THE BAYS PERSPECTIVE:

Bay health is influenced
by ocean and land

THE MARYLAND COASTAL BAYS 2016

This booklet provides an overview of the current science and management issues in the Maryland Coastal Bays and their watersheds in 2016. Previous assessments include the *2004 State of the Maryland Coastal Bays* and the 2009 book, *Shifting Sands: Environmental and cultural change in Maryland's Coastal Bays*. Both of these previous publications and this booklet, *Maryland Coastal Bays 2016: Land and bay perspectives* are available on IAN Press (*ian.umces.edu/press*).

Recognizing the importance of both a bay perspective and a land perspective, this booklet provides current data and insights into a) how bay health is influenced by ocean and land and b) how watershed health influences bay health. It includes two 'booklets' in one publication—one intended for those interested in the bay perspective, and the other for those interested in the land perspective. The two documents culminate in a summary centerfold which focuses on both watershed and bay issues.

Source material for this booklet is derived the 2015 Comprehensive Conservation Management Plan and the 2016 Ecosystem Health Assessment—both available at *http://mdcoastalbays.org/publications*. Data used in this publication is through 2013.

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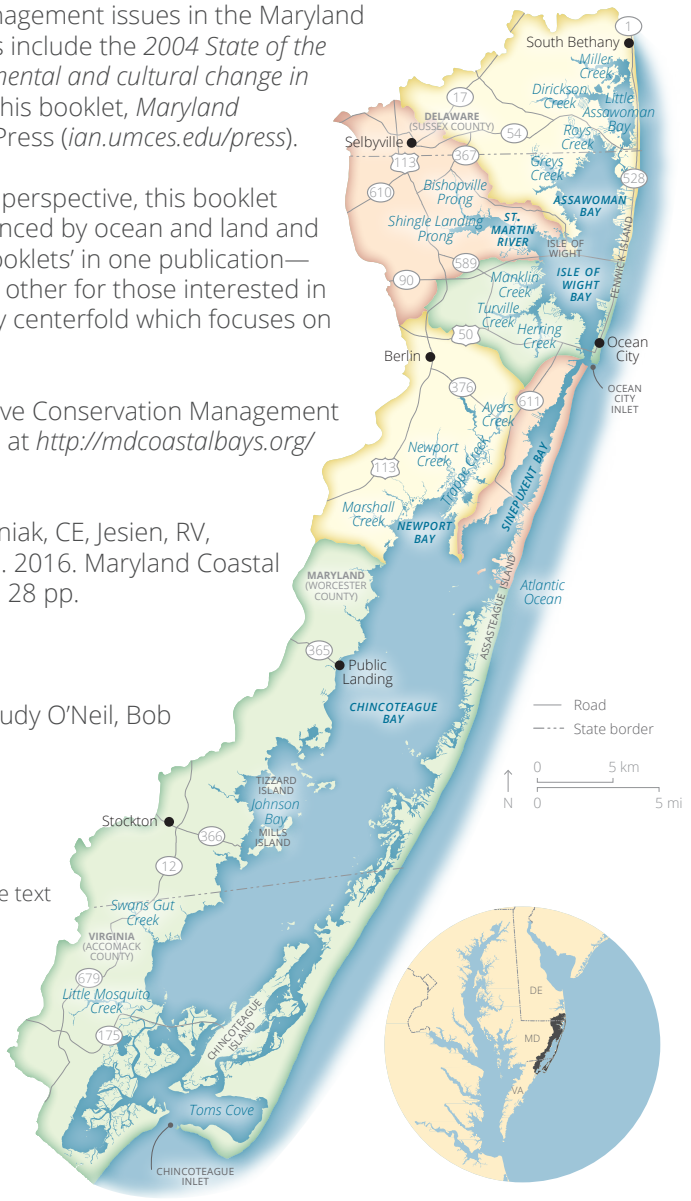

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Bays cover: Travis Turnbaugh.

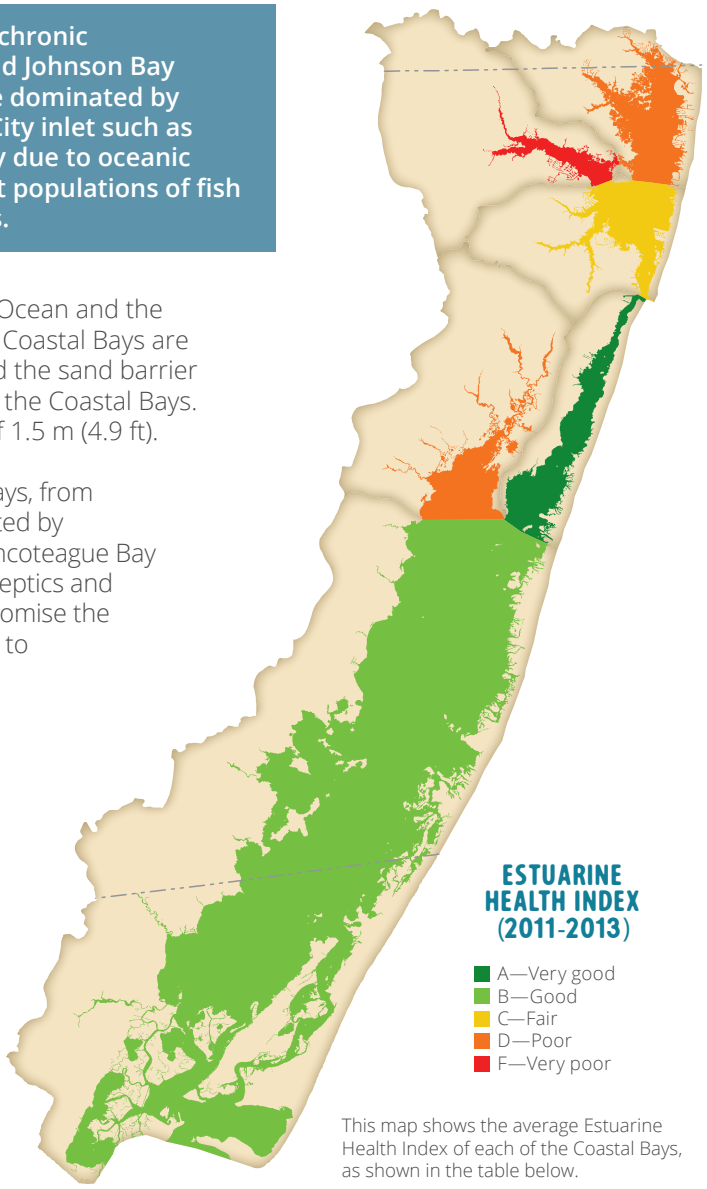
BAY HEALTH REFLECTS THE STATE OF THE LAND AND THE OCEAN

The ecosystem health of the Coastal Bays is variable, with chronic degradation occurring in St. Martin River, Newport Bay, and Johnson Bay (Chincoteague Bay)—areas that are poorly flushed and are dominated by watershed inputs of nutrients. The areas near the Ocean City inlet such as Sinepuxent Bay and Isle of Wight Bay are relatively healthy due to oceanic flushing. While the bays still support diverse and abundant populations of fish and shellfish, human activities are affecting their numbers.

The Maryland Coastal Bays are sandwiched between the Atlantic Ocean and the Delmarva (Delaware–Maryland–Virginia) Peninsula. The Maryland Coastal Bays are located adjacent to a narrow but highly developed watershed and the sand barrier islands (Fenwick and Assateague) which separate the ocean from the Coastal Bays. The Coastal Bays are very shallow, with an average water depth of 1.5 m (4.9 ft).

There are strong gradients in nutrient enrichment in the Coastal Bays, from well-flushed regions near the inlets to poorly flushed regions affected by watershed inputs and poor circulation. For example, southern Chincoteague Bay benefits from oceanic flushing, but nutrient inputs from streams (septics and agriculture) and from the unsewered town of Chincoteague compromise the effectiveness of flushing. We must continue to invest in monitoring to track key indicators and guide restoration of this complex system.

This report summarizes the current conditions of key indicators of bay health. Thanks to cooperation between our partners, we have completed two offshore cruises. These previously unassessed waters revealed high nutrients in areas and a possible new loading source to the bays. Summer discharge from the Ocean City wastewater treatment plant into the Atlantic Ocean may be one source of these high nutrients, as well as upwelling of nutrients as seen off the New Jersey coast. Research on groundwater has shown the significant role of ecological lag times on the impacts of best management practices on the Delmarva Peninsula. We have also documented blooms of the harmful algae that can cause diarrhetic shellfish poisoning and monitored shellfish to protect public health.



