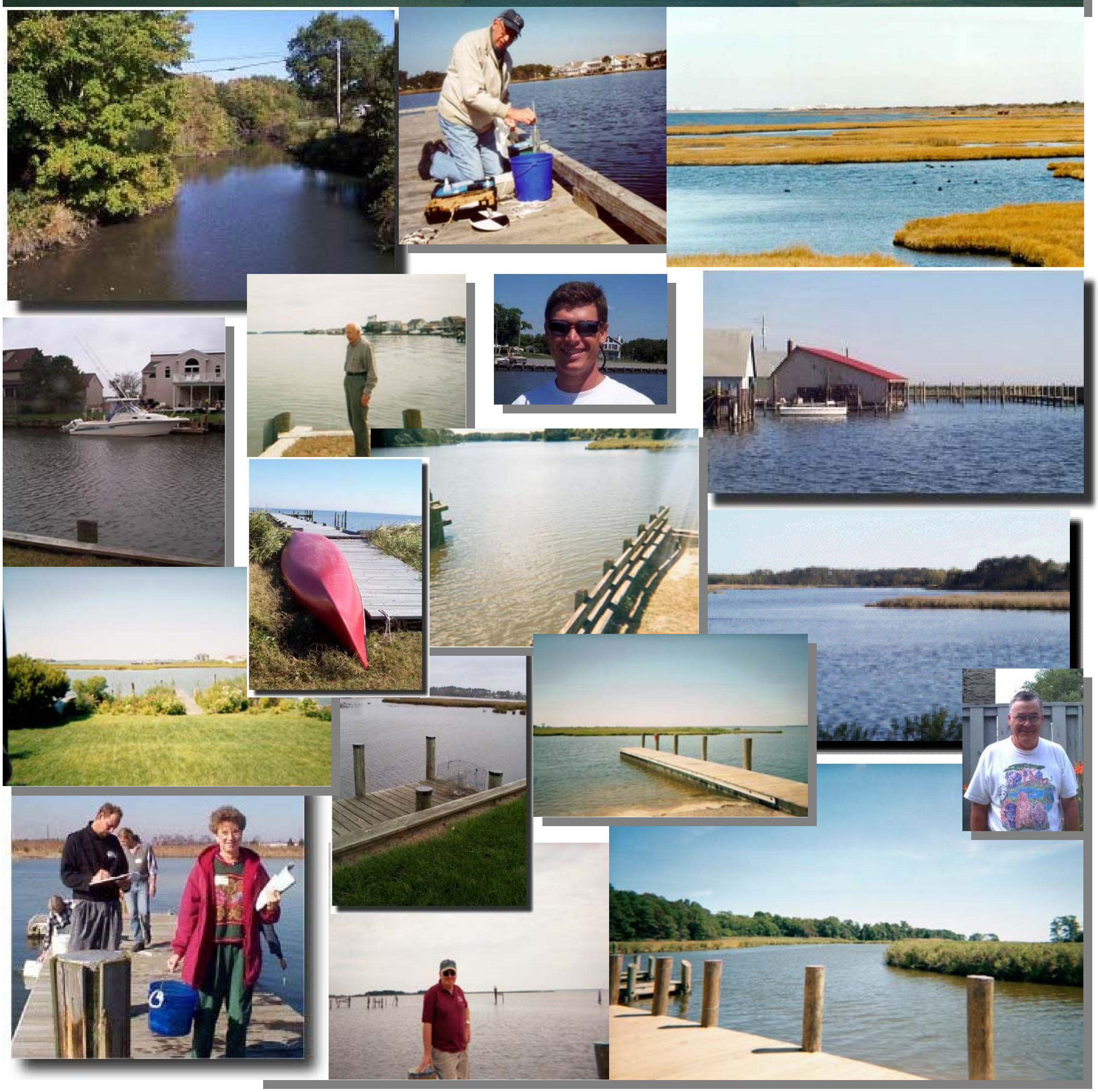
Maryland Coastal Bays Volunteer Water Quality Monitoring Report
1997— 2002

One person can make a difference…..



Acknowledgements:

This report would not be possible without the considerable contributions of many people. Foremost, the MCBP Citizen's Advisory Committee (CAC) and Maryland's Department of Natural Resources (DNR) who established the Volunteer Water Quality Monitoring Program to supplement existing state and federal monitoring resources. Of particular note is Catherine Wazniak of DNR who serves as the project manager and whose hard work resulted in the formation of the volunteer program in 1997. MCBP is also very appreciative of the guidance provided by the Scientific and Technical Advisory Committee (STAC).

Paramount recognition must be given to the many citizen volunteers who have braved the elements for over 5 years to gather site observations and water samples. They have received no other recognition or compensation above the satisfaction of making a difference in their community. We are deeply appreciative of their stewardship, dedication and efforts.

Additionally, MCBP is indebted to EPA, Maryland DNR Tidewater Ecosystem Division, Resource Assessment Service, Worcester County Regional GIS, the Center for Marine Conservation, and the National Atmospheric and Oceanic Administration for the use of their technical materials and graphics to make this report a visual tool for understanding the effects of eutrophication upon our natural ecosystems.

Disclaimer:

This report has been written for the citizen volunteers as a means of feedback for their continued support and participation. Data analyses were limited to monthly, seasonal, and yearly averages using MS Excel spreadsheets. Only those sites with more than 5 completed samples were considered in the individual site portion of this report. Throughout this report the values representing water clarity, measured as light attenuation coefficient (Kd), are referred to as turbidity for simplicity. These values should not be interpreted as National Turbidity Units or secchi disk meters. The conclusions drawn here should help to define existing near-shore baseline conditions, but do not presume to capture overall ecosystem health.

