as nitrogen and phosphorus compounds and other pollutants, and (2) to trap sediment and reduce suspended solids in the overlying water.

- Potentially damaging volumes of fast moving storm or flood water are temporarily stored in nontidal wetland areas. The gradual release of the water by the wetland minimizes erosion of agricultural fields and urban/suburban property.

- There is evidence that nontidal wetlands may discharge water to adjacent streams when stream flow is low. This maintains a certain level of base flow in the stream that allows aquatic plants and animals to survive. The wetland itself is recharged when the stream level is higher than that of the wetland.

- Nontidal wetlands also produce natural crops. The most valued commercial product is timber, an important industry on the Eastern Shore. Common species include loblolly pine, oak, and red maple. People also harvest crops of blueberries, cranberries, and crayfish for individual consumption.

- Nontidal wetlands have a natural beauty which has inspired painters and writers for centuries. They are now joined by enthusiasts with cameras and video and sound recorders.

- There are also endless opportunities for recreation such as fishing and waterfowl hunting, as well as hiking, birdwatching, canoeing, and other activities. The financial benefit of these wetland-dependent activities to the economy is significant.

Protective Measures: According to some estimates, Maryland has lost 73 percent of its wetland resources (tidal and nontidal) since first being colonized. The majority of this acreage consists of nontidal wetlands. The heaviest historic losses of wetlands are attributed to agricultural activities, recent residential and commercial development activities, and the conversion of vegetated wetlands to ponds.

Wetland loss can be due to direct human activity such as diking, draining, or filling to form dry land; or indirect impacts due to increased stormwater run-off and sediment and nutrient pollution. To protect wetlands, local communities must not only protect wetlands from draining and filling but from activities that contribute to erosion, sedimentation, hydrologic changes, stormwater runoff, and pollution in the surrounding watersheds.

The following is a list of recommended program objectives and protection measures for the management and protection of nontidal wetlands:

1. Identify and prioritize, on a watershed basis, areas where wetlands can be restored, enhanced, or created. Develop creative ways to protect existing wetlands while streamlining the regulatory process. Develop protection programs including acquisition of critical wetland habitat and buffer areas, cooperative agreements with landowners, the use of conservation easements, and other tax incentives to promote conservation.

2. Develop an appropriate definition of wetlands and coordinate with federal and State permitting agencies to protect locally important, environmentally sensitive aquatic habitats. Coordination can help to reduce wasted time and misunderstandings with applicants for permits.

3. Develop a program that encourages the use of Best Management Practices (BMPs) for land development, forestry and agriculture. BMPs refer to erosion and sediment control methods that trap sediment, eliminate erosion, and maximize water quality benefits of wetlands.

4. Conserve wetlands through comprehensive plan updates and local ordinances that encourage innovative development designs that preserve wetlands. Consider the use of overlay zoning districts that protect concentrated wetlands areas, adopt mandatory cluster ordinances, and consider programs that allow development rights to be transferred to more appropriate areas.

5. Base decisions regarding proposed activities, such as the development of new residential and recreation areas, on the impacts, both singly and cumulatively, of the activity on the functions and values of the affected aquatic habitat, and on other aquatic systems within the watershed and adjacent watersheds.

Mapping: *Maryland Nontidal Wetland Guidance Maps*, produced by the Maryland Department of Natural Resources, identify the general location of wetlands in Maryland. These maps show the U.S. Fish and Wildlife, National Wetland Inventory (NWI) data, and the general locations of Wetlands of Special State Concern. Regulatory wetland delineations are made through the use of the *Federal Wetland Delineation Manual* (U.S. Army Corps of Engineers,1987) and include an onsite analysis of soils, vegetation, and hydrologic factors. *Maryland Nontidal Wetland Guidance Maps* are available from the Maryland Department of Natural Resources, Chesapeake and Coastal Watershed Service. Reproduction of NWI maps as blueline copies is available from the Geological Survey at $4 per copy.

The county soils surveys published by the US Department of Agriculture, Soil Conservation Service can also be used to identify the general location of wetlands as well as the location of erodible soils. County soil surveys are used to identify hydric soils which give an indication of the extent and location of both tidal and nontidal wetlands.

In recent years, the creation of digital data sets and the availability of affordable computer hardware and software products has made it possible for counties to develop county wide screening programs and customized paper maps. Digital mapping is an ideal tool for presenting an array of information during the planning and decision making process. Maps made with digital data sets can be developed at a variety of scales with a choice of data layers. For example, a subwatershed map that includes data on forest cover and existing zoning can be developed as a watershed management planning tool. The following digital products are available to counties from government agencies:

<u>*Maryland Department of Natural Resources Wetland Data*</u> - The Department of Natural Resources is developing the next generation of digital wetland maps (tidal and nontidal). The project will result in ortho-photo quarter quadrangles at a scale of 1:12,000 (1 inch = 1000 feet) and will depict newly photo-interpreted wetlands boundaries. These new digital data sets are available for some counties and will be completed for all counties in a few years. Maryland Department of Natural Resources Wetlands Data will be used in the same way as Maryland Nontidal Wetland Guidance Maps and NWI maps, but will contain greater detail.

<u>*Technology Toolbox Data*</u> - Nontidal wetlands data including the location of Wetlands of Special State Concern are available from the Geographic Information Services Division, Maryland Department of Natural Resources.

Internet - Information about the US Fish and Wildlife Service, National Wetlands Inventory (NWI) program is available over the Internet. The NWI Internet address is: http://www.nwi.fws.gov. Wetland data can be retrieved using anonymous ftp. (Enterprise.nwi.fws.gov).

For additional information on digital data and paper maps, see *Appendix A*.

Additional Reading: Two publications that provide detailed guidance on how local governments can protect wetlands are the Terrene Institute's guide, *Local Ordinances: A User's Guide* (Terrene Institute, 1995) and the Environmental Law Institute's publication, *Protecting Wetlands: Tools For Local Governments in the Chesapeake Bay* (Environmental Law Institute, 1997). Terrene Institute publications can be purchased by writing to 1717 K Street, NW, Suite 801 Washington DC 20006, or calling (202) 833-8317. The Environmental Law Institute's publication is available from the Chesapeake Bay Program, Office of the Environmental Protection Agency by calling (800) 968-7229.

For further information on nontidal wetlands in Maryland, *Field Guide to Nontidal Wetland Identification* (Tiner, 1988) and *Wetlands of Maryland* (Tiner and Burke, 1995), are two very informative publications.

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B*.

- The Nontidal Wetlands and Waterways Division, Maryland Department of the Environment, is the best source of information on nontidal wetland protection. Personnel are experienced in delineating and assessing nontidal wetlands. They can be contacted for a copy of guidelines and the application necessary for a license, permit or approval from both the federal and state governments.

- The Critical Area Commission can be contacted for a copy of the Critical Area Criteria (Chesapeake Bay Critical Area Commission, 1988). The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources, can be contacted for information on the protection of wildlife habitat and specific threatened and endangered species that occur within wetlands.

- The United States Environmental Protection Agency can provide reference materials for local governments on protection techniques including management plans, zoning, and incentive programs. Information is available through a telephone hotline, various Internet webpages, and publications.

Vernal Pools

Definition: Vernal pools are a specialized category of non-tidal wetlands that are water filled rom early winter through mid-summer, but offer terrestrial habitat for the remainder of the season. Typically these wetlands are not in contact with free-flowing groundwater, but exist as small, discrete water tables perched atop clay deposits. Vernal pools are dependent on rainfall or meltwater, and all drainage is inward, with little or no outflow. As defined in the Maryland nontidal wetland regulations, a vernal pool is "a nontidal wetland in a confined depression that has surface water for at least two consecutive months during the growing season, and: a) is free of adult fish populations; b) provides habitat for amphibians; and c) lacks abundant herbaceous vegetation."

A working definition of vernal pools is often expanded by wildlife managers to include all pools that are free of predators (i.e. fish) and therefore can provide breeding habitat for amphibians.

Protection Benefits: Due to the yearly seasonal dry period the aquatic plants and animals characteristic of permanent wetlands are unable to persist in vernal pools. Likewise, the seasonal period of emersion is too stressful for most terrestrial herbaceous plants. Consequently, the flora and fauna typically consists of species that are adapted to this wet-dry cycle. Some of these are so specialized that they will not be found in other habitat types. Although knowledge of these species is very poor, preliminary survey indicates that many are rare and/or restricted in distribution, and that these habitats contribute significantly to Maryland's natural diversity.

Like other sorts of wetlands, vernal pools may act as an important factor in preserving natural watershed characteristics by reducing runoff during storm events. This is particularly important in areas were there is a high density of vernal pools, such as the eastern shore (Delmarva Bays). Although vernal pools do not always provide the normal watershed and water quality enhancement benefits of other non-tidal wetlands, they do provide unique wildlife and plant habitats, and must be preserved if their inhabitants are not to be extirpated or pass into extinction.

Protective Measures: Numerous vernal pools are drained or polluted as natural areas are converted to agriculture or development. Effective protection requires three things: 1) that their immediate drainage area (quite small) remain intact, 2) that no polluted runoff enter that drainage area, and 3) a sufficient undisturbed buffer remain to provide for the terrestrial phase of the life history of some vernal pool inhabitants. If the drainage area is reduced, the pool may not receive sufficient water to remain wet long enough for all species to complete their life cycle. Since all drainage into vernal pools stays in the pool with nothing running out, vernal pools can act as pollutant sinks. Polluted runoff from lawns, parking areas, and rooftops can eventually destroy the natural aquatic community. Since a significant number of vernal pool inhabitants migrate out of the pool each summer and return in winter or spring (hylid frogs and ambystomid salamanders, for instance), sufficient terrestrial habitat must be retained in order to maintain viable populations of those species during their "land" stage. For instance, a 25' buffer may protect the entire drainage area of a vernal pool, but if not enough habitat is provided outside of the buffer to support viable populations of some species, the natural diversity of species living within the vernal pool will be reduced and food webs will become simplified.

Maryland non-tidal wetlands regulations recognize "Delmarva Bays" as a distinct type of nontidal wetland distinct from vernal pools. In fact, Delmarva Bays are different from vernal pools in some significant ways that are important to their recognition and protection. In the majority of bays, there is a significant area (typically 1/4 acre to 1 acre, but up to 20 acres) that has virtually no woody cover and becomes a wet meadow after water recedes in the summer. The open canopy is essential to survival of the rare plant species. There are also delmarva bays that are entirely forested.

Hydrologically, bays differ significantly from the definition of vernal pools. Bays are primarily groundwater fed systems (research by USGS has confirmed this), whereas vernal pools are usually defined as being hydrologically confined by clay lenses. Protection of Delmarva Bay wetlands should therefore focus on the protection of adjacent wetlands and uplands which act as a source or sink for water from the bays depending on the time of year.

Mapping: Large vernal pools may show up as isolated wetlands on non-tidal wetlands maps. Pertinent resources include the *National Wetlands Inventory (NWI) Maps* published by the US Fish and Wildlife Service and the nontidal wetlands mapping data included in the geographic information (GIS) system maintained by the Maryland Department of Natural Resources. Vernal Pools that provide habitat for Federal or State listed rare, threatened, or endangered plant or animal species, may be regulated as Wetlands of Special State Concern by the Nontidal Wetlands and Waterways Division, Maryland Department of the Environment. The general locations of Wetlands of Special State Concern have been mapped statewide. Wetland data, including Wetlands of Special State Concern, are available in digital and hard copy (paper map) form from the Geographic Information Services Division, Maryland Department of Natural Resources.

The county soils surveys published by the US Department of Agriculture, Soil Conservation Service are also useful in identifying soils likely to support vernal pools. However, due to their small size and isolated occurrence, most Vernal Pools do not appear on available mapping. Consequently, careful survey of floodplain sites and sites where significant amounts of clay soils are present is necessary to ensure that vernal pools will be detected. This survey should be done during winter through early summer when these habitats are wet. However, reliable indicators will be present to indicate the presence of vernal pool habitat even when they are dry during mid to late summer and fall.

Blueline copies of NWI maps are available from the Maryland Geological Survey. Maps may be inspected and purchased at the Maryland Geological Survey, Publications Office, Maryland Department of Natural Resources. For additional information on digital data and paper maps, see *Appendix A*.

Additional Reading: Published information on these habitats is scanty and widely scattered. The following sources provide useful information and additional references: *The Ecology of Southern California Vernal Pools: a Community Profile* (Zedler, 1987), *The Animal Life of Temporary and Permanent Pools in Southern Michigan* (Kenk, 1949), and *The Ecology of Temporary Waters* (Williams, 1987).

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B.*

- Personnel of the Maryland Department of the Environment, Nontidal Wetlands and Waterways Division, are experienced with vernal pool identification, delineation, and impact assessment and mitigation. This agency can also provide information on Wetlands of Special State Concern and regulatory protection measures required by Maryland law.

- Arnold Norden of the Maryland Department of Natural Resources, Land and Water Conservation Service has extensive knowledge of biota and ecology of vernal pools in Maryland.

- For information on the protection of natural areas and for guidance on the protection of specific threatened and endangered species, contact the Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources.

Bogs

Definition: Under the regulations governing Maryland Nontidal Wetlands, a bog is defined as "a nontidal wetland characterized by organic soils, accumulated peat, and soils saturated to the surface throughout the year with minimal fluctuation in water level." Other attributes generally associated with bogs are low nutrient availability, relatively high acidity (low pH), an abundance of sphagnum moss, and the absence of an extensive woody overstory. Such peat filled wetland depressions are abundant in northern regions, particularly where landscapes have been shaped by glaciation. However, bogs are far less abundant in our area.

In Maryland, significant bogs occur in Garrett County, Anne Arundel County, Charles County, Prince Geoges County, and on the lower eastern shore, in Wicomico and Worcester Counties. Today, only Garrett County contains a sizable cluster of bogs. Probably the best known and most significant bog concentration in Maryland was the cluster of "Magnolia Bogs" once present in the area southeast of Washington, D.C. When W. L. McAtee wrote about these unusual wetlands in 1918, several had already been destroyed and, since then, virtually all of the rest of the bogs have been lost. The best existing remnant of this cluster is a small portion of the "Suitland Bog" that is now managed as a nature preserve by the Maryland-National Capital Park and Planning Commission.

Protection Benefits: As with most unusual habitats, bogs support unusual plant and animal species that are sensitive because of their rarity and disjunct distribution in this part of North America. When the Magnolia Bogs were destroyed, the rare species that inhabited them were also lost. Several plant species known from those bogs have never been found elsewhere in Maryland. Discussion of other rare and unusual bog inhabitants is found in the publications cited below. Some local bog inhabitants, such as the bog copper butterfly (*Lycaena epixanthe*) and the white fringed orchid (*Platanthera blephariglottis*), are so rare and localized in our region that the Maryland Department of Natural Resources has designated them as threatened or endangered.

