This document contains overall and specific condition of the Maryland Coastal Bays Program from the National Estuary Program Coastal Condition Report. The entire report can be downloaded from ***http://www.epa.gov/owow/oceans/nepccr/index.html***

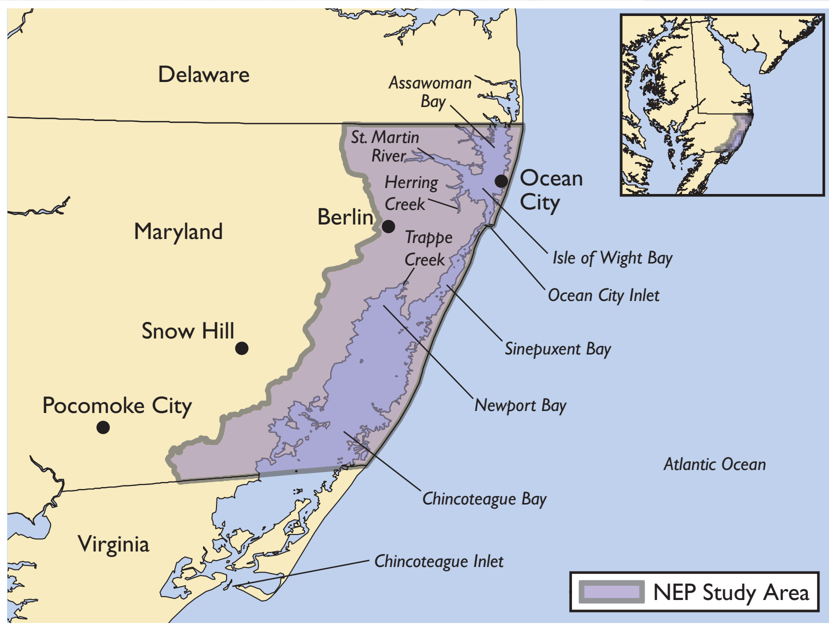
National Estuary Program Coastal Condition Report

Chapter 3: Northeast National Estuary Program Coastal Condition, Maryland Coastal bays Program

June 2007

Maryland Coastal Bays Program

www.mdcoastalbays.org



Background

The total watershed area of the Maryland Coastal Bays encompasses 175 mi^2 and includes more than 117,000 acres of land, 71,000 acres of water, and 280 miles of shoreline (ANEP, 2001b). To the east of Route 113, the watershed of the Coastal Bays includes Berlin and Ocean City, MD, as well as parts of Snow Hill and Pocomoke. The Maryland Coastal Bays make up one of the richest and most diverse estuaries on the Eastern Seaboard, with more than 115 species of finfish, 17 species of molluscs, 23 species of crustaceans, 360 species of birds, 44 species of mammals, and countless foraging/grazing organisms inhabiting these waterbodies (ANEP, 2001b; Maryland DNR, 2005a). The Maryland Coastal Bays are characterized as coastal lagoons with fairly uniform depths (< 10 feet) and relatively long water residence times (Wazniak et al., 2004; Wazniak and Hall, 2005). Circulation within the Bays is controlled by wind and tides, and flushing time is very slow across the system because tidal exchange is limited mainly to small channels separating the barrier islands. River inputs are fairly low due to the area's flat landscape and sandy soils, and groundwater is a major pathway for the introduction of fresh water and nutrients to the Bays. Salinity in the open Bays is similar to seawater, although portions of the upstream reaches of rivers and creeks remain fresh (Wazniak and Hall, 2005).

The Maryland Coastal Bays Program (MCBP) was established in 1996 as a partnership between the towns of Ocean City and Berlin, MD; EPA; the NPS; Worcester County, MD; and the Maryland Department of Natural Resources (DNR). The MCBP protects the land and waters of Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, Newport Bay, and Chincoteague Bay.

The Coastal Bays' multi-million dollar tourism industry is fueled by more than 11 million annual visitors who flock to the Bays to fish, boat, swim, or enjoy the atmosphere in their favorite bay-side restaurant (MCBP, 2005). Although more that 47,000 people lived in Worcester County in 2000, populations in the summer season have exceeded 300,000 people (Thompson and Wagenhals, 2002). Tourism-related activities generate $700 million in annual employee income in the Coastal Bays (Polhemus and Greeley, 2001). In 2002, commercial landings of fish and shellfish in Ocean City comprised 12.1 million pounds, valued at $8.1 million. In 2003, more than 700,000 people fished 7 million days in Maryland waters, and currently, recreational crabbing and fishing in the Bays generates at least $21 million annually (ANEP, 2001b; Wazniak and Hall, 2005). For more than a century, agriculture, forestry, fishing, farming, hunting, and tourism have sustained ways of life built on the land and water resources in these coastal communities. Worcester County's forests and 474 farms contribute hundreds of millions of dollars per year to the local economy and help provide the open space and natural land essential to the variety of wildlife species that call this area home (MCBP, 2005).

Environmental Concerns

A variety of environmental concerns in the Maryland Coastal Bays require the attention of environmental managers. The majority of these concerns are directly related to the area's growth and development. Projections indicate that there will be more than 60,000 residents living in the Coastal Bays' watershed by 2010 and more than 72,000 residents by 2020 (Wazniak and Hall, 2005). Pollution from agricultural and urban runoff, point-source discharges, septic tank system loadings, atmospheric deposition, and groundwater flow are all sources of nutrients in the Bays. With the right mixture of water quality conditions and nutrient loading levels, blooms of algae can form and block light infiltration to SAVs, foul boat propellers, and cause odor problems for homeowners along the Coastal Bays. Commercial development, the conversion of natural shorelines, the cumulative impacts of docks and boat traffic, and the invasion of exotic species have all degraded and/or eliminated tidal marsh and wetland habitats, and roughly 50% of the area's forest and wetlands have been lost during the past 300 years (ANEP, 2001b). Primary sources of pathogen contamination are runoff from livestock operations, urban areas with failing septic systems, and wildlife. Analysis of sediments has revealed higher than normal levels of DDT, arsenic, chlordane, and nickel, which have accumulated from agricultural sources, stormwater, and other sources (Wazniak and Hall, 2005). Dredging activities and boating in the Bays can easily resuspend contaminated sediments into the water column. Trash and debris that accumulate on estuary beaches of the Eastern Shore are a threat to local ecosystems and reduce the recreational value of popular sites along the coast. In 2002, approximately 50 volunteers scooped a ton and a half of garbage from the Bays and shoreline during a single-day event (MCBP, 2002).

