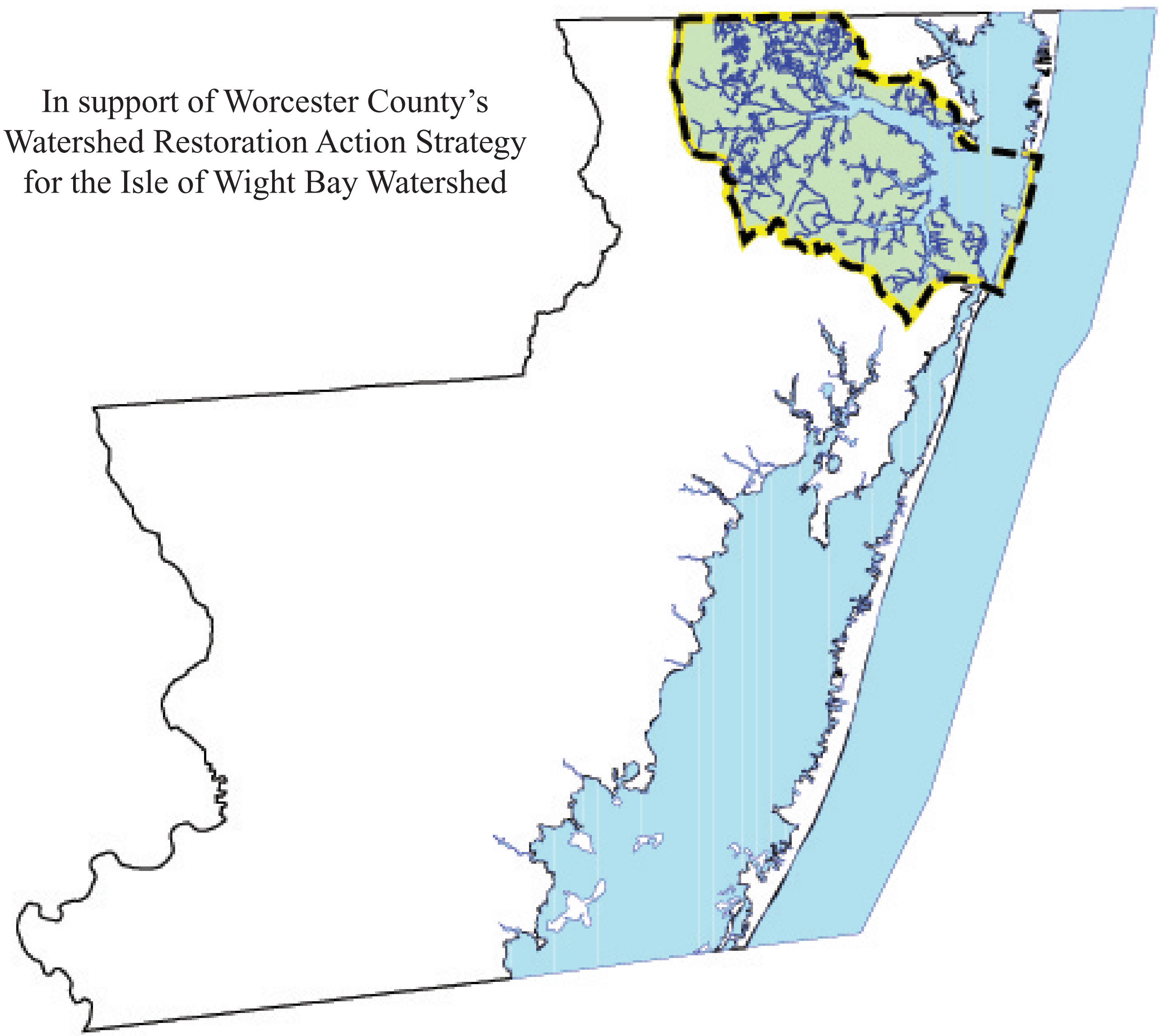
Isle of Wight Bay
Watershed Characterization

July 2001

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



Product of the
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In partnership with Worcester County

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To inspire people to enjoy and live in harmony with their environment, and
to protect what makes Maryland unique – our treasured Chesapeake Bay,
our diverse landscapes, and our living and natural resources.

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* See Abbreviation Key

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For The Isle of Wight Bay Characterization

The Isle of Wight Bay watershed encompasses about 47,400 acres in the Mid-Atlantic coastal plain of Maryland and Delaware. Maryland's area covers about 33,600 acres of land and tidal marsh with 7,500 acres of tidal water. Watershed waterways vary from coastal embayments to sluggish coastal streams fed by extensive ditching through hydric soils that dominate the watershed. Land use varies from rural headwaters dominated by forest, fields of corn and soy beans and chicken farms to suburban areas to the intensive development in Ocean City.

Worcester County, Maryland is receiving Federal grant funding and State technical assistance to prepare a Watershed Restoration Action Strategy (WRAS) for the Isle of Wight Bay watershed.

– The 1998 *Maryland Clean Water Action Plan* identified the Isle of Wight Bay watershed as a Priority Watershed "in need of restoration."
– Worcester County applied for grant funding and volunteered to develop a strategy in the watershed to improve water quality and other natural resources using protection and restoration projects.
– The WRAS project complements the Maryland Coastal Bays Program (MCBP) which is a much more broad and detailed effort to manage Maryland's Coastal Bays.

Water Quality

Isle of Wight Bay waterways are not meeting their designated uses primarily due to nutrient, dissolved oxygen and fecal coliform problems. Available information indicates that nonpoint sources of pollution are generally the origin of these problems.

Tidal waters in the vicinity of current shellfish harvesting closures have experienced water quality problems over about twenty years: St. Martin River and its tributaries, and the area of Herring and Turville Creeks. High nutrient levels are contributing to algae blooms and general algal growth levels that inhibit growth of submerged aquatic vegetation (SAV).

Nontidal tributaries to the St. Martin River exhibited high levels of nutrients arising from nonpoint sources in several subwatersheds in Maryland and Delaware. Low dissolved oxygen levels were found at about half of the sites sampled in June 1999. Buntings Branch exhibited high nutrient concentrations and loads. In Church Creek, high conductance (a measure of electrical resistance) appears to be a point source related problem.

Anticipated efforts during 2001 to estimate nutrient loads associated with shoreline erosion and to determine Total Maximum Daily Loads (TMDL) will likely improve understanding of water quality problems and nonpoint nutrient loads significantly.

Land Use

Land use is an important factor affecting nonpoint source pollution in the Isle of Wight Bay watershed. Within Maryland, agriculture and forest land use categories each covered about 37% of the watershed in 1997. Of the approximately 12,500 acres of agricultural land in the watershed, 94% is used for row crops and 1% is occupied by numerous feeding operations (primarily chicken houses).

Urban land uses covered about 23% of the watershed in 1997. Expansion of urban lands can be anticipated even though only about 20% of the watershed falls within Smart Growth Priority Funding Areas. Worcester County's recent *Worcester 2000* planning effort will be used to assist local growth management through the comprehensive planning process.

About 1% of land in the watershed has some form of protection from conversion to urban land uses via conservation ownership, easement, etc. Natural habitat in the watershed includes several small areas of state-significance that are part of Maryland's Green Infrastructure including the Isle of Wight, the Longridge Swamp vicinity and a portion of Herring Creek's headwaters. Natural areas of local significance include a Wetland of Special State Concern near West Ocean City and a portion of the riparian corridor on Church Creek. The only protected natural habitat area is the Isle of Wight WMA (a State Wildlife Management Area).

Living Resources and Habitat

Tidal waters were found to have healthy fish populations compared to other Lower Eastern Shore waterways assessed. The Isle of Wight Bay monitoring for toxic *Pfiesteria* and the organism that causes Brown Tide did not find harmful conditions between 1998 and 2000.

Assessment of algae populations in the upper tidal reaches of the St. Martin River identified summer dominance by bluegreen algae, which demonstrates the local eutrophication problem. This finding is consistent with eutrophic conditions including high nutrient concentrations. Open waters of the Isle of Wight Bay exhibited the least algae growth as measured by chlorophyll *a*.

In streams, nontidal fish populations are limited to species that are tolerant or moderately tolerant to pollution. Assessment of bottom-dwelling "bugs" living in streams (macroinvertebrate benthic organisms) indicates that overall water quality conditions are poor compared to other watersheds in the State. Macroinvertebrate populations and habitat assessment in St. Martin River tributaries found that healthier communities tended to be in larger streams and that stressed communities tended to be in upper watershed streams having little flow and impaired habitat.

Submerged Aquatic Vegetation (SAV) covers less than 10% of its potential habitat in the Isle of Wight Bay watershed. Algae growth appears to be inhibiting SAV in restricted tidal water areas including the St. Martin River based on interpretation of chlorophyll *a* concentrations. The exception to this finding is the Isle of Wight Bay which exhibited algae growth that should not inhibit SAV.

Restoration Targeting Tools

A stream corridor assessment completed in 1999 identified numerous restoration opportunities including riparian areas with unforested stream buffers, stream bank erosion, etc. Additional stream corridor assessment is scheduled for winter 2000/2001.

Computerized mapping was used to demonstrate techniques and to help target site investigations for potential stream buffer and wetland restoration. Opportunities were also identified to address 12 known fish blockages and to reduce overboard sewage discharge from boats by improving access to marina pumpout facilities.

INTRODUCTION

Watershed Selection

Maryland's Clean Water Action Plan, completed in 1998, identified water bodies that failed to meet water quality requirements and other natural resource goals. As part of the State's response, the Maryland Department of Natural Resources (DNR) is offering funding and technical assistance to Counties willing to work cooperatively to devise and implement a Watershed Restoration Action Strategy (WRAS) for the impaired water bodies.

Worcester County, which is one of five counties participating in the first round of the WRAS program. has selected the Isle of Wight Bay Watershed for restoration and protection.

Location

The majority of the Isle of Wight Bay watershed is in Worcester County, Maryland. This area is the focus of the Watershed Restoration Action Strategy and this Watershed Characterization. Map 2 WRAS Project Area and Map 3 Streams and Sub-Watersheds show the geographic location of the watershed in Maryland and selected features within it. In addition, about 16% of the watershed is in the State of Delaware. Also see the technical supplement Delaware's Bunting Branch Watershed. [32]

Isle of Wight Bay Watershed Acreage Summary

Area	Land	Water	Total
Maryland	33,611	7,509	41,120
Delaware	6,300	0	6,300
Watershed Total	39,911	7,509	47,420

Purpose of the Characterization

One of the earliest steps toward devising a Watershed Restoration Action Strategy is to characterize the watershed using immediately available information. This Watershed Characterization is intended to meet several objectives for this purpose:

– briefly summarize the most important or relevant information and issues
– provide preliminary findings based on this information
– identify sources for more information or analysis
– suggest opportunities for additional characterization and restoration work.

Additional Characterization Recommended

The Watershed Characterization is intended to be a starting point. It is part of a framework for a more thorough assessment involving an array of additional inputs:

- self-investigation by the local entity
- targeted technical assistance by partner agencies or contractors
- input from local stakeholders
- Stream Corridor Assessment, i.e. physically walking the stream and cataloguing issues, which is part of the technical assistance offered by DNR
- Synoptic water quality survey, i.e. a program of water sample analysis, can be used to focus on local issues like nutrient hot spots or point source discharges or other selected issues. This is also part of the technical assistance offered by DNR.

Identifying Gaps In Information

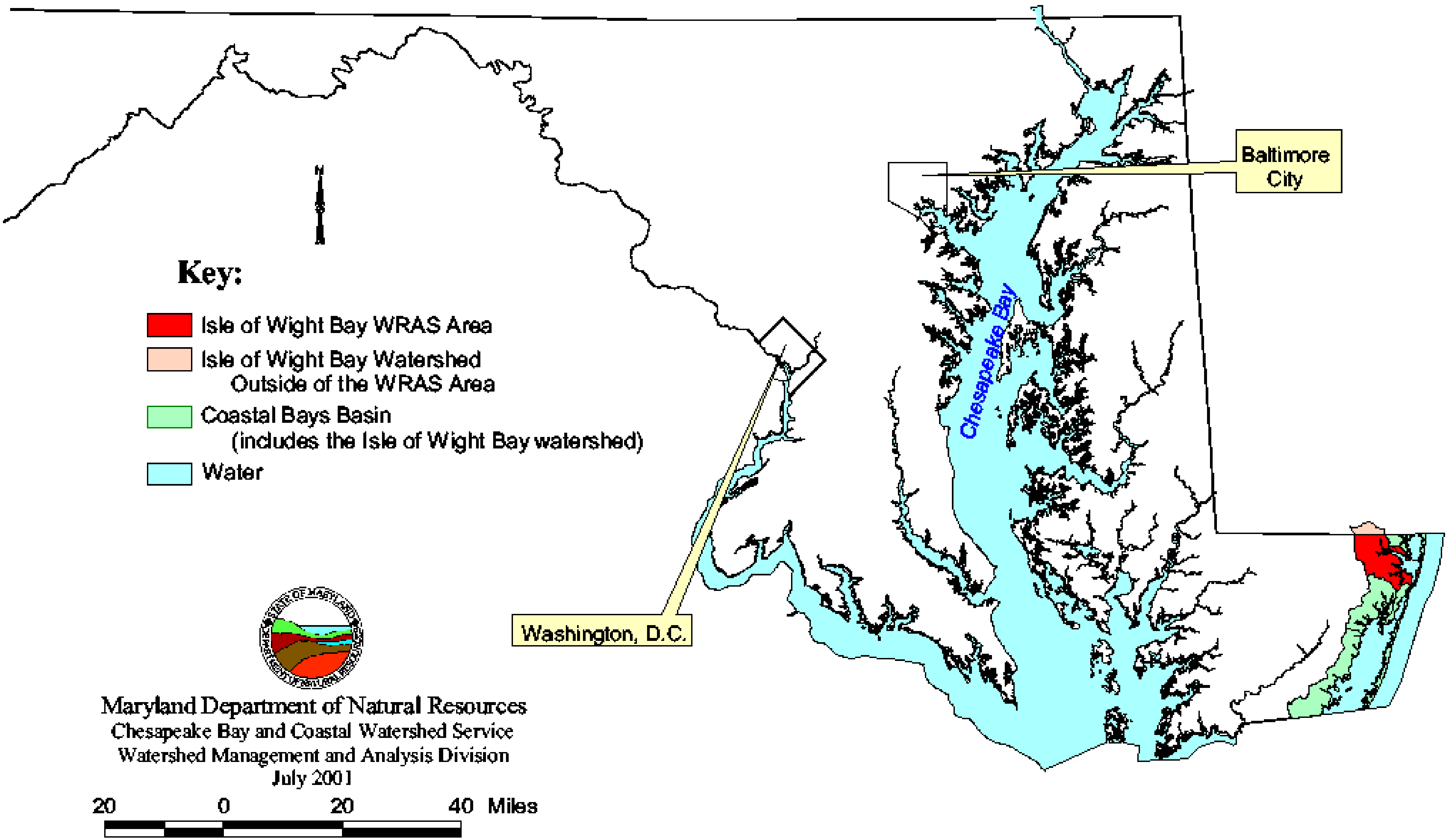
It is important to identify gaps in available watershed knowledge and gauge the importance of these gaps. One method is to review available information in the context of four physical / biological assessment categories that have been successfully applied in other watershed restoration efforts. The main categories that impact aquatic biota are listed here:

- Habitat: physical structure for stream stability and biotic community (including riparian zone)
- Water Quantity: high water - storm flow & 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.

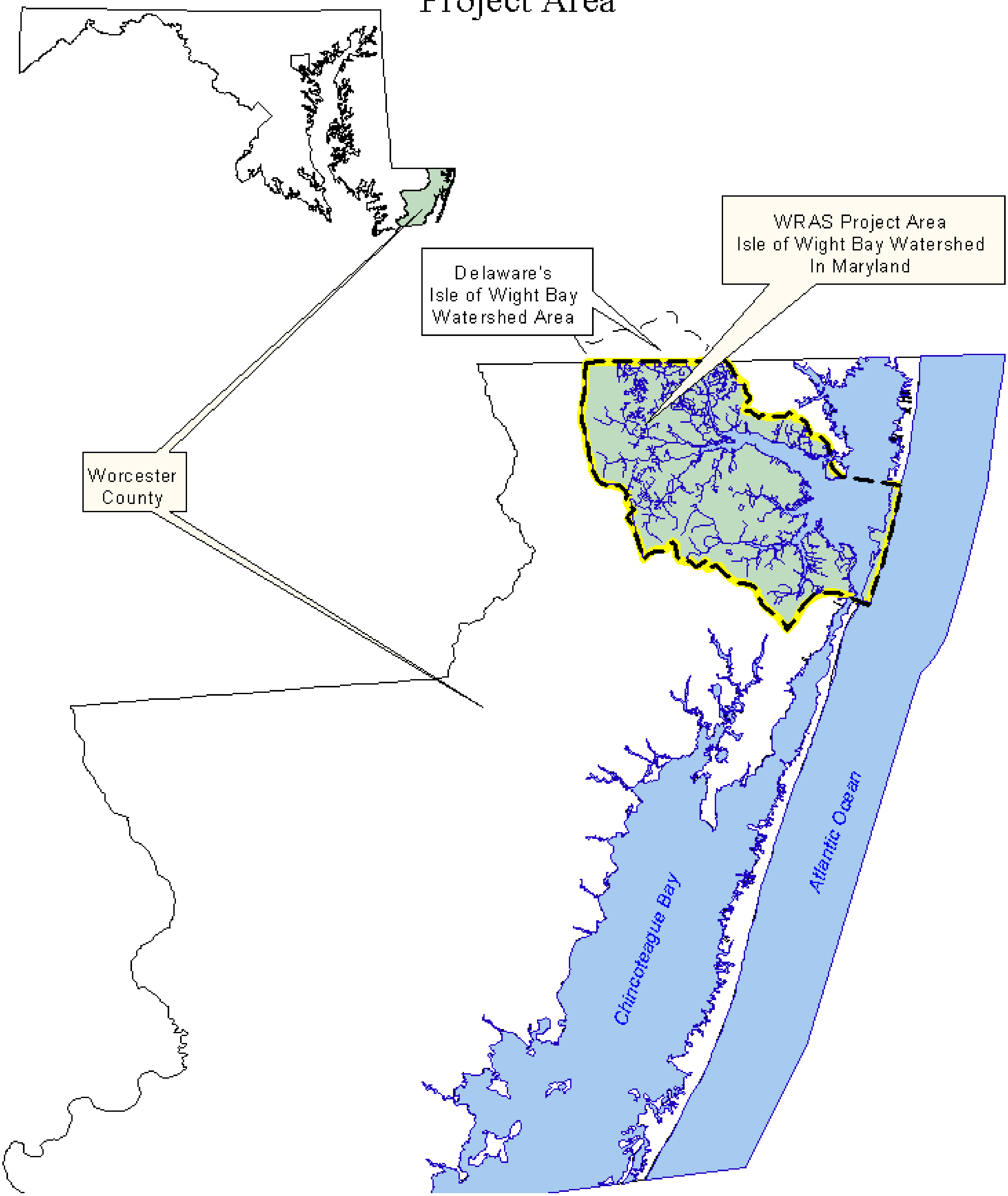
Adaptive Management

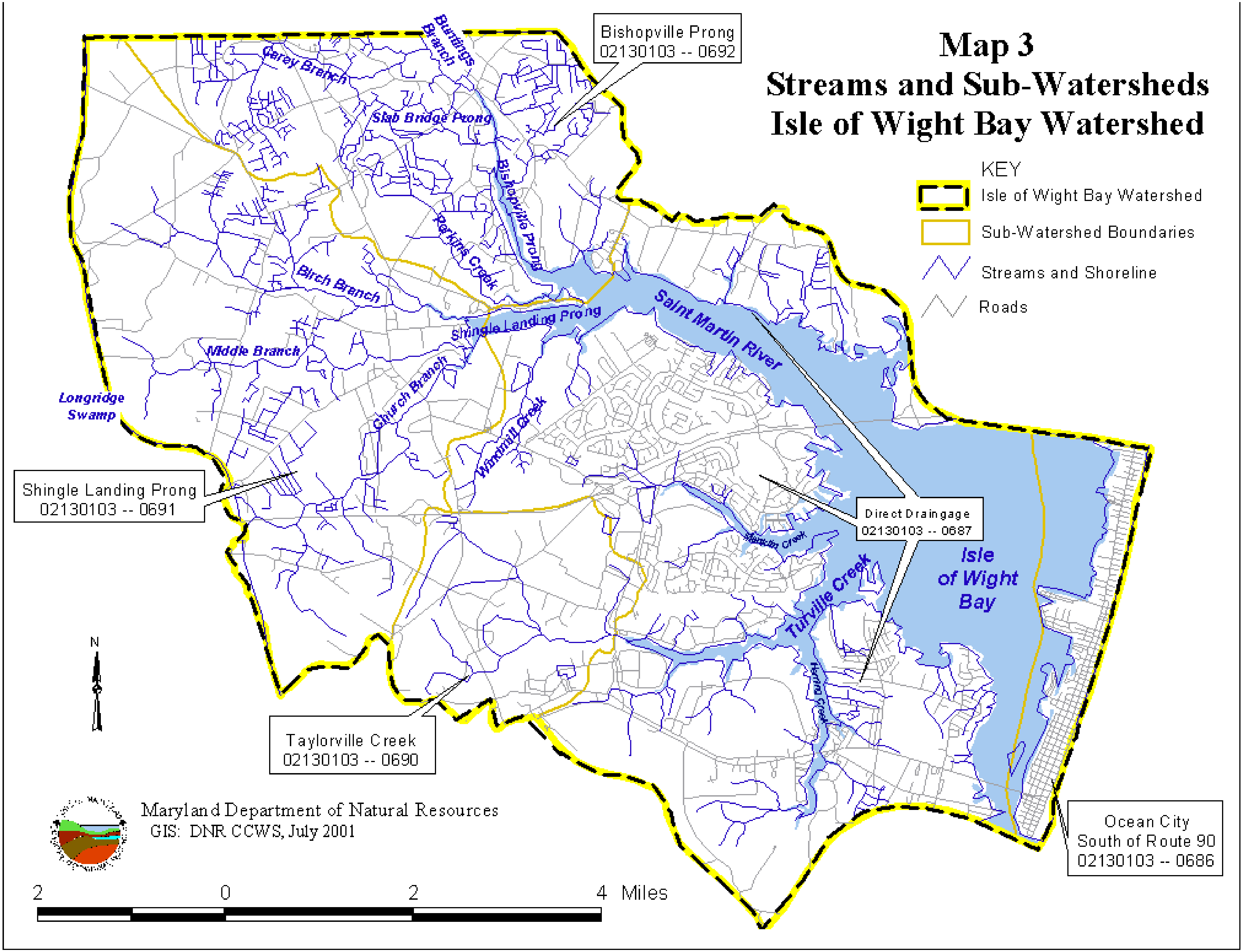
The Watershed Characterization and the Watershed Restoration Action Strategy should be maintained as living documents within an active evolving restoration process. These documents will have to be updated periodically as new, more relevant information becomes available and as the watershed response is monitored and reassessed. This approach to watershed restoration and protection is often referred to as "adaptive management."