Because of the acidity of bogs, the plant material that accumulates (peat) may be many meters deep. These concentrations represent a long period of history, and study of their contents has generated much useful information about the climate and ecology of the region dating back many thousands of years. Bogs may also preserve significant cultural materials. Bogs in Europe have yielded many well preserved artifacts, including building foundations and boats, and even organic remains. Although such finds are uncommon in North America, local bogs should be recognized as potential treasure troves of historic information.

Protective Measures: Several locally important bogs in Garrett County have been acquired for protection by the Maryland Department of Natural Resources and The Nature Conservancy. A good example of bog habitat that is being protected is present at Cedarville State Forest in Charles County, where a floating mat of bog vegetation is present at the upper end of a man-made lake.

The peat that accumulates in bog depressions has useful properties, and has been used in a variety of ways. Today it is in greatest demand for use in gardens as a soil conditioner, although it is still burned for fuel in some areas. Several Maryland bogs have been mined for peat in years past, and one western Maryland peat bog is still being mined commercially.

The effective protection of bogs requires four basic protection measures: 1) that bogs be protected from physical disturbance due to development or other construction, 2) that the sources of water flowing into and supporting bogs are protected, 3) the mining of peat be prevented or controlled, and 4) that the introduction of exotic species be controlled.

Mapping: Certain bogs supporting rare species have been mapped by the Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources. The location of selected peatland bogs in Garrett County was mapped by Fenwick and Boone (1984). Bogs that provide habitat for Federal or State listed rare, threatened, or endangered plant or animal species may be regulated Wetlands of Special State Concern by the Nontidal Wetlands and Waterways Division, Maryland Department of the Environment. The general locations of Wetlands of Special State Concern have been mapped statewide. Wetland data, including the locations of Wetlands of Special State Concern, are available in digital and hard copy (paper map) from the Geographic Information Services Division, Maryland Department of Natural Resources.

For additional information on digital data and paper maps, see *Appendix A*.

Additional Reading: W.L. McAtee's, "A Sketch of the Natural History of the District of Columbia" (McAtee, 1918), contains a detailed description of the "Magnolia Bogs," many of which were located in Prince George's County. This and the following publications are recommended for further reading: "The Peatlands of Western Maryland"(Fenwick and Boone, 1984), *Coastal Plain Bogs* (Maryland Natural Heritage Program, 1990), *The Ecology of Southeastern Shrub Bogs (Pocosins)* and *Carolina Bays: A Community Profile* (Sharitz and Gibbons, 1982), "The Suitland Bog" (Shetler, 1970).

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B*.

- The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources maintain an extensive database concerning the rare plants and animals that inhabit Maryland bogs. State Biologists with this program can provide guidance on the protection of specific threatened and endangered species.

- Several of these sensitive bog sites have been designated as Wetlands of Special State Concern. Information on Wetlands of Special State Concern and regulatory protection measures required by Maryland law is maintained by the Nontidal Wetlands Division of the Maryland Department of the Environment.

Trout Stream Watersheds

Definition: One species of trout, the brook trout, is native to the cold waters of the eastern United States. Two other species have been introduced, the brown trout from Europe and the rainbow trout from the western United States. Stream habitat conditions required by these species include a consistent source of cool, well oxygenated water, and a gravel stream bottom with little sediment.

Trout streams and rivers and their tributaries are protected in Maryland by water quality regulations. These streams are designated as Use III (Natural Trout) waters and are clearly identified by location and description in the Code of Maryland Regulations for Water Quality. The Fisheries Service of the Maryland Department of Natural Resources conducts surveys and prepares reports on the streams which support self sustaining trout populations in Maryland. These streams and their watersheds are considered to be significant fishery resources by the Maryland Department of Natural Resources, with high priority set on the protection of water quality.

The Code of Maryland Regulations (COMAR 26.08.02) also provides location information on streams that are identified as Use IV waters. These waters are suitable for stocking with hatchery raised trout, although the trout generally cannot survive year round.

Protection Benefits: Wild trout are indicator species for the State's highest quality coldwater streams. Trout are very sensitive to habitat degradation, having strict temperature requirements and a need for high quality stream substrate for feeding and reproduction. The presence of self-sustaining trout populations in coldwater streams indicates healthy watershed ecosystems. In addition, trout fishing is an important component of outdoor recreational opportunities for tourism in Maryland. Economic studies are available that analyze the economic benefits of recreational fishing at the statewide and the local community level.

Protective Measures: The major factors that lead to the degradation and loss of trout streams include elevated water temperatures, altered flow regimes and channel alteration, direct sedimentation, and stream blockages.

Elevated water temperatures - Preserving headwater areas where spring flow feeds cold water into the waterway is one of the keys to protecting natural trout streams. Trout require temperatures that rarely exceed 68 degrees Fahrenheit. As stream temperatures become warm, fish can find refuge by utilizing cool tributaries, areas near cool spring seeps, and deep pools, especially in areas where the banks are heavily shaded. Thus, the protection of vegetated headwaters, forested stream buffers, and natural habitat is extremely important. Forested buffers help stabilize stream banks against erosion, provide cover for fish with their roots and fallen trunks and large branches, provide shade to the stream, and provide leaf litter, the primary source of energy upon which the food web of a trout stream is based.

Water held in ponds, or in stormwater facilities with permanent or long term flooded basins, can be heated by the sun to temperatures well above the tolerance limit of trout. For this reason they should be strictly prohibited in the entire watershed of Use III streams unless they can be proven to not affect stream temperatures.

Altered flow regimes (increased storm flows and decreased baseflow) and channel alteration - Minimization of the amount of impervious surfaces is another important measure for protecting streams from impacts. As forests and open land are converted to roof tops, roads, and parking lots, the land loses its ability to infiltrate the amount of water necessary for maintaining groundwater seeps and springs, both of which help maintain constant stream flow and cold water temperatures. During the summer months, rainwater rapidly runs off the heated, impervious rooftops and roads, flooding streams and causing accelerated bank erosion, stream widening, and sudden elevations in water temperature. All of these impacts are very detrimental to trout survival.

Direct sedimentation - Another key protection measure for the conservation of trout streams is the use of effective sediment control measures, including the protection of steep slopes and erodible soils. Sediment pollutes a stream by smothering fish eggs, fouling the gills of young fish, and filling voids between the gravel on stream beds. These factors inhibit successful spawning and reduce the clean gravel habitat required by aquatic insects, which are one of the main food items of trout.

Stream Blockages - The construction of new blockages to fish passage is prohibited by Maryland law (Natural Resources Article, §§4-501 and 502, Annotated Code of Maryland). To improve habitat, structures such as dams, poorly planned or eroded culverts, and blockages resulting from the instream placement of "riprap" stones should be removed wherever possible.

Many aspects of development directly and indirectly contribute to the impacts discussed above. When developing subdivision regulations and local programs related to conservation and economic growth in Use III watersheds, consider the following strategies:

1. Watershed Management Planning - The establishment of land uses in Use III watersheds that protect headwater areas through low density development and conservation zoning is the ideal approach to the protection of trout streams. If a transfer of development rights (TDR) program is in place, the county can encourage the transfer of development rights to areas more appropriate for growth. In areas where development will occur within the Use III watershed, the use of wide forested stream buffers that are inclusive of adjacent sensitive areas such as steep slopes, wetlands and habitats of threatened and endangered species should be established. Restrictive guidelines for commercial, industrial, and clustered residential development should also be established.

2. Overlay Zoning - In watersheds already under development pressure, overlay zoning is a technique that can be used to assure that best management practices are implemented. In addition, the overlay zone can be a priority area for conservation programs such as mitigation projects, parks, and conservation easements.

3. Best Management Practices (BMPs) - Maryland Department of Natural Resources encourages the following BMPs in Use III watersheds:

- restoration of forested stream buffers along Use III tributaries, protection of existing buffers, and establishment of restrictions for development activities on steep slopes;

- stormwater infiltration devices;
- minimization of impervious surfaces;
- stormwater management detention basins that do not hold water longer than 12 hours; and
- stream fencing to exclude livestock, and the utilization of watering troughs for livestock on pasture lands.

Mapping: The Code of Maryland Regulations (COMAR 26.08.02) for water quality lists Use III streams and their boundaries. Generally, Use III designations include all flowing tributaries to the listed stream. Since first and second order streams are not always included on county maps, it may be necessary to conduct field reviews in order to identify the extent of this sensitive area.

The Fisheries Service of the Maryland Department of Natural Resources keeps updated maps of known self-sustaining wild trout populations. Using these maps and up-to-date survey information, the Environmental Review Unit of the Maryland Department of Natural Resources can help identify priority trout streams.

Technology Tool Box Data - Data sets on the location of streams, forest buffers, and sensitive species are being developed by the Maryland Department of Natural Resources, Geographic Information Services Division. For further information on digital data and paper maps is available from the Geographic Information Services Division, Maryland Department of Natural Resources, see *Appendix A*.

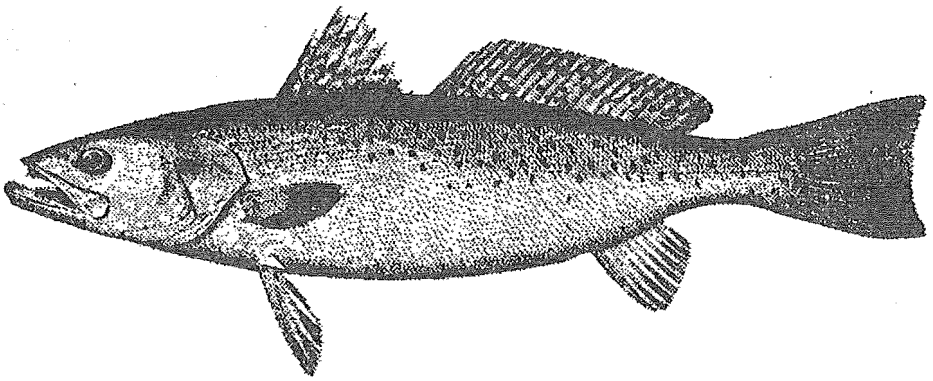
Wildlife and Natural Heritage Data - The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources can provide maps, digital data, and management guidance for the protection of rare, threatened, and endangered species of aquatic organisms. Although trout species are not listed as rare, threatened, or endangered in Maryland these data are important to consider when decisions about stream protection and management are being made.

Additional Reading: For guidance on stream buffer width and protection strategies *Site Planning for Urban Stream Protection* (Schueler, 1995), can provide current information. In addition, *Trout Fishing in Maryland: An Examination of Angler Characteristics, Behaviors and Economic Values*, provides information on economic values (Fedler, 1989). Other recommended references include *Riparian Buffer Strategies for Urban Watersheds* (Herson-Jones *et al.*, 1995) and *Better Trout Habitat: A Guide to Stream Restoration and Management* (Hunter, 1991).

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B*.

- The Environmental Review Unit, Maryland Department of Natural Resources, can provide information on issues pertaining to the protection of fishery resources.

- There are a number of programs which are aimed at making fishing more widely available to the public. Information is available on lakes and streams that are stocked with trout, equal access programs in parks, and on the "Hooked on Fishing not Drugs" program. For this information contact the Fishery Service, Maryland Department of Natural Resources.



Anadromous Fish Spawning Areas

Definition: Anadromous fish and semi-anadromous fish are those species that ascend freshwater streams and rivers in the spring to spawn. The young and adults may spend the other portion of their life in the saltier water of the Chesapeake Bay (semi-anadromous) or the ocean (anadromous). These species include striped bass, white perch, marine lamprey, yellow perch, and species of herring and shad. In general, anadromous fish have the potential to reach and spawn in most "unblocked" Maryland waters draining to the Chesapeake Bay and the ocean. Blockages or barriers can be caused by both natural and manmade features. Dams, weirs, and culverts which are elevated or extremely long or shallow form complete barriers unless structures specifically designed to allow fish passage are present. Significant permanent natural barriers such as falls or rapids at the geological fall line represent a natural barrier on many streams in Maryland.

Maryland counties bordering the Chesapeake Bay and its tidal tributaries have numerous watersheds where anadromous fish spawning occurs. Historically, anadromous fish spawning on the Potomac River reached as far as Great Falls in Montgomery County and spawning fish reached up into Carroll County on the Patapsco River.

Protection Benefits: Anadromous fish are an integral component in the natural food web, and they contribute to the aquatic fauna diversity that is essential for ecosystem health. As transients which travel from saltwater to freshwater ecosystems, they represent a unique transfer of energy and matter between these two areas.

Recreational and commercial fishing industries are important to the economic health of Maryland. For example, based on total commercial dockside value of striped bass in 1995, over a million pounds of fish generated nearly $6 million in economic activity in Maryland. Reports on the economic impact of recreational and commercial fishing are available from the Maryland Department of Natural Resources.

Protective Measures: The major factors that lead to the degradation and loss of anadromous fish spawning areas include stream blockages, direct impacts to wetlands and waterways, and many indirect impacts associated with urban development.

Stream Blockages - Maryland Law prohibits any unmitigated obstruction to the passage of fish (Natural Resources Article, §§4-501 and 4-502, Annotated Code of Maryland). Although the State is working to identify and remove any existing stream blockages which can impede migration of anadromous fish as well as other aquatic species, the effects of multiple road crossings utilizing culvert pipes on the fragmentation of aquatic habitat is still a subject of concern. The documentation on the ability of finfish and other aquatic life to pass through extended culverts, such as those often associated with county and State roadways, is somewhat limited. These impacts could be minimized through more comprehensive watershed planning, incorporating better coordination of property access routes across nontidal wetlands and waterways throughout the watershed.

Direct Impacts to Wetlands and Waterways - Another key protection measure for the conservation of anadromous fish is the use of effective sediment control measures and the conservation of wetlands, steep slopes, and erodible soils. Wetland plants and shallow water provide feeding areas and cover for young fish. Sediment degrades wetlands and pollutes a stream by fouling the gills of fish and smothering fish eggs.

Indirect impacts associated with urban development - Urban development is often associated with increased storm flows and decreased baseflow. Measures such as the minimization of the amount of impervious surfaces, the retention of forested tracts, and reforestation of riparian zone buffers can help protect streams from erosion, sedimentation, the increase in periods of low flow, and temperature impacts.

Management techniques in the Critical Area Criteria provide for the protection of anadromous fish propagation waters within the Critical Area. The following list of recommended program objectives and protection measures for anadromous fish spawning areas has been developed from the Criteria:

1. Extend the protection measures adopted by the local government Critical Area Program to the entire watershed where anadromous fish spawn. Consider the use of overlay zoning districts and requirements for cluster development that limits impervious surfaces and maximizes forested land cover.

2. Develop habitat enhancement programs which could include the increase of natural vegetation within anadromous fish spawning watersheds, the establishment of forested buffer areas along streams, cooperative agreements with landowners, the use of conservation easements, and other tax incentives to promote conservation.

3. Base decisions regarding proposed activities, such as the development of new residential and recreation areas, on the impacts, both singly and cumulatively, of the activity on anadromous fish spawning areas.