This map shows the average Estuarine Health Index of each of the Coastal Bays, as shown in the table below.

2011–2013 ESTUARINE HEALTH INDEX		Sinepuxent Bay	Chincoteague Bay	Isle of Wight Bay	Assawoman Bay	Newport Bay	St Martin River
WATER QUALITY	Water quality index	100	76	56	37	39	0
	Macroalgae	100	96	26	0	93	87
LIVING RESOURCES	Benthic index	100	65	33	45	13	0
	Hard clams	40	20	100	30	10	0
HABITAT	Seagrass area	100	72	32	54	22	0
	Wetland area	100	64	0	64	16	0
ESTUARINE HEALTH INDEX		**90**	**66**	**41**	**38**	**32**	**15**

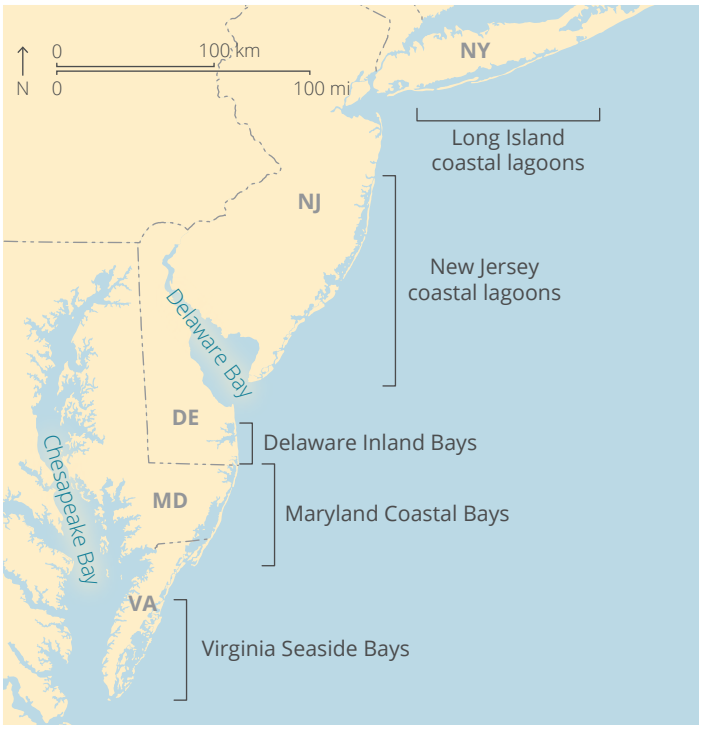
This table shows the 2011–2013 Estuarine Health Index for each of the Coastal Bays. Each indicator is scored from 0–100, based on how close it is to achieving the goal for that indicator, where a score of 0 = 0% attainment and a score of 100 = 100% attainment.

COASTAL LAGOONS ARE INFLUENCED BY PHYSICAL AND HUMAN FACTORS

The Delmarva (Delaware–Maryland–Virginia) lagoonal system is remarkably similar to the New Jersey and Long Island coastal lagoon complexes. The narrow barrier islands of all three regions are largely undeveloped, but the Long Island and New Jersey short drumstick barrier islands are extensively developed, unlike the uninhabited southern Delmarva barrier islands.

The Delmarva coastal embayments are heavily influenced by tides and currents. Except for a few short tidal rivers, freshwater inputs are dominated by groundwater percolating into streams. There are also differences among the Delmarva Bays in flushing rates (due to number and size of inlets) and development. In this continuum, the total nitrogen loadings and concentrations are highest in the Delaware Inland Bays, lowest in the Virginia Seaside Bays and in-between in the Maryland Coastal Bays.

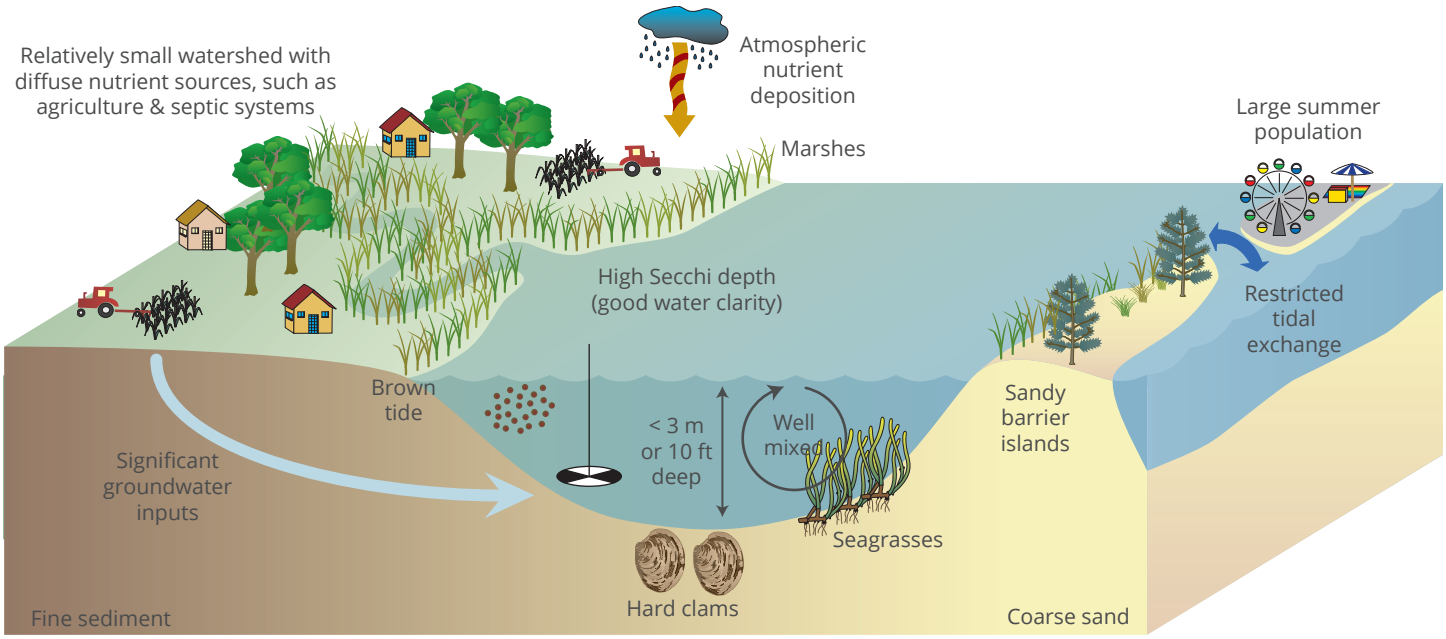
The gradient in nutrient loading and concentration along the Delmarva lagoons is reflected in the abundance trajectories of seagrasses. A seagrass restoration project in the Virginia Seaside Bays has resulted in expanding seagrass acreage since 1999. Maryland Coastal Bays seagrasses expanded in the 1990s, but have peaked and declined since. The Delaware Inland Bays currently support only small remnant seagrass populations near inlets.



The Maryland Coastal Bays are a segment of the overall barrier island lagoonal system that extends along the Atlantic coast of the U.S.

All three lagoon complexes of the Mid-Atlantic Bight have high recreational value, strong water quality gradients, historic oyster and hard clam fisheries, and seagrass and salt marsh habitat. They face similar challenges like eutrophication and harmful algal blooms, particularly brown tide, habitat loss, and fisheries declines, particularly shellfish. They are all sensitive to climate change, sea level rise, storm surge, and tidal inundation. The human footprint on these lagoon complexes varies, and the Maryland Coastal Bays can use the Long Island and New Jersey lagoons as surrogates for future development scenarios.

CHARACTERISTICS OF COASTAL LAGOON SYSTEMS



SHIFTING STRESSORS INFLUENCE BAY HEALTH

The bays are home to a diversity of species including marine mammals, seabirds and shorebirds, sea turtles, fishes, crabs and other invertebrates, seagrasses, and marine algae. Activities that put pressure on bay resources are also diverse. Some of the most prominent pressures include vessel traffic, commercial and recreational fishing, agriculture, residential and septic system runoff, coastal development, sea-level rise, and climate change. These pressures associated with human activities increase nutrient and sediment inputs, which in turn change the food webs in the bays and lead to harmful algal blooms. Some linkages with the land are observed more quickly, such as when new inlets are formed.

