St. Mary's River Watershed Characterization

Summer 2009

Prepared by the St. Mary's River Watershed Association, Inc. in partnership with St. Mary's County Government, Maryland Department of Natural Resources, St. Mary's College of Maryland, and local agencies and businesses.

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St. Mary's River
Watershed Characterization

Summer 2009

a supporting document to the
Watershed Restoration Action Strategy
for the
St. Mary's River

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TABLE OF CONTENTS

TABLE OF CONTENTS CONTINUED

TABLE OF CONTENTS CONTINUED

TABLE OF CONTENTS CONTINUED

TABLE OF CONTENTS CONTINUED

LIST OF MAPS

LIST OF TABLES

LIST OF FIGURES

BLANK PAGE

EXECUTIVE SUMMARY

OVERVIEW

The St. Mary's River Watershed Characterization Report, produced by the St. Mary's River Watershed Association and partners, is a summary of all readily available natural resources and other data for this watershed. This is data that has been collected at a broad-based state scale, at a regional scale, and at the local scale. The Characterization Report includes information on river history, heritage resources, water quality, landscape and land use, human needs and services, living resources, habitat, restoration, and conservation. It also includes information on projects related to this characterization. Incorporated into this document are summaries and reference to three supporting document: the **Synoptic Survey Report**, the **Stream Corridor Assessment Report**, and the **Water Quality Assessment**. For more information on the Watershed Characterization Report, please contact Bob Lewis at St. Mary's River Watershed Association at 301-737-2903 or smwatershed@yahoo.com.

The **Synoptic Survey Report** (September 2008), produced by Dr. Robert W. Paul at St. Mary's College of Maryland with the assistance of the Watershed Assessment Division of the Maryland Department of Natural Resources (DNR), is a water chemistry analysis (nutrients, temperature, conductivity, pH), and a biological survey (macro invertebrates, fishes, habitat) on 16 sites along stream corridors in the watershed. This Survey is summarized in this report and can be downloaded at: http://www.stmarysriver.org/pdfdocs/report_phase1_SS.pdf

The **Stream Corridor Assessment Report** (September 2008), produced by Dr. Robert W. Paul at St. Mary's College of Maryland with the assistance of the Watershed Services Unit of the Maryland Department of Natural Resources (DNR), summarizes results from a 118-mile stream corridor assessment survey using DNR's Stream Corridor Assessment Methodology. Of the watershed's 175 miles of streams, permission granted to

OVERVIEW

access 68% of the stream corridors dictated the survey area. Streams were walked and assessed for such problems as pipe outfalls, erosion sites, lack of buffers, fish passage blockages, sewer outfalls, or unusual conditions. Each site is rated for accessibility, severity, and correct-ability. Local governments are given the geographically referenced information on compact disc. Reports accessed within this characterization report are only summaries of the geographically referenced data. This Assessment is summarized in this report. If you would like more information please contact Bob Lewis at 301-737-2903 or download the reports at http://www.stmarysriver.org/pdfdocs/report_phase1_SCATSS.pdf

The **Water Quality Assessment** (September 2008, produced by Dr. Robert W. Paul at St. Mary's College of Maryland with the assistance of the Watershed Assessment Division of the Maryland Department of Natural Resources (DNR), is a comprehensive scientific compilation of information related to water quality over the past ten years. This Assessment is summarized in this report and can be downloaded at: http://www.stmarysriver.org/pdfdocs/report_phase1_WC.pdf

The **Watershed Restoration Action Strategy** is written by the St. Mary's River Watershed Association and partners. It is developed by considering the above technical assessment information plus local knowledge from stakeholder involvement. The final strategy or WRAS is the plan that can then be "shopped around" to secure funding for project implementation. The strategy includes:

- a well-stated, overarching goal aimed at protecting, preserving, and restoring habitat and water quality
- a description of the stakeholder process
- opportunities, concerns, and challenges
- a very detailed, prioritized, description of natural resource management objectives
- a prioritized list of feasible and fundable restoration projects

HERITAGE

St. Mary's City, located on the banks of the tidal St. Mary's River, was host to the fourth permanent English settlement in the New World—a settlement that served as Maryland capitol until 1695. The site is steeped in history and is recognized as the birthplace of religious tolerance, the site of the first African American descendent to vote, and the place where women first launched the fight for voting rights. Today this site is secured by the State as a living museum on several hundred acres and features a working plantation, a replica oceanic vessel, and a state-of-the-art interpretive center.

Additionally, the site boasts extensive archeological opportunities and, in partnership with St. Mary's College, provides a museum studies undergraduate program. Some work has been done on aquatic archeology.

Historic sites abound in the watershed although few have been preserved and only one other, Drayden Schoolhouse, has been preserved, interpreted, and is open to the public. The Navy secured land from the Jesuits in 1942 and today runs a large research facility on the east bank of the tidal river.

WATER QUALITY

Monitoring of the St. Mary's River watershed has increased substantially in the past 10 years. Overall the St. Mary's River watershed has good water quality; however, research indicates that increased urbanization and related pollution could pose a potential threat if not managed. A statewide assessment of all watersheds identified the St. Mary's River watershed as a pristine or sensitive watershed in need of an extra level of protection.

The watershed currently does not support all the designated uses assigned to it by state regulations, and first through fourth order streams are impaired for protection of aquatic life. The cause of the impairment is unknown. In addition, there are areas restricted for shellfish harvesting and a fish consumption advisory for St. Mary's Lake.

Excess nutrient loads have contributed to algal blooms and low dissolved oxygen in the tidal areas. Increased nutrient levels in spring runoff fuels algal blooms, which subsequently die off and decompose, reducing oxygen levels below levels adequate to support aquatic life. Erosion and sediment have also been identified as a problem in some areas of the watershed.

Studies have cited storm events as a leading cause of perturbation in St. Mary's River, transporting nutrients and sediments into the tidal main steam from various tributaries in the watershed and as far away as the development

The 73.78 square mile St. Mary's River watershed encompasses almost a quarter of St. Mary's County's 296 square miles. The watershed extends from the county airport south to St. George's Island and Kitt's Point at the mouth of Smith creek. Land area west of Route 235 and south of Airport Road for approximately seven and a half miles make up a good portion of the county's targeted development district, and is also within the watershed.

Landscape indicators of environmental health include impervious surface area, population density, historic wetland loss, unbuffered streams, and soil erodibility. General downward trends in environmental health are evident in all of these indicators.

Nearly half of the St. Mary's County population—46,000 people—live within the St. Mary's River watershed. Development in the Lexington Park development district and along Route 235 corridor to California has been intensive in recent years. Rapid increase in paved or otherwise impervious surfaces forces the river to run faster and dirtier.

Land use in the watershed is varied and typical of the southern Maryland region. Agriculture encompasses about XXX% of the watershed area. Additional industrial use such as mining are confined to small parcels less than 250???? acres. Office business parks and commercial use are extensive along the Route 235 and Great Mills Road corridors with additional commercial use along Route 5 in Great Mills and Callaway. Residential land use make up the largest percentage of developed land area.

Large contiguous protected areas exist in the upper central watershed and are comprised of the St. Mary's River Wildlands, and the former Hackerman and Bevan properties—both purchased with open space funds. In somewhat the same vicinity is St. Mary's Lake State Park. Other protected lands are scattered throughout the watershed.

Vulnerability to storm inundation and sea level rise is limited to areas immediately adjacent to tidal areas.

HUMAN NEEDS AND SERVICES

LIVING RESOURCES

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Print format of this document is on 100% recycled paper. This and other referenced documents can be found online or downloaded from www.StMarysRiver.org. Copies on CD-R can be requested from St. Mary's River Watershed Association, PO Box 94, St. Mary's City, MD 20686.

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INTRODUCTION

Background
- Location
- Purpose of Characterization
- Additional Characterization Work
- Identifying Gaps in Information

The St. Mary's River: History and Ecological Changes

The current condition of the St. Mary's River is the result of over four centuries of human activities that have deeply impacted the nature of this estuary. Therefore, in evaluation of its status, one must comprehend the nature and causes of changes that have created the conditions that are currently being monitored by the St. Mary's River project. Few aspects of the entire river system can be considered in a "natural" state uninfluenced by human actions. While natural processes continue to shape the overall character of the St. Mary's, androgenic factors have had a powerful influenced upon the drainage over the past 400 years. This section will very briefly review the history of human habitation, examine evidence of past vegetation and estuarine resources, and utilize a series of oyster shell samples to assess changes in the river.

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Prehistoric Peoples

The St. Mary's area was the scene of Native American habitation for a period of more than 12,000 years. Previous archaeological research has divided this broad span from ca. 11,000 B. C. to 1600 A.D. into three major segments. These are the Paleo-Indian Period (11,000 B.C. to 8000 B.C.), the Archaic Period (8000 B.C. to 1000 B.C.) and the Woodland Period (1000 B.C. to 1600 A.D.). These periods are defined by general cultural traits, environmental conditions and key artifacts, primarily stone projectile points and ceramics. The Archaic and Woodland periods are divided into a number of sub-periods that are thought to reflect changes in cultural development.

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The most ancient evidence for humans yet found in the area is a Clovis spear point from ca. 11,000 years ago discovered near the mouth of the St. Mary's. There is abundant evidence of people residing along the river in the subsequent Archaic period and even more sites from the Woodland period. Over this time, it is unlikely that humans had any significant effect upon the environment of the area, with one exception. That is the use of fire to manage the forest understory, facilitate travel, stimulate the growth of browse vegetation for white tailed deer, and drive deer in hunting. Data from other areas of the Chesapeake suggests that prehistoric peoples began using regular burning as a means of forest management as much as 6000 years ago. Hence, even the forests encountered by the first Maryland colonists were not, as they assumed, a reflection of pure natural conditions but was the result of human efforts. With the arrival of agriculture around 900 A.D., clearance of land for food production began. However, the Chesapeake Indians employed a sustainable form of agriculture based on the use of hoes, slash and burn methods and long fallow periods. Probably originating in Central America, this agrarian method resulted in only small land areas being in production at any given time. There was some intensification of agriculture in the period between ca. 1200 and 1600 A. D. but given its small scale and methodology, it had no measurable impact on the overall forested environment. We only know the name of the most recent group of people who lived on the St. Mary's, the Yaocomico Indians. Their population at the time the Maryland settlers arrived in the 1630s is difficult to determine, but is unlikely to have been more than 500 people.

Historic Period (ca. 1630-2008)

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The St. Mary's River is one of the most historically significant locations in the state of Maryland. It is where Lord Baltimore's colony began in 1634. Along the river, the colonists built Fort St. Maries, the first Governor's house, a Catholic chapel and the homes of the early settlers. The site became the capital for the colony from its founding until 1695, when the government was moved to Annapolis. It is where the first government policy of religious freedom and non-establishment of religion was employed in the New World. The St. Mary's River also saw development of the first tobacco plantations in the colony, as settlers gradually moved from Fort St. Mary's in 1636 or 1637. In 1668, the first incorporated city in Maryland was established here. Other notable historical aspect of the river is that the first industrial activity in the colony occurred along it, beginning with a water mill in the 1630s, the first large scale brick manufacture, and the attempt to make iron in the mid-17th-century. And it was on the St. Mary's River that the craft of printing began in all of English America outside of Boston.

Following departure of the provincial government in 1695 and movement of the county government to Leonardtown in 1708, all urban life ended along the St. Mary's and it became a completely rural landscape. Large plantations, middling family farms, the quarters of enslaved Africans and later African Americans, and poor tenant farms dotted the landscape of tobacco, corn and wheat fields, pastures and scrub land. A modest industrial complex did arise at a place named Great Mills. Poor agricultural practices, the impact of the American Revolution and destruction by the British in the War of 1812 affected residents of the St. Mary's River and led to the departure of some to new lands in Kentucky and elsewhere. But throughout the 19th century and for the first three quarters of the 20th century, the river area remained primarily a rural setting of farms. A good indication of the stable population is the U.S. Census data. From the first census in 1790 until the onset of World War II, the population of St. Mary's County did not change dramatically. In 1790, there were 15,544 people in the county, while in 1940, 14,626 people lived here. Over that 150 year period, the peak population was in 1900 with 17, 182 and the low occurred in 1820, after the trauma of the War of 1812, with only 12,794 people residing in the county. It was construction of the Patuxent River Naval Air Station in 1942 that brought dramatic changes to the county. But much of this impact was initially restricted to the newly emerging Lexington Park area.

Population growth, residential construction and economic development begin to intrude on the St. Mary's River drainage by the 1960s. One element was expansion of military research and development activities at Webster Field on St. Inigoes Creek. Even more significant was construction of new housing along the shorelines of the river, intensive commercial and residential development in the Lexington Park area, and the beginning of dramatic growth of St. Mary's College.

Vegetation Changes in the St. Mary's River Drainage

The nature of the terrestrial vegetation in the St. Mary's River drainage can be evaluated to some extent by using pollen found in sediment samples. Core sampling has been conducted at the Aud site in a marsh called Pete's Bog at the head of the St. Mary's (Brush 1996), just downstream from where Route 5 crosses the river, and in St. John's Pond at St. Mary's City (Kraft and Brush 1981). Based upon radiocarbon dating, these core samples extend back to 6380 years ago at Aud and 5339 years ago at St. Mary's City.

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The very oldest layer at the Aud site contains pollen from hemlock, likely a remnant of vegetation from the much colder proceeding era. In that sample, cedar, alder, birch and walnut are present. A marsh environment did not exist there 6000 years ago. Higher in the core, however, in layers deposited after 2500 B.C., there is clear evidence that a marsh had developed by that time. Indicators include cattail, some sedge and other marsh plants. This marsh development is likely related to sea level rise. Estuarine conditions are known to have been established in the Potomac and, hence the lower St. Mary's River, by 3000 B.C., based on oyster shell middens excavated along the Potomac (Potter 1992).

Still higher in the Aud site sample are layers deposited around 500 A. D., in which pollen from the holly is very abundant, oak and black gum are common, and plants like cinnamon fern, goldenrod and arrowood are present. The topmost layers in this core contain large quantities of pine and ragweed, indicating that these were deposited after plow agriculture was underway.

At St. Mary's City, over the past 5000 years, the lands were covered with a mixed deciduous forest, with some conifers. Little change in the composition of these forests is indicated by the core samples over most of this period. St. John's pond had a cattail marsh along its shores over 4000 years ago. Before ca. 2000 B.C., brackish to salt water had intruded into the pond area (as determined from Mercenaria mollusk fragments). Oak and hickory were the most abundant trees, with maple, river birch, beech, ash, and sweet gum major elements of the forest. Present in low frequencies was walnut, red cedar some pine, and perhaps chestnut. Chestnut is a poor pollen producer and this species was probably more common than the pollen samples suggest.

Vegetation Changes in the St. Mary's River Drainage continued

The greatest change in the pollen is associated with the arrival of Europeans. Since the colonists disembarked in 1634, the primary changes in the pollen profile have been a decline in oak and hickory and increases in pine, ragweed, chenopodium and grasses. These changes are almost certainly due to the clearance of land for agriculture and its temporary abandonment as part of the slash and burn and long fallow system, or the rise of more permanent plow agriculture. One significant feature of the pollen record at St. Mary's is that chenopodium (pigweed) shows a strong increase around the time of colonization but it suddenly declines in the early 19th century.   Palynologist Grace Brush suggests that this is associated with cycles of land clearance and abandonment associated with slash and burn agriculture that was used for tobacco and corn production in 17th and much of the 18th century in Maryland. In contrast, ragweed displays a significant increase in the early 19th-century. It can be associated with broad scale land disturbance, as occurs with plowing. Historical evidence indicates a transition occurred from hoe-based slash and burn agriculture to plow agriculture in the late 1700s or early 1800s and the pollen data support this.

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Human Usage of the St. Mary's River Drainage in History

While high quality scientific measurement of the status of the St. Mary's River drainage now spans more than a decade of time, it is essential to recognize that the current conditions are a consequence of long term natural processes and roughly four centuries of human actions. Earlier Chesapeake Indians had an impact on vegetation by regular use of fire to manage the forest understory but this probably did not have a major impact on the estuary itself. What was the river like in past centuries, when did major changes occur in its nature and what caused these changes? Some insights can be derived from data sets provided by archaeology and pollen analysis.

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When the first settlers arrived, the shores were covered with massive forest, except for the areas that had been farmed by the Yaocomico peoples. During the 17th-century, settlement was restricted to the lower, tidal portion of the river and the upper drainage area above Great Mills remained in forest. As tract maps developed by Historic St. Mary's City reveal, it was only in the 18th century that interior areas were settled and the forests cleared on lands suitable for agriculture in this inland zone. Due to the varied topography of interior areas, however, it is likely that many of the slopes and watercourses remained covered by vegetation.

Archaeological evidence from St. Mary's City shows that the river contained a diversity of wildlife. The most common fish are benthic-oriented species, especially the Sheephead, Red Drum, and Black Drum. Other species include white perch, sturgeon, sea trout. Today, the Sheepshead is nearly extinct in the Chesapeake, as is the Atlantic Sturgeon. Drums are rare in the St. Mary's. Abundant oyster shell deposits indicate the prevalence of the American Oyster in the river. Clams are not found, indicating that they were never a significant species on the St. Mary's. Attached organisms or epifauna on the shells include various sponges, oyster mudworms, and occasional barnicles. In some samples, oyster spat are common. This is strong evidence that a rich and vibrant benthic community existed in the St. Mary's River in past centuries, and this biotic community is significantly different today.

Since the St. Mary's river drainage was forest covered for thousands of years, one would anticipate that nutrient inflows were stable and sedimentation rates low. As noted above, the small human populations and use of the shifting field-slash and burn methods with hoes as the only tools would have added little to the input of nutrients or sediment into the St. Mary's River. English colonists adapted the same agrarian method using hoes for production of corn and tobacco. Although the human population grew at a very rapid rate after the mid-1600s, reliance upon the sustainable method of rotating field-slash and burn agriculture would have created only modest increases of nutrients and silt into the estuarine environment. The major consequence was a shift in the composition of the terrestrial vegetation, with an increase in species such as pine and ragweed. Field abandonment for a 20 year cycle encouraged the growth of succession species such as pine, at the expense of slower growth oak, hickory and other hardwoods.

Human Usage of the St. Mary's River Drainage in History continued

Androgenic impacts apparently did not become significant until a substantial shift in land use methods occurred. In this case, it was the change from hoe-based to plow agriculture. Plows had been present from the first decade of Maryland but due to massive trees with extensive root systems, it was normally more efficient to utilize the aboriginal method of hoe agriculture. Economic factors in the later 18th-century led to the widespread shift from tobacco to grain production in the Southern Maryland region, especially immediately after the Revolutionary war (Walsh 2001; Marks 1979). As a result, far larger areas of soil were left exposed each year to erosion, leading to a significant increase in the quantities of nutrients and sediment entering the rivers and creeks of the region. This nutrient enrichment may have initially enhanced the estuarine environment in terms of biological productivity. The upper courses of streams likely captured a substantial amount of the sediment initially, although major storm events would have flushed this silt into the main body of the river. In this regard, the development of millworks in the Great Mills area may have helped reduce this to some extent, since the mill ponds would have acted as unintended sediment traps. Nevertheless, severe storms would have resulted in the benthic environment being periodically inundated with a rain of sediment. In some cases, such as in Horseshoe Bay at St. Mary's City, the bottom may have been covered with silt. Evidence from the Tolle-Tabbs archaeological site inhabited in the first half of the 19th century suggests this. In its food bone sample, there is for the first time at any St. Mary's City site an absence of once common benthic species such as sheepshead and drum. Pelagic fish predominate. It seems quite clear that the move to plow-based agriculture around the turn of the 19th century resulted in the first significant androgenic changes in the natural environment of the St. Mary's River. In particular, eutrophication of the river occurred and the level of primary biological productivity would have increased.

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But gradual improvements in agriculture and some reforestation in the river area may have resulted in slight reduction of sedimentation in the later 19th century. After the Civil War, major commercial exploitation of oysters began, and this included exploitation of the St. Mary's. The river contained a number of very productive oyster bars and reefs, as late 19th-century oyster maps indicate. Over-harvesting of shell fish in the late 19th-century removed a vital element, filter feeders, which had helped cope with and reduce the negative consequences of eutrophication. Indeed, into the mid to late 20th century, the St. Mary's was still regarded as an important area for seed oyster production.

Sedimentation Rates in the St. Mary's River

As described above, the historical record provides strong evidence of changes in land use and one can suggest the consequences of this on the estuary. A major factor in these changes to the estuarine environment is sediment deposition. While sedimentation is a normal geological process, human activities can have a major influence on the extent of such deposition. In addition to the pollen evidence they yield about vegetation, core analysis can provide reliable measurements of the rate of annual deposition.

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During the era preceding the arrival of the Maryland settlers, we can assume that most of the St. Mary's River shoreline and its drainage were covered by mature forest. As a result, annual sedimentation is predicted to have been relatively low. After agriculture began with land clearance for tobacco and maize farming, sedimentation should have increased. However, the use of the Native American method of agriculture meant that a given parcel was only farmed for a decade or less, followed by its abandonment for at least 20 years if not longer. With this method, only relatively small amounts of land are left bare and exposed to erosion at any one time. With the onset of plow agriculture, however, extensive areas are left open and susceptible to soil erosion. Research with census records has shown that in Southern Maryland in the early 18^{th} century, the amount of land needed to grow the annual tobacco crop represented about 1.4% of the total and this rose to 3.6% by the 1770s (Froomer 1978). With the shift to grain production, a dramatic increase occurred, and by the 1830s nearly 40% of the land was in annual agricultural production. We would therefore predict that sedimentation rates on the St. Mary's River should reflect this changing land use.

Data on this is available from the Aud and St. Mary's sites (Table 1). While these are marsh or pond settings, the deposition rates found there reflect the silt that was potentially entering the river itself. In the centuries prior to the arrival of Europeans, there was apparently a low annual sedimentation rate, as one would anticipate. At the Aud site before ca. 500 A. D., this rate was only 0.005 cm per year, while it rises to 0.03 in the period from ca. 500 to 1600 A. D. (Brush 1996:1). In the 17^{th} and 18^{th} centuries, it increased to 0.05 cm/year. At St. Mary's City in the millennia before English colonization, the rate was 0.14 cm/year (Kraft and Brush 1981:9). This is higher than found at Aud at this time, and the difference is probably explained by the presence of a number of Chesapeake Indian settlements at St. Mary's City, as indicated by archaeology. In the 17^{th} and 18^{th} centuries, deposition at the Aud site rose to 0.05 cm/year, while at St. Mary's it was 0.25 cm/year. Again, there was far more intense human occupation at St. Mary's during this period than in the immediate vicinity of the Aud site. With the rise of plow agriculture, the rate at St. Mary's City increase still further, to 0.4 and 0.65 cm/year. Thus, the core data confirms that the sedimentation rate into the St. Mary's River did change significantly over time, with the changes almost certainly related to methods of land use.

