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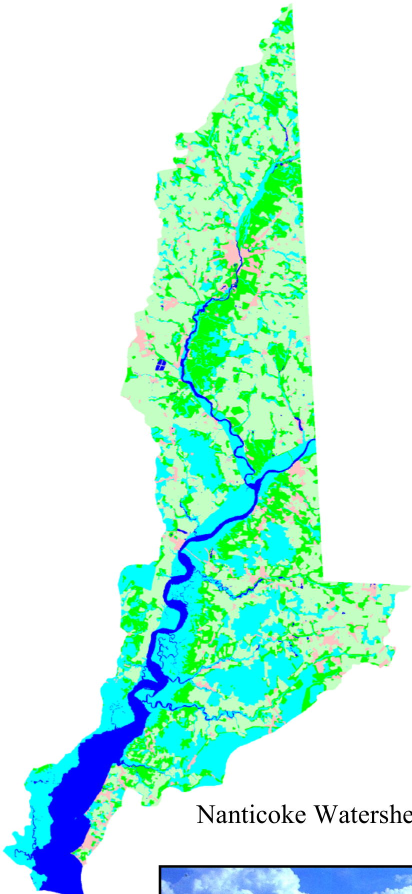
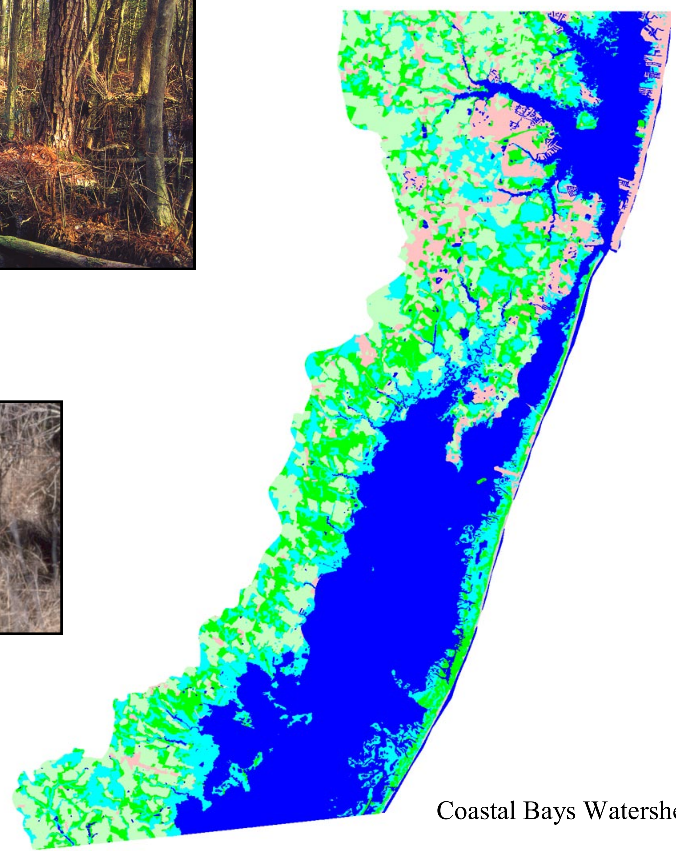
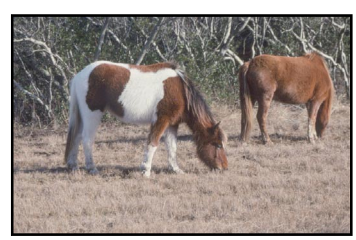
A Preliminary Assessment Report





Nanticoke Watershed

Coastal Bays Watershed



Watershed-based Wetland Characterization for Maryland's Nanticoke River and Coastal Bays Watersheds: A Preliminary Assessment Report

by

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Introduction

Today there is great interest in managing wetland resources from a watershed standpoint or landscape perspective. Wetland managers need information on a variety of topics including the location and type of existing wetlands, wetland functions, potential wetland restoration sites, and the overall condition of natural habitat in the watershed. The U.S. Fish and Wildlife Service's National Wetlands Inventory Program has developed products that expand the use of its conventional maps and digital products to aid in resource management. In particular, the NWI has improved and enhanced existing NWI databases to provide additional characteristics for mapped wetlands that are important for assessing potential wetland functions. The NWI has provided assistance to the State of Massachusetts in conducting watershed-wide inventories of potential wetland restoration sites. The NWI has also performed watershed-based analyses of the condition of natural habitat throughout watersheds while focusing on wetland and aquatic resources and their buffers. The State of Maryland is interested in using these sources of information for natural resource planning and provided funds to the Service to produce these products for two watersheds - the Nanticoke River watershed and the Coastal Bays watershed. This effort would be the first attempt at producing a watershed-based wetland characterization in the State. It could serve as a prototype of what might be done elsewhere in other watersheds. This work should help the State of Maryland develop a wetland protection strategy for individual watersheds that will address wetland acquisition, restoration, and other means of strengthening wetland protection in priority areas. It should serve as a foundation to build upon with additional site-specific studies.

Study Areas

The study areas are represented by two watersheds on Maryland's Eastern Shore on the Delmarva Peninsula -- the Nanticoke River watershed and the Coastal Bays watershed. The Nanticoke watershed covers an area approximately 323 square miles in size, encompassing parts of Dorchester, Wicomico, and Caroline Counties. Major tributaries of the Nanticoke River drainage basin are Marshyhope, Rewastico, Quantico, and Wetipquin Creeks. The watershed is comprised of 61 percent upland, 8 percent deepwater habitat, and 31 percent wetland. Estuarine waters total nearly 16,400 acres, while riverine tidal waters (610 acres) and lacustrine impoundments (330 acres) have a combined total of roughly 1000 acres. The Coastal Bays watershed occupies 296 square miles within Worcester County. The main waterbodies associated with the Coastal Bays watershed are Chincoteague, Newport, Sinepuxent, Isle of Wight, and Assawoman Bays, plus Greys Creek, and the St. Martin and Trappe Rivers. The watershed is comprised of 44 percent upland, 37 percent deepwater habitat, and 19 percent wetland. Nearly all (99%) of the deepwater habitats are estuarine (about 70,000 acres), with about 130 acres of lacustrine impoundments. General descriptions of wetlands associated with Maryland's Coastal Plain (which includes the study watersheds) can be found in "Wetlands of Maryland" (Tiner and Burke 1995) and are included as Appendix A of this report.

Methodology

The purpose of the project was to produce new information to assist Maryland wetland managers in wetland planning and evaluation at the watershed level. The foundation of this project was construction of a fairly comprehensive, geospatial wetland database. The existing wetland digital data for Maryland included the National Wetlands Inventory (NWI) data (based on 1:24,000 maps derived from mostly early 1980s-1:58K color infrared photography) and the State's wetland data (based on digital orthophoto quarter-quads produced from 1989-1:40K color infrared photographs). The NWI data were used as the foundation since they are part of a national database and match up well with other national digital data, especially hydrology data from the U.S. Geological Survey. The State data were used as collateral data to improve the delineation of wetlands in the NWI database.

The NWI database was also expanded to include hydrogeomorphic-type 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. The information contained within the database was then used to produce summary statistics, thematic maps, and a wetland characterization report for the watersheds. The characterization included: 1) a summary of the extent and distribution of wetland types (by NWI type and hydrogeomorphic type), 2) a preliminary assessment of wetland functions for each watershed, 3) an inventory of potential wetland restoration sites, 4) a description of the condition of wetland and waterbody buffers, 5) an overall assessment of natural habitat for the watershed, and 6) an assessment of the extent of ditching. The following discussion addresses procedures used to produce this information. The report summarizes the study findings for each watershed. The results of this report should be considered preliminary as it has not been subject to agency or field review.

Improved Baseline NWI Data

While the project did not call for a comprehensive update of NWI maps, we needed a more complete and up-to-date wetland database for the characterization and analysis of wetland functions for each watershed. Consequently, the first task was to improve the existing wetland dataset since the pre-existing NWI data were both dated (derived from early 1980s photography) and conservative (e.g., many flatwoods were not mapped). Since a complete remapping of wetlands was not scheduled, we performed a rapid assessment revision of the wetlands data using a digital transfer scope to facilitate integration of existing digital wetland and hydric soil data with photointerpretation of spring 1998-1:40K black-and-white aerial photography. The digital data used to assist in updating were: 1) digital data for Maryland wetlands produced by the State from 1989 photography, 2) digital data on submerged aquatic vegetation (for the Coastal Bays) from the Virginia Institute of Marine Sciences (VIMS), and 3) hydric soil digital data from the U.S.D.A. Natural Resources Conservation Service's (NRCS) soil surveys. Using a digital transfer scope, the existing NWI database was updated and improved. Utilizing hydric soils digital data to help expand the mapping of flatwood wetlands may have led to some errors of commission (i.e., inclusion of upland forests in flatwood polygons). These wetlands tended to be classified as a seasonally saturated forested wetland of some kind (broad-leaved deciduous, needle-leaved evergreen, or mixed; NWI codes such as PFO1B, PFO4B, PFO1/4B, and PFO4/1B). In earlier NWI mapping, most of the mapped wet flatwoods were labelled as temporarily flooded, since ponding was observed in a few places. Since the 1980s, more inventory work has been done in the Coastal Plain and the hydrology of wet flatwoods has been determined to be best described as “seasonally saturated”. This is because high water tables are typical in winter and early spring, with little standing water present; locally they are called “winter wet woods”. The older classifications of these flatwoods were retained (e.g., PFO1A or PFO4A) for the most part due to time and budget considerations; these areas should be reclassified at some point in the future to produce a more consistent database. Nonetheless, this effort produced a more accurate database on the distribution, extent, and type of wetlands for the study watersheds. The VIMS data for submerged aquatic vegetation were simply imported and added to the wetland database for the Coastal Bays watershed. These data were derived from mapping based on 1998-1:24,000 black and white aerial photography. The NRCS data for hydric soils and Maryland state wetland data were mainly used as collateral sources to aid in flatwood wetland identification and the former also for assisting with wetland classification and predictions of wetland functions.

Expanded NWI Data

Once a more complete inventory of wetlands was created, the NWI database was further expanded by adding hydrogeomorphic-type information to each mapped wetland. Landscape position, landform, water flow path, and other descriptors were applied to all wetlands in the NWI digital database by merging NWI data with on-line U.S. Geological Survey topographic maps and consulting aerial photography where necessary (see Tiner 2000; Appendix B of this report for keys to these descriptors).

Landscape position defines the relationship between a wetland and an adjacent waterbody, if present. Five landscape positions are relevant to the study watersheds: 1) marine (along the ocean and open euhaline embayments), 2) estuarine (along sheltered euhaline bays and brackish embayments and rivers), 3) lotic (along freshwater rivers and streams), 4) lentic (in lakes, reservoirs, and their basins), and 5) terrene (isolated, headwater, or fragments of former isolated or headwater wetlands that are now connected to downslope wetlands via drainage ditches). Lotic wetlands are further separated by river and stream gradients as high (e.g., shallow mountain streams on steep slopes - not present in the study areas), middle (e.g., streams with moderate slopes - not present in the study areas), low (e.g., mainstem rivers with considerable floodplain development as in the Nanticoke watershed), and tidal (i.e., under the influence of the tides). "Rivers" are separated from "streams" solely on the basis of channel width: watercourses mapped as linear (one-line) features on an NWI map and a U.S. Geological Survey topographic map were designated as streams, whereas two-lined channels (polygonal features; two banks shown) on these maps were classified as rivers.

Landform is the physical form of a wetland or the predominant land mass on which it occurs (e.g., floodplain or interfluve). Six types are recognized in the study areas: basin, interfluve, flat, floodplain, fringe, and island (see Table 1 for definitions). Wetlands on the following soil types were considered to be floodplain wetlands: Chicone, Fluvaquents, Indiantown, Mannington, Mixed Alluvial Land, Nanticoke, Puckum, and Zekiah.

Additional modifiers were assigned to indicate water flow paths associated with wetlands:

throughflow, inflow, outflow, bidirectional, or isolated. Throughflow wetlands have either a watercourse or another type of wetland above and below it, so water flows through the subject wetland. Lotic wetlands are mostly throughflow types, except for lotic tidal ones (i.e., bidirectional flow or two-way flow). Inflow wetlands are sinks where no outlets exist, yet water is entering via a stream, river, or upslope wetland. Outflow wetlands have water leaving them and moving downstream via a watercourse or a slope wetland. Isolated wetlands are usually closed depressions or flats where water comes via surface water runoff or ground water discharge.

Other descriptors applied to mapped wetlands include headwater, drainage-divide, and fragmented. Headwater wetlands are sources of streams or wetlands along first order (perennial) streams. They include wetlands connected to first order streams by ditching; these wetlands were also labeled with a ditched modifier. Many such wetlands are remnants of once larger interfluve wetlands that drained directly into streams. Drainage-divide wetlands are wetlands that occur in more than one watershed, straddling the defined watershed boundary line between the subject watershed and a neighboring one. We also attempted to address the issue of fragmentation of wetlands. For this, wetlands separated by major highways (federal and state roads) and wetlands broken up by land development (e.g., farming) were considered fragmented wetlands. The latter type required examining the hydric soils data layer where available. In applying the fragmented descriptor, we attempted to cull out once larger wetlands that have been divided into smaller pieces. We did not apply the descriptor to wetlands that were simply reduced in size due to land use practices. The listing of fragmented wetlands is probably conservative.

For open water habitats such as the ocean, estuaries, lakes, and ponds, we also applied additional descriptors following Tiner (2000). For the study watersheds, such classification was mainly relevant for the estuaries and ponds.

Preliminary Assessment of Wetland Functions

After improving and enhancing the NWI digital database, several analyses were performed to produce a preliminary assessment of wetland functions for the watershed. Ten wetland functions were evaluated: 1) surface water detention, 2) streamflow maintenance, 3) nutrient transformation, 4) sediment and other particulate retention, 5) coastal storm surge detention and shoreline stabilization, 6) inland shoreline stabilization, 7) fish and shellfish habitat, 8) waterfowl and waterbird habitat, 9) other wildlife habitat, and 10) conservation of biodiversity. The rationale for correlating wetland characteristics with wetland functions is described in a later section of this report. After running the analyses, a series of maps for the watershed were generated to highlight wetland types that may perform these functions at high or other significant levels. Statistics and topical maps for the study area were generated by ArcView software.

Table 1. Definitions and examples of landform types (Tiner 2000).

Landform Type	**General Definition**	**Examples**
Basin*	a depressional (concave) landform	lakefill bogs; wetlands in the saddle between two hills; wetlands in closed or open depressions, including narrow stream valleys
Slope	a landform extending uphill (on a slope)	seepage wetlands on hillside; wetlands along drainageways or mountain streams on slopes
Flat*	a relatively level landform, often on broad level landscapes	wetlands on flat areas with high seasonal ground-water levels; wetlands on terraces along rivers/streams; wetlands on hillside benches; wetlands at toes of slopes
Floodplain	a broad, generally flat landform occurring on a landscape shaped by fluvial or riverine processes	wetlands on alluvium; bottomland swamps
Interfluve	a broad level to imperceptibly depressional poorly drained landform occurring between two drainage systems (on interstream divides)	flatwood wetlands on coastal or glaciolacustrine plains
Fringe	a landform occurring along a flowing or standing waterbody (lake, river, stream) and typically subject to permanent, semipermanent flooding or frequent tidal flooding; including wetlands within stream or river channels and estuarine wetlands with unrestricted tidal flow	buttonbush swamps; aquatic beds; nonpersistent emergent wetlands; salt and brackish marshes
Island	a landform completely surrounded by water (including deltas)	deltaic and insular wetlands; floating bog islands

*May be applied as sub-landforms within the Interfluve and Floodplain landforms.

Wetland Restoration Site Inventory

Wetland restoration efforts have been accelerating over the past decade. Much of the work done to date has been on an ad-hoc basis without knowledge of a broader universe of potential sites. In most areas of the country, site selection for wetland restoration has simply been driven by opportunities and not by a holistic view of watersheds and wetland resources. Recently, the State of Massachusetts initiated a watershed-based restoration process, where potential wetland restoration sites are identified throughout an entire watershed, then matched with locations of various "watershed-deficits" (e.g., flooding problems, areas of degraded water quality, and areas lacking connectivity between significant fish and wildlife habitats) in an effort to promote wetland restoration where the greatest public good can be gained. Such work provides agencies, organizations, and others interested in wetland restoration with a wide selection of potential sites. The Maryland Department of Natural Resources is interested in this process, so we also identified potential wetland restoration sites for the two watersheds.

An inventory of potential wetland restoration sites was performed by examining aerial photos, hydric soil information, and existing wetland data (e.g., for farmed wetlands, wetlands experiencing possible hydrologic restrictions, plus diked, ditched, and excavated vegetated wetlands). Two major types of wetland restoration sites were identified: Type 1 sites - former vegetated wetlands that appear suitable for restoration, and Type 2 sites - existing vegetated wetlands whose functions appear to be significantly impaired by ditching, excavation, and impoundment. Type 1 restoration sites included former wetlands that were filled and that did not have buildings or other facilities constructed on them, farmed wetlands, and vegetated wetlands that were converted to deepwater habitats such as impounded lakes. Farmed wetlands may technically be considered Type 2 candidates, but since their condition is impaired to the point that they only minimally meet the definition of wetland in the subject areas, they were considered Type 1 sites. Type 2 restoration sites are mostly existing vegetated wetlands that are impounded, excavated, partly drained (ditched), and potentially tidally restricted, but also include shallow ponds which are technically considered wetlands by the Cowardin et al. (1979) wetland classification system. The latter sites may arguably be considered Type 1 sites for restoration, but for this study were identified as Type 2 sites. For ditched wetlands, no attempt was made to evaluate the severity of ditching as this requires field-based assessments. One, however, might consider the degree of ditching as observed on the map showing the extent of ditching as a way of evaluating the relative impact of ditching on various wetlands. Type 2 sites could be expanded to include wetlands where the adjacent land use may have significant effects on the quality of the wetland, but this was not an objective of this project. Many, if not most, wetlands in the subject watersheds could be highlighted as having potentially significantly adverse impacts from adjacent land use practices as many wetlands are surrounded by cropland. Many of these wetlands, however, were identified as being adversely impacted by ditching.

Sites identified as potential wetland restoration sites appeared to be restorable to vegetated wetlands in some way. Sites such as ponds on hydric soils and now surrounded by residential development were not considered to be viable sites. However, ponds and farmed wetlands surrounded by cropland (within hydric soil map units) were considered to have some restoration potential. Theoretically such sites could be restored to large forested wetlands with landowner permission due to the presence of extensive drained hydric soils in the surrounding agricultural fields.

Wetland and Waterbody Buffer Analysis

A 100m-wide buffer has been reported to be important for neotropical migrant bird species in the Mid-Atlantic region (Keller et al. 1993) and streamside vegetation providing canopy coverage over streams is important for lowering stream temperatures and moderating daily fluctuations that is vital to providing suitable habitat for certain fish species (e.g., trout). Review of the literature on buffers suggests wider buffers, such as 500m or more for certain species of wildlife (e.g., Kilgo et al. 1998 for southern bottomland hardwood stream corridors). An interesting article by Finlay and Houlahan (1996) indicates that land use practices around wetlands may be as important to wildlife as the size of the wetland itself. They reported that removing 20 percent of the forest within 1000m of a wetland may have the same effect on species as destroying 50 percent of the wetland. For literature reviews of wetland and stream buffers, see Castelle et al. (1994) and Desbonnet et al. (1994).

The condition of these buffers is also significant for locating possible sources of water quality degradation. Wooded corridors should provide the best protection of water quality, while developed corridors (e.g., urban or agriculture) should contribute to substantial water quality and aquatic habitat deterioration. Since wetland and waterbody buffers are important features that relate to the quality of these aquatic habitats, we performed an analysis of the condition of these buffers. This information was also used for evaluating the overall ecological condition or the condition of natural habitats for each watershed.

A 100m-wide buffer was selected for analysis. The buffer was positioned around wetlands, waterbodies, and ditches. To evaluate the condition of the upland buffer, we created a land use/land cover data layer by combining existing digital data with new photointerpretation. The state’s existing digital data on land use/land cover was used as the baseline data. These data were updated by interpreting 1998 aerial photography (1:40,000 black and white) using a digital transfer scope. We used the Anderson et al. (1976) land use/land cover classification system and classified upland habitats to level two in the system. The following categories were among those identified: developed land (residential, commercial, industrial, transportation/communication, utilities, other, institutional/government, and recreational, farmsteads/farm-related buildings), agricultural land (cropland/pasture, orchards/nurseries/horticulture, and feedlots/holding areas), forests (deciduous, evergreen, mixed, and clear-cut), wetlands (from NWI data), and transitional land (moving toward some type of development or agricultural use, but future status unknown). Data layers were constructed for the entire “land” area of each watershed so that information could also be used for assessing their overall ecological condition. Buffer analysis is one of the key landscape variables used to judge this condition.

Overall Ecological Condition of the Watershed

There are many ways to assess land use/cover changes and habitat disturbances. The health and ecological condition of a watershed may be assessed by considering such features as the integrity of the lotic wetlands and riparian forests (upland forests along streams), the percent of land uses that may adversely affect water quality in the watershed (% urban, % agriculture, % mining, etc.), the actual water quality, the percent of forest in the watershed, and the number of dams on streams, for example. Recent work on assessing the condition of watersheds has been done in the Pacific Northwest to address concerns for salmon (Wissmar et al. 1994; Naiman et al. 1992). A Wisconsin study by Wang et al. (1997) found that in-stream habitat quality declined when agricultural land use in a watershed exceeded 50 percent, while when only 10-20 percent of the watershed was urbanized, severe degradation occurred.

To assess the overall ecological condition of watersheds, the Northeast Region of the U.S. Fish and Wildlife Service has developed a set of largely remotely-sensed “natural habitat integrity” indices. The variables for these indices are derived through air photointerpretation and/or satellite image processing coupled with knowledge of the historical extent of wetlands and open waterbodies. They are coarse-filter variables for assessing the overall condition of watersheds. They are intended to augment, not supplant, other more rigorous, fine-filter approaches for describing the ecological condition of watersheds (e.g., indices of biological integrity for macroinvertebrates and fish and the extent and distribution of invasive species) and for examining relationships between human impacts and the natural world. The natural habitat integrity indices can be used to develop “habitat condition profiles” for individual watersheds of varying scales (i.e., subbasins to major watersheds). Indices can be used for comparative analysis of subbasins within watersheds and to compare one watershed with another. They may also serve as one set of statistics for reporting on the State-of-the-Environment by government agencies and environmental organizations.

The indices are rapid-assessment types that allow for frequent updating (e.g., every 5-10 years). They may be used to assess and monitor the amount of “natural habitat” compared to the amount of disturbed aquatic habitat (e.g., channelized streams, partly drained wetlands, and impounded wetlands) or developed habitat (e.g., cropland, grazed meadows, mined lands, suburban development, and urbanized land). The index variables include features important to natural resource managers attempting to lessen the impact of human development on the environment. The indices may also be compared with other environmental quality metrics such as indices of biological integrity for fish and/or macroinvertebrates or water quality parameters. If significant correlations can be found, they may aid in projecting a “carrying capacity” or threshold for development for individual subbasins. This would require further classification of the developed land category into agricultural types and urban/suburban types which is easily accomplished.

To date, a total of 9 indices have been developed. All of them, in one way or another, represent habitat condition in a watershed. Five indices address natural habitat extent (i.e., the amount of natural habitat occurring in the watershed and along wetlands and waterbodies): natural cover, stream corridor integrity, wetland and other waterbody buffer integrity, wetland extent, and standing waterbody extent. Use of terms like “natural habitat” and “natural vegetation” have stirred much debate, yet despite this, we feel that they are useful for discussing the effects of human activities on the environment. For purposes of this study, “natural habitats” are defined as areas where significant, frequent human activity is limited to nature observation, hunting, and fishing, and where vegetation is allowed to grow for many years without annual introduction of chemicals or annual harvesting of vegetation or fruits and berries for commercial purposes. Natural habitats may be managed, but they are places where wetland and terrestrial wildlife find food, shelter, and water. In other words, they are essentially plant communities represented by "natural" vegetation (such as forests, meadows, and shrub thickets). They are not developed sites (e.g., not impervious surfaces, lawns, turf, cropland, heavily grazed pastures, or mowed hayfields). Managed forests are included as natural habitat, whereas orchards and vineyards are not. "Natural habitat" therefore includes habitats ranging from pristine woodlands and wetlands to wetlands now colonized by invasive species (e.g., Phragmites australis or Lythrum salicaria) or commercial forests planted with loblolly pine. Natural vegetation does not imply that substantial groundcover must be present, but simply that the communities reflect the vegetation that is capable of growth and reproduction in accordance with site characteristics. Consequently, areas with sparse vegetation, such as sand dunes and beaches, qualify as natural habitat.

Three indices emphasize human-induced alterations to streams and wetlands. These "stream and wetland disturbance indices" address dammed stream flowage, channelized stream flowage, and wetland disturbance. The 8 specific indices may be combined into a single, composite index called "remotely-sensed natural habitat integrity index" for the watershed. All indices have a maximum value of 1.0 and a minimum value of zero. For the habitat extent indices, the higher the value, the more habitat available. For the disturbance indices, the higher the value, the more disturbance. For the remotely-sensed natural habitat integrity index, all indices are weighted, with the disturbance indices subtracted from the habitat extent indices to yield an overall "natural habitat integrity" score for the watershed.

Data for these indices came from the improved NWI digital database and a newly created land use/land cover database for the two watersheds. The data were derived primarily through aerial photointerpretation with review of existing information. Presently, the indices do not include certain qualitative information on the condition of the existing habitats (habitat quality) as reflected by the presence, absence, or abundance of invasive species or by fragmentation of forests, for example. It may be possible to add such data in the future, especially for the latter. Another consideration would be possible establishment of minimum size thresholds to determine what constitutes a viable "natural habitat" for analysis (e.g., 0.04 hectare/0.1 acre patch of forest or 0.4 hectare/1 acre minimum?). Other indices may also need to be developed to aid in water quality assessments (e.g., index of ditching density for agricultural and silvicultural lands). The 9 indices are summarized below.

Habitat Extent Indices

The Natural Cover Index (I_{NC}) is derived from a simple percentage of the subbasin that is wooded (e.g., upland forests or shrub thickets and forested or scrub-shrub wetlands) or "natural" open land (e.g., emergent wetlands or open, "old" fields; but not cropland, hayfields, lawns, turf, or heavily grazed pastures) - lands supporting "natural vegetation" (excluding open water of ponds, rivers, lakes, streams, and coastal bays):

$$I_{NC} = A_{NV}/A_W$$

where A_{NV} (area in natural vegetation) equals the area of the watershed's land surface in "natural" vegetation (e.g., woodland, open land [wildlife habitat, not farms, golf courses, ballparks, or playgrounds], and vegetated wetland). This index addresses only the "land" portion of the watershed (excludes open water from the calculations), so the area of "watershed" (A_W) for this index disregards the area occupied by open water.

The <u>Stream Corridor Integrity Index</u> (I_{SCI}) is derived by considering the condition of the stream corridors:

$$I_{SCI} = A_{VC}/A_{TC}$$

where A_{VC} (vegetated stream corridor area) is the area of the stream corridor that is colonized by "natural vegetation" and A_{TC} (total stream corridor area) is the total area of the stream corridor. The width of the stream corridor may be varied to suit project goals, but for this index, a 100-meter corridor (50m on each side of the stream) will usually be evaluated (at a minimum), due to its well-recognized role in water quality maintenance and contributions to aquatic habitat quality. If wildlife travel corridors are a primary concern, a larger corridor (e.g., 200m to 1000m) may be examined. The stream corridor may be restricted to "streams" (linear tributaries on a 1:24,000 map) or expanded to include "rivers" (polygonal features at this scale). If the latter is included in the index, it should be referred to as the River/Stream Corridor Integrity Index (I_{RSCI}).

The <u>Wetland and Other Waterbody Buffer Index</u> (I_{WWB}) is a measure of the condition of wetland and waterbody buffers within a specified distance (e.g., 100m) of mapped wetlands and waterbodies (mainly lakes and estuaries, excluding river/stream or stream corridors) for the entire watershed:

$$I_{WWB} = A_{VB}/A_{TB}$$

where A_{VB} (area of vegetated buffer) is the area of the buffer zone that is in natural vegetation cover and A_{TB} is the total area of the buffer zone. The buffer zone can include or exclude open water, with the latter emphasizing land use and land cover changes.

The <u>Wetland Extent Index</u> (I_{WE}) addresses the current extent of vegetated wetlands (excluding open-water wetlands) compared with the estimated historic extent - the approximate percent of wetlands remaining in the watershed:

$$I_{WE} = A_{CW}/A_{HW}$$

where A_{CW} is the current wetland area in the watershed and A_{HW} is the historic wetland area in the watershed (estimated).

For example, a watershed with a coverage of 10 percent wetland would have an I_{WE} of 1.0 where the estimated original extent of wetlands was 10 percent or an I_{WE} of 0.5 where 20 percent of the watershed once contained wetlands. The I_{WE} is an approximation of the extent of the original wetland acreage remaining in the watershed. If data on historical wetland area are not available, calculate this by either evaluating a relatively undisturbed subwatershed in the watershed (i.e., one with similar properties of landscape, soils, and surficial geology) or using the area of hydric soils (including land types that are predominantly wetlands such as swamp or tidal marsh) as the historic extent of vegetated wetlands. Recognize that areal extent of historic hydric soils could be less than the current extent due to level of mapping detail (e.g., scalar issues) or to wetland-creation activities, especially due to beaver influence and shallow pond construction. When the current extent of wetlands (e.g., percent of watershed) is greater than the historic estimate, for purposes of this landscape-level assessment, it is assumed that wetland change has not been significant and the I_{WE} is recorded as 1.0.

The Standing Waterbody Extent Index (I_{SWE}) considers the current extent of standing fresh waterbodies (e.g., lakes, reservoirs, and open-water wetlands - ponds) in a watershed relative to the historic area of such features:

$$I_{SWE} = A_{CSW}/A_{HSW}$$

where A_{CSW} is the current standing waterbody area and A_{HSW} is the historic standing waterbody area in the watershed.

The historic number is created by either consulting older USGS topographic maps or simply by subtracting the area of new large fresh waterbodies (e.g., reservoirs and large impoundments) from the current area. When it is obvious that extensive open waterbodies have been created (i.e., reservoirs, impoundments, ponds, and excavations) and the total area of open water has increased, it is not necessary to calculate this index. Simply, use a I_{SWE} value of 1.0 when applying this index to determine the remotely-sensed natural habitat integrity index. This is the case for many watersheds, especially those in agricultural and urban/suburban areas.

Stream and Wetland Disturbance Indices

The Dammed Stream Flowage Index (I_{DSF}) is a measure that attempts to highlight the direct impact of damming on rivers and streams in a watershed:

$$I_{DSF} = L_{DS}/L_{TS}$$

where L_{DS} is the length of perennial rivers and streams impounded by dams (combined pool length) and L_{TS} is the total length of perennial rivers and streams in the watershed. It does not attempt to predict the magnitude of downstream effects from such dams as they are not readily predicted from aerial photointerpretation or geographic information system technology.

The Channelized Stream Length Index (I_{CSL}) addresses the extent of channelization of streams within a watershed relative to its total stream length:

$$I_{CSL} = L_{CS}/L_{TS}$$

where L_{CS} is the channelized stream length and L_{TS} is the total stream length for the watershed. This index only addresses stream channelization; it does not include the length of artificial ditches excavated in farmfields and forests. It will usually emphasize perennial streams, but could include intermittent streams, if desirable.

The Wetland Disturbance Index (I_{WD}) is a measure of the extent of existing wetlands that are diked/impounded, ditched, or excavated:

$$I_{WD} = A_{DW}/A_{TW}$$

where A_{DW} is the area of disturbed or altered wetlands and A_{TW} is the total wetland area in the watershed. Wetlands are represented by vegetated and nonvegetated (e.g., shallow ponds) types and include natural and created wetlands.

Composite Habitat Index for the Watershed

The Index of Remotely-sensed Natural Habitat Integrity (I_{RNHI}) is a combination of the preceding indices. It seeks to express the overall condition of a watershed in terms of its potential ecological integrity or the relative intactness of natural plant communities and waterbodies. Variations of I_{RNHI} may be derived by considering buffer zones of different widths around wetlands and streams (e.g., $I_{RNHI\ 100}$ or $I_{RNHI\ 200}$) and by applying different weights to individual indices. An example is given below emphasizing a 100-meter buffer:

$$I_{RNHI\ 100} = (0.6 \text{ x } I_{NC}) + (0.1 \text{ x } I_{SCI200}) + (0.1 \text{ x } I_{WWB100}) + (0.1 \text{ x } I_{WE}), + (0.1 \text{ x } I_{SWE}) - (0.1 \text{ x } I_{DSF}) - (0.1 \text{ x } I_{CSL}) - (0.1 \text{ x } I_{WD})$$

where the condition of the 100m buffer is used throughout. (Note: With this size buffer, the stream corridor width becomes 200m.)

Ditch Inventory

To determine the extent of ditches in each watershed, we began with the digital hydrology coverage from the U.S. Geological Survey 1:24K map series (digital line graphs - DLGs). This coverage was reviewed through photointerpretation to help separate “natural streams” from “ditches” and formed the foundation for the “ditch” data layer. To create an up-to-date “ditch” coverage, photointerpretation of 1998 aerial photography[1] was performed using a digital transfer scope. Ditches were separated from channelized and natural streams. Data presented include number of ditch miles and the density of ditches per study watershed.

[1]For the Nanticoke watershed, initial mapping of ditches was accomplished by photointerpreting 1989 photos since the 1998 photos were not available until later in the project. These data were updated with the 1998 photos to create a 1998-era database for ditches.

General Scope and Limitations of the Study

Wetland Inventory and Digital Database

The wetlands inventory and digital database do not represent a complete re-inventory of wetlands in the subject watershed. They are, however, a significant improvement and update of the original NWI database and can serve as a foundation for a preliminary watershed characterization. Mapping of flatwood wetlands may be liberal due to the use of hydric soil data to aid in their interpretation.[1] One must recognize the limitations of any wetland mapping effort derived mainly through photointerpretation techniques (see Tiner 1997 for details). For example, use of spring aerial photography for wetland mapping precludes identification of freshwater aquatic beds. Such areas are included within areas mapped as open water (e.g, lacustrine and palustrine unconsolidated bottom) because vegetation is not developed so they appear as water on the aerial photographs. Also drier-end wetlands such as seasonally saturated and temporarily flooded wetllands are often difficult to separate from nonwetlands through photointerpretation. Future ground-truthing exercises will need to be performed to further improve the database.

An attempt was made to apply a “fragmented” descriptor to highlight wetlands that are fragments of once-larger wetlands. In the study watersheds, many wetlands are separated into variously-sized parcels due to agricultural land uses. Obvious fragments were identified. For some small wetland areas, it was not possible to readily determine whether they were fragments of a once larger interfluve wetland without reviewing of soil information and land use/cover data to verify the occurrence of a once larger wetland. This was done where digital soils data were available (e.g., entire Coastal Bays watershed and the Dorchester County portion of the Nanticoke watershed). The use of the fragmented descriptor should be considered conservative. Future discussion of what situation constitutes sufficient fragmentation to be highlighted for natural resource planning purposes may improve future application of this descriptor.

Preliminary Assessment of Wetland Functions

At the outset, it is important to emphasize that this functional assessment is a preliminary one based on wetland characteristics interpreted through remote sensing and using the best professional judgment of the authors, two U.S. Fish and Wildlife Service field offices (Chesapeake Bay Field Office and Delaware Bay Estuary Project Office), and staff from the Maryland Department of Natural Resources. Wetlands believed to be providing potentially high or other significant levels of performance for a particular function were highlighted. As the focus of this report is on wetlands, an assessment of deepwater habitats (e.g., lakes, rivers, and estuaries) for providing the listed functions was not done (e.g., it is rather obvious that such areas provide significant functions like fish habitat). Also, no attempt was made to produce a more qualitative ranking for each function or for each wetland based on multiple functions as this would require more input from others and more data, well beyond the scope of this study. For a technical review of wetland functions, see Mitsch and Gosselink (2000) and for a broad

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[1]Differences in projections and base map source data caused a mismatch between state wetland digital data and federal digital data (e.g., U.S. Geological Survey digital line graphics) which unfortunately precluded broad use of the former. Time was not available to rectify this problem.

overview, see Tiner (1998).

Functional assessment of wetlands can involve many parameters. Typically such assessments have been done in the field on a case-by-case basis, considering observed features relative to those required to perform certain functions or by actual measurement of performance. The present study does not seek to replace the need for such evaluations as they are the ultimate assessment of the functions for individual wetlands. Yet, for a watershed analysis, basinwide field-based assessments are not practical or cost-effective or even possible given access limitations. For watershed planning purposes, a more generalized assessment is worthwhile for targeting wetlands that may provide certain functions, especially for those functions dependent on landscape position and vegetation life form. Subsequently, these results can be field-verified when it comes to actually evaluating particular wetlands for acquisition purposes, e.g., for conservation of biodiversity or for preserving its flood storage function. Current aerial photography may also be examined to aid in further evaluations (e.g., condition of wetland/stream buffers or adjacent land use) that can supplement our preliminary assessment.

This study employs a watershed assessment approach that may be called "Watershed-based Preliminary Assessment of Wetland Functions" (W-PAWF). W-PAWF applies general knowledge about wetlands and their functions to develop a watershed overview that highlights possible wetlands of significance in terms of performance of various functions. To accomplish this objective, the relationships between wetlands and various functions must be simplified into a set of practical criteria or observable characteristics. Such assessments could also be further expanded to consider the condition of the associated waterbody and the neighboring upland or to evaluate the opportunity a wetland has to perform a particular function or service to society, for example.

W-PAWF usually does not account for the opportunity that a wetland has to provide a function resulting from a certain land use practice upstream or the presence of certain structures or land uses downstream. For example, two wetlands of equal size and like vegetation may be in the right landscape position to retain sediments. One, however, may be downstream of a land-clearing operation that has generated considerable suspended sediments in the water column, while the other is downstream from an undisturbed forest. The former should be actively performing sediment trapping in a major way, while the latter is not. Yet if land use conditions in the latter subwatershed area change, the second wetland will likely trap sediments as well as the first wetland. The entire analysis typically tends to ignore opportunity since such opportunity may occurred in the past or may occur in the future and the wetland is awaiting a call to perform this service at higher levels than presently. An exception would be for a wetland type that would not normally be considered significant for a particular function (e.g., sediment retention), but due to the current land use of adjacent areas, it now receives substantial sediment input and thereby performs the sediment-trapping function at a significant level.

W-PAWF also does not consider the condition of the adjacent upland (e.g., level of disturbance) or the actual water quality of the associated waterbody as important metrics for assessing the health of individual wetlands. Determining “wetland health” was not part of this study. Collection and analysis of some of these data were done for another part of this study but were not incorporated into the preliminary functional assessment.

We further emphasize that the preliminary assessment does not obviate the need for more detailed assessments of the various functions. This assessment should be viewed as a starting point for more rigorous assessments, as it attempts to cull out wetlands that may likely provide significant functions based on generally accepted principles and the source information used for this analysis. Further review of the wetland form/function protocols and study findings will undoubtedly lead to refinements of the study results in the future. The preliminary assessment done for this study is most useful for regional or watershed planning purposes. For site-specific evaluations, additional work will be required, especially field verification and collection of site-specific data for potential functions (e.g., following the HGM assessment approach as described by Brinson 1993a and other onsite evaluation procedures). This is particularly true for assessments of fish and wildlife habitats and biodiversity. Other sources of data may exist to help refine some of the findings of this report. Additional modeling could be done, for example, to identify habitats of likely significance to individual species of animals (based on their specific life history requirements).

Wetland Restoration Site Inventory

The results of this inventory were derived from air photointerpretation with review of hydric soils data and updated wetland and land use/cover geospatial data. Time did not permit for field checking, so results should be conservative. Areas identified as potential Type 1 restoration sites had visible evidence of restoration potential (e.g., wet depressions in cropland and fill sites without buildings). Rather than piecemeal restoration of small isolated wetlands, wetland restoration of large wetland blocks (e.g., restoring huge flatwood interfluves) appears more beneficial to a goal of restoring wetland ecosystems. To accomplish this, hydric soil information should be consulted. These data will reveal significantly larger areas of hydric soils, presumably former wetlands that are now cultivated, where smaller presently isolated farmed wetlands, small impoundments, and/or vegetated wetlands could be linked together to form a larger vegetated wetland that can be connected to an existing wetland. Where hydric soil data are not available in digital form, this could be done by visual examination of soil survey maps or perhaps by simply drawing lines around the ditch network to predict the extent of former wetlands. This type of evaluation can be made by consulting the wetland restoration site maps which can be used as references for identification large-scale restoration projects. Field work, however, is required to evaluate the true restoration potential of any site as there are often limitations and other issues (e.g., landowner support) that can only be determined during field inspection.

Appropriate Use of this Report

The report provides a basic characterization of wetlands in the two subject watersheds including a preliminary assessment of wetland functions in these areas. Keeping in mind the limitations mentioned above, the results are a first-cut or initial screening of each watershed's wetlands to designate wetlands that may have a significant potential to perform different functions. The targeted wetlands have been identified as being predicted to perform a given function at a significant level presumably important to the watershed's ability to provide that function. "Significance" is a relative term and is used in this analysis to identify wetlands that are likely to perform a given function at a level above that of wetlands not designated.

While the results are useful for gaining an overall perspective of the watershed's wetlands and their relative importance in performing certain functions, the report does not identify differences among wetlands of similar type and function. The latter information is often critical for making decisions about wetland acquisition and designating certain wetlands as more important for preservation versus others with the same categorization. Additional information may be gained through consulting with agencies having specific expertise in a subject area and by conducting field investigations to verify the preliminary assessments. When it comes to actually acquiring wetlands for preservation, other factors must be considered. Such factors may include: 1) the condition of the surrounding area, 2) the ownership of the surrounding area and the wetland itself, 3) site-specific assessment of wetland characteristics and functions, 4) more detailed comparison with similar wetlands based on field data, and 5) advice from other agencies (federal, state, and local) with special expertise on priority resources (e.g., for wildlife habitat, contact appropriate federal and state biologists). The latter agencies may have site-specific information or field-based assessment methods that can aid in further narrowing the choices to help insure that the best wetlands are acquired for the desired purpose.

The report is a watershed-based wetland characterization for two watersheds. The report does not make any comparisons between these watersheds. Be advised that there may be characteristics (e.g., water quality and habitat concerns) that actually make acquisition or preservation of certain wetlands in one of these watersheds or in a particular subbasin, a higher priority than protection of similar wetlands in the other watershed or other subbasins. This was beyond the scope of the present study.

The report is useful for general natural resource planning, as an initial screening for considering prioritization of wetlands (for acquisition, restoration, or strengthened protection), as an educational tool (e.g., helping the public and nonwetland specialists better understand the functions of wetlands and the relationships between wetland characteristics and performance of individual functions), and for characterizing the differences among wetlands in terms of both form and function within each watershed.

Rationale for Preliminary Functional Assessments

The list of functions evaluated included ten functions: 1) surface water detention, 2) streamflow maintenance, 3) nutrient transformation, 4) sediment and other particulate retention, 5) coastal storm surge detention and shoreline stabilization, 6) inland shoreline stabilization, 7) fish and shellfish habitat, 8) waterfowl and waterbird habitat, 9) other wildlife habitat, and 10) conservation of biodiversity. The criteria used for identifying these functions through the digital wetland database are discussed below. The criteria were developed by the principal author of the report based on previous work and reviewed and modified for the subject watersheds based on comments from U.S. Fish and Wildlife Service field personnel and specialists from the Maryland Department of Natural Resources (see Acknowledgments).

In developing a protocol for designating wetlands of potential significance, wetland size was generally disregarded from the criteria, with few exceptions (i.e., surface water detention, other wildlife habitat, and biodiversity functions). This approach was followed because it was felt that the State and others using the digital database and charged with setting priorities should make the decision on appropriate size criteria as a means of limiting the number of priority wetlands, if necessary. Our study was intended to present a more expansive characterization of wetlands and their likely functions and not to develop a rapid assessment method for ranking wetlands for acquisition, protection, or other purposes.

Surface Water Detention

This function is important for reducing downstream flooding and lowering flood heights, both of which aid in lessening property damage from such events. In a landmark report on the relationships between wetlands and flooding at the watershed scale, Novitzki (1979) reported that watersheds with 40 percent coverage by lakes and wetlands had significantly reduced flood flows -- lowered by as much as 80 percent -- compared to similar watersheds with no or few lakes and wetlands in Wisconsin. Floodplain wetlands, other lotic wetlands (basin and flat types), estuarine fringe wetlands along coastal rivers, and estuarine island wetlands in these rivers provide this function at significant levels. Wetlands dominated by trees and/or dense stands of shrubs (with higher frictional resistance) could be deemed to provide a higher level of this function as such vegetation may further aid in flood desynchronization versus similar wetlands with emergent cover. Trees and dense shrubs produce high roughness which helps dissipate energy and lower velocity of flood waters. This relationship (woody vegetation vs. emergents) was not applied to the data set as emergent wetlands along waterways are also likely to provide significant flood storage. Floodplain width could also be an important factor in evaluating the significance of performance of this function by individual wetlands (e.g., for acquisition or strengthened protection). There is no quantitative information to establish a significance threshold for size so floodplain width was not used as a selection factor in this study.

While lotic floodplain and basin wetlands were identified as having possible high potential for surface water detention, lotic wetlands higher on the landscape (i.e., lotic flat wetlands) are not inundated as often as these types and were therefore designated as having some potential. Although all ponds may be locally important as surface water storage basins, only the throughflow ponds were identified as having high potential for surface water detention due to their location on the landscape.

For terrene wetlands, size was considered to be an important factor for determining relative significance for storing surface water. The larger the area, the more water storage capacity, all other things being equal. Terrene wetlands 50 acres and greater in size (excluding any on barrier islands) were designated as having moderate to high potential for surface water detention. These areas represent broad flats with an undulating microtopography where precipitation falling on the land surface accumulates. Many of these wetlands are sources of streams. Moreover, many also have ditches running into them from adjacent agricultural lands which further increases the likelihood of significant surface water detention. Smaller terrene wetlands (20-50 acres in size) that were not ditched were considered to have some potential for this function. Since they are not ditched, they should retain precipitation and surface water runoff from local areas.

Streamflow Maintenance

Many wetlands are sources of groundwater discharge and some may be in a position to sustain streamflow in the watershed. Such wetlands are critically important for supporting aquatic life in streams. Terrene headwater wetlands (by definition, the sources of streams) perform these functions at notable levels. Lotic wetlands along first order streams may also be important for streamflow maintenance; they were also designated as headwater wetlands. Groundwater discharging into streamside wetlands may contribute substantial quantities of water for sustaining baseflows. Floodplain wetlands are known to store water in the form of bank storage, later releasing this water to maintain baseflows. This also aids in reducing flood peaks and improving water quality (Whiting 1998). Among several key factors affecting bank storage are porosity and permeability of the bank material, the width of the floodplain, and the hydraulic gradient (steepness of the water table). The wider the floodplain, the more bank storage given the same soils. Gravel floodplains drain in days, sandy floodplains in a few weeks to a few years, silty floodplains in years, and clayey floodplains in decades. In good water years, wide sandy floodplains may help maintain baseflows.

For this preliminary analysis, floodplain wetlands on nonsandy soils were designated as important for streamflow maintenance due to the above relationship. Narrow floodplains in the Coastal Bays watershed were classified as having as moderate to high potential for this function. They may actually be better represented as having some potential for this function. Review of this document by local experts should help clarify this. Headwater wetlands associated with streams were also identified in the moderate to high potential category for this function. Wetlands in headwater positions that were connected to streams via a drainage ditch network were viewed as having some potential for streamflow maintenance as such structures facilitate water flow to streams downslope.

Nutrient Transformation

All wetlands recycle nutrients, but those having a fluctuating water table are best able to recycle nitrogen and other nutrients. Vegetation slows the flow of water which causes deposition of mineral and organic particles and nutrients (nitrogen and phosphorus) bound to them, whereas hydric soils are the places where chemical transformations occur (Carter 1996). Microbial action in the soil is the driving force behind chemical transformations in wetlands. Microbes need a food source -- organic matter -- to survive, so wetlands with high amounts of organic matter should have an abundance of microflora to perform the nutrient transformation function. Wetlands are so effective at filtering and transforming nutrients that artificial wetlands are constructed for water quality renovation (Hammer 1992). Natural wetlands performing this function help improve local water quality of streams and other watercourses.

Numerous studies have demonstrated the importance of wetlands in denitrification. Simmons et al. (1992) found high removal of nitrate (greater than 80% removal) from groundwater during both the growing season and dormant season in Rhode Island streamside (lotic) wetlands. Groundwater temperatures throughout the dormant season were between 6.5 and 8.0 degrees C, so microbial activity was not limited by temperature. Even the nearby upland, especially transitional areas with somewhat poorly drained soils, experienced an increase in nitrogen removal during the dormant season. This was attributed to a seasonal rise in the water table that exposed the upper portion of the groundwater to more organic matter (nearer the ground surface), thereby supporting microbial activity and denitrification. Riparian forests dominated by wetlands have a greater proportion of groundwater (with nitrate) moving within the biologically active zone of the soil that makes nitrate susceptible to uptake by plants and microbes (Nelson et al. 1995). Riparian forests on well-drained soils are much less effective at removing nitrate. In a Rhode Island study, Nelson et al. (1995) found that November had the highest nitrate removal rate due to the highest water tables in the poorly drained soils, while June experienced the lowest removal rate when the deepest water table levels occurred. Similar results can be expected to occur in Maryland. For bottomland hardwood wetlands, DeLaune et al. (1996) reported decreases in nitrate from 59-82 percent after 40 days of flooding wetland soil cores taken from the Cache River floodplain in Arkansas. Moreover, they surmised that denitrification in these soils appeared to be carbon-limited: increased denitrification took place in soils with greater amounts of organic matter in the surface layer.

Nitrogen fixation is accomplished in wetlands by microbial-driven reduction processes that convert nitrate to nitrogen gas. Nitrogen removal rates for freshwater wetlands are very high (averaging from 20-80 grams/square meter) (Bowden 1987). The following information comes from a review paper on this topic by Buresh et al. (1980). Nitrogen fixation has been attributed to blue-green algae in the photic zone at the soil-water interface and to heterotrophic bacteria associated with plant roots. In working with rice, Matsuguchi (1979) believed that the significance of heterotrophic fixation in the soil layer beyond the roots has been underrated and presented data showing that such zones were the most important sites for nitrogen fixation in a Japanese rice field. This conclusion was further supported by Wada et al. (1978). Higher fixation rates have been found in the rhizosphere of wetland plants than in dryland plants.

Phosphorus removal is largely done by plant uptake (Patrick, undated manuscript). Wetlands that accumulate peat have a great capacity for phosphorus removal. Wetland drainage can, therefore, change a wetland from a phosphorus sink to a phosphorus source. This is a significant cause of water quality degradation in many areas of the world including the United States, where wetlands are drained for agricultural production. Hydric soils with significant clay constituents fix phosphorus due to its interaction with clay and inorganic colloids. Reduced soils have more sorption sites than oxidized soils (Patrick and Khalid 1974), while the latter soils have stronger bonding energy and adsorb phosphorus more tightly.

From the water quality standpoint, wetlands associated with watercourses are probably the most noteworthy. Numerous studies have found that forested wetlands along rivers and streams (“riparian forested wetlands”) are important for nutrient retention and sedimentation during floods (Whigham et al. 1988; Yarbro et al. 1984; Simpson et al. 1983; Peterjohn and Correll 1982). This function by forested riparian wetlands is especially important in agricultural areas. Brinson (1993b) suggests that riparian wetlands along low order streams may be more important for nutrient retention than those along higher order streams.

For this analysis, all lotic wetlands were considered to be performing this function at high or moderate to high levels. Those having soils rich in organic matter should have the highest potential for nutrient transformation. The organic matter in the upper part of the soil (A-horizon) provides for increased microbial populations responsible for denitrification and nutrient transformation as noted above. Lotic wetlands on the following soils were considered to have high potential for nutrient transformation: Chicone, Elkton, Kentuck, Pone, Puckum, Sunken, Muck, Indiantown, Pocomoke, Portsmouth, Rutlege, St. Johns (mucky loamy sand), Mannington, and Nanticoke. These soils have high organic matter content at or near the soil surface. Also, any remaining lotic wetlands designated as floodplains or having a seasonally flooded or wetter water regime, and estuarine vegetated fringe and island wetlands were designated as wetlands with predicted high potential for nutrient transformation. The soils of these wetlands should have substantial amounts of organic matter that would promote microbial activity.

Lotic flat wetlands and terrene outflow wetlands surrounded by cropland (50% or more of their upland perimeter is in contact with cropland) were deemed to have some potential for nutrient transformation. Since farming often introduces agrochemicals and sediment into streams, wetlands between cropland and streams lie in landscape positions to provide a ready means of recycling nutrients.

Retention of Sediments and Other Particulates

Many wetlands owe their existence to being located in areas of sediment deposition. This is especially true for floodplain wetlands. This function supports water quality maintenance by capturing sediments with bonded nutrients or heavy metals (as in and downstream of urban areas). Floodplain wetlands plus lotic fringe and basin wetlands (including lotic ponds) are likely to trap and retain sediments and particulates at significant levels. Estuarine fringe and island wetlands (including nonvegetated types) also accumulate sediments and particulates at notable levels. Salt and brackish marshes in these landforms were predicted to have high potential for significant sediment and particulate retention. Lotic flat wetlands are flooded only for brief periods and less frequently than the wetlands listed above due to their elevation. They were classified as having some potential along with terrene outflow wetlands surrounded by cropland that may now perform this function at a significant level due to erosion of soils induced by cultivation. Isolated ponds may be locally significant in retaining such materials, and were designated as having possible local potential.

Coastal Storm Surge Detention and Shoreline Stabilization

Vegetated wetlands along tidal shores (e.g., bays and coastal rivers) provide these functions. Vegetation stabilizes the soil, thereby preventing erosion. Salt marshes and other vegetated coastal wetlands serve as buffers to reduce erosion of uplands from tidal waters. These wetlands also serve to temporarily store water during storm events. Consequently, the analysis identified all estuarine intertidal vegetated wetlands and seasonally flooded tidal palustrine vegetated wetlands as wetlands of high potential significance regarding these functions. Nontidal palustrine wetlands bordering these wetlands were considered to be of moderate to high significance for this function as they appear in the proper position to temporarily hold coastal surge flood waters. Estuarine intertidal nonvegetated wetlands were identified as having some potential for these functions since they serve as potential water storage areas during low tide stages.

Inland Shoreline Stabilization

Like their coastal (estuarine) counterparts, inland vegetated wetlands located along shorelines of rivers, streams, and lakes help prevent upland erosion and stabilize shorelines. For this analysis, all lotic wetlands (except in-stream ponds and island wetlands) were predicted as having high potential. Estuarine river fringe wetlands also provide shoreline protection, but since they were identified as significant under the coastal storm surge detention/shoreline stabilization function, they were not highlighted here.

Provision of Fish and Shellfish Habitat

The assessment of potential habitat for fish and shellfish is based on general relationships that could be refined for individual species of interest at a later date. For this preliminary assessment, fish and shellfish were first separated into two general categories: estuarine fish and shellfish and freshwater species. All fishes and most aquatic invertebrates require permanent water, yet many also need seasonally flooded and semipermanently flooded wetlands and tidal wetlands for breeding and nursery grounds.

For coastal species, estuarine submerged aquatic beds, unconsolidated shores (tidal flats), and emergent wetlands were designated as having high potential due to their well-known functions as feeding areas and nursery grounds for estuarine fishes and as shellfish habitat. Palustrine tidal emergent wetlands may be important for some estuarine species, but were deemed more significant for freshwater species and were highlighted for the latter rather than for the former.

For freshwater species in general, the assessment emphasized palustrine and riverine tidal emergent wetlands and unconsolidated shores (tidal flats), and, for nontidal regions, semipermanently flooded wetlands over seasonally flooded types due to the longer duration of surface water and palustrine aquatic beds[2]. Palustrine forested wetlands along streams (lotic stream wetlands) were deemed important for maintaining fish habitat as their canopies help moderate water temperatures. Ponds and the shallow marsh-open water zone of impoundments were identified as wetlands having some potential for fish habitat.

Other wetlands providing significant fish habitat may exist, but were not be identified due to the study methods. Such wetlands may be individually identified based on actual observations or culled out from site-specific fisheries information that may be available from the State. Also recall that this assessment is focused on wetlands, not deepwater habitats[3], hence the exclusion of the latter from this analysis. In addition, all wetlands that are significant for the streamflow maintenance function could be considered vital to sustaining the watershed's ability to provide in-stream fish habitat. While these wetlands may not be providing significant fish habitat themselves, they typically support base flows essential to keeping water in streams for aquatic life.

[2]No palustrine aquatic beds were mapped, but these areas could be important fish habitat.

[3]These habitats are the primary residences for fish.

Provision of Waterfowl and Waterbird Habitat

Wetlands considered to be important waterfowl and waterbird habitat were estuarine and riverine emergent wetlands, estuarine mixed emergent/scrub-shrub wetlands, unconsolidated shores (estuarine and riverine tidal flats), palustrine and riverine tidal emergent wetlands, semipermanently flooded wetlands, mixed open water-emergent wetlands (palustrine and lacustrine), and aquatic beds[4] (including estuarine types). Ponds were considered to have some potential for providing waterfowl and waterbird habitat. Seasonally flooded lotic wetlands that were forested or mixtures of trees and shrubs were deemed as wetlands with significant potential for use by wood ducks. Also included as significant habitat for wood ducks were tidal freshwater tidal deciduous forested wetlands (seasonally flooded-tidal and semipermanently flooded-tidal) juxtaposed to estuarine wetlands. This grouping included mixtures of deciduous forested wetlands with scrub-shrub wetlands and emergent wetlands. Some of these forested wetlands may be also be utilized as rookery areas for wading birds.

Estuarine scrub-shrub wetlands, estuarine forested wetlands and palustrine forested wetlands bordering salt marshes in the Coastal Bays watershed were not highlighted in this report. Wading birds may nest in such areas, but rather than pull out the entire swath along the salt marsh edge, we decided to refer users to local biologists for information on such rookeries (contact the Maryland Department of Natural Resources). The significance of such areas should, however, be recognized by users of this report.

Seasonally flooded emergent wetlands were not designated as potentially significant for waterfowl and waterbirds. Field checking of these types may reveal that some are freshwater marshes that should be significant, so screening of these types may reveal additional wetlands of significance.

Provision of Other Wildlife Habitat

The provision of other wildlife habitat by wetlands was evaluated in general terms. Species-specific habitat requirements were not considered. In developing an evaluation method for wildlife habitat in the glaciated Northeast, Golet (1972) designated several types as outstanding wildlife wetlands including: 1) wetlands with rare, restricted, endemic, or relict flora and/or fauna, 2) wetlands with unusually high visual quality and infrequent occurrence, 3) wetlands with flora and fauna at the limits of their range, 4) wetlands with several seral stages of hydrarch succession, and 5) wetlands used by great numbers of migratory waterfowl, shorebirds, marsh birds, and wading birds. Golet subscribed to the principle that in general, as wetland size increases so does wildlife value, so wetland size was an important factor for determining wildlife habitat potential in his approach. Other important variables included dominant wetland class, site type (bottomland v. upland; associated with waterbody v. isolated), surrounding habitat type (e.g., natural vegetation v. developed land), degree of interspersion (water v. vegetation), wetland juxtaposition (proximity to other wetlands), and water chemistry.

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[4]Note that although no palustrine aquatic beds were mapped, they may be considered significant habitats for waterfowl and waterbirds.

For this project, wetlands important to waterfowl and waterbirds were identified in a separate assessment (see above). Emphasis for assessing "other wildlife" was placed on conditions that would likely provide significant habitat for other vertebrate wildlife (mainly herps, forest interior birds, and mammals). Opportunistic species that are highly adaptable to fragmented landscapes were not among the target organisms, since there seems to be more than ample habitat for these species now and in the future. Rather, animals whose populations may decline as wetland habitats become fragmented by development are of more concern. For example, breeding success of neotropical migrant birds in fragmented forests of Illinois was extremely low due to high predation rates and brood parasitism by brown-headed cowbirds (Robinson 1990). Newmark (1991) reported local extinctions of forest interior birds in Tanzania due to fragmentation of tropical forests. Fragmentation of wetlands is an important issue for wildlife managers to address. Some useful references on fragmentation relative to forest birds are Askins et al. (1987), Robbins et al. (1989), Freemark and Merriam (1986), and Freemark and Collins (1992). The work of Robbins et al. (1989) is particularly relevant to the study watersheds as they addressed area requirements of forest birds in the Mid-Atlantic states. They found that species such as the black-throated blue warbler, cerulean warbler, Canada warbler, and black-and-white warbler required very large tracts of forest for breeding. Table 2 lists some area-sensitive birds for the region. Ground-nesters, such as veery, black-and-white warbler, worm-eating warbler, ovenbird, waterthrushes, and Kentucky warbler, are particularly sensitive to predation which may be increased in fragmented landscapes. Robbins et al. (1989) suggest a minimum size of 7,410 acres to retain all species of the forest-breeding avifauna in the Mid-Atlantic region.

The analysis identified three wetland types as potentially significant for other wildlife: 1) large wetlands ($\geq$ 20 acres) regardless of vegetative cover, 2) smaller diverse wetlands (10-20 acres with multiple cover types), and 3) wetlands along stream corridors that connect large wetland complexes. While the latter were identified only for the Coastal Bays watershed, readers should realize that such corridors are equally important for the Nanticoke watershed. We simply did not have time to delineation such corridors for the Nanticoke.

Given the general nature of this assessment of "other wildlife habitat", the State may want to refine this assessment in the future by having biologists designate "target species" that may be used to identify important wildlife habitats in each watershed. After doing this, they could identify criteria that may be used to identify potentially significant habitat for these species in the watershed. Dr. Hank Short (U.S. Fish and Wildlife Service, retired) compiled a matrix listing 332 species of wildlife and their likely occurrence in wetlands of various types in New England (Appendix C) from ECOSEARCH models (Short et al. 1996, 1999) that he developed with Dr. Dick DeGraaf (U.S. Forest Service) and Dr. Jay Hestbeck (U.S. Fish and Wildlife Service). DeGraaf and Rudis (1986) summarized habitat, natural history, and distribution of New England wildlife. Much of what is in the ECOSEARCH models comes from this source. Freemark and Collins (1992) prepared a list of area-sensitive or forest interior birds of the eastern United States (Appendix D). Information on fish and wildlife use of Maryland’s wetlands from Tiner and Burke (1995) is presented in Appendix E. These sources may be useful starting points for determining relationships between wildlife and wetlands in the Mid-Atlantic region.

Table 2. List of some area-sensitive birds for forests of the Mid-Atlantic region. (Source: Robbins et al. 1989)

Species	Area (acres) at which probability of occurrence is reduced by 50%
<u>Neotropical Migrants</u>	
Acadian flycatcher	37
Blue-gray gnatcatcher	37
Veery	49
Northern parula	1,280
Black-throated blue warbler	2,500
Cerulean warbler	1,700
Black-and-white warbler	543
Worm-eating warbler	370
Ovenbird	15
Northern waterthrush	494
Louisiana waterthrush	865
Canada warbler	988
Summer tanager	99
Scarlet tanager	30
<u>Short-distance Migrants</u>	
Red-shouldered hawk	556
<u>Permanent Residents</u>	
Hairy woodpecker	17
Pileated woodpecker	408

Conservation of Biodiversity

In the context of this report, the term "biodiversity" is used to identify certain wetland types that appear to be scarce or relatively uncommon in the watershed or state, or individual wetlands that possess several different covertypes (i.e., diverse wetland complexes), or complexes of large wetlands. Schroeder (1996) noted that to conserve regional biodiversity, maintenance of large-area habitats for forest interior birds is essential. As noted in the other wildlife habitat discusssion above, Robbins et al. (1989) suggest a minimum forest size of 7,410 acres to retain all species of the forest-breeding avifauna in the Mid-Atlantic region.

For recognizing the conservation of biodiversity function, we attempted to highlight areas that may contribute to the preservation of an assemblage of wetlands that encompass the natural diversity of wetlands in the two study watersheds. Forested areas 7410 acres and larger that contained contiguous palustrine forested wetlands and upland forests were designated as important for maintaining regional biodiversity of avifauna based on recommendations by Robbins et al. (1989). We also identified other large wetlands in the watersheds (e.g., possibly important for interior nesting birds and wide-ranging wildlife in general) and wetlands that were either uncommon types (based on mapping classification, not on Natural Heritage Program data) or complexes of multiple-cover types (not related to timber harvest). All riverine tidal wetlands and oligohaline wetlands were identified as significant for this function because they are often colonized by a diverse assemblage of plants and are among the most diverse plant communities in the Mid-Atlantic region. Estuarine bay and barrier island fringe wetlands of the Coastal Bays watershed were also designated as significant since they represent the only wetlands of these types in the state -- wetlands associated with euhaline embayments and barrier islands. Moreover, relatively undeveloped barrier islands are significant natural resources regionally. The estuarine bay fringe category included tidal freshwater wetlands adjacent to these marshes. Estuarine aquatic beds in these coastal embayments were likewise considered significant.

There was no attempt to incorporate Natural Heritage Program data into this analysis. It is expected that Natural Heritage information will be utilized at a later date by the State for more detailed planning and evaluation. Consequently, the wetlands designated as potentially significant for biodiversity are simply a foundation to build upon. Local knowledge of significant wetlands will further refine the list of wetlands important for this function. For information on rare and endangered species, contact the Maryland Natural Heritage Program. Appendix F contains a listing of endangered and threatened plants compiled from 1990 data (Tiner and Burke 1995), while tables in Appendix E include information on various animals of state concern.

Results

Nanticoke Watershed

Wetland Characterization

Wetlands were classified according to the U.S. Fish and Wildlife Service's official wetland classification system (Cowardin et al. 1979) and by landscape position, landform, and water flow path descriptors following Tiner (2000). Summaries for the study area are given in Tables 3 and 4 and findings are illustrated in Maps 1NW through 4NW. Table 3 summarizes covertypes through the subclass level of the FWS classification ("NWI types"), while Table 4 tabulates statistical data on wetlands by landscape position and landform ("HGM types").

Thirty-one percent of the watershed area (which includes the river itself) is occupied by wetlands. If the river and its tributaries are excluded from the watershed area, the percent of "land" represented by wetlands amounts to 34 percent.

<u>Wetlands by NWI Types</u>

According to the NWI, the Nanticoke watershed had 64,139 acres of wetlands (Table 3). Palustrine wetlands were the most abundant types with nearly 47,000 acres, accounting for 73 percent of the watershed's wetland acreage. Estuarine wetlands totaled almost 16,840 acres and represented 26 percent of the wetlands. Riverine tidal wetlands comprised only 0.5 percent. Forested wetlands were the most abundant type of freshwater wetland, with nontidal types prevailing.

Estuarine wetlands were dominated by emergent wetlands (salt/brackish and oligohaline marshes) which comprised over 90 percent of these wetlands, with the more saline wetlands predominating. Almost 40 percent of the estuarine wetlands were oligohaline (slightly brackish) types. Nearly 250 acres of estuarine forested wetlands were inventoried. These wetlands signify areas where salt marshes are advancing landward into former low-lying forests, due to sea level rise and coastal plain subsidence.

Nontidal wetlands were the predominant palustrine wetland type, accounting for 86 percent of the palustrine wetlands. Tidal fresh wetlands represented only 14 percent (6713.9 acres). Forested wetlands comprised the bulk or 80 percent of the palustrine wetlands, totaling more than 37,500 acres (including mixed types, e.g., forested/scrub-shrub). Twelve percent of the palustrine wetlands were scrub-shrub types, with 5 percent being scrub-shrub and emergent wetlands. The latter category included recently harvested forested wetlands that are now in a state of succession.