Human population is expected to climb steadily, with more permanent residents compared to summer visitors. Resulting changes in landscape, especially as farmland is converted to residential development in the greater watershed, will bring added stressors to the Coastal Bays (increased runoff, flooding, wastewater). The watershed has already lost over 55,000 acres of forests and wetlands. Proactive management of development, along with improvements in wastewater and run-off projects, will be necessary to preserve the integrity of this ecosystem.

Long-term, gradual changes, such as changes in water quality and bay sediments within seagrass beds, lead to shifts in species composition. Runoff from land leads to changes in the bay sediment, covering sandy bottom with silty-clay deposits that are inhospitable to seagrasses. Species composition of the seagrass community may be impacted by rising temperatures. As sea level rises and wetlands cannot migrate inland, wetlands acreage will decline and distribution will be altered. The type of fertilizers used in the watershed has shifted from inorganic to organic forms of nitrogen, leading to water quality conditions that are more suited to harmful algal species.

Larger, more global issues, such as climate change and ocean acidification, are significant areas of concern. Some regional impacts are being detected already but long-term effects are not well understood. Effects brought about by climate changes (increased temperature, frequency of storms) will impact bay resources and likely lead to shifts in bay wildlife populations (southern species expanding northward and northern species receding).

The Coastal Bays community, both ecological and human, will certainly continue to change over time. The capacity to respond and adapt to this change over time should be preserved.

This juxtaposition of the heavily developed Ocean City/Fenwick Island and the undeveloped Assateague Island National Seashore captures the variety of stressors facing the Coastal Bays. Photo by Jane Thomas

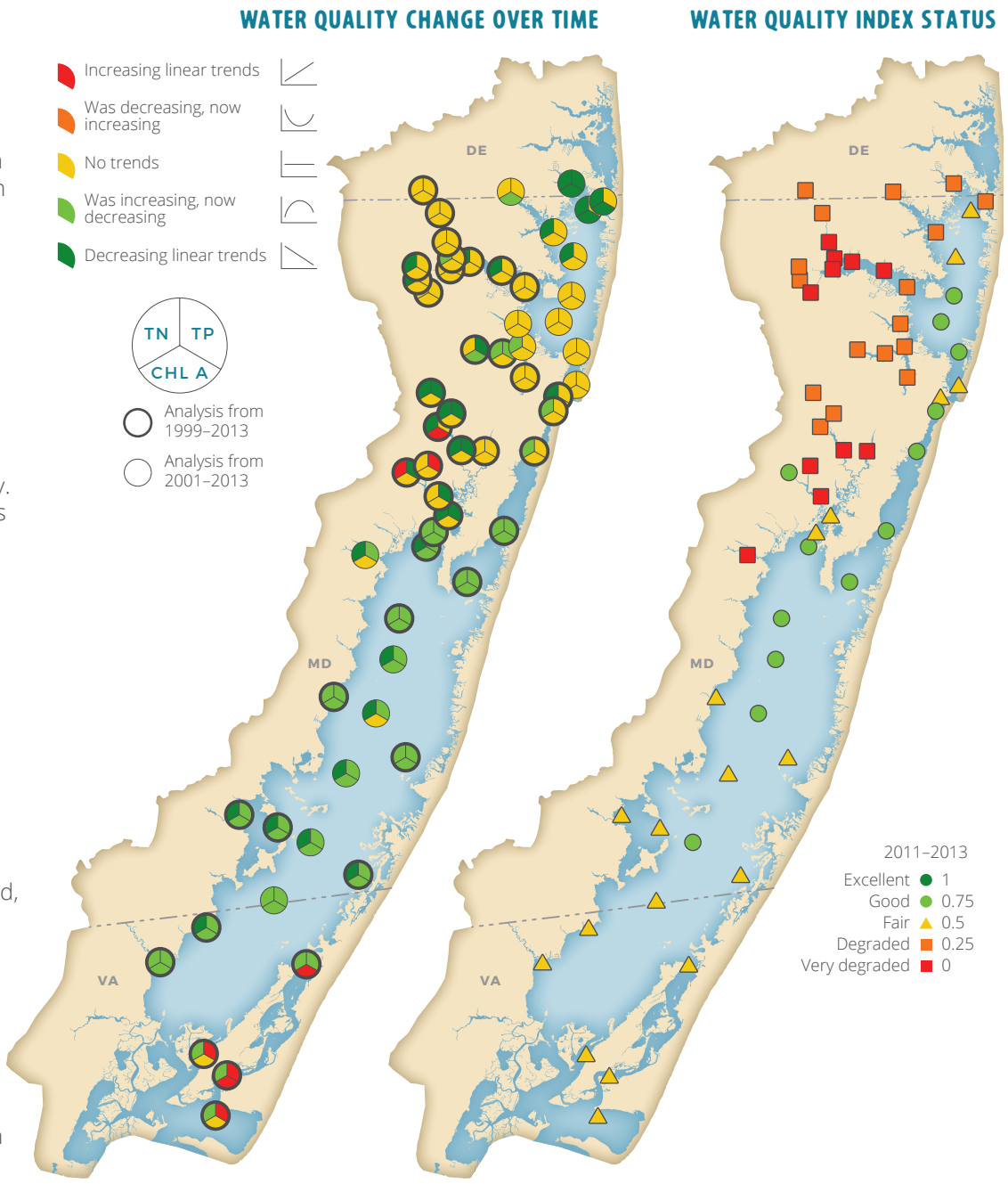
WATER QUALITY IMPROVEMENTS OFFER HOPE FOR SEAGRASS RECOVERY

WATER QUALITY INDEX STATUS

The water quality index is comprised of chlorophyll *a*, total nitrogen, total phosphorus, and dissolved oxygen. Strong gradients in water quality index occur in the Coastal Bays, averaged over three years (2011–2013). The most degraded regions were St. Martin River, Newport Bay, and Assawoman Bay. The highest water quality was near the Ocean City inlet in Isle of Wight Bay, Sinepuxent Bay, and northern Chincoteague Bay. Moderate water quality was observed in southern and central Chincoteague Bay.

WATER QUALITY CHANGE OVER TIME

Trends in three water quality parameters were calculated for the periods 1999–2013 or for 2001–2013. Total nitrogen, total phosphorus and chlorophyll *a* trends were generally similar—when one improved or decreased, the others followed suit. Improving trends were evident in Chincoteague Bay, except for sites near Chincoteague Island where a number of declining trends were observed. No trends were evident in most sites north of the Ocean City inlet. Sinepuxent Bay had improving trends or no trend, but no degrading trends.



Long-term trends in total nitrogen, total phosphorus, and chlorophyll a show improving conditions in many areas.

The Water Quality Index synthesizes the status of the four water quality indicators—chlorophyll *a* (algae), total nitrogen, total phosphorus, and dissolved oxygen—into a single indicator of water quality.

STATUS AND TRENDS

The overall picture emerging from this analysis is that water quality is improving or at least not degrading in most locations. Poor water quality in the north Coastal Bays is not getting worse, but also not getting better. However, water quality in Newport Bay and most of Chincoteague Bay is improving. The region around Chincoteague Island is markedly problematic, even with its proximity to the Chincoteague inlet.

BAY FISHERIES DEPEND ON OCEAN AND BAY HEALTH

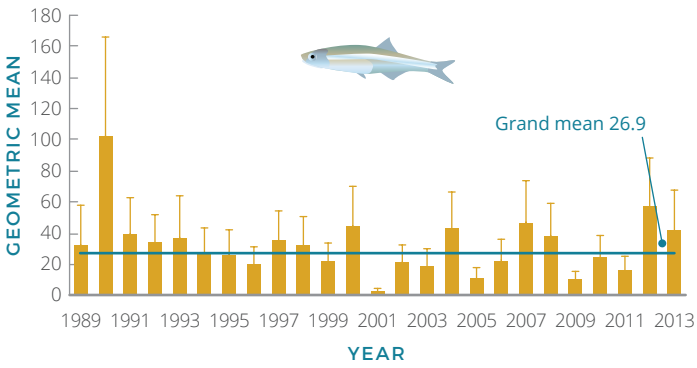
Maryland's Coastal Bays are important finfish nursery grounds. These shallow estuaries, at the interface between fresh and saltwater, provide habitat for a wide range of aquatic life. But like many coastal systems, they face threats from intense development, nutrients, sediments, and other stressors associated with human activities.