Sedimentation Rates in the St. Mary's River continued

Table 4-1: Annual Sedimentation Rates From Core Samples on the St. Mary's River

Time Period	Aud Site*	St. Mary's City**
Pre-500 A. D.	0.005 cm/yr	
Ca. 500-1600 A.D.	0.03 cm/yr	0.14 cm/yr
Ca.1600-1800 A. D.	0.05 cm/yr	0.25 cm.yr
Post-1820s	0.08 cm/yr	0.65 cm/yr

*Brush 1996 ** Kraft and Brush 1981

Oysters and Ecological Change

Given the above information, a significant question is how did the biotic community in the St. Mary's River respond to these changes? Did nutrification enhance or rapidly degrade the river environment? One way to address these questions is to examine the St. Mary's River oysters collected from well dated archaeological contexts. Due to the substantial level of archaeological research in the area, samples of shells dating from prehistory up to the present are available. Oysters can serve as sensors in an estuarine environment, and reflect the changes that occur within it. Shell shape, growth rates, isotopic content, attached epifauna, etc. all can provide insights into past conditions. Biologist Michael Kirby and Henry Miller conducted an analysis of oyster shell samples from 24 St. Mary's and Patuxent River sites (Kirby and Miller 2005) in an effort to examine the issues of eutrophication and shifts in the estuarine environment. Shell growth rates were one key data set collected by measuring shell length, shell thickness and the surface area covered by the abductor muscle, and determining the age of each oyster from growth ring analysis. Samples dating between the early 17th century and the early 21st century were used. Samples from sites along the lower portion of the Patuxent River were studied to provide comparative data.

Shell samples were divided into four temporal phases, based upon historical evidence regarding land use and harvesting intensity. These are:

1. (ca. 1600 – 1760) Era of Hoe-based Agriculture,

2. (ca. 1760-1860) Plow Based Agriculture and Limited Oystering

3. (ca. 1860-1920s) Era of Intensive Commercial Oystering

4. (ca. 1920s – 2002) Estuarine Degradation

We assume that the Chesapeake Bay remained in a relatively stable condition for centuries due to a forest-covered drainage, and a massive population of filter feeders, especially oysters, that consumed much of the phytoplankton, especially their preferred food of diatoms. In such a situation, nutrients were converted into biomass, removed from the water column by filter feeders that in turn supported a rich marine fauna. Our study hypothesized that oysters would initially respond to the nutrient enrichment caused by the greater sedimentation from plow agriculture by an increase in growth. However, as eutrophication continued to expand and commercial fishing began removing the majority of the Bay's shellfish population, growth would begin to decline due to degrading conditions, such as the onset of damaging algae blooms and hypoxia.

The shells reveal notable changes (Table 2). In both the St. Mary's and the Patuxent, a significant increase in oyster growth occurred during the initial eutrophication period between the late 18th century and mid 19th century. The increase was approximately one third greater growth compared to pre-plowing times. In both drainages, growth declines in the post-Civil War era. The decline is likely due to a very substantial increase in nutrient inputs (this is based on analysis of nutrient levels in sediments from cores taken in the Chesapeake Bay by Zimmerman and Canuel (2002), and overharvesting of filter feeder species. The oyster shell evidence shows similar responses by oysters in the St. Mary's and Patuxent from the time of initial colonial settlement until the early 20th century. However, in the post-1920 period, the Patuxent and St. Mary's data sets differ. Oyster growth rates on the Patuxent continue to decline while they return to early colonial rates on the St. Mary's. This may be due to a relatively stable human population in the St. Mary's area until late in the century, re-forestation of substantial portions of the St. Mary's river drainage in the 20th century, with the consequent reduction of nutrient and sediment inputs. On the Patuxent, however, ongoing agriculture, the increase of residential populations and nutrient inputs from sewage and other sources is the likely reason oyster growth in that river continued a downward trend.

Table 4-2: Oyster Shell Growth in Height By Time on the St. Mary's and Patuxent*

St. Mary's	1600-1760	1760-1860	1860-1920	1920-2002
Shell Height in mm/year	25.3	37.3	20.0	24.8
Patuxent				
Shell Height in mm/year	23.5	34.3	24.1	16.9

* From Kirby and Miller (2005)

Oysters and Ecological Change continued

This evidence fits with the fact that the St. Mary's River was still considered an important source of seed oysters by the Maryland Department of Natural Resources into the later 20th century. Shellfish data therefore reveals notable changes over time, changes related to variations in estuarine conditions that are ultimately linked to the nature of terrestrial land use. The later 20th-century shell evidence matches the findings of the recent monitoring conducted by the St. Mary's River project, indicating that excessive eutriphication is not as serious a problem here as is found in some other drainages. However, diseases such as Dermo and MSX have taken a toll, along with continued harvesting, leaving only a tiny remnant population of the once abundant oyster in the St. Mary's.

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The fact that the oysters responded to eutrophication by higher shell and soft tissue growth rates shows that they were consuming a portion of the greater primary biological production occurring in the river as a result of more nutrient inputs. By removing this organic matter, the oysters helped reduce the negative effects of initial eutrophication. They also made this increased biomass available to their predators and other species higher in the food chain. The concept that shellfish and other filter feeding species had a key role in maintaining the biological stability of the Chesapeake estuary by preventing the accumulation of excess organic matter is well established (Newell 1988; Jackson et al 2001). Throughout prehistory, the colonial period and the early Federal era, the Chesapeake Bay had a biotic system in which the phytoplankton suspended in the water column were consumed in large part by suspension feeding species in the benthic environment. This prevented the accumulation of unused organic matter and kept bacterial activity at a reduced level. However, when the oyster populations were decimated in the later 19th and early 20th century (see Rothschild et al 1994), this controlling element was severely degraded. Research indicates that this led to a change in the basic structure or tropic system of the Bay to one where bacteria consumed the accumulated organic material and the environment became dominated by microbes (Jonas 1997; Jackson et al. 2001). Algae blooms become more common, and algae can be harmful to oysters and are probably of less food value to the shellfish than diatoms. In turn, the microbial decomposition of the unused organic matter removes oxygen from the water column, leading to episodes of hypoxia (Paerl et al 1998). This shift to a bacteria-dominated ecology is directly related to degradation of estuaries.

The St. Mary's oyster study is the first to demonstrate with data directly from the historic period of initial nutrient enrichment that shellfish were indeed responding by removing a portion of the greater biological production from the water, as reflected in their enhanced growth. But the fact that this growth did not continue, despite continual increases in the amount of nutrients entering the water and thus even more abundant food, points to other factors, especially this shift in tropic systems from a plankton- and filter feeder-based one to one dominated by bacteria. This is not the place to present more data about this process but it does indicate that the health of the Chesapeake is in large part dependent upon the presence of huge numbers of filter feeders, especially the oyster.

Archaeology and history provide a valuable picture of the St. Mary's river in previous centuries and the amazingly rich bounty it once offered. This summary is a very cursory review of a large quantity of evidence and research. It is obvious that the decline of biological productivity in the St. Mary's River is very recent when compared to this long record. Reestablishment of a healthy benthic community, including SAV, control of nutrient inputs, intensive repopulation of filter feeders of various species, and a moratorium on harvesting are appropriate steps for maintaining and even restoring the St. Mary's River to some small reflection of its past abundance. Unlike many estuaries, the St. Mary's is not totally degraded and has many features that could allow it to recapture some of this lost productivity, especially in the form of the vital benthic filter feeders.

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Water quality is in many respects the driving condition in the health of Maryland's streams. Historically, the emphasis has been on chemical water quality. More recently, interest has focused on the biological conditions in streams and estuaries; active consideration of the physical parameters is even more recent. This developmental path is reflected in the ways in which streams have been monitored, the types of data gathered, and the regulatory approach taken.

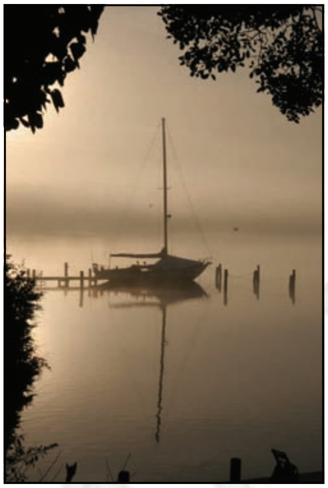
Water Quality Standards and Designated Uses

All streams and other water bodies in Maryland are assigned a designated use in the Code of Maryland Regulations, COMAR 26.08.02.08, which is associated with a set of water quality criteria necessary to support that use. In the St. Mary's River watershed all waters are categorized under two uses:

Use I, Water Contact Recreation and Protection of Aquatic Life: All surface waters not designated as Use II.

Use II, Shellfish Harvesting Waters: All estuarine areas.

Map X Designated Uses and Use Restrictions depicts the distribution of surface waters in each category. For official regulatory information consult COMAR or MDE.[41,42]



[41]Code of Maryland Regulations: www.dsd.state.md.us/comar/
[42]Maryland Department of the Environment: www.mde.state.md.us/

Map X Designated Uses and Use Restrictions

Use Impairments (Non-supporting Uses)

The Federal Clean Water Act requires states to assess and identify waters that do not meet water quality standards, sections 303(d), 305(b) and 314. Maryland meets these requirements by submitting a biennial report that integrates these sections. The Integrated Report describes the ongoing efforts of the state to monitor, assess, track and restore its waters.[43] The report identifies waters that do not support their designated uses, impaired waters, in a list often referred to as the 303(d) list. Waters on the list are prioritized and may require a Total Maximum Daily Load (TMDL). Information considered in setting the 303(d) list priorities includes the severity of the problem, threat to human health and high value resources, extent of understanding of problem causes and remedies.[44]

Biological

First through fourth order streams in the St. Mary's River watershed have been identified by MDE as impaired in the *2008 Integrated Report of Surface Water Quality in Maryland*. The impaired designated use is Aquatic Life and Wildlife (under Use I) because of poor results from a combination of benthic and fish bioassessments. The source of the impairment is unknown and the watershed was first placed on the 303d list for biological impairments in 2002. The St. Mary's River watershed is listed as a low priority for TMDL development.

Mercury

Tissue samples of fish taken from St. Mary's Lake also show high levels of methyl mercury due to atmospheric deposition and bioaccumulation of mercury. A Total Maximum Daily Load was approved for St. Mary's Lake in 2004; therefore, it does not appear on the 303(d) list. St. Mary's Lake is listed under category 4a in the *2008 Integrated Report of Surface Water Quality in Maryland*, surface waters that are still impaired but have a TMDL that has been completed or submitted to EPA.[45]

PHOTO or graphic

[43]Maryland Department of the Environment. *The 2008 Integrated Report of Surface Water Quality in Maryland.* www.mde.maryland.gov/Programs/WaterPrograms/TMDL/Maryland/303dlist/ 2008_Final_303d_list Accessed December 2008.
[44]Maryland Department of the Environment. TMDL home page. www.mde.state.md.us/tmdl/. Accessed September 2002.
[45]Maryland Department of the Environment. *The 2008 Integrated Report of Surface Water Quality in Maryland.* www.mde.maryland.gov/Programs/WaterPrograms/TMDL/Maryland/303dlist/ 2008_Final_303d_list Accessed December 2008.

Use Impairments (Non-supporting Uses) continued

Other

Segments of the St. Mary's River Basin were identified as impaired by nutrients, sediments and bacteria on the1996 303(d) list.[46] Due to 2008 changes in segmentation, the portion of the St. Mary's River Basin that appeared on the 303(d) list is now listed as the Potomac River Mesohaline Chesapeake Bay tidal segment and is listed as impaired for total nitrogen, total phosphorus and total suspended sediment.[47]

The source of the total nitrogen and phosphorus impairment is listed as agriculture and several designated use subcategories are impacted. It is a high priority for TMDL development. The source of total suspended sediment is unknown and the designated use subcategory affected is seasonal shallow-water submerged aquatic vegetation. It is a low priority for TMDL development. In addition, the Potomac River Mesohaline segment was listed in 2006 because of estuarine bioassessments. The source is unknown, and it is listed as a low priority for TMDL development.

A TMDL was approved for bacteria for the St. Mary's River Basin in 2005; however, tidal portions of Locust Grove Cove, Carthegena Creek and St. Indigoes Creek within the Potomac River Mesohaline segment appear in category 4a, still impaired, in the 2008 integrated report.[48,49]

St. Mary's Lake also appeared on the list in 1998 for nutrients, but a water quality analysis was done that determined that there were no uses impaired by nutrients.[50] It was later removed from the list.[51]

PHOTO or graphic

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PHOTO or graphic

[46]Maryland Department of Natural Resources. *Water Quality Newsletter for the Potomac River Tributaries of St. Mary's County*. April 2008. Pub 12-4142008-300.
[47]Rowe, Matthew. Maryland Department of the Environment. Personal communication. December 2008 and January 2009.
[48]Maryland Department of the Environment. Total Maximum Daily Loads of Fecal Coliform for Restricted Shellfish Harvesting Areas in the St. Mary's River Basin in St. Mary's County, MD. http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/ApprovedFinalTMDL/TMDL_final_stmarysriver_fc.asp Accessed January 2009.
[49]Maryland Department of the Environment. *The 2008 Integrated Report of Surface Water Quality in Maryland*. www.mde.maryland.gov/Programs/WaterPrograms/TMDL/Maryland/303dlist/ 2008_Final_303d_list Accessed December 2008.
[50]Maryland Department of the Environment. WQA of Eutrophication for St. Mary's Lake St. Mary's County, Maryland. http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/ ApprovedFinalTMDL/WQA_stmaryslake_final_eutro.asp Accessed January 2009.
[51]Rowe, Matthew. Maryland Department of the Environment. Personal communication. December 2008 and January 2009.

What Causes Water Quality Impairment?

Biological

Within selected stream segments, populations of benthic macroinvertebrates and fish and their associated physical habitat have been assessed by the Maryland Biological Stream Program. Based on criteria developed for each physiographic/ ecological zone in Maryland, each stream segment is rated as good, fair, poor or very poor. Ratings of poor and very poor were listed as biological impairment for the first time in Maryland in the draft 2002 303(d) list of impaired waters.

Nutrients

In Maryland, most water bodies naturally have low levels of the nutrients nitrogen or phosphorus. These nutrients enter waterways from all types of land and from the atmosphere. Nutrient pollution or over-enrichment problems may arise from numerous sources. Residential land can be an important contributor of nutrients depending on fertilizer use, extent of lawn and the status of septic systems. Many farmers carefully manage nutrients using different approaches, so nutrients entering waterways from crop land varies greatly depending on management techniques. Typically, smaller amounts of nutrients reach surface waters from an acre of forest land than from an acre of other types of land. The atmosphere can contribute various forms of nitrogen arising from the burning of fossil fuels in power plants and other industries, and from automobiles.

Suspended Sediment

Most unpolluted streams and tidal waters naturally have limited amounts of sediment moving suspended in the water. Excessive amounts of suspended sediment in waterways are considered pollution because they can inhibit light penetration, prevent plant growth, smother fish eggs, clog fish gills, etc. Sediment in streams tends to arise from stream bed and bank erosion and from land that is poorly vegetated or disturbed. Suspended sediment pollution may arise from construction sites, crop land, bare ground and exposed soil. The amount of sediment contributed varies greatly site to site depending upon stream stability, hydrology, management controls and other factors.

Fecal Coliforms

One class of bacteria typically found in the digestive tract of warm-blooded animals, including humans, is known as fecal coliforms. Fecal coliform bacteria are always found in animal waste and human sewage (unless it is treated to kill them). In unpolluted streams and tidal waters, it is common for water samples to contain very few of these bacteria. Water samples exhibiting significantly larger fecal coliform bacteria populations are indicators of contamination by animal, including human, waste. Depending on local conditions, sources of fecal contamination may include any combination of the following: inadequately treated sewage, failing septic systems, wild or domestic animals, urban storm water carrying pet waste and similar sources.

Toxic Substances

A wide array of materials may be considered toxic substances because they exhibit poisonous or lethal effects or otherwise harm aquatic life. These materials are very diverse in their sources and effects. Sometimes toxic substances can occur naturally. However, toxic substances of concern for water quality restoration are those types that are the product of human activity. For regulatory purposes, the U.S. Environmental Protection Agency maintains a list of substances that are considered to be toxic. Examples include heavy metals, polychlorinated biphenyls (PCBs), asbestos and many other materials.

Total Maximum Daily Loads

Waters that appear on the 303(d) list require a Total Maximum Daily Load. A TMDL establishes the maximum amount of pollutant a water body can receive and still meet water quality standards and designated uses. To calculate the TMDL, pollutant loads from point sources, nonpoint sources, projected growth and a margin of safety are determined and added together.[52] In general, TMDLs include several key parts:

PHOTO

- Existing conditions for pollutant loads and pollutant sources.
- Maximum pollutant load that the water can accept while still allowing the water body to meet its intended use.

Allocation of the maximum pollutant load to specific pollutant sources:

1. St. Mary's Lake TMDL

A TMDL for mercury in St. Mary's Lake was approved by EPA in 2004.

St. Mary's Lake receives mercury from atmospheric deposition and other industrial sources in the watershed. Mercury has accumulated in the lake over time, and it is important to note that sources of mercury air emissions from outside Maryland and even the United States contribute to the impairment. According to EPA, the primary source of mercury air emissions in Maryland is power plants.[53] Municipal waste combustors, medical waste incinerators, cements plants and other industries also contribute, but to a lesser extent.

The TMDL report lists a number of recent and ongoing initiatives within Maryland, ranging from voluntary to regulatory, that involve the phase-out of mercury usage, industrial handling of mercury-containing products and wastes, and consumer recycling of mercury containing products.[54]

2. St. Mary's River Watershed TMDL

A TMDL for fecal coliforms, a type of bacteria, for restricted shellfish harvesting areas in the St. Mary's River watershed was approved by EPA in 2005. The presence of fecal coliform bacteria indicates that fecal waste and other pathogenic bacteria may be present. High levels of pathogenic bacteria in the water could increase the likelihood of its presence in shellfish, which could pose a potential health threat if raw shellfish are consumed. More information on restricted shellfish harvesting areas can be found in the Living Resources section of this report.

Three areas are affected: Locust Grove Cove, St. Inigoes Creek and Carthegena Creek. According to the TMDL study the primary source of bacteria is nonpoint source pollution.[55] It has been estimated that the majority of bacteria comes

[52]Maryland Department of the Environment. TMDL home page. www.mde.state.md.us/Programs/WaterPrograms/TMDL/home/index. Accessed December 2008.

[53]Environmntal Protect Agency. St. Mary's Lake Mercury TMDL web page. http://www.epa.gov/reg3wapd/tmdl/MD_TMDLs/MercuryTMDLs/St.MarysLake/index.htm. Accessed January 2009.

[54]Maryland Department of the Environment. Total Maximum Daily Load of Mercury for St. Mary's Lake, St. Mary's County, Maryland. December 2002. Final TMDLs Approved by EPA. http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/ApprovedFinalTMDL/TMDL_stmaryslake_Hg_final.asp. Accessed January 2009.

[55]Maryland Department of the Environment. Total Maximum Daily Loads of Fecal Coliform for Restricted Shellfish Harvesting Areas in the St. Mary's River Basinin St. Mary's County, Maryland. September 2004. Final TMDL s Approved by EPA. http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/ApprovedFinalTMDL/TMDL_final_stmarysriver_fc.asp. Accessed Januarry 2009.

from livestock, followed by wildlife, pets and humans (failing septic systems and recreational vessels).

Tide and freshwater discharge have been identified as the most influential to the transport of fecal coliform into the shellfish harvesting areas. There were no permitted point sources that discharge into the three affected restricted shellfish harvesting areas in the St. Mary's River watershed. According to the TMDL, MDE will complete a Bacterial Source Tracking (BST) study in this watershed to evaluate the allocated loads. [Find completed if report, if there is one.]

In order to reduce fecal coliform levels, the TMDL suggests that Best Management Practices be implemented in the watershed. Funding and assistance is available through a number of state, federal and nonprofit programs, including Maryland's Agricultural Cost Share Program and the Clean Marina Program. More information on these and other programs can be found on DNR's web site, Conservation and Restoration Services: A Funding and Technical Services Guide (http://www.dnr.state.md.us/bay/services/summaries.html)[56]

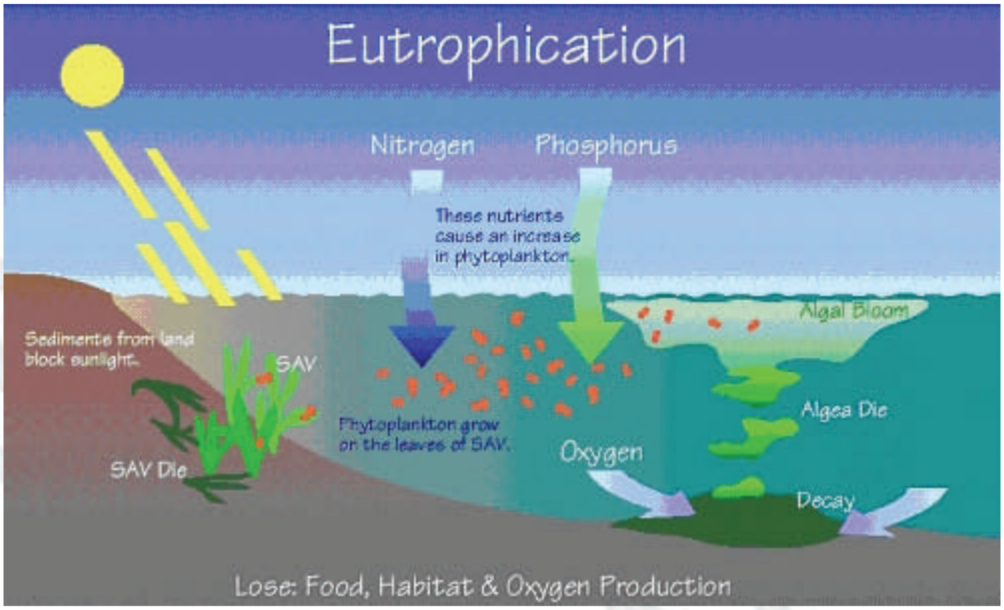


Figure 5-1. Graphic courtesy Florida International University Department of Environmental Studies *LAB 4: Nutrient Analysis*. http://www.fiu.edu/~envstud/labs/nutrientanalysis.html Accessed January 2009.