Population Pressures

The population of the NOAA-designated coastal county (Worcester) coincident with the MCBP study area increased by 96% during a 40-year period, from about 0.02 million people in 1960 to almost 0.05 million people in 2000 (Figure 3-101) (U.S. Census Bureau, 1991; 2001). This rate of population growth for the MCBP study area is four times the population growth rate of 24% for the collective NEP-coincident coastal counties of the Northeast Coast region. In 2000, the population density of this coastal county was 98 persons/mi^2, about one-tenth the population density of 1,055 persons/mi^2 for the collective

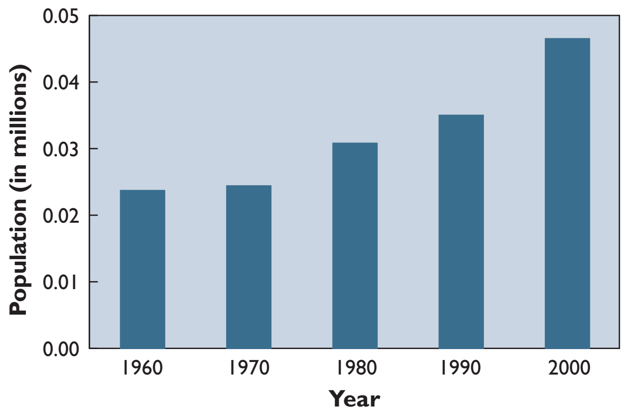


Figure 3-101. Population of NOAA-designated coastal county of the MCBP study area, 1960–2000 (U.S. Census Bureau, 1991; 2001).

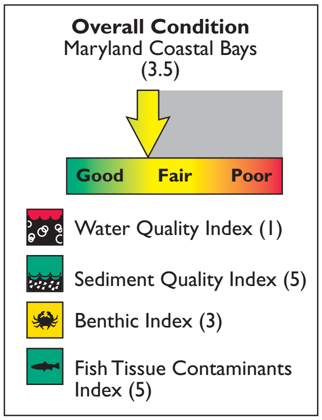


Figure 3-102. The overall condition of the MCBP estuarine area is fair (U.S. EPA/NCA).

NEP-coincident coastal counties of the Northeast Coast region (U.S. Census Bureau, 2001). Population pressures for the MCBP study area are especially high during the summer months because these beaches and bays serve as a major recreational center for the nearby metropolitan areas surrounding Washington, D.C.

NCA Indices of Estuarine Condition—Maryland Coastal Bays

The overall condition of the Maryland Coastal Bays is rated fair based on the four indices of estuarine condition used by the NCA (Figure 3-102). The water quality index for the Maryland Coastal Bays is rated poor, the sediment quality and fish tissue contaminants indices are rated good, and the benthic index is rated fair. Figure 3-103 provides a summary of the percentage of estuarine area rated good, fair, poor, or missing for each parameter considered. This assessment is based on data from 47 NCA sites sampled in the MCBP estuarine area in 2000 and 2001. Please refer to Tables 1-24, 1-25, and 1-26 (Chapter 1) for a summary of the criteria used to develop the rating for each index and component indicator.

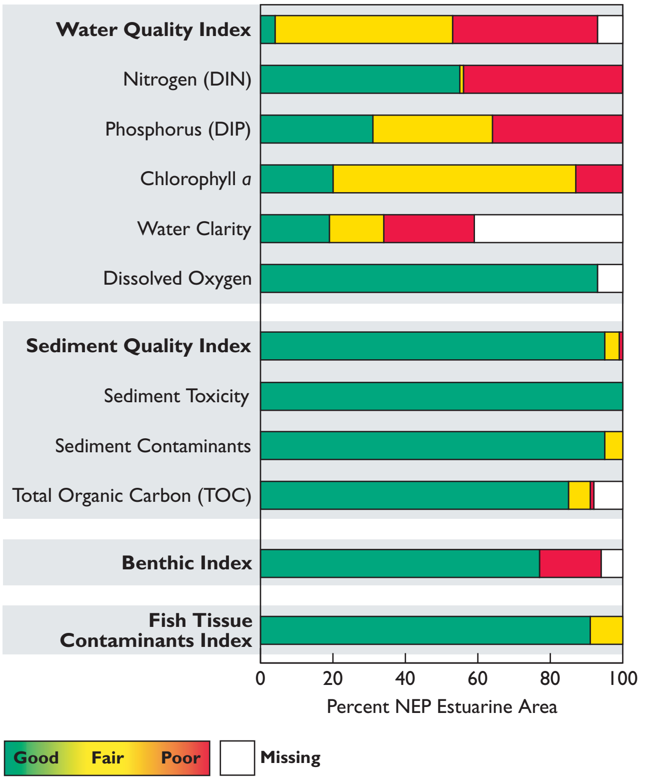


Figure 3-103. Percentage of NEP estuarine area achieving each rating for all indices and component indicators — Maryland Coastal Bays (U.S. EPA/NCA).

Water Quality Index

Based on NCA survey results, the water quality index for the Maryland Coastal Bays is rated poor (Figure 3-104). This index was developed using NCA data on five component indicators: DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen.

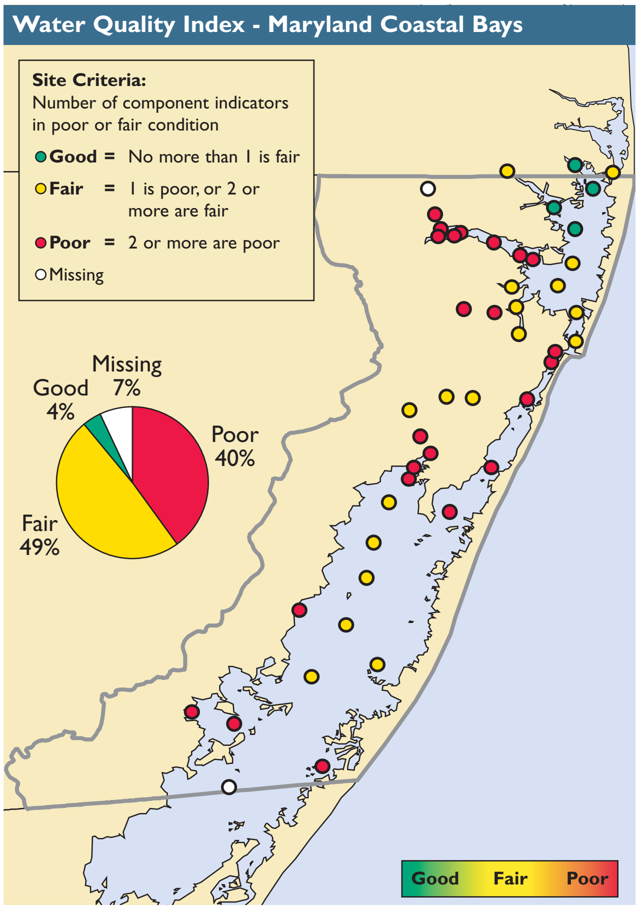


Figure 3-104. Water quality index data for the Maryland Coastal Bays, 2000–2001 (U.S. EPA/NCA).