Map 1 Regional Context
Isle of Wight Bay in Worcester County
Watershed Restoration Action Strategy (WRAS) Area



Map 2
Isle of Wight Bay Watershed
Watershed Restoration Action Strategy (WRAS)
Project Area





Map 3
Streams and Sub-Watersheds
Isle of Wight Bay Watershed
KEY
Isle of Wight Bay Watershed
Sub-Watershed Boundaries
Streams and Shoreline
Roads
Bishopville Prong
02130103 -- 0692
Shingle Landing Prong
02130103 -- 0691
Direct Draingage
02130103 -- 0687
Taylorville Creek
02130103 -- 0690
Ocean City
South of Route 90
02130103 -- 0686
Carey Branch
Buntings Branch
Slab Bridge Prong
Bishopville Prong
Perkins Creek
Birch Branch
Shingle Landing Prong
Saint Martin River
Middle Branch
Church Branch
Windmill Creek
Longridge Swamp
Manklin Creek
Turville Creek
Herring Creek
Isle of Wight Bay
N
Maryland Department of Natural Resources
GIS: DNR CCWS, July 2001
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4 Miles

WATER QUALITY

Introduction

Reducing or eliminating areas of poor water quality in the Isle of Wight Bay watershed is one of the motivations behind generating a Watershed Restoration Action Strategy. A regulatory definition for poor water quality are waters that fail to meet the Water Quality Criteria Specific to Designated Uses listed in COMAR 26.08.02.03-3. More generally, poor water quality may be considered waters that are unhealthful or objectionable for human use or for supporting desirable aquatic species. Nearly all aquatic life requires certain levels of water quality to survive.

Tracking the current status or changes in water quality can be measured in many ways including changes in water use capabilities, dissolved oxygen concentration, nutrient loads, the presence of selected aquatic species (indicator organisms) and other measurements.

In addition, water quality is intimately related to use of land and water, and the health of living resources and their habitat. Therefore, it is valuable to consider water quality improvement in the context of these relationships and its effects on other factors that determine the quality of life available within the watershed.

Designated Uses

All waters of the State are assigned a "Designated Use" in State regulation, COMAR 26.08.02.08, which is associated with a set of water quality criteria necessary to support that use. A simplified summary of the Designated Uses in the Isle of Wight Bay watershed is listed below. Map 4 Designated Uses shows these areas. [38]

- Use I: for water contact recreation and aquatic life: All waters not designated as Use II
- Use II: for shellfish harvesting – all tidal waters except:
    - – Bishopville Prong and tributaries above confluence with St. Martin River.
    - – Shingle Landing Prong and its tributaries above confluence with St. Martin River at Piney Island.
    - – Herring Creek and its tributaries upstream of Rt. 50.

Notes: The Department of the Environment should be contacted for official regulatory information. Use I criteria apply as minimum standards to all Waters of the State. Criteria for other Designated Use categories add additional restrictions beyond the Use I minimum. Exclusion of tidal waters from shellfish harvesting (Use II) is typically related to monitored levels of fecal coliform bacteria counts in these waters that exceed the State criteria.

Not Supporting Designated Use – 303(d) Listings

Significant portions of the Isle of Wight Bay waters either do not support their designated use or partially do not support their designated use.[2] As required under Section 303(d) of the Federal Clean Water Act, Maryland tracks waterways that did not support their designated use in a prioritized list of "Water Quality Limited Basin Segments" sometimes simply called the 303(d) list. The Isle of Wight Bay watershed is referenced in the list for nutrients, dissolved oxygen, fecal coliform. In the 1996 303(d) list, the Isle of Wight Bay is listed along with the other Maryland Coastal Bays as Priority #13. The problems that led to the 1996 listing were believed to be arising from nonpoint and natural sources. (Also see the section on point sources regarding in-stream conductivity issues.)

The 303(d) priority referenced above is established by the Maryland Department of the Environment. Information considered in setting these priorities include, but is not limited to, severity of the problem and the extent of understanding of problem causes and remedies. These priorities are used to help set State work schedules various programs including total maximum daily loads (TMDLs).

What Are the Effects of Nutrient Over-Enrichment?

National Academy Press, Clean Coastal Waters (2000) [25]

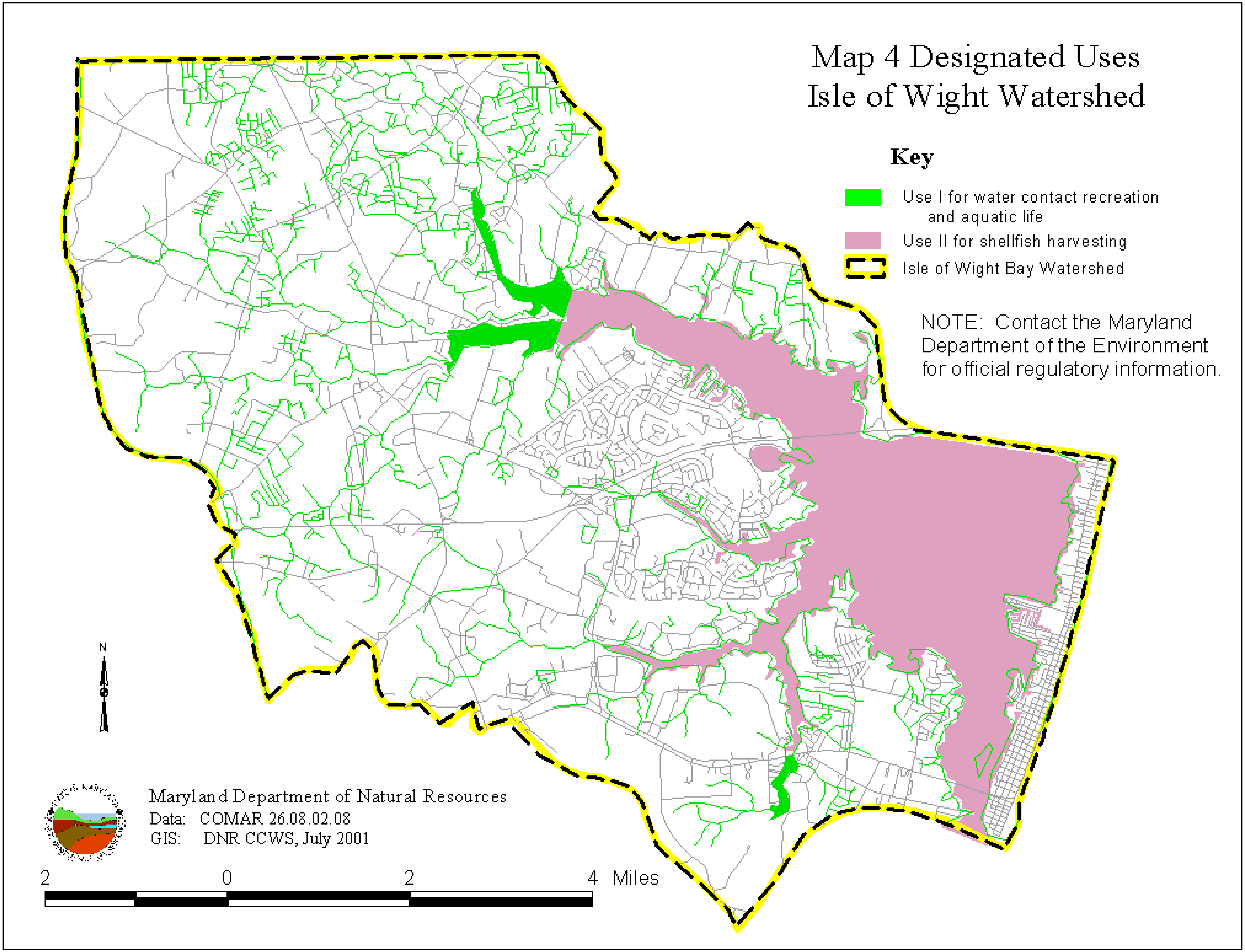
The productivity of many coastal marine systems is limited by nutrient availability, and the input of additional nutrients to these systems **increases primary productivity** [microscopic organisms including algae]. In moderation in some systems, nutrient enrichment can have beneficial impacts such as increasing fish production. However, more generally the consequences of nutrient enrichment for coastal marine ecosystems are detrimental and related to eutrophication.

The increased productivity from eutrophication increases oxygen consumption in the system and can lead to **low-oxygen** (hypoxia) or oxygen-free (anoxic) water bodies. This can lead to fish kills as well as more subtle changes in ecological structure and functioning, such as lowered biotic diversity and lowered recruitment of fish populations.

Eutrophication can also have deleterious consequences on estuaries even when low-oxygen events do not occur. These changes include **loss of biotic diversity**, and changes in the ecological structure of both planktonic and benthic communities, some of which may be deleterious to fisheries. Seagrass beds and coral reefs are particularly vulnerable to damage from eutrophication and nutrient over-enrichment.

Harmful algal blooms (HABs) harm fish, shellfish, and marine mammals and pose a direct public health threat to humans. The factors that cause HABs remain poorly known, and some events are entirely natural. However, nutrient over-enrichment of coastal waters leads to blooms of some organisms that are both longer in duration and of more frequent occurrence.

Although difficult to quantify, the **social and economic consequences** of nutrient over-enrichment include aesthetic, health, and livelihood impacts.


Map 4 Designated Uses
Isle of Wight Watershed
Key
Use I for water contact recreation and aquatic life
Use II for shellfish harvesting
Isle of Wight Bay Watershed
NOTE: Contact the Maryland Department of the Environment for official regulatory information.
N
Maryland Department of Natural Resources
Data: COMAR 26.08.02.08
GIS: DNR CCWS, July 2001
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Water Quality Indicators

The *Maryland Clean Water Action Plan* published in 1998 listed the water quality indicators for the Isle of Wight Bay summarized in the table below.[3] The Isle of Wight Bay is also identified in the Plan as a Category 1 Priority Watershed "in need of restoration during the next two years." Compared to other watersheds in Maryland, this watershed exhibits relatively poor tidal habitat and exhibits tidal eutrophication common among comparable watersheds. For more details on the *Clean Water Action Plan* see www.dnr.state.md.us/cwap/

Water Quality Indicator	Finding	Rank	Bench Mark
State 303(d) Impairment Number	1	Fail	"1" means that restoration is needed. This watershed is included in the 303d list
Tidal Habitat Index	category 1	Fail	138 watersheds in Maryland were ranked on a scale of 1 (worst) to 10 (best). 25% of the watersheds, (34) "failed" to meet standards for this index.
Tidal Eutrophication Index	category 2	Pass	138 watersheds in Maryland were ranked on a scale of 1 (worst) to 10 (best). 75% of the watersheds, (104) "passed" the standards for this index.

See Interpreting Water Quality Indicators for more information.

Interpreting Water Quality Indicators

State 303(d) Impairment Number. This number is used to characterize watersheds relative to regulatory requirements of the Federal Clean Water Act. It is based on numerous water quality-related factors that are tracked by the State of Maryland under these federal requirements.

Tidal Habitat Index. This index uses selected water quality parameters to gauge habitat quality for aquatic life like fish. Category 1 means that the Isle of Wight watershed needs restoration because its tidal habitat ranked in the lowest 25% of the 138 Maryland watersheds that were compared. This finding was developed using data from 1994-1996, measurements of surface chlorophyll *a*, secchi depth and summer (July-September) bottom dissolved oxygen were each ranked on a scale of 1 (most degraded) to 10 (best condition). These individual ranks were combined to create the single index.

Tidal Eutrophication Index. Eutrophication, as used here, refers to relative levels of nutrients and suspended solids in an aquatic system. The Finding of Category 2 means that the Isle of Wight watershed needs action to prevent degradation of current conditions. Using data from 1994-1996, measurements of surface mixed layer total nitrogen, total phosphorus and total suspended solids were each ranked on a scale of 1 (most degraded) to 10 (best condition). These individual ranks were combined to create the single index.

Water Quality Assessment

A systematic and thorough assessment of water quality in the Isle of Wight watershed has not been conducted. However, several recent water quality assessment efforts summarized here are valuable in attempting to gauge conditions in the watershed.

DNR recently reviewed the State's water quality monitoring reports from 1976 through 1999 for the Coastal Bay watersheds. Of the four areas that consistently had water quality problems, two were within the Isle of Wight Bay watershed: [28]

– St. Martin River and its tributaries

– Herring / Turville Creeks area

1. St. Martin River Tributaries

Currently, the entire St. Martin River is closed to shellfish harvesting. [39] This closure is based on periodic monitoring that is consistently finding high fecal coliform bacteria levels.

In 1999, water quality monitoring at 19 sites in the nontidal streams of the St. Martin River watershed identified several issue areas that are also addressed in other sections of the Characterization. The problems identified are related primarily to nonpoint sources. These sites are shown on Map 5 Monitoring Stations: [24]

– SM-1: Unnamed tributary at St. Martin Neck Road (phosphorus and nitrogen concentrations)
– SM-4: Buntings Branch at Delaware Route 54 in Selbyville (nitrogen load)
– SM-13: Birch Branch (nutrient concentrations and loads)
– SM-15: Church Branch at Route 113 (phosphorus and nitrogen loads, conductance)

2. Data Sources

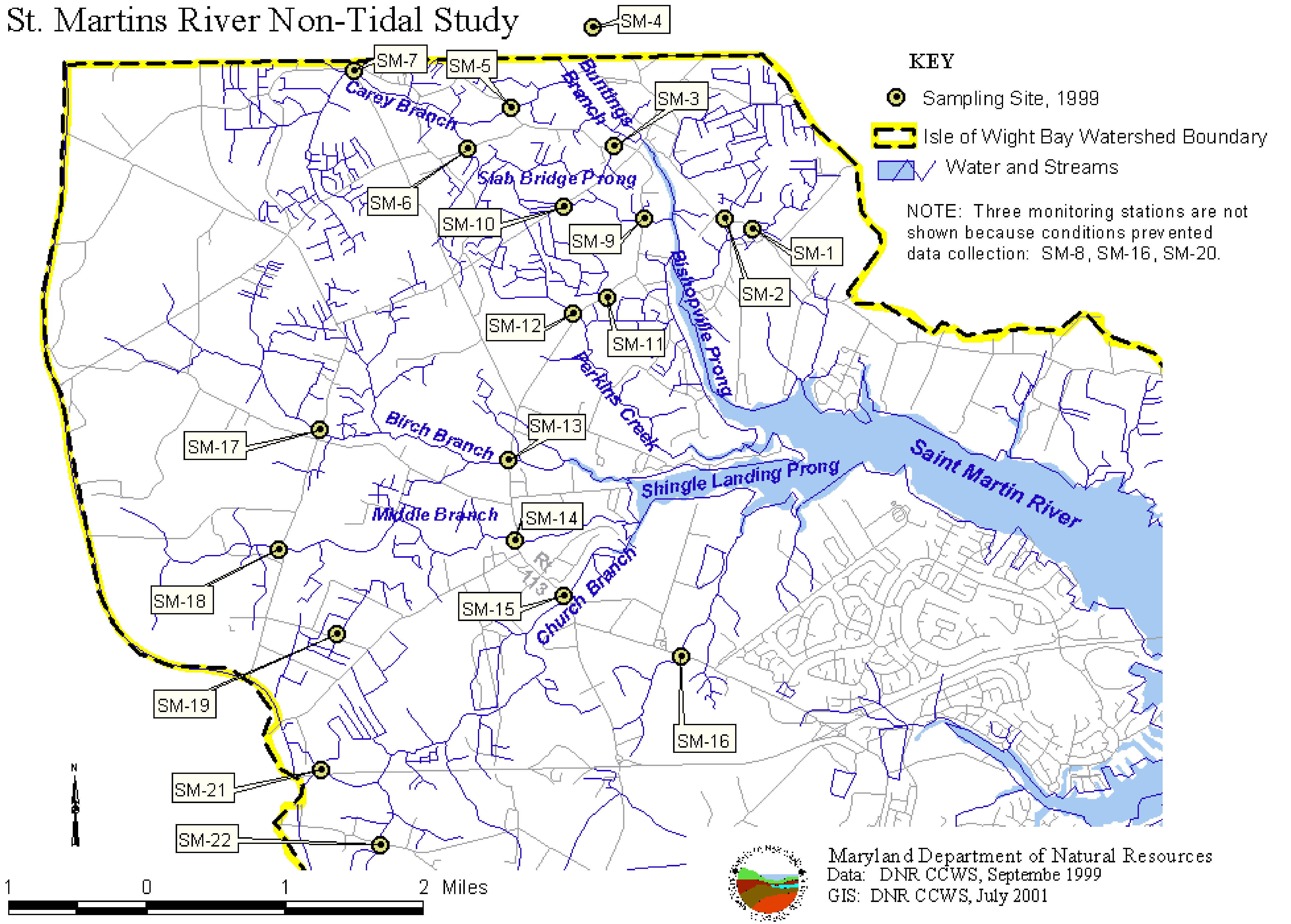
Maryland's Coastal Bays are the focus of numerous programs to monitor water quality. DNR has collected an extensive listing that can serve as a directory of potential information sources. [18] For example in the St. Martin River, in recent years the DNR (RAS MANTA program) has conducted water quality and habitat sampling at 16 sites to identify long term trends and/or to track conditions related to *Pfiesteria*. Much of this and other water quality-related data is available via the Internet. Two recommended Web sites are www.dnr.state.md.us/irc/datasets.html and www.chesapeakebay.net/wquality.htm .

Historical water quality data exist for some tidal areas in the Isle of Wight Bay watershed as listed below: [17]

– 1972 - 1979 St. Martin River Water Quality Survey
– 1983 St. Martin River Survey
– 1992 St. Martin River Survey

Historical water quality data for some free flowing streams in the Isle of Wight Bay watershed is available beginning in the late 1970s. Data are primarily in-stream physical measurements for dissolved oxygen, pH, conductivity and temperature. [36]

Map 5 Monitoring Stations
St. Martins River Non-Tidal Study



3. Total Maximum Daily Loads [17]

Maryland's northern coastal bays, including the Isle of Wight Bay, have significant nutrient loads that contribute to these areas not meeting water quality standards. As a step toward controlling nutrients loads to these waters, the Maryland Department of the Environment (MDE) is developing Total Maximum Daily Loads (TMDL). A draft TMDL for the Northern Coastal Bays including the Isle of Wight Bay and the Assawoman Bay, is anticipated to be available in late 2001. Information on the TMDL program and schedule is available at www.mde.state.md.us/tmdl/ .

Point Sources

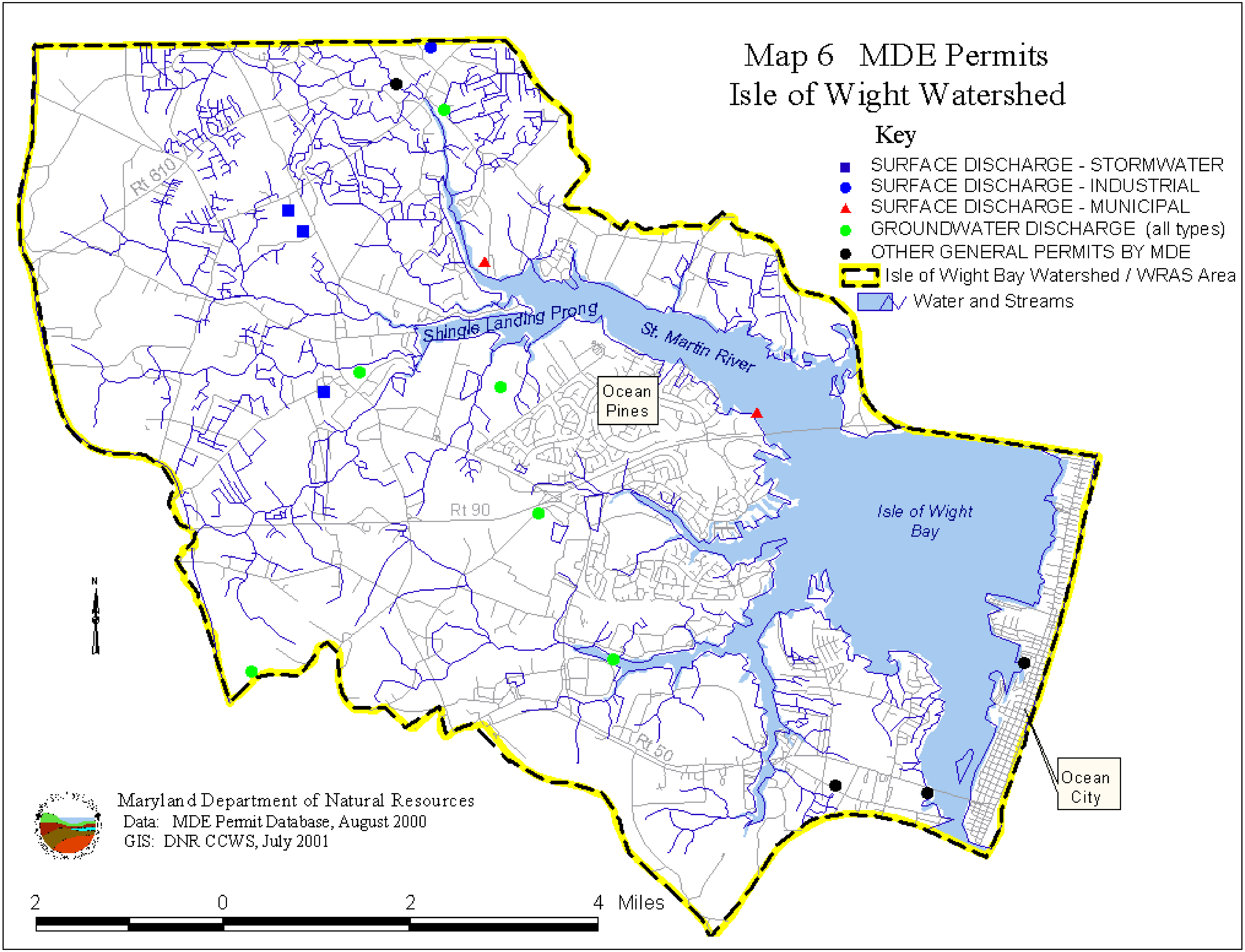
Discharges from discrete conveyances like pipes are called "point sources." Point sources may contribute pollution to surface water or to groundwater. For example, waste water treatment discharges may contribute nutrients or Biological Oxygen Demand (BOD) that reduce oxygen available for aquatic life. Stormwater discharges may contribute excessive flow of water and/or seasonally high temperatures. Industrial point sources may contribute other forms of pollution. Some understanding of point source discharges in a watershed targeted for restoration is useful in helping to prioritize potential restoration projects.

According to the Maryland Department of the Environment (MDE) permit data base summarized in following table and Map 6 MDE Permits, there are four permitted surface water discharges and seven permitted groundwater discharges in the Isle of Wight Bay watershed. Characteristics of these discharges (volume, temperature, pollutants, etc.) are tracked by MDE through the permit system. Most of this information is public and can be obtained from MDE.

