SECTION II: WETLANDS INVENTORY AND BASELINE

Regional Description of Maryland's Wetlands

The following wetland descriptions are summarized from *Wetlands of Maryland* (Tiner and Burke, 1995). In these descriptions, wetland distribution, occurrence and type are characterized according to the five physiographic Provinces of Maryland.

<u>Coastal Plain Province</u>
This region likely has the highest diversity of emergent estuarine and palustrine (freshwater) wetland communities in the state, since both tidal and nontidal freshwater marshes occur here. Wetlands are abundant in the Coastal Plain due to the low topographic relief and high groundwater table characteristic of the region.

Estuarine Wetlands
Estuarine wetlands are common throughout the Coastal Plain. These systems consist of salt and brackish tidal waters and contiguous wetlands where ocean water is at least occasionally diluted by freshwater runoff from the land. These wetlands extend extensively upstream in tidal rivers to freshwater areas. Differences in salinity and tidal flooding within estuaries have a significant effect on the distribution of these wetland systems. Salt marshes occur on the intertidal shores of tidal waters in areas of high salinity. Brackish marshes are the predominant estuarine wetland type in Maryland. They are found along the shores of Chesapeake Bay, mostly on the Eastern Shore, and for considerable distance upstream in coastal rivers. Estuarine shrub swamps are common along the Maryland coastal zone. Aquatic beds, comprised mostly of submerged aquatic vegetation, are abundant in shallow water zones of Maryland's estuaries, especially the Chesapeake Bay and its tributaries.

Palustrine Wetlands
Forested wetlands are the most abundant and widely distributed palustrine wetland type on the Coastal Plain. These wetlands are found on floodplains along the freshwater tidal and nontidal portions of rivers and streams, in upland depressions, and in broad flat areas between drainages. Tidal freshwater swamps occur along coastal rivers in areas subject to tidal influence. Semi-permanently flooded swamp forests, uncommon to Maryland, are found along Battle Creek on the Western Shore and the Pocomoke River on the lower Eastern Shore. Seasonally flooded swamp forests occur in these same areas as well as part of Calvert, Somerset, Wicomico, and Worcester Counties. Temporarily flooded swamp forests occur on isolated floodplains, in isolated depressions surrounded by uplands, or in interstream divides, and are particularly abundant on the Eastern Shore. Scrub-shrub swamps are not abundant on the Eastern Shore. Bog wetlands are rare in Maryland; sixteen have been identified in Anne Arundel, Charles, and Prince Georges Counties on the Western Shore. Emergent wetlands on the coastal plain comprise both tidal and nontidal freshwater marshes and are highly diverse wetland communities. Tidal fresh marshes are common along large coastal rivers, such as the Nanitcoke, Chester, Choptank, Pocomoke, Patuxent, and Potomac Rivers. Interdunal wet swales are found on Assateague Island. Seasonally flooded marshes are common to the coastal plain. On the Eastern Shore,

isolated wetlands, commonly referred to as potholes or Delmarva Bays, are most common in Caroline, Kent, and Queen Anne's Counties.

Piedmont Province

Overall, wetlands are less abundant and diverse in the Piedmont Province compared to the Coastal Plain, due to greater topographic relief, regional geology, a lower groundwater table and lack of tidal influence. Isolated palustrine and riverine wetlands are common in the region. Forested wetlands within the Piedmont are typically found on floodplains in stream valleys and are characterized by the relatively short frequency and duration of flooding (seasonally flooded and temporarily flooded forested wetlands). Scrub shrub wetlands are found in wide river floodplains, valleys and meadows. Emergent wetlands can occur in areas of former forested wetlands that were cleared for agricultural, meadows and valleys and are characterized by the greater frequency and duration of flooding (seasonally flooded marshes and meadows, and temporarily flooded wet meadows). The greater duration and frequency of flooding typically favors emergent plant species over scrub shrub and forested plant communities.

Western Maryland Provinces

The Appalachian Plateau, Valley and Ridge, and Blue Ridge Provinces comprise the region of western Maryland. Wetlands are uncommon in this region when compared with other regions of Maryland. Wetlands are often found in topographic depressions and associated with riverine and palustrine environments. Although less common, the wetlands of western Maryland are rather diverse, including forested, scrub-shrub (wet thickets and shrub bogs), emergent (seasonally-flooded wet meadows and marshes), palustrine (aquatic bed), riverine, and lacustrine (aquatic bed) wetlands.

Wetlands and Water Resources of Maryland

The following is an abbreviated version of *"An Overview of Maryland's Wetlands And Water Resources"* (Clearwater et al., 2000). The original document was prepared for the Maryland Wetland Conservation Plan Work Group (January 2000) to provide background information during Plan development. The complete document can be viewed at the MDE, Wetlands and Waterways Program website at: http://www.mde.state.md.us/wetlands/.

<u>General Description</u>

In total surface area, Maryland is the eighth smallest state in the nation. The State comprises 23 counties, the two largest being Frederick and Garrett Counties and the two smallest being Calvert and Howard Counties. Baltimore is an independent city occupying 80 square miles (Tiner and Burke, 1995). Maryland contains portions of two major U.S. ecoregions; the eastern portion of the state, roughly from Baltimore and Montgomery Counties east, falls within the Southeastern Mixed Forest, while the western section of the state is in the Appalachian Oak Forest (Bailey, 1978). Maryland also includes the majority of the Chesapeake Bay, which has a dominant influence on the region's climate, biological resources, and economy (Tiner and Burke, 1995).

Maryland's 9,837 square miles of land area lie in five distinct physiographic provinces, making it one of the most geologically and hydrologically diverse states in the northeastern United States. The five physiographic provinces, from east to west, include: the Coastal Plain, the Piedmont, the Blue Ridge, the Valley and Ridge and the Appalachian Plateau (Figure 1).

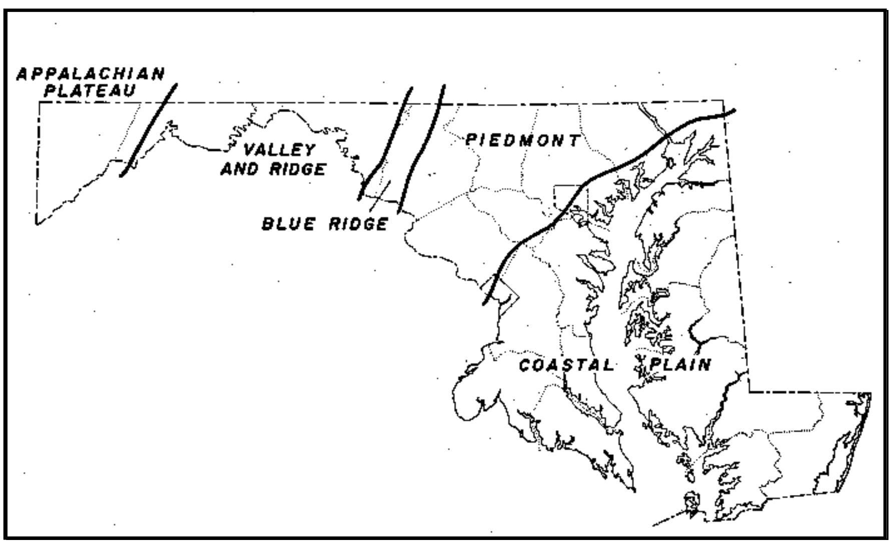

Figure II-1. Distribution of the five physiographic provinces of Maryland: Appalachian Plateau Province, Valley and Ridge Province, Blue Ridge Province, Piedmont Province and Coastal Plain Province (Tiner and Burke, 1995).

The topography of Maryland is highly variable; the land surface elevation increases gradually from the Atlantic Ocean across the Coastal Plain, and then increases rapidly over the Piedmont Province and the ridges of the Appalachian Plateau, culminating in the highlands of the

Allegheny Plateau in Garret County. The boundary between the Piedmont and Coastal Plain Provinces is commonly known as the 'Fall Line', because of the dense concentration of falls throughout the area, and is characterized by rapid changes in geologic, topographic and hydrologic features.

Definitions of Wetlands

There are many definitions of wetlands that have been developed by different groups, for different purposes. Like most ecological systems they may be characterized in different ways, depending on whether one is looking at habitats, natural processes, and other factors. The challenge for governmental organizations has been to develop definitions that not only describe what a wetland is, but to do so in a way that can be used to determine whether or not a given area is wetland, and where a wetland "boundary" begins and ends. The ability for a definition to allow one to delineate or put a "line" around a wetland, becomes important when legal issues arise.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service developed a scientifically based definition of the Nation's wetlands for resource management purposes and to help ensure accurate and consistent wetland determinations. "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes:

1) At least periodically, the land supports predominantly hydrophytes
2) The substrate is predominantly undrained hydric soil
3) The substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of the year." (Cowardin et. al. 1979)

Federal Agencies

Federal agencies define wetlands for regulatory and planning purposes. The U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA) define wetlands as follows: "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

State of Maryland

The State of Maryland defines wetlands for regulatory purposes, recognizing three main types of wetlands: nontidal wetlands, private tidal wetlands, and state tidal wetlands. Each wetland type is defined by their spatial distribution, hydrology, vegetation, and soils.

Nontidal Wetlands. Nontidal wetlands are "(a) an area that is inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation; (b) is determined according to the Federal Manual; (c) does not include tidal wetlands regulated under Natural Resources Article, Title 9, Annotated Code of Maryland." The Code of Maryland Regulations (COMAR) defines the following specific types of wetlands: emergent, farmed, forested, isolated and scrub-shrub.

The State has identified *nontidal wetlands of special State concern* which are “areas designated (COMAR 26.23.06.01) as having exceptional ecological or educational value of Statewide significance.” These wetlands are designated using the following criteria (COMAR 26.23.06.04):

a) Provide habitat or ecologically important buffers for the habitat of plant and animal species:
   (i) Listed as endangered or threatened by the U.S. Fish and Wildlife Service
   (ii) Listed as endangered or threatened, or species listed as in need of conservation by the Department of Natural Resources
   (iii) Considered to be a candidate for listing by the U.S. Fish and Wildlife service, or considered to be locally unusual or rare by the Department of Natural Resources
b) Are unique natural areas or contain ecologically unusual natural communities

The State also recognizes nontidal wetlands containing "Significant plant or wildlife value:

(a) of the following unusual or unique community types: (i) Bogs, (ii) Areas with bald cypress, Atlantic white cedar, red spruce, balsam fir, or American larch that contain at least 20 percent of these species in any strata as determined by the Federal Manual, or (iii) Delmarva Bays
(b) with water discharge that maintains minimum stream base flow important for maintaining plant and wildlife species
(c) with threatened or endangered species, or species in need of conservation
(d) adjacent to Class III or Class IV waters defined in COMAR 26.08.02.08
(e) of Special State Concern
(f) supporting vernal pools
(g) that is regularly or periodically influenced by tidal waters"

Tidal Wetlands Tidal wetlands are defined as "all State and private tidal wetlands, marshes, submerged aquatic vegetation, lands, and open water affected by the daily and periodic rise and fall of the tide within the Chesapeake Bay and its tributaries, the coastal bays adjacent to Maryland's coastal barrier islands, and the Atlantic Ocean to a distance of 3 miles offshore of the low water mark" (COMAR 26.24.01.02).

Vegetated tidal wetlands are also mapped by the State. State maps have been used since 1972 to identify the regulatory boundaries of wetlands under the jurisdiction of the Maryland Tidal Wetlands Act. According to the state maps, there are approximately 200,000 acres of vegetated tidal wetlands. Tidal wetlands include both fresh and brackish systems, with emergent, shrub, and forested vegetation. More recent aerial photographs, from the 1980’s and 1990’s, are used for guidance purposes (refer to Section IV, Goal 3 I for further discussion of Tidal Wetland maps).

State Tidal Wetlands State tidal wetlands are “any land under the navigable waters of the State below the mean high tide, affected by the regular rise and fall of the tide. Tidal wetlands of this category which have been transferred by the State by a valid lease, patent, or grant confirmed in Article 5 of the Maryland Declaration of Rights are considered private tidal wetlands to the extent of the interest transferred.”

Private Tidal Wetlands Private tidal wetlands are "a) land not considered State wetland bordering on or lying beneath tidal waters, which is subject to regular or periodic tidal action and supports aquatic growth; b) tidal wetlands transferred by the State by a valid lease, patent, or grant confirmed in Article 5 of the Maryland Declaration of Rights, to the extent of the interest transferred; and c) tidal waters created by the excavation of upland unless conveyed to the State."

<u>Wetland Distribution</u>
Wetlands may be permanently flooded by shallow water, permanently saturated by groundwater, or periodically inundated or saturated for varying periods during the growing season in most years. Many wetlands are the periodically flooded lands that occur between uplands and salt or fresh water bodies (ie., lakes, rivers, streams and estuaries). Other wetlands may be isolated in areas with seasonally high water tables that are surrounded by upland or occur on slopes where they are associated with groundwater seepage areas or drainageways. Wetlands are important natural resources providing numerous values to society, including fish and wildlife habitat, flood protection, erosion control and water quality preservation. Wetlands comprise a range of environments within interior and coastal regions of Maryland (Figure 2).

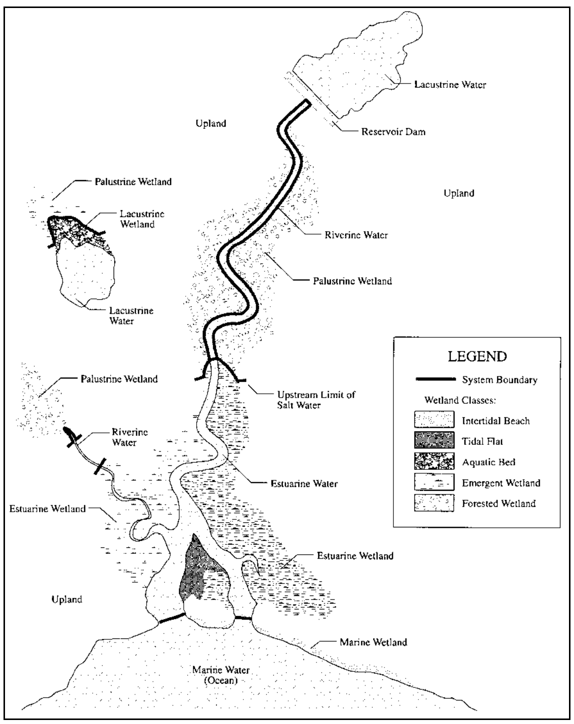

Figure II-2. Illustration of the predominant wetland classes that may be present in a continuum of lacustrine, riverine, palustrine, estuarine and marine environments of Maryland (Tiner and Burke, 1995).

<u>Distribution of Wetlands by County</u>
About 10 percent of the state is classified as wetland. Wetlands are most abundant on the Eastern Shore of the Coastal Plain, occupying 16 percent of the land area. Figure II-3 gives an overview of the distribution of Maryland's wetlands acreage by county and Table II-1 summarizes the total acreage and percent acreage in each county, by wetland type. The counties with the most wetlands acreage in the State are Dorchester County, with 28.3 percent, and Somerset County, with 13.6 percent. Baltimore City, a substantially urbanized area, has the least wetland acreage with 0.04 percent. Of the coastal wetlands of Maryland, more than one third (36.4%) are located

in Dorchester County and more than one quarter (26.0%) are located in Somerset County (McCormick and Somes, 1982).