Most finfish species found within Maryland's Coastal Bays are coastal spawners, illustrating the importance of the Coastal Bays as finfish nursery grounds. Summer flounder (*Paralichthys dentatus*) and black sea bass (*Centropristis striata*) are longer-lived species of recreational and commercial importance, while bay anchovy (*Anchoa hepsetus*) and silver perch (*Bairdiella chrysoura*) have shorter life spans and serve as food for larger fish.

Bay anchovy are often the most abundant species in the bays. They are a preferred forage species for larger game fish. They are equally abundant in all areas of the Coastal Bays. Being short–lived, they exhibit rather consistent recruitment and abundance. There has been more variability in their abundance in recent years compared to earlier surveys. However, abundances have been both above and below the long-term average and not indicative of a trend.

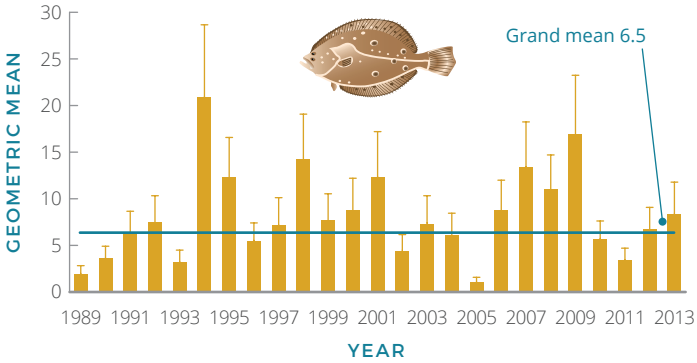
Summer flounder are the most sought-after recreational game fish in the Coastal Bays. The Summer Flounder Index reflects annual recruitment in the bays, and consequently also reflects nursery habitat. Summer flounder are abundant in all the Coastal Bays except for Sinepuxent Bay. The more extreme currents found in Sinepuxent Bay may inhibit its habitat value to juvenile summer flounder.

BAY ANCHOVY ABUNDANCE IN THE COASTAL BAYS



Bay anchovy (*Anchoa hepsetus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989–2015). Protocols of the Coastal Bays Fisheries Investigation Trawl and Seine Survey were standardized in 1989 (n=140/year).

SUMMER FLOUNDER ABUNDANCE IN THE COASTAL BAYS



Summer flounder (*Paralichthys dentatus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989–2015). Protocols of the Coastal Bays Fisheries Investigation Trawl and Seine Survey were standardized in 1989 (n=140/year).

Seining is one of the sampling methods used by the Maryand Department of Natural Resources to estimate fish populations in the Coastal Bays. Photo by Maryland Department of Natural Resources.

Blue crabs (*Callinectes sapidis*), an important fisheries resource throughout the bays, are dependent on ocean conditions. Although there is evidence that some internal recruitment may occur, the majority of young crabs that take up residence in the bays are transported by ocean currents from the mouth of the Chesapeake and Delaware Bays. Climate change, ocean acidification, and altered circulation patterns can directly affect blue crab abundance in the bays. Blue crabs support both a commercial and recreational fishery in the bays. Commercial harvest of hard, soft, and peeler crabs is around 1 million pounds per year and has fluctuated from a low of 0.5 million in 1998 to a high in 2010 when almost 2.5 million pounds were harvested.

CLIMATE EFFECTS CHALLENGE MANAGEMENT OF BAY RESOURCES

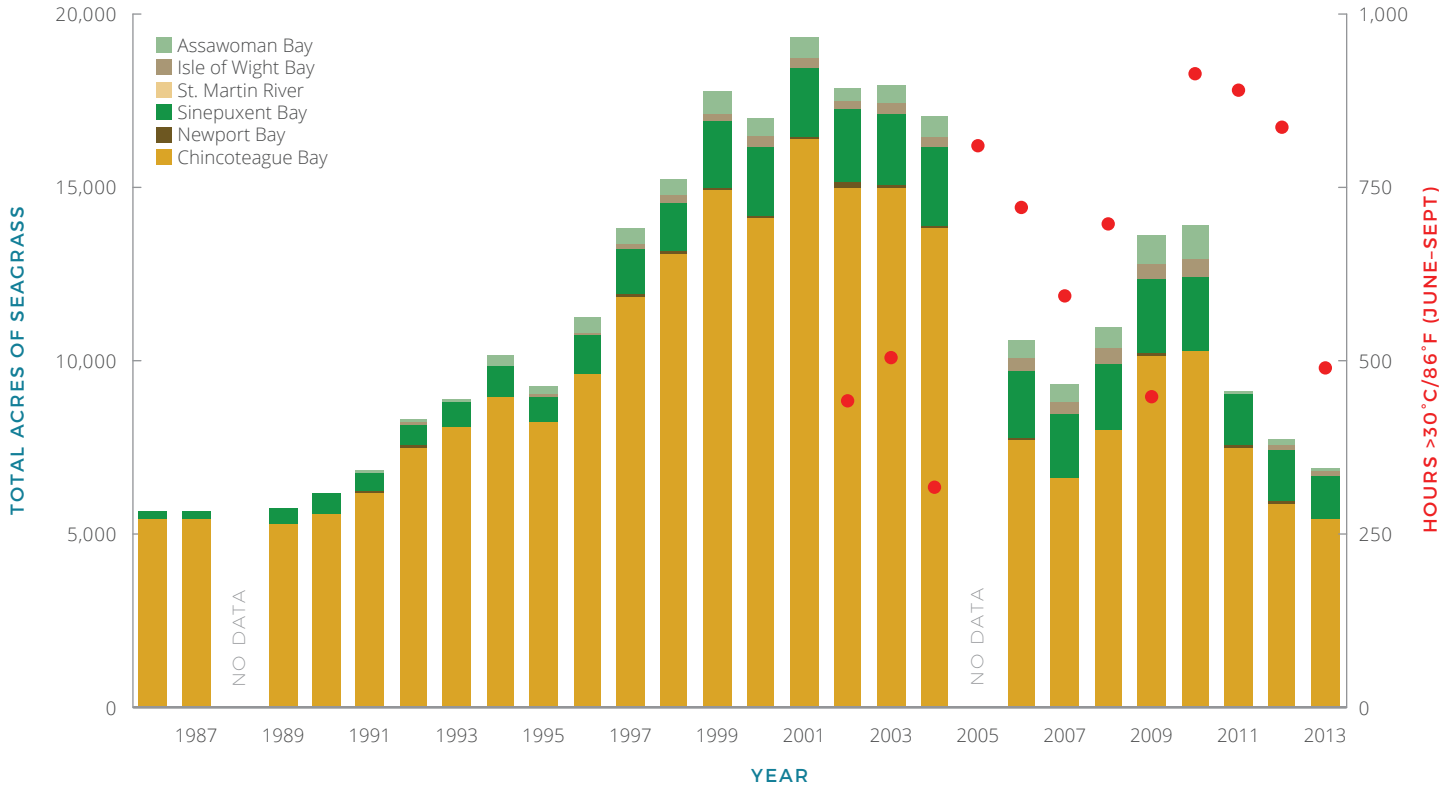
Maryland is one of the states most susceptible to sea level rise, due to its 3,100 miles of tidal shoreline and low-lying and rural areas. The Maryland Coastal Bays' geography and geology make this region one of the most vulnerable areas of the state. Historic tidal records show that sea levels have risen approximately one foot during the last century. Maryland is projected to have between 2.7 to 3.4 feet (0.8–1.0 meters) of sea level rise over the next 100 years.

In many cases, the Maryland Coastal Bays are already experiencing these problems. For example, seagrasses (specifically eelgrass) have experienced major declines since 2001 as a function of a) water quality degradation, b) temperature stress in 2005 and 2010, c) chronic harmful algae blooms, and d) loss of marshes. Climate change makes it even more difficult to manage these issues by changing the extent, frequency, intensity, and magnitude of the various problems that are occurring.