Compliance information for point sources in the Isle of Wight Bay watershed has not been assembled for the Watershed Characterization. However, DNR information suggests that two point source discharges are causing water quality impacts:

- The 1999 synoptic water quality survey of St. Martin River tributaries by DNR identified extremely high conductance in Church Branch at Route 113. (Conductance is a measure of resistance to electrical flow.) Previous monitoring in this stream indicates that this is an on-going issue. Because nonpoint sources generally do not create high conductance in streams, this finding suggests that a point source discharge problem is affecting the stream. [24]
- Anecdotal information indicates that, although the Selbyville Waste Water Treatment Plant now discharges to the Atlantic Ocean, overflows and other types of discharges have reached Maryland waters generating local complaints. [36]

Water quality problems associated with point sources will be addressed in detail in the soon to be released Total Maximum Daily Load (TMDL). Currently, no information is available suggesting that point sources are associated with nutrients, dissolved oxygen or fecal coliforms problems in the Isle of Wight Bay watershed.


Map 6 MDE Permits
Isle of Wight Watershed
Key
SURFACE DISCHARGE - STORMWATER
SURFACE DISCHARGE - INDUSTRIAL
SURFACE DISCHARGE - MUNICIPAL
GROUNDWATER DISCHARGE (all types)
OTHER GENERAL PERMITS BY MDE
Isle of Wight Bay Watershed / WRAS Area
Water and Streams
Rt 610
Shingle Landing Prong
St. Martin River
Ocean Pines
Rt 90
Isle of Wight Bay
Rt 50
Ocean City
N
Maryland Department of Natural Resources
Data: MDE Permit Database, August 2000
GIS: DNR CCWS, July 2001
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4 Miles

Point Source Summary – Isle of Wight Bay Watershed (8/2000 data)			
Discharge Type / MDE Permit Category	**Facility Name**	**NPDES Permit / MD Code**	**Receiving Stream / Location**
Surface Water / Waste Water Treatment Plant (WWTP)	Ocean Pines (County Operated)	MD0023477 91DP0708	St. Martin River (ADC 4H11)
	Riverview Mobile Homes (private)	MD0066362 92DP2982	Bishopville Prong (ADC 3K5)
Surface Water / Industrial	Perdue Farms, Inc. Showell Processing Plant	MD0000965 95DP0051A	Unnamed tributary of Church Branch / Shingle Landing Prong (ADC 3E12)
	Perdue Farms, Inc. Bishopville Hatchery	MD0050849 92DP0814	Unnamed tributary of Buntings Branch (ADC 3H1)
Groundwater / Waste Water Treatment Plant (WWTP)	Beach Club Golf Links	95DP3167	ADC 7D5
	Lighthouse Sound	95DP3155C	N/A (ADC ___)
	Riddle Farm	96DP2710A	ADC 8C9
	River Run	99DP2394	ADC 4A10
Groundwater / Industrial	Perdue Farms, Inc. Showell Hatchery	93DP2555	N/A (ADC 3D9)
	Kary Asphalt, Inc.	97DP2881	N/A (ADC 3J4)
	Shuler's Car Wash	99DP3290	ADC 7K3
General Industrial Stormwater Permit	Gumm Pit	97SW0929	inactive borrow pit
	Kary Asphalt, Inc.	97SW0836	(see above)
	Perdue Farms, Inc.	97SW0732	Showell Processing Plant (see above)
	Perdue Farms, Inc.	97SW0733	Bishopville Hatchery (see above)

Several categories of MDE permits and/or point source discharges located in the Isle of Wight Bay watershed are not listed in the point source table.

– Four General Permits (marinas, etc.)

– Point sources in the watershed that have outfalls located in the Atlantic Ocean are not listed. This includes the Ocean City Wastewater Treatment Plant and three point sources located in Delaware (Mt. Aire WWTP, Selbyville WWTP, and South Coastal WWTP.)

– Delaware point sources in general are not in the table. Of these, only one has its outfall located in the Isle of Wight Bay watershed – Mt. Aire Stormwater discharge. This discharge will be addressed in the TMDL.

Nonpoint Sources

Nonpoint sources of nutrients are generally believed to be significant contributors to ambient water quality problems in the Isle of Wight Bay based on various assessments. Some sources have reported that Nonpoint Sources (NPS) account for over 90% of the nutrients entering Maryland's Coastal Bays.

1. St. Martin River Watershed Assessment

In 1999, water quality samples where collected in tributaries to the St. Martin River during the period March 3 through September 2.[24] For the 19 subwatersheds sampled, water quality problems associated primarily with nonpoint sources were identified for nutrients and dissolved oxygen:

– In June, dissolved oxygen concentrations failed to meet the Class I water quality standard of 5.0 mg/l in eight sampling sites, seven sites met the standard and four sites had no water. Samples taken in April were significantly better with 18 sites above the standard and one site below the standard.

– On a per acre basis, total nitrogen loads were highest in the upper Buntings Branch watershed including Delaware drainage. In this area, the highest total nitrogen and total phosphorus concentrations tended to be in Spring. This finding is consistent with nonpoint nutrient sources during the typical high flows of the season.

– Four sampling sites list below were identified as having the high nutrient concentrations (ranked highest to lowest concentration.) The report noted that the concentrations measured where high enough to have water quality impacts but were also similar to those found in other agricultural watersheds on the Eastern Shore:
  - SM-1: Unnamed tributary at St. Martin Neck Road was the highest
  - SM-4: Buntings Branch at Delaware Route 54 at Selbyville
  - SM-15: Church Branch at Route 113
  - SM-13: Birch Branch at Route 113 and at Campbelltown Road.

2. Stream Bank Erosion

Anecdotal information on loss of navigability in the protected waters of the Isle of Wight Bay watershed suggests that sedimentation from upland sources has been significant. [11] Extensive areas of the watershed are drained by ditches which may tend to enhance transport of sediment. However, estimates of pollutant loads contributed by stream bank erosion have not been generated.

In the 1999 assessment of streams in the St. Martin River watershed, five areas of stream bank erosion were identified totaling about 550 feet in length. [23]

3. Shoreline Erosion

Erosion of shorelines can contribute significantly to nonpoint source pollution in tidal waters in the form of nutrients (mostly phosphorus) and sediment (particles that cause water column turbidity and habitat loss.) Wherever land and open water meet, change in the form of erosion or accretion of land is typically the inevitable result of natural processes. Human activity in these areas either tends to inadvertently accentuate these natural processes or purposefully attempts to control movement of water and/or loss of land.

Estimates of shoreline erosion for Maryland's Lower Eastern Shore indicate that more than 25% of Worcester County's shorelines are eroding.[8] For the Isle of Wight Bay watershed, the Maryland Geological Survey (MGS) calculated the average rate of shoreline change: [9]

– 159 acres of land lost for the period 1850 to 1989, or;
– On average, one (1) acre of land lost per year for that 139 year period.

Maps of historic shoreline change were produced in 1999 by the MGS in a cooperative effort between DNR Coastal Zone Management and the National Oceanic and Atmospheric Administration (NOAA). In the Isle of Wight Bay, the maps include digitized shorelines for the years 1850, 1942, 1961, and 1989. The maps show that extensive changes have occurred adjacent to all large bodies of open water including the Isle of Wight Bay and the St. Martin River. They also indicate that erosion rates are much less adjacent to smaller water bodies. Copies of these 1:24000 scale maps are available from the MGS.

Future shoreline change may accelerate due to change in sea level. Sea level in the Maryland Coastal Bay area is projected to rise about 0.5 feet by the year 2020. [10] Projections suggest that land adjacent to large bodies of water will erode significantly in coming decades.

4. Nutrient Loads from Shoreline Erosion to be Estimated

An assessment of nutrient loading from shoreline erosion in Maryland's Coastal Bays is projected for completion by October 2001. This project is a cooperative study by the MGS and the University of Maryland, Horn Point Laboratory under a Coastal Zone Management grant. Products from the study will include several categories of data: [35]

– Volumes of eroding sediments by sediment type
– Loadings from various types of shorelines (based on erosion rates, geology, geomorphology, etc.) for nutrients (carbon, nitrogen, and phosphorus) and metals (cadmium, chromium, copper, iron, manganese, nickel, lead and zinc)
– Biotic nutrient loadings from several marsh types based on vegetation (plant assemblages)

5. Stormwater

It is probable that local areas in the Isle of Wight Bay watershed are affected by stormwater runoff. Typical affects of inadequately controlled or managed stormwater discharges include high intensity flows, erosion, sedimentation, stream bank erosion and related problems.

Very little information is available to characterize the relative importance of this nonpoint source issue for the Isle of Wight Bay watershed. For example, is it known that all stormwater runoff from Ocean City, Ocean Pines and other developed areas of the watershed are directed to the Isle of Wight Bay. However, as the point source discussion indicates, stormwater permits have been issued to four industrial facilities but no other stormwater permits have been issued as of August 2000. No other information is available.

LAND USE
In The Isle of Wight Bay Watershed

Of the nearly 40,000 acres of land in the Isle of Wight Bay watershed, about 84% is in Maryland and about 16% is in Delaware. Overall, Maryland's portion of the watershed is more urban and projected urban growth is anticipated to be concentrated in Maryland. The watershed characterization presented here concentrates on the Maryland portion of the watershed. Also see the technical report Delaware's Bunting Branch Watershed. [32]

Land Use in the Isle of Wight Bay Watershed [40]				
Category	**Delaware**		**Maryland**	
	Acres	Percent	Acres	Percent
Agriculture	not reported	46	12,463	37
Forest	not reported	41	12,310	37
Urban	not reported	9	7,830	23
Other	not reported	4	1,008	3
Total By State	6,300	100	33,611	100
Total for Watershed: 39,911 acres				

Landscape Indicators

Water quality, particularly in streams and rivers, is affected by the land in the riparian area and throughout the watershed. In an effort to gauge the affects of land use on water quality, and to allow comparison between watersheds, DNR has developed a series of Landscape Indicators. These indicators can be used to portray landscape conditions at a watershed scale that tend to support good water quality or that tend to degrade water quality.

The *Maryland Clean Water Action Plan* published in 1998 listed landscape indicators for the Isle of Wight Bay as summarized in the table below.[3] Most indicator ranking (pass / fail) is a relative measure that compares the Isle of Wight Bay watershed with the other 137 watersheds of similar size that covers the entire State of Maryland.

Landscape Indicator	**Finding**	**Rank**	**Bench Mark**
Impervious Surface	6.9 % of watershed is impervious	Pass	Of 138 watersheds in Maryland, this one is among the lower 75%
Population Density	0.11 people per acre	Pass	Of 138 watersheds in Maryland, this one is among the lower 75%
Historic Wetland Loss Density	16129 acres	Fail	Of 138 watersheds in Maryland, this one is among the highest 25%
Unforested Stream Buffer	44 percent	Pass	Of 138 watersheds in Maryland, this one is among the lower 75%
Soil Erodibility	0.23 value per acre	Pass	Of 138 watersheds in Maryland, this one is among the lower 75%. (Soil erodibility is a natural condition, see not below.)

See Interpreting Landscape Indicators for more information.

NOTE: The soil erodibility indicator accounts for natural soil conditions but not for management of the land. The naturally erodible soils of the Isle of Wight Bay watershed are addressed by techniques called Best Management Practices (BMPs) to prevent soil loss that are typically in use on local farms. BMPs like no-till, reduced till, cover crops, field strips, and others significantly reduce erosion and sediment movement. These BMPs can be seen in use in many places in the watershed.

Interpreting Landscape Indicators Page 1 of 2

Impervious Surface. Reduction of impervious area can be a valuable component of a successful Watershed Restoration Action Strategy (WRAS). Roads, parking areas, roofs and other human constructions are collectively called impervious surface. Impervious surface blocks the natural movement of rain into the ground. Unlike many natural surfaces, impervious surface typically concentrates stormwater runoff, accelerates flow rate and directs flow to the nearest stream. Side-effects of impervious surfaces become increasingly significant as the percentage of impervious area increases. Examples include reduction of groundwater infiltration, soil and stream bank erosion, sedimentation, destabilization or loss of aquatic habitat, and “flashy” stream flows (reduced flow between storms and excessive flows associated with storms).

Population Density. While changing population density may be beyond the scope of a WRAS, directing growth is a potential WRAS component. Humans are usually very successful in competing for use of land and water. As human population increases, effects of human activity tend to degrade water quality and to displace or eliminate natural habitat. Watersheds with higher populations, assuming other factors are equal, tend to exhibit greater impacts on waterways and habitat. However, growth can be directed in ways to reduce negative impacts.

Historic Wetland Loss Density. About 39% of the Isle of Wight Bay watershed is hydric soil (about 16,000 out of 41,000 acres). The historic wetland loss estimate is based on the assumption that the hydric soils were all, at one time, wetlands. Thoughtful, selective restoration of historic wetland areas can be an effective WRAS component. In most of Maryland’s watersheds, extensive wetland areas have been converted to other uses by draining and filling. This conversion unavoidably reduces or eliminates the natural functions that wetlands provide. These functions include habitat and nursery areas for many aquatic organisms, buffering floods, and uptake and redistribution of nutrients. In general, watersheds exhibiting greater wetland loss tend to also exhibit greater loss of the beneficial functions that wetlands provide. Strategic replacement of wetlands can significantly improve natural function in local watershed areas.

Interpreting Landscape Indicators Page 2 of 2

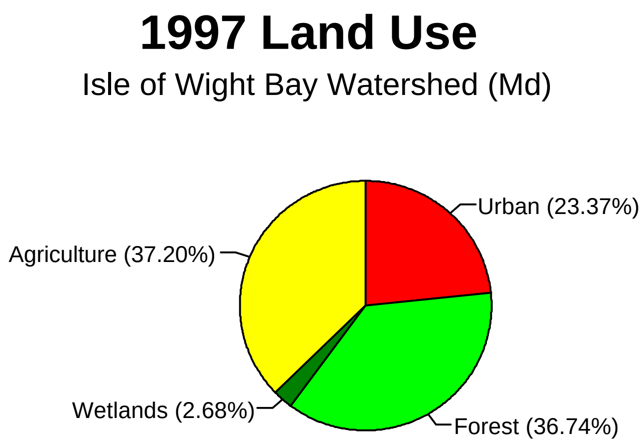
Unforested Stream Buffers. The finding listed in the table means that 44% of the "blue line" streams (excluding shoreline) in the watershed do not have sufficient stream buffers to promote high quality stream habitat. DNR recommends that forested buffer 100 feet wide , i.e. natural vegetation 50 feet wide on either side of the stream, is typically necessary to promote high quality aquatic habitat and diverse aquatic populations. Restoration of natural vegetation adjacent to streams can be a valuable and relatively inexpensive WRAS element. In most of Maryland, trees are key to healthy natural streams. They provide numerous essential habitat functions: shade to keep water temperatures down in warm months, leaf litter "food" for aquatic organisms, roots to stabilize stream banks, vegetative cover for wildlife, etc. In general, reduction or loss of riparian trees / stream buffers degrades stream habitat while replacement of trees / natural buffers enhance stream habitat.

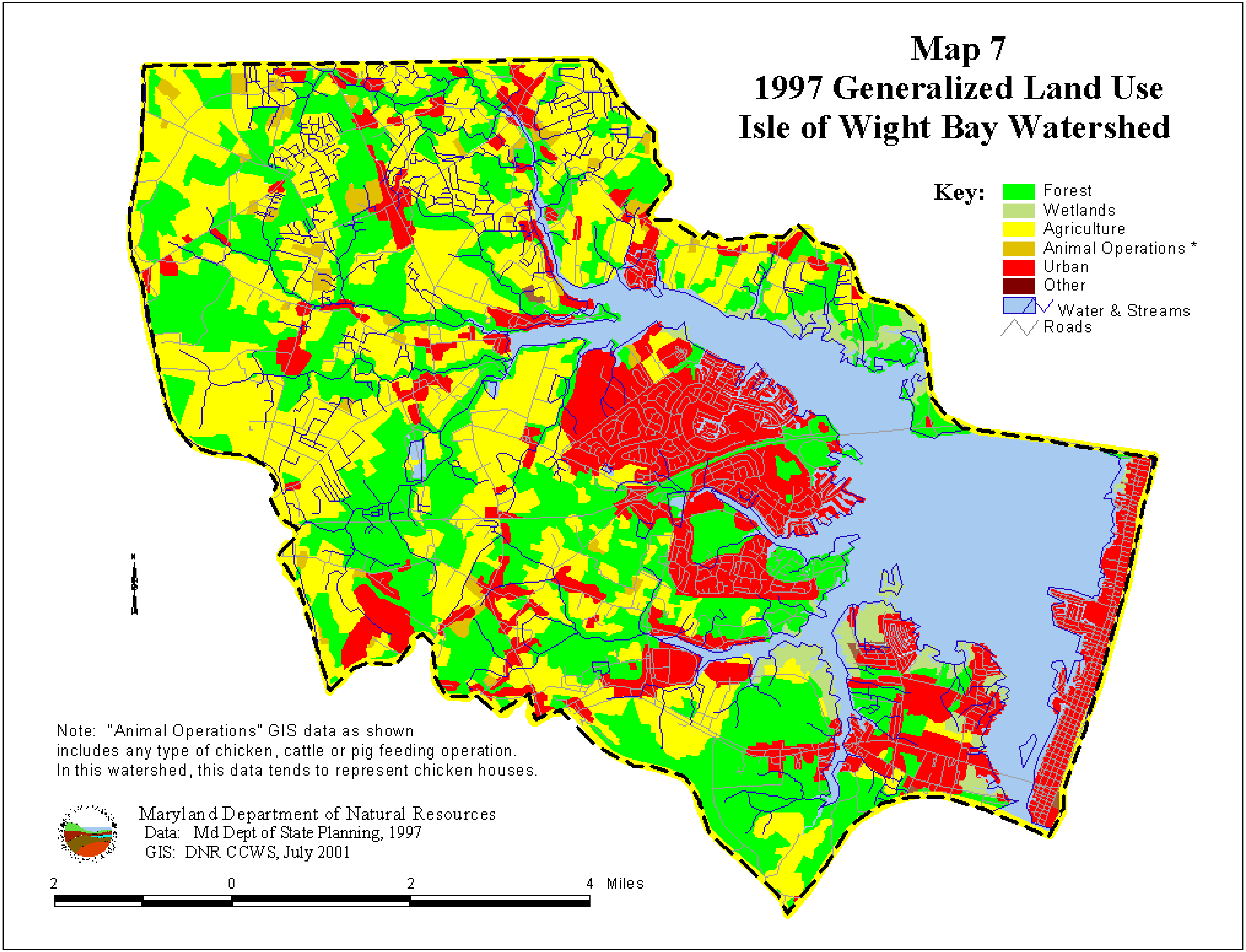
Soil Erodibility. A finding of 0.23 means that the Isle of Wight Bay watershed has "moderate" soil erodibility considering soils types, steep slopes and extent of cropland within 1000 feet of waterways. Watersheds with more easily erodible soils are naturally more susceptible to surface erosion, sedimentation, streambank erosion and other problems related to soil movement. These negative effects of soil erosion on water quality can be minimized through careful management. A WRAS can reasonably promote a reduction in disturbance of erodible soils and/or effective soil conservation practices like planting stream buffers.

1997 Land Use

The tables and pie chart show that forest and agriculture dominate the land use in the watershed in both States. Urban land is most significant in Maryland's portion of the watershed which is shown in Map 7 1997 Generalized Land Use. Viewing these land uses as potential nonpoint sources of nutrients, as a category agriculture land uses are probably the greatest contributors of nutrients in the Isle of Wight Bay. This generalization is based on size (37% of the watershed, 12,463 acres) and the typical nutrient loads that tend to arise from agricultural land. For more details, see the nonpoint source discussion and the Land Use Technical Report.

1997 Isle of Wight Bay Maryland Wetland and Beach Area	
Description	**Acres**
Tidal marsh, Emergent wetlands (Wetlands in pie chart)	899
Beaches and bare ground (not shown in pie chart)	109
Total for Maryland "Other" Land Use	**1,008**




Map 7
1997 Generalized Land Use
Isle of Wight Bay Watershed
Key:
Forest
Wetlands
Agriculture
Animal Operations *
Urban
Other
Water & Streams
Roads
Note: "Animal Operations" GIS data as shown includes any type of chicken, cattle or pig feeding operation. In this watershed, this data tends to represent chicken houses.
Maryland Department of Natural Resources
Data: Md Dept of State Planning, 1997
GIS: DNR CCWS, July 2001
2
0
2
4 Miles

Growth Management in Worcester County [26]

Worcester County is planning for growth consistent with the opportunities of Maryland's Smart Growth Program. The County has submitted a Priority Funding Areas map to the State that is consistent with the Program. Map 10 Protected Land and Smart Growth shows the Priority Funding Areas in the Isle of Wight Bay watershed (Worcester County's Rural Legacy Areas designated in the County are outside of the Isle of Wight Bay watershed).

Last year the County launched Worcester 2000, an initiative with the goal of bringing the citizens of Worcester County together to create a consensus "vision" of the County's future. Citizens were asked to participate, through a series of workshops, in identifying the characteristics of Worcester County that are worth protecting as the County continues to develop, and to express preferences regarding the pattern and intensity of future development. Citizens were also asked for input on short and long-term strategies to implement the consensus "vision". The final Worcester 2000 Report included results of the community visioning surveys, and a set of recommended changes to the comprehensive plan and the zoning and subdivision codes.

The final report was presented to the County Commissioners by the project consultant on November 8, 2000. Recommendations include directing new growth to concentrated areas largely in the Isle of Wight Bay watershed, preserving farms and forests with a transfer of development rights program, and promoting protection of environmentally sensitive areas through incentive programs. The County will now use this information as it begins to update the County comprehensive plan and to generate the Watershed Restoration Action Strategy for the Isle of Wight Bay watershed.

Other recent planning initiatives include adoption of the Route 50 Scenic and Transportation Corridor Plan, a scenic corridor protection initiative for Route 611, and the purchase of permanent easements on 2,500 acres of land in the Rural Legacy Area. The County is also working with the Maryland Coastal Bays Program to implement the Comprehensive Conservation and Management Plan for the Coastal Bays that was adopted in June 1999. Some of the work accomplished to date includes development of educational outreach materials and events, initiation of a septic system tracking program, and review and modification of the County's forest conservation law.

Ocean City

The area of Ocean City that lies between the Ocean City Inlet and Route 90, excluding the beach on the Atlantic Ocean, is entirely in the Isle of Wight watershed. As shown in Map 7 1997 Generalized Land Use, urban land use covers this entire area except for an area of tidal wetlands interspersed along the Ocean City's western boundary.

All the stormwater runoff generated by the impervious surfaces in Ocean City flow to the coastal bay side of the barrier island.[26] The density of the existing development will likely determine the extent and kind of stormwater management possible.