Dissolved Nitrogen and Phosphorus | The Maryland Coastal Bays are rated poor for DIN concentrations, with 55% of the estuarine area rated good for this component indicator, 1% of the area rated fair, and 43% of area rated poor. DIP concentrations in the Maryland Coastal Bays are also rated poor, with 31% of the estuarine area rated good, 33% of the area rated fair, and 35% of the area rated poor.

Chlorophyll a | The Maryland Coastal Bays are rated fair for chlorophyll *a* concentrations. Twenty percent of the estuarine area was rated good for this component indicator, 67% of the area was rated fair, and 12% of the area was rated poor.

Water Clarity | The water clarity rating for the Maryland Coastal Bays is poor. If light penetration at a depth of 1 meter below the water's surface was less than 10% of the surface illumination, water clarity at the sampling site was rated poor. Twenty-five percent of the estuarine area was rated poor for water clarity, 19% of the area was rated good, and 15% of the area was rated fair. NCA data on water clarity were unavailable for 41% of the MCBP estuarine area.

Dissolved Oxygen | The Maryland Coastal Bays are rated good for dissolved oxygen concentrations, with 93% of the estuarine area rated good for this component indicator and none of the area rated poor. NCA data on dissolved oxygen concentrations were unavailable for 7% of the MCBP estuarine area.

Replanting marsh grass in an effort to protect and rebuild a beach (Mary Hollinger, NOAA).

Sediment Quality Index

The sediment quality index for the Maryland Coastal Bays is rated good (Figure 3-105). This index was developed using data on three component indicators: sediment toxicity, sediment contaminants, and sediment TOC. No sediments collected from the Bays were toxic to amphipods, and only three sites in the St. Martins River had low sediment quality ratings due to moderate concentrations of sediment contaminants and high concentrations of TOC.

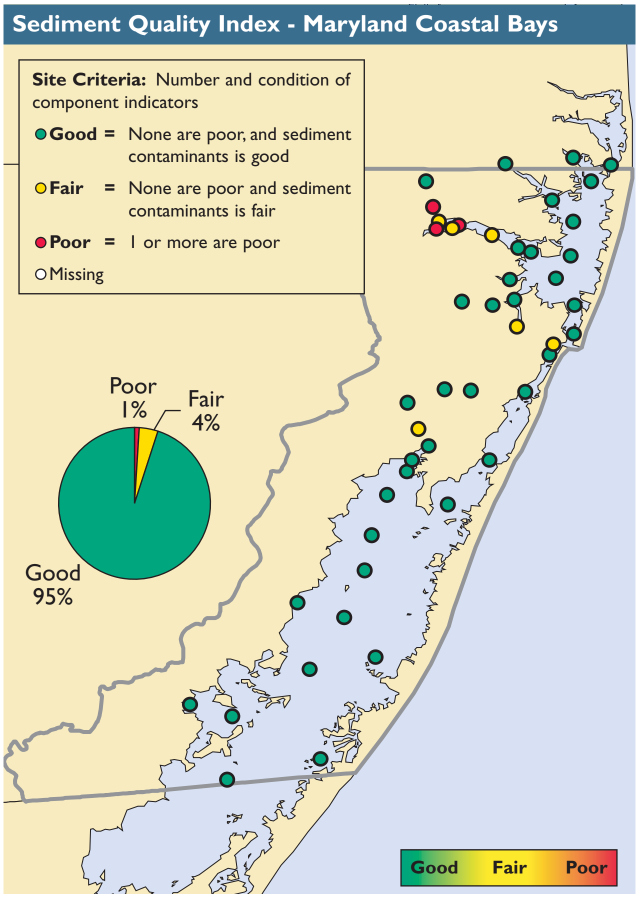


Figure 3-105. Sediment quality index data for the Maryland Coastal Bays, 2000–2001 (U.S. EPA/NCA).

Sediment Toxicity | The Maryland Coastal Bays are rated good for sediment toxicity because none of the estuarine area was rated poor.

Sediment Contaminants | The Maryland Coastal Bays are rated good for sediment contaminant concentrations, with 95% of the estuarine area rated good for this component indicator, 5% of the area rated fair, and none of the area rated poor.

Total Organic Carbon | The Maryland Coastal Bays are rated good for sediment TOC, with 85% of the estuarine area rated good and 6% of the area rated fair. Only 1% of the estuarine area was rated poor for this component indicator, and NCA data on sediment TOC concentrations were unavailable for 8% of the MCBP estuarine area.

Benthic Index

As evaluated by the Virginian Province Benthic Index, the benthic index for the Maryland Coastal Bays is rated fair, with 17% of the estuarine area rated poor for benthic condition (Figure 3-106). Seventy-seven percent of the estuarine area was rated good for benthic condition, and NCA data on benthic condition were unavailable for 6% of the MCBP estuarine area.

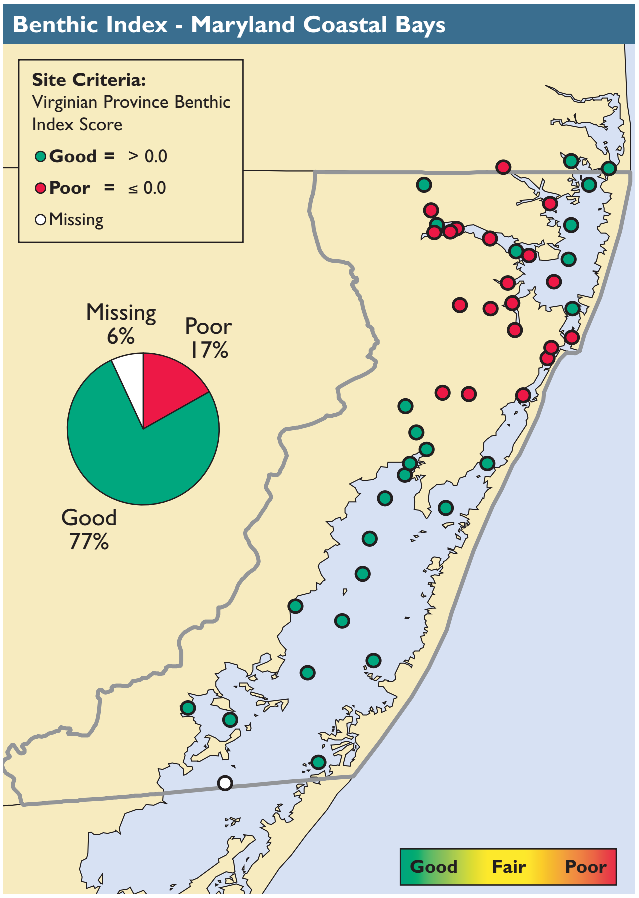


Figure 3-106. Benthic index data for the Maryland Coastal Bays, 2000–2001 (U.S. EPA/NCA).