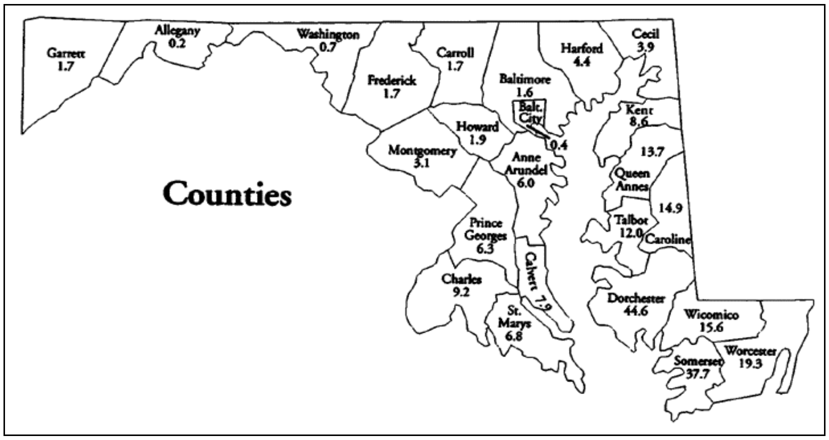

Figure II-3. Distribution of Maryland's wetlands by percent total acreage for each county (Tiner and Burke, 1995).

Table II-1. Wetland acreage for each county in Maryland as of 1981/1982, including wetland type, total wetland acreage and total percent of state (rounded to the nearest acre). Note: Acreages of palustrine wetlands may be conservative, especially for Eastern Shore Counties where temporarily flooded and seasonally saturated wetlands are difficult to identify (Tiner and Burke, 1995).

County	Estuarine Wetland Acreage	Palustrine Wetland Acreage	Riverine, Lacustrine, Marine Wetland Acreage	1981-1982 Total Acreage	Total Percent of the State	1988-90 Total Acreage
Allegany	--	612	5	617	0.10	
Anne Arundel	2,774	13,202	180	16,156	2.7	16,225
Baltimore City	64	155	31	250	0.04	
Baltimore County	2,491	3,384	367	6,242	1.0	
Calvert	3,630	7,077	--	10,707	1.8	10,734
Caroline	2,121	28,027	366	30,514	5.1	
Carroll	--	4,229	562	4,791	0.80	
Cecil	2,184	6,646	188	9,018	1.5	
Charles	4,909	21,755	22	26,686	4.5	27,010
Dorchester	100,529	68,259	380	169,168	28.3	
Frederick	--	7,243	82	7,325	1.2	
Garrett	--	7,068	14	7,082	1.2	
Harford	6,649	5,863	15	12,527	2.1	
Howard	--	2,977	140	3,117	0.50	
Kent	3,706	11,570	37	15,313	2.6	
Montgomery	--	9,566	133	9,699	1.6	
Prince Georges	2,019	17,309	188	19,516	3.3	19,470
Queen Anne's	8,453	24,040	18	32,511	5.4	
St. Mary's	6,600	9,671	25	16,296	2.7	16,730
Somerset	62,408	19,155	--	81,563	13.6	
Talbot	9,781	9,993	193	19,967	3.3	
Washington	--	2,101	9	2,110	0.40	
Wicomico	14,277	23,141	343	37,761	6.3	
Worcester	18,954	39,603	929	59,486	9.9	
Total	251,549	342,649	4,227	598,425	100	

Distribution of Wetlands by Watershed

As part of the National Wetland Inventory (NWI), U.S. Geological Survey hydrologic units (USGS, 1974) were used to determine the total acreage of wetlands throughout the State. This system defines 23 major watersheds in Maryland and names them based on the major rivers draining each geographical area (Figure 4) (Tiner and Burke, 1995). This information is illustrated in Figure II-4 and total wetland acreage for each watershed is summarized in Table II-2.

Table II-2. Total wetland acreage in Maryland, by watershed, as defined by U.S. Geological Survey hydrologic units (U.S.G.S, 1974). Data presented are from National Wetland Inventory (NWI) maps and do not include acreage of the narrow streams and wetlands mapped as linear features or wetland and waterways too small to depict on NWI maps (Tiner and Burke, 1995).

U.S.G.S. Hydrologic Unit	Watershed	Total Wetland Acreage
*2040205	*Christina	75
2050306	Susquehanna	1,079
2060001	Chesapeake Bay Shoreline	31,001
2060002	Chester, Sassafras, Elk, Wye and Miles	50,480
2060003	Patapsco, Gunpowder and Bush	20,593
2060004	Severn and Magothy	11,807
2060005	Choptank	85,655
2060006	Patuxent	33,972
2060007	Blackwater, Transquaking and Chicamacomico	118,537
2060008	Naticoke	46,651
2060009	Pocomoke	99,458
2060010	Chincoteague Bay	24,811
2070002	Savage, Wills and North Branch Potomac	1,577
2070003	Town Creek, North Branch Potomac, Fifteen Mile Creek, Cacapon and Sideling Hill Creek	206
2070004	Antietam, Conocoheague and Licking Creek	1,875
2070008	Catoctin and Seneca	8,749
2070009	Monocacy	8,390
2070010	Anacostia, Rock Creek, Piscataway Creek, Pain Brush and Indian Creek	7,032
5020006	Youghiogheny and Casselman	5,964
2070011	Wicomico, St. Mary's and Lower Potomac, Mattawoman Creek, Port Tobacco Creek,	40,134

* The majority of the Christina watershed lies in south-central Pennsylvania and only a small portion is located within the state of Maryland.

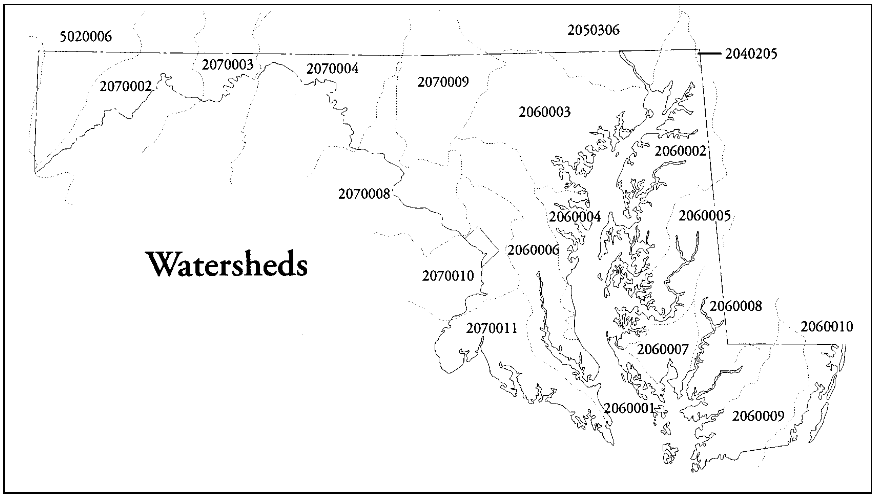

Figure II- 4. Distribution of the 23 major watersheds of Maryland based on the U.S. Geological Survey hydrologic units (USGS, 1974).

Based on the State designation, the twenty major watersheds are identified in Maryland. Many of these watersheds correspond with the USGS hydrologic unit designations with a few exceptions where smaller watersheds have been combined. Like the USGS designations, the Maryland designations are named after the primary river drainage(s) within the geographical area.

<u>Coastal Wetlands</u>
As shown in Table II-3, 66.4 percent of the coastal (tidal) wetlands in Maryland are located in the Pokomoke and Nanticoke River Basins (both part of the Lower Eastern Shore watershed) and the Choptank River Basin on the Eastern Shore.

Table II-3. Total acreage and percent acreage of coastal wetlands in the major watersheds of Maryland (McCormick and Somes, 1982).

Sub-Basin Designation	**Watershed**	**Acres**	**Percentage of Total Acreage**
02-12-02	Lower Susquehanna River	841	0.3
02-13-01	Coastal Area	17,225	6.6
02-13-02	Pocomoke River	53,246	20.4
02-13-03	Nanticoke River	83,409	31.9
02-13-04	Choptank River	36,877	14.1
02-13-05	Chester River	16,204	6.2
02-13-06	Elk River	3,848	1.5
02-13-07	Bush River	5,992	2.3
02-13-08	Gunpowder River	2,599	1.0
02-13-09	Patapsco River	819	0.3
02-13-10	West Chesapeake River	3,419	1.3
02-13-11	Patuxent River	6,773	2.6
02-13-99	Chesapeake Bay	21,321	8.2
02-14-01	Lower Potomac River	8,438	3.2
02-14-02	Washington Metropolitan Area	298	0.1
	Total	**261,309**	**100.0**

Tidal wetlands are abundant on the lower Eastern Shore of the Coastal Plain and cover extensive areas (Figure II-5). Tidal wetlands are distinguished by their flood regime: wetlands flooded at least once per day are considered “low marsh” and those flooded less than once per day are considered “high marsh.” High marshes are typically flooded by high spring or storm tides. During the current post-glacial period, the gradual rise of sea level has resulted in the conversion of vegetated tidal wetlands to open water areas, and the conversion of forested nontidal wetlands to tidal marsh. Sea level rise has also inundated 16,721 acres of estuarine-forested wetlands, equivalent to 6.7 percent of Maryland’s total estuarine wetlands acreage.

Eighty-two percent, 205,815 acres, of Maryland’s estuarine wetlands are emergent, thus making it the most common estuarine wetland type. Non-vegetated estuarine wetlands include 10.5 percent of the total acreage of estuarine wetlands. These coastal wetlands are extremely important to the Chesapeake Bay ecosystem and Maryland’s economy (Figure II-6).

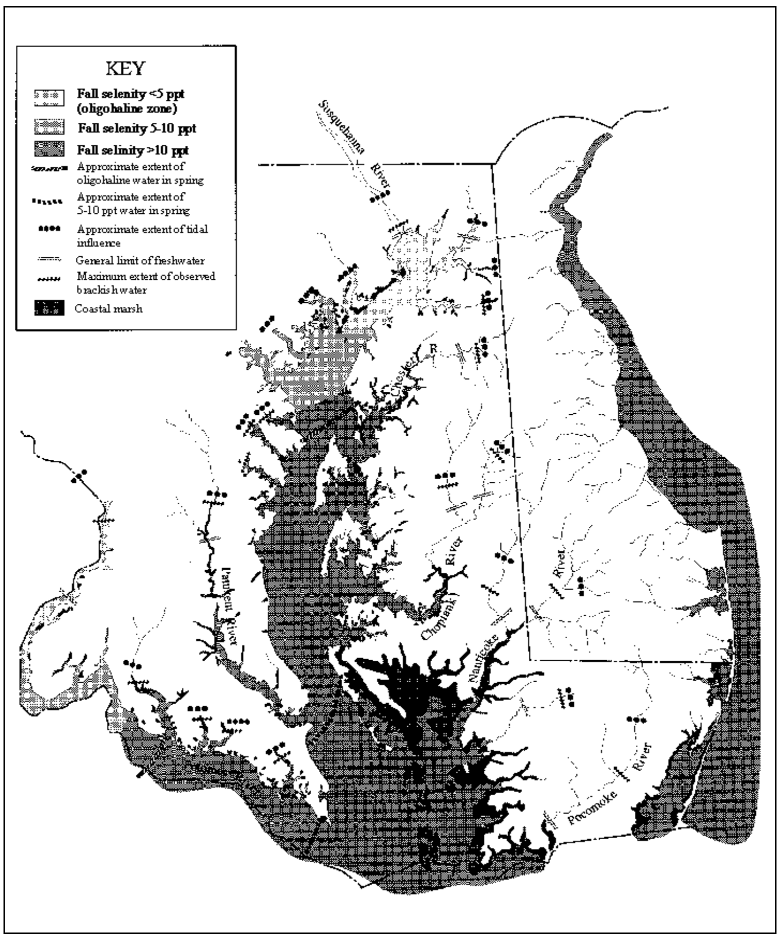

Figure II-5. Distribution of Maryland’s estuarine and tidal fresh marshes in Chesapeake Bay and its major tributaries (Tiner and Burke, 1995).

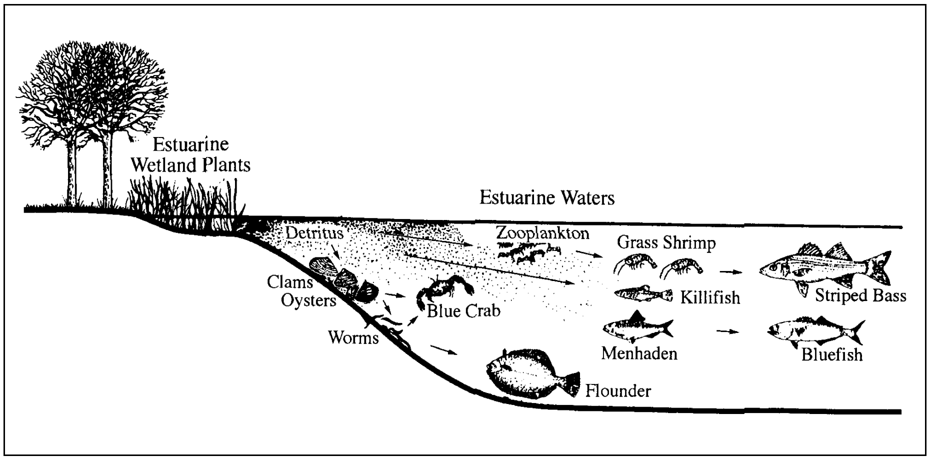

Figure II-6. Tidal marshes are the estuarine farmlands that produce tons of food each year that support Chesapeake Bay's living aquatic resources and ultimately, provide food for human consumption. Simplified food pathways from tidal marsh plants to commercial and sport fishes of value to humans are simplified for illustration (Tiner and Burke, 1995).

The following is a summary the predominant type(s) of wetland in each watershed. The Upper Eastern Shore (including the Chester and Elk River basins) contains mostly freshwater marshes but also some brackish high marshes. The Lower Eastern Shore (including the Nanticoke and Pokomoke River basins) contains a high amount of brackish high and low marshes, and submerged aquatic wetlands. The Choptank watershed contains mostly brackish high marshes and submerged aquatic wetlands. The Upper Western Shore (including the Bush, Gunpowder and Lower Susquehanna River Basins) and Patapsco watersheds predominately contain freshwater marshes. The Lower Western Shore, or West Chesapeake, watershed contains brackish high marshes and submerged aquatic wetlands. The Patuxent watershed contains almost equal proportions of freshwater marsh and brackish high marshes. The Lower Potomac contains mostly brackish high marshes. The Middle Potomac or Washington-Metro watershed contains mostly brackish high marshes, but also contains the highest percent of coastal wooded swamps in the state (26.8%). There are no coastal wetlands in the Upper Potomac watershed.

Nontidal Wetlands

Generally, the Eastern Shore nontidal wetlands are characteristically low and flat. These nontidal wetlands are often difficult to identify and delineate due to the minor variations in regional topography and the similarity of wetland vegetation to vegetation found in surrounding uplands. On the Lower Eastern Shore, the wetlands may cover broad areas. Predominantly clay rich soils, which have slow drainage and form confining layers, help to retain ground water in these wetlands. Landscapes on the Upper Eastern Shore have steeper grades, and wetlands tend to be less extensive and have more rapid drainage. Caroline, Kent, and Queen Anne's Counties have the most abundant numbers of a unique wetland type commonly called a Delmarva Bay. These wetlands are usually isolated from surface water drainage systems and are elliptical in shape with sandy rims. Rare plant species are often found in these wetlands on the Eastern Shore. Other wetland rare plant communities on the Eastern Shore include those with Bald cypress and Atlantic white cedar.

