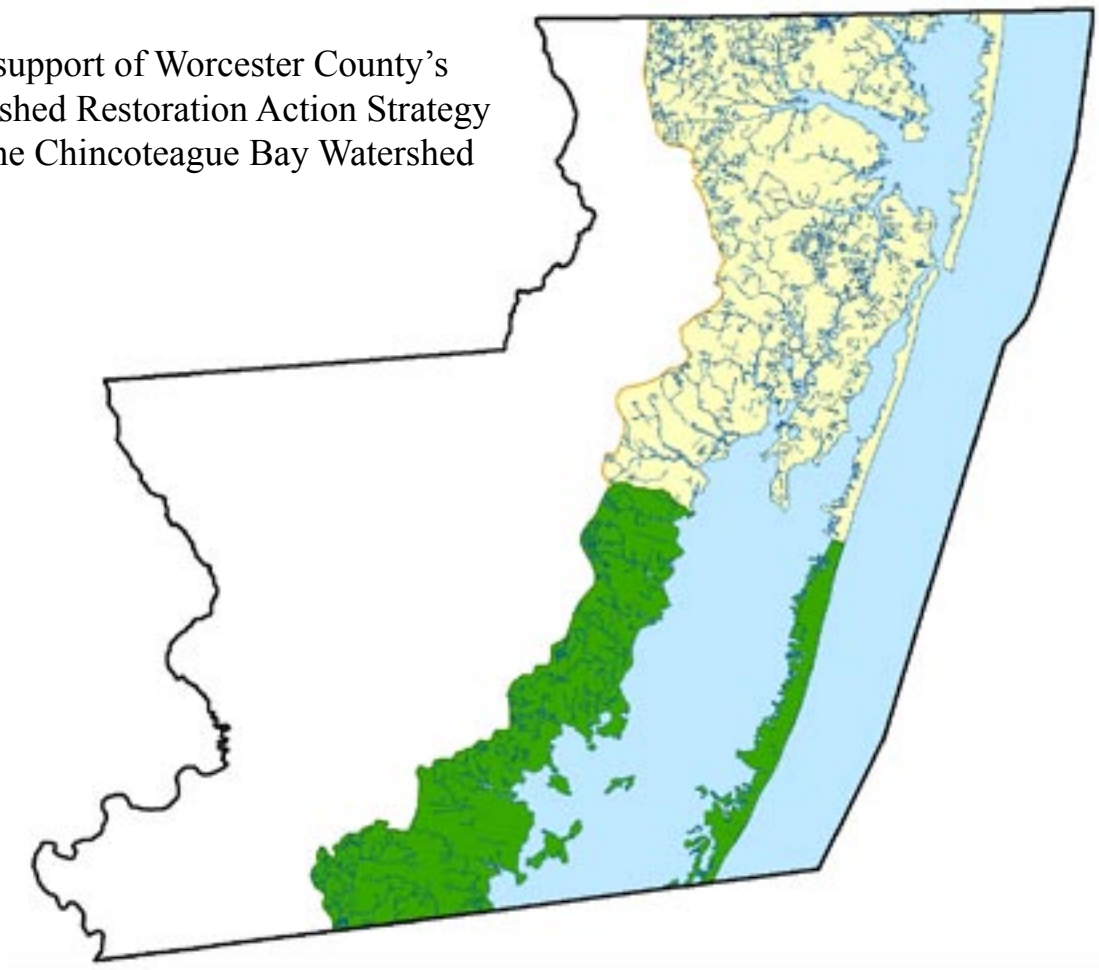
Characterization
Of The
Chincoteague Bay Watershed
In Worcester County, Maryland

March 2005

In support of Worcester County's
Watershed Restoration Action Strategy
for the Chincoteague Bay Watershed



Product of the
Maryland Department of Natural Resources
Watershed Services
In partnership with Worcester County

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Executive Summary

The Chincoteague Bay is the largest body of water in Maryland's Coastal Bays covering 72.6 square miles (46,483 acres). This bay is polyhaline ranging from 23 to 36 parts per thousand salinity. This embayment is created by Assateague Island, which is a barrier island that covers about 10.8 square miles (6,916 acres) in Maryland. The remaining land that drains to Chincoteague Bay in Maryland encompasses about 56.1 square miles (35,890 acres).

Worcester County, Maryland is receiving Federal grant funding to prepare a Watershed Restoration Action Strategy (WRAS) for the Chincoteague Bay Watershed. As part of the WRAS project, the Maryland Department of Natural Resources (DNR) is providing technical assistance, including preparation of a watershed characterization (compilation of available water quality and natural resources information and identification of issues), a stream corridor assessment (uses field data to catalog issues and rate severity) and a synoptic survey (analyzes benthic macroinvertebrates, fish and water samples with focus on nutrients). The County will consider the information generated in these efforts as it drafts the County Watershed Restoration Action Strategy.

Water Quality

All water bodies in the Chincoteague Bay watershed have a designated use. All tidal waters are designated for shellfish harvesting and all nontidal waters are designated to support water contact recreation and protection of aquatic life. Water quality impairments that affect these designated uses include dissolved oxygen, nutrients, biological impairment (poor or very poor ranking for fish or benthic macroinvertebrates based on in-stream assessments) and bacteria. Maryland's most recent list of impaired waters (the 303(d) List) recommends that the listing for bacteria impairment in Chincoteague Bay be dropped because recent water quality monitoring data did not find impairment by bacteria.

As a step toward eliminating impairments associated with nutrients, the Total Maximum Daily Loads of Phosphorus and Sediment to Big Millpond, Worcester County, Maryland was approved by EPA in 2002. It specifies limits for phosphorus and sediment entering Big Millpond that, if met, should prevent future episodes of low dissolved oxygen and reduce or eliminate other eutrophication-related problems in the pond.

In the open tidal waters of Chincoteague Bay, water quality tends to be good/excellent south of Figgs Point and good/fair north of Figgs Point. Where water quality problems exist but they are less severe than other Maryland coastal bay areas like Newport Bay or St. Martin River. Water clarity in Chincoteague Bay as measured by secchi disk tends to be less than 0.5 meters in summer months. Dissolved oxygen concentrations tend to be greater than 5.0 mg/l most of the time. However, dissolved oxygen levels lower than this are sometimes found in near-shore areas during summer months. Algae populations as measured by

Chlorophyll a in periodic sampling tend to be less than 30 micrograms per liter. Total nitrogen concentrations generally average less than 1 mg/l range but have been measured as high as 1.4 mg/l. Total phosphorus concentrations tend to average less than 0.09 mg/l but have been measured up to 0.14 mg/l.

In nontidal areas, elevated nutrient levels have been found in some streams. Total phosphorus greater than 0.1 mg/l and total nitrogen greater than 4 mg/l have been measured. Nitrate concentrations averaging greater than 2 mg/l were identified in four streams.

In Big Millpond during warm-weather months, dissolved oxygen concentrations less than 2 mg/l have been measured. Chlorophyll a concentrations were found between 20 and 50 micrograms per liter.

No point source discharges in the Chincoteague Bay watershed are listed in the State's permit database. The only marina located on Chincoteague Bay offers pumpout service.

Natural Resources

According to SSURGO soil data, more than half of the soil in the watershed is prime agricultural soil. About one third of this soil (5,200 acres) requires drainage and/or irrigation and the other two thirds (11,400 acres) does not require this kind of management. Soils with hydric characteristics are found on about 14,400 acres.

Green Infrastructure is a network of natural areas identified by DNR that are ecologically important on a statewide or regional scale. The Green Infrastructure includes areas like large blocks of forest or wetlands, habitat for sensitive species and protected conservation areas. These areas are grouped into hubs that contain the bulk of these resources and corridors than link the hubs together. In the Chincoteague Bay watershed, Assateague Island in its entirety constitutes the largest Green Infrastructure hub. Most of the wetlands adjacent to Chincoteague Bay along the mainland are part of Green Infrastructure hubs. On the mainland draining to Chincoteague Bay, over 14,000 acres of forest contribute to Green Infrastructure hubs. Nearly 7,300 acres of forest are likely to be high quality forest interior habitat. Several hubs in the Chincoteague Bay watershed ranked very high among all hubs in Maryland's eastern coastal eco-region.

Nearly 15,600 acres of wetlands are identified in the watershed. Chincoteague Bay supports over 8,700 acres of estuarine emergent wetlands and over 3,000 acres of unconsolidated shore wetlands. In the mainland, the most common wetland type is forested palustrine wetlands, which cover nearly 2,900 acres. While large areas of wetland have been converted to other uses historically, tracking of wetland permitting indicates that there has been a small net gain in wetland acreage since 1991 (over 13 acres). About 400 acres are designated as Wetlands of Special State Concern, which listed in State regulation to help provide additional protection for the sensitive species that these wetlands support.

About 5,100 acres of 100-year floodplain have been identified in Chincoteague Bay watershed. Updated floodplain mapping using high-resolution elevation data will be available in 2005.

An assessment of stream buffer restoration opportunities in Maryland's portion of the Chincoteague Bay watershed was conducted using computerized GIS. There are about 182 miles of streams and ditches, excluding shoreline of Chincoteague Bay and Big Millpond. Based on 2002 land use, about 92 miles of

stream/ditch buffer are characterized by natural vegetation. About 88 miles are in some type of agricultural use and remainder is developed (2 miles). Nearly half of the stream/ditch buffers characterized by agricultural use are on hydric soil. Depending on landowner interests and field verification of hydric soil conditions, these stream/ditch buffers present potential opportunities for restoration of naturally vegetated buffers and/or wetland restoration.

Living Resources and Habitat

In tidal waters of the coastal bays, over 130 species of fish have been identified in the past 30 years. Sampling by DNR Fisheries Service identified 77 species in 2001 and 80 species in 2002. Among those species identified, most are estuarine-dependent like summer flounder, croaker, weakfish, spot, striped bass and black sea bass.

Oysters were once an important regional fishery in Maryland's Coastal Bays. However, they have declined drastically during the twentieth century due to harvesting, disease and predation. Early in the century there were over 1,600 acres of natural oyster bars but now there are no legally designated oyster beds in Chincoteague Bay. However, 765 acres of Bay bottom are covered by oyster lease areas.

In the 1930s, a disease nearly eliminated all submerged aquatic vegetation (SAV) in Maryland's Coastal Bays. Since monitoring began in 1986, in general there has been a steady increase in area covered by SAV beds increasing from about 3,522 acres in 1987 to about 7,625 acres in 2002. During the past 20 years, SAV has always been found adjacent to Assateague Island but its presence along the mainland has been seen only in recent years.

During the period 1987 through 2002, the majority of SAV tends to found on the eastern side of Chincoteague Bay along Assateague Island. Then, in the late 1990s SAV began to reappear on the western side of the Bay around Miller Island. By 2002, large areas of Parker Bay and more areas around Miller Island had SAV beds. During the same 2002 growing season, SAV also appeared on the south side of Tizzard Island, the north shore of Rowley Cove and on some of the north shoreline of Brockanorton Bay.

In nontidal waters, the Maryland Biological Stream Survey reported findings using the Fish Index of Biological Integrity on one nontidal stream site in the Chincoteague Bay watershed, which was rated as poor. The DNR staff who performed these surveys found only three species of fish at this site: American Eel, Eastern Mudminnow and Pirate Perch. Using their Benthic Index of Biological Integrity, they reported on two sites in which one was rated very poor and the other was rated poor. These findings are indicative of a relatively limited benthic community, which suggests that a combination of poor habitat and/or water quality were present at that time.

A Statewide fish consumption advisory regarding fish caught in impoundments anywhere in Maryland recommends limiting meals that would include smallmouth bass, largemouth bass and/or bluegill. The concern is the potential for contamination by methylmercury.

One blockage to fish movement in the Chincoteague Bay watershed is identified in the database maintained by DNR Fisheries Service. This blockage is the impoundment that forms Big Millpond. Additional blockages may be identified by the stream corridor assessment conducted in 2004.

Overall in the Chincoteague Bay watershed, Maryland tracks sensitive species of 17 ani-

mals and 43 plants in the Chincoteague Bay watershed. These species are found in at least 30 ecologically significant areas (ESAs) mapped by the DNR Natural Heritage program.

Land Use / Land Cover

In the Chincoteague Bay watershed, wetlands cover nearly one quarter of the entire area that is not open water. The remaining watershed area is 40% forest and brush, 33% agriculture and 4% developed land and bare ground.

On the mainland that drains to Chincoteague Bay, if only dry land is considered (wetlands excluded), forest and brush account for 51% of the land and agriculture accounts for 47%. The remainder is developed or bare ground.

The entire barrier island within Maryland's Chincoteague Bay watershed is managed by the National Park Service as the Assateague Island National Seashore.

Over 88% of the remaining land in the watershed is privately owned (31,740 acres). Within these privately owned lands, about 8% (2,601 acres) are protected by conservation easement and about 3% (1,033 acres) are protected by agricultural easement.

On the mainland, the Maryland Department of Natural Resources manages about 4,059 acres including the Vaughn Wildlife Management Area and the Chesapeake Forest properties.

The Coastal Bays Rural Legacy Area in the southern end of the watershed allows for targeting of State Program Open Space funds to help protect lands from conversion to developed land use. This Rural Legacy Area is adjacent to the greatest concentration of existing protected lands on the mainland area that drains to Chincoteague Bay.

Introduction

Watershed Planning Background

As a foundation for watershed monitoring, analysis and planning, the State of Maryland defined over 130 watersheds that cover the entire State in the 1970s. In 1998, the Maryland Clean Water Action Plan presented an assessment of water quality conditions in each of these watersheds. Based on these assessments, it also established State priorities for watershed restoration and protection.

In 2000, the Maryland Department of Natural Resources (DNR) initiated the Watershed Restoration Action Strategy (WRAS) Program as one of several new approaches to implementing water quality and habitat restoration and protection. The WRAS Program solicits local governments to focus on priority watersheds for restoration and protection. Since inception of the program, local governments have received grants and technical assistance from DNR for 20 WRAS projects in which local government, with input from citizens, identifies local watershed priorities for restoration, protection and implementation.

Chincoteague Bay WRAS Project

The Chincoteague Bay Watershed is in the Atlantic Ocean drainage area, which includes the Mid-Atlantic Coastal Bays in Maryland and Virginia. The Chincoteague Bay watershed in Worcester County, Maryland as shown in Map1 Location is the focus for this WRAS project. The Chincoteague Bay watershed prioritized in the Maryland Clean Water Action Plan in two ways. Regarding restoration needs, the Chincoteague Bay watershed is a Category 1 watershed for restoration, which recognizes the presence of water quality impairments that need improvement. Regarding protection of existing natural resources, the Chincoteague Bay watershed is a Selected Category 3 watershed, which is the State's highest priority for protection.

The County is working on a WRAS project to be completed in 2005. Worcester County's project is intended to dovetail with existing efforts including Coastal Zone Management, the Maryland Coastal Bays Program and others. Consistent with the existing plan, Today's Treasures for Tomorrow: Towards a Brighter Future, The Comprehensive Conservation and Management Plan for Maryland's Coastal Bays, Worcester County WRAS will identify and prioritize local restoration and protection needs associated with water quality and habitat. To support this effort, the Maryland Department of Natural Resources (DNR) has provided grant funding and technical assistance, which includes production of this Watershed Characterization.

Map 2 WRAS Project Area shows the Chincoteague Bay watershed in greater detail and the table on the nest page summarizes major acreage categories. In total, Maryland's portion of the watershed is about 48% land coving about 42,806 acres of dry land and wetlands and 52% water, which covers about 46,483 acres.

Land Area In Maryland's Chincoteague Bay Watershed In Acres		
	Mainland	**Barrier Island**
"Dry" Land	30,186	2,795
Wetlands	5,704	4,121
Total Land Area	35,890	6,916
Water	46,483	
Total Watershed	89,289	

Purpose of the Characterization

In support of the WRAS project, the Watershed Characterization helps to meet several objectives:

- Summarize immediately available information and issues that may add to that already gathered by the Maryland Coastal Bays Program
- Provide preliminary findings based on this information
- Identify sources for more information or analysis
- Suggest opportunities for additional characterization and restoration work.
- Provide a common base of knowledge about the watershed for government, citizens, businesses and other interested groups.

The Watershed Characterization adds to other efforts that are important for the County's WRAS project:

- Local investigation by the County
- Stream Corridor Assessment, in which DNR personnel physically walk the streams and catalogue important issues
- Synoptic water quality survey, i.e. a program of water sample analysis, that can be used to focus on local issues like nutrient hot spots, point source discharges or other selected issues. This is also part of the technical assistance offered by DNR
- Technical assistance and assessment by partner agencies or contractors

Moving Beyond The Characterization

In addition to the information presented in this document, it is important to identify gaps in available watershed knowledge and to gauge the importance of these gaps. As new information becomes available, the Watershed Characterization and other components of the WRAS should be updated and enhanced as needed. Here are some examples of issues for potential additional work:

- Habitat: physical structure, stream stability, biotic community (incl. the riparian zone)
- Water Quantity: high water–storm flow and flooding; low water–baseflow problems from dams, water withdrawals, reduced infiltration
- Water Quality: water chemistry; toxics, nutrients, sediment, nuisance odors/scums, etc.
- Cumulative effects associated with habitat, water quantity and water quality.

Restoration and natural resource protection is an active evolving process. The information that supports the Watershed Restoration Action

Strategy, including the Watershed Characterization, should be maintained as living documents within an active evolving restoration process. These documents will need to be updated periodically as new, more relevant information becomes available and as the watershed response is monitored and reassessed.

More Information Sources

References are presented in parenthesis throughout the text that direct the reader to endnotes in the Reference Section of the document. These references provide more detailed information that is only very briefly summarized here.

The WRAS Program Internet home page has additional information on the program and an index of available electronic copies of WRAS-related documents that can be downloaded free of charge. Available documents include detailed program information, completed WRAS strategies, stream corridor assessments, synoptic surveys and watershed characterizations. Please visit the WRAS Home Page at http://www.dnr.state.md.us/watersheds/wras/

Additional information on over 130 watersheds in Maryland is available on DNR's Internet page Surf Your Watershed at http://www.dnr.state.md.us/watersheds/surf/index.html

The Maryland Clean Water Action Plan is available at www.dnr.maryland.gov/cwap/

Additional information on the Maryland Coastal Bays Program is available at http://www.mdcoastalbays.org/

Water Quality

Water quality is in many respects the driving condition in the health of Maryland's streams and other water bodies. Historically, efforts to protect water quality have focused on chemical water quality. More recently, additional factors are being considered like measurements of selected biological conditions and physical conditions that affect habitat quality in streams and estuaries. This expanded view is reflected in current approaches to monitoring, data gathering, and regulation of water bodies as reflected in this watershed characterization.

Designated Uses For Streams

Streams and other water bodies in Maryland are each assigned a "designated use" in the Code of Maryland Regulation (COMAR) 26.08.02.08, which is associated with a set of water quality criteria necessary to support that use. Together, the designated use and the criteria are commonly referred to as "Water Quality Standards;" they are established by the Maryland Department of the Environment (MDE) in regulation.

In Maryland's portion of the Chincoteague Bay watershed, all bodies of water are categorized under one of two designated uses:

- Use 1- Recreation and Aquatic Life applies to all surface waters except for those designated as Use 2. (This includes all nontidal water bodies.)
- Use 2- Shellfish Harvesting encompasses all

portions of the territorial seas and estuarine portions of bays and tributaries.

Use Impairments

Some streams or other water bodies in the WRAS project area cannot be used to the full extent envisioned by their designated use in Maryland regulation. These areas, known as "impaired waters", are tracked by the Maryland Department of the Environment under Section 303(d) requirements of the Federal Clean Water Act. The list of impairments for waterbodies in the Chincoteague Bay watershed are summarized below.

Bacteria

The 1996 303(d) list included Chincoteague Bay for impairment associated with fecal coliform bacteria arising from natural sources and nonpoint sources. However, the draft 2004 303(d) list indicates that Chincoteague Bay meets standards for shellfish waters based on 2003 monitoring data and proposes removal of the previous listing for impairment by bacteria.

Biological

The draft 2004 303(d) list includes waterbodies in the Chincoteague Bay watershed for biological impairment based on assessment of fish and benthos by the Maryland Biological Stream Survey (MBSS) using their indices of biological integrity: Five Mile Branch, Powell Creek, Waterworks Creek. These streams are listed because Index of Biological Integrity for either fish or benthos was found to be poor or very poor. (See Benthic Organisms for more information.)

Dissolved Oxygen

In Maryland's Coastal Bays including Chincoteague Bay, dissolved oxygen levels are known to drop below the State standard. The cause is associated with nutrient enrichment and algae over-population in warm months. This dissolved oxygen data is used to support listing impairment by nutrients. (Prior to 2002, low dissolved oxygen impairment was listed separately.)

Nutrients

Big Mill Pond was listed 1998 and Chincoteague Bay was listed in 1996 for impairments associated with nutrients from nonpoint and natural sources.

Total Maximum Daily Loads

In Maryland, the Department of the Environment (MDE) uses the 303(d) list of impaired waters to determine the need for establishing Total Maximum Daily Loads (TMDLs). A TMDL is the amount of pollutant that a water body can assimilate and still meet its designated use. A water body may have multiple impairments and multiple TMDLs to address them. MDE is responsible for establishing TMDLs. In general, TMDLs have two key parts:

1- Maximum pollutant load that the water can accept while still allowing the water body to meet its intended use.
2- Allocation of the maximum pollutant load to specific pollutant sources.

As of the of December 2004 in the Chincoteague Bay watershed, one TMDL has been approved (summarized below) for Big Millpond. Additionally, work is in progress to delist Chincoteague Bay for impairment by bacteria. An opportunity for public comment for the draft Water Quality Assessment for bacteria in the Chincoteague Bay was conducted in 2004. (1)

Phosphorus and Sediment TMDLs for Big Millpond

EPA approved a TMDL for Big Mill Pond in April 2002 that was submitted by MDE in December 2001. The TMDL is designed to address water quality problems associated with nutrients, low dissolved oxygen, algae blooms and excessive sedimentation by limiting phosphorus entering the pond. (2)

Big Millpond is a 100-year old recreational pond owned by Worcester County on Swans Gut Creek near Welbourne. The pond and its watershed are entirely in Maryland. The pond drains to Swans Gut Creek which flows into Virginia before reaching the Horntown Bay portion of Chincoteague Bay.
Water quality problems in this freshwater impoundment are low dissolved oxygen, algae blooms and sedimentation. Water quality monitoring and modeling conducted for Big Millpond demonstrate that control of the nutrient phosphorus can prevent excessive algae growth and thereby eliminate an underlying cause of the dissolved oxygen depletion.

The Big Millpond TMDLs for phosphorus and sediment are related. The phosphorus TMDL is designed to eliminate low dissolved oxygen problems and algae blooms, which will foster the pond's warm water recreational fishery. In addition, because phosphorus is known to have a tendency to bind to sediments, the sediment TMDL is derived from the phosphorus TMDL. The sediment TMDL is projected to preserve 58% of the impoundment's design volume over a 101-year period.

The allocation for both of the Big Millpond TMDLs is divided between nonpoint sources and the margin of safety because no point sources are present within the watershed that darins to the impoundment.

Big Millpond TMDL		
Phosphorus	880 pounds per year	Average 2.4 pounds per day
Sediment	931.9 cubic meters per year	Average 2.6 cubic meters per day

Water Quality In Tidal Areas

Map 3 Water Monitoring and Marinas shows the locations of the sampling sites identified in the watershed. Summaries of findings from the tidal sampling sites are listed collectively and by station. Additional information is available in several current documents available via the Internet or in print:

- DNR's Eye's On The Bay Internet Site. (3)
- Coastal Bays 2004 report (4)
- Maryland's Coastal Bays Ecosystem Health Assessment 2004 (5)
- Appendix B - Water Quality Monitoring In Tidal Water

Overview

Overall, water quality in Maryland's portion of Chincoteague Bay is better than Maryland's northern Coastal Bays. In the open Bay south of Figgs Landing tends to exhibit good or excellent water quality even though high phosphorus concentrations are found in this area. The open Bay north of Figgs Landing to Waterworks Creek/Newport Bay tends to have good/fair water quality. From Public Landing northward, excessive nutrients were measured. Water quality close to some shoreline areas along the shoreline, Johnson Bay and near Public Landing, exhibit more quality problems than open waters. (4-page 20, 5-Section 4)

Trend analysis on long-term water quality data collected from National Park Service monitoring sites in Chincoteague Bay indicate that most areas exhibit no trend or slight improvement. (6) However, the Johnson Bay station exhibited some deterioration. (5-Section 4.1)

A snap shot of conditions in Chincoteague Bay, summarized by water quality parameter based on recent data from DNR monitoring stations, is presented below in the following subsections.

Salinity

Salinity in Chincoteague Bay is always polyhaline, which is greater than 18 parts per thousand (ppt). The measured salinity is highly variable with a range between 23 and 36 ppt.