Fish Tissue Contaminants Index

The fish tissue contaminants index for the Maryland Coastal Bays is rated good, with 91% of fish samples rated good for contaminant concentrations. Only two fish samples (9%) analyzed for chemical contaminants had contaminant concentrations that exceeded the EPA Advisory Guidance values for fish consumption (Figure 3-107). In both cases, the samples contained elevated concentrations of PCBs.

Fish Tissue Contaminants Index - Maryland Coastal Bays

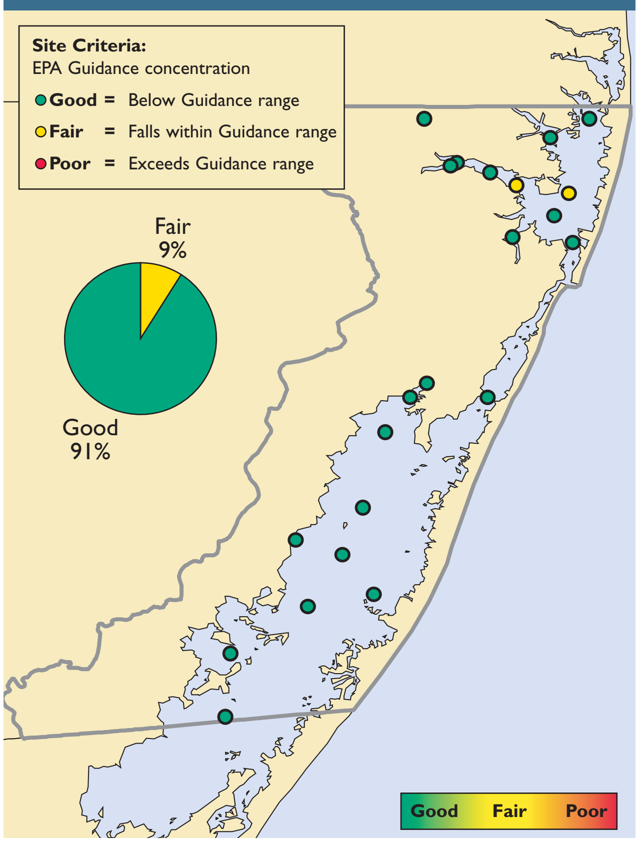


Figure 3-107. Fish tissue contaminants index data for the Maryland Coastal Bays, 2000–2001 (U.S. EPA/NCA).

Maryland Coastal Bays Program Indicators of Estuarine Condition

A variety of indicators are used to assess estuarine health in the Maryland Coastal Bays. The thresholds for each indicator were approved by the MCBP's STAC. Many local, state, and federal agencies participate in monitoring the Coastal Bays' ecosystem. Monitoring data are used to characterize water quality, habitat, and living resource conditions in the Coastal Bays, providing essential information for management actions. The STAC has developed a variety of indicators for assessing water quality, stream health, sediment quality, habitat, living resources, and harmful algae in the Maryland Coastal Bays. Table 3-6 presents these indicators, along with their thresholds and monitoring frequencies. The status and trends of some of these indicators are discussed below. Additional information about the Maryland Coastal Bays environmental indicators is available at http://www.dnr.state.md.us/coastalbays.

Water and Sediment Quality

The STAC's water quality indicators are monitored by several agencies, including the Maryland DNR, the NPS at Assateague Island, and MCBP volunteers. In addition, the University of Maryland Center for Environmental Science provides expertise in water quality mapping. The Maryland DNR also assesses stream health and monitors stream resources and sediment quality, whereas the USGS analyzes groundwater inputs to the estuary (Wazniak et al., 2004).

Four water quality indicators are assessed in the Maryland Coastal Bays— chlorophyll *a*, total nitrogen, total phosphorus, and dissolved oxygen. Overall, nutrient loading is showing measurable impacts on the area's ecosystem. Monitoring data collected between 2001 and 2003 demonstrated that the upper tributaries are severely enriched by nitrogen and that phosphorus enrichment is more widespread throughout the Coastal Bays. Although many of these upstream areas had nutrient concentrations above the MCBP's threshold levels, chlorophyll *a* concentrations were generally low in the open Bays. These results are significant because chlorophyll *a* measurements are often used to represent the amount of algae in the water column.

Table 3-6. Water Quality, Stream Health, and Sediment Quality Indicators, Thresholds, and Monitoring Frequencies for the Maryland Coastal Bays (Wazniak et al., 2004; Maryland DNR, 2005b)

Aquatic Ecosystem Monitoring	Indicator	Threshold	Monitoring Frequency
Water Quality	Total nitrogen	No more than 0.65 mg/L for seagrass growth No more than 1 mg/L as set by STAC	Monthly
	Total phosphorus	No more than 0.037 mg/L for seagrass growth No more than 0.01 mg/L as set by STAC	Monthly
	Chlorophyll *a*	No more than 15 µg/L to prevent low dissolved oxygen levels No more than 50 µg/L as set by STAC	Monthly, as well as continuous monitoring and water quality mapping (the latter two measure total chlorophyll)
	Dissolved oxygen	No less than 5 mg/L to prevent effects on aquatic life No less than 3 mg/L as set by STAC	Monthly, as well as continuous monitoring and water quality mapping
	Water quality index	Greater than 0.6	Calculated by combining values from all water quality indicators
Stream Health	Stream nitrate	Less than 1 mg/L	Variable
	Stream bottom-dwelling Animal Index 1	Less than or equal to 2.8	Annually
	Stream bottom-dwelling Animal Index 2	Less than or equal to 4	Every 5 years
	Freshwater fish index	Greater than or equal to 4	Every 5 years
Sediment Quality	Excess organic carbon	Less than or equal to 1%	Periodically
	Ambient toxicity	Significant difference from uncontaminated sediment	Annually (2000–2003)
	Mean Apparent Effects Threshold	None	Calculated from sediment contaminant data (2000–2003)
Habitat	Seagrass	18,951 acres	Annual survey
	Macroalgae	None	Not routinely monitored
	Wetlands	No net loss	Not monitored directly
Living Resources	Fish	No decreasing trend in forage fish index	Monthly trawl: April – October Seine: June and September
	Fish kills	None	As needed
	Blue crabs	None	Monthly with fish survey
	Shellfish (clams, scallops, oysters)	None	Clams – Annual survey
	Bottom-dwelling animals	MAIA benthic index value > 3	Annually (2000–2003)
	Phytoplankton	None	Monthly – Weekly
Harmful Algae	HABs	Species-specific thresholds	As needed, when water quality indicates algae are at high levels