Funding:

EPA has provided the lion's share of funding to support the Maryland Coastal Bays program including this initiative. Local businesses and citizens have been greatly generous in support and donations for various MCBP fundraisers. Supplemental funds were provided by The Community Foundation of the Eastern Shore, which allowed for additional laboratory testing of nutrients at existing monitoring sites.

Volunteers: Past and Present

MD Conservation Corps
Bill Killinger
Alice Tweedy
Mike Evans
John McFalls
Sandy Miller
Chris & Liane McGillen
John Clifton
Joel Mitchell
John Kelly
George Seymore
George Staples
Richard Mueller
Evelyn Adams
Joe O'Hara
Joseph H.Smith
Hobie Kernan
Jim & Barbara Spang
Mary Ochse
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Jeff Anderson
Jim Packer
Dee Rigsby
Erin Fitzsimmons
Tom & Tina Cropper
Don Winslow
Tom Patton
Mike & Beverly Arentz
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Anj Young
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Dave & Janis Foley
Bill Everett
Jeff Figgs
Ray Jackson
Ernie Emond
Dawn Scher
Fred Dinges
James & Nancy Harvey
Hollis Martin
Chris Wade
Monty Hawkins
Michael Goldberg
Kim Cotter
Walter Powers
Annette Cropper
Beth Gismondi
Bill Edmanson
Jack McAllister

Maryland Coastal Bays Program Volunteer Water Quality Report August 1997 – July 2002

Introduction:

In August of 1997 The Maryland Department of Natural Resources and the Maryland Coastal Bays Program (MCBP) initiated the citizen Volunteer Water Quality Monitoring Program. The purpose of the Volunteer Program is twofold: engage citizens and communities throughout the watershed to take ownership of local waterways through hands-on projects and to collect baseline water quality data in areas not routinely monitored.

Volunteer water quality monitoring is a popular tool utilized across our nation by environmental groups to serve as a bridge between citizens and policy makers. To promote this communication the Environmental Protection Agency (EPA) established the National Estuary Program, in 1987, by amendments to the Clean Water Act. The purpose was to identify, restore, and protect nationally significant estuaries of the United States. Each Estuary Program is a voluntary, community based, watershed program which focuses not just on improving water quality in an estuary, but on maintaining the integrity of the whole system-its chemical, physical, and biological properties, **as well as** its economic, recreational, and aesthetic values.

Of the 102 estuaries in the United States, only 28 (excluding the Chesapeake Bay) have been designated as "Nationally Significant". The Maryland Coastal Bays Program, established in 1996, is proud to be included as one of the significant 28. We work with a diverse group of local stakeholders who make protecting the watershed possible. Partners include citizens, business leaders, educators, environmental groups, researchers, and federal, state, and local government agencies responsible for managing the estuary's resources. The partners identify problems in the estuary, develop specific actions to address them, and create and implement a formal management plan to restore and protect the watershed. With this guidance for the program, the local community directs its policy and substance through a non-profit which was organized to manage the program. Ultimately we hope to show an improvement in water quality over time as a measure of the effectiveness of management actions by the program partners.

Maryland's coastal embayments average only 4 feet in depth and are increasingly stressed by anthropogenic pollution. Eutrophication (the over-enrichment of nutrients) and its impacts to living resources has been identified by the Program partners as the most pressing environmental issue facing the bays. With increasing development of our coastal areas it is imperative to educate ourselves and monitor our environment. Otherwise we risk ruining the very qualities of life that many move here to enjoy.

Table of Contents

Background:

Estuaries are transitional areas where salt water from the sea mixes with fresh water flowing off the land. Here the water is naturally turbid, nutrient rich, and full of plants and animals. Plants (phytoplankton, macroalgae and sea grasses) convert energy from the sun and minerals (nutrients) from the water into a form that can be used by animals. The smallest plants (phytoplankton) and animals (zooplankton) form the base of the food web for some of the most productive and populated areas around the world. Phytoplankton provide food for zooplankton, which in turn, feeds a multitude of other organisms. Because of the high concentration and retention of nutrients from the land and sea, estuaries provide habitat for many birds, mammals, fish, and other aquatic life. The shallow areas allow sea grasses to propagate in the presence of sunlight. These grasses provide shelter, habitat, and a food source for many organisms. They are particularly valuable as food for waterfowl and nursery areas where young marine animals easily find food and are protected against the harsher environment of the open ocean. Additionally, grasses benefit the overall ecosystem by recycling nutrients, adding dissolved oxygen to the water through photosynthesis, stabilizing sediments, and protecting the shoreline against erosion.