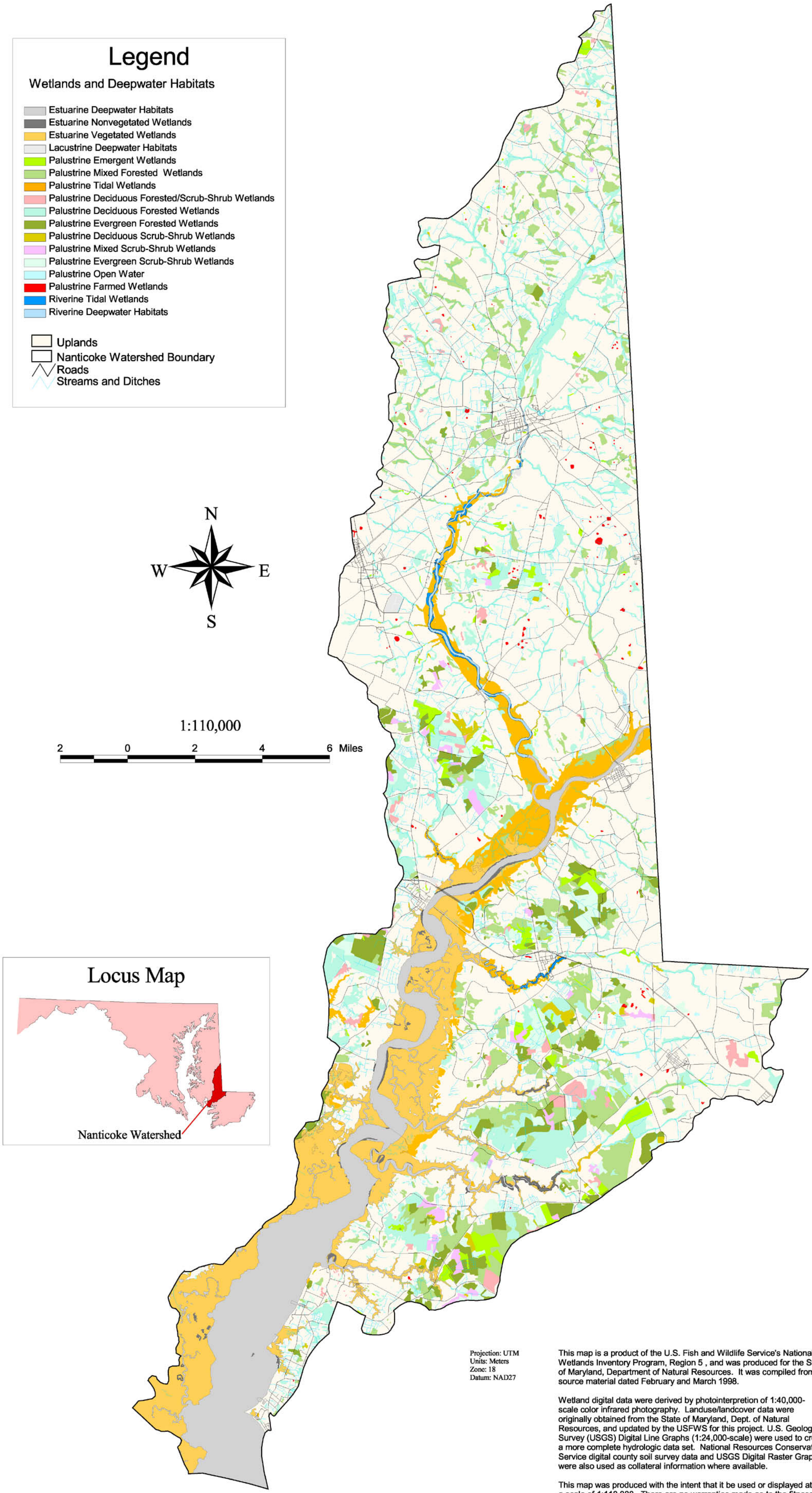
Map 1NW shows the general distribution of wetlands in the Nanticoke River watershed according to NWI types. See Appendix A for general descriptions of wetland plant communities for the Coastal Plain.

Table 3. Wetlands in the Nanticoke watershed classified by NWI type to the class level (Cowardin et al. 1979). Other modifiers have been deleted from NWI types for this compilation.

NWI Wetland Type	Acreage	
Estuarine Wetlands		
Emergent (Irregularly flooded)	15,243.4	(oligohaline=6020.4)
Emergent (Regularly flooded)	639.8	(oligohaline=239.0)
Forested	173.9	
Forested/Emergent	67.2	
Scrub-Shrub	78.3	(oligohaline=29.0)
Shrub/Emergent	61.0	(oligohaline=56.3)
Unconsolidated Shore	574.0	(oligohaline=274.4)
Subtotal	**16,837.6**	
Palustrine Wetlands		
Emergent (Nontidal)	302.8	
Emergent (Tidal)	204.4	
Farmed	213.6	
Evergreen Scrub-Shrub/Emergent (Nontidal)	1271.4	
Deciduous Scrub-Shrub/Emergent (Nontidal)	1009.5	
Broad-leaved Deciduous Forested (Nontidal)	13,269.4	
Broad-leaved Deciduous Forested (Tidal)	6060.6	
Needle-leaved Evergreen Forested	3668.8	(including 95.3 tidal)
Mixed Forested (Nontidal)	12,658.4	
Mixed Forested (Tidal)	140.7	(including 26.0 w/cypress)
Deciduous Forested/Emergent	98.7	(including 22.6 tidal)
Evergreen Forested/Scrub-Shrub (Nontidal)	421.4	
Deciduous Forested/Scrub-Shrub	1227.4	(including 95.7 tidal)
Dead Forested (Nontidal)	16.7	
Deciduous Scrub-Shrub	693.3	(including 38.6 tidal)
Needle-leaved Evergreen Scrub-Shrub	3130.1	(including 24.8 tidal)
Mixed Scrub-Shrub	2016.4	(including 31.2 tidal)
Deciduous Scrub-Shrub/Unconsolidated Bottom	5.2	
Unconsolidated Bottom (Nontidal)	548.0	
Subtotal	**46,959.8**	
Riverine Wetlands		
Emergent (Tidal)	298.5	
Unconsolidated Shore (Tidal)	46.4	
Subtotal	**344.9**	
GRAND TOTAL (ALL WETLANDS)	**64,139.2**	

Wetlands and Deepwater Habitats of the Nanticoke Watershed, Maryland
*Classified by National Wetlands Inventory Types

Map 1NW



Projection: UTM
Units: Meters
Zone: 18
Datum: NAD27

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Hydrogeomorphic-Type Wetlands[1]

Nearly 1380 wetlands were inventoried in the Nanticoke River watershed and classified by their hydrogeomorphic features (Table 4). Roughly two-thirds of the individual wetlands (excluding ponds) occurred in terrene landscape positions. These wetlands accounted for 52 percent of the watershed's wetland acreage. Estuarine wetlands had the next highest acreage and comprised 34 percent of the total acreage. Lotic wetlands were third-ranked in extent, making up 13 percent.

From the landform standpoint, interfluve wetlands and fringe wetlands were represented in nearly equal amounts, with the former having a slight edge. With nearly 24,000 acres, interfluve wetlands comprised 37 percent of the wetland acreage, while fringe wetlands associated with the estuary portion of the watershed and tidal fresh waters accounted for 35 percent. Flat wetlands, most of which were likely remnants of once-larger interfluve types, ranked next in abundance, totaling over 11,000 acres and comprising 17 percent of the watershed's wetland acreage. If flat wetlands are combined with interfluve wetlands, their grand total exceeds 50 percent which is not surprising for this Coastal Plain watershed. Less than 1000 acres of basin wetlands were present in the watershed.

Outflow wetlands were the predominant water flow path type. They totaled over 30,000 acres and represented nearly half of the wetland acreage. Bidirectional flow types were second-ranked, accounting for 38 percent, with throughflow wetlands next at 9 percent. Only 3 percent of the wetland acreage was isolated.

Maps 2NW, 3NW, and 4NW show the distribution of wetlands classified according to landscape position, landform, and a combination of landscape position and landform, respectively.

[1] All wetlands, except ponds, were characterized by HGM-type descriptors.

Table 4. Estuarine and freshwater wetlands (excluding 548.0 acres of ponds) in the Nanticoke watershed classified by landscape position, landform, and water flow path (Tiner 2000). See Appendix B for definitions.

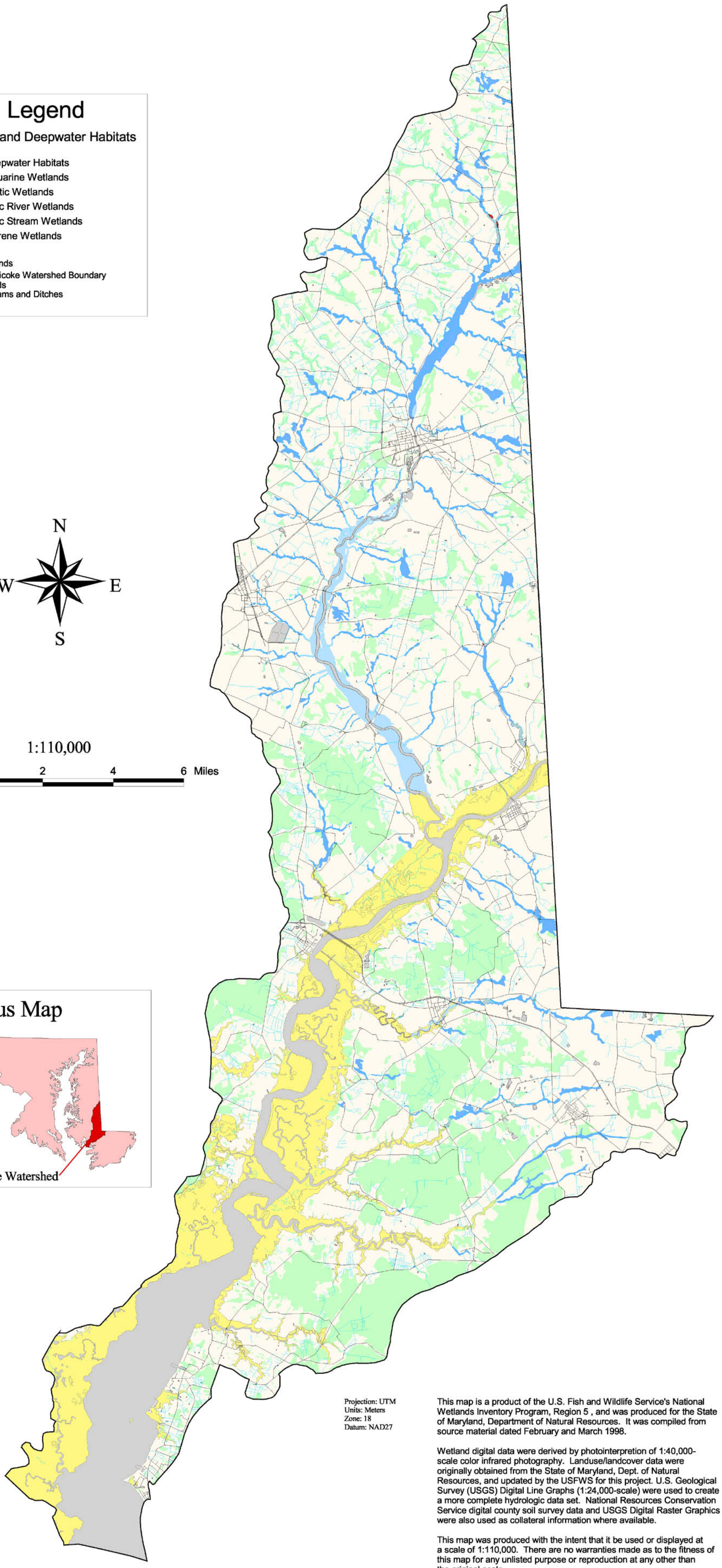
Landscape Position	Landform	Water Flow	# of Wetlands	Acreage
Estuarine			**139**	**22,065.6**
	Fringe*	Bidirectional	137	21,817.1
	Island	Bidirectional	2	248.5
Terrene			**937**	**33,400.1**
	Interfluve	Outflow	126	23,720.7
	Basin	Isolated	46	157.9
		Outflow	38	549.3
	Flat	Isolated	347	1813.4
		Outflow	380	7158.8
Lotic River			**96**	**2132.4**
	Floodplain	Bidirectional**	38	1598.5
		Throughflow	1	18.3
	Fringe	Bidirectional**	57	515.6
Lotic Stream			**203**	**5983.4**
	Basin	Throughflow	17	197.1
	Flat	Throughflow	100	2037.9
	(includes 1-2.8 acre flat along the intermittent gradient)			
	Floodplain	Throughflow	86	3748.4
Lentic			**3**	**9.5**
	Basin	Throughflow	3	9.5

*Includes tidal freshwater wetlands along edge of estuary
**Freshwater tidal reach

Wetlands and Deepwater Habitats of the Nanticoke Watershed, Maryland

*Classified by Landscape Position

Map 2NW



Legend

Wetlands and Deepwater Habitats

- Deepwater Habitats
- Estuarine Wetlands
- Lentic Wetlands
- Lotic River Wetlands
- Lotic Stream Wetlands
- Terrene Wetlands

- Uplands
- Nanticoke Watershed Boundary
- Roads
- Streams and Ditches

N W E S

1:110,000

2 0 2 4 6 Miles

Locus Map

Projection: UTM
Units: Meters
Zone: 18
Datum: NAD27

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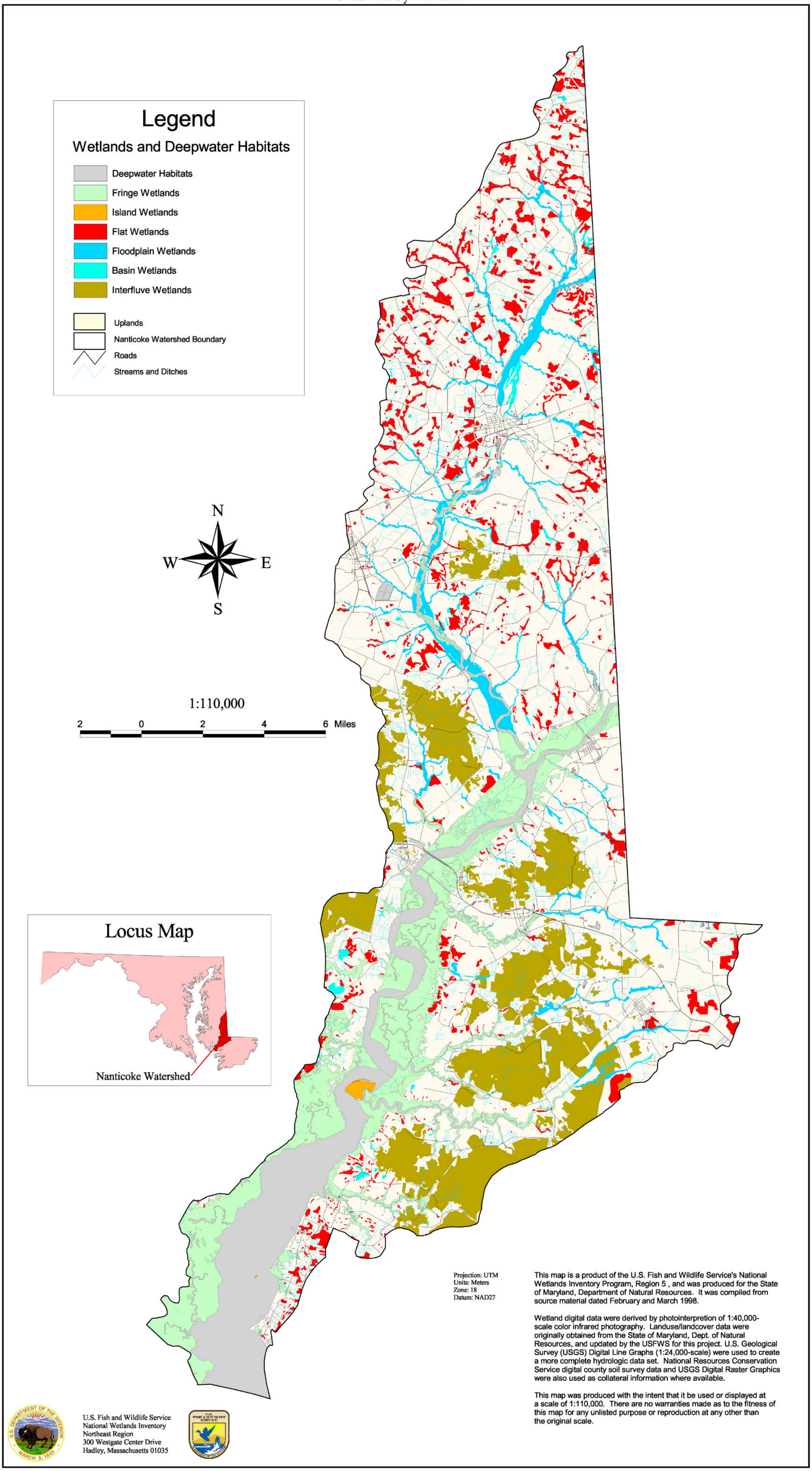
Wetlands and Deepwater Habitats of the Nanticoke Watershed, Maryland
*Classified by Landform

Map 3NW



Projection: UTM
Units: Meters
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Datum: NAD27

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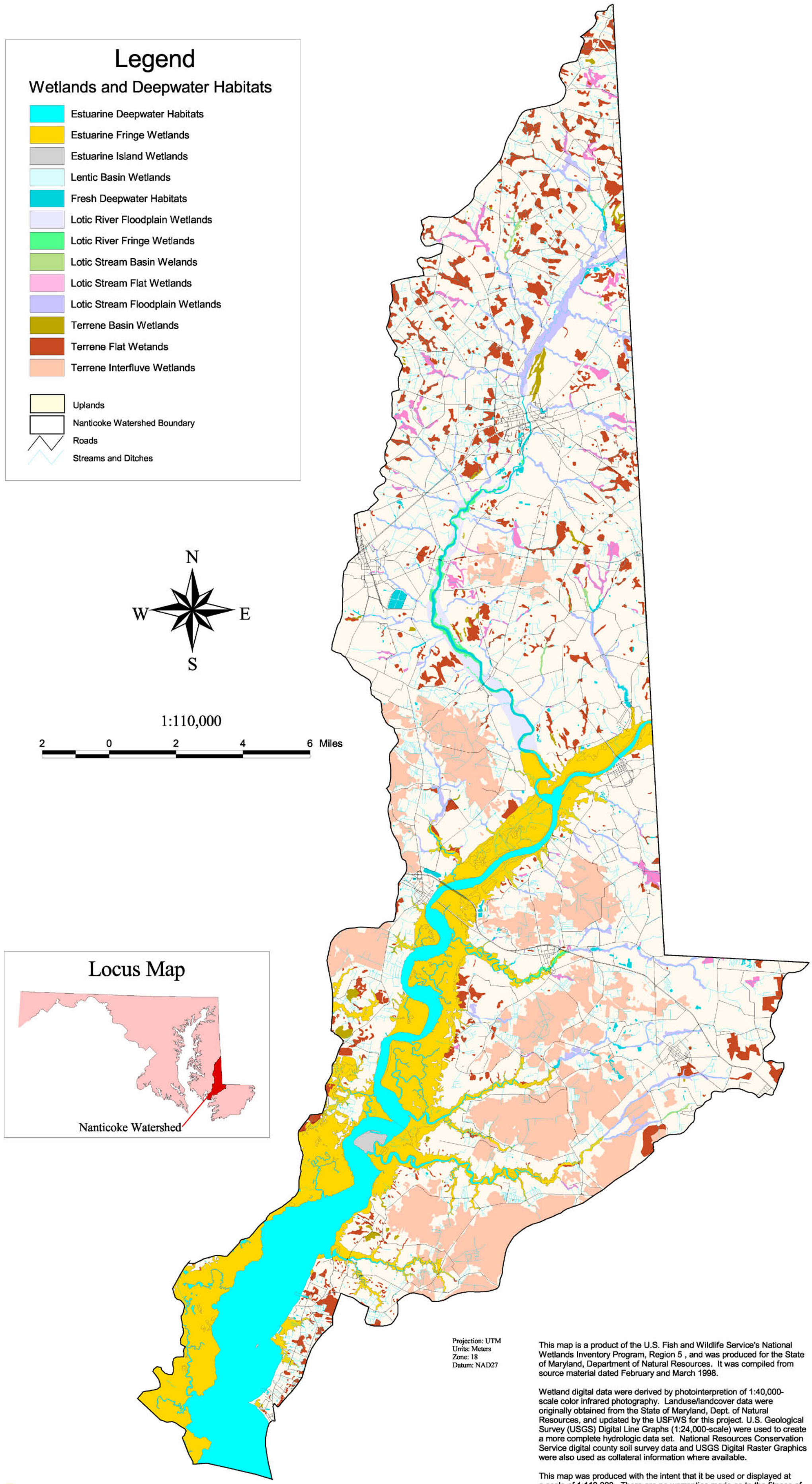
Wetlands and Deepwater Habitats of the Nanticoke Watershed, Maryland
*Classified by Landscape Position and Landform

Map 4NW



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Maps

A series of 18 maps have been produced at 1:110,000 to profile the Nanticoke's wetlands and watershed. These maps have been distributed to the Maryland Department of Natural Resources. They are included in the CD version and on-line version of this report (see the NWI homepage: wetlands.fws.gov, listed under "reports and publications").

A list of the 18 maps follows:

Map 1NW - Wetlands and Deepwater Habitats Classified by NWI Types
Map 2NW - Wetlands Classified by Landscape Position
Map 3NW - Wetlands Classified by Landform
Map 4NW - Wetlands Classified by Landscape Position and Landform
Map 5NW - Potential Wetlands of Significance for Surface Water Detention
Map 6NW - Potential Wetlands of Significance for Streamflow Maintenance
Map 7NW - Potential Wetlands of Significance for Nutrient Transformation
Map 8NW - Potential Wetlands of Significance for Sediment and Other Particulate Retention
Map 9NW - Potential Wetlands of Significance for Coastal Storm Surge Detention and Shoreline Stabilization
Map 10NW - Potential Wetlands of Significance for Inland Shoreline Stabilization
Map 11NW - Potential Wetlands of Significance for Fish and Shellfish Habitat
Map 12NW - Potential Wetlands of Significance for Waterfowl and Waterbird Habitat
Map 13NW - Potential Wetlands of Significance for Other Wildlife Habitat
Map 14NW - Potential Wetlands of Significance for Biodiversity
Map 15NW - Potential Wetland Restoration Sites
Map 16NW - Condition of Wetland and Waterbody Buffers
Map 17NW - Extent of Natural Habitat in the Watershed
Map 18NW - Extent of Ditches and Condition of Streams

The first four maps depict wetlands by the FWS system (NWI types) and by landscape position/landform (HGM types). Maps 5-14 highlight wetlands that perform each of the assessed functions at a significant level. Maps 15-18 address the other important features of the watershed - potential wetland restoration sites, condition of wetland and stream buffers, the overall extent of natural habitat in the watershed, and the extent of ditching and condition of streams.

Summary of Thematic Map Data

The rationale for preliminary assessment of wetlands for performing each of ten functions is given in an earlier section of this report. The following section summarizes the results for each function. The findings are presented mostly in tabular form within the text.

Surface Water Detention

Roughly 92 percent of the watershed's wetland acreage were categorized as having possible significant potential for this function. Forty-four percent were rated as highly significant, 43 percent as moderate to high, and 5 percent as locally significant (see below).

Predicted with High Potential

Wetland Type	Acreage
Estuarine Fringe (ESFR)	21,817.1
Estuarine Island (ESIS)	245.7
Lentic Basin Throughflow (LEBATH)	8.4
Lotic River Floodplain (LR1FP)	18.3
Lotic River Tidal Floodplain (LR5FP)	1598.5
Lotic River Tidal Fringe (LR5FR)	469.2
Lotic Stream Basin (LS1BA)	197.1
Lotic Stream Floodplain (LS1FP)	3748.4
Throughflow Pond	82.0
Total	28, 184.7

Predicted with Moderate to High Potential

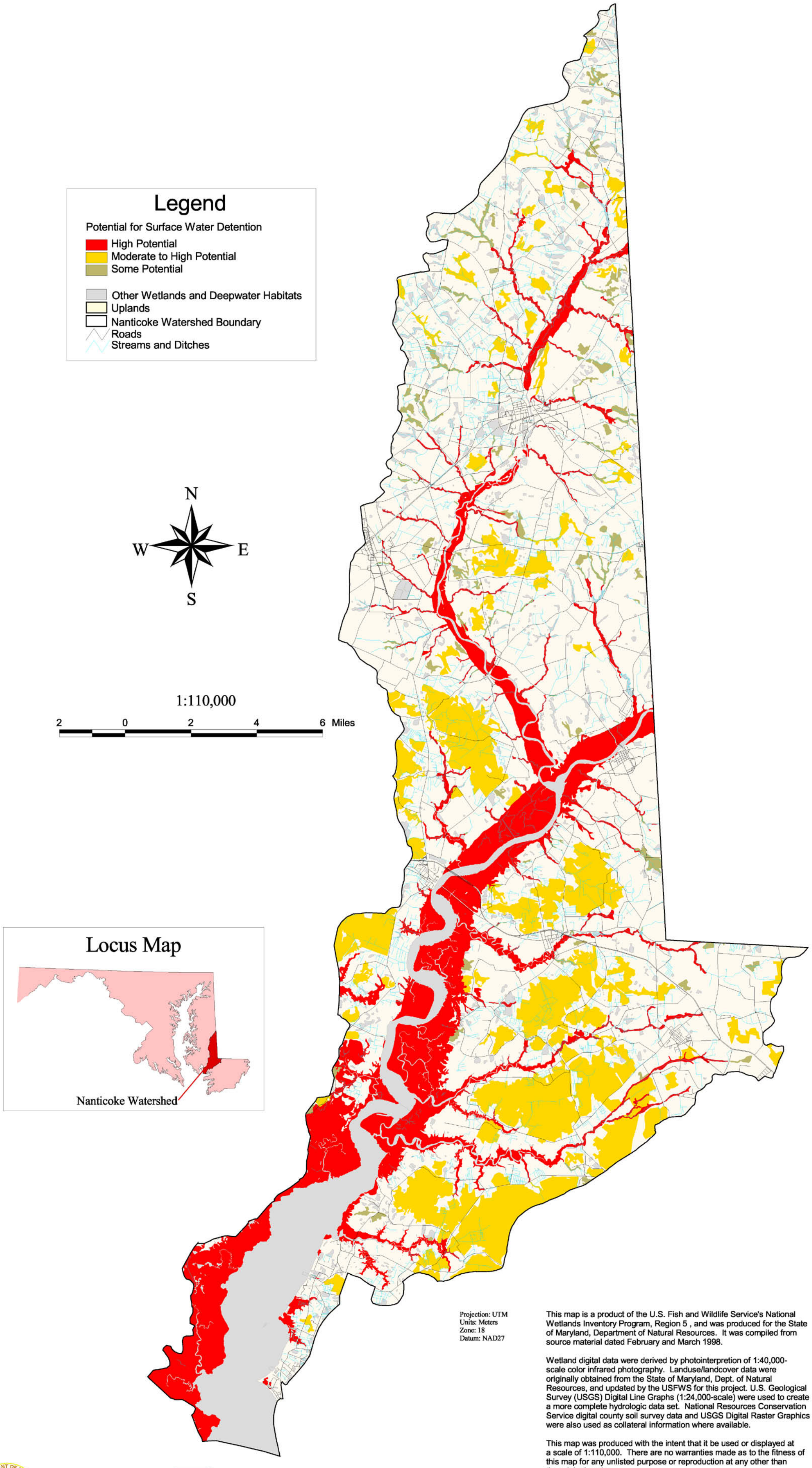
Terrene Basin Outflow (TEBAOU)	400.8
Terrene Flat Isolated (TEFLIS)	512.1
Terrene Flat Outflow (TEFLOU)	3597.6
Terrene Interfluve-basin (TEIFba)	100.9
Terrene Interfluve-flat (TEIFfl)	22,876.7
Total	27,488.1

Predicted with Some Potential

Lotic Stream Flat (mostly LS1FL)	2038.0
Terrene Basin Isolated (TEBAIS)	49.1
Terrene Basin Outflow (TEBAOU)	44.9
Terrene Flat Isolated (TEFLIS)	358.7
Terrene Flat Outflow (TEFLOU)	530.9
Terrene Interfluve-flat (TEIFfl)	149.9
Total	3171.5

Potential Wetlands of Significance for Surface Water Detention
Nanticoke Watershed, Maryland

Map 5NW



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Streamflow Maintenance

About 58 percent of the watershed's wetland acreage were identified as headwater wetlands being potentially significant for streamflow maintenance. Seventeen percent were ranked as highly significant, whereas 41 percent were designated as having some potential.

Predicted With High Potential

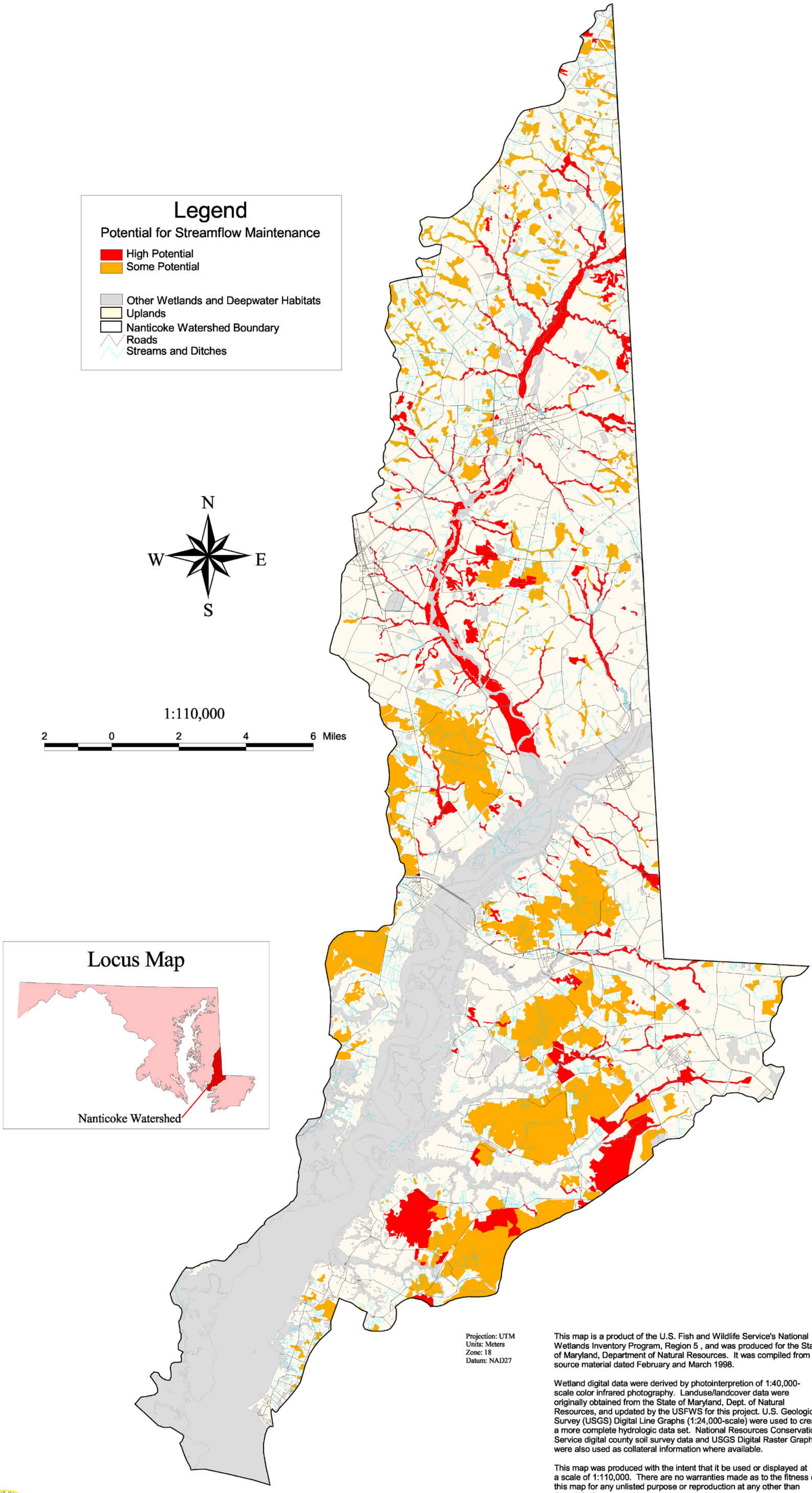
Wetland Type	Acreage
Lotic River Floodplain (LR1FP)	18.3
Lotic River Tidal Floodplain (LR5FP)	1534.0
Lotic Stream Basin (LS1BA)	140.8
Lotic Stream Flat (LS1FL)	936.5
Lotic Stream Floodplain (LS1FP)	3748.4
Throughflow Pond	29.8
Outflow Pond	54.4
Terrene Basin Outflow (TEBAOU)	23.1
Terrene Flat Outflow (TEFLOU)	836.1
Terrene Interfluve (TEIF)	3614.2
Total	10,935.6

Predicted with Some Potential (ditched headwater wetlands)

Lotic Stream Basin (LS1BA)	48.4
Lotic Stream Flat (mostly LS1FL)	1098.2
Terrene Basin Outflow ditched (TEBAOU)	285.3
Terrene Flat Outflow (TEFLOU)	5214.8
Terrene Interfluve Outflow (TEIFOU)	19,490.2
Total	26,136.9

Potential Wetlands of Significance for Streamflow Maintenance
Nanticoke Watershed, Maryland

Map 6NW



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Nutrient Transformation

Several wetland types were considered to be potentially important for nutrient cycling. About 46 percent of the watershed's wetlands were identified as potentially significant for this function, with 43 percent predicted to have high potential and 3 percent to have some potential.

Predicted with High Potential

Wetland Type	Acreage
Estuarine Fringe-vegetated (ESFR)	20,978.1
Estuarine Island-vegetated (ESIS)	245.7
Lotic River Floodplain (LR1FP)	18.3
Lotic River Tidal Floodplain (LR5FP)	1576.2
Lotic River Tidal Fringe-vegetated (LR5FR)	162.7
Lotic Stream Basin (LS1BA)	193.3
Lotic Stream Flat (LS1FL)	354.0
Lotic Stream Floodplain (LS1FP)	3748.4
Total	27,276.7

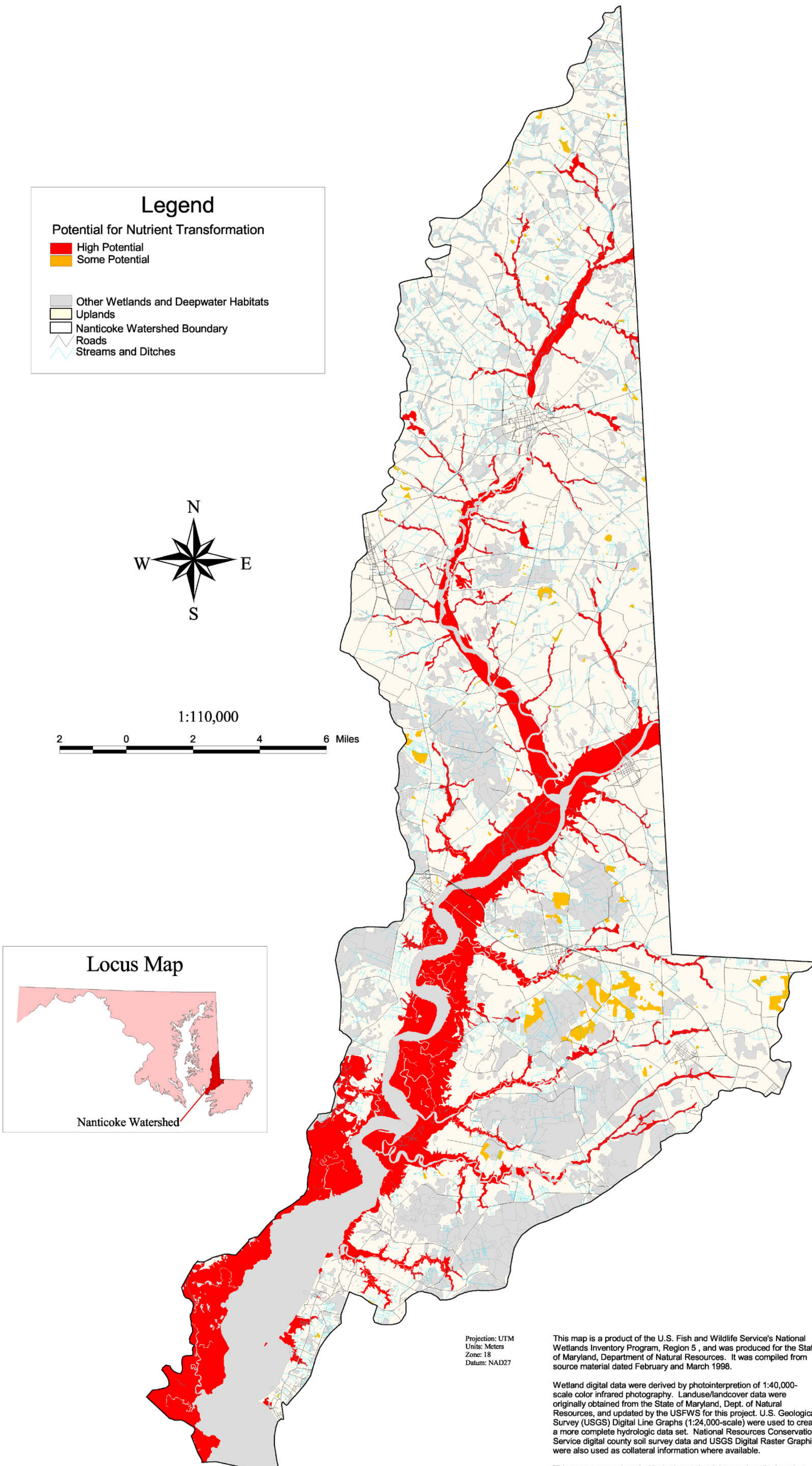
Predicted with Some Potential

Other Lotic* (mostly LS1FL)	117.4
Terrene Basin Outflow* (TEBAOU)	3.6
Terrene Flat Outflow* (TEFLOU)	461.7
Terrene Interfluve Isolated (TEIFIS)	81.8
Terrene Interfluve Outflow (TEIFOU)	1377.4
Total	2041.9

*Effectively surrounded by cropland (>50% of border).

Potential Wetlands of Significance for Nutrient Transformation
Nanticoke Watershed, Maryland

Map 7NW



Projection: UTM
Units: Meters
Zone: 18
Datum: NAD27

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Retention of Sediments and Other Particulates

About 52 percent of the watershed's wetland acreage was designated as having possible significance for sediment and other particulate retention. Forty-four percent were rated as having high potential, with 8 percent predicted to have some potential. Roughly 300 acres of isolated ponds were identified as having possible local significance.

Predicted with High Potential

Wetland Type	Acreage
Estuarine Fringe (ESFR)	21,817.1
Estuarine Island (ESIS)	248.5
Lentic Basin (LEBA)	8.4
Lotic River Floodplain (LR1FP)	18.3
Lotic River Tidal Floodplain (LR5FP)	1598.5
Lotic River Tidal Fringe (LR5FR)	469.2
Lotic Stream Basin (LS1BA)	197.1
Lotic Stream Floodplain (LS1FP)	3747.8
Throughflow Pond	82.0
Total	28,186.9

Predicted with Some Potential

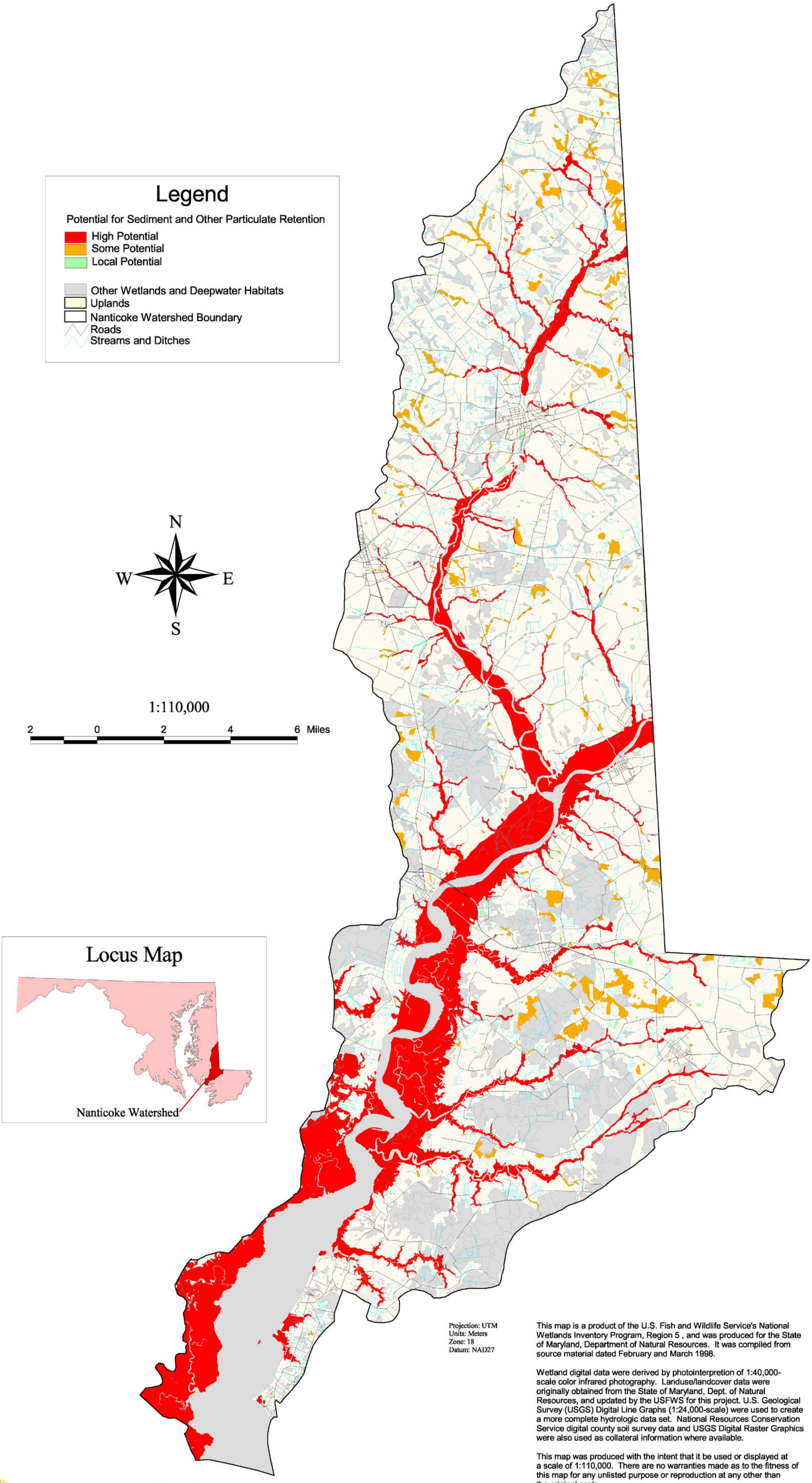
Lotic Stream Flat (mostly LS1FL)	1982.8
Lotic Stream Floodplain (LS1FP)	0.6
Terrene Basin Outflow (TEBAOU)	62.6
Terrene Flat Outflow (TEFLOU)	1104.9
Terrene Interfluve (TEIF)	1748.2
Total	4899.1

Predicted with Local Significance

Isolated Pond	292.6
Total	292.6

Potential Wetlands of Significance for Sediment and Other Particulate Retention
Nanticoke Watershed, Maryland

Map 8NW



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Coastal Storm Surge Detention and Shoreline Stabilization

About 42 percent of the watershed's wetland acreage was categorized as possibly having significant potential for coastal surge protection and shoreline stabilization. Wetlands with high potential accounted for 37 percent of the watershed's wetlands. Those designated as having moderate to high potential represented 4 percent, while those predicted as having some potential comprised about 1 percent of the watershed's wetlands.

Predicted with High Potential

Wetland Type	Acreage
Estuarine Fringe-vegetated (ESFR)	21,259.9
Estuarine Island-vegetated (ESIS)	248.5
Lotic River Tidal Fringe (LR5FR)	469.2
Lotic River Tidal Floodplain (LR5FP)	1592.7
Lotic Stream Floodplain (LS1FP)	16.2
Total	23,586.5

Predicted with Moderate to High Potential

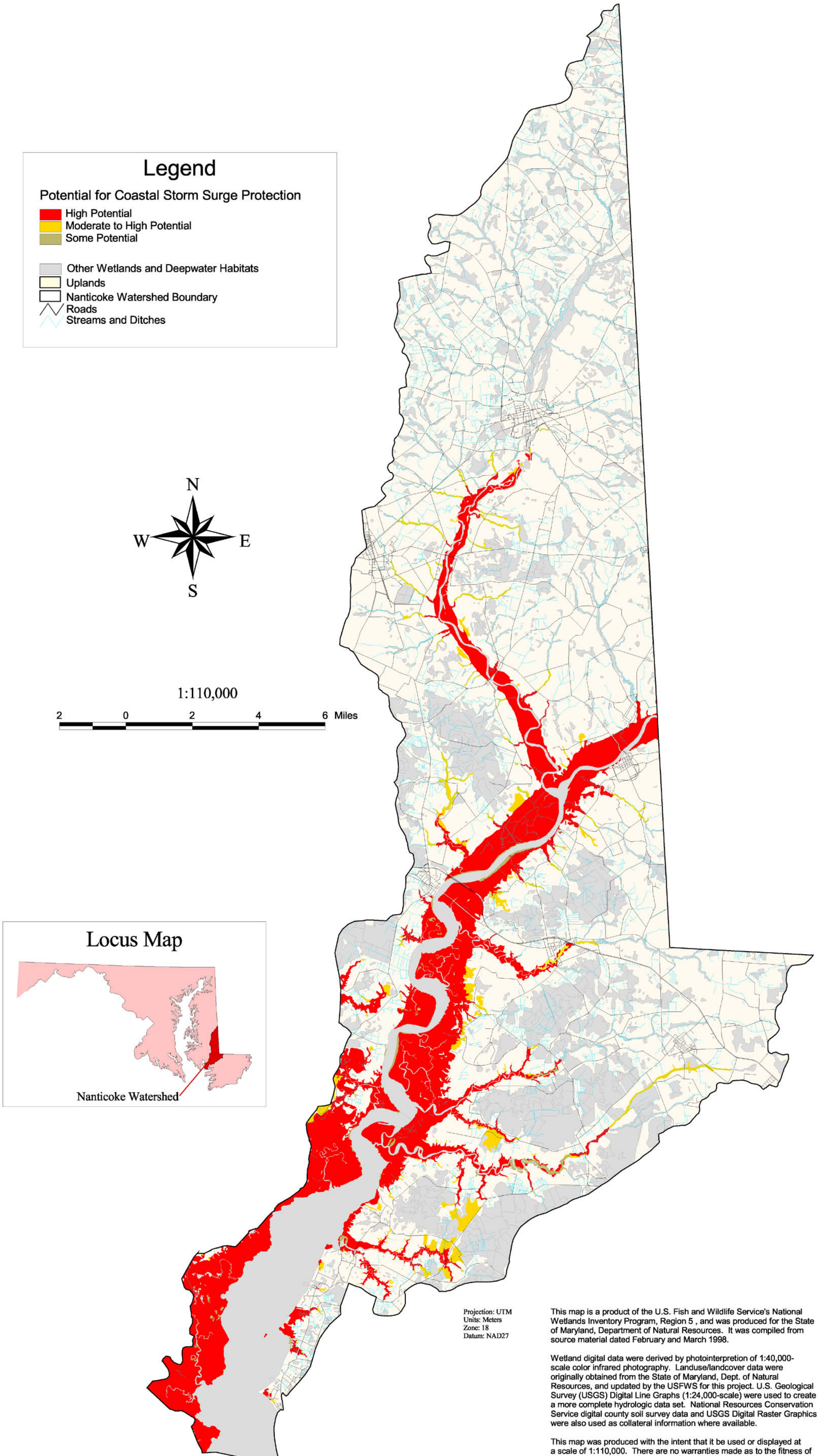
Lotic River Tidal Floodplain (LR5FP)	5.9
Lotic Stream Basin (LS1BA)	17.3
Lotic Stream Flat (LS1FL)	60.6
Lotic Stream Floodplain (LS1FP)	960.2
Terrene Basin Outflow (TEBAOU)	54.5
Terrene Flat Outflow (TEFLOU)	747.4
Terrene Interfluve (TEIF)	762.1
Total	2608.0

Predicted with Some Potential Significance

Estuarine Fringe-nonvegetated (ESFR)	557.3
Lotic River Tidal Fringe-nonvegetated (LR5FR)	46.4
Total	603.7

Potential Wetlands of Significance for Coastal Storm Surge Detention/Shoreline Stabilization
Nanticoke Watershed, Maryland

Map 9NW



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Inland Shoreline Stabilization

Vegetated wetlands along lakes, rivers, and streams help stabilize the soils and protect adjacent uplands from water-borne erosion. Only 12 percent of the watershed's wetland acreage was designated potentially significant for inland shoreline stabilization. The percentage would have been higher if the estuarine river fringe wetlands were included. Since they were already identified as highly significant for the Coastal Storm Surge Detention and Shoreline Stabilization function, they were not included as significant for "inland shoreline" stabilization. They are, however, obviously significant for shoreline stabilization along the estuarine portion of the watershed.

Predicted with High Potential

Wetland Type	Acreage
Lotic River Floodplain (LR1FP)	18.3
Lotic River Tidal Floodplain (LR5FP)	1598.5
Lotic River Tidal Fringe (LR5FR)	170.7
Lotic Stream Basin (LS1BA)	197.1
Lotic Stream Flat (LS1FL)	2038.0
Lotic Stream Floodplain (LS1FP)	3748.4
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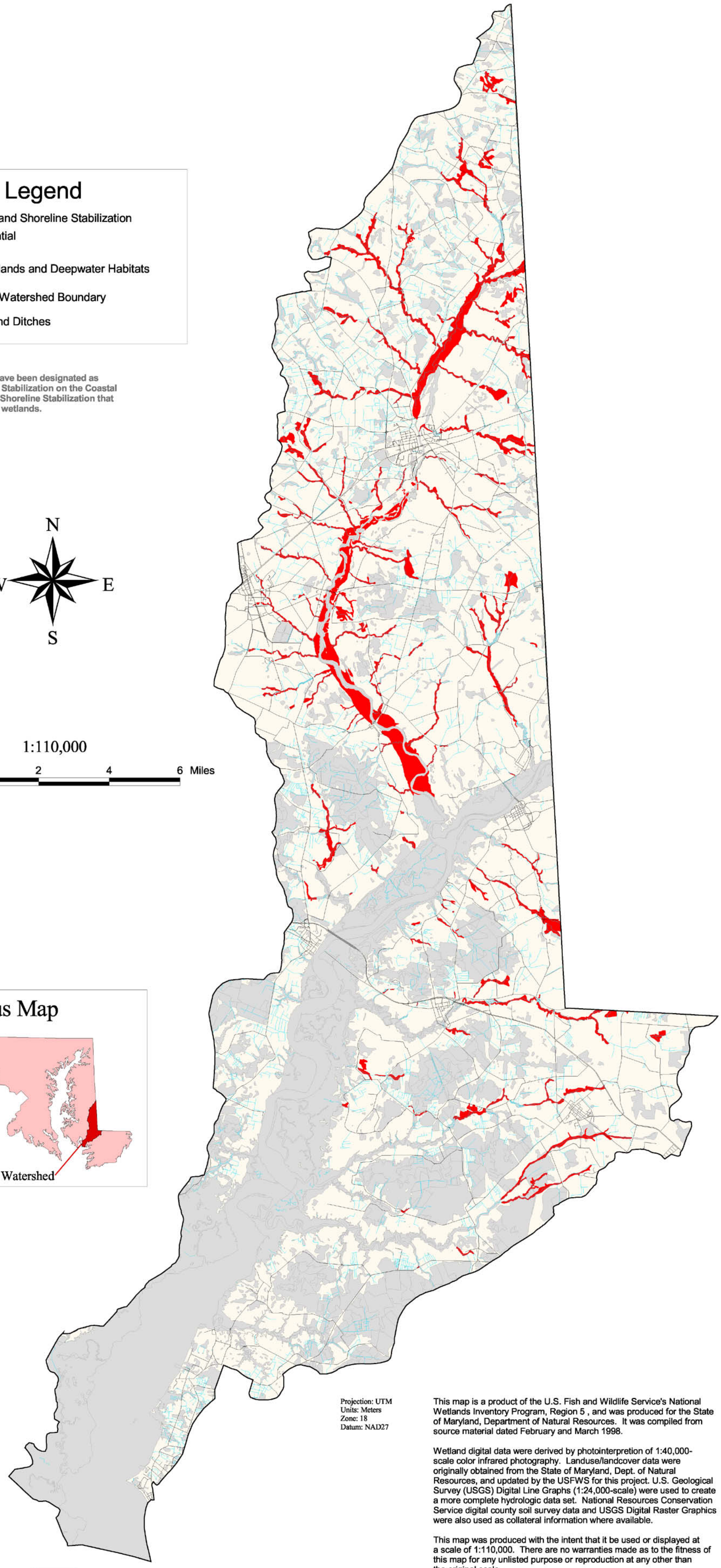
Total	7771.0

Potential Wetlands of Significance for Inland Shoreline Stabilization
Nanticoke Watershed, Maryland *

Map 10NW



Legend

Potential for Inland Shoreline Stabilization

- High Potential
- Other Wetlands and Deepwater Habitats
- Uplands
- Nanticoke Watershed Boundary
- Roads
- Streams and Ditches

* Estuarine Wetlands have been designated as important for Shoreline Stabilization on the Coastal Storm Surge Detention/Shoreline Stabilization that emphasizes freshwater wetlands.

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Locus Map

Nanticoke Watershed

Projection: UTM
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Fish and Shellfish Habitat

Wetlands predicted as significant fish and shellfish habitat represented about 37 percent of the watershed's wetland acreage. Those with high potential significance for estuarine fish and shellfish amounted to 26 percent, whereas 0.6 percent was designated as having high potential for freshwater species. Forested and scrub-shrub wetlands along streams that may be important for moderating stream temperatures comprised 9 percent of the watershed's wetlands. Ponds accounted for less than 1 percent of the watershed's wetlands. Some wetlands not identified as significant for this function may be considered vital to sustaining the watershed's ability to provide in-stream fish habitat, especially those important for streamflow maintenance (see pertinent map).

Predicted with High Potential for Estuarine Species

Wetland Type	Acreage
Estuarine Emergent	15,893.3
Estuarine Unconsolidated Shore (tidal flat)	574.0
Total	16,467.3

Predicted with High Potential for Freshwater Species

Riverine Tidal Unconsolidated Shore	46.4
Riverine Tidal Emergent	298.5
Palustrine Tidal Emergent	32.5
Palustrine Emergent Semipermanently Flooded	10.0
Palustrine Emergent/Unconsolidated Bottom	6.6
Total	394.0

Predicted to Be Important for Maintaining Stream Fish Habitat

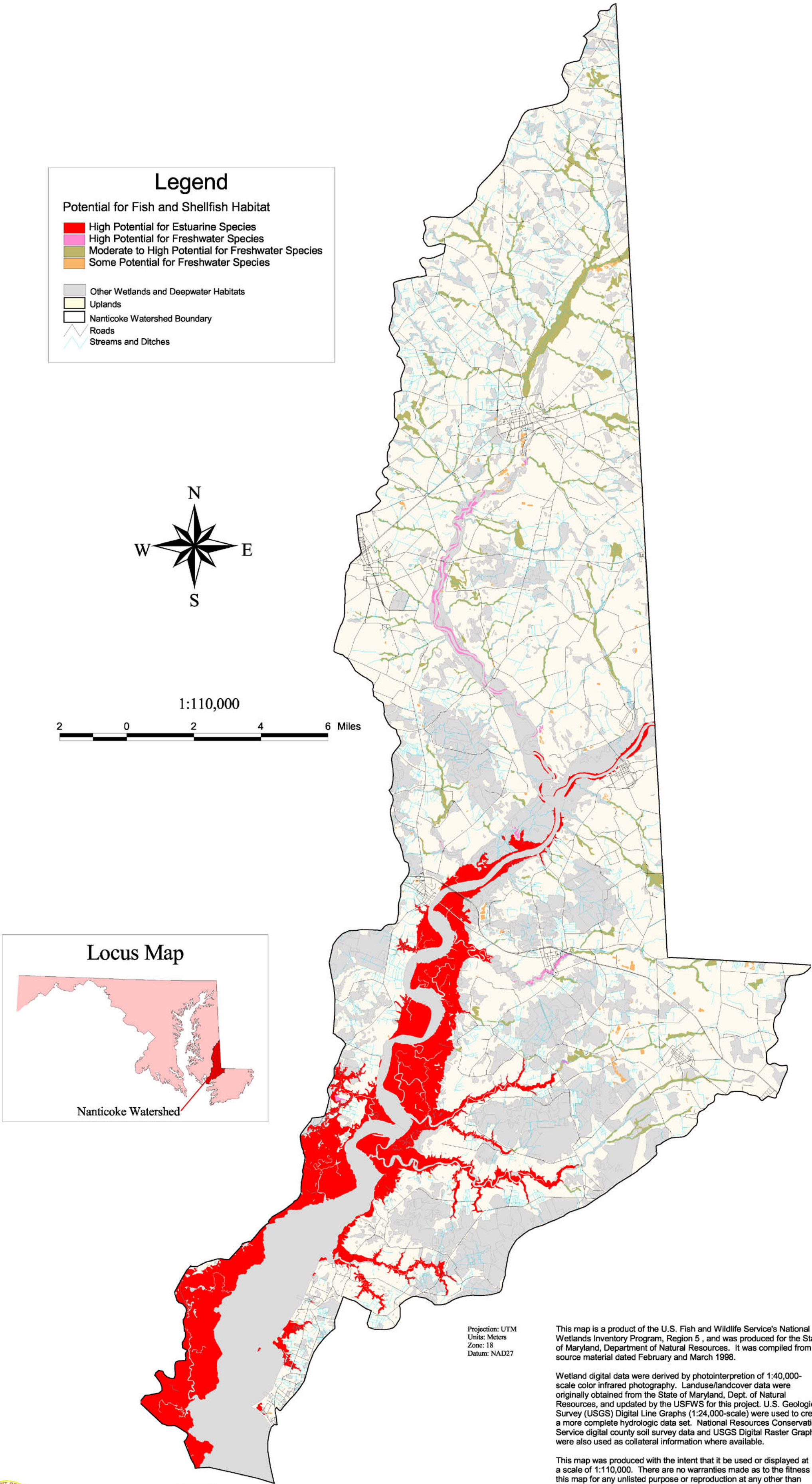
Palustrine Forested	5750.3
Palustrine Mixed Forested (with Scrub-Shrub or Emergent Wetland)	26.0
Total	5776.3

Predicted with Some Potential for Freshwater Species

Pond	548.0
Total	548.0

Potential Wetlands of Significance for Fish and Shellfish Habitat
Nanticoke Watershed, Maryland

Map 11NW



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Waterfowl and Waterbird Habitat

About 40 percent of the watershed's wetlands was designated as having potential significance for waterfowl and waterbirds. Twenty-six percent was predicted to have high significance for waterfowl and waterbirds, while another 13 percent was identified as potentially important for wood duck. Ponds were identified as having some potential; they represented less than 1 percent of the watershed's wetlands.

Predicted with High Potential

Wetland Type	Acreage
Estuarine Emergent	15,883.4
Estuarine Unconsolidated Shore (tidal flat)	574.0
Riverine Tidal Emergent	298.5
Palustrine Semipermanently Flooded	22.9
Riverine Tidal Unconsolidated Bottom	46.4
Total	16,825.2

Predicted with Some Potential

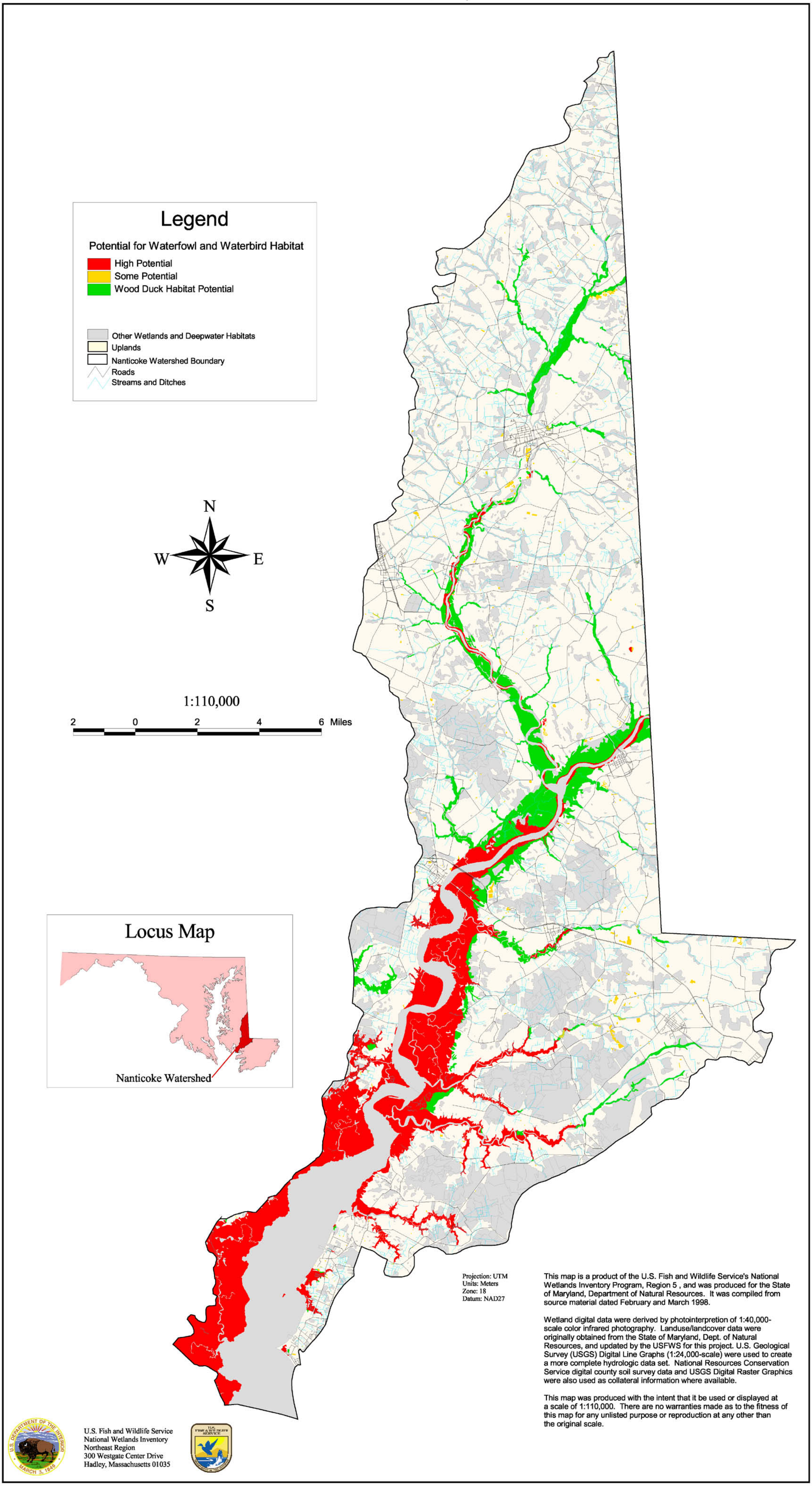
Palustrine Unconsolidated Bottom (pond)	548.0
Total	548.0

Predicted with Significance to Wood Duck

Palustrine Tidal Forested	5962.0
Palustrine Nontidal Forested	2146.4
Palustrine Tidal Scrub-Shrub	69.9
Palustrine Nontidal Scrub-Shrub	59.4
Total	8237.7

Potential Wetlands of Significance for Waterfowl and Waterbird Habitat
Nanticoke Watershed, Maryland

Map 12NW



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Other Wildlife Habitat

Most (92%) of the watershed's wetlands were predicted as important to other wildlife. Two categories of wetlands were chosen: 1) wetlands $\geq$ 20 acres and 2) small diverse wetlands (10-20 acres and with 2 or more different covertypes at the class level).

Wetland Type	Acreage
Large Wetlands	58,848.9
Small Diverse Wetlands	137.1
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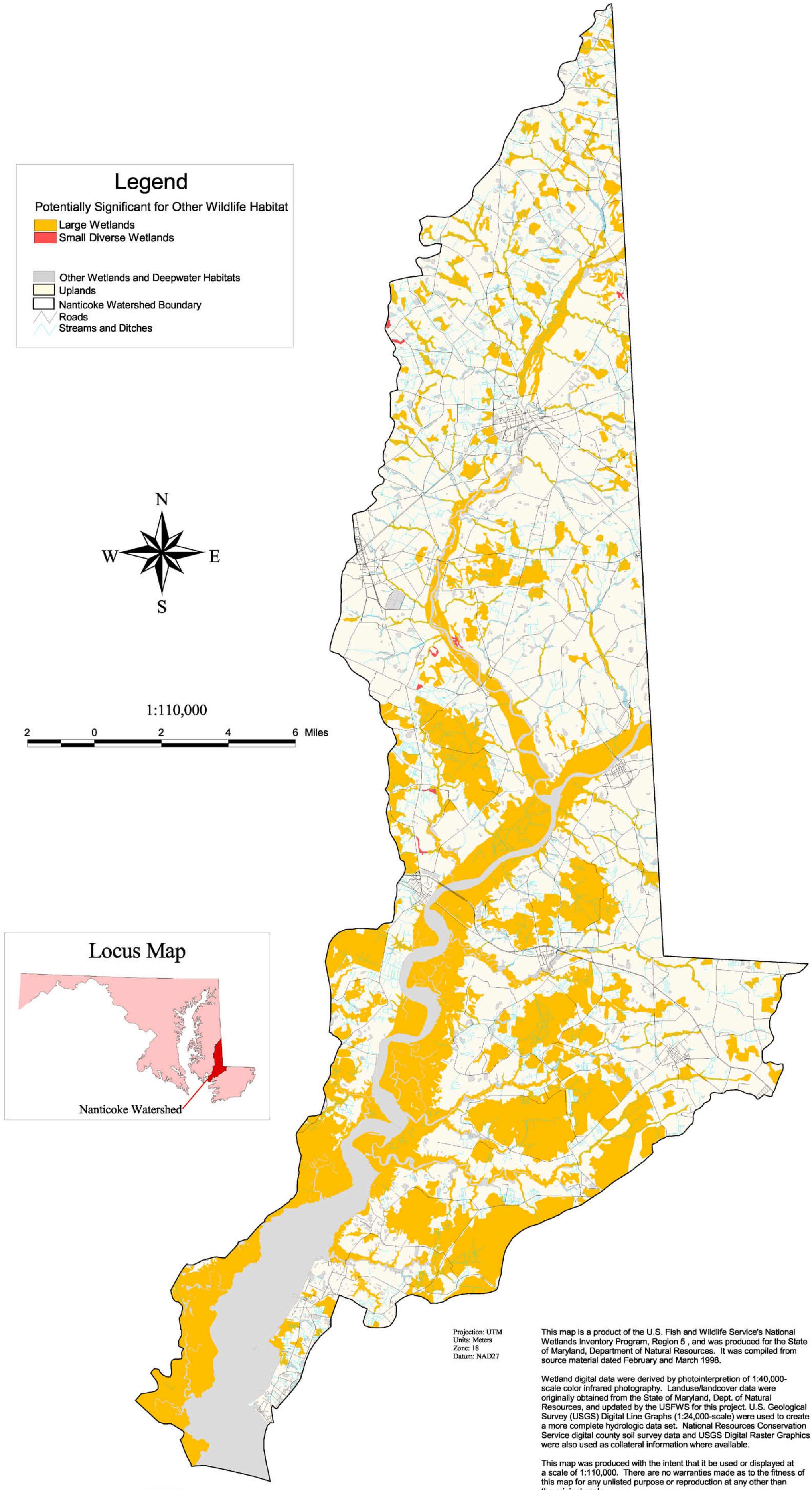
Total	58,986.0

Potential Wetlands of Significance for Other Wildlife Habitat
Nanticoke Watershed, Maryland

Map 13NW



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Conservation of Biodiversity

Certain wetland types appeared relatively uncommon in the watershed. While they may be abundant elsewhere in the state, they may be viewed as important for maintaining biodiversity within the limits of the Nanticoke watershed, given the watershed focus of this analysis. The following types were highlighted: 1) oligohaline estuarine scrub-shrub wetlands (85.3 acres), 2) estuarine evergreen scrub-shrub wetlands (53.9 acres), 3) estuarine forested wetlands (173.9 acres), 4) estuarine mixed forested/emergent wetlands (67.2 acres), 5) tidal forested wetlands where bald cypress was co-dominant (26.0 acres), 6) palustrine tidal emergent wetlands (204.4 acres), 7) palustrine tidal scrub-shrub wetlands (94.6 acres), 8) riverine tidal emergent wetlands (298.5 acres), 9) riverine tidal unconsolidated shore wetlands (46.4 acres), 10) palustrine tidal evergreen forested wetlands (95.3 acres), 11) palustrine tidal forested/emergent wetlands (22.6 acres), 12) seasonally flooded and semipermanently flooded emergent wetlands (47.8 acres), 13) seasonally flooded deciduous scrub-shrub wetlands (21.4 acres), and 14) seasonally flooded forested/emergent wetlands (4.1 acres).