Mapping: Maps showing where anadromous fish spawning areas have been documented are included in the State's anadromous fish survey reports completed over the past twenty years. The Chesapeake Bay Program publication, *Habitat Requirements for Chesapeake Bay Living Resources* (Funderburk *et al.*, 1991), also provides information on the distribution of fish species that may be useful in geographically locating important fish resource areas.

Restoration efforts are under way in several watersheds to restore populations of anadromous fish species. Maps generally do not accurately address potential restoration of various species to a watershed and the restoration of fish passage. These maps are well suited for displaying known resource areas, but not for providing a final definition of all areas where there is a concern for the given resource. The general protection mechanisms for anadromous fish should be applied on a regional watershed basis rather than by strict use of mapped resources. Note that the protection mechanisms for anadromous fish also directly apply to all resident fish species found in the same streams.

Technology Tool Box Data - Data sets on the location of streams, forest buffers, existing stream blockages, and sensitive species are being developed by the Maryland Department of Natural Resources, Geographic Information Services Division. A computerized database is also being developed on important fish resource areas from which maps of such areas can be produced. For further information on digital data and paper maps available from the Geographic Information Services Division, Maryland Department of Natural Resources, see *Appendix A*.

Wildlife and Natural Heritage Data - The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources can provide maps, digital data, and management guidance for the protection of rare, threatened, and endangered species of aquatic organisms. Although anadromous fish species are not listed as rare, threatened, or endangered in Maryland, these data are important to consider when decisions about stream protection and management are being made.

Additional Reading: For guidance on stream buffer width and protection strategies, *Site Planning for Urban Stream Protection* (Schuler, 1995), can provide current information. In addition, *An Economic Assessment of Marine Recreational Fishing in Maryland* (American Sportfishing Association, 1995), provides information on economic values. Habitat requirements for specific species of anadromous and semi-anadromous fish are outlined in detail in some of the following publications: *Habitat Requirements for Chesapeake Bay Living Resources* (Funderburk *et al.*, 1991), *Chesapeake Bay Alosid Management Plan* (Chesapeake Bay Program, 1989b), and *Chesapeake Bay Fishery Management Plans* (MD DNR).

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B*.

- The Environmental Review Unit, Maryland Department of Natural Resources, can provide information on the location of anadromous fish spawning areas and other issues pertaining to the protection of aquatic resources. The Fish Passage Program can provide information on projects to restore fish passage.

- For information on Maryland permit policies please contact the Maryland Department of the Environment, Water Management Administration.

- For information on Best Management Practices and copies of the Tributary Strategy documents contact the Maryland Department of Natural Resources, Chesapeake Bay and Watershed Programs.

Section C Groundwater and Mineral Resources

Groundwater

Definition: Groundwater is naturally occurring water that fills (saturates) pores between rock grains or in cracks and crevices in rocks. Such openings are most common near the land surface; at great depth, they are closed by the weight of overlying materials. Rain and snowmelt percolating down through the soil are the source of groundwater. Below some depth beneath the surface, all the pores, cracks, and crevices are completely filled with water. This is referred to as the zone of saturation, and the water within that zone is groundwater. The rocks and sediments that transmit groundwater constitute what is known as an aquifer. They serve both as conduits and as underground storage reservoirs for groundwater. Groundwater is usually in motion, moving slowly under the force of gravity to lower areas where it may discharge as a spring, or to a stream, or to the ocean. In Maryland and in all humid temperate climates, streamflow is sustained by groundwater which depends on a continuous renewal, or recharge, from rain and snowmelt.

Protection Benefits: Our society depends on an adequate water supply, both in terms of quality and quantity, for residential, agricultural, commercial, and industrial uses, and for the conservation of aquatic life. The most obvious reason for local governments to protect ground-water resources is the risk of pollution. Polluted groundwater is generally unsafe for human consumption and may be unsuitable for other uses, depending on specific conditions. Polluted aquifers are very difficult to clean up; contamination can render aquifers unusable as a water source for decades. Remedial measures to remove contaminants add to the cost of water in municipal and industrial water supplies and may force the abandonment of domestic water wells. Overpumping, or overdraft, is another important ground-water issue. Overpumping occurs when groundwater is pumped out of the ground at a rate faster than it can be recharged. Results can include declining water quantity, ground subsidence, salt-water intrusion into the freshwater aquifer in coastal areas, and other types of contamination.

Aquatic populations in streams, springs, and spring-fed wetlands also rely on an adequate supply of groundwater. Major regrading and resurfacing of the natural ground surface with macadam, concrete, or other impervious material can reduce or eliminate the recharge of ground-water supplies. As a result of increased impervious surface, the amount of spring-fed base flow in streams decreases. Small, spring-fed streams may dry up, thus reducing the amount of habitat for aquatic life such as trout, which require clean cool water, and perch and herring, which migrate to the headwater areas of streams to spawn.

Protective Measures: Maryland has a number of programs, established by State law, to protect groundwater from various sources of contamination. These programs are part of an overall Ground-Water Protection Strategy that includes water appropriation permits and the regulation of hazardous substances, septic tanks and underground storage tanks. Most of these programs regulate the contaminant sources to at least meet drinking water standards.

Historically, the issue of groundwater conservation and protection has been overlooked in local water-supply planning and management. However, in recent years, there has been a growing concern for the protection of the quantity and quality of groundwater. In addition to including a discussion of groundwater in comprehensive plans, many local governments are developing watershed management plans to guide land use planning and water resource development.

The general program objectives and protection measures listed below are recommended for consideration by local governments. Specific approaches to ground-water conservation and protection will vary greatly depending on land use and the geology of a region.

- Consider the impact of construction activities on groundwater recharge during the local planning process. A comprehensive watershed management plan can provide a framework for land use decisions.

- Adopt the Maryland Model Wellhead Protection Ordinance (MDE, 1997). This ordinance was developed by Maryland Department of the Environment in cooperation with local county health departments and local planning agencies.

- Adopt ordinances prohibiting the location of hazardous material in well recharge areas. This measure has been adopted by Frederick County and the City of Salisbury to protect water-supply wells.

- Promote the use of *best management practices* (BMPs). The planting of winter cover crops is a practice that takes up excess fertilizer left in the soil after the harvest. Grassed swales can enhance pollutant removal prior to infiltration into groundwater. Maryland nonpoint source infiltration standards help protect groundwater by requiring a separation distance of four feet between the top of the water table or bedrock and the base of any infiltration system.

- Promote nutrient management and integrated pest management by fertilizer and pesticide applicators such as lawn care companies and farmers. These BMPs involve finding out precisely how much fertilizer or pesticide is required, and using that amount and no more. Many farmers in Maryland participate in the State Nutrient Management Program. In addition, some farmers have enrolled land within wellhead protection areas into Conservation Programs and in return received initial cost share and annual rent subsidies.

Mapping: Informed decision making, planning, and management need to be based on a knowledge and understanding of the regional hydrogeology and hydrology – i.e., how the geology affects groundwater flow, circulation, quality, and quantity. Fundamental to understanding regional and local hydrologic conditions are data collection and monitoring. The following are a few examples of the information required for analysis and decision making in regard to groundwater: hydrogeologic maps showing extent and boundaries of all aquifers and non-water-bearing rocks; water-table, bedrock-configuration, and saturated-thickness maps; maps showing transmissivity and variations in storage coefficient; maps showing seasonal variations in depth to groundwater; relation of saturated thickness to transmissivity; hydraulic connection of streams to aquifers; type and extent of recharge areas (recharge basins, recharge wells, natural recharge

areas); surface-water diversions; groundwater pumpage (distribution in time and space); areal distribution of water quality in an aquifer; streamflow quality (distribution in time and space); and geochemical and hydraulic relations of rocks, natural water, and artificially introduced water or waste liquids.

A variety of maps is available from the Maryland Geological Survey for many counties in Maryland, and many counties have undertaken cooperative agreements with the Maryland Geological Survey to conduct water-resource studies. Site-specific investigations, if needed, may be contracted to private geologic and engineering consultants.

Maps showing locations of potential and known sites of groundwater contamination, location of public water supply wells, and wellhead protection areas are available from the Maryland Department of the Environment. For additional information on digital data and paper maps, see *Appendix A*.

Additional Reading: An updated list of Maryland Geological Survey publications is available from their publications office in Baltimore, Maryland. Many other pertinent publication are available from the United States printing office. The following publications are recommended: *Turning the Tide: Saving the Chesapeake Bay* (Horton and Eichbaum, 1991), *Groundwater in the Piedmont Upland of Central Maryland* (Richardson, 1982), *Groundwater Issues and Answers* (American Institute of Professional Geologists, 1984), *The Quantity and Quality of Natural Groundwater in Maryland* (MD DNR, 1987), *Groundwater Aquifers and Mineral Commodities of Maryland* (MGS, 1969), and *Groundwater Resources of the Southern Maryland Coastal Plain* (Otton, 1955).

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B*.

- The Maryland Geological Survey has produced numerous maps and reports dealing with various aspects of groundwater resources. A list of Maryland Geological Survey publications is available and many public libraries and college libraries also contain these publications. For further information contact the Maryland Geological Survey Publications Office.

- The Maryland Department of the Environment and the United States Environmental Protection Agency are sources of information concerning the regulatory aspects of groundwater.

Wellhead Protection Areas

Definition: The Safe Drinking Water Act Amendments of 1986 define a wellhead protection area (WHPA) as "the surface and subsurface area surrounding a water well or wellfield, supplying a public water system, through which contaminants are reasonably likely to move and reach such a water well or wellfield." In practice, a WHPA is a designated geographic area, usually surrounding a well or wellfield, within which potential contaminants sources are identified and management practices are instituted that will reduce potential threats to the groundwater that supplies the well or wellfield. WHPAs can be defined for public-supply wells in all types of aquifers.

The Maryland Department of the Environment received approval from the United States Environmental Protection Agency in 1991 to implement the Maryland Wellhead Protection Program. Maryland's program is designed as a cooperative effort between local and State governments for the protection of valuable water supplies. A model ordinance that relies on local authority granted under Article 66B has been developed for the use of local governments.

Protection Benefits: The provision of safe water is a fundamental service that local governments daily deliver to their communities. Public water supply systems are significant financial investments. The cost of developing new sources of supply can range from $20,000 for the smallest systems to over one million dollars for large complex systems. Protecting sources of supplies from contamination is one way that government demonstrates responsibility in the eyes of its citizens, ensures the long term viability and safety of their supply, and protects the financial investment made.

Pumping a well causes a lowering (drawdown) of water levels in the aquifer surrounding the well and causes water in the aquifer to flow towards the well. Water pumped by a well originates as precipitation that has infiltrated from land surface into the groundwater system. Similarly, contaminants can also enter the groundwater system, pollute the water supply and flow towards a pumping well. Therefore, WHPAs generally have one or more of the following purposes: 1) to provide a remedial action zone (a buffer zone) that will provide an adequate amount of time to identify and clean up contaminants before they reach a well; 2) to provide a protection area that is large enough to allow for the attenuation of potential contaminants to acceptable levels before they reach the well; and 3) to provide a management zone that will protect all or part of the area supplying water to a well. Such management can help ensure that the high quality of groundwater recharge and well yield are maintained.

Protective Measures: Both regulatory and nonregulatory management approaches are useful for protecting groundwater sources from contamination. Much can be achieved at the local level through appropriate land use planning and zoning, business outreach, and educational projects.

The Maryland Department of the Environment has assisted over 50 communities in defining wellhead protection areas, identifying potential contaminant sources, and recommending ways to manage wellhead protection areas. The Maryland Department of the Environment's Wellhead Protection Program suggests the following steps for developing a local protection program:

- **Form a community planning team**. Planning teams should represent all of the interests in your community. Water suppliers, elected officials, local environmental health departments, local planning agencies, local businesses, developers, community service organizations such as the League of Women Voters, environmental groups, farmers, and interested citizens can work together to reach a consensus on how to protect your water supply. The planning team should define clear goals and objectives for measuring progress.

- **Delineate wellhead protection areas**. The first step for a planning team is to define an area around the drinking water well where contaminants could enter and pollute the well. This area becomes the "Wellhead Protection Area" or "WHPA." WHPAs have been delineated by the Maryland Department of the Environment, the Maryland Geological Survey, and by private consultants. Computer groundwater flow models are used in coastal plain areas. Topography, formation boundaries, and other indicators of groundwater flow are factored into delineations conducted in the Piedmont and Western Provinces. Information on well depth, screened interval, water bearing zones, aquifer transmissivity and porosity, and pumping rate is needed to complete and evaluate delineations. For coastal plain sources, the Maryland Department of the Environment recommends that at least one-year and ten-year time of travel zones be mapped around each supply. In the Piedmont and Western Provinces time of travel is more difficult to define, but two different zones may be delineated.

- **Inventory contaminants**. Next, the planning team should identify existing and potential sources of contamination in the WHPA. This inventory can include commercial and industrial operations that generate pollutants, underground storage tanks, homes and industries discharging to septic systems, agricultural operations, hazardous or solid waste disposal facilities, and abandoned wells. Maryland's Wellhead Protection Program can provide communities with lists of regulated activities within their wellhead protection areas. Communities can then conduct their own search for additional potential contaminant sources, such as abandoned wells or unregulated waste disposal sites. The best sources of information about existing sites are the citizens of the community. In some areas of the country local volunteers, particularly senior citizens, have been extremely valuable in identifying and locating potential contaminant sources in their communities.

- **Manage your wellhead protection area**. There are many methods that communities can use to manage their WHPAs. Educating citizens about their water supply is one method. An educational project could include the placement of road signs at boundaries of wellhead protection areas. Other management techniques include purchasing land around the well and encouraging potential polluters to adopt best management practices. For existing facilities, monitoring groundwater quality can detect pollution before it reaches the well. Communities can use local planning, zoning, and health ordinances to effectively manage the types of activities that can occur in a designated wellhead protection area. Each community should develop its own management program to suit its individual needs. Maryland's Wellhead Protection Program advises communities about ways to protect their water supplies.

- **Plan for the future**. Contingency plans discuss what the community will do in the event the source of drinking water is unexpectedly contaminated or the supply is disrupted. Typically, these plans include both short and long term strategies for replacing the water supply if necessary. The plan should specify what will be done, and who should be notified in case of disaster. In addition, the community should know where funding will come from if a water supply needs to be cleaned up or replaced.

- **Site new wells carefully**. Protection of new wells is an important part of wellhead protection. Maryland's Wellhead Protection Program reviews each new public drinking water supply well application to ensure that new wells are located so that the risk of pollution is reduced. Communities should propose new well locations where there is little risk of contamination from existing or future land uses.