On the Western Shore of the Coastal Plain, wetlands have more varied topography and are generally easier to delineate in comparison to wetlands on the Eastern Shore. These wetlands are often located near streams, although the prevalence of long-term overbank flooding is rare in these areas. Most Western Shore wetlands are supported by localized, perched water tables than by shallow groundwater.

Nontidal Wetlands of Special State Concern.
Nontidal wetlands of Special State Concern are some of the most ecologically important of Maryland's nontidal wetland habitats and are designated for special protection under the State's nontidal wetland regulations. These 358 wetland sites have exceptional ecological and educational value and offer landowners opportunities to observe and safeguard the beauty and natural diversity of Maryland's remaining wetlands. Many of these special wetlands contain populations of rare and endangered native plants and animals. Other nontidal wetlands of Special State concern represent examples of unique wetland types and collective habitats for species that thrive in specialized environments. Examples of these special types of wetlands are bogs, Delmarva bays and coniferous swamp forests. Bogs are highly acidic wetlands that lack the nutrients most common plants require and, therefore, provide habitat for specific communities of plants and animals. The Delmarva Bays are depressions on the Eastern Shore that fill with water in the winter and spring, and dry in the late summer and fall. Because these environments are isolated and their supporting characteristics in the landscape are limited , they support many rare and unique species. Coniferous swamp forests are uncommon to Maryland and found in areas such as Garrett County.

Wetlands Conservation
Although Maryland has lost 45-65 percent of its original wetlands, many of which were drained for agricultural purposes, wetlands remain quite abundant. Increased federal and State efforts in wetland restoration may eventually help achieve a net gain in wetlands, provided wetland regulatory programs maintain effective control of existing wetland resources (Tiner and Burke, 1995). Government regulatory programs have improved wetland conservation by providing for better protection of wetlands than at anytime before. As populations expand, there will be increased demand for development of commercial, resort, and residential real estate that will undoubtedly place additional pressure on remaining wetlands. To date, the public has supported wetland protection efforts by recognizing the important water quality, flood storage, wildlife habitat, and other functions that wetlands perform. (Tiner and Burke, 1995).

In addition, wetlands can be negatively impacted by water quality problems throughout the State. While many wetlands provide water quality improvement functions, and are valued for this service, the wetlands do have limits to their capacity for filtering pollutants. Although control of point sources of water pollution such as industrial effluents and municipal wastewater treatment plants, is improving the quality of many of Maryland's waterways, urban and agricultural runoff continue to degrade water quality. Improved techniques for storm water discharge treatment, riparian habitat management and employment of best management practices on farmland and managed forests, may further enhance water and wetland quality (Tiner and Burke, 1995).

Water Resources of Maryland

A comprehensive assessment of existing water resources (including detailed, physical data) is important for planning of future development adjacent to streams, implementing flood control measures, determining the potentialities for public water supplies, and managing wetlands throughout the state. The two major sources of water in the State of Maryland are surface water and ground water.

Mitsch and Gosselink (1986) stress the importance of hydrologic processes with respect to wetlands. The following is a summary of the basic components of wetland hydrology. Hydrology is the single most important determinant for the establishment and maintenance of wetlands and wetland processes. The hydrology of wetlands creates the unique physical and chemical conditions that make these ecosystems different from upland, terrestrial systems and deepwater aquatic systems. Hydrologic pathways including groundwater, precipitation, surface water (surface runoff, river floods) and tides transport energy, sediment and nutrients to and from wetlands. Hydrologic parameters, such as water depth, flow patterns and the duration and frequency of flooding, which are the result of all of the hydrologic inputs and outputs, influence the biochemistry of wetland soils and are major factors in the selection of wetland biota. Because wetlands are intermediate environments, between terrestrial and deepwater aquatic systems, they are particularly sensitive to changes in local and regional patterns of water storage, water movement and fluctuations of the water table. The hydrologic budget of wetlands includes the following factors: 1) the balance between the inflows and outflows of surface water and/or groundwater; 2) surface contours of the landscape which affect retention of water at a site; and 3) subsurface soil, geology and groundwater conditions.

The availability of surface water and groundwater greatly influences the distribution of wetlands and types of wetlands present in the different physiographic regions of Maryland. The following is an overview of surface water and groundwater resources for the five physiographic provinces of Maryland, including general information about water chemistry, quality, availability, sources and uses.

Surface Water Resources

Surface water is almost wholly derived from rivers in various drainage basins throughout the State. There are no large natural lakes, and saline waters cover the extensive swamps along the shores of Chesapeake Bay. The major drainage basins of Maryland are illustrated in Figure II-4, by USGS hydrologic unit, and in Figure II-5 by the Maryland designation. The streams in the Piedmont and Appalachian Provinces tend to have fairly steep gradients and flow over underlain by bedrock. Numerous rapids and gorges afford opportunities for waterpower development, particularly adjacent to the Fall Line (the boundary between the Piedmont and Coastal Plain Provinces). This energy source was utilized locally by early grain and cotton mills, however, current potential for hydroelectric power has declined (Vokes and Edwards, 1974).

In the Coastal Plain Province, streams have lower gradients and meandering channel forms, and are underlain by unconsolidated, fine-grained deposits (gravel, sand, silt, clay). These streams flow into tidal estuaries before reaching the Chesapeake Bay. On the Coastal Plain, the Eastern Shore streams usually have a longer main stem, where the Western Shore streams (except for the

Patuxent and Potomac) may have more and larger tributaries. The larger streams are navigable in their lower course, but for many streams the head of navigation is now several miles downstream from its original position (Vokes and Edwards, 1974). This loss of navigable waters is caused by the process of siltation; the filling in of drainage systems caused by increased soil erosion resulting from poor farming practices within the Coastal Plain (Vokes and Edwards, 1974) as well as soil erosion in the Piedmont.The volume of water conveyed by streams (the discharge) varies according to seasonal changes in climate and severe storms. In highly developed and agricultural areas, water runs over the land surface rapidly during heavy precipitation events, greatly increasing stream discharges. In wooded or heavily vegetated areas, water is intercepted as it flows over land, reaching streams more gradually (Figure II-7). This aids in the reduction of flood-related stream discharges and promotes lower, sustained flows and less variation between high and low water stages. This in turn promotes stream channel stability by reducing the potential for erosion commonly associated with storm events. Periods of highest stream discharges generally occur in spring months when average precipitation and snowmelt are combined to produce unusually large volumes of water (Figure II-8). In addition, maximum flooding events are produced by the torrential rains associated with tropical storms, which are common events in Maryland (Vokes and Edwards, 1974).

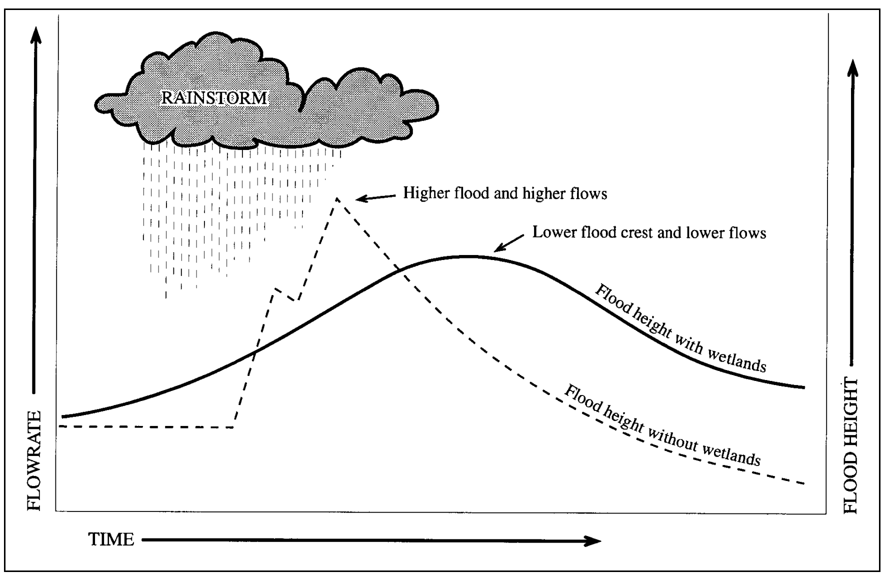

Figure II-7. Wetlands provide important flood control functions in watersheds. They reduce flood volumes and flow rates by delaying peak flood volumes after rainstorms (Tiner and Burke, 1995).

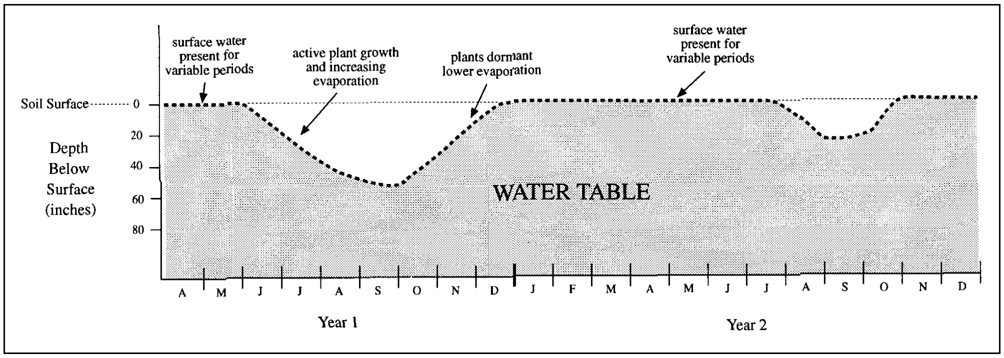

Figure II-8. An example of water table fluctuations in a seasonally flooded wetland; the water table is at or near the surface through winter and early spring, drops markedly through summer and rises through fall. The water table can fluctuate daily, seasonally and annually (Tiner and Burke, 1995).

Groundwater Resources

Coastal Plain ground water occurs under unconfined (water table) and confined (artesian) conditions. The water supply in unconfined aquifers fluctuates with recharge from rain, resulting in fluctuations (often seasonal) of the water table. Confined aquifers are recharged at their outcrop areas and by movement of water through overlying and adjacent rock units, and are less effected by surface precipitation. Because the Coastal Plain aquifers store enormous volumes of water, the supply of ground water is treated as infinite in local studies of ground water availability. The major aquifers of the Coastal Plain Province are contained in the Patuxent, Patapsco, Magothy, Aquia and Piney Point Formations, the Chesapeake Group, and Quaternary sediments. The Patuxent, Patapsco, and Magothy Formations contain aquifers that are most important for water supply in regions nearest the Fall Line. The Aquia Formation is an important aquifer in southern Maryland and portions of the Eastern Shore. The Piney Point Formation is an important aquifer also in portions of southern Maryland and the central Eastern Shore. The Chesapeake Group and Quaternary aquifers are most important on the lower Eastern Shore (Somerset, Wicomico, and Worcester Counties).

Significant quantities of ground water occur in the igneous and sedimentary rock units of the Piedmont Province. Movement of water through these rocks is restricted but water is extracted through fractures, saprolite (fractured and weathered upper layer of bedrock), and topographically low areas such as valleys, where bedrock is highly fractured. Ground water supplies are usually sufficient for most domestic and commercial needs. Many municipal, industrial and irrigation water needs are provided by surface water supplies.

Ground water sources in western Maryland are variable within the Blue Ridge, Valley and Ridge, and Appalachian Plateau Provinces. In the Blue Ridge Province, ground water occurs in fractures and saprolite, which provide adequate amounts of water for domestic uses. Most large water supplies (such as industrial uses) are obtained from springs and surface water. In the Valley and Ridge Province, ground water is most abundant in the Great Valley and Allegany Ridge areas. Ground water occurs in large, interconnected solution channels in limestone and dolomite rocks of the Great Valley. This water supply can be plentiful but can produce very low yields in some wells. Ground water occurs in sedimentary rocks of Allegany Ridge, with secondary productivity from fracturing and solution of bedrock. Most wells in this region produce only enough water for domestic, light commercial, and some agricultural uses.

Historic Wetland Inventories

Stakeholders interested in wetland management are fortunate to have many information sources available for reference. Maryland has not only has numerous inventories of wetlands from the past, but has had a complete set of wetland maps since the 1980's. A second set of more detailed maps is nearly complete.

The earliest known wetland acreage estimates for Maryland date from the turn of the century. The *Report of the Maryland Conservation Commission for 1908-1909* (1909) described what are now considered nontidal wetlands, as freshwater swamps and marshes. The purpose of the survey at the time was to identify which wetlands could be drained or otherwise converted for agricultural and other uses. The description and accompanying photographs suggest that these lands were flooded most of the year or were immediately adjacent to surface water bodies. The report was extremely vague as to what constituted the divisions of "large" or "small" wetlands. No description is included of how the survey was conducted or what maps or information may have been used. Wetland acreage estimates of "large" wetland tracts are listed for each county, but no complete estimates can be calculated because of the unspecified "small" wetlands. A total of 118,912 acres of freshwater swamps were located in coastal counties. It is unknown how many of these acres were tidally influenced. In the central and western counties, 5,440 acres of large swamp tracts were identified. In addition, there were over 170,000 acres of small swamps and marshes on farmland. The total amount of freshwater wetlands based on the casual definitions of the time, was nearly 300,000 acres (Clearwater, unpublished).

In 1956, the U.S. Fish and Wildlife Service published *Wetlands of the United States: Their Extent and Their Value For Waterfowl and Other Wildlife,* also known as *Circular 39*, the first attempt to classify wetlands. Wetlands were characterized by their hydrology (inland versus coastal, open water versus shallow water) and major vegetation, such as swamp, marsh or bog. Seven of the twenty wetland types defined fit the current description of nontidal wetlands. Wetlands were also evaluated according to their functions as waterfowl habitat. The report additionally addresses issues affecting wetlands conservation and preservation and uses of the inventory, including water control, land use planning, and flyway management.

Data from Maryland that was prepared for a state report (*Wetlands of Maryland*, U.S. Fish and Wildlife Service, Office of River Basin Studies, 1954), in conjunction with *Circular 39*, was obtained from aerial photographs, U.S. Geological Survey quadrangle maps, and field investigations. The purpose of the report was to address concerns about the loss of wildlife habitat through increased rates of wetland drainage, fill, and pollution and a commitment by the U.S. Fish and Wildlife Service to adopt a program of integrated land use planning for the State. The report also identifies the general values of wetlands to wildlife, improvement of wetlands for wildlife, and land use changes affecting wetlands. Only the Coastal Plain was surveyed for this report. The report concluded that over 90% of Maryland's wetlands were found in the Coastal Plain. Only contiguous wetland tracts over 40 acres in size were included in the study which estimated a total of 77,460 acres of inland, freshwater wetlands present.