[56]Maryland Department of Natural Resources. Conservation and Restoration Services: A Funding and Technical Services Guide. http://www.dnr.state.md.us/bay/services/summaries.html. Accessed January 2009.

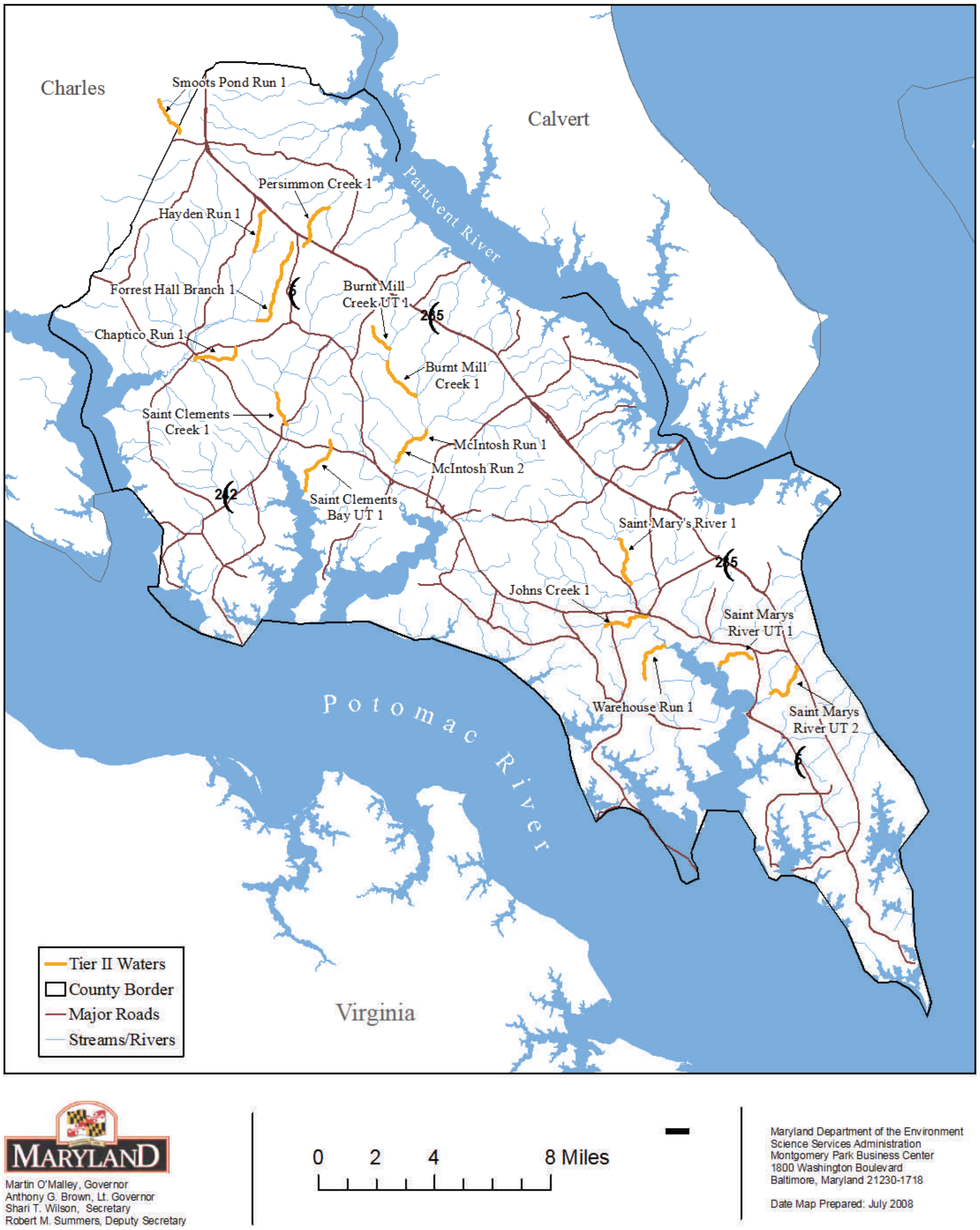
Antidegredation

The Clean Water Act requires Maryland to adopt an antidegradation policy to ensure that high quality waters are not degraded without proper social and economic justification. Maryland's antidegredation policy places waters in several tiers, depending on their quality.[57] Tier I waters should at a minimum meet the designated uses and criteria identified in the state's water quality standards. Tier II waters are high quality waters and Tier III waters are the highest quality waters, such as Outstanding National Resource Waters.

At this time, Maryland has not identified any Tier III waters in the state. However, several Tier II waters have been identified and some of these are located in the St. Mary's River watershed. Figure XX shows the Tier II waters currently identified in the St. Mary's County.

[57]Maryland Department of the Environment. Maryland's High Quality Waters (Tier II). http://www.mde.state.md.us/ResearchCenter/Data/waterQualityStandards/Antidegradation/index.asp. Accessed January 2009.

High Quality (Tier II) Waters in Saint Mary's County



Map XX. Tier II waters identified in St. Mary's County. (From Maryland Department of the Environment, Maryland's High Quality Waters (Tier II): Maps depicting Locations of High Quality Waters by County. http://www.mde.state.md.us/ResearchCenter/Data/waterQualityStandards/Antidegradation/index.asp. Accessed. January 2009.

What Are the Effects of Nutrient Over-Enrichment?
National Academy Press, Clean Coastal Waters (2000)

The productivity of many [lake, estuary and] 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 [lake, estuarine and] coastal marine ecosystems are detrimental. Many of these detrimental consequences are associated with 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 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 includes aesthetic, health, and livelihood impacts.

SOURCE: National Academy of Sciences. *Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution*. National Academy Press. 2000.

Water Quality Indicators – Setting Priority for Restoration and Protection

Maryland's Clean Water Action Plan 1998 *Unified Watershed Assessment*[58] established priorities for watersheds in the state for restoration and protection.

As the basis for the prioritization, indicators of water quality, landscape and living resources were developed for all watersheds in Maryland. Other approaches to assessing water quality have been in use for several years and are further described below. In general they do not look comparatively at watersheds as the *Unified Watershed Assessment* did in an effort to set priorities. It also considered a range of living resource and landscape indicators discussed later.

The *Unified Watershed Assessment* looked at five water quality indicators in comparing the state's 134 watersheds (based on Maryland's 8-digit watershed code), though not all watersheds had information to allow generation of each indicator.

In the plan, the St. Mary's River watershed fell into two of four categories but was not considered a priority for restoration: Category 1 - Watersheds not meeting clean water and other natural resource goals and therefore needing restoration and Category 3 (Select) - pristine or sensitive watersheds that need an extra level of protection. The other categories were Category 2 -Watersheds currently meeting goals that need preventive action to sustain water quality and aquatic resources and Category 4 – insufficient data. [Discuss more in Living Resources?]

[58]Clean Water Action Plan Technical Workgroup. Maryland Clean Water Action Plan. December 1998. www.dnr.state.md.us/cwap/ Accessed January 2009.

Water Quality Monitoring

There has been a large amount of water quality and related data collected in the St. Mary's River watershed in recent years. In 1999, the St. Mary's River Project began collecting water quality data from approximately 25 tidal and non-tidal stations in the area. A stream corridor assessment and tidal shoreline survey was conducted in 2008 by St. Mary's College with support from DNR, NOAA and SMRWA. The assessment identified several potential problem sites and record basic habitat information.[59] St. Mary's College of Maryland also completed a synoptic survey in 2008 which included water quality monitoring and nutrient analysis.[60] Data collected by the St. Mary's River Project is summarized in another report, *St. Mary's River Water Quality Assessment*, and discussed later in this document.

Three shore stations monitored by citizens were established by the Alliance for the Chesapeake Bay and St. Mary's College of Maryland in 1997 in the tidal St. Mary's River to determine the feasibility of restoring species of SAV.[61]

The Maryland Department of Natural Resources Maryland Biological Stream Survey (MBSS) began sampling nontidal wadable streams on a five-year rotation throughout the state in 1994, including fish, benthic macroinvertebrates, water chemistry and habitat. Two streams were monitored in the watershed in 1995. Many streams were monitored in 2000 and 2003, with plans to monitor again in 2009.[62]

The Department of Natural Resources also has a program in which volunteers collect data, Maryland Stream Waders. The stream waders program began in 2000, and volunteers sampled streams within the St. Mary's River Watershed in 2000 and every year since 2003. Volunteers have collected data from than twenty sites. Results from these programs will be discussed in the Living Resources section of this report.

There is also a U.S. Geological Survey gaging station in the St. Mary's River which has been collecting data annually since 1946, with the exception of 2006.[63] In addition, the U.S. Army Corps of Engineers and Maryland DNR have conducted studies in the watershed.[64]

The Maryland Department of the Environment historically collected fecal coliform and other limited water quality data because of concern over commercial shellfish harvests.[65] The St. Mary's County Health Department also performs bacterial water quality monitoring from Memorial Day to Labor Day at various beaches throughout the county. Within the St. Mary's River watershed, the county monitors Sanner's Lake.[66]

59 Paul, Robert W. *St. Mary's River Stream Corridor Assessment and Tidal Shoreline Survey*. September 2008. 48 pages.
60 Paul, Robert W. *St. Mary's River Watershed Synoptic Survey*. September 2008. 49 pages.
61 Paul, Robert W. *St. Mary's River Watershed Water Quality Assessment*. September 2008. 123 pages.
62 Maryland Department of Natural Resources. MBSS Data Search. mddnr.chesapeakebay.net/mbss/search. Accessed January 2009.
63 Paul, Robert W. *St. Mary's River Watershed Water Quality Assessment*. September 2008. 123 pages.
64 Ibid.
65 Ibid.
66 St. Mary's County Health Department. St. Mary's County Water Quality Summary Report web page. http://www.smchd.org/smchdbeachqualitymonitoringreport.htm. Accessed January 2009.

Water Quality Overview

The St. Mary's River watershed consists of approximately 168 miles of streams, including non-tidal freshwater and tidal areas. About 74 percent are first order streams.

Water quality in the St. Mary's River watershed is generally good. [Expand]

St. Mary's River Project

St. Mary's College with support from DNR, NOAA and SMRWA prepared a report that reviewed the past 10 years of data collected though the St. Mary's River Project. A brief summary of the findings follows[67]:

Non-tidal Portion

Dissolved Oxygen

Dissolved oxygen levels in the non-tidal portions of the St. Mary's River watershed were consistently high in the last 10 years of data collected. Readings below 5mg/L in surface waters indicate insufficient oxygen to support aquatic life.

Nutrients

Nutrients were typically low; however, there were some sites with higher levels. The Locust Grove Cove site has higher nutrient levels compared to others, and data suggests thatt nutrients are primarily from organic sources. The tributary from the St. Andrew's Church Landfill also has higher nutrient levels and is experiencing increased urbanization. Nutrients are lower further downstream. The Hickory Hills tributary has higher levels of nutrients which could also be due to runoff and land development. It is suspected that heavy precipitation probably plays large role in transporting nutrients into St. Mary's River tributaries.

Total Suspended Solids

Generally, the mean TSS values were relatively low (<20mg/L) in the watershed. Variability was closely tied to precipitation, and was most noticeable in Pembrook Run, Fisherman Creek, and Church Creek. The Church Creek site was observed to have poor storm water controls and high discharges that lead to erosion. In addition, high levels of sediment in St. Indigoes Creek have been noted by nearby residents.

Alkalinity, pH and Dissolved Organic Carbon

Alkalinity and pH in the St. Mary's River watershed are similar to levels in other areas of the coastal plains. Alkalinity is generally low, less than 50 mg/L of $CaCO_3$, and pH levels are generally between 6.5 and 7 standard units. Overall, dissolved organic carbon levels were low, less than 10mg/L, with the exception of the tidally-influenced site at Locust Grove Cove.

Temperature

Temperatures of the non-tidal sites averaged 25C, and followed a seasonally pattern. Temperatures of St. Mary's Lake were higher overall due to surface warming, and the sample site downstream of the release also had higher temperatures. In addition, the tidally influenced Locust Grove site also had higher temperature. Healthy levels are typically below 30C.

[67] Paul, Robert W. *St. Mary's River Watershed Water Quality Assessment*. September 2008. 123 pages.

Tidal Portion

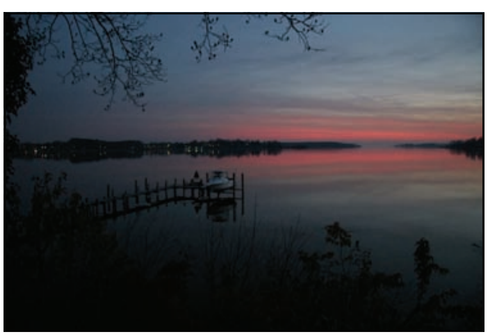
Much of the variability in tidal results seems to be driven by season weather patterns, precipitation, algal growth and decay, and oxygen profiles in the water column.

Dissolved Oxygen

Low oxygen levels have been found at the deeper sites of St. Mary’s River every summer for the past nine years. Tidal creek stations also showed low oxygen levels, but not as severe as the main channel of the river. It is believed that this low oxygen is related to nutrient enrichment in the spring from runoff, which fuels algal blooms, which subsequently die off and decompose, reducing oxygen levels.

Nutrients

Nitrogen concentrations were quite variable, but generally occurred in relatively low concentrations at all sites. The tidal stations located furthest upstream, closest to freshwater sources, generally had the highest nitrogen and phosphorus levels.



Total Suspended Solids

Concentrations were variable between stations and sampling periods, ranging between less than 5mg/L to nearly 100mg/L. TSS was linked to precipitation and was highest in spring and summer. Higher levels were sometimes recorded after storm events. For Use I waters Maryland water quality standards state that sediment loads should not be more than 150 at any one time, or 50 as a monthly averages. Concentrations of 15 mg/l or greater are is believed to generally inhibit growth of SAV because light can not penetrate to the plants’ leaves.

Chlorophyll

Chlorophyll can be used to assess phytoplankton in the water column. Phytoplankton blooms are stimulated by a combination of factors including high nutrient levels and light. In spring of 2000 Maryland DNR reported the highest densities of a dinoflagellate species in 20 years. While no fish kills were reported for the St. Mary's River, observations of a mahogany color of the surface waters and high levels of chlorophyll indicate that a bloom occurred in the river as well. The chlorophyll threshold is exceeded most years, but the highest chlorophyll values were reported in spring of 2000, and the summers of 2001 and 2003. The high chlorophyll and algal concentrations likely contributed to decreased oxygen levels in the bottom waters of the St. Mary's River and its tributaries.

St. Mary's River Project continued

pH

The sites located furthest up-river tended to display the lowest pH values and the most variation because these sites are more directly effected by activities on land and are farther from the cleansing and stabilizing forces of oceanic waters, explaining the lower and more variable pH at the upper most end of the tidal river.

Salinity

The tidal portion of St. Mary's River is largely a partially-mixed mesohaline (moderate salinity) estuary with salinities between 10ppt and 20ppt. Salinity showed an annual cycle with highest levels in the fall and early winter and lowest levels in late spring and summer due to increased rainfall.

Temperature

Water temperature showed pronounced seasonal variation at all tidal stations. For most of the year the water column was partially mixed, but distinct temperature and/or salinity layers were observed, indicating that the river can become highly stratified.

Visit the St. Mary's River Project:
http://smrpweb.smcm.edu/

Lower Potomac River Tributary Team

Tributary Teams are part of Maryland's Tributary Team Strategy Program which works to reduce nutrient pollution and preserve and restore habitat in the Chesapeake Bay watershed through the partnership of citizen and government. There are 10 tributary teams in the state comprised of local citizens, farmers, business leaders and government officials. The teams focus on policy, legislation, implementation and education.[68]

The St. Mary's River watershed is one of eleven smaller watersheds within the Lower Potomac River, one of the 10 tributary teams. The majority of the Lower Potomac River basin is forested, and the largest sources of nutrients are nonpoint sources (urban and agriculture) and point sources.[69] The use of agricultural best management practices (BMPs) and point source reductions have resulted in the reduction of nutrients loads in the basin; however, from 1985 to 2000 nitrogen loading from septic systems increased by 23 percent.

The Chesapeake Bay Program developed nutrient caps in 2003 for the Lower Potomac River basin, which are 1.65 million pounds of nitrogen and .10 pounds of phosphorus.[70] Nutrient reductions are needed to meet these caps.

According to the *Maryland Tributary Strategy Lower Potomac River Basin Summary Report for 1985-2005 Data*[71] modeled nitrogen, phosphorus, and sediment loadings have decreased from 1985 to 2005. The report found that:

- Total nitrogen loadings are down 0.14 million pounds per year, 11 percent of Tributary Strategy goal.
- Total phosphorus loadings are down 0.12 million pounds, 74 percent of Tributary Strategy goal.

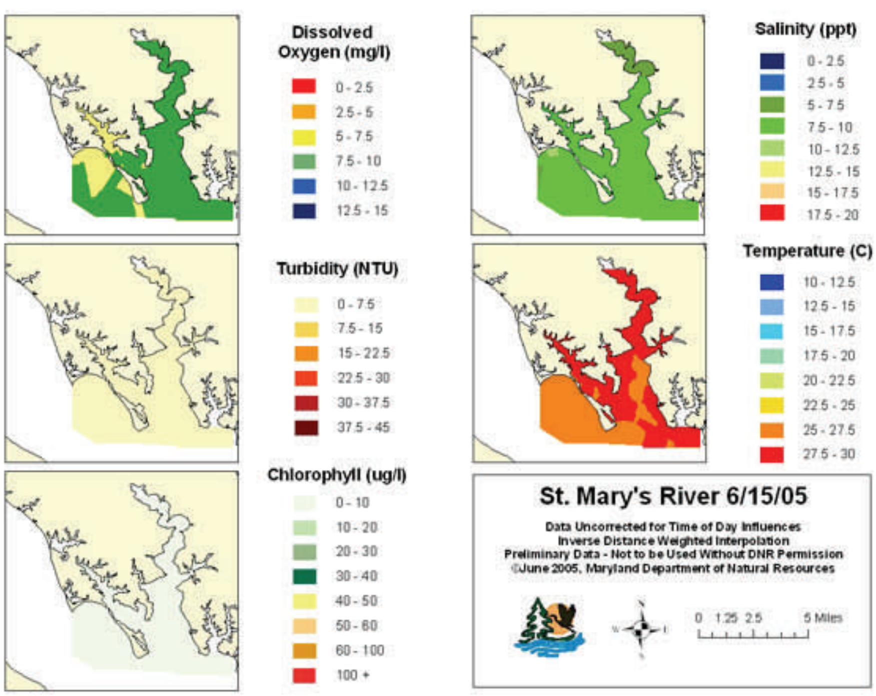


Figure xx – St. Mary's River 2005 Water Quality Mapping Highlights http://mddnr.chesapeakebay.net/sim/dataflow_data.cfm#stmary (Taken from *Maryland Tributary Strategy Lower Potomac River Basin Summary Report for 1985-2005 Data* with permission).

[68] Maryland Department of Natural Resources. Tributary Strategies Frequently Asked Questions. http://www.dnr.state.md.us/bay/tribstrat/faq.html#1 Accessed January 2009.
[69] Maryland Department of Natural Resources. Lower Potomac Basin Overview. November 2003. http://www.dnr.state.md.us/bay/tribstrat/low_pot/low_pot.pdf. Accessed January 2009.
[70] Ibid.
[71] Maryland Department of Natural Rources. Maryland Tributary Strategy Lower Potomac River Basin Summary Report for 1985-2005 Data. August 2007. http://www.dnr.state.md.us/bay/tribstrat/basin_summaries.html. Accessed January 2009.

Sources of Pollution

Since European settlement of North America there has been an explosive growth in human population, supported by more intensive agriculture and the growth of industry. Vast transportation systems have been developed making the entire continent mutually interdependent. In general, water quality in the St. Mary's River watershed is good and most problems in the watershed are localized.

Point Sources

Discharges from a single identifiable source, such as a pipe or other discrete conveyances are called point sources. This includes discharges from waste water treatment plants and industrially sources. Point sources may contribute pollution to surface water or to groundwater. Identifying point source discharges in a watershed can be useful in potential restoration measures. There are no major wastewater treatment plants with discharges in the watershed.

There are currently 10 facilities that discharge into the St. Mary's River watershed permitted under the National Pollutant Discharge Elimination System (NPDES) by the Maryland Department of the Environment.[72] There are 24 general stormwater and groundwater discharge permits in the watershed. A summary of this information is present in Table XX and on Map XX.

In addition, MDE permitted approximately 28 stormwater discharge permits associated with construction in St. Mary's County during 2008 and the beginning of 2009.[73] At least three of these are in the St. Mary's River watershed. Information on permits can be obtained from MDE's Environmental Permits Service Center (EPSC) or Water Management Administration.

[72] Gosden, Andrew. Maryland Department of the Environment. Personal Communication. January 2009.
[73] Maryland Department of the Environment. NOI Database Search Utility http://www.mde.state.md.us/Permits/WaterManagementPermits/water_applications/gp_construction.asp Accessed January 2009.