Water Clarity

Water clarity in Chincoteague Bay as measured by secchi disk tends to vary between one half and one meter. However, secchi depths less than 0.5 meters are common in summer months which tends to limit growth potential for submerged aquatic vegetation. In general, water clarity is reduced as more suspended sediment, algae and other plankton occurs in the water.

Dissolved Oxygen

Dissolved oxygen (DO) thresholds used for Chincoteague Bay are: greater than 5 milligram per liter (mg/l) supports aquatic life, 3 to 5 mg/l threaten aquatic life and less than 3 mg/l does not meet objectives. Chincoteague Bay DO is commonly greater than 5.0 mg/l. However, DO less than 5 milligram per liter (mg/l) has been measured during warm weather months in some open water sites in the Chincoteague Bay ranging from near Virginia to near Newport Bay, in the Johnson Bay and Parker Bay vicinity near Vaughn Wildlife Management Area and in Brocknorton Bay near Boxiron Creek. (7) Areas exhibiting lower DO identified by spatially intensive monitoring were mostly in coves or along shoreline, especially around Figgs Landing and Green Run Bay. (5-Section 4.3)

Chlorophyll (Algae)

Chlorophyll a is used as a way to measure the size of green and blue-green algae populations. Chlorophyll a concentrations greater than 15 micrograms per liter (ug/l) negatively affect sea grasses by blocking more and more light as concentrations increase. Concentrations greater than 50 ug/l are associated with algae populations that are great enough to negatively affect dissolved oxygen. Most of the time, monitoring in Chincoteague Bay exhibits less that 15 ug/l Chlorophyll a. However, concentrations ranging between 15 and 50 ug/l where common in warm weather months near Public Landing and Taylor Landing, which is next to Vaughn Wildlife Management Area. Trends identified were toward improvement at Public Landing and degrading in Johnson Bay (5-Section 4.2)

Nitrogen

Nitrogen is likely to be the nutrient that limits algae growth in the saline waters of Chincoteague Bay. Concentrations greater than 1 mg/l indicate eutrophic conditions and less than 0.64 mg/l are considered best for growth of submerged aquatic vegetation (SAV). Most of the time, total nitrogen (TN) concentrations are less than 1.0 mg/l. TN concentrations in some central areas of the bay tend to be in the range between 0.64 to 1.0 mg/l. Toward the southern end of Chincoteage Bay in Maryland, TN concentrations tend to be lowest. Low TN concentrations limits algae growth in Chincoteague Bay. (5-Section 4.1)

Phosphorus

Total phosphorus concentrations greater than 0.1 mg/l indicate eutrophic conditions and less than 0.037 mg/l are considered best for growth of submerged aquatic vegetation (SAV). Total phosphorus (TP) concentrations are typically less than 0.1 mg/l. Open water areas in mid bay from Virginia to Newport Bay tend to have TP concentrations tend to range between 0.037 and 0.043 mg/l. TP concentrations in Johnson Bay and near Public Landing tend to range between 0.043 and 1.0 mg/l. (5-Section 4.1)

Sediment Contaminants

Sediments frequently retain traces of contamination by metals, pesticides and other substances that enter surface water. Contamination can contribute to toxicity of the sediment. In general for sediment sampled from Chincoteague Bay, concentrations of metals are within background levels and organic contaminants are at trace levels or below detection limits. Overall, sites in Chincoteague Bay generally showed no toxicity. One site tested in 1993 in mid Chincoteague Bay was found to have sandy sediment with high heptachlor (herbicide) concentrations. (One site that showed toxicity one year did not yield the same result the following year.) (5-Sections 5.2 and 5.3)

Total Organic Carbon

Total organic carbon (TOC) in sediments is an indicator of pollution and eutrophication. Higher concentrations suggest a greater tendency to eutrophication. In Maryland's coastal bays, high TOC is found in the northern bays, which indicates eutrophication problems. However, high TOC is not found in Chincoteague Bay, which suggests that eutrophication problems are relatively limited. (5-Section 5.1)

Summary by Monitoring Station

A different view of tidal water quality in Chincoteague Bay can be seen by looking at selected DNR monitoring stations. Summaries of findings start with the north end of Chincoteague Bay and conclude at the south end near the Maryland/Virginia border.

Station XBM1562 – North Chincoteague Bay

- Depth at this site is slightly less than 2 meters (just over six feet).
- Dissolved Oxygen is usually above 5 mg/l but has reached as low as 4 mg/l in May through June.
- Water clarity as measured by secchi depth is highly variable. In spring, secchi depths vary between one quarter and 1.5 meters. In summer, it tends to be around one half meter. In autumn, secchi depths over one meter are common.
- The pH is slightly alkaline ranging between 7.5 and 8.4.

Station XBM8149 – Mid Chincoteague Bay

- Depth at this site is about 2 meters (about 6.5 feet).
- Dissolved oxygen is generally above 5 mg/l (2001 through 2004). However, during June and July concentrations between 3.5 and 5 mg/l have been documented.
- Water clarity as measured by secchi depth shows a lot of seasonal variation. In June through August, secchi depths between one quarter and one half meter are typical. However, in October to November secchi depths around 1.5 meters are common.
- The pH is slightly alkaline ranging between 7.6 and 8.3.

Station XBM1301 – South Chincoteague Bay near Maryland/Virginia Border

- Depth at this site is about three meters (just under 10 feet).
- Dissolved oxygen is consistently above 5 mg/l (2001 through 2004)
- Water clarity as measured by secchi depth is usually between 0.5 and 1.5 meters. However, it is sometimes as great as 1.5 to 2 meters. It has also been measured at nearly zero.
- Total nitrogen averages over 0.7 mg/l (range 0.49 to 1.15 mg/l)
- Total phosphorus averages over 0.05 mg/l (range 0.022 to 0.115 mg/l)
- The pH is slightly alkaline ranging between 7.6 and 8.4.

Water Quality In Nontidal Areas

Overview

On Maryland's lower Eastern Shore, improvement to drainage such as ditching is very common. Many natural streams are modified to speed surface drainage and/or to lower the water table. In some places, natural streams may not exist. Commonly, the nontidal water quality information available does not indicate if the water body sampled is a natural stream or drainage ditch. Therefore, the term stream is used here as a generic term for all nontidal surface water conveyance. No streams have been identified on Assateague Island.

Sampling of 10 streams in 1999-2000 found that elevated nitrate levels are common. As shown in Map 3 Water Monitoring and Marinas, three streams averaged less than 0.4 mg/l, which is considered to be a natural level for nitrate in local streams. However, seven streams exhibited elevated nitrate including three that averaged between 0.4 and 2 mg/l and four that averaged over 2 mg/l. (4-page 12, 5-Section 3.1, 8)

Additional details of water quality findings for nontidal streams are summarized in Appendix C - Water Quality Monitoring In Nontidal Streams and Impoundments

Big Millpond

Water quality sampling has been conducted in Big Millpond in June and August of 1993 as well as October 2000 through August 2001 (to support TMDL work). Water quality samples were collected near the surface once in each month from three stations. "The Maryland Department of Health and Mental Hygiene analyzed samples for total phosphorus, soluble orthophosphorus, total Kjeldahl nitrogen, total organic solvents and chlorophyll a. Physical measurements of depths, water temperatures, PH, conductivity and dissolved oxygen were recorded in the field." (2)

Dissolved oxygen in Big Millpond is typically less than 5.0 mg/l in warm weather months. Some measurements less than 2 mg/l were also collected in the pond. Fish are severely stressed and/or eliminated in these very low oxygen areas. Upstream in Little Mill Run and Payne Ditch DO concentrations tend to be much higher. Measurements were always greater than 5 mg/l and were commonly greater than 7 mg/l. These upstream oxygen levels are favorable to most fish species.

Algae population density as measured by Chlorophyll a found concentrations between 20 and 50 micrograms per liter are common in the pond. Measurements from the upstream sites in Little Mill Run and Payne Ditch found much less algae – typically less than 8 and always less than 15 micrograms per liter. These findings indicate eutrophication is occurring in the pond but not in the headwaters sampled.

Total phorphorus concentrations in the downstream end of the pond averaged 0.04 micro-

grams per liter and were commonly over 0.1 in the upstream end. These measurements indicate eutrophic conditions in the pond. Lakes that do not exhibit eutrophic conditions tend to range between 0.01 and 0.03 mg/l total phosphorus. In the upstream samples, total phosphorus was also consistently greater than 0.1 mg/l with concentrations more than twice that concentration.

Total nitrogen (TN) concentrations in the 1 to 2 mg/l range were common in Big Millpond. In the upstream sampling, TN concentrations in Payne Ditch were roughly similar to those in the pond. However, TN concentrations in Little Mill Run were roughly twice as high ranging from 2.4 to 4.4 mg/l. Nitrogen levels like these in streams or fresh water ponds do not adversely affect local nontidal stream quality but they probably contribute to water quality issues in nearby tidal waters.

Groundwater Quality

In the year 2000, the US Geological Survey collected groundwater quality samples from a series of wells drilled in the Chincoteague Bay watershed as shown on Map 3 Water Monitoring and Marinas. Based on their overall findings, US Geological Survey indicates that nitrate concentrations between 0 and 1 mg/l are prevalent. However, their data identifies several areas with higher concentrations.

The map shows which parts of the watershed where elevated nitrate was found. Each square icon on the map represents a cluster of wells. The color of the icon represents the individual well with the highest average concentration of nitrate. The highest average nitrate concentrations (indicated by red squares on the map) where found in the vicinity of Big Millpond (over 15 mg/l) and near Lower Scarboro Creek (nearly 10 mg/l). (9)

Point Sources

Discharges from pipes or other "discrete conveyances" are called "point sources." Point sources may contribute pollution to surface water or to groundwater. Many types of point sources operate under permits issued by the Maryland Department of the Environment (MDE). A search of the MDE permit database conducted in 2004 found no MDE permits in the Chincoteague Bay Watershed.

Marinas

Discharges of sewage from boats are a concern for water quality because they release nutrients, biochemical oxygen demand and pathogens. These discharges are preventable if a sufficient number of pumpout facilities are locally available and boat operators take advantage of these services. Boat maintenance and operation also can contribute petroleum and other noxious materials to the aquatic environment.

There are 22 marinas in Worcester County according to DNR's Marina database as summarized in the table below. One of these marinas in located in the Chincoteague Bay watershed as shown on Map 3 Water Monitoring and Marinas.

In July 2004, the marina on the Chincoteague Bay added boat pumpout facilities for the first time. Funding for this installation was provided through the federal Clean Vessel Act (75%) and the state Waterway Improvement Fund (25%). Installation of this facility was accomplished through DNR's programs to help protect water quality from boating-related impacts. (10)

For marina owners/operators who are able to implement a more extensive array of envi-

ronmental controls and safeguards, the Clean Marinas Program is a way to obtain funding, certification and public recognition. The program involves voluntarily adoption of marina design, operation, and maintenance practices intended to properly manage all kinds of marine products and activities, and to reduce and properly manage waste. DNR also funds installation and maintenance of marine pumpout facilities, including those at certified Clean Marinas. (See www.dnr.maryland.gov/boating for details.)

In the table below, an entry of "awarded" in the Clean Marina column means that voluntary Clean Marina requirements have been met. An entry of "pledge" means that the marina is working toward meeting voluntary Clean Marina requirements. No entry indicates that the marina has not made a pledge.

Marinas In Worcester County, Maryland (11)			
Location	**Name**	**Pumpout**	**Clean Marina**
Assawoman Bay	Action Marine		
	Advanced Marina	Yes	Awarded
Chincoteauge Bay	Riggi's Marina	Yes	
Isle of White Bay	Ocean City Fishing Center	Yes	Awarded
	54th Street Marina		
	Bahia Marina Inc	Yes	Awarded
	Bayside Boatel Inc	Yes	
	Captain Bill Bunting		
	Harbour Island Marina	Yes	
	Ocean Pines Marina	Yes	Awarded
	Pines Point Marina	Yes	Pledge
	Talbot Street Pier Inc		
	White Marlin Marina	Yes	
Ocean City Inlet	Ocean City Fishermans Marina Inc		
Pocomoke River	Pocomoke City Marina	Yes	
	Pocomoke River State Park-Shad Landing	Yes	Awarded
	Port of Snow Hill	Yes	
Sinepuxent Bay	Assateague State Park		Pledge
	Frontier Town Campground		Pledge
	Sunset Marina	Yes	Awarded
	Waterways		
St. Martin River	St. Martins by the Bay HOA		

Natural Resources

Water quality and quantity in surface waters and groundwater are greatly influenced by natural resources. Physical factors like geology and soils largely determine local topography, hydrology and potential for erosion. Variation of vegetation types in riparian areas and throughout the watershed produces additional influences that determine potential for stormwater infiltration or runoff and habitat quality. This chapter presents immediately available natural resource information for the Chincoteague Bay watershed.

Soils

Soil type and moisture conditions greatly affect how land may be used and the potential for vegetation and habitat on the land. Soil conditions are also one determining factor for water quality in streams and rivers. Soils are an important factor to incorporate in targeting projects aimed at improving water quality or habitat.

Local soil conditions vary greatly from site to site according to published information in SSURGO digital soils data for Worcester County. A summary of this information is shown for the WRAS watershed in Map 4 Soils. The map aggregates the SSURGO information to help show the distribution of soils important to watershed planning in the watershed:

- Overall, about 38% (over 11,400 acres) of the watershed is prime agricultural soil that does not require drainage or irrigation. Another 17% (over 5,200 acres) that requires either drainage or irrigation is also potentially prime agricultural soil.
- Nearly 14,400 acres of the soils in the watershed exhibit hydric characteristics. As the map shows, most of these soils are located on the west side of Chincoteague Bay. On the mainland in the Chincoteague Bay watershed, nearly half of the nonwetland soils are hydric. On Assateague Island, hydric soils tend to be located toward the south end of the island in Maryland.
- Hydric soils adjacent to streams or wetlands may offer opportunities for restoration of natural vegetated buffers or wetlands that could intercept nitrogen moving in groundwater before it reaches surface waters. See the Stream Buffer section for details.

Green Infrastructure

Forest and wetlands in the Chincoteague Bay watershed, particularly extensive areas of contiguous natural lands, provide valuable water quality and habitat benefits. In general, actions taken to assure that forest cover will be maintained, to avoid fragmentation of forest, and to restore forest in areas that have been cleared will contribute significantly to improving the water quality in this watershed and to conserving the biodiversity of the State.

Definition

DNR has mapped a network of ecologically important lands, comprised of hubs and linking corridors, using several of the GIS data layers

used to develop other indicators. Hubs contain one or more of the following:

- Areas containing sensitive plant or animal species;
- Large blocks of contiguous interior forest (at least 250 contiguous acres, plus the 300 foot transition zone);
- Wetland complexes with at least 250 acres of unmodified wetlands;
- Streams or rivers with aquatic species of concern, rare coldwater or blackwater ecosystems, or important to anadromous fish, and their associated riparian forest and wetlands; and
- Conservation areas already protected by public (primarily DNR or the federal government) and private organizations like The Nature Conservancy or Maryland Ornithological Society.

This "Green Infrastructure" provides the bulk of the state's natural support system. Ecosystem services, such as cleaning the air, filtering and cooling water, storing and cycling nutrients, conserving and generating soils, pollinating crops and other plants, regulating climate, protecting areas against storm and flood damage, and maintaining hydrologic function. For more information on the Green Infrastructure identification project in Maryland, see www.dnr.maryland.gov/greenways/

Local Findings and Rank

Map 5 Green Infrastructure shows that, from the statewide perspective that guided the analysis, extensive Green Infrastructure features are found in the Chincoteague Bay watershed. Most of the areas identified as Green Infrastructure on the map are hubs that ranked as important to the eastern coastal plain eco-region as listed in the table and the next page.

- While all areas defined as hubs are important to Maryland's Green Infrastructure, the Eco-Region Percent Rank is presented to provide one view for comparing hubs and for considering the potential management objectives that may be useful for the hubs.

Green Infrastructure Hub Rank For the Chincoteague Bay Area Within The Eastern Coastal Plain Eco-Region Scale from 1 (important larger hubs) to 100 (also important but smaller hubs)

Percent Rank	Description of Green Infrastructure Hub
3	Assateague Island in its entirety
5.2	Between Snow Hill and Berlin along Chincoteague and Newport Bays
5.6	From the Stockton area to near Tanhouse Creek including Vaughn Wildlife Management Area
11.2	Tanhouse Creek vicinity (the area of natural vegetation between the two higher-ranked mainland hubs)
29.3	Big Millpond hub (natural area in the Big Millpond subwatershed)
31	Purnell Bay hub (around the bay and extending toward Stockton)
Other	Six additional small Green Infrastructure hubs are identified in the Chincoteague Bay watershed including several areas on the mainland and the islands in the bay

- In general, larger hubs are ranked higher and smaller hubs are ranked lower for Eco-Region Percent Rank. For large hubs, maintaining integrity of the large block natural area already in the hub is an important management objective. For small hubs, enhancing connectivity, i.e. allowing two small hubs to function as one larger hub, is an additional management objective. Numerous other measurements of environmental integrity also contribute to this ranking.
- Most of Assateague Island is natural vegetation, which contributes to its high Eco-Region Percent Rank. It also provides habitats that are relatively unique in Maryland.
- On the mainland, land associated with Green Infrastructure is identified in most parts of the watershed. About 14,080 acres of forest contribute to the Green Infrastructure based on 2002 land use / land cover data developed by the Maryland Department of Planning. About 12% of this forest (1,720 acres) has some form of protection from conversion to development like easements or public park ownership.
- The largest gaps in and around Green Infrastructure hubs tend to be in agricultural use. Other gaps, including development and road corridors, are relatively small and scattered. These gaps are frequently used in the Green Infrastructure model to define hub boundaries. Therefore, management of these gaps can be used to improve or protect an individual Green Infrastructure hub and/or the Green Infrastructure network in the region. Examples of gap management include reducing the width of a road corridor or creating/enhancing a naturally vegetated corridor through or around an agricultural area.
- Protection of Green Infrastructure lands may be addressed through various existing programs including Rural Legacy, Program Open Space, conservation easements and others. Within Program Open Space, the Green Print program helps to target funds to protect Green Infrastructure areas.

Large Forest Blocks

Large blocks of forest provide habitat for species that are specialized for conditions with relatively little influence by species from open areas or humans. For example, forest interior dwelling birds require forest interior habitat for their survival and they cannot tolerate much human presence. Map 6 Forest Interior shows blocks of contiguous forest that are at least 50 acres in size with at least 10 acres of forest interior (forest edge is at least 300 feet away) that may be important locally within the watershed. This size threshold was chosen to help ensure that the forest interior is large enough to likely provide locally significant habitat for sensitive forest interior dwelling species. The forest interior assessment map differs from the Green Infrastructure assessment in that forest interior areas are more numerous and more widely distributed because the forest interior size threshold is lower. Several findings on Chincoteague Bay watershed forest interior can be seen on the map or interpreted in comparing it with the Green Infrastructure and protected lands maps:

- All high quality forest interior habitat in the Chincoteague Bay watershed is found on the mainland. This includes about 7,269 acres of large-block forest. These large blocks of forest are found in inland areas in many subwatersheds.
- High quality forest interior was not identified on Assateague Island. Therefore, the forest habitat in the barrier island is less likely to support forest interior dwelling species. Consequently, protection of high quality forest interior habitat on the mainland is necessary if forest interior habitats/species

are to survive in the Chincoteague Bay watershed.

Wetlands

As Map 7 Wetlands and Floodplains shows the distribution of approximately 15,572 acres of wetlands in the Chincoteague Bay watershed. The majority of these wetlands are estuarine, which account for over 75% of the watershed's wetlands as shown in the following table. On the mainland, 82% of the wetlands are forested palustrine wetlands (18% of total wetlands in the Chincoteague Bay watershed).

The remainder of the wetland assessment in this section was contributed by MDE during the drafting of their wetlands report for the Coastal Bays. The MDE report has since been released and is available for additional reference. (12, 13)

In general, the most extensive wetland distributions in Maryland occur on the Lower Eastern Shore (Dorchester, Somerset, Wicomico and Worcester Counties). Wetlands are very abundant in this region due to the low topographic relief, low elevations, and high ground water table. These factors result in the presence of large, broad wetland complexes extending from tidally influenced waters to the nontidal headwaters. Wetland hydrology may be primarily from tidal influence, high ground water, ponding, overbank flooding, or a combination of these sources. Although overbank flooding does still occur, an extensive network of ditches may have reduced the contribution of overbank flooding to the wetland hydrology. There are also wide expanses of wetlands on drainage divides that are fed primarily by high ground water, though small streams may also be present. Despite the narrow width of the Coastal Bays watershed, many of the wetlands are fairly similar to wetlands throughout the Lower Eastern Shore, with the exception of saline marsh unique to Worcester County.

Wetland Acreage Summary for the Chincoteague Bay Watershed			
Wetland Categories		**Acres**	**Percent**
Estuarine	Emergent	8,720	56
	Unconsolidated Shore	3,055	20
	Other	279	2
Palustrine	Forested	2,884	18
	Other	557	4
Marine	All Types	77	--
Total Wetlands		15,572	100

Wetland Functions

Wetlands in Chincoteague Bay have the potential to provide functions for water quality improvement, due to nutrient retention/cycling and sediment removal. It has been estimated that wetlands along the bay and streams have the potential to provide the most nutrient cycling and sediment retention6. Wetlands further up in the watershed may also be important for nutrient and sediment retention where they are adjacent to agriculture. The dense vegeta-

tion and flat topography of these wetlands also may provide some attenuation of floodwaters. Although ditches in this watershed are not as extensive as in the northern Coastal Bays, ditches have reduced the connectivity of the floodwater to the wetlands, possibly reducing the natural potential of the wetlands to store floodwater and improve water quality in the floodwater. Ditching also lowers the water table, thus reducing the ability of plant roots to intercept nutrients in groundwater. Wildlife habitat would continue to be an important wetland function, though changes in hydrology may affect species that rely on seasonal ponding, such as amphibians. Wetland wildlife habitat may be contiguous between wetlands of the Coastal Bays and Pocomoke watersheds since there are few major barriers to wildlife movement.

Wetland Categories

Tiner and Burke (1995) describe the Coastal Bays tidal wetlands as gradually grading into tidal fresh marshes, then to palustrine forested wetlands or areas that end abruptly at the upland. (14)

Estuarine wetlands consist of salt and brackish tidal waters and contiguous wetlands where ocean water is at least occasionally diluted by freshwater runoff from the land. These wetlands may extend upstream in tidal rivers to freshwater areas. Differences in salinity and tidal flooding within estuaries have a significant effect on the distribution of these wetland systems. Salt marshes occur on the intertidal shores of tidal waters in areas of high salinity. Salt marshes typically have low plant species diversity due largely to the high salinity levels, with plant diversity often increasing with decreased salinity levels. An extensive estuarine wetland corridor exists along either side of the bay and extends up into the tidal rivers. There are large areas of saline low marsh (smooth cordgrass) along the shoreline and saline high marsh further up in the mainland. (15)

Palustrine wetlands are freshwater wetlands often associated with high water tables or intermittent ponding on land. Forested wetlands are the most abundant type and widely distributed palustrine wetland type on the Coastal Plain. In these areas, wetlands are found on floodplains along the freshwater tidal and nontidal portions of rivers and streams, in uplands depressions, and in broad flat areas between otherwise distinct watersheds. Tidal freshwater swamps occur along coastal rivers in areas subject to tidal influence. Scrub-shrub swamps are represented in the Newport Bay and Sinepuxent Bay watersheds. Emergent wetlands on the Coastal Plain are characterized by a wide range of vegetation depending on water regime. Palustrine wetlands in Chincoteague Bay watershed follow many stream corridors and are also common in the headwaters.

Tracking Wetlands

Oversight of activities affecting wetlands involves several regulatory jurisdictions. The Maryland Department of the Environment (MDE) is the lead agency for the State and cooperates with DNR, the Army Corps of Engineers and other Federal and local agencies. As part of its responsibility, MDE tracks State permitting and the net gain or loss of wetlands over time. As the table on the next page shows, the State regulatory program has measured a net increase of wetland acreage in the Chincoteague Bay Watershed since 1991. In addition to the regulated wetland change summarized in the table, there have been at least 1,142 acres of non-regulated wetland restoration/enhancement within this watershed. Some of the groups performing this work include the Natural Resources Conservation Service, Ducks Unlimited, US Fish and Wildlife Service, and DNR.

Tracking Nontidal Wetland Change Chincoteague Bay Watershed In Maryland 1/1/1991 through 12/31/2003 Tracking MDE In Acres				
Permanent Impacts	**Permittee Mitigation**	**Programmatic Gains**	**Other Gains**	**Net**
-2.04	0	11.40	3.92	13.29

Notes for table: 1) Regulatory tracking for authorized nontidal wetland losses began in 1991. Comprehensive tracking of voluntary wetland gains began in 1998.
2) "Permanent Impacts" refers to acres altered (filled, drained) under permit from MDE.
3) "Permittee Mitigation" refers to acres restored by a permit holder as required by terms of the permit from MDE.
4) "Programmatic Gains" refers to acres restored by MDE using fees paid into a compensation fund by a permit holder in lieu of undertaking mitigation himself.
5) "Other Gains" refers to acres of wetlands restored when not required as mitigation for permitted losses.