Mapping: The Maryland Department of the Environment and the United States Environmental Protection Agency have published guides to help define wellhead protection areas. There are several different methods of mapping WHPAs. They range from drawing a circle with a specified radius around the well to more detailed calculations and the use of computer models. According to the U.S. Environmental Protection Agency, if there is no site-specific information on which to base a more accurate WHPA delineation, an initial area having a radius of one-half to one mile around the public water supply well would be considered a good starting point. More detailed methods can be used to calculate accurate WHPAs when site-specific information on well construction, soils, aquifer characteristics, well pumpage rates, bedrock geology, and groundwater flow is available.

Digital Data - The Maryland Department of the Environment maintains an updated community wells database, which combines well construction information with aquifer characteristics. A geographic information system (GIS) is being developed to connect this database to digitized maps and digitized point source data that identifies potential contaminant sources, and to other databases, such as the one being developed by the Underground Injection Control Program. For further information on digital data and paper maps, see *Appendix A*.

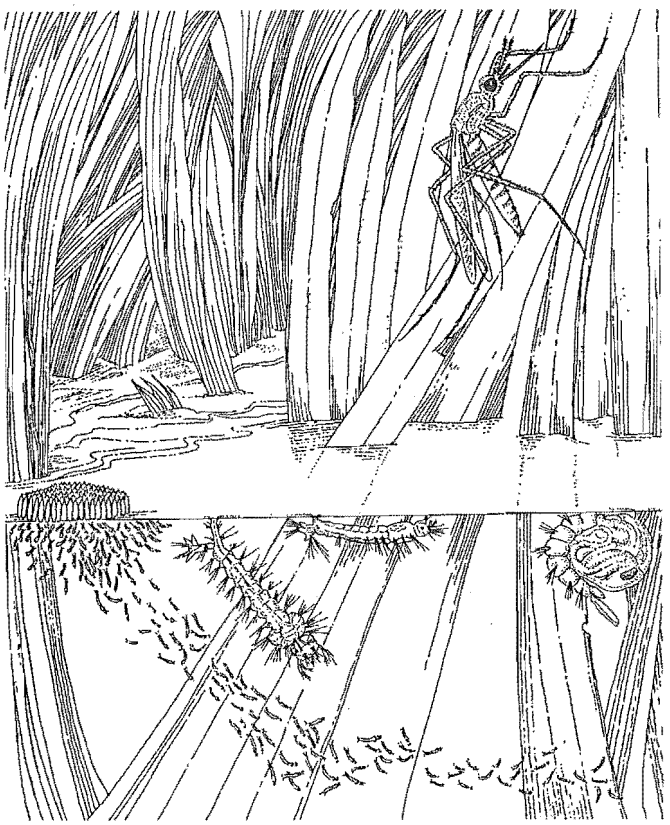
Additional Reading: For guidance on protection measures, contact the Maryland Department of the Environment, Wellhead Protection Program. Publication available include *Maryland Model Wellhead Protection Ordinance* (MDE, 1997), *State of Maryland Wellhead Protection Program* (MDE, 1991a) and *Wellhead Protection Training Manual* (MDE, 1991b). In addition, the following U.S. Environmental Protection Agency publications are available: *Wellhead Protection – A Guide for Small Communities* (US EPA, 1993), *Protecting Local Groundwater Supplies Through Wellhead Protection* (US EPA, 1991), and *Guidelines for Delineation of Wellhead Protection Areas* (US EPA, 1989).

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B*.

- The primary contact regarding wellhead protection in Maryland is the Wellhead Protection Program, Maryland Department of the Environment.

- For maps and reports dealing with the hydrogeology and geology of the counties of Maryland contact the Maryland Geological Survey, Maryland Department of Natural Resources.

- The United States Environmental Protection Agency has produced many publications on wellhead protection. For further information contact the Office of Groundwater, United States Environmental Protection Agency.



Springs and Seeps

Definition: Springs and seepage areas represent locations where groundwater resurges at the surface. The distinction between springs and seeps is vague, but springs typically represent a point of concentrated discharge with a defined opening, while seeps represent a more dispersed "oozing" flow. Various authors have separated these resurgences using other criteria such as seasonality (springs permanent, seeps temporary), nature of discharge (springs under hydrostatic pressure, seeps by capillary action), or other criteria. However, they do merge and a useful distinction is difficult to define. Local springs and seepage areas range in size from dribbles producing less than a gallon per minute to major outpourings generating up to ten thousand gallons per minute. The largest Maryland spring is Potomac Blue Spring in Allegany County, which has produced a measured volume of 9,750 gal/min, although its normal production may only be half that volume (Otton and Hilleary, 1985).

Protection Benefits: Springs can provide dependable sources of potable water. As such they were of considerable importance to early residents of Maryland. Without question, springs flowing today were also utilized by the first native Americans to reach this region more than ten thousand years ago. Later, as European settlers moved into and through Maryland, strategically located springs became important stopover localities for travelers. These locations then became the sites of early settlements. Such sites are documented by place names like Green Spring Valley, Bentley Springs, Big Spring, Clear Spring, Cool Spring, Fountain Rock, Indian Springs, Silver Spring, and Springdale. Unfortunately, although some of these local springs have been preserved, many have become polluted and no longer provide water suitable for human use.

In some rural areas of Maryland, springs are still utilized for drinking water or other purposes. Typically these springs are relatively small and have been walled in to increase the depth of the pool, primarily to make the filling of containers easier. Others have been encased in spring houses. Prior to the availability of mechanical refrigerators, spring houses were important facilities for storing and extending the life of butter, milk, and other perishables. Certain large volume springs have found use as sources of pure, cool water suitable for cold water fish hatching operations. A fine example of this use is the large spring that feeds the Albert Powell State Fish Hatchery near Hagerstown. Several other very large springs in this same area have been harnessed to feed commercial watercress ponds.

Springs and seepage areas also provide habitat for a variety of sensitive plants and animals, many of which are quite rare and restricted in their distribution. Some of these are highly specialized residents of groundwater. These species, such as the amphipods of the genus *Stygobromus* or the isopod *Caecidotea pricei*, may occur at surface resurgences only when they wash out of the aquifer after wet periods in spring or fall. However, at least a few large springs support what appear to be permanent populations of these subterranean species. Others represent surface dwelling species that require pure, consistently cold water. Some of these, like the pearl dace (*Semotilus margarita*) and slimy sculpin (*Cottus cognatus*) are species typical of more northern areas. Local populations of these are "Pleistocene relicts" which were pushed southward into Maryland when the glaciers extended as far as central Pennsylvania. As the ice sheets receded between ten and twenty thousand years ago, these displaced northern species followed them back northward to reoccupy their former range, leaving behind isolated, disjunct populations restricted

to large, cold springs that continue to provided suitable habitat. Other sensitive local species associated with spring or seepage-fed habitats include the bog turtle (*Clemmys muhlenbergii*) and the rock vole (*Microtus chrotorrhinus*), species so restricted in our area that they have been designated as threatened or endangered. Springs and seepage areas may also play a role in modifying local aquatic conditions. For instance, persistent cool resurgences can reduce water temperature enough to allow for the survival of cool water species like brook trout in regions where they would otherwise be unable to survive through the summer. The occurrence of natural trout reproduction in Jabez Branch (Anne Arundel County) is due to this circumstance.

Protective Measures: Since springs and seeps represent the resurgence of pure groundwater, protective measures must include keeping pollutants out of the groundwater, ensuring that the aquifers supplying them will continue to be recharged and will not be diverted, and preventing the destruction or covering of a spring or seep as a result of construction or development.

Pollution of groundwater can occur in many ways. Typically, pollutants will bind to soil particles, so allowing surface water to filter downward through the soil generally provides a reasonable degree of quality control. However, excessive use of pesticides or other chemicals over shallow aquifers can be a potential problem, as can leaking storage tanks and landfills, poorly functioning septic systems, or sites where contaminated surface runoff enters sinkholes. That these problems are occurring today, is evidenced by instances where potentially dangerous chemicals have been detected in wells. In areas where groundwater flows through specific rock strata or shallow unconsolidated sediments, surface or deep mining can cause serious problems. The flow of water through pervious rock can be diverted or reduced by quarrying that may occur between recharge areas and the point of resurgence.

Obviously, major regrading and resurfacing of the natural ground surface with macadam, concrete, or other impervious material can reduce or eliminate both the recharge of groundwater supplies that feed springs or seeps, as well as the actual places where they emerge from the ground. Local planning processes should consider the impact of such construction activities on springs and seeps. Although evaluating the effect of construction on groundwater hydrology requires the attention of an expert, the technology is available to most private consultants.

Mapping: Springs are shown on the U.S.G.S. Quadrangle maps and the county topographic maps available from the Maryland Department of Natural Resources, Maryland Geological Survey. In addition, the Maryland Geological Survey publication entitled "Maryland Springs -- Their Physical, Thermal, and Chemical Characteristics" (Otten and Hilleary, 1985) gives detailed locations for 100 Maryland springs.

Wildlife and Natural Heritage Data - The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources can provide maps, digital data, and management guidance for the protection of rare, threatened, and endangered species of aquatic organisms. These data are important to consider when decisions about the protection and management of springs are being made. For further information on digital data and paper maps, see *Appendix A*.

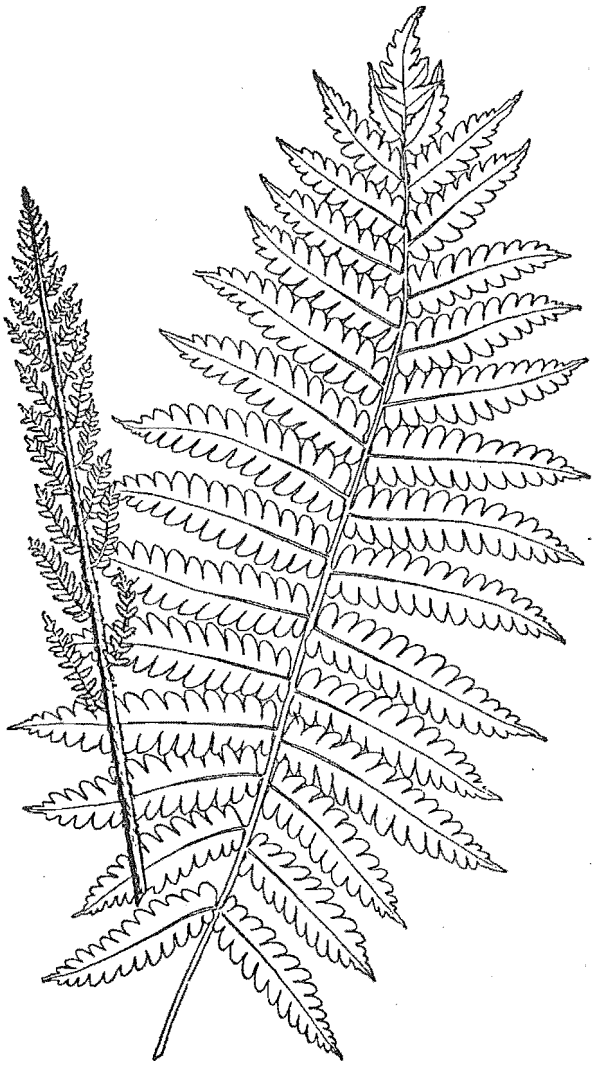
Additional Reading:

Otton, Edmond, and John Hilleary, 1985. *Maryland Springs - Their Physical, Thermal, and Chemical Characteristics*, Baltimore, MD: Maryland Geological Survey, Report of Investigations, No. 42. 151 pages.

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B.*

- Contact the Maryland Geological Survey, Maryland Department of Natural Resources, for information on Maryland springs and regional groundwater supplies.

- The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources, maintain a database on sensitive species found in springs and seeps.



Caves

Definition: Caves are subterranean cavities. The authors of "Caves of Maryland" adopted a definition of a cave as "any natural cavity or opening in rock which is large enough for a human to enter." Most caves are connected to the surface with obvious openings, but mines and wells occasionally intercept caves without apparent surface connections. These underground cavities typically result from the solution of water-soluble carbonate rocks (limestone, dolomite, and marble) by acidified groundwater (solution caves), although some may result from mechanical processes (fissure or shelter caves). Maryland's approximately 161 caves are generally restricted to Allegany, Frederick, Garrett, and Washington Counties where limestone and dolomite occur. However, several small solution caves are present in western Carroll County, and there are also a few shallow shelter caves in Baltimore and Howard Counties.

Solution caves are longer, deeper, and more complex than either fissure or shelter caves, and hence more interesting and popular for touring or "spelunking." The two longest caves in Maryland (2200 and 4200 feet of passage) are both in Garrett County, but most local caves are considerably shorter. Because caves were created by groundwater, they affect local drainage patterns and, where well developed, may create surface topography characterized as karst. (In certain areas, such as the Hagerstown and Frederick Valleys, this rolling topography punctuated with sink holes that may drain surface streams is well illustrated.) Several Maryland caves have significant streams discharging from or flowing into their entrances, and a mile-long section of Flintstone Creek flows through an underground passage.

Protection Benefits: Caves deserve protection for several reasons. Because they may be direct connections to groundwater, pollutants entering them reach this valuable natural resource without benefit of the cleansing that occurs when water percolates down through layers of soil. They are individually unique geologic features that sometimes display mineralogical formations of great beauty and interest. They have been visited by humans for millennia and frequently contain cultural artifacts of extreme historic and archeological significance. Finally, caves are remarkable natural habitats that support numerous rare species, many of which are so specialized for survival in these subterranean systems that they occur nowhere else in the world.

Because the cave environment includes darkness, surface-dwelling species which depend on sight to survive are not typically present. Some species (various bats, camel crickets, and the allegheny woodrat for instance) move out of caves at night to feed, then return to the cave during the day where they digest their food, defecate, and sometimes die. This imported organic material can be an important contribution to food resources utilized by subterranean communities. Since photosynthesis is impossible in caves, virtually all food must be imported by animals, or be transported in the form of leaves and other debris that fall, blow, or wash into caves. Since the amount of such material is limited and highly seasonal, cave communities are energy poor, and permanent cave inhabitants are physiologically and metabolically specialized. Some of the characteristic adaptations exhibited are loss of eyes, lack of pigment, elongation of appendages, reduced fecundity, long lives, and small numbers of individuals. These creatures are also characterised by their tendency to be restricted in their distribution, and some local cave-inhabiting species are apparently limited to Maryland, or even to single caves in Maryland.

Protective Measures: Protective strategies for caves and their specialized inhabitants must provide for physical impact to the cavity itself, the environment provided by the cavity, and any surface or subterranean water that flows through the cavity. These impacts are discussed below.

Physical Impact - Known Maryland caves have been destroyed (Busheys Cavern, Washington County) or severely damaged (King Quarry Cave, Washington County) by quarrying or mining operations. As indicated previously, most local caves are developed in limestone or dolomite rocks, both of which are utilized locally for construction purposes. No quarrying or blasting activity should be conducted above or in close proximity to known caves.