The next inventory, *Classification and Inventory of Wildlife Habitats in Maryland*, was conducted by the Maryland State Planning Department (1965) from statewide aerial photography. The photography was taken by the Maryland Department of Game and Inland Fish (1962-1964), supplemented by material from the Maryland Soil and Water Conservation Needs Inventory (1960). The photographic interpretation involved analysis of more than 2500 100-acre sample plots distributed randomly throughout the state. The plots represent a four percent sample of the state's total land area, which was thought to provide a reliable estimate of the extent of various wildlife habitats. There was no mention of the scale of the photographs, which precludes accurate comparisons of wetland acreage. Wetlands were evaluated in terms of game habitat, and classified as wooded swamp, shrub swamps, freshwater marsh, saltwater marsh, and agricultural wet meadows. The first four types may be considered comparable to today's nontidal wetland classifications, though some may have been tidally influenced. Swamps were said to occur along watercourses and marshes were considered "semi-inundated". Wet meadows included areas such as peat bogs, patchy swamps and wet areas with marsh vegetation. The total statewide estimated acreage for these wetlands was 295,000, the majority of which were wooded swamps.

In 1967-68, a statewide planning survey was conducted using extensive fieldwork. The publication *Wetlands In Maryland* (Department of State Planning, No. 157, 1973) evaluated all wetlands, using the classification system of *Circular 39,* that were over 5 acres in size. In addition to field investigations, aerial photographs were interpreted and indicated that substantial losses occurred during the previous decade. The total estimated loss was calculated by comparing [then] recent U.S. Geological Survey maps with those dated back to 1942. Within this period, there was a 15.3% loss of inventoried wetlands, bringing the 1968 estimate of identified nontidal wetlands to 74,457 acres.

Table II-4a. Summary of historic wetland acreage loss based on hydric soils.

County	Historic Acreage	Present Acreage	Acreage Loss	% Acreage Loss
Allegany	7,300	617	6,683	92
Anne Arundel	38,805	16,156	22,649	58
Baltimore County	27,350	6,242	21,108	77
Calvert	14,270	10,707	3,563	25
Caroline	68,958	30,514	38,444	56
Carroll	13,164	4,791	8,373	64
Cecil	25,450	9,018	16,432	65
Charles	66,318	26,686	39,632	60
Dorchester	253,629	169,168	84,461	33
Frederick	16,980	7,325	9,655	57
Garrett	68,870	7,082	61,788	90
Harford	18,300	12,527	5,773	32
Howard	8,744	3,117	5,627	64
Kent	31,208	15,313	15,895	51
Montgomery	29,044	9,699	19,345	67
Prince George's	41,647	19,516	22,131	53
Queen Anne’s	86,929	32,511	54,418	63
St. Mary's	49,578	16,296	33,282	67
Somerset	167,456	81,563	85,893	51
Talbot	64,325	19,967	44,358	69
Washington	5,271	2,110	3,161	60
Wicomico	129,165	37,761	91,404	71
Worcester	186,750	59,486	127,264	68
TOTAL	**1,419,511**	**598,172**	**821,339**	**58**

1) Historic wetland acreage was calculated using acreage of "potential" hydric soils in Maryland by county based on SCS mapping (Tiner and Burke, Wetlands of Maryland, 1995, p. 74). The use of hydric soils is believed to yield an over-estimation of historic wetland acreage, based on comparison with actual digitized soil surveys.
2) Present wetland acreage was estimated by visual interpretation of NWI (National Wetland Inventory) maps compiled in the early-mid 1980's (Tiner and Burke, *Wetlands of Maryland*, 1995). The use of NWI maps is believed to yield an under-estimation of present wetland acreage

Wetland acreage loss was calculated by subtracting present wetland acreage from historic wetland acreage. Percent wetland acreage loss was calculated by dividing wetland acreage loss by historic wetland acreage (multiplied by 100). Based on 1 and 2, the calculation of the percent acreage loss is likely too high.

Wetland acreage figures do not include submerged aquatic vegetation.

Table II-4b. Summary of historic wetland acreage loss and voluntary wetland gains.

County	Historic Acreage	Present Acreage	Acreage Loss	Wetland Gains 1998-2001
Allegany	7,300	617	6,683	11
Anne Arundel	38,805	16,156	22,649	39
Baltimore County	27,350	6,242	21,108	47
Calvert	14,270	10,707	3,563	10
Caroline	68,958	30,514	38,444	210
Carroll	13,164	4,791	8,373	199
Cecil	25,450	9,018	16,432	99
Charles	66,318	26,686	39,632	85
Dorchester	253,629	169,168	84,461	1184
Frederick	16,980	7,325	9,655	19
Garrett	68,870	7,082	61,788	51
Harford	18,300	12,527	5,773	105
Howard	8,744	3,117	5,627	32
Kent	31,208	15,313	15,895	469
Montgomery	29,044	9,699	19,345	26
Prince George's	41,647	19,516	22,131	207
Queen Anne’s	86,929	32,511	54,418	543
St. Mary's	49,578	16,296	33,282	93
Somerset	167,456	81,563	85,893	1326
Talbot	64,325	19,967	44,358	496
Washington	5,271	2,110	3,161	10
Wicomico	129,165	37,761	91,404	513
Worcester	186,750	59,486	127,264	1192
TOTAL	**1,419,511**	**598,172**	**821,339**	**6,966**

Maps and Analytical Tools

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Many of the data and analytical tools that are available in Maryland are derived from remotely sensed source materials and are often produced using unique geospatial technologies for particular applications. These data and tools must be thoroughly understood to ensure that they are applied properly in wetland management efforts.

Wetland Maps

National Wetlands Inventory (NWI) – U.S. Fish & Wildlife Service
The National Wetlands Inventory is a statewide digital coverage of wetlands, typed using the U.S. Fish and Wildlife Service's (FWS) official wetlands classification system (Cowardin), by dominant vegetation, hydrology, soils and other properties. NWI digital wetland coverages were produced from 1980 to 1989 using black and white, color infrared, or natural color aerial photograph film transparency at scales ranging from 1:20,000 to 1:132,000. NWI produced 255 maps, at a scale of 1:24,000.

NWI Limitations
Maps produced prior to 1980, during NWI's operational testing of the system, tend to underestimate wetland acreage by omission. Identification of wetlands using photo interpretation has several inherent problems, which limit the accuracy of the final maps.

1) Photo interpretation is never as accurate as field delineation.
2) Identification is not exact since wetlands are transitional areas between upland and aquatic environments and boundaries are often difficult to delineate.
3) The accuracy of identification and mapping of wetlands depends on the landscape setting (local topographic variation) and wetland type. For example, palustrine forested wetlands are most difficult to map using photo interpretation.
4) The scale at which certain wetland types are mapped varies. The NWI target mapping unit (tmu) is defined as the size class of the smallest group of wetland that NWI attempts to map consistently.

NWI Strengths
Maps produced after 1980 are more accurate for several reasons:

1) Better technical understanding of the concept of the definition of a wetland.
2) Changes in mapping technology such as the use of color infrared photography versus black and white photography and larger scale photography.
3) Improved procedures such as increased level of quality control and field review. In many areas of the country, NWI maps are the only wetland maps available for planning and management purposes. In Maryland, Department of Natural Resources (DNR) digital ortho-quarter-quad (DOQQ) wetland data is available for most of the Coastal Plain and Piedmont regions. NWI maps are more accurate in identifying wetlands than USGS topographic maps.

Nontidal Wetlands Guidance Maps

Nontidal wetland guidance maps were created when the nontidal wetlands protection program was implemented in 1989, to assist permit reviewers and the public in determining the extent and nature of nontidal wetlands. These maps were produced digitally and displayed the NWI digital data over SPOT 10-meter panchromatic satellite imagery. The maps also showed the locations of Wetlands of Special State Concern as they were mapped at that time by the Heritage Program of the Department of Natural Resources. The maps were produced at 1:24000 scale using the standard USGS 7.5' tile system. Maps are today produced only for an entire County.

Limitations.

These maps have omission and commission errors based on individual wetland types. They were also affixed in time and were quickly out of date. No effort was made to keep them up-to-date and they were phased out of production in 1997. The Department of Natural Resources large scale DOQ wetland mapping effort was intended to replace this map series.

Tidal Wetland Maps of Maryland - Maryland Dept. of the Environment

The first major task of the State in implementing the Wetlands Act was to map the upland boundary of the tidal wetlands to establish regulatory jurisdiction for privately owned wetlands. It should be noted that the majority of wetlands evaluated under the Maryland Program are State owned wetlands which include low marsh and open water. The Tidal Wetland Maps of Maryland were completed in 1972 using low-altitude photographs of tidally influenced areas of the coastal and interior bays of Maryland. These maps have not been formally updated since 1972. MDE staff make formal amendments to the maps on a parcel-by-parcel basis for areas that are no longer tidally influenced (refer to Section IV, Goal 3 I for discussion of uses and limitations).

Natural Resources Inventory (NRI) – U.S. Dept. of Agriculture, Natural Resource Conservation Service (NRCS)

The Natural Resources Inventory is a statistically based database of land use and natural resource conditions and trends on United States nonfederal lands. The 1997 NRI has been designed and implemented using scientific principles to assess conditions and trends of land cover and use, soils, wetlands, habitat diversity, selected conservation practices and related resource attributes at more than 800,000 sample sites. At each sample point, information is available for 1982, 1987, 1992, and 1997, so that trends and changes in land use and resource characteristics over a 15-year time period can be examined and analyzed. From 1995 to the present, NRCS has conducted special small-scale inventories each year to supplement the major NRI database. The 1997 NRI data covers all 50 States, Puerto Rico, the U.S. Virgin Islands and some Pacific Basin locations.

Purpose and Uses

Information derived from the NRI is used by natural resource managers; policy makers and analysts; consultants; the media; other Federal agencies; State governments; universities; environmental, commodity, and farm groups; and the public. NRI information and data on natural resources and environmental conditions is used to formulate effective public policies, fashion agricultural and natural resources legislation, develop State and National conservation programs, allocate USDA financial and technical assistance in addressing natural resource concerns, and enhance the public's understanding of natural resources and environmental issues.

Limitations
NRI relied heavily on remote sensing, computer-based technologies, and aerial photography, which introduce interpretative inconsistencies similar to those of NWI. Because NRI is a statistical sampling of natural resource attributes and conditions, it does not represent a comprehensive resource inventory. Rather, it is best used as a tool to identify current and future natural resource status and trends.

Department of Natural Resources (DNR) Wetland Maps
This map series is created by combining new 1:12000 scale wetland interpretations with color infrared imagery. The hardcopy map sheets are typically produced at a scale of 1:8400 and printed on demand. The classification system is consistent with the Cowardin et al. 1979 classification protocol used by the National Wetlands Inventory. The orthophoto base maps are complete for the state at this time. The wetlands delineations are complete for all areas east of Washington County, except for four quarter quadrangles in Howard County. Washington County and portions of Allegany County are in production. Complete coverage of the State should be available in 2003.

Purpose
These data provide consultants, planners, and resource managers with more precise information on wetland location and type. The data were collected to create a reasonably accurate wetlands baseline for Maryland and assist in wetland/resource management efforts such as those undertaken by wetland regulatory programs, the Chesapeake Bay Program, Coastal Bays Program, and the Coastal Zone Management Program.

Methods
The interpretations are made on 1:40000 scale color infrared diapositive film using conventional manual stereoscope techniques. The interpreters use ancillary data including soil surveys and the existing NWI maps, and they field check photo signatures prior to work in new areas. Delineated wetland boundaries are digitally transferred and registered to the DNR 3.75' DOQ maps. The digital data files include feature lead lines and labels, in addition to standard attribution, to assist in paper map production. Quality control steps occur throughout the photo interpretation, data management and map production processes. All photo interpretable wetlands are delineated. In general the minimum mapping unit is 1/4 acre depending on the wetland type. Precise delineation of wetlands is very difficult In regions where evergreen forested wetlands predominate and in areas obscured by dense forest cover, therefore, a detailed on-the-ground and historical analysis of these sites may result in significant revisions to the photographic interpretation. In addition, small wetlands can be obscured by a variety of land covers and may not be included in this data set.

Use and Limitations
The DNR-DOQQ wetlands inventory utilizes the U.S. Fish and Wildlife wetland definition and classification system (Cowardin, 1979). Federal, State, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory (Cowardin, L.M., V. Carter, F. Golet, and E. LaRoe, 1979).

Shoreline Change Maps - Maryland Geological Survey (MGS)

The Maryland Geological Survey (MGS) has produced a series of shoreline change maps, which depict historic shorelines for the Chesapeake Bay from 1849, 1942, and 1962. There are approximately 100 maps covering all of tidewater Maryland: the main stem of the Chesapeake Bay, its tidal tributaries, and the Atlantic coastal bays. Currently, the MGS is updating 15 of the shoreline change maps for the northern coastal bays of Maryland, to include the 1989 shoreline and calculate land loss from the period from 1942 to 1989. Digital shorelines were compiled from existing maps and digital wetlands delineation, displayed over recent orthophotography, and plotted as 7.5-minute shoreline change maps. To the extent that past conditions can help predict future changes, examining previous shoreline positions may reveal the reaches of shoreline most susceptible to erosion. The digital data will facilitate future shoreline updates and comparisons, as well as GIS-based research and decision-making, regarding the Maryland's coastal and interior bays.

FEMA Floodplain Maps

Floodplain maps are intended for use as guidance or reference maps to aid in regulatory determinations in areas where floodplain studies have not been performed and detailed hydraulic and hydrologic conditions are unknown. Digital floodplain maps are completed and available for distribution for the following counties: Allegany, Anne Arundel, Baltimore City, Baltimore County, Calvert, Caroline, Carroll, Cecil, Dorchester, Frederick, Harford, Kent, Prince George's, Queen Anne's, Somerset, Saint Mary's, Talbot, Washington, Wicomico and Worcester. For the several counties, floodplain maps are completed but are not available for distribution due to data ownership issues: Charles, Garrett, Howard and Montgomery. The maps are coded using standard Federal FIPS codes (also used by FEMA) and should be used to order or reference individual maps. Maps are also organized by county. The format of the maps is Map Info, and the projection uses State Plane '83 meters.

Limitations

The major limitation to the FEMA digital floodplain maps is that they may only be used for planning (not regulatory) purposes. This is because the placement of flood lines may shift when digitized. Regulatory decisions should be made using the FEMA paper maps. Other limitations of the county digital floodplain maps are that scale varies by county (depends on area); file sizes are equal to 1-2 MB per map which may be cumbersome; cost is approximately $500-$1,000 per map; and copyright and use restrictions apply to a single user and ownership.

Digital Soil Survey Maps, Natural Resource Conservation Service (NRCS)

The Maryland National Resource Conservation Service (NRCS) is currently in the process of updating and digitizing existing County soil survey maps. Map availability and timeframe for completion and publication are summarized below. In some cases, existing soil surveys are published in paper form only and often greater than 30 years old. Soil survey data can be downloaded from the NRCS website at http://www.md.nrcs.usda.gov/soils/ssstat.htm.

Hydric Soils Data

Soil attribute and classification data is available for County soil survey maps that have been or are scheduled to be, updated and digitized, including those in the SSURGO database. Using a spatial database program, hydric soils (attributes and classifications) can be queried and displayed as a separate coverage.

Table II-5. Listing of the status and availability of County soil survey maps (also in the SSURGO database).