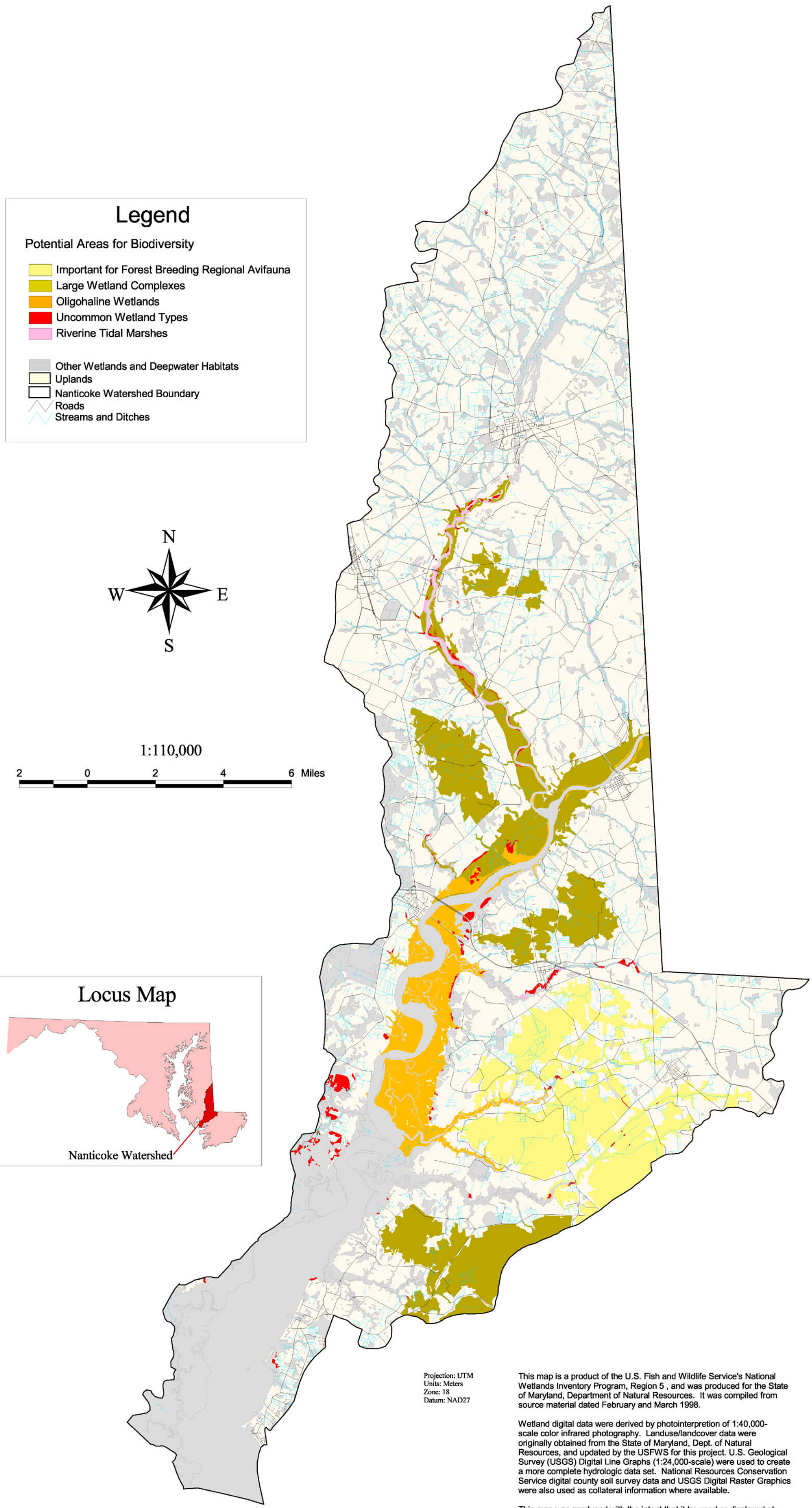
Despite their relative abundance in this watershed, estuarine oligohaline emergent wetlands (slightly brackish marshes; 6259.4 acres) were highlighted as significant for biodiversity because they are among the most diverse wetland plant communities in the state. They accounted for 10 percent of the watershed's wetland acreage.

Following recommendations by Robbins et al. (1989) for protecting habitat to maintain the Mid-Atlantic region's forest-breeding avifauna, we located one large interconnected forested tract of 12,839 acres in the southeastern part of the watershed (roughly between Barren Creek and Manumsco Creek). This area contained 10,275 acres of mostly forested wetlands which represent 16 percent of the watershed's wetlands. Besides this significant area, several large wetland complexes were considered to be potentially important for biodiversity. They totaled 16,357 acres and represented about 26 percent of the watershed's wetlands.

Overall, slightly more than 50 percent of the Nanticoke wetlands were designated as potentially significant for biodiversity. Remember that this assessment was based on remote sensing techniques and that known sites important to maintaining biodiversity such as those on record with the Maryland Natural Heritage Program or reported in other sources may not be included since those records were not consulted. Consequently, the listing is conservative and represents a starting point, not an end point for an assessment of wetlands important for conservation of species. These sources could be added to the list at a later date by the State in their future planning and evaluation efforts. Consult the state's MERLIN database for information on "wetlands of special state concern."

Potential Wetlands of Significance for Biodiversity
Nanticoke Watershed, Maryland

Map 14NW



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Potential Wetland Restoration Sites

Due to the history of human activities in this watershed, there is a wealth of opportunities for wetland restoration. Former wetlands (Type 1 wetland restoration sites) and existing wetlands whose functions may be impaired by ditching, impoundment, excavation, and restricted tidal flows (Type 2 restoration sites) represent these opportunities.

A total of 273 Type 1 wetland restoration sites were identified in the Nanticoke watershed. Sixty-seven percent of the Type 1 acreage was represented by farmed wetlands, while the remainder was comprised of former vegetated wetlands that are now deepwater habitats due to impoundment. The Type 1 total is conservative as many areas of hydric soils (i.e., effectively drained and cultivated in the watershed) were not identified as candidates for wetland restoration. They were not designated because they have undergone major land-leveling and appeared to be productive cropland, virtually indistinguishable from other cropland (i.e., on nonhydric soils) on the aerial photographs. Moreover, it may be difficult to convince landowners to support wetland restoration for such areas. When considering wetland restoration of Type 1 sites, however, it should be possible to pursue restoration of much larger wetlands than the Type 1 data would suggest, since the Type 1 sites are usually surrounded by effectively drained hydric soils.

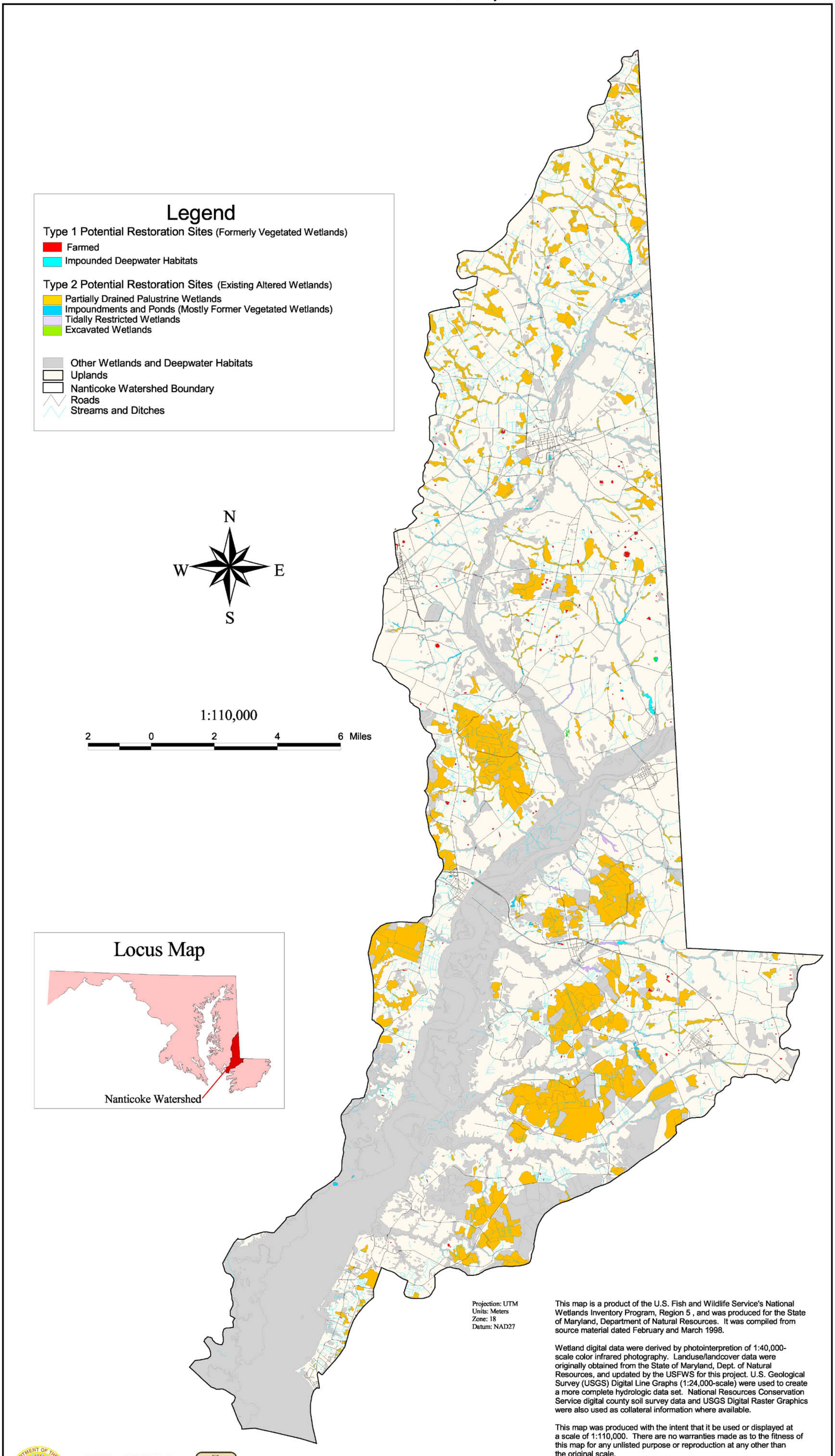
Type 1 Sites	No. of Sites	Acreage
Effectively drained former wetlands (farmed wetlands)	269	241.8
Impoundments (former vegetated wetlands)	4	118.1
Total	273	359.9

Roughly one-third of the watershed's wetlands were designated as Type 2 sites (degraded wetlands whose functions may be improved by various types of restoration). Most of the Type 2 sites were partly drained wetlands that have been ditched to varying degrees. The effect of drainage on these wetlands must be evaluated in the field on a case-by-case basis. Many of these wetlands may have minimal effects, while many others may be seriously impacted by the drainage ditches. Partly drained wetlands with drier water regimes (e.g., temporarily flooded or seasonally flooded [PFO1Ad and PFO1Cd, for example]) contiguous to wetter wetlands (e.g., seasonally flooded/saturated - PFO1E) may indicate more significant drainage impacts. Some of the impounded wetlands listed under Type 2 sites may include both former vegetated wetlands and uplands (e.g., created wetlands). Field investigations are required to sort out the differences. Nonetheless, most appeared in landscape positions (i.e., adjacent to floodplains) were they could be configured to provide floodplain wetland functions, if desirable. Nearly 150 acres of wetlands where tidal flow may be restricted were identified.

Type 2 Sites	Acreage
Tidally restricted Wetlands	147.3
Impounded Wetlands and Ponds (formerly vegetated wetlands)	211.7
Ditched Palustrine Wetlands	21,771.6
Excavated Wetlands	15.0
Total	22,145.6

Potential Wetland Restoration Sites
Nanticoke Watershed, Maryland

Map 15NW



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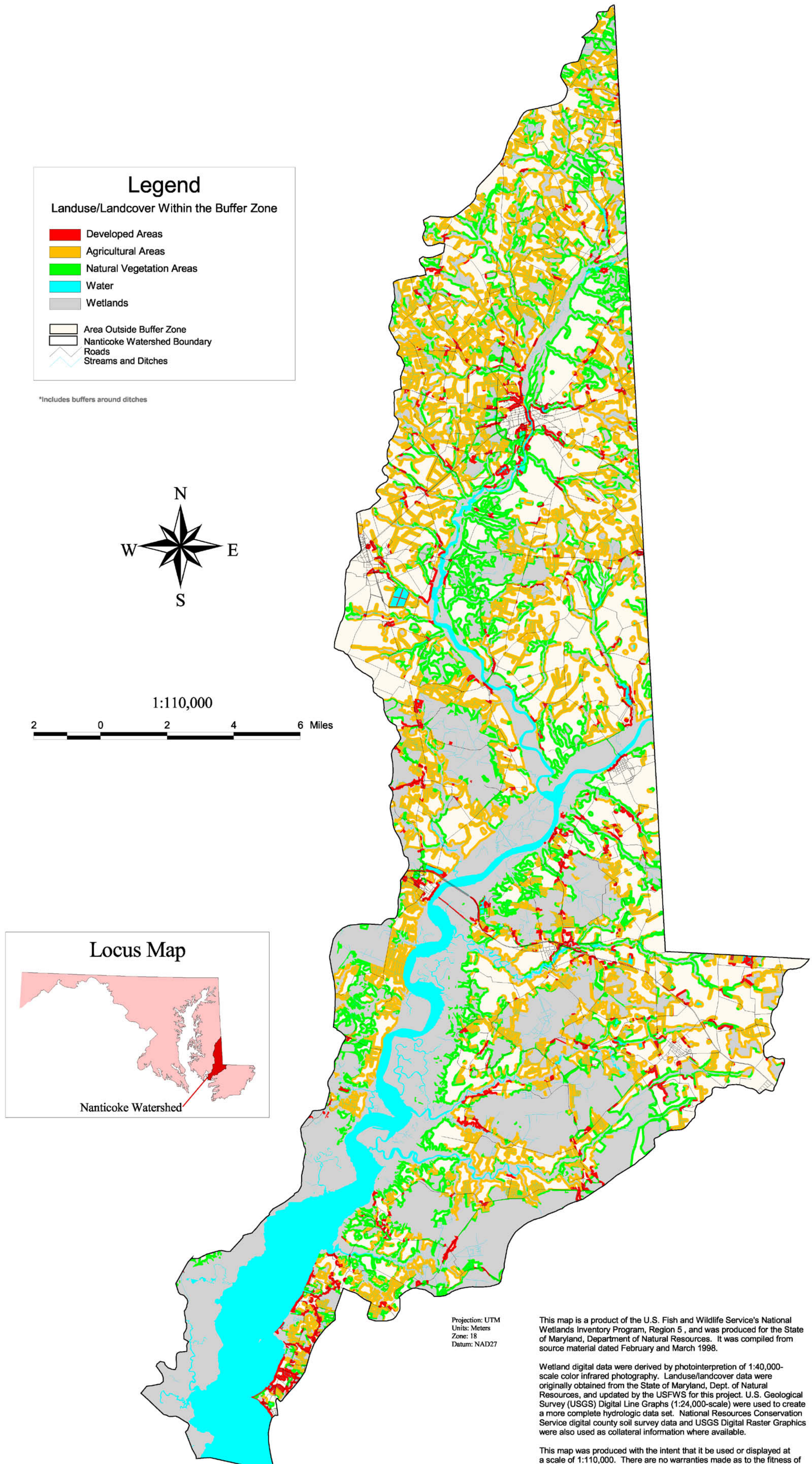
Wetland and Waterbody Buffer Analysis

The condition of the 100m upland buffer zone around wetlands and waterbodies (including ditches) was evaluated. Activities in this zone may affect the quality of wetlands and waterbodies. The upland buffer zone for the Nanticoke watershed amounted to 69,792 acres. Approximately 34 percent of this buffer (or 23,544 acres) still possessed natural vegetation in tact, while 59 percent was in agricultural usage and only 7 percent was developed. Map #16NW shows the condition of this buffer for the watershed.

Condition of Wetland and Waterbody Buffers* (100m)
Nanticoke Watershed, Maryland

Map 16NW



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Natural Habitat Integrity Indices

The values for the nine indices for the Nanticoke watershed are calculated and presented below.

Natural Cover Index = 98,544 acres of natural vegetation/188,410 acres of land in watershed = **0.52**

Stream Corridor Integrity Index (100m buffer = 200m corridor)* = 13,581 acres of natural vegetation in upland buffer/20,552 acres of upland buffer = **0.66**

*Excludes open water areas from assessment; also the index value for the 100m corridor is 0.73, so the narrower buffer zone is in slightly better condition than the 200m corridor

Wetland and Other Waterbody Buffer Index (100m)* = 23181 acres of natural vegetation in upland buffer/46,978 acres of upland buffer = **0.49**

*Excludes stream buffers which are covered under Stream Corridor Integrity Index

Wetland Extent Index* = 25,387 acres of wetlands/31,761 acres of hydric soil map units = **0.79**

*Estimated from hydric soil data available for Dorchester County portion of watershed

Standing Waterbody Extent Index = **1.0** due to impoundment and pond construction

Dammed Stream Flowage Index = 6.5 miles dammed/259.3 miles of perennial nontidal rivers and streams = **0.03**

Channelized Stream Length Index = 101.3 miles of channelized streams/259.3 miles of perennial nontidal rivers and streams = **0.39**

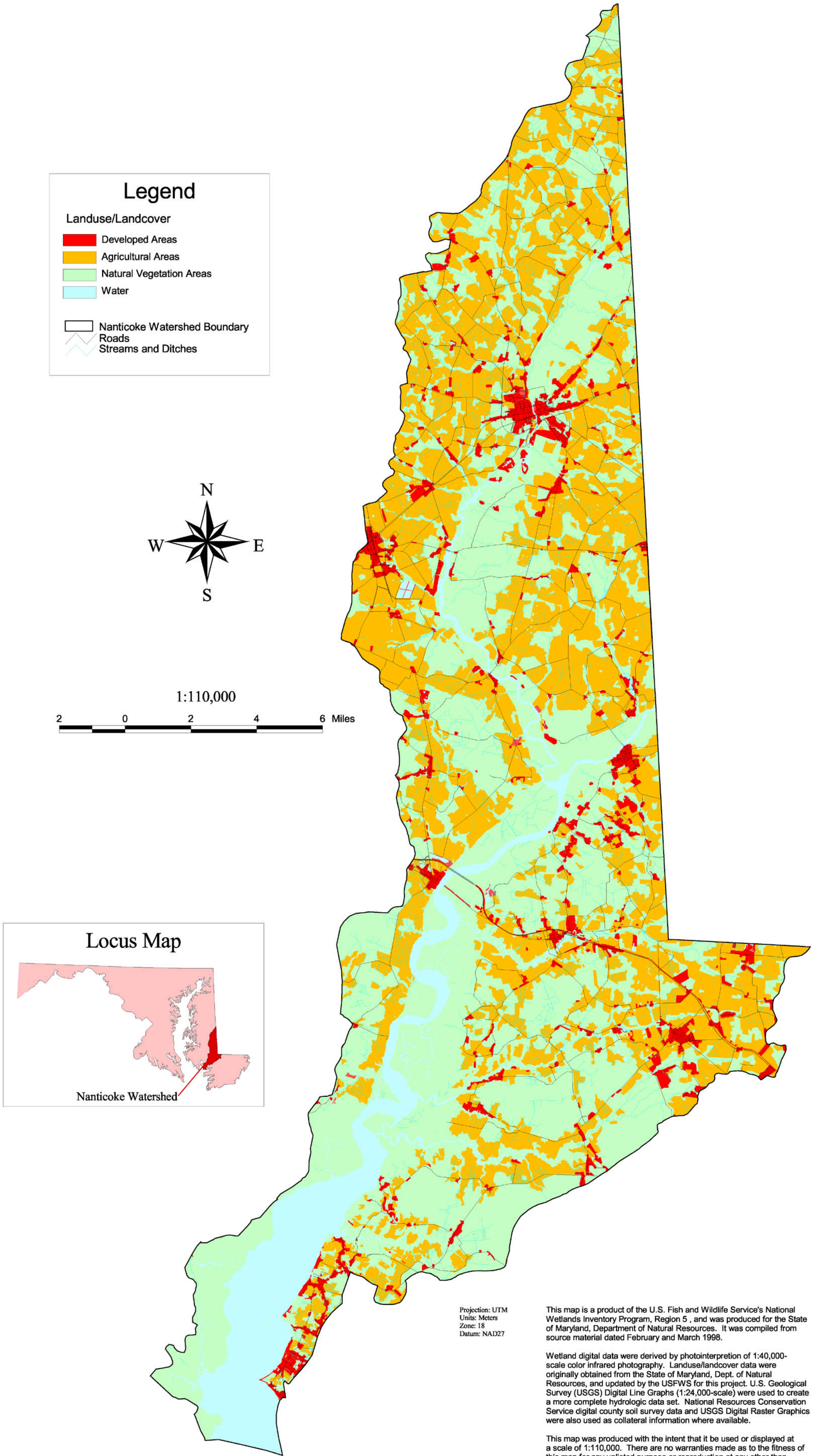
Wetland Disturbance Index = 22,767 acres of altered wetlands/64,139 acres of wetlands = **0.35**

Index of Remotely-sensed Natural Habitat Integrity = $I_{RNHI\ 100}$ = (0.6 x I_{NC}) + (0.1 x I_{SCI200}) + (0.1 x I_{WWB100}) + (0.1 x I_{WE}), + (0.1 x I_{SWE}) - (0.1 x I_{DSF}) - (0.1 x I_{CSL}) - (0.1 x I_{WD}) = (0.6 x 0.52) + (0.1 x 0.66) + (0.1 x 0.49) + (0.1 x 0.79) + (0.1 x 1.0) - (0.1 x 0.03) - (0.1 x 0.39) - (0.1 x 0.35) = **0.53**

The above indices provide evidence of a stressed system. A pristine watershed has an index value of 1.0 for natural habitat integrity. The value of 0.53 for the Nanticoke watershed signifies significant human modification. While stream corridors seem to be in reasonable shape re: natural vegetation (66% of the 200m corridor and 73% of the 100m corridor are in natural vegetation), about half of the wetland and other waterbody buffer has been developed. Overall, the Nanticoke watershed has lost about half of its natural habitat and almost 40 percent of its streams have been channelized. While slightly more than half (52%) of the land in the watershed is covered with "natural vegetation", about 42 percent is in agriculture and only 6 percent is developed. Application of these indices to individual subbasins within the watershed could aid in targeting areas for preservation and restoration.

Extent of Natural Habitat
Nanticoke Watershed, Maryland

Map 17NW



Projection: UTM
Units: Meters
Zone: 18
Datum: NAD27

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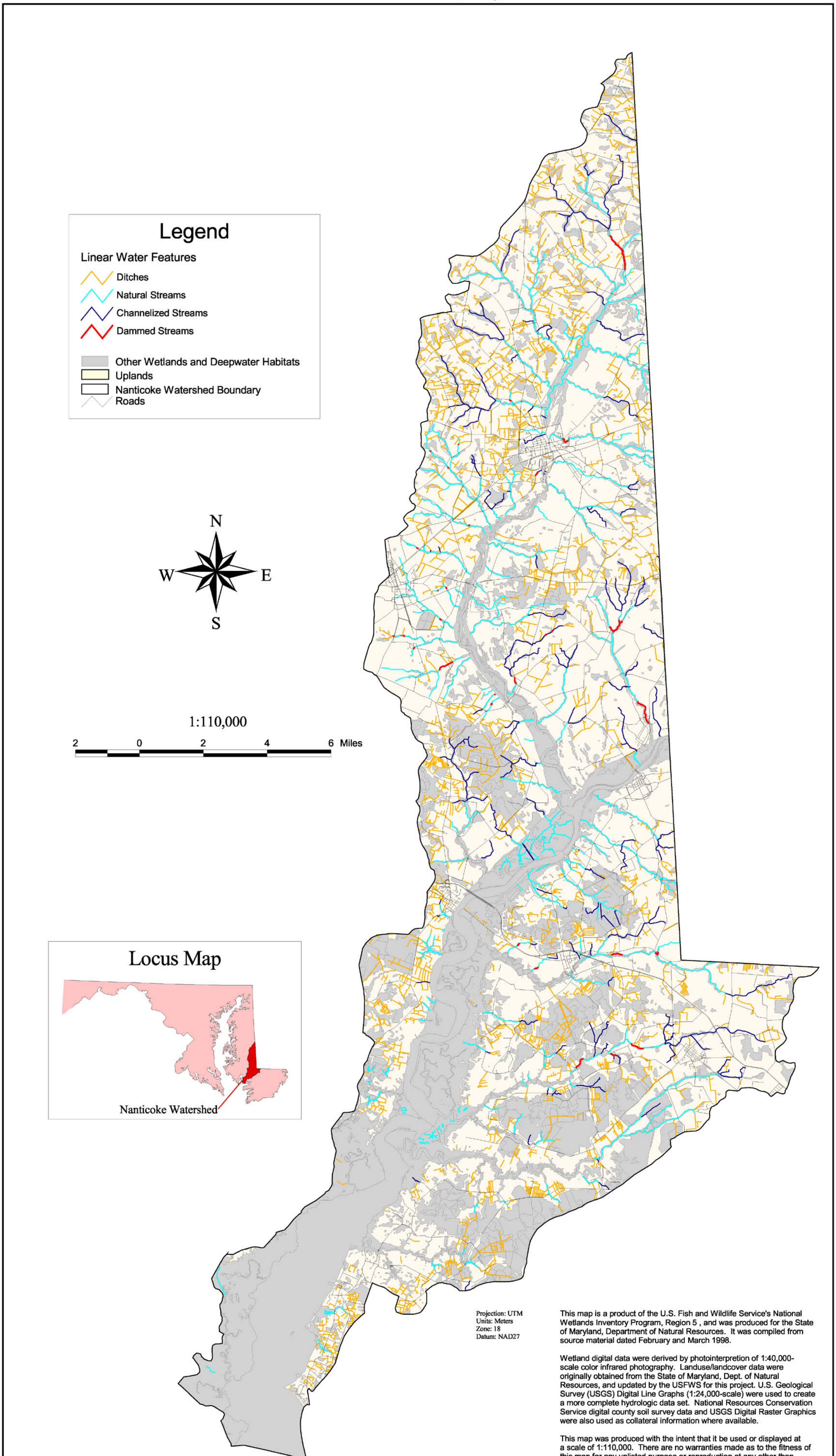
Extent of Ditching

Approximately 551 miles of ditches were inventoried by this project.   This total accounts for 1.9 miles of ditches per square mile of land area. Map #18NW shows the extent of ditching in the Nanticoke watershed.

Extent of Ditches and Condition of Streams
Nanticoke Watershed, Maryland

Map 18NW



Projection: UTM
Units: Meters
Zone: 18
Datum: NAD27

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Coastal Bays Watershed

Wetland Characterization

Wetlands were classified according to the U.S. Fish and Wildlife Service's official wetland classification system (Cowardin et al. 1979) and by landscape position, landform, and water flow path descriptors following Tiner (2000). Summaries for the study area are given in Tables 5 and 6 and findings are illustrated in Maps 1CB through 4CB. Table 5 summarizes covertypes through the subclass level of the FWS classification ("NWI types"), while Table 6 tabulates statistical data on wetlands by landscape position and landform ("HGM types").

Nineteen percent of the watershed area (which includes all the bays) is occupied by wetlands. If the bays are excluded from the watershed total, the percent of "land" represented by wetlands comes to 31 percent.[2]

Wetlands by NWI Types

According to the NWI, the Coastal Bays watershed had nearly 1500 wetlands totaling 36,435 acres. Estuarine and palustrine wetlands were nearly equally abundant, with the former having slightly more acreage (18,153.5 vs. 17,757.0 acres). Estuarine wetlands accounted for 50 percent of the wetlands and palustrine wetlands represented 49 percent. The 525 acres of marine wetlands (intertidal beaches) inventoried made up about 1 percent of the wetland acreage.

Emergent wetlands (salt and brackish marshes) comprised about 91 percent of the estuarine wetlands. Unconsolidated shores (tidal flats) represented 6 percent, while scrub-shrub wetlands accounted for about 3 percent of the estuarine wetlands. Technically classified as deepwater habitat, eelgrass beds totaling 8,311 acres occurred in the shallow bay waters behind Assateague Island.

Forested wetlands were the predominant palustrine type in the watershed accounting for 74 percent of the palustrine wetlands. Scrub-shrub wetlands were next in abundance among these wetlands, representing about 14 percent. Emergent wetlands (including shrub/emergent mixtures) made up 8 percent. The remaining palustrine wetlands were ponds (unconsolidated shores; about 3%) and farmed wetlands (less than 1%).

Map 1CB shows the distribution of wetlands in the Coastal Bays watershed according to NWI types. See Appendix A for general descriptions of wetland plant communities for the Coastal Plain.

[2]Land mass is represented by uplands plus wetlands; deepwater habitats are excluded.

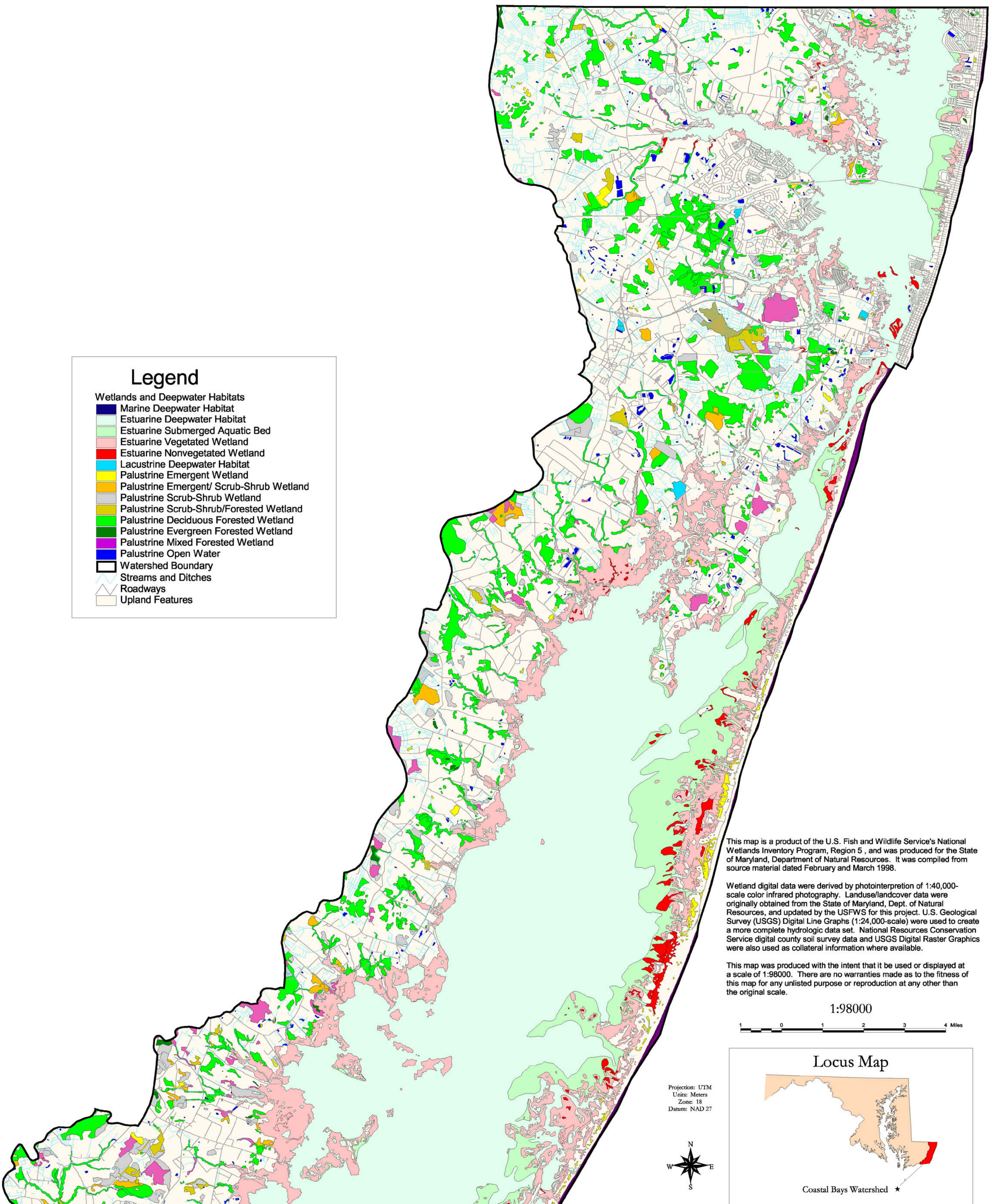
Table 5. Wetlands in the Coastal Bays watershed classified by NWI type to the class level (Cowardin et al. 1979). Other modifiers have been deleted for this compilation.

NWI Wetland Type	Acreage
Marine Wetlands	
Unconsolidated Shore (Beaches)	**524.8**
Estuarine Wetlands	
Emergent (Regularly flooded)	50.7
Emergent (Irregularly flooded)	16,404.9
Emergent/Shrub	44.0
Scrub-Shrub	514.4
Evergreen Forested	39.4
Deciduous Forested/Shrub	15.2
Unconsolidated Shore	1084.9 (w/181.6 irregularly flooded)
-------------------------------------	-----------
Subtotal	**18,153.5**
Palustrine Wetlands	
Emergent (Nontidal)	669.0
Emergent (Tidal)	6.2
Emergent/Scrub-Shrub (Nontidal)	737.3
Emergent/Scrub-Shrub (Tidal)	51.5
Broad-leaved Deciduous Forested (Nontidal)	10,215.6
Broad-leaved Deciduous Forested (Tidal)	179.5
Needle-leaved Evergreen Forested (Nontidal)	165.7
Mixed Forested	1543.0 (includes 2.6 tidal)
Forested/Emergent (Nontidal)	25.9
Evergreen Forested/Scrub-Shrub (Nontidal)	15.5
Deciduous Forested/Deciduous Shrub	852.9 (includes 18.0 tidal)
Deciduous Forested/Evergreen Shrub (Nontidal)	121.7
Deciduous Scrub-Shrub (Nontidal)	404.1
Deciduous Scrub-Shrub (Tidal)	47.4
Needle-leaved Evergreen Scrub-Shrub (Nontidal)	1290.3
Needle-leaved Evergreen Scrub-Shrub (Tidal)	21.8
Mixed Scrub-Shrub (Nontidal)	730.1
Mixed Scrub-Shrub (Tidal)	18.1
Unconsolidated Bottom (Nontidal)	614.2 (includes 3.3 uncon. shore)
Farmed	47.2
--	-----------
Subtotal	**17,757.0**
GRAND TOTAL (ALL WETLANDS)	**36,435.3**

Wetlands and Deepwater Habitats of the Coastal Bays Watershed, Maryland

Map 1CB

*Classified by National Wetlands Inventory Types



* According to "Classification of Wetlands and Deepwater Habitats of the United States" by L.M. Cowardin et al. (1979).

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Hydrogeomorphic-Type Wetlands[3]

Slightly more than half of the wetland acreage and 39 percent of the individual wetlands in the Coastal Bays watershed were associated with estuaries. They included typical estuarine wetlands (the salt and brackish tidal wetlands of Cowardin et al. 1979) plus tidally influenced freshwater wetlands along the upland edge of the estuarine reaches of the watershed (e.g., seasonally flooded-tidal palustrine forested wetlands). Terrene wetlands accounted for 36 percent of the wetlands by acreage and nearly half of the wetlands by number (Table 6). This contrast means that, on average, terrene wetlands were much smaller in size than estuarine wetlands. Lotic wetlands ranked third in both abundance (12% of the wetlands by number) and acreage (10% of the wetland acreage).

From the landform perspective, fringe wetlands were most abundant due to the predominance of estuarine wetlands. They accounted for 48 percent of the wetland acreage. Interfluve wetlands were second-ranked, representing 24 percent of the acreage. Flats were next-ranked, comprising just over 10 percent of the acreage. Most of the flats are remnants of interfluve wetlands that have been fragmented by the conversion to cropland. Floodplain wetlands had about 300 acres fewer than the flats and therefore ranked fourth in acreage (nearly 10%). Island wetlands and basin wetlands each represented about 4 percent of the wetland acreage.

Considering water flow path for freshwater wetlands, four types were found in the Coastal Bays watershed: 1) outflow, 2) throughflow, 3) bidirectional flow (associated with lakes, estuaries, and tidal rivers), and 4) isolated. Due to the tidal influence in this watershed, bidirectional flow dominated, affecting over 43 percent of the wetlands by number and about 57 percent by acreage (nearly 21,000 acres). For wetlands beyond the reach of the tide, outflow types (including outflow ponds) predominated with about 12,053 acres (about 20% by number and 33% of the total wetland acreage). Throughflow wetlands (including in-stream ponds) accounted for over 2,400 acres. Isolated wetlands were second-ranked in number (538 including ponds), but occupied only 1,137 acres, showing that most of these wetlands were small (about 2 acres on average). Many were fragments of once larger wetlands.

Maps 2CB, 3CB, and 4CB show the distribution of wetlands in the Coastal Bays watershed as classified by landscape position, landform, and a combination of landscape position and landform, respectively.

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[3] Note all wetlands except ponds were categorized by HGM-type descriptors. Ponds were classified according to pond types such as isolated (174 ponds/272.6 acres), outflow (50/105.7), bidirectional (6/42.8), or throughflow (93/189.8).

Table 6. Estuarine and freshwater wetlands (excluding 610.9 acres of ponds) in the Coastal Bays watershed classified by landscape position, landform, and water flow path (Tiner 2000). See Appendix B for definitions.

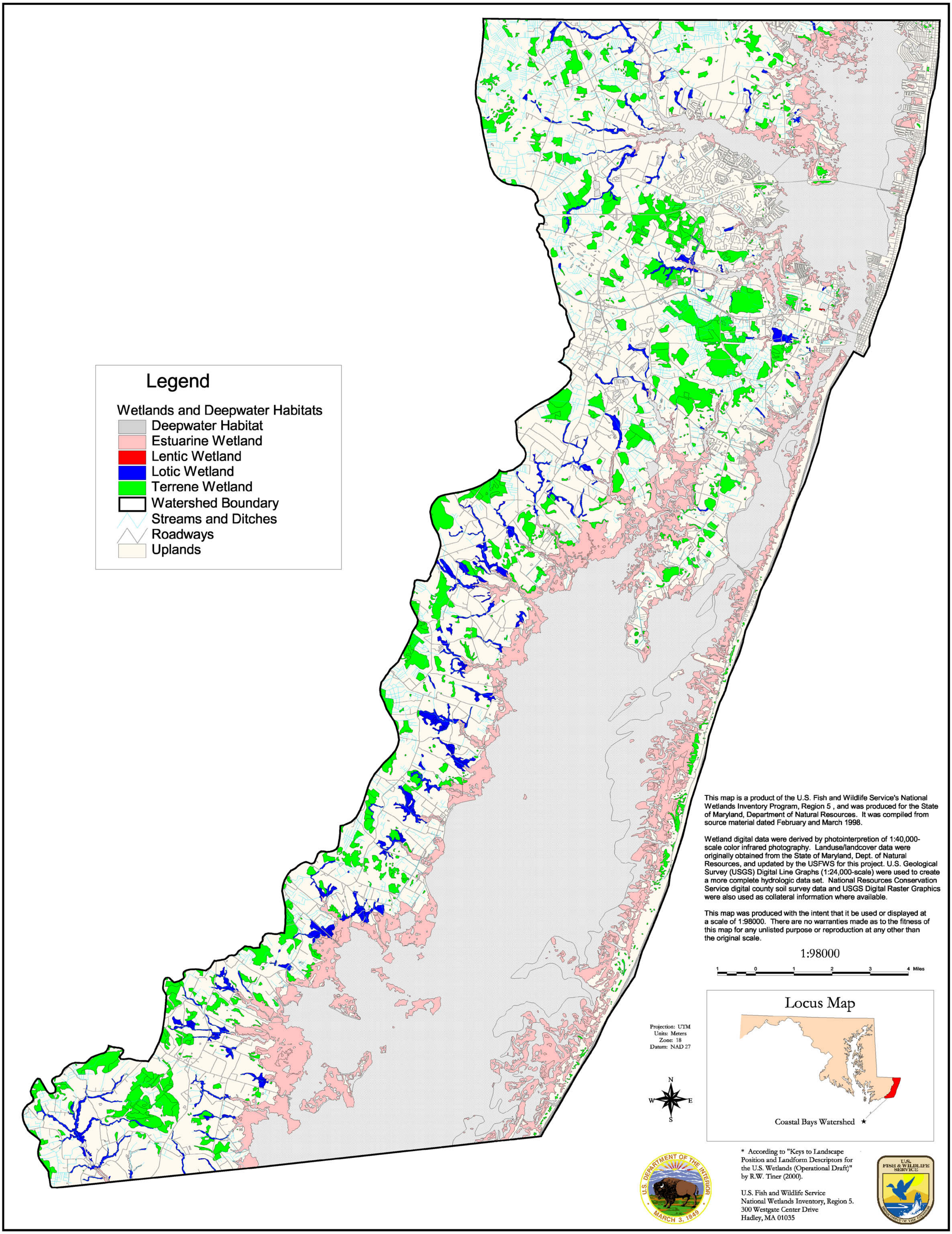
Landscape Position	**Landform**	**Water Flow**	**# of Wetlands**	**Acreage**
Marine	Fringe	Bidirectional	*	**524.8**
Estuarine			**583**	**18,592.9**
	Fringe*	Bidirectional	344	16,939.8
	Island	Bidirectional	239	1653.1
Terrene			**727**	**13,179.5**
	Interfluve	Outflow	114	8691.4
	Basin	Isolated	183	280.7
		Outflow	65	429.8
	Flat	Isolated	181	583.6
		Outflow	150	2826.2
		Throughflow	34	367.8
Lotic Stream			**184**	**3,523.5**
	Basin	Throughflow	9	16.7
		Bidirectional***	1	2.2
	Flat	Throughflow	11	27.3
	Floodplain	Throughflow	93	1833.9
		Bidirectional***	70	1643.4
Lentic	Basin	Bidirectional	**1**	**3.5**

* Did not compute; ocean beaches.
**Includes tidal freshwater wetlands along edge of estuary.
***Freshwater tidal reach.

Wetlands and Deepwater Habitats of the Coastal Bays Watershed, Maryland

*Classified by Landscape Position

Map 2CB



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* According to "Keys to Landscape Position and Landform Descriptors for the U.S. Wetlands (Operational Draft)" by R.W. Tiner (2000).

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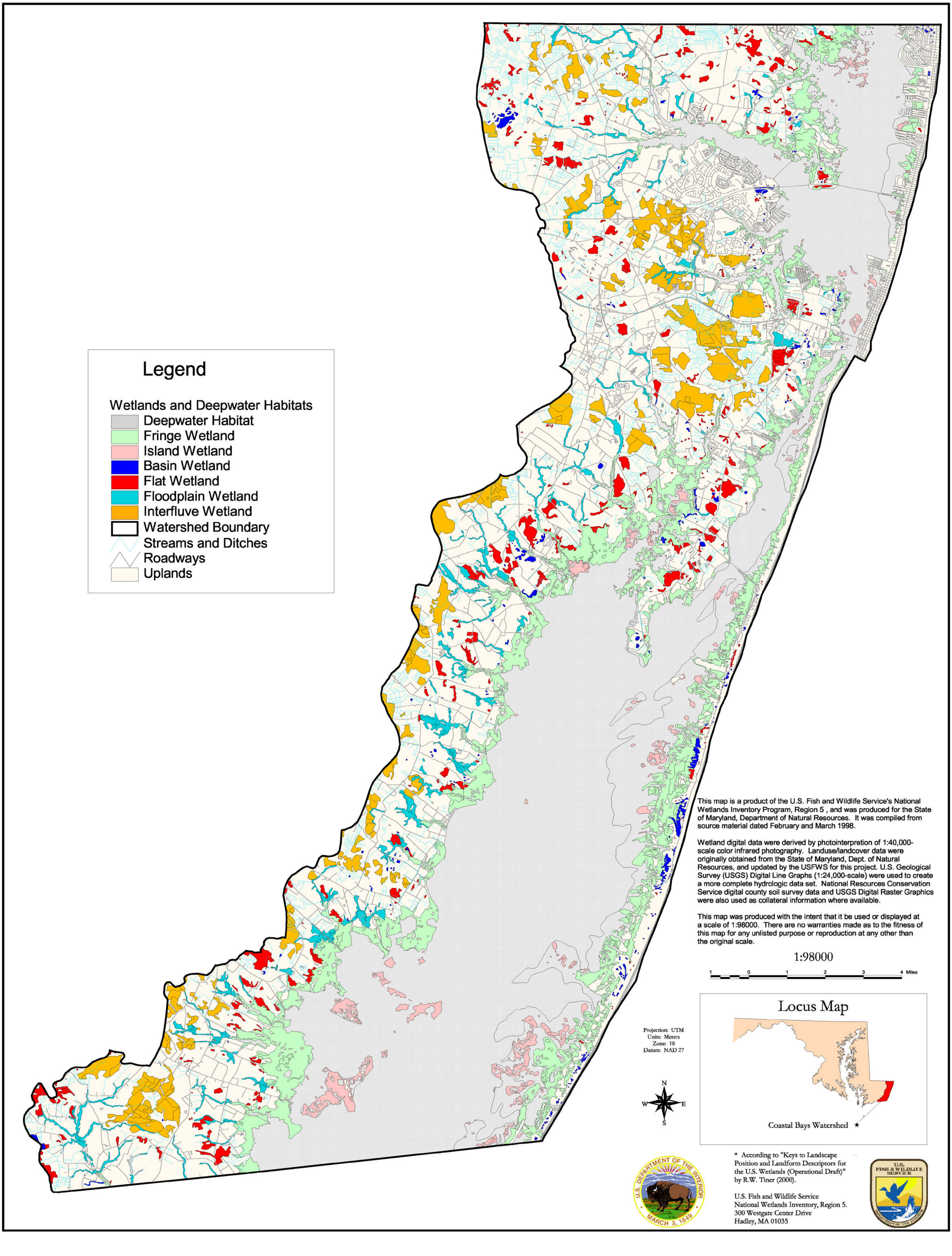
Wetlands and Deepwater Habitats of the Coastal Bays Watershed, Maryland

*Classified by Landform

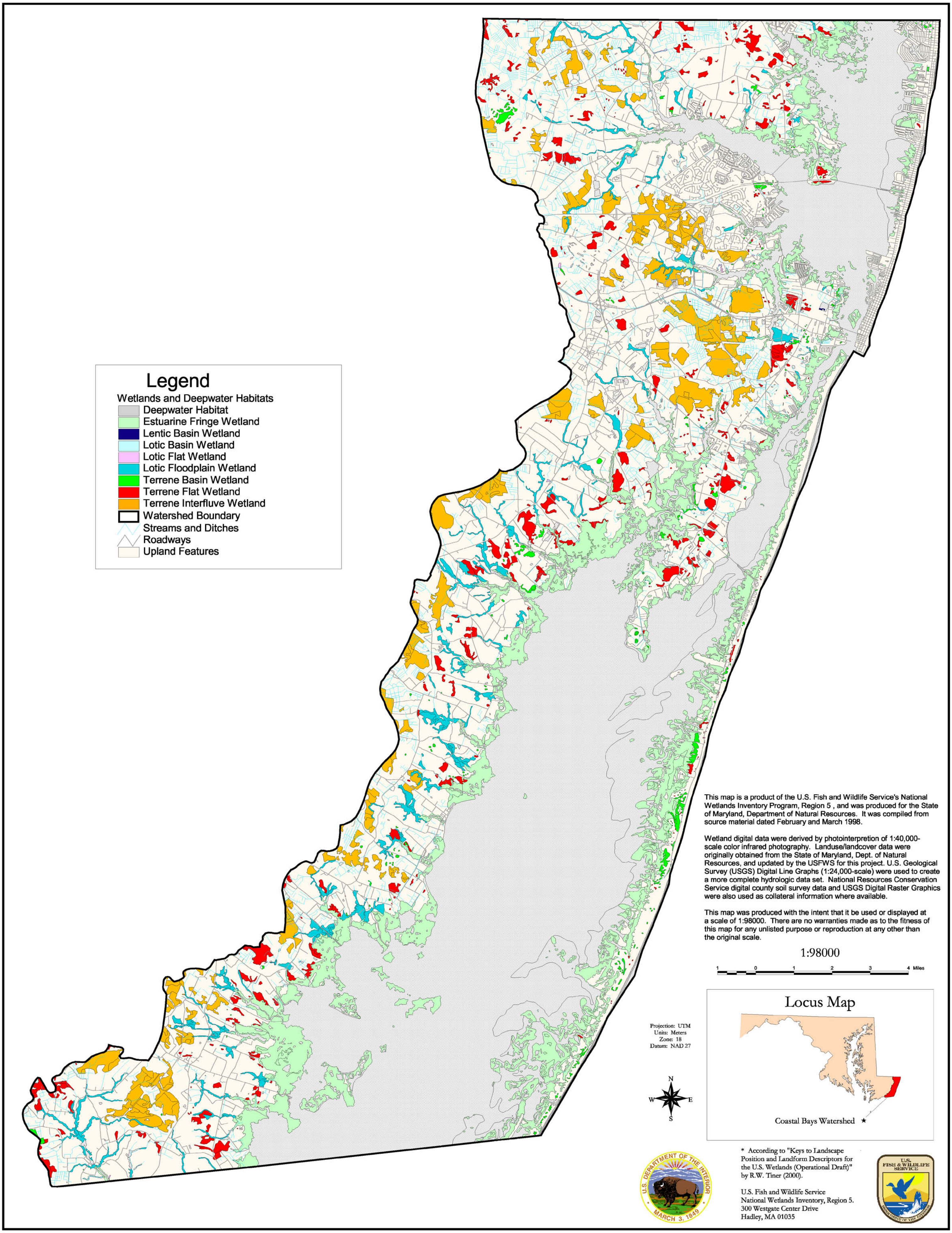
Map 3CB



Wetlands and Deepwater Habitats of the Coastal Bays Watershed, Maryland

Map 4CB

*Classified by Landscape Position and Landform



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Maps

A series of 18 maps have been produced at 1:98,000 to profile the Coastal Bays' wetlands and watershed. These maps have been distributed to the Maryland Department of Natural Resources. They are included in the CD version and on-line version of this report (see the NWI homepage: wetlands.fws.gov listed under "reports and publications").

A list of the 18 maps follows:

Map 1CB - Wetlands and Deepwater Habitats Classified by NWI Types
Map 2CB - Wetlands Classified by Landscape Position
Map 3CB - Wetlands Classified by Landform
Map 4CB - Wetlands Classified by Landscape Position and Landform
Map 5CB - Potential Wetlands of Significance for Surface Water Detention
Map 6CB - Potential Wetlands of Significance for Streamflow Maintenance
Map 7CB - Potential Wetlands of Significance for Nutrient Transformation
Map 8CB - Potential Wetlands of Significance for Sediment and Other Particulate Retention
Map 9CB - Potential Wetlands of Significance for Coastal Storm Surge Detention and Shoreline Stabilization
Map 10CB - Potential Wetlands of Significance for Inland Shoreline Stabilization
Map 11CB - Potential Wetlands of Significance for Fish and Shellfish Habitat
Map 12CB - Potential Wetlands of Significance for Waterfowl and Waterbird Habitat
Map 13CB - Potential Wetlands of Significance for Other Wildlife Habitat
Map 14CB - Potential Wetlands of Significance for Biodiversity
Map 15CB - Potential Wetland Restoration Sites
Map 16CB - Condition of Wetland and Waterbody Buffers
Map 17CB - Extent of Natural Habitat
Map 18CB - Extent of Ditches and Condition of Streams

The first four maps depict wetlands by the FWS system (NWI types) and by landscape position/landform (HGM types). Maps 5-14 highlight wetlands that perform each of the assessed functions at a significant level. Maps 15-18 address the other important features of the watershed - potential wetland restoration sites, condition of wetland and stream buffers, the overall extent of natural habitat in the watershed, and the extent of ditches and condition of streams.

Summary of Thematic Map Data

The rationale for preliminary assessment of wetlands for performing each of ten functions is provided in an earlier section of this report. The following section summarizes the results for each function. The findings are presented mostly in tabular form within the text.

Surface Water Detention

Roughly 35 percent of the Coastal Bays watershed's wetland acreage was categorized as being potentially significant for this function. Ten percent were rated as having high potential, 24 percent with moderate to high potential, and about 1 percent with some potential for surface water detention.

Predicted with High Potential

Wetland Type	Acreage
Lotic Stream Basin (LS1BA)	16.7
Lotic Stream Floodplain (LS1FP)	1832.9
Lotic Tidal Stream Basin (LS5BA)	2.2
Lotic Tidal Stream Floodplain (LS5FP)	1643.4
Instream Pond	184.0
Total	3679.2

Predicted with Moderate to High Potential*

Terrene Interfluve (TEIF)	7665.0
Terrene Basin Outflow (TEBAOU)	9.3
Terrene Flat Outflow (TEFLOU)	993.1
Terrene Flat Throughflow (TEFLTH)	128.7
Total	8796.1

*Part of a wetland 50 acres or larger in size

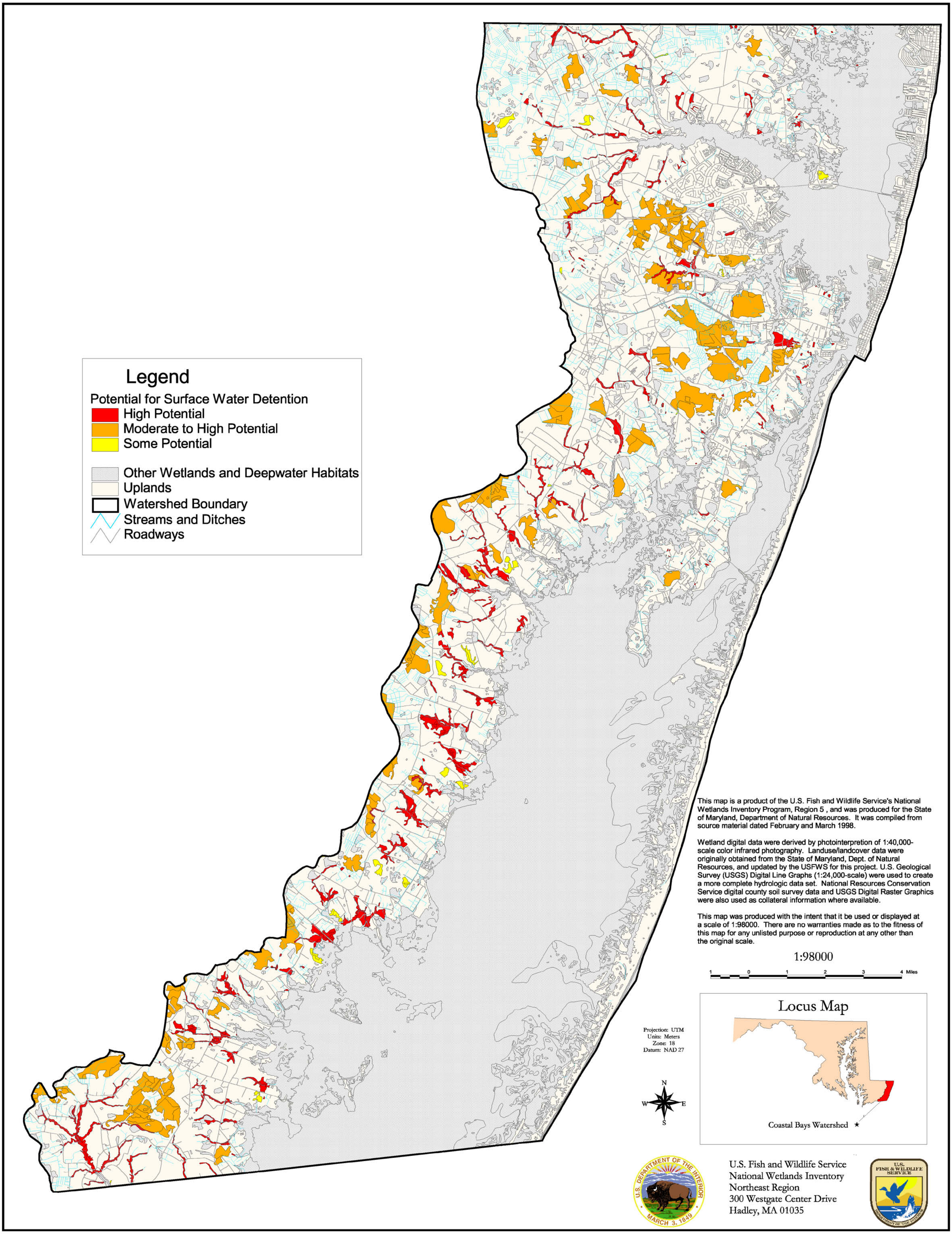
Predicted with Some Potential

Lotic Stream Flat (LS1FL)	27.3
Terrene Interfluve Outflow* (TEIFOU)	56.3
Terrene Basin Isolated* (TEBAIS)	48.1
Terrene Flat Isolated* (TEFLIS)	87.4
Terrene Basin Outflow* (TEBAOU)	0.5
Terrene Flat Outflow* (TEFLOU)	208.4
Total	428.0

*Part of a 20- to 50-acre wetland and not ditched

Potential Wetlands of Significance for Surface Water Detention
Coastal Bays Watershed, Maryland

Map 5CB



Streamflow Maintenance

Nearly 40 percent of the watershed's wetland acreage was identified as potentially significant for streamflow maintenance. Thirty-one percent was rated as having moderate to high potential, while 8 percent was designated as having some potential significance.

Predicted With Moderate to High Potential

Wetland Type	Acreage
Terrene Basin Outflow (TEBAOU)	49.8
Terrene Flat Outflow (TEFLOU)	1051.6
Terrene Interfluve Outflow (TEIFOU)	6565.5
Terrene Flat Throughflow (TEFLTH)	23.5
Lotic Stream Basin (LS1BA)	14.3
Lotic Stream Flat (LS1FL)	9.6
Lotic Floodplain (LS1FP)	1832.9
Lotic Tidal Floodplain (LS5FP)	1643.4
Throughflow Headwater Pond	38.1
Outflow Headwater Pond	80.2
Total	11,308.9

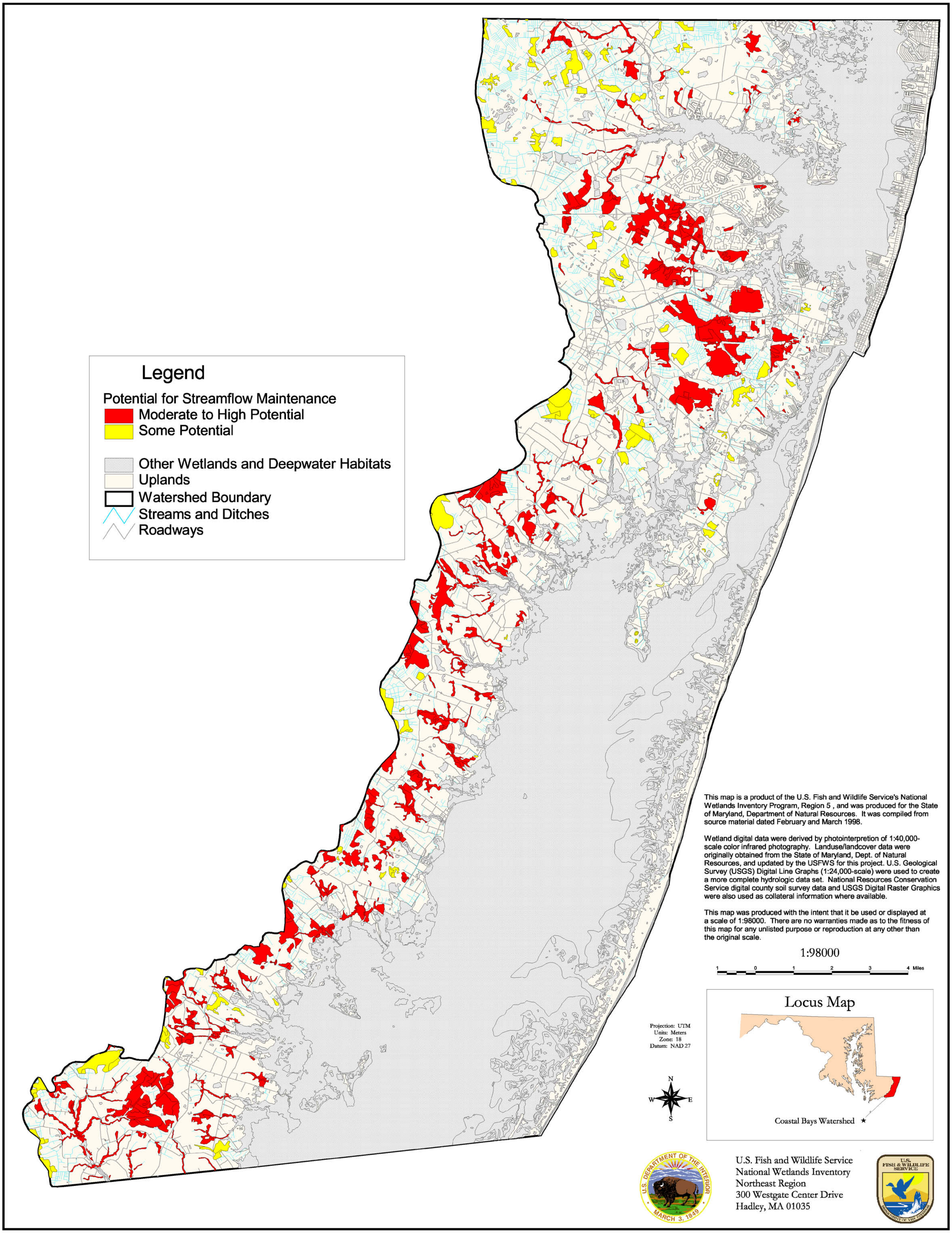
Predicted with Some Potential*

Lotic Stream Basin (LS1BA)	1.1
Outflow Pond	5.6
Terrene Interfluve Outflow (TEIFOU)	2125.8
Terrene Basin Outflow (TEBAOU)	56.9
Terrene Flat Outflow (TEFLOU)	754.0
Terrene Flat Throughflow (TEFLTH)	82.5
Total	3025.9

*Ditched headwater wetlands

Potential Wetlands of Significance for Streamflow Maintenance
Coastal Bays Watershed, Maryland

Map 6CB



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Nutrient Transformation

Several wetland types were considered to be potentially important for nutrient cycling. About 67 percent of the watershed's wetlands were identified as potentially significant for this function. Those predicted to have high potential represented about 58 percent of the Coastal Bays watershed’s wetlands.

Predicted with High Potential

Wetland Type	Acreage
Estuarine Fringe (ESFR)	16,125.3
Estuarine Island (ESIS)	1382.7
Lotic Stream Basin (LS1BA)	15.4
Lotic Stream Flat (LS1FL)	15.3
Lotic Stream Floodplain (LS1FP)	1833.9
Lotic Stream Tidal Floodplain (LS5FP)	1643.4
Lotic Stream Tidal Basin (LS5BA)	2.2
Total	21,018.2

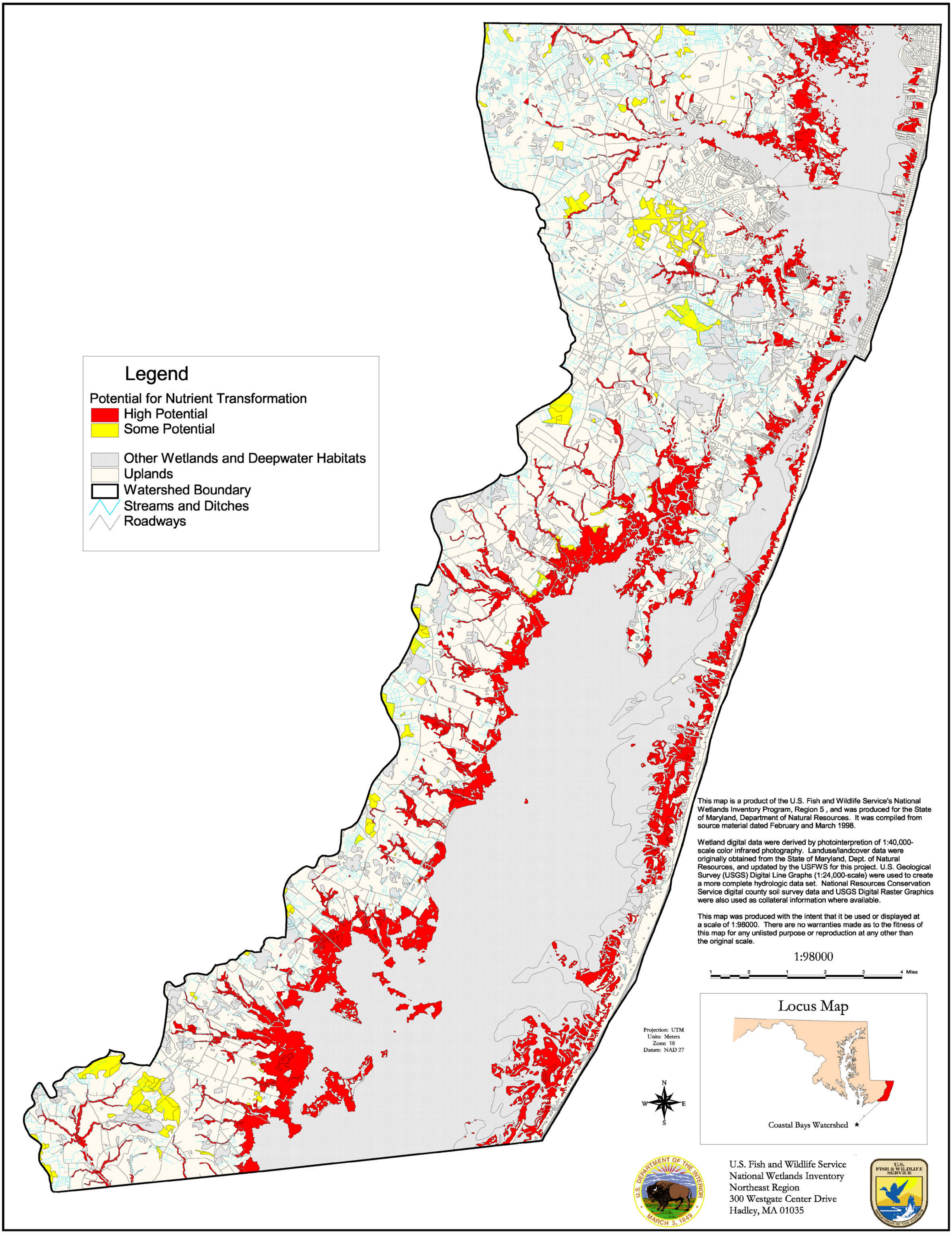
Predicted with Some Potential*

Terrene Interfluve Outflow (TEIFOU)	2821.7
Terrene Basin Outflow (TEBAOU)	62.9
Terrene Flat Outflow (TEFLOU)	481.3
Total	3365.9

*Effectively surrounded by cropland (>50% of border).

Potential Wetlands of Significance for Nutrient Transformation
Coastal Bays Watershed, Maryland

Map 7CB



Retention of Sediments and Other Particulates

Nearly 72 percent of the watershed's wetland acreage was predicted to significantly contribute to sediment and other particulate retention. Sixty-one percent of the wetlands were rated as having high potential, while about 10 percent were designated as having some potential.