Table XX Groundwater discharge, surface water discharge and other general permits, except those associated with construction, in the St. Mary's River Watershed. From the Maryland Department of Environment Permit Tracking System (PERTs) database, January 2009.[74]

Facility Name	City	Permit	Permit Type	Permit Number	NPDES Number
St. John's Site Museum	Lexington Park	Discharge	Groundwater Industrial Discharge	06DP3537	
California Mobile Home Park	California	General	Hydrostatic Test	06HT9497	
Cook's & Garrett Park Water Supply System	Park Hall	General	Hydrostatic Test	06HT9499	
Langley Mobile Home Park	Lexington Park	General	Hydrostatic Test	06HT9489	
Lord Calvert Trailer Park	Lexington Park	General	Hydrostatic Test	06HT9440	
Saint Mary's College Wtp & Distribution System	Lexington Park	General	Hydrostatic Test	06HT5039	
Saint Mary's River State Park Wtp & Distribution System	Callaway	General	Hydrostatic Test	06HT9524	
Saint Mary's Visitors Center Wtp	Lexington Park	General	Hydrostatic Test	06HT5045	
Aud Pit	Great Mills	General	Industrial Stormwater	02SW2036	
Champion Used Auto Parts, Llc	Valley Lee	General	Industrial Stormwater	02SW1696	
Knott Land Clearing Debris Landfill 2818	Great Mills	General	Industrial Stormwater	02SW0762	
Kopp Mining Co.- Biscoe Pit #2	Lexington Park	General	Industrial Stormwater	02SW0763	
St. Andrew's Municipal Landfill	California	General	Industrial Stormwater	02SW0656	
St. Mary's County Airport	California	General	Industrial Stormwater	02SW0657	
St. Mary's County Vehicle Maintenance Facility	California	General	Industrial Stormwater	02SW0658	
U.S. Naval Air Station Patuxent River- Webster Field Annex	St. Inigoes	General	Industrial Stormwater	02SW0903	
Waste Management Of Maryland - Saint Mary's Hauling	California	General	Industrial Stormwater	02SW1453	
St. Mary's Yachting Center	Drayden	General	Marina	02MA9164	
Bardon, Inc.	California	General	Mineral Mines	00MM9853	
Bean Pit #1	California	General	Mineral Mines	00MM9862A	
Carruth & Son, Inc. - Lexington Park	Lexington Park	General	Mineral Mines	00MM9746	
Chaney Enterprises - Hollywood Readymix Plant	California	General	Mineral Mines	00MM9876A	MDG499876
Chaney Enterprises - Quatman Road	Lexington Park	General	Mineral Mines	00MM9802	MDG499802
Chaney Enterprises - Stewart's Grant	Lexington Park	General	Mineral Mines	00MM9728A	MDG499728
Howlin Concrete, Inc. - Hollywood Batch Plant	Hollywood	General	Mineral Mines	00MM9858	MDG499858
Kessler Development Company	St. Mary's City	General	Mineral Mines	00MM9702	
Phillip Moore Pit	Callaway	General	Mineral Mines	00MM9719	
Maryland Seafood, Inc.	Drayden	General	Seafood Processing	06SE2405	
Robert Lumpkins, T/A Golden Eye Seafood	Tall Timbers	General	Seafood Processing	06SE2347	MDG522347
Piney Point Aquaculture Center	Piney Point	Discharge	Surface Industrial Discharge	00DP2622	MD0063843
U.S. Naval Air Station Patuxent River- Webster Field Annex	St. Inigoes	Discharge	Surface Municipal Discharge	02DP2523	MD0020095
Winters' Apartments Wwtp	Redgate	Discharge	Surface Municipal Discharge	05DP1683	MD0057606
Lundeberg Maryland Seamanship School	Piney Point	General	Swimming Pool	07SI6006	MDG766006
St. Mary's Yachting Center	Drayden	General	Swimming Pool	07SI6012	MDG766012

[74]Gosden, Andrew. Maryland Department of the Environment. Personal Communication. January 2009.
[75]Maryland Department of Natural Resources. Maryland Tributary Strategy Lower Potomac River Basin Summary Report for 1985-2005 Data August 2007 http://www.dnr.state.md.us/bay/tribstrat/basin_summaries.html Accessed January 2009.
[76]Paul, Robert W. *St. Mary's River Watershed Water Quality Assessment*. September 2008. 123 Pages.

Sources of Pollution

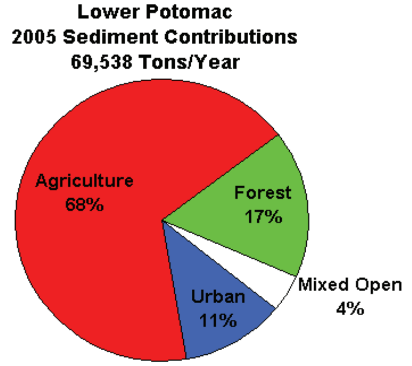
Nonpoint Sources

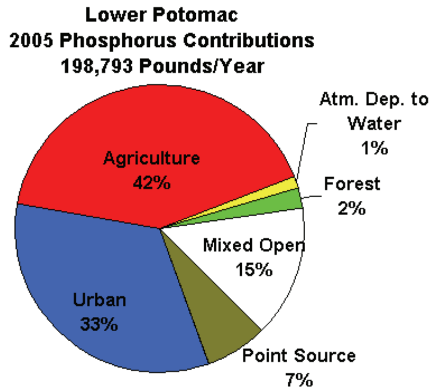
Nonpoint sources are also significant contributors of pollutants, particularly nutrients and sediments. This pollution comes from many diffuse sources. This includes rain water that runs off roofs, streets and parking lots, as well s runoff from farm fields, yards and to a lesser extent forests. Atmospheric deposition and contributions from groundwater, where septic systems are a factor, are also considered nonpoint source pollution.

Nonpoint source pollution is a potential problem in the St. Mary's River watershed. Storm events have a major impact on the river and streams by carrying sediments and nutrients downstream and into the tidal river. Several sources of nonpoint source pollution are identified in the Lower Potomac River basin summary and are listed below[75]:

- urban – from industrial, residential, institutional, mining and open urban lands
- septic – onsite wastewater treatment/disposal
- agriculture –from row crop, hay, pasture, manure acres
- forest –from forested lands
- mixed open –from non-agricultural grasslands including right-of-ways and some golf courses
- atmospheric deposition to water – deposited from the atmosphere directly to water

The majority of nutrients and sediments in the Lower Potomac River basin are from agriculture. The percentage of nutrients and sediments entering the basin were identified in the *Maryland Tributary Srtategy Lower Potomac River Basin Summary Report for 1985-2005 Data* and are shown in the graphic below. Additional studies have cited increased development as a concern in the St. Mary's River watershed.[76]





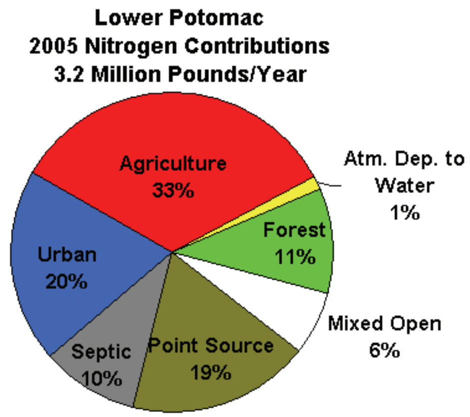


Figure XX – 2005 Nitrogen, Phosphorus and Sediment Contribution to the Lower Potomac River Basin by Source. Data from 2005 'Progress' Watershed Model 4.3 Delivered Loads, , Chesapeake Bay Program 11-30-06 http://www.chesapeakebay.net/data/index.htm. (Taken from *Maryland Tributary Strategy Lower Potomac River Basin Summary Report for 1985-2005 Data)*

<u>Sources of Pollution continued</u>

Shoreline Erosion

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. Erosion of shorelines can contribute significant amounts of nutrients (mostly phosphorus) and sediment (water column turbidity, habitat loss).

Countywide shoreline erosion is summarized in the following table.[77]

St. Mary's County Shore Erosion Rate Summary (Miles to Shoreline)				
Total Shoreline	**Total Eroding Shoreline**	**Erosion Rate**		
		0 to 2 feet / year	**0 to 4 feet / year**	**4 or more feet / year**
297	**87 (29%)**	**61**	**9**	**17**

Maps of historic shoreline change were produced in 1999 by the Maryland Geological Survey (MGS) in a cooperative effort between DNR and the National Oceanic and Atmospheric Administration (NOAA). These maps included digitized shorelines for several different years in St. Mary's County. The maps show that extensive changes have occurred adjacent to large bodies of open water. Copies of these 1:24000 scale maps are available from the MGS.

Currently, DNR is working to improve our ability to predict areas of high-rate shoreline erosion. In addition to considering historic erosion rates, contributory effects of land subsidence and sea level rise are being considered. To help generate predictive tools, two pilot areas have been selected: St. Mary's County and Dorchester County. Results from this work are not currently available but information will be shared with St. Mary's County and other interests when they become available.[Is this data available?]

A tidal shoreline survey was conducted by students of St. Mary's College in 2008. Several areas of shoreline erosion were identified are shown in Figure XX.

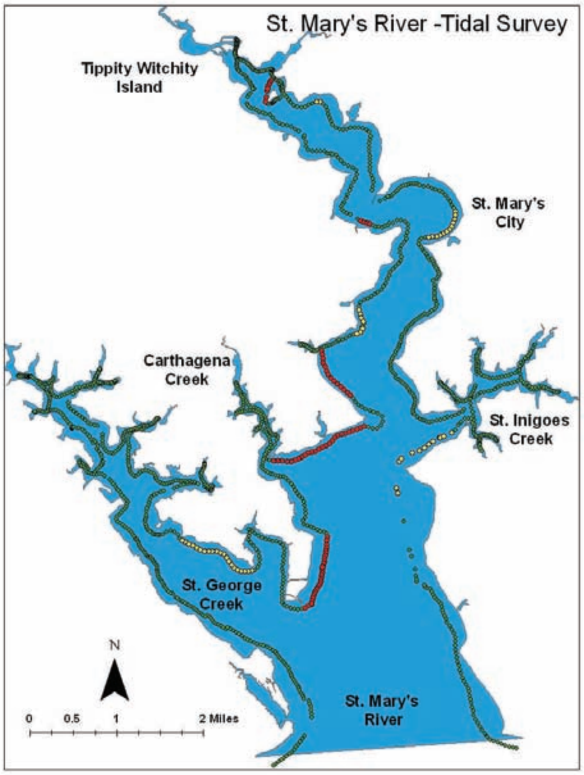


Figure XX. Tidal shoreline of the St. Mary's River with an assessment of shoreline stability. Green markers indicate stable shoreline, red markers show shoreline erosion sites, and yellow markers show shoreline segments without corresponding geo-referenced photographs of the shoreline. (From St. Mary's River Stream Corridor Assessment and Tidal Shoreline Survey.[78])

[77]Maryland Shore Erosion Task Force. *Final Report, State of Maryland Shore Erosion TaskForce.* January 2000. 64 pages.
[78]Paul, Robert W. *St. Mary's River Stream Corridor Assessment and Tidal Shoreline Survey.* September 2008. 48 pages.

Sources of Pollution continued

Impact of the Potomac River

The mouth of the St. Mary's River empties into the Potomac River, but because of the tidal nature the Potomac River can have an impact on St. Mary's River water quality.

Landscape Indicators
1. Impervious Surface (KCI Study)
2. Population Density
3. Historic Wetland Loss
4. Unbuffered Streams (Mark Muir)
5. Soil Erodibility
Land Use
2008 RPD Task Force Study
2008 Encroachment Study
Lands With Significant Natural Resource Value and Large Area
1. Green Infrastructure
2. Large Forest Blocks
Mining – need and impacts
Protected Lands
1. St. Mary's River Wildlands
2. St. Mary's Lake
3. County Parklands
Soils of the St. Mary's River Watershed
1. Interpreting Local Conditions with Natural Soil Groups
2. Soils and Watershed Planning
Wetlands
1. Wetland Categories (Eyes on the Bay web site)
2. Tracking Wetlands (ground truthing wetlands)
3. Interpreting Wetland Distribution
Floodplains
Steep Slopes
Low Elevation Areas Subject to Sea Level Rise
Hurricane and Storm Inundation
KCI Study on mitigation sites
Lands Targeted for Development
1. Lexington Park Development District
2. Towns, Villages, and Rural Centers

Bruce/Sue—erodibility

Bruce— soils, mining,

Robin—encroachment, & Navy

Bob L.— AICUZ

Sue—landscape indicators, lands of significant, wetlands, floodplains, steep slopes, land ...sea level rise

—RPD task force

The Unified Watershed Assessment and the Use of Indicators

In 1998, to comply with directives of the federal Clean Water Action Plan, Maryland completed a state-wide watershed assessment and action plan for its "8-digit" watersheds.[1] Hereafter called the *1998 Watershed Assessment*, this study evaluated water quality and living resources conditions, using a variety of scientifically validated indicators of aquatic and landscape variables, to classify the watersheds in the following categories:

- *Priority Category 1* -- not meeting clean water or natural resource goals and in need of restoration;
- *Priority Category 2* -- needing preventa-tive actions to sustain water quality and aquatic life; or
- *Select Category 3* -- needing protection to maintain pristine or high quality resources.

Overall, the St. Mary's Watershed was classified as a Select Category 3, due to the presence of the following natural resources:

- A migratory fish spawning area
- Over 25% of headwater streams occurring in interior forest
- 67% of watershed forested
- 1,459 wildland acres (St. Mary's River, St. Mary's River State Park).[2]

Despite having a Select Category 3 status, the watershed also had four failing indicators, which call to attention the need for possible remedial actions. The failed indicators were:

- Submerged Aquatic Vegetation (SAV) Abundance
- SAV Habitat
- Historic wetland loss (a landscape parameter), and
- Three occurrences on the 303(d) list of the Federal Water Pollution Control Act (clean water requirements).

The indicators used in assessing the St. Mary's River watershed are described in further detail in the following Landscape and and Living Resources sections and also presented with their scores in Table TBD[1] . It is best to view the findings from the *1998 Watershed Assessment* in combination with additional assessments of local conditions, because most of the indicators were extrapolated from a limited number of sampling sites and lack details about resources. The present document also provides more recent, detailed data from the Maryland Department of Natural Resources, the St. Mary's River Project 's(SMRP) long-term monitoring efforts, and the Synoptic Survey completed for the WRAS project in 2008.

[1]Maryland Clean Water Action Plan Final 1998 Report on Unified Watershed Assessment, Watershed Prioritization and Plans for Restoration Action Strategies. Dec. 31, 1998. http://www.dnr.state.md.us/cwap/cwap.htm Accessed February 9, 2009.

[2]2007 DNR Owned Land Acreage Report. Maryland Department of Natural Resources. http://www.dnr.state.md.us/land/lps/pdfs/2007acreagereport.pdf Accessed February 9, 2009.

Protected Lands

Critical Areas, RCA, LDA, IDA[8]

Lands within 1000 feet of the tidal waters are governed by the Chesapeake Bay Protection Act of 1984—also known as the **Critical Areas**. Most of the tidal shoreline of the St. Mary's River is zoned Resource Conservation Area (RCA), areas where development is discouraged.

Within the RCA areas, floating overlays allow for additional development and intensity in two categories, Limited Development Areas and Intensely Developed Areas. LDA areas in the St. Mary's River watershed include marinas and St. Mary's College of Maryland's waterfront. There are no IDA lands in the watershed. Generally, development is discouraged in the critical areas and specific restrictions and limitations are in effect for the 200-foot buffer to the tidal waters.

8

Protected Lands continued

Agricultural and Forested Lands

Bob L., Donna & Bruce

Protected agricultural lands are scattered throughout the watershed and are protected under a variety of programs, which are outlined in section 9 of this report,

Three significant forested parcels provide for the beginnings of greenway corridors. A 203-acre parcel in the lower Hilton run subwatershed, known as Hunting Quarter is preserved in the Maryland Historic Trust program and provides protection from development for a vital section of marshes. These marshes and accompanying beaver dams help to further mitigate the polluting effects of intense development upstream.

Two other adjacent wooded parcels make up a 200+ acre tract in the upper western branch of the river—the area above St. Mary's Lake. Combined with an additional ???-acre agricultural property currently enrolled in the Agricultural Preservation district program, these three parcels along with the adjacent and downriver St. Mary's Lake State Park, provide excellent beginnings of a greenways corridor.

[1] St.

Protected Lands

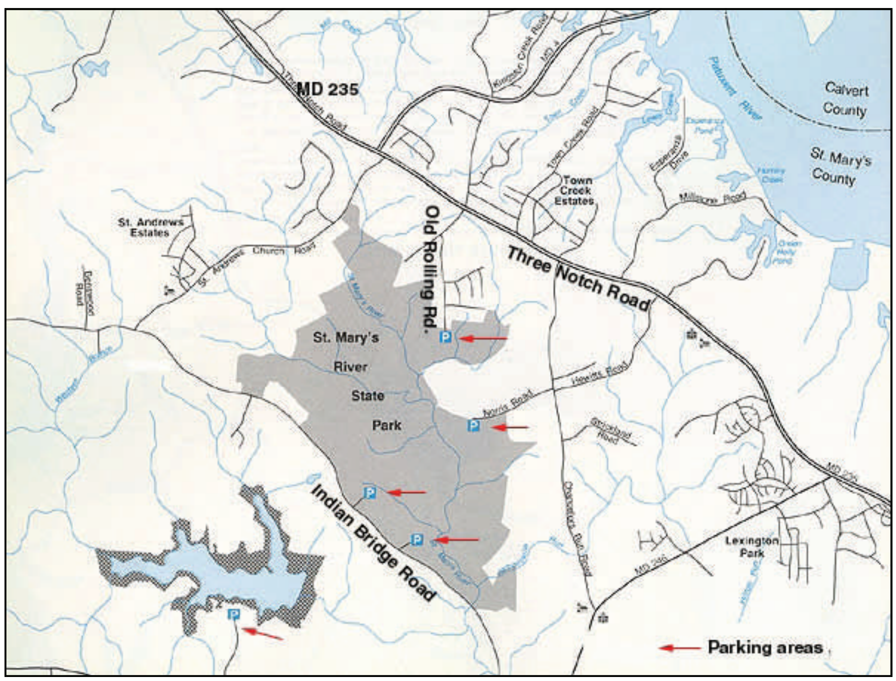
State-owned Lands[1]

Situated at the northern end of the St. Mary's River watershed, the St. Mary's River State Park is comprise of a wide range of habitats, from wooded acres and fields to swamps and small streams. The park is host to many different types of plant and animal species, and includes several threatened and endangered species such as the Narrowmouth Toad.

St. Mary's River State Park is separated into two areas. The southern area holds the 250-acre St. Mary's Lake and hosts a boat launching ramp. It is located along Maryland Route 5, between Leonardtown and Great Mills, at the end of Camp Cosoma Road. The area has become a popular freshwater fishing spot. Several species of fish are common to the lake including largemouth bass, chain pickerel, crappie, bluegill, and sunfish. The lake has been designated a trophy bass lake and as such, special fishing regulations may be in effect. Fishermen should check bulletin boards or contact park personnel for details.

A 7.5 mile trail circles the lake, allowing the area to be fished from shore or by boat. The trail is regularly used for hiking, biking, and horseback riding. Permitted hunters can access designated sites for waterfowl hunting. Modern comfort station, picnic tables, playground, boat launch ramps and a large gravel parking lot are provided. Picnicking is permitted but tables are limited. This is a fee area ($3 per vehicle or seasonal pass).

The area north and east of Indian Bridge Road comprises the second site. It is approximately 2,200 acres and is primarily undeveloped. It is a wildlands area and a managed hunting area. There are no formal trails in the wildlands, although trails abound from illegal motorized all-terrain vehicles. This area was preserved for the purpose of control downstream flooding. This is also a fee area, but note that not all access points support fee collection.



[1] St. Mary's River State Park, Maryland Park Service, Maryland Department of Natural Resources; http://www.dnr.state.md.us/ .publiclands/ southern/stmarysriver.html Map located at http://www.dnr.state.md.us/publiclands/southern/stmarysriver.html Accessed January 20, 2009.

History of Historic St. Mary's City Museum[888]

In the late 16th and early 17th centuries, England began efforts to develop a New World empire in North America. The beginnings were financed by allowing entrepreneurs, some of them joint stock companies, some of them individual proprietors, to establish colonies along the Atlantic seacoast. In 1632, Cecil Calvert, the second Baron of Baltimore, was granted a charter to what is now the state of Maryland.

Cecil's father, George Calvert, had been King James I's principal Secretary of State, at a time when conflict between Catholic Europe and Protestant England was serious. Calvert championed a marriage between the King's son Charles and a Spanish princess but the effort failed. Soon afterward, George Calvert resigned as Secretary and converted—or returned—to Catholicism (he had been Catholic until the age of 12 when he was forced to become Anglican). That the Protestant king granted the colony of Maryland to the Catholic George Calvert was remarkable—and Maryland was Calvert's *second* land grant. His first was Avalon in Newfoundland, but after one exceptionally harsh winter, Calvert opted to return to England and lobby for land in a more temperate clime.

In the Maryland charter, largely written by Calvert, the king granted the Calverts princely rights, with the power to raise an army, collect taxes, make laws, and give away land. Clearly, the King held George Calvert in high regard, despite his religious convictions.

George Calvert had a long-standing interest in colonization. He invested in the Virginia Company and other early efforts. He applied lessons learned in these ventures to plan the Maryland colony. The preponderance of the investors in Maryland were Catholic and the majority of workers the investors transported to build the colony were Protestant, creating potential religious conflict that could destroy Maryland. To avoid this, the Calverts instituted a progressive policy of liberty of conscience, allowing people of varied faiths to freely worship in Maryland. Related to this was another revolutionary decision that the colony would have no official established religion, neither Catholic nor Protestant.

George Calvert did not live to see the founding of the colony. His son, Cecilius, inherited the charter. His second son, Leonard, led the adventurers who set off for the Chesapeake on the *Ark* and the *Dove* in November 1633, while Cecilius stayed in England to defend the charter. In 1634, the colonists established the first settlement and new capital of the colony, which they called St. Mary's City. The Calvert's hold on the fledgling colony was tenuous at best as Virginians, religious suspicions, the English Civil Wars, and political intrigues threatened or temporarily disrupted their efforts.

[888] History, Historic St. Mary's City web site: http://www.stmaryscity.org/History.html,. Accessed January 21, 2009.

The second half of the century was St. Mary's heyday, marked by a strong tobacco economy and growth in population that warranted construction of public buildings. For a time, the colony offered remarkable opportunities for economic and social advancement to those endowed with the ability to work hard and a bit of luck. But political and religious animosity again arose late in the century and a group of disgruntled Protestants led a revolution against Lord Baltimore in 1689. The crown appointed royal governors and they moved the capital from St. Mary's City to Annapolis in 1695. The colonial statehouse was turned into a Protestant (Anglican) church in the same year; and in 1704 the principle of liberty of conscience was dramatically overturned when Catholic churches and schools were closed in accordance with "An Act to Prevent the Growth of Popery within this Province." Abandoned for the most part, St. Mary's City sank back into the soil from which it had arisen and by the time of the American Revolution, little of Lord Baltimore's capital was left but memories of its former importance.

Today, everything that once stood on the 17th-century town lands has disappeared-at least above ground. Fortunately, there was very little later development to destroy the site of what was once the first capital. Early in the 20th century, interest in the ancient city revived and historical research and archaeological excavations began to uncover the 17th-century settlement. Because the old city had remained relatively undisturbed over the years, the area is one of the finest 17th-century colonial archaeology sites in the nation. St. Mary's City has been recognized as a National Historic Landmark since 1969,

Decades of research are the foundation of exhibits at Historic St. Mary's City, the state museum that commemorates the state's founding. The museum's archaeological collection of over 5 million artifacts is a internationally significant resource for professional archaeologists and other scholars. Dr. Lois Green Carr, staff historian since the inception of the research program in 1967, is broadly considered the dean of early Chesapeake studies. Dr. Carr's work has distilled the human spirit from the archival records and has greatly augmented the discoveries of archaeologists led by Director of Research Garry Wheeler Stone (1971-1986) and Dr. Henry Miller (1987 – pre-sent). From the beginning, the research program at HSMC has been a collaborative effort of historians, architectural historians and archaeologists working to explore the nature of early Maryland. It has served as a model for interdisciplinary research in Early American history. Dr. Carr's books include *Maryland's Revolution of Government:1689-1692* (with David Jordan:1971), and *Robert Cole's World* (with Lorena Walsh and Russell Menard:1991). The results of many of the historical research projects are available here, and the Maryland State Archives, web sites. For archaeological and architectural discoveries, see the Archaeology section of this site.