Status of County Soil Surveys	**Counties**	**Completion and Publication Date**
Digitized (existing maps not updated)	Carroll	Completed
Digitization in Progress (existing maps not updated)	Kent Caroline	In Progress
Not Scheduled for Update (paper form only)	Cecil Harford (partial) Baltimore County	N/A
Digitized and Published	Baltimore City Dorchester Aberdeen Proving Grounds Montgomery Washington Queen Anne's Worcester Frederick	Completed
Digitized (existing maps updated)	Queen Anne's Worcester	Completed
Update of Existing Maps in Progress (to be digitized)	Anne Arundel Wicomico	6 months
Digitization in Progress (existing maps updated)	Charles Howard Prince Georges Somerset Talbot	2-3 years
Special Projects	Allegany – C & O Canal Baltimore County – Gwynns Falls Watershed	In Progress

SSURGO Database

Digital soils surveys, in the Soil Survey Geographic (SSURGO) database, are available for the following counties in Maryland (dates of publication): Carroll (10/13/98), Dorchester (4/24/98), Montgomery (2/24/98), Queen Anne's (1998), Washington (1/22/2002), Frederick (1/23/2002), City of Baltimore (8/23/96), and Harford-Aberdeen Proving Ground (3/22/99). SSURGO is linked to an attribute database (Map Unit Interpretations Record or MUIR). The attribute database gives the proportionate extent of the component soils and their properties for each map unit. The MUIR database includes over 25 physical and chemical soil properties. Examples of information that can be queried from the data base are available water capacity, soil reaction, salinity, flooding, water table, and bedrock; land uses; cropland, woodland, rangeland, pastureland, and wildlife; and recreational development.

Methods. Field mapping methods using national standards are used to construct the soil maps in the Soil Survey Geographic (SSURGO) database. Mapping scales generally range from 1:12,000 to 1:63,360; SSURGO is the most detailed level of soil mapping done by the Natural Resources Conservation Service (NRCS). SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, townships, and county natural resource planning and management. The user should be knowledgeable of soils data and their characteristics.

Digitization. Digitizing is done by line segment (vector) format in accordance with Natural Resources Conservation Service (NRCS) digitizing standards. The mapping bases meet national map accuracy standards and are either orthophotoquads or 7.5-minute topographic quadrangles. SSURGO data are produced in 7.5-minute quadrangle maps, and distributed as complete coverage for a soil survey area

Map Format. The map extent for a Soil Survey Geographic (SSURGO) data set is a soil survey area, which may consist of a county, multiple counties, or parts of multiple counties. A SSURGO data set consists of map data, attribute data, and metadata. Technical data and other information can be obtained from the NRCS/SSURGO website at http://www.ftw.nrcs.usda.gov/ssurgo.html.

Other Analytical Tools

Watershed-Based Wetland Functional Assessment
The U.S. Fish and Wildlife Service NWI has been enhancing NWI digital databases in selected areas in the country, especially in the northeastern United States. With funding from the State of Maryland through NOAA, Region 5's NWI Program has published "Watershed-based Wetland Characterization for Maryland's Nanticoke River and Coastal Bays Watershed: A Preliminary Assessment Report." These studies are the first watershed-based wetland characterizations in the State. The report contains summaries of wetlands by NWI types and by hydrogeomorphic (HGM) types (following landscape position, landform, and water flow path descriptors), a preliminary assessment of wetland functions throughout these watersheds (ten functions are evaluated), an inventory of potential wetland restoration sites, a watershed characterization of "natural habitat integrity" (a set of indices designed to portray the overall condition of relatively natural areas in these watersheds), and descriptive information on Maryland's wetlands. The report includes statistics, color maps, and narratives on these topics. The results are preliminary and are intended to provide a foundation for further assessments based on field studies and incorporation of other data. These analyses can help the State develop wetland protection strategies for individual watersheds that will address wetland acquisition, restoration, and other means of strengthening wetland protection in priority areas. The project also serves as a model

for additional site-specific studies. The report can be accessed through the Service's website at: www.wetlands.fws.gov - listed under publications/reports. It is in a PDF format, which can be downloaded or viewed on the web.

Limitations. The watershed-based characterizations have various limitations due to the scope and purpose of the studies.

1) The wetland inventory and digital database do not represent a complete re-inventory of wetlands in the selected watersheds.
2) Seasonal variations in the vegetation cover influence estimates of vegetated and open water wetland types.
3) Identification of fragmented (interfluve) wetland complexes is limited by availability of land use/cover and hydric soils data.
4) Functional assessments of deepwater habitats were not done.
5) No qualitative ranking for each function or for each wetland based on multiple functions was done.
6) This watershed assessment approach does not account for the opportunity that a wetland has to provide a function resulting from certain land use practices, or the presence of structures, both upstream and downstream.
7) This approach does not consider the condition of the adjacent upland, the water quality of associated water bodies as important metrics for assessing the health of individual wetlands. Determining wetland health was not within the scope of the studies.
8) For site-specific evaluations, additional field work will be required, especially field verification and collection of wetland-specific data for refined functional assessments.

Scope and Intended Use

The analysis provides a preliminary assessment of wetland functions in the designated areas. The targeted wetlands are identified as being predicted to perform a given function at a [significant] level, presumably important to the watershed’s ability to provide that function. Since basinwide field-based assessments are often not practical, cost-effective, or even possible given access limitations, these watershed-based functional assessments provide valuable information for many purposes. The analyses are useful tools for: general natural resource planning, initial prioritization of wetlands, education and outreach, and for broad characterization of differences among wetlands in terms of both form and function within a watershed.

<u>GreenPrint’s Green Infrastructure Land Network - Maryland Dept. of Natural Resources (DNR)</u>

The Green Infrastructure Land network is a spatial database and analytical reference used for management, preservation and conservation of natural resources such as wetlands. The purpose of the Green Infrastructure Land Network is to:

1) Systematically identify and protect ecologically important lands
2) Address problems of forest fragmentation, habitat degradation and water quality
3) Maximize the influence and effectiveness of public and private conservation interests
4) Promote shared responsibilities for land conservation between public and private sectors
5) Guide and encourage compatible uses and land management practices

The Network is comprised of hubs, large contiguous of blocks of natural resource lands, and corridors, ecological zones between hubs. To integrate regional and local natural resource protection, the Network identifies two important elements:

1) "Green Infrastructure elements" including cross-watershed linkages, major riparian links among hubs, large forest habitat blocks, and large watershed complexes
2) "Complementary local elements" including small or isolated Natural Heritage elements, streams and their buffers, steep slopes, floodplains, and small, isolated wetlands.

Limitations
The network's analytical capabilities are limited to features (or elements) with GIS data available statewide. Therefore, prior to beginning restoration project site design, fieldwork needs to be conducted to verify results of the GIS model.

Technical References

Status and Trends

Wetlands Regulatory Database - Maryland Department of the Environment
The database contains brief and detailed summaries of laws and programs that affect the management or regulation of wetlands on the State, federal and local level. The database provides links to complete text of many of the laws and programs referenced. The database can be searched by individual laws and programs, or the entire database can be searched by keyword or subject using the Adobe acrobat program. The keywords or subject will be highlighted in each law or program searched. The web version of the database is available at

"Wetlands of Maryland" (Tiner and Burke, 1995) - Maryland Department of Natural Resources
"Wetlands of Maryland" is a report of the findings of the U.S. FWS National Wetland Inventory (NWI) of wetlands in Maryland. The inventory is based on the official U.S. FWS wetland classification (Cowardin). Wetland classes are fully described as well as the major wetland and deepwater habitat systems. Wetlands and estimates of wetland acreage are reported by physiographic province, county, and major watershed. Other topics included in the report are: wetland formation and hydrology, hydric soils, vegetation and plant communities, wetland values, Maryland wetland trends, and wetland protection. An extensive listing of wetland vegetation and plant communities is provided for different wetland classes.

"The Coastal Wetlands of Maryland" (McCormick and Somes, 1982) - Maryland Department of Natural Resources, Coastal Zone Management Program
"The Coastal Wetlands of Maryland" is a report that identifies, measures and analyzes coastal wetlands and describes the habitat values of wetlands in Maryland. The purpose of this report was to systematically identify, measure, and analyze the coastal wetland vegetation of Maryland and to describe the habitat values of those wetlands. Vegetation types were mapped in detail from aerial photographs, and the acreage of each type was calculated by county, by major watershed, and statewide. The vegetation types are described fully and are illustrated photographically. A review of wetland values and an evaluation and comparative ranking of individual wetlands (calibrated for freshwater, brackish and saline conditions) are included. Relationships with previous classifications are indicated. The detailed maps and acreage measurements produced in the report establish an historical tidal wetland baseline.

"Wetlands and Water Resources of Maryland" - Maryland Dept. of the Environment, (2000)
The document *"Wetlands and Water Resources of Maryland"* contains an overview of Maryland's wetlands including definitions, surveys, distribution by county and major watershed, descriptions of tidal and nontidal wetlands (also Nontidal Wetlands of Special State Concern), and conservation. The second section contains qualitative descriptions of Maryland's surface water and groundwater resources of the five physiographic provinces: Coastal Plain, Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau.

Other Technical Studies

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Wetland Status and Trends in Maryland

Wetland Status and Trends in Selected Regions of Maryland

<u>Status and Trends Overview</u>

In 1995, the Maryland Department of Natural Resources, Water Resources Administration (now part of MDE's Water Management Administration), published county-based wetland trends studies in selected counties of Maryland. These studies identify the extent and nature of wetland alterations for designated local areas. This research followed stringent scientific methods and guidelines, as described in the *Methods* section below. The authors provide qualitative conclusions, at the end of each report, regarding future wetland impacts and conditions, as described in the *Conclusions* section below. The paragraphs *Methods* and *Conclusions* are excerpted from these reports.

Methods

The following description of Methods was applied to all of the status and trends reports produced for the Department of Natural Resources (Tiner and Foulis 1994), U.S. Fish and Wildlife Service.

> "Wetlands trends analysis involves comparing aerial photography from at least two time periods. Fore these studies, aerial photos from 1981-82 and 1988-89 were examined and compared to determine the extent of the wetland changes (losses, gains, or conversions) that occurred during the time period in the study area."

The 1981-82 photography was 1:58,000 scale color infrared photography acquired by the National High Altitude Photography Program (NHAP). The 1988-89 photography was 1:40,000 scale color infrared aerial photography acquired by the National Aerial Photography Program (NAPP). Wetlands and deepwater habitats were interpreted on the NHAP photography and classified according to the U.S. FWS's official wetland classification system (Cowardin, et al., 1979) following standard NWI mapping conventions (National Wetlands Inventory, 1990). These interpretations served as the basis for evaluating recent wetland trends.

The two sets of photographs were compared and changes were delineated on Mylar overlays attached to the NAPP photographs. Cause of change was recorded for each polygon. The minimum mapping unit for wetlands was generally 0.5 acres, except for ponds, which were mapped at 0.1 acres or larger in size. Wetland boundaries were improved, and previously undetected wetlands were added to the original maps because the larger scale and more apparent signs of wetland hydrology in the NAPP photos improved the ability to detect and classify wetlands. Delineated changes and map refinements were then transferred to the corresponding NWI maps. Quality control of all photo interpretation was performed by a second photo interpreter.

Conclusions

The following statement about potential changes in the quality of remaining wetlands is included in all of the status and trends reports produced for the Department of Natural Resources (Tiner and Foulis 1994), U.S. FWS.

> "While [this] report documents recent trends in the County's wetlands, it does not address changes in the quality of the remaining wetlands. As development increases, the quality of wetlands can be expected to deteriorate due to agricultural runoff, increased sedimentation, groundwater withdrawals, increased water pollution, and other factors, unless adequate safeguards are taken to protect not only the existence of wetlands, but their quality."

The following statistical information was summarized from the status and trends reports from the period 1981-82 to 1988-89, prepared by the U.S. Fish and Wildlife Service, Region 5, Ecological Services.

Table II-6. Causes of vegetated wetland loss to upland, reported in acres, for selected areas of Maryland from the period 1981-82 to 1988-89. These data do not include conversions from one wetland type to another wetland type.

County	**Agri-culture**	**Roads/ Highways**	**Housing**	**Ditching**	**Commercial/ Industrial**	*Forestry,* **Timber**	**Sand & Gravel Mining**	**Public-Federal Facilities**	**Construct Pond Dams**	**Unknown and Other**	**Total Losses**
Western Shore											
St. Mary's	11.8	4.30	14.4	3.10	10.7	---	---	0.40	---	4.40	49.10
Calvert	8.70	8.60	---	---	---	---	---	10.90	---	0.30	28.60
Charles	4.20	12.3	44.9	1.1	19.3	---	---	---	---	30.9	122.60
Prince Georges	1.6	32.0	14.7	1.7	32.2	---	18.9	15.3	---	6.2	122.60
Anne Arundel	3.30	38.2	37.3	---	25.6	---	4.30	24.3	---	6.20	139.20
Western Shore	5.78	11.51	51.28	---	17.40	---	22.78	2.82	---	31.83	143.40
Eastern Shore											
Dorchester	1,059.06	84.74	14.01	13.10	9.79	173.57	5.00	18.71	6.57	49.76	1,438.38
Kent Isl., Queenstown	13.32	10.02	43.34	---	12.72	---	---	7.41	1.17	---	87.98
North East Quadrangle	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Lower East. Shore	106.8	0.58	9.20	51.89	---	2.50	---	13.96	1.91	1.72*	187.84
Piedmont Region											
Fall Zone	---	6.75	8.57	---	---	---	0.35	---	---	0.44	16.11
Piedmont Region	44.16	28.76	9.14	2.09	1.59	--	---	---	---	2.71	88.45
Total Losses											**2,424.26**

Unknown and Other includes: junkyard expansion and dredge material disposal
Public and Federal Facilities includes: recreational, marina and airport facilities, and wildlife improvement

Eastern Shore

State of Maryland

Maryland lost about 7,000 acres of palustrine vegetated wetlands due to agriculture and another 7,000 acres to other factors (chiefly channelization); this amounts to roughly 66 percent of the State's recent wetland losses. Most (91 percent) of the losses of palustrine vegetated wetlands took place on the Coastal Plain (the Eastern Shore). Emergent wetlands were most often lost due to agricultural conversion. About 4,000 acres of emergent wetlands and 2,000 acres of forested wetlands were converted to farmland (Tiner, 1988).

Choptank Watershed

The U.S. Fish & Wildlife Service identified wetland changes between 1952/1954 and 1981/1982 in the Choptank watershed. This 92 square miles watershed is located in three counties (Caroline and Queen Anne's Counties in Maryland and Kent County in Delaware). In the early 1950's, the Choptank watershed contained 13,814 acres of wetlands. By 1981/1982, a total of 2,778 acres of palustrine vegetated wetlands had been destroyed; this amounts to a 20 percent loss. Direct conversion of wetlands to farmland accounted for 9 percent (or 260 acres) of the total loss. Incidental drainage of wetlands from channelization projects, supporting agricultural activities, produced a loss of 2,027 acres (73 percent of total losses). Excavation of channels and disposal of spoil material caused 16 percent (or 445 acres) of the total losses. Urban development produced less than one percent of the total losses (Tiner, 1988).