Nontidal Wetlands of Special State Concern

Nontidal wetlands containing rare, threatened, endangered species or unique habitat are identified as nontidal wetlands of special state concern (NTWSSC) in MDE regulations. Ten sites were designated as nontidal wetlands of special state concern in this watershed. Site descriptions, as found in MNDR Natural Heritage documents for rare, threatened and endangered (RTE) species are as follows: (16, 17, 18)

- Hancock Creek Swamp - This site is a mature deciduous swamp surrounded by steep forested slopes. It contains a state-threatened species (also globally rare), a state-endangered plant species, and a state "Watch List" plant species.
- Little Mill Run - This site is a diverse wetland complex of bottomland forest, seepage wetland, and aquatic habitat including open water at Big Millpond. This site contains three threatened or endangered plant species, a vulnerable threatened species, and a vulnerable species "In Need of Conservation". Recently, canopy gaps created during tornadoes have allowed oriental stilt grass to invade the site.
- PawPaw Creek - This wetland/stream complex is unusual for the lower coastal plain, having a relatively steep bluff and topography more similar to the Piedmont in one section. The lower section is low open forest. This site contains two threatened species (one which is globally rare), and a state "Watch List" plant species.
- Pikes Creek - One of the habitats at this site, mature bottomland hardwood forests is fairly rare for the region. Some areas have been recently clear-cut. Plant species at this site are more common in the Piedmont than the Eastern Shore. This site contains a state-threatened species and the surrounding habitat contains other threatened or endangered species.
- Stockton Powerlines - This is a bog-like wetland that was once fairly common to the region, but is now unusual. This site is located in the headwaters of Chincoteague Bay, so is important for the bay's water quality. It contains seven state-RTE species and two state "Watch List" species.
- Powell Creek - This mature deciduous forested wetland is surrounded by steep forested slopes. It has a state threatened (also considered to be globally rare) species

and other uncommon plant species. Forest interior birds are also present.

- Riley Creek Swamp - This deciduous forested wetland contained a state-threatened (also considered globally rare) species during earlier surveys. Most of the swamp is in good condition.
- Scarboro Creek Woods - This area is a mature deciduous forest and swamp within the headwaters of Scarboro Creek. It contains a state-threatened (also considered globally rare) species and two state "Watch List" plant species.
- Scotts Landing Pond - This 1-acre herbaceous Delmarva Bay, or seasonal depression wetland, is in good condition. It is one of the few naturally occurring open freshwater wetlands in this region and is more unusual because it is rarely dry. It contains two state "Watch List" plant species and provides good amphibian habitat.
- Tanhouse Creek - This swamp forest is unusual for the lower coastal plain, having a relatively steep topography. There is a diverse sedge community present and two RTE species (one also considered globally rare). This wetland is surrounded by diverse forest.

MDNR Natural Heritage Program also identified four additional wetland areas for possible future designation as NTWSSC. These wetlands are associated with Waterworks Creek, Spencer Pond, Brockatonorton Bay, and Pikes Creek.

Wetland Restoration

Historic wetland loss in Chincoteague Bay watershed is estimated to be 28,820 acres. (19)

Much of this wetland loss has been due to artificial drainage for agriculture, forest, and development. There have also been some wetlands lost through fill and impoundment. (20)

The most common type of human-induced wetland impacts continuing to occur in this watershed are from the development of individual homes and piers, including some long piers that are greater than 100 feet in length. There is concern that these piers fragment the marsh system, thereby changing the marsh environment. Marsh loss is also occurring due to erosion and sea level rise.

Additionally, the majority of large tidal wetland complexes have mosquito ditching, which alters the wetland hydrology by creating deepwater habitats in the channels and placing this sediment in the surrounding marsh. These ditches change the hydrology of the system and also some of the resulting functions. For instance, these ditches may decrease the filtering capacity of the marsh and change the accessibility of the marsh to fish. There has been growing interest to restore the hydrology back to these systems.

In order to have the most cost-effective wetland projects, it is ideal to restore sites where little effort is required to promote wetland conditions by restoring the hydrology. To restore the hydrology on drained hydric soils, wetland drains can be plugged or the wetland can be built adjacent to the ditch by using a low-level berm.

MDE anticipates releasing an extensive assessment of wetland restoration priorities in a report entitled "Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays". (21)

The document compiles information from numerous resource inventories and management plans in a comprehensive document on the wetlands, their surrounding environment and its conditions, and management and restoration recommendations. The document will set priorities for restoration and identify

sites and practices that will be most suitable for voluntary restoration/mitigation projects. Since nearly half of the soil in this watershed on the mainland is hydric and the water table is so close to the surface, wetland restoration in many locations will successfully create wetlands. The intent of the MDE prioritization project is to focus on the areas that may provide the best functionality described below:

- Hydric, very poorly drained soils with high organic matter were the most desirable sites (e.g., Berryland, Indiantown, Kentuck).
- Areas of poor water quality.
- Sites that contribute to the green infrastructure network, rural legacy area, and/or connected to other natural systems.
- Sites on open land within 150 feet of a stream, especially if it is a source of pollution.
- Farmed wetlands.
- Forested lands were considered (although as a slightly lower priority), especially when they were within the green infrastructure network.
- In order to preserve the most productive farmland, prime agricultural soils currently in agriculture use were excluded.

To improve the chances of finding an interested property-owner, we also considered:

- Property owners with large lots having development restrictions, since they may have more interest in large wetland restoration projects (Zoning classifications of Resource Conservation, Agriculture, or Estate).
- Protected land having hydric soil that is not currently wetland.

Resulting sites are often located in the headwaters, including around Big Millpond, on large lots currently in agriculture.

As mentioned previously, this watershed still has extensive wetlands, so wetland protection should also be a high priority. Protection should focus on:

- Nontidal wetlands of special state concern and their supporting systems.
- Proposed nontidal wetlands of special state concern.
- Tidal wetlands identified by the Emergency Wetlands Resources Act of 1986 (Big Bay Marshes, Mills Island, and Tizzard Island).
- Other areas of high ecological importance.
- Areas designated rural legacy, green infrastructure network, or adjacent to protected land.
- Extensive wetland complexes.

Floodplains

Map 7 Wetlands and Floodplains shows that the 100-year floodplains cover about 5,100 acres in the Chincoteague Bay watershed. They extend along all coastal areas of the mainland. In some parts of the mainland, the 100-year floodplain encompasses large areas well inland from the shore of the Bay.

Floodplains, particularly those that contain hydric soils, tend to present conditions that limit intensive use. These conditions also present opportunities for maintenance or restoration of natural vegetation, habitat and water quality. Targeting of water quality-related projects, like stream buffers, or habitat-related projects like Green Infrastructure enhancement, should consider local floodplain conditions.

Updating of floodplain maps utilizing high-resolution elevation data (LIDAR) is anticipated through the MDE Floodplain Mapping Program in coordination with FEMA. Worcester County is highest on the State priority list among counties where LIDAR coverage exists.

The flood hazards shown on National Flood Insurance Program (NFIP) maps will soon begin to be updated utilizing LIDAR as most maps were developed utilizing the best information available at the time the maps were prepared. In many areas, hydraulic and hydrologic studies were conducted to reflect the long-term projection of flood risk. However, the availability of highly resolution Digital Elevation Models (DEMs) will more accurately identify the area at risk for flood events. DEMs are also relevant to the quantification of TMDL estimates and stormwater runoff modeling. MDE has expressed a priority in not only utilizing LIDAR to delineate flood hazards, but also applying it to non-point source management and regulation. New floodplain information and maps is anticipated in 2005. (22)

Shoreline and Sea Level Rise

About 99% of Chincoteague Bay's shoreline is in natural condition, which is primarily vegetated or beach. Very little shoreline here is protected (bulkhead and riprap) or disturbed in other ways. (5-Section 6.5)

In 2004, Worcester County data was collected to support a comprehensive inventory of shoreline conditions that is part of a Maryland effort that covers 16 coastal counties. The data to be used is a compilation of information pertaining to riparian land use, bank condition, and shoreline features. The product of the inventory will be a snap shot of the shoreline condition at one moment in time. The inventory can be used for multiple management and planning objectives, including the opportunity for cumulative impact assessments, local/regional planning and permitting activities, and restoration targeting. The protocol for the inventory utilizes on the ground GPS surveying techniques, combined with GIS for database management and map display. Worcester County data collection for the inventory was completed in Summer 2004. Data and maps will be available in 2005. (22)

Information for counties where the inventory has been completed (Dorchester and St. Mary's) is posted on the Internet at http://ccrm.vims.edu/gis/gisdata.html.

Along the Chincoteague Bay shoreline, low elevation areas on both the mainland and barrier island, have the potential to be affected by sea level rise according to a report DNR Coastal Zone Management report issued in October 2000. (23)

The DNR Coastal Zone Management Division (CZM) and U.S. Geological Survey (USGS) are negotiating the development of a sea level rise inundation model for Worcester County. Given the availability of LIDAR for the County and the identified need for enhanced sea level rise planning stated in the Coastal Bays Comprehensive Conservation and Management Plan, the County is a priority for piloting an inundation model on a countywide scale. The modeling is intended to quantify the range of potential inundation scenarios resulting from sea level rise in the next 100 years using the current and global warming trend rate. This effort will provide the opportunity to understand wetland migration patterns, predict future shoreline position, and identify threats to public infrastructure. The development of the model is contingent on the development of a Memorandum of Understanding between USGS and CZM. Anticipated completion of the sea level inundation model for Worcester County is 2005. (22)

Stream Buffers

The Chincoteague Bay watershed has about 182 miles of streams, excluding shoreline of Chincoteague Bay and Big Millpond. (24)

Map 8 Stream Buffers shows the general land use adjacent to these streams using computerized GIS. This method of assessing buffer condition can be used in the absence of field data collected by stream corridor assessment. The summary table on the map indicates that about 50% (92 miles) of stream buffer is characterized by natural vegetation. About 48% (88 miles) of stream buffer is in some type of agricultural use and nearly 2% (2 miles) is developed.

Nearly half of the stream buffers characterized by agriculture use are on hydric soil. These waterways may be ditches within agricultural fields, ditches on field edges, other ditches or natural/modified streams. Depending on landowner interests and field verification of hydric soil conditions, these stream buffers present potential opportunities for stream buffer restoration and/or wetland restoration.

The map also shows stream buffer restoration projects for two years that DNR Forest Service has collected data. The database lists 20 projects stretching along about 24 miles of stream bank and covering about 474 acres.

Benefits of Stream Buffers

Natural vegetation in stream riparian zones, particularly forest, provides numerous valuable environmental benefits:

- Reducing surface runoff
- Preventing erosion and sediment movement
- Using nutrients for vegetative growth and moderating nutrient entry into the stream
- Moderating temperature, particularly reducing warm season water temperature
- Providing organic material (decomposing leaves) that are the foundation of natural food webs in stream systems
- Providing overhead and in-stream cover and habitat
- Promoting high quality aquatic habitat and diverse populations of aquatic species.

Headwater Streams

Headwater streams are also called first order streams. For many watersheds, first order streams drain the majority of the land within the entire watershed. Therefore, stream buffers restored along headwater streams tend to have greater potential to intercept nutrients and sediments than stream buffers placed elsewhere. In targeting stream buffer restoration projects, giving higher priority to headwater streams is one approach to optimizing nutrient and sediment retention.

Restoring headwater stream buffers can also provide habitat benefits that can extend downstream of the project area. Forested headwater streams provide important organic material, like decomposing leaves that "feed" the stream's food web. They also introduce woody debris that enhances in-stream physical habitat. The potential for riparian forest buffers to significantly influence stream temperature is greatest in headwater regions. These factors, in addition to positive water quality effects, are key to improving aquatic habitat.

Land Use Adjacent to Streams

One factor that affects the ability of stream buffers to intercept nonpoint source pollutants is adjacent land use. Nutrient and sediment loads from different land uses can vary significantly.

Stream buffers can effectively intercept nonpoint source sediment and phosphorus if these pollutants arise from land that is characterized by continuing soil disturbance/exposure. Examples of these land uses are some types of agriculture, poorly vegetated lawns and athletic fields, unpaved roads and parking areas.

Based on monitoring conducted in Maryland, nonpoint source nitrogen entering streams appears to be greatest from development using septic systems and from certain types of agriculture depending on past and present application of fertilizer and manure. Targeting stream buffer restoration, using deep-rooted vegetation, to these areas may intercept nitrogen in groundwater before it emerges in streams. Naturally vegetated stream buffers on hydric soil have the potential to intercept nitrogen because plant roots are more likely to be in contact with groundwater for longer periods of time.

Optimizing Stream Buffer Restorations

Strategic targeting of stream buffer restoration projects may provide many different benefits. To maximize multiple benefits, site selection and project design need to incorporate numerous factors. For example, finding a site with a mix of attributes like those in the following list could result in the greatest control of nonpoint source pollution and enhancement to living resources:

- Land owner willingness / incentives
- Marginal land use currently in the riparian zone
- Headwater stream areas
- Soil type including hydric or highly erodible soils
- Selecting appropriate woody or grass species, natural vegetation for habitat
- Adjacent wetlands and habitat that may be enhanced.

Living Resources and Habitat

Living resources, including all the animals, plants and other organisms require water to survive. They and their habitats are intimately connected to water quality and availability. Living resources respond to changes in water and habitat conditions in ways that help us interpret the status of water bodies and the effects of watershed conditions.

In some cases, water quality is measured in terms of its ability to support specific living resources like trout or shellfish. Information on living resources is presented here to provide a gauge of water quality and habitat conditions in the watershed. It is also a potential measure of efforts to manage water quality and watersheds for the living resources that depend on them.

Blue Crabs

Information specific to Chincoteague Bay is not available for blue crab (Callinectes sapidus) but generalized information from Maryland's Coastal Bays may be indicative of local conditions. Blue crab abundance in Maryland's Coastal Bays, based on commercial landings and DNR surveys (trawl and siene), varies year to year with no identified trend. The reported average annual catch was over 1,165,000 pounds for the period 1997 through 2003. Average size has not declined over a thirteen-year period, which suggests that fishing pressure is not excessive. In addition to fishing, the blue crab population is also affected by several other factors that affect abundance: parasites that kill crabs in late summer

and autumn, and competition from nonnative invasive green crabs and Asian shore crabs. (4-page 31, 5-Section 8.6)

Fish

Overall, more information is available on fish in tidal waters than for fish in nontidal waters (streams, ditches and impoundments). Available analyses of fish in tidal areas generalize findings for Maryland's Coastal bays, so Chincoteague Bay findings must be drawn by inference. Available analysis for nontidal areas is site-specific and cannot be generalized to cover a broader area.

Tidal Areas

In tidal waters of the coastal bays, over 130 species of fish have been identified in the past 30 years. Sampling by DNR Fisheries Service identified 77 species in 2001 and 80 species in 2002. Among those identified, most species are estuarine-dependent like summer flounder, croaker, weakfish, spot, striped bass and black sea bass. Chincoteague Bay, along with Maryland's other coastal bays, is an ideal nursery for fish due to its swallow warm water and connections to the ocean. In 2002, 20 species of juvenile fish were identified in the bays that are important to coastal commercial and recreational fisheries. Additional assessment of fish stocks can be obtained in various DNR and EPA publications. (4-pages 29-30; 5-Section 8.2; 25; 26; 27)

In tidal waters of Maryland's Coastal Bays, DNR uses a forage fish index to measure the abundance of the four most common forage fish species: bay anchovy, menhaden, spot, and Atlantic silverside. Since monitoring began in 1972 using both trawl and seine surveys, a trend toward a slow decline has been identified that began in the mid-1980s. (5-Section 8.2)

Nontidal Areas

In nontidal waters, insufficient information is available to characterize fish populations in streams/ditches. The Maryland Biological Stream Survey reported findings using the Fish Index of Biological Integrity on one nontidal stream site in the Chincoteague Bay watershed. Map 9 Fish, Oysters and Benthic Organisms shows that this site was rated as poor in 2001 relative to other comparable sites based on a standardized assessment of fish populations. Only three species of fish were found there: American Eel, Eastern Mudminnow and Pirate Perch. (5-Section 3.2)

The database maintained by DNR Fisheries Service identifies one blockage to fish movement in the Chincoteague Bay watershed at Big Millpond as shown on the map. Additional blockages may be identified by the stream corridor assessment conducted in 2004. In general, blockages limit fish movement and thereby reduce available habitat area, which constrains reproduction and survival potential.

Fish Consumption Advisory

In June 2004, MDE issued revised fish consumption advisories for Maryland. No advisory specifically names areas in the Chincoteague Bay watershed but several statewide advisories affect portions of the watershed.

In the summary table below, MDE's recommendations are listed in "meals per year". An easier way to consider the recommendation might be to think in terms of weekly menus. For example, it would be best to limit eating bluegill taken from ponds or lakes to less than two meals a week. For smallmouth and largemouth bass from ponds and lakes, the recommendation is to limit consumption to less than one meal per week for adults and less than one

meal per month for children. (Children are more susceptible to toxicity than adults.)

Methyl mercury is the form of mercury that is most biologically active. It enters the atmosphere mostly from burning of coal (generating electricity) and waste incineration. It then returns to the land and water in dust and rain. Mercury is also commonly used in dry cell batteries and some lighting. The concern is that this toxic compound can accumulate over time in the bodily tissues of fish and people who eat those fish. Eventually levels in a person could reach levels that would cause health problems.

2004 Fish Consumption Advisories –Chincoteague Bay Watershed
Recommended Maximum Allowable Meals Per Year

Species	Area	General Population 8 oz meal	Women 6 oz meal	Children 6 oz meal	Contaminant
Smallmouth Bass & Largemouth Bass	Lakes, Impoundments	48	48	24	Methyl-Mercury
	Rivers and Streams	No advisory	96	96	
Bluegill	Lakes and Impoundments	96	96	96	

Harmful Algae Blooms

More than a dozen species of potentially harmful species of algae have been identified in Maryland's Coastal Bays. No evidence of toxicity caused by these algae has been reported here. However, these algae are considered harmful because they have the potential to negatively affect human activities or to cause harm to other aquatic life.

Most reports of harmful algae in Maryland's Coastal Bays occur outside of Chincoteague Bay with the exception of brown tide, which is discussed in more detail below. Two other types of harmful algae have been reported near the northern edge of Chincoteague Bay around Marshall Creek and Massey Branch: Pfiesteria and Chattonella. (5-Section 7.2)

The organism that causes brown tide, *Aureococcus anophagefferens*, has been known to have population explosions or blooms in Chincoteague Bay. The causes of these blooms are not well understood. The potential of these blooms to stress shellfish (reduced feeding and growth) and seagrass (reduced growth caused by shading) is the reason monitoring of this organism was initiated in 1999. Since monitoring began, the area of Maryland's Coastal Bays that has most consistently experienced the highest levels of this organism includes north Chincoteague Bay and Newport Bay. This area is roughly bounded on the north by Newport Bay and bounded on the south by Public Landing / Tingles Island. Lesser blooms have been recorded in Chincoteague Bay including the areas of Taylors Landing and Pirate Islands. (5-Section 7.1)

Shellfish

Analysis of shellfish in Maryland's Coastal Bays that present specific findings for Chincoteague address three species of interest: oysters, hard clams bay scallops.

Oysters

Oysters were once an important regional fishery in Maryland's Coastal Bays. However, they have declined drastically during the twentieth century due to harvesting, disease and predation. (4-page 33; 29)

Early in the century, extensive natural oysters bars were found in Maryland's Coastal Bays according to a survey of oyster beds by C.C. Yates conducted between 1906 and 1912. As shown on Map 9 Fish, Benthos and Oysters, about 1,637 acres of natural oyster bars were once located in Chincoteague Bay. (30)

Currently, no legally designated oyster beds are located in Maryland's Coastal Bays, including Chincoteague Bay. (31)

However, as the map also shows, oyster lease areas covering a total of about 765 acres are located in Chincoteague Bay. These are areas that do not contain designated oyster beds that the holder may use for oyster-related aquaculture. The majority of this acreage is in Johnson Bay and Brockanorton Bay. Other oyster lease areas tend to be concentrated around Parker Bay, Purnell Bay and smaller leases in the vicinity of northern-most Scarboro Creek.

Hard Clams

Sampling of hard clams (*Mercenaria mercenaria*) in Chincoteague Bay was initiated in 1993. During the past 10 years, hard clam density has been relatively stable averaging about 0.27 clams per square meter. During this period, the clam density in Chincoteague Bay was generally similar to that found in the other Maryland Coastal Bays.

Historically, there were more clams in Chincoteague Bay. A survey conducted in 1953 reported a clam density of 1.3 clams per square meter, which is five times higher than the recent ten-year average. The 1953 data also indicated that Chincoteague Bay had greater clam density than the other Maryland Coastal Bays. (4-page 33, 5-Section 8.4)

Bay Scallops

In the late 1990s, DNR planted over one million bay scallops (*Argopecten irradians*) in an effort to re-establish the population that has been found in Chincoteague Bay intermittently during the last century. The 2003 Hard Clam Survey found bay scallops are continuing to survive at low population densities primarily in northern Chincoteague Bay, Sinepuxent Bay and Isle of Wight Bay. (4-page 34, 5-Section 8)

Benthic Organisms

Limited monitoring of benthic organisms, specifically bottom dwelling animals, has been conducted in tidal waters of Maryland's Coastal Bays and in nontidal streams/ditches in their watersheds.

Tidal Area Benthos

Chincoteague Bay has been monitored as part of larger effort to assess the health of benthic organisms in the open water of the Coastal Bays. Each year from 2000 through 2003, organisms gathered from sample sites were collected and the number and type of species were assessed in a lab. The relative abundance of species was identified and ranked considering the relative occurrence of species tolerant

or intolerant to stresses like pollution. The system used for ranking was the Mid-Atlantic Integrated Assessment benthic index, which assigns a number within a range of 1 (most severely degraded) to 5 (most healthy benthic community). Any area ranking between 3 and 5 on the index overall, considering a samples taken over several years, meets the goal for a healthy benthic community. Overall, Chincoteague Bay meets the benthic index goal. (5-Section 8.5)

Nontidal Stream/Ditch Benthos

Unimpaired natural streams may support a great diversity of species like bacteria, algae, invertebrates like crayfish and insects to fish, birds, reptiles and mammals. All these groups of organisms have been extensively assessed relative to water quality and habitat quality. One group, benthic invertebrates, was found to serve as a good indicator of stream condition including water quality and habitat quality.

Benthic invertebrates are sometimes called "stream bugs" though that name overly simplifies the diverse membership of this group. This group includes mayflies, caddisflies, crayfish, etc., that inhabit the stream bottom, its sediments, organic debris and live on plant life (macrophytes) within the stream. Benthic macro-invertebrates are an important component of a stream's ecosystem.

The food web in streams relies significantly on benthic organisms. Benthos is often the most abundant source of food for fish and other small animals. Many benthic macroinvertebrates live on decomposing leaves and other organic materials in the stream. By this activity, these organisms are significant processors of organic materials in the stream. Benthos often provides the primary means that nutrients from organic debris are transformed to other biologically usable forms. These nutrients become available again and are transported downstream where other organisms use them.

Assessment of benthic organisms is a valuable tool for stream evaluation. Sedimentation and eutrophication both negatively affect benthic macroinvertebrate populations in reasonably consistent and predictable ways. These organisms serve as good indicators of water resource integrity because they are fairly sedentary in nature and their diversity offers numerous ways to interpret conditions. Various species of benthos have different sensitivities to changing conditions, a wide range of functions in the stream and they use different life cycle strategies for survival. In a stream, measuring differences in their population characteristics can be used as indicators of stream problems. Consequently, this group of species has been extensively used in water quality assessment, in evaluating biological conditions of streams and in gauging influences on streams by surrounding lands.

The Maryland Biological Stream Survey (MBSS) sampled stream conditions in the Chincoteague Bay watershed in 2001. Conditions that underlie the indices are complex and apply primarily to a local stream segment. Typically, a stream segment ranks as a mix of good, fair, poor and/or very poor for the three indices. There is a tendency for good/fair conditions to be associated with watersheds with the least disturbance (natural vegetation, forest) and for poor/very poor conditions to be associated with greater disturbance (impervious area, agriculture, construction sites).

MBSS findings based on assessment of benthic macroinvertebrates (benthos or stream bugs) are shown on Map 9 Fish, Oysters and Benthic Organisms. The map shows that findings are reported for two sites. The Waterworks Creek tributary site was rated very poor and the Powell Creek site was rated poor. These findings

are indicative of a relatively limited benthic community, which suggests that a combination of poor habitat and/or water quality were present at that time. (7-Section 3.2)

Sensitive Species

Sensitive species are generally recognized as being the plants or animals that are most at risk in regards to their ability to maintain healthy population levels. The most widely known are perhaps the State and Federally-listed Endangered or Threatened animals such as the bald eagle and Delmarva fox squirrel. In addition to animals such as these however, both the United States Fish and Wildlife Service and the Maryland DNR work through their respective Federal and State programs to protect a wide variety of declining non-game animals, rare plants, and the unique natural communities that support them.