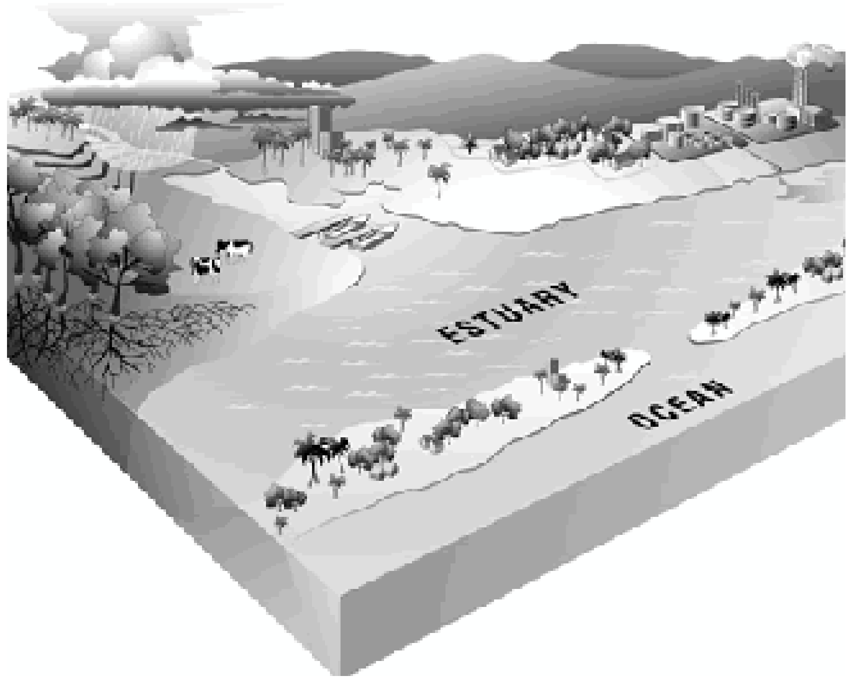


Figure 1. Estuaries are transitional zones between land and the ocean (EPA)

However, when the natural balance is disturbed the water becomes too murky and over-enriched in nutrients. This is referred to as eutrophication. Symptoms of eutrophication include the following:

- An over-abundance of nutrients
- Excessive blooms of algae
- Increased presence of macroalgae ('seaweeds' such as sea lettuce)
- Diminished water clarity
- Loss of sea grasses (SAV- Submerged Aquatic Vegetation)
- Depletion of dissolved oxygen
- Disruption of food webs
- Increased outbreaks of harmful organisms such as red tide and *pfiesteria*

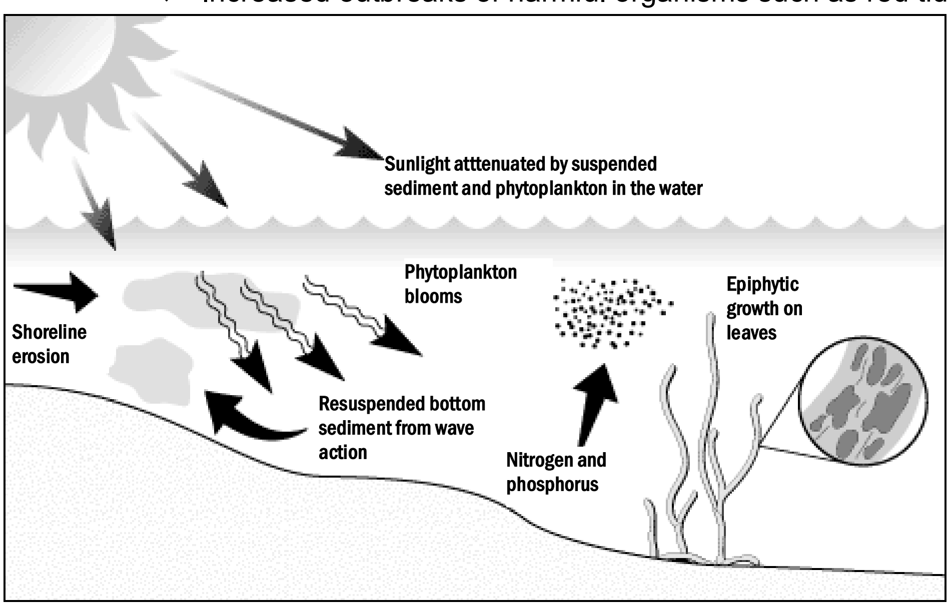


Figure 2. Impacts on SAV. Sediments, nutrients, (and accompanying algal blooms), and epiphytic growth can ultimately affect the amount of sunlight reaching the plants. (EPA)

When large algae blooms occur it blocks sunlight to the submerged aquatic vegetation (SAV). Eventually, the excessive algae blooms die off, but as they decay oxygen within the water is depleted. If this cycle is repeated enough, SAV will die, nutrients from the plants are released into the water, which further fuels the algae bloom cycle.

How does the MCBP Volunteer Water Quality Program help to track the effects of eutrophication?

Eutrophication and its impacts to living resources was identified in the Maryland Coastal Bays Program Characterization Report *'Today's Treasures for Tomorrow'* as the most pressing environmental issue facing our waterways. As a result, the Scientific and Technical Advisory Committee (STAC) to MCBP recommended monitoring nutrient and sediment inputs and the impacts on living resources. Given the importance of SAV, the water quality requirements for these plants serve as the measuring stick of good vs. bad water quality. Based on the water quality standards for SAV in the Chesapeake Bay, STAC recommended the following constituents be measured:

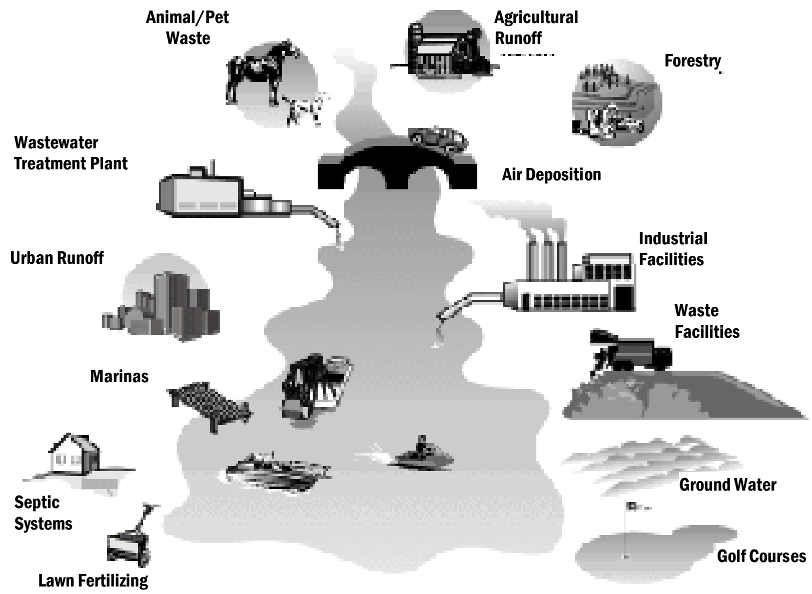
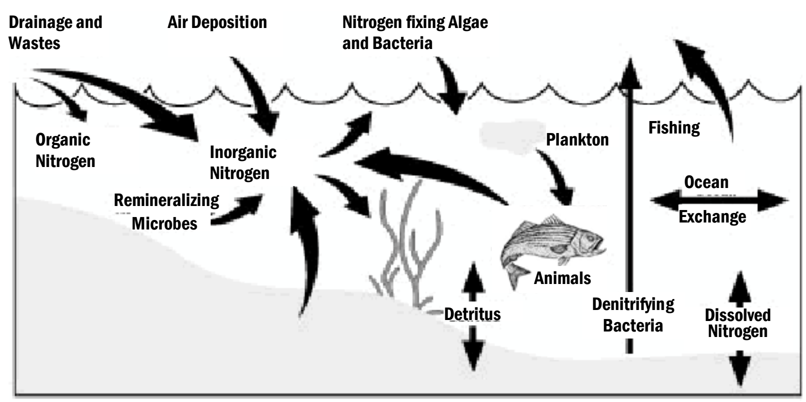


Figure 3. Potential sources of nutrient pollution. (EPA)

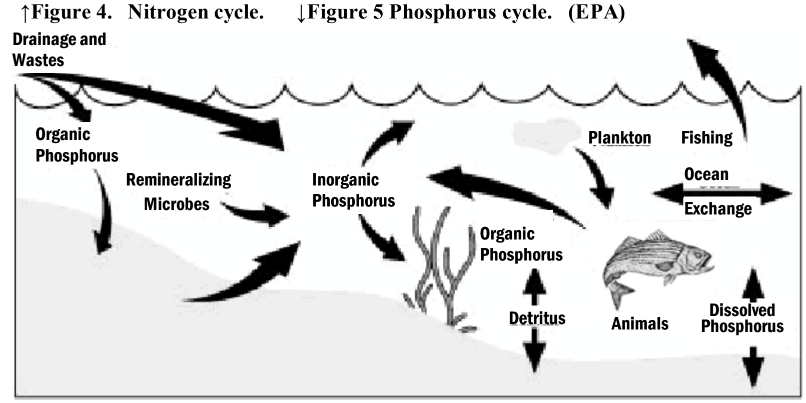
<u>Nutrients</u>**:** **nitrate, nitrite, ammonia**, total phosphorous and **orthophosphate**
<u>Site conditions:</u> **pH, salinity**, dissolved oxygen, **temperature, light attenuation**
<u>Physical parameters:</u> **Chlorophyll-a concentrations**, dissolved organic carbon, and total suspended solids.

*Due to financial constraints, the MCBP Volunteer WQ Program measures only the **bold** parameters. Funding for supplies and lab analyses are generated through numerous fundraising events each year. During 2002, funding from the Community Foundation of the Eastern Shore allowed MCBP to expand nutrient analysis to all participating sites.*

Nitrate, Nitrite, Ammonia, and Orthophosphate are inorganic nutrients that are dissolved in the water and easily accessible for plants to absorb. These forms of nutrients are abundant in the spring through runoff of spring rains coupled with increased fertilization of lawns, golf courses, and agricultural fields. Thus tributaries often exhibit higher levels than the open waters of the bays. Additionally, areas where treated wastewater is discharged or areas with failing septic systems will contribute to the amount of nutrients found in the water. At high concentrations nitrates are toxic to eelgrass, and ammonia is toxic to fish. In this report nitrates, nitrites, and ammonia, which are dissolved forms of inorganic nitrogen, will be referred to collectively **DIN,** orthophosphate results will be reported as **DIP** (dissolved inorganic phosphorus).



↑**Figure 4. Nitrogen cycle.** ↓**Figure 5 Phosphorus cycle. (EPA)**



pH is a measure of the amount of acidity or alkalinity in the water. Water with a pH of 7.0 is referred to as neutral. In the upper tributary areas, where more fresh water is found, the average pH is usually 7.0 to 7.5. Conversely, as the water becomes saltier the pH raises to 8.0 to 8.6. Natural buffers maintain freshwater at about neutral, much as buffers do in a swimming pool. Seawater is buffered for a pH of about 8.3. Most marine organisms prefer conditions with pH values ranging from 6.5 to 8.5. The pH of rainwater is about 5.6, but acids from industrial activities can cause the pH to drop to 4.5 or lower. Blooms of algae can cause pH to fluctuate dramatically over a few hour period, greatly stressing local organisms. Acid rain, which lowers pH, can diminish the survival rate of eggs deposited by spawning fish.