Green Infrastructure

An additional way to interpret land use / land cover information is to identify “Green Infrastructure.” In the GIS application developed by Maryland DNR and its partners, Green Infrastructure refers to areas of natural vegetation and habitat that have statewide or regional importance as defined by criteria developed by DNR. The criteria for identifying of lands as Green Infrastructure is limited to considering natural resource attributes currently found on those lands. One example of the criteria is that interior forest and wetlands complexes at least 250 acres in size are considered as part of Green Infrastructure. As a second example, sensitive species habitat that is located within areas of natural vegetation at least 100 acres in size is also counted as Green Infrastructure. The Green Infrastructure assessment of lands did not consider ownership or status of protection, but these attributes may be considered independently.

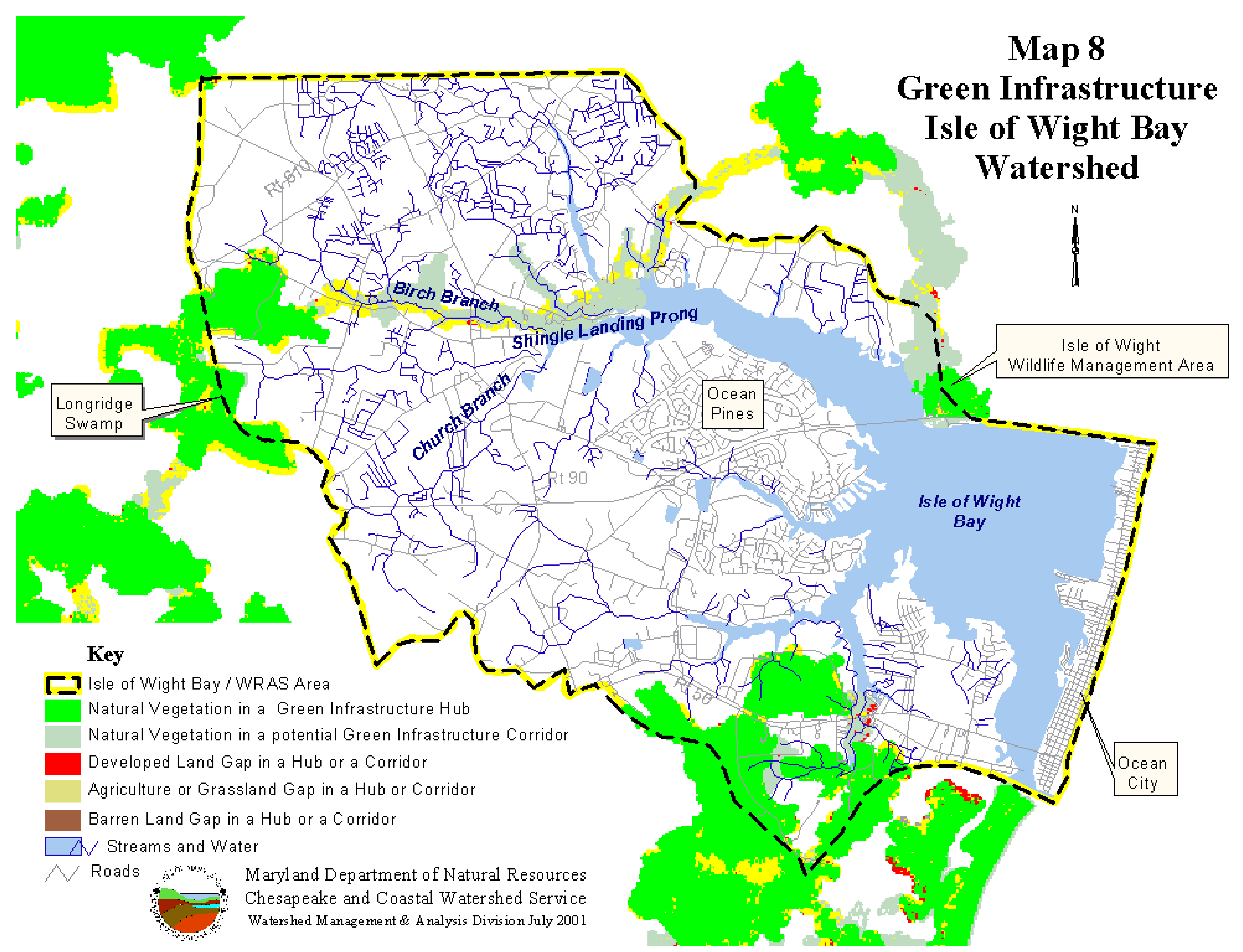
Within the Green Infrastructure network, large blocks of natural areas are called hubs, and the existing or potential connections between them, called links or corridors. Together the hubs and corridors form the Green Infrastructure network which can be considered the backbone of the region’s natural environment.[7]

Protection of Green Infrastructure lands may be addressed through various existing programs including Rural Legacy, Program Open Space, conservation easements and others. The 2001 Maryland General Assembly approved $35 million for the Green Print program which is targeted primarily to protecting Green Infrastructure areas. This new funding category will be administered by Program Open Space.

The Green Infrastructure in the Isle of Wight Bay watershed, as shown in Map 8 Green Infrastructure, exhibits several significant characteristics:

– In the map, which is part of a Statewide scenario, the majority of the watershed is not identified as a Green Infrastructure component. This is probably because most areas of natural vegetation in the watershed are smaller than 100 acres. This minimum size was selected to meet statewide interests for identifying Green Infrastructure of statewide or regional importance. In addition to this Statewide scenario, it may be valuable to identify Green Infrastructure that is important at the local watershed scale.
– Several Green Infrastructure hubs appear in the watershed that are concentrated in three areas: 1) the Isle of Wight Wildlife Management Area (WMA), 2) in the Turville / Herring Creek subwatershed and 3) an area of Shingle Landing Prong’s headwaters running from Longridge Swamp down Birch Branch along the north side of Shingle Landing Prong and into the Assawoman Bay drainage area..
– In the Isle of Wight watershed, the map shows one Green Infrastructure corridor connecting the hubs in the Shingle Landing Prong and Assawoman Bay subwatersheds.

One way to interpret this view of the watershed is to suggest that protection and/or enhancement of the Isle of Wight Bay Green Infrastructure hubs could be considered as one component of the Watershed Restoration Action Plan.


Map 8
Green Infrastructure
Isle of Wight Bay
Watershed
N
Birch Branch
Shingle Landing Prong
Church Branch
Rt 610
Rt 90
Rt 50
Ocean Pines
Isle of Wight Bay
Isle of Wight Wildlife Management Area
Longridge Swamp
Ocean City
Key
Isle of Wight Bay / WRAS Area
Natural Vegetation in a Green Infrastructure Hub
Natural Vegetation in a potential Green Infrastructure Corridor
Developed Land Gap in a Hub or a Corridor
Agriculture or Grassland Gap in a Hub or Corridor
Barren Land Gap in a Hub or a Corridor
Streams and Water
Roads
Maryland Department of Natural Resources
Chesapeake and Coastal Watershed Service
Watershed Management & Analysis Division July 2001

Natural Resource Areas At the Watershed Scale

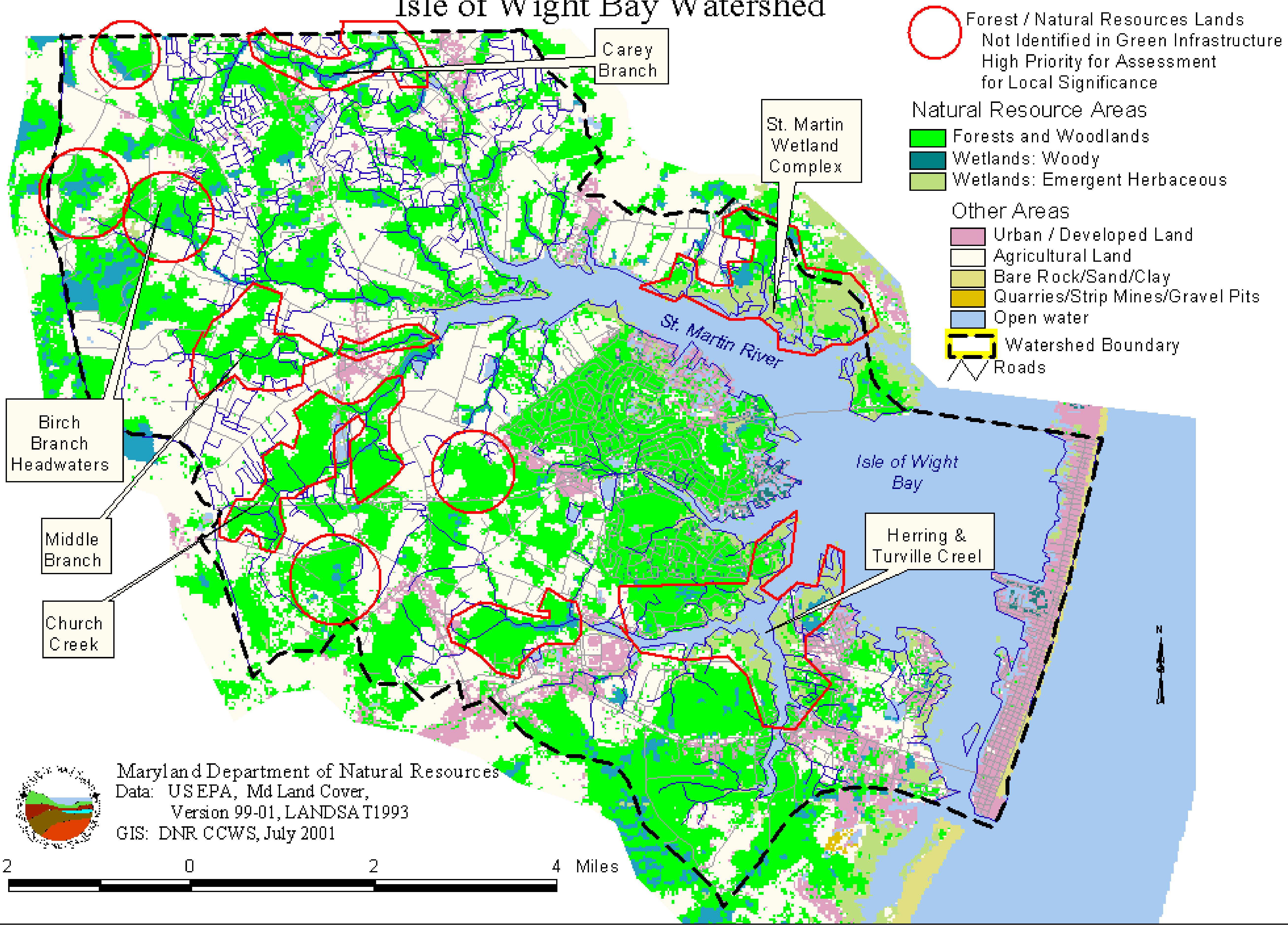
Map 8 Green Infrastructure, due to its Statewide and regional focus, may not identify natural resource areas that are locally significant. Therefore, it is reasonable to employ other information to help identify natural areas of potential local significance.

For example, the 1999 stream corridor assessment work conducted in the Saint Martin River drainage area is one information source. DNR staff who assessed Church Branch report that it has significant riparian areas with natural vegetation intact.[23] This area, and perhaps others, could be considered Green Infrastructure important at the local watershed scale.

Additional perspective is presented in Map 9 Natural Resource Areas of Potential Local Significance. It uses land cover data LANDSAT satellite imagery to suggest areas for local consideration and investigation. The areas of forest and wetlands highlighted with red outlines on the map were too small to be identified as Green Infrastructure. However, the outlined areas appear to be relatively large blocks of forest and wetland at the watershed scale.

Further assessment of these areas will be needed to determine if they exhibit natural resource values that are locally significant.

Map 9 Natural Resource Areas of Potential Local Significance
Isle of Wight Bay Watershed



Protected Lands

"Protected land," as used here, 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 recreational intent, or private ownership where a third party acquired development rights or otherwise acquired the right to limit use through an easement purchase, etc. The extent of "protection" varies greatly from one circumstance to the next and it may be necessary to explore the details of land protection parcel by parcel through the local land records office.

For purposes of watershed restoration, a knowledge of existing protected lands can provide a starting point in prioritizing potential 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.

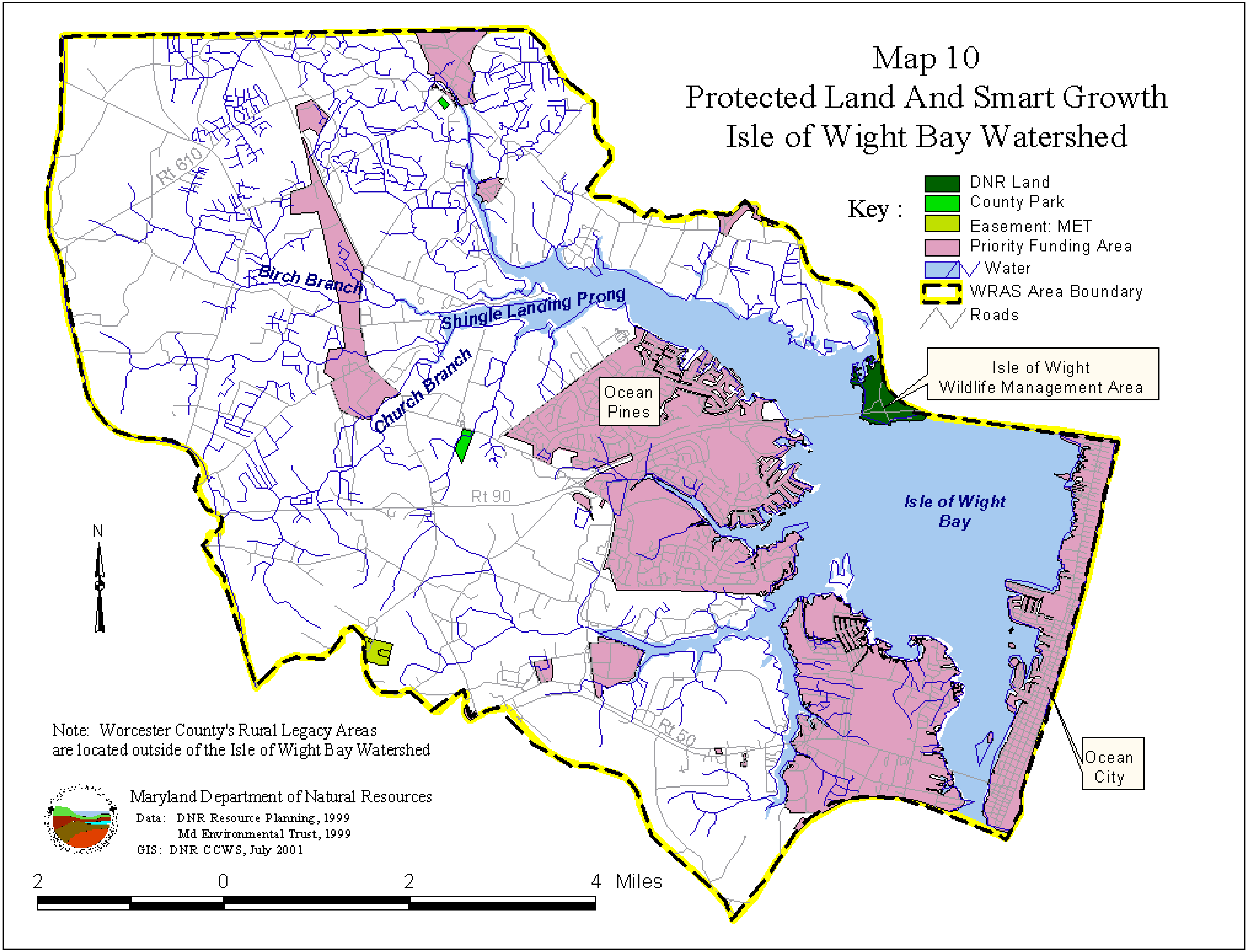
The following listing and Map 10 Protected Land and Smart Growth summarize the status of protected lands in the Isle of Wight Bay watershed.

– The vast majority of land in the watershed does not meet the definition of "protected" as applied in this assessment. Therefore, promoting opportunities available for private land owners to protect rural, agricultural and similar land values may be valuable in the Watershed Restoration Action Strategy.
– Local / County parks are concentrated in two areas: Bishopville Park and the Showell Recreation Area.
– DNR land in the watershed is limited to the southwestern half of the Isle of Wight Wildlife Management Area.
– One conservation easement area is located at the edge of the watershed north of Berlin.
– No agricultural easements have been identified in the Isle of Wight Bay watershed.

Smart Growth

Maryland's Smart Growth program has two programs that should be considered as watershed restoration project priorities are established. In Rural Legacy Areas, protection of land from future development through purchase of easements (or in fee simple) is promoted. In Primary Funding Areas, State funding for infrastructure may be available to support development and redevelopment:

- Rural Legacy Areas. Located in the southern portion of the County, not in the Isle of Wight Bay watershed.
- Priority Funding Areas. Several are in the Isle of Wight Bay watershed as shown on Map 10 Protected Land and Smart Growth. In Priority Funding Areas, new development and/or redevelopment may be anticipated. Planning for watershed restoration projects in Priority Funding Areas, or downstream of them, needs to account for potential changing conditions during the life of the project. For example, increasing impervious area may alter stormwater conditions that a watershed restoration project will have to adequately address.


Map 10
Protected Land And Smart Growth
Isle of Wight Bay Watershed
Key :
DNR Land
County Park
Easement: MET
Priority Funding Area
Water
WRAS Area Boundary
Roads
Isle of Wight
Wildlife Management Area
Ocean
Pines
Birch Branch
Shingle Landing Prong
Church Branch
Rt 610
Rt 90
Rt 50
Isle of Wight
Bay
Ocean
City
N
Note: Worcester County's Rural Legacy Areas
are located outside of the Isle of Wight Bay Watershed
Maryland Department of Natural Resources
Data: DNR Resource Planning, 1999
Md Environmental Trust, 1999
GIS: DNR CCWS, July 2001
2
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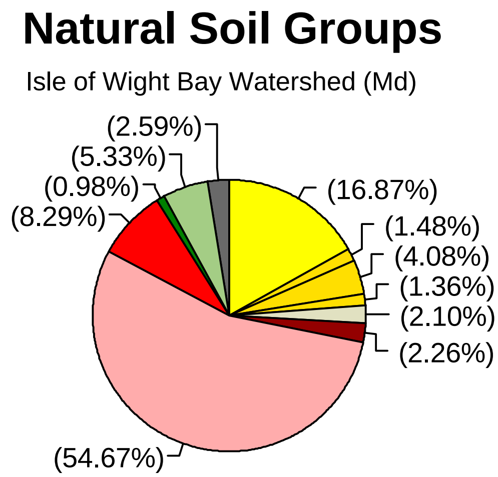
4 Miles

Soils of the Isle of Wight Bay Watershed

1. Interpreting Local Conditions with Natural Soil Groups

Soil conditions, like soil type and moisture conditions, greatly affect how land may be used and potential for vegetation and habitat on the land. Soil conditions also one determining factor for water quality in streams and rivers. Local soil conditions vary greatly from site to site as published information in the Soil Survey for Worcester County shows. This complicated information can be effectively summarized using Natural Soil Groups to help identify useful generalizations about groups of soils.

In Map 11 Soils and the pie chart, prime farmland is depicted in yellow or yellow with crosshatching. About 24% of the Isle of Wight Bay Watershed in Worcester County is prime farmland.



The various shades of reds and greens depict soil areas with wetness conditions that affect their agricultural or development potential. Nearly 72% of the watershed exhibits wetness-related limitations.

2. Soils and Watershed Planning

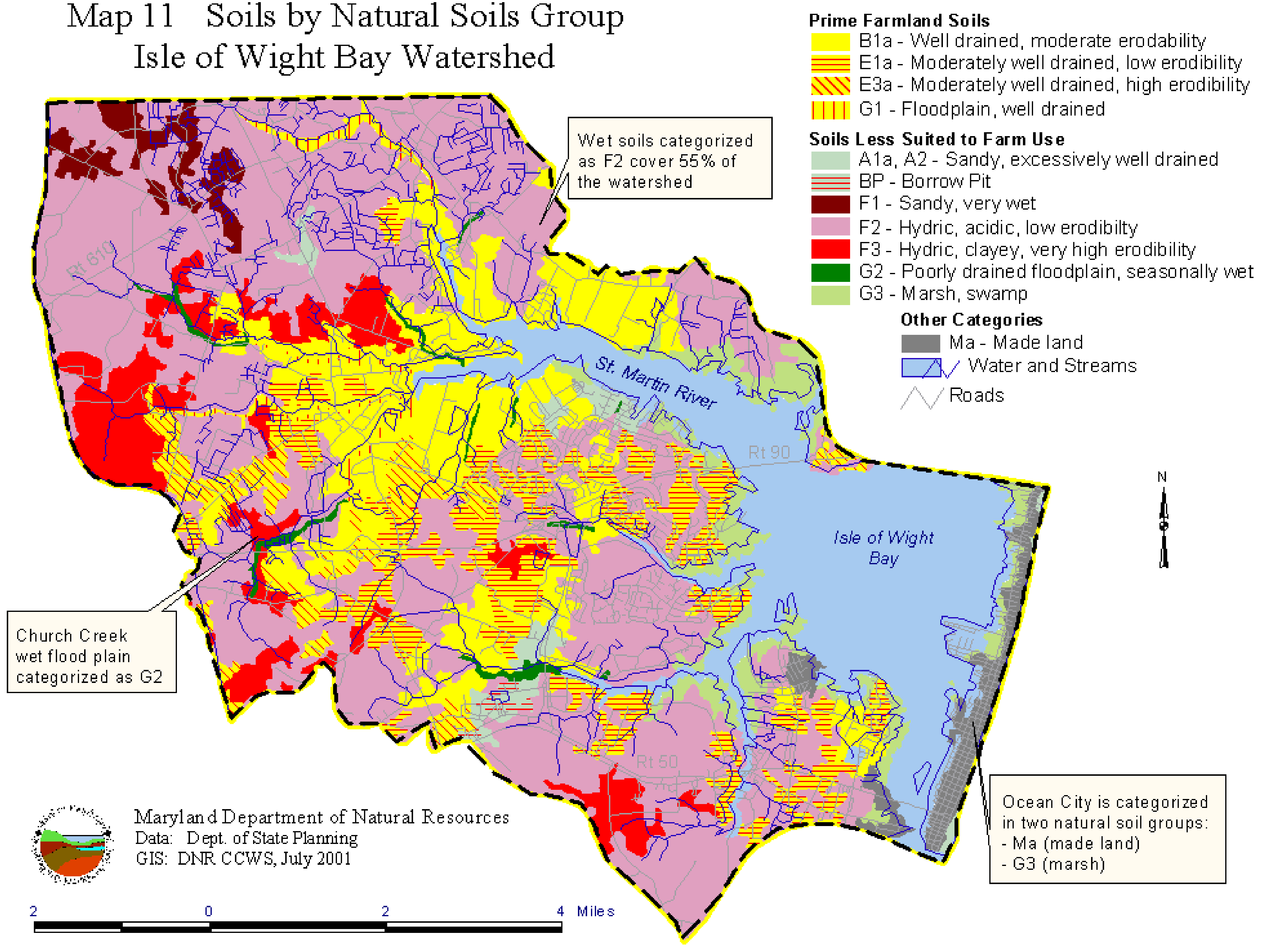
Local soil conditions can be a useful element in watershed planning and for targeting restoration projects. Soils with limitations related to wetness naturally affect farming practices and may inhibit active use for farming or development. Wet soils are so extensive in the watershed that land owners have invested substantial effort in ditching to improve drainage and utility of the land. However, land owners have also tended to leave some of the wetter areas in natural vegetation or other low intensity use. By comparing the soils map to other information including the maps listed below, it is possible to see that existing natural habitat areas in the watershed frequently are associated with areas wet soils:

– Map 7 1997 General Land Use, Map 8 Green Infrastructure

– Map 9 Natural Resource Areas of Potential Local Significance

Natural Soil Groups or similar soils assessment techniques can be used to help identify potential areas for restoration projects or habitat enhancement and protection. For example, the wet flood plain soil (G2) coincides with existing high-quality naturally-vegetated stream buffer identified on upper Church Creek in the 1999 stream corridor assessment. This could be an area for protection with conservation easements or for enhancement with adjacent restoration projects. After areas for restoration are targeted and land owner interest is verified, additional on-site soil assessment is an essential step in identifying viable restoration project sites.