Alteration of Environment - Cave inhabiting animals are so highly adapted to the environment provided by the caves where they occur that they can be severely impacted by seemingly minor alterations. For instance, closing cave entrances, which is frequently done by land owners who have concerns about liability or the danger that sinkholes pose to children or livestock, will reduce the amount of deciduous leaves, fallen branches and other organic material entering the system, the movement of species such as bats and camel crickets to and from the cave, and the volume and temperature of the air moving within the cavity. Since food is always critical to cave inhabitants, even a small reduction in decomposing leaves or the amount of bat or beetle guano can result in the extirpation of populations. In addition, subtle changes in humidity and air temperature can affect the ability of hibernating bats to survive the winter. No cave entrances should be closed, and only well designed "bat gates" should be utilized to control access.

Changes in Flow of Water - Where surface streams or runoff enters caves, the quality and quantity of flow should be protected. For this reason it is imperative that runoff from industrial sites, agricultural fields, roadways, parking areas, or other sources of pollutants not be allowed to enter sinkholes or cave entrances. For the same reason, garbage or other potentially polluting fill should never be introduced into a sinkhole. Care must also be taken to avoid pollution or alteration of groundwater supplies in regions where caves are known to occur. For example, the impact of large-scale mineral extraction on aquifers should be determined before such activities are permitted in areas adjacent to caves.

Attention should also be directed toward preservation of geologic, paleontological, and cultural resources present in local caves. A number of Maryland caves are known to include fossil-bearing deposits, geological formations (primarily speleothems such as stalagmites, stalactites, flowstone), and human artifacts. Extraction of cultural or fossil materials should always be done by experts. Not only is their scientific value much greater when they are properly documented and deposited in public collections, but such materials are frequently so fragile that excavation by amateurs often results in their destruction. Numerous local caves exhibit scars documenting the removal of speleothems by visitors. These geological features require lengthy periods of formation (hundreds to thousands of years) and once removed, can never be enjoyed by others.

In certain instances, visitors to local caves have defaced cave walls and formations, destroyed bats for amusement, lit fires, and performed other acts of vandalism. In other instances, visitors to popular caves have littered the premises, left gates open, and otherwise inconvenienced landowners. Finally, some caves are dangerous to enter and persons have been so seriously injured as to require rescue. As a result some caves have been closed by owners and entry into others should be carefully controlled.

Maryland law (Natural Resources Article §5-1401 to 1406, Annotated Code of Maryland) provides that speleothems may not be sold in Maryland or exported for sale elsewhere, cave life may not be collected or disturbed without a special permit, no "historic or prehistoric ruins, archeological or paleontological site" may be disturbed without a special permit, and no natural material within a cave may be removed or disturbed without written permission of the owner. Further, a "person may not dispose of, dump, store, or otherwise introduce into any cave, sinkhole, or subterranean drainage system any litter, refuse, dead animals, sewage, trash, garbage, or any chemical or biological contaminant which is potentially dangerous to man or any form of cave life." Permits for certain of these activities may be issued by the Secretary of the Maryland Department of Natural Resources.

Mapping: Some notable caves are identified on the quadrangle maps produced by the U.S. Geological Survey or the county topographic maps available from the Maryland Geological Survey. Due to the sensitivity of local caves and their fauna, the Maryland Geological Survey publication "Caves of Maryland" provides only very general map locations. However information provided in that publication can be used to determine location on the U.S.G.S. quads. The Maryland Historical Trust maintains a set of U.S.G.S. quad maps with the location of Maryland caves indicated.

Wildlife and Natural Heritage Data - The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources, provides maps, digital data, and management guidance for the protection of rare, threatened, and endangered species. For further information on digital data and paper maps, see *Appendix A.*

Additional Reading: Published information on caves is frequently limited to technical publications that may be difficult to obtain. Sources that can provide useful information include *Caves of Maryland* (Franz and Slifer, 1971), *Cave Life, Evolution and Ecology* (Culver, 1982), and *American Caves and Caving: Techniques* (Halliday, 1974), "Observations on the Ecology of Caves," (Barr, 1967), "Cave Ecology and the Evolution of Troglobites" (Barr, 1968), and "The Cave Environment" (Poulson and White, 1980).

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B.*

- The Maryland Geological Survey, Maryland Department of Natural Resources, is the best source of information on Maryland caves. The publication "Caves of Maryland" (Franz and Slifer, 1971) is available from Publications Office. Technical questions should be addressed to the Hydrogeology and Hydrology Program.

- The Heritage and Biodiversity Conservation Programs, Maryland Department of Natural Resources, maintain information on rare species of animal inhabiting caves in Maryland.

Mineral Resources

Definition: Mineral resource is a general term applied to naturally occurring bodies of earth materials that are of economic value, either for their bulk nature (e.g., building stone) or for some geologic material contained within them (e.g., iron ore). The term mineral reserve is a more specific term for mineral resources from which a desired product, or commodity, can be extracted profitably with existing technology and under present economic conditions. Mineral resources and reserves are further subdivided as either fuel minerals or non-fuel minerals, and within the non-fuel category, either metallic or non-metallic. In Maryland, fuel mineral reserves include coal and natural gas. No oil has ever been produced in Maryland. Present day non-fuel mineral reserves in Maryland are all non-metallic and include crushed stone, fire clay, flagstone, dimension stone, sand and gravel, and the components for the manufacture of Portland cement which include limestone, shale, and sand. Metallic minerals that were mined in Maryland in the past include iron, copper, chromium, and gold.

Protection Benefits: Land use regulations that protect the economic viability of mineral extraction are beneficial to the economic health of the State and the economies of individual counties. The establishment of mineral extraction districts can be designed to prevent the preemption of mineral extraction by other land uses. Benefits associated with mineral extraction regulations include safety standards, conservation of water supply, and the protection of wildlife habitat and water quality. Regulations can also assure that post excavation uses of the land are consistent with the intent of the comprehensive plan.

One of the most critical factors in determining the cost of mineral resources is the cost of transportation from the source to the customer. Having readily available sources within relatively close distances to the marketplace benefits both the industry and the consumer. As population increases, demand for mineral products also increases. In Maryland, the vast majority of non-fuel mineral resources is used in the construction industry (including highway construction) and supports much of our infrastructure.

Protective Measures: In 1977 the State of Maryland established a comprehensive regulatory program governing the extraction of non-coal minerals. This program includes a surface mining statute which requires that mining be conducted so as to maximize protection of the environment and public safety. Since surface mining is a temporary use of land, reclamation of active and abandoned mining sites is emphasized. Regulations also require environmental controls related to oil and gas well drilling and production. Pending regulations for oil and gas drilling in the Critical Area and on state lands are considerably more stringent to protect these sensitive areas.

The Annotated Code of Maryland, "Zoning and Planning," Article 66B, §3.05, requires that a mineral resource component be included in the local land use plan. The law specifies that this component should identify: 1) "undeveloped land that should be kept in its undeveloped state until the land can be used to provide or assist in providing a continuous supply of minerals"; 2) "appropriate post-excavation uses for this land that are consistent with the local land planning process"; and 3) "land use policies and recommendations for regulations to prevent the preemption of mineral resource extraction by other land uses."

- Keeping land in an undeveloped state should be accomplished through zoning that adequately restricts development, particularly residential development. Cecil County, for example, restricts development in certain mineral extraction zones to a maximum of one dwelling unit per 50 acres. This very low density zoning creates an economic disincentive to subdivide resource-bearing lands for housing.

- Determining appropriate post- excavation uses requires an analysis of the Comprehensive Plan, particularly in terms of the planned land uses surrounding, and in the vicinity of, the excavated site. Generally, the state of excavated lands are not suitable for intensive development. Many excavated sites are used for recreation, open space, rubble-fill, agriculture, and silvaculture; some are converted into open water bodies, such as ponds and lakes. It is preferable that post-excavation uses be addressed in the comprehensive planning process, rather than through piecemeal decisions made after excavation is complete.

- Environmental features such as stream buffers and important habitat should be protected during excavation and enhanced where possible as part of the reclamation plan for the property.

Mapping: The Maryland Geological Survey has produced numerous maps and reports about the mineral resources of Maryland. Mineral resource maps are available for Anne Arundel, Baltimore County, Baltimore City, Calvert, Caroline, Carroll, Charles, Dorchester, Kent, Prince George's, Queen Anne's, St. Mary's, Somerset, Talbot, Wicomico, and Worcester Counties. Lands for Potential Mineral Resource Development maps are available for Allegany (excluding coal), Anne Arundel, Baltimore County and City, Carroll, Cecil, Frederick, Garrett (excluding coal), Harford, Howard, Montgomery, Prince George's, and Washington Counties. These maps are at a scale of 1 inch equals approximately 1 mile. Thus, they are somewhat general and should not be used for site-specific evaluations. Mineral resources are also discussed in various reports of the Maryland Geological Survey. For further information on digital data and paper maps, see *Appendix A*.

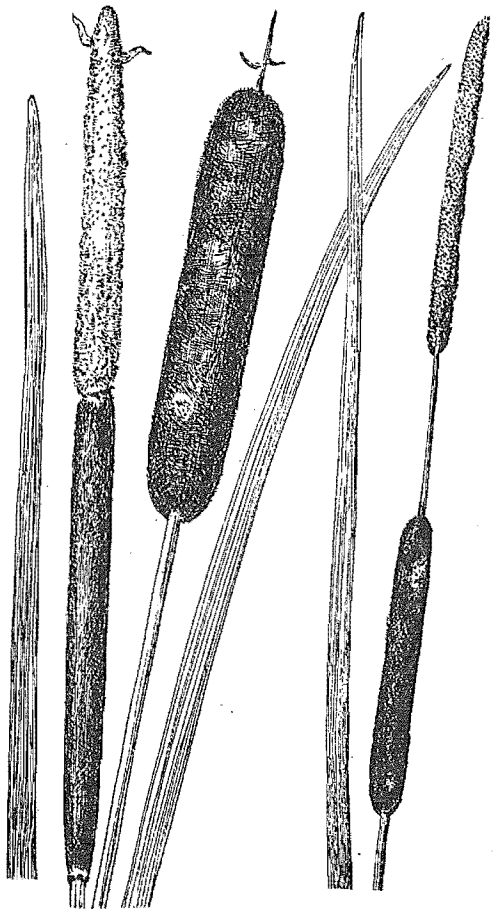
Additional Reading: For guidance on protection measures, contact the Maryland Office of Planning, Publications Office, for their publication, *Mineral Resource Planning* (Duket and Atkinson, 1997). Recommended publcation includes: *Mining Constraints and Mineral Resource Availability in Maryland* (Kuff, 1984), *Sand and Gravel Resources – Planning Directions* (Maryland Department of State Planning, 1982), "Mineral resources and multiple land use" (Flawn, 1971), "Extraction operations and the comprehensive plan" (Moore, 1991), and *Regulating Sensitive Lands* (Kusler, 1980). The Maryland Office of Planning and the Maryland Geological Survey both have libraries that contain these publications.

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B*.

- Through its staff and published maps and reports, the Maryland Geological Survey, Maryland Department of Natural Resources, can provide information about the occurrence and distribution of Maryland's mineral resources.

- Questions concerning mining permits, enforcement, production statistics, and other regulatory issues should be addressed to the Mining Program, Maryland Department of the Environment.

- Questions about planning should be addressed to Planning Assistance and Neighborhood Development, Maryland Office of Planning.



Section D Landscape Conservation

Wildlife Corridors

Definition: Wildlife corridors are undeveloped, linear stretches of land connecting larger patches of wildlife habitat. These corridors function as swaths of habitat through which nondomesticated organisms (wildlife) may move between habitat patches, landscapes, or even regions over long periods of time. Wildlife corridors can occur as natural geologic features in the landscape, such as rivers and their floodplains; or can be part of the manmade landscape occurring along roads, railways and power lines; or they may occur as the remnants of natural landscapes following clearing and development. These corridors often constitute a significant proportion of the vegetation in a developing landscape and can provide habitat for some of the landscape's original flora and fauna. In some cases in Maryland, endangered plant species occur only within these undeveloped strips.

Greenway programs protect linear open spaces for both recreation and conservation purposes. Many recreational greenways, however, are narrow and broken up by roads and trails so that they provide habitat only for wildlife that is most adapted to forest fragmentation and human contact. Exactly how wide a corridor needs to be in order to provide wildlife conservation benefits depends on the habitat structure and quality within the corridor, the length of the corridor, the particular species of wildlife expected to use the corridor and other factors such as human land use patters adjacent to the corridor. For this reason, it is best for greenway planners to consult with professional ecologists to determine the most effective locations and widths for wildlife corridor plans. The following, however, are a few general guidelines that can help greenway planners identify greenways that may act as wildlife corridors.

Corridors for Species Requiring Forest Interior Habitat - Species adapted to forest interior habitats are often unable to survive in forest edge environments and may require the incorporation of protected interior habitat into wildlife corridors. Edge environments exist at the edge of forests where increased light and wind results in dryer soils, tree blowdowns, and light-favoring plants. Forest interior habitat refers to the moist soils and shady environment of the forest interior. Many species of reptiles and amphibians require forest interior habitat. A corridor for these species should be wide enough to protect interior habitat and should link vernal pools and associated uplands. In addition, many forest interior species are not adapted to the presence of species which inhabit edge habitat. Edge species such as crows, jays, opossums, raccoons, foxes, skunks, and domestic dogs and cats are often plentiful in narrow corridors that include an insufficient width of interior habitat. The presence of these predators reduces or eliminates populations of low-nesting birds and other forest interior species.

Riparian Zone Corridors - Riparian zone refers to the area surrounding a stream or river and is composed of the stream, its flat floodplain, the steeper banks, and the adjacent wooded uplands. Corridors that incorporate the riparian zone not only provide a good corridor for wildlife movement but often provide habitat for more wildlife species and more individuals than corridors in drier surrounding land. For the protection of species that require riparian habitat, as well as water quality and floodplain protection, a riparian corridor should be wide enough to include the entire riparian zone on at least one side of the stream and interior forest habitat in associated uplands.

Combining Wildlife Corridors with Recreation - If trails or other recreational facilities occur within a corridor, as they generally do within greenways, the corridor should be wide enough so that the most sensitive animals using the corridor are not disturbed by human activity (Noss, 1993).

Protection Benefits: Wildlife corridors provide an important route for the shifting and migration of wildlife populations and individuals. Corridors can give a protected wildlife reserve a connection to other reserves and wildlife populations. Research on the effects of isolation of wildlife has shown that isolation of populations of wildlife may lead to the eventual loss of species. Isolated populations of a species are less able to adapt to environmental stress such as disease and may be unable to disperse and recolonize during periods of disturbance and stress such as drought or flood.