There are many ways in which climate change may affect the Maryland Coastal Bays including:

- **Accelerated barrier island migration toward mainland, increased dune and beach erosion, and increased island breaches/inlets or property damage in Ocean City.**
- **Decreased eelgrass population (possibly replaced by more southern species).**
- **Increased Coastal Bays depth and stronger tidal forces, causing more erosion and increased tidal prism .**
- **Increased nuisance flooding due to elevation changes**
- **Decline in marsh acreage (no retreat).**
- **More frequent and expansive low oxygen events (dead zones).**
- **Declining water quality, decreased water clarity, and increases in harmful algal blooms.**
- **Changing species composition.**
- **Hotter summers—up to 60 additional days/year of temperatures >90°F, milder winters, and more precipitation in winter and spring; less in summer.**
- **Increased storm frequency and intensity.**

HIGH TEMPERATURES AFFECT SEAGRASS ABUNDANCE



Seagrass coverage in the Coastal Bays increased until 2001, after which it has been declining and variable. This may be related to the temperature stress to seagrass that occurs when the water temperature exceeds 30°C/86°F. Years with lower water temperature correspond to years with higher seagrass abundance, and vice versa. Data courtesy of Virginia Institute of Marine Science and Maryland DNR.

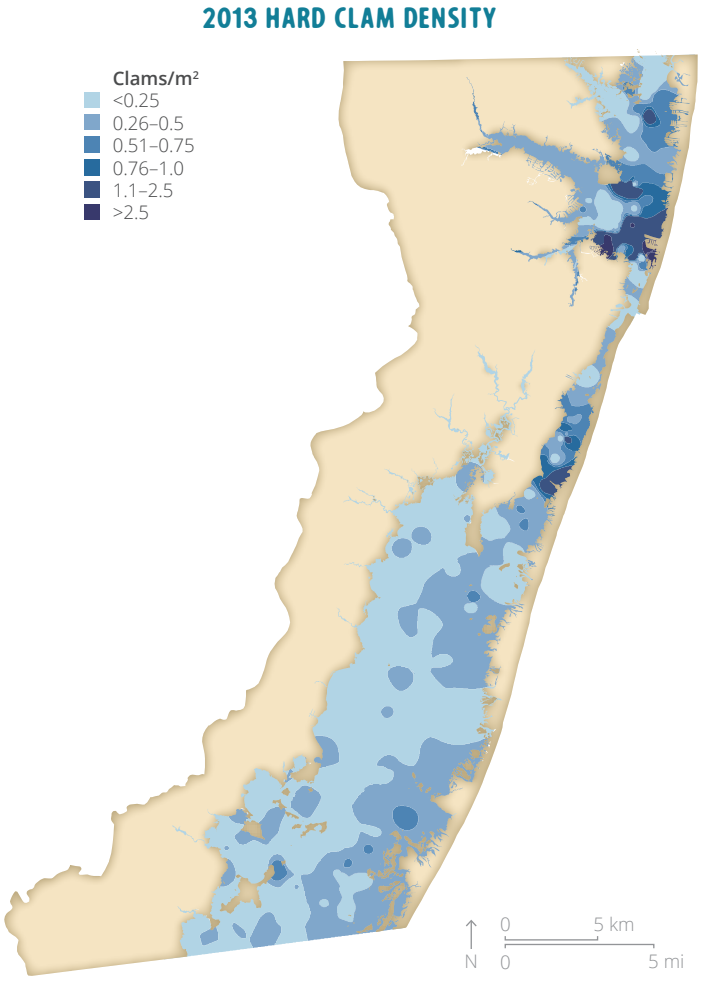
FISHERIES MANAGEMENT STRATEGIES NEED TO CONSIDER ALL USERS

Fish populations are ecologically and economically important to the Coastal Bays. Harvests of fish and shellfish must be balanced between recreational and commercial users, while maintaining populations that support ecosystem needs (food source for other fish and bird species, filtering the bay, shoreline protection, habitat). Fishery management plans have been developed for blue crabs and hard clams that balance the needs of multiple users. The northern bays have significantly higher densities of finfish than the southern bays. Temporal changes in abundance of many species are mostly the result of stock-wide recruitment processes in Atlantic coastal populations. Therefore, the harvest of many finfish species is managed on a coastwide basis.

Despite a ban on mechanical harvesting for shellfish in the Coastal Bays beginning in 2008, current hard clam densities in all of the bays remain lower than historical levels. Density trends in the northern bays have been improving, with the Isle of Wight Bay clam population approaching the 60-year benchmark. Observed mortalities have been negligible throughout the bays. The Coastal Bays populations are dominated by older, larger clams, with recruitment generally low and sporadic in the lower bays. Parts of Sinepuxent, Isle of Wight, and Assawoman Bays experienced a strong recruitment period during the late 2000s which accounted for the boost in clam densities, but has tailed off since then. Poor recruitment may be a factor of the small and patchy clam population. Shellfish aquaculture is beginning to expand in the State and may help boost wild populations in some areas. Recreational clamming has long been popular in the Coastal Bays.

Extremely low densities of bay scallops over the past four years, diminishing habitat, and declining water quality suggest that the long-term viability of the bay scallop population is in question.

Shellfish sampling in the Coastal Bays. Photo by Robert Bussell/MD DNR.

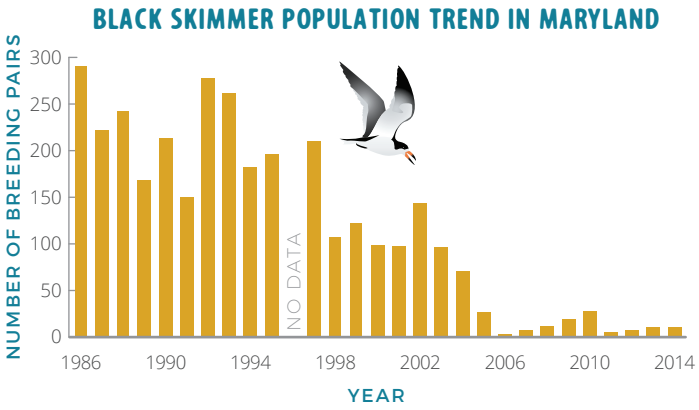


This map shows the density of hard clams in the Coastal Bays in 2013.

ISLAND RESTORATION RECOVERS CRITICAL BIRD HABITAT

Several species of threatened or endangered colonial nesting birds make the Maryland Coastal Bays their home. In the state of Maryland, least terns (*Sternula antillarum*) are listed as threatened, while black skimmers (*Rynchops niger*), common terns (*Sterna hirundo*), and royal terns (*Thalasseus maximus*) are listed as endangered. These birds rely on sandy beaches on which to build their nests; however, this habitat is becoming harder to come by. Development, erosion, and sea-level rise are all factors that have taken away valuable nesting area. The islands that dot our Coastal Bays are the last remaining refuges for these birds because they are ideal habitats. Mostly devoid of possible predators such as foxes and raccoons, islands provide the sandy beaches that are essential to these birds. Since 1989, almost 300 acres of islands have eroded away.

The Army Corps of Engineers created four islands throughout the Coastal Bays, with the project reaching completion in the fall of 2015. The project added 10 acres of habitat for colonial nesting birds. The islands are considered natural resources of the state of Maryland and are under management of the Department of Natural Resources as wildlife management areas. The islands have restricted access from April 1 to September 15 to protect vulnerable nests and chicks from direct harm, and to prevent parent birds from being frightened away and unable to defend their eggs and chicks from predatory gulls and crows. It is essential for boaters to avoid landing on these islands during this time.



The black skimmer population of the Coastal Bays has been declining for the past several decades.

This photo shows Tern Island in Isle of Wight Bay in the foreground, one of four constructed islands in the Coastal Bays that are providing new habitat for colonial nesting birds. The approximate location of these four islands are shown with arrows. Photo by Kathy Phillips/Assateague Coastal Trust.

WETLAND REHABILITATION RESTORES NEEDED FUNCTIONS

The salt marshes of the Maryland Coastal Bays were ditched in the 1930s as a mosquito control measure, using the Civilian Conservation Corps. In addition, impoundments were created in marshes to attract waterfowl in the 1950s. These marsh modifications changed the natural water flow of the salt marshes, and the scars have persisted to the current time. In addition to altered hydrology, the ditched marshes have different salt marsh species diversity and altered habitat value. Both State and Federal agencies have been working to restore marshes by plugging and filling the ditches.