Predicted with High Potential

Wetland Type	Acreage
Estuarine Fringe (ESFR)	16,939.8
Estuarine Island (ESIS)	1653.1
Lotic Stream Basin (LS1BA)	16.7
Lotic Stream Floodplain (LS1FP)	1833.9
Lotic Stream Tidal Floodplain (LS5FP)	1643.4
Lotic Stream Tidal Basin (LS1BA)	2.2
In-stream Pond	189.8
Total	22,278.9

Predicted with Some Potential

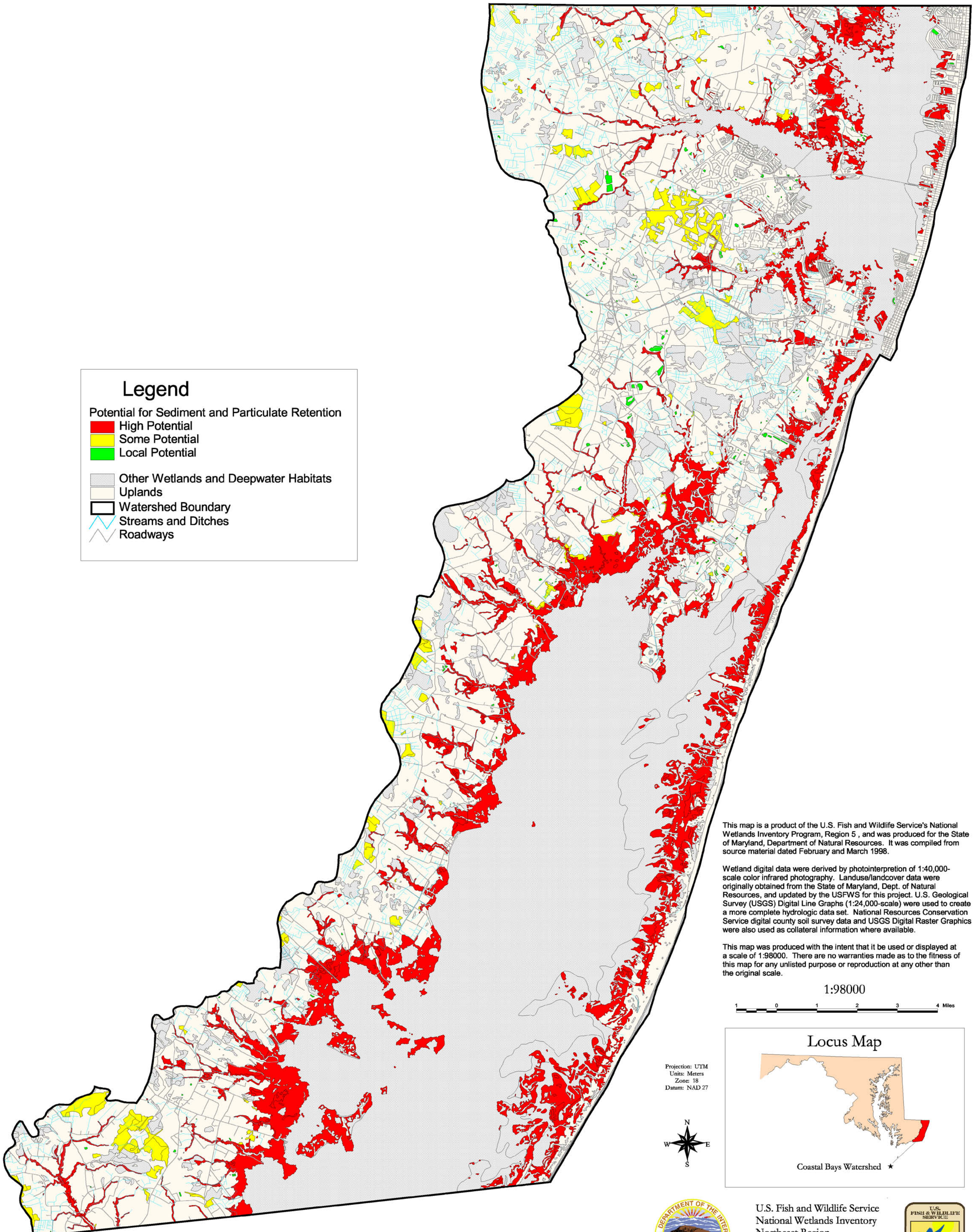
Lotic Flat (LS1FL)	27.3
Terrene Interfluve Outflow (TEIFOU)	2821.7
Terrene Basin Outflow (TEBAOU)	62.9
Terrene Flat Outflow (TEFLOU)	481.3
Terrene Flat Throughflow (TEFLTH)	238.6
Total	3631.8

Predicted with Local Significance

Isolated Pond	268.7
Total	268.7

Potential Wetlands of Significance for Sediment and Other Particulate Retention
Coastal Bays Watershed, Maryland

Map 8CB



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1:98000

1 0 1 2 3 4 Miles

Projection: UTM
Units: Meters
Zone: 18
Datum: NAD 27

N W E S

Locus Map

Coastal Bays Watershed

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Coastal Storm Surge Detention and Shoreline Stabilization

About 59 percent of the watershed's wetland acreage was categorized as having possible high potential for coastal surge protection and shoreline stabilization. While most of the acreage of potentially significant wetlands for this function is estuarine wetlands, freshwater tidal wetlands were included since they do serve as significant water storage reservoirs for coastal storm surge. They represented 53 percent of the watershed's wetlands. Wetlands bordering estuarine and tidal fresh wetlands were considered to have moderate to high potential for storm surge floodwater detention due to their low topography and adjacency to tidal waters. They represented 4 percent of the Coastal Bays watershed's wetlands. Nonvegetated tidal wetlands were designated as having some potential. They comprised about 2 percent of the wetlands.

Predicted with High Potential

Wetland Type	Acreage
Estuarine Fringe-vegetated (ESFR)	16,304.2
Estuarine Island-vegetated (ESIS)	1385.4
Lotic Stream Tidal Basin (LS5BA)	2.2
Lotic Stream Tidal Floodplain (LS5FP)	1643.4
Total	19,335.2

Predicted with Moderate to High Potential*

Terrene Basin Outflow (TEBAOU)	309.1
Terrene Flat Outflow (TEFLOU)	1011.7
Terrene Flat Throughflow (TEFLTH)	56.4
Total	1377.2

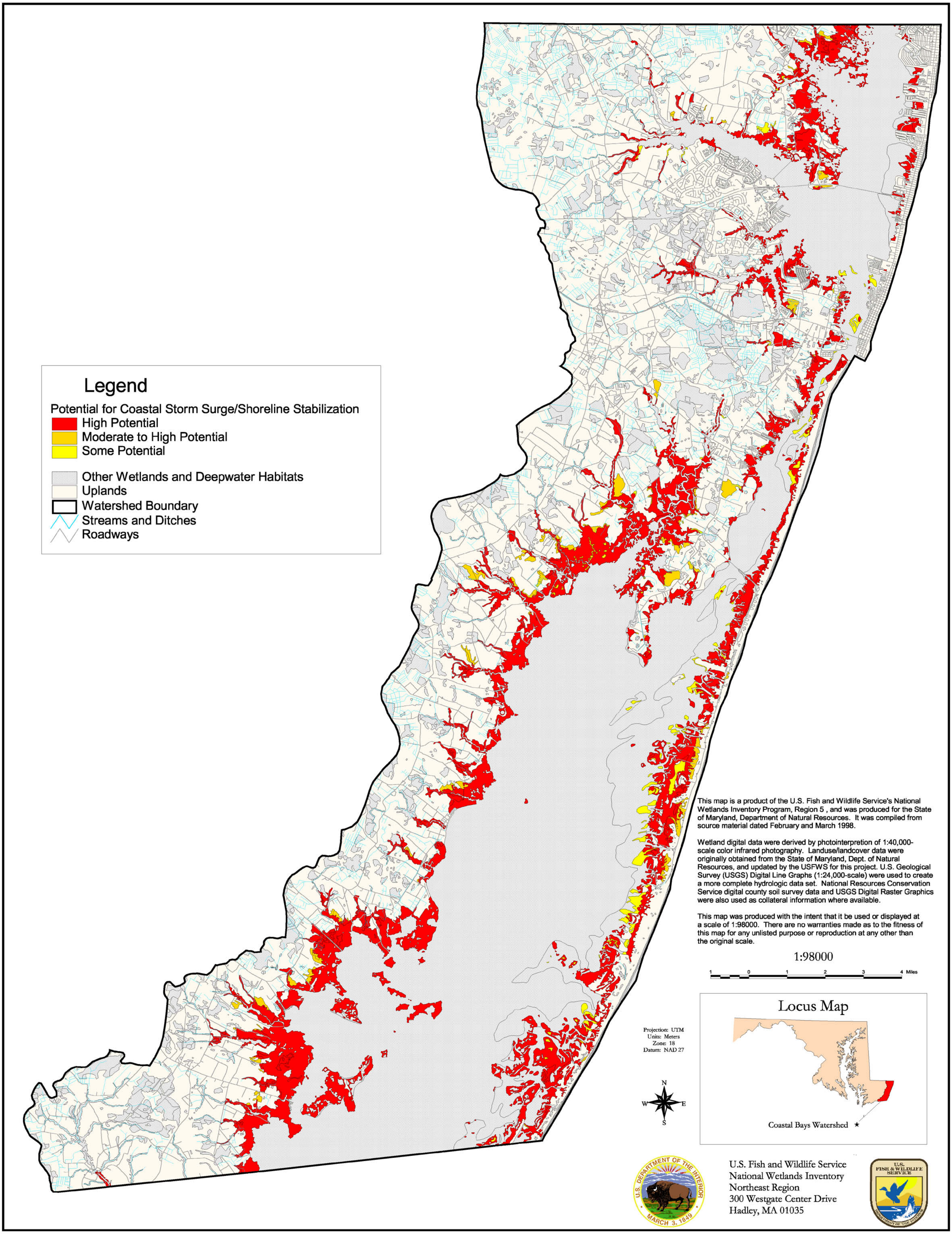
*Palustrine nontidal wetlands bordering estuarine fringe and lotic tidal wetlands

Predicted with Some Potential

Estuarine Fringe-nonvegetated (ESFR)	635.6
Estuarine Island-nonvegetated (ESIS)	267.7
Total	903.3

Potential Wetlands of Significance for Coastal Storm Surge Detention/Shoreline Stabilization
Coastal Bays Watershed, Maryland

Map 9CB



Inland Shoreline Stabilization

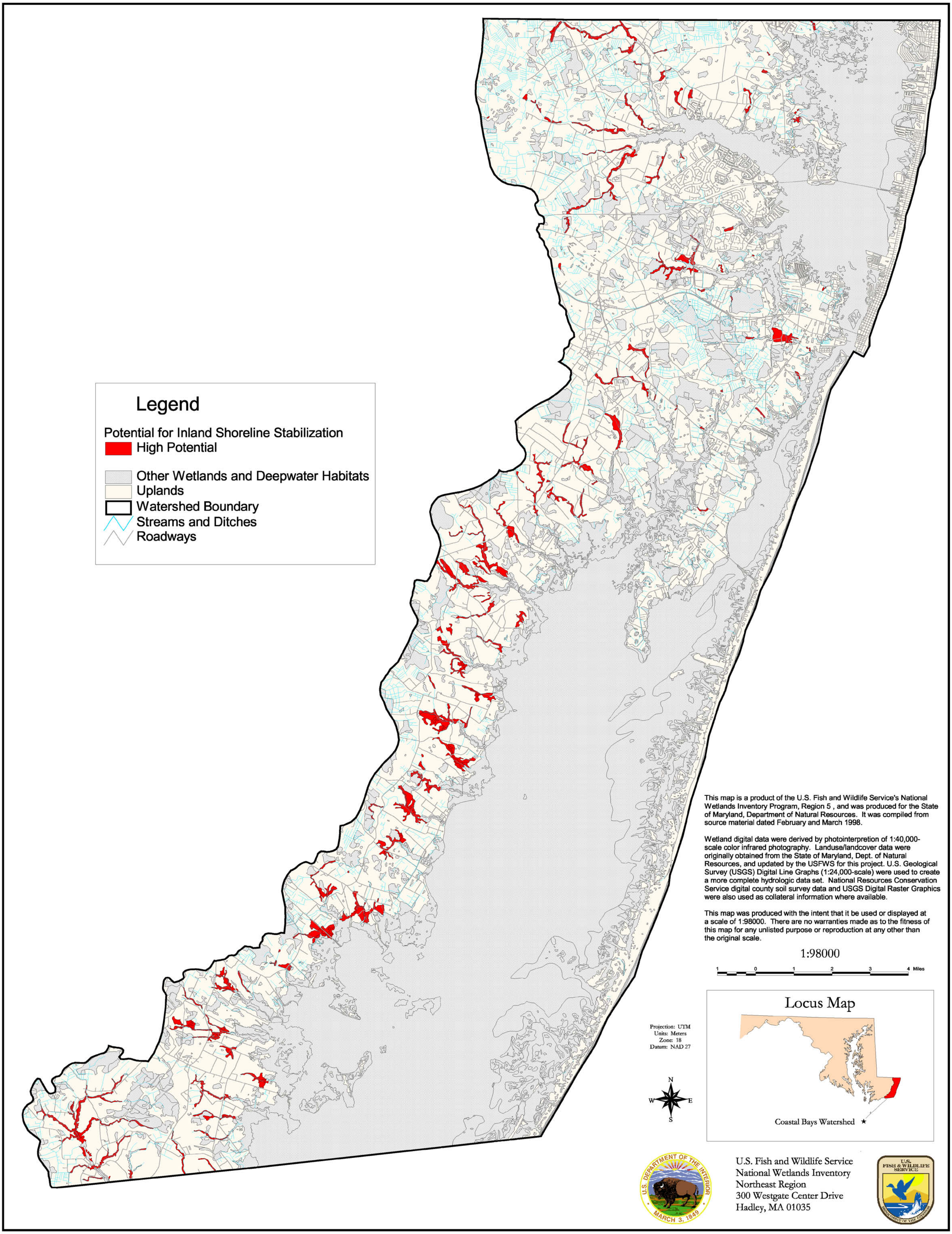
Vegetated wetlands along lakes, rivers, and streams help stabilize the soils and protect adjacent uplands from water-borne erosion. About 10 percent of the watershed's wetland acreage was represented by wetlands with a high potential to help stabilize inland shorelines.

Predicted with High Potential

Wetland Type	Acreage
Lotic Stream Basin (LS1BA)	16.7
Lotic Stream Flat (LS1FL)	27.3
Lotic Stream Floodplain (LS1FP)	1832.9
Lotic Stream Tidal Floodplain (LS5FR)	1643.4
Lotic Stream Tidal Basin (LS5BA)	2.2
Total	3522.5

Potential Wetlands of Significance for Inland Shoreline Stabilization
Coastal Bays Watershed, Maryland

Map 10CB



Fish and Shellfish Habitat

Wetlands with predicted significant potential to serve as or support fish and shellfish habitat represented about 59 percent of the watershed's wetland acreage. Wetlands with high potential for estuarine species dominated the totals. They alone comprised 48 percent of the watershed's wetlands. High potential habitat for freshwater species was less abundant, making up only 0.1 percent of the Coastal Bays wetlands. Forested and shrub wetlands along streams were deemed potentially significant for maintaining stream water temperatures that are important to resident fishes. They accounted for 9 percent of the watershed's wetland acreage. Although not designated as important for fish habitat, headwater wetlands (e.g., terrene outflow types) are likely to be vital to sustaining the watershed's ability to provide in-stream fish habitat; they can be observed on the map of streamflow maintenance.

Predicted with High Potential for Estuarine Species

Wetland Type	Acreage
Estuarine Aquatic Bed (eelgrass beds)*	8311.4
Estuarine Emergent Wetland	16,462.5
Estuarine Unconsolidated Shore (tidal flats)	1084.9
Total	25,858.8 (includes "deepwater" eelgrass beds)

*Deepwater habitat but important shallow-water, submerged aquatic bed community for fish and shellfish; some beds may be intermittently exposed and may be classified as wetlands.

Predicted with High Potential for Freshwater Species

Palustrine Tidal Emergent	12.0
Palustrine Emergent Semipermanently Flooded	31.7
Total	43.7

Predicted to Be Important for Maintaining Stream Fish Habitat*

Lotic and Palustrine Forested	3024.3
Lotic and Palustrine Mixed Forested/Shrub	130.3
Total	3154.6

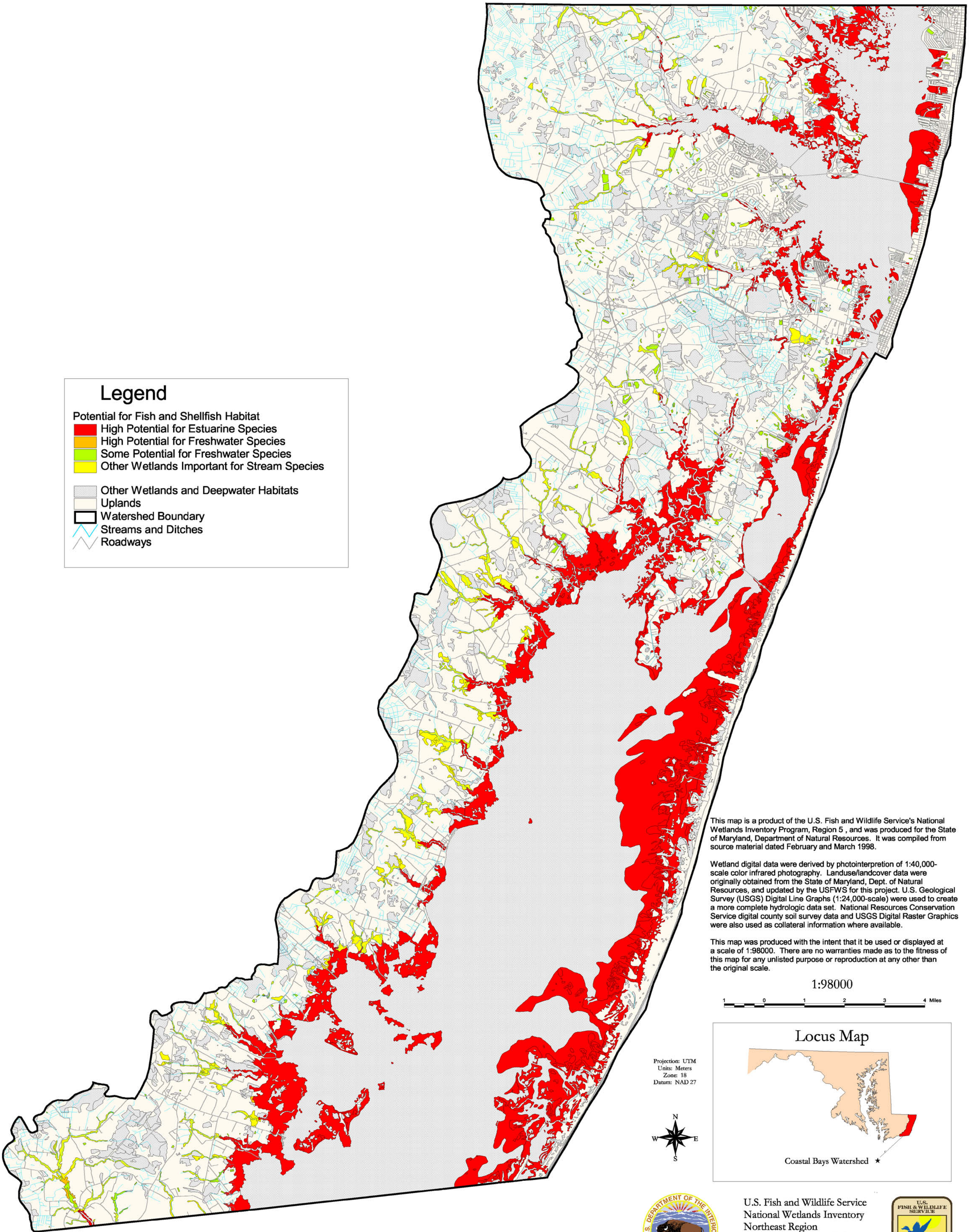
*These forested and shrub wetlands are likely important for maintaining water temperatures in streams and thereby vital to maintaining suitable fish habitat.

Predicted With Some Potential for Freshwater Species

Wetland Type	Acreage
Pond	610.9
------------	-------
Total	610.9

Potential Wetlands of Significance for Fish and Shellfish Habitat
Coastal Bays Watershed, Maryland

Map 11CB



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Waterfowl and Waterbird Habitat

Wetlands of potential significance for waterfowl and waterbirds represent 53 percent of the watershed's wetlands. The abundance of estuarine wetlands in this watershed led to a high percentage of wetlands being designated with high potential: 48 percent of the wetlands. Over 8300 acres of estuarine aquatic beds (deepwater habitats) were also identified as having high potential for supporting waterfowl and waterbirds. Over 1000 acres of additional wetlands (or 3 percent of the wetland acreage) were predicted to be important for wood duck, while 611 acres of ponds were identified as likely to provide some waterfowl and waterbird habitat.

Predicted with High Potential

Wetland Type	Acreage
Estuarine Aquatic Bed*	8311.4
Estuarine Fringe (salt/brackish emergent)	15,079.8
Estuarine Fringe (salt/brackish shrub/emergent)	37.0
Estuarine Fringe (freshwater emergent)	12.0
Estuarine Fringe (nonvegetated)	814.5
Estuarine Island (emergent)	1382.7
Estuarine Island (nonvegetated)	270.4
Semipermanently Flooded Emergent	33.8
Semipermanently Flooded Forested/Shrub	12.3
Semipermanently Flooded Shrub/Emergent	3.5
Total	25,957.4

*Classified as deepwater habitat

Predicted with Some Potential Significance

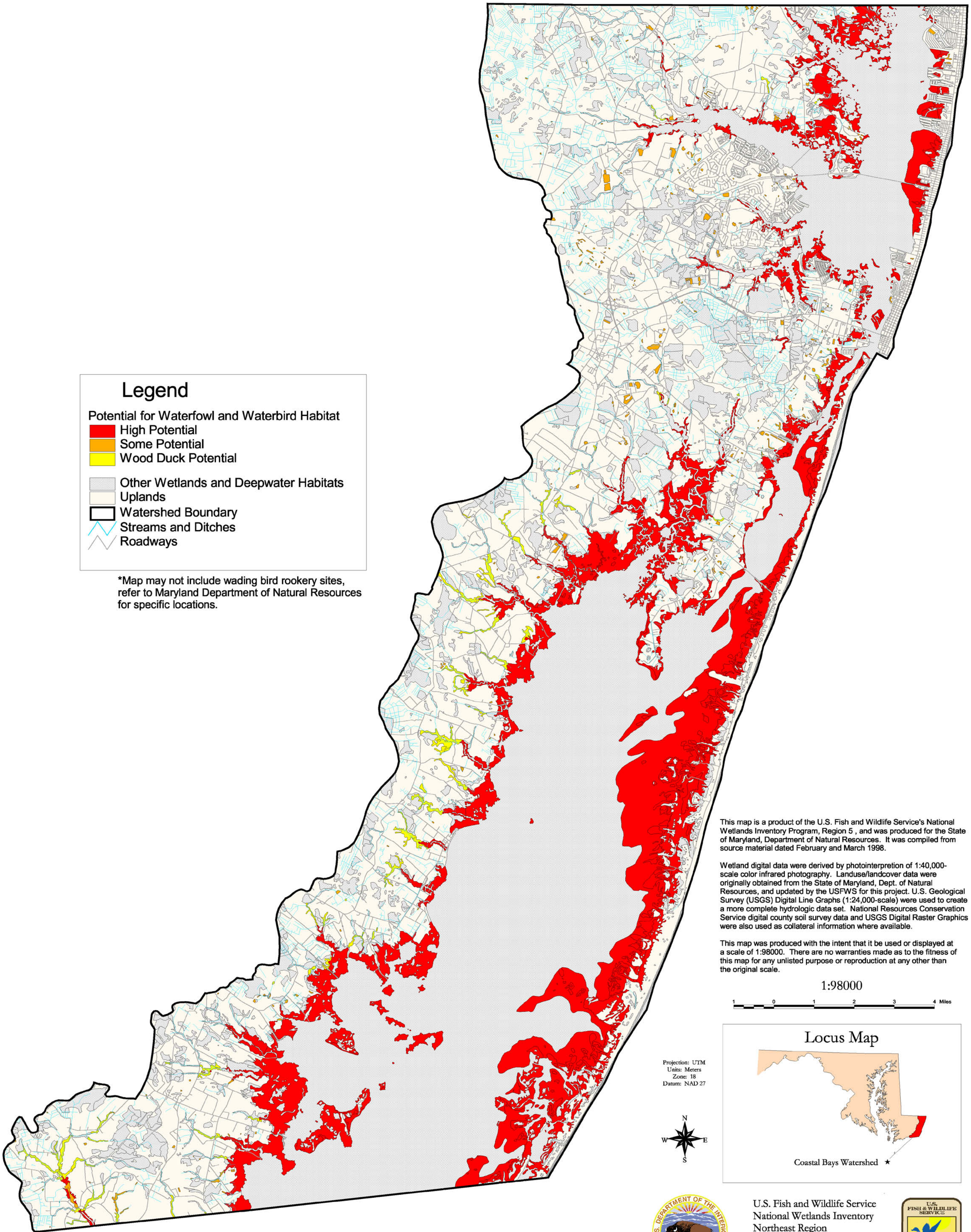
Palustrine Unconsolidated Bottom (pond)	610.9
Total	610.9

Predicted with Significance to Wood Duck

Lotic and Palustrine Forested	1097.5
Lotic and Palustrine Forested/Shrub	28.3
Lotic and Palustrine Scrub-Shrub	23.0
Total	1148.8

Potential Wetlands of Significance for Waterfowl and Waterbird Habitat*
Coastal Bays Watershed, Maryland

Map 12CB



*Map may not include wading bird rookery sites, refer to Maryland Department of Natural Resources for specific locations.

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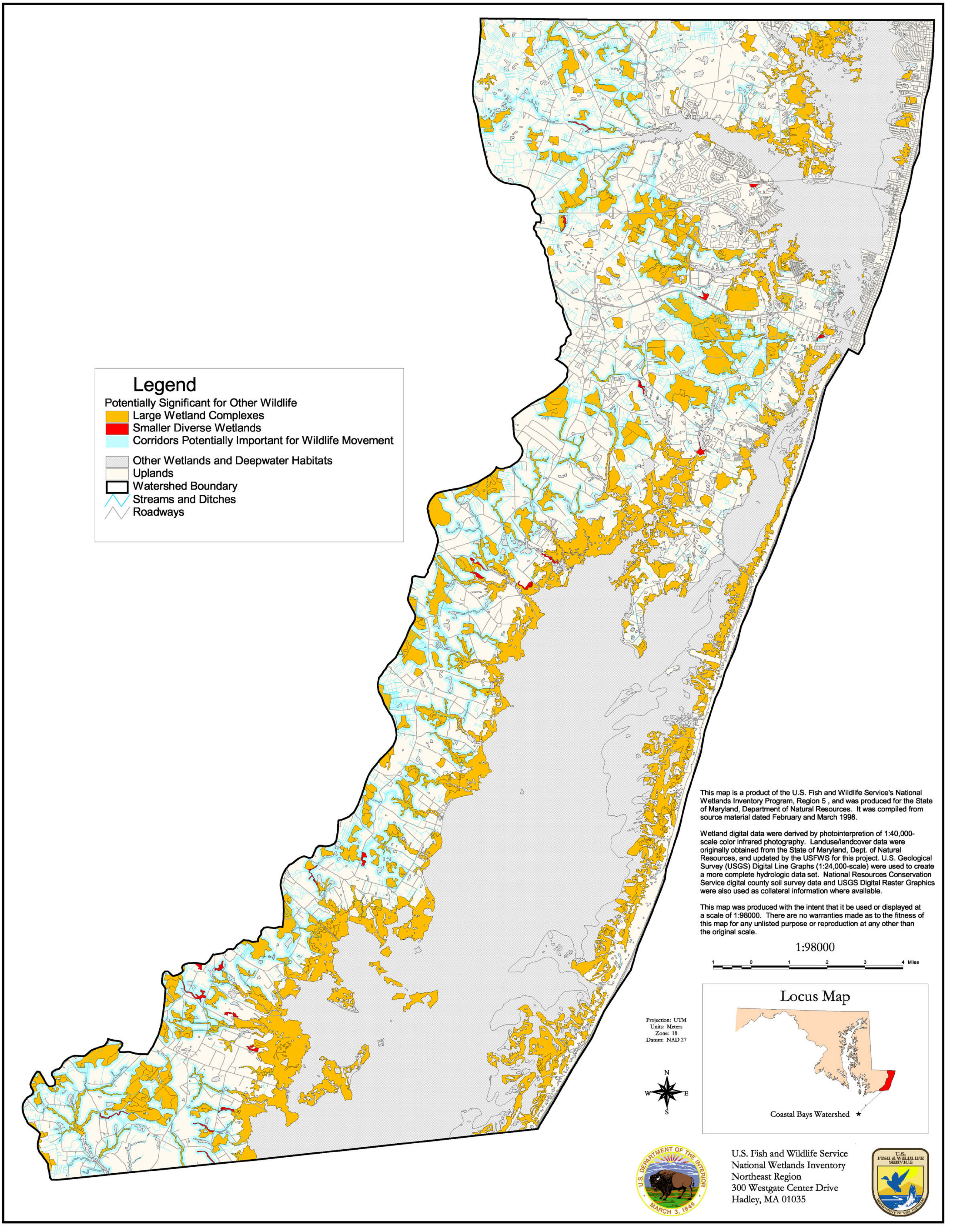
Other Wildlife Habitat

Three categories of wetlands were identified as potentially significant for other wildlife: 1) wetlands ≥ 20 acres, 2) small diverse wetlands (10-20 acres and with 2 or more different covertypes at the class level), and 3) wetland corridors that may be important for wildlife travel. No acreage data were tabulated for the latter category. The "other wildlife habitat" map shows these corridors that interconnect wetlands and may be valuable as travel corridors for terrestrial wildlife in the watershed. The first two wetland types comprised about 84 percent of the watershed's wetland acreage.

Wetland Type	Acreage
Large Wetlands	30,362.5
Small Diverse Wetlands	325.3
Total	30,687.8

Potential Wetlands of Significance for Other Wildlife Habitat
Coastal Bays Watershed, Maryland



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Conservation of Biodiversity

Certain wetland types appeared relatively uncommon in the watershed. While some may be abundant elsewhere in the state, they may be viewed as important for maintaining biodiversity within the limits of the Coastal Bays watershed, given the watershed focus of this analysis. The following types were highlighted: 1) interdunal wetlands (325.4 acres), 2) fresh tidal wetlands contiguous to salt marshes (211.4 acres), 3) semipermanently flooded emergent and/or scrub-shrub wetlands (4.6 acres; not ditched or impounded)[4], and 4) seasonally flooded emergent or mixed emergent/shrub wetlands (9.7 acres; not ditched or impounded).

All estuarine aquatic beds (8311.4 acres) and salt marshes (15,469.1 acres) associated with Assateague Island (barrier island marshes) and the saline embayments (Chincoteague Bay and others) were viewed as important for maintaining biodiversity. This region is the only area in the State where these types of saline bays occur.

Robbins et al. (1989) suggested a minimum size of 7,410 acres to retain all species of the forest-breeding avifauna in the Mid-Atlantic region. One such area totaling 9102 acres was found in the Coastal Bays watershed. It is a combination of forested wetlands (2455.4 acres) and forested uplands (6646.4 acres).

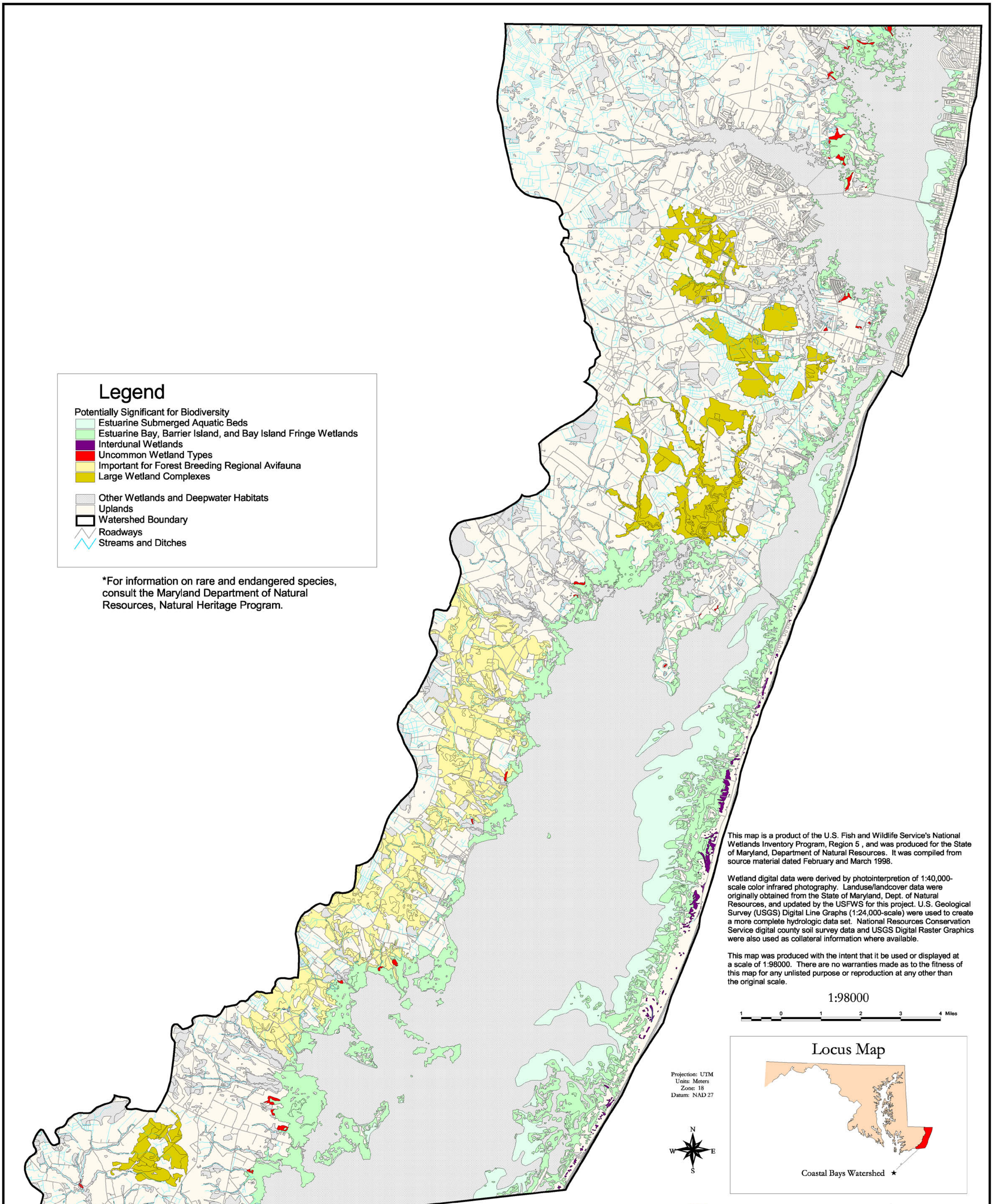
Also in reviewing the color-coded watershed map of NWI wetland types, 5 to 6 large wetland complexes (5911.0 acres of wetlands) appeared worth noting due to their possible importance to species conservation.

In total, about two-thirds of the wetlands in the watershed were rated as important for biodiversity. The reason this total is very high is mainly due to the inclusion of most of the watershed's estuarine wetlands in the assessment. Remember that this assessment was based on remote sensing techniques and that known sites important to maintaining biodiversity such as those on record with the Maryland Natural Heritage Program or reported in other sources may not be included since those records were not consulted. Consequently, the listing represents a starting point, not an end point for an assessment of wetlands important for conservation of species. These sources should be reviewed as the next step in future planning and evaluation efforts for the watershed. Consult the state's MERLIN database for information on "wetlands of special state concern."

[4]These wetlands should be field checked to verify that they are not ditched or impounded and evaluated as to their significance for biodiversity.

Wetlands of Significance for Biodiversity*
Coastal Bays Watershed, Maryland

Map 14CB



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Potential Wetland Restoration Sites

Due to the history of human activities in this watershed, there is a wealth of opportunities for wetland restoration. Former wetlands (Type 1 wetland restoration sites) and existing wetlands whose functions may be impaired by ditching, impoundment, excavation, and restricted tidal flows (Type 2 restoration sites) represent these opportunities. A total of 25,365 acres were identified in the Coastal Bays watershed as having potential for wetland restoration.

Of the Type 1 sites, farmed wetlands predominated by number (89% of the sites) while representing about 33 percent of the acreage. Tidally restricted areas (former vegetated wetlands that are now open water) had a slightly higher acreage total (119 acres vs. 108 acres for farmed wetlands). Five sites made up this acreage. Twenty-two filled areas were identified as potential Type 1 restoration sites and two impounded areas were believed to constructed in sites that were formerly vegetated wetlands. Restoration of Type 1 sites would produce a net gain in wetland acreage.

Type 1 Sites	No. of Sites	Acreage
Effectively drained former wetlands (now mostly farmed wetlands)	247	108.4
Filled former wetlands	22	62.6
Impounded former vegetated wetlands	2	42.3
Tidally restricted former vegetated wetlands (now open water)	5	118.9
Total	276	332.2

The Type 1 totals could have been larger, but their identification was conservative -- based on recognizable photo-signatures. If all former hydric soil areas were included as Type 1 sites, the total for this category would have been enormous, since about 40 percent of the hydric soil map units are not classified as wetlands. They were not designated because they have undergone major land-leveling and appeared to be productive cropland, virtually indistinguishable from other cropland (i.e., on nonhydric soils) on the aerial photographs. Moreover, it may be difficult to convince landowners to support wetland restoration for such areas. When considering wetland restoration of identified Type 1 sites, however, it should be possible to pursue restoration of much larger wetlands than the Type 1 data would suggest, since the Type 1 sites are usually surrounded by effectively drained hydric soils.

Nearly all the designated wetland restoration acreage in the watershed was comprised of Type 2 sites (mostly wetlands with altered hydrology). In total, they represent nearly 70 percent of the watershed's wetlands. Drained wetlands dominated the Type 2 restoration sites, with nearly equal amounts of palustrine and estuarine wetland acreage affected. Site-specific studies are required to evaluate the scope and effect of the ditching and to determine whether wetland restoration should be considered. Many of these wetlands may have minimal effects, while many others may be seriously impacted by the drainage ditches. Partly drained nontidal wetlands with drier water regimes (e.g., temporarily flooded or seasonally flooded [PFO1Ad and PFO1Cd, for example]) contiguous to wetter wetlands (e.g., seasonally flooded/saturated - PFO1E) may indicate more significant drainage impacts. Type 2 restoration sites also included

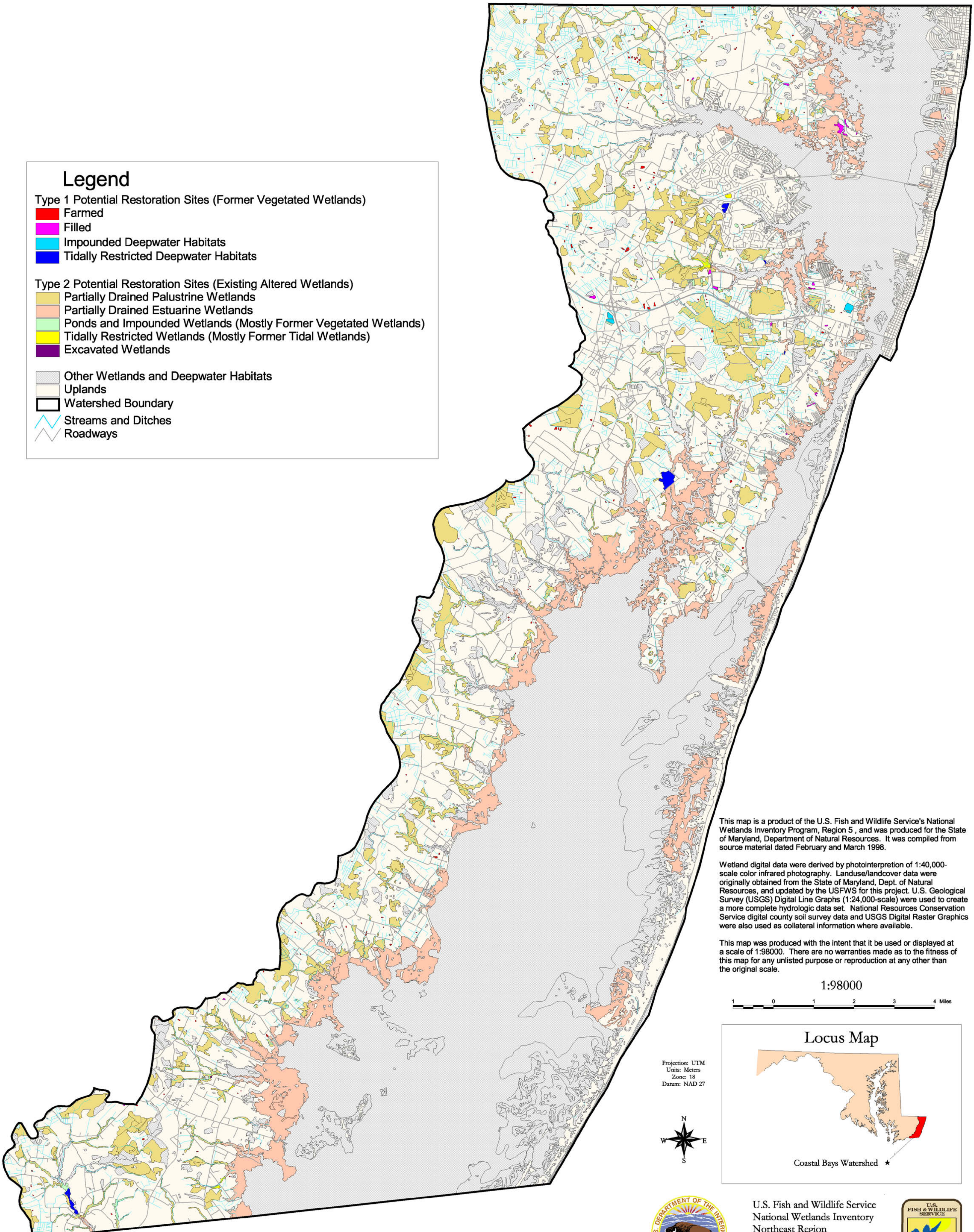
63 acres of tidally restricted sites. These sites are mostly ponds that appeared to be former tidal wetlands. Restoration of Type 2 sites would produce net gains in one or more wetland functions.

Type 2 Sites	Acreage
Tidally restricted Wetlands	62.9
Impounded Wetlands and Ponds (formerly vegetated wetlands)	170.6
Ditched Palustrine Wetlands*	12,351.4
Ditched Estuarine Wetlands*	12,446.5
Excavated Wetlands	1.0
Total	25,032.4

*The effect of drainage on wetlands must be evaluated in the field on a case-by-case basis.

Potential Wetland Restoration Sites
Coastal Bays Watershed, Maryland

Map 15CB



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1:98000

1 0 1 2 3 4 Miles

Projection: UTM
Units: Meters
Zone: 18
Datum: NAD 27

N W E S

Locus Map

Coastal Bays Watershed

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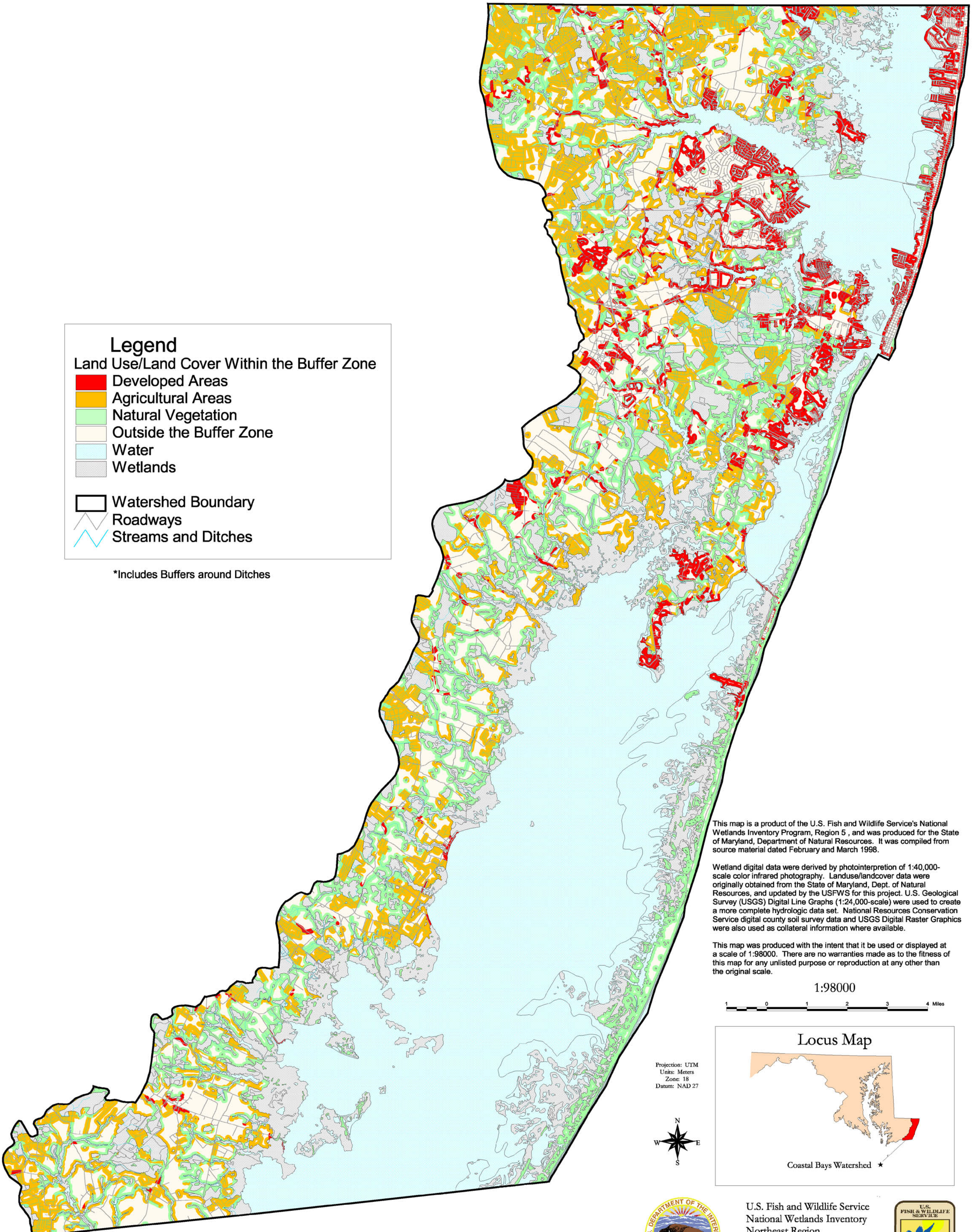
Wetland and Waterbody Buffer Analysis

The condition of a 100m upland buffer zone around wetlands and waterbodies (including ditches) was evaluated. The upland buffer zone for the Coastal Bays watershed amounted to 55,421 acres. Approximately 41 percent of this buffer (22,759 acres) still had natural vegetation in tact, while 42 percent was in agricultural usage and 17 percent developed. Map #16CB shows the condition of this buffer for the watershed.

Condition of Wetland and Waterbody Buffers* (100m)
Coastal Bays Watershed, Maryland

Map 16CB



Legend

Land Use/Land Cover Within the Buffer Zone

- Developed Areas
- Agricultural Areas
- Natural Vegetation
- Outside the Buffer Zone
- Water
- Wetlands

- Watershed Boundary
- Roadways
- Streams and Ditches

*Includes Buffers around Ditches

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1:98000

1 0 1 2 3 4 Miles

Projection: UTM
Units: Meters
Zone: 18
Datum: NAD 27

N W E S

Locus Map

Coastal Bays Watershed

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Natural Habitat Integrity Indices

The values for the nine indices for the Coastal Bays watershed are calculated and presented below.

Natural Cover Index = 64,074 acres of natural vegetation/116,560 acres of land in watershed = **0.55**

Stream Corridor Integrity Index (100m buffer = 200m corridor)* = 5183 acres of natural vegetation in upland buffer/9526 acres of upland buffer = **0.54**

*Excludes open water areas from assessment; also the index value for the 100m corridor is 0.59, so the narrower buffer zone is in slightly better condition than the 200m corridor

Wetland and Other Waterbody Buffer Index (100m)* = 20,021 acres of natural vegetation in upland buffer/37,489 acres of upland buffer = **0.53**

*Excludes stream buffers which are covered under Stream Corridor Integrity Index

Wetland Extent Index = 36,435 acres of wetlands/62,156 acres of hydric soil map units = **0.59**

Standing Waterbody Extent Index = **1.0** due to impoundment and pond construction

Dammed Stream Flowage Index = 1.6 miles dammed/169.7 miles of perennial nontidal rivers and streams = **0.01**

Channelized Stream Length Index = 165.2 miles of channelized streams/169.7 miles of perennial nontidal rivers and streams = **0.97**

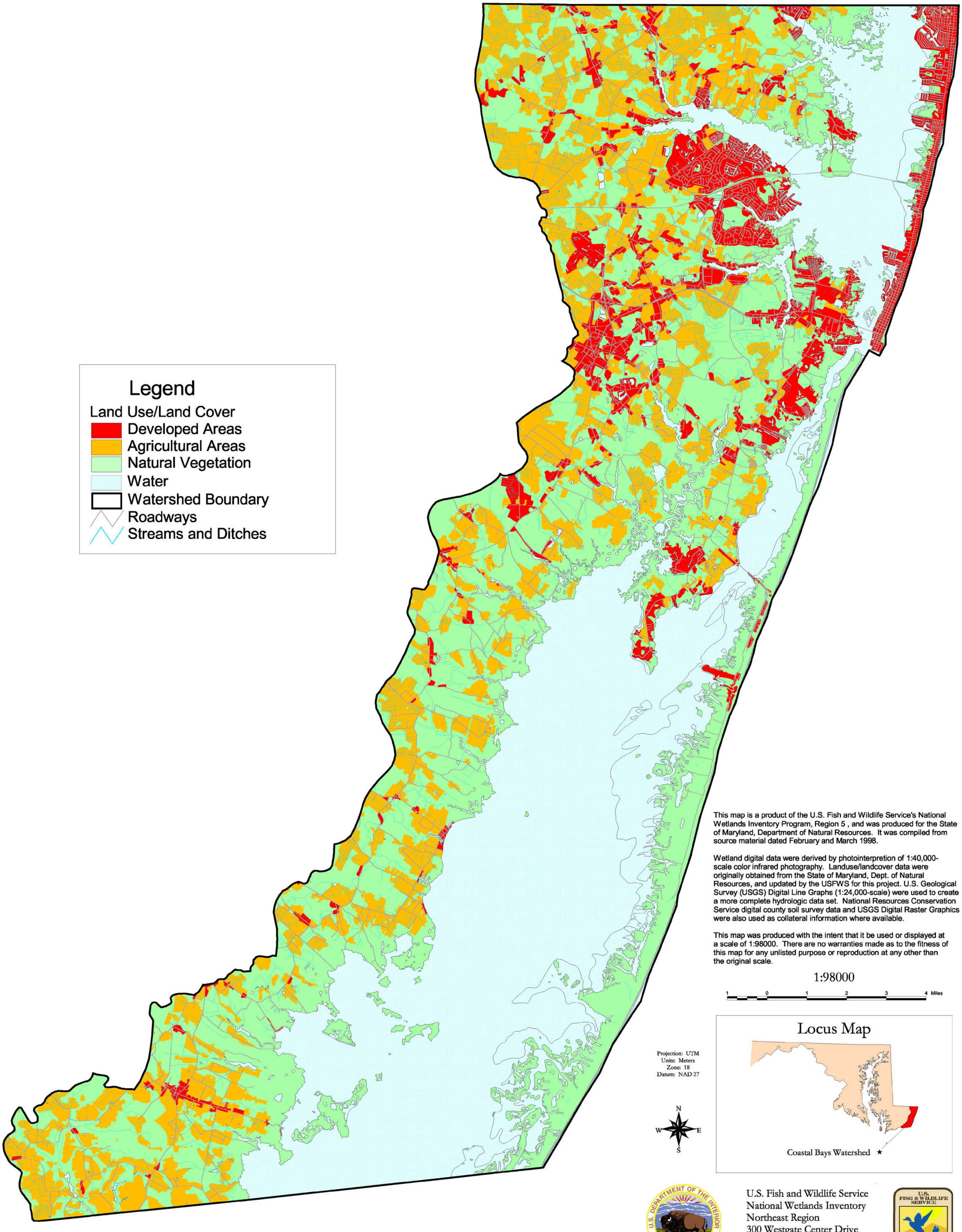
Wetland Disturbance Index = 25,442.9 acres of altered wetlands/36,435 acres of wetlands = **0.70**

Index of Remotely-sensed Natural Habitat Integrity = $I_{RNHI\ 100}$ = (0.6 x I_{NC}) + (0.1 x I_{SCI100}) + (0.1 x I_{WWB100}) + (0.1 x I_{WE}), + (0.1 x I_{SWE}) - (0.1 x I_{DSF}) - (0.1 x I_{CSL}) - (0.1 x I_{WD}) = (0.6 x 0.55) + (0.1 x 0.54) + (0.1 x 0.53) + (0.1 x 0.59) + (0.1 x 1.0) - (0.1 x 0.01) - (0.1 x 0.97) - (0.1 x 0.70) = **0.42**

The above indices provide evidence of a severely stressed system. A pristine watershed has an index value of 1.0 for natural habitat integrity. The Coastal Bays watershed's natural habitat integrity value was 0.42, indicating much human disturbance. Nearly half of its natural habitats are gone, possibly as much as 40 percent of its wetlands have been converted to other uses, and about half of its wetland and waterbody buffers are now developed (e.g., cropland, residential development, or other land uses). Virtually all of its streams have been channelized. Also while 60 percent of its pre-settlement wetlands may still exist, about 70 percent of them are altered in some way (e.g., ditched, impounded, or excavated). About 32 percent of the watershed is being used for agriculture and another 13 percent is developed. Application of the natural habitat integrity indices to individual subbasins within the Coastal Bays watershed may aid in setting priorities for protection and restoration.

Extent of Natural Habitat
Coastal Bays Watershed, Maryland

Map 17CB



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1:98000

1 0 1 2 3 4 Miles

Locus Map

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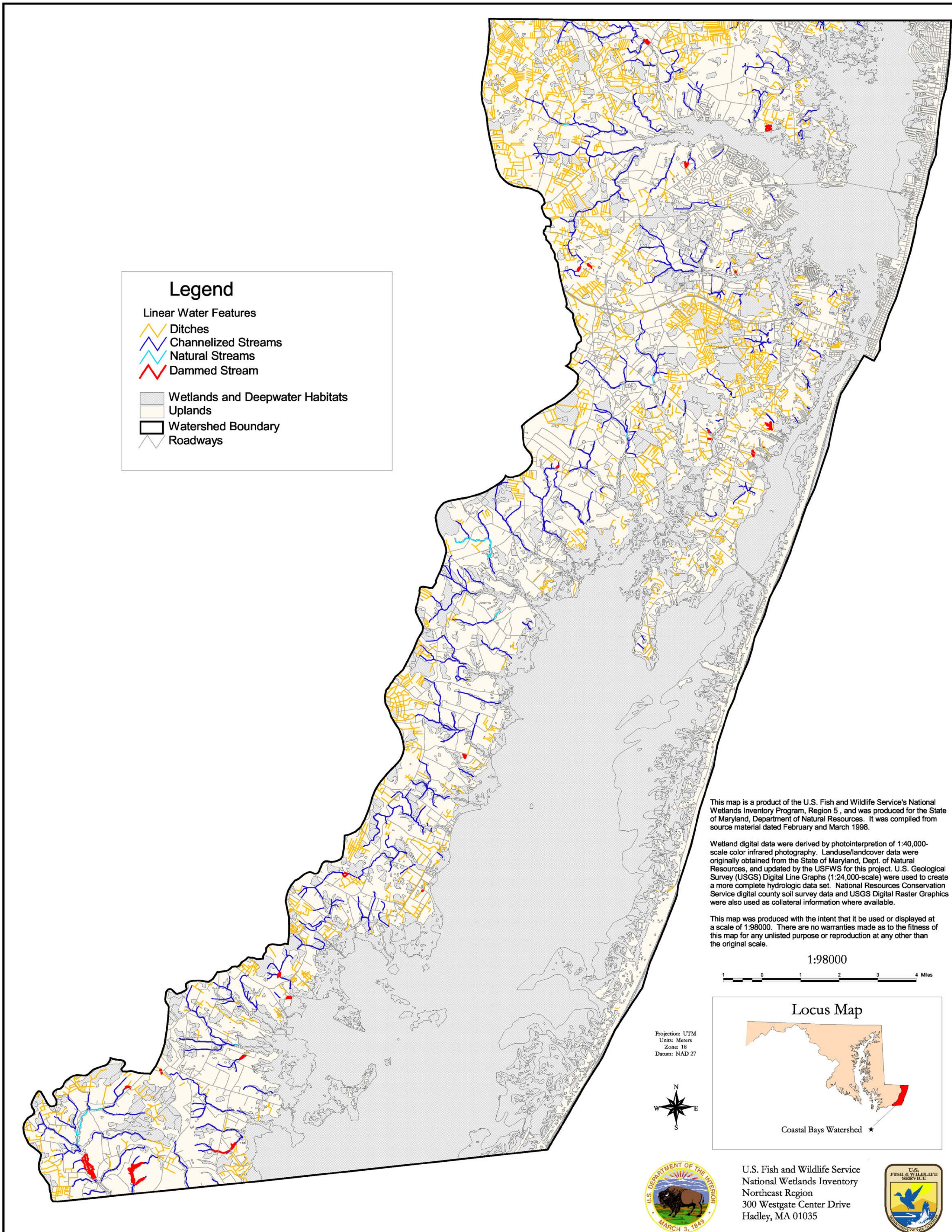
Extent of Ditching

Approximately 448.7 miles of ditches were inventoried by this project. This total accounts for 2.4 miles of ditches per square mile of land area. Map #18CB shows the extent of ditching in the Coastal Bays watershed along with information on the condition of streams (channelized; dammed; or unaltered).

Extent of Ditches and Condition of Streams
Coastal Bays Watershed, Maryland

Map 18CB



Comments on Fragmentation

One outstanding issue involved fragmentation of wetlands. Although not a prime objective of the current study, we attempted to identify wetlands that were subjected to significant fragmentation. In both watersheds, many small wetlands were actually the remaining fragments (remnants) of once large wetlands. For this report, we attempted to apply the fragmentation descriptor ("fg") to wetlands that were divided into two or more units by roads, railroads, or other structures which likely disrupted the hydrology and created an increased risk for wildlife crossing. Fragmentation in this context, therefore, did not address the issue from the broad landscape perspective which is more encompassing and requires documentation of changes in large tracts of forests as a result of increasing human-use (e.g., conversion to agricultural lands or to other types of human development such as residential housing or urbanization).

During the study, the question arose as to what level of separation constitutes significant fragmentation of wetlands to warrant "flagging"? While a 4-lane highway (interstate) should clearly represent sufficient fragmentation, does a 2-lane paved road produce similar consequences? How about unpaved roads? Perhaps the fragmentation descriptor should be restricted to wetlands that are chopped up into multiple pieces by developments and associated roadways and only note the presence of a "fragmentation feature" (e.g., I-95) for larger wetlands crossed by major highways. The application of the "fg" descriptor was not as consistent as we would have liked as this was only our second attempt using it. Consequently, we have not reported any results on the extent of fragmented wetlands in the watershed, yet these data are in the digital database for possible future use.

Another question arose in applying the fragmentation descriptor to wetland polygons - should this descriptor be applied to: 1) the entire wetland (main wetland body and the fragmented section), or 2) only to the fragmented piece(s)? Many large wetlands only had a small portion that was fragmented and we don't want to exaggerate the effect of fragmentation.

Conclusions

The findings of this report should be considered preliminary. Field checking should be conducted to validate the interpretations. The report should, however, serve as a guide to wetlands in each watershed and to their functions. It is a starting point for resource planning rather than an end point. The characterization serves as one tool to aid in wetland conservation and watershed management. It should be used with other tools based on field observations and site-specific data.

Acknowledgments

This study was funded by the Maryland Department of Natural Resources through a grant from the National Oceanic and Atmospheric Administration (Coastal Zone Management Award No. NA87OZ0236). Bill Jenkins was the project coordinator, serving as the liasion between the State and the principal investigator (R. Tiner).

Photointerpretation for this project was performed by John Swords and Matt Starr. John did the wetland interpretation including potential restoration sites, while Matt interpreted the land use and cover. Wetland classification following Tiner (2000) was performed by Matt Starr and Herb Bergquist, with Matt focusing on the Coastal Bays watershed and Herb on the Nanticoke. They also performed geographic information processing for these watersheds. Ralph Tiner reviewed their work and developed the correlations between wetland characteristics and wetland functions used to produce the preliminary assessment of wetland functions for each watershed. He also analyzed the data and prepared the project report.

We also thank Bill Jenkins and his staff and co-workers for providing information for use in this study, especially Ken Miller, David Bleil, Tirumal Jallepalli, Glenn Therress, and Paul Kazyak. Others contributing to this study included: Gabe DeAlessio (U.S. Fish and Wildlife Service, Hadley, MA), Greg Breese (USFWS, Delaware Bay Estuary Program, Smyrna, DE), Bob Zepp (USFWS, Chesapeake Bay Field Office, Annapolis, MD), Becky Stanley (USFWS, National Wetlands Inventory Center, St. Petersburg, FL), and Michael Whited (USDA Natural Resources Conservation Service, Hadley, MA).

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APPENDICES

Appendix A. General Description of Maryland's Coastal Plain Wetlands. (Source: Tiner and Burke 1995)

Vegetation and Plant Communities of Maryland's Wetlands

Introduction

Most of Maryland's wetlands are colonized by plants adapted to existing hydrologic, water chemistry, and soil conditions, while certain wetland types (e.g., tidal mud flats) or parts of wetlands (e.g., salt flats of estuarine marshes) are devoid of macrophytic plants. Most wetland definitions have traditionally relied heavily, oftentimes solely, on characteristic vegetation for identification and classification purposes. The presence of "*hydrophytes*" or "*hydrophytic vegetation*" is one of the three key attributes of the Service's wetland definition (Cowardin *et al.* 1979) and for identifying a Federal jurisdictional wetland (Environmental Laboratory 1987; Federal Interagency Committee for Wetland Delineation 1989). Vegetation is usually the most conspicuous feature of wetlands and one that may be often readily identified in the field. In this chapter, after briefly discussing the concept of "hydrophyte," major plant communities of Maryland's wetlands will be described.

Hydrophyte Definition and Concept

Wetland plants are technically referred to as "*hydrophytes*" or "*hydrophytic vegetation.*" The Service defines a "*hydrophyte*" as "any plant growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content" (Cowardin *et al.* 1979). Thus, hydrophytes are not restricted to true aquatic plants growing in water (e.g., ponds, lakes, rivers, and estuaries), but also include plants morphologically and/or physiologically adapted to periodic flooding or prolonged saturated soil conditions typical of marshes, swamps, bogs, and many bottomland forests. The concept of hydrophyte applies to individual plants and not simply to species of plants, although certain genera and species may be represented entirely by hydrophytes, such as arrowheads (*Sagittaria* spp.), pondweeds (*Potamogeton* spp.), smooth cordgrass (*Spartina alterniflora*), and broad-leaved cattail (*Typha latifolia*) (Tiner 1991). Certain individuals of species common on uplands, such as American holly (*Ilex opaca*), white oak (*Quercus alba*), pitch pine (*Pinus rigida*), and tulip poplar (*Liriodendron tulipifera*), are considered hydrophytes when they grow in hydric soils having a seasonal high water table near the surface or subject to frequent inundation. Wetland ecotypes of many plant species undoubtedly exist and these ecotypes are typically adapted for a wetland existence (Tiner 1991). All plants growing in wetlands have adapted in one way or another for life in periodically flooded or saturated, anaerobic soils. Consequently, these individuals are considered hydrophytes.

The Service, with support from other Federal agencies, has prepared a comprehensive list of plant species found in the Nation's wetlands to help clarify its wetland definition (Reed 1988). A list of plant species that occur in Maryland's wetlands has been extracted from the national list and is presented in the Appendices. This list contains 1,644 species of plants that may occur in Maryland's wetlands, including 80 species of aquatics, 65 species of ferns and fern allies, 170 species of grasses, 202 species of sedges, 33 species of rushes, 809 species of forbs (other herbaceous plants), 115 species of shrubs, 121 species of trees, and 49 species of vines. In the near future, a supplement to the 1988 regional list will be issued. This list will update the indicator status for certain species based on new information. In addition, the Northeast region will be separated into a few subregions (e.g., Coastal Plain) where some key plant species have different affinities for wetlands than they do in the rest of the region. The Service recognizes four types of indicator plants that occur in wetlands: (1) obligate wetland (OBL), (2) facultative wetland (FACW), (3) facultative (FAC), and (4) facultative upland (FACU). Obligate hydrophytes are those plants which nearly always (more than 99 percent of the time) occur in wetlands under natural conditions. The facultative types can be found in both wetlands and uplands to varying degrees. Facultative wetland (FACW) plants usually occur in wetlands (from 67 to 99 percent of the time), while purely facultative plants (FAC) show no affinity to wetlands or uplands (equally likely to occur in both habitats) and are found in wetlands with a frequency of occurrence between 34-66 percent. By contrast, facultative upland (FACU) species usually occur in uplands, but are present in wetlands between 1-33 percent of the time. When present, they are often in drier wetlands including wetlands with sandier soils where they may dominate, or at higher elevations (e.g., hummocks) in wetter areas. Table 6-1 shows the number of plant species in each wetland indicator status category. OBL species represent 29 percent of the

Maryland wetland plant list, FACW species 23 percent, FAC species 19 percent, and FACU species 26 percent. Examples of these four major types of wetland plants for Maryland are presented in Table 6-2. Field guides for identifying Maryland's wetland plants are available (Tiner 1987, 1988b, 1993).

Wetland Plant Communities

Many factors influence wetland vegetation and community structure, including climate, hydrology, water chemistry, soils, and human activities. Penfound (1952) identified five site-specific physical factors as most important: (1) location of the water table, (2) fluctuation of water levels, (3) soil type, (4) acidity, and (5) salinity. He also recognized the role of biotic factors, i.e., plant competition, animal actions (e.g., herbivory or grazing), and human activities. Man probably exhibits the greatest impact on current vegetation patterns in both wetlands and nonwetlands in Maryland, while rising sea level is very important along the coast, especially on the Eastern Shore from Dorchester County south. Many construction projects alter the hydrology of wetlands through channelization, drainage, and groundwater withdrawals or by changing surface water runoff patterns, especially in urban areas, or by impounding water. These activities often have a profound effect on plant composition. In coastal marshes, mosquito ditching has increased the abundance of high-tide bush (*Iva frutescens*), and groundsel-bush (*Baccharis halimifolia*) especially on spoil mounds adjacent to ditches. Restriction of tidal flow often leads to replacement of typical salt marsh species by common reed (*Phragmites australis*). Repeated timber cutting, mowing, heavy grazing, and severe fires also have profound effects on wetland communities. Controlled burning is a common wildlife management technique for brackish marshes. Its use is particularly widespread on the lower Eastern Shore.

Maryland's wetlands fall within five ecological systems inventoried by the NWI: Marine, Estuarine, Riverine, Lacustrine and Palustrine. In coastal areas, the estuarine marshes (including salt and brackish marshes and tidal mud flats) are most abundant along Chesapeake, Chincoteague, and Assawoman Bays, with marine wetlands limited to intertidal beaches along the Atlantic Ocean from Ocean City south. Palustrine wetlands encompass the overwhelming majority of freshwater marshes, swamps, and ponds. Wetlands within the riverine and lacustrine systems are largely restricted to nonpersistent emergent wetlands, aquatic beds, and nonvegetated flats. Overall, palustrine wetlands predominate by a somewhat small margin, representing about 57 percent of the state's wetlands, whereas estuarine wetlands represent 42 percent. The high percentage of the latter wetlands reflects the significance of Chesapeake Bay with its tidal tributaries to Maryland.

The following sections address major wetland types in each ecological system. Descriptions are primarily based on NWI field observations and a review of scientific literature. While this chapter is not an exhaustive treatment of all the potential wetland plant communities that exist in Maryland, the chapter is fairly comprehensive in discussing plant composition of the major wetland types found throughout the state by giving many specific examples of wetland plant communities observed during the survey and by others. *(Note: Tables 6-5 through 6-35 summarize wetland community data; they are presented at the end of the chapter due to the number and length of these tables.)*

Marine Wetlands

The Marine System is represented by the open ocean overlying the continental shelf and the associated high-energy coastline. Deepwater habitats predominate this system, with wetlands generally limited to sandy intertidal beaches along the Atlantic Ocean. Most of Maryland's marine intertidal beaches are located on Assateague Island. Vegetation is sparse and scattered along the upper zones of beaches. Vascular plants, such as sea rocket (*Cakile edentula*), seaside broomspurge (*Euphorbia polygonifolia*), saltwort (*Salsola kali*),

Table 6-1. Number of Maryland plant species in each wetland indicator status according to the 1988 wetland plant list. (Reed 1988) The asterisk (*) denotes tentative assignments.

Indicator Status	Number of Species
OBL	482
OBL*	1
FACW+	107
FACW	231
FACW*	1
FACW-	34
FAC+	41
FAC	271
FAC*	1
FAC-	46
FACU+	20
FACU	277
FACU*	8
FACU-	125
	1,644

Table 6-2. Examples of Maryland plants in each wetland indicator status category.