North East Quadrangle

The North East Quadrangle is located in Cecil County, Maryland. The study area has about 3 percent of its land mass covered by wetlands. Wetlands totaling 890 acres in 1988 were identified in the study area by the U.S.FWS's National Wetlands Inventory. Palustrine forested wetlands is the dominant wetland type, representing 33 percent of the wetlands in the North East Quadrangle. Between 1981 and 1988, this area lost less than 1 acre of vegetated wetlands (temporarily flooded palustrine emergent wetland) to upland conversion due to commercial /business development. Other losses of vegetated wetland were increases in some wetland types, mostly palustrine scrub-shrub and estuarine emergent wetlands. Pond construction added about 9 acres of palustrine nonvegetated wetlands, but this gain was offset by pond losses to upland and vegetated wetlands. The overall trends for this area were loss of vegetated wetlands and slight gains in nonvegetated wetlands, mostly ponds associated with detention basin construction and those built in undeveloped areas (Tiner and Foulis, 1993).

Kent Island and Queenstown Quadrangles

The Kent Island and Queenstown Quadrangles have about 2 percent of its land mass covered by wetlands. Wetlands totaling 6,700 acres in 1989 were identified in this area by the U.S.F.W.S. National Wetlands Inventory. Between 1982 and 1989, the area lost about 93 acres of vegetated wetlands; this includes conversion of about 88 acres of vegetated wetlands to upland. Over 60 acres of this loss were estuarine emergent wetlands and approximately 12 acres were palustrine forested wetlands. Housing developments were the most significant cause of vegetated wetland loss, accounting for over 43 acres. More than 37 of these acres were estuarine emergent wetlands that were filled for housing development and 20 acres were lost by commercial development and road or highway construction. Approximately 3 acres of palustrine vegetated wetlands were created in uplands and nearly 2 acres of estuarine emergent wetlands developed in what were previously deepwater habitats. The overall trend for the area was loss of vegetated wetlands with significant gains in nonvegetated wetlands, which were mostly ponds (Tiner and Foulis, 1993).

Dorchester County
Between 1981-82 and 1988-89, Dorchester County lost about 1,605 acres of vegetated wetlands, with roughly 1,438 acres converted to upland. Annual losses to upland were roughly 200 acres per year. Agriculture was the most significant cause of vegetated wetland loss with other losses due to timber harvest and road/highway construction. Temporarily flooded wetland was the type most frequently converted to upland (Tiner et al., 1995).

Pond construction added about 312 acres of palustrine nonvegetated wetlands, but this gain was reduced to a net total increase of about 268 acres by pond losses to upland and vegetated wetlands. More than 8 acres of ponds were converted to upland and roughly 23 acres succeeded to vegetated uplands. Sea level rise impacted nearly 1,280 acres of wetlands. Of this total, approximately 1,000 acres were loblolly pine dominated estuarine forested wetlands that were replaced by deadwood marshes, mixed and broken canopies of pines, or salt marsh (Tiner et al. 1995).

Lower Eastern Shore
The study area of the Lower Eastern Shore of the Delmarva Peninsula has a combined land surface area of approximately 293 square miles. The study area includes the following U.S. Geological Survey topographic quadrangles (1:24,000): Delmar, Pittsville, Princess Anne, Salisbury, and Wango. In 1988-89, the study area contained about 37,000 acres of wetlands, excluding linear fringing wetlands along narrow streams. The overall trends for the study area's wetlands were loss of vegetated wetlands and lesser gains of nonvegetated wetlands, which were mostly ponds (Tiner and Foulis, 1994).

Between 1982 and 1988-89, the study area lost about 190 acres of vegetated wetlands, with roughly 187 acres converted to upland (mostly temporarily flooded forested wetland), caused by agricultural activities, ditching, and forestry practices. Less than 2 acres of vegetated wetlands were created from upland and most gains in vegetated wetlands came from other vegetated wetland types (Tiner and Foulis, 1994).

Western Shore
The study area of the Western Shore Region has a combined land area of approximately 464 square miles. In 1988, the study areas contained about 24,236 acres of wetlands, excluding linear fringing wetlands along narrow streams. The study area includes the following U.S. Geological Survey topographic quadrangles (1:24,000): Odenton, Deale, Upper Marlboro, Brandywine, Piscataway, Hughesville, La Plata, and Popes Creek.

In 1988, the study area contained about 24,236 acres of wetlands, excluding linear fringing wetlands along narrow streams. The overall trends for the study area's wetlands were loss of vegetated wetlands and significant gains in nonvegetated wetlands (mostly ponds).

Between 1981 and 1988, the study area lost about 178 acres of vegetated wetlands, with roughly 143 acres converted to upland (mostly palustrine forested wetlands). Significant causes of losses were housing development, sand and gravel pits, and commercial development. Beaver activity resulted in the following changes: changes in water regime only, 26.29 acres; changes in vegetated class, 9.44 acres; and gains from upland, 14.51 acres. Pond construction (mostly from sand and gravel mining and farm construction) added about 167 acres of palustrine nonvegetated wetlands, with 130 acres from uplands and 35 acres from vegetated wetlands (Tiner and Foulis, 1993).

Anne Arundel County
About 6.1 percent of the land area in Anne Arundel County is covered by wetlands. A total of 16,225 acres of wetlands was identified by the U.S.F.W.S. National Wetlands Inventory. Between 1981-1982 and 1988-90, Anne Arundel County lost about 179 acres of vegetated wetlands, with roughly 139 acres converted to upland. Temporarily flooded forested wetland was the most frequently converted type. During the study period, freshwater pond construction increased the acreage of nonvegetated wetlands by 159 acres. Over 81 percent of these ponds were created in uplands and others were built in vegetated wetlands, mostly palustrine emergent wetlands. Nearly 30 percent of the new upland ponds were created in sand and gravel pits or on farmland, but most of the ponds were built for unknown purposes. The overall trends for Anne Arundel County were loss of vegetated wetlands and gains in nonvegetated wetlands, which were mostly ponds (Tiner and Foulis, 1992).

St. Mary's County
In 1988-89, St. Mary's County contained about 16,730 acres of wetlands (roughly 7% of the County's land surface), excluding linear fringing wetlands along narrow streams. The overall trends for the County's wetlands were loss of vegetated wetlands and gains in nonvegetated wetlands (Tiner and Foulis, 1994).

Between 1981-82 and 1988-89, over 49 acres of vegetated wetlands were converted to upland, affecting mostly palustrine forested wetlands. Housing and agriculture were the most significant cause of vegetated wetland loss, as well as commercial construction. About 154 acres of vegetated wetland changed from one to another. Approximately 232 acres of palustrine forested wetlands were converted to upland or changed to other wetland types. Vegetated wetland gains from upland were limited to approximately 11 acres. Most gains in particular types of vegetated wetlands resulted from conversion from other vegetated wetland types. Beaver activity affected 118 acres of vegetated wetlands (see Table 7 of report for statistics; change in water regime only, 74.2 acres; change in vegetated class, 37.1 acres; gain from upland, 6.8 acres).

About 119 acres of nonvegetated wetlands (mostly new farm ponds) were created from upland, and over 39 acres were constructed in vegetated wetlands. More than 7 acres of ponds were converted to upland, while 39 acres changed to vegetated wetlands (Tiner and Foulis, 1994).

Calvert County
In 1988-89, Calvert County contained about 10,734 acres of wetlands (roughly 7.8% of the County'' land area), excluding linear fringing wetlands along narrow streams. The overall trends

for the County's wetlands were loss of vegetated wetlands and gains in nonvegetated wetlands (Tiner and Foulis, 1994).

Between 1981-82 and 1988-89, the County lost about 74 acres of vegetated wetlands, with roughly 29 acres converted to upland. The majority of these losses affected palustrine emergent wetlands, and to a lesser extent, palustrine forested and estuarine emergent wetlands. The most significant causes of these upland conversions were agriculture, road and highway construction, and recreational facilities development. Pond construction added about 70 acres of palustrine nonvegetated wetlands, but this gain was reduced to about 58 acres by pond losses to upland and vegetated wetlands. Beaver activity affected 57 acres of vegetated wetlands (Tiner and Foulis, 1994).

Charles County
In 1988-89, Charles County contained about 27,010 acres of wetlands (roughly 9.3% of the County's land area), excluding fringing wetlands along narrow streams. The overall trends for the County's wetlands were loss of vegetated wetlands and gains in nonvegetated wetlands (Tiner and Foulis, 1994).

Between 1981-82 and 1988-89, the County lost about 163 acres of vegetated wetlands, with roughly 122 acres converted to upland (mostly temporarily flooded wetland). Pond construction (27% in urban areas) added about 135 acres of palustrine nonvegetated wetlands, but this gain was reduced to about 88 acres by pond losses to upland and vegetated wetlands (Tiner and Foulis, 1994).

Prince George's County
In 1988-89, Prince George's County contained about 19,740 acres of wetlands, excluding linear fringing wetlands along narrow streams. The overall trends for the County's wetlands were loss of vegetated wetlands and gains in nonvegetated wetlands (mostly ponds). Within this time period, only 2% of the vegetated wetlands changed in some way or lost. Approximately 32% of losses (mostly palustrine forested wetlands) involved filling of wetlands to create upland for development (Tiner and Foulis, 1992).

Between 1981 and 1988-89, The County lost about 229 acres of vegetated wetlands, with roughly 123 acres converted to upland (mostly temporarily flooded forested wetland). During this period, pond construction accounted for increases in nonvegetated wetlands by 196 acres (includes palustrine unconsolidated shores). Gains in vegetated wetlands (34.6 acres from nonvegetated wetlands and 32.2 acres from uplands) involved the creation of palustrine emergent wetlands (freshwater marshes) in sand and gravel pits or along the shores of newly created ponds (Tiner and Foulis, 1992).

Piedmont Region and the Fall Zone

Fall Zone
The study area in the Fall Zone of Maryland has a combined land surface area of 114 square miles. The study area includes two U.S. Geological Survey topographic quadrangles (1:24,000): Relay and White Marsh. In 1988-89, the study are contained about 1,692 acres of wetlands,

excluding linear fringing wetlands along narrow streams. The overall trends for the study area's wetlands were loss of vegetated wetlands and slight gains in nonvegetated wetlands (mostly ponds).

During the study period (1981-82 to1988-89), most of the vegetated wetlands remained unchanged, with only 2.1% changed or converted. Fifty-two percent of these changes (mostly palustrine forested wetlands) involved filling of wetlands for land development. Vegetated wetland gains resulted from establishment of palustrine emergent wetlands (freshwater marshes) due to both natural and anthropogenic succession. However, there was a net loss of vegetated wetlands in the study area of about 10 acres between 1981-82 and 1988-89.

Nonvegetated palustrine increased by 6.02 acres, largely due to pond construction. However, approximately 97% of this gain was offset by conversion of gravel pit ponds to nonvegetated lacustrine wetlands, with a net increase of only 0.2 acres of nonvegetated palustrine wetlands (Tiner and Foulis, 1993).

Piedmont Region
The study area in the Piedmont Region of Maryland has a combined land surface area of 345 square miles. In 1988-89, the study area contained about 4,298 acres of wetlands, excluding linear fringing wetlands along narrow streams. The overall trends for the study area's wetlands were loss of vegetated wetlands and lesser gains in nonvegetated wetlands (mostly ponds).

In 1988-89, the study area contained about 4,298 acres of wetlands, excluding linear fringing wetlands along narrow streams. Between 1980-81 and 1988-89, the study area lost about 98 acres of vegetated wetlands (3.5 percent of total vegetated wetlands), with roughly 89 acres converted to upland (mostly temporarily flooded emergent wetlands). Pond construction added about 85 acres of palustrine nonvegetated wetlands, but this gain was reduced to about 56 acres by pond losses to upland and vegetated wetlands (Tiner and Foulis, 1993).

<u>Chesapeake Bay watershed study</u>

The report summarizes major findings of a wetland status and trends study completed for the 63,000 square mile Chesapeake Bay Watershed. The study was conducted with funding support from the U.S. Fish and Wildlife Service and the Environmental Protection Agency at the request of the Living Resources Subcommittee of the interagency Chesapeake Bay Program.

Within the Chesapeake Bay watershed, approximately 27 percent of the total wetlands are located within Maryland. Based on the statistical analysis, the Eastern Shore of Maryland was identified (by experts from Federal and State agencies) as one of seven geographic areas within the Chesapeake watershed where significant losses or conversions of certain wetland types have occurred. From 1982 to 1989, Maryland's wetland losses include about 5,000 acres of palustrine vegetated wetlands, 2,400 acres of emergent wetlands, 500 acres of scrub shrub wetlands, and over 2,500 acres of palustrine forested wetlands (Tiner and Foulis, 1994).

Table II-7. Statistical data describing the major causes of wetland conversions for specific geographic areas in Maryland. These areas represent either highly vulnerable areas or other geographical areas of interest.

[PFO = Palustrine, forested, PSS = Palustrine, scrub-shrub, PEM = Palustrine, emergent, E2EM = Estuarine intertidal, emergent, E2ESS = Estuarine intertidal, scrub-shrub, E2FO = Estuarine intertidal, forested]

Study Area	Study Period	Wetland Type	Acres Converted to Upland	Acres Converted to Water body	Major Causes of Wetland Conversion to Upland (acres)
Dorchester County	1981/82-1988/89	PFO PSS PEM	608 111 63	63 4 38	Agriculture/Regulated Shooting Areas (711), Roads (18), Housing/Commercial Development (15) ***see "Note"***
Lower Eastern Shore	1982-1988/89	PFO PSS PEM	174 3 12	2 -- --	Agriculture (106), Ditching (52), Public Facilities (14), Housing (9)
Western Shore	1981-1988	PFO PSS PEM	115 6 22	22 9 4	Housing (51), Unknown (32), Sand/Gravel Pits (23), Commercial Development (17), Road Construction (12)
Kent Island Area	1982-1989	E2EM E2SS PFO PSS PEM	61 4 12 8 4	5 -- -- -- --	Housing (43), Agriculture (13), Commercial Development (13), Roads/Highways (10)
Piedmont Region	1980/81-1988-89	PFO PSS PEM	28 4 57	2 1 8	Agriculture (44), Roads/Highways (29), Housing (9)

Note: Also lost 74 acres of estuarine forested wetlands to agriculture/regulated shooting areas and detected significant changes in estuarine wetlands due to sea level rise and coastal erosion.

** Standard error is equal to or less than 20 percent of the estimated acreage.

* Standard error is less than 50 percent of the estimate, but greater than 20 percent of the estimated acreage.

Estimates without an asterisk have higher standard errors.

Table II-8. Summary of changes in specific types of vegetated wetlands in the Chesapeake Watershed (1982-1989). Overall, the status of estuarine wetlands (salt and brackish tidal marshes) has improved.

Vegetated Wetland Type	1982 Acres	1989 Acres	Acres Changed to Other Vegetated Wetlands	Acres Gained From Vegetated Wetlands	Acres Lost	Acres Gained From Other Areas	Net Change
<u>PFO</u>	1,003,745**	989,339**	25,655**	22,355**	14,700*	3.594	-14,406*
PSS	178,424**	177,458**	26,673**	35,193**	10,693	1,207*	-966
PEM	171,499**	167,216**	19,230**	13,993**	10,642**	11,596*	-4,283
E2EM	170,311**	169,815**	281*	741	1,085*	129*	-496
E2SS	3,321**	3,694**	196*	590*	0	69	+463*
E2FO	23,784*	22,913*	1,306	469*	62	28	-871

** Standard error is equal to or less than 20 percent of the estimated acreage.

* Standard error is less than 50 percent of the estimate, but greater than 20 percent of the estimated acreage.

Note: Estimates without an asterisk have higher standard errors.