SOURCE: History page, Historic St. Mary's City web site: http://www.stmaryscity.org/History.html,. Accessed January 21, 2009.

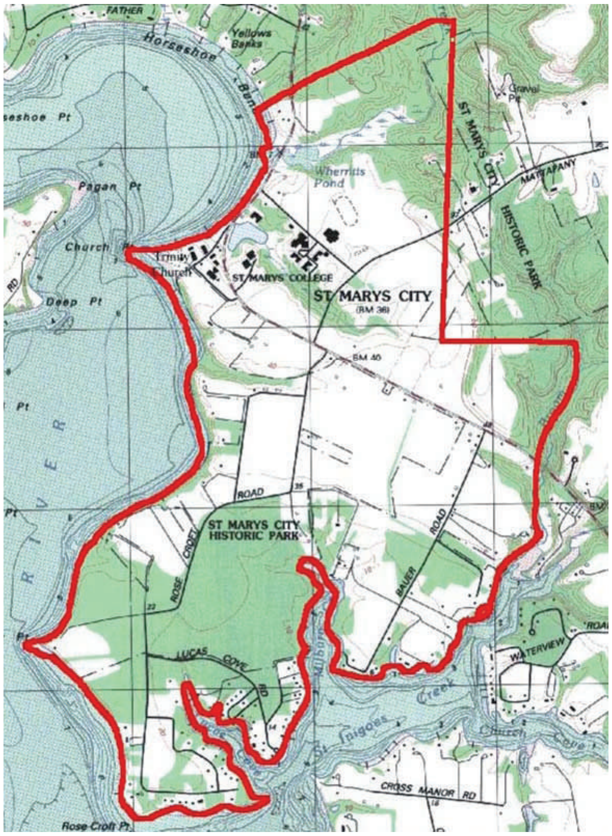
Protected Lands continued

Historic St. Mary's City

Located on the east bank of the tidal St. Mary's River, Historic St. Mary's City museum and park comprises approximately 1200 acres and about 1.8 miles of shoreline. It is a registered National Historic Landmark. The former British settlement has been recreated in the form of an early tobacco plantation on about 165 acres, the State House of 1676, a woodland Indian hamlet, several replica buildings and frames of buildings, and a recreation of the 17th century trans-Atlantic vessel, the Dove. The park is staffed by costumed interpreters who are there to help visitors learn about St. Mary's City's past. Informative videos and displays enrich the experience. The park is also home to many significant archaeological finds which are interpreted through museum exhibits. Historic St. Mary's City is open from mid March to late November. Hours of operation vary by season. Visit the official St. Mary's City web site for operating hours: http://www.stmaryscity.org/

A 3.2 mile hiking trail wonders around the wooded southern portion of the property. Bikes and horses are discouraged and motorized vehicles are prohibited. Features along the way include panoramic vistas of the tidal St. Mary's River, tidal pond habitat, mature mixed forest habitat, and the historic 1840 Brome Howard Inn and slave quarters.[999] There are another 2 miles of paved trails that wind through the exhibits; this is a ticketed area and no bikes or horses are permitted here.

Historic St. Mary's City museum and park is co-located with St. Mary's College of Maryland, along Maryland Route 5, in St. Mary's County.



Boundaries of the City of St. Mary's as Incorporated by Lord Baltimore in 1668. These form the basis for the National Historic Landmark of St. Mary's City.

[999]The Brome Howard Inn, web site: http://www.bromehowardinn.com/ Accessed January 21, 2008

Protected Lands continued

County-owned Lands

The county operates three parks[999] within the St. Mary's River watershed that have access to the water:

- Great Mills Canoe and Kayak Launch
- Piney Point Landing
- St. George Island Landing

Other county-run parks are:

- Chancellor's Run Regional Park
- Great Mills Swimming Pool
- George B. Cecil Park
- Jarboesville Park
- John G. Lancaster Park
- Nicolet park
- St. Andrew's Estates Park
- Carver Community Park

Hours of operation of county parks is typically sunrise to sunset. Check the county web site for specific hours: http://www.co.saint-marys.md.us/recreate/

Great Mills Canoe and Kayak Launch is located on Maryland Route 5 about 75 yards south of the intersection with Indian Bridge Road. Parking is available for about 30 vehicles and access is from a small dock or steep bank. Generally, water levels in this stretch of the river are insufficient for paddling. A moderate rain in the winter and spring or heavy rains in the summer generate enough flow for paddling. Caution should be exercised when the river is high. There are no bathroom facilities at this 1.7-acre site.

Piney Point Landing is located on Piney Point Road (Maryland Route 249) at the bridge to St. George Island. The 2.83-acre site has parking for more than 50 cars and trailers and no bathroom facilities. Two well-equipped boat ramps provide good access for larger boats and boats on trailers. Two short piers provide access to the boat ramps and limited fishing. Fishing from the shore is encouraged. The shoreline is hardened with large boulders and presents

[999] St. Mary's County Department of Recreation , Parks and Community Services, http://www.co.saint-marys.md.us/recreate/ Accessed January 21, 2009.

difficult access for canoes and kayaks. A private access on the northeast side of the bridge has a sand beach and is ideal for paddlers.

St. George Island Landing is located at the end of Thomas Road on St. George Island. The 1/2-acre site has a fishing pier and no bathroom facilities.

Chancellor's Run Regional Park is located on Chancellor's Run Road approximately 2 miles east of the intersection with Maryland Route 235. Dedicated in 1990, the 80-acre site host a variety of ball fields, an activity center, two sand volley ball courts, and the Softball Hall of Fame pavilion. Containing the most amenities of all the parklands in the watershed, Chancellor's Run Regional Park facilities are available for rental and feature full commercial kitchen facilities and well as modern bathrooms. Lighting over ball fields provide for evening activities. Hiking/ walking is encouraged on the site and there is one partially wooded trail. Access to the park, like all St. Mary's County parks, is free. Service and facility charges may be required. There is no access to the river.

Great Mills Swimming Pool is located on Great Mills Road (Maryland Route 246) approximately 3/4 mile north of the intersection with Maryland Route 5. The 19-acre site is partially wooded and provides some walking. The 25 yard x 25 meter pool includes six lanes and has a "zero depth" entry for maximum accessibility. The pool is covered with an air-inflated "bubble" from September until May to allow year round usage. The facility's bathhouse includes showers, lockers, restrooms and a lifeguard room; a toddler pool is also part of the aquatic facility and will be open during the summer months. Access to the grounds is free. Fees are charged for use of the swimming pool.

Dedicated in 1983, the **George B. Cecil Park** is located on St. Georges Church Road approximately 1/3 mile west of the intersection with Flat Iron Road. The park provides baseball/softball fields, tennis courts, fixed playground equipment, picnic tables, and a pavilion. A concession building is on site with modern bathroom facilities.

The five-acre **Jarboesville Park** is located at the intersection of Thomas Drive and Williams Drive, and behind Lexington Park Elementary School. The park was dedicated in 1975 and provides fixed playground equipment, tennis courts, and baseball/softball fields. There are porta-a-potties on site.

John G. Lancaster Park is located on Willows Road approximately 1/4 mile south of the intersection with South Shangri La Drive. The approximately 47-acre park, dedicated in 2001 and to be expanded to 80 acres in 2010, features a fixed playground area as well as numerous ball fields, a dog-walk, picnic tables, pavilion, basketball and tennis courts, and hiking along the exterior as well as in the former Lexington Manor subdivision. Lighting on some ball fields provide for evening activities. Modern bathroom facilities are available.

Nicolet Park is located on the north side of the Patuxent Homes subdivision and is accessed from Bunker Hill Drive and Wasp Road. Fixed playground equipment compliment open areas, basketball courts, a softball/baseball field and two pavilions. The only county park with a skateboard facility, Nicolet Park hosts regional skateboarding competition annually. Modern bathroom facilities are available. The 35-acre park is open evenings for special events.

St. Andrew's Estates Park is located at the end of St. Andrew's Lane. The 4-acre park hosts a 60-foot baseball field, a basketball court, picnic tables, and fixed playground equipment. Port-a-potties are provided seasonally.

The county purchased the 76-acre **Beavan property** in December 2008. The wooded site is located on Indian Bridge Road adjacent to the state-owned Salem Track and about 2000 feet south of the intersection with St. Andrew's Church Road. It is anticipated the property will be used in the future for a combination of active recreation (ball fields, playground, restroom) and nature interpretation/natural resource protection.

[999]The

Protected Lands continued

County-owned Lands

[999] The

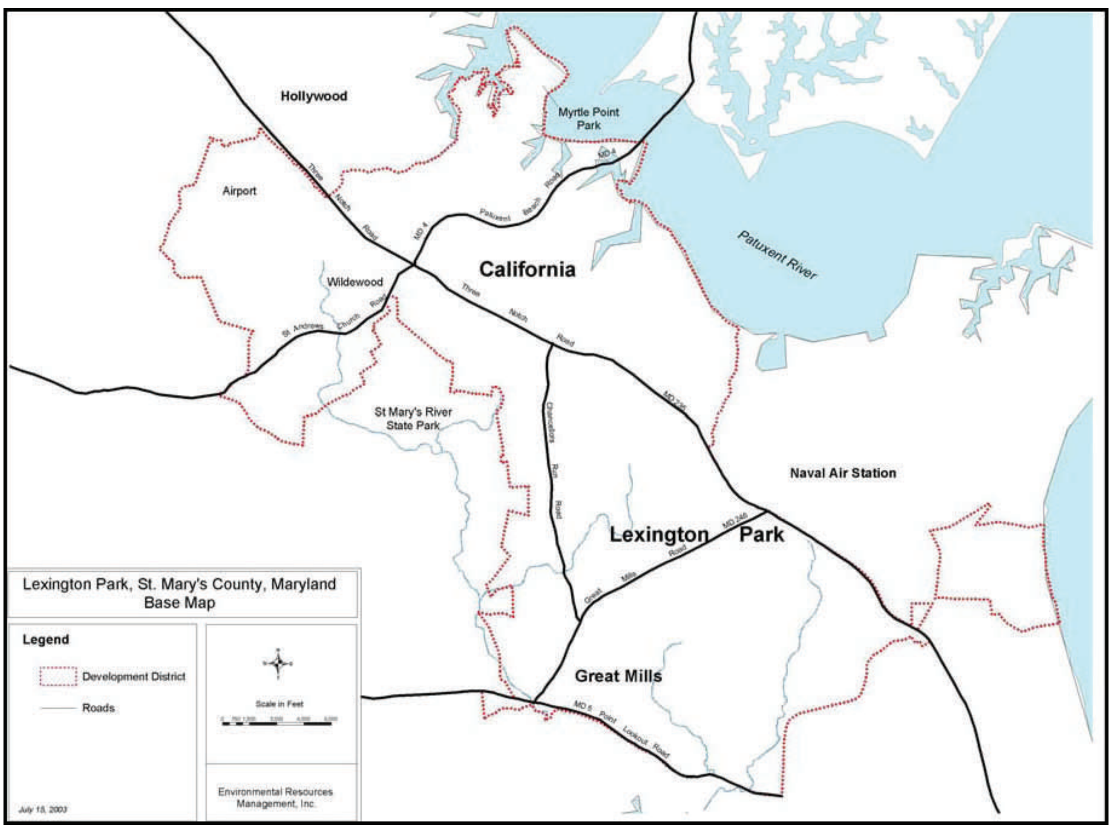
Lands Targeted for Development continued

Lexington Park Development District Master Plan

The Lexington Park Development District is the larger of the County's two development districts. Land use is dictated by a plan, *Lexington Park Development District Master Plan*, separate to and supporting the county's *Comprehensive Plan*. The term "development district" refers to areas of St. Mary's County designated in the Comprehensive Plan where the County directs and encourages development as part of its growth management strategy.[1]

The Lexington Park Development District extends from just south of Hollywood in the north to Hermanville Road in the south, and lies in the St. Mary's River, Patuxent River, and Chesapeake Bay watersheds. It includes the communities of Lexington Park, California, and Great Mills. While the county's *Comprehensive Plan* contains countywide land use policies, this plan details how these policies should be implemented in the Lexington Park Development District.[2]

Map 6-10: Lexington Park Development District



[1]*Lexington Park Development District Concept Plan*; St. Mary's County. Adopted 2005, pES-1.
[2]ibid.

Lands Targeted for Development continued

Snapshot of Lexington Park Development District

- 26 square miles
- 17,000 acres or about 7% of the county's land area
- approximately 50% land area is developed
- 5% committed to development
- 5% parks and protected land
- 40% remains available for development
- 70% or about 11,900 acres are within the St. Mary's River watershed
- Population 27,500; projected to increase to 31,330 in year 2030

SOURCE: *Lexington Park Development District Master Plan*; St. Mary's County. Adopted November 1, 2005, pES-1,2.

Specifically, the *Lexington Park Development Master Plan* is intended to address the following questions:[3]

• How can the Lexington Park - California - Great Mills Area become a better place to live, work, and play?

• Which areas are most suitable for growth? Which areas may be unsuitable?

• How should the LPDD relate physically and economically to other parts of the county?

• How should the different parts of the LPDD relate physically to each other?

• What public facilities such as schools, roads, and parks as well as transportation and public safety services are needed to serve the area?

• How should environmentally sensitive areas be best protected?

[3]*Lexington Park Development District Master Plan*; St. Mary's County. Adopted 2005, pES-1.

Lands Targeted for Development continued

Lexington Park Plan

The Lexington Park Plan was adopted in 2000 as part of the update to the St. Mary's County Comprehensive Plan. The Lexington Park Plan was also incorporated into the Lexington Park Development District Master Plan which was adopted November 1, 2005 and will be reviewed again in significant detail in 2010-2011.

The Lexington Park Plan is the master plan for the revitalization of the core area of Lexington Park—also known in earlier documents as the "wedge." The revitalization of this area is an ongoing and necessary endeavor to tackle the consequences of aging and eroding infrastructure, deteriorating housing and neighborhoods, commercial blight, and the subsequent increasing incidents of crime. Two projects have recently been funded to address aging infrastructure.

The first project entails the reconstruction of roads, sidewalks, curbs and gutters, and storm water inlets—and the replacement of all sewer and water lines throughout Patuxent Park, a late-1940s era community of approximately 350 single family homes located north of Great Mills Road between FDR Boulevard and Pacific Drive/ Pegg Road . The first phase of this project will be under construction in late summer 2009 and will entail roadway reconstruction of Midway Drive from Great Mills Road to Bunker Hill including replacement of sewer and water lines. Reconstruction of roads, sewer and water lines on Gambier Place, Princeton Drive and Bunker Hill Drive will also be completed in Phase 1. Construction of Phase 1 is expected to be completed within nine months.

Add map of the "core" redevelopment area boundaries of Lexington Park

Sewer and water line reconstruction throughout Patuxent Park will be completed in three phases and will require approximately three years to complete. Roadway reconstruction requires five phases and will take approximately six years to complete. Funding for the replacement of sewer and water line in Patuxent Park is fully funded in METCOM's projected budget. Likewise, roadway reconstruction funding is earmarked in the County's six year Capital Improvement Project's budget although funding must be authorized annually. Sewer and water line reconstruction is projected to cost an additional $1.6 million. Roadway reconstruction in Patuxent Park is projected to cost $6.8 million. *(need to double check this figure)*

The second project entails the reconstruction of a 1.4 mile section of Great Mills Road from Coral Drive to the entrance of St. Mary's Square. This project entails the re-surfacing of the roadway, reconstruction of sidewalks, curbs and gutters, storm water inlets, and the replacement of sewer and water lines. The project will result in continuous seven foot wide sidewalks, consolidated commercial entrances, enhanced pedestrian safety features including a partial median strip between Coral Drive and FDR Boulevard, handicapped signalization, and articulated crosswalks throughout the project area.

The reconstruction of Great Mills Road is scheduled to begin in the summer of 2009 and will take approximately 18 months to complete. The cost of the roadway portion of this project is estimated at $5.4 million whereas the cost of sewer and water replacement will require an additional $1.2 million. *(need to double check this figure)*

Another figure???

Towns, Villages, and Rural Centers

In addition to the two development districts, St. Mary's County also directs development to towns, villages and rural service centers. **Town centers** are the second priority for new development and are intended for mixed use. Permitted uses include residential up to 5 dwelling units per acre and carefully planned commercial (discourages strip centers). Town centers are receiving areas for development rights in the TDR program (transfer of development rights program). Two town center lies partially within the St. Mary's River watershed: Hollywood and Piney Point.[4]

Village centers are similar to town centers in many respects and are receiving areas for development rights. New development in village centers is intended to be less intense than in town centers and redevelopment and infill in strongly encouraged. Village centers within the St. Mary's River watershed are: Callaway, Valley Lee, and St. Inigoes.[5]

Rural centers are intended to accommodate existing commercial development in rural areas. Historically, rural commercial properties were deemed as non-conforming uses thereby restricting the businesses ability to grow and prosper. Current zoning allows these businesses to enlarge and for infill development. Rural centers are not receiving areas for development rights. Rural centers within the St. Mary's River watershed are: Dameron, Park Hall, and St. James.[6]

Another zoning classification, **rural commercial use**, allows for continuation of certain commercial uses not located within a development district, town, village, or rural service center. At these locations only infill of certain vacant properties zoned C-General Commercial (per Board of County Commissioners Ordinance Z90-11) where such uses and commercial zoning classifications predate current plans and ordinances. Limited increases in the size and intensity of existing commercial use is permitted. These commercial uses generally will not alter the area's historic character.[7] An example of the rural commercial use is Winter's Sheet Metal Inc. located on Point lookout Road approximately 1/2 mile north of Chingville Road, and located within the St. Mary's River watershed.

[4]St. Mary's County Comprehensive Plan, *QUALITY OF LIFE IN ST. MARY'S COUNTY – A STRATEGY FOR THE 21ST CENTURY –* , Adopted February 19, 2002, Amended March 24, 2003, p37.
[5]ibid, p38.
[6]ibid, p39.
[7]ibid.

Lands Targeted for Development continued

Housing & Welfare
- Workforce Housing Study
- Homeless ?? do we have anything?
- Soup Kitchens
- Health & Medicine ?? do we have anything?
- Mental Health Clinics

Employment
- Water-based economies and businesses – impacts and greening

Infrastructure
- Transportation – impacts from snow removal

Joe—housing, welfare

—employment

John Groeger—public transportation, waste issues, etc.

Point Source Discharges—Sewerage and Landfills

Discharges from pipes or other discrete conveyances are called point source. Point sources may contribute pollution to surface water or to ground water. For example, wastewater treatment plant discharges may contribute to nutrient or microbes that consume oxygen measured as Biochemical Oxygen Demand (BOD). The BOD reduces the oxygen supply available for aquatic life where discharge occur . Industrial point sources may contribute various forms of pollution. Some understanding of point source discharges in a watershed can be useful in helping to identify and prioritizing potential restoration measures.

In the St. Mary's River watershed, there are several permitted point source discharges based on information from the Maryland Department of the Environment.

- The Webster Field Sewage Treatment Plant is the only treatment plant discharging directly into the St. Mary's River. The plant is permitted for a capacity of 45,000 gallons per day. The plant handles the domestic waste generated on the Navy's Webster Field facility. (Permit No. NPDES #MD0020095)
- The St. Andrews Municipal Landfill is also located in the watershed. The landfill is currently not in operation; however there is an open permit to expand the filling activities in the future if the need arises. (Permit No. 2005-WMF-0138)
- The Knott Land Clearing Debris Landfill is permitted by the Maryland Department of the Environment and is located ¼ of a mile north of the intersection of Flat Iron Road and Booth Road in Great Mills, MD. (Permit No. 2006-WLC-0134)

Other large industrial and institutional sites in the watershed are:

- Valero Petroleum Company's transshipment and storage facility. The facility is of regional importance since it supplies petroleum to the Washington D.C. area.
- The Harry Lundeberg School of Seamanship is also located with in the St. Mary's River drainage area. The school specializes in providing vocational training to those persons seeking a career in Merchant Marines.

Can we get two photos?? Outfall of Webster Field and Landfill?

Point Source Discharges—Existing Sewer Systems

A large portion of the St. Mary's River watershed lies within the St. Mary's County Metropolitan Commission's Sanitary Districts #5 (Piney Point) and #8 (Lexington Park). The lower eastern shore of the St. Mary's River is within the Sanitary District #7 which is not served by public facilities at this time. The public sewage collection system in these areas directs the sewage to the Marley Taylor Water Recovery Facility and after treatment the effluent is discharged into the Chesapeake Bay. There are 42 major sewage pumping stations in Sanitary District #8 and four major pump stations in Sanitary District #5. Those pump stations are shown in Table 7-1.

Pump Station	Pump Station ID	Sanitary District	Address	Design Flow
Great Mills	015	8	20208 Pint Lookout Road	400
Greenbrier	029	8	47113 Schwarzkopf Drive	450
Hickory Hills	022	8	45599 Amber Drive	825
Hilton Run	017	8	46740 Hilton Drive	273
Hunting Quarters	034	8	20881 Hunting Quarter Drive	300
Laurel Glen	031	8	26695 Laurel Glen Road	80
Lynn Drive	009	8	21325 Lynn Drive	250
Meadow Lake	048	8	45484 Columbine Place	194
Moorings	028	8	48261 Keel Drive	80
Patuxent Park West	016	8	21637 Liberty Street	240
Pegg Road	047	8	21895 Pegg Road	92
Pembrooke	054	8	20540 Pershing Drive	600
Picketts Harbor	024	8	48251 Pisketts Harbor Court	107
Planters Court	035	8	46839 Planters Court	120
Riverbay	052	8	48053 Spinnaker Circle	209
Rue Woods	044	8	22666 Sylvan Way	85
Southgate	021	8	21111 Three Notch Road	65
Spring Valley	011	8	46485 Rosewood Drive	250
St. Mary's City	004	8	17061 Point Lookout Road	568
St. Mary's Industrial Park	027	8	23751 Three Notch Road	293
St. Mary's Square	007	8	21592 Great Mills Road	150
Waters Edge	019	8	48400 Surfside Drive	145
Westbury	056	8	21572 Croaker Court	260
Widgeon	042	8	44919 Widgeon Place	42
Wildewood #1	003	8	23251 Laurel Hill Drive	446
Wildewood #2	026	8	45574 Aspen Lane	295
Wildewood #3	032	8	44437 Redwood Lane	243
Willow Woods	051	8	46687 Sandalwood Street	40
Piney Point	002	5	45271 Bloch Avenue	350
Piney Point Landings	025	5	17999 Driftwood Drive	220
Sheehan	041	5	17831 St. Georges Park Road	125
St. George Island	030	5	16668 Piney Point Road	140

Only 32 in table—text mentions "42"

Table 7-1. Source: St. Mary's County Metropolitan Commission, 2009.