Map 11 Soils by Natural Soils Group
Isle of Wight Bay Watershed



Wetlands

1. Introduction to Wetland Categories [41]

The Eastern Coastal Plain Province likely has the highest diversity of emergent estuarine and palustrine wetland communities relative to other Maryland physiographic regions because both tidal and nontidal freshwater marshes occur here. Wetlands are most abundant in the Coastal Plain due to the low topographic relief and high groundwater table characteristic of the region.

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

Palustrine wetlands. Forested wetlands are the most abundant and widely distributed palustrine wetland type on the Coastal Plain. These wetlands are found on floodplains along the freshwater tidal and nontidal portions of rivers and streams, in upland depressions, and in broad flat areas between otherwise distinct watersheds. Tidal freshwater swamps occur along coastal rivers in areas subject to tidal influence. Scrub-shrub swamps are not abundant on the Eastern Shore but are represented in the Isle of Wight Bay watershed. Emergent wetlands on the Coastal Plain are characterized by a wide range of vegetation, depending on water regime. (Adapted from *Wetlands of Maryland*, Tiner and Burke, 1995.)

2. Tracking Wetlands [41]

Oversight of activities affecting wetlands involves several regulatory jurisdictions. The Maryland Dept. 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 Wetlands Regulatory Status table shows, changes tracked in the State regulatory program have been minor in the Isle of Wight Bay watershed.

Tracking Nontidal Wetland Change
Isle of Wight Bay Watershed
Permits Authorized = 11
Letters of Authorization Issued = 588

Wetland Class	**Acres**
Permanent Impacts	-46.86
Mitigation by Permittee	26.16
Other Gains (Regulatory)	0.70
Programmatic Gains	5.00
Net Gain/Loss	-15.00

Note: Regulatory tracking for authorized nontidal wetland losses began in 1991. Comprehensive tracking of voluntary wetland gains began in 1998. Tidal wetland changes are not shown.

3. Interpreting Wetland Distribution

Wetlands in the Isle of Wight Bay watershed tend to occur along waterways as shown in Map 12 Wetlands. In comparing this map to the Map 7 1997 Generalized Land Use, it can be seen that forested land in the watershed is frequently found in association with wetlands or adjacent to them.

A comparison of the two maps shows that many of the nontidal wetland areas are depicted as forest on the land use map. This difference is simply the result of two differing views of the landscape. For example, wooded nontidal wetlands can be viewed as "wetlands" from a habitat / regulatory perspective and they can be viewed as "forest" from a land use perspective.

In the Isle of Wight Bay watershed, differing perspectives on counting wetlands are significant for watershed management. From a land use perspective, 899 acres of wetlands are identified by the Maryland Department of Planning. From a habitat / regulatory perspective, there are between 3600 and 5300 acres of wetlands in the watershed depending on the estimate that you use (see total wetlands in table.).

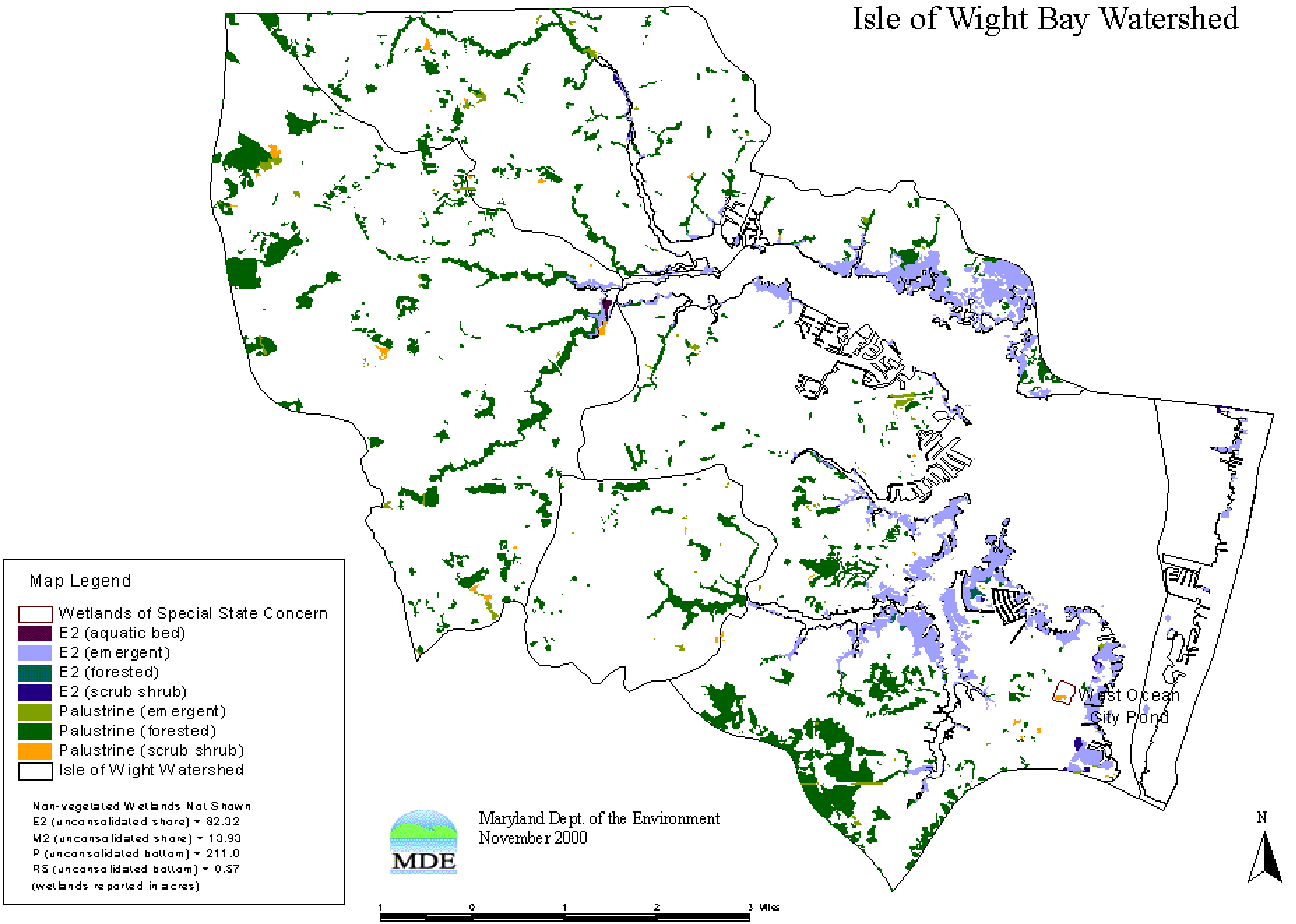
Wetland Acreage Summary
Isle of Wight Bay Watershed[41,42]

Wetland Class		Acres
Estuarine, Intertidal (E2)	aquatic bed	5
	beach bar	0
	emergent	1,316
	forested	16
	scrub shrub	31
Palustrine (P)	aquatic bed	0
	emergent	124
	flat	0
	forested	2,856
	scrub shrub	57
Riverine, Lower Perennial (R2)	beach bar	0
Riverine, Upper Perennial (R3)	beach bar	0
Total Wetlands	Total from above	4,405
	DOQQ (DNR estimate)	5,266
	National Wetlands Inventory	3,619

Wetlands of Special State Concern (WSSC) 26 acres
NOTE: WSSC regulations apply to selected wetlands listed in table above. See the Sensitive Species Section for discussion.

In the context of the Watershed Restoration Action Strategy (WRAS), wetlands serve valuable water quality and habitat functions that may not be provided by other land uses. Therefore, protection and enhancement of existing wetlands, and restoration of past wetland areas, can be a valuable element in the WRAS. (Also see Wetland Restoration.)

Map 12 Wetlands
Isle of Wight Bay Watershed



Maryland Dept. of the Environment
November 2000

LIVING RESOURCES AND HABITAT
In The Isle of Wight Bay Watershed

Overview

Living resources, including all the animals, plants and other organisms that call the land and waters of the Isle of Wight Bay watershed home, are being affected by human activity. The information summarized in this characterization suggests some of the significant stresses in the watershed are related to water quality problems from excessive movement of sediment and excessive availability of nutrients and from manipulation of habitat.

The living resource information summarized here should be considered a partial representation because numerous areas of potential interest or concern could not be included due to lack of information, time, etc. For example, information on many forms of aquatic life, woodland communities, terrestrial habitats, etc. should be considered as watershed restoration decisions are being made. Therefore, it is recommended that stakeholders in the watershed identify important living resource issues or priorities so that additional effort can be focused where it is most needed. New information should be added or referenced as it becomes available.

Living Resource Indicators

Aquatic organisms are sensitive, in varying degrees, to changes in water quality and the habitat associated with water. This association offers two perspectives that are important for watershed restoration. First, goals for watershed restoration and water quality improvement can be based on improvements for living resources. Second, the status of selected of living resources can be used to gauge local conditions for water quality, habitat, etc. This second perspective is the basis for using living resources as an "indicator."

The *Maryland Clean Water Action Plan* published in 1998 listed the following living resource indicators for the Isle of Wight Bay.[3] The Isle of Wight Bay is also identified in the Plan as a Category 1 Priority Watershed "in need of restoration during the next two years." Compared to other watersheds in Maryland, the Isle of Wight Bay watershed exhibits poor abundance of submerged aquatic vegetation (SAV) and monitoring found poor conditions in nontidal streams.

Living Resource Indicator	**Score**	**Rank**	**Bench Mark** (percent is based on 138 watersheds)
SAV Abundance Index	1.0	Fail	Scale of 1 (worst) to 10 (best) Score of "1" yields a rank of "fail"
Nontidal Benthic Index of Biotic Integrity	5.4	Fail	Scale of 1 (worst) to 10 (best) Score less than 6 yields a rank of "fail"
Nontidal In-Stream Habitat Index	5.40	Pass	Scale of 1 (worst) to 10 (best). Of 138 watersheds in Maryland, the 34 (25%) with the lowest nontidal in-stream habitat index received a rank of "fail" and were designated as Category 1 watersheds in need of restoration. The top 34 (25%) were designated as Category 3 watersheds in need of protection.

Also see Interpreting Living Resource Indicators.

Interpreting Living Resource Indicators

General. Several of these indices rely on index rankings generated from a limited number of sampling sites which were then generalized to represent entire watersheds. Considering this limitation, it may be beneficial to conduct additional assessments to provide a more complete understanding of local conditions as part of the WRAS:

SAV Abundance Index. The Finding of "1.0" means that Submerged Aquatic Vegetation (SAV) in 1996 covered 10% or less of the potential SAV habitat. This index allows comparison of watersheds based on the actual versus potential SAV area. To generate the number under Finding, the watershed area covered by SAV in a single year is measured using aerial survey. The year used here was 1996. The potential SAV area is determined by water depth (water area up to two feet deep), physical characteristics and historic occurrence of SAV.

Nontidal Benthic Index of Biotic Integrity. This index allows comparison of streams based on the populations of bottom-dwelling "bugs" (benthic macroinvertebrate organisms) found in the stream. For coastal plain streams, this index employs seven measurements of these populations which is translated into a rank for each sampling site. An index less than 6 indicates that benthic organisms are significantly stressed by local conditions.

Nontidal In-Stream Habitat Index. This index allows comparison of streams based fish and benthic habitat as measured by in-stream and riparian conditions. For each stream site, that was assessed, visual field observations are used to score the site for substrate type, habitat features, bank conditions, riparian vegetation width, remoteness, aesthetic value, etc. These scores are then integrated to generate a single rank for each stream site.

Plankton

Plankton are microscopic plants and animals that are important contributors to natural aquatic systems. Among other valuable functions, they are important food sources for fish and shellfish. When population explosions of some plankton species occur, like algae blooms, many problems may result: fish may die from low dissolved oxygen, submerged aquatic vegetation (SAV) can not survive because essential light is blocked, etc.

1. Algae

The technical report Algae Including Phytoplankton, Harmful Algal Blooms and Macroalgae includes extensive assessment and interpretation of data on plankton and algae populations for the Isle of Wight Bay. [34] Some of the report's findings are summarized below.

– Eutrophication problems associated with algae are greatest in tidal waters with limited flushing characteristics.
– Bluegreen algae dominated the plankton community in Bishopville Prong and Shingle Landing Prong area in August. In Bishopville Prong, this dominance lasted about four months. This finding of relatively high bluegreen algae populations compared to other algae is an indicator of eutrophication which suggests that nutrients are overly abundant. This assessment considered the period June through October 1998.
– During the study, algae growth in the Bishopville Prong / Shingle Landing Prong area was high enough to inhibit submerged aquatic vegetation (SAV) according to measured chlorophyll *a* concentrations. Concentrations of chlorophyll *a* tended to be around 50 *ug*/L in this area between July 1998 and July 2000. (It is recommended that 15 *ug*/L or less chlorophyll *a* is necessary to support SAV habitat. [27]) There were also significant algae blooms during this time frame, particularly in 2000 in Bishopville Prong, when chlorophyll *a* concentrations reached about 200 and 300 *ug*/L. (Chlorophyll *a* concentrations were used as an indicator of algae biomass.)
– In the St. Martin River, average chlorophyll *a* concentrations remained higher than the SAV habitat requirement of 15 *ug*/L throughout the year. Monitoring showed a pattern of summer algae bloom (higher chlorophyll *a* concentrations) in July.
– In the open waters of the Isle of Wight Bay, chlorophyll *a* concentrations were generally stable averaging less than 15 *ug*/L, which tends to be more supportive of SAV habitat.
– Either nitrogen or phosphorus limits algae growth in tidal waters of the Isle of Wight Bay watershed depending upon time and location. This suggests that controlling both nutrients is necessary to reduce the potential for algae blooms and to support SAV restoration.
– The mouth of Herring and Turville Creeks have exhibited "very high biomass" of macroalgae during surveys conducted in the past two years. The most common of these species are known as red algae. This finding could suggest gaps in understanding its role in the local ecosystem. [37]
– During the year 2000, DNR monitored macroalgae in response to citizen concerns. No harmful conditions were reported.

2. *Pfiesteria*. [13]

Following the 1997 *Pfiesteria* outbreaks in several Chesapeake Bay rivers in the Lower Eastern Shore, monitoring of St. Martin River was initiated because it exhibits similar characteristics to watersheds that experienced problems.

Pfiesteria was not found in the water or sediment samples from the St. Martin River during the 1998 through September 2000 monitoring. [21]

3. Brown Tide [34]

Brown tide is a concern primarily because it can cause fish kills. The organism that is responsible for brown tide, *Aureococus*, has been monitored in the Isle of Wight Bay watershed since 1998. In general, blooms tend to occur seasonally in June/July. This monitoring was prompted by high population levels found in December 1998 in Delaware's Little Assawoman Bay. Typically, the brown tide problem is found in cooler waters off New Jersey and in areas further north.

In Maryland, 1999 monitoring results raised concerns but measurable problems were not identified. Samples collected in 2000 indicated that the population had declined with the highest levels found near Ocean Pines. It is unclear if the conditions observed lasted long enough to impact bivalves or seagrasses. DNR is continuing to work with the University of Maryland to better understand this organism.

Benthos in Nontidal Streams

Two recent assessments in 1997 and 1999 examined macroinvertibrates (bugs) and habitat conditions in nontidal streams as a measurement of stream health.[24, 28] For one area of Carey Branch, both assessments generally agreed that in-stream habitat was moderately impaired or "fair."

In 1999, DNR Watershed Restoration Division assessed nontidal tributaries to the St. Martin River. The report, issued February 2000, identified nutrient concentrations, macro invertebrate communities and riparian corridor conditions. Thirteen sites were ranked by macro invertebrate community and by habitat: [24]

– Findings on the benthic community and on habitat condition for individual monitoring sites did not correlate well, i.e. sometimes poorer habitat conditions were not reflected by correspondingly poorer benthic communities.
– Best communities (more diverse, more sensitive species) were found in larger streams
  - Birch Branch at Campbelltown Road crossing (station SM-17)
  - Middle Branch at the Route 113 crossing (station SM-14)
  - Birch Branch at the Route 113 crossing (station SM-13)
  - Church Creek at the Route 113 crossing (station SM-15)
– Poorest communities were found in upper watershed streams having little flow and impaired habitat.

In 2001, ten sites in the Isle of Wight Bay watershed are scheduled for assessment by the Maryland Biological Stream Survey (MBSS). The focus of this work will be to assess the in-stream aquatic community and habitat conditions. [19]

Historical data on macroinvertebrates are available for some free flowing streams in the Isle of Wight Bay watershed. Records begin in the late 1970s. [36]

Why Look At Benthos In Streams?

Benthos are sometimes called "stream bugs" though that name overly simplifies the diverse membership of this group. Unimpaired natural streams may support a great diversity of species ranging from bacteria and algae to invertebrates like crayfish and insects to fish, reptiles and mammals. Benthic macro-invertebrates, also called benthos, are an important component of a stream's ecosystem. 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.

The food web in streams relies significantly on benthos. Benthos are 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 provide 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.

Benthos are a valuable tool for stream evaluation. This group of species has been extensively evaluated for use in water quality assessment, in evaluating biological conditions of streams and in gauging influences on streams by surrounding lands. Benthos serve as good indicators of water resource integrity because they are fairly sedentary in nature and their diversity offers numerous ways to interpret conditions. (They have different sensitivities to changing conditions. They have a wide range of functions in the stream. They use different life cycle strategies for survival.)

Fish

Overall, economically important fishery resources in the Coastal Bays, including the Isle of Wight Bay, are found in open tidal waters. The Coastal Bays area, including Isle of Wight Bay, serves as a spawning, nursery and feeding area for many species of fish and invertebrates. [20]

The fish species that now dominate the Coastal Bays are very different from those that were found prior to 1933 when a storm created the Ocean City Inlet. The permanent opening in the barrier island changed the Coastal Bays salinity regime, reduced habitat for anadromous fish and eliminated commercial fisheries for anadromous species like American shad, alewife and others.[28] The Isle of Wight Bay's immediate proximity to the Inlet suggests that it experienced a dramatic fish population shift to salt tolerant species.

An ongoing Maryland DNR seine and trawl survey has collected more than 115 fish species from Maryland's Coastal Bays since 1972. This survey has also recorded over 157 species of benthic invertebrates. [29]

In nontidal streams of the Isle of Wight Bay watershed, the fish community assessments found only species that are tolerant or moderately tolerant to pollution. This means that other fish species that would typically inhabit these nontidal waterways in these streams have died out due to problems such as loss of habitat and/or pollution. There are no significant commercial or recreational fisheries in the nontidal streams of the Ocean Coastal Basin. [24, 28, 30]

Sampling in tidal areas in and around the St. Martin River was conducted from 1998 through 2000 as part of the *Pfiesteria* monitoring program. In comparing the extent of disease in fish tested, it was reported that St. Martins River-area fish populations there were among the healthiest of the Lower Eastern Shore waterways observed. [21]

Maryland's coastal bays have supported a recreational sport fishery for many years. The primary sport fishing areas are generally located in the open waters of the coastal bays including an area extending from the Isle of Wight Bay into Assawoman Bay.[20] In the Coastal Bays generally, recreational anglers catch many marine fishes including flounder, weakfish, spotted sea trout, striped bass, red drum, tautog, black sea bass, spot, croaker, and bluefish.[29]

Oysters, Clams and Crabs

Oyster lease areas are currently located in the Assawoman Bay, Sinepuxent Bay and Chincoteague Bay but not in the Isle of Wight Bay. Oysters were once an important regional fishery but have declined drastically during the twentieth century due to harvesting, disease and predation.[31] A survey conducted from 1906 to 1912 identified oyster beds in Chincoteague Bay and the extreme southern portion of Newport Bay but none were identified in the Isle of Wight Bay.[22]

In the Coastal Bays generally, blue crabs and hard clams have commercial and recreational importance.[29] Information for the Isle of Wight Bay is not available.

Sensitive Species

Sensitive species are most widely known in the form of Federally listed endangered or threatened animals such as the bald eagle. In addition to these charismatic rare animals, both US EPA and Maryland DNR work through their respective Federal and State programs to protect numerous endangered, threatened, or rare species of plants, animals and ecological communities of those species.

For the purposes of watershed restoration, it is valuable to account for known habitat locations for these species. These places are often indicators, and sometimes important constituents, of the network of natural areas or "Green Infrastructure" that are the foundation for many essential natural watershed processes. Protecting these species and/or promoting expansion of their habitats can be an effective foundation for a watershed restoration program.

1. Habitat Protection Categories

One way to characterize a watershed for sensitive species is to identify known habitat locations using several broad categories employed by DNR's Wildlife and Heritage Division. The table Maryland's Sensitive Species Protection Categories and Map 13 Sensitive Species summarize this approach.

The three categories listed in the accompanying table (SSPRA, NHA, WSSC) are considered during review of applications for a State permit, for a State approval or for projects that involve State funds. For projects potentially affecting these areas, the State permit or approval will include recommendations and/or requirements to protect sensitive species and their habitat. In addition, many counties have incorporated safeguards for these areas into their permit review process.

These categories do not place requirements on any activities that do not require a permit or approval or involve State funds. However, there are State and Federal restrictions that address "takings" of protected species that apply more broadly. In addition, property owners are encouraged to seek advice on protecting the sensitive species / habitat within their ownership.