Forestry Activities

There was a 12-fold increase in the net annual loss rate of forested wetlands. From 1982-1989, the annual loss rate was about 2,000 acres versus almost 200 acres from earlier periods (mid 1950's-1980's). Much of this forested wetland "loss" resulted from increased timber harvest during the study period. In managed forests, this "loss" of forested wetlands is usually not a loss of wetland, but simply a temporary change or conversion, of wetland type. The emergent and scrub-shrub wetlands resulting from timber harvest are success ional types of wetlands that eventually become forested wetlands, over time. Other harvested forested wetlands, however, may be converted to other uses. Almost 15,000 acres of palustrine forests were destroyed through conversion to dry lands and to open water bodies (e.g., reservoirs and ponds).

Wetland Losses In the United States, 1780's to 1980's

In December of 1989, the Emergency Wetlands Resource Act (Section 401 (a)) was amended to require the following:

a) An assessment of the estimated total number of acres of wetland habitat as of the 1780's in the areas that now comprise each state
b) An assessment of the estimated total number of acres of wetlands in each state as of the 1980's, and the percentage of loss of wetlands in each state between 1780's and the 1980's

In 1990, a report was issued to Congress by the Department of the Interior, Fish and Wildlife Service, National Wetlands Inventory. For each State, estimates of historic wetland losses were compiled from colonial and state historical records, land uses records (land conversions, drainage statistics, hydric soils information), and historical wetland acreage data. For Maryland, estimates of wetland losses through the 1980's were based on existing NWI data for the State. The report includes the following statistics on wetland loss in Maryland from the 1780's to 1980's:

1) Estimates of original wetlands in the 1780's equal approximately 1,650,480 acres
2) Estimates of original wetlands in the 1980's equal approximately 440,000 acres
3) Estimated wetland loss from 1780s to 1980's equal approximately 1,210,000 acres or 73% of original total acreage

Status and Trends in the U.S. 1986 to 1997

Recently published estimates in "Status and Trends of Wetlands in the Conterminous United States 1986 to 1997," by the U.S. Department of the Interior, Fish and Wildlife Service, report the rate of wetland loss in the United States has decreased by 80 percent in the past decade. The major findings of the report are:

1) Freshwater and forested wetlands in coastal areas continue to be susceptible to the greatest losses resulting from development.
2) The overall decline in wetland loss was attributed to wetland policies and programs enacted during this time that reduced draining and filling of wetlands, and increased wetland restoration, creation and enhancement. Important components include regulation of activities that impact wetlands, elimination of incentives for wetland drainage, acquisition and conservation easements, public education and outreach about wetlands, private land initiatives, coastal resource protection programs, and collaborative actions by Federal, State and local agencies with business, citizen associations and youth groups.

3) The U.S. Army Corps of Engineers has improved the effectiveness of wetlands regulations under Section 404 of the Clean Water Act (reduction of permitted losses and discharges, and improved forestry practices and compensatory mitigation). In addition, the Clean Water Action Plan of 1999 initiated intergovernmental coordination to restore and protect wetlands.
4) Federal properties, such as the National Wildlife Refuges and national Parks and Seashores, contain tracts of wetlands that provide key habitats that are unique to certain regions and of the United States.
5) Congress has given Federal agencies new or redefined environmental missions that benefit wetlands.
6) The report offers a series of specific actions to be taken for future protection of the Nation's wetlands:
    - The average estimated loss of 58,500 acres of wetlands each year does not achieve "no not loss" commitments.
    - Comprehensive protection, acquisition, restoration options need to be developed to reduce future losses of forested and freshwater wetlands and to restore these ecosystems.
    - Wetland assessments specific to strategic geographic regions and watersheds are needed to provide status and trends information to policy makers to address wetlands issues.
    - The Federal agencies should enhance existing partnerships and develop new ones.
    - "Future wetland policies and initiatives will need to consider and emphasize wetland quality by promoting functional restoration of existing degraded wetlands, protecting and improving water and soil quality in aquatic habitats, and enforcing comprehensive standards for compensatory wetland mitigation efforts."
    - The Federal environmental community needs to intensify outreach efforts to provide information, to States and the public, about successful projects and future wetland issues and opportunities.

Threats and Trends

Wetland threats and trends have been documented by historic wetland inventories and other natural resource surveys conducted in Maryland from the early 1900's to the present. However, recent inventories have stressed the need for regional assessments of threats and trends due to the variability of factors, such as physiography and anthropogenic factors that effect wetlands. Current inventories rely not only on wetland acreage estimates, but apply technical tools such as GIS and satellite imagery, to update estimates of wetland acreage and evaluate changes in wetland condition over time. (Refer to historic status and trends reports summarized previously in Section II.)

The USGS Patuxent Research Center and the U.S. EPA are pursuing current research that will add significantly to the State's goals of assessing wetland threats and trends. Their collective research focuses largely on development of ecosystem simulation models, regionally calibrated functional assessment models, and assessments of ecosystem condition, derived from remotely sensed data and local databases. The major environmental problems addressed include effects of development, water quality degradation, habitat and living resource loss, conflicting land uses and zoning, pollutant sources, loss of wetlands and shallow water habitat, excessive loading sources, watershed sustainability, patterns of change in biological diversity, and many other environmental factors.

The EPA is funding local-scale projects for the Anacostia River, Maryland's Atlantic Coastal Bays, and the Patuxent River Watershed. Large-scale protection-based efforts include: the Atlantic Coastal Plain Aquifer System Project, the Chesapeake Bay Program, Mid-Atlantic Landscape-Scale Assessments, and the Mid-Atlantic Integrated Assessment (MAIA).

Sea Level Rise

Losses of coastal wetlands due to sea level rise have generated considerable dicussion. However, natural processes do result in conversion of tidal marshes to open water areas, as well as causing the development of new marshes. The shorelines of Chesapeake and Coastal Bays have been in a cycle of formation, "drowning" and erosion for thousands of years. Depending on the rate of sea level rise, the total acreage of coastal wetlands could either naturally increase or decrease. Losses by natural processes are more of a concern when manmade actions have interrupted or prevent natural processes that form new wetlands.

Various federal, State, and local agencies, voluntary programs and the academic community are actively investigating the effects of sea level rise in Maryland. Current statewide initiatives will help guide the State's efforts to protect and conserve coastal resources and lands; these include the Chesapeake 2000 Agreement, development of the Maryland Wetland Conservation Plan (MDE), the Sea Level Rise Response Strategy (DNR, Coastal Zone Management Division), and the Coastal Bays Management Plan. The Coastal and Watershed Resources Advisory Committee (CWRAC) held a forum (May 1999) addressing the impacts of climate change and sea level rise in the Chesapeake Bay. The forum produced a report outlining management strategies and recommendations for the Chesapeake 2000 Agreement.

A Sea Level Rise Workshop (January 2001) was hosted by MDE to begin examining the issue for Maryland's State Wetland Conservation Plan and related commitments in the Chesapeake Bay 2000 Agreement. Workshop participants included researchers and technical experts, representatives from State resource and regulatory agencies, and local government agencies. The workshop addressed a wide range of issues relating to the effects of sea level rise on wetlands in Maryland. A prominent concern throughout the Workshop was the need for further definition of the causes and effects of sea level rise in Maryland. Participants identified the following research topics to better define the current and future impacts of sea level rise on coastal wetlands;

1) Rate of Sea Level Rise: In certain areas of Maryland the average rate of sea level rise is significantly greater than the global average; factors contributing to localized increases in the rate of sea level rise include land subsidence due to groundwater withdrawals and regional post-glacial adjustments of the crust. [Note: The Mid-Atlantic region was located just beyond the southernmost extent of the continental ice sheet (also called the forebulge area). During glaciation, this region was uplifted upward due to compression and displacement caused by downwarping of the crust to the north. Subsequently, the Mid-Atlantic region continues to subside while the Northeast region rebounds.

2) Resource Risk Assessment: Because the rate of sea level is variable throughout the coastal region, certain counties will be at higher risk for impacts. Therefore, the spatial distribution of potential lands and resources at risk should be identified as well as the estimated rates of inundation, coastal erosion, and loss of resources.
3) Loss of Wetland Function: The threat of rising seas imposes numerous threats to coastal wetlands, especially loss of functions that are valuable to local communities. Wetlands provide water quality, flood protection, habitat, and recreational and commercial resources, all of which may be at risk in many coastal areas.
4) Integration With Other Rationales: The potential widespread impacts due to sea level rise could seriously compromise the economic and social structure of coastal communities. Many local agencies will face these considerations in future planning and management strategies, including erosion control, flood prevention and mitigation, land use opportunities, location of infrastructure, public safety, navigation, and land and resource management practices.
5) Ecological Impacts: Incremental changes in sea level rise over time pose serious threats to coastal wetland ecosystems and the Chesapeake Bay. The ability of these ecosystems to adapt to change will depend upon future resource regulation and management.

Data, Technical and Assessments Needs
The workshop participants identified a list of essential data, technical, and assessment resources to define the processes associated with sea level rise, both temporally and spatially.

- Effectiveness of Wetland Restoration and Creation Techniques
- High Resolution Digital Elevation Data
- Planning Scenario Maps
- Education and Outreach
- Tidal Wetlands Maps (update or replace)
- Wetland Risk Assessment
- Map of Existing Hardened Shoreline Structures
- Refined Sea Level Rise Forecast and Model
- Develop Functional Assessment Method to Assess the Effects of Sea Level Rise

Coastal Erosion
A comprehensive, and most current, review of coastal erosion was produced by the Shore Erosion Task Force. The Shore Erosion Task Force was created under Resolution 13, passed during the 1999 Legislative Session. It's mission was to identify county needs, clarify stakeholder roles, develop long range plans and review plan effectiveness, regarding shore erosion in Maryland. . The primary findings of the task force include the need to address the following issues: (1) develop a comprehensive and regional approach to shore erosion control; (2) improve coordination of shore protection activities among various entities; (3) establish project review and selection criteria; (4) encourage the use of dredge materials in regional projects; (5) review engineering standards and conduct technical evaluations; (6) develop a financial strategy to address funding needs; (7) conduct public education; and (8) determine and fulfill data needs. The report outlines specific recommendations for each of these issues and an implementation strategy.

Invasive and Exotic Species

The following commitment, from the Chesapeake 2000 Agreement, outlines a general strategy for management of non-native, invasive and problematic species within the Chesapeake Bay watershed.

> "By 2001, identify and rank non-native, invasive aquatic and terrestrial species which are causing or have the potential to cause significant negative impacts to the Bay's aquatic ecosystem. By 2003, develop and implement management plans for those species deemed problematic to the restoration and integrity of the Bay's ecosystem."

In 1994, the Chesapeake Bay Program's (CBP), Wetlands Workgroup (now the Tidal Wetlands Workgroup and the Nontidal Habitat Workgroup) recognized the potential adverse affects of exotic species on Bay wetlands and adopted objectives to address the problem of exotic species management.

Currently, the Non-Native and Invasive Species Ad Hoc Workgroup is coordinating this issue for the Living Resources Subcommittee (CBP). The Workgroup is coordinating with other agencies to obtain data and information to develop the following tasks and related actions.

1) Assess, utilize, and influence current non-native invasive species mangement programs throughout the Bay watershed and the nation.
   Actions – inventory current programs that address non-native invasive species in the Bay ecosystem; discuss establishment of an advisory panel; and provide recommendations on the 2001 re-authorization of the Non-indigenous Aquatic Nuisance Program and Control Act (NANPCA).
2) Identify and rank non-native, invasive aquatic and terrestrial species which are causing or have the potential to cause significant negative impacts to the Bay's aquatic ecosystem.
   Actions – develop criteria for identifying priority issues, identify potential priority species, and identify and rank non-native species of concern; assessment of the social, legal, and jurisdictional implications of managing select species; and assessment of the ecological consequences of select species through scientific review.
3) Develop and implement management plans for those species deemed problematic to the restoration and integrity of the Bay's ecosystem.
   Actions – develop management plans for selected problematic species, development and implementation of a ballast water management plan.

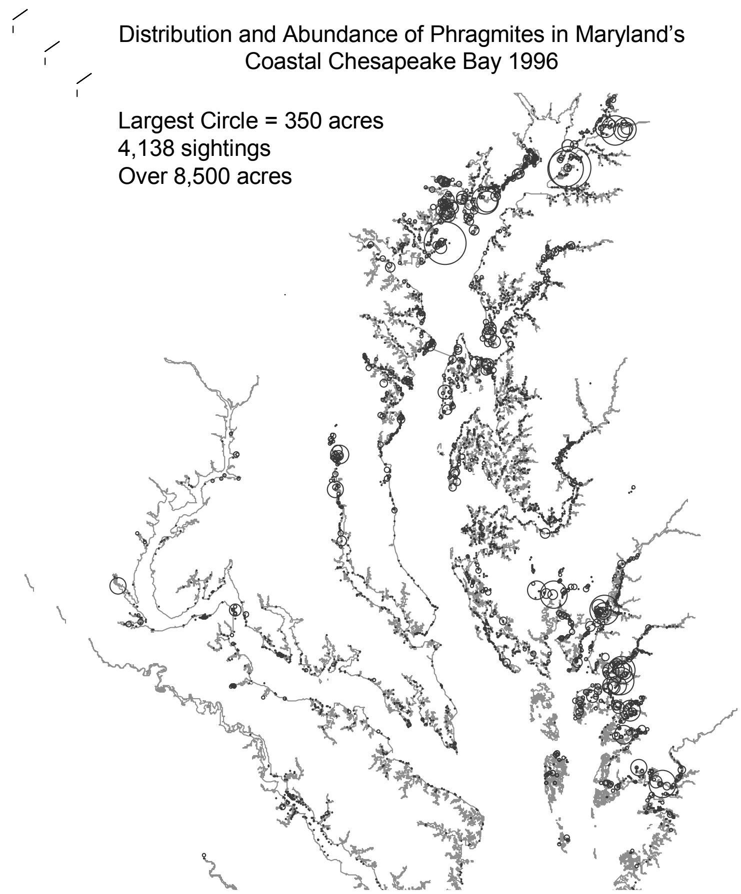
Phragmites

Phragmites, or common reed (*Phragmites australis*), is a large perennial grass often found in wetlands and disturbed areas. *Phragmites* is widely viewed as a destructive component of wetlands, contributing to widespread loss and degradation of both nontidal and tidal wetlands in Maryland. The negative aspects of *Phragmites* include: formation large dense stands that provide little wildlife value, reduction in the diversity of plant and wildlife species, and rapid spreading by creeping rhizomes.

Phragmites control programs use combination approaches including chemical treatment (herbicides) and physical removal (mowing, flooding, draining, and burning). The U.S. Fish and Wildlife Service conducted an aerial survey of *Phragmites* distribution along the shorelines of Chesapeake Bay from 1995 to 1997.

Figure II-9.

Map courtesy Doug Forsell, USFWS



Control of *Phragmites* is advocated by various federal and State government agencies and private industries, such as the U.S. Fish and Wildlife Service, Chesapeake Wildlife Heritage,

Wildfowl Trust of North America, Inc., and the Maryland Departments of Natural Resources, Agriculture, and Environment.