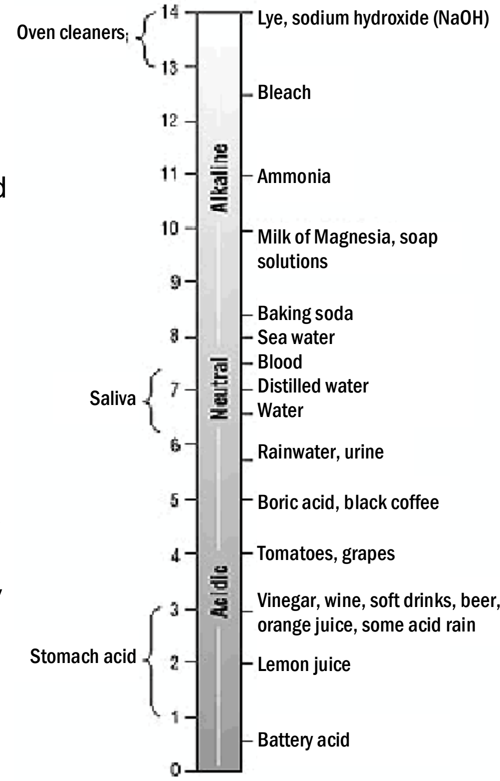


Figure 6. pH gradient. (EPA)

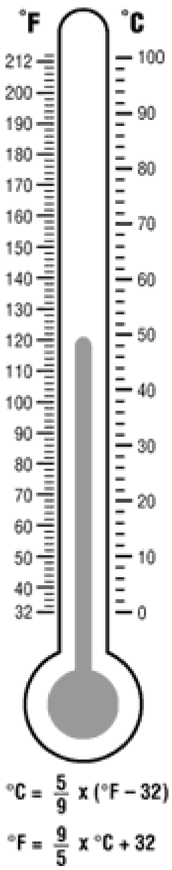


Figure 7. Temperature Conversion (EPA)

Salinity, Temperature, and Light Attenuation are all physical measurements which vary temporally and spatially. Salinity is simply a measure of the amount of salts dissolved in water, and is usually expressed in parts per thousand (ppt). Estuaries usually exhibit a gradual increase in salinity as fresh water entering from its tributaries mixes with seawater moving in from the ocean. Generally, salinity also increases with water depth unless the water column is well mixed by tides and wind. The coastal bays average 4 feet in depth and are considered well mixed by tides and wind. Due to this shallow nature, the evaporation of water in the warm weather months can result in an increase in salinity. Conversely, salinity will decline with the influx of spring rains. Where fresh water meets salt water, particles clump together and reduce visibility. Wind, tides, freshwater inflow, industrial or municipal discharge, and excessive stormwater runoff can re-suspend sediments and further decrease the amount of light penetrating the water.

The rates of biological and chemical processes depend on temperature. Temperature affects the oxygen content of water (oxygen levels decrease when temperatures increase), the rate of photosynthesis by aquatic plants, the metabolic rates of aquatic organisms, and the sensitivity of organisms to toxic compounds, parasites, and diseases. Many species regulate the timing of important events, such as reproduction and migration, according to specific water temperatures. Water depth, groundwater inflow, influent streams and rivers, the ocean, tidal stage, incident sunlight, and air temperature are factors affecting temperature. Additionally, removal of stream bank vegetation and hot stormwater from streets and rooftops will influence water temperatures.

Light attenuation is a function of the clarity (turbidity) within the water column. Particles in the water such as phytoplankton, zooplankton, eroded soil, and re-suspended bottom sediment interfere with light penetration and lessen the transparency of the water. The depth at which it disappears is called the Secchi depth and can be related to light attenuation by dividing the depth by 1.65. Many of the sampling sites along the Coastal Bays are not deep enough (and/or are clear enough) to prevent successful measurements of light attenuation as measured with a secchi disk. Often the disk is still visible on the bay bottom, thus there is sufficient light for seagrass growth. A more effective technique would be to use a light meter, however is would be cost-prohibitive to provide one for each site.