Hydrophyte Type	Plant Common Name	Scientific Name
Obligate	Royal Fern	*Osmunda regalis*
	White Water Lily	*Nymphaea odorata*
	Smooth Cordgrass	*Spartina alterniflora*
	Black Needlerush	*Juncus roemerianus*
	Bluejoint	*Calamagrostis canadensis*
	Sweet Flag	*Acorus calamus*
	Lizard's Tail	*Saururus cernuus*
	Three-way Sedge	*Dulichium arundinaceum*
	Broad-leaved Cattail	*Typha latifolia*
	Water Willow	*Decodon verticillatus*
	Swamp Rose	*Rosa palustris*
	Southern Wild Raisin	*Viburnum nudum*
	Virginia Sweet-spires	*Itea virginica*
	Buttonbush	*Cephalanthus occidentalis*
	Bald Cypress	*Taxodium distichum*
	Atlantic White Cedar	*Chamaecyparis thyoides*
Facultative Wetland	Cinnamon Fern	*Osmunda cinnamomea*
	Salt Hay Grass	*Spartina patens*
	Common Reed	*Phragmites australis*
	False Nettle	*Boehmeria cylindrica*
	Boneset	*Eupatorium perfoliatum*
	Reed Canary Grass	*Phalaris arundinaceum*
	High-tide Bush	*Iva frutescens*
	Speckled Alder	*Alnus rugosa*
	Highbush Blueberry	*Vaccinium corymbosum*
	Common Elderberry	*Sambucus canadensis*
	Steeplebush	*Spiraea tomentosa*
	Sweet Bay	*Magnolia virginiana*
	Drummond Red Maple	*Acer rubrum ssp. drummondii*
	Green Ash	*Fraxinus pennsylvanica*
	Cherrybark Oak	*Quercus falcata var. pagodifolia*
	American Elm	*Ulmus americana*
	Rosebay Rhododendron	*Rhododendron maximum*
Facultative	Foxtail Grass	*Setaria geniculata*
	Rough-stemmed Goldenrod	*Solidago rugosa*
	Purple Joe-Pye-weed	*Eupatoriadelphus purpureus*
	Jumpseed	*Polygonum virginianum*
	Poison Ivy	*Toxicodendron radicans*
	Sweet Pepperbush	*Clethra alnifolia*
	Southern Arrowwood	*Viburnum dentatum*
	Japanese Honeysuckle	*Lonicera japonica*
	Red Maple	*Acer rubrum*
	Sweet Gum	*Liquidambar styraciflua*
	Loblolly Pine	*Pinus taeda*
	Ironwood	*Carpinus caroliniana*
Facultative Upland	Ground-pine	*Lycopodium obscurum*
	Partridgeberry	*Mitchella repens*
	Flowering Dogwood	*Cornus florida*
	Black Huckleberry	*Gaylussacia baccata*
	Multiflora Rose	*Rosa multiflora*
	Black Haw	*Viburnum prunifolium*
	American Holly	*Ilex opaca*
	White Oak	*Quercus alba*
	Tulip Poplar	*Liriodendron tulipifera*
	Red Spruce	*Picea rubens*
	Hemlock	*Tsuga canadensis*

beach grass (*Ammophila breviligulata*), seabeach orach (*Atriplex arenaria*), sea purslane (*Sesuvium maritimum*), and beach bean (*Strophostyles helvola*) may occur in these areas (Silberhorn 1982; Higgins *et al.* 1971). The first three species are also typical of estuarine beaches along Chesapeake Bay (Chrysler 1910).

Estuarine Wetlands

The Estuarine System consists of salt and brackish tidal waters and contiguous wetlands where ocean water is at least occasionally diluted by freshwater runoff from the land. It extends upstream in tidal rivers to freshwater where no measurable ocean-derived salts (less than 0.5 parts per thousand) can be detected during average annual low flows (Cowardin *et al.* 1979).

From a salinity standpoint, Maryland estuaries can be divided into three distinct reaches: (1) polyhaline—strongly saline areas (18-30 parts per thousand salinity), (2) mesohaline (5-18 ppt), and (3) oligohaline—slightly brackish areas (0.5-5 ppt). Chincoteague, Sinepuxent, and Assawoman Bays are examples of polyhaline estuaries. Chesapeake Bay and its tidal tributaries become increasingly fresher upstream from their mouths as saltwater is more diluted by freshwater runoff. These areas range from polyhaline to oligohaline waters and eventually to freshwater. The Maryland portion of Chesapeake Bay falls within the mesohaline, oligohaline, and freshwater zones (Figure 6-1).

Vegetation patterns are greatly affected by salinity levels and by differences in the duration and frequency of tidal flooding. Major estuarine wetland types in Maryland include: (1) intertidal flats, (2) emergent wetlands, (3) scrub-shrub wetlands, (4) forested wetlands, and (5) aquatic beds.

Estuarine Intertidal Flats

Intertidal flats of mud and/or sand (technically called unconsolidated shores) are a common feature in estuaries, particularly between salt marshes and coastal waters. Estuarine tidal flats are typically flooded by tides and exposed to air twice daily or are exposed less often by low "spring" tides. These flats are typically devoid of macrophytes. While tidal flats are characteristically nonvegetated by vascular plants, some plants do colonize these sites, although their occurrence is usually rare. Smooth cordgrass (*Spartina alterniflora*) may occur in isolated clumps on mud flats in polyhaline and mesohaline waters. Sea lettuce (*Ulva lactuca*) and other macroscopic algae may be present in considerable amounts. Microscopic plants, especially diatoms, euglenoids, dinoflagellates and blue green algae, are often extremely abundant, yet inconspicuous (Whitlatch 1982). On occasion, sea grass beds of widgeongrass (*Ruppia maritima*), Eurasian

Table 6-3. Some tidal marsh species listed in approximate descending order (left column, then right) of their salt tolerance, based on observations by Chrysler (1910) for the Western Shore and the senior author's experiences in the Northeast.

Common Name	Scientific Name	Common Name	Scientific Name
Common Glasswort	*Salicornia europaea*	Switchgrass	*Panicum virgatum*
Sea Lavender	*Limonium carolinanum*	Mock Bishop-weed	*Ptilimnium capillaceum*
Smooth Cordgrass	*Spartina alterniflora*	Lance-leaf Frog-fruit	*Phyla lanceolata*
Salt Hay Grass	*Spartina patens*	Water Pepper	*Polygonum hydropiper*
Salt Grass	*Distichlis spicata*	Walter Millet	*Echinochloa walteri*
Salt Marsh Aster	*Aster tenuifolius*	Seashore Mallow	*Kosteletzkya virginica*
Marsh Orach	*Atriplex patula*	Rose Mallow	*Hibiscus moscheutos*
High-tide Bush	*Iva frutescens*	Narrow-leaved Cattail	*Typha angustifolia*
Seaside Goldenrod	*Solidago sempervirens*	Wax Myrtle	*Myrica cerifera*
Salt Marsh Bulrush	*Scirpus robustus*	Pickerelweed	*Pontederia cordata*
Salt Marsh Fleabane	*Pluchea purpurascens*	Swamp Milkweed	*Asclepias incarnata*
Salt Marsh Pink	*Sabatia stellaris*	Wild Rice	*Zizania aquatica*
Black Needlerush	*Juncus roemerianus*	Cardinal Flower	*Lobelia cardinalis*
Olney Three-square	*Scirpus americanus*	Mistflower	*Conoclinium coelestinum*
Salt Marsh Loosestrife	*Lythrum lineare*	Smooth Alder	*Alnus serrulata*
Big Cordgrass	*Spartina cynosuroides*	Swamp Rose	*Rosa palustris*
Groundsel-bush	*Baccharis halimifolia*	Big-leaved Arrowhead	*Sagittaria latifolia*
Water Hemp	*Amaranthus cannabinus*	Lizard's Tail	*Saururus cernuus*
Purple Gerardia	*Agalinis purpurea*	Beck's Water-marigold	*Megalodonta beckii*

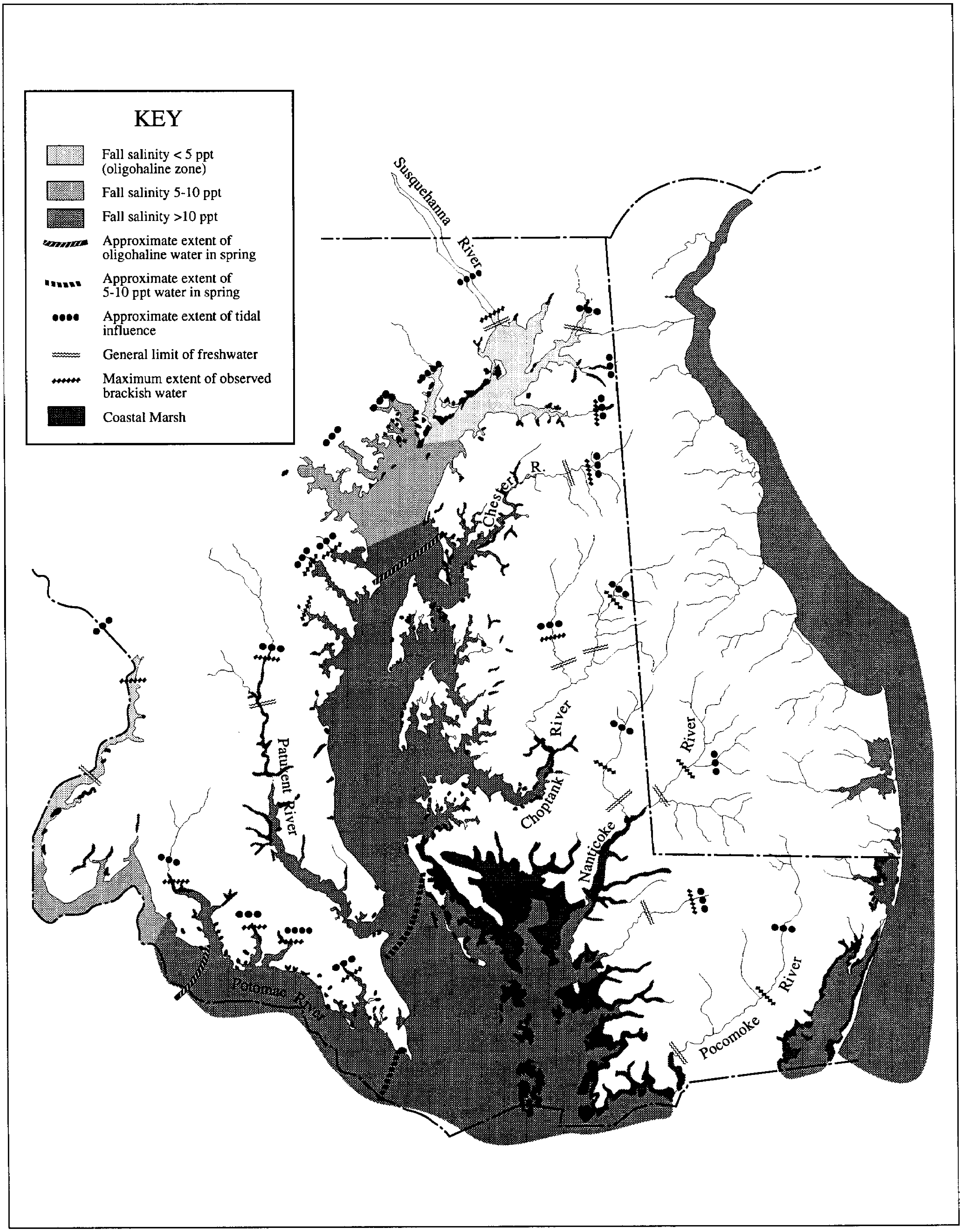

Figure 6-1. General distribution of Maryland's estuarine and tidal fresh marshes and spring and fall salinity zones in Chesapeake Bay and its major tributaries. (Compiled from Tiner 1987, Webb and Heidel 1970, and White 1990)

water milfoil (*Myriophyllum spicatum*), and eelgrass (*Zostera marina*) may be exposed during extreme low tides. Tidal flats and shores in slightly brackish areas may be colonized by pygmy-weed (*Crassula aquatica*, formerly *Tillaea aquatica*), kidney-leaf mud plantain (*Heteranthera reniformis*), American waterwort (*Elatine americana*), water purslane (*Ludwigia palustris*), mudwort (*Limosella subulata*), and mudflower (*Hemianthus micranthemum*, formerly *Micranthemem micranthemoides*) (Thompson 1974). Many of these species are regarded as rare plants and some are now believed to be extirpated from Maryland. Pygmy-weed, American waterwort, water purslane, mudwort, and mudflower also occur in tidal freshwater areas, where they may be more characteristic. Shreve (1910) found least spike-rush (*Eleocharis acicularis*) and eastern lilaeopsis (*Lilaeopsis chinensis*) common on tidal fresh mudflats, with other species much less common: awl-leaf arrowhead (*Sagittaria subulata*), grass-leaved arrowhead (*S. graminea*) and quillwort (*Isoetes saccharata*).

Estuarine Emergent Wetlands

Differences in salinity and tidal flooding within estuaries have a profound and visible effect on the distribution of emergent vegetation. Plant composition changes markedly from the more saline regions to the brackish areas further inland. Table 6-3 lists some major plant species of tidal marshes in order of their tolerance to salt water. Even within areas of similar salinity, vegetation differs largely due to the frequency and duration of tidal flooding and, locally, due to freshwater runoff or groundwater seepage. Table 6-4 outlines different types of estuarine wetlands. Much of the following discussion is based on observations during NWI field trips plus the work of McCormick and Somes (1982) which presented existing information on Maryland's coastal wetlands, and of Thompson (1974). Sipple (1982) also summarized information on coastal wetlands, with emphasis on the Eastern Shore. The Botany Department of the University of Maryland compiled a list of plant species found within estuarine wetlands of Chesapeake Bay and its tributaries (Krauss *et al.* 1971). Tables 6-5 and 6-6 present examples of estuarine wetland communities observed during the survey. Plates 7, 8 and 9 illustrate typical estuarine wetlands in Maryland. Figure 6-2 shows the general location of salt, brackish and other tidal wetlands within the coastal zone.

Salt Marshes

Salt marshes are the most seaward of Maryland's estuarine emergent wetlands. They have formed on the intertidal shores of tidal waters in areas of high salinity (polyhaline). They occur along Chincoteague, Assawoman, and Sinepuxent Bays in Worcester County (Figure 6-3). Adjacent to the mainland, salt marshes may gradually grade into tidal fresh marshes and then into palustrine forested wetlands or may simply end abruptly beside the upland.

Table 6-4. General estuarine wetland types of Maryland with major species listed.

Wetland Type	Predominant Species*
Low Salt Marsh	Smooth Cordgrass-tall form
High Salt Marsh	Salt Hay Grass, Salt Grass, and Smooth Cordgrass-short form
High Salt Marsh Panne	Glassworts
High Salt Marsh Border	Black Needlerush, Switchgrass, and Salt Marsh Fimbristylis
Salt Shrub Swamp	High-tide Bush and Groundsel-bush with Salt Hay Grass
Low Brackish Marsh	Smooth Cordgrass-tall form and Water Hemp
High Brackish Marsh	Salt Hay Grass, Salt Grass, Black Needlerush, Smooth Cordgrass-short form, Olney Three-square, Switchgrass, Common Three-square, Narrow-leaved Cattail, Rose Mallow, Big Cordgrass, Salt Marsh Bulrush, Common Reed, and Seaside Goldenrod
Brackish Shrub Swamp	High-tide Bush and Groundsel-bush, with Salt Hay Grass and Rose Mallow
Brackish Evergreen Forested Wetland	Loblolly Pine
Low Oligohaline Marsh	Arrow Arum, Pickerelweed, Spatterdock, Wild Rice, Soft-stemmed Bulrush, Narrow-leaved Cattail, Water Hemp, and Common Three-square
High Oligohaline Marsh	Big Cordgrass, Common Reed, Narrow-leaved Cattail, Wild Rice, Broad-leaved Cattail, and Sweet Flag

*Pure or mixed stands of these species may occur.

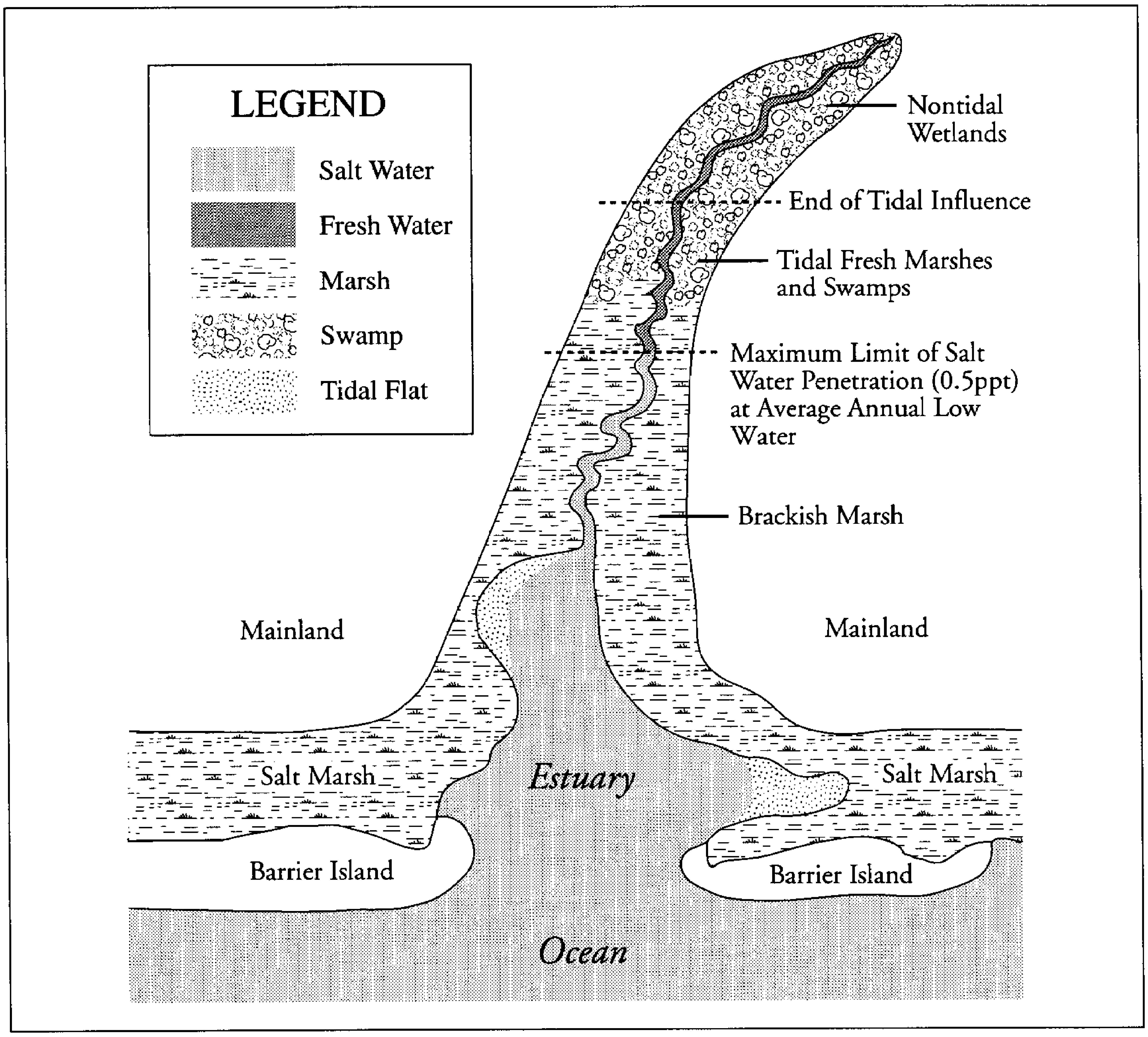

Figure 6-2. General location of different types of tidal wetlands in the estuary. (Redrawn from Tiner 1993)

Differences in tidal flooding regimes have created two general vegetative zones within salt marshes: (1) regularly flooded low marsh and (2) irregularly flooded high marsh. The vegetation within each zone is different due largely to flooding frequency and duration. The low marsh is flooded usually twice a day by the tides, while the high marsh is flooded less often than daily. Overall, plant diversity is low in salt marshes and only along the upland border where the effects of salt water are minimized does diversity increase substantially. Of the 50 taxa reported in salt marshes by McCormick and Somes (1982), only about a dozen may be considered abundant species.

A single plant—the tall form (approximately 3-6 feet high or more) of smooth cordgrass (*Spartina alterniflora*)—typically dominates the low marsh forming monotypic stands from approximately mean sea level to the mean high water mark. The low marsh is generally limited to creekbanks and upper borders of tidal flats. Annual glasswort (*Salicornia europaea*) may also occur in low numbers intermixed with smooth cordgrass in this zone. A study in Connecticut found that the tall form of smooth cordgrass was an accurate indicator of the landward extent of mean high tide (Kennard *et al.* 1983).

The high marsh is often a complex mosaic of vegetation types rather than a distinct zonation of species. Plant diversity generally rises with increasing elevation in the high marsh. Among the more abundant or typical species are a short form of smooth cordgrass (generally less than 1 ½ feet tall), salt hay grass (*Spartina patens*), spike or salt grass (*Distichlis spicata*), glassworts (*Salicornia bigelovii, S. europaea,* and *S. virginica*), marsh orach (*Atriplex patula*), sea lavender (*Limonium carolinianum* and *L. nashii*), perennial salt marsh aster (*Aster tenuifolius*), and black needlerush (*Juncus roemerianus*). Pools and tidal creeks within the salt marshes may be vegetated with widgeongrass and sea lettuce or other algae.

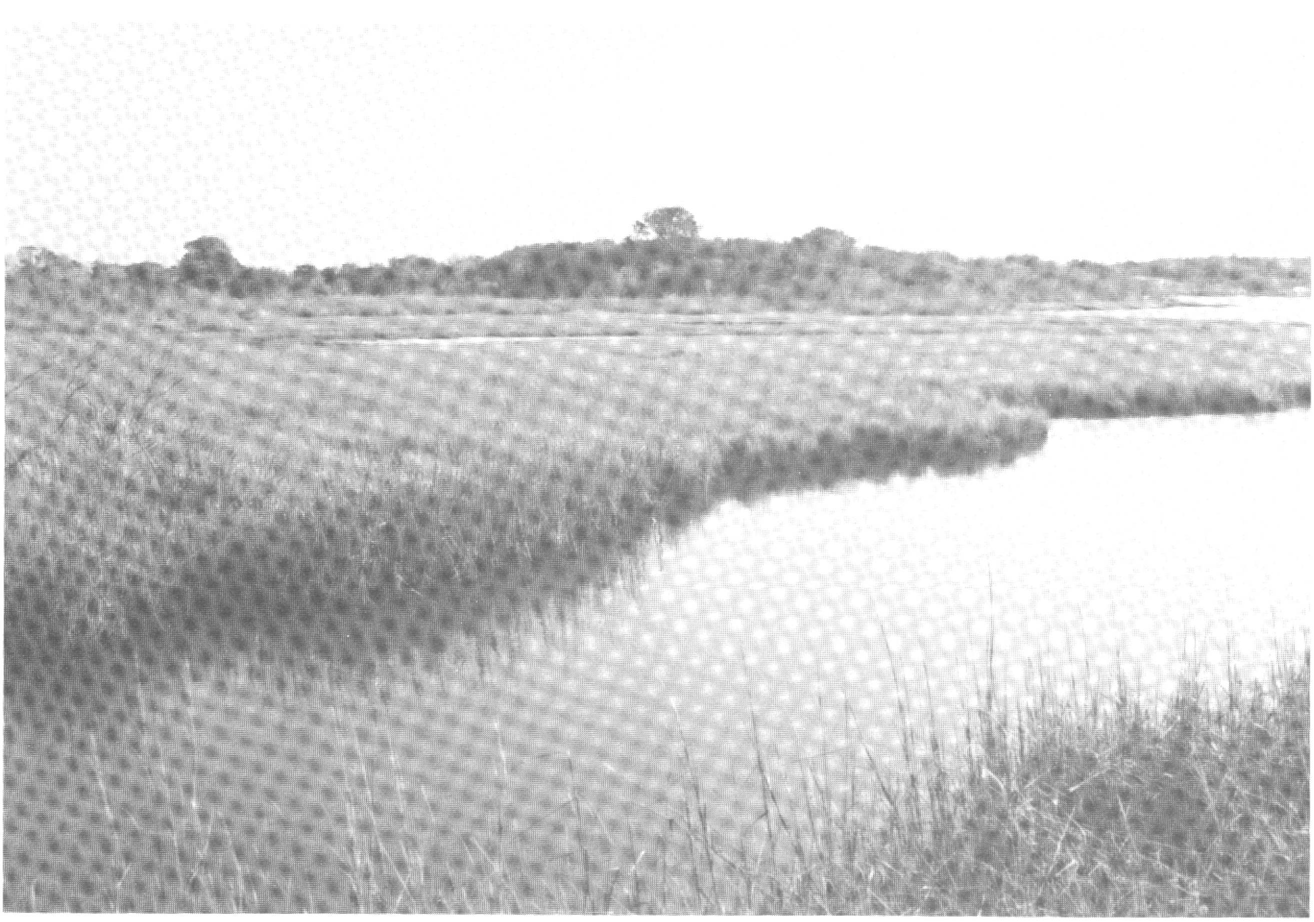

Figure 6-3. Salt marsh behind Assateague Island (Worcester County). (Ralph Tiner photo)

The short form of smooth cordgrass forms extensive stands just above the low marsh. This community occurs in the most frequently flooded zone of the high marsh. Glassworts and sea lavender may be observed in these stands.

Above the short cordgrass marsh in areas subject to less frequent tidal flooding, two grasses and one rush predominate: salt hay grass, spike grass, and black needlerush. Salt hay grass often forms nearly pure stands, but it is frequently intermixed with spike grass. Spike grass usually forms pure or nearly pure stands in the more poorly drained high marsh areas where surface water is present for extended periods. An intermediate form of smooth cordgrass (from 1 1/2 to 3 feet tall) frequently occurs in this middle high marsh zone and is often intermixed with salt hay grass. Black needlerush is found in abundance at slightly higher elevations. Other typical high marsh plants include salt marsh bulrush (*Scirpus robustus*), black grass (*Juncus gerardii*), sea lavender, marsh orach, perennial salt marsh aster, seaside goldenrod (*Solidago sempervirens*), and high-tide bush (*Iva frutescens*). Among the less common associates are sea-blites (*Suaeda linearis* and *S. americana*), smooth heath aster (*Aster pilosus*), salt marsh pink (*Sabatia stellaris*), purple gerardia (*Agalinis purpurea*), foxtail grass (*Setaria geniculata*), and spike-rushes (*Eleocharis parvula* and *E. palustris*) (Higgins *et al.* 1971). Many of these species are characteristic of the marsh-upland border. Creeks and ditches throughout the high marsh are often immediately bordered by a tall or intermediate form of smooth cordgrass, while old spoil mounds adjacent to these mosquito ditches may be colonized by high-tide bush or groundsel-bush.

At the upland edge of salt marshes within reach of the highest spring tides and storm tides, plant diversity is relatively high at least by salt marsh standards. These occasionally flooded, yet nearly permanently saturated soils are colonized by many species, including black needlerush, switchgrass (*Panicum virgatum*), big cordgrass (*Spartina cynosuroides*), common reed (*Phragmites australis*), groundsel-bush (*Baccharis halimifolia*), high-tide bush, rose mallow (*Hibiscus moscheutos*), seaside goldenrod, grass-leaved goldenrod (*Euthamia graminifolia*), northern bayberry (*Myrica pensylvanica*), wax myrtle (*Myrica cerifera*) and red cedar (*Juniperus virginiana*). Black needlerush often forms a marginal band along the upper marsh. Other plants present in border areas include poison

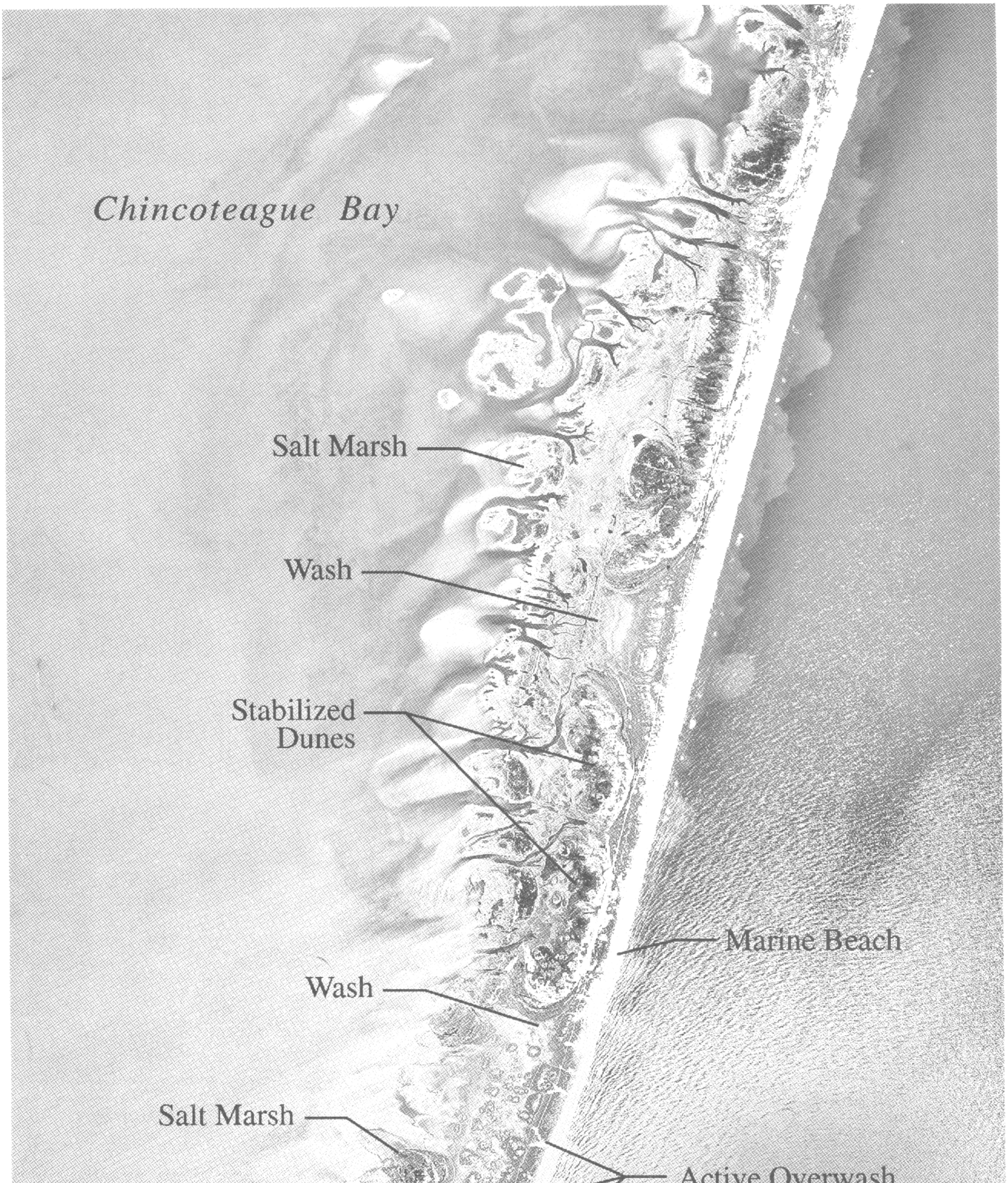

Figure 6-4. Washes lie on the bayside of Assateague Island and form a complex mosaic with salt marshes and sand dunes.

ivy (*Toxicodendron radicans*), American germander (*Teucrium canadense*), salt marsh fimbristylis (*Fimbristylis castanea*), lowland broom-sedge (*Andropogon glomeratus*), black grass, and salt marsh pink.

Where freshwater influence from the upland is strong, narrow-leaved cattail (*Typha angustifolia*), three-squares (*Scirpus americanus* and *S. pungens*), marsh fern (*Thelypteris thelypteroides*), rose mallow, spike-rushes (*Eleocharis* spp.), and other species may characterize the marsh-upland border. These areas resemble brackish marshes which are more extensive upstream along tidal rivers.

Within the high marsh are low depressions called "salt pans" where salt water collects at "spring" tides and similar high tides. As the water evaporates in these pans, the salts are left behind where they accumulate in the soil. These pans are subjected to extreme temperatures and salinity, with salinities ranging from above 40 parts per thousand in summer (Martin 1959) to fresh after heavy rains. These areas are the most salt-stressed environments in the estuarine marshes; in places, they are devoid of plantlife. Blue-green algae often form surface encrustations in these pans.

"*Washes*" are similarly salt-stressed habitats on Assateague Island that lie between the Atlantic Ocean and estuarine embayments. These sandy flats are flooded only by the most extreme high tides and subject to periodic overwash (Figure 6-4).

Vegetative cover of pans and washes may be sparse or abundant varying widely over time. Plant species are restricted to the most salt-tolerant of the halophytes, including common glasswort (*Salicornia europaea*), Bigelow's glasswort (*S. bigelovii*), saltwort (*Salsola kali*), sea purslane, seabeach knotweed (*Polygonum glaucum*), sea rocket, seabeach orach, and salt marsh sand spurrey (*Spergularia marina*). Associated species along the less salt-stressed edges include hairy smother-weed (*Bassia hirsuta*), witchgrass (*Panicum capillare*), switchgrass, rabbit-foot grass (*Polypogon monspeliensis*), smooth cordgrass-short form, spike grass, salt hay grass, Nuttall's cyperus (*Cyperus filicinis*), slender flatsedge (*Cyperus filiculmis*), toad-rush (*Juncus bufonius*), spring ladies-tresses (*Spiranthes vernalis*), stiff yellow flax (*Linum medium*), Virginia meadow-beauty (*Rhexia virginica*), water-hyssop (*Bacopa monnieri*), purple gerardia, seaside gerardia (*Agalinis maritima*), perennial salt marsh aster, annual salt marsh aster (*Aster subulatus*), and stinking fleabane (*Pluchea foetida*) (Higgins *et al.* 1971).

Two Fish and Wildlife Service reports on New England salt marshes (Nixon 1982; Teal 1986) and one for the southeastern coastal marshes (Wiegert and Freeman 1990) serve as useful regional references on the ecology of salt marshes. Plants characteristic of these and other tidal wetlands are described in Tiner (1987, 1993). The distribution of these plants in Maryland has been reported by Thompson (1974) and Sipple (1978a). McCormick and Somes (1981) provides an excellent review of the vegetation of Maryland's coastal marshes and their values. A bibliography of pre-1978 publications discussing Maryland's tidal wetlands (Sipple 1978b) is also available from the Maryland Department of Natural Resources.

Brackish Marshes

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 distances upstream in coastal rivers where the salinity ranges from about 25 parts per thousand (ppt) to about 0.5 ppt at low river flow (Plates 7 through 9). There is a wide zone of marked transition within the brackish marshes from the more seaward brackish marshes with many representatives of salt marsh species to the more inland marshes with considerable representation by typical freshwater species. Consequently, plant diversity is usually higher than that of the salt marshes. Along the Patuxent River, Anderson and others (1968) recorded an increase in diversity from 14 species in the strongly brackish marshes to 56 species in tidal fresh marshes upstream. Sipple (1990) also described this inverse relationship between salinity and species richness in estuarine wetlands. Tables 6-4 and 6-5 present some examples of wetland plant communities observed in Maryland's estuaries.

The more seaward brackish marshes are characterized by salt marsh species. For example, smooth cordgrass-intermediate form dominates regularly flooded creekbanks (low marsh), while its short form, salt hay grass, and spike grass are major components of the irregularly flooded high marsh. Other dominant species in this zone include Olney three-square (*Scirpus americanus*, formerly *S. olneyi*), black needlerush, salt marsh bulrush, switchgrass, seaside goldenrod, common reed, and high-tide bush. Plants of common occurrence are salt marsh loosestrife (*Lythrum lineare*), seashore mallow (*Kosteletzkya virginica*), spike-rushes, groundsel-bush, perennial salt marsh aster, marsh orach, salt marsh fleabane (*Pluchea purpurascens*), and salt marsh pink. Other species include salt marsh fimbristylis, foxtail grass, black grass, umbrella sedge (*Cyperus strigosus*), sedges (*Carex* spp.), annual glasswort, mock bishop-weed (*Ptilimnium capillaceum*), water pimpernel (*Samolus parviflorus*), mild water-pepper

Figure 6-5. Mosaic vegetation pattern of brackish marshes along Chesapeake Bay on the lower Eastern Shore (Somerset County). (Ralph Tiner photo)

(*Polygonum hydropiperoides*), camphorweed (*Pluchea camphorata*), seaside gerardia, annual salt marsh aster, and sea lavender (McCormick and Somes 1982; personal observations). Flowers (1978) and Philipp and Brown (1965) discussed marsh plant zonation in a tributary of the Patuxent River (Calvert County) and the South River (Anne Arundel County), respectively.

Black needlerush dominates extensive areas of brackish marshes on the Eastern Shore. It forms nearly pure stands that are intermixed with stands of salt hay grass, spike grass, three-squares, and smooth cordgrass forming a mosaic pattern (Figure 6-5). Seaside goldenrod, salt marsh fleabane, perennial salt marsh aster, black grass, foxtail grass, salt marsh fimbristylis, and salt marsh bulrush may also occur in substantial amounts. Seashore mallow and marsh orach may also be present (McCormick and Somes 1982). Smooth cordgrass typically dominates the regularly flooded creekbanks. Stands of black needlerush-salt hay grass marshes are most abundant in Dorchester and Somerset Counties, while they also occur in Queen Annes, Talbot, and Wicomico Counties and to a lesser extent in St. Marys County (Sipple 1982, Chrysler 1910).

Further upstream or along the upland edges of the more brackish marshes, the following species may be abundant: Olney three-square, common reed, narrow-leaved cattail, switchgrass, big cordgrass, salt marsh bulrush, seaside goldenrod, and rose mallow. The first five species typically form nearly pure stands. Black grass and salt marsh fimbristylis may form part of the upper border. The uppermost boundary, however, is often represented by a shrubby zone of high-tide bush and groundsel-bush mixed with wax myrtle and several herbs. Olney three-square occupies the more seaward of these marshes, along with the following species: rose mallow, spike grass, salt marsh bulrush, smooth cordgrass, salt hay grass, seashore mallow, salt marsh loosestrife, salt marsh fleabane, umbrella sedge, black needlerush, high-tide bush, water hemp (*Amaranthus cannabinus*), and seaside goldenrod. Swamp milkweed (*Asclepias incarnata*) has been observed with common reed and rose mallow along the Chaptico River in St. Marys County (Chrysler 1910). Salt hay grass often assumes a tussocked appearance (habit) in the more upstream brackish marshes. Rose mallow and narrow-leaved cattail are frequent co-dominants in other brackish marshes further upstream. Co-existing with these two species are spike grass, Olney three-square, common three-square, switchgrass, big cordgrass, and giant foxtail (*Setaria magna*). Where switchgrass or big cordgrass predominate, a host of other species may occur, including mock bishop-weed, arrow-leaved tearthumb (*Polygonum sagittatum*), arrow arum (*Peltandra virginica*), swamp milkweed, and ground-nut (*Apios americana*).

Oligohaline Marshes

The uppermost of the estuarine marshes have been called oligohaline, slightly brackish, intermediate, or transitional marshes (Plate 9; Tiner 1993). They occur in a predominantly fresh water zone that is subject to periodic salt water intrusion (especially in late summer and early fall during low river flows). Consequently these marshes have representatives of both fresh water and brackish marshes with the majority of species having fresh water affinities (Tables 6-4, 6-6, and 6-7). They are found along the upper reaches of tidal rivers, being abundant in the Choptank, Nanticoke, and Wicomico Rivers, and in tidal tributaries feeding into the upper part of Chesapeake Bay (Sipple 1982).

Common plants in the regularly flooded zone or low marsh include narrow-leaved cattail, big-leaved arrowhead, bull-tongue (*Sagittaria falcata*), soft-stemmed bulrush, water hemp, arrow arum, common reed, pickerelweed, sedge (*Carex alata*), sweet flag (*Acorus calamus*), greater bur-reed (*Sparganium eurycarpum*), swamp dock (*Rumex verticillatus*), rice cutgrass (*Leersia oryzoides*), and spatterdock (*Nuphar luteum*). Smooth cordgrass also occurs along the water's edge in some places, but is gradually replaced by the other species listed above.

Big cordgrass often forms pure stands on the natural levees and is also a common high marsh plant. Other prominent high marsh species include narrow-leaved cattail, common reed, common three-square, switchgrass, spike-rushes, dotted smartweed (*Polygonum punctatum*), rose mallow, swamp milkweed, American germander, Virginia bugleweed (*Lycopus virginicus*), and swamp rose. Other herbaceous species observed along the Nanticoke River near Vienna are also characteristic of these wetlands, including Walter millet (*Echinochloa walteri*), salt marsh fleabane, seashore mallow, arrow-leaved tearthumb, water parsnip (*Sium suave*), mock bishop-weed, boneset (*Eupatorium perfoliatum*), salt marsh loosestrife, marsh fern, twig rush (*Cladium mariscoides*), umbrella sedge, salt marsh bulrush, climbing hempweed (*Mikania scandens*), rice cutgrass, fall panic grass (*Panicum dichotomiflorum*), tussock sedge (*Carex stricta*), fireweed or pilewort (*Erechtites hieracifolia*), large fruit beggar-ticks (*Bidens coronata*), foxtail grass, elongated lobelia (*Lobelia elongata*), jewelweed (*Impatiens capensis*), halberd-leaved tearthumb (*Polygonum arifolium*), and New York ironweed (*Vernonia noveboracensis*). Woody shrubs and vines may be scattered in these marshes and they may include groundsel-bush, wax myrtle, poison ivy, and Virginia creeper (*Parthenocissus quinquefolia*). An occasional bald cypress (*Taxodium distichum*) may rarely occur in these marshes (Thompson 1974), providing evidence of minimal salt tolerance of this species. Anderson and others (1968) and Sipple (1990) described the distribution of plants from brackish to fresh waters in the upper Patuxent River.

Estuarine Scrub-Shrub Wetlands

Estuarine shrub swamps are common along the Maryland coastal zone. They are usually dominated by two species: high-tide bush and/or groundsel-bush, which are common along the upper edges of salt marshes and in the more saline brackish marshes. High-tide bush may form relatively large stands in brackish and slightly brackish marshes around Chesapeake Bay (Bill Sipple, pers. comm.). Red cedar, wax myrtle, and poison ivy are commonly associated woody species. Shining sumac (*Rhus copallina*) may also occur at higher levels (McCormick and Somes 1982). Salt hay grass, spike grass, smooth cordgrass-short form, black grass, switchgrass, foxtail grass, lowland broom-sedge, Olney three-square, seaside goldenrod, rose mallow, and other "high marsh" species are often present with these shrubs. Purple gerardia, salt marsh pink, and pink wild bean (*Strophostyles umbellata*) have also been reported in more open shrubby areas (Chrysler 1910; personal observations). Two vines—climbing hempweed and dodder (*Cuscuta* sp.)—may be observed on the shrubs (Chrysler 1910). Along the slightly brackish to freshwater reaches of tidal rivers, wax myrtle may form a dense shrub thicket. Poison ivy is often present in these thickets. Some examples of estuarine shrub communities are given in Tables 6-4, 6-6, and 6-8.

Estuarine Forested Wetlands

The apparent effects of rising sea level and coastal subsidence on the Delmarva Peninsula may be readily observed along the borders of the more saline estuarine marshes where low-lying pine flatwoods dominated by loblolly pine (*Pinus taeda*) are now subject to frequent tidal flooding with salt water. The now salty soils favor the growth of halophytes, so the salt marshes are advancing into these areas. This is not a recent phenomena, since similar observations were reported in the early 1900s (Shreve 1910a). This situation is especially evident in Dorchester and Somerset Counties (see enclosed state wetland map). It is also occurring at Point Lookout on the Western Shore (Plate 7).

Many of these estuarine forested wetlands are in designated wildlife management areas subject to frequent controlled marsh burning. Such activities probably accelerate the effects of sea level rise and coastal subsidence by burning off the upper peats that would otherwise naturally form and raise the surface of the wetland, perhaps sufficiently to keep pace with the rising water levels. Chrysler (1910) warned against using controlled burning, since it destroys the organic layer of the soil. Whatever the cause, it is plain to see that pines are dying and/or severely stressed (chlorotic) due to salt water intrusion as standing dead trunks characterize the seaward margins of these areas. Some of the estuarine pine forests have salt hay grass, spike grass, switchgrass, common reed, or black needlerush as common herbaceous species or even as co-dominants in more open forests. High-tide bush, groundsel-bush, and wax myrtle are typical shrubs in these wetlands. Other plants that may be present include salt marsh aster, swamp rose, poison ivy, American holly (*Ilex opaca*), grass-leaved goldenrod, salt marsh bulrush, rose mallow, spike-rushes, persimmon (*Diospyros virginiana*), sweet gum, and common greenbrier (McCormick and Somes 1982; personal observations).

Estuarine Aquatic Beds

The shallow water zones of Maryland's estuaries, especially Chesapeake Bay and its tributaries, often contain considerable amounts of aquatic beds. Most of these beds are comprised of "submerged aquatic vegetation" ("SAV"). In more saline waters such as Chincoteague and Assawoman Bays and the lower part of the Chesapeake Bay, eelgrass and widgeongrass are the typical aquatic bed species. Widgeongrass is most common in salt marsh pools and ditches (Thompson 1974). As salinity decreases toward the head of Chesapeake Bay or in tidal rivers, widgeongrass remains important, but eelgrass is replaced by other species, including redhead-grass (*Potamogeton perfoliatum*), sago pondweed (*Potamogeton pectinatus*), and horned pondweed (*Zannichellia palustris*). Further upstream in slightly brackish waters, species diversity of aquatic beds increases with the addition of the following species: wild celery (*Vallisneria americana*), Eurasian water milfoil (*Myriophyllum spicatum*), naiads or bushy pondweeds (*Najas guadalupensis* and *N. flexilis*), coontail (*Ceratophyllum demersum*), pondweeds (*Potamogeton amplifolius, P. crispus, P. epihydrus, P. nodosus, P. pulcher, P. pusillus, P. richardsonii*, and *P. robbinsii*), waterweeds (*Elodea canadensis* and *E. nuttallii*), hydrilla (*Hydrilla verticillata*), water star-grass (*Zosterella dubia*, formerly *Heteranthera dubia*), pygmy-weed, muskgrass (*Nitella flexilis*), awl-leaf arrowhead, eastern bur-reed (*Sparganium americanum*), and water chestnut (*Trapa natans*). Floating-leaved plants may also form aquatic beds in slightly brackish waters. Common species are spatterdock and white water lily (*Nymphaea odorata*). Table 6-9 shows the relationship between tidal aquatic species and salinity.

Much recent scientific study has been devoted to assessing the distribution and trends in submerged aquatic vegetation in Chesapeake Bay (Anderson 1972; Orth *et al.* 1985, 1986, 1987, 1993, 1994) and in the Potomac River (Carter *et al.* 1983, 1985a, 1987b; Carter and Rybicki 1987; Haramis and Carter 1983; Paschal *et al.* 1982; Rybicki *et al.* 1986, 1987). An annotated bibliography of Chesapeake Bay submerged aquatic vegetation has been published (Chesapeake Research Consortium, Inc. 1978).

Palustrine Wetlands

Maryland's palustrine wetlands are represented by fresh water marshes and swamps, including tidal and nontidal wetlands. Structurally, palustrine wetland communities can be divided into four major types based on predominant vegetation: (1) forested wetlands, (2) scrub-shrub wetlands, (3) emergent wetlands, and (4) aquatic beds. Forested wetlands are characterized by the dominance of woody vegetation 20 feet (6 m) or taller, while scrub-shrub wetlands are dominated by woody plants less than 20 feet (6 m) in height. In contrast, emergent wetlands are represented by erect, herbaceous (non-woody) vegetation and aquatic beds by various floating-leaved, free-floating or submerged plants.

The following discussion emphasizes major palustrine wetland communities in Maryland based primarily on NWI field observations and a review of available literature. It must be recognized that individual wetland communities vary from site to site due to local conditions and that this discussion attempts to characterize the major types and in doing so, makes necessary generalizations. Community descriptions are arranged according to physiographic region, except for aquatic bed communities which are discussed at the end of this section. Figure 6-6 shows the general location of these physiographic regions.

Coastal Plain Wetlands

Forested Wetlands

Forested wetlands are the most abundant and widely distributed palustrine wetland type on the Coastal Plain (Plates 10 through 13). These wetlands are found on floodplains along the freshwater tidal and nontidal portions of rivers and streams, in upland depressions, and in broad flats between drainage streams (i.e., interstream divides). Four general types of forested wetlands can be identified based on differences in

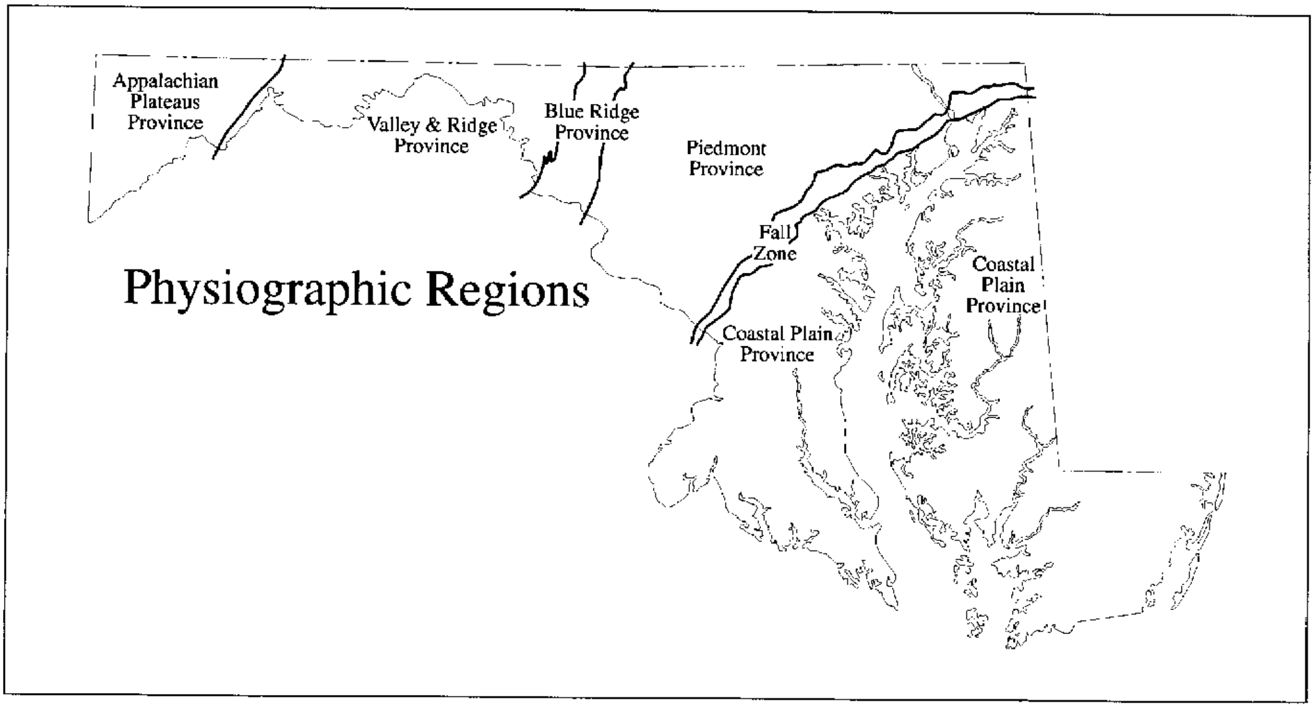

Figure 6-6. Physiographic regions of Maryland.

flooding characteristics: (1) tidally flooded (freshwater), (2) semipermanently flooded, (3) seasonally flooded, and (4) temporarily flooded. The first type is flooded periodically by tides, while the rest are nontidal wetlands. The second type is flooded throughout the growing season in most years and the wetland surface is only infrequently exposed to air. The latter two types are flooded for varying periods: the seasonally flooded type has standing surface water for extended periods (usually more than two weeks) during the growing season, while the temporarily flooded type is inundated only briefly (perhaps a week or so), usually in winter and early spring. The temporarily flooded type sometimes called "winter wet woods" or "wet flatwoods" is the most common forested wetland type on the Coastal Plain. This type also includes seasonally saturated wetlands which are maintained by seasonal high water tables from late winter to late spring, with surface water rarely present. Coastal Plain forested wetlands may be dominated by deciduous and/or evergreen tree species.

At the turn of the century, Forrest Shreve (1910a) described eight general types of forested wetlands for the Eastern Shore: (1) clay upland swamps of the Talbot Terrace, (2) sandy loam upland swamps, (3) wetter floodplain forests, (4) drier floodplain forests, (5) sandy floodplains, (6) upland swamps of the Wicomico Terrace, (7) river swamps, and (8) stream swamps. Table 6-10 summarizes characteristic vegetation of each type. These descriptions provide an interesting historical perspective on Eastern Shore wetlands. Shreve felt that low topographic position was the important factor determining the vegetation of the river swamps, while soil texture was more important for other types, especially various upland swamps. The upland swamps typically occupied broad flats between drainage streams (interstream divides). Yet despite being separated from streams, their vegetation was essentially identical to swamps that occurred behind various tidal marshes. Shreve also commented that the poor drainage of the Talbot Terrace caused considerable seasonal fluctuations in soil moisture of the upland swamps due to rainfall. Interestingly, he noticed that the vegetation of the upland swamps on lighter soils was more distinct from "the Upland" than that of the clay soils[1]. Clay upland swamps occupied Elkton clays and similar soils, covering much of Dorchester County. Their vegetation was very similar to that of the "clay upland forest" with the notable difference being the absence of certain species. The sandy loam upland swamps were found mainly south of the Nanticoke River, occurring in the interstream divides or contiguous with the tidal marshes. Loblolly pine often predominated, while several deciduous

[1]Readers interested in wetland delineation should read chapters in *The Plant Life of Maryland* (Shreve *et al.* 1910), particularly Shreve's chapter on the Eastern Shore which aptly shows that some of the earliest plant geographers considered much of the Eastern Shore, especially Dorchester County, to be some type of wetland. After reading this book, one might likely conclude that the concept of wetland in the 1989 Federal interagency wetland delineation manual is remarkably similar to that described in 1910.

species made up 10-40 percent of the tree stratum in the wet pine flatwoods. Deciduous trees also dominated many sandy loam upland swamps. Upland swamps of the Wicomico Terrace were most abundant in the northeastern part of Queen Annes County. They resembled the clay upland swamps of Dorchester County, except for the conspicuous absence of loblolly pine. River swamps bordered the Pocomoke River, Dividing Creek, and Nassawango Creek. Bald cypress characterized the outer zone of these swamps, while the inner zone resembled the sandy loam upland swamps. River swamps were diverse in plant composition, with often thick undergrowth. Stream swamps bordered the Nanticoke and Choptank Rivers and all small streams of the Talbot Formation. These swamps were characterized by a mix of rather short deciduous trees mixed with many shrubs and herbs.

Tidal Swamp Forests

Tidal freshwater swamps occur along coastal rivers in areas subject to tidal influence, but beyond the maximum penetration of salt water. These forested wetlands are usually dominated by red maple (*Acer rubrum*) and/or green ash (*Fraxinus pensylvanica var. subintegerrima*), but black willow (*Salix nigra*) and black gum (*Nyssa sylvatica*) may also co-dominate (Tables 6-11 and 6-12). Black gum appears to be more prevalent at higher elevations in tidal swamps. Swamp black gum (*N. sylvatica var. biflora*) may characterize the wetter areas along with bald cypress (*Taxodium distichum*) as noted by Beaven and Oosting (1939) along the Pocomoke River. The latter species is also common in the tidal portion of Battle Creek Cypress Swamp in Calvert County on the Western Shore. Other trees that may occur in tidal swamps include Atlantic white cedar (*Chamaecyparis thyoides*), sweet gum (*Liquidambar styraciflua*), American elm, and loblolly pine. The latter three species may predominate at higher elevations subject to infrequent tidal inundation—temporarily flooded-tidal swamps. Large areas of tidal pine swamp occur on the lower Eastern Shore in Dorchester and Somerset Counties (Bill Sipple, pers. comm.). Pin oak (*Quercus palustris*) co-dominated a couple of stands of tidal swamps in Harford County on the upper Western Shore, while sweet gum was the other dominant species. Swamp cottonwood (*Populus heterophylla*) may also exist in small numbers as observed along the Pocomoke River (Beaven and Oosting 1939).

Shrubs characteristic of the wettest tidal swamps are buttonbush (*Cephalanthus occidentalis*), swamp rose, and smooth alder (*Alnus serrulata*). Other common shrubs are southern arrowwood (*Viburnum dentatum*), silky dogwood (*Cornus amomum*), highbush blueberry (*Vaccinium corymbosum*), fetterbush (*Leucothoe racemosa*), sweet pepperbush (*Clethra alnifolia*), swamp azalea (*Rhododendron viscosum*), wax myrtle, winterberry (*Ilex verticillata*), and saplings of common tree species. Seaside alder (*Alnus maritima*) was observed along the edge of tidal freshwater swamps and marshes bordering Marshyhope Creek and Nassawango Creek. In the eastern U.S., this species is restricted to wetland habitats on the Delmarva Peninsula. Spicebush (*Lindera benzoin*), black haw (*Viburnum prunifolium*), red chokeberry (*Aronia arbutifolia*), common elderberry (*Sambucus canadensis*), and maleberry (*Lyonia ligustrina*) are less common. Pawpaw (*Asimina triloba*) may occur on drier sites, especially on the Western Shore.

Herbs characteristic of wetter swamps include lizard's tail (*Saururus cernuus*), royal fern (*Osmunda regalis*), cinnamon fern (*O. cinnamomea*), stiff-leaved cowbane (*Oxypolis rigidior*), jewelweed, sensitive fern, halberd-leaved tearthumb (*Polygonum arifolium*), and tussock sedge (*Carex stricta)* (Sipple 1978a, McCormick and Somes 1982; personal observations). Less common plants may include wood reed (*Cinna arundinacea*), marsh horsetail (*Equisetrum fluviatile*), arrow-leaved tearthumb, and manna grass (*Glyceria striata*). In more open locations, such as along channels, water-willow or swamp loosestrife (*Decodon verticillatus*), blue flag (*Iris versicolor*), dotted and other smartweeds, spatterdock, arrow arum, and rose mallow may occur. Drier tidal swamps may have false nettle (*Boehmeria cylindrica*) present.

Vines such as common greenbrier (*Smilax rotundifolia*), poison ivy, Virginia creeper (*Parthenocissus quinquefolia*), and Japanese honeysuckle (*Lonicera japonica*) may be present, especially in temporarily flooded-tidal swamps or high levels in wetter swamps. Cross vine (*Bignonia capreolata*), a southern vine at its northern limits in Maryland, is common along the Pocomoke River, often in tidal swamps with some bald cypress. Laurel-leaved greenbrier (*Smilax laurifolia*) and American mistletoe (*Phoradendron flavescens*), an epiphyte, may also be observed on deciduous trees in wetter tidal swamps.

Semipermanently Flooded Swamp Forests

Semipermanently flooded forested wetlands are uncommon in Maryland, although they are more abundant in eastern Virginia and further south. These wetlands may be found along Battle Creek on the Western Shore and along the Pocomoke River on the lower Eastern Shore. Bald cypress dominates these wetlands. Associated trees at higher elevations are red maple, swamp black gum, black gum, sweet bay, ironwood, fringe tree, and swamp cottonwood. The shrub layer is usually quite diverse, including southern wild raisin (*Viburnum nudum*), highbush blueberry, buttonbush, smooth alder, swamp azalea, and Virginia sweet-spires, among others (Bill Sipple, pers. comm.). Emergent vegetation associated with these wetlands include sedges (including *C. stricta, C. intumescens, C. lupuliformis*), wood reed, manna grasses (*Glyceria* spp.), lizard's tail, arrow arum, and beggar-ticks. Typical vines include those found in tidal swamps, plus trumpet creeper (*Campsis radicans*). Cross vine may occur in these wetlands along the Pocomoke River (Bill Sipple, pers. comm.).

Seasonally Flooded Swamp Forests

Seasonally flooded forested wetlands are usually dominated by one or more of the following species: red maple, sweet gum, willow oak (*Quercus phellos*), basket or swamp chestnut oak (*Quercus michauxii*), pin oak, loblolly pine, and less commonly by bald cypress, swamp black gum, and Atlantic white cedar (Plates 10 and 11). Other trees common in seasonally flooded swamps are green ash, black gum, American elm, and sweet bay (*Magnolia virginiana*). Less common trees include overcup oak (*Quercus lyrata*), swamp cottonwood, white oak (*Quercus alba*), American holly (*Ilex opaca*), pond pine (*Pinus serotina*), and persimmon which may be common in forested "pothole" wetlands in the Millington-Goldsboro-Sudlersville area (see Figure 4-2; Plate 12; Sipple and Klockner 1984). Seasonally flooded forested wetlands include red maple swamps, bottomland hardwood swamps, loblolly pine flatwoods, mixed pine-hardwood flatwoods, Atlantic white cedar swamps, and bald cypress swamps. Examples of typical communities of these wetlands are shown in Tables 6-13 through 6-17.

Shrubs often form a dense understory thicket in seasonally flooded swamps. Dominant shrubs include southern arrowwood, highbush blueberry, smooth alder, fetterbush, sweet pepperbush, and swamp azalea. Other shrubs present in variable amounts may be spicebush, common elderberry, Virginia sweet-spires (*Itea virginica*), silky dogwood, common winterberry, smooth winterberry (*I. laevigata*), and dangleberry (*Gaylussacia frondosa*). Grapes (*Vitis* spp.) and poison ivy vines may be common, with other vines usually less common, including common greenbrier, Virginia creeper, trumpet creeper, and Japanese honeysuckle. Swamp dewberry (*Rubus hispidus*), a trailing shrub, may form some of the groundcover in these swamps.

Herbaceous vegetation may be abundant or sparse in seasonally flooded swamps depending on local conditions. Common emergents (herbs) include wood reed, manna grasses (*Glyceria* spp., especially *G. striata*), tussock sedge, other sedges, cardinal flower (*Lobelia cardinalis*), royal fern, cinnamon fern, marsh fern (*Thelypteris thelypteroides*), sensitive fern, net-veined chain fern (*Woodwardia areolata*), skunk cabbage (*Symplocarpus foetidus*), violets (*Viola* spp.), false nettle, lizard's tail, three-way sedge (*Dulichium arundinaceum*), and jewelweed (*Impatiens capensis*). In many seasonally flooded swamps, peat mosses (*Sphagnum* spp.) are common in wet depressions, while bog moss (*Aulacomnium palustre*) also occurs in these swamps.

Bald cypress swamps occur in the Pocomoke River drainage on the Eastern Shore (e.g., Atkins Pond in Wicomico County and along Nassawango Creek) and along Battle Creek in Calvert County on the Western Shore. Bald cypress has also been reported in scattered locations elsewhere on the Western Shore by Mansueti (1955). Stands where bald cypress is dominant or co-dominant have been mapped by the current survey in Calvert, Somerset, Wicomico, and Worcester Counties. A rather detailed floristic study of the Pocomoke Swamp has been performed by Beaven and Oosting (1939).

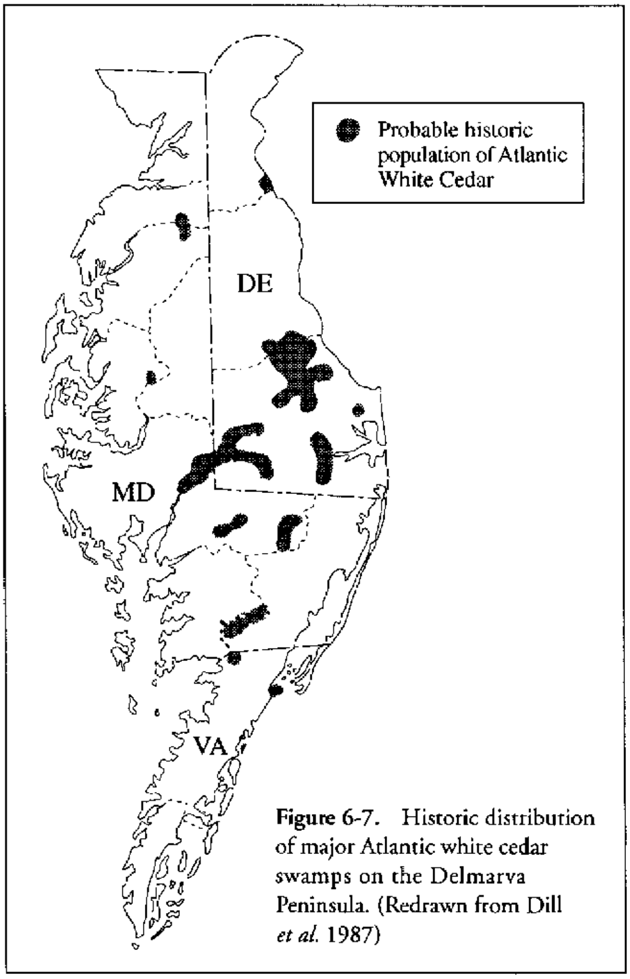

Figure 6-7. Historic distribution of major Atlantic white cedar swamps on the Delmarva Peninsula. (Redrawn from Dill *et al.* 1987)

Table 6-18 lists plant species associated with this cypress swamp.

Atlantic white cedar swamps were more abundant in Maryland than they are today. Figure 6-7 shows the probable historic range of Atlantic white cedar on the Delmarva Peninsula. The Pocomoke and Nanticoke River systems had the most cedar swamps in Maryland. Most of the swamps have been cut over in the past and now are hardwood swamps. Dill and others (1987) described the historical and current distribution of cedar swamps on the Delmarva Peninsula. Seventeen of the 58 reported Delmarva sites occur in Maryland: 9 in Wicomico County (5-Nanticoke River, 3-Wicomico River, 1-Pocomoke River), 3 in Worcester County (Pocomoke River), 2 in Dorchester County (Nanticoke River), 1 in Talbot County (Choptank River), 1 in Queen Annes County (Chester River), and 1 in Kent County (Chester River). Table 6-19 lists species of Atlantic white cedar swamps on the Delmarva Peninsula and includes representatives of 117 taxa. Many rare or endangered plants may be found in cedar swamps, including dragon's mouth (*Arethusa bulbosa*), swamp pink (*Helonias bullata*), Collins' sedge (*Carex collinsii*), slender blue flag (*Iris prismatica*), and northern pitcher plant (*Sarracenia purpurea*) (Dill *et al.* 1987). Beaven and Oosting (1939) found significant and nearly pure stands of Atlantic white cedar bordering the upland in nontidal portions of the Pocomoke River. Shreve (1910) reported cedar swamps along the Nanticoke River from Marshyhope Creek upstream into Delaware. Seaside alder was a common associate.

While more common on the Eastern Shore, Sipple and Klockner (1980, 1984) found two small cedar swamps in Anne Arundel County. Associated species were highbush blueberry, royal fern, cinnamon fern, and peat mosses. In part of one of the swamps, red maple was the dominant tree, with sweet bay, black gum, sweet pepperbush, swamp azalea, cinnamon fern, and peat mosses also present. In total, plants from 39 taxa were found in the Cypress Creek cedar swamp (Sipple and Klockner 1980). Hull and Whigham (1987) also described vegetation of this wetland in addition to some other wetlands in the vicinity of Annapolis.

Temporarily Flooded Swamp Forests[2]

Temporarily flooded forested wetlands occur on floodplains, in isolated depressions surrounded by uplands, or in interstream divides (Plate 13). The latter two types have been commonly referred to as "winter wet woods" because they are wettest in winter and are relatively dry during the late spring, summer and early fall, except after heavy rains. Since many of these wetlands occur in broad flats between drainage streams (i.e., interstream divides), they may also be called "wet flatwoods." Shreve (1910) called these types of wetlands "upland swamps" and noted their abundance on the Talbot Terrace which represents most of Maryland's Eastern Shore, particularly Worcester, Wicomico, Somerset, Dorchester and Talbot Counties. He also commented on the similarity of their vegetation with swamps bordering extensive marshes on the Eastern Shore. Interestingly, he also noticed the subtle differences in plant composition versus the adjacent upland and that the absence of species was more notable than the presence of species in separating the swamp from the upland. Many tree species may dominate the canopy of temporarily flooded forested wetlands: red maple, sweet gum, black gum, basket oak, willow oak, water oak (*Quercus nigra*), southern red oak (*Quercus falcata*), swamp white oak (*Quercus bicolor*), sycamore (*Platanus occidentalis*), black willow, sweet bay, American holly, and loblolly pine.

Loblolly pine dominates many temporarily flooded swamps, especially flatwoods on the lower Eastern Shore in Somerset, Dorchester, and Wicomico Counties. These wetlands are the northern extension of the wet pine flatwoods that dominate much of the Coastal Plain in the Southeast. Shreve (1901) reported loblolly pine as the dominant tree of "sandy loam upland swamps" which are found mostly south of the Nanticoke. Deciduous trees made up 10-40 percent of these swamp forests earlier in this century. Willow oak, basket oak, American holly, sweet bay, and white oak (*Quercus alba*) were chief associates and may still be common in areas not actively managed for pines. Shrubs, including sweet pepperbush, highbush blueberry, and wax myrtle may be present in variable amounts. Herbs are usually sparse and may include slender spikegrass (*Chasmanthium laxum*) and partridgeberry (*Mitchella repens*). Many of these wetlands are periodically cut over to produce timber products. In attempting to collect data on the plant composition of these wetlands for this state wetland report, the senior author encountered many harvested areas (Figure 6-8). Cutover pine swamp forests and mixed pine-hardwood swamp forests may be recolonized by lowland broom-sedge (*Andropogon glomeratus*), wool grass (*Scirpus cyperinus*), soft rush, other rushes, slender spike-grass, deer-tongue (*Dicanthelium clandestinum*), sedges, umbrella sedges, beak-rushes, purple gerardia, seedbox, meadow-beauty, asters, grass-leaved and

[2]Palustrine forests with brief periods of surface water ponding (in depressions) and seasonal high water tables were mapped as temporarily flooded forested wetlands. Many of these wetlands are perhaps better defined as seasonally saturated, since surface water is absent in most areas and the presence of seasonal high water tables creates conditions favoring wetland establishment.