For the purposes of watershed restoration, it is valuable to account for the known locations and areas of potential habitat for sensitive species in a given area. They are often indicators, and sometimes, important constituents, of the network of natural areas which form the foundation for many essential natural watershed processes. In fact, in addition to conserving biodiversity in general, protecting these species and/or promoting expansion of their habitats can be an effective component for a watershed restoration program.

DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation in different ways. Several sensitive species overlays are used by the State of Maryland to delineate habitat associated with these species. The purpose of utilizing these delineations is to help protect sensitive species by identifying the areas in which they are known to occur. Doing so allows DNR to work toward the conservation of these sensitive resources by evaluating potential impacts of proposed actions. Specifically, working within an established procedural framework, the Wildlife and Heritage Service reviews projects and provides recommendations for activities falling within these overlays.

Map 10 Sensitive Species shows the general locations of sensitive species conservation areas in Maryland's Chincoteague Bay watershed. A complete list of rare species tracked by Maryland in the watershed is in the Appendix Sensitive Species.

The geographic areas covered by these overlays are course filters. To allow for uncertainty pertaining to interpretation discrepancies, the polygons used on the map to depict these locations have been buffered. Accurate on-the-ground information regarding species locations and habitat delineations for a specific area can be obtained from DNR's Natural Heritage Program. It is also important to note that outside of the Critical Area for the Atlantic Coastal and Chesapeake Bay, DNR generally only places requirements on projects requiring a permit/approval or those that are utilizing State funds. However, there are more broadly applied State and Federal laws and regulations that address "takings" of listed species. In addition, many counties have incorporated safeguards for areas associated with sensitive species into their project and permit review processes as well as adopting specific ordinances in some cases to protect them. In all instances, property owners are encouraged to seek advice on protecting the sensitive species / habitat within their ownership.

Property owners and other citizens can help protect sensitive species by obtaining advise from DNR Natural Heritage or other knowledgeable people like the Native Plant Society.

Ecologically Sensitive Area (ESA)

At least 30 ESAs are identified in the Chincoteague Bay Watershed as shown in Map 10 Sensitive Species. Each ESA contains one or more sensitive species habitats associated with about 60 species. However, the entire ESA is not considered sensitive habitat. The ESA is an envelope identified for review purposes to help ensure that applications for permit or approval in or near sensitive areas receive adequate attention and safeguards for the sensitive species / habitat they contain.

Wetlands of Special State Concern (WSSC)

There are about 10 general areas that contain WSSC sites designated in the Chincoteague Bay Watershed as described in the Wetlands Section and shown on Map 10 Sensitive Species. These selected wetlands totaling about 400 acres generally represent some of the best examples of Maryland's nontidal wetland habitats. In the Chincoteague Bay watershed, most of these wetlands are found within Green Infrastructure hubs but the one at Powell Creek is not.

These wetlands have additional protection in State law beyond the permitting requirements that apply to wetlands generally. To help ensure that proposed projects that may affect a WSSC are adequately reviewed, an ESA is always designated to encompass each WSSC and the area surrounding it. The Maryland Department of the Environment may be contacted for more information regarding these regulations and/or see a listing of designated sites in COMAR 26.23.06.01 at www.dsd.state.md.us

Natural Heritage Area (NHA)

No NHAs are located in the Chincoteague Bay Watershed. In general, NHAs are designated because they represent rare ecological communities. They are areas that provide important sensitive species habitat. They are designated in State regulation (COMAR 08.03.08.10) and are afforded specific protections in the Critical Area Law criteria. For proposed projects that could potential affect a particular NHA, recommendations and/or requirements may be put in place during the permit or approval process. These would be specifically aimed at protecting the ecological integrity of the NHA itself. To help ensure that proposed projects that may affect a given NHA are adequately reviewed, an ESA is always designated to encompass each NHA and the area surrounding it.

Submerged Aquatic Vegetation

The well-defined link between water quality and submerged aquatic vegetation (SAV) distribution/abundance make SAV communities good barometers of the health of estuarine ecosystems. SAV is not only important as an indicator of water quality, but it is also a critical nursery habitat for many estuarine species. For example, blue crab "post-larvae" are up to 30 times more abundant in SAV beds than in adjacent unvegetated areas. Additionally, several species of waterfowl depend on SAV for food when they over-winter in the Mid-Atlantic region.

In the 1930s, a disease nearly eliminated all SAV in Maryland's Coastal Bays. Since about 1986 when monitoring began, there has been a steady trend toward increasing area covered by SAV beds. As Map 11 Submerged Aquatic Vegetation shows, acreage of SAV in Chincoteague Bay increased from about 3,522 acres in 1987 to about 7,625 acres in 2002. However, because of the relatively brief timeframe represented by monitoring data, it is difficult to put this positive trend into historical context. The extent of natural fluctuation over longer periods of time is not known.

During the period from 1987 through 2002, the majority of SAV beds tend to be found on the eastern side of Chincoteague Bay along Assateague Island. Then, beginning in the late 1990s SAV began to reappear on the western side of the Bay around Miller Island. Then, by 2002, large areas of Parker Bay and more areas around Miller Island also had SAV beds. During the same 2002 growing season, SAV also appeared in several other places: the south side of Tizzard Island, the north shore of Rowley Cove and on some of the north shoreline of Brockanorton Bay. (4-pages 21-22, 5-Sections 6.1 and 6.2)

Land Use And Land Cover

Water quality in streams, rivers and estuaries is greatly influenced by land in the riparian area, land use throughout the watershed, soils, vegetative cover and many other terrestrial factors. This chapter explores the immediately available information that relates to land use and land cover in the Chincoteague Bay watershed.

2002 Land Use / Land Cover

Map 12 Land Use / Land Cover shows the distribution of major land use categories in the Chincoteague Bay watershed based on 2002 data produced by the Maryland Department of Planning (MDP). A separate MDP report on the Chincoteague Bay watershed is anticipated to be available in 2005 will address additional perspectives like land use change over time.

Considering all types of land across the entire watershed, forest and brush lands account for about 40% of the watershed and wetlands cover about 23%. Active land uses encompass about 35% of the watershed including agriculture (33%) and developed land (2%). Throughout the watershed, it can be seen that there is a tendency for developed lands to be in small areas while agriculture is found throughout the watershed.

Considering only the mainland and excluding wetlands as shown in the table below, it can be seen that active land use and natural vegetation on dry land are roughly equal in area.

Viewing these generalized land use categories as potential nonpoint sources of nutrients, developed lands are likely to have effects that are limited to immediately adjacent streams in this watershed. Agriculture is likely to be the dominant source of locally controllable nutrients. (Other potentially significant sources are atmospheric deposition, stream bank erosion and shoreline erosion.)

Mainland Acreage Summary Excluding Wetlands Chincoteague Bay Watershed

Land Type	Acres	Percent
Forest and Brush	15,284	51
Agriculture	14,214	47
Developed Land	677	2
Barren Land	10	--
Total	**30,185**	**100**

Protected Lands

As used in the context of watershed protection and restoration, "protected land" includes any land with some form of long-term limitation on conversion to urban / developed land use. This protection may be in various forms: public ownership for natural resource or low impact recreational intent, private ownership where a third party acquired the development rights or otherwise acquired the right to limit use through the purchase of an easement, etc. The extent of "protection" varies greatly from one circumstance to the next. Therefore, for some protected land, it may be necessary to explore the details of land protection parcel-by-parcel through the local land records office to determine the true extent of protection.

For purposes of watershed management, an understanding of existing protected lands can provide a starting point in prioritizing potential protection and restoration activities. In some cases, protected lands may provide opportunities for restoration projects because owners of these lands may value natural resource protection or enhancement goals.

Map 13 Protected Land shows the status of protected lands in the Chincoteague Bay watershed. On the map, some land parcels may be affected by more than one type of protection. For example, government-owned parkland may also have a conservation easement on it.

Public Land

The largest category of protected land in the watershed is ownership and management in the Assateague Island National Seashore by the National Park Service. The National Seashore encompasses the entire portion of the barrier island in the Chincoteague Bay watershed, which is nearly 7,200 acres. No Federal ownership is found on the mainland.

On the mainland, the largest category of land protection is State ownership and management by the Maryland Department of Natural Resources (DNR):

- E.A. Vaughn Wildlife Management Area includes 2,897 acres in two large blocks adjacent to Johnson Bay and Parker Bay.
- Chesapeake Forest includes about 1,162 acres in multiple parcels inland from the bays.
- The Wetland Reserve easements that are shown on the map appear to be entirely on public land in the E.A. Vaughn WMA.

The third type of public ownership is County ownership, which includes 91 acres on the drainage divide between Chincoteague Bay and the Pocomoke River.

Private Lands

On private land, the largest protected land category is conservation easements on private land covering 2,601 acres. All of these easements are held by the Maryland Environmental Trust. Agricultural easements cover 1,033 acres of private land that tends to be in the central area of the mainland in the watershed. Forest conservation easements apply to about 18 acres of land adjacent to Chincoteague Bay north of Tanhouse Creek.

Rural Legacy

Worcester County, through the State's Rural Legacy Program, has established the Coastal Bays Rural Legacy Area. Map 13 Protected Land shows this area is located in southeast Worcester County. It covers about 15,830 acres, with over 13,700 acres in the Chincoteague Bay watershed. Program Open Space funds can be targeted to this area to help pay for protecting properties from development using fee simple purchase or easements.

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Appendix A - Glossary	
303(d)	A section of the federal Clean Water Act requiring the states to report waters impaired for the uses for which they have been designated, and the reasons for the impairment. Waters included in the "303(d) list" are candidates for having TMDLs developed for them.
305(b)	A section of the federal Clean Water Act that requires periodic assessment of the status of waters in a State or similar jurisdiction.
319	A section of the federal Clean Water Act dealing with non-point sources of pollution. The number is often used alone as either a noun or an adjective to refer to some aspect of that section of the law, such as grants.
8-digit watershed	Maryland has divided the state into 138 watersheds, each comprising an average of about 75 square miles, that are known as 8-digit watersheds because there are 8 numbers in the identification number each has been given. These nest into the 21 larger 6-digit watersheds in Maryland which are also called Tributary Basins or River Basins. Within the Chesapeake Bay drainage, 8-digit watersheds also nest into 10 Tributary Team Basins.
Anadromous Fish	Fish that live most of their lives in salt water but migrate upstream into fresh water to spawn.
Benthos	Organism that live on the bottom of a body of water.
BMP	Best Management Practice. As used here refers to on-the-ground approaches to control erosion, sedimentation, or stormwater movement.
CBNERR	The Chesapeake Bay National Estuarine Research Reserve in a federal, state and local partnership to protect valuable estuarine habitats for research, monitoring and education. The Maryland Reserve has three components: Jug Bay on the Patuxent River in Anne Arundel and Prince Georges' Counties, Otter Point Creek in Harford County and Monie Bay in Somerset County.
COMAR	Code Of Maryland Regulations (Maryland State regulations)
CREP	Conservation Reserve Enhancement Program, a program of MDA. CREP is a federal/state and private partnership which reimburses farmers at above normal rental rates for establishing riparian forest or grass buffers, planting permanent cover on sensitive agricultural lands and restoring wetlands for the health of the Chesapeake Bay.
CRP	Conservation Reserve Program, a program of Farm Service Agency in cooperation with local Soil Conservation Districts. CRP encourages farmers to take highly erodible and other environmentally-sensitive farm land out of production for ten to fifteen years.
CWAP	Clean Water Action Plan, promulgated by EPA in 1998. It mandates a statewide assessment of watershed conditions and provides for development of Watershed Restoration Action Strategies (WRASs) for priority watersheds deemed in need of restoration.

Appendix A - Glossary	
CWiC	Chesapeake 2000 Agreement watershed commitments. CWiC is a shorthand phrase used in the Chesapeake Bay Program.
CZARA	The Coastal Zone Reauthorization Amendments of 1990, intended to address coastal non-point source pollution. Section 6217 of CZARA established that each state with an approved Coastal Zone Management program must develop and submit a Coastal Non-Point Source program for joint EPA/NOAA approval in order to "develop and implement management measures for NPS pollution to restore and protect coastal waters".
CZMA	Coastal Zone Management Act of 1972, establishing a program for states and territories to voluntarily develop comprehensive programs to protect and manage coastal resources (including the Great Lakes). Federal funding is available to states with approved programs.
Conservation Easement	A legal document recorded in the local land records office that specifies conditions and/or restrictions on the use of and title to a parcel of land. Conservation easements run with the title of the land and typically restrict development and protect natural attributes of the parcel. Easements may stay in effect for a specified period of time, or they may run into perpetuity.
DNR	Department of Natural Resources (Maryland State)
EPA	Environmental Protection Agency (United States)
ESA	Ecologically Significant Area, an imprecisely defined area in which DNR has identified the occurrence of rare, threatened and/or endangered species of plants or animals, or of other important natural resources such as rookeries and waterfowl staging areas.
GIS	Geographic Information System, a computerized method of capturing, storing, analyzing, manipulating and presenting geographical data.
MBSS	Maryland Biological Stream Survey, a program in DNR that samples small streams throughout the state to assess the condition of their living resources.
MDA	Maryland Department of Agriculture
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
MET	Maryland Environmental Trust, an organization that holds conservation easements on private lands and assists local land trusts to do similar land protection work.
MGS	Maryland Geological Survey, a program in DNR
NHA	Natural Heritage Area, a particular type of DNR land holding, designated in COMAR
NOAA	National Oceanic and Atmospheric Administration, an agency of the US Department of Commerce that, among other things, supports the Coastal Zone Management program, a source of funding for some local environmental activities, including restoration work.

Appendix A - Glossary	
NPS	Non-Point Source, pollution that originates in the landscape that is not collected and discharged through an identifiable outlet.
NRCS	Natural Resources Conservation Service, formerly the Soil Conservation Service, an agency of the US Department of Agriculture that, through local Soil Conservation Districts, provides technical assistance to help farmers develop conservation systems suited to their land. NRCS participates as a partner in other community-based resource protection and restoration efforts.
PDA	Public Drainage Association
RAS	Resource Assessment Service, a unit of DNR that carries out a range of monitoring and assessment activities affecting the aquatic environment.
Riparian Area	1. Land adjacent to a stream. 2. Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e. a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines. (National Research Council, *Riparian Areas: Functions and Strategies for Management*. Executive Summary page 3. 2002)
SAV	Submerged Aquatic Vegetation, important shallow-water sea grasses that serve as a source of food and shelter for many species of fin- and shell-fish.
SCA(M)	Stream Corridor Assessment is an activity carried out by DNR Watershed Services in support of WRAS development and other management needs, in which trained personnel walk up stream channels noting important physical features and possible sources of problems.
SCD	Soil Conservation District is a county-based, self-governing body whose purpose is to provide technical assistance and advice to farmers and landowners on the installation of soil conservation practices and the management of farmland to prevent erosion.
Synoptic Survey	A short term sampling of water quality and analysis of those samples to measure selected water quality parameters. A synoptic survey as performed by DNR in support of watershed planning may be expanded to include additional types of assessment like benthic macroinvertebrate sampling or physical habitat assessment.
TMDL	Total Maximum Daily Load, a determination by MDE of the upper limit of one or more pollutants that can be added to a particular body of water beyond which water quality would be deemed impaired.

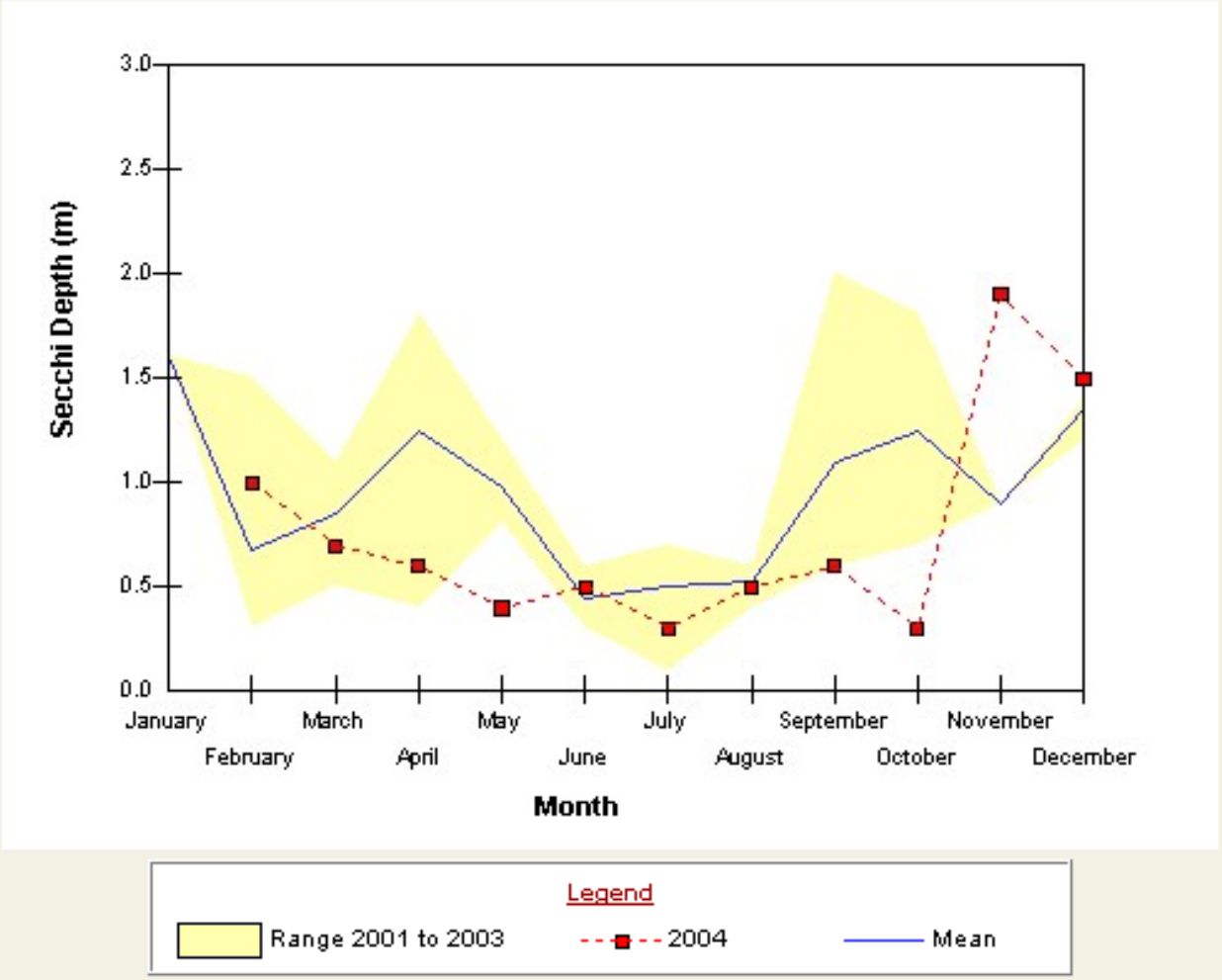
Appendix A - Glossary	
Tributary Teams	Geographically-focused groups, appointed by the Governor, oriented to each of the 10 major Chesapeake Bay tributary basins found in Maryland. The teams focus on policy, legislation, hands-on implementation of projects, and public education. Each basin has a plan, or Tributary Strategy.
USFWS	United States Fish and Wildlife Service, in the Department of Interior
USGS	United States Geological Survey
Water Quality Standard	Surface water quality standards consist of two parts: (a) designated uses of each water body; and (b) water quality criteria necessary to support the designated uses. Designated uses of for all surface waters in Maryland (like shell fish harvesting or public water supply) are defined in regulation. Water quality criteria may be qualitative (like "no objectionable odors") or quantitative (toxic limitations or dissolved oxygen requirements)
Watershed	All the land that drains to an identified body of water or point on a stream.
WRAS	Watershed Restoration Action Strategy, a document outlining the condition of a designated watershed, identifying problems and commiting to solutions of prioritized problems.
WSSC	Wetland of Special State Concern, a designation by MDE in COMAR.
WWTP	Wastewater Treatment Plant. Usually refers to sewage treatment facility.

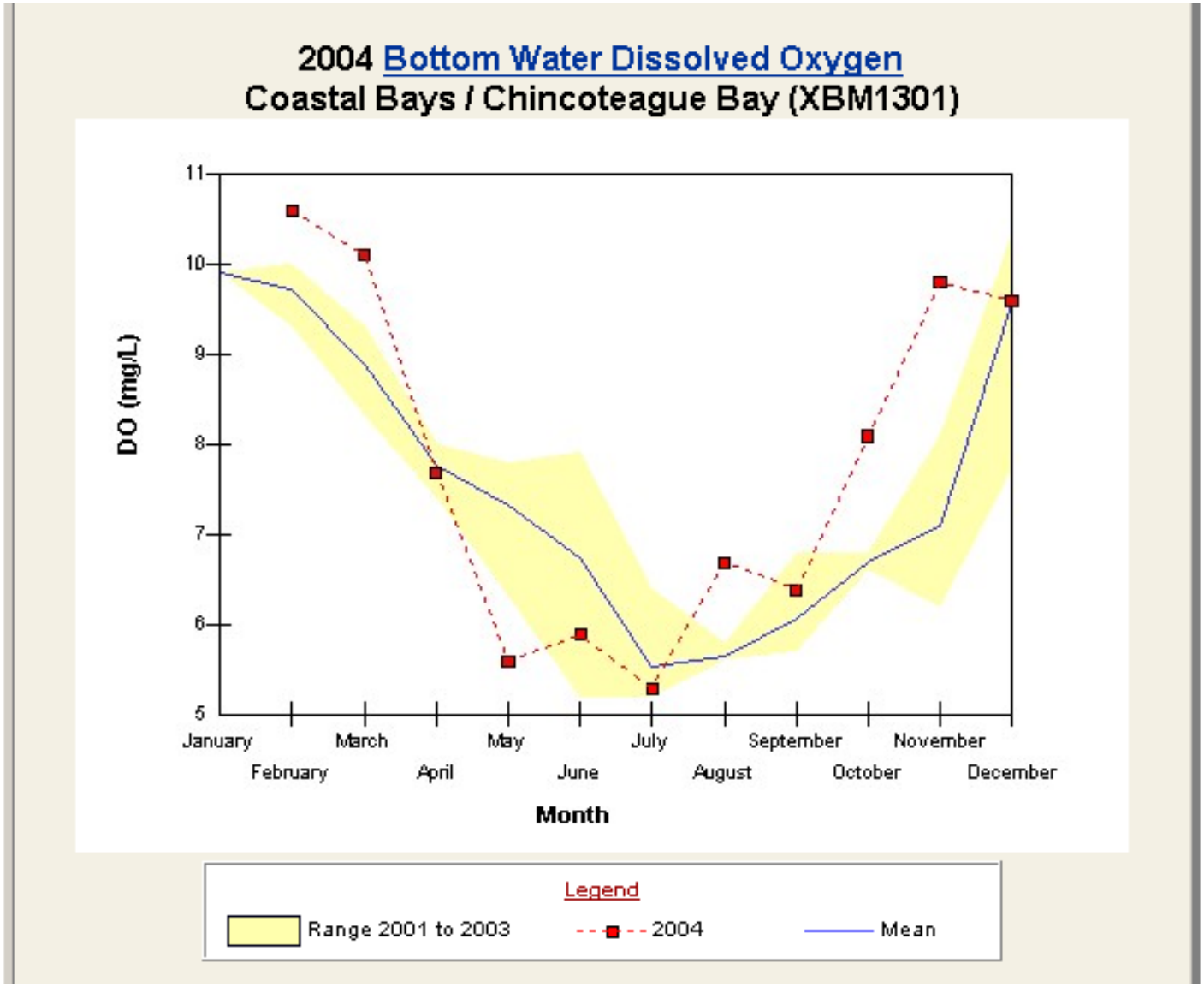
Appendix B
Water Quality Monitoring -- Tidal Water