Ground Water and Water Supply—Aquifers

Potable water is supplied through three confined aquifers throughout St. Mary's County. They are the Piney Point, Aquia, and Upper Patapsco. Sporadic use, mostly for agriculture, is supplied by a fourth unconfined aquifer, the surficial aquifer commonly referred to as the water table. This source is generally not reliable in drought years or seasonally. The surficial aquifer may contain contaminants.[71] Historically, hand-dug wells into the surficial aquifer were used for potable usage. Over time and through extensive Federal water projects in the 1940s, these wells have been replaced with public water supplies or modern wells drilled into the Piney Point or Aquia. It is not known how many, if any, of these wells that supply drinking water are still in existence.

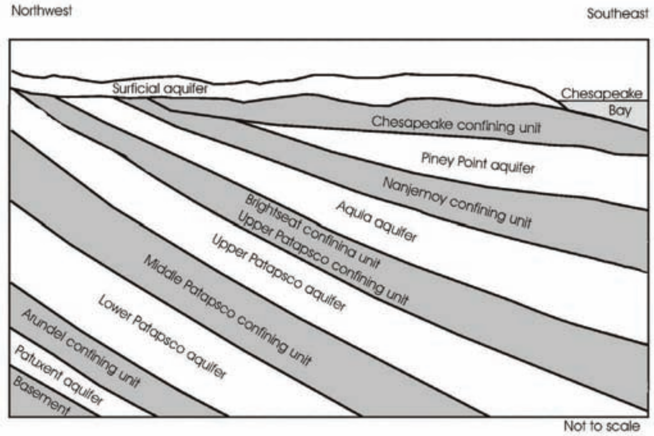


Figure 7-1. Schematic cross section of the hydrogeological units in southern Maryland. Source: Drummond, 2005, p27.

Figure 7-1 depicts the aquifers and the separating clay layers, which inhibit the movement of ground water. Shown from highest to lowest elevation, they are the surficial, Piney Point, Aquia, Upper Patapsco, Lower Patapsco, and Patuxent. Below the Patuxent is bedrock and it is not considered to be a significant water supply.[72] The aquifers and confining units are sloped downward from northwest to southeast, thus allowing the northwest end of each aquifer to subcrop (extend to the land surface) and mix with the surficial aquifer. These areas allow surface water to enter each of the confined aquifers and recharging water supplies. Confined aquifers are under pressure from the weight of the land and water causing the water to rise in height within wells to a level somewhat above the top of the aquifer at each well location. This water level is referred to as the potentiometric surface.

5.

Maryland Department of the Environment regulates water withdrawal from aquifers. When potentiometric surface levels reach a point 80% below the land surface and the top of the aquifer, additional withdrawals are curtailed. Withdrawal below this level may cause land subsidence, reduced productivity, and/or brackish water intrusion.[73]

The **Piney Point** aquifer, known in some research reports as the Nanjemoy or Piney Point Nanjemoy, subcrops in central Charles and Calvert counties. It is primarily used for private domestic water supply for older homes in the Lexington Park development district and homes in rural areas of the St. Mary's River watershed. Water supplies from the Piney Point are high quality and generally contain only trace amounts, if any, of arsenic. The Piney Point is available throughout the St. Mary's River watershed.

[71]Drummond, David D., WATER-SUPPLY POTENTIAL OF THE COASTAL PLAIN AQUIFERS IN CALVERT, CHARLES, AND ST. MARY'S COUNTIES, MARYLAND, WITH EMPHASIS ON THE UPPER PATAPSCO AND LOWER PATAPSCO AQUIFERS; Maryland Department of Natural Resources Resource Assessment Service; June 2005, p4.

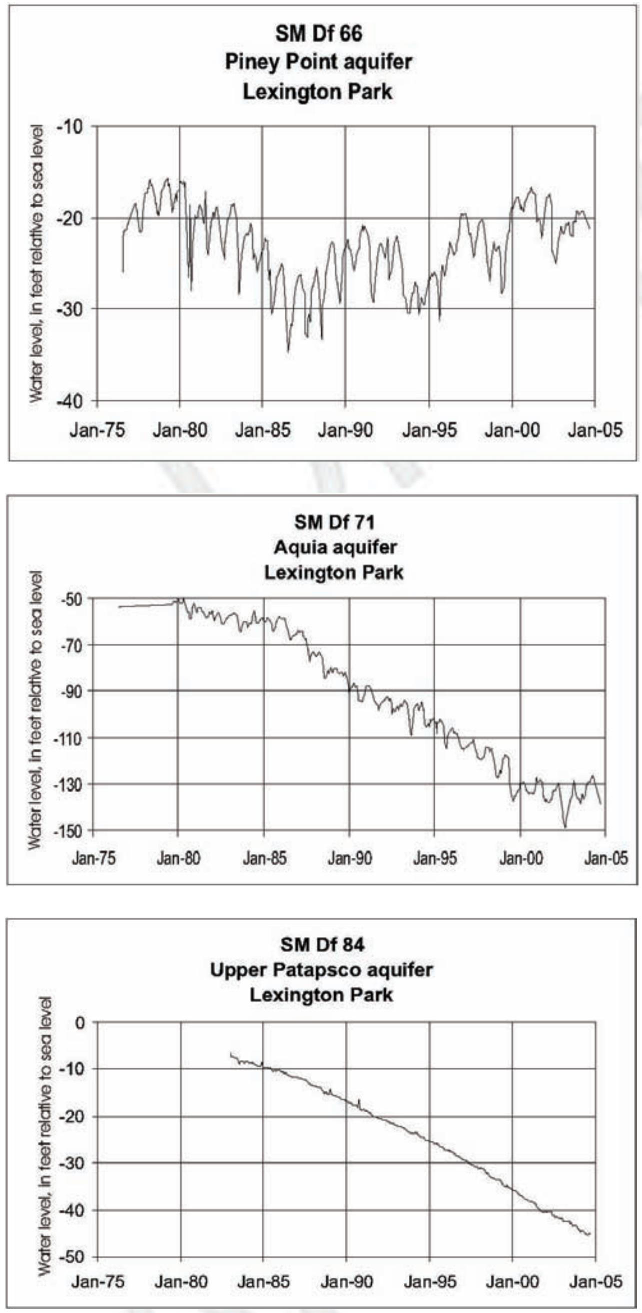
[72]ibid, p3.

[73]Drummond, D.D., 1988, Hydrogeology, brackish-water occurrence, and simulation of flow and brackish-water movement in the Aquia aquifer in the Kent Island area, Maryland: Maryland Geological Survey Report of Investigations No. 51, p31.

The **Aquia** aquifer is separated from the Piney Point by the Marlboro Clay confining layer. This aquifer is used extensively for domestic and major-user supplies in southern Maryland, as well as in Virginia and the Eastern Shore of Maryland. It is also used by commercial, industrial, and military users within the watershed. The Aquia subcrops in northwestern Charles County.[74] It is available throughout the St. Mary's River watershed (it is not productive in southern St. Mary's County).

Water quality in the Aquia is generally good, except naturally occurring arsenic concentrations exceed the new U.S. Environmental Protection Agency Maximum Contaminant Level (MCL) of 10 micrograms per liter (µg/L) (Federal Register, 2001) for public water supplies.[75] For this reason, expansion of public water supplies are supplied by the Patapsco. Existing waters supplies in the Aquia not meeting the new MCL are being terminated and replaced by the Patapsco. Lowered potentiometric surface in excess of 220 feet form a deep cone of depression in the Lexington Park area due to heavy withdrawals. (see Map 7-1) Levels dropped more than 90 feet in the 1990s.[76]

The **Upper Patapsco** and **Lower Patapsco** aquifers are believe to have some localized exchange of water. Within each aquifer there are complex stratified sandy units separated locally by silty sand and clayey units. These sands appear to be interconnected at a regional scale to form a single aquifer.



Figures 7-2, 7-3, 7-4. Hydrographs showing long-term potentiometric surface trends in Lexington Park. Source: Drummond, 2005, p35.

[74]Drummond, David D., WATER-SUPPLY POTENTIAL OF THE COASTAL PLAIN AQUIFERS IN CALVERT, CHARLES, AND ST. MARY'S COUNTIES, MARYLAND, WITH EMPHASIS ON THE UPPER PATAPSCO AND LOWER PATAPSCO AQUIFERS; Maryland Department of Natural Resources Resource Assessment Service; June 2005, p5.
[75]ibid, p5.
[76]ibid, p5,7.

Recharge of the Patapsco is at or near to the fall line or along Interstate 95. Salt water intrusion at Indian Head is believed to be due to a cone of depression allowing the interconnection between the subcrop area and the Potomac River. Potentiometric surface of the Upper Patapsco in Lexington Park has dropped 37 feet since 1983.[77] Water quality in the Patapsco is very good and no arsenic has been detected.

The **Patuxent** aquifer lies on bedrock and is the deepest aquifer in southern Maryland. A test well in Lexington Park supplied brackish water, therefore, the Patuxent is not considered a source of potable water.[78]

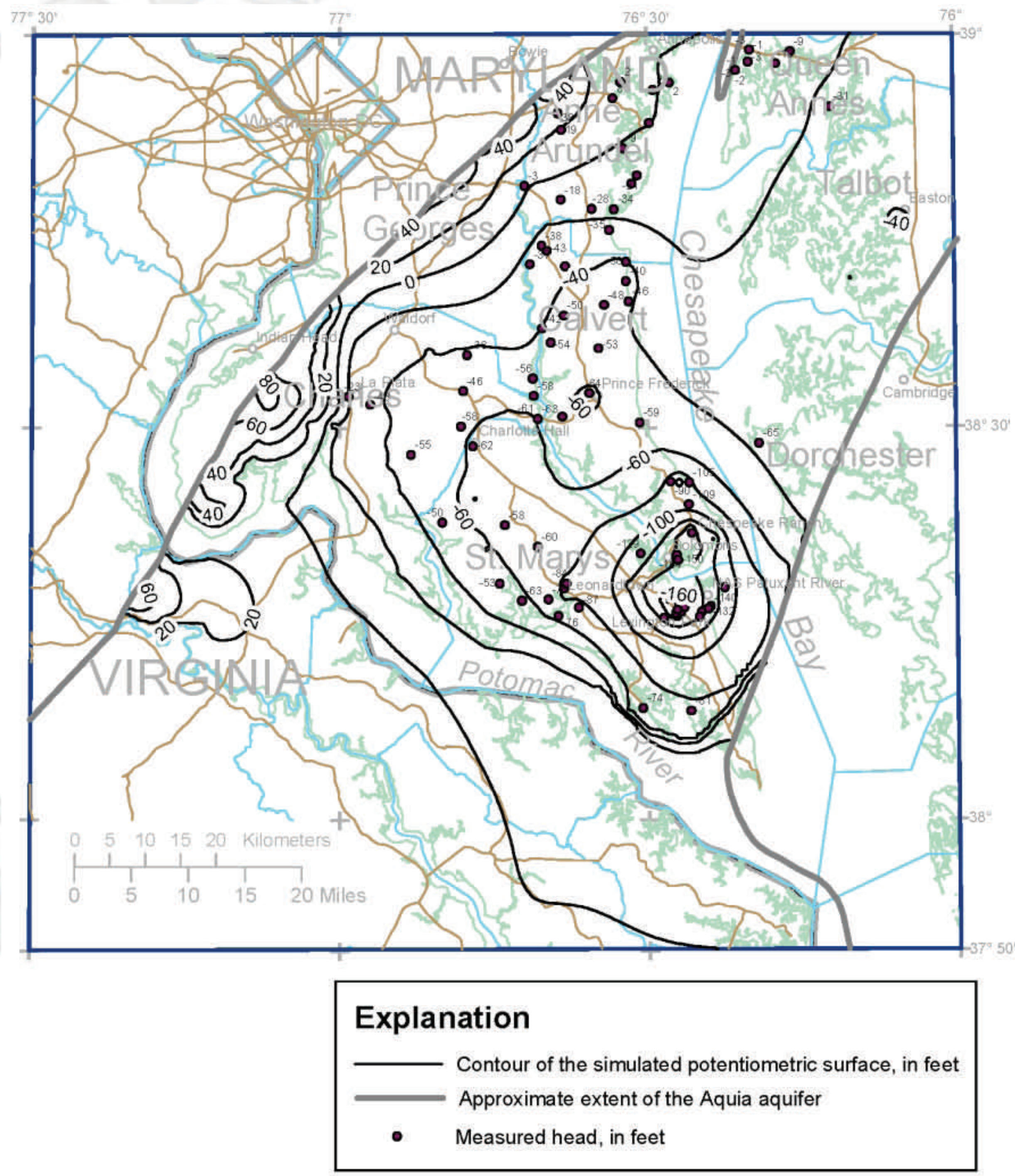
A fourth confined aquifer, the **Magothy** regionally located between the Aquia and the Upper Patapsco, does not extend into the St. Mary's River watershed area.

Effects of falling potentiometric surface can negatively affect private wells. Wells have been constructed with 4-inch diameter casings near to the land surface to accommodate a submersible pump, but reduce to 2-inch diameter below that to save on construction costs. These are referred to as **telescoping wells**. Drummond writes, "If the potentiometric level falls below the reduction point (or near to the reduction point due to pump drawdown) in such a well, the pump cannot be lowered further and the well must be replaced. … [this] may cause significant economic impact in areas where telescoping wells are common."[79]

Within the St. Mary's River watershed area the effects of withdrawals and lower potentiometric surface of the Aquia generally have no effect on the water table.[80] A lowered water table may include reduced base flow to streams, a decrease in water available for plant transpiration, and altered ecology of wetlands.[81] These processes are complex and localized, and were not addressed in the June 2008 Drummond study. Additionally, excessive drawdown may invite river water or Bay water intrusions; this effect noted currently in the Indian Head area for the Upper Patapsco.

According to the June 2008 Drummond study, **future pumping trends** in the St. Mary's River watershed and the Lexington Park area do not anticipate any significant negative effects to the three confined aquifers through the year 2030. As the public supply continues to limit additional pumpage in the Piney Point and Aquia, potentiometric surface lowering should decrease. Increased use of the Patapsco was studied according to land use regulations at the time. Recently, the county adopted new rules for designated growth patterns (Annual Growth Policy, August 19, 2008), which may increase development pressure in the Lexington Park development district and cause further lowering of potentiometric surface than Drummond's model projected. Likewise, the Drummond model does not anticipate any new major users (industrial, agricultural, military, or extraction).

[77]Drummond, David D., WATER-SUPPLY POTENTIAL OF THE COASTAL PLAIN AQUIFERS IN CALVERT, CHARLES, AND ST. MARY'S COUNTIES, MARYLAND, WITH EMPHASIS ON THE UPPER PATAPSCO AND LOWER PATAPSCO AQUIFERS; Maryland Department of Natural Resources Resource Assessment Service; June 2005, p7.
[78]Hansen, H. J., and Wilson, J. M., 1984, Summary of hydrogeologic data from a deep (2,678 ft.) well at Lexington Park, St. Mary's County, Maryland: Maryland Geological Survey Open-File Report No. 84-02-1, p61.
[79]Drummond, June 2005, p8.
[80]ibid, p.
[81]Achmad, Grufron, 1991, Simulated hydrologic effects of the development of the Patapsco aquifer system in Glen Burnie, Anne Arundel County, Maryland: Maryland Geological Survey Report of Investigations No. 54, p90.



Map 7-1. Simulated potentiometric surface in the Aquia aquifer, 2002. Source: Drummond, 2005, p29.

Ground Water and Water Supply—Public Water Systems

The public water system is operated by the St. Mary's County Metropolitan Commission and utilizes water supplied through confined aquifers. The production wells for this system are screened in three unconsolidated confined aquifers. Ranging from shallowest to deepest these are the Piney Point, Aquia, and Patapsco Aquifers. Most of the wells are screened in the Aquia Aquifer (16 wells), while the Patapsco (5 wells) and the Piney Point (3 wells) aquifers feature a significant fewer number of wells. A similar ratio is exhibited for the well population supporting the small community systems.

Presently the St. Mary's County Metropolitan Commission operates 24 production wells in the Lexington Park system with a total average pumping capacity of about 220 gallons per minute per well across a range of 55 to 600 gallons per minute. Independent of the public system, more than 35 small community systems (trailer parks, developments, military bases) operate 104 wells to meet the local demand in St. Mary's County. The public wells in the Lexington Park area are shown in Table 7-2.

Need to mention that METCOM has removed service from some wells (arsenic) and replace that service with wells in the Patapsco…

Well	Pump Flow Rate	Aquifer	MDE Allocation*
Abberly Farms	450	Patapsco	450
Bank Square	270	Aquia	1010
Colony Square	170	Aquia	1010
Espranza Farms	140	Aquia	1010
Essex Drive	140	Aquia	100
First Colony #1	220	Patapsco	330
First Colony #2	300	Patapsco	330
Great Mills	140	Piney Point	140
Greenbrier #1	450	Patapsco	80
Greenbrier #2	280	Aquia	30
Greenview Knolls #3	120	Aquia	60
Hickory Hills	55	Aquia	10
Laurel Glen	200	Aquia	40
Pegg Road	435	Aquia	1010
San Souci	120	Aquia	1010
St. Mary's Industrial Park	350	Patapsco	240
Town Creek #3	115	Piney Point	140
Town Creek #6	145	Piney Point	140
Tubman Douglas	60	Aquia	30
Wildewood #1	85	Aquia	240
Wildewood #2	80	Aquia	240
Wildewood #3	120	Aquia	240
Wildewood #4	600	Aquia	600
Willow Road	140	Aquia	1010
*Note: Flow Rate and MDE Allocation given in gallons per minute			

Table 7-2. Source: St. Mary's County Metropolitan Commission, 2009.

Emergency Services

Emergency Services
1. Hazard Mitigation Plan
2. Emergency Evacuation Plan

Agriculture
Growing for Local Consumption
Grains and bio-fuel
Animal Operations
Equine Facility Needs & Impacts

—emergency services

Bruce/Donna—agriculture

Living Resource Indicators

Because aquatic organisms are sensitive to changes in water quality, aquatic habitat, and the landscape, certain indicator species or indices that combine ecological factors were used in Maryland's *1998 Watershed Assessment*[8-1] to evaluate the health of watersheds. The indicators provide a general assessment of the quality of resources within a watershed, rather than specific details about the resources. As such they can be used to point to areas that might need further investigation, protection, or restorative actions.

Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV) performs critical ecological functions such as providing nursery grounds and habitat for numerous species of aquatic animals and food for waterfowl. In addition the presence of SAV meadows improves water quality by trapping suspended sediment particles and absorbing dissolved nutrients. SAV is also an important indicator of water quality as populations decline or expand in response to changes in water clarity from suspended particles and to changes in nutrients loads.

SAV Status

SAV increased dramatically in the tidal St. Mary's River from no SAV as recently as 1994 to a high of 1,332 acres in 2002.[8-2] The primary species in the tidal St. Mary's River is widgeon grass (*Ruppia maritima*) with some eelgrass (*Zostera marina*) as the result of SAV restoration projects. In addition horned pondweed (*Zannichellia palustris*) can be found in the spring and early summer, primarily in the upper tidal St. Mary's River.

REPLACE THIS GRAPHIC

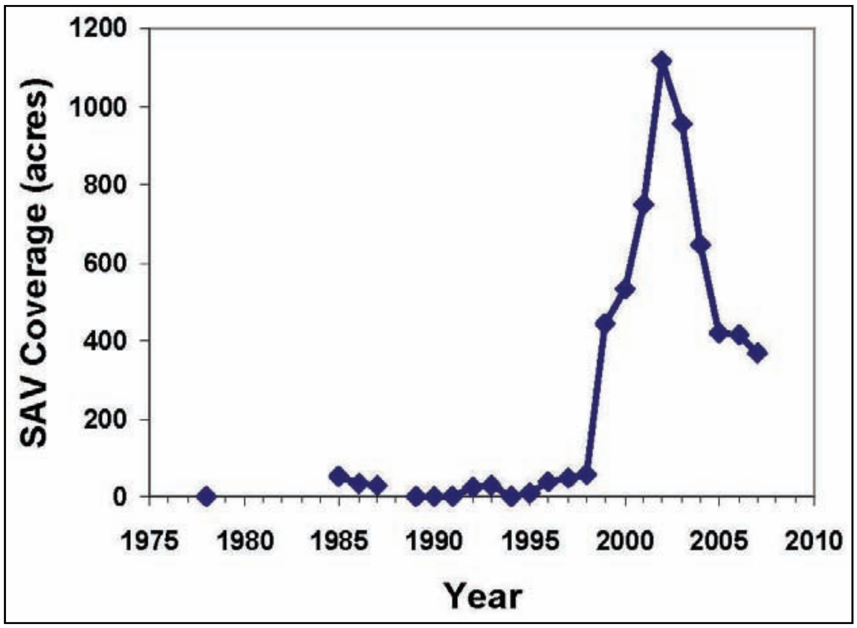


Figure 1. SAV in the St. Mary's River north from Cherryfield Point (Quadrangle 80, VIMS aerial surveys, http://www.vims.edu/research/topics/sav/index.php).

[8-1]Maryland Clean Water Action Plan Final 1998 Report on Unified Watershed Assessment, Watershed Prioritization and Plans for Restoration Action Strategies. Dec. 31, 1998. http://www.dnr.state.md.us/cwap/cwap.htm

[8-2] data from quadrangles 80 and 89 VIMS aerial surveys, http://www.vims.edu/research/topics/sav/index.php

Living Resource Indicators continued

[8-3]Landwehr, J. M., J. T. Reel, N. B. Rybicki, H. A. Ruhl, and V. Carter. 1999. Chesapeake Bay habitat criteria scores and the distribution of submersed aquatic vegetation in the tidal Potomac River and Potomac estuary, 1983-1997. U.S. Geologic Survey Open-File Report 99-219.
[8-4]Kemp, W. M., P. Bergstrom, E. Koch, L. Murray, J. C. Stevenson, R. Bartleson, V. Carter, N. B. Rybicki, J. M. Landwehr, C. Gallegos, L. Karrh, M. Naylor, D. Wilcox, K. A. Moore, and R. Batiuk. 2004. Habitat requirements for submerged aquatic vegetation in Chesapeake Bay: water quality, light regime, and physical-chemical factors. Estuaries 27:363-377.
[8-5]Pfitzenmeyer, H. T., and K. G. Drobeck. 1963. Benthic survey for populations of soft-shelled clams, *Mya arenaria*, in the Lower Potomac River, Maryland. Chesapeake Science 4:67-74.