Figure 6-8. Former palustrine forest recently harvested, now colonized mainly by wool grass (*Scirpus cyperinus*). (Ralph Tiner photo)

other goldenrods, various other grasses, swamp dewberry, sweet pepperbush, highbush blueberry, brambles (*Rubus* sp.), and wax myrtle. Pokeweed (*Phytolacca americana*) and fireweed are disturbance species that may become established soon after timber harvest. Seedlings of tree species from surrounding forests, e.g., sweet bay, loblolly pine, red maple, sweet gum, black gum, and various oaks, usually become established and eventually bring the return of forested wetlands to these sites. Tables 6-20 and 6-21 include a few examples of wet pine flatwoods in Maryland.

Many temporarily flooded forested wetlands are dominated by two or more tree species, as shown in Tables 6-20 through 6-24. White oak, beech (*Fagus grandifolia*), and tulip poplar (*Liriodendron tulipifera*) may be present and even dominant or co-dominant in some wetlands or the upper portions of other wetlands. Bitternut hickory (*Carya cordiformis*) and fringe-tree (*Chionanthus virginiana*) may occur in low numbers. Box elder (*Acer negundo*) and pawpaw are more important on the Western Shore, with the latter characteristic of natural levees along floodplains. Brush and others (1980) reported that the river birch-sycamore association was absent from most floodplains of the lower Eastern Shore. The shrub understory usually consists of sweet pepperbush, highbush blueberry, southern arrowwood, spicebush, and elderberry. Wax myrtle and smooth alder may also occur and partridgeberry frequently grows in patches on the forest floor. Vines are common, especially common greenbrier, poison ivy, Japanese honeysuckle, grapes, and trumpet creeper. Although present in seasonally flooded swamps, these vines are usually more abundant in drier swamps. Wintergreen (*Gaultheria procumbens*) may infrequently occur on the ground. Herbs are usually few in number and scattered throughout these wetlands. Among those that may be present are net-veined chain fern, cinnamon fern, royal fern, clearweed (*Pilea pumila*), false nettle, sedges, and grasses. Virginia knotweed (*Polygonum virginicum*) is a typical floodplain species of common occurrence on the Western Shore. Lizard's tail, skunk cabbage, and bugleweed may be found in wetter spots in temporarily flooded swamps.

Scrub-Shrub Wetlands

Shrub swamps are not particularly abundant on the Eastern Shore, but where present, they are dominated by true shrubs of buttonbush (*Cephalanthus occidentalis*), silky dogwood, southern arrowwood, and smooth alder, and/or by saplings of deciduous trees, such as red maple, black gum, green ash, and black willow (Table 6-25). Less common shrubs include winterberries, chokeberries (*Aronia* spp.), and inkberry (*Ilex glabra*). Buttonbush is most abundant in semipermanently flooded and the wetter seasonally flooded shrub swamps, such as Eastern Shore potholes (see Figure 6-9; Sipple and Klockner 1981; personal observations). The other species are more characteristic of other seasonally flooded wetlands and temporarily flooded swamps. Water-willow,

Figure 6-9. Buttonbush swamps occupy many potholes on the upper Eastern Shore (Kent County). (Ralph Tiner photo)

arrow arum, spatterdock, broad-leaved cattail (*Typha latifolia*), and persimmon may be associated with buttonbush swamps. Emergent plants commonly intermixed with seasonally flooded shrubs and include broad-leaved cattail, rice cutgrass, wool grass, green bulrush (*Scirpus atrovirens*), red-tinged bulrush (*S. microcarpus*, formerly *S. rubrotinctus*), river bulrush (*S. fluviatilis*), dotted smartweed, other smartweeds (*Polygonum* spp.), water hemlock (*Cicuta maculata*), skunk cabbage, jewelweed, dodder (*Cuscuta* sp.), sedges, soft rush (*Juncus effusus*), sensitive fern, and various mosses. Some pothole shrub swamps on the Eastern Shore have abundant emergent growth by smartweeds and rice cutgrass in summer when surface water is absent (Sipple and Klockner 1981). Other plants, such as autumn sedge or slender fimbry (*Fimbristylis autumnalis*) and long-beak baldrush (*Psilocarya scirpoides*), may also be present at such times.

Bogs are rare wetlands on Maryland's Coastal Plain. Sipple and Klockner (1984) identified six on the Western Shore: Round Bay Bog, Eagle Hill Bog, Angel's Bog, South Gray's Bog, Suitland Bog, and Muirkirk Bog (Figure 6-10). The first four are in Anne Arundel County and the latter two (called "magnolia bogs") in Prince Georges County. Dominant shrubs in these bogs include big cranberry (*Vaccinium macrocarpon*) and leatherleaf (*Chamaedaphne calyculata*). Water-willow (*swamp loosestrife*), a shrublike herb, is also a dominant in some bogs. Associated species include white beak-rush (*Rhynchospora alba*), three-way sedge, pine barren rush (*Juncus abortivus*), Virginia meadow-beauty (*Rhexia virginica*), round-leaved sundew (*Drosera rotundifolia*), spatulate-leaved sundew (*D. intermedia*), Virginia chain fern (*Woodwardia virginica*), rose pogonia (*Pogonia ophioglossoides*), red maple, long-tubercle spikerush (*Eleocharis tuberculosa*), manna grass (*Glyceria obtusa*), among others. Hull and Whigham (1987) provided a quantitative assessment of the vegetation in these bogs. Only peat mosses (*Sphagnum* spp.) and marsh St. John's-wort (*Triadenum virginicum*) were present in all six bogs, but five other species were found in five bogs including white water lily, white beak-rush, pine barren rush, fibrous bladderwort (*Utricularia fibrosa*), and spatulate-leaved sundew. Surprisingly, giant cane (*Arundinaria gigantea*), a plant more typical of swamps and wet thickets from Virginia south, occurred in two bogs (South Gray's and Eagle Hill). Table 6-26 lists some of the more abundant species recorded in these bogs. Chrysler (1910) also reported the existence of a bog in Anne Arundel County and listed characteristic species including many of those referenced above, plus purple pitcher-plant (*Sarracenia purpurea*), Carolina yellow-eyed grass (*Xyris caroliniana*), bog clubmoss (*Lycopodium inundation*), and ten-angle pipewort (*Eriocaulon decangulare*).

Hitchcock and Standley (1919) and McAtee (1918) were the first to describe the magnolia bogs. These bogs were observed south of Beltsville and near Suitland. Sweet bay is one of the more common species, along with the following: peat mosses, cypress witchgrass (*Dicanthelium dichotomum*), southern bog clubmoss (*Lycopodium appressum*), Virginia cotton-grass (*Eriophorum virginicum*), white beak-rush, few-

Figure 6-10. Eagle Hill bog in Anne Arundel County. (David Burke photo)

flower nutrush (*Scleria pauciflora*), hairy umbrella-sedge (*Fuirena squarrosa*), yellow-eyed grass, ten-angle pipewort, coastal false-asphodel (*Tofieldia racemosa*), white-fringed orchid (*Platanthera blephariglottis*), bog orchid (*P. clavellata*), rose pogonia, grass-pink (*Calopogon tuberosus*), wax myrtle, sundews, black chokeberry (*Aronia melanocarpa*), downy serviceberry (*Amelanchier arborea*), cross-leaf milkwort (*Polygala cruciata*), Virginia meadow-beauty, swamp azalea, sheep laurel, zig-zag bladderwort (*Utricularia subulata*), southern wild raisin, and hairy thorough-wort (*Eupatorium pilosum*). The bogs were usually underlain by gravel and located on sloping ground, next to a stream. Magnolia bogs still occur on the Oxon Run floodplain near Suitland (R.C. Dintaman, pers. comm.).

Emergent Wetlands

Emergent wetlands on the Coastal Plain may be characterized by a wide range of plants, depending on water regime. This region probably has the highest diversity of emergent wetland communities in the state, since both tidal and nontidal freshwater marshes occur here.

Tidal Fresh Marshes

Tidal freshwater marshes are common along large coastal rivers, such as the Nanticoke, Chester, Choptank, Pocomoke, Patuxent, and Potomac Rivers. They occur between the oligohaline (slightly brackish) marshes and the tidal freshwater swamps upstream. Tidal fresh marshes are probably maintained by two factors: the frequency and duration of tidal flooding and perhaps, we speculate, by periodic episodes of salt water intrusion. Such intrusion may favor the growth of herbaceous vegetation over woody species and prevent succession to forested wetlands at these locations. Rising sea level is perhaps accelerating this process and facilitating the replacement of forested wetlands with marshes, as is occurring along Delmarva salt and brackish marshes. Some tidal marshes may have higher levees colonized by trees bordering the streams. This situation occurs along Western Shore marshes on the Patuxent, Gunpowder, and Port Tobacco Rivers (Bill Sipple, pers. comm.).

Tidal fresh marshes may have a more diverse assemblage of plants from the oligohaline estuarine marshes just downstream. Sipple (1990, 1978) reported an increase from an average of 20 species to an average of 28 species along the Patuxent River from Cocktown Creek (fresh-brackish transition) to above Ferry Landing (tidal fresh). Common species of tidal fresh marshes may include cattails, big cordgrass, common reed, three-squares, river bulrush, switchgrass, rose mallow, wild rice (*Zizania aquatica*), fall panic grass, rice cutgrass, wood reed, Walter millet, three-way sedge (*Dulichium arundinaceum*), water-willow, climbing

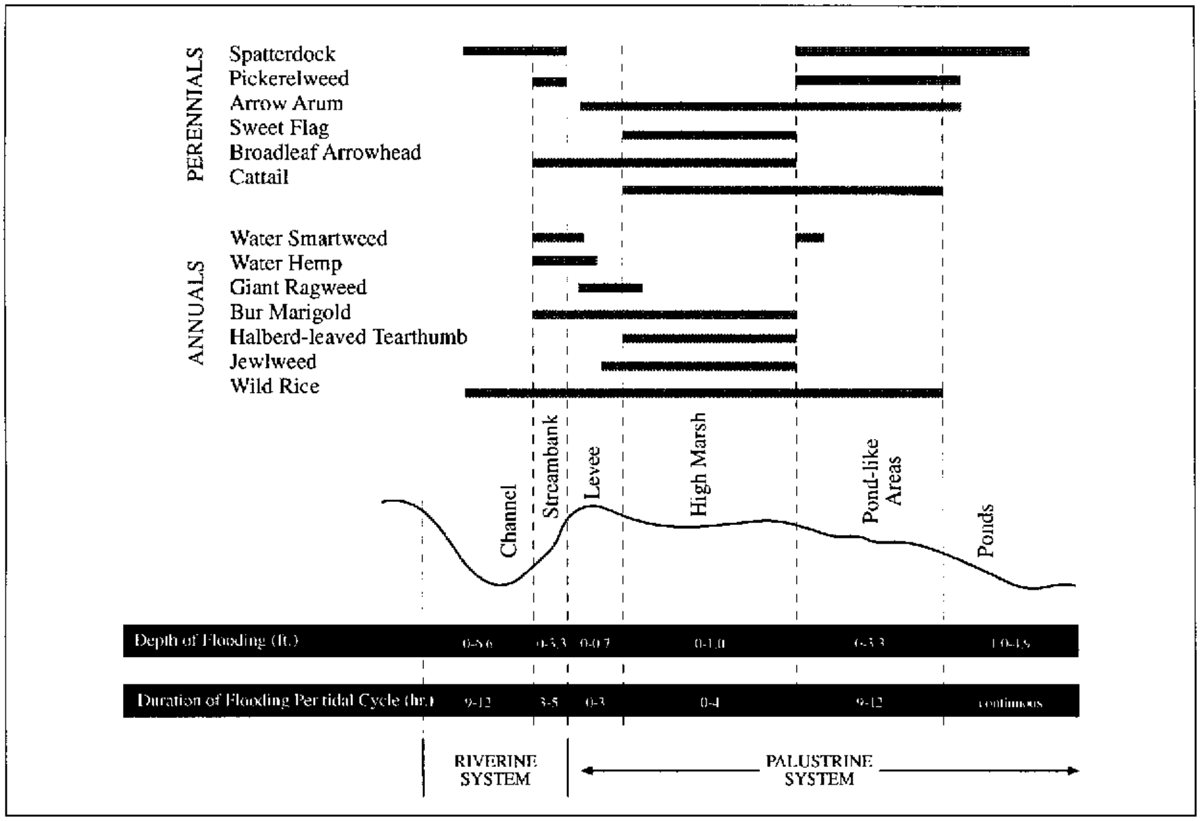

Figure 6-11. Generalized plant zonation in a freshwater tidal marsh in New Jersey, somewhat similar patterns occur in Maryland, although there undoubtedly are differences, e.g. sweet flag may also occur on streambank. (Redrawn from Simpson *et al.* 1983) Note that vegetation occurs in two systems—Riverine and Palustrine.

hempweed, water parsnip, golden club (*Orontium aquaticum*), bur-marigold (*Bidens laevis*), beggar-ticks (*Bidens cernua, B. coronata,* and *B. frondosa*), sneezeweed (*Helenium autumnale*), white panicled aster (*Aster lanceolatus,* formerly *A. paniculatus*), clearweed, greater bur-reed, spike-rushes, sedges, jewelweed, tearthumbs (*Polygonum arifolium* and *P. sagittatum*), and smartweeds (especially *P. punctatum*) plus low marsh plants typical of oligohaline marshes, especially spatterdock, arrow arum, pickerelweed, big arrowhead, and sweet flag. Extensive monospecific stands of spatterdock, pickerelweed, and arrow arum may exist, as reported by Sipple (1990) along the Pocomoke and Choptank Rivers. McCormick and Somes (1982) recognized numerous dominance types of tidal fresh marshes (Table 6-27). It is interesting to note that common reed was not common in Maryland in the early 1900s (Shreve 1910). Baxter (1973) and Sipple (1980) reported that common reed has replaced wild rice in many marshes along the Patuxent River due to increased sedimentation from eroded uplands in the watershed. Table 6-28 lists most, if not all, of the more significant species found in Maryland's tidal fresh marshes. Various woody plants, such as swamp rose, buttonbush, smooth alder, common elderberry, wax myrtle, and red maple (saplings), may be intermixed with the herbaceous species. Oftentimes, tidal fresh marsh communities have high diversity and, therefore, are vital habitats for the preservation of biodiversity.

The changing vegetative appearance (e.g., seasonal dominance and aspect) of tidal fresh marshes has been reported in numerous areas along the Atlantic and Gulf coasts (McCormick and Somes 1982, Eleuterius 1972, McCormick and Ashbaugh 1972, Ecological Analysts, Inc. 1978, Shima *et al.* 1976, Sipple 1990). Seasonal changes in dominants typically occur in these wetlands. Along Piscataway Creek on the Western Shore, sweet flag predominated in the spring, died-back in summer, and was replaced in the fall by jewelweed, tearthumbs, and smartweeds (Ecological Analysts, Inc. 1978). Shima and others (1976) also noted the following as fall dominants along the Patuxent River: tearthumbs, rose mallow, jewelweed, and a sedge. Seasonal vegetation changes in tidal fresh marshes are attributed to varying species growth rates and their flowering sequence (Sipple 1990).

Tidal fresh marshes may exhibit a distinct zonation pattern (low marsh v. high marsh) due to the frequency and duration of tidal flooding. Simpson and others (1983) and Whigham and Simpson (1975) have described this zonation for the Delaware River (Figure 6-11), while Shreve (1910) outlined the following zonation for Maryland. Spatterdock occurs at the water's edge just above mean sea level. This zone has the longest hydroperiod. The next zone is dominated by arrow arum, pickerelweed, big-leaved arrowhead, and river bulrush. Rose mallow may be locally abundant in this zone. Although not mentioned by Shreve, wild rice may be expected to be common in this zone in summer and early fall. Cattails are also expected to occur at the higher levels.

Interdunal Wet Swales

Wet swales between the dunes on Assateague Island and similar environs represent a distinctive type of palustrine emergent wetland. These swales are areas where the water table is in close contact with the land surface. As a result of this surface wetness, hydrophytic plants have colonized these sites in marked contrast to the xeric species of neighboring dunes.

Dominant plants of interdunal swales are common three-square, salt hay grass, and rabbit-foot grass (Higgins *et al.* 1971; personal observations). Associated plants may include wax myrtle, big cranberry, marsh fern, needlepod rush (*Juncus scirpoides)*, turnflower rush (*J. biflorus*), Canada rush (*J. canadensis*), grass-leaved goldenrod, seaside goldenrod, beak-rushes (*Rhynchospora* spp.), foxtail grass, mock bishop-weed, dotted smartweed, straw sedge (*Carex hormathodes*), Virginia meadow-beauty, many-flower pennywort (*Hydrocotyle umbellata*), Carolina yellow-eyed grass, bugleweed (*Lycopus americanus*), and pink wild bean (*Strophostyles umbellata*). Purple gerardia, salt marsh pink, and narrow-leaved cattail may also occur in these wetlands (Bill Sipple, pers. comm.)

Semipermanently Flooded Marshes

Semipermanently flooded marshes are dominated by several species including broad-leaved and narrow-leaved cattails, spatterdock, arrow arum, water-willow, and bur-reeds (*Sparganium* spp.). Also common are duckweeds (*Spirodela polyrhiza* and *Lemna* spp.), rose mallow, big arrowhead, pickerelweed, blue flag, and various aquatic species such as white water lily (*Nymphaea odorata*). Water shield (*Brasenia schreberi*) may occur less commonly.

Seasonally Flooded Marshes

Dominant emergents in seasonally flooded marshes include rice cutgrass, broad-leaved cattail, narrow-leaved cattail, soft rush, arrow arum, switchgrass, wool grass, and sedges. Reed canary grass (*Phalaris arundinacea*) may be dominant on the Western Shore, but is more common further inland in the Piedmont region. Common herbs are jewelweed, tearthumbs, smartweeds, willow-herbs (*Epilobium* spp.), common reed, beak-rushes, beggar-ticks, Virginia meadow-beauty, boneset (*Eupatorium perfoliatum*), big arrowhead (*Sagittaria latifolia*), spike-rushes, and Joe-Pye-weeds (*Eupatoriadelphus* spp.). Other herbs include lowland broom-sedge and skunk cabbage. An herbaceous vine—climbing hempweed—may be present. Peat mosses (*Sphagnum* spp.) may occur in some of the wettest of the seasonally flooded marshes. Various shrubs may be intermixed with the herbs, including buttonbush, swamp rose, common elderberry, southern arrowwood, southern wild raisin, silky dogwood, smooth alder, and saplings of red maple, sweet gum, black gum, and black willow.

Sipple and Klockner (1984) described a wet savanna along Cypress Creek in Anne Arundel County as one of several uncommon wetlands on Maryland's Coastal Plain. This wetland was dominated by twig-rush and white beak-rush, with scattered shrubs of Atlantic white cedar and a ground cover of peat mosses. Plants from 47 taxa were found in this savanna (Sipple and Klockner 1980). White beak-rush also characterized two other bogs in this County.

On the Eastern Shore in the vicinity of Millington and Sudlersville, isolated wetlands variously called "potholes," "Carolina bays," or "Delmarva bays" exist in somewhat circular depressions (see Figure 4-2; Sipple and Klockner 1984, Tyndall *et al.* 1990). These wetlands are most common in a five-county region on the Delmarva Peninsula: Caroline, Kent, and Queen Annes Counties in Maryland and Kent and New Castle Counties in Delaware. Similar wetlands occur along the Atlantic Coastal Plain from New Jersey to Florida, with concentrations in the Carolinas (Tyndall *et al.* 1990). Eastern Shore potholes may be dominated by trees, shrubs, or emergent vegetation in various combinations. Those characterized by the latter are called "glades." Common dominants include Walter's sedge (*Carex walteriana*), giant beardgrass (*Erianthus giganteus*), maidencane (*Panicum hemitomom*), Virginia meadow-beauty, loose-head beak-rush (*Rhynchospora charalocephala*), warty panic grass (*Panicum verrucosum*), water-willow, twig-rush, and smartweeds (Sipple and Klockner 1984, Boone *et al.* 1984, Tyndall *et al.* 1990). Peat mosses form the groundcover, while scattered buttonbush, sweet gum, red maple, and persimmon may be present. Tyndall and others (1990) described plant zonation within six Carolina bays. A fetterbush zone formed the border between the adjacent forest and the emergent wetlands. Maidencane and warty panic grass often represent the next zone. Various emergent species dominated zones within the marsh, including Virginia meadow-beauty, Walter's sedge, netted nutrush (*Scleria reticularis*), and creeping seedbox (*Ludwigia sphaerocarpa*). Such zonation patterns with an inner community of herbs and an outer zone of trees is typical of Carolina bays (Sharitz and Gibbons 1982). Species in the herbaceous zones may vary annually due to hydrologic conditions. Table 6-29 lists characteristic plants of Eastern Shore glades.

Temporarily Flooded Wet Meadows

Temporarily flooded wet meadows may be dominated by soft rush, common reed, Walter millet, goldenrods (*Solidago* spp. and *Euthamia* spp.), Joe-Pye-weeds, New York ironweed (*Vernonia noveboracensis*), and asters, as well as many other grasses and sedges. Soft rush often dominates heavily grazed wet meadows. Many emergent wetlands are temporary successional communities being the result of recent timber harvest. Lowland broom-sedge and wool grass are common dominant species in these cutover areas (Figure 6.8). See discussion under temporary flooded swamp forests in this section for details.

Piedmont Wetlands

Forested Wetlands

Forested wetlands within the Piedmont are typically found on floodplains in stream valleys (Plate 14). The two most common types are distinguished on the basis of flooding frequency and duration: (1) seasonally flooded forested wetland and (2) temporarily flooded forested wetland. The former type is flooded more often and for longer periods (i.e., usually more than two weeks during the growing season) than the latter, which is flooded only briefly (about a week or less), usually during early spring. Forested swamps in this region are dominated by broad-leaved deciduous trees.

Seasonally Flooded Swamp Forests

Red maple is the principal dominant of seasonally flooded forested wetlands called red maple swamps. Black willow and green ash are common and may frequently be co-dominant with red maple (Table 6-30). Red maple-green ash swamps are relatively common. Other trees present, but usually less numerous, include ironwood (*Carpinus carolinianus*), tulip poplar, American elm, swamp white oak, pin oak, box elder, black gum, river birch, white ash (*Fraxinus americana*), and sycamore. Many of these trees are more abundant and typical of temporarily flooded swamps. Sweet gum and black walnut (*Juglans nigra*) are uncommon associates. A dense understory of shrubs and emergents usually characterizes seasonally flooded swamps. Spicebush and southern arrowwood are perhaps the most frequently occurring shrub associates. Other understory shrubs include common elderberry, smooth alder, multiflora rose (*Rosa multiflora*), silky dogwood, and winterberry. Highbush blueberry, swamp azalea, and sweet pepperbush may occur near the coast in the Fall Zone, but they are not typical of the Piedmont. Poison ivy and brambles (*Rubus* spp.) are less common. Skunk cabbage is a characteristic and the predominant herb in many red maple swamps (Plate 15). Other frequently occurring and sometimes abundant herbs are tussock sedge, other sedges, lizard's tail, cardinal flower, royal fern, cinnamon fern, wood reed, false nettle, tearthumbs, smartweeds, manna grasses, beggar-ticks, and jewelweed. Asiatic tearthumb (*Polygonum perfoliatum*), an invasive exotic, may be abundant in more open areas in floodplain swamps. Less abundant emergents include three-way sedge, arrow arum, soft rush, sensitive fern, clearweed, skullcaps (*Scutellaria* spp.), blue flag, jack-in-the-pulpit (*Arisaema triphyllum*), asters, green-headed coneflower (*Rudbeckia laciniata*), white grass (*Leersia virginica*), deer-tongue, stinging nettle (*Urtica dioica*), tall meadow-rue (*Thalictrum pubescens*), and lady's thumb (*Polygonum persicaria*). The herbaceous layer is more diverse in swamps with relatively open canopies. Vines are also quite common in many areas and they include grapes, climbing hempweed (in more open areas), poison ivy, and, on occasion, common greenbrier and Japanese honeysuckle.

Temporarily Flooded Swamp Forests

Temporarily flooded forested wetlands occur on floodplains of rivers and streams throughout the Piedmont. They may be dominated by one or more of the following trees: red maple, sycamore, pin oak, silver maple (*Acer saccharinum*), green ash, tulip poplar, box elder, black walnut, and black locust (*Robinia pseudoacacia*) (Table 6-31). Brush and others (1980) reported the sycamore-green ash-box elder-silver maple association was characteristic of all floodplains in the Piedmont. On the Potomac River floodplain, eastern cottonwood (*Populus deltoides*) and silver maple may co-dominate, with sycamore and black willow also common. Ironwood is sometimes a common subcanopy species. Less common trees are bitternut hickory, shagbark hickory (*Carya ovata*), American basswood (*Tilia americana*), American elm, beech, white ash, common hackberry (*Celtis occidentalis*), black cherry (*Prunus serotina*), and choke cherry (*Prunus virginiana*). The shrub understory is usually not as dense as in seasonally flooded forests, but common species include multiflora rose, spicebush, southern arrowwood, and silky dogwood. Pawpaw may be common at higher levels in floodplain forests. Less common shrubs may include common

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Table 6-5. Examples of salt and brackish marsh communities observed in Maryland.

Dominance Type (Location)	Common Associates	Less Common Species
Black Needlerush (Dorchester County)	Salt Grass	High-tide Bush, Seaside Goldenrod, Marsh Orach
Black Needlerush (Somerset County)	None	Salt Grass, Sea Lavender, Salt Hay Grass (in openings)
Common Reed (Kent County)	Rose Mallow, Mock Bishop-weed, Salt Hay Grass, Black Grass, Olney Three-square	None
Common Reed (Long Point, Queen Annes County)	None	None
Narrow-leaved Cattail-Salt Hay Grass-Salt Grass (Dorchester County)	Rose Mallow, High-tide Bush, Salt Marsh Bulrush, Switchgrass, Black Needlerush, Olney Three-square	Broad-leaved Cattail, Spike-rush, Wax Myrtle, Black Grass
Olney Three-square (Dorchester County)	None	Switchgrass, Cattails, Salt Marsh Bulrush, Salt Grass, High-tide Bush, Wax Myrtle
Olney Three-square (Kent Island, Kent County)	Seashore Mallow, Salt Hay Grass, Salt Grass	Salt Marsh Pink, High-tide Bush, Groundsel-bush, Salt Marsh Fleabane, Salt Marsh Fimbristylis, Common Reed (edge)
Olney Three-square (Muddy Creek, Queen Annes County)	Black Needlerush, Seashore Mallow, Salt Hay Grass	Seaside Gerardia, Salt Marsh Fimbristylis, Salt Marsh Aster, Flatsedge, Salt Marsh Fleabane, Salt Marsh Loosestrife
Salt Hay Grass (Patuxent River, Charles County)	Smooth Cordgrass, Common Reed	Arrow Arum, Salt Marsh Fleabane, High-tide Bush, Big Cordgrass, Olney Three-square, Rose Mallow, Groundsel-bush
Salt Hay Grass (Kent County)	None	Salt Marsh Loosestrife, Salt Marsh Pink, High-tide Bush, Marsh Orach
Salt Hay Grass (Muddy Creek, Queen Annes County)	Salt Marsh Fimbristylis	Salt Grass, Seashore Mallow, Salt Marsh Fleabane, Salt Marsh Bulrush, Seaside Goldenrod
Salt Hay Grass-Black Needlerush-High-tide Bush (Somerset County)	Groundsel-bush, Salt Marsh Aster, Seaside Goldenrod, Salt Grass (wetter sites)	Salt Marsh Bulrush, Wax Myrtle, Foxtail Grass
Salt Hay Grass-Salt Grass (Somerset County)	Seaside Goldenrod, Groundsel-bush, High-tide Bush	Poison Ivy, Wax Myrtle, Common Reed, Salt Marsh Bulrush, Grass-leaved Goldenrod, Flatsedge
Smooth Cordgrass (Long Point, Queen Annes County)	Salt Hay Grass, Salt Grass	Salt Marsh Fleabane, Black Needlerush, Common Reed, Aster, Marsh Orach, Water Hemp, Seaside Gerardi
Smooth Cordgrass (Worcester County)	None	None
Spike-rush-Switchgrass (Caroline County)	Rose Mallow, Water Hemp, Umbrella Sedge, Mock Bishop-weed, Dwarf Spike-rush, Aster, Salt Hay Grass, Olney Three-square	Rush, Walter Millet, Flatsedge

Table 6-6. Examples of oligohaline wetland plant communities observed in Maryland. Communities marked with an asterisk (*) are scrub-shrub wetlands; the remainder are emergent types.

Dominance Type (Location)	Common Associates	Less Common Species
Big Cordgrass (Graham Creek/Patuxent River, Calvert County)	Arrow Arum, Narrow-leaved Cattail, Smooth Cordgrass, Olney Three-square	Water Parsnip, Pickerelweed, Arrow-leaved Tearthumb, Swamp Milkweed, Big Arrowhead, Rose Mallow, Walter Millet, Seashore Mallow, Hedge Bindweed
Big Cordgrass (Allens Fresh Run, Charles County)	Narrow-leaved Cattail, Rose Mallow, Seashore Mallow, Three-squares, Halberd-leaved Tearthumb, Pickerelweed, Climbing Hempweed	Wax Myrtle (edge)
Big Cordgrass-Narrow-leaved Cattail (Morgan Creek, Kent County)	Rose Mallow, Common Reed	Smooth Cordgrass, Arrow Arum
Mixed Community (Patuxent River, Charles County)	Big Cordgrass, High-tide Bush, Groundsel-bush, Salt Grass, Olney Three-square, Common Reed, Salt Hay Grass, Smooth Cordgrass, Salt Marsh Fleabane	Narrow-leaved Cattail, Arrow Arum, Seashore Mallow
Narrow-leaved Cattail (St. Marys County)	Rose Mallow, Swamp Rose, Dodder	Wool Grass, Black Willow (edges)
Narrow-leaved Cattail-Switchgrass (Chicamacomico River, Dorchester County)	Rose Mallow	Smartweed, Big Cordgrass, Wax Myrtle
Narrow-leaved Cattail-Olney Three-square (Transquaking River, Dorchester County)	Rose Mallow	Seashore Mallow, Switchgrass, Common Reed, Big Cordgrass (creekside levee)
Narrow-leaved Cattail-Rose Mallow (Manokin River, Somerset County)	Arrow Arum	Big Cordgrass, Arrow-leaved Tearthumb, Climbing Hempweed, Sedge, Swamp Rose, Aster, Smartweed, Water-willow
Switchgrass (Chicamacomico River, Dorchester County)	Olney Three-square, Narrow-leaved Cattail, Salt Hay Grass	Smartweed
*Wax Myrtle (Chicamacomico River, Dorchester County)	Rose Mallow, Salt Hay Grass, Poison Ivy, Swamp Rose	Seashore Mallow, Red Cedar, Red Maple, Loblolly Pine
*Wax Myrtle (Assateague, Worcester County)	Poison Ivy, Wool Grass, Common Reed, Climbing Hempweed, Switchgrass	False Nettle, Canada Rush, Dwarf St. John's-wort, Mock Bishop-weed, Virginia Rye Grass

Table 6-7. Plant species often occurring in oligohaline marshes (Thompson 1974 and personal observations).

Salt/Brackish Water Species	Fresh Water Species
Grass or Grasslike Plants:	***Aquatic Bed Plants:***
Fragrant Galingale (*Cyperus odoratus*)	Spatterdock (*Nuphar luteum*)
Creeping Spike-rush (*Eleocharis palustris*)	White Water Lily (*Nymphaea odorata*)
Dwarf Spike-rush (*Eleocharis parvula*)	***Grass and Grasslike Plants:***
Beaked Spike-rush (*Eleocharis rostellata*)	Sedges (*Carex* spp.)
Canada Rush (*Juncus canadensis*)	Wood Reed (*Cinna arundinacea*)
Switchgrass (*Panicum virgatum*)	Twig-rush (*Cladium mariscoides*)
Common Reed (*Phragmites australis*)	Umbrella Sedges (*Cyperus* spp.)
Foxtail Grass (*Setaria geniculata*)	Three-way Sedge (*Dulichium arundinaceum*)
Giant Foxtail (*S. magna*)	Walter Millet (*Echinochloa walteri*)
Olney Three-square (*Scirpus americanus*)	Soft Rush (*Juncus effusus*)
Common Three-square (*S. pungens*)	Fall Panic Grass (*Panicum dichotomiflorum*)
Salt Marsh Bulrush (*Scirpus robustus*)	Panic Grasses (*Panicum* spp.)
New England Bulrush (*S. cylindricus*)	Reed Canary Grass (*Phalaris arundinacea*)
Big Cordgrass (*Spartina cynosuroides*)	Brownish Beak-rush (*Rhynchospora capitellata*)
Salt Hay Grass (*S. patens*)	Wool Grass (*Scirpus cyperinus*)
Smooth Cordgrass (*S. alterniflora*)	River Bulrush (*S. fluviatilis*)
Herbs:	Soft-stemmed Bulrush (*S. validus*)
Water Hemp (*Amaranthus cannabinus*)	Wild Rice (*Zizania aquatica*)
Small-flowered Salt Marsh Aster (*Aster subulatus*)	***Herbs:***
Grass-leaved Goldenrod (*Euthamia graminifolia*)	Sweet Flag (*Acorus calamus*)
Purple Gerardia (*Gerardia purpurea*)	Swamp Milkweed (*Asclepias incarnata*)
Rose Mallow (*Hibiscus moscheutos*)	Swamp Aster (*Aster puniceus*)
Seashore Mallow (*Kosteletzkya virginica*)	Bur-marigold (*Bidens laevis*)
Eastern Lilaeopsis (*Lilaeopsis chinensis*)	Beggar-ticks (*Bidens* spp.)
Salt Marsh Fleabane (*Pluchea purpurascens*)	Partridge Pea (*Cassia fasciculata*)
Curly Dock (*Rumex crispus*)	Water Hemlock (*Cicuta maculata*)
Large Marsh Pink (*Sabatia dodecandra*)	Water-willow (*Decodon verticillatus*)
Salt Marsh Pink (*Sabatia stellaris*)	Rattlesnake Master (*Eryngium aquaticum*)
American Germander (*Teucrium canadense*)	Maryland Meadow-beauty (*Rhexia mariana*)
Narrow-leaved Cattail (*Typha angustifolia*)	Boneset (*Eupatorium perfoliatum*)
Water Pimpernel (*Samolus parviflorus*)	Bedstraws (*Galium* spp.)
Shrubs:	Hedge-hyssops (*Gratiola* spp.)
Groundsel-bush (*Baccharis halimifolia*)	Sneezeweed (*Helenium autumnale*)
High-tide Bush (*Iva frutescens*)	Swamp Dock (*Rumex verticillatus*)
Wax Myrtle (*Myrica cerifera*)	Water Pennywort (*Hydrocotyle ranunculoides*)
Poison Ivy (*Toxicodendron radicans*)	Marsh Pennywort (*H. umbellata*)
Vines:	St. John's-wort (*Hypericum* spp.)
Climbing Hempweed (*Mikania scandens*)	Jewelweed (*Impatiens capensis*)
	Yellow Flag (*Iris pseudacorus*)
	Blue Flag (*I. versicolor*)
	Seedbox (*Ludwigia alternifolia*)
	Water Horehound (*Lycopus americanus*)
	Bugleweed (*L. virginicus*)
	Purple Loosestrife (*Lythrum salicaria*)
	Golden Club (*Orontium aquaticum*)
	Royal Fern (*Osmunda regalis*)
	Arrow Arum (*Peltandra virginica*)
	Clearweed (*Pilea pumila*)
	Halberd-leaved Tearthumb (*Polygonum arifolium*)
	Cespitose Knotweed (*P. caespitosum*)
	Mild Water-pepper (*P. hydropiper*)
	Water-pepper (*P. hydropiperoides*)
	Pinkweed (*P. pennsylvanicum*)
	Lady's Thumb (*P. persicaria*)

Table 6-7. (continued)

	Fresh Water Species (continued)
	Herbs (continued): Water Smartweed (*P. punctatum*) Arrow-leaved Tearthumb (*P. sagittatum*) Pickerelweed (*Pontederia cordata*) Mock Bishop-weed (*Ptilimnium capillaceum*) Bull-tongue (*Sagittaria falcata*) Big-leaved Arrowhead (*Sagittaria latifolia*) Lizard's Tail (*Saururus cernuus*) Water Parsnip (*Sium suave*) Bur-reeds (*Sparganium* spp.) Marsh Fern (*Thelypteris thelypteroides*) Marsh St. John's-wort (*Triadenum virginicum*) Broad-leaved Cattail (*Typha latifolia*) Blue Vervain (*Verbena hastata*) ***Vines:*** Ground-nut (*Apios americana*) Hedge Bindweed (*Calystegia sepium*) Virginia Creeper (*Parthenocissus quinquefolia*) Trailing Wild bean (*Strophostyles helvola*) ***Shrubs:*** Swamp Rose (*Rosa palustris*)

Table 6-8. Examples of estuarine scrub-shrub and forested wetland communities observed in Maryland.

Dominance Type (Location)	Common Associates	Less Common Species
High-tide Bush-Rose Mallow (Rockhold Creek, Anne Arundel County)	Salt Hay Grass, Seaside Goldenrod	Big Cordgrass, Groundsel-bush, Salt Grass, Smooth Cordgrass, Seashore Mallow
High-tide Bush-Salt Hay Grass (Dorchester County)	Salt Grass, Black Needlerush, Switchgrass, Groundsel-bush	Olney Three-square, Smooth Cordgrass, Marsh Orach
High-tide Bush-Salt Marsh Bulrush (Church Creek, Dorchester County)	None	Salt Grass, Marsh Orach, Common Reed, Cattail, Switchgrass, Seaside Goldenrod, Water Dock
High-tide Bush-Salt Grass (St. Marys County)	None	Black Grass, Big Cordgrass, Salt Marsh Bulrush, Rose Mallow, Seaside Goldenrod, Smooth Cordgrass, Salt Hay Grass, Red Cedar
Loblolly Pine-Salt Hay Grass (Monie Bay Estuarine Sanctuary, Somerset County)	Groundsel-bush, Poison Ivy, Common Reed, Switchgrass	Wax Myrtle, Salt Marsh Aster, Swamp Rose, American Holly, High-tide Bush, Grass-leaved Goldenrod, Narrow-leaved Cattail, Spike-rush, Lowland Broom-sedge (on berm)
Loblolly Pine-Salt Hay Grass (Upper Fairmont, Somerset County)	Groundsel-bush, High-tide Bush	Salt Marsh Aster, Salt Marsh Bulrush, Poison Ivy, Wax Myrtle, Rose Mallow

Table 6-9. Salinity ranges of tidal aquatic plants. Based largely on Stewart (1962) and Anderson (1972) as reported by McCormick and Somes (1982).

	Saline	Highly Brackish	Moderately Brackish	Slightly Brackish	Fresh
Sea Lettuce (*Ulva lactuca*)	x	x	x		
Green Algae (*Enteromorpha* sp.)	x	x	x		
Eelgrass (*Zostera marina*)	x	x	x		
Widgeongrass (*Ruppia maritima*)	x	x			
Horned Pondweed (*Zannichellia palustris*)		x	x	x	x
Sago Pondweed (*Potamogeton pectinatus*)		x	x	x	x
Redhead-grass (*P. perfoliatus*)		x	x	x	x
Eurasian Water-milfoil (*Myriophyllum spicatum*)		x	x	x	x
Common Waterweed (*Elodea densa*)			x	x	x
Muskgrasses (*Chara* spp.)			x	x	x
Curly Pondweed (*P. crispus*)			x	x	x
Wild Celery (*Vallisneria americana*)				x	x
Southern Naiad (*Najas guadalupensis*)				x	x
Small Pondweed (*P. pusillus*)				x	x
Coontail (*Ceratophyllus demersum*)				x	x
Slender Naiad (*N. flexilis*)			x		x
Water Chestnut (*Trapa natans*)				x	x
Hydrilla (*Hydrilla verticillata*)				x	x
White Water Lily (*Nymphaea odorata*)				x	x
Nuttall's Waterweed (*Elodea nuttallii*)					x
Other Pondweeds: (*P. amplifolius, P. epihydrus, P. foliosus, P. gramineus, P. nodosus, P. robbinsii*)					x
Cutleaf Water-milfoil (*M. tenellum*)					x
Threadlike Naiad (*N. gracillima*)					x
Water Star-grass (*Zosterella dubia*)					x

Table 6-10. Vegetation of Eastern Shore swamps and floodplains according to Shreve (1910a).

Wetland Type	Common Associates
Clay Upland Swamps	Trees: Sweet Gum, White Oak, Black Gum, Willow Oak, Red Maple, Swamp White Oak, Loblolly Pine; also less commonly, American Holly, Basket Oak Shrubs: Sweet Pepperbush, Maleberry, Highbush Blueberry, Swamp Azalea, Fetterbush, Southern Arrowwood, Virginia Sweet-spires, Black Haw, Sweet Bay, Common Winterberry, Flowering Dogwood, Smooth Alder Herbs: Sedges (*Carex caroliniana, C. comosa, C. lupulina, C. hirta*), and Pale Manna Grass (*Glyceria pallida*) Others: Peat Moss
Sandy-Loam Upland Swamps	Trees: Loblolly Pine, Willow Oak, White Oak, Sweet Gum, Red Maple, Water Oak, Basket Oak, Black Gum, Sweet Bay, American Holly, Flowering Dogwood; also less commonly, Fringe-tree, River Birch Shrubs: Wax Myrtle, Southern Arrowwood, Poison Sumac, Staggerbush, Virginia Sweet-spires, Devil's Walking Stick, Red Chokeberry, American Strawberrybush Herbs: Not specified Others: Peat Moss
Wetter Floodplain Forests	Trees: Red Maple, Black Gum, White Ash, Sweet Bay Shrubs: Common Winterberry, Sweet Pepperbush, Smooth Alder, Southern Arrowwood, Buttonbush, Poison Sumac Herbs: Lizard's Tail, Cinnamon Fern, Sensitive Fern, Golden Saxifrage, Turtlehead, Marsh St. John's-wort, Jewelweed, Sweet White Violet, Cursed Crowfoot, Bladder Sedge, Sweet-scented Bedstraw
Sandy Floodplains	Trees: Loblolly Pine, Water Oak, American Holly, Black Gum, Sweet Bay, White Ash, Fringe-tree, Flowering Dogwood, Ironwood Shrubs: Sweet Pepperbush, Southern Arrowwood, Pink Azalea, American Strawberrybush Herbs: Partridgeberry, Bladder Sedge, Long Sedge, Sedge (*Carex laxiculmis*) Vines: Common Greenbrier, Virginia Creeper, Fox Grape, Trumpet Creeper, Wild Yam
Drier Floodplain Forests	Trees: Tulip Poplar, Ironwood, Sweet Gum, White Ash, Sycamore, American Elm,Willow Oak, Red Maple, Black Gum Shrubs: Spicebush, Southern Arrowwood, American Strawberrybush Herbs: Virginia Grape Fern, White Grass, Smooth Solomon's-seal, Jack-in-the-pulpit, Sweet White Violet, Swamp Aster, Wood Sorrel
Upland Swamps of Wicomico Terrace	Trees: Black Gum, Swamp White Oak, Red Maple, Sweet Gum, Willow Oak, White Oak; also American Holly, Beech, Sweet Bay, Swamp Cottonwood Shrubs: Virginia Sweet-spires, Red Chokeberry, Swamp Azalea Herbs: Water Smartweed, Inflated Bladderwort, Mermaid-weed
River Swamps	Trees: Bald Cypress (outer zone), Black Gum, Red Maple, Sweet Gum, Swamp Black Gum, Green Ash, Sweet Bay; also less commonly, Tulip Poplar, Ironwood, Swamp Cottonwood, Water Oak, Atlantic White Cedar (outer zone), Loblolly Pine, White Oak, American Holly (inner zone) Shrubs: Wax Myrtle, Sweet Pepperbush, Maleberry, Smooth Alder, Buttonbush, Silky Dogwood, Southern Arrowwood, Staggerbush, Water-willow (Swamp Loosestrife), Dangleberry Vines: Trumpet Creeper, Grapes, Common Greenbrier, Virginia Creeper, Poison Ivy, Cross Vine Herbs: Dwarf St. John's-wort, Jewelweed, Water Pennywort, Marsh St. John's-wort, Marsh Fern, Cardinal Flower, Three-way Sedge, Water Primrose, Mermaid-weed, Lizard's Tail, False Nettle, Ditch Stonecrop, Virginia Bugleweed, Hoplike Sedge
Stream Swamps	Trees (small sized): Red Maple and Green Ash; also less commonly, Loblolly Pine, Atlantic White Cedar, Black Gum, Sweet Bay, Sweet Gum, Black Willow, Swamp White Oak, River Birch Shrubs: Common Winterberry, Sweet Pepperbush, Buttonbush, Smooth Alder, Water-willow (Swamp Loosestrife), Silky Dogwood, Virginia Sweet-spires, Poison Sumac, Southern Arrowwood, Swamp Rose Herbs: Broad-leaved Cattail, Cinnamon Fern, Jewelweed, Lizard's Tail, Royal Fern, Big-leaved Arrowhead, Water Hemlock, Water Dock, Arrow Arum, Pickerelweed, New York Ironweed, Water Pepper, Blue Flag, Mermaid-weed, Tall Meadow-rue, Marsh Blue Violet, False Nettle

Table 6-11. Examples of tidal swamp communities on Maryland's Eastern Shore. Communities marked with an asterisk (*) are temporarily flooded-tidal, while the rest are seasonally flooded-tidal.

Dominance Type (Location)	Common Associates	Less Common Species
Green Ash (Chicamacomico River, Dorchester County)	Winterberry, Highbush Blueberry, Fetterbush, Red Maple, Silky Dogwood, Sweet Pepperbush, Swamp Azalea, Tussock Sedge, Sweet Bay	Smooth Alder, Japanese Honeysuckle, Sweet Gum, Poison Ivy, Marsh Fern, Laurel-leaved Greenbrier, Common Greenbrier, Swamp Rose, Black Gum, Royal Fern, Wax Myrtle, Buttonbush, Rose Mallow, Mistletoe
Green Ash (Marshyhope Creek, Dorchester County)	Red Maple, Smooth Alder, Seaside Alder, Tussock Sedge	Common Winterberry, Sedge, Climbing Buckwheat, Poison Ivy, Laurel-leaved Greenbrier, Swamp Rose, Red Chokeberry, Sweet Bay, Highbush Blueberry, Sweet Pepperbush, Fetterbush, Maleberry, Swamp Azalea, Aster, Buttonbush, Climbing Hempweed, Umbrella Sedge
Green Ash (Dividing Creek, Somerset County)	Fetterbush, Swamp Azalea, Southern Arrowwood, Sedges	Bald Cypress, Winterberry, American Holly, Highbush Blueberry, Sweet Pepperbush, Cross Vine, Sweet Gum, Red Maple, Black Gum, Sweet Bay, Poison Ivy, Grape, Laurel-leaved Greenbrier, Wood Reed, Ironwood
Green Ash-Bald Cypress (Pocomoke River, Worcester County)	Common Greenbrier, Sweet Bay, Red Maple, Southern Arrowwood, Japanese Honeysuckle	Willow Oak, Poison Ivy, Serviceberry, Cross Vine, Southern Wild Raisin, Grape, Tall Meadow-rue Swamp Azalea, Sedges, Sweet Pepperbush, Fetterbush, Loblolly Pine
Green Ash-Black Gum (Wagram Creek, Worcester County)	Lizard's Tail, Sweet Gum	Cross Vine, River Birch, Red Maple, Winterberry
*Loblolly Pine-Wax Myrtle (Worcester County)	Cinnamon Fern, Royal Fern, Virginia Creeper, Poison Ivy, Sweet Gum, Grape, Common Greenbrier	Sensitive Fern, Trumpet Creeper
*Red Maple (Worcester County)	Willow Oak, Sweet Gum, Southern Arrowwood, Common Greenbrier, Virginia Creeper, Sedge, False Nettle	Sweet Bay, Elderberry, Grape, Cardinal Flower, Black Gum

Table 6-13. Examples of seasonally flooded palustrine (nontidal) forested wetland communities observed on the Lower Eastern Shore of Maryland. These communities are typical of the Lower Coastal Plain or the Gulf-Atlantic Coastal Flats of Hammond (1970).

Dominance Type (Location)	Associates
Swamp Black Gum (Wicomico County)	Trees: Red Maple, Sweet Bay, Green Ash, Sweet Gum Shrubs: Sweet Pepperbush, Fetterbush, Southern Wild Raisin Herbs: Bladder Sedge, False Nettle, Net-veined Chain Fern, Manna Grass, Devil's Beggar-ticks, Bugleweed, Long Sedge, Wood Reed, Lizard's Tail, Joe-Pye-weed Vines: Common Greenbrier
Loblolly Pine (Kings Creek, Somerset County)	Trees: Red Maple, Sweet Gum Shrubs: Wax Myrtle, Common Winterberry Herbs: Royal Fern, Sedge, Pennywort
Red Maple (Kentuck Swamp, Dorchester County)	Trees: Black Gum, Swamp Black Gum, Loblolly Pine, Willow Oak, Sweet Gum, Swamp White Oak, Southern Red Oak, Basket Oak Shrubs: Sweet Pepperbush, Common Winterberry, Highbush Blueberry, American Holly, Fetterbush Herbs: Slender Spike-grass, Bladder Sedge, Unidentified Grass, Sedges, White Grass, Panic Grass Others: Common Greenbrier, Grape, Japanese Honeysuckle, Partridgeberry, Poison Ivy
Red Maple (Somerset County)	Trees: Loblolly Pine, Sweet Bay, American Holly, Sweet Gum, Cherrybark Oak Shrubs: Southern Arrowwood, Silky Dogwood, Common Winterberry, Common Elderberry Herbs: Wood Reed, Cinnamon Fern, Net-veined Chain Fern, Sedge, False Nettle Others: Japanese Honeysuckle, Swamp Dewberry, Grape, Common Greenbrier
Red Maple (Wicomico County)	Trees: American Holly, Sweet Gum, Sweet Bay, Basket Oak Shrubs: Sweet Pepperbush Herbs: False Nettle, Virginia Chain Fern, Net-veined Chain Fern, Rice Cutgrass, Cinnamon Fern, Lizard's Tail (creek)
Red Maple (Wicomico County)	Trees: American Holly, Loblolly Pine, Sweet Bay Shrubs: Sweet Pepperbush, Highbush Blueberry, Fetterbush Herbs: Virginia Chain Fern, Cinnamon Fern Others: Peat Moss, Common Greenbrier
Red Maple (Little Mill Creek, Worcester County)	Trees: Sweet Bay, Loblolly Pine, Willow Oak, Sweet Gum, American Holly, Water Oak Shrubs: Common Winterberry, Highbush Blueberry, Southern Arrowwood, Sweet Pepperbush, Red Chokeberry Herbs: Sedge Others: Japanese Honeysuckle, Laurel-leaved Greenbrier
Red Maple-American Holly (Wicomico State Forest, Wicomico County)	Trees: Sweet Bay, Water Oak (edge), Sassafras (edge) Shrubs: Sweet Pepperbush, Highbush Blueberry, Fetterbush Herbs: Cinnamon Fern, Net-veined Chain Fern Others: Peat Moss, Common Greenbrier
Red Maple-Bald Cypress (Pocomoke River, Worcester County)	Trees/Saplings: Green Ash, Swamp Cottonwood, Water Tupelo Shrubs: Pawpaw, Elderberry, Fetterbush, Silky Dogwood, Smooth Alder, Swamp Rose, Winterberry, Spicebush Herbs: False Nettle, Jewelweed, Bladder Sedge, Lizard's Tail, Beggar-ticks, Wood Reed, Three-way Sedge, Cardinal Flower, Cinnamon Fern, Net-veined Chain Fern, Marsh Blue Violet, Water Horsetail, Arrow Arum, Royal Fern Others: Riverbank Grape
Red Maple-Basket Oak (Dorchester County)	Trees: Sweet Gum, Overcup Oak, Southern Red Oak, Black Gum, Sweet Bay, American Holly Shrubs: Sweet Pepperbush, Highbush Blueberry, Swamp Azalea Herbs: Sedge, Unidentified Grass Others: Common Greenbrier, Poison Ivy, Peat Moss
Red Maple-Basket Oak-Willow Oak (Dorchester County)	Trees: Loblolly Pine, Sweet Gum, White Oak Shrubs: Sweet Pepperbush, Highbush Blueberry Herbs: Slender Spike-grass, Sedge Others: Common Greenbrier, Partridgeberry (high spots), Peat Moss (depressions)

Table 6-13. (continued)

Dominance Type (Location)	Associates
Red Maple-Black Gum (Massey's Crossing, Worcester County)	Trees: Sweet Gum Shrubs: Elderberry, Spicebush Herbs: Pokeweed, False Nettle, Bristlebract Sedge, Spinulose Wood Fern, Hoplike Sedge, Wood Reed Others: Brambles, Japanese Honeysuckle, Poison Ivy
Red Maple-Green Ash (Wicomico River, Wicomico County)	Trees: Swamp Black Gum, Ironwood, Sweet Bay, American Holly, Black Gum, Atlantic White Cedar, Loblolly Pine, Tulip Poplar Shrubs: Spicebush, Sweet Pepperbush, Highbush Blueberry, Winterberry Herbs: Cinnamon Fern, Net-veined Chain Fern, Jack-in-the-pulpit, Royal Fern, Violet, Jewelweed, Wild Yam Others: Grape, Common Greenbrier, Partridgeberry, Poison Ivy
Red Maple-Loblolly Pine-Swamp White Oak (Wicomico County)	Trees: American Holly, Willow Oak, Sweet Bay, Black Gum Shrubs: Sweet Pepperbush, Highbush Blueberry Herbs: Sedges Others: Common Greenbrier, Peat Moss, Partridgeberry
Red Maple-Loblolly Pine-Sweet Gum (Wicomico County)	Trees: Black Gum, American Holly, Sweet Bay Shrubs: Highbush Blueberry, Sweet Pepperbush, Swamp Azalea, Dangleberry, Fetterbush, Winterberry Herbs: Sedge, Cinnamon Fern, Partridgeberry, Slender Spikegrass Others: Peat Moss, Common Greenbrier
Red Maple-Pin Oak (Worcester County)	Trees: American Holly, Sweet Bay, Sweet Gum, Loblolly Pine, Black Gum, Basket Oak, Ironwood, Devil's Walking-stick, Tulip Poplar Shrubs: Highbush Blueberry, Southern Arrowwood, Fetterbush Herbs: Sensitive Fern, Royal Fern, Cinnamon Fern, Jack-in-the-pulpit, Marsh Fern, Bladder Sedge, Lurid Sedge, Goldenrod, False Nettle, Big-leaved Arrowhead, Cardinal Flower, Soft Rush, Virginia Chain Fern, Marsh St. John's wort Others: Common Greenbrier, Peat Moss, Virginia Creeper, Partridgeberry, Blackberry, Hair-cap Moss
Red Maple-Sweet Gum (Winton Crossing, Worcester County)	Trees: American Elm, Ironwood, Sweet Bay, Black Gum, Bald Cypress, Swamp Cottonwood, American Holly, Pin Oak, Basket Oak Shrubs: Virginia Sweet-spires, Sweet Pepperbush, Spicebush (higher spot) Herbs: Sedges, Lizard's Tail, Net-veined Chain Fern, Wood Reed, White Grass, Royal Fern, Three-way Sedge Others: Cross Vine
Red Maple-Sweet Gum-Basket Oak-Overcup Oak-Willow Oak (Dorchester County)	Trees: American Holly, Beech, Loblolly Pine Shrubs: Highbush Blueberry, Sweet Pepperbush, Fetterbush, Red Chokeberry, Swamp Azalea, Huckleberry Herbs: Royal Fern, Wool Grass (low spots), Switchgrass, Unidentified Grass, Common Reed, Soft Rush Others: Peat Moss, Common Greenbrier, Partridgeberry (high spots)
Red Maple-Sweet Gum-Black Gum (Worcester County)	Trees: American Holly, Sweet Bay Shrubs: Highbush Blueberry, Fetterbush, Sweet Pepperbush Herbs: Sensitive Fern Others: Peat Moss, Common Greenbrier
Red Maple-Sweet Gum-Black Gum (Worcester County)	Trees: American Holly, Sweet Bay Shrubs: Highbush Blueberry, Fetterbush, Sweet Pepperbush Herbs: Sensitive Fern Others: Peat Moss, Common Greenbrier
Sweet Gum-Red Maple (Dorchester County)	Trees: American Holly, Sweet Bay, Tulip Poplar, Water Oak, White Oak Shrubs: Swamp Azalea, Southern Arrowwood, Black Haw, Sweet Pepperbush, Spicebush, Fetterbush Herbs: Net-veined Chain Fern, Royal Fern Others: Japanese Honeysuckle

Table 6-14. Examples of seasonally flooded palustrine (nontidal) forested wetland communities observed on the Upper Eastern Shore of Maryland. These communities are typical of the Lower Coastal Plain or the Gulf-Atlantic Coastal Flats of Hammond (1970). Communities marked by an asterisk (*) are pothole forested wetlands, characteristic of Caroline, Kent, and Queen Annes Counties.

Dominance Type (Location)	Associates	
Black Gum-Red Maple (Caroline County)	Trees:	Ironwood, Tulip Poplar, Sweet Gum, American Holly, Sweet Bay, Loblolly Pine (edge), Green Ash
	Shrubs:	Sweet Pepperbush, Elderberry, Virginia Sweet-spires, Spicebush, Highbush Blueberry, American Strawberrybush
	Herbs:	Skunk Cabbage, Net-veined Chain Fern, Violet, Sedge, Aster, Royal Fern, Cinnamon Fern, Jewelweed
	Others:	Common Greenbrier, Poison Ivy
*Black Gum-Sweet Gum-Basket Oak-Willow Oak (Kent County)	Trees:	Sweet Bay
	Shrubs:	Sweet Pepperbush, Highbush Blueberry, Swamp Azalea, Fetterbush
	Herbs:	Sedge
	Others:	Common Greenbrier, Peat Moss
Green Ash (Miles River, Talbot County)	Trees:	Sweet Gum, American Elm
	Shrubs:	Silky Dogwood, Spicebush, Smooth Alder
	Herbs:	Unidentified Grass, White Avens, Field Garlic
	Others:	Japanese Honeysuckle, Grape, Common Greenbrier
*Red Maple (Caroline County)	Trees:	Persimmon, Sweet Gum, Sweet Bay
	Shrubs:	Highbush Blueberry, Sweet Pepperbush (edge)
	Herbs:	Net-veined Chain Fern, White Grass
	Others:	Common Greenbrier, Peat Moss
Red Maple (Herring Run, Caroline County)	Trees:	American Elm, Tulip Poplar, American Holly
	Shrubs:	Southern Arrowwood, Spicebush, Silky Dogwood
	Herbs:	Skunk Cabbage, Field Garlic
	Others:	Japanese Honeysuckle, Poison Ivy
Red Maple (Kent County)	Shrubs:	Southern Arrowwood, Silky Dogwood, Common Elderberry, Winterberry
	Herbs:	Unidentified Grass, Jewelweed, Sensitive Fern
	Others:	Common Greenbrier, Japanese Honeysuckle, Brambles
Red Maple (Kent County)	Trees:	Ironwood, River Birch, Swamp White or Basket Oak, American Elm, Black Willow (river bank) American Elm, Black Willow (river bank)
	Herbs:	Wood Reed, Sedge, Aster
	Others:	Common Greenbrier, Poison Ivy
Red Maple (Talbot County)	Trees:	Sweet Gum, Sweet Bay, American Holly, Basket Oak, Devil's Walking-stick
	Shrubs:	Sweet Pepperbush
	Herbs:	Wood Reed
	Others:	Common Greenbrier, Peat Moss (depressions)
Red Maple-Black Gum-Green Ash-Smooth Alder (Cecil County)	Trees:	Sycamore
	Shrubs:	Silky Dogwood
	Herbs:	Swamp Beggar-ticks, Skunk Cabbage, Jewelweed, Joe-Pye-Weed
	Others:	Common Greenbrier, Poison Ivy
*Red Maple-Green Ash (Queen Annes County)	Trees:	Sweet Gum
	Shrubs:	Virginia Sweet-spires, Southern Arrowwood, Sweet Pepperbush, Silky Dogwood
	Herbs:	Wood Reed, Virginia Spring Beauty (hummocks), Aster, False Nettle, Violet
	Others:	Common Greenbrier, Poison Ivy, Grape, Virginia Creeper
Red Maple-Green Ash (Talbot County)	Trees:	Sweet Bay, American Elm, Sweet Gum
	Shrubs:	Fetterbush, Elderberry, Virginia Sweet-spires, Wild Raisin
	Herbs:	Wood Reed, Goldenrod, False Nettle, Jewelweed
	Others:	Poison Ivy, Common Greenbrier

Table 6-14. (continued)

Dominance Type (Location)	Associates
*Red Maple-Sweet Gum (Queen Annes County)	Trees: Southern Red Oak, River Birch, Willow Oak Shrubs: Highbush Blueberry, Sweet Pepperbush (edge), Fetterbush (edge) Others: Common Greenbrier (edge)
Sweet Gum-Red Maple (Watts Creek, Caroline County)	Trees: Ironwood, Tulip Poplar, River Birch, Sycamore, Beech, American Holly Shrubs: Elderberry, Spicebush, Multiflora Rose, Southern Arrowwood Herbs: Wood Reed, Field Garlic, Sedge, Jewelweed, Skunk Cabbage, Aster Others: Grape, Japanese Honeysuckle, Poison Ivy, Common Greenbrier
*Sweet Gum-Red Maple-Southern Red Oak (Kent County)	Trees: Black Gum, White Oak Shrubs: Highbush Blueberry, Fetterbush, Sweet Pepperbush Others: Common Greenbrier
Sycamore-Red Maple-Green Ash (Mill Creek, Talbot County)	Trees: American Elm, Ironwood Shrubs: Spicebush, Silky Dogwood, Common Winterberry Herbs: Wood Reed, Skunk Cabbage, Christmas Fern, White Avens, Violet, False Nettle Others: Japanese Honeysuckle, Poison Ivy, Grape, Common Greenbrier, Brambles

Table 6-20. Examples of temporarily flooded palustrine (nontidal) forested wetland communities observed on the Lower Eastern Shore of Maryland. These communities are typical of the Lower Coastal Plain or the Gulf-Atlantic Coastal Flats of Hammond (1970). Communities marked by an asterisk (*) were observed by William Sipple.

Dominance Type (Location)	Associates
American Holly-Loblolly Pine-Red Maple (Worcester County)	Trees: Sweet Gum, Sweet Bay Shrubs: Highbush Blueberry, Sweet Pepperbush, Maleberry
Loblolly Pine (Dorchester County)	Trees: Sweet Gum Shrubs: Wax Myrtle Herbs: Switchgrass Others: Poison Ivy, Japanese Honeysuckle
Loblolly Pine (Dorchester County)	Trees: Black Gum, American Holly Shrubs: Wax Myrtle Herbs: Switchgrass Others: Common Greenbrier, Poison Ivy
Loblolly Pine (Wicomico County)	Trees: Red Maple, Sweet Gum, American Holly Shrubs: Poison Ivy
Loblolly Pine-Black Gum (Dorchester County)	Trees: Sweet Gum, Red Maple, Southern Red Oak, Cherry, Tulip Poplar, Swamp White Oak Shrubs: Highbush Blueberry, Wax Myrtle, Sweet Bay, Sweet Pepperbush, Inkberry
Red Maple (Millpond River, Dorchester County)	Trees: Sweet Bay, American Holly, Black Cherry (on ditch berm), Sweet Gum, Willow Oak Shrubs: Sweet Pepperbush, Spicebush, Winterberry, Southern Arrowwood, Fetterbush Herbs: Slender Spike-grass, Lizard's Tail (creek), Bur-reed (creek) Others: Japanese Honeysuckle, Common Greenbrier
Red Maple-American Holly (Tulls Swamp, Somerset County)	Trees: Black Gum, Basket Oak, Sweet Gum, Sweet Bay, White Oak, Cherrybark Oak Shrubs: Sweet Pepperbush, Highbush Blueberry, Fetterbush Others: Common Greenbrier
Red Maple-Black Gum (Worcester County)	Trees: Sweet Gum, Loblolly Pine, Basket Oak, American Holly, Sweet Bay Shrubs: Sweet Pepperbush, Highbush Blueberry, Swamp Azalea, Mountain Laurel Herbs: Sensitive Fern Others: Peat Moss (low spots), Partridgeberry, Common Greenbrier, Wintergreen
*Red Maple-Southern Red Oak-White Oak (Worcester County)	Trees: Sweet Gum, Loblolly Pine, Black Gum Shrubs: Sweet Pepperbush, Highbush Blueberry Herbs: Slender Spike-grass
Red Oak-Southern Red Oak-Loblolly Pine (Dorchester County)	Trees: White Oak, Red Maple, Sweet Gum, Beech, Black Gum, Basket Oak Shrubs: Highbush Blueberry, American Holly, Sweet Pepperbush, Serviceberry Herbs: Slender Spike-grass
Sweet Gum-Red Maple (Worcester County)	Trees: American Holly, White Oak, Sweet Bay, Black Gum, Tulip Poplar, Sassafras, Flowering Dogwood, Loblolly Pine Shrubs: Sweet Pepperbush, Highbush Blueberry, Mountain Laurel Herbs: Sensitive Fern, Cinnamon Fern, Royal Fern Others: Peat Moss (low spots), Wintergreen, Common Greenbrier
*Water Oak-White Oak (Wicomico County)	Trees: Willow Oak, Red Maple, Loblolly Pine, Sweet Gum, Sweet Bay, Black Gum, American Holly, Sassafras Shrubs: Sweet Pepperbush, Highbush Blueberry, Swamp Azalea Herbs: Slender Spike-grass, Netted Chain Fern, Sensitive Fern Others: Common Greenbrier, Partridgeberry

Table 6-13. Examples of seasonally flooded palustrine (nontidal) forested wetland communities observed on the Lower Eastern Shore of Maryland. These communities are typical of the Lower Coastal Plain or the Gulf-Atlantic Coastal Flats of Hammond (1970).