Despite its negative impacts to wetlands, *Phragmites* does have several beneficial qualities. Along shorelines that are eroding rapidly, *Phragmites* stabilizes marsh substrate and other shoreline sediments. Often these areas are highly disturbed and are unable to support native wetland plant communities. Eradication methods (such as mowing, flooding, draining, and burning) could have significant negative impacts on these already unstable coastal marsh systems.

Nutria

The South American nutria (*Myocastor coypus*) was introduced to parts of the Eastern Shore during the 1940's by Maryland's fur industry. The introduction of these large herbivorous rodents has coincided with the loss of extensive tracts of emergent marsh in Dorchester County, particularly along the Blackwater River Basin. It is assumed that decline of the fur industry has caused overpopulation of the species. In response to overabundance of nutria and significant loss of marsh in this region, the State legislature proposed a 10-year nutria eradication program. However, the effect of nutria activity on marsh loss is unclear and the eradication program has been postponed, pending more conclusive information. In 1995, the Maryland Department of Natural Resources and Patuxent Wildlife Research Center developed a study plan developed to isolate the effects of nutria activity on marsh loss and determine whether exclusion of nutria from emergent marsh habitats will stabilize or recover marsh vegetation. Preliminary findings indicate that cumulative sediment deposition is reduced on non-vegetated marsh surfaces, and without vegetation to stabilize the marsh, the sediments will continue to erode. In areas where nutria were excluded, only partial marsh revegetation occurred. The study suggests that marsh accretion and restoration would be needed to elevate the marsh surface to establish vegetative growth (Haramis, 2000).

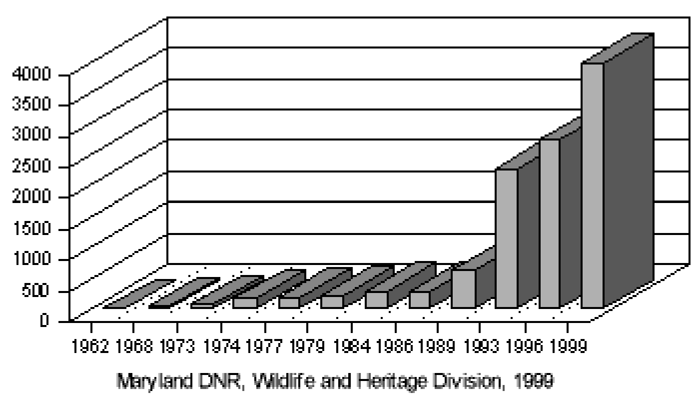
The Maryland Marsh Restoration and Nutria Control Program is a team of state, federal, and non-governmental biologists and natural resource managers who have been researching nutria for last 10 years. The Program goal is to better understand basic nutria reproductive biology, determine the most effective control techniques, understand the cause and effect relationship between nutria activity and marsh loss, and to educate the public about the impacts of nutria on other wildlife communities and wetlands (National Wetlands Newsletter, July-August 2000). The Program aims to control nutria populations while working toward eliminating this non-native species from Maryland.

Mute Swans

The Maryland Mute Swan Task Force

The Maryland Mute Swan Task Force was assembled in 1998 through a joint effort of the Department of Natural Resources and the Maryland Waterfowl Advisory Committee. The task force was the first step in a process to have DNR identify and assess the existing techniques available for managing mute swans, and to generate public input on the management of mute swans.

Figure II-10. Expansion of Mute Swan Populations in the Atlantic Flyway



The Mute Swan Task Force has the following goals:

1) summarize population status of mute swans and their impacts on habitat, native species, and the public;
2) generate a plan detailing problems presented by mute swans, specifically, potential/documented problems and site-specific/ecosystem-wide problems, and detailing responses to these problems. In addition, the Mute Swan Task Force was asked by DNR to develop long-term and short-term management recommendations.

The task force is the start of a longer process designed to provide a broad representation of public input on mute swan management. This process will attempt to generate consensus on the following issues: mute swan population status; credibility of information on its population and existing or potential impacts on the Chesapeake Bay and native species; and management objectives and techniques to control mute swan populations. The task force will produce a white paper detailing existing information on the biology and population dynamics of mute swans, management objectives and techniques, and specific areas of consensus.

Human Impacts

Human influences have caused significant changes in the function and quality of many wetlands. These changes have resulted from alteration of the physical, chemical and biological components of wetland ecosystems. Filling, grading and excavation for development in a wetland typically destroys it.

Alterations to wetland hydrology, such as by ditching, may result in a lowering of wetlands and shorter durations of inundation that wetland dependent plants die and are replaced by more transitional or upland longer. Extensive ditching in an area may lower water levels so much that the area is no longer considered to be a wetland. Other effects of ditching may cause a reduction in base flow provided by the wetland to an adjacent stream. Other human activities that can have lasting effects on wetland ecosystems include; stream channelization, dam construction, discharge of industrial wastes and municipal sewage (point source pollution) and runoff urban and agricultural areas (non-point source pollution). These activities contribute to changes in the flood regime of wetlands and the input and cycling of nutrients.

Indirect or Secondary Impacts

A wide range of off-site activities can affect the condition and function of wetlands. Certain activities conducted in ground water and surface water discharge areas, streams, and other water bodies, can alter the hydrologic regime of wetlands. Increases in impervious surface that result in less groundwater recharge may reduce the amount of groundwater that provides much of a wetland's hydrology. This change, in turn, can influence wetland vegetation communities, which can include sensitive and rare species, and can facilitate colonization of invasive or non-native species.

Indirect or secondary impacts result from disturbances that occur in areas outside of the wetland, such as uplands, adjacent wetlands, floodplains, and waterways. Common indirect impacts include influx of surface water and sediments, fragmentation of a wetland from a contiguous wetland complex, loss of recharge area, or changes in local drainage patterns. Widespread land development and clearing have also caused increased erosion in uplands areas leading to increased sedimentation in lowland wetlands. This increased accumulation of sediment can alter the chemical and hydrologic regime of the wetlands in a relatively short time. However, sediment transport is part of a natural process and erosions and re-deposition is essential for maintaining streams and tidal wetlands.

Many indirect impacts are regulated by State and federal laws and programs, including impacts associated with stormwater management, ground water and surface water discharges, , and sediment deposition and erosion.

Cumulative impacts, sometimes referred to as "cumulative effects", may also include indirect and secondary impacts. Indirect impacts can be identified through a cumulative impacts assessment. Cumulative impacts are considered in the review process for proposed activities in wetlands and other waters under the Clean Water Act. Regulatory and management issues and recommendations associated with cumulative impacts are discussed in Objective 3 H.

Assessment of indirect impacts on wetlands is often a component of a wetland functional assessment and cumulative impact assessment. See *Recommendations* and *Tasks* for Objective 1C, Wetland Functional Assessment, and Objective 3H, Assessment of Cumulative Wetland Impacts.

Wetland Functional Assessment Methods

Wetland functional assessments are performed by several federal and State agencies, private consulting firms, and non-profit organizations (watershed groups, land trusts, etc.). Functional assessments are conducted to determine the functions provided by an individual wetland, a specific wetland type, or a comparison of several wetlands. These assessments are often done for the purposes of evaluating existing or restored wetlands, or wetlands proposed for impact. These assessments are also used in developing restoration, conservation, or preservation goals for resource regulation and management, watershed planning, and local planning. Table II-9 summarizes the basic components of the most widely used wetland functional assessment methods in Maryland.

MDE completes informal wetland functional assessments during the permit application review process. These assessments help to evaluate functions that are to be lost, and consist of subjective evaluations based on a reviewer's best professional judgment (BPJ). The assessment parameters include hydrology source, biological factors, habitat, recreational/educational use, water quality, and hydrologic functions. Various sources of information may be used to determine local hydrology, vegetation, soils, drainage basin area, adjacent land use and land cover, and topography. Information sources may include GIS-based information, soil surveys, guidance maps, and information provided by local agencies and landowners. Information collected on impacted wetlands is entered in a reporting form that is completed by the project reviewer when an authorization is issued.

MDE also completes functional assessments on programmatic mitigation sites, and requires functional assessments on permittee mitigation sites. For projects requiring permittee mitigation, applicants must demonstrate prior to issuance of an authorization, that a proposed mitigation site will replace or surpass the functions lost from the proposed impacts. Additionally, applicants must submit yearly monitoring reports for permittee mitigation sites, which give an indication of the functional performance of the site. Functional assessments required for mitigation sites are not comprehensive, but rather concentrate on some basic indicators of wetland function including depth of/to water, water source, and type and density of vegetation. Mitigation sites may be required to reach certain threshold measurements of wetland functional indicators, such as the number of woody plants per acre.

The Maryland State Highway Administration (MD SHA) conducts formal, comprehensive wetland functional assessments as part of the planning process for most highway projects and to determine wetland mitigation requirements. MD SHA uses the New Hampshire Method (NH

Method) and the Evaluation For Planned Wetlands (EPW) as part of their planning process for highway construction projects and wetland mitigation projects. These methods are more formal and less subjective than using BPJ, and give some quantifiable indication of a wetland's functions.

The aforementioned types of wetland assessment are mostly used to evaluate the performance of individual sites; other types of assessments are geared toward regional and landscape planning and evaluation. Currently, one of type of "planning-scale" wetland evaluation that has generated much interest is the hydrogeomorphic (HGM) assessment. This type of assessment first classifies wetlands by type according to their geomorphic setting, water source, and hydrodynamics. After a wetland is classified in this manner, HGM uses a reference wetland to help the user to make comparisons. As opposed to most other wetland assessment methods, HGM does not evaluate individual functions for a site and then assign a score, but rather it enables a comparison for the functions of the wetlands according to their potential. A disadvantage of HGM is that extensive and expensive fieldwork must be done to gather data to build the assessment models for wetland types in specific physiographic regions. A method for wetlands in the Ridge and Valley Province has been completed in Pennsylvania and models are under development for certain wetland types on the Eastern Shore and in the Piedmont. Substantial federal or other sources of funding would be required to complete development of HGM models. Current staff shortages in the regulatory programs would also limit frequent use of any labor-intensive assessment approaches. The small size of the typical proposed wetland impact and mitigation site also limits the practical benefits of using this approach in day to day regulatory program implementation, though there may be some benefits for work in larger planning efforts. As a result, HGM has rarely been used in Maryland.

The Department of Natural Resources (DNR) recently conducted a preliminary HGM assessment, in conjunction with US. Fish and Wildlife Service, National Wetlands Inventory (NWI), in the report "Watershed-based Wetland Characterization for Maryland's Nanticoke River and Coastal Bays Watersheds." The study's aim is to improve existing NWI databases and provide additional characteristics for mapped wetlands that are important for assessing potential wetland functions. The NWI wetland maps were updated using DNR wetlands data (re-interpreted from 1:40,000 scale digital orthophoto quarterquads) The NWI database was enhanced to include hydrogeomorphic based attributes for all mapped wetlands and waterbodies, an inventory of ditches, an inventory of potential wetland restoration sites, and geospatial data on land use and land cover in both watersheds.

Additionally, MDE has developed an assessment methodology based on the HGM framework, but tailored to the Piedmont and Coastal Plain of Maryland. The methodology is described in a report entitled "A Method for the Assessment of Wetland Function," and was produced in association with the Fugro East company. This method is intended for use at the landscape level, to aid in planning and evaluation for a given study area for both field and office use (Fugro East, 1995). The Fugro East HGM methodology has already been adapted and used for watershed planning in Montgomery County. Further adaptations of the HGM methodology have been developed for use in the Eastern Coastal Plain, by the Smithsonian Environmental Resource Center, and for use in the Ridge and Valley Region, by Pennsylvania State University.

Other assessment methodologies are also occasionally used for planning purposes. An adapted version of the New Hampshire method has been used in special area management plans (SAMPs) in Baltimore County. The results are used to guide permit decisions. Variations of the New Hampshire method and the Wetland Evaluation Technique (WET) have also been used for studies in Somerset, Calvert, and Montgomery Counties.

Another assessment approach which may have promise is the use of Indices of Biological Integrity. The approach is being promoted by EPA as a means to assess wetland condition. Biological integrity is considered to be one of the best indicators of wetland integrity. Unlike traditional wetland assessments that examine physical attributes of a wetland, an IBI examines the biological community to determine if chemical, physical, or biological stressors have damaged a wetland. Macro-invertebrates, vascular plants, and amphibians are among the biological indicators used as biological indicators. Methodologies are currently being developed to support wetland programs in Pennsylvania and Ohio and are under development in twelve other states. IBI is also being used by the USDA Natural Resources Conservation Service and the U.S. Geological Survey at the Patuxent Wildlife Research Center in Laurel, Maryland to evaluate their wetland restoration projects. However, use of IBIs has the same disadvantages as HGM methodologies, primarily due to cost and staff limitations. Use of IBIs is expected to be considered as part of the recent EPA directive regarding wetland monitoring. The directive requires that states begin implementation of a program to monitor wetland condition by 2012.

Table II-9. Description of methods used in Maryland, (Bartoldus, 1999, Fugro East, 1995).

NEW HAMPSHIRE METHOD (NH Method)	
Primary Purpose	Evaluate wetlands for planning, education, and wetland inventories Not intended for detailed impact analysis on individual wetlands
Applicable Habitat Types	Nontidal wetlands in New Hampshire
Categories Assessed	Functional values assessed: wildlife habitat, finfish habitat, educational potential, visual/aesthetic quality, water based recreation, flood control potential, ground water use potential, sediment trapping, nutrient attenuation, shoreline stability, erosion attenuation, urban quality of life, historical site potential, and noteworthiness.
Procedure	Creation of wetland base map/data overlays using available information Site visit Complete data sheets: a) evaluation questions, b) list evaluation criteria for each question, c) assign a functional value index to criteria for each question, d) calculate the average functional capacity index and wetland value units
Output	Measure of functional value of wetland; evaluates the relative value of a wetland or wetlands
Design Applications	NH Method should not be used as a guide to wetland design since thresholds are not established for the variables used in the assessment; variables can be regionally calibrated using established/validated thresholds for specific wetland types which would improve the predictive capabilities of the method
EVALUATION FOR PLANNED WETLANDS (EPW)	
Primary Purpose	Evaluate wetland functions and determine whether a planned wetland has been adequately designed to achieve defined function goals; also used in regulatory, planning and management situations
Applicable Habitat Types	All wetland types in the United States
Categories Assessed	Six functions: shoreline bank erosion control, sediment stabilization, water quality, wildlife, fish, and uniqueness/heritage
Procedure	Site visit or plan review for future conditions Complete data sheets: a) identify the individual model elements, b) list conditions of model elements, c) assign score to conditions for each element, d) include the model for calculating the functional capacity index. Calculate the functional capacity units for each function (multiply applicable area by functional capacity index)
Output	Measure of functional capacity of a site
Design Applications	EPW can be used as a guide for design; EPW models provide design criteria with defined measurements and values
Method for Assessment of Wetland Function (Fugro Method)	
Primary Purpose	Designed for use by informed lay persons dealing with watershed management issues, particularly county planners.
Applicable Habitat Types	Maryland's Piedmont and Coastal Plain
Categories Assessed	Functions: ground water discharge, flood flow attenuation, modification of water quality, sediment stabilization, aquatic and wildlife diversity
Procedure	Characteristics of the landscape determined Functions of individual wetlands determined Functions compared to reference functions and indicators for valuation
Output	Comparative valuation of wetland functions to their potential
Design Applications	Rapid assessment of wetland functions for broad area planning purposes where actual and potential future relative wetland functions are considered.