3. Nontidal Benthic Index of Biotic Integrity (IBI)
(Score: 7.43; Range: 1, most degraded, to 10, best condition)

Insects, insect larvae, crayfish, and other creatures living on the bottoms of streams are essential to the functioning of aquatic ecosystems. Such benthic organisms are particularly sensitive to changes in water quality and physical habitat. The Benthic Index of Biological Integrity (B-IBI) looks at the benthic community and considers the number and diversity of species and the presence of sensitive species. Reference conditions for the B-IBI, were established from minimally-impacted streams, with the scale ranging from 1, most degraded, to 10, best condition. Watersheds with a score of 6.0 or greater were classified as meeting restoration goals; those scoring less than 6 were classified as needing restoration. The St. Mary's River watershed had a B-IBI of 7.43.

WHAT YEAR??? What is it in 2008??

4. Nontidal Fish Index of Biotic Integrity (IBI)
(Score: 6.0; Range: 1, most degraded, to 10, best condition)

Indexes of Biotic Integrity (IBIs) for fishes were developed for small (first- to third-order) nontidal streams, as are found in the St. Mary's River watershed. A fish IBI score was calculated for each sampled stream from measured characteristics of the fish community -- the numbers of native species, benthic species, and tolerant individuals; the percent of tolerant species, dominant species, generalists, omnivores, and insectivores; the number of individuals per square meter; biomass in grams per square meter; percent of lithophilic spawners; and percent insectivores. Scores were reported as means for the sites within each watershed, with less than 6 representing a failed indicator. The St. Mary's watershed had a passing score of 6. (Note that IBI's were also computed for the sites monitored by the St. Mary's River Project and the synoptic survey, discussed in the section on nontidal fish. These IBI's in this section were changed to reflect a 10-point scale for comparison reasons.)

5. Non-tidal In-stream Habitat
(Score: 4.75; Range: 1, most degraded, to 10, best condition.)

This physical habitat indicator, developed for small (first- to third-order) non-tidal streams, is based on measures that rate the quantity and quality of physical habitat available for fish and benthic macroinvertebrate colonization and rate the degree of alteration to the stream channel. Watersheds with scores in the lower 25% receive a Category 1 rating. Low or declining scores reflect both natural disturbances and human-induced alterations of the stream habitat. The indicator as applied to Coastal Plain streams includes five characteristics: in-stream habitat structure, velocity-depth diversity, pool quality, riffle quality, and aesthetic quality. The score of 4.75 given the St. Mary's River watershed suggests natural or human induced alteration in the stream habitat, but the *1998 Watershed Assessment* does not provide basin-specific information; one could surmise that aspects of these 5 characters may have been influenced by land use and land-cover patterns in the watershed, such as the destruction of riparian forests, an increase in impervious land cover, channelization, encroachment by livestock, and blockages to fish movement. Understanding the specific factors could point towards the appropriate corrective actions.

6. Migratory Fish Spawning Area
Score: 1 (range, 0- 7)

This living resources indicator -- used in the *1998 Watershed Assessment* to identify watersheds that are candidates for conservation and protection -- rates watersheds based on the diversity of spawning habitat for American Shad, Hickory Shad, Alewife, Blueback Herring, White Perch, Striped Bass, and Yellow Perch. St. Mary’s was given a score of 1, indicating the presence of one migratory fish, the Yellow Perch. This indicator reflects vulnerability to human-induced damage and the condition of the resource, such as physical blockages from dams, road culverts etc., to water quality impairment, or to combinations of these factors.

Living Resource Indicators continued

FIDS

Birds

Fish and Crabs

1. Tidal Areas

Commercial fisheries harvest information -- considered an indicator of the health of an aquatic system -- is tracked by Maryland Department of Natural Resources (DNR) Fisheries Service. The following information on crab and striped bass in the St. Mary's River watershed was obtained from the DNR's internet site (http://www.dnr.state.md.us/fisheries/commercial/chbayharvest.htm).

Crab

The commercial crab catch for the St. Mary's River is combined with that from other tidal Potomac River tributaries. According to the most recent DNR data, 1,226,144 pounds of hard and soft-shelled crab were harvested in the Potomac tributaries in 2006. This was slightly lower than the previous two years, more than twice the size of the harvest at its 10-year low in 2000. Even so, it is likely the St. Mary's River crab fishery reflects the state of the overall Chesapeake Bay blue crab population, which has been in a period of low recruitment since 1997-1998 and in 2008 was only moderately above the minimum safe threshold of 86 million reproductive-age crabs established by the Chesapeake Bay blue crab management authorities.

Striped Bass

The last year reported for striped bass commercial fishery in the St. Mary's River by the DNR Fisheries web site was 2002, when the harvest had fallen to 15,486 pounds, down from an average of 21,609 for the previous three years.

Does anyone in the group have any more insight on crabs and striped bass?

3 Maryland Department Natural Resource (DNR) Fisheries Service web site: http://mddnr.chesapeakebay.net/mdcomfish/crab/hscmcfquery.cfm?Noaacode=074&Spcode=7000

4 2008 Chesapeake Bay Blue Crab Advisory Report
Approved by the Fisheries Steering Committee: July 21, 2008. http://chesapeakebay.noaa.gov/docs/CBSAC2008bluecrabreport.pdf

2. Nontidal Areas

Data has been gathered about nontidal fishes in the St. Mary's River Watershed at 13-15 monitoring stations (see map, Figure XX) since 1999 by the following three monitoring efforts:

- The Maryland Department of Natural Resources (DNR) surveyed the St. Mary's River watershed in 1995 during the Maryland Biological Stream Survey (MBSS). Table ____ summarizes MBSS findings. **(TABLE TO BE PROVIDED BY LINDSAY IF POSSIBLE**
- The St. Mary's River Project (SMRP) has sampled for fish during the MBSS Summer Index Period since 1999. Although the number of stations sampled by SMRP has not been consistent, nearly all stations were collected from in 1999, 2001, and 2008. Table XX (at End) displays fish species and numbers collected by year and sampling station.
- As part of the 2008 the watershed synoptic survey conducted by Dr. Robert Paul of St. Mary's College of Maryland, fish sampling was conducted in July 2008 following MBSS protocols.

The SMRP and synoptic survey data showed that from 1999-2008, a total of 6,612 individual fish were captured and released -- representing 11 families and 41 species. Of this total, 817 fishes were collected in 2008, representing 10 families and 26 species. Data from the years 1999 and 2001 (when samples were conducted at most stations) showed that 4 species represented nearly 80% of the fish collected. The MBSS study had slightly different results, showing that 6 species comprised 75% of the total captured. While differences among the SMRP and MBSS samples existed, both agreed that the dominant species in the watershed were:

Eastern mudminnow

Least brook lamprey

American eel, and

Tessellated darter.

5 Boward, et al. 1998.

Living Resource Indicators continued

The following noteworthy points can be surmised from the different surveys:

Fisherman's Creek (NT13) had less fish diversity than other sites, likely due to poorer habitat conditions. Most sites had at least 9 fish species and 100 individuals in 1999, whereas the 75-m section of Fisherman Creek has only 4 species. The number increased to 8 in 2005, then back down to 6 in 2008.

The fish communities at Hickory Hills (NT06) and Jarboesville Run (NT08) tributaries are declining in numbers and diversity. It is probable that urbanization in these subwatersheds has detrimentally affected the habitat and resources.

The 2008 survey pointed to problems at Norris Road (NT07) and Hilton Run (NT10). Norris Road has rather poor fish habitat, but the results from Hilton Run were surprising in that previous samples had good fish diversity, according to the Index of Biological Integrity (IBI) scores.

Largemouth bass represented an anomaly: In 1999, none were collected; in 2001, 10 were captured; in 2008, 4 were counted.

A large decrease was seen in the percentage of Least brook lampreys from the SMRP surveys. In 1999, they represented 19% of all fish; in 2008, they were only 5.6% of the sample. It is possible, however, that the large decline was related to sampling efficiency, rather than stream habitat change.

Incorrect field identification may account for 3 rare species in the SMRP samples (Bridled shiner, Warmouth, and Satin fin shiner).

IBI scores were computed yearly for all SMRP stations, as they were for the MBSS data (using Roth et al's method). A total of 36 scores were computed (see table below). Taken as a whole, they show that more than half of the streams provide good habitat. At the other end of the spectrum, Landfill Tributary (NT05) had a score bordering "poor," and Hickory Hills and Church Creek both had "poor" scores -- in other words, these three sites might be in need of remedial attention.

6 Roth, N.E., M.T. Southerland, J.C. Chaillou, J.H. Volstad, S.B. Weisberg, H.T. Wilson, D.G. Heimbuch, and J.C. Seibel. 1996. *Maryland biological stream survey:*

Living Resource Indicators continued

Table: Index of Biological Integrity Scores for Sampling Stations

Of 36 IBI scores, 67% were good (IBI values > 4.0); 28% were fair (IBI values 3.0 to 4.0); 5% were poor (IBI values <3).

Station Number	Site Name	SMRP IBI's 1999	2000	2001	2003	2005	MBSS IBI's 2000
NT02	Warehouse Run	4.25	-	4.75	4.50	4.25	-
NT03	Below SM Lake	4.00	-	-	-	-	-
NT05	Landfill Trib	-	4.25	3.75	4.00	3.25	-
NT06	Hickory Hills	3.50	-	4.00	4.50	-	2.75
NT07	Norris Road	3.50	-	4.00	-	-	-
NT08	Jarboesville Run	4.25	-	4.25	-	-	3.75
NT09	US Gaging Station	3.75	-	3.50	-	-	-
NT09.5	Johns Creek	-	-	4.50	-	-	4.75
NT10	Hilton Run	4.25	-	4.50	3.50	4.00	3.00
NT11	Pembrook Run	4.25	4.00	4.25	3.75	4.25	4.25
NT12	Eastern Branch	4.50	-	4.75	-	-	-
NT13	Fisherman's Creek	2.75	3.50	4.50	4.50	-	-
NT14	Church Creek	-	3.50	2.50	-	-	-

3. Fish Consumption Advisory

The Maryland Department of the Environment (MDE) is responsible for determining how much of a given species caught in Maryland's waters can be safely consumed. There are statewide advisories for the consumption of small and largemouth bass from all public waters, as well as an advisory on sunfish, including bluegill, from lakes and other impoundments. M**ore information on Maryland and Federal fish consumption advisories, can be obtained from MDE or the MDE Fish and Shellfish home page:** www.mde.state.md.us/CitizensInfoCenter/FishandShellfish/home/index**.**

Benthic Macroinvertebrates

Macroinvertebrates were collected at different non-tidal stations in the St. Mary's River Project (SMRP) in the springs of 1999, 2000, 2001, 2003, and 2008. In the studies from 1999 through 2006, 57 families of aquatic insects were found. In 2008, three new stations were added, and a total of 536 individuals (36 families; 8 orders) were obtained (Table 7). The 2008 collections seem to be good representations of macroinvertebrates based on SMRP historic sampling.

In the 2008 survey Diptera (31.6%) and Ephemeroptera (29.7%) were the most common orders, followed by Odonata (14.0%), Plecoptera (9.6%), Trichoptera (7.9%), and Coleoptera (6.3%). Megaloptera (0.8%) and Hemiptera (0.2%) were relatively rare. The number of insect families at each station ranged between 4 and 20 families. Generally, the insects found reflected specific stream conditions. It was apparent that Craney Creek had a poor community as represented by few insects and minimal diversity. Hickory Hills (NT06) and Pembrook Run (NT11) also had fewer numbers than the other stations, although not as low as at Craney Creek.

The presence or absence of aquatic insect indicator species reflects environmental conditions. In general, the low richness and diversity of benthic macroinvertebrates in a stream may indicate impairment. In particular, the absence of pollution sensitive aquatic insect orders -- *Ephemeroptera* (mayflies), *Plecoptera (stoneflies)*, and *Trichoptera* (cadisflies) -- versus the dominance of pollution-tolerant groups (Oligochaetes or Chironomids) often indicates pollution. On the other hand, other factors, such as predation, competition, or geographic barriers also can contribute to loss of a species. To assess the station samples from the 2008 survey, the systematic comparison of such indicator species -- EPT ratios -- were used. Below are characteristics that were observed: WHERE ARE THE CHARACTERISTICS??

In general, the 2008 results for aquatic insect abundance, diversity, and community structure echoed historic SMRP data from 1999 to 2006 and MBSS studies (Boward et al. 1998; Stranko and Rodney, 2001). A picture of relatively strong biological heath emerged from the data. Generally, stream insect communities reflected healthy in-stream aquatic habitat.

<u>Living Resource Indicators continued</u>

The highest numbers of individuals were found at the Below IBR station (94 individuals), at Warehouse Run [NT02] (93 individuals), and at Landfill Tributary [NT05] (85 individuals). Of these stations, the findings at NT02 were unclear, since this site had the lowest EPT rating, having no *Ephemeroptera*. Craney Creek had the lowest diversity (4 taxa) and lowest number of aquatic insects (8 individuals), but because this is the first year that Craney Creek has been sampled, it is difficult to determine whether it is perturbed or has historical problems.

Four other subwatersheds showed signs of negative impacts: Hickory Hills Tributary (NT06), Jarboesville Run (NT08), Pembrooke Run (NT11), and Church Creek (NT14). The first three sites have their headwaters in the Lexington Park development district. It is fairly clear from stream channel morphology that the bottom habitat of these streams has been altered by sedimentation. Likely, up-stream erosion is occurring, due to impervious surface development and poor storm water management practices. Church Creek has been long know to have difficulties because of poor storm water management off Route 5 in the vicinity of Villa Road. Although the State Highway Administration has attempted to rectify this problem with a storm water catchment, the solution seems ineffective.

There also were some surprising anomalies encountered in 2008 compared to other years and these are difficult to explain. The most surprising results came from Landfill Tributary (NT05). It had a large number of insects (85) and a 42.3% EPT ratio, despite heavy stream bank erosion and siltation, coupled with high ammonia concentrations. Despite historic water quality problems, this station has had a mixture of high and low aquatic insect densities (90 individuals in 2000; 32 in 2005). Warehouse Run, which has had excellent insect diversity since 1999, had poor results in 2008. These confusing results could be better understood with repeated spring sampling at these stations in the future.

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 macroinvertebrates, collectively 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 used 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.

Living Resource Indicators continued

Oysters

The 2007 Annual Fall Oyster Survey, conducted by the Maryland Department of Natural Resources (MDNR) Fisheries Service, was the most recent survey thoroughly reported on DNR's web site. Throughout most of the bay, oyster spatfall was well below the 23-year average. One Key Bar (bars used to determine the spat index) in the St. Mary's River, named Pagan, accounted for 75% of the index. Excluding that bar, the spat index was dismal. Aside from St. Mary's River, the highest spatfall on all bars (not just Key Bars) was around Tangier Sound. The oyster harvests shown below for the St. Mary's River and Smith Creek show a precipitous decline from 1985 through 2004.

Year	1985-86	'86-87	'87-88	'88-89	'89-90	'90-91	'91-92	'92-93	'93-94	'94-95	'95-96	'96-97
Bushels	80,700	30,700	2,300	500	1,100	1700	100	60	30	3,900	900	16,200

Year	'97-98	'98-99	'99-2000	2000-01	2001-02	2002-03	2003-04	2004-05
Bushels	36,700	16,400	4,500	6,150	1650	0	0	91

The Survey also found that both Dermo disease (caused by the parasite *Perkinsus marinus*) and MSX disease (caused by the parasite *Haplosporidium nelsoni)* increased appreciably throughout the Maryland oyster bars after being somewhat suppressed for 4 consecutive years. Despite high spat levels, the St. Mary's River also had a high prevalence and intensity of Dermo for the past two years (as seen in the chart below). Its mean intensity for Dermo was higher than the 2007 mean for all surveyed bars. MSX disease also was detected in the southern part of the St. Mary's River. The 2007 observed mortality from disease in the St. Mary's River was 20% for Chicken Cock bar and 4% for Pagan bar.

The *Point Lookout* sanctuary nearby at the mouth of the Potomac River remained a "hotbed" of dermo disease, with 97% prevalence, an extremely high intensity of 4.6, and a mortality rate of 39%.

St. Mary's River Oyster Survey Bars	1990 Dermo Prevalence (%) Dermo Intensity Combined Disease Mortality (%)	1994	1998	2002	2006	2007
Chicken Cock	100% 4.2 27%	40% 1.0 11%	80% 1.7 24%	100% 2.9 63%	90% 3.4 20%	90% 4.0 20%
Pagan	93% 3.3 39%	10% 0.3 4%	73% 1.7 3%	93% 4.4 84%	80% 3.1 9%	90 2.5 4%

7 Maryland Oyster Population *Status Report 2006 Fall Survey. Maryland Department of Natural Resources Shellfish Program and Cooperative Oxford Laboratory. MDNR Publ. No. 17-7272007-233. Aug. 2007. http://www.dnr.maryland.gov/fisheries/commercial/oysters/fallsurvey/fs06webver.pdf*

Living Resource Indicators continued

LIVING RESOURCES AND HABITAT

7. High Quality Habitat for Forest Interior Dwelling Species (FIDS)

Birds

Oysters

Sensitive Species

1. Habitat Protection Categories

2. St. Mary's River Bottomlands Heritage Area

2. Rare, Threatened and Endangered Species List

Ernie??—FIDS, birds

Sue??—Habitat Protection Categories

Sue??—SMR Bottomlands?

Fish Consumption Advisory

Many fish are safe to eat; however, some fish contain chemicals that may harm children and adults. The Maryland Department of the Environment is responsible for determining how much of a given species caught in Maryland's waters can be safely consumed.

There are statewide advisories for the consumption of small and largemouth bass from all public waters, as well as an advisory on sunfish, including bluegill, from lakes and other impoundments. St. Mary's Lake has an additional advisory for small and largemouth bass due to high mercury levels.

For more information on state and federal fish consumption advisories, please contact MDE or visit the MDE Fish and Shellfish home page, www.mde.state.md.us/CitizensInfoCenter/FishandShellfish/home/index.

Bacterial disease in Chesapeake Bay Striped Bass. Photo courtesy Maryland Department of Natural Resources.

Shellfish Harvesting Restrictions

Portions of the St. Mary's River watershed are affected by shellfish harvesting restrictions. The Maryland Department of Environment is responsible for regulating shellfish harvest. Shellfish, such as oysters and clams, are filter-feeders, which means they filter water through their gills in order trap their food. If the water is contaminated with disease-causing bacteria, the bacteria are also trapped. This could pose a possible health risk if contaminated shellfish are eaten.[47]

PHOTO

Restricted areas are those in which no harvesting is allowed at any time. In conditionally approved areas, harvesting can occur except for the three days following a rain event of greater than one inch in a twenty-four hour period due to the potential for elevated bacteria levels due to runoff. Harvesting can occur at any time in areas designated as open or approved.

There areas are shown in Map X Designated Uses and Use Restrictions. Please visit the MDE's Shellfish Harvesting Areas Web page for the most up-to-date information (http://www.mde.state.md.us/CitizensInfoCenter/FishandShellfish/harvesting_notices/index).

Index of Biotic Integrity: Lower Potomac River

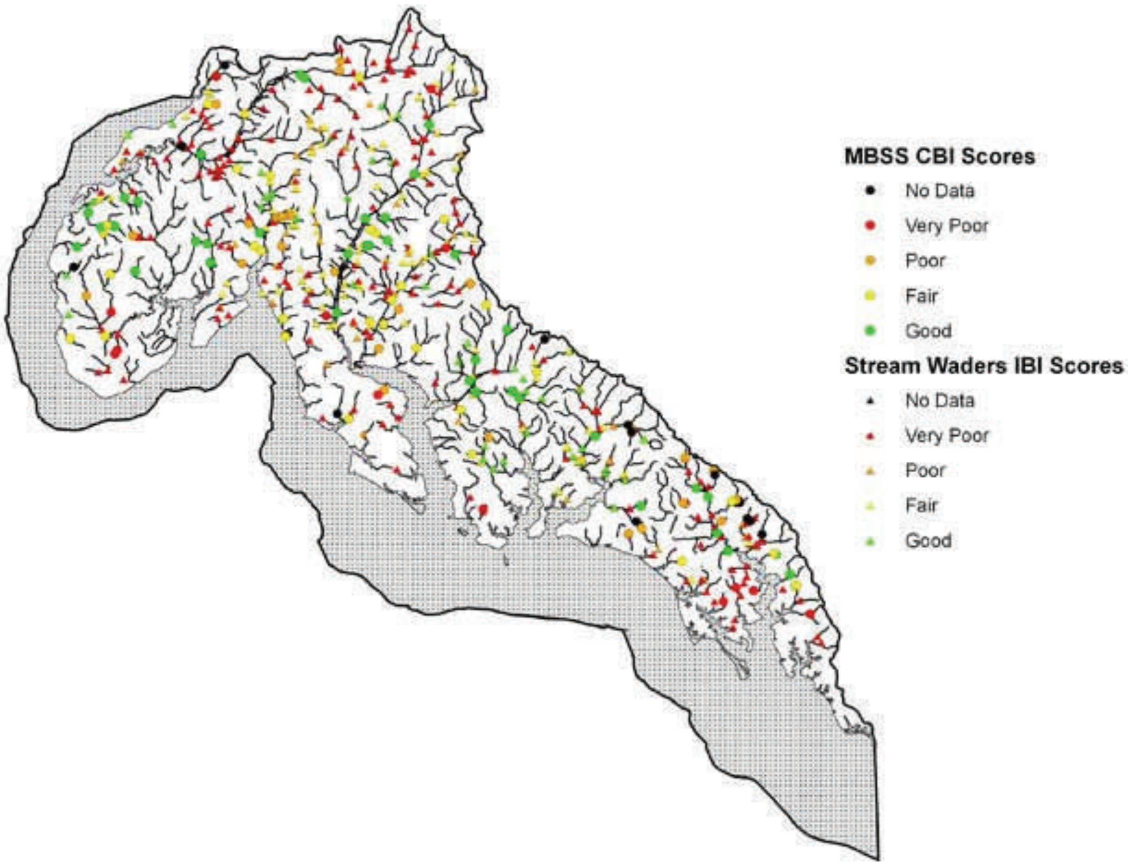


Figure XX. Index of Biotic Integrity: Lower Potomac River (Taken from Maryland Department of Natural Resources. Tributary Strategies Lower Potomac River Team, http://www.dnr.state.md.us/bay/tribstrat/low_pot/lp_status_trends.html)

Benthic Macroinvertebrates didn't we cover them already??