Dominance Type (Location)	Associates
Swamp Black Gum (Wicomico County)	Trees: Red Maple, Sweet Bay, Green Ash, Sweet Gum Shrubs: Sweet Pepperbush, Fetterbush, Southern Wild Raisin Herbs: Bladder Sedge, False Nettle, Net-veined Chain Fern, Manna Grass, Devil's Beggar-ticks, Bugleweed, Long Sedge, Wood Reed, Lizard's Tail, Joe-Pye-weed Vines: Common Greenbrier
Loblolly Pine (Kings Creek, Somerset County)	Trees: Red Maple, Sweet Gum Shrubs: Wax Myrtle, Common Winterberry Herbs: Royal Fern, Sedge, Pennywort
Red Maple (Kentuck Swamp, Dorchester County)	Trees: Black Gum, Swamp Black Gum, Loblolly Pine, Willow Oak, Sweet Gum, Swamp White Oak, Southern Red Oak, Basket Oak Shrubs: Sweet Pepperbush, Common Winterberry, Highbush Blueberry, American Holly, Fetterbush Herbs: Slender Spike-grass, Bladder Sedge, Unidentified Grass, Sedges, White Grass, Panic Grass Others: Common Greenbrier, Grape, Japanese Honeysuckle, Partridgeberry, Poison Ivy
Red Maple (Somerset County)	Trees: Loblolly Pine, Sweet Bay, American Holly, Sweet Gum, Cherrybark Oak Shrubs: Southern Arrowwood, Silky Dogwood, Common Winterberry, Common Elderberry Herbs: Wood Reed, Cinnamon Fern, Net-veined Chain Fern, Sedge, False Nettle Others: Japanese Honeysuckle, Swamp Dewberry, Grape, Common Greenbrier
Red Maple (Wicomico County)	Trees: American Holly, Sweet Gum, Sweet Bay, Basket Oak Shrubs: Sweet Pepperbush Herbs: False Nettle, Virginia Chain Fern, Net-veined Chain Fern, Rice Cutgrass, Cinnamon Fern, Lizard's Tail (creek)
Red Maple (Wicomico County)	Trees: American Holly, Loblolly Pine, Sweet Bay Shrubs: Sweet Pepperbush, Highbush Blueberry, Fetterbush Herbs: Virginia Chain Fern, Cinnamon Fern Others: Peat Moss, Common Greenbrier
Red Maple (Little Mill Creek, Worcester County)	Trees: Sweet Bay, Loblolly Pine, Willow Oak, Sweet Gum, American Holly, Water Oak Shrubs: Common Winterberry, Highbush Blueberry, Southern Arrowwood, Sweet Pepperbush, Red Chokeberry Herbs: Sedge Others: Japanese Honeysuckle, Laurel-leaved Greenbrier
Red Maple-American Holly (Wicomico State Forest, Wicomico County)	Trees: Sweet Bay, Water Oak (edge), Sassafras (edge) Shrubs: Sweet Pepperbush, Highbush Blueberry, Fetterbush Herbs: Cinnamon Fern, Net-veined Chain Fern Others: Peat Moss, Common Greenbrier
Red Maple-Bald Cypress (Pocomoke River, Worcester County)	Trees/Saplings: Green Ash, Swamp Cottonwood, Water Tupelo Shrubs: Pawpaw, Elderberry, Fetterbush, Silky Dogwood, Smooth Alder, Swamp Rose, Winterberry, Spicebush Herbs: False Nettle, Jewelweed, Bladder Sedge, Lizard's Tail, Beggar-ticks, Wood Reed, Three-way Sedge, Cardinal Flower, Cinnamon Fern, Net-veined Chain Fern, Marsh Blue Violet, Water Horsetail, Arrow Arum, Royal Fern Others: Riverbank Grape
Red Maple-Basket Oak (Dorchester County)	Trees: Sweet Gum, Overcup Oak, Southern Red Oak, Black Gum, Sweet Bay, American Holly Shrubs: Sweet Pepperbush, Highbush Blueberry, Swamp Azalea Herbs: Sedge, Unidentified Grass Others: Common Greenbrier, Poison Ivy, Peat Moss
Red Maple-Basket Oak-Willow Oak (Dorchester County)	Trees: Loblolly Pine, Sweet Gum, White Oak Shrubs: Sweet Pepperbush, Highbush Blueberry Herbs: Slender Spike-grass, Sedge Others: Common Greenbrier, Partridgeberry (high spots), Peat Moss (depressions)

Table 6-21. (continued)

Dominance Type (Location)	Associates
Sweet Gum-Red Maple (Caroline County)	Trees: Ironwood, Sweet Bay, Black Gum, Basket Oak, Loblolly Pine, Beech Shrubs: Sweet Pepperbush, Fetterbush, Virginia Sweet-spires, American Strawberrybush Herbs: Skunk Cabbage (low spots) Others: Common Greenbrier
Sweet Gum-Red Maple (tributary of Kings Creek, Talbot County)	Trees: Ironwood, Beech, Basket Oak Shrubs: Spicebush, Elderberry, Wild Raisin Herbs: Virginia Spring Beauty, False Hellebore (low spots), Field Garlic, Bedstraw Others: Japanese Honeysuckle, Common Greenbrier
Sycamore-Black Willow-Sweet Gum (Granny Finley Branch, Queen Annes County)	Shrubs: Multiflora Rose, Smooth Alder, Elderberry, Spicebush Herbs: Jewelweed, Spotted Joe-Pye Weed, Halberd-leaved Tearthumb, Giant Ragweed Others: Poison Ivy, Trumpet Creeper, Japanese Honeysuckle, Dodder
Sycamore-Tulip Poplar-Sweet Gum (Williams Creek, Talbot County)	Trees: American Elm, Red Maple, Pawpaw, Sweet Bay, American Holly, Beech Shrubs: Spicebush, Multiflora Rose Herbs: Field Garlic, Virginia Spring Beauty, Ground Ivy, False Nettle Others: Japanese Honeysuckle, Grape, Common Greenbrier, Poison Ivy
White Oak (Queen Annes County)	Trees: Beech, Loblolly Pine, Sweet Gum, Black Gum, Red Maple Herbs: Slender Spike-grass Others: Common Greenbrier
White Oak (Talbot County)	Trees: Loblolly Pine, Black Gum, Red Maple, Sweet Gum, American Holly Shrubs: Sweet Pepperbush, Highbush Blueberry, Serviceberry, American Strawberry-bush Others: Virginia Creeper, Poison Ivy, Raspberry, Common Greenbrier
*White Oak (Talbot County)	Trees: Loblolly Pine, Red Maple, Willow Oak, Black Gum, Sassafras, Willow Oak, Southern Red Oak, Black Cherry, Eastern Red Cedar Shrubs: Sweet Pepperbush, Highbush Blueberry, Swamp Azalea, Fetterbush, Red Chokeberry, Oblong-leaf Juneberry Herbs: Pink Lady's-slipper Others: Common Greenbrier
White Oak-Red Maple-Black Gum-Loblolly Pine (Talbot County)	Trees: Southern Red Oak, Basket Oak, American Holly, Sweet Gum Shrubs: Highbush Blueberry, Sweet Pepperbush, American Strawberry-bush Others: Common Greenbrier, Poison Ivy
Willow Oak-American Holly-Red Maple (Caroline County)	Trees: White Oak, Sweet Gum, Black Gum, Southern Red Oak, Loblolly Pine, White Oak Shrubs: Sweet Pepperbush, Highbush Blueberry, Swamp Azalea, Fetterbush, Eastern Red Cedar, Dangleberry Herbs: Slender Spike-grass Others: Common Greenbrier, Partridgeberry
Willow Oak-Red Oak (Caroline County)	Trees: Black Gum, Red Maple, Sweet Gum, Loblolly Pine Shrubs: Highbush Blueberry, Fetterbush Others: Common Greenbrier, Peat Moss (depressions)

Table 6-25. Examples of palustrine scrub-shrub wetlands observed in Maryland. Communities marked by an asterisk (*) have limited distributions. All communities represent seasonally flooded types, except for buttonbush which is semipermanently flooded.

Dominance Type (Physiographic Region)	Associates
Buttonbush (Coastal Plain)	None
*Seaside Alder (Lower Coastal Plain)	Herbs: Smartweed, Halberd-leaved Tearthumb, Water Hemlock
Smooth Alder/Swamp Rose (Coastal Plain)	Trees/Saplings: Persimmon, Black Willow Shrubs: Elderberry, Silky Dogwood Herbs: Broad-leaved Cattail, Swamp Aster, Boneset, Big-leaved Arrowhead, Jewelweed, Mint, Dwarf St. John's-wort, Rice Cutgrass, Soft Rush, Seedbox, Dye Bedstraw, Sensitive Fern, Arrow-leaved Tearthumb, Tussock Sedge, Reed Canary Grass, Lurid Sedge, Small Purple-fringed Orchid, Water Pepper, Bugleweed, Skunk Cabbage Others: Virgin's Bower
Black Chokeberry (Appalachian Highlands)	Trees/Saplings: Red Maple Shrubs: Northern Arrowwood Herbs: Sedges, Long Sedge, Soft Rush Others: Big Cranberry, Peat Mosses, Swamp Dewberry
Highbush Blueberry/ Speckled Alder (Appalachian Highlands)	Trees/Saplings: Black Gum, Red Maple, Larch, White Pine, Hemlock Shrubs: Red Chokeberry, Winterberry, Mountain Holly, Arrowwood, Elderberry, Northern Wild Raisin, Swamp Rose, Rosebay Rhododendron Herbs: Wild Calla, Marsh St. John's-wort, Cinnamon Fern, Bugleweed, Jewelweed, Rattlesnake Grass, Skunk Cabbage, Rice Cutgrass, Tussock Sedge, Arrow-leaved Tearthumb Others: Peat Mosses, Blackberry
Narrow-leaved Meadow-sweet (Appalachian Highlands)	Shrubs: Silky Dogwood, Broad-leaved Meadowsweet, Alder, Bushy St. John's-wort Herbs: Bluejoint, Sedges, Wool Grass
Speckled Alder-Emergents (*Mixed Shrub Swamp-Wet Meadow*) (Appalachian Highlands)	Shrubs: Elderberry, Ninebark, Northern Arrowwood, Winterberry Herbs: Tussock Sedge, Rice Cutgrass, Tall Meadow-rue, Fringed Sedge, Sensitive Fern, Jewelweed, Arrow-leaved Tearthumb, Long Sedge, Skunk Cabbage, Green Bulrush, Fringe-top Closed Gentian, Soft Rush, New England Aster, New York Aster, Square-stemmed Monkeyflower, Northern Willow-herb, Fox Sedge Others: Swamp Dewberry
Speckled Alder-Northern Arrowwood (Appalachian Highlands)	Trees/Saplings: Yellow Birch, Black Gum, Rosebay Rhododendron Shrubs: Common Winterberry Herbs: Sedges, Soft Rush, Rough-stemmed Goldenrod, Rice Cutgrass, Jack-in-the-pulpit, Bugleweed, Arrow-leaved Tearthumb, Sensitive Fern, Cinnamon Fern, New England Aster, Jewelweed, Marsh St. John's-wort, Manna Grass
Speckled Alder-Red Osier Dogwood (Appalachian Highlands)	Shrubs: Elderberry, Northern Wild Raisin, Swamp Rose Herbs: Bluejoint, Goldenrod, Sensitive Fern Shrubs: Arrowwood, Elderberry
Alders (Appalachian Highlands)	Herbs: Bluejoint
Arrowwood-Bluejoint (*Mixed Shrub Swamp-Wet Meadow*) (Appalachian Highlands)	Trees: White Pine (dying), Hemlock Shrubs: Smooth Winterberry, Swamp Rose, Alder, Meadowsweet Herbs: Rice Cutgrass, Jewelweed, Tussock Sedge, Arrow-leaved Tearthumb

Table 6-26. More abundant species found in six bogs in Anne Arundel County (compiled from Hull and Whigham 1987).

Life Form	Plant Species
Herbs	Giant Cane, False Nettle*, Lurid Sedge*, Twig-rush, Dodder, Spatulate-leaved Sundew, Three-way Sedge, Pine Barren Rush, Soft Rush, White Water Lily, Royal Fern*, Warty Panic Grass (*Panicum verrucosum*), White Beak-rush, Peat mosses, Marsh Fern*, Marsh St. John's-wort, Fibrous Bladderwort, Virginia Chain Fern*
Shrubs	Leatherleaf, Sweet Pepperbush, Swamp Loosestrife or Water willow, Northern Bayberry, Swamp Azalea, Highbush Blueberry
Woody Vines and Trailing Plants	Poison Ivy, Swamp Dewberry*, Big Cranberry
Trees/Saplings	Red Maple, Atlantic White Cedar*, Sweet Gum, Sweet Bay, Black Gum, Pitch Pine

*Only occurred in one bog.

Table 6-27. Dominance types of tidal fresh marshes and some commonly observed associates in Maryland and other Mid-Atlantic states. (Source: McCormick and Somes 1982)

Dominance Type	Common Associates
Arrowheads	Jewelweed, Spatterdock, Arrow Arum, Tearthumb
Big Cordgrass	
Bulrushes (mostly Common Three-square)	
Bur-marigold	Water Hemp, Jewelweed, Arrow Arum, Tearthumbs, Big Arrowhead, Wild Rice
Cattails	Rose Mallow, Bur-marigold, Jewelweed, Spatterdock, Sensitive Fern, Arrow Arum, Smartweeds, Tearthumbs, Pickerelweed, Big Arrowhead, Sweet Flag
Common Reed Giant Ragweed	Rose Mallow, Bindweed, Jewelweed, Arrow Arum, Tearthumbs
Golden Club	Cattails
Pickerelweed/Arrow Arum	Jewelweed, Spatterdock, Big Arrowhead
Purple Loosestrife	
Reed Canary Grass	
Rose Mallow	Arrow Arum, Smartweeds, Cattails
Smartweed/Rice Cutgrass	Rose Mallow, Bur-marigold, Jewelweed, Spatterdock, Arrow Arum, Clearweed, Tearthumbs, Soft-stemmed Bulrush, Wild Rice

Table 6-28. Plants of Maryland's tidal fresh marshes. (List prepared from personal observations, McCormick and Somes 1982, and Shreve 1910)

Ferns
Marsh Fern (*Theypteris thelypteroides*)
Sensitive Fern (*Onoclea sensibilis*)
Royal Fern (*Osmunda regalis*)

Grasses
Big Cordgrass (*Spartina cynosuroides*)
Common Reed (*Phragmites australis*)
Switchgrass (*Panicum virgatum*)
Fall Panic-grass (*P. dichotomiflorum*)
Wild Rice (*Zizania aquatica*)
Rice Cutgrass (*Leersia oryzoides*)
Walter Millet (*Echinochloa walteri*)
Wood Reed (*Cinna arundinacea*)
Virginia Rye Grass (*Elymus virginicus*)
Swamp Wedgescale (*Sphenopholis pensylvanicum*)
Reed Canary Grass (*Phalaris arundinaceum*)

Grasslike Plants
Narrow-leaved Cattail (*Typha angustifolia*)
Broad-leaved Cattail (*T. latifolia*)
Southern Cattail (*T. domingensis*)
River Bulrush (*Scirpus fluviatilis*)
Sedges (*Carex alata, C. lurida, C. crinita, C. albolutescens, C. squarrosa, C. stipata*)
Soft Rush (*Juncus effusus*)
Salt Marsh Bulrush (*Scirpus robustus*)
Three-way Sedge (*Dulichium arundinaceum*)
Soft-stemmed Bulrush (*Scirpus validus*)
Spike-rushes (*Eleocharis* spp.)
Wool Grass (*Scirpus cyperinus*)
Common Three-square (*Scirpus pungens*)
Autumn Sedge (*Fimbristylis autumnalis*)
Tall Beak-rush (*Rhynchospora macrostachya*)
Yellow Flatsedge (*Cyperus flavescens*)
Canada Rush (*Juncus canadensis*)
Tapertip Rush (*J. acuminatus*)
Umbrella Sedge (*Cyperus nuttallii*)
Sweet Flag (*Acorus calamus*)
Greater Bur-reed (*Sparganium eurycarpum*)

Flowering Herbs
Rose Mallow (*Hibiscus moscheutos*)
Seashore Mallow (*Kosteletzkya virginica*)
Spatterdock (*Nuphar luteum*)
Arrow Arum (*Peltandra virginica*)
Pickerelweed (*Pontederia cordata*)
Big-leaved Arrowhead (*Sagittaria latifolia*)
Bull-tongue (*S. lancifolia*)
Water-willow (*Decodon verticillatus*)
Water Parsnip (*Sium suave*)
Water Hemp (*Amaranthus cannabinus*)
Golden Club (*Orontinum aquaticum*)
Bur-marigold (*Bidens laevis*)
Beggar-ticks (*Bidens cernua, B. coronata, B. frondosa*)
Blue Flag (*Iris versicolor*)
Yellow Flag (*I. pseudacorus*)
Clearweed (*Pilea pumila*)
Sneezeweed (*Helenium autumnale*)
Jewelweed (*Impatiens capensis*)
Tearthumbs (*Polygonum arifolium, P. sagittatum*)
Smartweeds (*Polygonum hydropiper, P. hydropiperoides*)
New York Ironweed (*Vernonia noveboracensis*)
Swamp Milkweed (*Asclepias incarnata*)
Boneset (*Eupatorium perfoliatum*)
Marsh Eryngo (*Eryngium aquaticum*)
Elongate Lobelia (*Lobelia elongata*)
Seaside Goldenrod (*Solidago sempervirens*)
Mock Bishop-weed (*Ptilimnium capillaceum*)
Dwarf St. John's-wort (*Hypericum mutilum*)
Marsh Pennywort (*Hydrocotyle umbellata*)
Lance-leaved Frog-fruit (*Lippia lanceolata*)
Purple-leaved Willowherb (*Epilobium coloratum*)
Small Salt Marsh Pink (*Sabatia stellaris*)
Large Salt Marsh Pink (*S. dodecandra*)
Stiff Cowbane (*Oxypolis rigidior*)
Canada St. John's-wort (*Hypericum canadense*)
Sweet-scent Bedstraw (*Galium triflorum*)
Marsh St. John's-wort (*Triadenum virginicum*)
Marsh Mermaid-weed (*Proserpinaca palustris*)
Sensitive Joint Vetch (*Aeschynomene virginica*)
Broad-tooth Hedge-nettle (*Stachys latidens*)
Water Pimpernel (*Samolus parviflorus*)
Swamp Candles (*Lysimachia terrestris*)
Water Hemlock (*Cicuta maculata*)
Dye Bedstraw (*Galium tinctorium*)
White Water Lily (*Nymphaea odorata*)
Dotted Smartweed (*Polygonum punctatum*)
Water Dock (*Rumex verticillatus*)
Pinkweed (*Polygonum pennsylvanicum*)
White Panicled Aster (*Aster lanceolatus*)
Asters (*Aster* spp.)

Shrubs
Groundsel-bush (*Baccharis halimifolia*)
Swamp Rose (*Rosa palustris*)
Multiflora Rosa (*R. multiflora*)
Smooth Alder (*Alnus serrulata*)
Seaside Alder (*Alnus maritima*)
Willow (*Salix* sp.)

Vines
Climbing Hempweed (*Mikania scandens*)
Virginia Creeper (*Parthenocissus quinquefolia*)
Hedge Bindweed (*Calystegia sepium*)
Dodder (*Cuscuta* spp.)
Bittersweet Nightshade (*Solanum dulcamara*)

Table 6-29. Characteristic plants of Eastern Shore glades. (Compiled from Boone *et al.* 1984, Sipple and Klockner 1984, Tyndall *et al.* 1990, and personal observations.) An asterisk (*) designates a potentially dominant species. An "e" designates species typical of the woodland edges.

Aquatic Herbs
*Mermaid-weed (*Proserpinaca pectinata*)
*Water-willow (*Decodon verticillatus*)
Hidden-fruit Bladderwort (*Utricularia geminiscapa*)
Purple Bladderwort (*U. purpurea*)
Featherfoil (*Hottonia inflata*)
White Water Lily (*Nymphaea odorata*)
Yellow Water Buttercup (*Ranunculus flabellaris*)

Grasses
*Giant Beardgrass (*Erianthus giganteus*)
*Maiden-cane (*Panicum hemitomom*)
Warty Panic Grass (*Panicum verrucosum*)
*Fall Panic Grass (*P. dichotomiflorum*)
Panic Grass (*P. longifolium*)
*Panic Grass (*P. spretum*)
Club-head Cutgrass (*Leersia hexandra*)
Rice Cutgrass (*L. oryzoides*)
New Jersey Muhly (*Muhlenbergia torreyana*)
Knotgrass (*Paspalum dissectum*)

Sedges and Rushes
*Walter's Sedge (*Carex walteriana*)
Button Sedge (*C. bullata*)
*Twig-rush (*Cladium mariscoides*)
Small-fruit Spike-rush (*Eleocharis microcarpa*)
Black-fruit Spike-rush (*E. melanocarpa*)
Robbins' Spike-rush (*E. robbinsii*)
Three-way Sedge (*Dulichium arundinaceum*)
Autumn Sedge (*Fimbristylis autumnalis*)
Harper's Fimbry (*F. perpusilla*)
Long-beak Baldrush (*Psilocarya scirpoides*)
Thread-leaf Beak-rush (*Rhynchospora filifolia*)
Loose-head Beak-rush (*R. charalocephala*)
Tall Beak-rush (*R. macrostachya*)
Wool Grass (*Scirpus cyperinus*)
*Netted Nutrush (*Scleria reticularis*)
Soft Rush (*Juncus effusus*)
Canada Rush (*J. canadensis*)

Flowering Herbs
*Smartweeds (*Polygonum* spp.)
*Globe-fruit Seedbox (*Ludwigia sphaerocarpa*)
Seedbox (*L. alternifolia*)
Englemann's Arrowhead (*Sagittaria engelmanniana*)
Creeping St. John's-wort (*Hypericum adpressum*)
Coppery St. John's-wort (*H. denticulatum*)
Marsh St. John's-wort (*Triadenum virginicum*)
Canby's Lobelia (*Lobelia canbyi*)
White Boltonia (*Boltonia asteroides*)
Clustered Bluet (*Oldenlandia uniflora*)
Canby's Cowbane (*Oxypolis canbyi*)
Lizard's Tail (*Saururus cernuus*)
*Virginia Meadow-beauty (*Rhexia virginica*)
Carolina Redroot (*Lachnanthes caroliniana*)
Sundews (*Drosera* spp.)
Lance-leaf Violet (*Viola lanceolata*)
*Virginia Chain Fern (*Woodwardia virginica*)

Woody Plants
*Buttonbush (*Cephalanthus occidentalis*)
e Sweet Gum (*Liquidambar styraciflua*)
e Willow Oak (*Quercus phellos*)
e * Fetterbush (*Leucothoe racemosa*)
e Swamp Azalea (*Rhododendron viscosum*)
e Highbush Blueberry (*Vaccinium corymbosum*)
e Common Greenbrier (*Smilax rotundifolia*)

Appendix B. Keys to Waterbody Type and Hydrogeomorphic-type Wetland Descriptors for for U.S. Waters and Wetlands (Operational Draft). (Source: Tiner 2000)

Keys to Waterbody Type and
Hydrogeomorphic-type Wetland Descriptors
for U.S. Waters and Wetlands
(Operational Draft)

U.S. Fish and Wildlife Service
National Wetlands Inventory Project
Northeast Region
300 Westgate Center Drive
Hadley, MA 01035

September 2000

Keys to Hydrogeomorphic-type Wetland Descriptors and Waterbody Types for U.S. Wetlands and Waters (Operational Draft)

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September 2000

Introduction

The U.S. Fish and Wildlife Service's official wetland and deepwater habitat classification emphasizes a host of characteristics associated with these habitats including vegetation, soils, hydrology, salinity, and certain impacts (e.g., beaver, partly drained, and impounded) (Cowardin et al. 1979). These are important characteristics for describing wetlands and for assessing fish and wildlife habitat, but are not adequate for addressing abiotic features important for evaluating other wetland functions (e.g., chemical characteristics of the water, habitat maintenance, and water storage and transport) (Brinson 1993). Moreover, the classification of deepwater habitats is quite limited mainly to general aquatic ecosystem (marine, estuarine, lacustrine, and riverine) and bottom substrate type, with a few subsystems noted for riverine deepwater habitats. There is need for more indepth classifications for both wetlands and waterbodies.

For example, Dr.Mark Brinson created a hydrogeomorphic (HGM) classification system to fill this void (Brinson 1993). The HGM system is actually more of "a generic approach to classification and not a specific one to be used in practice" (p. 2). It is a way of looking at wetlands in a geographic region for assessing ecosystem functions. Current studies are underway in several regions to develop HGM profiles for certain types of wetlands.

To aid in use of HGM data when available and to better describe wetlands from the abiotic standpoint, a set of keys have been developed (Tiner 1997). These keys attempt to bridge the gap between the Service's classification and the HGM system by providing descriptors for landscape position and landform. While more specific than the basic HGM types, the new descriptors can be easily correlated with these types to make use of HGM data when they become available. The landscape position and landform descriptors can be added to existing National Wetlands Inventory maps and digital data or to other wetland maps. These descriptors can also be used to describe wetlands for reports of various kinds including wetland permit reviews, wetland trend reports, and other reports requiring more comprehensive descriptions of individual wetlands. This information can be used to prepare a characterization of the functions performed by similar wetland types. These characterizations may be used to predict the likely functions of individual wetlands or to estimate the capacity of an entire suite of wetlands to perform certain functions in a watershed, for example. These characterizations would be derived from our current knowledge of wetland functions for specific types and be refined in the future, as needed, based on the applicable HGM profiles. Based on experiences over the past 3 years, some revisions to the keys in Tiner 1997 have been made and are included in this document.

For deepwater habitats, additional information is also useful. For example, identification of the extent of dammed rivers and streams in the United States is a valuable statistic, yet according to the Service's classification dammed rivers are classified as Lacustrine deepwater habitats with no provision for separating dammed rivers from natural lakes and large impoundments (e.g., reservoirs). The description of estuarine deepwater habitats is also limited following Cowardin et al. 1979. Information on different types of estuaries would be useful.

Two sets of keys have been developed to enhance the current classification of wetlands and waterbodies. The added features are considered descriptors for application to the existing system or can be used independently to describe a wetland or deepwater habitat.
The first set of keys is for describing wetlands by landscape position, landform, water flow path and other modifiers. It is an update of an earlier set of keys published in 1997 as “Keys to

Landscape Position and Landform Descriptors for U.S. Wetlands (Operational Draft)" (Tiner 1997). Application of these operational keys has revealed the need for minor adjustments and additional modifiers. Pilot studies applying these keys also underscored the need to better describe associated waterbodies. This led to the development of the second set of keys focusing on deepwater habitats and other waterbodies (e.g., ponds). The keys provided are still considered operational draft as they have mainly been used in the Northeastern U.S. and need to be applied to arid, semiarid, and arctic regions for further testing. A glossary of technical terms is provided at the end of this publication.

Wetland Keys

Three keys are provided to identify wetland landscape position and landform for individual wetlands: Key A for classifying the former and Keys B and C for the latter (for inland wetlands and coastal wetlands, respectively). Users should first identify the landscape position associated with the subject wetland following Key A. Afterwards, using Key B for inland wetlands and Key C for salt and brackish wetlands, users will determine the associated landform. The landform keys include provisions for identifying specific regional wetland types such as Carolina bays, pocosins, flatwoods, cypress domes, prairie potholes, playas, woodland vernal pools, West Coast vernal pools, interdunal swales, and salt flats. Various modifiers may also be applied to better describe wetlands, such as inflow, throughflow and outflow types, pond types, headwater areas, and other features of interest.

Key A: Key to Wetland Landscape Position

This key characterizes wetlands based on their location in or along a waterbody, in a drainageway, or in isolation.

1. Wetland is located in or along a lake, estuary, ocean, stream, or river and any associated floodplain...2
1. Wetland occurs on a slope, flat, or in a depression (including ponds, potholes, and playas) lacking a stream, but may be ditched*...................................**Terrene** (*go to Key B for landform*)

> *Stream may originate from a terrene wetland, but if a stream enters and exits the wetland even if flow is nonchannelized within, the wetland is <u>lotic</u> and not terrene because the wetland is part of the hydrologic (downstream) flow of the stream system.
>
> [<u>Note</u>: *Modifiers* may include H<u>eadwater</u> (for first-order streams, possibly second-order streams also; including large wetlands in upper portion of watershed believed to be significant groundwater discharge sites) and for terrene wetlands whose outflow goes directly to an estuary or the ocean: <u>Estuarine Outflow</u> or <u>Marine Outflow</u>, respectively.]

2. Wetland is located in or along a salt or brackish waterbody (ocean or estuary).........................3
2. Wetland is located in or along a fresh waterbody...4

3. Wetland is located along shores of the ocean.......................**Marine** (*go to Key C for landform*)
3. Wetland is located in or along an estuary (salt or brackish waters)............................**Estuarine** (*go to Key C for landform*) (<u>Note</u>: If area was formerly connected to estuary but now is completely cut-off from tidal flow, consider as one of inland landforms - Terrene, Lentic, or

Lotic, depending on current site characteristics. Such areas should be designated with a modifier to identify such wetlands as "former estuarine wetland.")

4. Wetland is located in or along a lake or reservoir (standing waters).........**Lentic** (*go to Key B for landform*)

> [<u>Note</u>: Lentic wetlands consist of all wetlands in a lake basin, including those bordering streams that empty into the lake. The upstream limit of lentic wetlands is defined by the upstream influence of the lake which is usually approximated by the limits of the basin within which the lake occurs. These streamside lentic wetlands are designated as "<u>Throughflow</u>", thereby emphasizing the stream flow through these wetlands. Other lentic wetlands are typically classified as "<u>Bidirectional Flow</u>" since waters rise and fall with lake levels during the year.]

4. Wetland is located in or along a river or stream (flowing waters)....................................**Lotic** (*specify whether wetland is associated with a River or Stream - see following note, then go to couplet "a" below; also see note under first couplet #4 re: streamside wetlands in lake basins*)

> [<u>Note</u>: A <u>River</u> is a broad channel mapped as a polygon (2-lined watercourse) on a U.S.G.S. topographic map, while a narrower channel mapped as a linear feature is a <u>Stream</u>. Artificial drainageways--ditches--are considered part of the Lotic classification. *Modifiers* may be applied: <u>Perennial</u> (flowing water year-round), <u>Intermittent</u> (seasonal flow only), <u>Headwater</u> (first order streams, possibly second order streams also; including large wetlands in upper portion of watershed believed to be significant groundwater discharge sites), and <u>Channelization</u> (excavated and/or stream course modified). See Waterbody Key for classification of rivers, streams, canals, and ditches.]

> a. Flow of water is bidirectional due to tidal influence (freshwater tidal areas)...........**Tidal Gradient** (*go to Key B for landform*)
> a. Flow is unidirectional; no tidal influence...b
>
> b. Water flow is generally rapid due to steep gradient; typically little or no floodplain development; watercourse is generally shallow with rock, cobbles, or gravel bottoms; first and second order "streams"; part of Cowardin's Upper Perennial and Intermittent subsystems..**High Gradient** (*go to Key B for landform*)
> b. Watercourse characteristics are not so; "stream" order greater than 2...........................c
>
> c. Water flow is generally slow; typically with extensive floodplain; water course shallow or deep with mud or sand bottoms; typically fifth and higher order "streams", but includes lower order streams in nearly level landscapes such as the Great Lakes Plain (former glacial lakebed) and the Coastal Plain (the latter streams may lack significant floodplain development) and ditches; Cowardin's Lower Perennial subsystem...........…………………………….**Low Gradient** (*go to Key B for landform*)
> c. Water flow is fast to moderate; with little to some floodplain; usually third and fourth order "streams"; part of Cowardin's Upper Perennial subsystem.............................**Middle Gradient** (*go to Key B for landform*)

Key B: Key to Inland Landforms

1. Wetland occurs on a noticeable slope (e.g., greater than a 2 percent slope)........**Slope Wetland**

a. Wetland created by paludification processes (where in areas of low evapotranspiration and high rainfall, peat moss moves uphill creating wetlands on hillslopes) which cause wetland to develop upslope of primary water source.................…………Paludified Slope Wetland

a. Wetland not formed by paludification processes..b

b. No surface water inflow from a stream or other waterbody, or no suspected significant surface or ground water inflow from nonslope wetland or other waterbody at a higher elevation and no outflow to a stream or no suspected significant surface or ground water flow to a wetland or waterbody at a lower elevation..............Isolated Slope Wetland

b. Wetland not hydrologically isolated..c

c. Surface water inflow from a stream or other waterbody, or suspected significant surface or ground water inflow from a nonslope wetland or other waterbody at a higher elevation and no observable or known significant outflow of surface or ground water to a stream or a nonslope wetland or waterbody at a lower elevation.......Inflow Slope Wetland

c. Wetland not an inflow wetland, but either throughflow or outflow..............................d

d. No surface water inflow from a stream or other waterbody, or no suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation, and water is discharged from this wetland to a stream or other waterbody, or there is significant outflow of surface or ground water to a wetland or other waterbody at a lower elevation..Outflow Slope Wetland

d. Surface water inflow from a stream or other waterbody, or suspected significant surface or ground water inflow from a nonslope wetland or other waterbody at a higher elevation and water passes through the subject wetland to a stream, another wetland, or other waterbody at a lower elevation.....................................Throughflow Slope Wetland

[*Modifiers* can be applied to Slope Wetlands to designate the type of inflow or outflow as Channelized Inflow or Outflow (intermittent or perennial, stream or river), Nonchannelized Inflow or Outflow (wetland lacking stream, but connected by observable surface seepage flow), or Nonchannelized-Subsurface Inflow or Outflow (suspected subsurface flow from or to a neighboring wetland upslope or downslope, respectively).]

1. Wetland does not occur on a distinct slope...2

2. Wetland forms an island..**Island Wetland**

a. Island formed in a delta at the mouth of a river or stream.............………..Delta Island Wetland

a. Island not formed in a delta..b

b. Island surrounded by a river or stream...River Island Wetland or Stream Island Wetland

b. Island formed in a lake or pond...............Lake Island Wetland or Pond Island Wetland

[Note: Vegetation class and subclass from Cowardin et al. 1979 should be applied to characterize the vegetation of these wetland islands; vegetation is assumed to be rooted unless designated by a *modifier* (Floating Mat) to indicate a floating island.]

2. Wetland does not form an island..3

3. Wetland occurs within the banks of a river or stream or along the shores of a pond, lake, or island, or behind a barrier beach or island, and is typically permanently inundated, semipermanently flooded, or otherwise flooded for most of the growing season, or permanently saturated due to this location..**Fringe Wetland**

a. Wetland forms along the shores of an upland island within a lake, pond, river, or stream..b
a. Wetland does not form along the shores of an island...c

b. Wetland forms along an upland island in a river or stream.....................River Island Fringe Wetland or Stream Island Fringe Wetland
b. Wetland forms along an upland island in a lake or pond.........................Lake Island Fringe Wetland or Pond Island Fringe Wetland

c. Wetland forms in or along a river or stream...............River Fringe Wetland or Stream Fringe Wetland
c. Wetland forms in or along a pond or lake...d

d. Wetland forms along a pond shore...Pond Fringe Wetland
d. Wetland forms along a lake...e

e. Wetland forms behind a barrier island or beach along a lake...........Barrier Island Fringe Wetland or Barrier Beach Fringe Wetland
e. Wetland forms along a lake shore...Lake Fringe Wetland

[Note: Vegetation is assumed to be rooted unless designated by a *modifier* to indicate a floating mat (Floating Mat).]

3. Wetland does not exist along these shores..4

4. Wetland occurs on an active or inactive (former) floodplain (alluvial processes dominate currently or did so in the past, historically)...**Floodplain Wetland*** (could specify the river system, if desirable). Sub-landforms are listed below.

a. Wetland occurs on the active floodplain, not separated from the river by dikes or artificial levees...b
a. Wetland is now isolated from typical floodplain processes, separated by dikes, artificial levees, or road/railroad embankments (former or historic floodplain).........................c

b. Wetland forms in a depressional feature on a floodplain..................Floodplain Basin

Wetland or Floodplain Oxbow Wetland (a special type of depression)
b. Wetland forms on a broad nearly level terrace...........................Floodplain Flat Wetland

c. Wetland is a depressional feature on an isolated floodplain........Former Floodplain Basin Wetland or Former Floodplain Oxbow Wetland (a special type of depression)
c. Wetland forms on a broad nearly level terrace..................Former Floodplain Flat Wetland

*[Note: Questionable floodplain areas may be verified by consulting soil surveys and locating the presence of alluvial soils, e.g., Fluvaquents or Fluvents, or soils with Fluvaquentic subgroups. Water flow path for "former floodplain wetlands" may be designated, e.g., Inflow, Outflow, or Isolated.]

[*Modifiers*: Partly Drained. Confluence wetland - wetland at the intersection of two or more streams. River-mouth or stream-mouth wetland - wetland at point where a river and stream empties into a lake. Meander scar wetland - floodplain basin wetland, the remnant of a former river meander.]

4. Wetland does not occur on a floodplain...5

5. Wetland occurs on an interstream divide (interfluve)..................................**Interfluve Wetland** or specify *regional types* of interfluve wetlands, for example: **Carolina Bay Interfluve Wetland**, **Pocosin Interfluve Wetland**, and **Flatwood Interfluve Wetland** (Southeast). Sub-landforms are listed below.

a. Wetland forms in a depressional feature.. Interfluve Basin Wetland
a. Wetland forms on a broad nearly level terrace ....Interfluve Flat Wetland

[*Modifiers*: Partly Drained. Should designate Water Flow Path: most will be outflow, but other types: throughflow, inflow, and isolated, see couplet #6 below.]

5. Wetland does not occur on an interfluve...6

6. Wetland exists in a distinct depression...**Basin Wetland** or specify *regional types* of basin wetlands, for example: **Carolina Bay Basin Wetland** and **Pocosin Basin Wetland** (Atlantic Coastal Plain), **Cypress Dome Basin Wetland** (Florida), **Prairie Pothole Basin Wetland** (Upper Midwest), **"Salt Flat" Basin Wetland** (arid West), **Playa Basin Wetland** (Southwest), **West Coast Vernal Pool Basin Wetland** (California and Pacific Northwest), **Interdunal Basin Wetland** (sand dunes), **Woodland Vernal Pool Basin Wetland** (forests throughout the country), **Polygonal Basin Wetland** (Alaska), **Sinkhole Basin Wetland** (karst/limestone regions), or **Pond Wetland Basin** (throughout country).

a. No surface water inflow from stream or other waterbody, or no suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation and no outflow to stream or no suspected significant surface or ground water flow to a wetland or waterbody at a lower elevation ....Isolated

Basin Wetland
a. Wetland not hydrologically isolated..b

b. Surface water inflow from a stream or other waterbody, or suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation and no observable or known significant outflow of surface or ground water to a stream or a wetland or waterbody at a lower elevation.....................................Inflow Basin Wetland
b. Wetland not an inflow wetland...c

c. Surface water inflow from a stream or other waterbody, or suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation and water passes through the subject wetland to a stream, another wetland, or other waterbody at a lower elevation; this includes wetlands along lakes (lentic basin wetlands) which have a stream flowing through them..........................………..Throughflow Basin Wetland
(Note: If wetland is a lentic basin wetland, the directional flow of throughflow should be designated as lake inflow or lake outflow.)
c. Wetland not subjected to throughflow...d

d. No surface water inflow from a stream or other waterbody, or no suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation, and water is discharged from this wetland to a stream or other waterbody, or there is significant outflow of surface or ground water to a wetland or other waterbody at a lower elevation...Outflow Basin Wetland

d. Along a lake and subjected to fluctuating water levels (including water tables) principally due to changes in lake levels................Bidirectional Flow Lentic Basin Wetland

[Note: *Modifiers* may be applied to indicate artificially created basins due to beaver activity or human actions or artificially drained basins: Beaver (beaver-created), Human-caused (created for various purposes or unintentionally formed due to human activities; may want to specify purpose), and Partly drained (drainage ditches observed). Other *modifiers* may be applied to designate the type of inflow or outflow as Channelized (intermittent or perennial, stream or river), Nonchannelized-wetland (contiguous wetland lacking stream), or Nonchannelized-subsurface flow (suspected subsurface flow to neighboring wetland), or to identify a headwater basin (Headwater) or a drainage divide wetland that discharges into two or more watershed (Drainage divide), or to denote a spring-fed wetland (Spring-fed), a wetland bordering a pond (Pond border) and a wetland bordering an upland island in a pond (Pond island border). For ponds, may also want to add modifiers that identify the nature of the area surrounding the pond, e.g., farm, residential, commercial, industrial, coal mine, forest, and others - see "Waterbody Keys". For lotic basin wetlands, consider additional modifiers such as confluence wetland - wetland at the intersection of two or more streams; river-mouth or stream-mouth wetland - wetland at point where a river and a stream empties into a lake.]

6. Wetland exists in a relatively level area..**Flat Wetland** or specify *regional types* of flat wetlands, for example: **Salt Flat Wetland** (in the Great Basin).

a. Wetland created by paludification processes (where in areas of low evapotranspiration and high rainfall, peat moss moves uphill creating wetlands on hillslopes and broad upland flats) which cause wetland to develop upslope of primary water source....Paludified Flat Wetland
a. Wetland not formed by paludification processes...b

b. No surface water inflow from stream or other waterbody, or no suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation and no outflow to stream or no suspected significant surface or ground water flow to a wetland or waterbody at a lower elevation.......................................Isolated Flat Wetland
b. Wetland not hydrologically isolated..c

c. Surface water inflow from a stream or other waterbody, or suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation and water passes through the subject wetland to a stream, another wetland, or other waterbody at a lower elevation; this includes wetlands along lakes (lentic flat wetlands) which have a stream flowing through them...............................Throughflow Flat Wetland (Note: If wetland is a lentic flat wetland, the directional flow of throughflow should be designated as lake inflow or lake outflow.)
c. Wetland not subjected to throughflow..d

d. No surface water inflow from a stream or other waterbody, or no suspected significant surface or ground water inflow from a wetland or other waterbody at a higher elevation, and water is discharged from this wetland to a stream or other waterbody, or there is significant outflow of surface or ground water to a wetland or other waterbody at a lower elevation...Outflow Flat Wetland

d. Along a lake and subjected to fluctuating water levels (including water tables) principally due to changes in lake levels..............Bidirectional Flow Lentic Flat Wetland

[Note: If desirable a *modifier* for drained flats can be applied: Partly drained. Other *modifiers* can be applied to designate the type of inflow or outflow as Channelized (intermittent or perennial, stream or river), Nonchannelized-wetland (contiguous wetland lacking stream), or Nonchannelized-subsurface flow (suspected subsurface flow to neighboring wetland). For lotic flat wetlands, consider additional modifiers such as confluence wetland - wetland at the intersection of two or more streams; river-mouth or stream-mouth wetland - wetland at point where a river and a stream empties into a lake.]

Key C: Key to Coastal Landforms

1. Wetland forms an island...**Island Wetland**

a. Occurs in a delta...Delta Island Wetland
a. Occurs elsewhere either in a river or an embayment..b

b. Occurs in a river...River Island Wetland
b. Occurs in a coastal embayment..Bay Island Wetland

1. Wetland does not form an island, but occurs elsewhere..2

2. Wetland occurs along the shore..**Fringe Wetland**

a. Occurs behind a barrier island or barrier beach spit.........………...Barrier Island Fringe Wetland or Barrier Beach Fringe Wetland [*Modifier* for overwash areas....Overwash]
a. Occurs elsewhere...b

b. Occurs along a coastal embayment or along an island in a bay..........Bay Fringe Wetland or Bay Island Fringe Wetland or Coastal Pond Fringe Wetland (a special type of embayment, typically with periodic connection to the ocean unless artificially connected by a bulkheaded inlet) or Coastal Pond Island Fringe Wetland
b. Occurs elsewhere...c

c. Occurs along a coastal river or along an island in a river..............River Fringe Wetland or River Island Fringe Wetland
c. Occurs elsewhere..d

d. Occurs along an oceanic island..Ocean Island Fringe Wetland
d. Occurs along the shores of exposed rocky mainland.............…………Headland Fringe Wetland

2. Wetland occurs in an artificial impoundment or behind a road or railroad embankment where tidal flow is at least somewhat restricted...**Basin Wetland**

[*Modifiers* may be applied to designate created basins: Human-induced (managed fish and wildlife areas; salt hay; tidally restricted-road, tidally restricted-railroad, other road crossing (no significant tidal restriction suspected), other railroad crossing (no significant tidal restriction suspected), and other situations to be determined.]

Waterbody Keys

These keys are designed to expand the classification of waterbodies beyond the system and subsystem levels in the Service's wetland classification system (Cowardin et al. 1979). Users are advised first to classify the waterbody in one of the five ecosystems: 1) marine (open ocean and associated coastline), 2) estuarine (mixing zone of fresh and ocean-derived salt water), 3) lacustrine (lakes, reservoirs, large impoundments, and dammed rivers), 4) riverine (undammed rivers and tributaries), and 5) palustrine (e.g., nontidal ponds) and then apply the waterbody type descriptors below.

Five sets of keys are given. Key A helps describe the major waterbody type. Key B identifies different stream gradients for rivers and streams. It is similar to the subsystems of Cowardin's Riverine system, but includes provisions for dammed rivers to be identified as well as a middle gradient reach similar to that of Brinson's hydrogeomorphic classification system. The third key, Key C, addresses lake types, while Keys D and E further define ocean and estuary types, respectively. Key F is a key to water flow paths of ponds, lakes, and reservoirs. Keys G and H are for coastal waterbodies: the former is for describing tidal ranges and the latter is for describing general circulation patterns in estuaries. The coastal terminology applies concepts of coastal hydrogeomorphology.

Key A. Key to Major Waterbody Type

1. Waterbody is predominantly flowing water, either unidirectional or tidal.................................2
  2. Flow is unidirectional and waterbody is a river, stream, or similar channel............................3
    3. Waterbody is a polygonal feature on a U.S. Geological Survey map or a National Wetlands Inventory Map (1:24,000/1:25,000)...**River**
    3. Waterbody is a linear feature on such maps...**Stream**

    Go to River/Stream Gradient Key and for other modifiers (Key B).

  2. Flow is tidal (bidirectional) at least seasonally; waterbody is an ocean, embayment, river, stream, or lake..4
    4.Waterbody is freshwater...5
      5. Waterbody is a polygonal feature on a U.S. Geological Survey map or a National Wetlands Inventory Map (1:24,000/1:25,000)....................................**River***
      5. Waterbody is a linear feature on such maps...**Stream**

      * Note: In rare cases, lakes may be tidal (if so, waterbody is classified as a Tidal Lake).

      Go to River/Stream Gradient Key and for other modifiers (Key B).

    4.Waterbody is salt or brackish..6
      7. Part of a major ocean or its associated embayment (Marine system of Cowardin et al. 1979) ....**Ocean**

      Go to Ocean Key (Key D).

7. Part of an estuary where fresh water mixes with salt water (Estuarine system of Cowardin et al. 1979)...**Estuary**

Go to Estuary Key (Key E).

1. Waterbody is predominantly standing water or essentially so; not subjected to tides*...............8

* Note: In rare cases, fresh waterbodies may be tidal (if so, waterbody is classified as a Tidal Lake or Tidal Pond using criteria below to separate lakes from ponds).

8. Waterbody is permanently flooded and deep (>than 6.6 ft at low water).......................**Lake**

Go to Lake Key (Key C).

8. Waterbody is shallow (< 6.6 ft at low water)...9

9. Waterbody is small (< 20 acres)...**Pond**

Separate natural from artificial ponds, then add other modifiers like the following. Some *examples* of modifiers for ponds: beaver, alligator, marsh, swamp, vernal, Prairie Pothole, Sandhill, sinkhole/karst, Grady, interdunal, farm-cropland, farm-livestock, golf, industrial, sewage/wastewater treatment, stormwater, aquaculture-catfish, aquaculture-shrimp, aquaculture-crayfish, cranberry, irrigation, aesthetic-business, acid-mine, arctic polygonal, kettle, woodland, borrow pit, Carolina bay, tundra, coastal plain, and in-stream.

(Note: Wetlands associated with ponds are typically either Terrene basin wetlands, such as a Cypress dome or cypress-gum pond, or Terrene pond fringe wetlands, such as semipermanently flooded wetlands along margins of pond.)

9. Waterbody is large (≥20 acres)..**Lake**

Go to Lake Key (Key C).

Key B. River/Stream Gradient and Other Modifiers Key

1. Water flow is under tidal influence...**Tidal Gradient**

Type of tidal river or stream: 1) natural river, 2) natural stream, 3) channelized river, 4) channelized stream, 5) canal (artificial polygonal lotic feature), 6) ditch (artificial linear lotic feature), 7) restored river segment (part of river where restoration was performed), and 8) restored stream segment (part of stream where restoration was performed).

1. Water flow is not under tidal influence (nontidal)...2

2. Water flow is dammed, yet still free-flowing at least seasonally ....**Dammed Gradient**

Type of dammed river: 1) lock and dammed (canalized river, a series of locks and dams are present to aid navigation), 2) run-of-river dammed (low dam allowing flow during high water periods; often used for low-head hydropower generation), and 3) other dammed (unspecified, but not major western hydropower dam as such waterbodies are considered lakes, e.g., Lake Mead and Lake Powell).

2. Water flow is unrestricted..3
   3. Water flow is perennial (year-round); perennial rivers and streams...................................4
      4. Water flow is generally rapid due to steep gradient; typically little or no floodplain development; watercourse is generally shallow with rock, cobbles, or gravel bottoms; first and second order "streams"; part of Cowardin's Upper Perennial subsystem.......................... ....**High Gradient***
      4. Water flow is not so; some to much floodplain development......................................5
         5. Water flow is generally slow; typically with extensive floodplain; water course shallow or deep with mud or sand bottoms; typically fifth and higher order "streams", but includes lower order streams in nearly level landscapes such as the Great Lakes Plain (former glacial lakebed) and the Coastal Plain (the latter streams may lack significant floodplain development); Cowardin's Lower Perennial subsystem ....**Low Gradient***
         5. Water flow is fast to moderate; with little to some floodplain; usually third and fourth order "streams"; part of Cowardin's Upper Perennial subsystem ....**Middle Gradient***
   3. Water flow is seasonal or aperiodic (intermittent); Cowardin's Intermittent subsystem...**Intermittent Gradient***

*Type of river or stream: 1) natural river- single thread (one channel), 2) natural river - multiple thread (braided) (multiple, wide, shallow channels), 3) natural river-multiple thread (anastomosed) (multiple, deep narrow channels), 4) natural stream-single thread, 5) channelized river (dredged/excavated), 6) channelized stream, 7) canal (artificial polygonal lotic feature), 8) ditch (artificial linear lotic feature), 9) restored river segment (part of river where restoration was performed), and 10) restored stream segment (part of stream where restoration was performed). Other possible descriptors: 1) for perennial rivers and streams can distinguish riffles (shallow, rippling water areas), pools (deeper, quiet water areas), and waterfalls (cascades), 2) deep rivers ($\geq$6.6 ft at low water) from shallow rivers (<6.6 ft at low water), 3) nontidal river or stream segment emptying into an estuary, ocean, or lake (estuary-discharge, ocean-discharge, or lake-discharge), 4) classification by stream order (1^{st}, 2^{nd}, 3^{rd}, etc), and 5) channels patterns (straight, slight meandering, moderate meandering, and high meandering).

Key C. Key to Lakes.

1. Waterbody is permanently flooded and deep (>than 6.6 ft at low water)..................................2
   2. Waterbody is not dammed or impounded...**Natural Lake**

   Modifiers for main body, semi-enclosed embayment, and seiche-influenced; also river-fed and stream-fed descriptors.

   2. Waterbody is dammed or impounded...3
      3. Dammed river valley..**Dammed Valley Lake**
      3. Dammed natural lake...**Dammed Lake**

Modifiers for main body, semi-enclosed embayment, water-level controlled lake, reservoir (public water supply), high-dam impoundment, other impoundment, and seiche-influenced; also river-fed and stream-fed descriptors.

1.Waterbody is shallow (< 6.6 ft at low water)...4
4. Waterbody is essentially permanently flooded...**Shallow Lake***
4. Waterbody is not permanent, goes dry in most years..5
5. Waterbody is seasonally flooded in most years....................................**Seasonal Lake***
5. Waterbody is flooded intermittently...**Intermittent Lake***

*Can use additional modifiers listed under Pond (see Key A) and others (e.g., crater, lava flow, aeolian, fjord, oxbow, other floodplain, glacial, alkali, and manmade), as appropriate; also river-fed and stream-fed descriptors. Wetlands associated with these types of lakes are typically considered Terrene basin and flat wetlands.

Key D. Ocean Key.

1. Waterbody is completely open, not protected by any feature.................................**Open Ocean**
1. Waterbody is somewhat protected..…2
2. Associated with coral reef or island ....…3
3. Open but protected by coral reef ....… **Reef-protected Waters**
3. Protected by a coral island...… **Atoll Lagoon**
2. Not associated with coral reef or island...…4
4. Deep embayment cut by glaciers, with an underwater sill at front end, restricting circulation; associated with rocky headlands...**Fjord**
4. Other semi-protected embayment......................**Semi-protected Oceanic Embayment**

Key E. Estuary Key.

1. Estuary is surrounded by rocky headlands and shores...2
2. Deep embayment cut by glaciers, with an underwater sill at front end, restricting circulation..**Fjord Estuary**
2. Not so, either open or semi-enclosed..................................**Rocky Headland Bay Estuary***

* Modifiers: Open or Semi-enclosed

1. Estuary not surrounded by rocky headlands and shores..3
3. Estuary is a drowned river valley ....**Drowned River Valley Estuary***

*Modifiers: Open Bay, River Channel, Semi-enclosed Bay

3. Estuary is not a drowned river valley...4
4. Waterbody is behind and protected by barrier islands or barrier beaches...................……………………………………………………………………5
5. Waterbody is behind a barrier island ....**Barrier Island Back Bay Estuary**
5. Waterbody is behind a barrier beach...6
6. Waterbody is completely protected by beaches and intermittently connected to

salt water except where artificially kept open..…7
7. Water is brackish to fresh ....**Coastal Pond Estuary**
7. Water is hypersaline..**Hypersaline Lagoon Estuary**
6. Waterbody is protected by beaches, but has free exchange of tidal water due to natural forces..**Barrier Beach Back Bay Estuary**

4. Waterbody is not behind barrier islands or beaches, but is an open or semi-enclosed embayment...….8
8. Waterbody is protected by islands.............................**Island Protected Bay Estuary**
8. Waterbody is not protected by islands...................................**Shoreline Bay Estuary**

<u>Modifier: Tidal Inlet</u> (includes any ebb- or flood- deltas that are completed submerged) <u>and Shoals</u> (shallow water areas).

Key F. Key to Water Flow Paths for Ponds, Lakes, and Reservoirs

1. Water flow is mainly out of the pond, lake or reservoir via a river, stream, or ditch..………………………………………………………………………………**Outflow***
1. Water flow is not so..….2
   2. Water flow comes in from river, stream, or ditch, goes through and out of the lake or reservoir via a river, stream, or ditch...**Throughflow***
   2. Water flow is not throughflow...….3
      3. Water flow enters via a river, stream, or ditch, but does not exit pond, lake or reservoir; waterbody serves as a sink for water..**Inflow***
      3. No apparent channelized inflow, source of water either by precipitation or by underground sources ....**Isolated**

*<u>Modifier: Ditch</u> (for inflow, outflow, and throughflow via a ditch network).

Key G. Key to Tidal Range Types

1. Tide range is greater than 4m (approx. >12 feet) ....**Macrotidal**
1. Tidal range is less than 4m 2
   2. Tidal range is 2-4m (approx. 6-12 feet) ....**Mesotidal**
   2. Tidal range is less than 2m (approx. < 6 feet) ....**Microtidal**

Key H. Key to Estuarine Hydrologic Circulation Types

1. Estuary is river-dominated with distinct salt wedge moves seasonally up and down the river; fresh water at surface with most saline waters at bottom; low energy system with silt and clay bottoms .....**Salt-wedge Estuary**
1. Estuary is not river-dominated 2
   2. Estuarine water is well-mixed, no significant salinity stratification, salinity more or less the same from top to bottom of water column; high-energy system with sand bottom ....**Homogeneous Estuary**
   2. Estuarine water is partially mixed, salinities different from top to bottom, but not strongly stratified; low energy system ....**Partially Mixed Estuary**

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Glossary

Barrier Beach -- a coastal peninsular landform extending from the mainland into the ocean or large embayment or large lake (e.g., Great Lakes), typically providing protection to waters on the backside and allowing the establishment of salt marshes; similar to the barrier island, except connected to the mainland

Barrier Island -- a coastal insular landform, an island typically between the ocean (or possibly the Great Lakes) and the mainland; its presence usually promotes the formation of salt marshes on the backside

Basin -- a depressional (concave) landform; various types are further defined by the absence of a stream (isolated), by the presence of a stream and its position relative to a wetland (throughflow, outflow, inflow), or by its occurrence on a floodplain (floodplain basins include ox-bows and sloughs, for example)

Bay -- a coastal embayment of variable size and shape that is always opens to the sea through an inlet or other features

Carolina Bay -- a wetland formed in a semicircular or egg-shaped basin with a northwest to southeast orientation, found along the Atlantic Coastal Plain from southern New Jersey to Florida, and perhaps most common in Horry County, South Carolina

Channelization -- the act or result of excavating a stream or river channel to increase downstream flow of water or to increase depth for navigational purposes

Channelized -- water flow through a conspicuous drainageway, a stream or a river

Cypress Dome -- a wetland dominated by bald cypress growing in a basin that may be formed by the collapse of underlying limestone, forest canopy takes on a domed appearance with tallest trees in center and becoming progressively shorter as move toward margins of basin

Delta -- a typically lobed-shaped or fan-shaped landform formed by sedimentation processes at the mouth of a river carrying heavy sediment loads

Ditch – a linear, often shallow, artificial channel created by excavation with intent to improve drainage of or to irrigate adjacent lands

Drained, Partly -- condition where a wetland has been ditched or tiled to lower the ground water table, but the area is still wet long enough and often enough to fall within the range of conditions associated with wetland hydrology

Estuarine -- the landscape of estuaries (salt and brackish tidal waterbodies, such as bays and coastal rivers) including associated wetlands, typically occurring in sheltered or protected areas, not exposed to oceanic currents

Flat -- a relatively level landform; may be a component of a floodplain or the landform of an interfluve

Flatwood -- forest of pines, hardwoods or mixed stands growing on interfluves on the Gulf-Atlantic Coastal Plain, typically with imperfectly drained soils; some flatwoods are wetlands, while others are dryland

Floodplain -- a broad, generally flat landform occurring in a landscape shaped by fluvial or riverine processes; for purposes of this classification limited to the broad plain associated with large river systems subject to periodic flooding (once every 100 years) and typically having alluvial soils; further subdivided into several subcategories: flat (broad, nearly level to gently sloping areas) and basin (depressional features such as ox-bows and sloughs)

Fringe -- a wetland occurring along a flowing or standing waterbody, i.e., a lake, river, stream, estuary, or ocean; note that ponds are excluded

Ground Water -- water below ground, held in the soil or underground aquifers

Headland -- the seaward edge of the major continental land mass (North America), commonly called the mainland; not an island

High Gradient -- the fast-flowing segment of a drainage system, typically with no floodplain development; equivalent to the Upper Perennial and Intermittent Subsystems of the Riverine System in Cowardin et al. 1979

Inflow -- water enters; an inflow wetland is one that receives surface water from a stream or other waterbody or from significant surface or ground water from a wetland or waterbody at a higher elevation and has no significant discharge

Interdunal -- occurring between sand dunes, as in interdunal swale wetlands found in dunefields behind ocean and estuarine beaches and in sand plains like the Nebraska Sandhills

Interfluve -- a broad level to imperceptibly depressional poorly drained landform occurring between two drainage systems, most typical of the Coastal Plain

Island -- a landform completely surrounded by water and not a delta; some islands are entirely wetland, while others are uplands with or without a fringe wetland

Karst -- a limestone region characterized by sinkholes and underground caverns

Lentic -- the landscape position associated with large, deep standing waterbodies (such as lakes and reservoirs) and contiguous wetlands formed in the lake basin (excludes seasonal and shallow lakes which are included in the *Terrene* landscape position).

Lotic -- the landscape position associated with flowing water systems (such as rivers, creeks, perennial streams, intermittent streams, and similar waterbodies) and contiguous wetlands
Low Gradient -- the slow-flowing segment of a drainage system, typically with considerable floodplain development; equivalent to the Lower Perennial Subsystem of the Riverine System in Cowardin et al. 1979 plus contiguous wetlands

Marine -- the landscape position (or seascape) associated with the ocean's shoreline

Middle Gradient -- the segment of a drainage system with characteristic intermediate between the high and low gradient reaches, typically with limited floodplain development; equivalent to areas mapped as Riverine Unknown (R5) in the Northeast Region plus contiguous wetlands

Nonchannelized -- water exits through seepage, not through a river or stream channel or ditch

Outflow -- water exits; an outflow wetland has water leaving via a stream or seepage to a wetland or waterbody at a lower elevation, it lacks an inflow source

Oxbow -- a former mainstem river bend now partly or completely cut off from mainstem

Paludified -- subjected to paludification, the process by which peat moss engulfs terrains of varying elevations due to an excess of water, typically associated with cold, humid climates of northern areas (boreal/arctic regions and fog-shrouded coasts)

Playa -- a type of basin wetland in the Southwest characterized by drastic fluctuations in water levels over the normal wet-dry cycle

Pocosin -- a shrub and/or forested wetland forming on organic soils in interstream divides (interfluves) on the Atlantic Coast Plain from Virginia to Florida, mostly in North Carolina

Pond -- a natural or human-made shallow open waterbody that may be subjected to periodic drawdowns

Prairie Pothole -- a glacially formed basin wetland found in the Upper Midwest especially in the Dakotas, western Minnesota, and Iowa.

Reservoir -- a large, deep waterbody formed by a dike or dam created for a water supply for drinking water or agricultural purposes or for flood control, or similar purposes.

Salt Pond -- a coastal embayment of variable size and shape that is periodically and temporarily cut off from the sea by natural accretion processes; some may be kept permanently open by jetties and periodic maintenance dredging

Salt Flat -- a broad expanse of alkaline wetlands associated with arid regions, especially the Great Basin in the western United States

Sinkhole -- a depression formed by the collapse of underlying limestone deposits; may be wetland or nonwetland depending on drainage characteristics

Slope -- a wetland occurring on a slope; various types include those along a sloping stream (fringe), those (paludified) formed by paludification -- the process of bogging or swamping of uplands by peat moss in northern climes (humid and cold), and those not designated as one of the above and typically called seeps types: *perennial* where water flows continously in all years except drought or extremely dry years; intermittent where water flows only seasonally in most years; channelized where stream bed has been excavated or dredged

Subsurface Flow -- water leaves via ground water

Surface Water -- water occurring above the ground as in flooded or ponded conditions

Terrene -- wetlands surrounded or nearly so by uplands and lacking a channelized outlet stream; a stream may enter or exit this type of wetland but it does not flow through it as a channel; includes a variety of wetlands and natural and human-made ponds

Throughflow -- water entering and exiting, passing through; a throughflow wetland receives significant surface or ground water which passes through the wetland and is discharged to a stream, wetland or other waterbody at a lower elevation

Tidal Gradient -- the segment of a drainage basin that is subjected to tidal influence; essentially the freshwater tidal reach of coastal rivers; equivalent to the Tidal Subsystem of the Riverine System in Cowardin et al. 1979 plus contiguous wetlands

Vernal Pool -- a temporarily flooded basin; woodland vernal pools are found in humid temperature regions dominated by trees, these pools are surrounded by upland forests, are usually flooded from winter through mid-summer, and serve as critical breeding grounds for salamanders and woodland frogs; West Coast vernal pools occur in California, Oregon, and Washington on clayey soils, they are important habitats for many rare plants and animals

Appendix C. Wildlife x Freshwater Wetland Type Matrix based on ECOSEARCH models (prepared by Dr. Hank Short, U.S. Fish and Wildlife Service retired). Expected occurrence of certain wildlife in nontidal wetlands in New England; data may have some relevance to Maryland.

Note: Wetland types are NWI types based on a combination of predominant vegetative life form (e.g., broad-leaved deciduous trees and shrubs [PFO1; PSS1], needle-leaved evergreen trees [PFO4], broad-leaved evergreen shrubs [PSS3], persistent emergent herbs [PEM1], and nonpersistent emergent herbs [PEM2]), and water regime (a - temporarily flooded; b - saturated; c - seasonally flooded [including seasonally flooded/saturated - the "E" water regime on NWI maps], and f- semipermanently flooded). Common names are given for animal species. The first three columns address other habitat requirements related to wetlands, namely special requirements (springs, seepage areas, temporary rain pools, ponds, and bogs), lotic (associated with rivers and streams), and lentic (associated with lakes).