Maryland Coastal Bays Program

Applied Monitoring: Incorporating Stable Isotope Analysis into a Water Quality Index

Environmental managers for the Maryland Coastal Bays have set several environmental objectives, including reducing sewage/septic inputs to the Bays and maintaining suitable habitat for seagrass and fisheries. Each objective can be linked to a water quality indicator. Managers have set reference values for each indicator to determine whether or not a particular waterbody is achieving an individual objective. During a pilot study in 2004, six water quality indicators (dissolved oxygen, Secchi depth, chlorophyll *a*, total phosphorus, total nitrogen, and isotopic ratios of nitrogen) were used to develop a water quality index for the Maryland Coastal Bays and tributaries (Jones et al., 2004). The table below shows the management objective and reference value for each water quality indicator.

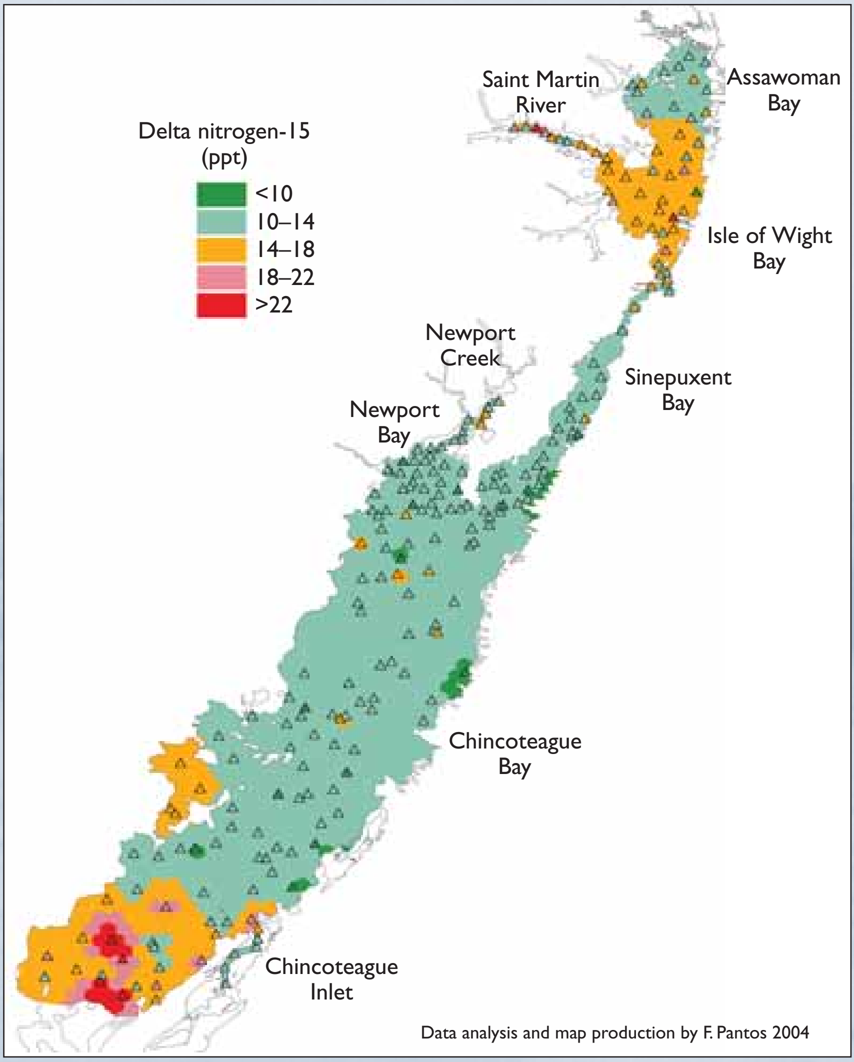
In June 2004, a field-sampling program was conducted to measure the 6 indicators at approximately 250 sites in the Maryland Coastal Bays. Secchi depths were determined, and water samples were analyzed for dissolved oxygen, chlorophyll *a*, total phosphorus, and total nitrogen concentrations. Isotopic ratios of nitrogen (delta nitrogen-15 values) were also measured. Measuring isotopic ratios of nitrogen is important because various sources of nitrogen to the Bays often have distinguishable isotopic ratios. For example, elevated delta nitrogen-15 ($\delta^{15}N$) values are associated with treated sewage effluent. The figure on the next page displays the sampling results for $\delta^{15}N$ in the Maryland Coastal Bays. Elevated $\delta^{15}N$ values were found in the St. Martin River, Isle of Wight Bay, and the southern portion of Chincoteague Bay (near the town of Chincoteague and Wallops Island). These elevated values indicate that sewage is a major source of nutrients in these portions of the Bays (Jones et al., 2004).

The sampling sites were divided into reporting regions by waterbody, and a water quality index for each region was calculated by comparing the measured values for each of the six indicators to the reference values for each management objective (see table below). The calculated water quality index is a number between zero

Indicators, Management Objectives, and Reference Values Used in the Calculation of the Water Quality Index for the Maryland Coastal Bays (Jones et al., 2004)

Indicator	Management Objective	Reference Value
Dissolved oxygen	Maintain suitable fisheries habitat	> 5 mg/L
Secchi depth	Clear water	> 1 meter
Chlorophyll *a*	Reduce phytoplankton	< 15 µg/L
Total phosphorus	Reduce phosphorus	< 0.037 mg/L (1.2 µM)
Total nitrogen	Reduce nitrogen	< 0.65 mg/L (46 µM)
Total ratio of nitrogen (delta nitrogen-15)	Reduce sewage/septic inputs	< 14%

and one. A score of 0.8 and above indicates that habitat conditions are considered good for fish and seagrass survival, whereas a score of 0.4 or below indicates unsuitable habitat for either fish or seagrass. Intermediate values indicate that the system is variable and that some ecosystem functions (e.g., seagrass beds or fish) may be expected to be present some of the time. The table below presents the water quality indices for several waterbodies in the Maryland Coastal Bays. The Isle of Wight Bay received a good water quality index rating, probably due to the relatively high flushing rate with the ocean at the southern end of the Bays. The areas with the lowest water quality index values were the St. Martin River and the western side of Chincoteague Bay (Newport Bay). Secchi, total phosphorus, and chlorophyll *a* were the main factors resulting in the poor overall water quality index rating for Chincoteague Bay (Jones et al., 2004).