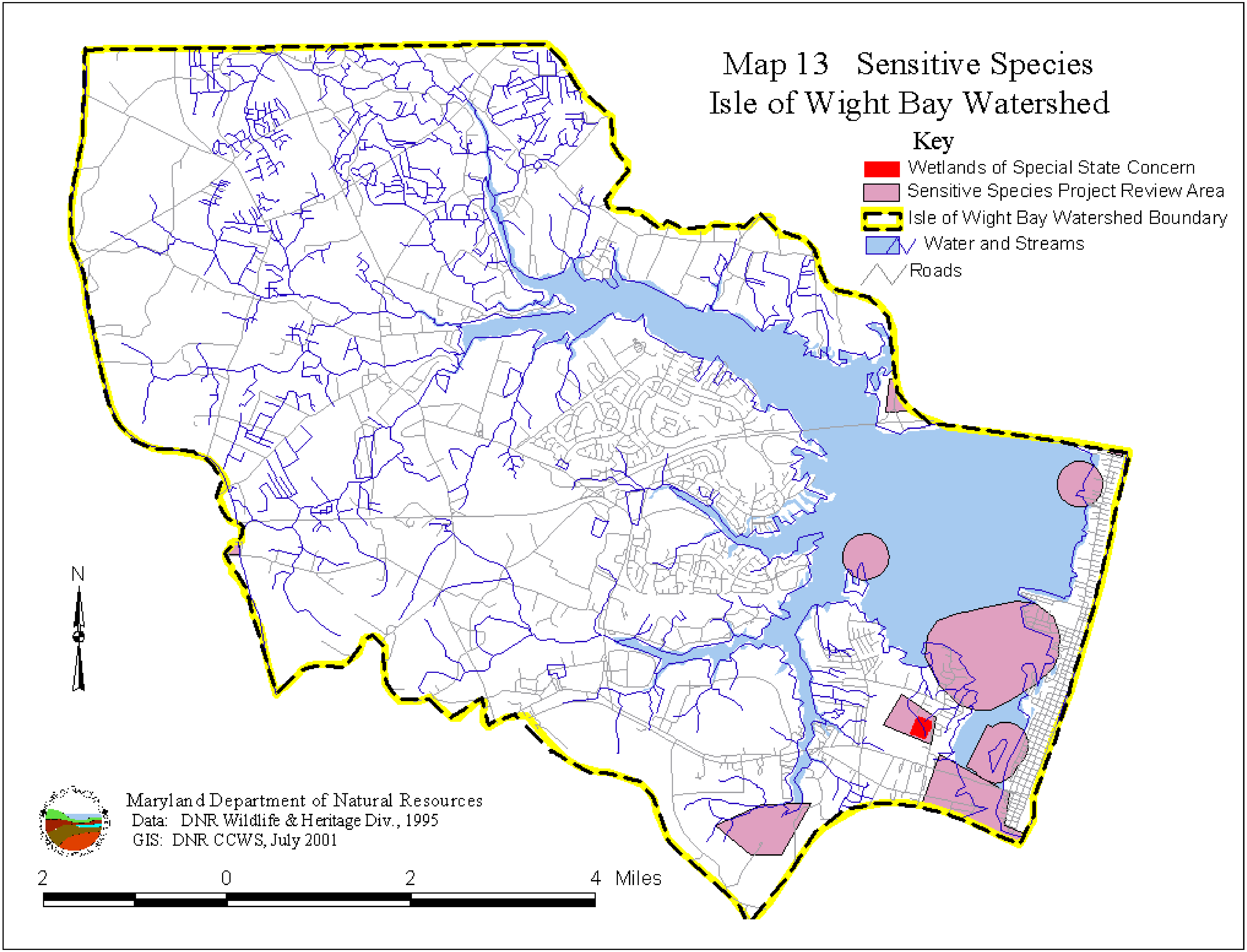
2. Rare Fish and Mussels

DNR recently initiated a project to rank watersheds across Maryland to aid in targeting conservation and restoration efforts to benefit known populations of rare fish and mussels. In comparison to the more than 1000 small (12-digit) watersheds identified by DNR in Maryland, the entire Isle of Wight Bay watershed (all four 12-digit sub-watersheds) received a rank of "neutral." A ranking of neutral indicates that information is insufficient (rather than absence of these species or low priority.) In neutral ranked areas, it is reasonable to rely on other available criteria for targeting watershed conservation and restoration projects.

This ranking considers information from 1970 to 1997 only for rare species of fish or mussels in Maryland that are tracked by DNR. Four possible ranks were used for this project: Very High, High, Moderately High and Neutral. Each rare species being tracked contributed to this ranking based on two types of criteria: 1) presence or absence of the species, and 2) if present, weighting relative rarity on worldwide and Statewide scales. A listing of species considered and project description (metadata) is available upon request.

Maryland's Sensitive Species Protection Categories

Sensitive Species Project Review Area (SSPRA)	Natural Heritage Area (NHA)	Wetlands of Special State Concern (WSSC)
At least eight SSPRAs are identified in the Isle of Wight Bay watershed. Each SSPRA contains one or more sensitive species habitats. However, the entire SSPRA is not considered sensitive habitat. The SSPRA 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 and habitat they contain. At least one SSPRA encompasses each NHA and WSSC. Also see Map 13 Sensitive Species.	No NHAs are located in the Isle of Wight Bay watershed. NHAs are rare ecological communities that encompass sensitive species habitat. They are designated in State regulation COMAR 08.03.08.10. For any proposed project that requires a State permit or approval that may affect an NHA, recommendations and/or requirements are placed in the permit or approval that are specifically aimed at protecting the NHA.	One WSSC is designated in the Isle of Wight Bay watershed. These wetlands are associated with one or more sensitive species habitats that are in or near the wetland. For any proposed project that requires a wetland permit, these selected wetlands have additional regulatory requirements beyond the permitting requirements that apply to wetlands generally. For a listing of designated sites see COMAR 26.23.06.01



Map 13 Sensitive Species
Isle of Wight Bay Watershed
Key
Wetlands of Special State Concern
Sensitive Species Project Review Area
Isle of Wight Bay Watershed Boundary
Water and Streams
Roads
N
Maryland Department of Natural Resources
Data: DNR Wildlife & Heritage Div., 1995
GIS: DNR CCWS, July 2001
2
0
2
4 Miles

Submerged Aquatic Vegetation

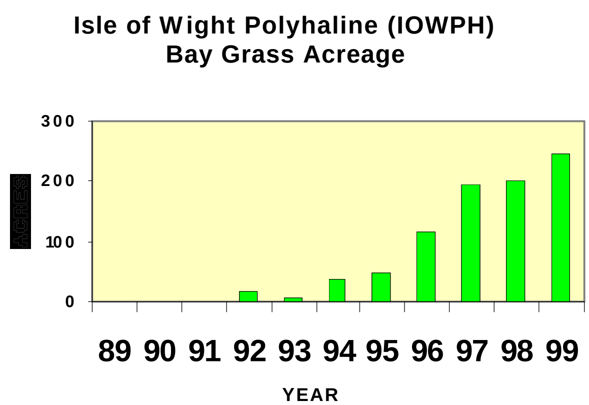
Submerged Aquatic Vegetation (SAV) is considered a significant natural resource in Maryland's tidal waters because it provides food and habitat for fish, waterfowl, and numerous aquatic organisms. It also provides a visible indication of good water quality and functions as an important stabilizer for sediments, a nutrient buffer, and it aids in water oxygenation.

Prior to the 1930s, SAV beds were extensive in the Coastal Bays. During the 1930s, extensive SAV beds died for unknown reasons. The low SAV population levels persisted until recent years. [43]

Abundance of SAV has been slowly increasing since the middle 1980's. SAV beds are limited to relatively shallow areas where adequate light can penetrate the water column for SAV growth.

SAV acreage in the Isle of Wight Bay has been increasing since 1991. The majority of the SAV acreage is located on the eastern shore of Isle of Wight Bay. New SAV beds appeared in 1999 in Turville Creek, and on the south and west shores of Isle of Wight. [14] Two species of SAV species are found in the Isle of Wight Bay area:

– *Ruppia maritima* - Widgeon grass
– *Zostera marina* - Eelgrass



The source of the SAV data shown here is the Virginia Institute of Marine Science. The most current SAV information (1999) is available online at the Virginia Institute of Marine Science website (http://www.vims.edu/bio/sav.) All 1999 SAV acreage data is still preliminary. DNR's Internet site MERLIN (http://www.mdmerlin.net) offers maps for viewing that show SAV bed presence by county for each year 1984 through 1996.

The US EPA Chesapeake Bay Program recently published an extensive assessment of water quality and habitat requirements for SAV. This document is available for viewing at www.chesapeakebay.net (under publications, key word SAV).

In addition to the annual tracking of SAV described above, aerial photography is currently being used to evaluate damage to SAV beds in the Coastal Bays from water-based activities (motor boats, jet skis, front establishments, hydraulic clam dredging, etc.)

RESTORATION TARGETING TOOLS
For The Isle of Wight Bay Watershed

1999 Stream Corridor Assessment

Within the Isle of Wight Bay watershed, a Stream Corridor Assessment was conducted in the St. Martin River by the DNR Watershed Restoration Division 1999. [24] This effort included on-the-ground assessment of the stream corridor conditions summarized below and water quality monitoring and a benthic organism assessment (presented elsewhere in this Characterization).

The Findings Summary Table indicates the range of potential problems identified during the assessment. In the table under severity frequency, columns 1 through 5 are a severity ranking with 1 being the most severe occurrences and 5 being the least severe. For the potential problems listed, the numbers shown in the columns under severity frequency are a count of occurrences for that problem category ranked by severity.

2000/2001 Stream Corridor Assessment

Using the Stream Corridor Assessment Methodology (SCAM) developed and applied by the DNR Watershed Restoration Division, additional valuable information can be compiled to assist in restoration activities. In partnership with Worcester County, DNR is conducting a Stream Corridor Assessment for the Isle of Wight Bay watershed during winter 2000/2001. Trained teams from the Maryland Conservation Corps will walk along streams to identify and document potential problems and restoration opportunities such as inadequate stream buffers. The team working in the Isle of Wight Bay received training relevant to coastal plain stream conditions and problems.

A report will be generated, including maps and photographs, to support targeting decisions for restoration projects. Draft data summaries are expected to be available in Summer 2001 with a final report by December 2001. The data from this assessment will provide an important companion report for this watershed characterization and will be used in development of the Watershed Restoration Action Strategy.

Findings Summary - St. Martin River Watershed Stream Corridor Assessment							
Potential Problems Identified	**Count**	**Length Est. feet / miles ***	**Severity Frequency**				
			1	**2**	**3**	**4**	**5**
Pipe Outfalls	6	--	--	5	--	--	1
Pond Sites	0	--					
Tree Blockages	0	--					
Inadequate Buffers *	24	94,870 / 18	--	6	7	6	5
Erosion	5	550 / 0.1	--	1	1	2	1
Fish Blockages	8	--	4	--	--	1	3
Channel Alternation	11	32,720 / 6.2	1	--	6	4	--
Exposed Pipe	1	6 / –	--	--	--	--	1
Unusual Conditions	3	--	--	--	--	2	1
Trash Dumping	0	--					
In or Near Stream Construction	0	--					
TOTAL	58	--	5	12	14	15	12

As used here, inadequate buffer means that natural vegetation at least 50 feet wide was not found adjacent to the stream on either side (100 foot total width). This buffer size and condition is being promoted by DNR to enhance natural resource conditions but it is not a requirement. Each side of the stream is reported separately. To generate the length estimate, the two sides of the stream are added together for a total. All other length estimates in the table are reported as a single linear measurement.

Clean Marinas Program

Overboard sewage discharges from boats are a concern for water quality because these discharges contribute nutrients, biological oxygen demand, pathogens, etc. These discharges are preventable if a sufficient number of pumpout facilities are locally available and boat operators take advantage of these services.

Sixteen of the twenty-seven marinas located in Worcester County are located in the Isle of Wight Bay waters. In the Isle of Wight Bay watershed, five marinas offer pumpout facilities and one of these five marinas is currently participating in Maryland's Clean Marinas Program as shown in Map 14 Fish Blockages and Marinas. The Clean Marinas Program is a voluntary way for marina owners to demonstrate that their pumpout service and other high quality boating services provided in accordance with Program guidelines are helping keep local waters clean.

One potential element of a Watershed Restoration Action Strategy (WRAS) is to encourage and/or support adding marina pumpout facilities serving the local area and increasing participation in the Clean Marinas Program.

Fish Blockages

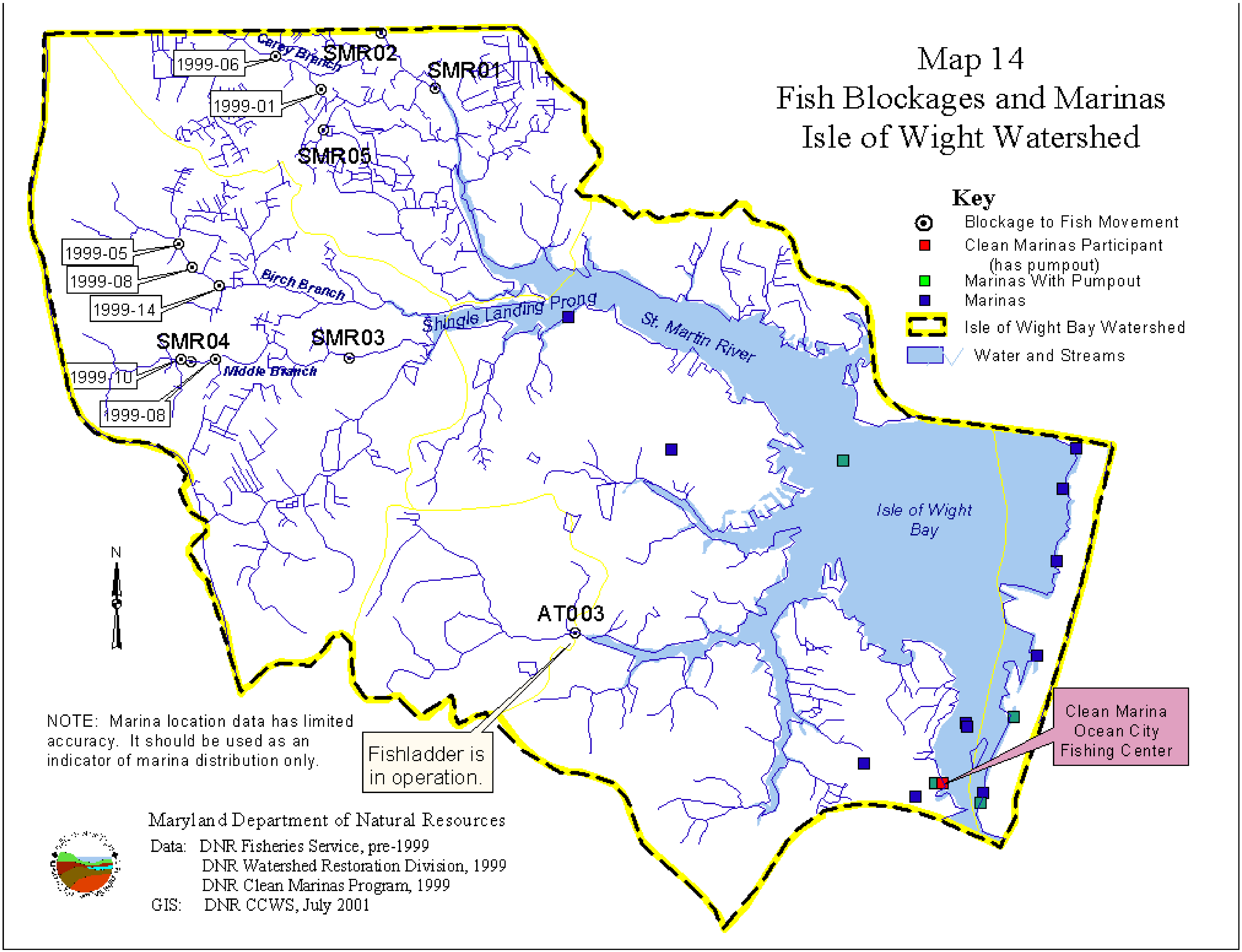
Many fish species need to move from one stream segment to the next in order to maintain healthy resilient populations. This is particularly true for anadromous fish species because they spawn and hatch from eggs in free flowing streams but live most of their lives in estuarine or ocean waters. Blockages in streams can inhibit or prevent many fish species from moving up stream to otherwise viable habitat.

To help prioritize stream blockages for mitigation or removal, the DNR Fish Passage Program maintains a database of significant blockages to fish movement. In addition, new information on blockages is being collected like the blockages identified during the recent Stream Corridor Assessment in the Isle of Wight Bay watershed. A summary of the 13 blockages in the Isle of Wight Bay watershed known as of December 2000 appears in the Fish Blockages Table and Map 14 Fish Blockages and Marinas. One of these has been corrected. As additional Stream Corridor Assessment is done, it is likely that additional potential fish blockage problems will be identified.

Some blockages to fish movement may be structural components of drainage ditches and/or Public Drainage Associations (PDAs). If a blockage is found to be in this category, circumstances like requirements for drainage control function and public need are considered in determining the potential for a restoration project.

Fish Blockages Known in the Isle of Wight Bay Watershed				
Stream Affected		Station *	Blockage Corrected	Name / Location of Fish Blockage
Bishopville Prong Tributaries	Bunting Creek	SMR01		Route 367
	Bunting Creek	SMR02		1.5 miles north of Route 367
	Carey Branch	1999-06		grade control structure, total blockage
	Carey Branch	1999-01		grade control structure, total blockage
	Slab Bridge Prong	SMR05		Old Stage Road
Shingle Landing Prong Tributaries	Birch Branch	1999-05		grade control structure (dam), total blockage
	Birch Branch	1999-08		grade control structure (dam), total blockage
	Birch Branch	1999-14		grade control structure (dam), total blockage
	Middle Branch	SMR03	projected	Route 113, fishway under design
	Middle Branch	1999-08		shallow water caused by low dam
	Middle Branch	SMR04 1999-09		Campbelltown Road. When culvert replacement occurs, regulatory design requirements will eliminate the blockage.
	West Middle Branch	1999-10		shallow water caused by low dam
	Turville Creek	AT003	yes	Route 589 culvert, fishway is in place

* Lettered station names are in the fish blockage data base based on pre-1999 information. Dated station names (1999), were newly identified during the 1999 stream corridor assessment in the St. Martin River watershed.



Map 14
Fish Blockages and Marinas
Isle of Wight Watershed
Key
Blockage to Fish Movement
Clean Marinas Participant (has pumpout)
Marinas With Pumpout
Marinas
Isle of Wight Bay Watershed
Water and Streams
SMR02
SMR01
SMR05
SMR04
SMR03
AT003
1999-06
1999-01
1999-05
1999-08
1999-14
1999-10
1999-08
Carey Branch
Birch Branch
Middle Branch
Shingle Landing Prong
St. Martin River
Isle of Wight Bay
Clean Marina Ocean City Fishing Center
Fishladder is in operation.
N
NOTE: Marina location data has limited accuracy. It should be used as an indicator of marina distribution only.
Maryland Department of Natural Resources
Data: DNR Fisheries Service, pre-1999
DNR Watershed Restoration Division, 1999
DNR Clean Marinas Program, 1999
GIS: DNR CCWS, July 2001

Stream Buffer Restoration

1. Benefits and General Recommendations

In the1999 Stream Corridor Assessment, 45% of the streams assessed in the St. Martin River watershed did not have buffers that were at least 50 feet of natural vegetation on each side of the stream (100 feet total). The assessment covered 20 linear miles of streams with the left and right banks handled separately. Of the 40 miles of stream bank assessed. 18 miles of stream bank buffer were found to be inadequate. In the same assessment, Church Branch was found to have significant riparian areas with natural vegetation intact.[23]

Expanding areas with natural vegetation in stream riparian zones serves as stream buffer that can provide 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.

To realize these environmental benefits, DNR generally recommends that forested stream buffers be at least 100 feet wide , i.e. natural vegetation 50 feet wide on either side of the stream. Therefore, DNR is promoting this type of stream buffer for local jurisdictions and land owners who are willing to go beyond the minimum buffers standards. The DNR Watershed Restoration Division and other programs like CREP are available to assist land owners who volunteer to explore these opportunities.

A determination of the impacts and compatibility of instituting buffers can be assessed using various methods including those discussed in this section. These methods, combined with other local factors like water quality, land owner and community interests, etc. can be used to establish priorities for buffer restoration.

2. Using GIS

Identifying the areas that could benefit from stream buffer restoration, prioritizing them for projects and tracking protected areas is often a time-consuming and expensive effort. Fortunately, use of a computerized Geographic Information System (GIS) to manipulate remote sensing data can help save limited time and funds. To assist in this technical endeavor, DNR Watershed Management and Analysis Division has developed GIS-based tools to assist in the buffer restoration targeting process. With these tools, GIS maps and other information can be generated to help select stream segments for additional Stream Corridor Assessment, to identify geographic areas for community and land owner contact and for similar uses. Then, with an appropriate level of on-the-ground verification or "ground truthing," these GIS tools can provide an efficient first step toward stream buffer restoration.

Several scenarios are presented here to help consider potential areas for stream buffer restoration. These scenarios can be used alone or in combination as models for targeting and field verifying potential restoration sites. These maps are intended to demonstrate a methodology that can be used to locate sites having a high probability of optimizing certain ecological benefits. The resolution of the data used to generate these maps is not sufficient for an accurate site assessment, but can be used to identify potential candidate sites for detailed investigation.

3. Headwater Stream Buffers

Headwater streams are also called First Order Streams. These streams, unlike other streams (Second Order, etc.), intercept all of the surface runoff within the watersheds that they drain. In addition, for many watersheds, first order streams drain the majority of the land within the entire watershed. Therefore, stream buffers restored along headwater streams (First Order) 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 which 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 habitat for aquatic resources.

4. Land Use and Stream Buffers

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 as shown in the accompanying table's generalized data. As the table indicates, crop land typically contributes the greats nutrient and sediment loads. However, under some conditions urban land can contribute higher phosphorus loads.

By identifying land uses in riparian areas with inadequate stream buffers, like crop land adjacent to streams, potential to reduce nutrient and sediment loads can be improved. To assist in finding areas with crop land adjacent to streams, the same land use data shown in Map 7 1997 Generalized Land Use can be filtered using GIS. The new scenario shown in Map 15 Land Use Scenario Map focuses on the land use within 150 feet of a

Nonpoint Source Pollution Load Rates By Land Use
Chesapeake Bay Watershed Model, in kg/ha-yr

Land Use		Nitrogen	Phosphorus	Sediment
Crop land		17.11	1.21	0.74
Urban	Impervious	8.43	0.58	0.00
	Pervious	10.79	1.56	0.20
Pasture		8.40	1.15	0.30
Forest		1.42	0.00	0.03

stream. This view, supplemented with the land use pollution loading rates, suggests potential buffer restoration opportunities that could maximize nutrient and sediment loads.

5. Nutrient Uptake from Hydric Soils in Stream Buffers

In general, the nutrient nitrogen moves from the land into streams in surface water runoff and in groundwater. In watersheds like the Isle of Wight Bay, a relatively high percentage of nitrogen, and perhaps the majority, enters streams in groundwater.[36] Stream buffers can be used to capture nitrogen moving in groundwater if buffer restoration projects have several attributes:
– Plant with roots deep enough to intercept groundwater as it moves toward the stream
– Plants with high nitrogen uptake capability, and
– Targeting buffer restoration projects to maximize groundwater inception by buffer plants.