Army Corps of Engineers 2009 Reports

Several well known programs and tools exist to implement goals for watershed restoration and protection. Several of these programs have been utilized in and for the St. Mary's watershed since 2001. These programs have resulted in the publication of five (5) specific documents as detailed below which contain generalized goals and objectives for restoration or conservation as well as more specific actions including public policy implementation and physical on-the-ground actions. This section will identify by study, those policies and physical activities. These are referenced in many cases to either print or digital GIS resources available at the St. Mary's County Department of Land Use and Growth Management (LUGM) which identify our target restoration and conservation efforts.

Upper St. Mary's River Baseline Watershed Assessment - November 2001

This study resulted in recommendations to limit impervious surfaces and to make storm water management retrofits.

Policies: Direct Growth to already degraded catchments (>10% impervious surfaces) while maintaining good conditions where they exist in others (<10%). (Catchment GIS maps at LUGM).

Actions: Storm Water Management Retrofits: Identify and provide improvements to existing storm water retention, infiltration, bioretention and other facilities and conveyance systems. Prioritize the retrofits by catchment quality. (Retrofit location GIS maps at LUGM).

Army Corps of Engineers 2009 Reports continued

St. Mary's River Watershed and Feasibility Study – Stormwater Retrofit Opportunities – February 2002

This report describes the specific process of locating, identifying and prioritizing potential stormwater retrofit sites for the Upper St. Mary's, Jarboesville, Hilton and Pembrooke Run subwatersheds as advocated in the Baseline Assessment.

The report uses a retrofit implementation strategy and concludes with a detailed recommendation for 28 candidate sites and an appendix of retrofit inventory sheets, site detail descriptions and conceptual sketches of a likely retrofit option for

Table 6. Tier 1 and Tier 2 Candidate Retrofit Sites

Site ID	#1 Score	#2 Score	#3 Score	#4 Score	#5 Score	Total Score	Practice	
HR1	20.7	0.0	10.0	13.0	-2.0	41.7	shallow marsh	TIER 1
JR12	17.3	0.0	6.0	15.0	1.0	39.3	wet ED	
USM1	12.0	0.0	8.0	13.0	1.0	34.0	swale pretreatment	
HR4	12.3	10.0	4.0	18.0	-12.0	32.3	wet ED	
HR2	16.0	0.0	8.0	13.0	-5.0	32.0	wet ED	
USM7	2.2	0.0	6.0	20.0	3.0	31.2	wet ED	
JR12B	10.8	0.0	6.0	18.0	-4.0	30.8	shallow marsh	
JR13	15.8	0.0	0.0	11.0	3.0	29.8	bioretention	
USM3	13.5	0.0	8.0	11.0	-4.0	28.5	wet ED	
HR5	4.7	0.0	8.0	13.0	1.0	26.7	shallow marsh	TIER 2
JR2A	5.0	0.0	0.0	13.0	7.0	25.0	shallow marsh	
HR5A	6.0	0.0	2.0	13.0	3.0	24.0	bioretention	
USM11	2.0	0.0	0.0	18.0	2.0	22.0	bioretention	
JR11	3.6	0.0	0.0	13.0	1.0	17.6	bioretention	
HR2A	0.8	0.0	2.0	11.0	1.0	14.8	bioretention	
JR2B	2.9	0.0	0.0	9.0	1.0	12.9	dry swale	
HR6/PR1	19.8	10.0	8.0	15.0	1.0	53.8	pond modification	Small Scale Changes
JR15	23.5	0.0	10.0	15.0	1.0	49.5	pond modification	
USM5	16.3	10.0	10.0	10.0	1.0	47.3	pond modification	
HR7	19.3	0.0	10.0	15.0	1.0	45.3	pond modification	
USM9	20.7	0.0	8.0	15.0	1.0	44.7	pond modification	
USM4	12.3	10.0	8.0	10.0	1.0	41.3	pond modification	
USM6	14.8	0.0	8.0	15.0	1.0	38.8	pond modification	
JR14	8.5	0.0	8.0	15.0	1.0	32.5	pond modification	
JR2	5.3	0.0	8.0	15.0	1.0	29.3	pond modification	
JR11A	6.6	0.0	6.0	15.0	1.0	28.6	pond modification	
JR3A	1.2	0.0	8.0	15.0	1.0	25.2	pond modification	
JR3	1.5	0.0	8.0	13.0	1.0	23.5	pond modification	

Those 28 sites are as shown in Table 6, page 10 from the study.

Army Corps of Engineers 2009 Reports continued

Final Report – The Upper St. Mary's River Watershed Stream and Floodplain Condition Assessment – March 2002

This Technical Memorandum follows the Baseline Assessment to conduct detailed field assessment of stream channel and floodplain conditions along 30 miles of non-tidal streams. The study identifies three (3) parameters (stream condition impairment, biological quality and future land use (catchment impervious surface) to gauge stream reach restoration priorities. The study concludes with a three (3) tiered restoration priority ranking for 15 reaches. Focus again is on high quality reaches with the greatest potential to succeed given a projected land development scenario. The 15 restoration priority reaches are given in Table E-7 of the Technical Memorandum.

Table E-7. Restoration Priority Based Upon Reach Impairment, Biological Quality, and Future Land Use

1st Priority	Stream Condition Impairment	Biological Quality	Future Catchment Impervious Cover***	2nd Priority	Stream Condition Impairment	Biological Quality	Future Catchment Impervious Cover	3rd Priority	Stream Condition Impairment	Biological Quality	Future Catchment Impervious Cover
JR101*	slight	Good	High	PR101	slight	Good	High	JR102	Significant	Fair	High
HR201	slight	Good	Medium	PR102	slight	Good**	Low	UE101	Significant	Poor	High
FC102	moderate	Good	Low	PR103	significant	Fair**	Low	USM104	Significant	Fair	High
JC101	slight	Good**	Low	PR201	moderate	Good	Low	USM105	Significant	Poor	High
JC102	moderate	Good**	Low	FC101	slight	Fair	Low				
JC201	slight	Good	Low								

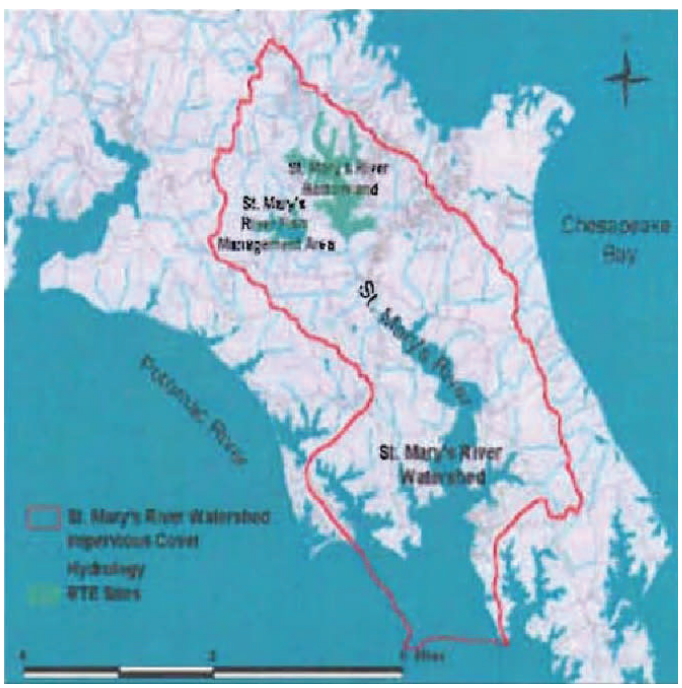
* RTE species present
** predicted biological quality
*** Future Catchment impervious cover is rated as:
High >30%
Medium 15-25%
Low <15%

Army Corps of Engineers 2009 Reports continued

Natural Resources Conservation Summary for St. Mary's County, Maryland – September 2002

This document presents an inventory of potential conservation resources for 1) Rare, Threatened and Endangered (RTE) species, 2) Contiguous Forest Resources, 3) Wetland areas and 4) other wildlife and habitats in need of conservation. The document is intended for use by planners and development plan reviewers to quickly evaluate potential impacts on or near proposed development sites.

The inventory concludes that one of two specific areas in the county that support a diversity of plant and animal species and important habitats is in the upper St. Mary's River watershed in the St. Mary's River Bottomland and St. Mary's River Fish Management Area. While these areas are predominantly within St. Mary's River State Park, additional conservation actions could be directed to those otherwise unprotected areas. Map 9-1 from the inventory identifies the location within the watershed of the Bottomland and Fish Management Area.



Map 9-1—St. Mary's River Watershed, Bottomland and Fish Management Area.

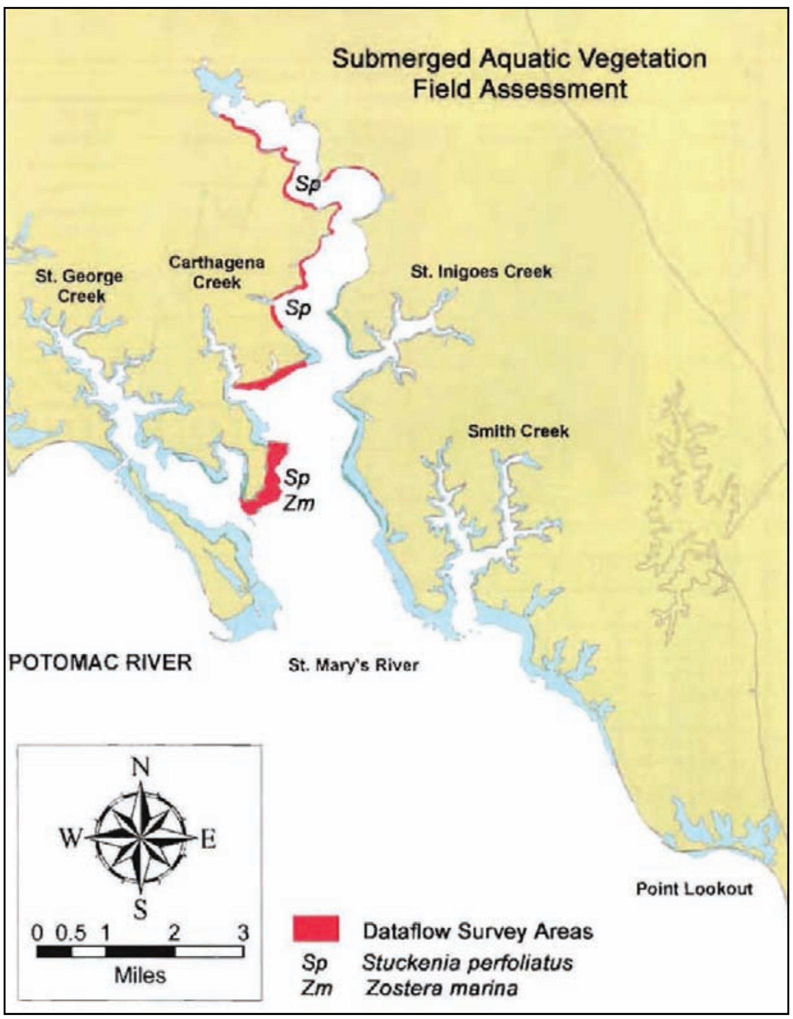
Army Corps of Engineers 2009 Reports continued

Lower Potomac River Basin Seagrass and Oyster Restoration Feasibility Study – November 2003

This study used a multi-faceted approach to analyze the ability of the lower Potomac River basin and its tributaries to support SAV and oyster restoration projects. GIS analysis of site selection criteria from literature reviews, expert interviews, historic data and water quality and physical data resulted in recommendations for both SAV and oyster restoration projects in designated areas of the St. Mary's River.

SAV restoration is recommended in specific narrow one meter depth contour areas in the upper river.

Map 9-2 from the study identifies the location of recommended SAV restoration sites.



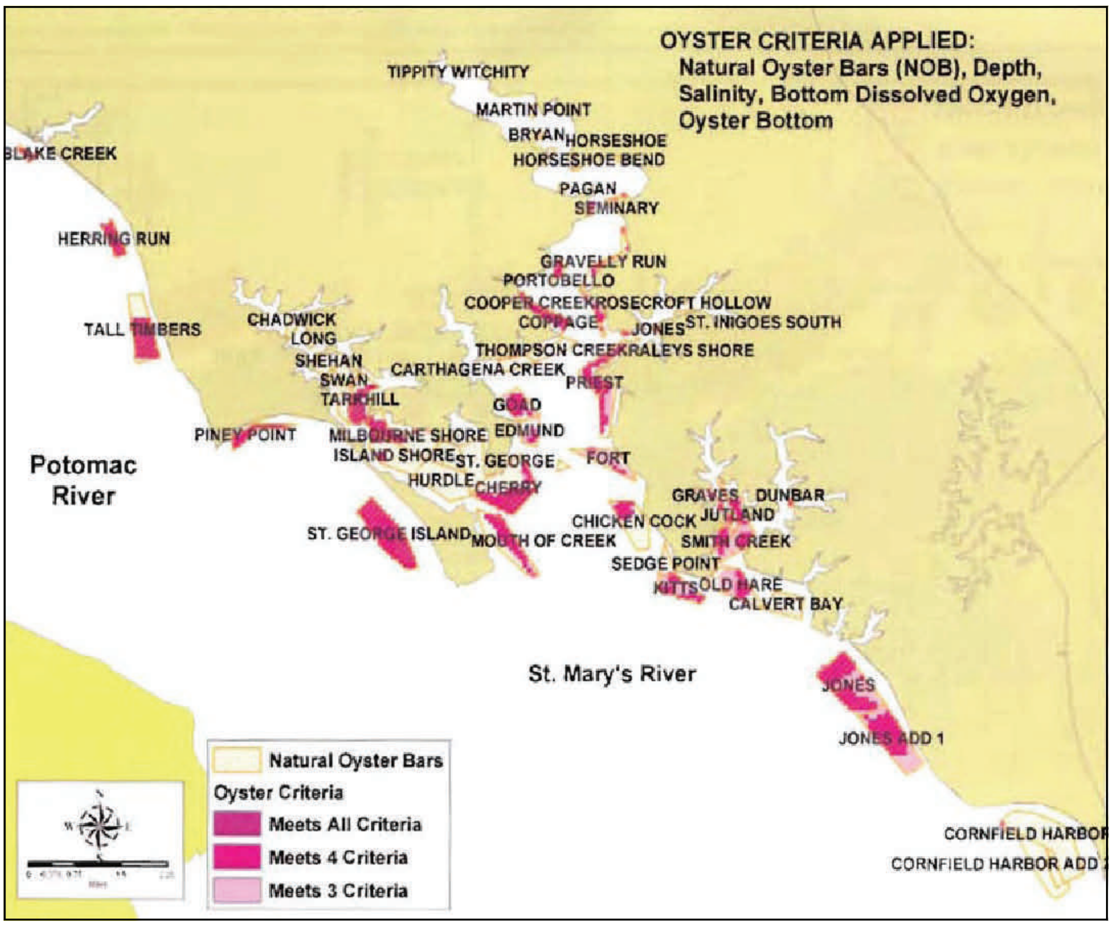
Map 9-2—Location of Recommended SAV Restoration Sites.

SECTION 9—RESTORATION AND CONSERVATION TARGETING

_Army Corps of Engineers 2009 Reports continued**

Oyster restoration is recommended in the lower portion of St. George's Creek opposite Piney Point and south.

Map 9-3 from the study identifies the location of recommended oyster restoration sites.



Map 9-3—Location of Recommended Oyster Restoration.

Additional policies, programs and restoration actions are detailed in the following sections.

RESTORATION AND CONSERVATION TARGETING

2007 VIMS Performance of Sills - shoreline study

Conservation Programs

1. Agricultural Conservation Programs(RuralLegacy, Ag Dist., Ag Pres, CREP)
2. Energy
3. Oyster Floats

Smart Growth

1. Priority Funding Areas
2. Transfer of Development Rights
3. Forest Stands and Open Space

Green Site Design

1. Adding Green Infrastructure to Developments

Green Building

1. Gray Water Reuse
2. Septic System Upgrades and Grant Program
3. Energy Conservation

Marina Programs (Clean Marinas web page on DNR site)

Bruce—sillreport (please summarize)

Bob L.—ag consv., smart growth, PFAs TDRs, marina programs, nutrient uptake,

Donna—forest stands/open space (lands targeted)

Larry—green building

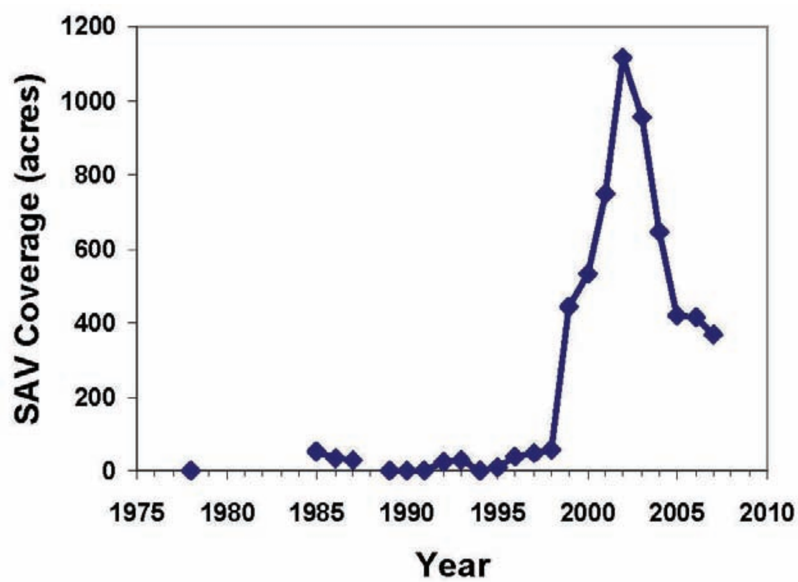
SAV Restoration

The Chesapeake Bay Program's "Strategy to Accelerate the Protection and Restoration of Submerged Aquatic Vegetation in the Chesapeake Bay" set a goal of increasing the SAV acreage in the Bay to 185,000 acres by 2010. The acreage in the bay was 64,917 acres in 2007. This goal is to be met by improving water clarity, protecting existing SAV beds and planting 1,000 acres of SAV. The SAV acreage goal for the lower mesohaline Potomac River, of which the St. Mary's River is part of, was set at 10,173 acres. There were 677 acres of SAV in the lower Potomac in 2007. Although the SAV goal for the St. Mary's River is not available, there were 1,072 acres of SAV in the St. Mary's River in 1952, a year that was used to determine SAV goals based upon extensive SAV acreage. In 2002 and 2003 the SAV acreage exceeded the 1952 acreage, but since has declined to about half of the 1952 level (Fig. 1).

The lower St. Mary's River was identified as an area that met the habitat conditions suitable for SAV[8-3, 8-4] but which lacked seeds or propagules for some species that were historically found in the river. In particular, eelgrass was once abundant at the mouth of the St. Mary's River and in the lower Potomac.[8-5] The lower St. Mary's River and the adjacent Piney Point were selected for several eelgrass restoration projects based on evaluations of water quality, sediments characteristics, historic SAV distribution, location of hydraulic clam dredging, and the success of preliminary test plantings.

Organizations that have sponsored projects include Maryland Department of Natural Resources (MD DNR; http://www.dnr.state.md.us/bay/sav/restoration/pot_gen_info.asp), Woodrow Wilson Bridge Project (http://www.wilsonbridge.com/ea-Mitigation.htm), Alliance for the Chesapeake Bay (http://www.acb-online.org/project.cfm), and the St. Mary's River Project (http://smrpweb.smcm.edu/) with over 25 acres planted.

Eelgrass restoration in the St. Mary's River has had limited success with the plants generally not surviving beyond two years. The best results have been along the southeast side of St. George Island, within St. George Creek, where plantings by MD DNR have survived for more than four years. Possible reasons for the limited success in restoring eelgrass in the St. Mary's River include years with than higher than average precipitation and/or temperatures. Eelgrass becomes stressed at lower salinities (salinity less than 10) and high temperatures (water temperatures greater than 30° C or 86° F). Low salinities in 2003 and 2004, and high temperatures combined with low dissolved oxygen in 2005 and 2006 are suspected as the cause of eelgrass mortalities at restoration sites in the lower St. Mary's.



REPLACE THIS GRAPHIC

Maryland Department of Natural Resources Programs

1. Fish Blockage Removal

Stream Buffer Restoration

1. Benefits and General Recommendations
2. Using GIS
3. Headwater Stream Buffers
4. Land Use and Stream Buffers
5. Nutrient Uptake from Hydric Soils in Stream Buffers
6. Optimizing Water Quality Benefits by Combining Priorities

Forestation and Wetland Restoration (KCI Study)

—fish blockage removal programs (DNR programs?)

Bob P./Chris—Stream Buffer Restoration, Using GIS, Headwater Stream Buffers, Land Use and Stream Buffers, Optimizing Water Quality Benefits by Combining Priorities

Bob P.—forestation/wetland/KCI study (Bob to provide study)

PROJECTS RELATED TO THE WRAS PROCESS

Corps Studies

Watershed Evaluation for St. Mary's River Watershed

Piney Point Aquiculture Facility

1. SAV and Crab Study
2.

St. Mary's River Watershed Association Oyster Recovery Assessment Study

Potomac Riverkeeper River Watchers

Potomac Riverkeeper Get The Mud Out

Lexington Park Redevelopment Campaign

Transportation

1. Pegg Road Extension
2. Chancellors Run Road Expansion
3. FDR Boulevard

SMC Dept. Public Works & Transportation Survey of Storm Water Control Facilities

Potomac River Association Storm Water Facilities Survey

Robin—LP redevelopment campaign

John G.—transportation, survey of SW facilities,

Bob L.—PRA SW survey

—Corps Studies, Watershed Evaluation for St. Mary's River Watershed, Piney Point Aquiculture Facility, SMRWA Oyster Recovery Assessment Study, Potomac Riverkeeper River Watchers, Potomac Riverkeeper Get The Mud Out

POTENTIAL BENCHMARKS FOR WRAS GOAL SETTING

REFERENCES

GLOSSARY

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BACK COVER