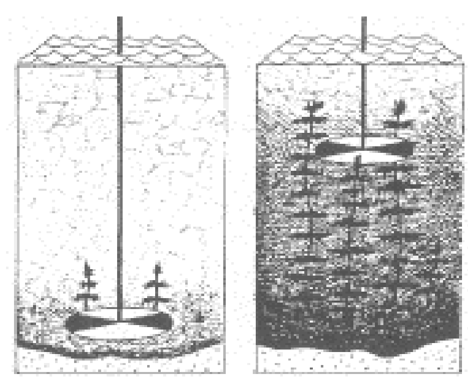


Figure 9. Source: http://www.sebagolakeassc.org/secchi.htm

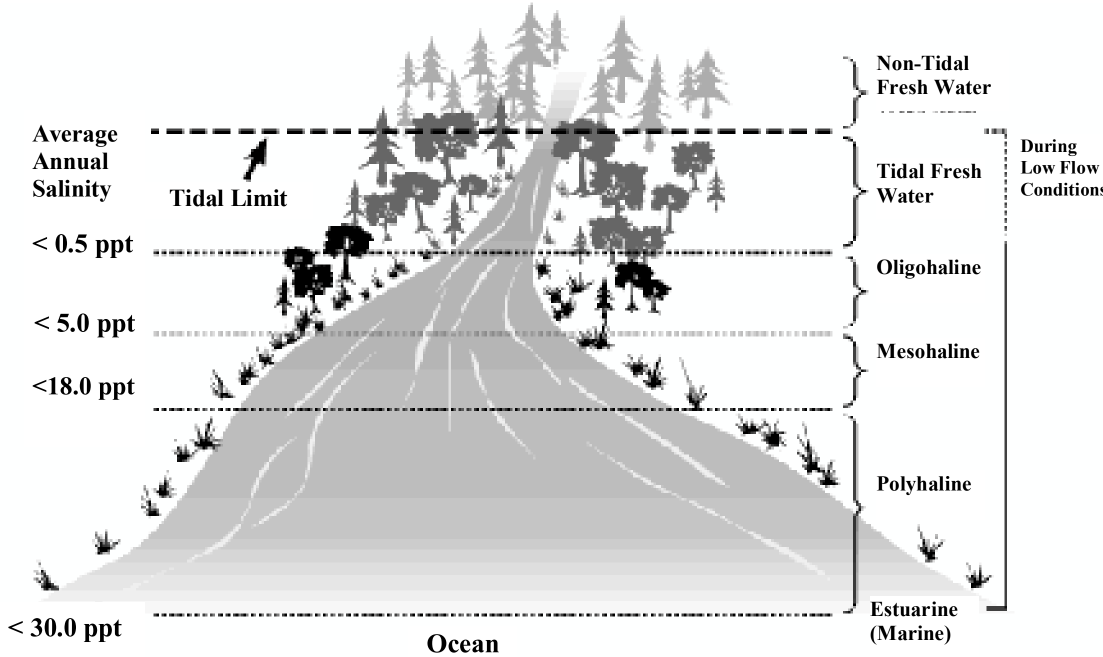


Figure 8. Salinity Transition Zones (EPA)

Chlorophyll-a is a pigment common to all photosynthetic algae, and as such is a measurement of the abundance of phytoplankton present throughout the year. Phytoplankton forms the base of the food web within our estuary and blooms are a natural part of the feeding cycle. As with all plants phytoplankton need light and nutrients to grow and reproduce. Sunlight is limited during the winter, and nutrient supplies decrease during the summer and fall. A large Spring bloom occurs when the increasing sun angle delivers enough light for the dormant algae to begin using the abundant nutrients available from the well-mixed wintertime waters. This first generation of algae dies, decomposes, and releases the nutrients back into the system.

Smaller blooms occur throughout the summer when storms mix the water, bringing nutrients from the bottom into the sunlit surface waters where the phytoplankton reside. In a healthy system, the blooms are short-lived because nutrients quickly become depleted, and the population of zooplankton explodes to graze the phytoplankton crop. Crustaceans, filter feeders, and small fish eat these organisms, which are in turn eaten by larger predators. The estuary is fed and the murky waters clear until the next bloom. When the cycle becomes unbalanced due to excessive nutrients, phytoplankton and macroalgae (seaweeds) will bloom continuously, clogging the estuary with uneaten and decaying plant material which depletes the water of oxygen. Additionally, persistent blooms of plant material can form into large mats which shade out SAV, foul boat propellers, and cause odor problems for homeowners.

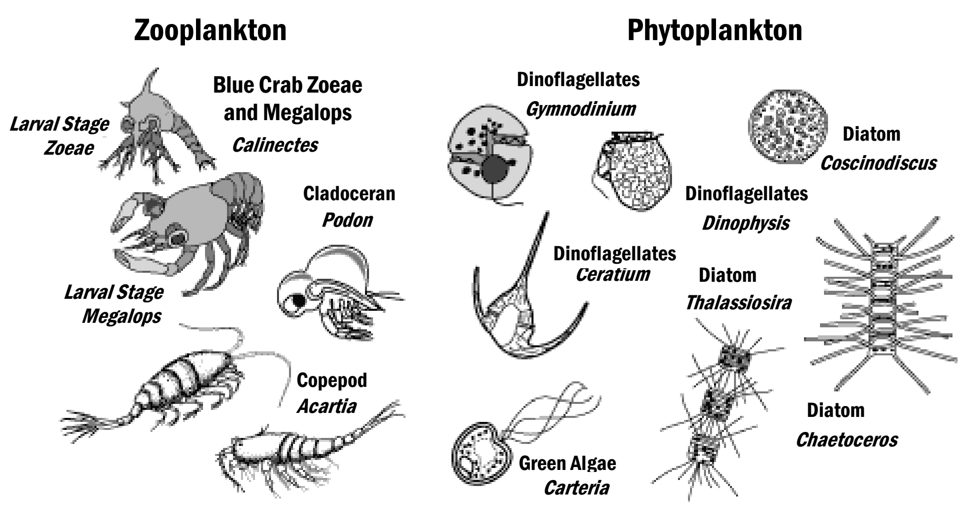


Figure 10. Examples of various planktonic forms found in coastal and estuarine water. (EPA)

MCBP Methods

The Volunteer Water Quality Monitoring Program measures a suite of physical and chemical parameters in the near-shore environment. Samples are collected bi-monthly from March through November and once per month December through February for a total of 21 sample dates per year. Physical measurements are collected *in situ* (on site), while chemical parameters are determined at the University of Maryland Horn Point Laboratory.