MATRIX 332 x
WETLAND TYPE

SPECIES	Special *	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Mudpuppy	d	X	X			X			X								X		
Marbled salamander				X	X	X				X	X	X	X	X	X			X	X
Jefferson salamander	d			X	X	X				X	X	X	X	X	X	X	X	X	X
Blue-spotted salamander	d, e			X	X	X				X	X	X	X	X	X			X	X
Spotted salamander	d	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-spotted newt	d	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Northern dusky salamander	a, b, d	X				X			X			X		X	X			X	X
Redback salamander	e			X	X	X	X	X	X	X	X	X	X						
Slimy salamander	e			X	X	X				X	X	X	X						
Four-toed salamander	d, e	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Northern spring salamander	a, b, e	X				X			X			X							
Northern two-lined salamander	a, b, e	X		X	X	X	X	X	X	X	X	X	X						
Eastern spadefoot	c																		
Eastern American toad	d	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fowler's toad	d		X	X	X	X				X	X	X	X	X	X			X	X
Northern spring peeper	d	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Gray treefrog	d, e		X	X	X	X				X	X	X	X				X		
Bullfrog	d	X	X			X						X				X	X		
Green frog	d	X	X			X						X		X	X	X	X	X	X
Mink frog	d	X	X			X						X				X	X		
Wood frog	d, e	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Northern leopard frog	d, e	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X
Pickerel frog	d, e	X	X	X	X	X	X	X	X	X	X	X	X						
Common snapping turtle	d, e	X	X			X						X				X	X		
Stinkpot	d	X	X														X		
Spotted turtle	d, e	X												X	X	X	X	X	X
Bog turtle	e					X						X		X	X	X	X	X	X
Wood turtle	d	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Eastern box turtle	e	X		X	X	X				X	X	X	X	X	X			X	X
Map turtle		X	X																
Plymouth redbelly turtle			X																
Eastern (Midland) painted turtle	d	X	X			X						X		X	X		X	X	X

* a = springs
b = seepage area
c = temporary rain pools
d = pond
e = bog

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Blanding's turtle	d,e		x														x		
Eastern spiny softshell		x	x																
Five-lined skink				x	x					x	x		x						
Northern water snake	d,e	x	x			x						x		x	x			x	x
Northern brown snake				x	x	x				x	x	x	x	x	x			x	x
Northern redbelly snake	e			x	x	x				x	x	x	x	x	x			x	x
Eastern garter snake	e	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Eastern ribbon snake	d,e	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x
Eastern hognose snake																x			
Northern ringneck snake				x	x	x	x	x	x	x	x	x	x						
Eastern worm snake																			
Northern black racer				x	x	x				x	x	x	x			x	x		
Eastern smooth green snake				x	x	x				x	x	x	x	x	x	x		x	x
Black rat snake				x	x	x				x	x	x	x						
Eastern milk snake	e	x		x	x	x				x	x	x	x						
Northern copperhead				x	x	x				x	x	x	x						
Timber rattlesnake				x	x					x	x		x						
Common loon	d	x	x																
Pied-billed grebe	d	x	x											x	x	x	x	x	x
Double-crested cormorant	d	x	x	x	x	x	x	x	x										
American bittern	d											x		x	x	x	x	x	x
Least bittern	d,e	x	x									x		x	x	x	x	x	x
Great blue heron	d,e	x	x	x	x	x						x		x	x	x	x	x	x
Snowy egret	d		x	x	x	x				x	x	x		x	x	x	x	x	x
Cattle egret				x	x	x				x	x	x		x	x			x	
Green heron	d	x	x	x	x	x						x		x	x	x	x	x	x
Black-crowned night heron	d	x										x				x	x		
Yellow-crowned night heron												x		x	x	x	x	x	x
Glossy ibis	d	x	x									x		x	x	x	x	x	x
Mute swan	d	x	x											x	x		x	x	x
Canada goose		x	x													x			
Wood duck	d	x	x	x	x	x						x				x	x		

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Green-winged teal	d															x	x		
American black duck	d, e	x	x			x						x		x	x	x	x	x	x
Mallard	d, e	x	x									x		x	x	x	x	x	x
Northern pintail																x	x		
Blue-winged teal	d															x	x		
Gadwall	d		x									x		x	x	x	x	x	x
American wigeon	d		x											x	x	x	x	x	x
Canvasback			x													x	x		
Ring-necked duck	d	x	x									x					x		
Common goldeneye	d	x	x			x			x										
Bufflehead		x	x			x													
Hooded merganser	d	x	x			x			x								x		
Common merganser	d	x	x			x			x										
Red-breasted merganser	d	x	x																
Turkey vulture				x	x	x													
Osprey		x	x																
Bald eagle		x	x						x										
Northern harrier										x	x	x	x	x	x	x	x	x	x
Sharp-shinned hawk				x	x	x	x	x	x										
Cooper's hawk				x	x	x	x	x	x										
Northern goshawk				x	x	x	x	x	x										
Red-shouldered hawk				x	x	x				x	x	x	x						
Broad-winged hawk				x	x	x													
Red-tailed hawk				x	x	x													
Rough-legged hawk										x	x	x	x	x	x	x		x	x
Golden eagle	d						x	x	x					x	x	x		x	x
American kestrel				x	x	x				x	x	x	x	x	x	x		x	x
Merlin							x	x	x	x	x	x	x	x	x	x		x	x
Peregrine falcon				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Gray partridge																			
Ring-necked pheasant																			
Spruce grouse	e						x	x	x										

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Ruffed grouse				x	x	x	x	x	x										
Wild turkey				x	x	x													
Northern bobwhite																			
King rail														x	x	x	x	x	x
Virginia rail														x	x	x	x	x	x
Sora	d											x		x	x	x	x	x	x
Common moorhen	d		x													x	x		
American coot	d		x													x	x		
Killdeer														x	x			x	x
Spotted sandpiper	d	x	x																
Upland sandpiper																			
Common snipe	e											x		x	x	x		x	x
American woodcock	e			x	x	x	x	x	x	x	x	x	x	x	x			x	x
Ring-billed gull		x	x											x	x			x	x
Herring gull		x	x																
Great black-backed gull																			
Common tern																			
Black tern			x													x	x		
Rock dove																			
Mourning dove				x	x	x	x	x	x										
Black-billed cuckoo							x	x	x	x	x	x	x						
Yellow-billed cuckoo				x	x	x													
Common barn owl																			
Eastern screech owl				x	x	x	x	x	x					x	x	x		x	x
Great-horned owl				x	x	x	x	x	x	x	x	x	x	x	x			x	x
Snowy owl														x	x			x	x
Northern hawk owl	e						x	x	x	x	x	x	x						
Barred owl		x		x	x	x	x	x	x										
Great gray owl	e			x	x	x	x	x	x	x	x	x	x						
Long-eared owl	e			x	x	x	x	x	x					x	x			x	x
Short-eared owl																x			
Boreal owl	e						x	x	x										

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Northern saw-whet owl				x	x	x	x	x	x										
Common nighthawk				x	x	x	x	x	x										
Whip-poor-will				x	x	x								x	x			x	x
Chimney swift																			
Ruby-throated hummingbird				x	x	x	x	x	x					x	x			x	x
Belted kingfisher	d	X	X																
Red-headed woodpecker				x	x	x													
Red-bellied woodpecker				x	x	x													
Yellow-bellied sapsucker				x	x	x	x	x	x										
Downy woodpecker				x	x	x	x	x	x										
Hairy woodpecker				x	x	x	x	x	x										
Three-toed woodpecker	e						x	x	x										
Black-backed woodpecker	e						x	x	x										
Northern flicker				x	x	x	x	x	x										
Pileated woodpecker				x	x	x	x	x	x										
Olive-sided flycatcher	d,e			x	x	x	x	x	x										
Eastern wood-pewee				x	x	x	x	x	x										
Yellow-bellied flycatcher	e						x	x	x	x	x	x	x						
Acadian flycatcher				x	x	x													
Alder flycatcher	e			x	x	x	x	x	x	x	x	x	x						
Willow flycatcher				x	x	x													
Least flycatcher				x	x	x	x	x	x										
Eastern phoebe				x	x	x	x	x	x										
Great crested flycatcher				x	x	x	x	x	x										
Eastern kingbird				x	x	x													
Horned lark																			
Purple martin	d	x	x	x	x	x	x	x	x					x	x	x	x	x	x
Tree swallow	d,e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Northern rough-winged swallow	d	x		x	x	x	x	x	x					x	x	x	x	x	x
Bank swallow	d	x		x	x	x	x	x	x					x	x	x	x	x	x
Cliff swallow	d			x	x	x	x	x	x					x	x	x	x	x	x
Barn swallow	d	x		x	x	x	x	x	x					x	x	x	x	x	x

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Gray jay							x	x	x										
Blue jay				x	x	x	x	x	x										
American crow				x	x	x	x	x	x										
Fish crow	d	x	x													x	x		
Common raven	e		x	x	x	x	x	x	x										
Black-capped chickadee				x	x	x	x	x	x										
Boreal chickadee	e						x	x	x										
Tufted titmouse				x	x	x													
Red-breasted nuthatch	e						x	x	x										
White-breasted nuthatch				x	x	x													
Brown creeper	e			x	x	x	x	x	x										
Carolina wren				x	x	x													
House wren				x	x	x													
Winter wren				x	x	x	x	x	x	x	x	x	x						
Sedge wren														x	x			x	x
Marsh wren																x	x		
Golden-crowned kinglet				x	x	x	x	x	x										
Ruby-crowned kinglet							x	x	x										
Blue-gray gnatcatcher				x	x	x				x	x	x	x						
Eastern bluebird				x	x	x													
Veery				x	x	x	x	x	x										
Gray-cheeked thrush							x	x	x										
Swainson's thrush							x	x	x										
Hermit thrush	e			x	x	x	x	x	x	x	x	x	x						
Wood thrush				x	x	x	x	x	x										
American robin	e			x	x	x	x	x	x	x	x	x	x						
Gray catbird	e			x	x	x													
Northern mockingbird				x	x	x													
Brown thrasher				x	x	x													
Bohemian waxwing				x	x	x	x	x	x										
Cedar waxwing				x	x	x	x	x	x	x	x	x	x						
Northern shrike				x	x	x	x	x	x					x	x	x		x	x

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Loggerhead shrike							x	x	x					x	x	x		x	x
European starling				x	x	x								x	x				
White-eyed vireo				x	x	x				x	x	x	x						
Solitary vireo				x	x	x	x	x	x										
Yellow-throated vireo				x	x	x													
Warbling vireo				x	x	x													
Philadelphia vireo				x	x	x													
Red-eyed vireo				x	x	x	x	x	x										
Blue-winged warbler				x	x	x				x	x	x	x						
Golden-winged warbler				x	x	x													
Tennessee warbler	e			x	x	x	x	x	x	x	x	x	x						
Nashville warbler	e			x	x	x	x	x	x	x	x	x	x						
Northern parula	e			x	x	x	x	x	x	x	x	x	x						
Yellow warbler				x	x	x	x	x	x	x	x	x	x						
Chestnut-sided warbler				x	x	x				x	x	x	x						
Magnolia warbler							x	x	x										
Cape May warbler							x	x	x										
Black-throated blue warbler				x	x	x	x	x	x										
Yellow-rumped warbler				x	x	x	x	x	x	x	x	x	x						
Black-throated green warbler				x	x	x	x	x	x										
Blackburnian warbler							x	x	x										
Pine warbler																			
Prairie warbler																			
Palm warbler	e						x	x	x	x	x	x	x						
Bay-breasted warbler							x	x	x										
Blackpoll warbler							x	x	x										
Cerulean warbler				x	x	x													
Black-and-white warbler	e			x	x	x	x	x	x										
American redstart				x	x	x	x	x	x										
Prothonotary warbler				x	x	x				x	x	x	x						
Worm-eating warbler																			
Ovenbird				x	x	x	x	x	x										

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Northern waterthrush	e	x		x	x	x	x	x	x	x	x	x	x						
Louisiana waterthrush				x	x	x				x	x	x	x						
Mourning warbler	e			x	x	x	x	x	x	x	x	x	x						
Common yellowthroat	d, e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hooded warbler				x	x	x				x	x	x	x						
Wilson's warbler	e						x	x	x	x	x	x	x						
Canada warbler	e			x	x	x	x	x	x	x	x	x	x						
Yellow-breasted chat				x	x	x													
Scarlet tanager				x	x	x													
Northern cardinal		x		x	x	x				x	x	x	x						
Rose-breasted grosbeak				x	x	x	x	x	x										
Indigo bunting				x	x	x													
Rufous-sided towhee				x	x	x													
American tree sparrow				x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Chipping sparrow				x	x	x	x	x	x										
Field sparrow				x	x	x													
Vesper sparrow														x	x			x	x
Savannah sparrow														x	x	x		x	x
Grasshopper sparrow																			
Henslow's sparrow														x	x			x	x
Fox sparrow				x	x	x													
Song sparrow				x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Lincoln's sparrow	e						x	x	x	x	x	x	x						
Swamp sparrow	d, e						x	x	x	x	x	x	x	x	x	x	x	x	x
White-throated sparrow				x	x	x	x	x	x										
Dark-eyed junco				x	x	x	x	x	x										
Lapland longspur																			
Snow bunting														x	x	x		x	x
Bobolink														x	x	x		x	x
Red-winged blackbird	d, e			x	x	x				x	x	x	x	x	x	x	x	x	x
Eastern meadowlark																			
Rusty blackbird	d, e	x		x	x	x	x	x	x	x	x	x	x						

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Common grackle	e		X	X	X	X				X	X	X	X	X	X	X	X	X	X
Brown-headed cowbird				X	X	X	X	X	X					X	X	X	X	X	X
Orchard oriole				X	X	X													
Northern oriole				X	X	X													
Pine grosbeak				X	X	X	X	X	X										
Purple finch				X	X	X	X	X	X										
House finch																			
Red crossbill							X	X	X										
White-winged crossbill							X	X	X										
Common redpoll							X	X	X										
Hoary redpoll							X	X	X										
Pine siskin	e			X	X	X	X	X	X										
American goldfinch	e			X	X	X	X	X	X	X	X	X	X			X			
Evening grosbeak				X	X	X	X	X	X										
House sparrow																			
Virginia opossum				X	X	X				X	X	X	X	X	X	X	X	X	X
Masked shrew	e			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Water shrew	d, e	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Smoky shrew	e			X	X	X	X	X	X										
Long-tailed shrew							X	X	X										
Pygmy shrew	e						X	X	X	X	X	X	X	X	X			X	X
Northern short-tailed shrew	e			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Least shrew				X	X	X								X	X	X		X	X
Hairy-tailed mole				X	X	X	X	X	X										
Eastern mole				X	X	X													
Star-nosed mole	d, e	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Little brown myotis	d, e	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Northern long-eared bat	d, e	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Indiana myotis	d, e	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Small-footed myotis	d, e	X					X	X	X	X	X	X	X	X	X	X	X	X	X
Silver-haired bat	d, e	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Eastern pipistrelle	d, e	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
	d,e	x	x	a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Big brown bat	d,e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Red bat	d,e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hoary bat				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Eastern cottontail				x	x	x				x	x	x	x	x	x	x	x	x	x
New England cottontail				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Snowshoe hare	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
European hare				x	x	x				x	x	x	x						
Eastern chipmunk				x	x	x	x	x	x										
Woodchuck				x			x												
Gray squirrel				x	x	x													
Red squirrel				x	x	x	x	x	x										
Southern flying squirrel				x	x	x													
Northern flying squirrel							x	x	x										
Beaver	d,e	x	x			x			x			x				x	x		
Deer mouse				x	x	x	x	x	x										
White-footed mouse	e			x	x	x	x	x	x	x	x	x	x	x	x			x	x
Southern red-backed vole	e			x	x	x	x	x	x	x	x	x	x						
Meadow vole	e			x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Rock vole	–						x	x	x										
Woodland vole				x	x	x													
Muskrat	d,e	x	x							x	x	x	x	x	x	x	x	x	x
Southern bog lemming	e			x	x	x	x	x	x					x	x	x		x	x
Northern bog lemming	e						x	x	x					x	x	x		x	x
Norway rat																			
House mouse																			
Meadow jumping mouse	e			x			x			x	x	x	x	x	x	x		x	x
Woodland jumping mouse				x			x			x	x	x	x						
Porcupine				x	x	x	x	x	x	x	x	x	x	x	x			x	x
Coyote	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Red fox	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Gray fox				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Black bear	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

MATRIX 332 x
WETLAND TYPE

SPECIES	Special	Lotic	Lentic	PFO 1			PFO 4			PSS 1			PSS 3	PEM 1				PEM 2	
				a	b	c	a	b	c	a	b	c	b	a	b	c	f	c	f
Raccoon	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Marten	.						x	x	x										
Fisher	e			x	x	x	x	x	x	x	x	x	x	x	x			x	x
Ermine	e			x	x	x	x	x	x	x	x	x	x						
Long-tailed weasel	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Mink	d,e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Striped skunk	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
River otter	d,e	x	x			x			x			x				x	x		
Lynx	e			x	x	x	x	x	x	x	x	x	x						
Bobcat	e			x	x	x	x	x	x	x	x	x	x	x	x			x	x
White-tailed deer	e			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Moose	d,e	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Appendix D. List of Area-sensitive or Forest Interior Birds of the Eastern United States. (Source: Freemark and Collins 1992 as reported in Schroeder 1996)

Table 1
Eastern Forest Birds Classified as Either Area Sensitive or Forest Interior Occupants (from Freemark and Collins 1992)

Species	Area Sensitive	Forest Interior
Cooper's hawk (*Accipiter cooperii*)		X
Red-shouldered hawk (*Buteo lineatus*)	X	
Broad-winged hawk (*Buteo platypterus*)		X
Barred owl (*Strix varia*)		X
Red-bellied woodpecker (*Melanerpes carolinus*)	X	
Hairy woodpecker (*Picoides villosus*)	X	X
Pileated woodpecker (*Dryocopus pileatus*)	X	X
Olive-sided flycatcher (*Contopus borealis*)		X
Acadian flycatcher (*Empidonax virescens*)	X	X
Least flycatcher (*Empidonax minimus*)	X	
Great crested flycatcher (*Myiarchus crinitus*)	X	
American crow (*Corvus brachyrhynchos*)	X	
Common raven (*Corvus corax*)		X
Tufted titmouse (*Parus bicolor*)	X	
Red-breasted nuthatch (*Sitta canadensis*)		X
White-breasted nuthatch (*Sitta carolinensis*)	X	X
Brown creeper (*Certhia americana*)	X	X
Winter wren (*Troglodytes troglodytes*)		X

(Continued)

Table 1 (Concluded)		
Species	Area Sensitive	Forest Interior
Golden-crowned kinglet (*Regulus satrapa*)		X
Blue-gray gnatcatcher (*Polioptila caerulea*)	X	
Veery (*Catharus fuscescens*)	X	X
Swainson's thrush (*Catharus ustulatus*)		X
Hermit thrush (*Catharus guttatus*)	X	X
Wood thrush (*Hylocichla mustelina*)	X	
Yellow-throated vireo (*Vireo flavifrons*)	X	
Red-eyed vireo (*Vireo olivaceus*)	X	
Chestnut-sided warbler (*Dendroica pensylvanica*)	X	
Magnolia warbler (*Dendroica magnolia*)		X
Black-throated blue warbler (*Dendroica caerulescens*)	X	X
Yellow-rumped warbler (*Dendroica coronata*)		X
Black-throated green warbler (*Dendroica virens*)	X	X
Blackburnian warbler (*Dendroica fusca*)		X
Yellow-throated warbler (*Dendroica dominica*)		X
Pine warbler (*Dendroica pinus*)		X
Cerulean warbler (*Dendroica cerulea*)	X	X
Black and white warbler (*Mniotilta varia*)	X	X
American redstart (*Setophaga ruticilla*)	X	X
Worm-eating warbler (*Helmintheros vermivorous*)	X	X
Ovenbird (*Seiurus aurocapilus*)	X	X
Northern waterthrush (*Seiurus noveboracensis*)	X	X
Louisiana waterthrush (*Seiurus motacilla*)	X	X
Kentucky warbler (*Oporornis formosus*)	X	X
Mourning warbler (*Oporornis philadelphia*)	X	
Hooded warbler (*Wilsonia citrina*)	X	X
Canada warbler (*Wilsonia canadensis*)	X	X
Summer tanager (*Piranga rubra*)	X	
Scarlet tanager (*Piranga olivacae*)	X	X
Rose-breasted grosbeak (*Pheucticus ludovicianus*)	X	

Appendix E. Information on Fish and Wildlife Uses of Maryland's Wetlands. (Source: Tiner and Burke 1995)

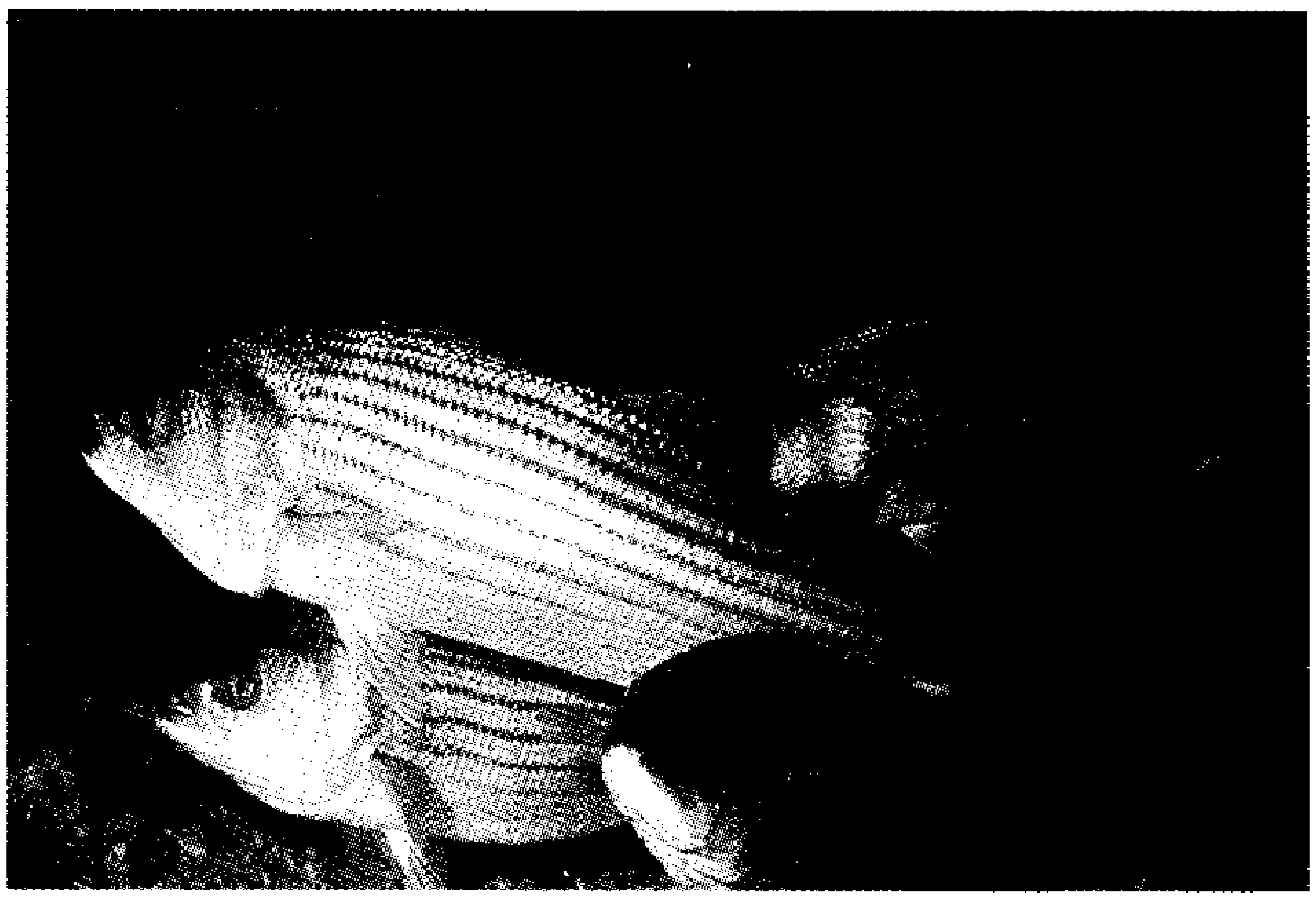

Figure 7-1. Striped bass or rockfish is an important sport fish that spawns in Chesapeake Bay tributaries. (FWS photo)

Fish and Shellfish Habitat

Numerous studies of fish habitat have been conducted, principally along the Atlantic and Gulf Coasts, showing that freshwater, marine and estuarine fish species use or depend upon wetlands for various purposes during their life cycles. Nearly all freshwater finfish and shellfish species that are harvested commercially or for sport require shallow water for various life stages. About two-thirds of the commercial fishery landings in the United States depend on estuaries including deepwater habitats and associated wetlands (McHugh 1966). Even a higher percentage (97%) of the fish harvest in the Chesapeake Bay area is estuarine-dependent (McHugh 1976). Approximately 200 species of fishes frequent or inhabit Chesapeake Bay waters (Figure 7-1).

In Maryland, species such as the American oyster and white perch complete their entire life cycles in estuarine waters (Goodger 1985). Freshwater spawning marine species, such as striped bass and American shad, and many marine spawners, including bluefish and menhaden, depend on wetlands for nursery, feeding and cover areas. Major tributaries of Chesapeake Bay account for approximately 90 percent of the striped bass spawned on the East Coast (Berggren and Lieberman 1977). Metzgar (1973) recognized irregularly flooded salt marsh as a highly valued habitat for fishery resources based on usage by 21 species including prized commercial and sport fish such as bluefish, striped bass and white perch. He documented the usage (spawning, nursery, and adult feeding), season of usage, and abundance of 44 different fish species in an irregularly flooded salt marsh and nearby water at a location in Dorchester County (Table 7-2). Heinle and others (1976) found that in the Patuxent River, most of the tidal marsh detritus input occurs in January and February when ice scouring removes biomass from the marshes. At such times, estuarine detritivores, such as copepod (*Eurytemora affinis*) and mysid shrimp (*Neomysis americana*), become very abundant. Both of these species are important food for young-of-the-year striped bass.

Menhaden is the most abundant fish species in Chesapeake Bay. More pounds of menhaden are landed annually than all other commercial fish species combined. Menhaden convert planktonic plants and animals dependent on wetlands into an oil-rich protein that is used in cosmetics, paints, and tempering products for steel. It is also used commercially as chicken feed and plant fertilizer. Menhaden is also the principal food of juvenile striped bass. Other common Bay fish species include blueback herring, spot, bay anchovy, Atlantic silverside, white perch, spottail shiner, alewife, bluefish, and mummichog.

Blue crab is the most abundant and valuable shellfish catch in Maryland. Nearly 42 million pounds of blue crab, worth over 20 million dollars, were harvested in 1987.

Approximately 15 species of submerged aquatic vegetation (SAV) commonly occur in the Bay (Hurley 1990). SAV beds provide cover from predators for estuarine-spawning fishes and their offspring including shad, herring and rockfish and many small fish such as minnows and killifish. Highly vulnerable to predation, molting blue crabs hide in SAV beds until their shells harden. Fishes may consume as much as 7.5 percent of the standing crop of rooted aquatics each day (McCormick and Somes 1982). Additionally, a gelatinous film of diatoms covers many SAV species, providing a suitable surface for the attachment of algae, bacteria, protozoans, eggs, and small invertebrates that are eaten by fish.

Although freshwater fish species similarly benefit from the habitat offered by nontidal wetland types, much less is generally known about these relationships. Many of Maryland's wetlands are seasonally flooded palustrine forests. Both seasonally and temporarily flooded wetlands may be critical to the development of some warmwater riverine and palustrine species, which use these areas for spawning, feeding and nursery habitat during flooding periods (Adamus and Stockwell 1983). Similarly, the invertebrate food base of many riverine fisheries is greatest where canopy vegetation permits considerable input of insects, or where aquatic bed or emergent vegetation is present in moderate, interspersed amounts. The state's riverine and palustrine wetlands are important spawning and nursery areas for blueback herring and alewife.

Maryland's freshwater wetlands are usually dominated by forage species, such as shiners (*Cyprinidae*) and sunfish

(*Centrarchidae*) (Pete Jensen, pers. comm.)(Table 7-3). Although freshwater fishes of the Coastal Plain typically inhabit freshwater streams, many species range further downstream into brackish waters up to the limit of their salinity tolerance. A total of 46 freshwater species typically inhabit the Coastal Plain, while an additional 32 species sometimes stray from above the Fall Line (White 1989). Pumpkinseeds are common along all tributaries into brackish waters; black crappies (introduced) are restricted to nontidal and tidal fresh waters; largemouth bass and golden shiners inhabit fresh and slightly brackish streams; and bluespotted sunfish and tadpole madtoms reside in sluggish streams and swamps.

Waterfowl and Other Bird Habitat

Wetlands provide year-round habitats for resident birds and are particularly important breeding grounds, overwintering areas and feeding grounds for migratory waterfowl and numerous other birds (Figure 7-2). Both tidal and nontidal wetlands are valuable bird habitats. For more comprehensive information concerning wetland birds, readers should see Meanley (1975) and Stewart (1949).

The Chesapeake Bay and associated wetlands has been the winter home of approximately one-third of all the waterfowl using the Atlantic Flyway. Prior to the 1950s, the Bay historically attracted about one million waterfowl each year between October and April. Waterfowl populations have declined somewhat since then, and shifts in the relative abundance of specific species have occurred. Among the principal reasons for this decline is the widespread deterioration of shallow water habitats and marshes around the Bay and the significant reduction in valuable food for wintering waterfowl especially submerged aquatic vegetation (Chesapeake Bay Program 1990a).[1]

Chesapeake Bay waterfowl include over two dozen species belonging to the taxonomic family of swans, geese and ducks (Anatidae). Two swans, the nonmigratory mute swan and the migratory tundra swan, inhabit the Bay. Tundra swans have historically fed on SAV, but have more recently adapted to feeding on row and grain crops in agricultural fields. Canada geese similarly rely on agricultural food sources and are attracted to ponded areas with easy access to open water. Snow geese winter in Maryland, favoring coastal locations, where they feed extensively on estuarine emergent wetland plants and rootstocks, especially common three-square, smooth cordgrass, and salt marsh bulrush. The Atlantic brant inhabits shallow, open brackish waters and is primarily an aquatic feeder, eating primarily sea lettuce, followed by eelgrass, widgeongrass, and smooth cordgrass.

Dabbling ducks (surface-feeding ducks, marsh ducks, puddle ducks) use a host of emergent and submergent hydrophytes over a wide range of habitats, including inland ponds, marshes and shallow tributaries of the Bay. Dabblers breeding in Maryland include black duck, mallard, wood duck, gadwall, and blue-winged teal. Black ducks prefer ground nests, free from human disturbances, in well hidden, densely vegetated upland areas next to favored wetland brood areas including tidal marshes, cattail marshes, beaver ponds, SAV beds, and alder-fringed streams. Mallards favor similar nesting habitats but are more tolerant of human presence.

Wood ducks are one of the few locally breeding species of waterfowl common to Chesapeake Bay. They are typically associated with forested wetlands adjacent to rivers, streams and beaver ponds. Wood ducks nest in tree cavities and nest boxes, foraging on the ground or in shallow water for mast and fruits, aquatic plants and seeds, insects, and aquatic invertebrates. Wood ducks are largely summer residents whose major wintering range occurs south of Maryland.

Bay ducks are diving ducks that variously feed on animal life, shellfish, and SAV. Greater scaup prefer SAV where available, but principally consume clams. Lesser scaup frequent diverse habitats of open water at various depths and feed primarily on animal life, but will eat seeds and foliage of pondweeds and widgeongrass. Ring-necked ducks are often associated with tidal freshwater wetlands and impoundments, feeding on coontail, pondweeds, and duckweeds; on seeds of pondweeds, sedges and smartweeds; and on snails. Redhead ducks prefer feeding habitats similar to ring-necked ducks, while canvasbacks primarily feed upon clams. Some sea ducks, including the hooded merganser, common merganser, common goldeneye, and bufflehead, are associated with inland waters to a much greater extent than other sea ducks that prefer marine waters and the open Bay.

Maryland's vast acreage of forested wetlands provide birds shelter, nesting areas, water, and food. Nontidal wetlands are important habitats for many species of birds in Maryland (Table 7-4). There are approximately 348 species of birds that have been recorded in Maryland. Of those species, 129 (37%) regularly use vegetated nontidal wetlands, and 31 (9%) are dependent on wetlands for their survival.

[1]Waterfowl information derived from Chesapeake Bay Program (1990a), unless otherwise noted.

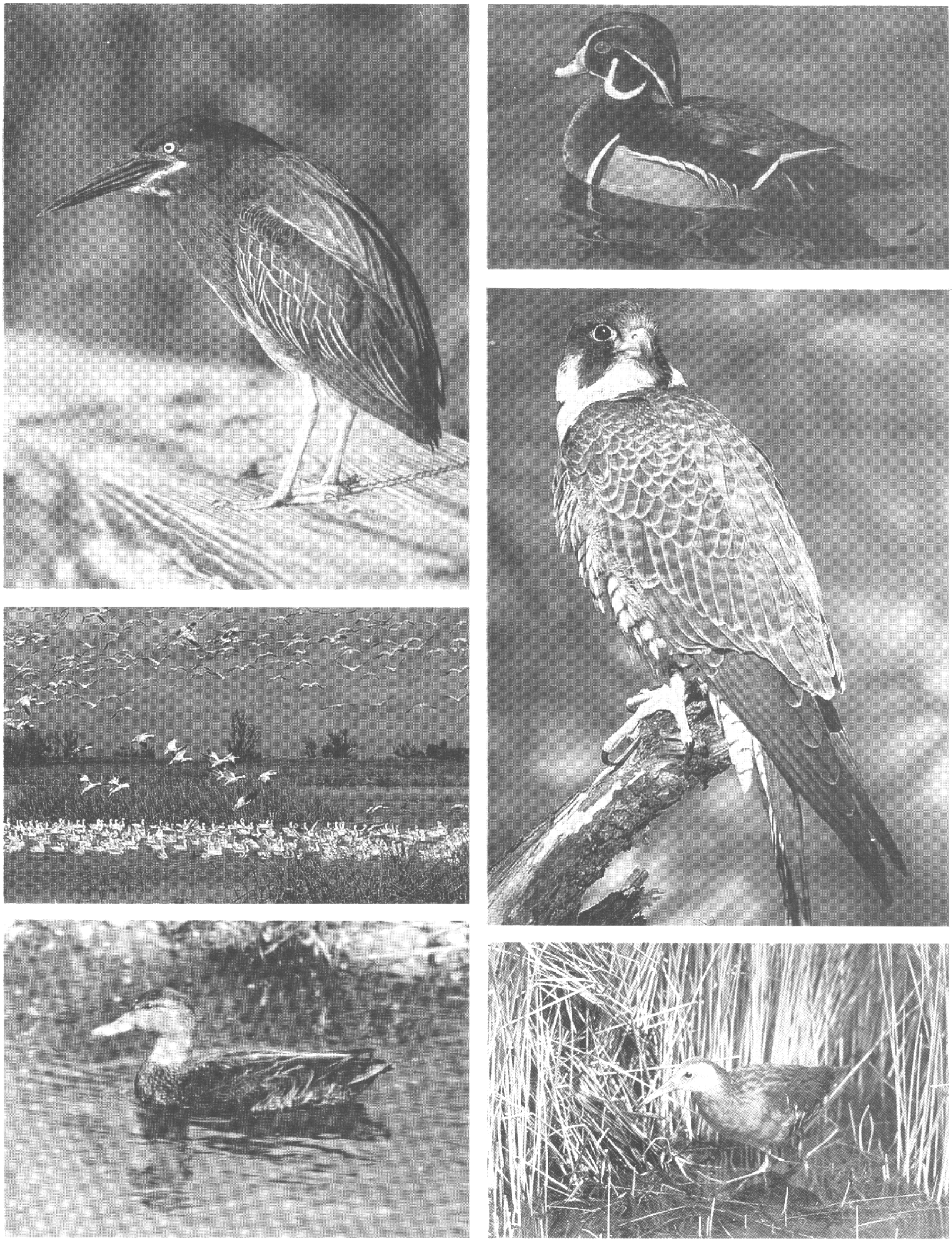

Figure 7-2. Some of the many birds that depend on wetland: green-backed heron (top left), the wood duck (top right), snow geese (center left), endangered peregrine falcon (center right), black duck (bottom left), and Virginia rail (bottom right). (Black duck–FWS photo; Virginia rail photo by Phil Norton).

The prothonotary warbler, Swainson's warbler and northern waterthrush are dependent upon forested wetlands for nesting. Several species of owls and woodpeckers are year-round residents of forested wetlands, including eastern screech-owl, great horned owl, barred owl, red-bellied woodpecker, pileated woodpecker, downy woodpecker, and hairy woodpecker. Migratory species that nest in forested wetlands include yellow-throated vireo, red-eyed vireo, northern parula, yellow-throated warbler, worm-eating warbler, scarlet tanager, eastern wood-pewee, acadian flycatcher, and great crested flycatcher. Migratory species residing in scrub-shrub wetland habitats include alder flycatcher (listed as in need of conservation in Maryland), willow flycatcher and white-eyed vireo. Shorebirds are largely migratory and feed on insects, mosquito and fly larvae and a host of invertebrates occupying beaches, mud flats, emergent wetlands and adjacent shorelines. Representative species include greater yellowlegs, solitary sandpiper, spotted sandpiper, semipalmated plover, and black-bellied plover. Some of the more well known and visible wetland birds are the wading birds including great blue heron, green-backed heron, black-crowned night heron, great egret, and snowy egret. These birds use forested, scrub-shrub, and emergent wetlands and feed on the larger aquatic life forms, including fish, frogs, and snakes. Concerning riparian forests, Keller and others (1993) recommend that riparian forests be at least 300 feet (100 m) wide to provide some nesting habitat for area-sensitive species.

Wetlands are, therefore, crucial for the existence of many birds, ranging from waterfowl and shorebirds to migratory songbirds. Some spend their entire lives in wetland environments, while others primarily use wetlands for breeding, feeding or resting.

Mammal and Other Wildlife Habitat

Many mammals and other wildlife inhabit Maryland wetlands (Table 7-5). Readers may wish to consult Paridiso (1969) for more comprehensive information concerning mammals in Maryland. There are approximately 64 species of mammals that live in Maryland (not including marine mammals), and 38 (60%) of them regularly use vegetated nontidal wetlands. Nine (14%) of these species are dependent on wetlands for their survival. Muskrats are perhaps the most typical and widespread wetland mammal (Figure 7-3). Muskrats are known to feed extensively on the shoots, roots, and rhizomes of three-squares, cattail, sweet flag, arrow arum, and other marsh plants and use parts of these plants to build houses above the marsh floor with hidden, underwater entrances (Department of the Interior 1984). Other common

Figure 7-3. Muskrat and their lodges are common sites in many inland marshes and slightly brackish to fresh tidal marshes. They are trapped for their furs and are also served as a local delicacy at some Eastern Shore restaurants. (Robert Fields photo)

furbearers associated with wetlands include beaver, mink, nutria, otter and raccoon. Nutria are similar to muskrats but do not build houses, preferring shallow burrows in mud banks or sleeping in the open. Nutria were imported to Maryland in the 1940s for breeding on fur farms and apparently escaped or were released into the wild (White 1989). Nutria are now common in Maryland, although less so than muskrats. They are particularly abundant in the marshes of Dorchester and Somerset Counties (Evans 1970). Beavers inhabit scrub-shrub and forested headwater wetlands along small streams and creeks dominated by red maple, willow, alder, willow oak, loblolly and pond pine stands. Once extirpated in Maryland, beavers are now becoming much more common. In fact, recent conflicts with private landowners have become so frequent that the Department of Natural Resources has initiated a relocation program to manage the range of beaver. Mink and river otter are similar species that range seasonally between fresh and brackish tidal marshes in search of food. Mink prey on mice, meadow voles, small birds and occasionally, muskrats. River otter are principally fish eaters. Raccoons are frequent visitors to all types of wetland habitats. They prey upon muskrats in brackish tidal marshes and frequent forested wetlands and streambanks looking for frogs, aquatic insects, crustaceans, wild fruits, and nuts. Other mammals frequenting wetlands include the wild ponies of Assateague Island (Figure 7-4), white-tailed deer, sika deer, red fox, eastern cottontail rabbits, black bear (in western Maryland), and star-nosed mole. Smaller mammals also use wetlands including southern red-backed vole, meadow vole, meadow jumping mouse, marsh rice rat, least shrew, masked shrew, and short-tailed weasel.

Figure 7-4. Wild ponies feed on salt marsh grasses behind Assateague Island. They are a natural attraction for Maryland residents and tourists alike. (Ralph Tiner photo)

Figure 7-5. Painted turtles are frequently seen in many fresh-water marshes and ponds. (FWS photo)

Besides mammals and birds, other forms of wildlife make their homes in wetlands. Reptiles (i.e., turtles, lizards and snakes) and amphibians (i.e., toads, frogs, and salamanders) are important residents, principally, of freshwater tidal and nontidal wetlands (Table 7-6). For detailed information regarding amphibians and reptiles in Maryland, readers should see Harris (1975). Reptiles (turtles, lizards, snakes, and crocodilians) have lungs and scaled skin, and either lay shelled eggs or give birth to live young. Amphibians (salamanders, toads, and frogs) have smooth, moist skin, and most go through a gilled, aquatic, juvenile stage after hatching from eggs that are covered by a jelly-like substance and laid in water. There are approximately 40 species of reptiles (not including sea turtles) and 38 species of amphibians that live in Maryland. Of those, 33 (83%) of the reptiles and 32 (84%) of the amphibians regularly use vegetated nontidal wetlands. Ten (25%) of the reptiles and 31 (82%) of the amphibians are dependent on nontidal wetlands. Painted turtles are commonly found in channels, ponds, and along the banks of freshwater wetlands (Figure 7-5). Other species are found in both freshwater and brackish wetlands, including spotted turtle, mud turtle, red-bellied turtle, and snapping turtle (McCormick and Somes 1982). The five-lined skink and broad-headed skink are lizards that occur in Maryland wetlands. Many species of snakes are found in and near wetlands. The northern water snake is a resident of virtually every swamp, stream, river, and marsh in the Bay region (White 1989). Other snakes include northern copperhead, common kingsnake, northern black racer, northern brown snake, black rat snake, and eastern ribbon snake. Toads and frogs are found in great numbers in vernal pools in forested wetlands (Figure 7-6) and along the shorelines of ponds and streams. Common toads include the American toad and Fowler's toad. Southern leopard frog, green frog, pickerel frog, bull frog, and northern spring peeper are among the most common frogs. Less common frogs include the northern leopard frog and carpenter frog. Adults of the red-spotted newt live in ponds with an abundance of submerged vegetation, while the juveniles are terrestrial. Many salamanders use vernal pools or wetlands for breeding, although they may spend most of their years in upland or streamside habitats. Nearly all of the approximately 190 species of amphibians in North America are wetland-dependent at least for breeding (Clark 1979). Salamanders using Maryland wetlands are numerous including, among others, spotted salamander, mountain dusky salamander, northern dusky salamander, eastern mud salamander, and northern two-lined salamander.

The Role of Wetlands in Preserving Plant and Animal Species Diversity

Oftentimes wetlands possess unique characteristics derived from particular soil, water, and sunlight conditions that interact together to form specialized habitats that certain plant and animal species are especially adapted to or dependent upon. More than half of the fishes and amphibians, 30 percent of the reptiles and birds, and 15 percent of the mammals endangered or threatened in the United States are dependent on wetlands for survival (Williams and Dodd 1979). In Maryland, of the 101 plant species classified as "endangered," about one-half (50 species) are plants that are found only (99% of the time) in wetlands (Tables 7-7 and 7-8). Similarly, of the 28 "threatened" plant species in the state, over one-third are found only in wetlands. Excluding marine mammals, there are 38 species of mammals, birds, reptiles and amphibians that are classified as endangered, threatened or in need of conservation. Of this total, 18 species (47%) use wetlands, and 11 of these 18 species directly depend on wetlands for their survival (Table 7-9). Norden and others (1984) have prepared a summary of threatened endangered plants and animals for Maryland.

Environmental Quality Values

Besides providing habitat for fish and wildlife, wetlands play a less conspicuous but essential role in maintaining high environmental quality, especially in aquatic habitats. They do this in a number of ways, including purifying natural waters by removing nutrients, chemical and organic pollutants, and sediment, and producing food which supports aquatic life.

Water Quality Improvement

Wetlands help maintain good water quality or improve degraded waters in several ways: (1) nutrient removal and retention, (2) processing chemical and organic wastes, and (3) reducing the sediment load of water. Wetlands are particularly good water filters because of their locations between land and open water (Figure 7-7). Thus, they can both intercept runoff from land before it reaches the water and help filter nutrients, wastes and sediment from flooding waters. Clean waters are important to humans as well as to aquatic life.

First, wetlands remove nutrients, especially nitrogen and phosphorus, from flooding waters for plant growth and help prevent eutrophication or overenrichment of natural waters. Much of the nutrients are stored in the wetland soil. Although most wetlands have the ability to improve water quality, this function may vary considerably from site to site depending upon hydrological characteristics (especially the turnover rate or contact time of water), type of substrate and plants, seasonal patterns of nutrient immobilization, and the type of wetland. At the Smithsonian Environmental Research Center in Edgewater, Peterjohn and Correll (1982) extensively studied a "riparian forest," later recognized as part of the "wetland continuum" by Whigham and others (1988), for its ability to process nutrients. Their study showed that dissolved nitrogen compounds in surface water runoff declined dramatically after traversing the riparian forest, with the greatest change occurring in the first 63 feet (19 m). A total reduction of 79 percent for nitrate was observed. Similarly, 90 percent and 98 percent total decreases in the mean annual groundwater

Figure 7-6. Vernal pools (temporarily flooded waterbodies in forested wetlands) provide critical breeding areas for many amphibians, including spring peepers and spotted salamanders. (Ralph Tiner photo)

Table 7-2. Survey sample of fishery resource usage and abundance in irregularly flooded salt marshes or nearby waters of Dorchester County, Maryland (Metzgar 1973).

FISH SPECIES PRESENT:

Scientific name	Common name	Spawning	Nursery	Adult Feeding	Spr.	Sum.	Fall	Wntr.	High	Mod.	Low
**Petromyzon marinus*	Sea Lamprey	•									
Carcharhinus leucas	Bull Shark			•		•					
Carcharhinus milberti	Sandbar Shark			•		•					
Sphyrna zygaena	Hammerhead Shark			•		•					
Raja eglanteria	Clearnose Skate			•		•					
Rhinoptera bonasus	Cownose Ray			•		•					
**Acipenser oxyrhynchus*	Atlantic sturgeon	•			•				•		
**Alosa aestivalis*	Blueback Herring	•			•				•		
**Alosa mediocris*	Hickory Shad	•			•				•		
**Alosa pseudoharengus*	Alewife	•			•				•		
**Alosa sapidissima*	American (White) Shad	•			•				•		
Brevoortia tyrannus	Atlantic Menhaden		•	•	•	•			•		
Dorosoma cepedianum	Gizzard Shad		•	•		•	•				•
Anchoa mitchilli	Bay Anchovy	•	•	•	•	•	•	•	•		
Cyprinus carpio	Carp			•			•	•			•
Notropis hudsonius	Spottail Shiner			•			•	•			•
Ictalurus catus	White Catfish		•		•						•
Anguilla rostrata	American Eel		•	•	•	•	•	•	•		
Strongylura marina	Atlantic Needlefish	•	•	•	•	•	•	•	•		
Hyporamphus unifasciatus	Halfbeak		•	•		•	•		•		
Cyprinodon variegatus	Sheepshead Minnow	•	•	•	•	•	•	•	•		
Fundulus heteroclitus	Mummichog	•	•	•	•	•	•	•	•		
Fundulus majalis	Striped Killifish	•	•	•	•	•	•	•	•		
Lucania parva	Rainwater Killifish	•	•	•	•	•	•	•	•		
Syngnathus fuscus	Northern Pipefish	•	•	•	•	•	•	•	•		
**Roccus americanus*	White Perch	•	•	•	•	•	•	•	•		
**Roccus saxatilis*	Striped Bass	•	•	•	•	•	•	•	•		
Bairdiella chrysura	Mademoiselle		•	•		•	•			•	
Cynoscion regalis	Greytrout (Weakfish)		•	•		•	•				•
Cynoscion nebulosus	Spotted Seatrout		•	•		•	•				•
Pomatomus saltatrix	Bluefish		•	•		•	•		•		
Leiostomus xanthurus	Spot		•	•		•	•		•		
Micropogon undulatus	Atlantic Croaker		•	•		•	•				•
Pogonias cromis	Black Drum		•	•		•	•			•	
Sciaenops ocellata	Channel Bass (Red Drum)		•	•		•	•				•
Chasmodes bosquianus	Striped Blenny	•	•	•	•	•	•	•			•
Peprilus alepidotus	Butterfish (Southern Harvestfish)		•		•	•	•				•
Menidia menidia	Atlantic Silverside	•	•	•	•	•	•	•	•		
Paralichthys dentatus	Summer Flounder		•			•					•
Pseudopleuronectes americanus	Winter Flounder		•		•			•		•	
Trinectes maculatus	Hog Choker	•	•	•	•	•	•	•	•		
Gobiesox strumosus	Clingfish (Skilletfish)	•	•	•	•	•	•	•			•
Opsanus tau	Oyster Toadfish	•	•	•	•	•	•	•		•	
Spharoides maculatus	Northern Puffer		•			•					

*Adults present during spawning migration, but not used as a spawning ground *per se*.

Table 7-3. Freshwater species found in Maryland's inland riverine wetlands (Pete Jensen and Robert Bachman, pers. comm.).

Freshwater Species of Inland Riverine Wetlands
Salmonidae
Brook Trout *(Salvelinus fontinalis)*
Brown Trout *(Salmo trutta)*
Rainbow Trout *(Salmo gairdneri)*
Esocidae
Northern Pike (*Esox lucius*)
Chain Pickerel *(Esox niger)*
Redfin Pickerel (*Esox americorus*)
Cyprinidae
Stoneroller *(Compostoma ananalum)*
Rosyside Dace *(Clinostomus funduloides)*
Carp *(Cyprinus carpio)*
Cutlips Minnow *(Exoglossum maixillingua)*
Blacknose Dace *(Rhinichthys atratulus)*
Longnose Dace *(Rhinichthys cataractae)*
Creek Chub *(Semotilus atromaculatus)*
Fallfish *(Semotilus corporalis)*
River Chub *(Nocomis micropogon)*
Common Shiner *(Notropis cornutus)*
Spottail Shiner *(Notropis hudsonius)*
Rosyface Shiner *(Notropis rubellus)*
Spotfin Shiner *(Notropis spilopterus)*
Bluntnose Minnow *(Pimephales notatus)*
Golden Shiner (*Notemigonas crysolencas*)
Catostomidae
Northern Hogsucker *(Hypentelium nigricans)*
White Sucker *(Catostomus commersoni)*
Crack Chubsucker (*Erimyzon oblongers*)
Ictaluridae
Margined Madtom *(Noturus insignis)*
Brown Bullhead *(Ictalurus nebulosus)*
Channel Catfish (*Ictalurus punctatus*)
Gottidae
Mottled Sculpin *(Cottus bairdi)*
Centrarchidae
Rock Bass *(Ambloplites rupestris)*
Pumpkinseed Sunfish *(Lepomis gibbosus)*
Green Sunfish *(Lepomis cyanellus)*
Redbreast Sunfish *(Lepomis auritus)*
Bluegill Sunfish *(Lepomis macrochirus)*
Smallmouth Bass *(Micropterus dolomieui)*
Largemouth Bass *(Micropterus salmoides)*
Percidae
Tessellated Darter *(Etheostoma olmstedi)*
Glassy Darter *(Etheostoma vitreum)*
Fantail Darter *(Etheostoma flabellare)*
Greenside Darter *(Etheostoma blennioides)*
Walleye (*Stizostedion vitreum*)
Yellow Perch (*Perca flavescens*)

Table 7-4. Use of nontidal wetlands by birds in Maryland.

This list shows the birds that regularly use three types of vegetated nontidal wetlands: forested, scrub-shrub, and emergent. Information for this list was gathered from Robbins and Bystrack (1977), field guides, and discussions with biologists. For more comprehensive information regarding birds, readers should reference Stewart and Robbins (1958) and McCormick and Somes (1982). The following symbols are used throughout the list:

- W species uses this nontidal wetland type during winter;
- M species uses this nontidal wetland type during spring and fall migration;
- N species nests regularly in this nontidal wetland type or upland habitat adjacent to this nontidal wetland type;
- + species is dependent on these wetland types (some species also use these types of tidal wetlands);
- E species is listed as "Endangered in Maryland" by the Maryland Department of Natural Resources (in 1990);
- I species is listed as "In Need of Conservation in Maryland" by the Maryland Department of Natural Resources (in 1990);
- H locally rare species that is being monitored by the Natural Heritage Program of the Maryland Department of Natural Resources (in 1990);
- * species is a year-round resident and does not migrate.

Species	Wetland Type Forested	Scrub-shrub	Emergent
Grebes			
Pied-billed Grebe—H			WMN+
Wading Birds			
American Bittern—I		WMN	WMN+
Least Bittern—I			MN+
Great Blue Heron	WMN+	WMN+	WM+
Great Egret	M+	M+	M+
Snowy Egret	M+	M+	M+
Little Blue Heron—I		M+	M+
Green-backed Heron	M+	MN+	M+
Black-crowned Night-heron	WMN+	WMN+	WMN+
Yellow-crowned Night-heron	MN	M	M
Waterfowl			
Canada Goose		N+	WMN+
Wood Duck	MN+		
Green-winged Teal			WM+
American Black Duck		WMN+	WMN+
Mallard		WMN+	WMN+
Northern Pintail			WM+
Blue-winged Teal			WMN+
Northern Shoveler			WM+
Gadwall			WM+
American Wigeon			WM+
Ring-necked Duck			WM+
Hooded Merganser—H	M+	M+	M+
Birds of Prey			
Northern Harrier—H			WMN
Red-shouldered Hawk	WMN		
Gallinaceous Game Birds			
Ring-necked Pheasant*		W	W
Ruffed Grouse*	W	W	
Rails			
Virginia Rail		WMN	WMN+
Sora—H			MN+
Black Rail—I		MN+	MN+
Common Moorhen—I			MN+
Shorebirds			
Killdeer			MN
Black-necked Stilt			MN
American Avocet			M
Greater Yellowlegs			M
Lesser Yellowlegs			M
Solitary Sandpiper			M
Spotted Sandpiper			M
Semipalmated Sandpiper			M
Western Sandpiper			M
Least Sandpiper			M
Baird's Sandpiper			M
Pectoral Sandpiper			M
Dunlin			WM
Stilt Sandpiper			M
Short-billed Dowitcher			M
Long-billed Dowitcher			M
Common Snipe		WM	WM
American Woodcock	WMN	WMN	WMN
Wilson's Phalarope			M
Red-necked Phalarope			M
Owls			
Eastern Screech-owl*	WN		
Great Horned Owl*	WN		
Barred Owl*	WN		
Northern Saw-whet Owl—H	WM	WM	
Hummingbirds			
Ruby-throated Hummingbird	M	MN	
Kingfishers			
Belted Kingfisher	WMN		
Woodpeckers			
Red-headed Woodpecker	WMN		
Red-bellied Woodpecker*	WN		
Yellow-bellied Sapsucker—H	WM		
Downy Woodpecker*	WN		
Hairy Woodpecker*	WN		
Common Flicker	WN		
Pileated Woodpecker*	WN		
Perching Birds			
Olive-sided Flycatcher—H	M		
Eastern Wood-pewee	MN		
Acadian Flycatcher	MN		
Alder Flycatcher—H		MN+	
Willow Flycatcher		MN	
Eastern Phoebe	MN		
Great Crested Flycatcher	MN		
Eastern Kingbird	M	M	

Table 7-4. (continued)

Species	Forested	Wetland Type Scrub-shrub	Emergent
Perching Birds (continued)			
Black-capped Chickadee*	WN	WN	
Carolina Chickadee*	WN	WN	
Tufted Titmouse*	WN	WN	
Red-breasted Nuthatch—H	WMN		
White-breasted Nuthatch	WM	WM	
Brown Creeper	WMN	WM	
Carolina Wren*	WN	WN	
Winter Wren—H	WMN	WM	
Sedge Wren—I		M	MN
Marsh Wren			MN+
Golden-crowned Kinglet—H	WM	WM	
Ruby-crowned Kinglet	WM	WM	
Blue-gray Gnatcatcher	MN	MN	
Eastern Bluebird		WM	WM
Veery	MN	M	
Gray-cheeked Thrush	M		
Hermit Thrush	WMN	WM	
Wood Thrush	MN		
American Robin	WMN	WM	
Gray Catbird	MN	MN	
Northern Mockingbird		WMN	
Brown Thrasher		WMN	
Water Pipit			M
White-eyed Vireo		MN	
Yellow-throated Vireo	MN		
Philadelphia Vireo	M	M	
Red-eyed Vireo	MN		
Blue-winged Warbler	M	MN	
Golden-winged Warbler	M	MN	
Nashville Warbler—H	MN	MN	
Northern Parula	MN		
Yellow Warbler	M	MN	M
Yellow-rumped Warbler—H	WM		
Yellow-throated Warbler	MN		
Palm Warbler	M	M	M
Cerulean Warbler	MN	M	
Black-and-white Warbler	MN	M	
American Redstart	MN	MN	
Prothonotary Warbler	MN+	M	
Worm-eating Warbler	MN		
Swainson's Warbler—I	MN+		
Northern Waterthrush	MN+	M	
Louisiana Waterthrush	MN	M	
Kentucky Warbler	MN	M	
Connecticut Warbler	M	M	
Mourning Warbler—H	M	M	
Common Yellowthroat	MN	MN	MN
Hooded Warbler	MN	M	
Wilson's Warbler	M	M	
Canada Warbler	MN	M	
Summer Tanager	MN		
Scarlet Tanager	MN		

Species	Forested	Wetland Type Scrub-shrub	Emergent
Perching Birds (continued)			
Northern Cardinal*	W	WN	
Song Sparrow		WMN	
Swamp Sparrow	WM	WMN+	WMN+
White-throated Sparrow	WM	WM	
Red-winged Blackbird	W	WMN	WMN
Rusty Blackbird	WM	WM	WM
Total Species	**80**	**67**	**57**
Total Dependent Species	**10**	**13**	**28**

Table 7-5. Use of nontidal wetlands by mammals in Maryland.

This list shows the mammals that regularly use three types of vegetated nontidal wetlands: forested, scrub-shrub, and emergent. Information for this list was gathered from Paradiso (1969), field guides and discussions with biologists.

The following symbols are used throughout the list:

- X species occurs in this nontidal wetland habitat;
- \+ species is dependent on these wetland types (some species also use these types of tidal wetlands);
- E species is listed as "Endangered in Maryland" by the Maryland Department of Natural Resources (in 1990);
- I species is listed as "In Need of Conservation in Maryland" by the Maryland Department of Natural Resources (in 1990);
- H locally rare species that are being monitored by the Natural Heritage Program of the Maryland Department of Natural Resources (in 1990).

Species	Wetland Type Forested	Scrub-shrub	Emergent
Marsupials			
Virginia Opossum	X	X	X
Shrews and Moles			
Masked Shrew	X	X	X
Southeastern Shrew—I	X	X	X
Southern Water Shrew—E	X+	X+	X+
Smoky Shrew—H	X	X	
Pygmy Shrew—H	X	X	X
Short-tailed Shrew	X	X	
Least Shrew	X	X	X
Star-nosed Mole	X+	X+	X+
Rabbits			
Eastern Cottontail	X	X	X
Rodents			
Fox Squirrel—(Delmarva subspecies E)	X		
Southern Flying Squirrel	X		
Beaver	X+	X+	X+
Marsh Rice Rat			X+
Eastern Harvest Mouse			X
Deer Mouse	X	X	
White-footed Mouse	X	X	
Southern Red-backed Vole	X	X	
Meadow Vole		X	X
Southern Rock Vole—H	X		
Muskrat		X+	X+
Southern Bog Lemming—H			X+
Meadow Jumping Mouse		X	X
Woodland Jumping Mouse	X		
Nutria			X+
Carnivores			
Red Fox	X	X	X
Gray Fox	X	X	X
Black Bear	X	X	X
Raccoon	X	X	X
Fisher	X		
Short-tailed Weasel	X	X	X
Least Weasel—I	X	X	
Long-tailed Weasel	X	X	X
Mink	X+	X+	X+
River Otter	X+	X+	X+
Bobcat—I	X	X	
Deer			
Sika Deer	X	X	X
White-tailed Deer	X	X	X
Total Species	30	29	27
Total Dependent Species	5	6	9

Table 7-6. Use of nontidal wetlands by reptiles and amphibians in Maryland.

This list shows the reptiles and amphibians that regularly use three types of vegetated nontidal wetlands: forested, scrub-shrub, and emergent. Information for this list was gathered from Harris (1975), field guides, and discussions with biologists.

The following symbols are used throughout the list:

- X species occurs in this nontidal wetland habitat;
- \+ species is dependent on these wetland types (some species also use these types of tidal wetlands);
- E species is listed as "Endangered in Maryland" by the Maryland Department of Natural Resources (in 1990);
- I species is listed as "In Need of Conservation in Maryland" by the Maryland Department of Natural Resources (in 1990);
- H locally rare species that are being monitored by the Natural Heritage Program of the Maryland Department of Natural Resources (in 1990).

	Wetland Type		
Species	Forested	Scrub-shrub	Emergent
Amphibians			
Salamanders			
Mudpuppy	X		
Red-spotted Newt	X+	X+	X+
Jefferson Salamander—H	X+	X+	X+
Spotted Salamander	X+	X+	X+
Marbled Salamander	X+	X+	X+
Eastern Tiger Salamander—E	X+	X+	X+
Northern Two-lined Salamander	X+		
Long-tailed Salamander	X+		
Four-toed Salamander	X+	X+	X+
Northern Spring Salamander	X+		
Eastern Mud Salamander	X+	X+	X+
Northern Red Salamander	X+	X+	X+
Northern Dusky Salamander	X+		
Mountain Dusky Salamander	X+		
Appalachian Seal Salamander	X+		
Frogs and Toads			
Eastern Spadefoot	X+	X+	X+
American Toad	X+	X+	X+
Fowler's Toad	X+	X+	X+
Northern Cricket Frog	X+	X+	X+
Green Treefrog	X+	X+	X+
Northern Spring Peeper	X+	X+	X+
Eastern Gray Treefrog	X+	X+	X+
Southern Gray Treefrog	X+	X+	X+
Mountain Chorus Frog—H	X+		
Chorus Frog	X+	X+	X+
Eastern Narrow-mouthed Toad—E	X+	X+	X+
Bullfrog	X+	X+	X+
Carpenter Frog—I	X+	X+	X+
Green Frog	X+	X+	X+
Southern Leopard Frog	X+	X+	X+
Pickerel Frog	X+	X+	X+
Wood Frog	X+	X+	X+
Total Species	31	24	25
Total Dependent Species	31	24	24

	Wetland Type		
Species	Forested	Scrub-shrub	Emergent
Reptiles			
Lizards			
Ground Skink	X		
Northern Coal Skink—E	X	X	X
Five-lined Skink	X		
Broad-headed Skink	X	X	
Snakes			
Eastern Worm Snake	X	X	
Ringneck Snake	X	X	
Rough Green Snake	X	X	
Eastern Smooth Green Snake	X	X	
Northern Black Racer	X	X	X
Black Rat Snake	X	X	X
Corn Snake	X	X	
Common (Eastern) Kingsnake	X	X	X
Milk Snake	X	X	X
Red-bellied Water Snake	X	X	X
Northern Water Snake	X	X	X
Queen Snake	X	X	X
Northern Brown Snake	X	X	X
Northern Red-bellied Snake	X	X	X
Smooth Earth Snake—(Mountain subspecies E)	X	X	X
Eastern Ribbon Snake	X+	X+	X+
Eastern Garter Snake	X	X	X
Northern Copperhead	X	X	X
Turtles			
Stinkpot	X+	X+	X+
Eastern Mud Turtle	X+	X+	X+
Common Snapping Turtle	X+	X+	
Spotted Turtle	X+	X+	X+
Wood Turtle	X+	X+	X+
Bog Turtle—H	X+	X+	
Eastern Box Turtle	X	X	X
Map Turtle—I		X+	
Painted Turtle	X+	X+	X+
Red-bellied Turtle	X+	X+	X+
Red-eared Turtle (feral)	X	X	
Total Species	28	30	26
Total Dependent Species	7	9	10

Appendix F. List of Maryland's Endangered and Threatened Plants. (Source: Tiner and Burke 1995)

Table 7-7. Endangered and threatened plant species of Maryland by wetland plant indicator status. Data compiled in 1990 from Maryland Natural Heritage Program; contact them for updated information.

ENDANGERED PLANT SPECIES

Species	Wetland Plant Indicator Status*
1. Sensitive Joint-Vetch (*Aeschynomene virginica*)	OBL
2. Sandplain Gerardia (*Agalinis acuta*)	UPL*
3. Fascicled Gerardia (*Agalinis fasciculata*)	FAC
4. Thread-Leaved Gerardia (*Agalinis setacea*)	UPL*
5. Woolly Three-Awn (*Aristida lanosa*)	UPL*
6. Virginia Heartleaf (*Asarum virginicum*)	FACU
7. Red Milkweed (*Asclepias rubra*)	OBL
8. Serpentine Aster (*Aster depaupertaus*)	UPL*
9. Tickseed Sunflower (*Bidens coronata*)	OBL
10. Small Beggar-Ticks (*Bidens discoidea*)	FACW
11. Small-Fruited Beggar-Ticks (*Bidens mitis*)	OBL
12. Aster-Like Boltonia (*Boltonia asteroides*)	FACW
13. Grass-Pink (*Calopogon tuberosus*)	FACW
14. Long's Bittercress (*Cardamine longii*)	OBL
15. Barratt's Sedge (*Carex barrattii*)	OBL
16. Buxbaum's Sedge (*Carex buxbaumi*)	OBL
17. Coast Sedge (*Carex exilis*)	OBL
18. Giant Sedge (*Carex gigantoea*)	OBL
19. Cypress-Swamp Sedge (*Carex joorii*)	OBL
20. Dark Green Sedge (*Carex venusta*)	OBL
21. Marsh Wild Senna (*Cassia fasciculata var. macrosperma*)	FACU
22. Spreading Pogonia (*Cleistes divaricata*)	FAC
23. Wrinkled Jointgrass (*Ceolorachis rugosa*)	OBL
24. Wister's Coralroot (*Corallorhiza wisteriana*)	FAC
25. Fraser's Sedge (*Cymophyllus fraseri*)	UPL*
26. Smooth Tick-Trefoil (*Desmodium laevigatum*)	UPL*
27. Linear-Leaved Tick-Trefoil (*Desmodium lineatum*)	UPL*
28. Cream-Flowered Tick-Trefoil (*Desmodium ochroleucum*)	UPL*
29. Rigid Tick-Trefoil (*Desmodium rigidum*)	UPL*
30. Pineland Tick-Trefoil (*Desmodium strictum*)	UPL*
31. Pink Sundew (*Drosera capillaris*)	OBL
32. Long Fern (*Dryopteris celsa*)	OBL
33. Knotted Spikerush (*Eleocharis equisetoides*)	OBL
34. Black-Fruited Spikerush (*Eleocharis melanocarpa*)	FACW
35. Robbins' Spikerush (*Eleocharis robbinsii*)	OBL
36. Water Horsetail (*Equisetum fluviatile*)	OBL
37. Bent-Awn Plumegrass (*Erianthus contortus*)	FAC
38. Parker's Pipewort (*Ericaulon parkeri*)	OBL
39. White-Bracted Boneset (*Eupatorium leucolepis*)	FACW
40. Darlington's Spurge (*Euphorbia purpurea*)	FAC
41. Harper's Fimbristylis (*Fimbristylis perpusilla*)	FACW
42. Box Huckleberry (*Gaylussacia brachycera*)	UPL*
43. Swamp-Pink (*Helonias bullata*)	OBL
44. Featherfoil (*Hottonia inflata*)	OBL
45. Creeping St. John's-Wort (*Hypericum adpressum*)	OBL
46. Coppery St. John's-Wort (*Hypericum denticulatum*)	FACW
47. Dwarf Iris (*Iris verna*)	UPL*
48. Red-Root (*Lachnanthes caroliana*)	OBL
49. Club-Headed Cutgrass (*Leersia hexandra*)	OBL
50. Star Duckweed (*Lemna trisulca*)	OBL
51. Downy Bushclover (*Lespedeza stuevei*)	UPL*

ENDANGERED PLANT SPECIES

Species	Wetland Plant Indicator Status*
52. Mudwort (*Limosella subulata*)	OBL
53. Sandplain Flax (*Linum intercursum*)	UPL*
54. Pondspice (*Litsea aestivalis*)	OBL
55. Canby's Lobelia (*Lobelia canbyi*)	OBL
56. Cylindric-Fruited Seedbox (*Ludwigia glandulosa*)	OBL
57. Hairy Ludwigia (*Ludwigia hirtella*)	OBL
58. Sessile-Leaved Water-Horehound (*Lycopus amplectens*)	OBL
59. Erect Water-Hyssop (*Mecardonia acuminata*)	OBL
60. Torrey's Dropseed (*Muhlenbergia torreyana*)	FACW
61. Low Water-Milfoil (*Myriophyllum humile*)	OBL
62. Floating-Heart (*Nymphoides cordata*)	OBL
63. Virginia False-Gromwell (*Onosmodium virginianum*)	UPL*
64. Canby's Dropwort (*Oxypolis canbyi*)	OBL
65. Tall Swamp Panicgrass (*Panicum scabriusculum*)	OBL
66. Wright's Panicgrass (*Panicum wrightianum*)	FAC
67. Kidneyleaf Grass-of-Parnassus (*Parnassia asarifolia*)	OBL
68. Yellow Nailwort (*Paronychia virginica*)	UPL*
69. Walter's Paspalum (*Paspalum dissectum*)	OBL
70. Canby's Mountain Lover (*Paxistima canbyi*)	UPL*
71. Blue Scorpion-Weed (*Phacelia ranunculacea*)	FACW
72. Jacob's Ladder (*Polemonium van-bruntiae*)	FACW
73. Cross-Leaved Milkwort (*Polygala cruciata*)	FACW
74. Dense-Flowered Knotweed (*Polygonum densiflorum*)	OBL
75. Slender Rattlesnake-Root (*Prenanthes autumnalis*)	FAC
76. Alleghany Plum (*Prunus alleghaniensis*)	UPL*
77. Short-Beaked Baldrush (*Psilocarya nitens*)	OBL
78. Long-Beaked Baldrush (*Psilocarya scirpoides*)	OBL
79. Harperella (*Ptilimnium nodosum*)	UPL*
80. One-Sided Pyrola (*Pyrola secunda*)	FAC
81. Yellow Water-Crowfoot (*Ranunculus flabellaris*)	OBL
82. Hairy Snoutbean (*Rhynchosia tomentosa*)	UPL*
83. Short-Bristled Hornedrush (*Rhynchospora corniculata*)	OBL
84. Thread-Leaved Beakrush (*Rhynchospora filifolia*)	FAC
85. Grass-Like Beakrush (*Rhynchospora globularis*)	FACW
86. Clustered Beakrush (*Rhynchospora glomerata*)	OBL
87. Drowned Hornedrush (*Rhynchospora inundata*)	OBL
88. Torrey's Beakrush (*Rhynchospora torreyana*)	FACW
89. Sacciolepis (*Sacciolepis striata*)	OBL
90. Sessile-Fruited Arrowhead (*Sagittaria rigida*)	OBL
91. Sandbar Willow (*Salix exigua*)	OBL
92. Canby's Bulrush (*Scirpus etuberculatus*)	OBL
93. Water Clubrush (*Scirpus subterminalis*)	OBL
94. Slender Nutrush (*Scleria minor*)	FACW
95. Pink Bog-Button (*Sclerolepis uniflora*)	OBL
96. Halberd-Leaved Greenbrier (*Smilax pseudo-china*)	FAC
97. Red-Berried Greenbrier (*Smilax walteri*)	OBL
98. Showy Goldenrod (*Solidago speciosa*)	UPL*
99. Two-Flowered Bladderwort (*Utricularia biflora*)	OBL
100. Fringed Yelloweyed-Grass (*Xyris fimbriata*)	OBL
101. Small's Yelloweyed-Grass (*Xyris smalliana*)	OBL

Table 7-7. (continued)

THREATENED PLANT SPECIES

Species	Wetland Plant Indicator Status*
1. Single-Headed Pussytoes (*Antennaria solitaria*)	UPL*
2. Giant Cane (*Arundinaria gigantea*)	FACW
3. Glade Fern (*Athyrium pycnocarpon*)	FAC
4. Maryland Bur-Marigold (*Bidens bidentoides*)	FACW
5. Button Sedge (*Carex bullata*)	OBL
6. Shoreline Sedge (*Carex hyalinolepis*)	OBL
7. Inflated Sedge (*Carex vesicaria*)	OBL
8. Leatherleaf (*Chamaedaphne calyculata*)	OBL
9. Red Turtlehead (*Chelone obliqua*)	OBL
10. Goldenseal (*Hydrastis canadenis*)	UPL*
11. Deciduous Holly (*Ilex decidua*)	FACW
12. Narrow-Leaved Bushclover (*Lespedeza augustifolia*)	FAC
13. Wild Lupine (*Lupinus perennis*)	UPL*
14. Climbing Fern (*Lygodium palmatum*)	FACW
15. American Lotus (*Nelumbo lutea*)	OBL
16. Red Bay (*Persea borbonia*)	FACW
17. Pale Green Orchis (*Platanthera flava*)	FACW
18. Purple Fringeless Orchis (*Platanthera peramoena*)	FACW
19. Spongy Lophotocarpus (*Sagittaria calycina*)	OBL
20. Englemann's Arrowhead (*Sagittaria engelmanniana*)	OBL
21. Northern Pitcher-Plant (*Sarracenia purpurea*)	OBL
22. Virginia Mallow (*Sida hermaphrodita*)	FAC
23. Featherbells (*Stenanthium gramineum*)	FACW
24. Mountain Pimpernel (*Taenidia montana*)	UPL*
25. Steel's Meadowrue (*Thalicturm steeleanum*)	FACU
26. Kate's-Mountain Clover (*Trifolium virginicum*)	FACW
27. Dwarf Trillium (*Trillium pusillum*)	FACW
28. Purple Bladderwort (*Utricularia purpurea*)	OBL

*The wetland plant indicator status according to Reed (1988). See Chapter 6 for discussion.

Table 7-8. Numbers and percentages of threatened and endangered plants of Maryland by wetland plant indicator status (according to Reed 1988). Data compiled in 1990 from the Maryland Natural Heritage Program.

Classification	Wetland Indicator Status of Plants	Number of Species	% of Endangered or Threatened Species
Endangered	OBL	54	53.5
	FACW	14	13.9
	FAC	10	9.9
	FACU	2	1.9
	UPL	21	20.8
	Total	**101**	**100**
Threatened	OBL	10	35.7
	FACW	10	35.7
	FAC	3	10.7
	FACU	1	3.6
	UPL	4	14.3
	Total	**28**	**100**

Table 7-9. Wildlife species using nontidal wetlands and classified as endangered, threatened, or in need of conservation in Maryland. Data compiled in 1990 from the Maryland Natural Heritage Program.

Group	Total Number of Species	Number of Species Using Nontidal Wetlands
Mammals	8	5 (1 "dependent")*
Birds	17	7 (6 "dependent")
Reptiles	8	3 (1 "dependent")
Amphibians	5	3 (3 "dependent")
	38	**18**

* "Dependent" means that species directly depends upon nontidal wetlands for survival of the species.