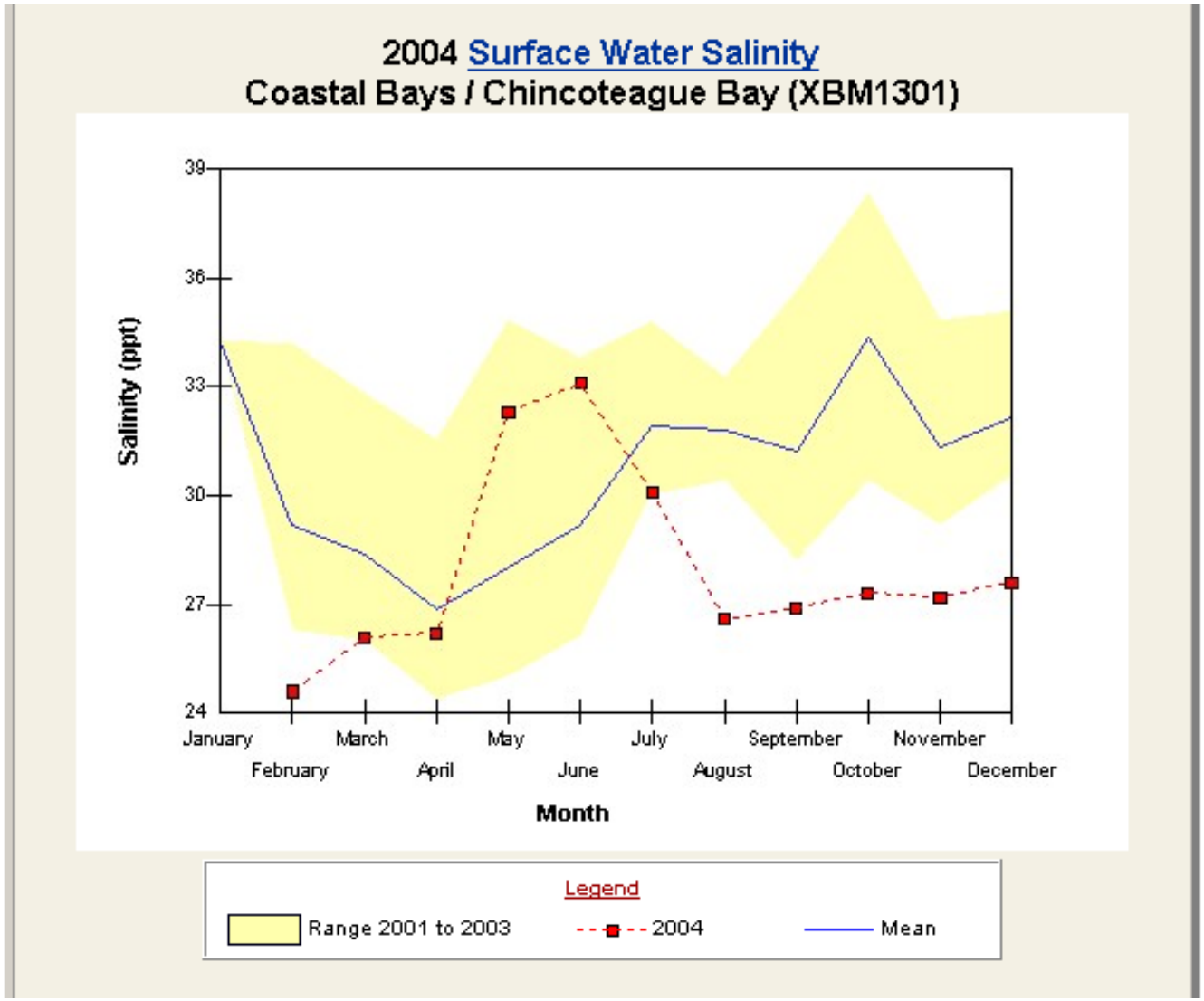
Graphs were taken from DNR's *Eyes On The Bay* Internet Site for three monitoring stations in Mid Chincoteague Bay:

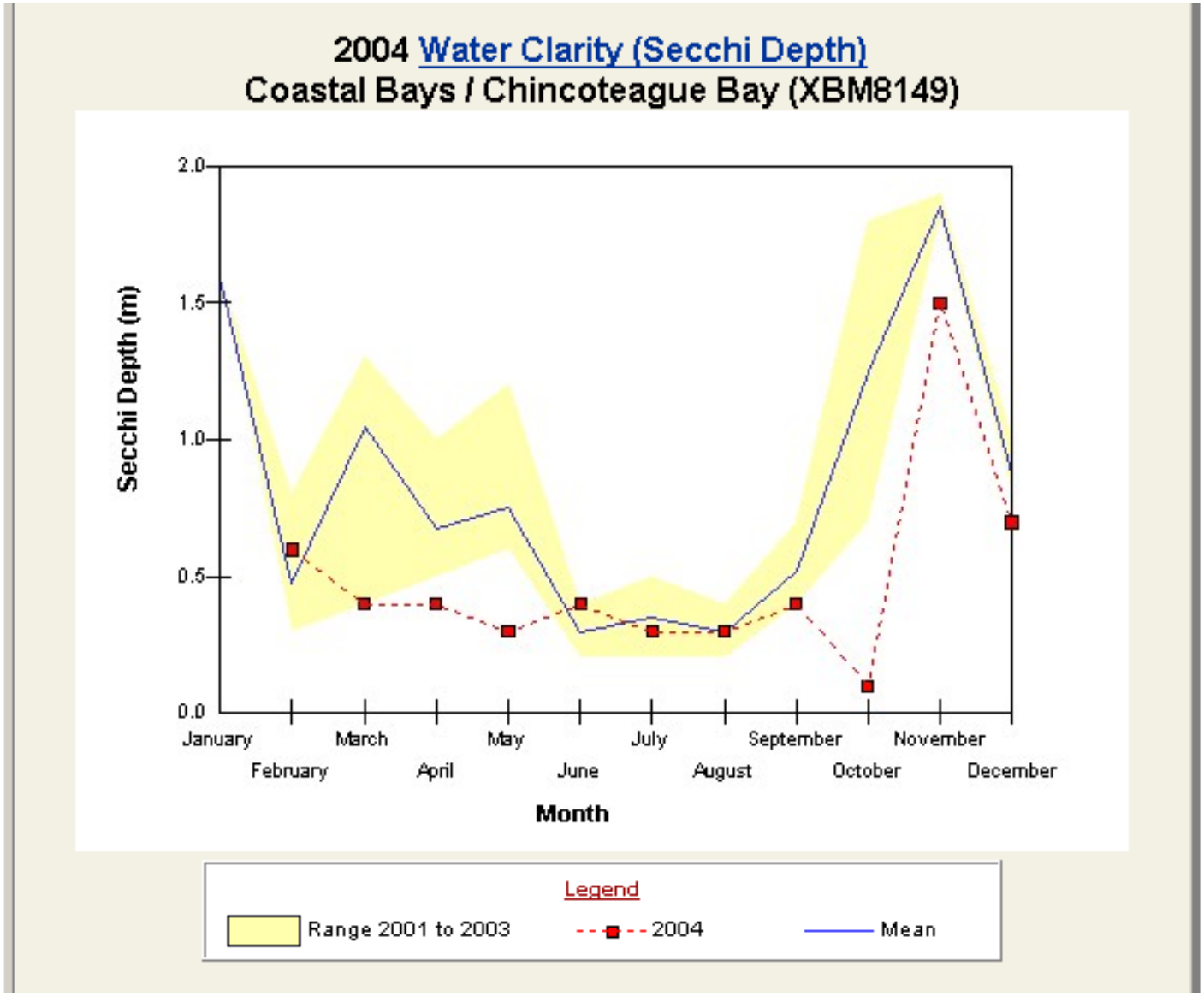
Map Number	Station ID Number	Location
1	XCM1562	Vicinity of Waterworks Creek
4	XBM8149	Between Tanhouse Creek and Brockanorton Bay
6	XBM1301	Near the Maryland-Virginia border

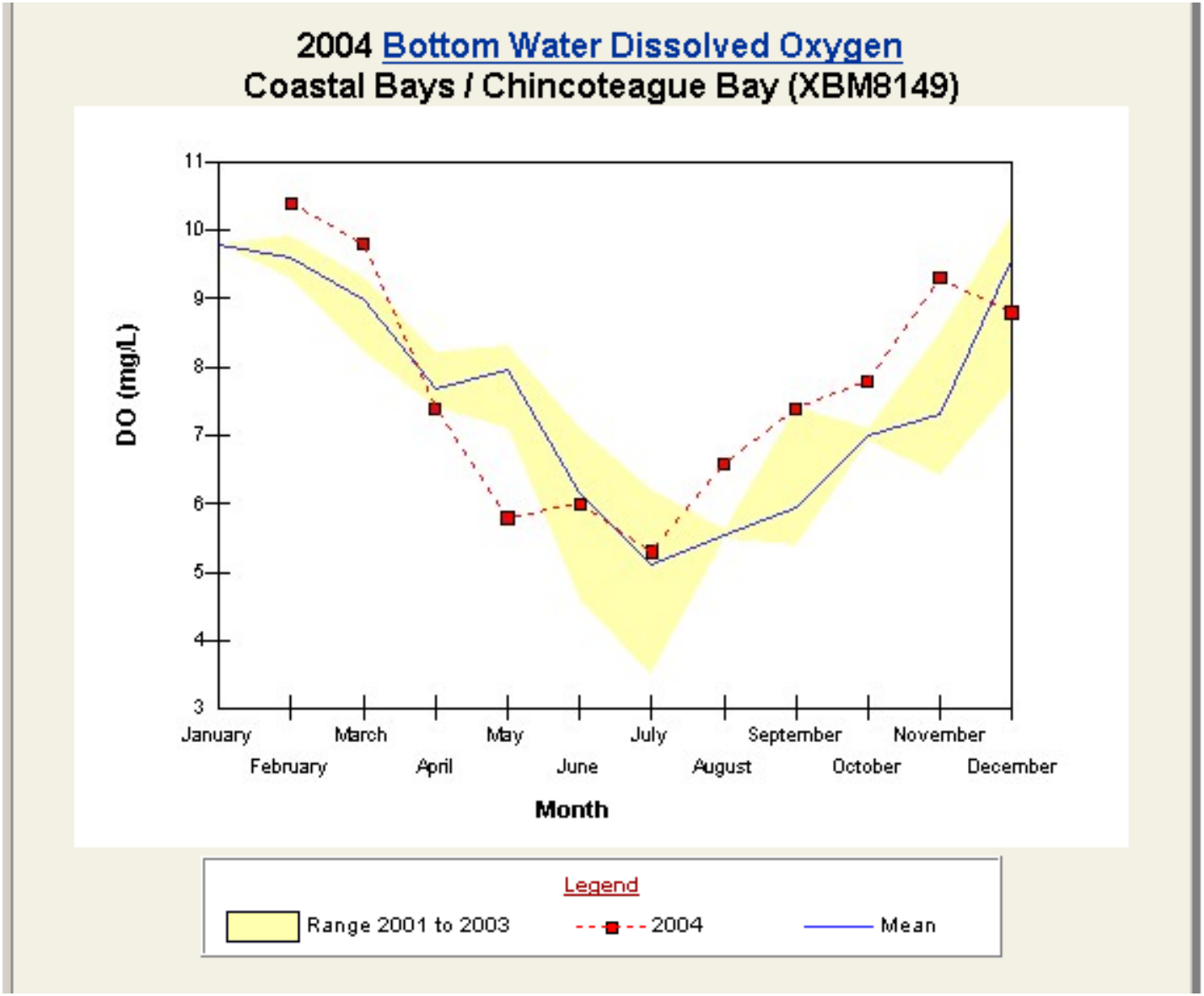
2004 Water Clarity (Secchi Depth)
Coastal Bays / Chincoteague Bay (XBM1301)

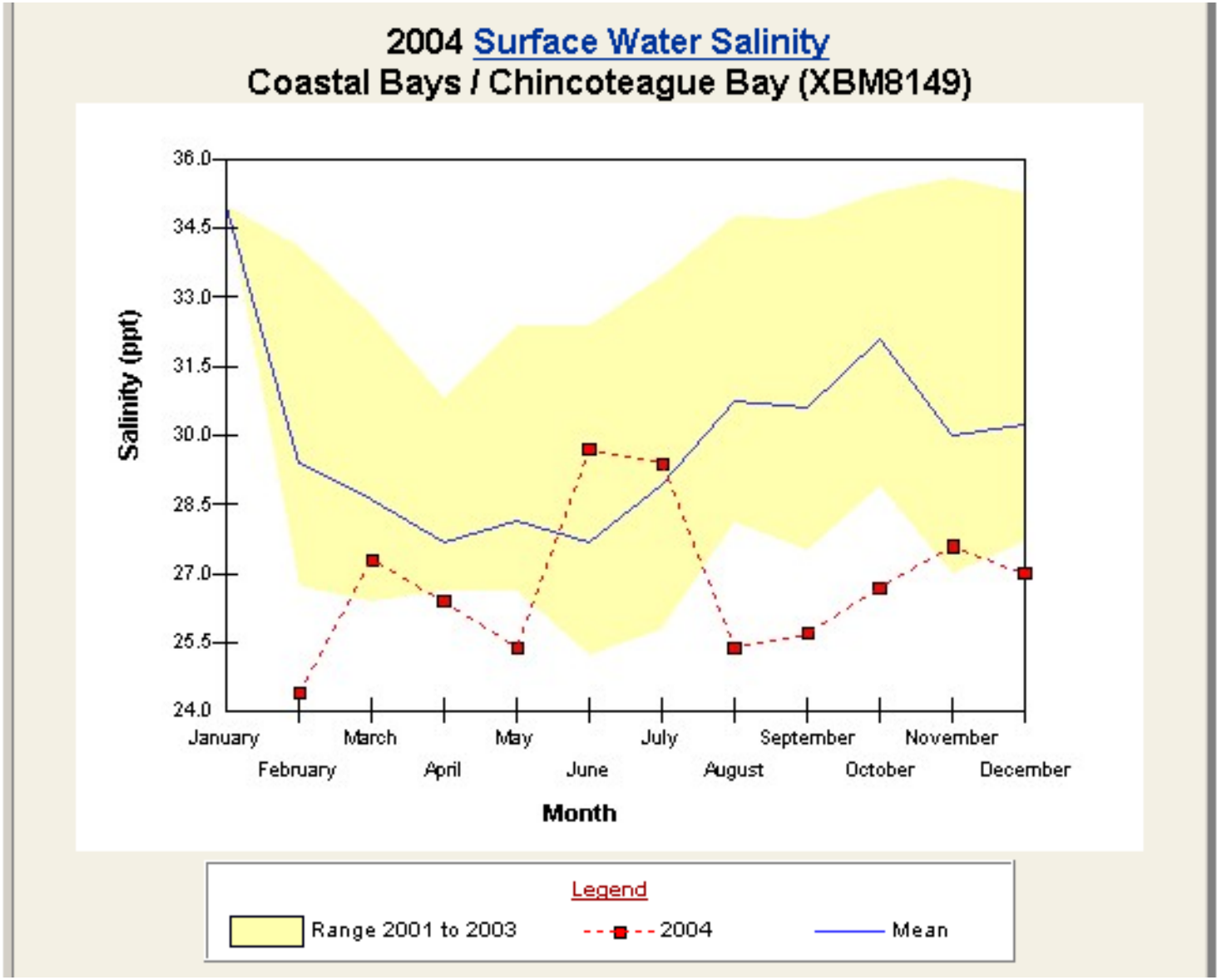



2004 Bottom Water Dissolved Oxygen
Coastal Bays / Chincoteague Bay (XBM1301)
DO (mg/L)
11
10
9
8
7
6
5
January
February
March
April
May
June
July
August
September
October
November
December
Month
Legend
Range 2001 to 2003
2004
Mean

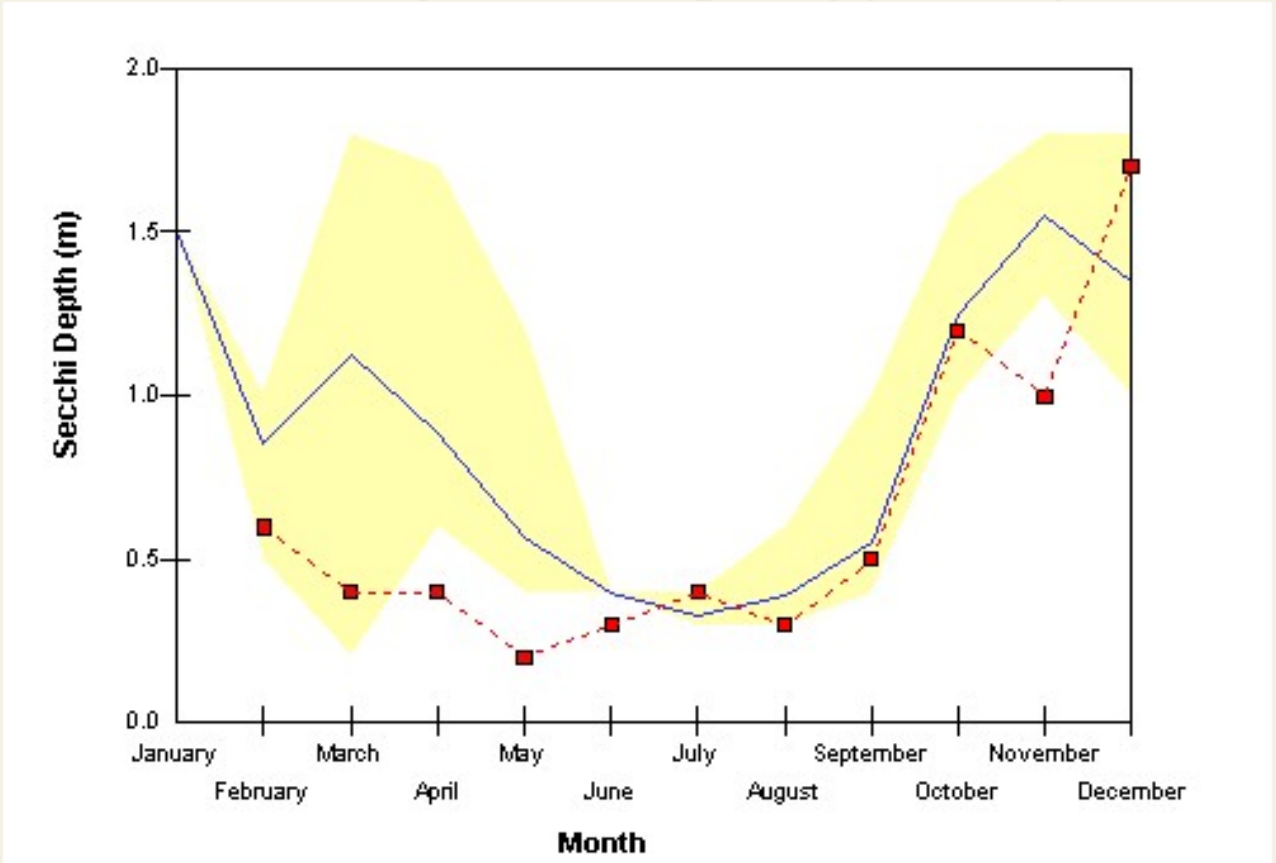

2004 Surface Water Salinity
Coastal Bays / Chincoteague Bay (XBM1301)
Salinity (ppt)
39
36
33
30
27
24
January
February
March
April
May
June
July
August
September
October
November
December
Month
Legend
Range 2001 to 2003
2004
Mean

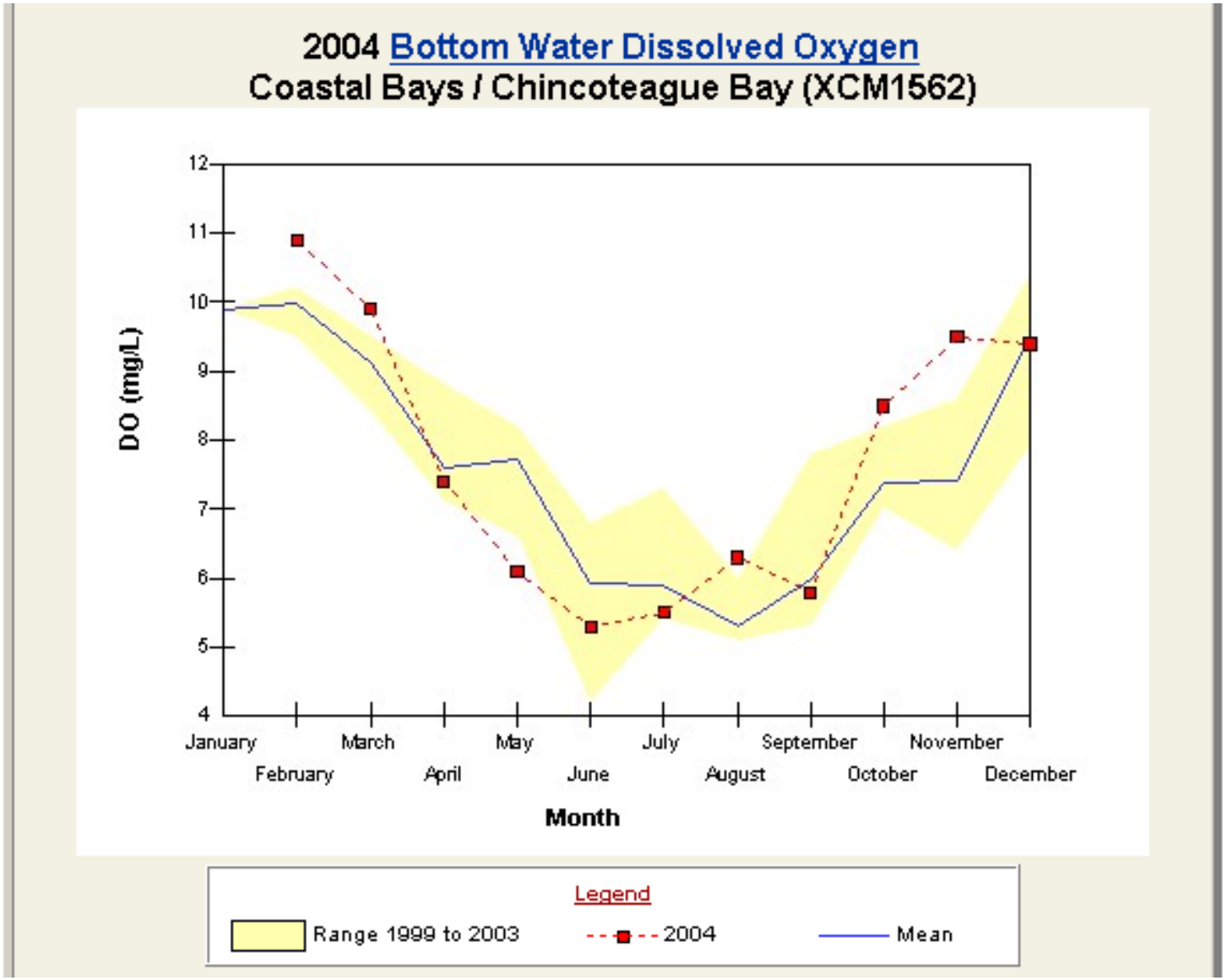

2004 Water Clarity (Secchi Depth)
Coastal Bays / Chincoteague Bay (XBM8149)
Secchi Depth (m)
2.0
1.5
1.0
0.5
0.0
January
February
March
April
May
June
July
August
September
October
November
December
Month
Legend
Range 2001 to 2003
2004
Mean

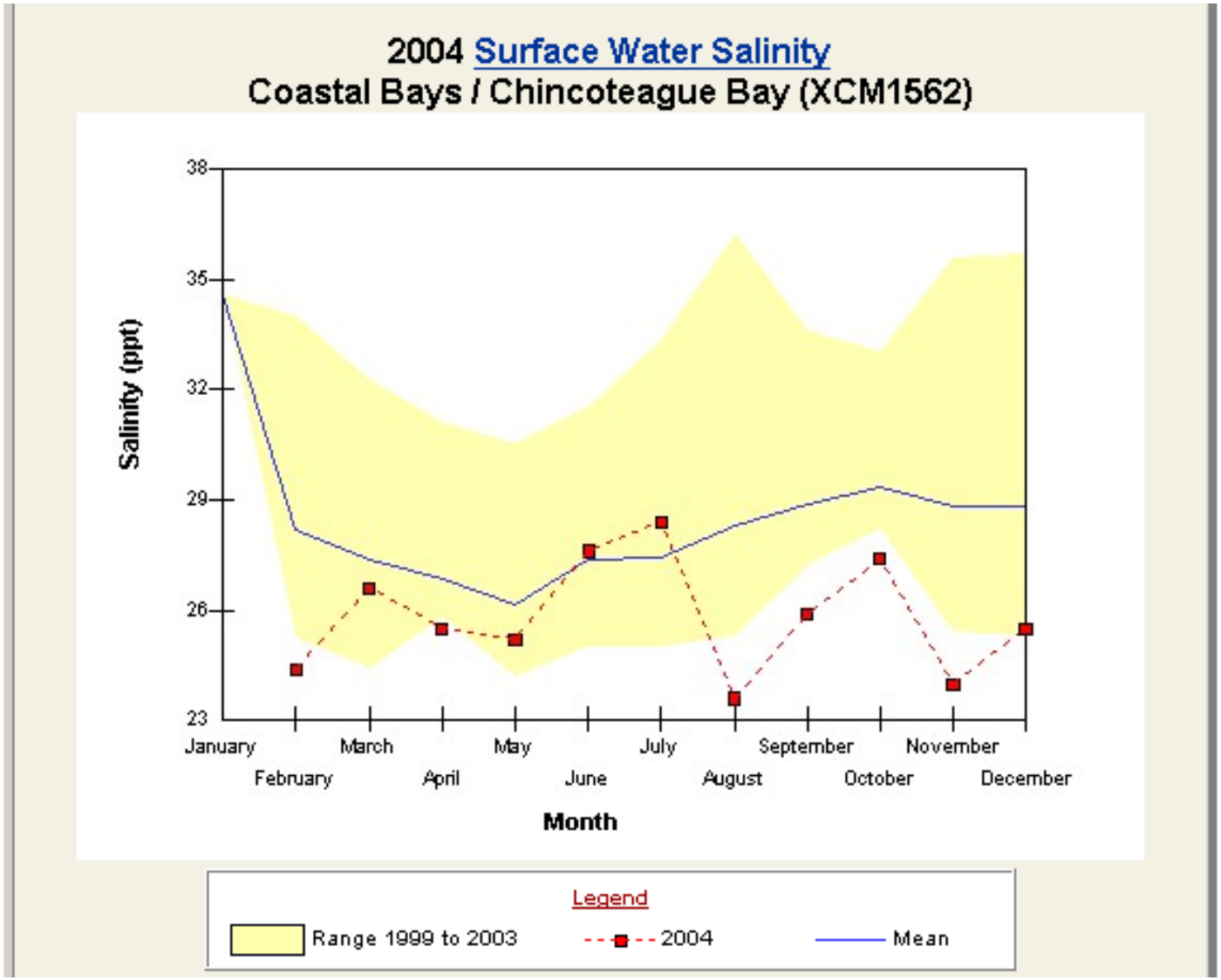

2004 Bottom Water Dissolved Oxygen
Coastal Bays / Chincoteague Bay (XBM8149)
DO (mg/L)
11
10
9
8
7
6
5
4
3
January
February
March
April
May
June
July
August
September
October
November
December
Month
Legend
Range 2001 to 2003
2004
Mean