The National Park Service has been restoring Assateague Island marshes since 2008. Marsh restoration is conducted during winter months. The top layer of beach sand is scraped off, transported to a staging area, then hauled to the ditches using a temporary corrugated oak logging mat. The mouth of the ditch is plugged with non-treated plywood that will decay over time. There are over 2,300 acres of ditched salt marshes on Assateague Island and restoration has been conducted on 800–900 acres to date. The ditches are not visible just a few years after restoration. Restored ditches attract shrimp, crabs, wading birds, breeding black ducks, and other waterfowl. Enhanced vegetative marsh growth is evident in marshes with restored natural hydrology. In addition, marsh accretion rates measured with Surface Elevation Tables appear higher in restored marshes, which will allow them more opportunity to keep pace with relative sea level rise.

Maryland Department of Natural Resources has been plugging ditches using polycarbonate dams and fiberglass plugs in locations like the E.A. Vaughn Wildlife Management Area and on the Isle of Wight. Without ready access to beach sand, these restoration projects do not use fill material, relying on marsh accretion to eventually fill in the ditches. In Delaware, some marshes have had a thin layer of sediments from dredging applied to the marsh surface, and this technique may be a way to mitigate marsh loss due to relative sea level rise.

Clockwise from top left: an unrestored mosquito ditch; filling the ditch with sand to restore hydrological function; a ditch immediately after being filled with sand; a plugged ditch 18 months after restoration. Photos by Brian Sturgis/ Assateague Island National Seashore.

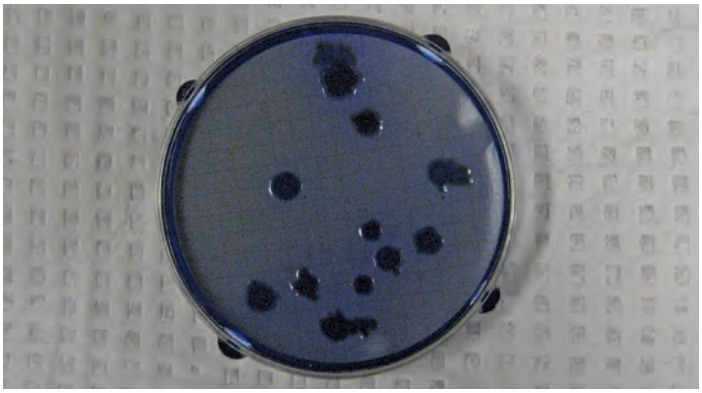
INNOVATIVE MONITORING HELPS IDENTIFY NUTRIENT SOURCES

When the *State of the Bays* was published in 2004 and Shifting Sands was published in 2009, scientists and resource managers were puzzled by the degrading ecosystem health of Chincoteague Bay. The development pressures were largely confined to north of the Ocean City inlet, yet water quality improvements were observed in these regions while Chincoteague Bay water quality was inexplicably declining. The Maryland Coastal Bays Program has funded targeted research projects during the past 10 years which have provided insights into important long-standing questions about potential nutrient sources.

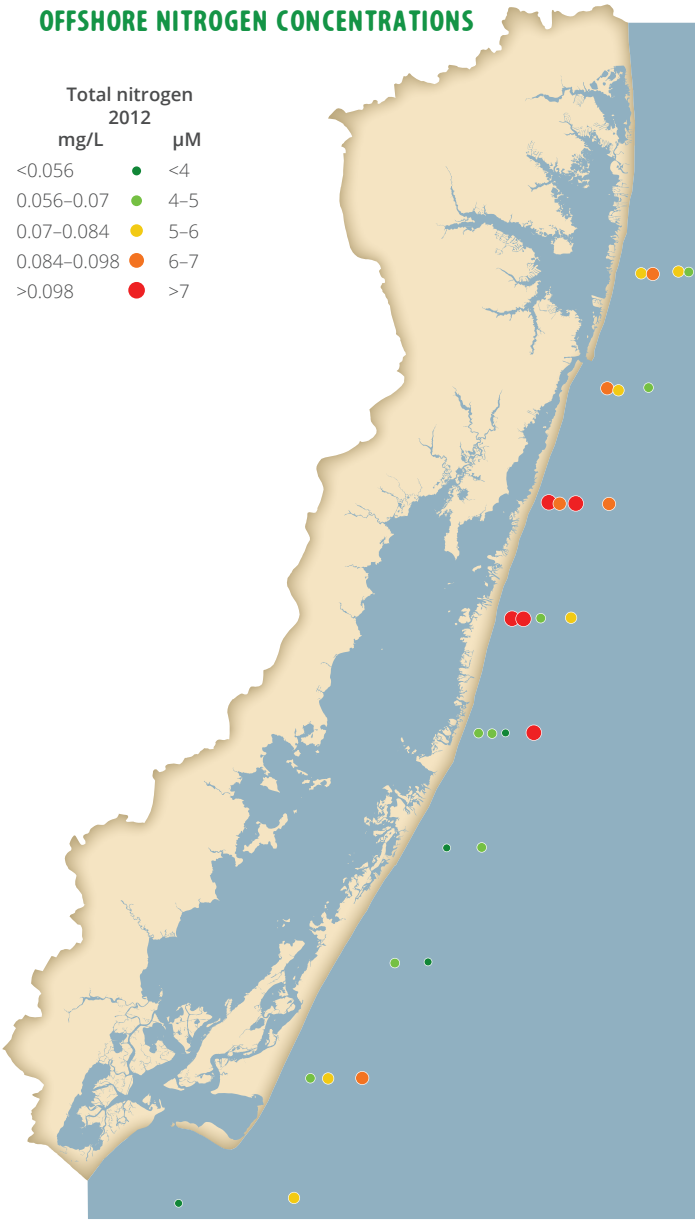
One project used a novel technique of measuring nitrogen stable isotopes in macroalgae as bioindicators throughout the Coastal Bays. This technique identified sewage nitrogen sources in the vicinity of Chincoteague Island. Chincoteague Island is a porous sand island with 4,300 permanent residents and over one million visitors annually relying on septic systems. Traditional septic systems do not remove nutrients which was evident from the sewage nitrogen plume observed.

Two offshore sampling cruises in the nearshore Atlantic Ocean in 2012 found areas of elevated nitrogen, phosphorus, and chlorophyll, as well as some harmful algae species. Elevated nutrients may be from Delaware Bay outflow, upwelling, and/or emanating from the offshore discharge of the Ocean City sewage treatment plant in the summertime (increased tourist population may impact the bay at its most vulnerable time). Entrainment of these high nutrient ocean waters into the Coastal Bays via the Ocean City inlet is a possible nutrient source. Additional study is warranted to help understand the causes and potential impacts of oceanic nutrient loads.

Enterococcus bacteria are found in animal guts, including humans. If *Enterococcus* bacteria make their way into water bodies, the contaminated water is unfit for human contact. People infected with *Enterococcus* bacteria are often treated with antibiotics, which has led to various strains of *Enterococcus* bacteria developing a resistance to antibiotics. The resistance of *Enterococcus* bacteria to various antibiotics can be measured and compared to different sources of *Enterococcus*. This provides an indication of different potential sources of organic material contamination. This technique was employed using *Enterococcus* bacteria collected from streams flowing into Chincoteague Bay in the vicinity of Johnson Bay. The antibiotic resistance in *Enterococcus* bacteria from Scarboro Creek were most similar in a cluster analysis to poultry runoff and poultry litter. The antibiotic resistance in samples from Powell and Boxiron Creeks were most similar to biosolids, which are derived from sludge generated at sewage treatment plants. These results, combined with observations of high levels of nutrients measured in the steams, indicate that chicken and human waste applied to agricultural land is making its way into Chincoteague Bay.



Presence of *Enteroccocus* bacteria in streams and bays can indicate fecal contamination, from either human or animal sources. Photo by Katie Studholme.



There are elevated levels of nitrogen in the nearshore Atlantic Ocean, particularly offshore from Ocean City and northern Assateague Island.

FREQUENT COMMUNICATION AND SYNTHESIS IMPROVES MANAGEMENT AND UNDERSTANDING

Monitoring data and scientific research can be hard to interpret. But frequent and easy-to-understand reporting, that is supported by quantitative measures and results, help identify the main messages that the data and research contain—they help us see the big picture, as well as the most important details.