Unlike landscape that is cleared, mowed, and maintained as lawn and garden, wildlife corridors conserve water and require little maintenance. Corridors can protect the function of natural wetlands and streams and stabilize and protect sensitive areas such as steep slopes and floodplains from disturbance. In addition, the existence of these natural areas and undeveloped spaces often increases the desirability of an area as a place to live and work. Since corridors are linear and connect areas in communities to parks and bike paths, they offer convenient recreational opportunities close to home and increase land values and marketability of homes. (Arendt, 1996)

Protective Measures: The following are a few basic guidelines for establishing wildlife corridors. They have been excerpted from two excellent references, *How Greenways Work*, a handbook published by the National Park Service and edited by Jonathan M. Labaree, and the chapter "Wildlife Corridors" by Reed F. Noss from the book, *The Ecology of Greenways*, which was published by the University of Minnesota Press.

1. Undertake a natural resource inventory before planning and designing a greenway. The inventory will identify the area's native mixture of species and special plants, animals, and habitats. Follow the inventory with a review of research done on the local landscape. Such a review may reveal studies concerning conservation needs of native plants and animal species or local impacts of edge effects.

2. Identify the needs of the most sensitive species for which the greenway is to provide habitat. For the most part, greenways will not, by themselves, provide good habitat. Therefore, do not allow greenway projects to proceed at the expense of other initiatives which will provide habitat, such as large reserves.

3. Concentrate on matching natural characteristics of the landscape, both in terms of species composition and connecting patches of habitat which were originally connected but human development has left isolated.

4. Ensure that the greenway meets the movement needs of the species which are most sensitive to people. It may be necessary to build tunnels under roads or include specific habitat which a particular species requires.

5. Base greenway width on comprehensive study of the site. For example, riparian greenways which neighbor intensive land uses such as clearcutting, monoculture, or shopping malls will need to be wide enough to absorb excess nutrients and toxins.

Mapping: Atlases, paper maps, and digital data layers including land use and land cover, forest buffers, wetlands, watershed boundaries, protected lands, floodplains and a great deal of other information about land ownership and sensitive resources are available from the Maryland Department of Natural Resources and other State, local, and federal agencies. A selection of mapping resources are listed below. For additional information on digital data and paper maps, see *Appendix A*.

- **The Maryland Greenways Atlas** (Maryland Greenways Commission, 1996) contains a brief description of existing and potential greenways for each Maryland county and Baltimore City. Maps show protected lands and the general location of greenway corridors. Copies of this document may be obtained from the Maryland Greenways Commission, Maryland Department of Natural Resources.

- **The Statewide Integrated Natural Resources Assessment** is being developed by the Watershed Management and Analysis Division, Maryland Department of Natural Resources. This project will include identification of a statewide green infrastructure, focusing on areas with high ecological value, and will provide a consistent, science-based method for targeting land conservation and restoation efforts. For further information, contact Watershed Management and Planning, Maryland Department of Natural Resources.

- **The Technology Toolbox** provides pre-packaged data for geographic information systems (GIS). For information, contact the Maryland Department of Natural Resources, Geographic Information Services Division.

- **Information on wildlife and threatened and endangered species** is available from the Maryland Department of Natural Resources, Heritage and Biodiversity Conservation Programs. Management guidance for the protection of sensitive species should be considered when decisions concerning the protection and management of a natural area are being made.

- **Atlas of Agricultural Land Preservation in Maryland: Location, Protection, Threat, and Priorities for the Future**, developed by the Maryland Office of Planning, contains county maps, two series of regional maps, and four State maps. The maps show agricultural zoning (and its level of protection), existing and planned development, development pressure on agriculturally zoned land, conservation easements, publicly owned land, agricultural use on land zoned for development, and soil quality on agriculturally zoned land (prime/productive or other).

- **Maryland Comprehensive Forest Resources Inventory** is a data set that provides information about the forest resources in Maryland. These data sets will be available to counties from the State Forest Service, Maryland Department of Natural Resources, within a year.

Additional Reading: Corridors for wildlife conservation can be established in many ways: direct donation or public purchase of land, donation of a scenic or conservation easement, abandonment of a rail or utility right-of-way, purchase of development rights, proffer by a developer, or through environmental regulatory programs like those which govern floodplains, critical areas or steep slopes. Some of the many resources and tools which can be used to protect corridors for wildlife in Maryland are listed in the Maryland Greenways Atlas (Maryland Greenways Commission, 1996).

For information on recommended corridor widths, the chapter "Wildlife Corridors." *in the Ecology of Greenways* (Noss, 1993), and *How Greenways Work: A Handbook on Ecology* (Labaree, 1992) are two important references. Some recommended articles include, "Nest predation in forest tracts and the decline of migratory songbirds" (Wilcove, 1985), "Habitat fragmentation in the temperate zone"(Wilcove *et al.*, 1986), "Breeding Productivity Considerations: what are the appropriate habitat features for management?" (Martin, 1992), and "Land use planning and wildlife maintenance: Guidelines for conserving wildlife in an urban landscape" (Soule' ,1991), "Effects of forest fragmentation on breeding bird communities in Maryland" (Lynch, 1984).

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B*.

- The Maryland Greenways Commission is involved in planning and implementing greenway projects in every region of the State and works closely with the Maryland Department of Natural Resources, the Maryland Department of Transportation, and the Maryland Office of Planning to track and promote a variety of land conservation activities in Maryland.

- The Maryland Department of Natural Resources, Forest, Wildlife and Heritage can provide technical assistance. Field and Regional offices statewide may assist with specific location and management information.

- The Critical Area Commission can provide guidelines for the protection of wildlife corridors in the critical area.

Agricultural Land

Definition: Agricultural lands are lands having prime and productive soils that serve a wide variety of farming activities including the growing of crops, orchards, and nursery products; lands being used for the raising of livestock and poultry; and other rural lands capable of supporting farming and related activities.

The definition of Agriculture that is used by the Critical Area Criteria includes "all methods of production and management of livestock, crops, vegetation, and soil. This includes, but is not limited to, the related activities of tillage, fertilization, pest control, harvesting and marketing. It also includes, but is not limited to, the activities of feeding, housing, and maintaining of animals such as cattle, dairy cows, sheep, goats, hogs, horses, and poultry and handling their byproducts."

Protection Benefits: Protection of Maryland's agricultural land is of critical importance to the public welfare. First, agriculture and its associated industries and businesses contribute 11 billion dollars annually to the State's economy (MDA, 1994). These economic endeavors are the primary source of jobs in several counties, and where agriculture is not the primary employer, it still provides the diversity needed for healthy local and regional economies. Second, farming provides fresh produce, nursery stock, and other valuable commodities for Maryland's residents. Third, and perhaps most important from a growth management perspective, protection of agricultural land helps to steer growth and development towards those areas where it is most desirable, thus reducing environmental and governmental costs that would otherwise result from inefficient scattered and sprawling development. Finally, protection helps to preserve rural character and scenic vistas, and thus yields a coherent landscape and a rational pattern of development.

Conservation of high quality agricultural soils and a diverse agricultural economy is also an important issue for farmland protection. The economy in agricultural areas is sustained for future generations through the conservation of soil and water. Many new and innovative techniques are being developed that produce high crop yields while limiting the environmental effects of agricultural activities on soil resources, wildlife, and ground and surface water resources. Wildlife conservation in agricultural areas adds diversity to the economy. Hunting for wild game, commercial and recreational fishing, wildlife viewing, vacation resorts, and recreational boat use all add significantly to the economy of agricultural areas.

Protective Measures: The Critical Area Criteria (Chesapeake Bay Critical Area Commission, 1988) establishes policies that 1) assure that agriculture lands are identified and that programs are established to maintain, where appropriate, agricultural lands in agricultural use; and 2) protect bay resources and wildlife habitat. Listed in the Criteria document are specific criteria for the development of local government agricultural protection plans which are an excellent resource for developing county wide protection measures throughout the State. These criteria contain the following three necessary components of an agricultural protection plan:

- Identification, inventory, and mapping of agricultural lands.

- Identification of agricultural lands which include specific sensitive areas.

- The establishment of programs that maintain agricultural land in agricultural use while also protecting water quality and plant and wildlife habitat.

The following are several very effective techniques for protecting agricultural industries by minimizing development potential within the rural landscape.

Prohibitions on Major Subdivision Activity - Planners often distinguish between "minor" subdivisions and "major" ones. Typically, Maryland jurisdictions draw the separation between minor and major projects at around five lots; that is, five or fewer lots are treated as a minor subdivision, and projects proposing more than five lots are treated as major subdivisions.

Worcester County protects agricultural land by simply "saying no" to major residential projects. The County's Agricultural zone limits development to five lots on a parcel of farmland; no further subdivision activity is allowed on the original parcel, unless the parcel's zoning is later changed to a more permissive category.

Very Low Density Zoning - There are two ways in which very low density zoning can assist in the protection of agricultural land. First, minimizing the number of residential lots that can be carved out of an original parcel acts as an economic disincentive and (theoretically) discourages residential subdivision from occurring. Second, if such subdivision does occur, the resulting developed acreage is relatively small (in relation to the acreage of the original parcel), thus permitting most of the best agricultural soils to be saved. However, additional regulations or guidelines are needed to ensure that development is sited so as to produce the least impact on farmland and farming.

Good examples in Maryland are found in Frederick and Baltimore Counties. Frederick County's Agricultural zone permits three dwelling units per original parcel (as of 1976), with additional units at the rate of one dwelling unit per 50 acres, if the development is clustered. Baltimore County's Resource Conservation-2 zone permits one dwelling unit per 50 acres (with special rules for small parcels).

Rural Clustering - To protect farmland and farming, special design guidelines must complement the use of cluster development. These guidelines are aimed at maximizing the protection of the best farm soils, and achieving a site design that minimizes the impact of housing development on rural character and farming. Such guidelines require that housing development be compact in form, unobtrusive to the rural neighborhood, and sited to keep residential traffic and other activities separated from farming activities. For example, some cluster ordinances require subdivision road design that minimizes residential traffic on local roads needed for farm equipment, and that houses be sited away from cropland so that farmers can safely use pesticides and fertilizers.

Counties that use rural clustering as a conservation technique in agricultural areas include Calvert County, Carroll County, Queen Anne's County, and Kent County.

Transferable Development Rights (TDR) - TDR involve severing the development potential from property that should be protected (the "sending" area) and allowing it to be transferred to a more suitable development site (the "receiving" area). Montgomery County's Farmland Preservation Program is an example of an effective preservation program that incorporates TDR. It is recognized as one of the most successful TDR programs in the nation, having preserved 32,225 acres of important agricultural land.

The northern half of Montgomery County contains important agricultural soils and farming operations and businesses, and has relatively little development or infrastructure for growth. In 1980, the County embarked on a new TDR program as a replacement for its less-than-successful five-acre-lot agricultural zoning. The County's first step was to downzone agricultural lands to one dwelling unit per 25 acres. Then, to compensate property owners for lost development potential, the TDR program established the level of transferable rights at one right per every five acres (the development potential that existed prior to downzoning). These rights may not be used on agricultural land; however, the development rights are commodities that can be sold to developers and transferred to designated areas in the County where growth and development are desired. The private marketplace establishes the value of a development right, and the County is responsible for tracking the sale and transfer of rights through its land records. The TDR system has the advantage of using the private sector to fund the protection of farmland. The program is integrated into the County's Comprehensive Plan and zoning ordinance.

Mapping: Atlases, paper maps, and digital data layers including land use and land cover, forest buffers, wetlands, watershed boundaries, protected lands, floodplains and a great deal of other information about land ownership and sensitive resources are available from State, local, and federal agencies. A selection of mapping resources is listed below. For additional information on digital data and paper maps, see *Appendix A*.

- **Atlas of Agricultural Land Preservation in Maryland: Locationm Protection, Threat, and Priorities for the Future**, developed by the Maryland Office of Planning, contains county maps, two series of regional maps, and four State maps. The maps show agricultural zoning (and its level of protection), existing and planned development, development pressure on agriculturally zoned land, conservation easements, publicly owned land, agricultural use on land zoned for development, and soil quality on agriculturally zoned land (prime/productive or other).

- **Land Use Maps** and other data are available from Maryland Office of Planning, Planning Data Unit. Soil Survey Maps for Maryland Counties may be inspected at the Maryland Office of Planning library.

- **The Technology Toolbox** provides pre-packaged data for geographic information systems (GIS). For information, contact the Geographic Information Services Division, Maryland Department of Natural Resources.

Additional Reading: The Maryland Office of Planning's Models and Guidelines series should be consulted for further information on rural clustering (Duket, 1994), and transferable development rights (Maryland Office of Planning, 1995a). For examples of development plans that are designed for the protection of agricultural land, *Conservation Design for Subdivisions: A Practical Guide To Creating Open Space Networks* (Arendt, 1996) may be of value. In addition, an article on Agriculture in Maryland, "Maryland Agriculture in a Changing Policy Environment" (Gardener and Lichtenberg, 1998) is included in the 1996 proceedings from the Land Use and Management in Maryland Working Conference, The Aspen Institute and University of Maryland.

Agency Contacts: For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B.*

- Local government planning and zoning offices can be contacted for information on their programs. Addresses and telephone numbers are available from the Maryland Office of Planning.

- For copies of publications in the Models and Guidelines Series, contact the Maryland Office Of Planning library.

- For a copy of the Maryland Agricultural Land Preservation Foundation Annual Report and information on a variety of agricultural easement programs, agricultural certification programs, and cost share programs for soil conservation, contact the Maryland Department of Agriculture, Maryland Agricultural Land Preservation Foundation.

- For information on the Chesapeake Bay Program and Tributary Strategies watershed planning programs in Maryland contact the Maryland Department of Natural Resources, Chesapeake Bay and Watershed Programs.

- For a copy of the Critical Area Criteria (Chesapeake Bay Critical Area Commission, 1988) contact the Critical Area Commission.

Scenic Vistas and Geologic Features

Definitions:

Scenic Vistas - Scenic vistas are distant views seen from an elevated point or through an opening—such as between stands of forest, or between buildings, which reveal dramatic natural scenery. For the purpose of comprehensive land use planning, vistas should be associated with views from key public vantage points — such as parks, highways, and rest areas.

Geologic Feature - A geologic feature is defined as either a natural or manmade exposure of a geologic formation that is worth protecting for its rarity, historical interest, educational, aesthetic, or recreational values.

Protection Benefits: Scenic vistas are important as attractions for tourists, vacationers, naturalists, and hiking-biking enthusiasts. They are also often associated with many features of landscapes that society values for their beauty, rarity, and historicity. There is a general acceptance that features such as a very old tree, an historic church, or a battlefield are worth protecting for these values. A rock outcrop or other geologic feature may also be of value for beauty, rarity, and the close association of the geology with the history of a region. Geologic features of regional interest may include a scenic waterfall, a serpentine barrens, a barrier island, or an outcrop rich in fossils (e.g., Bone Cave in Allegany County or Calvert Cliffs in Calvert County). Geologic features that are worthy of protection often overlap with sensitive biological features; for example, cliffs, caves, and barrier islands have their own biological claim to protection, yet they are of interest as geologic features as well.