2004 Surface Water Salinity
Coastal Bays / Chincoteague Bay (XBM8149)
Salinity (ppt)
36.0
34.5
33.0
31.5
30.0
28.5
27.0
25.5
24.0
January
February
March
April
May
June
July
August
September
October
November
December
Month
Legend
Range 2001 to 2003
2004
Mean

2004 Water Clarity (Secchi Depth)
Coastal Bays / Chincoteague Bay (XCM1562)




2004 Bottom Water Dissolved Oxygen
Coastal Bays / Chincoteague Bay (XCM1562)
DO (mg/L)
12
11
10
9
8
7
6
5
4
January
February
March
April
May
June
July
August
September
October
November
December
Month
Legend
Range 1999 to 2003
2004
Mean


2004 Surface Water Salinity
Coastal Bays / Chincoteague Bay (XCM1562)
Salinity (ppt)
38
35
32
29
26
23
January
February
March
April
May
June
July
August
September
October
November
December
Month
Legend
Range 1999 to 2003
2004
Mean

Appendix C
Water Quality Monitoring -- Nontidal Streams and Impoundments

Stations Included

Little Mill Creek
LML0000
LML0001
LML0002
LML0003
LML0005
LML0006
LML0021

Payne Ditch
PAD0008

Little Mill Run Station LML0000								
DATE	SECCHI METERS	DO MG /L	CONDUCTIVITY µOMHOS /CM	pH	TN MG /L	TP MG /L	TSS MG /L	CHLOROPHYLL µG /L
11/28/2000	.	11.8	203	7.2	1.09	0.024	2.4	1.0
2/21/2001	.	8.2	167	6.6	2.08	0.038	2.4	2.1
3/28/2001	.	10.3	178	6.5	2.54	0.042	2.4	2.2
12/19/2000	.	10.5	181	7.4	1.18	0.035	2.4	2.7
5/2/2001	.	13.5	180	9.3	1.57	0.030	4.8	3.5
1/23/2001	.	12.2	183	6.8	2.09	0.043	2.4	5.6
10/31/2000	.	11.3	205	7.4	0.70	0.036	4.0	10.7
4/11/2001	.	8.9	70	6.8	1.77	0.042	4.7	11.4
6/5/2001	.	8.5	183	6.9	1.34	0.075	9.0	61.0
AVERAGE	---	10.6	172	7.2	1.60	0.040	3.8	11.1

Little Mill Run Station LML0001								
DATE	SECCHI METERS	DO MG /L	CONDUCTIVITY µOMHOS /CM	pH	TN MG /L	TP MG /L	TSS MG /L	CHLOROPHYLL µG /L
7/23/2001	1.2	2.3	200	6.7				6.4
7/26/2001	ON BOTTOM	3.1	213	6.9				19.1
7/26/2001	ON BOTTOM	3.1	213	6.9				21.0
8/6/2001	1.3	3.6	195	6.4				22.0
8/6/2001	1.3	3.6	195	6.4	0.80	0.071	4.0	24.1
7/30/2001	1.1	3.1	192	6.6				37.4
7/30/2001	1.1	3.1	192	6.6	0.92	0.086	2.4	43.4
7/26/2001	ON BOTTOM	3.5	213	6.9				
7/30/2001	ON BOTTOM	3.5	189	6.6				
AVERAGE	1.2	3.2	200	6.7	0.86	0.078	3.2	24.8

Little Mill Run Station LML0002								
DATE	**SECCHI DEPTH METERS**	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**pH**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
7/23/2001	1.1	3.9	200	6.8				
7/26/2001	0.5	2.9	213	6.8				
7/26/2001	0.5	1.9	218	6.8				
8/6/2001	ON BOTTOM	3.9	198	6.4				
AVERAGE	0.7	3.2	207	6.7	---	---	---	---

Little Mill Run Station LML0003								
DATE	**SECCHI DEPTH METERS**	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**pH**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
7/23/2001	1.1	5.1	200	6.9				
7/26/2001	0.3	5.0	211	7.0				
7/30/2001	0.6	2.7	191	6.4				
8/6/2001	1.0	4.6	204	6.6				
AVERAGE	0.8	4.4	202	6.7	---	---	---	---

Little Mill Run Station LML0005								
DATE	**SECCHI DEPTH METERS**	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**pH**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
7/23/2001	1.0	7.9	200	7.1				
7/26/2001	0.3	2.8	212	6.8				
7/30/2001	0.2	3.0	187	6.2				
8/6/2001	0.9	2.5	205	6.5				
AVERAGE	0.6	4.1	201	6.7	---	---	---	---

Little Mill Run Station LML0006								
DATE	**SECCHI DEPTH METERS**	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**pH**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
7/30/2001	0.5	4.0	225	6.1				4.6
7/30/2001	0.5	4.0	225	6.1	1.02	0.117	2.4	4.8
7/23/2001	0.7	8.3	200	7.2				16.6
7/26/2001	0.2	1.3	230	6.7				39.6
7/26/2001	0.2	1.3	230	6.7				44.4
8/6/2001	ON BOTTOM	0.8	213	6.4	1.28	0.166	10.0	53.1
8/6/2001	ON BOTTOM	0.8	213	6.4				56.4
AVERAGE	0.4	2.9	219	6.5	1.15	0.141	6.2	31.4

Little Mill Run Station LML0021								
DATE	SECCHI METERS	DO MG /L	CONDUCTIVITY µOMHOS /CM	pH	TN MG /L	TP MG /L	TSS MG /L	CHLOROPHYLL µG /L
11/28/2000	.	7.7	215	6.3	2.47	0.020	2.4	0.4
6/5/2001	.	6.7	146	6.4	2.92	0.060	10.0	0.8
2/21/2001	.	10.4	224	6.7	3.71	0.039	8.0	1.3
3/28/2001	.	10.8	185	6.2	3.59	0.047	9.4	1.3
5/2/2001	.	8.7	210	6.5	4.43	0.031	4.3	1.3
12/19/2000	.	10.2	238	8.7	3.99	0.021	2.4	2.0
1/23/2001	.	12.1	239	6.6	3.69	0.031	3.0	7.6
4/11/2001	.	8.8	60	6.2	2.89	0.086	37.0	14.3
10/31/2000	.	7.0	212	6.4	2.78	0.020	2.4	
AVERAGE	---	9.2	192	6.7	3.39	0.040	8.8	3.6

Payne Ditch Station PAD0008								
DATE	SECCHI METERS	DO MG /L	CONDUCTIVITY µOMHOS /CM	pH	TN MG /L	TP MG /L	TSS MG /L	CHLOROPHYLL µG /L
10/31/2000	.	5.2	188	6.5	1.51	0.016	2.4	0.0
11/28/2000	.	6.0	189	6.3	1.27	0.017	2.4	0.0
12/19/2000	.	8.9	181	7.6	1.87	0.018	2.4	0.1
5/2/2001	.	7.3	160	6.5	3.63	0.043	5.2	0.6
3/28/2001	.	10.5	113	6.1	1.79	0.022	2.4	0.8
2/21/2001	.	9.7	150	6.4	1.85	0.021	2.4	1.0
6/5/2001	.	7.5	181	6.4	2.98	0.068	16.0	1.7
1/23/2001	.	11.1	177	6.2	1.82	0.019	2.4	1.8
4/11/2001	.	7.7	41	5.6	1.80	0.051	8.0	2.0
AVERAGE	---	8.2	153	6.4	2.06	0.031	4.8	0.9

Appendix D - Sensitive Species
Chincoteague Bay Watershed In Maryland

EXPLANATION OF RANK AND STATUS CODES

As of January 2003, the global and state ranking system is used by all 50 state Natural Heritage Programs and numerous Conservation Data Centers in other countries in this hemisphere. Because they are assigned based upon standard criteria, the ranks can be used to assess the range-wide status of a species as well as the status within portions of the species' range. The primary criterion used to define these ranks are the number of known distinct occurrences with consideration given to the total number of individuals at each locality. Additional factors considered include the current level of protection, the types and degree of threats, ecological vulnerability, and population trends. Global and state ranks are used in combination to set inventory, protection, and management priorities for species both at the state as well as regional level.

Blank means that no rank or status is assigned – all categories.

GLOBAL RANK

- G1 Highly globally rare. Critically imperiled globally because of extreme rarity (typically 5 or fewer estimated occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
- G2 Globally rare. Imperiled globally because of rarity (typically 6 to 20 estimated occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
- G3 Either very rare and local throughout its range or distributed locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range; typically with 21 to 100 estimated occurrences.
- G4 Apparently secure globally, although it may be quite rare in parts of its range, especially at the periphery.
- G5 Demonstrably secure globally, although it may be quite rare in parts of its range, especially at the periphery.
- GH No known extant occurrences (i.e., formerly part of the established biota, with the expectation that it may be rediscovered).
- GU Possibly in peril range-wide, but its status is uncertain; more information is needed.
- GX Believed to be extinct throughout its range (e.g., passenger pigeon) with virtually no likelihood that it will be rediscovered.
- G? The species has not yet been ranked.
- _Q Species containing a "Q" in the rank indicates that the taxon is of questionable or uncertain taxonomic standing (i.e., some taxonomists regard it as a full species, while others treat it at an infraspecific level).
- _T Ranks containing a "T" indicate that the infraspecific taxon is being ranked differently than the full species.

STATE RANK

S1 Highly State rare. Critically imperiled in Maryland because of extreme rarity (typically 5 or fewer estimated occurrences or very few remaining individuals or acres in the State) or because of some factor(s) making it especially vulnerable to extirpation. Species with this rank are actively tracked by the Natural Heritage Program.

S2 State rare. Imperiled in Maryland because of rarity (typically 6 to 20 estimated occurrences or few remaining individuals or acres in the State) or because of some factor(s) making it vulnerable to becoming extirpated. Species with this rank are actively tracked by the Natural Heritage Program.

S3 Rare to uncommon with the number of occurrences typically in the range of 21 to 100 in Maryland. It may have fewer occurrences but with a large number of individuals in some populations, and it may be susceptible to large-scale disturbances. Species with this rank are not actively tracked by the Natural Heritage Program.

S3.1 A species that is actively tracked by the Natural Heritage Program because of the global significance of Maryland occurrences. For instance, a G3 S3 species is globally rare to uncommon, and although it may not be currently threatened with extirpation in Maryland, its occurrences in Maryland may be critical to the long term security of the species. Therefore, its status in the State is being monitored.

S4 Apparently secure in Maryland with typically more than 100 occurrences in the State or may have fewer occurrences if they contain large numbers of individuals. It is apparently secure under present conditions, although it may be restricted to only a portion of the State.

S5 Demonstrably secure in Maryland under present conditions.

SA Accidental or considered to be a vagrant in Maryland.

SE Established, but not native to Maryland; it may be native elsewhere in North America.

SH Historically known from Maryland, but not verified for an extended period (usually 20 or more years), with the expectation that it may be rediscovered.

SP Potentially occurring in Maryland or likely to have occurred in Maryland (but without persuasive documentation).

SR Reported from Maryland, but without persuasive documentation that would provide a basis for either accepting or rejecting the report (e.g., no voucher specimen exists).

SRF Reported falsely (in error) from Maryland, and the error may persist in the literature.

SU Possibly rare in Maryland, but of uncertain status for reasons including lack of historical records, low search effort, cryptic nature of the species, or concerns that the species may not be native to the State. Uncertainty spans a range of 4 or 5 ranks as defined above.

SX Believed to be extirpated in Maryland with virtually no chance of rediscovery.

SYN Currently considered synonymous with another taxon and, therefore, not a valid entity.

SZ A migratory species which does not inhabit specific locations for long periods of time.

S? The species has not yet been ranked.

-B This species is migratory and the rank refers only to the breeding status of the species. Such a migrant may have a different rarity rank for non-breeding populations.

-N This species is migratory and the rank refers only to the non-breeding status of the species. Such a migrant may have a different rarity rank for breeding populations.

STATE STATUS

This is the status of a species as determined by the Maryland Department of Natural Resources, in accordance with the Nongame and Endangered Species Conservation Act. Definitions for the following categories have been taken from Code of Maryland Regulations (COMAR) 08.03.08.

- E Endangered; a species whose continued existence as a viable component of the State's flora or fauna is determined to be in jeopardy.
- I In Need of Conservation; an animal species whose population is limited or declining in the State such that it may become threatened in the foreseeable future if current trends or conditions persist.
- T Threatened; a species of flora or fauna which appears likely, within the foreseeable future, to become endangered in the State.
- X Endangered Extirpated; a species that was once a viable component of the flora or fauna of the State, but for which no naturally occurring populations are known to exist in the State.
- * A qualifier denoting the species is listed in a limited geographic area only.
- PE Proposed Endangered; a species whose continued existence as a viable component of the State's flora or fauna is determined to be in jeopardy.
- PT Proposed Threatened; a species of flora or fauna which appears likely, within the foreseeable future, to become endangered in the State.
- PX Proposed Endangered Extirpated; a species that was once a viable component of the flora or fauna of the State, but for which no naturally occurring populations are known to exist in the State.
- PD Proposed to be deleted or removed from the State Threatened & Endangered Species list.

FEDERAL STATUS

This is the status of a species as determined by the U.S. Fish and Wildlife Service's Office of Endangered Species, in accordance with the Endangered Species Act. Definitions for the following categories have been modified from 50 CRF 17.

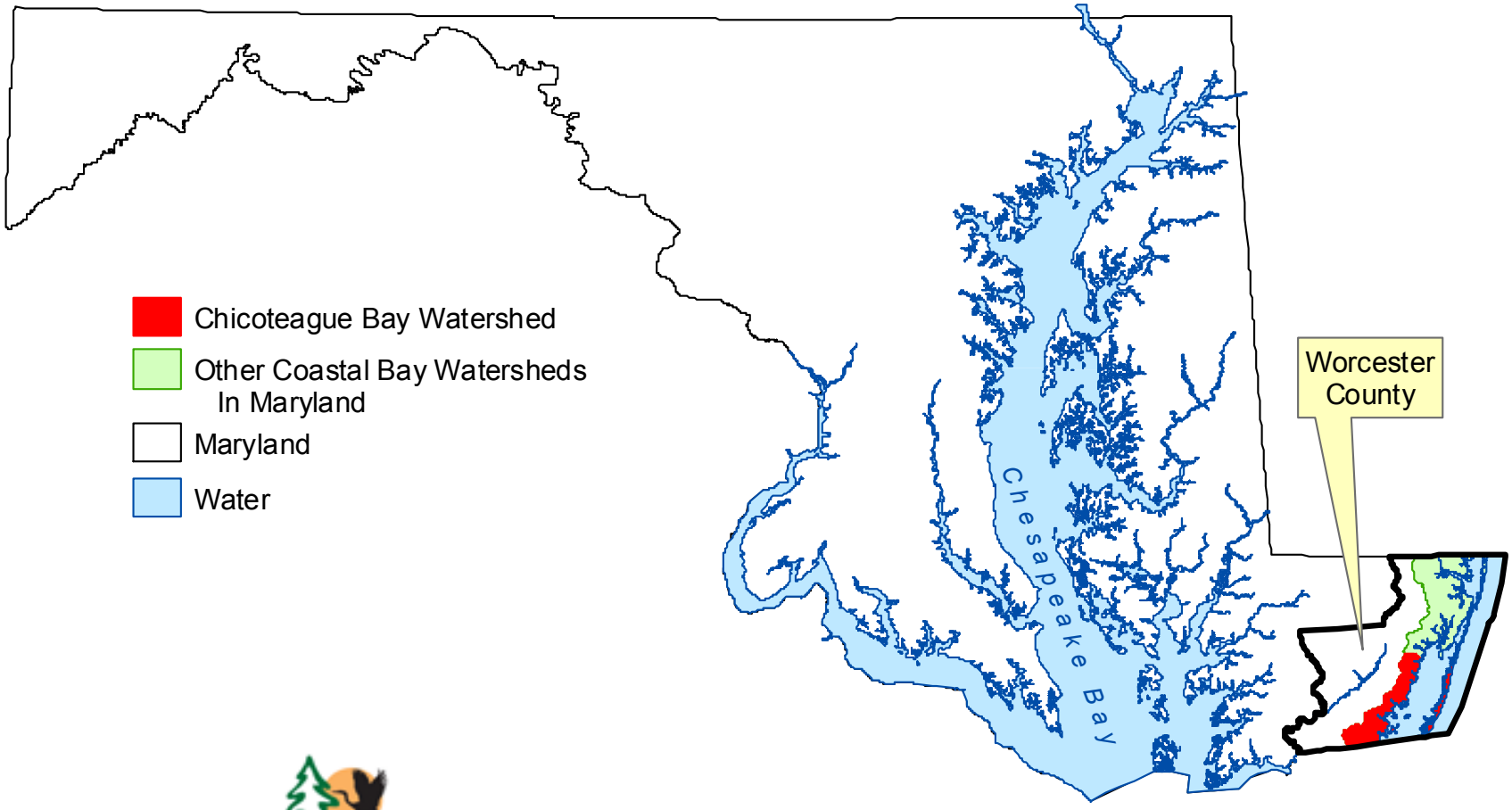
- LE Taxa listed as endangered; in danger of extinction throughout all or a significant portion of their range.
- LT Taxa listed as threatened; likely to become endangered within the foreseeable future throughout all or a significant portion of their range.
- PE Taxa proposed to be listed as endangered.
- PT Taxa proposed to be listed as threatened.
- C Candidate taxa for listing for which the Service has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened.

Current and Historical Rare, Threatened, and Endangered Species Chincoteague Bay Watershed - January 2004					
Scientific name	Common name	G-rank	S-rank	MD	US
Acantharchus pomotis	Mud sunfish	G5	S2	I	
Amaranthus pumilus	Seabeach amaranth	G2	S1	E	LT
Ammannia latifolia	Koehne's ammannia	G5	S2		
Antennaria solitaria	Single-headed pussytoes	G5	S2	T	
Aristida tuberculosa	Sea-beach three-awn	G5	S1		
Axonopus furcatus	Big carpet grass	G5	SH	X	
Azolla caroliniana	Mosquito fern	G5	SU		
Carex mitchelliana	Mitchell's sedge	G3G4	S1		
Carex silicea	Sea-beach sedge	G5	S1	E	
Charadrius melodus	Piping plover	G3	S1B	E	LT
Cicindela dorsalis media	White tiger beetle	G4T4	S1	E	
Cicindela lepida	Little white tiger beetle	G4	S1	E	
Circus cyaneus	Northern harrier	G5	S2B		
Cistothorus platensis	Sedge wren	G5	S1B	E	
Dermochelys coriacea	Atlantic leatherback turtle	G2	S1	E	LE
Dryopteris celsa	Log fern	G4	S3.1	T	
Eleocharis albida	White spikerush	G4G5	S2	T	
Eleocharis rostellata	Beaked spikerush	G5	S2?		
Epilobium ciliatum	Northern willowherb	G5	S1	E	
Eriocaulon decangulare	Ten-angled pipewort	G5	S2		
Eupatorium leucolepis	White-bracted boneset	G5	S2S3	T	
Fimbristylis caroliniana	Carolina fimbry	G4	S1S2		
Fuirena pumila	Smooth fuirena	G4	S2S3		
Fundulus luciae	Spotfin killifish	G4	S2?		
Galium hispidulum	Coast bedstraw	G5	S1	E	
Haliaeetus leucocephalus	Bald eagle	G4	S2S3B	T	LT
Hypericum denticulatum	Coppery St. John's-wort	G5	S2	T	
Ixobrychus exilis	Least bittern	G5	S2S3B	I	
Juncus polycephalus	Many-headed rush	G5	SU		
Leptochloa fascicularis	Long-awned diplachne	G5	SU		
Lycopodiella caroliniana	Carolina clubmoss	G5	S1	X	
Myrica heterophylla	Evergreen bayberry	G5	S1	E	
Myriophyllum heterophyllum	Broadleaf water-milfoil	G5	S1		
Nyctanassa violacea	Yellow-crowned night-heron	G5	S2B		
Panicum flexile	Wiry witch-grass	G5	S1	E	
Persea borbonia	Red bay	G5	S1	E	
Picoides borealis	Red-cockaded woodpecker	G3	SHB	X	LE
Pluchea camphorata	Marsh fleabane	G5	S1	E	
Polygala cruciata	Cross-leaved milkwort	G5	S2	T	

Current and Historical Rare, Threatened, and Endangered Species Chincoteague Bay Watershed - January 2004					
Scientific name	Common name	G-rank	S-rank	MD	US
Polygonum glaucum	Seaside knotweed	G3	S1	E	
Prunus maritima	Beach plum	G4	S1	E	
Pycnanthemum setosum	Awned mountain-mint	G3?	S3.1	T	
Rana virgatipes	Carpenter frog	G5	S2	I	
Rhynchospora microcephala	Tiny-headed beakrush	G5	S2S3		
Rynchops niger	Black skimmer	G5	S1B	E	
Sacciolepis striata	Sacciolepis	G5	S1	E	
Sciurus niger cinereus	Delmarva fox squirrel	G5T3	S1	E	LE
Scleria verticillata	Whorled nutrush	G5	S1	E	
Sesuvium maritimum	Sea-purslane	G5	S1	E	
Sphenopholis pensylvanica	Swamp-oats	G4	S1S2	T	
Sterna antillarum	Least tern	G4	S2B	T	
Sterna maxima	Royal tern	G5	S1B	E	
Sterna nilotica	Gull-billed tern	G5	S1B	E	
Trachelospermum difforme	Climbing dogbane	G4G5	S1	E	
Triglochin striata	Three-ribbed arrow-grass	G5	S1	E	
Trillium pusillum var virginianum	Dwarf trillium	G3T2	S2	T	
Utricularia inflata	Swollen bladderwort	G5	S1	E	
Wolffia papulifera	Water-meal	G4	S2		
Wolffia punctata	Dotted water-meal	G5	S2		
Zephyranthes atamasca	Atamasco lily	G4G5	S1	E	
Other:					
Colonial Waterbird nesting colony					

This list was created by the Dept. of Natural Resources Natural Heritage Program in May 2004. Color code for rows: No color – plants; Yellow – animals (mammals, birds, etc.)