Hydric soils in riparian areas can be used as one factor to help select stream buffer restoration sites.   Siting buffer restoration on hydric soils would offer several benefits:
– Plant roots are more likely to be in contact with groundwater for longer periods of time
– Hydric soils tend to be marginal for many agricultural and urban land uses
– Natural vegetation in wet areas often offers greater potential for habitat.

Map 16 Nutrient Retention Using Hydric Soils Scenario identifies lands adjacent to streams that are on hydric soil and also have insufficient stream buffers in the Isle of Wight Bay watershed. To generate the map, hydric soils (Natural Soils Group of Maryland, MDP) were grouped into three classes and rated in terms of their potential to maximize groundwater/root zone interaction: tidal and marsh soils (very high), poorly drained hydric soils (high), and moderately well drained hydric soils (moderately high). An important next step in using this information is verification of field conditions. Care must be taken during field validation to evaluate any hydrologic modification of these soils, such as ditching or draining activities, which would serve to decrease potential benefits.

6. Wetland Associations

Wetlands and adjacent natural uplands form complex habitats that offer a range of habitat opportunities for many species. These "habitat complexes" tend to offer greater species diversity and other ecological values that are greater than the values that the wetland or uplands could offer independently. Therefore, restoring stream buffers adjacent to or near to existing wetlands tends to offer greater habitat benefits than the restoration project could otherwise produce. Map 18 Wetland Proximity Scenario identifies unforested buffers zones that are in close proximity (within 300 feet) to wetlands (National Wetlands Inventory). Restoration projects in these areas may offer opportunities to enhance and expand wetland habitat in addition to the other desirable buffer functions.

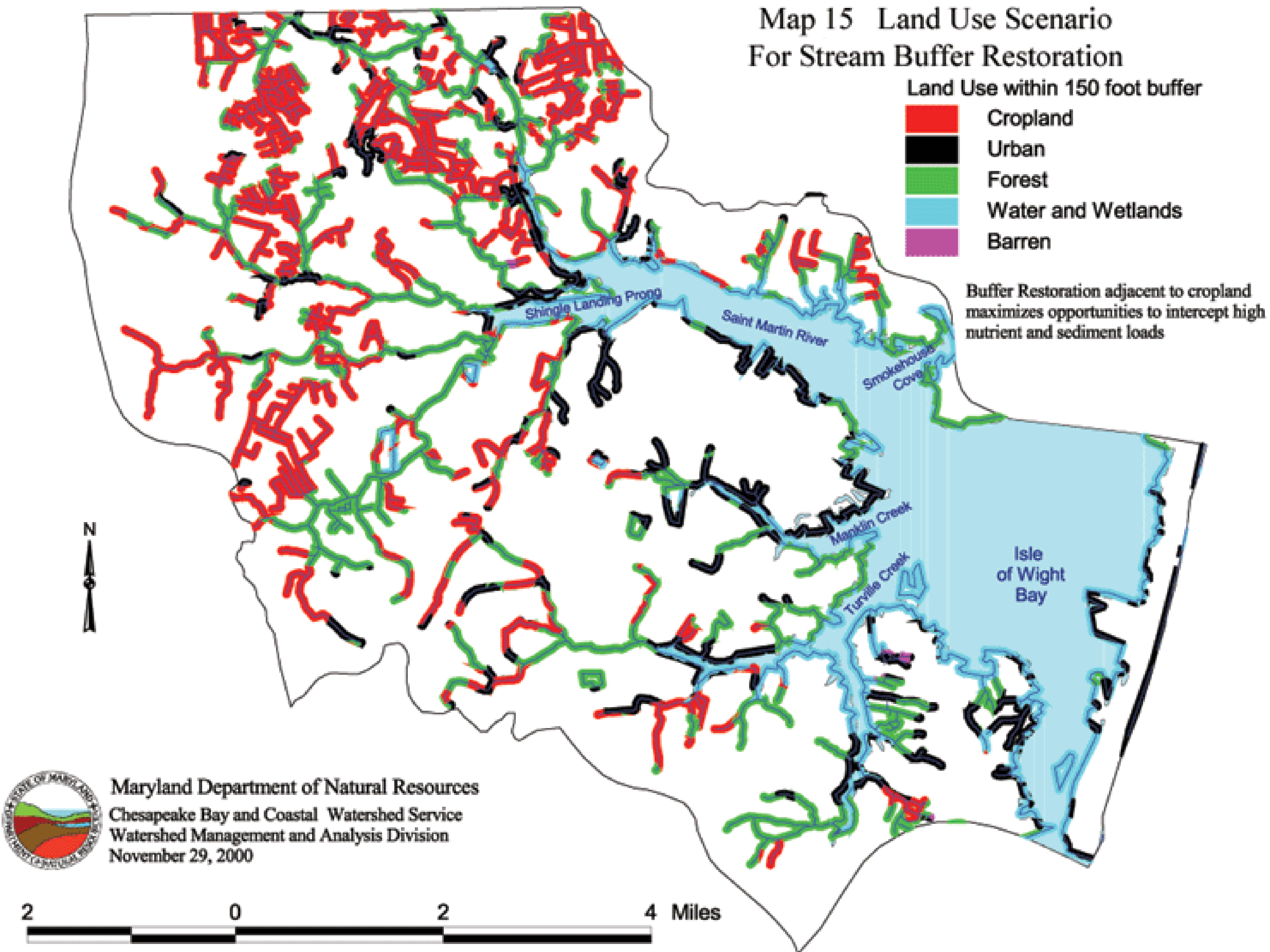
7. Optimizing Water Quality Benefits by Combining Priorities

Strategic targeting of stream buffer restoration projects can take into account many different potential benefits. Several of these scenarios are presented independently in this section. However, site selection and project design generally incorporate numerous factors to optimize benefits from the project. 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 in the riparian zone
– headwater stream
– hydric soils
– selecting appropriate woody/grass species
– adjacent to existing wetlands / habitat

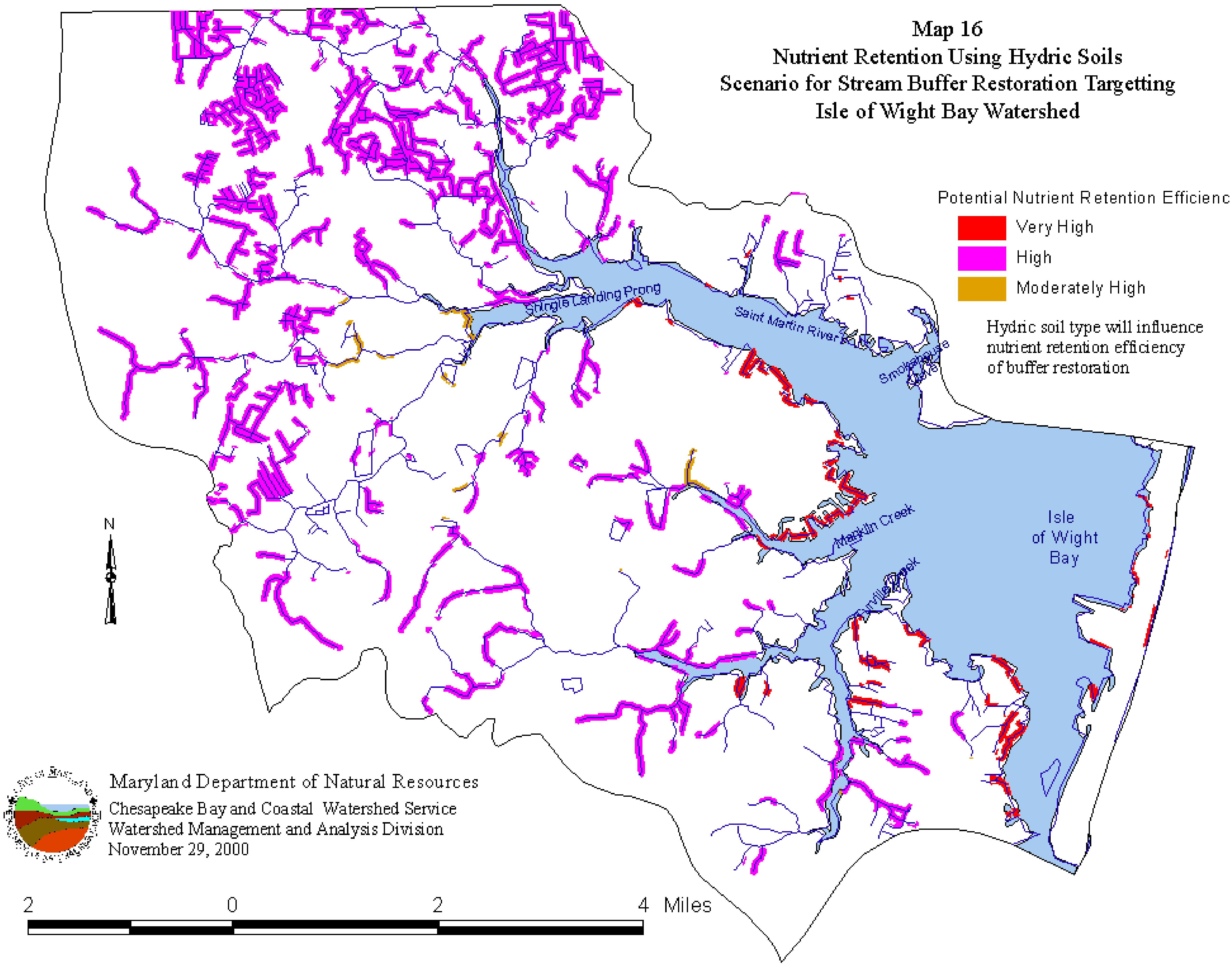
Two of many possible scenarios for prioritizing stream segments as candidates for additional investigation as examples. Map 17 Nutrient Retention Scenario: Hydric Soils Associated With Cropland suggests that targeting buffer restoration on hydric soils between a stream and cropland may offer the greatest reduction in nutrients reaching the stream.

Map 19 Prioritizing Streams Scenario combines several elements discussed here into one possible scenario: lack of adequate naturally vegetated buffers, land use adjacent to the stream and headwater stream status.



Map 15 Land Use Scenario
For Stream Buffer Restoration
Land Use within 150 foot buffer
Cropland
Urban
Forest
Water and Wetlands
Barren
Buffer Restoration adjacent to cropland maximizes opportunities to intercept high nutrient and sediment loads
Shingle Landing Prong
Saint Martin River
Smokehouse Cove
Manklin Creek
Turville Creek
Isle of Wight Bay
N
Maryland Department of Natural Resources
Chesapeake Bay and Coastal Watershed Service
Watershed Management and Analysis Division
November 29, 2000
2
0
2
4 Miles

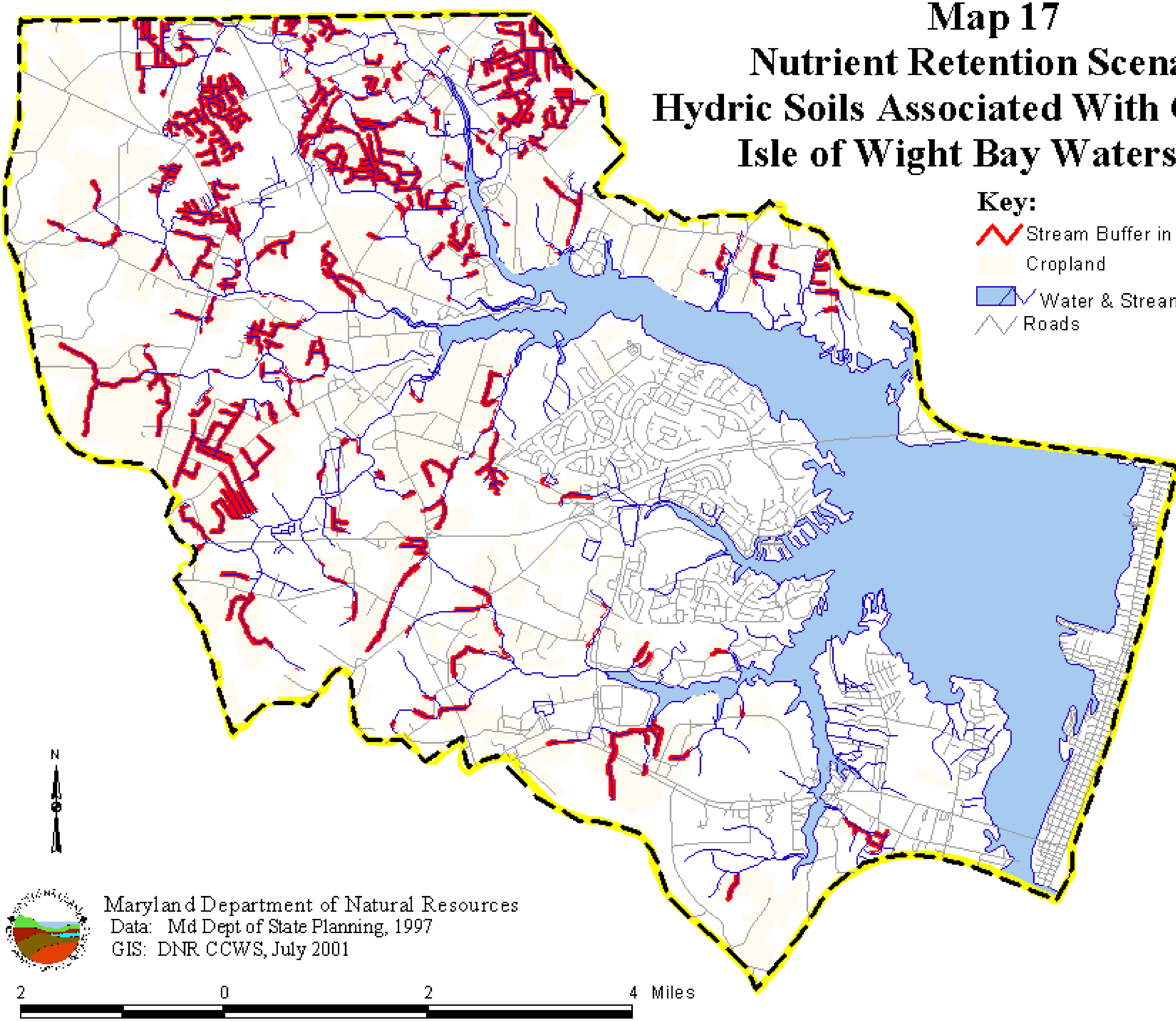
Map 16
Nutrient Retention Using Hydric Soils
Scenario for Stream Buffer Restoration Targetting
Isle of Wight Bay Watershed



Map 17
Nutrient Retention Scenario
Hydric Soils Associated With Cropland
Isle of Wight Bay Watershed

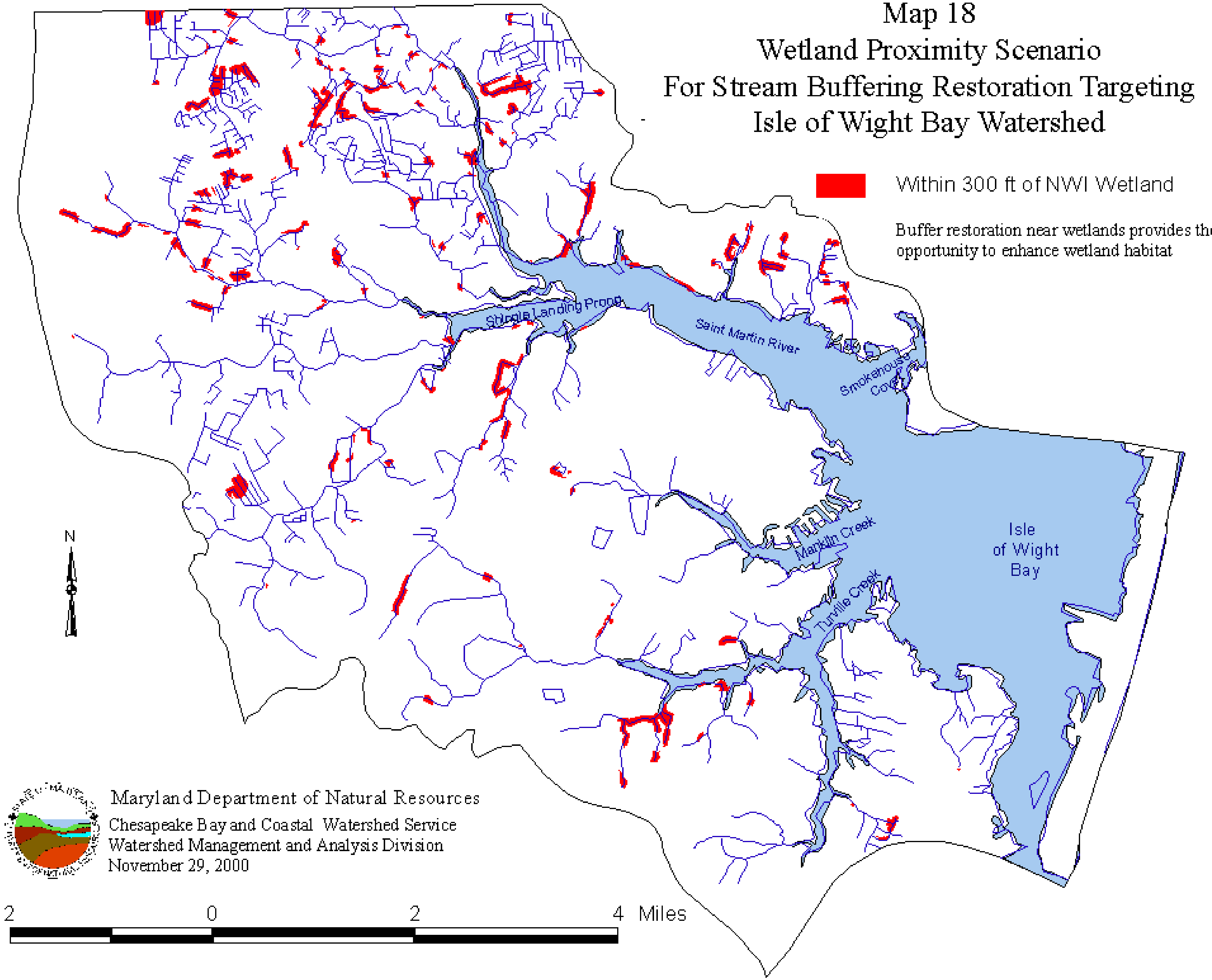
Key:

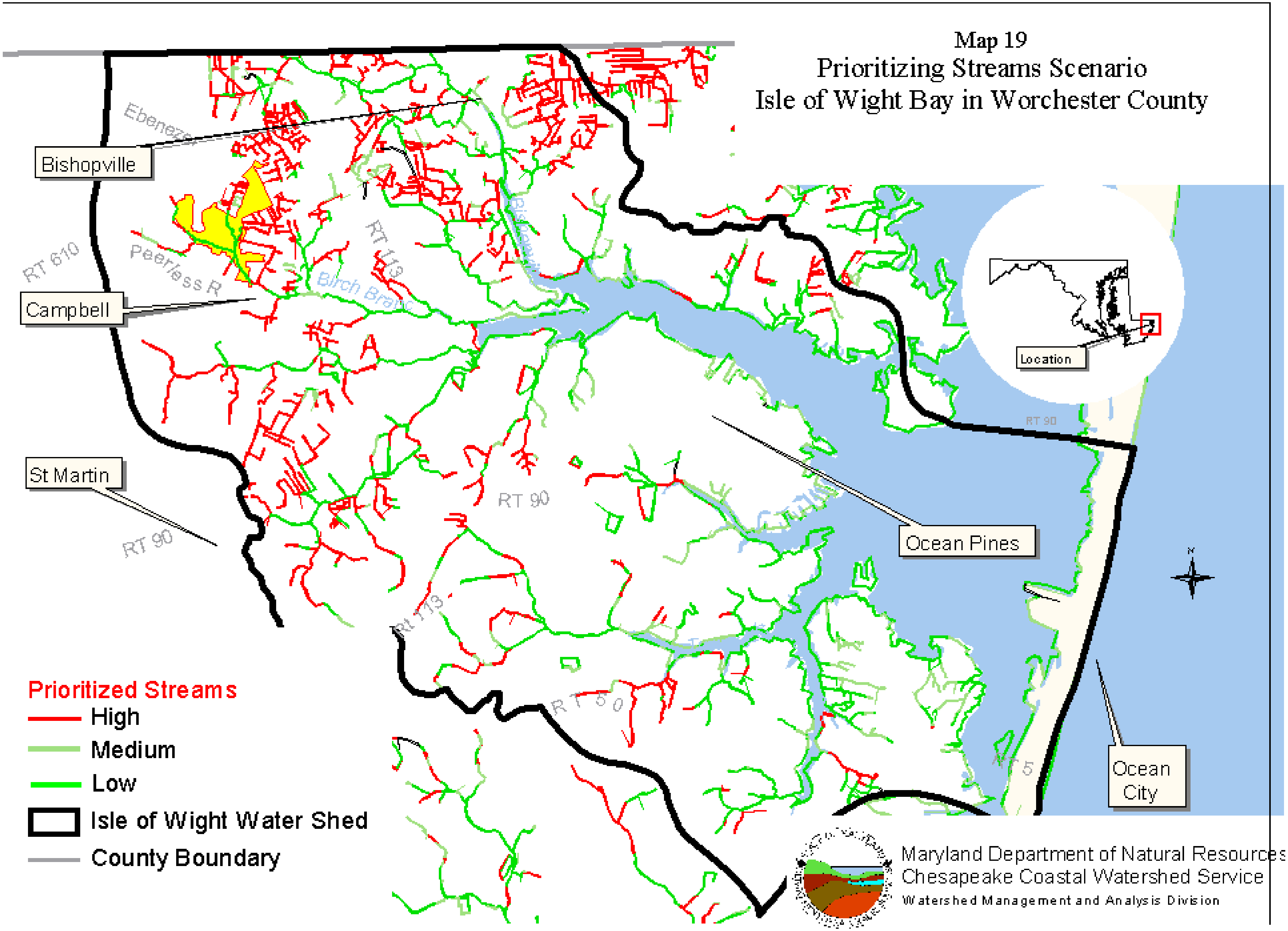
- Stream Buffer in Cropland
- Cropland
- Water & Streams
- Roads



Maryland Department of Natural Resources
Data: Md Dept of State Planning, 1997
GIS: DNR CCWS, July 2001

Map 18
Wetland Proximity Scenario
For Stream Buffering Restoration Targeting
Isle of Wight Bay Watershed




Map 19
Prioritizing Streams Scenario
Isle of Wight Bay in Worchester County
Bishopville
Campbell
St Martin
Ocean Pines
Ocean City
Location
RT 610
RT 90
RT 113
RT 50
Peerless R
Birch Branc
Prioritized Streams
High
Medium
Low
Isle of Wight Water Shed
County Boundary
Maryland Department of Natural Resources
Chesapeake Coastal Watershed Service
Watershed Management and Analysis Division

Wetland Restoration

Wetlands serve important environmental functions such as providing habitat and nursery areas for many organisms, nutrient uptake and recycling, erosion control, etc. However, most watersheds in Maryland have significantly fewer wetland acres today than in the past. This loss due to draining, filling, etc. has led to habitat loss and water quality impacts in streams and estuaries. Reversing this historic trend is an important goal of wetland restoration. One approach to finding candidate wetland restoration sites involves identification of “historic” wetland areas. In this approach, identifying areas of hydric soils is the first step in the investigation. This step in the process can be accelerated by using GIS to manipulate soils information with other data like land use. The GIS products can then assist in initiating the candidate site search process, targeting site investigations and helping to identify land owners.