Samples are collected +/- 2 days of the scheduled sample date, generally take 30 minutes and adhere to the following protocol:

Parameter (units)	**Sampling Equipment**	**Sample Preservative**	**Maximum Holding Time**	**Method /Reference**
pH (standard units)	LaMotte wide-range pH color comparators	None	Not applicable *in situ*	LaMotte method 1996
Temperature air & water (°C)	LaMotte armored thermometers	None	Not applicable *in situ*	EPA 842-B-93-004
Salinity (ppt)	LaMotte 0 - 1.0 specific gravity hydrometer	None	Not applicable *in situ*	LaMotte method 1993
Visual clarity (m)	Secchi disc	None	Not applicable *in situ*	EPA 842-B-93-004
Chlorophyll-a (µg/L)	Luer Lok 60 cc syringe, Whatman 25 mm GF filters	Frozen storage	12 Weeks	HPL TS-264-00 2000 Turner Fluorometer Std. Methods 10200, 1992
Nitrate/ Nitrite filtered (µg/L as N)	Luer Lok 60 cc syringe, Whatman 25 mm GF filters	Frozen storage	12 Weeks	HPL TS-264-00 2000 Technicon AutoAnalyzer II EPA 1979 Method 353.2
Ammonium filtered (µg/L as N)	Luer Lok 60 cc syringe, Whatman 25 mm GF filters	Frozen storage	12 Weeks	HPL TS-264-00 2000 Technicon AutoAnalyzer II EPA 1979 Method 350.1
Orthophos-phate filtered (µg/L as P)	Luer Lok 60 cc syringe, Whatman 25 mm GF filters	Frozen storage	12 Weeks	HPL TS-264-00 2000 Technicon AutoAnalyzer II EPA 1979 Method 365.1

All volunteer monitors complete a general training session to learn how to collect samples, perform physical/chemical tests, sample handling and the cleaning/storage of equipment. On-going staff support is available for any volunteer who requests additional guidance.

Consultation with other volunteer monitoring programs revealed that there are limitations in the distance volunteer monitors will travel, and long-term volunteers are typically those that collect data at or near their home. Therefore, volunteers are allowed to choose the locations they would monitor with limited guidance from staff. Volunteers have been encouraged to choose previous monitoring sites and sites near state fish monitoring stations, when possible. In some instances, volunteers are recruited to maintain a balanced distribution in all major bays and tributaries.

The main objectives of the **MCBP Volunteer Water Quality Monitoring Program** are to first collect water quality data to help determine the current status and future trends of the coastal bays nearshore areas, to help support management decisions in the coastal bays watershed and to increase public participation and support for the protection and management of these resources. Data collected by the program can augment existing monitoring programs (Maryland Department of the Environment, Maryland Department of Natural Resources, Assateague Island National Seashore, and Worcester County Department of Health) by:

- providing general long-term water quality trend data in areas which are not routinely monitored.
- providing more frequent sampling to yield time-series data with the large number of data points required to establish response and lag times in changes
- providing observational information on weather, living resources, and site conditions.

During program development three goals were identified to serve as a gauge of effectiveness:

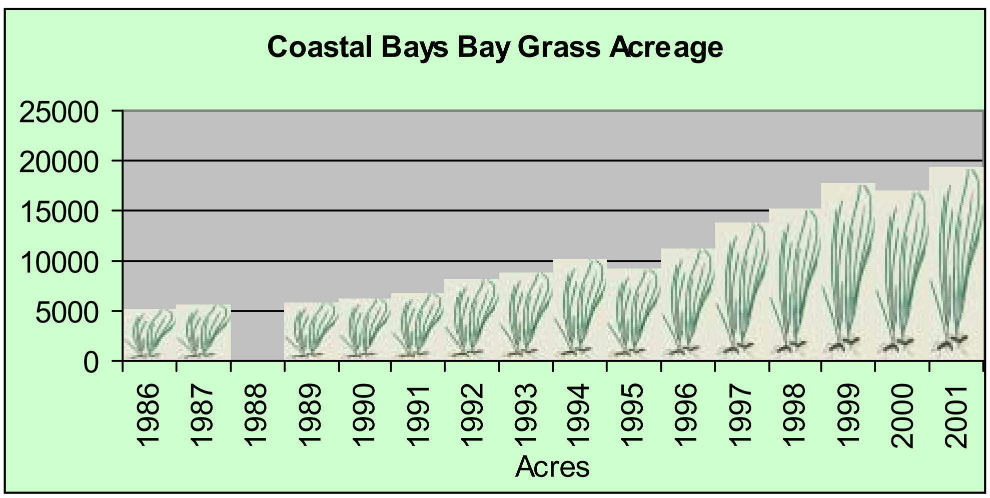
Goal 1: Collect data from at least three (3) stations in each bay segment.

Goal 2: Collect 80% of scheduled samples from each segment.

Goal 3: Determine the number of stations that meet SAV habitat conditions.

The baseline data resulting from Goals 1 and 2 will help in identifying pollution sources and evaluating the effectiveness of implemented actions in the watershed as part of the MCBP Comprehensive Conservation Management Plan. Because SAV abundance and distribution is an indicator of ecosystem health, Goal 3 uses the criteria for suitable environmental conditions that supports SAV. In *Chesapeake Bay Submerged Aquatic Vegetation Habitat Requirements and Restoration Targets: A Technical Synthesis (1992),* SAV habitat requirements were defined in terms of five water quality variables: dissolved inorganic nitrogen, dissolved inorganic phosphorus, water column light penetration, chlorophyll-a concentrations, and the amount of total suspended solids within the water column.

- DIN < 10 μM
- DIP <0.67 μM
- Light attenuation coefficient < 1.5 meter
- Chlorophyll-a <15 ug/L
- Total Solids < 15 mg/L (not done by MCBP due to budget constraints)



The dominant SAV species in the Maryland Coastal Bays are eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*). In the 1930's, eelgrass populations throughout the mid-Atlantic region were decimated by eelgrass blight. Populations in the Coastal Bays, as in other mid-Atlantic estuaries , have been slowly recovering for much of this century. In 2002, MCBP provided the Maryland DNR with a Implementation Grant to interpret 1950's aerial photos taken by USDA to help determine what historical SAV levels may have been. Because no historical acreage data exists prior to the late 1970's we can not definitively determine if the expansion of SAV coverage seen since 1986 is an indicator of ecosystem health or the continuing recovery of historical beds. Aerial overflights conducted during 1991—2001 have shown a 35% increase in bed acreage. How these numbers compare to pre-blight conditions though is still to be determined.