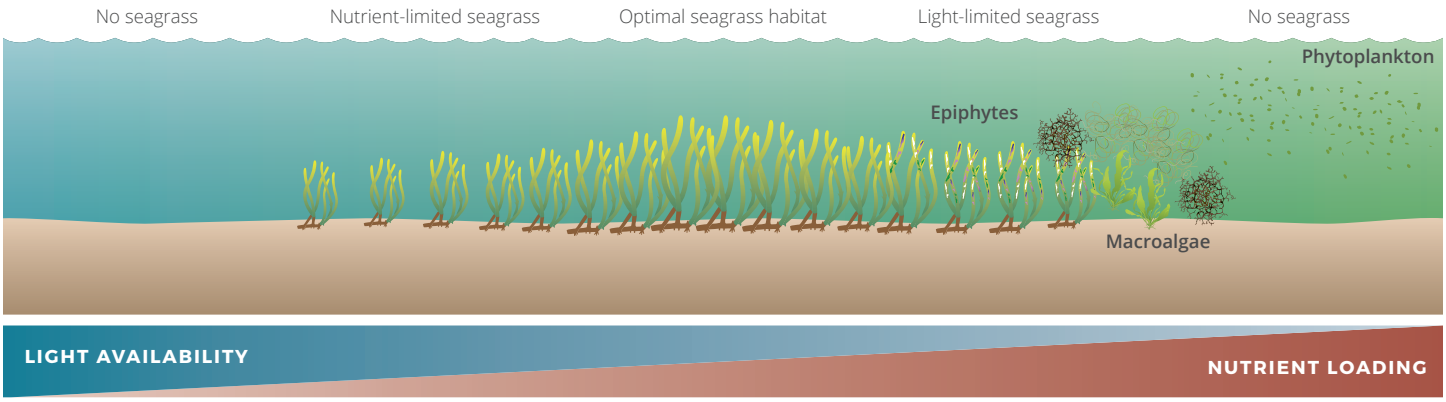
Frequent communications like annual Report Cards, books, and reports remind us of the things we value in the Coastal Bays ecosystems. They also remind us about how the ecosystem supports these values. For example, poor water quality and loss of seagrass create poor habitat for fish and crabs. But, decisions to reduce pollution and stormwater runoff into the Coastal Bays, along with good fishery management can lead to improved habitat and improved fishing and crabbing opportunities.

Highlighting these issues with frequent communication can also help us identify recurring themes or problems, and can keep them in the public eye. This also reinforces our understanding of the way ecosystems work and the things we can do to improve them. This type of public discourse can lead to better management and sustainable decisions. A more informed public creates pressure to protect the things we value.

Local residents provide input on Coastal Bays' direction and activities through the Citizens Advisory Committee, which meets frequently for citizens to provide input. The Science and Technical Advisory Committee provides sound science-based input on Coastal Bays issues.

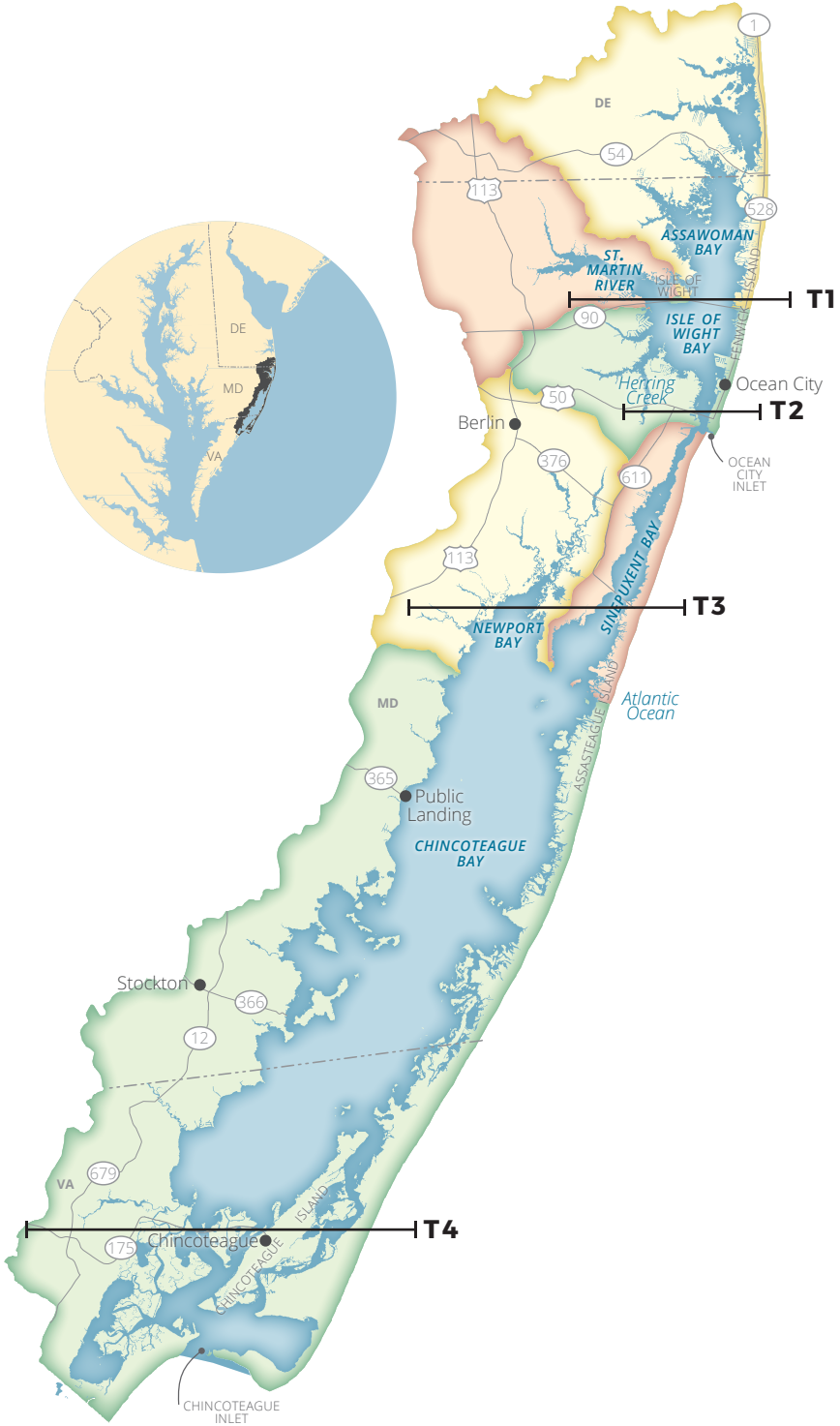
Communication products of the Maryland Coastal Bays include the 2009 book *Shifting Sands: Environmental and cultural change in Maryland's Coastal Bays* (top left) as well as annual ecosystem health report cards (top right). The annual report cards are officially released during a media event held on the shores of the bays. Photo by Jane Thomas.

EFFECT OF INCREASING NUTRIENTS ON SEAGRASSES AND OTHER PLANTS

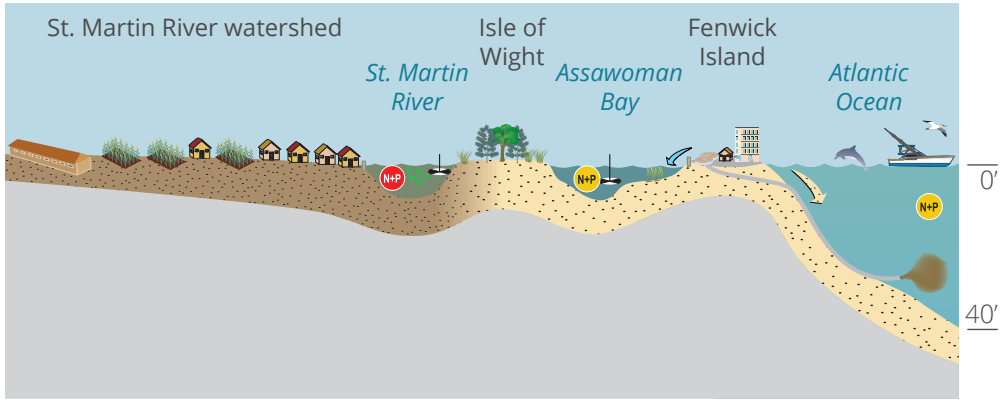


Conceptual diagrams such as this one are an effective way to communicate complex processes to a wide audience. This diagram depicts how increasing nutrients affect seagrasses by reducing light availability. This iconic figure has been used in many different communication products for the Coastal Bays.