For the Isle of Wight Bay watershed, GIS was used to map and prioritize areas of hydric soil for potential wetland restoration. The steps and priorities used to generate the map are listed below:

– Data used: Hydric soils (Natural Soil Group), existing wetlands (National Wetland Inventory), land use (Dept. Of State Planning, 1997).

– Identify candidate hydric soil areas based on land use. Hydric soils on open land (agricultural fields, bare ground, etc.) are retained while those underlying natural vegetation and urban lands are excluded.

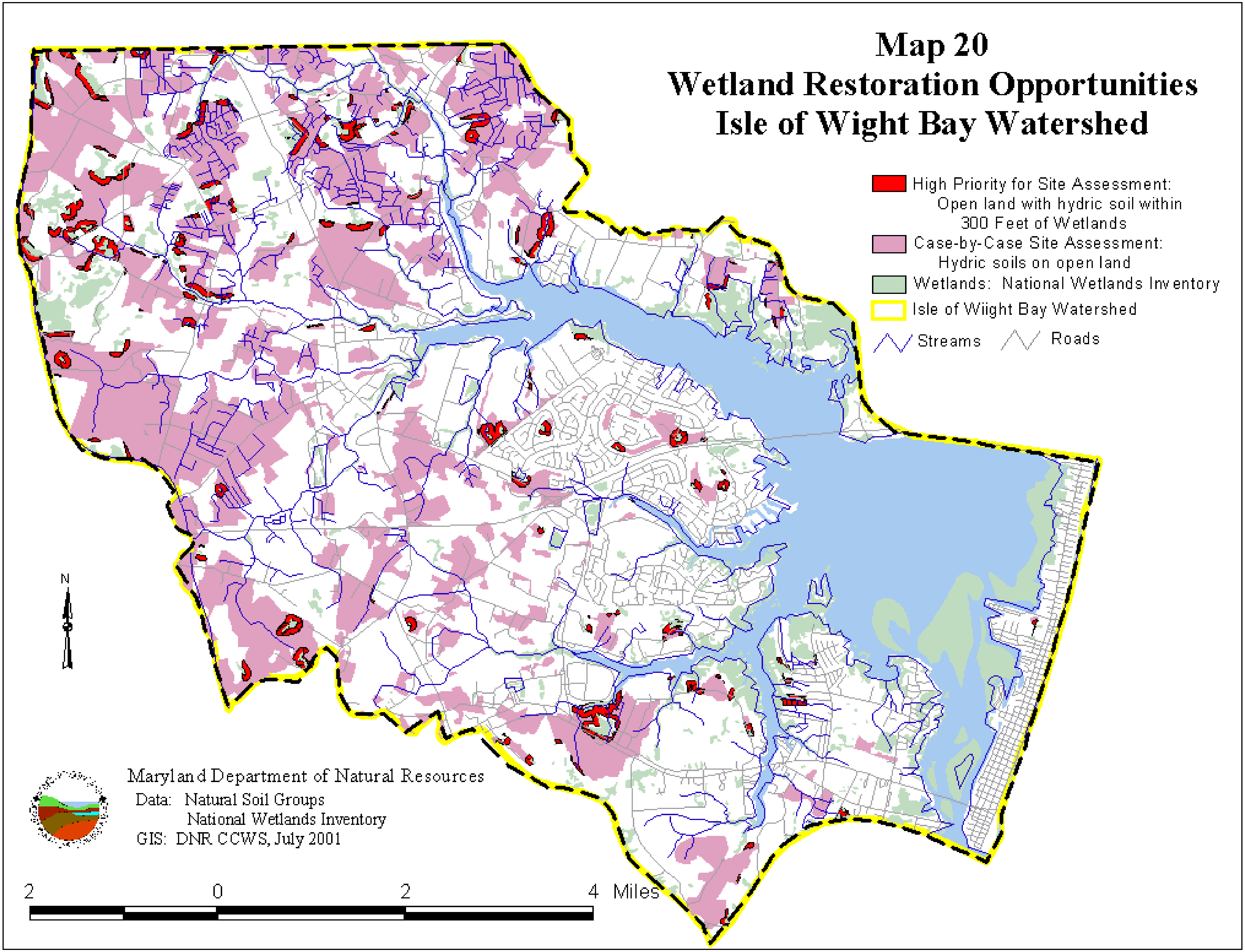
– Explore hydric soils based on proximity to existing wetlands or streams. In the Isle of Wight Bay watershed, hydric soils occur adjacent to existing wetland with significant frequency.

Two scenarios for the first step in finding potential wetland restoration sites are presented in accompanying maps:

– Map 20 Wetland Restoration Opportunities shows approximately 100 sites that fit three criteria: 1) hydric soil, 2) on open land, and 3) within 300 feet of existing wetlands.

– Map 19 Opportunities to Maximize Nutrient Retention shows numerous potential wetland restoration sites considering: 1) hydric soils, 2) on open land, 3) adjacent to streams, and 4) potential to address nutrients in groundwater based on soil type.

The potential wetland restoration sites suggested in these scenarios can be filtered further by using more accurate wetlands and soil information, considering landownership, etc. Additional steps to apply this information would likely include considering additional criteria like habitat enhancement opportunities, sensitive species protection, targeting specific streams or subwatersheds for intensive restoration, using Conservation Reserve Enhancement Program (CREP) information, etc.


Map 20
Wetland Restoration Opportunities
Isle of Wight Bay Watershed
High Priority for Site Assessment: Open land with hydric soil within 300 Feet of Wetlands
Case-by-Case Site Assessment: Hydric soils on open land
Wetlands: National Wetlands Inventory
Isle of Wiight Bay Watershed
Streams
Roads
N
Maryland Department of Natural Resources
Data: Natural Soil Groups
National Wetlands Inventory
GIS: DNR CCWS, July 2001
2
0
2
4 Miles

PROJECTS RELATED TO THE WRAS PROCESS

Isle of Wight Bay Watershed

Overview

There are numerous projects and programs that have the potential to contribute to successful development and implementation of a Watershed Restoration Action Strategy (WRAS). The listing included here suggests opportunities for cooperation and coordination that can improve the likelihood of success for the WRAS. This listing is not all-inclusive -- additions should be made to include other related projects. Additionally, follow-up should continue to be undertaken to promote the WRAS process with these and other projects and programs.

319(h)-Funded Projects

The Federal funding via the Clean Water Act section generally known as "319" is funding several projects affecting the Isle of Wight Bay watershed:

Smith Farm. This farm is currently in agricultural production. The 2-acre wetland restoration site is directly adjacent to Middle Branch which is a tributary to the St Martin River. Work at this site will include the installation of a low profile berm and minor grading to provide diverse habitats. The wetland area will be managed for native herbaceous vegetation through moist soil management.

Coastal Bays Forestry Initiative. This project funded a contractual position in the MD DNR Forest Service beginning June 1999 for two years to improve water quality, enhance living resource habitat and promote sustainable forest management by:

– Preparing a Comprehensive Forestry Strategy for the Maryland Coastal Bays,
– Increasing awareness and use of forest harvesting best management practices (BMPs),
– Providing technical support to install 10 miles of riparian forest buffers, and
– Implementing forest conservation easements through Forest Legacy.

Septic System Nutrient Input Reduction. The project will improve the water quality in the Maryland Coastal Bays through the initiation of a tracking system for onsite septic systems in the county and by the installation of alternative and innovative systems. This project is expected to reduce the amount of nutrient flow into the bays from groundwater by

– Implementing a septic tracking system in Worcester County.
– Demonstrating projects to show the utility of the tracking system in the identification and retrofitting of inefficient systems.
– Working to designate the Coastal Bays as an "Area of Special Concern."
– Developing educational materials on maintaining/operating onsite disposal systems and alternative/innovative on-site disposal systems.

Progressive Best Management Practices for Lower Eastern Shore Public Drainage Associations (PDA) - A Demonstration Project. The Maryland Dept. of Agriculture project funded from June 1999 through September 2000 is intended to improve water quality in the

Lower Eastern Shore by installing best management practices on PDAs to reduce the amount of sediment flow and nutrients into rivers that receive agricultural drainage by:

– Installing weirs or other water control structures on 50 miles of public drainage systems for water quality improvement.
– Demonstrating the viability of pocket wetland systems on public drainage systems on the Lower Eastern Shore.
– Providing cost-share funds for repair and stabilization of emergency blowouts, channel obstructions and weir maintenance on existing PDAs for water quality protection.
– Providing cost-share funds to increase PDA buffer protection and maintenance areas up to 35 feet from the drainage system center line.

Other Projects

This section summarizes projects that have the potential to contribute to development and implementation of the Watershed Restoration Action Strategy that have not been addressed elsewhere in the watershed characterization

Conservation Reserve Program (CRP). The CRP program pays farmers on a per acre basis to remove fields from production. One of numerous benefits from the program is reduction of sediment and nutrient movement into streams.

Conservation and Restoration Enhancement Program (CREP). The CREP program reimburses farmers who restore stream riparian areas to natural vegetation. Under the program, this land creates new or enhanced stream buffer which is placed under a conservation easement.

Greenways. The Year 2000 edition of the Maryland Greenways Atlas identifies Greenway and Green Infrastructure projects and issues important to Worcester County and the Isle of Wight Bay watershed.

POTENTIAL BENCHMARKS FOR WRAS GOAL SETTING

Several programs designed to manage water quality and/or living resources have existing or proposed goals that are relevant to setting goals for the Isle of Wight Bay Watershed Restoration Action Strategy (WRAS). The goals from these other programs tend to overlap and run parallel to potential interests for developing WRAS goals. Therefore, to assist in WRAS development, selected goals from other programs are included here as points of reference.

Maryland Coastal Bays Watershed Conservation and Management Plan for the Land and Waters of Assawoman, Isle of Wight, Newport, Sinepuxent and Chincoteague Bays.

– Numerous goals and objectives that are currently in place or in revision will provide important guidance and benchmarks for the WRAS process.

Goals from the *Clean Water Action Plan* [3]:

– Clean Water Goals - Maryland watersheds should meet water quality standards, including numerical criteria as well as narrative standards and designated uses.

– Other Natural Resource Goals - Watersheds should achieve healthy conditions as indicated by natural resource indicators related to the condition of the water itself (e.g., water chemistry), aquatic living resources and physical habitat, as well as landscape factors (e.g., buffered streams and wetland restoration).

Draft Total Maximum Daily Load

– "A chlorophyll *a* goal of 50 *ug*/l will be used in the tributaries to the open bays." [17] (See TMDL section for additional details.)

Water Quality Improvement Act of 1998

– The most significant feature is requiring nutrient management plans for virtually all Maryland farms. The requirement is being phased in over a several year period:
  - Nitrogen-based plan implementation will be required in 2002
  - Phosphorus-based plan implementation will be required in 2005

– Assistance with costs of manure transportation has the potential to move nutrients to sites where they are needed.

ADDITIONAL INFORMATION

Sources Used for the Characterization

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Linder, C.C. *Ecological Integrity of Maryland's Coastal Bays: Effects of Water Quality, Physical Habitat and Land Use Characteristics.* Published by DNR. 1996.

Wells, D.V. *Geochemistry and Geophysical Framework of the Shallow Sediments of Assawoman Bay and Isle of Wight Bay in Maryland.*

Bathymetry and Tide Data: not addressed. Year 2000 hydrographic surveys and tide data for St. Martin River and Isle of Wight are available from Maryland Geological Survey (MGS) or the Army Corps of Engineers.

Bottom Sediment Characteristics: not addressed (Available from MGS for the St. Martin River and Isle of Wight Bay including physical and chemical characteristics including sulfur, metals and total nutrients/carbon.)

Geology: not addressed (Substrate-Coastal Plain sediments- generalized geology map of watershed is available from MGS.)

Green Infrastructure: Digital remote imagery and land cover interpretation.

Groundwater: Assessment limited to qualitative description and listing of groundwater discharges. (MGS and US Geological Survey have more information.)

Land Use: Generalized land use from Md. Department of Planning (MDP). This data does not account for nontidal wetlands within land use categories.

Soils: Natural Soils Groups (More detailed digital soil survey of Worcester Co., Md. available from web site: www.ftw.nrcs.usda.gov/ssur_data.html)

Wetlands: National Wetlands Inventory (more detailed DNR digital wetlands data are available.)

Abbreviation Key

CCWS - Chesapeake and Coastal Watershed Service (Part of DNR)
COMAR - Code Of Maryland Regulations (Maryland State regulations)
CREP - Conservation and Restoration Enhancement Program (program of MDA)
CRP - Conservation Reserve Program (program of MDA)
CWAP - Clean Water Action Plan (Adopted by Maryland December 1998)
DCP - Department of Comprehensive Planning, Worcester County
DNR - Department of Natural Resources (Maryland State)
EPA - Environmental Protection Agency (United States)
MBSS - Maryland Biological Stream Survey (program in DNR RAS)
MDA - Maryland Department of Agriculture
MDE - Maryland Department of the Environment
MDP - Maryland Department of Planning
MET - Maryland Environmental Trust
MGS - Maryland Geological Survey
NHA - Natural Heritage Area (designation by DNR in COMAR)
NOAA - National Oceanagraphic and Atmospheric Agency
PDA - Public Drainage Association
RAS - Resource Assessment Service (part of DNR)
SAV - Submerged Aquatic Vegetation
SSPRA - Sensitive Species Protection Review Area (designation by DNR)
TMDL - Total Maximum Daily Loads
USFWS - United States Fish and Wildlife Service
USGS - United State Geological Survey
WRAS - Watershed Restoration Action Strategy (funding/assistance project by DNR)
WSSC - Wetland of Special State Concern (designation by MDE in COMAR)

Contacts for More Information
Isle of Wight Bay Watershed
Watershed Restoration Action Strategy (WRAS)

Worcester County	
Department of Comprehensive Planning. Sandy Coyman, Director	410-632-5651
Maryland Department of Natural Resources	
Watershed Restoration Action Strategy Coordinator(s)	
Statewide, Katharine Dowell	410-260-8741
Coastal Bays, Mary Conley	410-260-8984
Watershed Characterization	
Ken Shanks	410-260-8786
Watershed Restoration	
Kevin Smith	410-260-8797

Technical Reports Referenced

Algae Including Phytoplankton, Harmful Algal Blooms and Macroalgae [34]

Delaware's Bunting Branch Watershed [32]

Land Use Technical Report
Isle of Wight Bay Watershed
Worcester County, Maryland
November 30, 2000

- Maryland and Delaware Land Use Summary
- 1997 Land Use Summary
- Land Use Changes 1985 to 1990
- Map of Significant Land Use Change 1985 to 1990

Maryland and Delaware Land Use Summary
Headwaters to the Isle of Wight Bay Watershed
Worcester County, Maryland

The States of Delaware and Maryland share portions of the watersheds that drain toward the embayments near Ocean City on the Atlantic Coast. Each State refers to these watersheds by different names. For the watershed addressed in this report, the names used are listed here:

- In Maryland: Isle of Wight Bay watershed.
- In Delaware: Buntings Branch watershed.

The majority of Delaware's portion of the watershed drains to Buntings Branch before entering Maryland. The remainder flows into Maryland via Carey Branch and unnamed surface ditches west of Carey Branch and east of Buntings Branch.

This appendix summarizes water quality and related information for the Delaware portion of the watershed. Its contents are taken directly from the 1996 *State of Delaware Watershed Assessment Report* which was prepared pursuant to Section 305(b) of the Federal Clean Water Act.

Land Use in the Isle of Wight Bay Watershed

Category	**Delaware**		**Maryland**	
	Acres	Percent	Acres	Percent
Agriculture	not reported	46	12,463	37
Forest	not reported	41	12,310	37
Urban	not reported	9	7,830	23
Other	not reported	4	1,008	3
Total By State	6,300	100	33,611	100
Total for Watershed: 39,911 acres				

1997 Land Use Summary for the Isle of Wight Bay Watershed – Worcester County Only Maryland Department of Planning Estimates							
Category	**Acres**	**Percent of Watershed**	**Land Use**	**Code #**	**Acres**	**Percent of Category**	**Percent of Watershed**
Agriculture	12,463	30	Row Crop	21	11753	94	29
			Pasture	22	6	--	--
			Row and Garden Crops	25	74	1	--
			Feeding Operations	241	589	5	1
			Ag Building	242	41	–	--
Forest *	12,310	30	Deciduous	41	709	6	2
			Evergreen	42	838	7	2
			Mixed Deciduous & Evergreen	43	10509	85	26
			Brush	44	254	2	1
Urban	7,830	19	Residential Low Density	11	2019	26	5
			Residential Medium Density	12	2774	35	7
			Residential High Density	13	326	4	1
			Commercial	14	1634	21	4
			Industrial	15	32	1	--
			Institutional	16	160	2	--
			Open Urban Land	18	885	11	2
Water	7,509	18		50	7509	100	18
Wetlands*	899	2		60	899	100	2
Other	109	1	Beaches	71	65	60	--
			Bare Ground	73	44	40	--
TOTAL	41,120		Isle of Wight Bay (Worcester Co.)		41120		100

* Ground survey is needed to establish percentage of forest cover types (deciduous, etc.); also to look at age, density and diversity.

* Wetlands counted here are those large tidal marshes and emergent wetlands that can be identified using remote sensing. In this table's accounting of wetlands, many nontidal wetlands, particularly those with woody vegetation, are included under forest and other land uses.

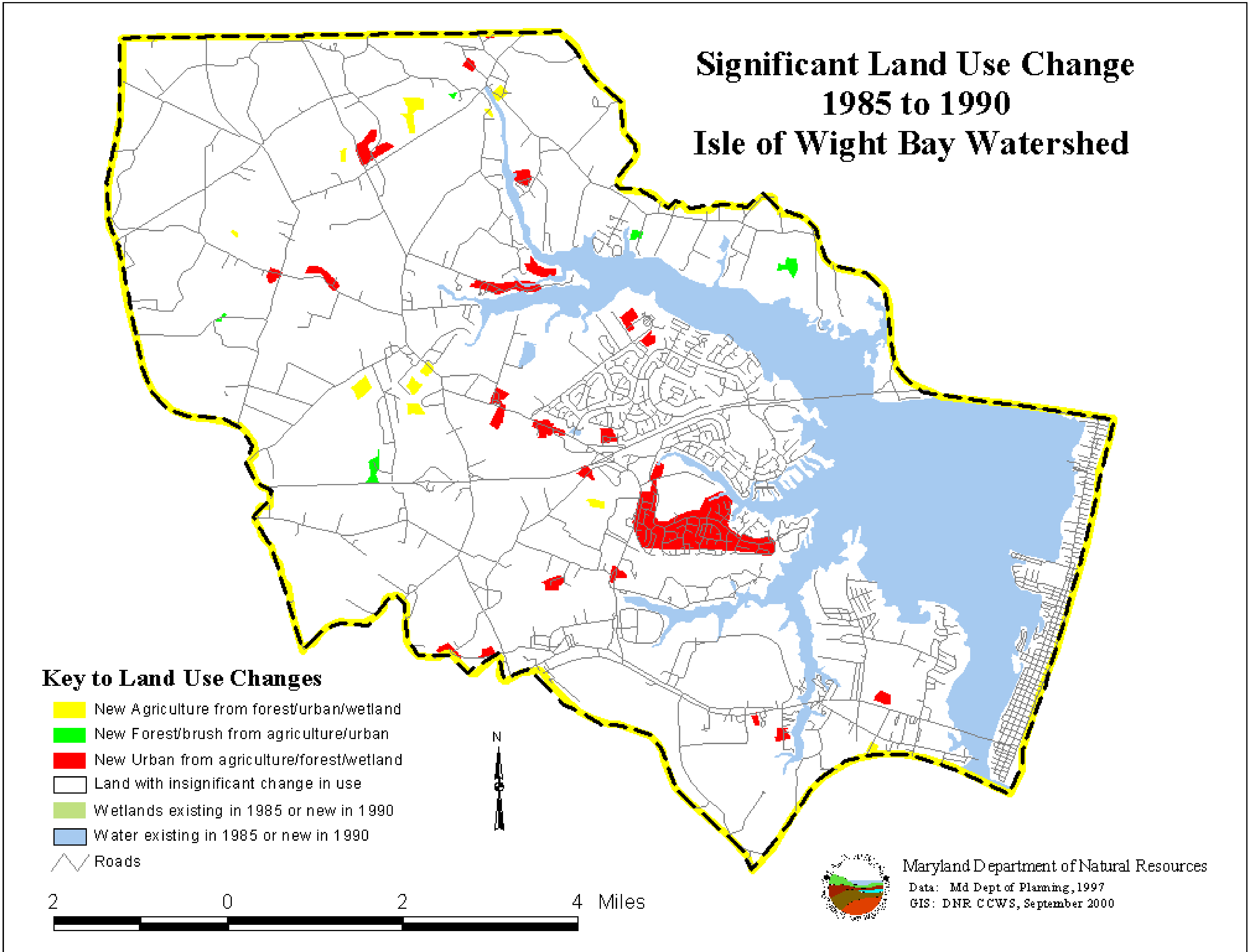
Land Use Change 1985 to 1990

Worcester County and the Isle of Wight Bay Watershed have experienced significant pressures for change in land use due to two very different factors: 1) an increase in residential and commercial development, and 2) the agricultural shift to chicken production. For example as summarized in the accompanying map for the Isle of Wight Bay watershed, significant land use change for the period 1985 to 1990 exhibits several characteristics:

– Creation of “new urban land” from agriculture/forest/wetlands accounts for most significant land use change in terms of land area.

– Creation of “new” agriculture or forest/brush land from other land uses is less significant in terms of land area. However, the mapped information suggests that 12 new feeding operations were created between 1985 and 1990. Change of this kind has the potential to be significant in terms of nutrient management issues.

– Several patterns of land use change in the 1985 to 1990 period are apparent . New urban land tends to be near water and near major roadways. New agriculture land and/or feeding operations are relatively dispersed throughout the Isle of Wight Bay watershed.



Significant Land Use Change
1985 to 1990
Isle of Wight Bay Watershed
Key to Land Use Changes
New Agriculture from forest/urban/wetland
New Forest/brush from agriculture/urban
New Urban from agriculture/forest/wetland
Land with insignificant change in use
Wetlands existing in 1985 or new in 1990
Water existing in 1985 or new in 1990
Roads
N
2 0 2 4 Miles
Maryland Department of Natural Resources
Data: Md Dept of Planning, 1997
GIS: DNR CCWS, September 2000