Distribution of isotopic ratios of nitrogen in the Maryland Coastal Bays (Jones et al., 2004).

Summary of Water Quality Index Ratings by Region (Jones et al., 2004)

Region	Sites	WQI	Health
Assawoman Bay	18	0.56	Fair
Chincoteague Bay	106	0.42	Fair
Isle of Wight Bay	20	0.69	Good
Newport Bay	31	0.33	Poor
Sinepuxent Bay	36	0.68	Good
Chincoteague Inlet	7	0.62	Good
St. Martin River	11	0.29	Poor
Newport Creek	10	0.36	Poor

Large algal blooms can limit the amount of light available to seagrasses or reduce dissolved oxygen levels in the water. Although shallow lagoons typically do not stratify, oxygen values in the Coastal Bays were frequently low in some areas. For example, continuous monitoring data collected during the summer seasons of 2002 through 2004 show that dissolved oxygen levels in the tributaries Bishopville Prong and Turville Creek were low (less than 5 mg/L) approximately 40% to 60% of the time (Table 3-7) (Wazniak and Hall, 2005).

The monitoring data on the four component indicators collected from around the Bays between 2001 and 2003 were compared to the threshold values listed in Table 3-6, which are known to maintain fisheries and seagrasses. The results of this comparison were then used to develop the water quality index for a given waterbody. This index ranks the Bays from best to worst as follows: Sinepuxent, Chincoteague, Isle of Wright, Newport, Assawoman, and St. Martin River (Wazniak and Hall, 2005).

The health of the streams in the MCBP study area is also assessed for the water quality index. Streams and small creeks often serve as the initial receptors for the nutrients, sediments, and chemicals that are later transported to the Bays, and fish and benthic communities are used as indicators of stream health. Most streams in the watershed are degraded with excess nutrients, and high stream nitrate levels have been observed in all segments of the Coastal Bays. These elevated stream nitrate levels indicate excess inputs from human activities, which can be transported to the stream via surface runoff or groundwater flow. Data on fish and benthic animals indicate that most streams in the Coastal Bays are degraded; however, long-term trend data indicate that conditions are improving. Most animals found in the streams were classified as pollution tolerant. Impacts to the biota of Coastal Bays streams are likely the result of physical habitat modification within the watershed due to the extensive ditching that has increased the number of creeks and tributaries in the region. Man-made ditched streams generally have less habitat diversity and lower flows than the minimally altered streams of the Coastal Plain, which retain a more natural wetland character. This ditching may also affect nutrient levels in the region's creeks, tributaries, and bays by allowing groundwater to enter streams more quickly, thereby decreasing the filtration that the groundwater would normally have encountered before entering the Bays (Wazniak and Hall, 2005).

Excess organic carbon, ambient toxicity, and the mean Apparent Effects Threshold (AET) are used to assess sediment quality in the Maryland Coastal Bays. Excess organic carbon is an important measure of sediment quality because it can be used as an indicator of an area's rate of eutrophication and degree of pollution. High excess carbon levels may be caused by frequent algal blooms, the deposition of excessive plant debris (e.g., from an eroding marsh), or human inputs. Elevated excess carbon may also be significant because metals and other pollutants tend to attach to organic carbon, concentrating these contaminants in the sediment. St. Martin River, Herring Creek, and Newport

Table 3-7. Percent of the Time that Dissolved Oxygen Concentrations Were Below Threshold Levels in Two Tributary Creeks Based on Continuous Monitoring Data Collected During the Summer Season (2002–2004) (Wazniak and Hall, 2005)

Site	Dissolved Oxygen Threshold Level (mg/L)	2002	2003	2004
Bishopville Prong	< 5	59%	66%	49%
	< 3	30%	47%	24%
Turville Creek	< 5	39%	39%	39%
	< 3	7%	11%	9%

Creek have excessively organic-rich sediments, which may have an impact on benthic communities. Sediments in the open-water areas of the Bays are not enriched in organic carbon (Wazniak et al., 2004; Wazniak and Hall, 2005). In 1999, the Maryland DNR conducted a pilot study of sediment toxicity in samples collected from five sites in the Coastal Bays, with subsequent toxicity studies conducted by the NCA. Overall, sediments in the study area show little evidence of toxicity (Wazniak and Hall, 2005).

Mean AET values are an evaluation criterion derived from a correlation of the weight of evidence from multiple matched chemical and biological effects data sets. AET values generally fall between the ERL and ERM values (Wazniak and Hall, 2005). The AET is used to assess the combined impact of multiple contaminants and is more sensitive to low contaminant concentrations. The AET results show a higher potential for chemical contaminants to impact living resources in the St. Martin River, Assawoman Bay, and Herring, Turville, and Newport creeks (Figure 3-108). Higher AET results can also indicate higher levels of contaminants in the sediment (Wazniak et al., 2004). Based on the AET and using NCA 2000 contaminant data, bottom sediments in the southern Maryland Coastal Bays (Sinepuxent, Newport, and Chincoteague bays) and the open water areas in Assawoman and Isle of Wight bays are not impaired by high levels of contaminants; concentrations for most metals are generally within background levels; and most organic contaminants are at trace levels or below detection limits.

Higher contaminant levels were restricted to localized areas in tributaries in the northern bays and in Newport Creek. These areas were also high in TOC (Wazniak and Hall, 2005).