Map 1 Location: Chincoteague Bay Watershed
WRAS Project Area In Maryland

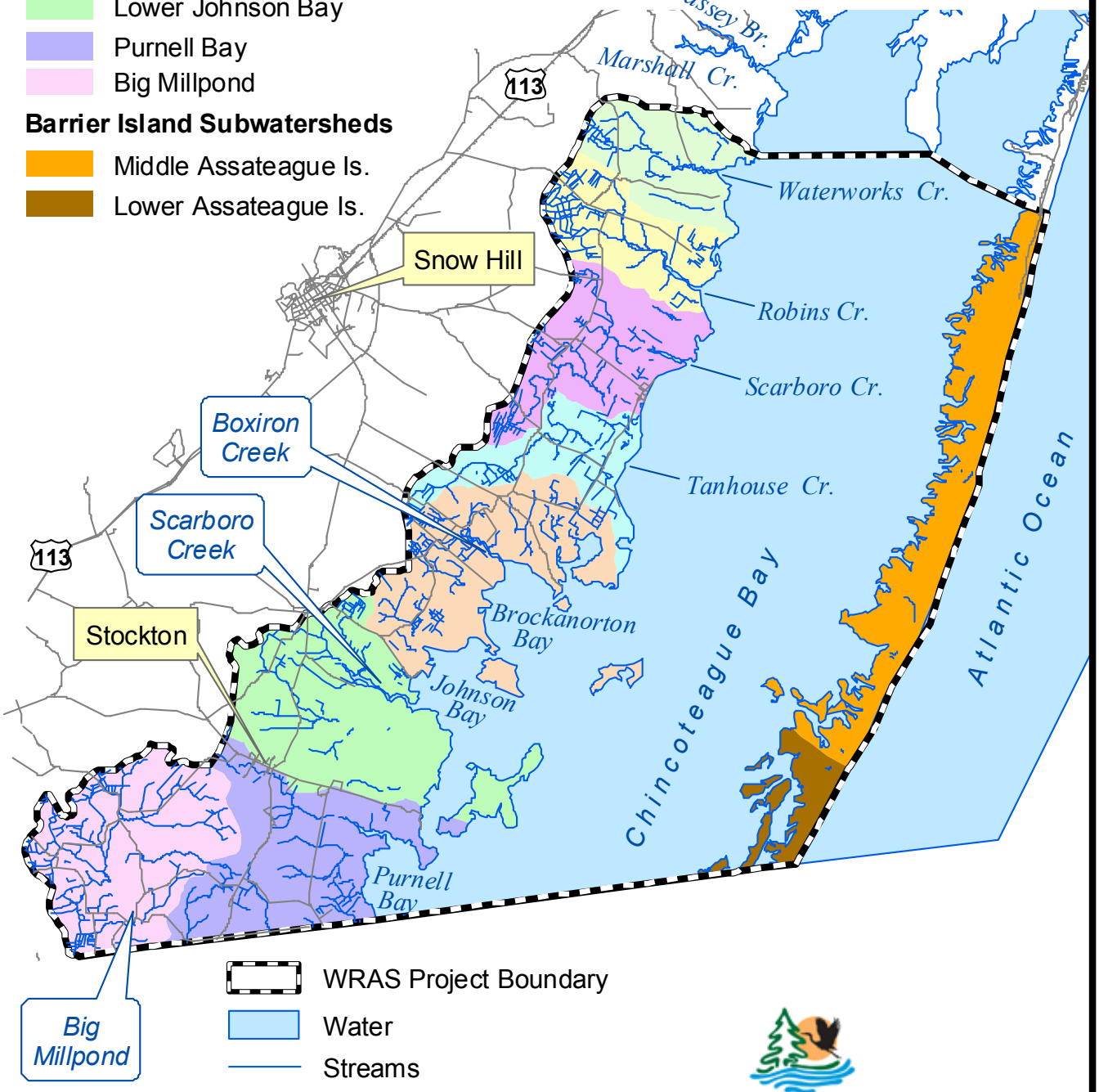


Maryland Dept. of Natural Resources
Watershed Services LWAD
December 2004

0 12.5 25 50 75 100
Miles

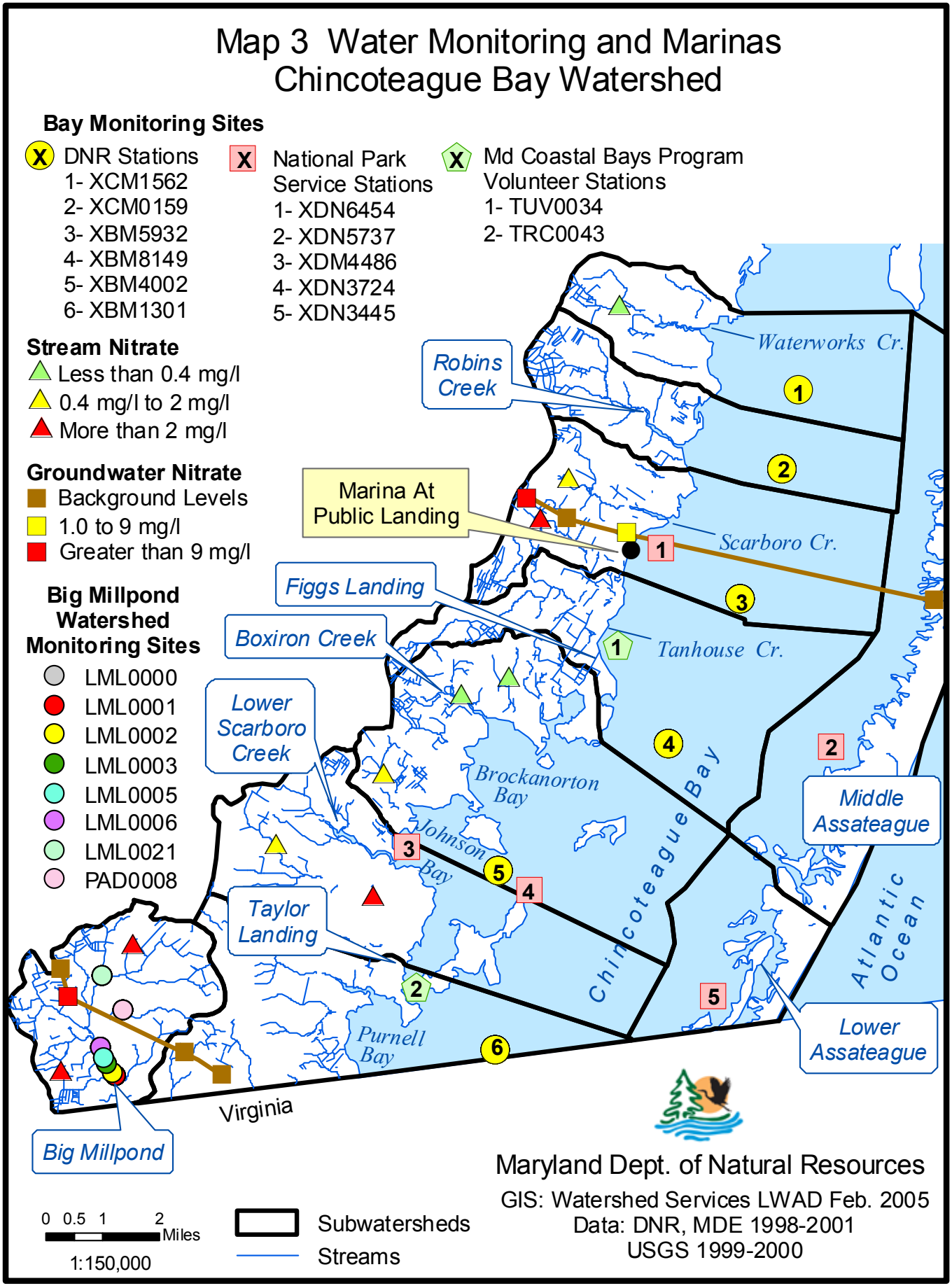
1:175,000

Map 2 WRAS Project Area
Chincoteague Bay Watershed Vicinity

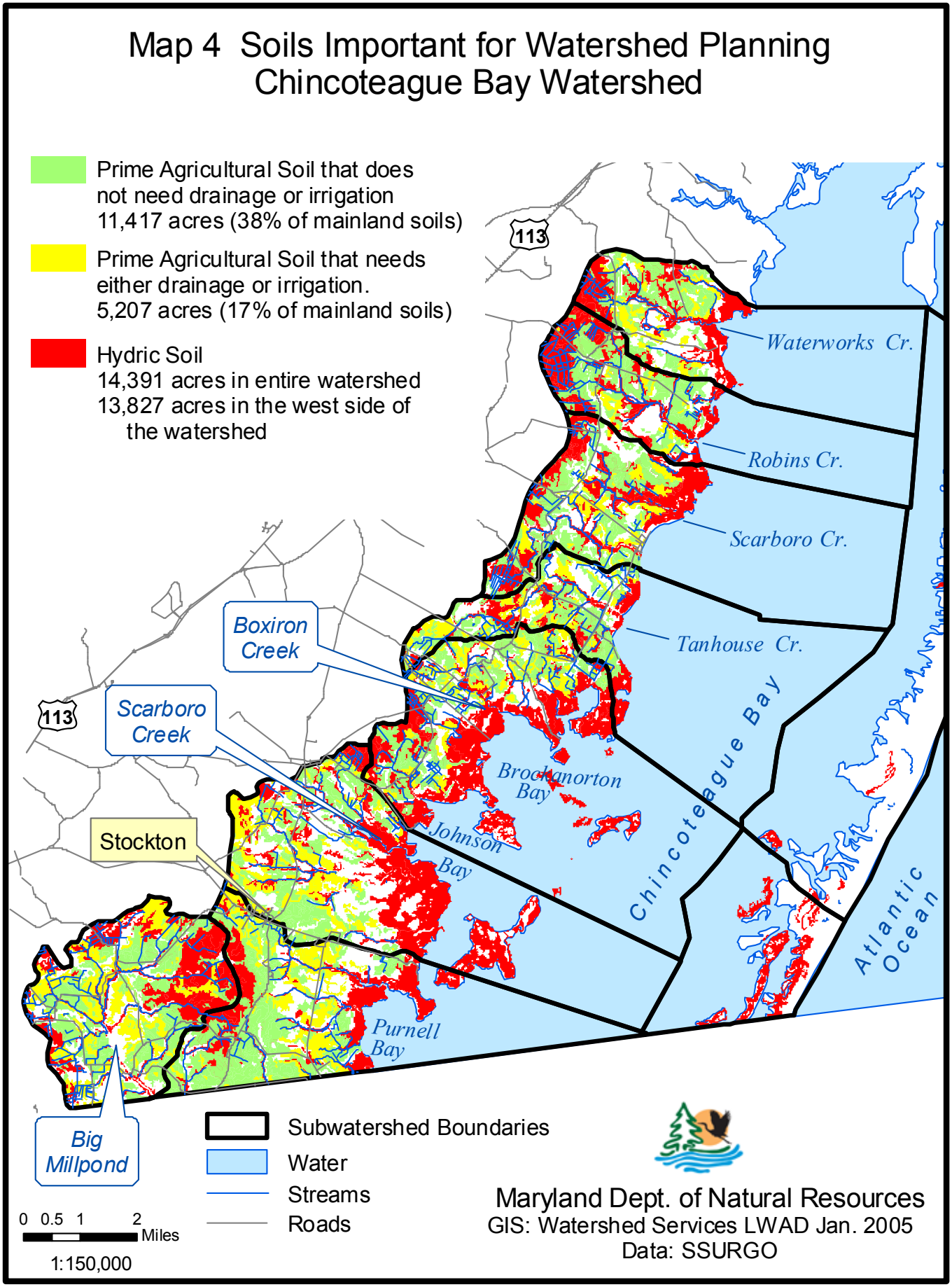


Maryland Dept. of Natural Resources
GIS: Watershed Services LWAD Dec. 2004
Data: DNR

Map 3 Water Monitoring and Marinas
Chincoteague Bay Watershed



Map 4 Soils Important for Watershed Planning
Chincoteague Bay Watershed



Map 5 Green Infrastructure
Chincoteague Bay Watershed

Green Infrastructure (GI)

Large blocks of habitat that are important at a Statewide scale.

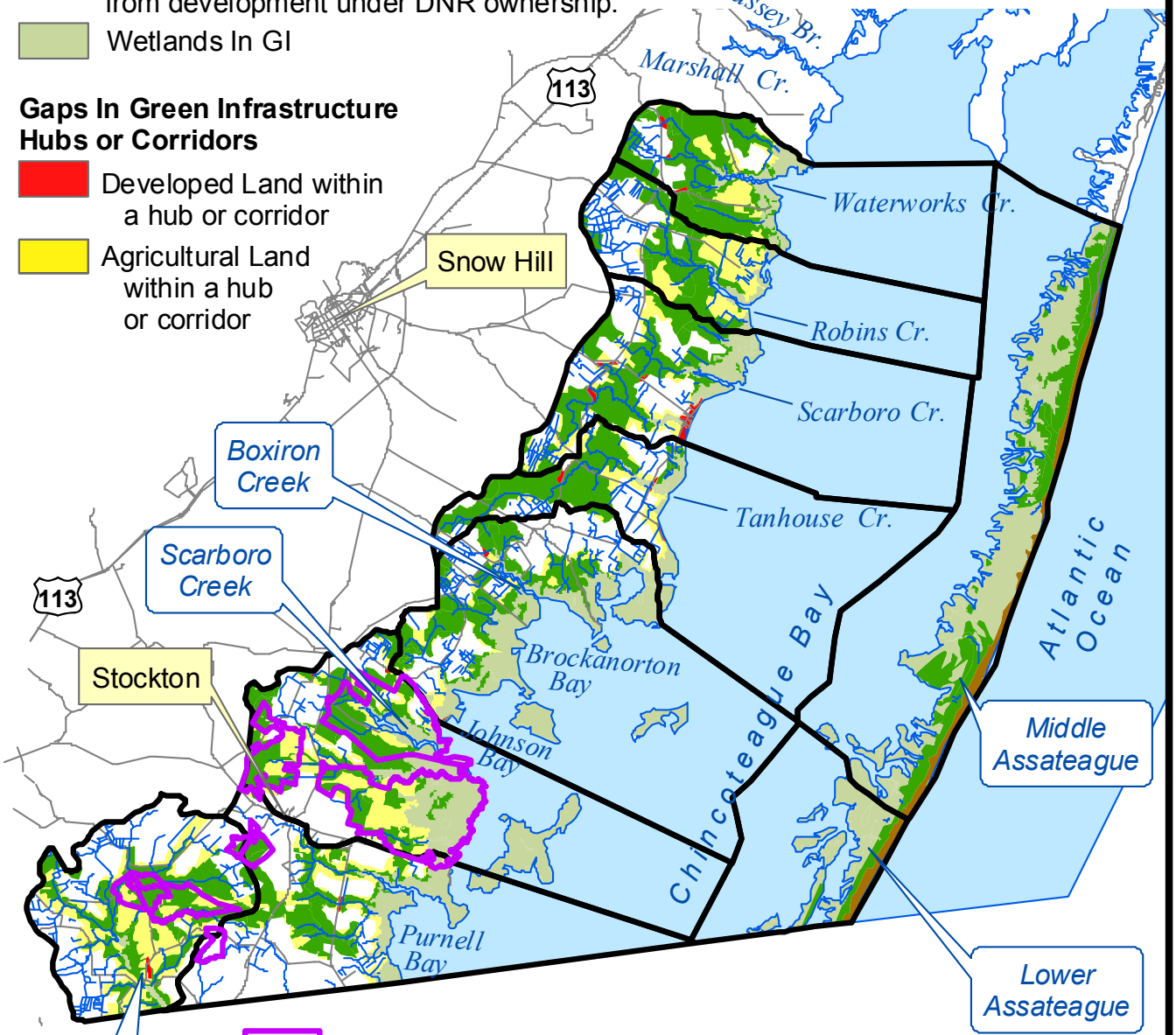
Forests In GI cover about 14,080 acres
About 1,720 acres (12 %) are protected from development under DNR ownership.

Wetlands In GI

Gaps In Green Infrastructure Hubs or Corridors

Developed Land within a hub or corridor

Agricultural Land within a hub or corridor



DNR Lands

Water

Streams

Roads

0 1 2 4 Miles

1:175,000

Maryland Dept. of Natural Resources

GIS: Watershed Services LWAD Feb. 2005

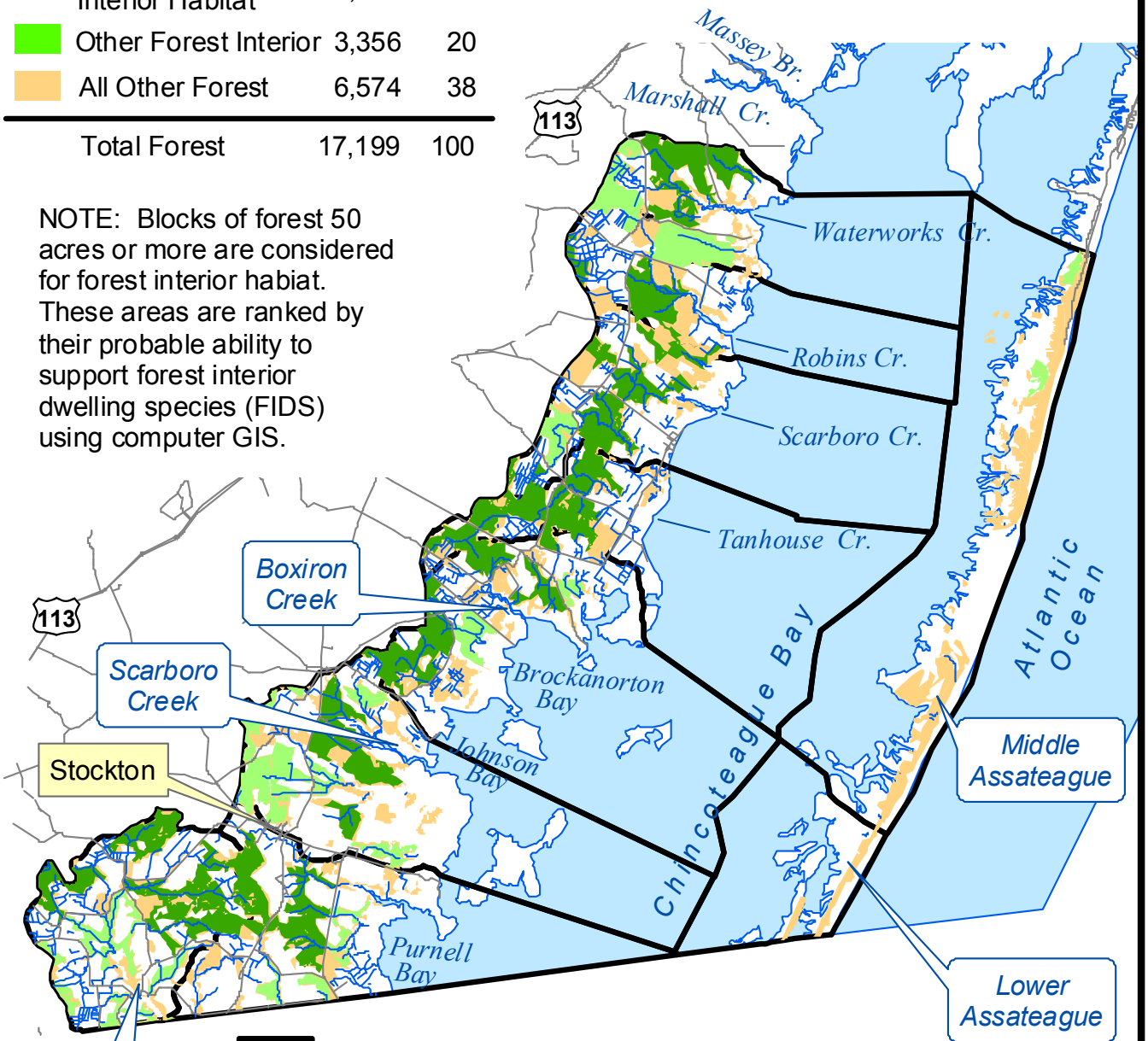
Land Data: MDP 2002

GI Data: DNR 2000

Map 6 Large Block Forest Habitat
Chincoteague Bay Watershed

Forest Block Type	Ac.	Percent
High Quality Forest Interior Habitat	7,269	42
Other Forest Interior	3,356	20
All Other Forest	6,574	38
Total Forest	17,199	100

NOTE: Blocks of forest 50 acres or more are considered for forest interior habiat. These areas are ranked by their probable ability to support forest interior dwelling species (FIDS) using computer GIS.



Maryland Dept. of Natural Resources

GIS: Watershed Services LWAD Jan. 2005
Forest Data: MDP 2002
Forest Interior Habitat Data: DNR 2001

Map 7 Wetlands and Floodplains
Chincoteague Bay Watershed

Wetlands
(15,572 Acres Total)

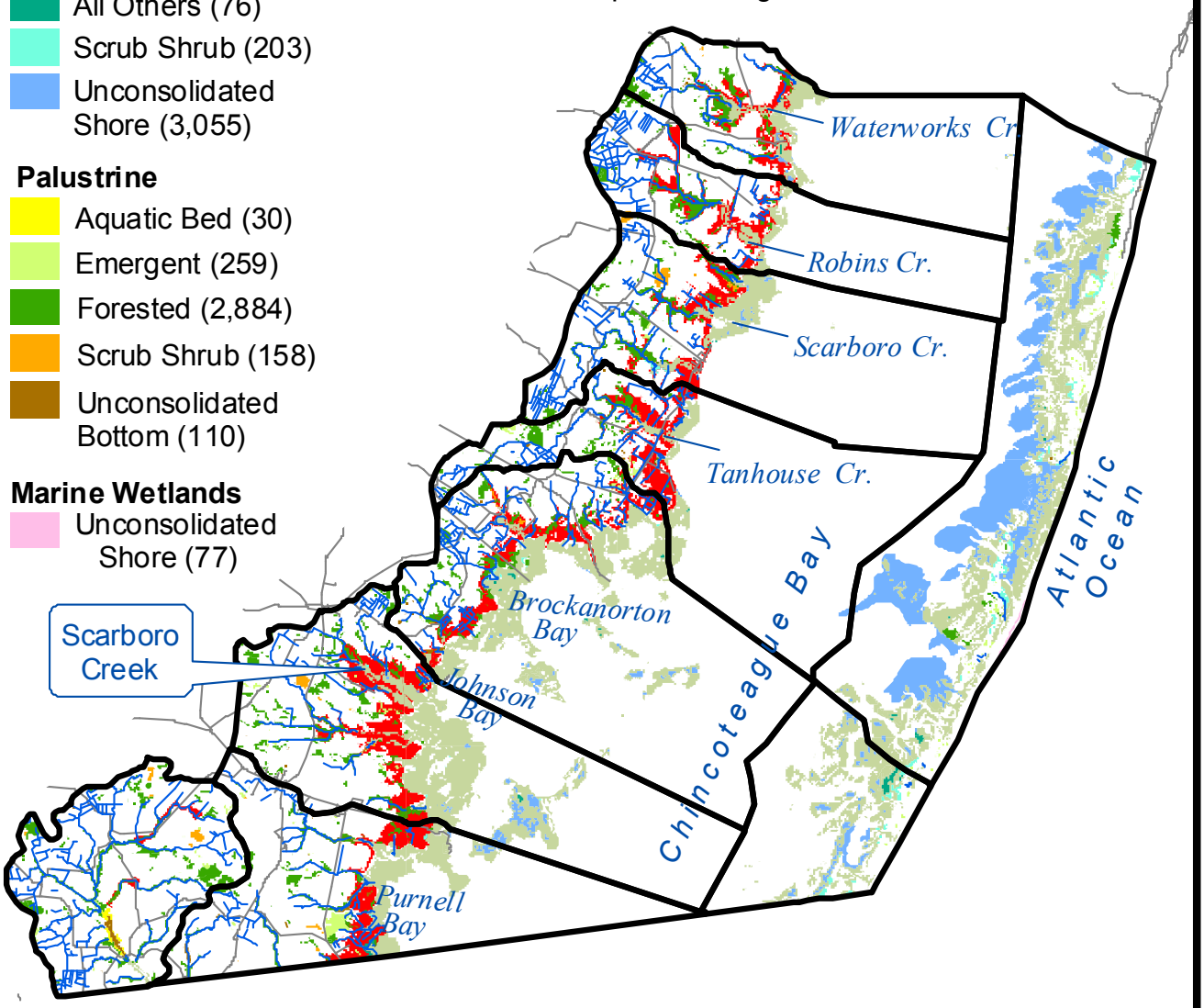
Estuarine
- Emergent (8,720)
- All Others (76)
- Scrub Shrub (203)
- Unconsolidated Shore (3,055)

Palustrine
- Aquatic Bed (30)
- Emergent (259)
- Forested (2,884)
- Scrub Shrub (158)
- Unconsolidated Bottom (110)

Marine Wetlands
- Unconsolidated Shore (77)

100-Year Floodplain On The Mainland
Totals More Than 5,100 Acres

NOTE: Floodplains sometimes include wetlands, i.e. their acreages are not mutually exclusive. The barrier island floodplain acreage is not counted above.