The geology of a region often manifests itself in the landscape in such a way that it often becomes part of our heritage. Arizona's Grand Canyon and Wyoming's Yellowstone are examples of landscapes that have been protected as National Parks for over a century in large part for their impact to our emotions and to our identity as a country. Geologic features that qualify as worthy of protection may have one or many values for a community including scenic qualities, educational opportunities, and opportunities for scientific investigation. The area around Sharpsburg, Maryland played a role in the Battle of Antietam during the American Civil War and the geologic features of the area have been protected from major alterations in order to preserve this aspect of American history. The history of Maryland may also be revealed by old mines such as the mine in Frederick County that once was the largest copper mine in the United States. The huge roadcut on I-68 where it crosses Sideling Hill in western Washington County now exposes a cross-section view of the folded bedrock unlike any other in the Eastern United States. It was deemed significant enough to warrant the construction of a geologic exhibit center at the roadcut. This has proven to be a very popular educational feature for thousands of visitors.

Finally, the protection of scenic vistas including geologic features helps to create a pleasing environment that makes Maryland an attractive choice for economic growth.

Protective Measures: The ideal method for protecting scenic vistas and geologic features is to incorporate them into State and local recreation and open space plans. There are also certain regulatory techniques that can be very helpful. For example, important vistas could be protected as "sending areas" in a local transferable development rights program, or with the use of very low density zoning and site design guidelines.

Protection of scenic landscapes is more effective when multiple reasons exist to justify protective regulations. Thus, efforts at protecting scenic vistas, or geologic features should be integrated into a jurisdiction's overall plans for managing growth and protecting sensitive areas. The following are guidelines to consider for the protection of unique geological features and scenic vistas.

- Identify areas that may already have some level of protection. In some areas, the scenery may be self-protecting because the lands are too steep for development, or because there are no access roads to support development.

- Where scenic vistas include lands that are planned development, consider adopting the Maryland model ordinance for protecting scenic vistas. It was prepared by the Maryland Office of Planning as part of the *National Freeway (I-68) Scenic Corridor Study* (Maryland Office of Planning, 1995b). This model ordinance is structured as an overlay zone and can be found in Appendix C.

- Incorporate the protection of Maryland's natural heritage into programs for scenic vista protection and the conservation of geologic features. For example, ridge lines provide corridors for wildlife migration and the seasonal movement of wildlife, and rocky crags often support communities of rare species.

- Consider including greenway features. The Maryland Greenways Atlas contains a brief description of existing and potential greenways for each Maryland county and Baltimore City. This atlas contains a map for each county showing protected lands and the general location of greenway corridors.

Mapping: A windshield survey is helpful in identifying scenic vistas; the scope of the survey can be narrowed with the use of anecdotal information from residents, interest groups, and local tourism agencies and tour guides. Recommended references include the *National Freeway (I-68) Scenic Corridor Study* (Maryland Office of Planning, 1995b); and, for information on a Geographic Information System methodology, the National Park Service, Denver Design Center's publication *Antietam: Analysis of the Visible Landscape - A Viewshed Study*. These reports are available in the Maryland Office of Planning library as reference material.

One way to identify "unique geologic features" is to look at geologic maps and topographic maps. Examples of some of the geologic features whose names may be obtained from such maps and/or consultation with the Maryland Geological Survey include Cumberland Bone Cave, Cumberland Narrows, Pinto geologic section, Roundtop geologic section, Gwynns Falls Valley, Gunpowder Gorge, Soldiers Delight, Calvert Cliffs, Conowingo Barrens, Zekiah Swamp, Devil's Racecourse, Great Falls of the Potomac, and Pocomoke River Swamp. Literally hundreds of

features could justifiably be included in this list. Many already enjoy some degree of protection; others do not. Planners and developers are strongly encouraged to examine and consider such geologic features in the planning process. For additional information on digital data and paper maps, see *Appendix A.*

Additional Reading: There are many publications that describe the geology of different regions in the United States and many publications that describe the methods and various values associated with the protection of historic landscapes, scenic areas, and geologic feature. One of these publications, *Outstanding Scenic Geologic Features of Pennsylvania* (Geyer and Bolles, 1979), contains hundreds of examples plus a list of criteria by which features were judged to be outstanding. Another publication, *Catalog of Natural Areas in Maryland* (Metzgar, 1968), contains a somewhat dated list of 184 natural areas and features, and is still an excellent starting point for the types of features to be considered for protection.

Agency Contacts: Potential local sources of information include college faculty (especially geology and geography departments); local government geologists and hydrologists; State Park rangers and superintendents; members of local rock, gem, and mineral clubs; and local environmental groups. A number of organizations and agencies can provide further information including: Scenic America, Maryland Geological Survey of the Maryland Department of Natural Resources, and the Maryland Office of Planning. For a complete list of agency contacts, including addresses, telephone numbers, and web page addresses, see *Appendix B.*

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APPENDIX

Appendix A: Guide to Mapping

Maps, Charts, Data

Tidal Wetlands Inventory (TWI) Maps, 1971, Maryland Department of the Environment
TWI maps provide detailed site information at a low scale 1:2,400 (1 inch = 200 feet) and are used for determining the boundaries of wetlands that are regulated by the State of Maryland Tidal Wetlands regulations.

Maps are available only as blue line copies from the Geological Survey Publications Office, Maryland Department of Natural Resources, 2300 St. Paul Street, Baltimore, MD 21218, Phone: (410) 554-5505.

National Wetland Inventory (NWI) Maps and Data, U.S. Fish and Wildlife Service
NWI maps provide a large scale representation of the extent and location of tidal wetlands in Maryland 1:24,000 (1 inch = 2,000 feet) and are primarily used for general screening and planning purposes.

Blueline copies are available from the Geological Survey Publications Office, Maryland Department of Natural Resources, 2300 St. Paul Street, Baltimore, MD 21218, Phone: (410) 554-5505.

Information about the U.S. Fish and Wildlife Service, National Wetlands Inventory (NWI) program and wetlands. Data are available over the Internet. The National Wetlands Inventory Internet address is: (http://www.nwi.fws.gov). Wetland data can be retrieved using anonymous ftp. (Enterprise.nwi.fws.gov)

Countywide or Statewide data are available through the Maryland Department of Natural Resources.

Maryland Department of Natural Resources Wetland Data
The Department is developing the next generation of digital wetland (tidal and nontidal) maps. The project will result in ortho-photo quarter quadrangles at a scale of 1:12,000 (1 inch = 1000 feet) and will depict newly photo-interpreted wetlands boundaries. These new digital data sets are available for some counties and will be completed for all counties in a few years. DNR Wetlands Data will be used in the same way as NWI maps but will contain greater detail, however, TWI maps continue to provide the only official delineation for tidal wetlands regulatory boundaries.

Countywide or Statewide data are available through the Maryland Department of Natural Resources.

Sensitive Species Project Review Areas (SSPRA) Maps and Data
Data on rare threatened and endangered species have been combined with other wildlife data and called Sensitive Species Project Review Areas (SSPRA) maps.

Data sets are available as two distinct products: 1) the Technology Toolbox data are for individual counties and are designed to work with the Maryland Office of Planning's Maryland Property View parcel mapping product; and 2) Statewide data are also available in formats suitable for geographical information systems (GIS). For more information, please contact Kenneth M. Miller, Maryland Department of Natural Resources, Chesapeake and Coastal Watershed Service, Geographic Information Services Division, 580 Taylor Avenue, D-2, Annapolis, Maryland 21401, Phone: (410) 260-8750, Fax: (410) 260-8759 or e-mail at kenmiller@dnr.state.md.us.

SAV Data, Maps, Atlases and Survey Reports for the Chesapeake Bay, its Tributaries, and Chincoteague Bay
The first baywide survey was conducted in 1978. Survey reports for years since this date provide information on past SAV distribution and abundance, loss of habitat and recovery of habitat. Survey maps are developed using aerial photographs taken during the growing season and compiled with additional ground truth information in reports by Robert J. Orth.

Reports are available from the Chesapeake Bay Program, Publications Office, 410 Severn Ave., Suite 109, Annapolis, MD 21403, Phone: (410) 267-5773

SAV maps (scale 1:24,000 / 1 inch = 2,000 feet) are available as blueline copies from the Maryland Geological Survey at $4 per copy.

Updated SAV data and Bathymetric Soundings data are available via the Virginia Institute of Marine Science Web Page/Chesapeake Bay Program's Web page (http://www.epa.gov/r3chespk).

Natural Oyster Bar (NOB) Charts
NOB charts delineate Maryland's natural oyster bars as defined by the Bay Bottom Survey. This survey was completed by the Maryland Department of Natural Resources (DNR) in the early 1980s. There are 41 charts for Maryland with a scale of 1:20,000. Also available are charts of privately leased oyster bottom in Maryland. In areas of the Bay that allow clamming, clamming can occur only in those areas that are not charted as NOB. Copies of Oyster Bar Charts are available from Louis Wright, Natural Resources Police, Maryland Department of Natural Resources, Phone: (410)643-6521.

Maps and Data on Eroding Shorelines
Historical changes in shorelines, both erosion and accretion, have been determined by analysis of historical maps and aerial photographs. Average long-term erosion rates and gains can be calculated by dividing amount of shoreline lost or gained by the number of years between the dates of the maps and/or aerial photographs.

Paper maps are available from the Maryland Geological Survey (scale 1:24,000/ 1 inch = 2,000 feet) compiled in 1986 for 7.5-minute quadrangles covering the Chesapeake Bay, the Potomac River, and the Atlantic Coast. A map series is in production with both digital and hard copy for quadrangles (scale of 1:24,000) around the Bay; 56 maps have been completed, primarily for the western shore of the Bay. Customers of Maryland Geological Survey are requested to call ahead to make arrangements for viewing or obtaining copies of maps. The contact is: Mr. Dale Shelton, Publications Office, Maryland Geological Survey, 2300 St. Paul Street, Baltimore, MD 21218, Phone: (410) 554-5505.

Digital shorelines based on NOAA's nautical charts is available via the Chesapeake Bay Program's Web page (http://www.epa.gov/r3chespk). Bathymetric Soundings data are also available from the Bay program. Bathymetric, water depth data sets are updated annually.

Tidal Floodplain Maps

The Federal Emergency Management Agency (FEMA), National Flood Insurance Program (NFIP) produces maps that are based on studies performed by the Virginia Institute of Marine Sciences. Additional wave height studies have been conducted to delineate coastal high hazard areas and these are included on the NFIP maps. However, shorelines that are significant specifically because they are subject to erosion, have not been included on these maps. For updated information on mapping in Maryland, consult the updated Maryland Geographic Information Systems Resource Guide and Maryland Geologic Survey List of Publications.

The Maryland Geological Survey requests that customers call ahead to make arrangements for viewing or obtaining copies of maps. The contact is Mr. Dale Shelton, Publications Office, Maryland Geological Survey, 2300 St. Paul Street, Baltimore, MD 21218, Phone: (410) 554-5505.

The Maryland Department of the Environment, in partnership with FEMA and the Maryland Department of Natural Resources, anticipates completion of digitized floodplain mapping by 1999. For information on digital data sets that are available, contact Kenneth M. Miller, Maryland Department of Natural Resources, Chesapeake and Coastal Watershed Service, Geographic Information Services Division, 580 Taylor Avenue, D-2, Annapolis, MD 21401, Phone: (410) 260-8750, Fax: (410) 260-8759 or e-mail: kenmiller@dnr.state.md.us.

Maryland Nontidal Wetland Guidance Maps

Produced by the Department of Natural Resources, are available only for the purpose of identifying the general location of wetlands. There are no regulatory maps depicting the location and boundaries of nontidal wetlands in Maryland. Maryland Nontidal Wetland Guidance Maps show the U.S. Fish and Wildlife, National Wetland Inventory (NWI) data, and the general locations of Wetlands of Special State Concern. Regulatory wetland delineations are made through the use of the official Federal Wetland Delineation Manual and include an onsite analysis of soils, vegetation, and hydrologic factors.

Nontidal Wetland Guidance Maps and NWI maps are available from the Maryland Department of Natural Resources, Chesapeake and Coastal Watershed Service, Geographic Information Services Division, 580 Taylor Avenue, D-2, Annapolis, MD 21401, Phone: (410) 260-8750, Fax (410) 260-8759.

Wetlands of Special State Concern
Wetlands of Special State Concern are delineated and regulated by the Maryland Department of the Environment. The Department of Natural Resources, Geographic Information Service Division is developing maps of these areas that will be available soon.

For further information contact Kenneth M. Miller, Maryland Department of Natural Resources, Chesapeake and Coastal Watershed Service, Geographic Information Services Division, 580 Taylor Avenue, D-2, Annapolis, MD 21401, Phone: (410) 260-8750, Fax: (410) 260-8759 or e-mail: kenmiller@dnr.state.md.us.

Groundwater Data
The Maryland Department of the Environment maintains the Community Wells Database which integarates well construction information with data on aquifer characteristics. A geographic information system (GIS) is being developed which will integate the Community Wells data with digitized maps, digitized point source data that identifies potential contaminant sources, and with other databases that contain information about water quality.

Mineral Resources Maps
The Maryland Geological Survey has produced numerous maps and reports about the mineral resources of Maryland. Mineral resource maps are available for Anne Arundel, Baltimore County and Baltimore City, Calvert, Caroline, Carroll, Charles, Dorchester, Kent, Prince George's, Queen Anne's, St. Mary's, Somerset, Talbot, Wicomico, and Worcester Counties. Lands for Potential Mineral Resource Development maps are available for Allegany (excluding coal), Anne Arundel, Baltimore County and City, Carroll, Cecil, Frederick, Garrett (excluding coal), Harford, Howard, Montgomery, Prince George's, and Washington Counties. These maps are at a scale of 1 inch equals approximately 1 mile. Thus, they are somewhat general and should not be used for site-specific evaluations. Mineral resources are also discussed in various reports of the Maryland Geological Survey.

Maryland Comprehensive Forest Resources Inventory
Data sets provide information about the forest resources in Maryland. Data sets will be available to counties from the State Forest Service, Maryland Department of Natural Resources, within a year.

The Maryland Greenways Atlas
Contains a brief description of existing and potential greenways in each Maryland county and Baltimore City along with a map showing protected lands and the general location of greenway corridors. For the purpose of this atlas, a greenway is considered as an "existing" greenway only if it has some form of permanent protection and a management plan. Existing greenways, greenways currently in the planning or conceptual stage, and potential greenways are represented by arrows which provide a general location for these corridors. Contact Teresa Moore (410) 260-8780.

Integrated Natural Resource Assessment
A statewide natural resources assessment is underway in the Maryland Department of Natural Resource's Watershed Management and Analysis Division. This project will include identification of a statewide green infrastructure, focusing on areas with high ecological value. This document will provide a consistent, science-based method for targeting land conservation and restoration efforts. Contact John Wolf for further information (410) 260-8794.