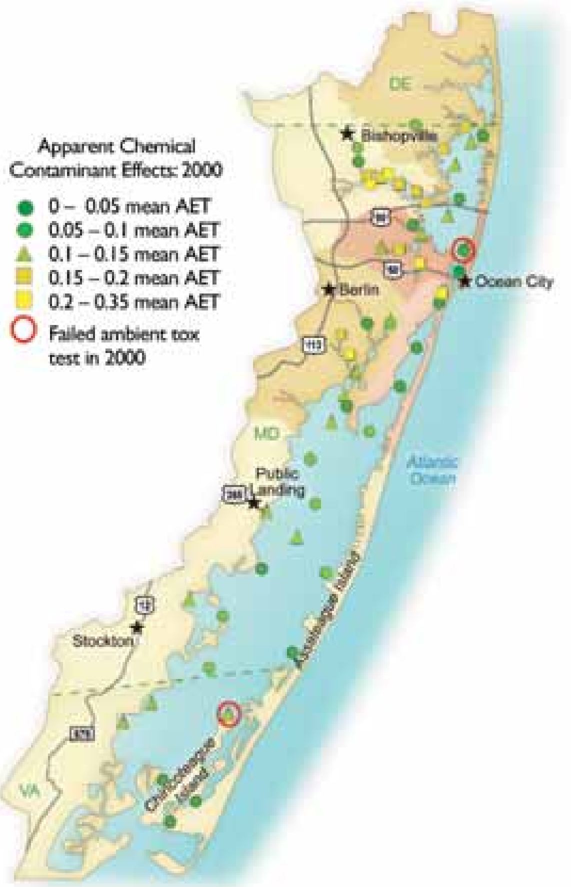


Figure 3-108. Map of mean Apparent Effects Threshold measurements for samples collected in 2000 by the Maryland Geological Survey (Wazniak et al., 2004).

Assateague Island National Seashore, Maryland (NPS).

Habitat Quality

The status and trends of seagrass, macroalgae, and wetlands habitat in the Maryland Coastal Bays have been assessed. Virginia Institute of Marine Science (VIMS) conducts an annual aerial survey of seagrass bed distribution, whereas the Maryland DNR monitors macroalgae abundance and distribution. In addition, the Maryland Department of the Environment (MDE) teams with the Maryland DNR to collect data on wetlands. Seagrasses have been increasing in the Coastal Bays and are estimated to cover 67% of the potential habitat in the Bays. The 2003 acreage of 17,942 acres represents the second-highest total documented in the Coastal Bays and an overall 320% increase since annual data collection began in 1986 (Wazniak et al., in press) (Figure 3-109). Macroalgae, also known as seaweeds, are abundant and distributed throughout the Bays (Wazniak and Hall, 2005). Some macroalgae species are occurring at harmful levels in some areas, causing such problems as blocking needed light from SAV, decreasing oxygen levels, and fouling boat propellers (Wazniak et al., 2004). Wetlands in the Coastal Bays have decreased substantially (up to 60%), especially in the northern Bays (Wazniak and Hall, 2005).

Living Resources

Fish, shellfish, and benthic communities are surveyed by the Maryland DNR and VERSAR, whereas fish kills are monitored by the MDE. There are species-specific thresholds that are used to determine if an HAB has occurred. Monitoring is also performed as needed when routine water quality indicates algae at high levels or a specific incidence occurs (e.g., fish kill, color complaint).

The Maryland Coastal Bays provide habitat for 140 species of finfish (Wazniak et al., 2004; Wazniak and Hall, 2005). Although finfish in the Bays are diverse, the forage fish index has been declining over time. This index is based on the abundance of the four most common forage species (e.g., bay anchovy, menhaden, spot, and Atlantic silverside). The decline in the forage fish index has been dominated by the decreasing abundance of spot; however, the populations of other species assessed by the index have also been slowly declining. Low dissolved oxygen levels in the Maryland Coastal Bays have caused two-thirds of fish kills (where the cause was determined), and sporadic fish kills due to low oxygen appear to be increasing in frequency (Wazniak and Hall, 2005).

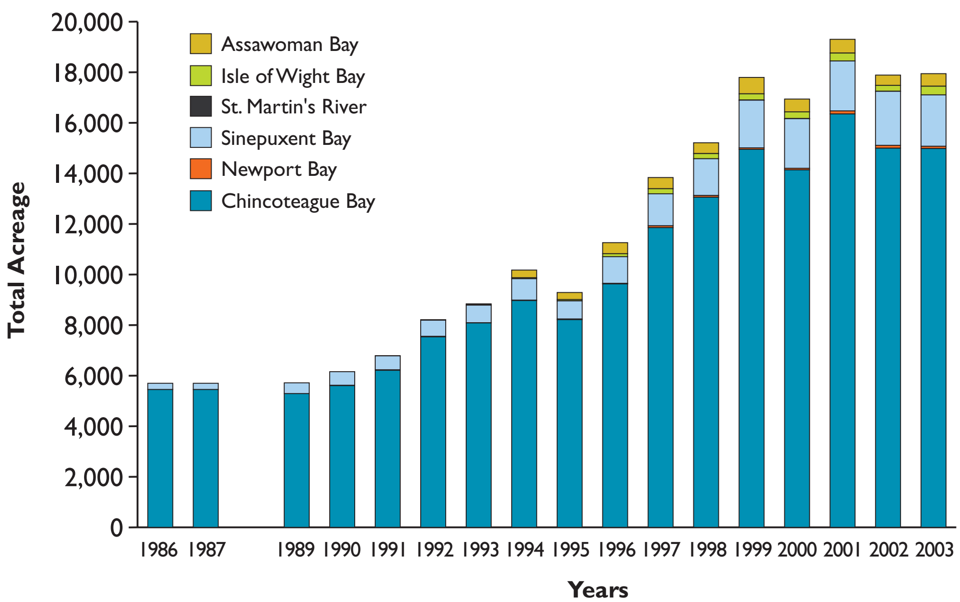


Figure 3-109. Seagrass abundance in the Maryland Coastal Bays (Wazniak and Hall, 2005).

Based on the MAIA benthic index, benthic communities are generally faring poorly in the creeks and better in the open Bays (Figure 3-110). Catches of hard clams have declined during the past three decades, but have been relatively stable for the past ten years. Bay scallops have recently returned to the area and have been found in most Bay segments, although in low numbers (Wazniak and Hall, 2005).

Between 2001 and 2003, the highest diversity of phytoplankton in the Maryland Coastal Bays occurred during the winter, with varied long-term phytoplankton trends at individual sampling sites. For example, phytoplankton abundance decreased in the St. Martin River, and phytoplankton density increased in the tributaries of the Isle of Wight Bay (Wazniak and Hall, 2005).