- Subwatershed Boundaries
- Streams
- Roads

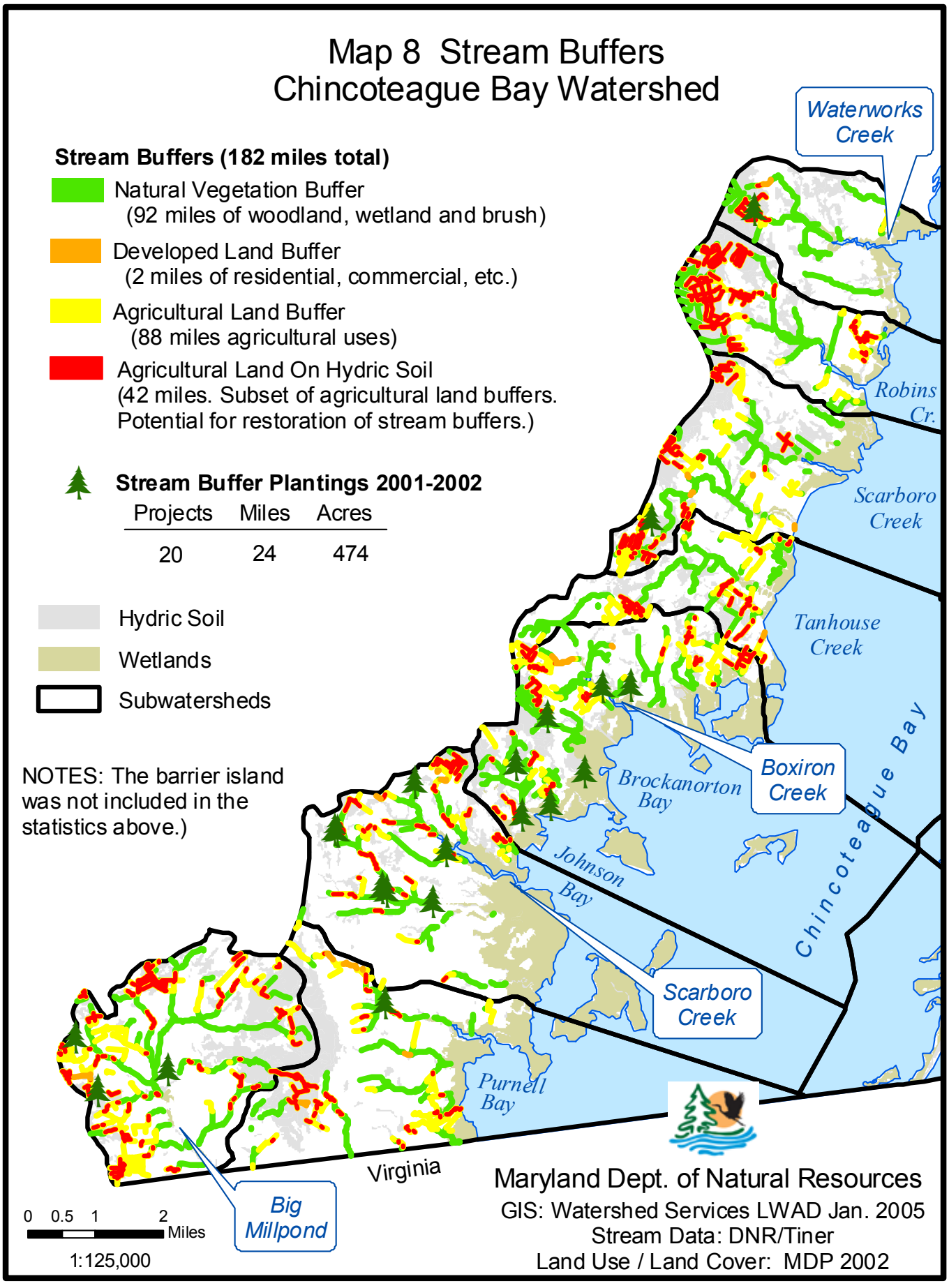
0 1 2 4 Miles

1:175,000

Maryland Dept. of Natural Resources

GIS: Watershed Services LWAD Jan. 2004
Wetlands Data: DNR. Floodplain Data: FEMA

Map 8 Stream Buffers
Chincoteague Bay Watershed



Stream Buffers (182 miles total)

- Natural Vegetation Buffer (92 miles of woodland, wetland and brush)
- Developed Land Buffer (2 miles of residential, commercial, etc.)
- Agricultural Land Buffer (88 miles agricultural uses)
- Agricultural Land On Hydric Soil (42 miles. Subset of agricultural land buffers. Potential for restoration of stream buffers.)

Stream Buffer Plantings 2001-2002

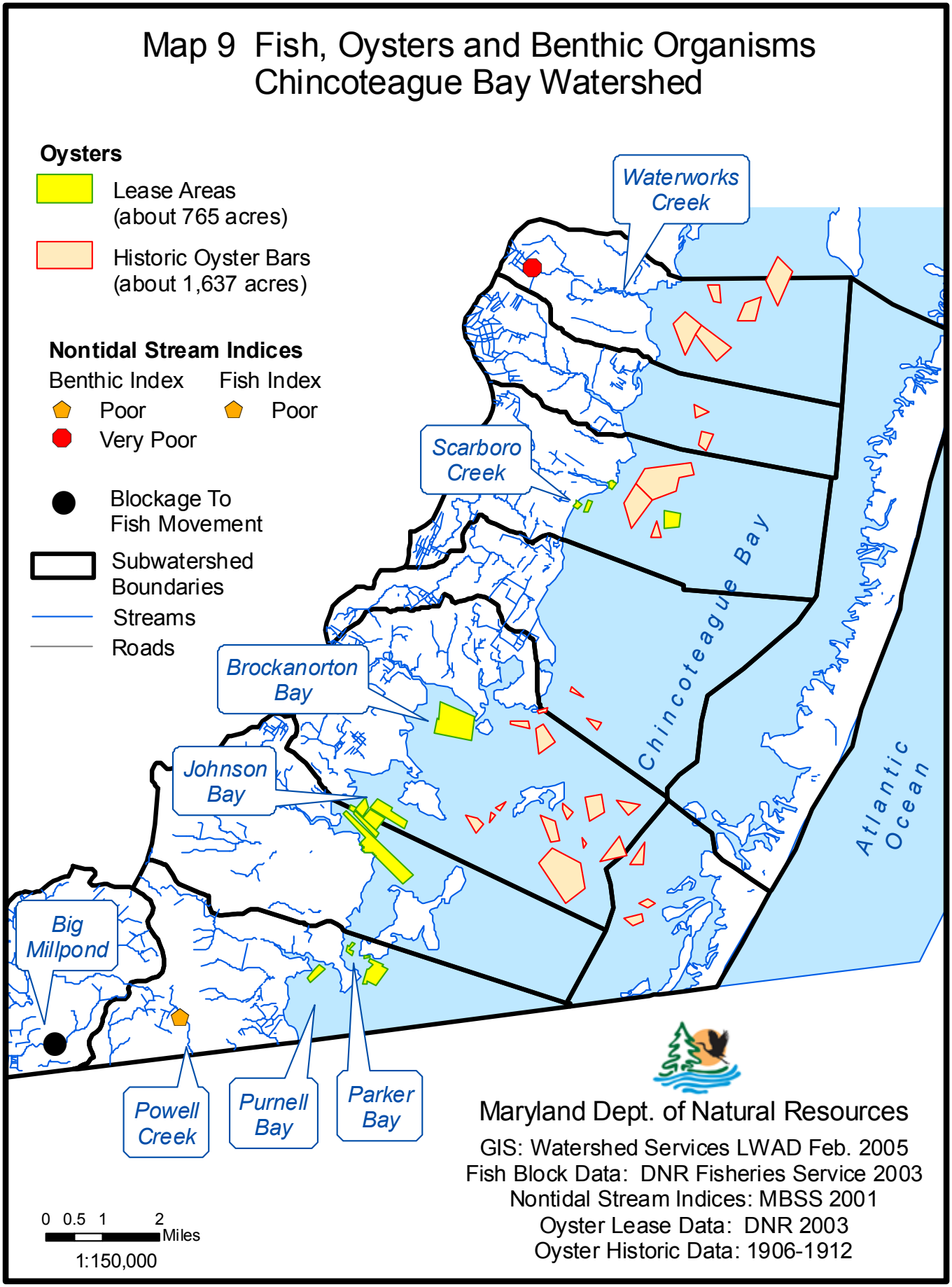
Projects	Miles	Acres
20	24	474

- Hydric Soil
- Wetlands
- Subwatersheds

NOTES: The barrier island was not included in the statistics above.)

Maryland Dept. of Natural Resources
GIS: Watershed Services LWAD Jan. 2005
Stream Data: DNR/Tiner
Land Use / Land Cover: MDP 2002

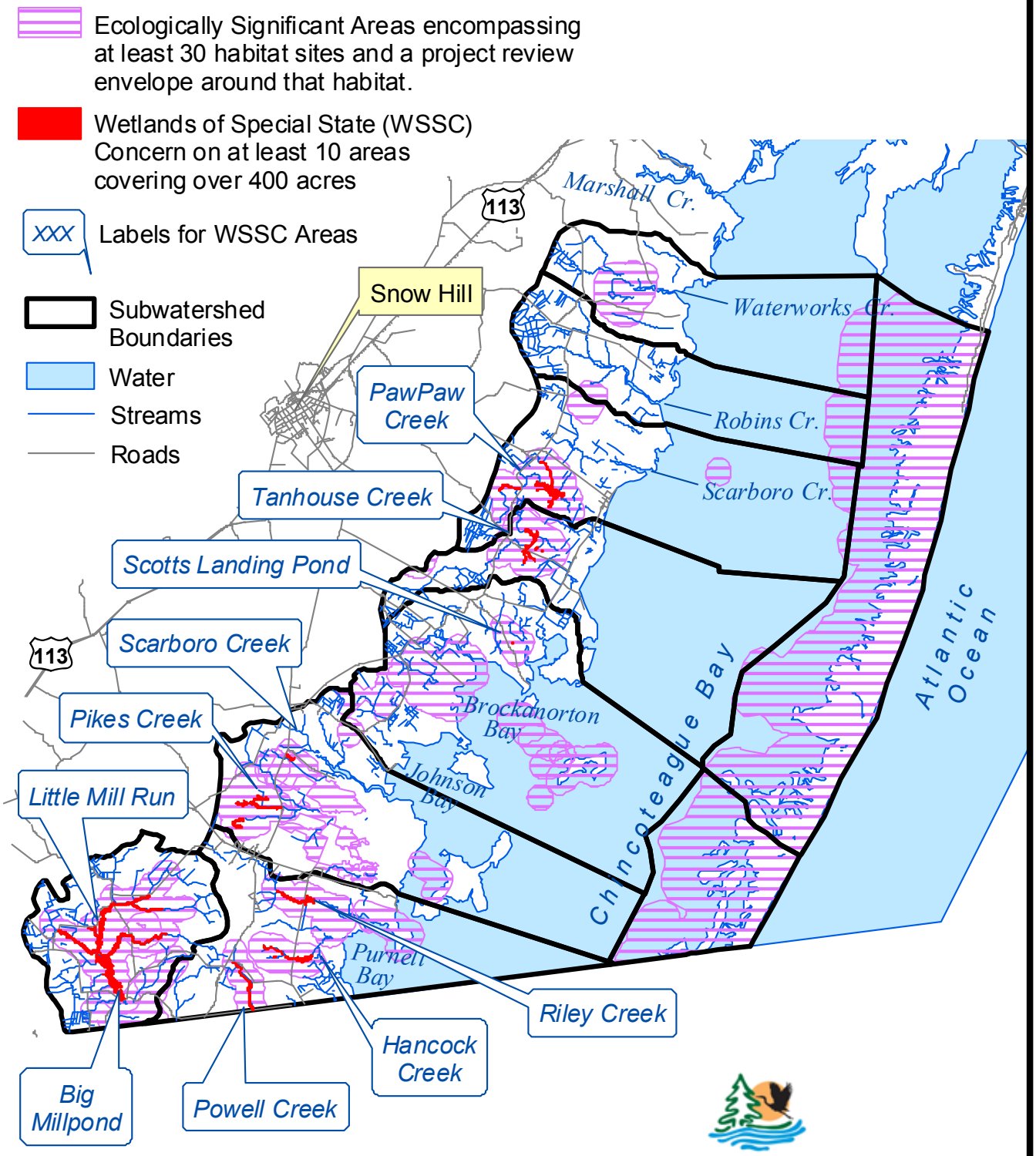
Map 9 Fish, Oysters and Benthic Organisms
Chincoteague Bay Watershed



Maryland Dept. of Natural Resources

GIS: Watershed Services LWAD Feb. 2005
Fish Block Data: DNR Fisheries Service 2003
Nontidal Stream Indices: MBSS 2001
Oyster Lease Data: DNR 2003
Oyster Historic Data: 1906-1912

Map 10 Sensitive Species
Chincoteague Bay Watershed

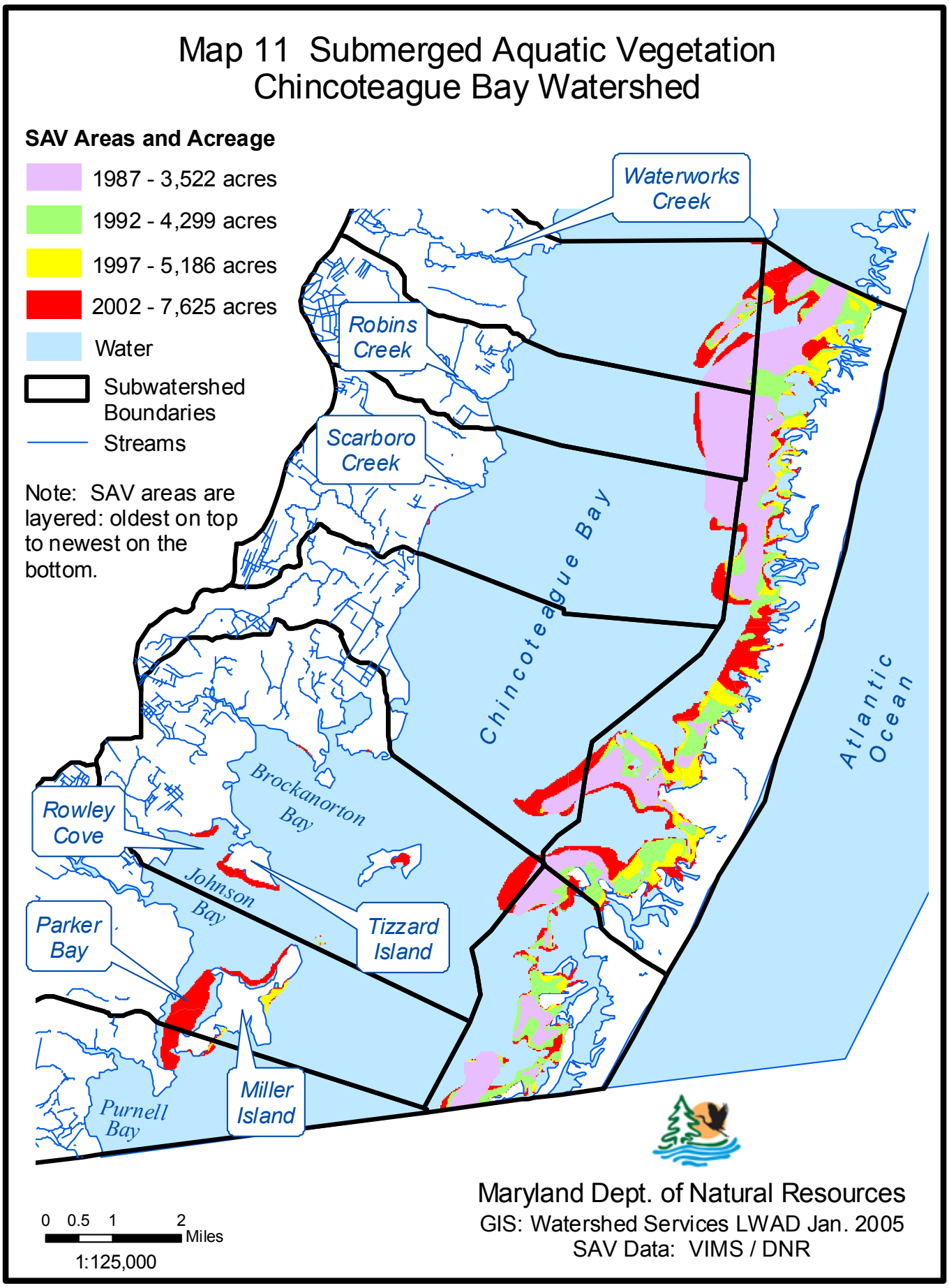


Maryland Dept. of Natural Resources

GIS: Watershed Services LWAD Feb. 2005

Sensitive Species Data: June 2004

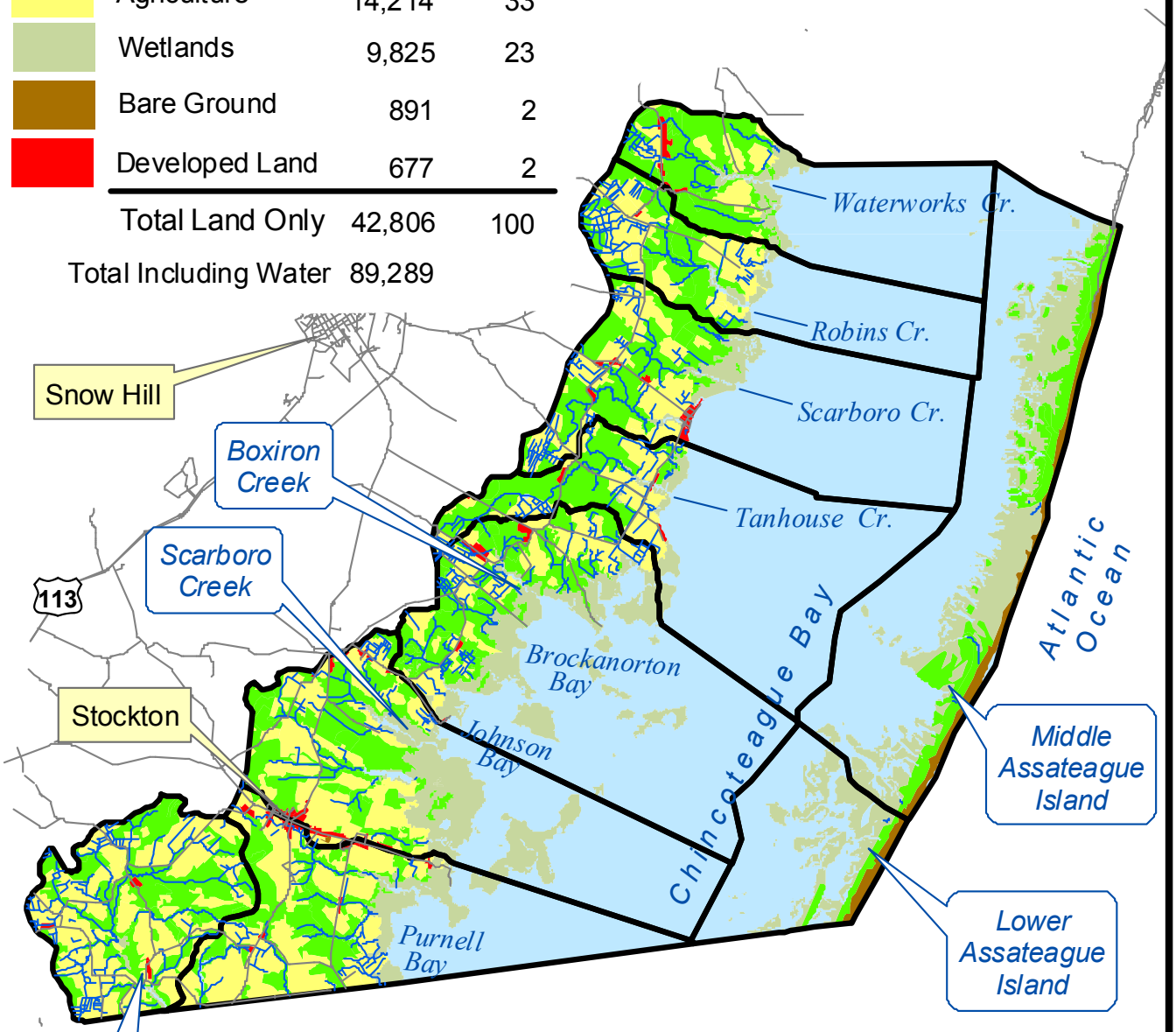
Map 11 Submerged Aquatic Vegetation
Chincoteague Bay Watershed



Maryland Dept. of Natural Resources
GIS: Watershed Services LWAD Jan. 2005
SAV Data: VIMS / DNR

Map 12 Land Use / Land Cover
Chincoteague Bay Watershed

Land Use / Cover	Acres	Percent
Forest & Brush	17,199	40
Agriculture	14,214	33
Wetlands	9,825	23
Bare Ground	891	2
Developed Land	677	2
Total Land Only	42,806	100
Total Including Water	89,289	



0 1 2 4 Miles

1:175,000

Maryland Dept. of Natural Resources
GIS: Watershed Services LWAD Jan. 2005
Data: MDP 2002

Map 13 Protected Land
Chincoteague Bay Watershed

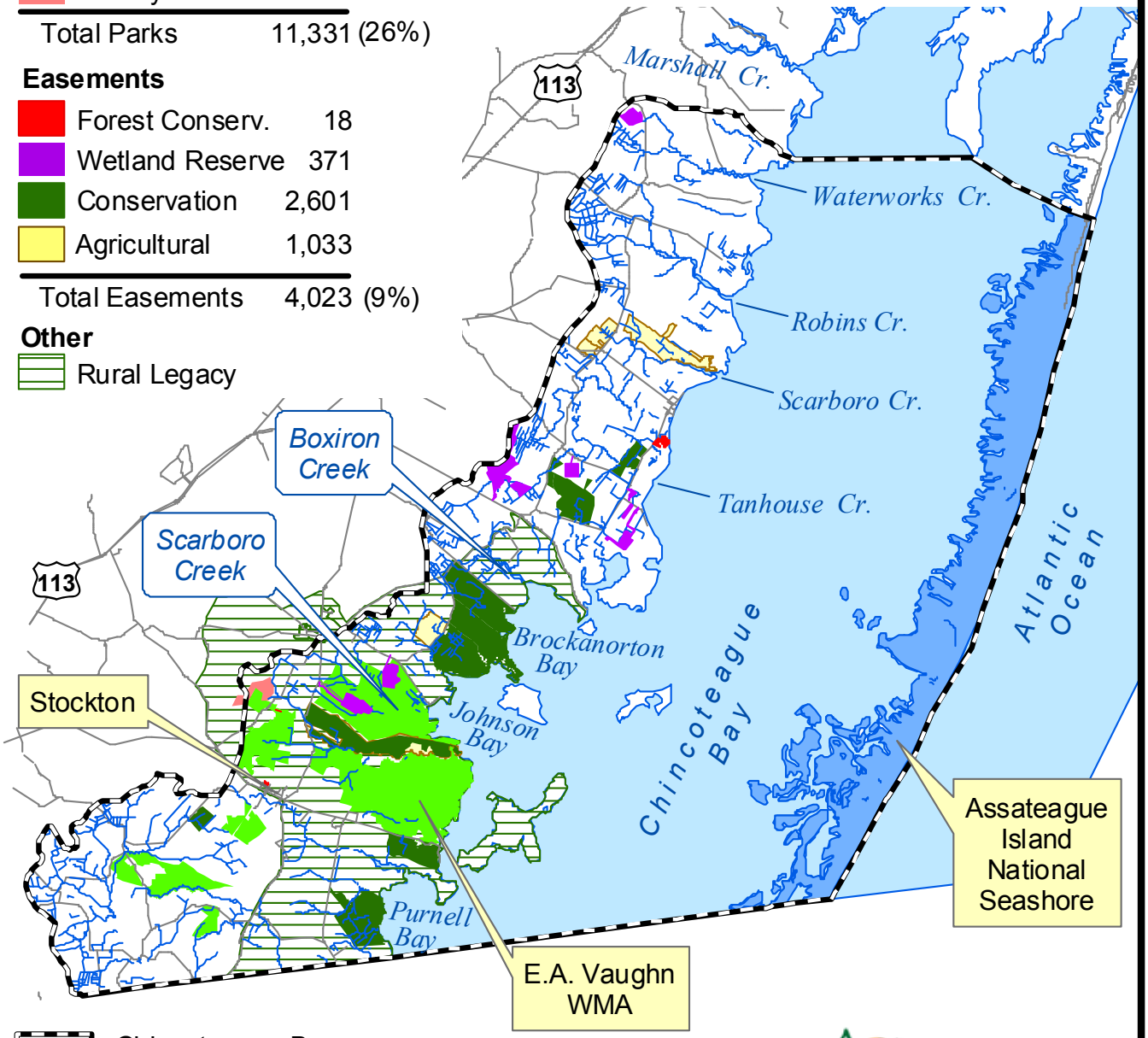
Parks	Acreage
National	7,181
DNR Lands	4,059
County	91
Total Parks	11,331 (26%)

Easements	
Forest Conserv.	18
Wetland Reserve	371
Conservation	2,601
Agricultural	1,033
Total Easements	4,023 (9%)

Other

Rural Legacy

NOTE: Total watershed has 42,806 acres of land. Some acreage has multiple protection. For example, a parcel of land can have more than one easement or a park area can have an easement placed on it.



Chincoteague Bay Watershed

Water

Streams

Roads

0 1 2 4 Miles

1:175,000

Maryland Dept. of Natural Resources

GIS: Watershed Services LWAD Feb. 2005

County Data: 2002 Forest Conservation

2002 Wetland Reserve