Agricultural Land
The Maryland Office of Planning can provide maps and assistance. Data, including 1990 Land Use Maps, are available from the Maryland Office of Planning, Planning Data Unit, (410) 767-4450. Soil Survey Maps for Maryland Counties may be inspected at the Maryland Office of Planning library, Phone: (410) 225-4458.

Land use data and data sets on the location of streams and forest buffers are being developed by the Department of Natural Resources. Digital data are available from the Department of Natural Resources as two distinct products: 1) the Technology Toolbox data are for individual counties and are designed to work with the Maryland Office of Planning's Maryland Property View parcel mapping product; and 2) Statewide data are also available in formats suitable for geographical information systems (GIS). For more information, please contact Kenneth M. Miller, Maryland Department of Natural Resources, Chesapeake and Coastal Watershed Service, Geographic Information Services Division, 580 Taylor Avenue, D-2, Annapolis, MD 21401, Phone (410) 260-8750, Fax: (410) 260-8759 or e-mail: kenmiller@dnr.state.md.us.

Geologic Maps
Geologic maps are available for most counties in Maryland (scale 1 inch equals approximately 1 mile) and for several dozen of the more than 250 7.5-minute quadrangles covering Maryland. County topographic maps (1 inch equals approximately 1 mile) are published by Maryland Geological Survey, and 7.5-minute quadrangle topographic maps (1 inch equals 2000 feet) are published by the U.S. Geological Survey for the entire State.

Geologic Maps are sold by the Maryland Geological Survey. Customers are requested to call ahead to make arrangements for viewing or obtaining copies. The contact is Mr. Dale Shelton, Publications Office, Maryland Geological Survey, 2300 St. Paul Street, Baltimore, MD 21218, Phone: (410) 554-5505.

Appendix B: Agency Contacts

Environmental Law Institute
web page at www.eli.org.

Maryland Department of Agriculture, Maryland Agricultural Land Preservation Foundation, 50 Harry S. Truman Parkway, Annapolis MD, (410) 841-5860

Maryland Department of the Environment, 2500 Broening Highway, Baltimore MD 21224, General Information Switchboard: (410) 631-3000

Tidal Wetlands Division, (410) 631-8075
Nontidal Wetlands Division, (410) 974-3841
Shellfish Harvest Water Quality Certification, (410) 631-3906
National Flood Insurance Program State Coordinating Office, (410) 631-4164
Well Construction, (410) 631-3784
Water Rights Division, (410) 631-3591
Groundwater Permits Program, (410) 631-3779
Public Drinking Water Program, (410) 631-3702
Oil Control Program, (410) 631-3386
Groundwater Coordination/Wellhead Protection Program, (410) 631-3714
Environmental Restoration and Redevelopment Program, (410) 631-3437
Solid Waste Program, (410) 631-3318
RCRA Program, (410) 631-3343

Maryland Department of Natural Resources, Public Information, (410) 260-8000
Headquarters Office, Tawes State Office Building, B-2, 580 Taylor Avenue, Annapolis MD 21401

Chesapeake Bay Critical Area Commission, 45 Calvert Street, Second Floor, Annapolis MD 21401, Main Number: (410) 974-2426
Maryland Geological Survey, (410) 554-5559, 2300 St. Paul Street, Baltimore MD 21218-5210
  Publications Office, (410-554-5505)
  MGS Library, (410-554-5524)
  Coastal & Estuarine Geology Program, (410) 554-5544
  Hydrogeology & Hydrology Program, (410) 554-5550
Fisheries Service, (410) 260-8250
  Fish Passage Program, (410) 260-8250
  Oxford Lab, (410) 226-0078
Natural Resources Police, Technical Services Division, (410) 643-6521
Environmental Review Unit, (410) 260-8330
Tributary Strategies Program, (410) 260-8710
Maryland Greenways Commission, (410) 260-8780
Heritage and Biodiversity Conservation Programs
- Lynn Davidson, Database Manager, (410) 260-8540

- Larry Hindman, Waterfowl Project Manager, (410) 827-8612
- Lori Byrn, Waterbird Biologist, (410) 260-8540

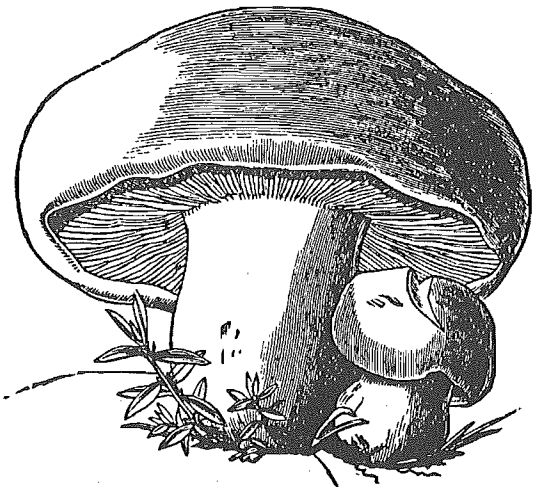
Shore Erosion Control Program, (410) 260-8531
Forest Service, (410) 260-8531

Maryland Office of Planning, 301 West Preston Street, Baltimore MD 21201-2365, Main Switchboard: (410) 767-4500, Fax: (410) 767-4480
Planning Data Services (mapping), (410) 767-4450
Library, (410) 767-4458
Planning Assistance and Neighborhood Development, (410) 767-4550

Scenic America, 21 Dupont Circle N.W., Washington, DC 20036, (202) 833-4300

United States Environmental Protection Agency
Wetlands Protection telephone hotline: 1-800-832-7828

United States Environmental Protection Agency, Region 3, Office of Groundwater, Water Management Division, 841 Chestnut Street, Philadelphia PA 19107, (215) 597-2786
Chesapeake Bay Program, 410 Severn Avenue, Suite 109, Annapolis MD 21403, (410) 267-5700
Publications, 1-800-968-7229.



Appendix C: Model Ordinance - Protection of Scenic Sensitive Areas

Section ___, Scenic Sensitive Areas

The Comprehensive Plan of [name of jurisdiction] recommends protection of certain views and vistas associated with specific public vantage points. These views, vistas, and public vantage points shall be mapped in the Comprehensive Plan, on the Zoning Map, or other map of suitable character that is officially adopted as part of this ordinance. The [Board of County Commissioners] finds that the protection of the areas designated by and in accordance with this [Section, Article] help protect the public health, safety, and welfare, and further, that the regulations in this [Section, Article] will substantially advance these legitimate public purposes.

1. Scenic Areas designated for protection as "Sensitive Areas" are as follows:

   (a) The view of [name of the area], as seen from [name of the public vantage point], looking [e.g., in an easterly direction], as mapped on [e.g., the Zoning Map as a Scenic Overlay Zone].

   (b) [Repeat format in 1(a) for each additional area]

2. This subsection is intended to minimize adverse visual impacts upon the public views and vistas associated with designated Scenic Areas. Certain development and land use activities shall be regulated to assure minimal visual intrusiveness from public vantage points. The following methods shall apply: use sensitive site planning, building design, and type of materials; appropriate scale, height, and bulk of development and activities; limits upon parking, on-site activities, and storage; and effective visual buffering. This subsection is not intended to prevent development of specific uses that may be permitted as a matter of right by zoning, however, the Board of Appeals retains its authority to deny a requested special exception per [Article ___, Section ___] of the Zoning Ordinance.

3. The following procedures and regulations shall apply.

   (a) The Zoning Administrator, Planning Commission, and Board of Appeals shall review applications submitted to them as approving authorities under the zoning ordinance and subdivision regulations to determine if the proposed use of the property generally falls within a designated Scenic Area and has likely potential, if unconditionally approved, to adversely affect public views or vistas associated with Scenic Areas. The assessment of adverse effect shall include aspects of scale, bulk, materials, height, storage, mechanical equipment, signage, lighting, glare, smoke, fumes, parking, and traffic normally or reasonably associated with the proposed use.

   (b) A determination of "potential adverse effect" by the approving authority shall cause the application to be evaluated by the Planning Commission. The Planning Commission shall apply Section ___, Special Design Objectives and Standards, and may exercise authority otherwise granted to it by the zoning ordinance and subdivision regulations, for the purpose of minimizing and eliminating adverse impacts on public views of the Scenic Area. The Planning Commission shall require, as part of this process, that the applicant submit a site plan for the proposed use of the property.

(c) The Planning Commission must approve, approve with conditions, or deny with reasons in writing, the site plan within 60 days of receiving or making a determination of potential adverse effect. A failure of action by the Planning Commission within the prescribed time period shall constitute approval of the site plan with respect to protection of Scenic Areas.

(d) An approved site plan shall be referred back to the approving authority for ultimate disposition of the application, with the provision that any and all conditions imposed by the Planning Commission including the approved site plan, shall apply and be made part of the approving authority's action on the application.

Section ___, Special Design Objectives and Standards

The purpose of this section is to establish regulations to control site design, building design, land clearing and alteration, and other visual aspects of development proposed in designated scenic areas.

The Planning Commission shall apply the following objectives and design standards in order to minimize, insofar as possible, the adverse impacts of proposed development upon public views and vistas associated with designated scenic areas.

(A) Prohibited Uses

The following uses shall be prohibited:

Junkyards, salvage yards, sewerage disposal, solid waste disposal, used car lots, mobil home sales, auto or motorcycle speedways, and outdoor storage, except where ancillary to a permitted primary use.

(B) Objectives

1. Assure that the height, bulk, and location of all proposed buildings minimize adverse impacts on scenic views, insofar as possible, through the design standards listed below, by retaining and creating forested and vegetative buffers and earth berms, or as may otherwise be lawfully imposed through the Zoning Ordinance and Subdivision Regulations, and other land use and environmental laws and regulations.

2. Assure that mechanical equipment, on-site storage, and on-site activities and processes do not adversely affect public views. This shall be accomplished through low-visibility man-made screening, natural buffering, careful site planning, and control of placement and size of signs.

3. Assure parking lots and ingress and egress to the site are situated, designed, and buffered so as to minimize adverse impacts on public views.

4. Assure that obtrusiveness of structures and activities, including those by virtue of height, bulk, and materials are eliminated or minimized by careful site and building design, buffering, and use of impact-reducing techniques.

(C) Design Standards

1. Signage:

(a) Off-premise signs or advertising shall not be permitted.

(b) Flashing, rotating, or animated signs shall not be permitted.

(c) Signs shall be in accordance with the following standards:

Commercial/Retail Uses: For each establishment, a maximum of two signs attached to the building facade will be permitted; the total sign area shall not exceed 25 square feet. In addition, the Planning Commission, upon review, may approve one freestanding sign, not to exceed an area of 48 square feet and not to exceed 20 feet in height, and shall be for the purpose of identifying a group of businesses or an individual business. In its review of proposed freestanding signs, the Planning Commission shall evaluate the likely adverse impact on designated scenic areas and shall consider the proximity and number of freestanding signs already existing and in view from the public vantage point.

Industrial Use: A business sign may be placed on the front face of the building and shall be limited to an area equal to two times the length of the building's face, but shall not exceed 100 square feet in area. In addition, one free-standing sign, not to exceed an area of 48 square feet and a height of 12 feet, will be permitted for the purpose of identifying an establishment.

Residential Use: A sign may be placed at each entrance to a residential subdivision or community. The sign shall not exceed an area of 48 square feet or a height of 6 feet.

2. Parking, Loading, and Storage Areas

All parking, loading, and outdoor storage areas shall be sited and designed to minimize adverse visual impact on a scenic area. Landscape trees and shrubs shall be provided to adequately screen these areas, as determined by the Planing Commission.

3. Landscaping

All open portions of a lot not improved for buildings, parking, loading, driveways, or walkways, shall be adequately landscaped with trees in order to minimize visual impacts, as determined by the Planning Commission.

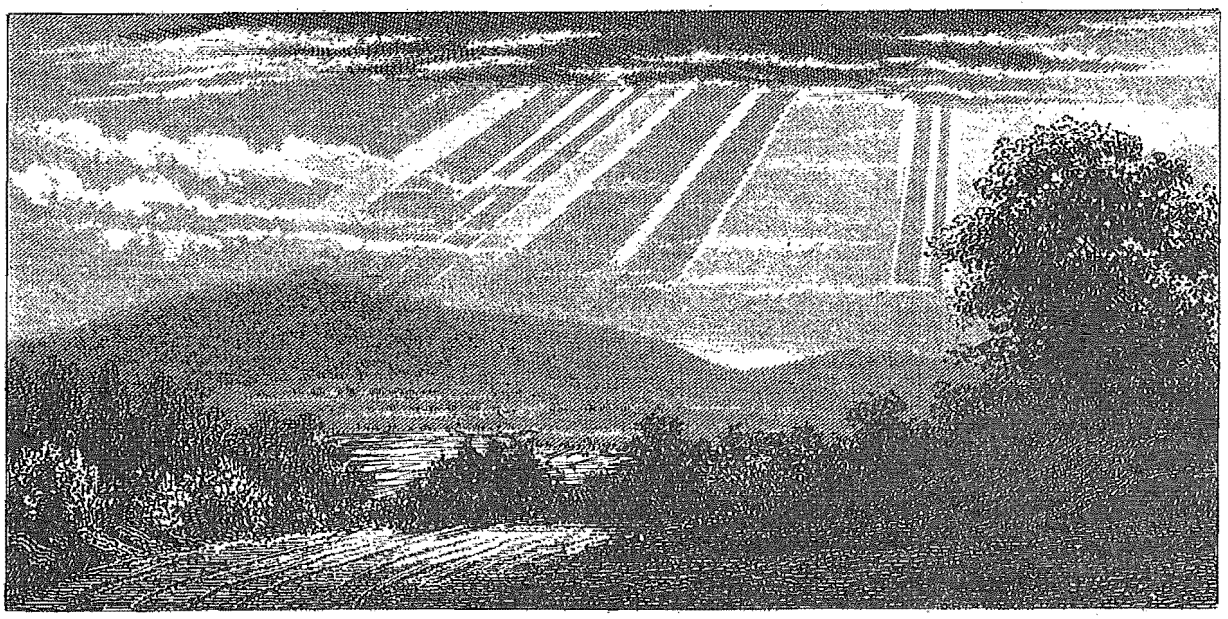
4. Existing Trees

Retention of trees shall be maximized to the extent possible. Trees of six inch diameter (at breast height) or larger shall not be destroyed, cut, or removed except when removal is necessary for maintenance purposes or for enhancement of important views, and where determined by the Planning Commission to be absolutely necessary to accommodate development. The intent is to preserve the natural beauty and environmental benefits of wooded areas as much as possible.

(D) Design Review

All plans to develop land located in a designated scenic area shall be submitted to, reviewed, and decided by the Planning Commission. Such plans may include, as determined by the Planning Commission, site plans, building designs, signage plans, and other plans that describe the plans for development and scenic protection on the subject site.

(E) Appeals shall be made to the Board of Zoning Appeals as specified in [Section ___] of the Zoning Ordinance.



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