Certain types of algae may become harmful if they occur in large amounts as HABs or if they produce a toxin that can harm aquatic life or humans. Approximately 5% of the phytoplankton species identified in the Maryland Coastal Bays represent potential HAB species. The presence of these species is richest in the polluted tributaries of St. Martin River and Newport Bay. In recent years, brown tide (*Aureococcus anophagefferens*) has been the most widespread and prolific HAB species in the area, affecting the growth of juvenile clams in test studies and potentially impacting seagrass distribution and growth in the Bays. Although no evidence of toxic activity has been detected among the phytoplankton in Maryland Coastal Bays, some of the species found in the Bays have been responsible for positive toxic bioassays, detectable toxin levels, and/or fish kills in other areas along the eastern shore of the United States. Tracking the diversity, abundance, distribution, and toxic activity of potential HAB species over time provides important indicators of environmental change for the Coastal Bays (Wazniak and Hall, 2005).

Environmental Stressors

The Maryland DNR monitors shoreline change as an indicator of human impacts on habitat quality in the Maryland Coastal Bays. Evaluations of aerial photography taken in 1989 showed that approximately 10% of the Coastal Bays have artificially hardened shoreline (e.g., bulkheads or riprap). The percentage of hardened shoreline was higher in the northern Bays (Assawoman Bay, Isle of Wight Bay, and St. Martin River), where percentages ranged from 21% to 44% (Wazniak et al., 2004; Wazniak and Hall, 2005).

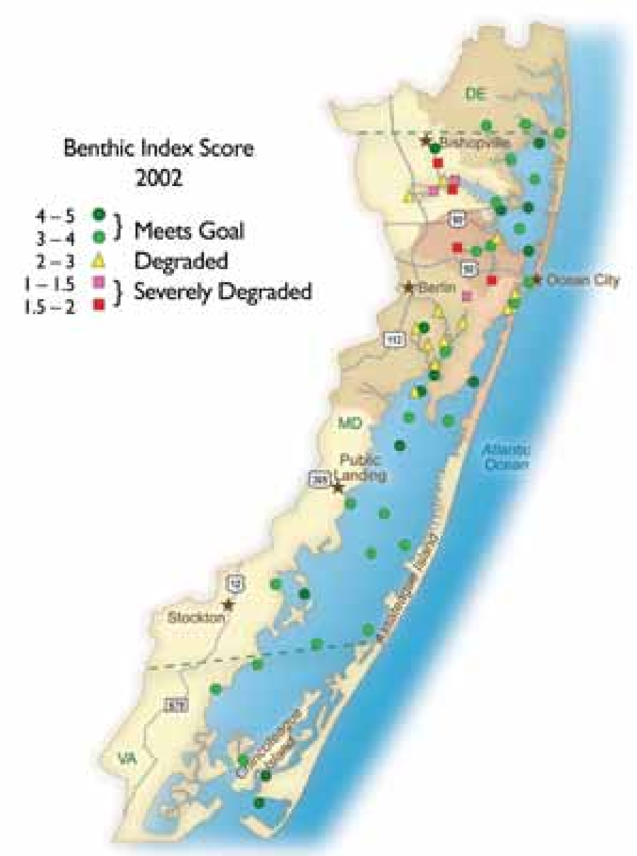


Figure 3-110. Map of 2002 MAIA benthic index results for the Maryland Coastal Bays (Wazniak et al., 2004).

Current Projects, Accomplishments, and Future Goals

Some of the recent environmental success stories and restoration efforts completed around the Coastal Bays include the following:

- The Maryland DNR's Fish Advisory Committee has completed fishery management plans for hard clams and blue crabs and has also obtained a $25,000 NOAA Coastal Services Center Grant for developing the concepts of water zoning and sanctuaries to manage resources.
- In April 2002, the Maryland Saltwater Sportfishermen's Association and local anglers coordinated a cooperative angler flounder survey to collect and assess data to promote better fishing techniques and legislation to benefit both fish and fishermen (Wazniak et al., 2004).
- Co-organized by the MCBP, the Delmarva Birding Weekend highlights the watershed's status as an internationally significant route on the Atlantic Flyway by featuring more than 27 kayaking, boating, and walking tours through the watershed and other parts of the Delmarva Peninsula. More than 500 people from 20 states attended this event in 2005 (MCBP, 2005).
- Recognizing shortcomings in state enforcement of wetland laws, Worcester County, the MCBP, planners, regulators, and wetland delineators formed the Wetland Planning Group to discuss projects, laws, and issues affecting area wetlands. The group has served as a coordinator among agencies and spawned a wetland White Paper on ways to better protect wetlands in the Coastal Bays' watershed.
- The Bishopville Restoration Project is funded under the Estuary Restoration Act of 2000 and focuses efforts to initiate restoration efforts in the upper St. Martin River, which is considered the most degraded waterbody in the Bays. The restoration project is a cooperative effort among the MCBP, Maryland DNR, USACE, State Highway Administration, and Worcester County to restore about 1,000 feet of stream and streamside vegetation and remove the existing dam at Bishopville to open the stream to fish passage (MCBP, 2005).
- Worcester County government has pursued local responsibility for achieving nutrient-reduction goals through sub-watershed planning by engaging stakeholders in each sub-watershed to develop strategies for meeting reduction goals. The new comprehensive development plan included strategies for TMDL implementation.
- The Maryland DNR has worked with the U.S. Department of Agriculture (USDA) Forest Service in programs such as Rural Legacy and Stream ReLeaf to improve forest character, develop educational outreach programs, and identify and promote programs that protect these areas (Wazniak et al., 2004).
- The MCBP has developed a homeowner's guide that provides more than 100 ways to protect the Maryland Coastal Bays.
- The MCBP has completed more than 500 news articles, 11 school projects, and 33 television spots to help educate the public about the Maryland Coastal Bays. In 2000, 11 radio shows highlighted the MCBP's efforts (ANEP, 2001b).

Conclusion

The overall condition of the Maryland Coastal Bays is rated fair based on the four indices of estuarine condition used by the NCA survey. Based on the findings of the MCBP, water and sediment quality are generally poorer in and near tributaries than in the open Bays, and, in general, most streams in the MCBP study area are degraded with excess nutrients. Higher contaminant and organic carbon levels in sediments were restricted to localized areas in tributaries in the northern Bays and in Newport Creek. Seagrass acreage has been increasing, and wetlands have been decreasing. Macroalgae communities are abundant and well distributed throughout the area; however, some macroalgae species occur at harmful levels. Although finfish in the Bays are diverse, the forage fish index has been declining over time. Overall, benthic communities are faring poorly in the creeks and better in the open Bays, and the presence of HAB species is richest in the polluted tributaries of St. Martin River and Newport Bay.