A LOOK ACROSS THE COASTAL BAYS

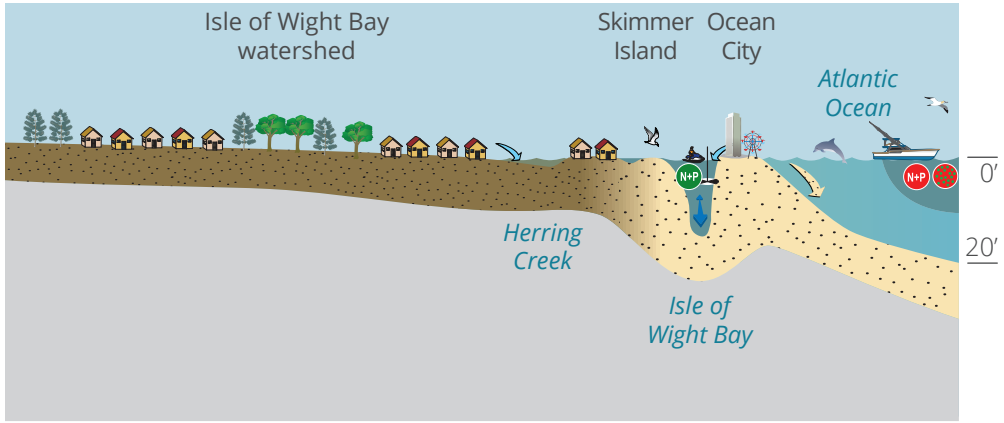


T1: ROUTE 90 TRANSECT



- St. Martin River watershed is highly developed leading to degraded water quality in St. Martin River.
- Ocean City sewage treatment effluent discharges offshore (~30' water depth).
- Assawoman Bay has moderate water quality with remnant seagrasses.

T2: ROUTE 50 TRANSECT

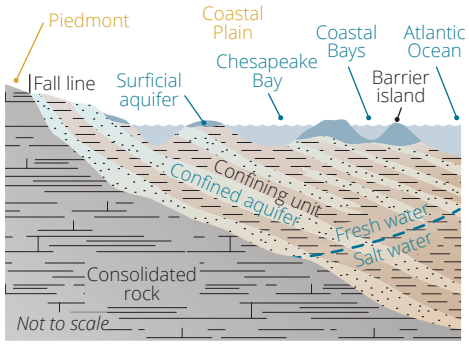


- Isle of Wight Bay watershed is residential and commercial; Isle of Wight Bay is well flushed with clams and fishing, Skimmer Island supports waterfowl.
- Ocean City inlet is maintained by dredging and tidal scouring.
- Ocean City is highly urbanized for summer tourism with impervious surfaces and stormwater runoff.

Four parallel east–west transects were established to provide insights into the features of the Maryland Coastal Bays. From north to south, these transects were the following:

T1: Route 90 bridge transect
T2: Route 50 bridge transect
T3: Verrazano Bridge transect
T4: Chincoteague Island transect

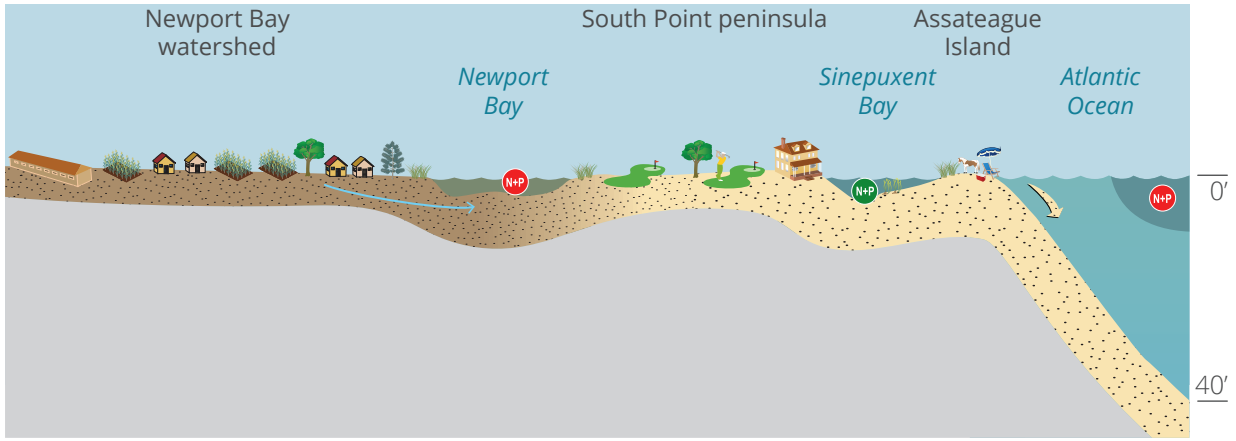
CROSS SECTION OF THE ATLANTIC COASTAL PLAIN



LEGEND

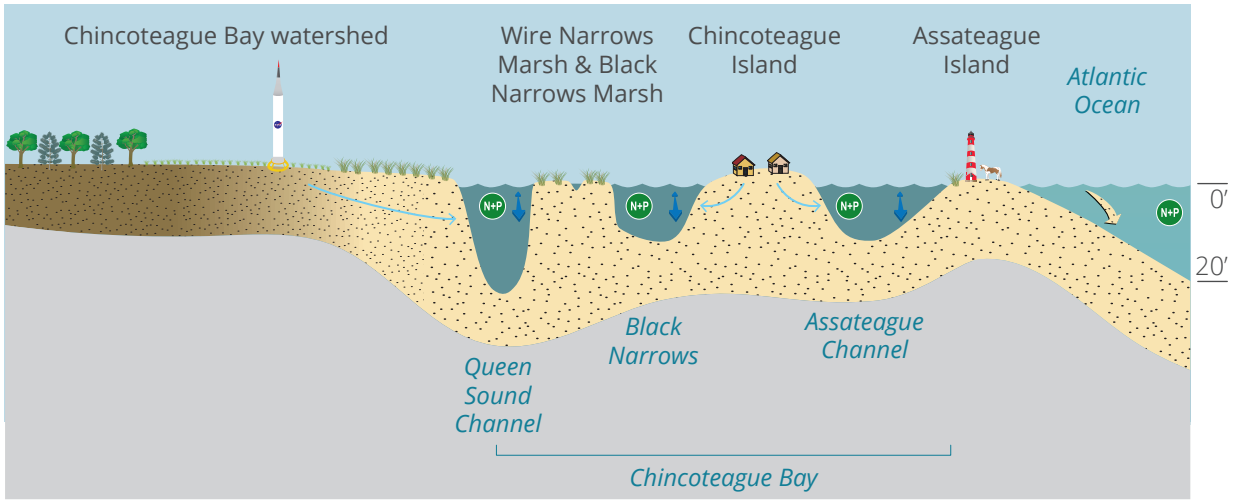
- Sandy bottom
- Muddy bottom
- Water clarity
- Nutrient concentration—low
- Nutrient concentration—moderate
- Nutrient concentration—high
- Chlorophyll concentration—high
- Algal bloom
- Seagrass
- Stormwater runoff
- Longshore sediment transport
- Tidal flushing
- Groundwater flow
- Hardened shoreline

T3: VERRAZANO BRIDGE TRANSECT



- Newport Bay watershed is rural with forest and agriculture leading to nutrient runoff into poorly flushed Newport Bay.
- Sinepuxent Bay is shallow and well flushed, supporting extensive seagrass meadows.
- Assateague Island is managed with the National Park Service for natural geomorphological processes, with herds of iconic feral ponies.

T4: CHINCOTEAGUE ISLAND TRANSECT



- Southern Chincoteague Bay watershed includes housing developments and Wallops Island Flight Center, as well as forest and agriculture.
- Southern Chincoteague bay is well flushed with low ambient nutrient concentrations.
- Chincoteague Island supports the town of Chincoteague which is on septic systems on sandy soil which leads to nutrient discharge to Southern Chincoteague Bay via groundwater.