Conclusions:

Goal 1: Collect data from at least three stations in each bay segment.

- **Assawoman Bay** needs at least two additional monitoring sites. One would preferably be in the Grey's Creek area, (Back Creek is also a possibility), and another site in Ocean City, north of the Route 90 bridge .

- **St. Martin's River** has had exceptional coverage at Site # 11 (Bishopville Boat Ramp) and at Site # 13 (Holiday Harbor). Site # 3, a boat ramp at Ocean Pines, White Horse Park has recently been re-adopted and will help to determine nutrient loads and/or sinks within this dead-end canal. Considering the development pressures in the northern portion of the watershed, the need exists to re-establish monitoring at Site # 22 (Shingle Landing Prong) to measure nutrient delivery to the river and the Isle of Wight Bay.

- **Isle of Wight Bay** also benefits from some of our most dedicated volunteers. This is very fortunate for the program since this area includes Manklin, Turville, and Herring Creeks which all exhibit stress from excess nutrients and low dissolved oxygen levels, (Sites # 16, #30, #6 respectively). Two other sites which have been continually monitored and are almost parallel with each other is Site # 9 (Ocean Pines Wood Duck Canal) and Site # 5 (Butterfish Cove) in Ocean City. Currently, Site # 2 at Hitchen's Ave. (36th Street) is monitored by the MD Conservation Corps. This site would benefit from a local volunteer and year-round resident.

- **Sinepuxent Bay** has 2 of 3 sites monitored; Site # 31 (Snug Harbor) and Site # 10 (South Point Landing). A site could easily be maintained at Assateague Landing which is nearly equidistant between these two established sites.

- **Newport Bay** has shown to be very stressed by nutrients. Fortunately the Maryland Conservation Corps has been fantastic about measuring Trappe Creek (Site # 23), Ayres Creek (Site # 33), Newport Golf Course (Site #15), and Mason's Landing (Site # 12). However, opportunities exist for year-round residents who have a stake in the quality of their watershed and would like to volunteer.

- **Chincoteague Bay** This is a long, narrow watershed which would benefit from more attention and stewardship. Public Landing has almost 3 years of baseline measurements but is no longer being monitored. Recruitment should be targeted here. This site along with Figg's Landing (Site # 18) and George Island Landing (Site # 27) would meet the goal of monitoring 3 sites per subwatershed.

Goal 2: Collect 80% of scheduled samples from each segment.

- 21 sample dates per year, over 5 years equates to 105 potential samples per site.
  Eighty percent = 84 samples

- Of the 28 sites monitored by volunteers over a five year period,
  7 sites (25 %) met or exceeded the 80 % goal .
  Of additional note; 10 sites (36%) monitored at least 50% of the time.

- Feedback of results may be the most important incentive to keep volunteers engaged. While some volunteers are expected to drop-out after a short time, MCBP may have exacerbated attrition by a lack of timely feedback. A full-time volunteer coordinator to facilitate the monitoring program could encourage more citizen involvement and target areas for future monitoring (and restoration if applicable).

Goal 3: Determine the number of sites that meet Submerged Aquatic Vegetation (SAV) habitat requirements.

Overall: No sites meet all four of the parameters measured by MCBP.

Light Availability/Turbidity:

Turbidity is a measure of the relative clarity of water: the greater the turbidity, the murkier the water. Turbidity increases as a result of suspended solids which reduce the transmission of light. Suspended solids are varied, ranging from clay, silt and plankton, to sewage and industrial/commercial/residential runoff. As turbidity increases, organism diversity decreases, water becomes warmer as particles absorb heat, photosynthesis decreases, and oxygen levels drop.

In this study, the vast majority (93%) of secchi reading indicate insufficient light is available to support SAV growth and reproduction. This result may be skewed due to the difficulty in obtaining secchi reading in near-shore shallow water areas. Recommendation: collect and monitor suspended solids using a turbidimeter or spectrophotometer.

Chlorophyll-a:

Since all phytoplankton must have chlorophyll to conduct photosynthesis, measuring the total amount of chlorophyll in a given water sample is one way to measure the base of the food chain.

More than half of the time (54%), Chlorophyll-a results met SAV habitat requirement levels. The Isle of Wight, Sinepuxent, and Chincoteague Bays were on average all below the 15 ug/L threshold, at 11.36 ug/L, 7.99 ug/L, and 9.73 ug/L respectively.

However, the St. Martin River averages an 81% failure rate, while Assawoman Bay which receives the water flow from this river averages 54% failure, (16.33 ug/L). Over a five year period the average concentrations observed in the St. Martin River are 37.78 ug/L, more than twice the threshold level. It must be noted though that tributaries often exhibit higher concentrations of nutrients and thus higher concentrations of phytoplankton. Newport Bay failed to meet the chlorophyll standard 58% of the time, and reveals an average concentration of approximately 24 ug/L.

Dissolved Inorganic Nitrogen:

DIN is composed of ammonia (NH_3), nitrates (NO_3), and nitrites (NO_2). When plants and animals die and decompose ammonia is produced. Bacteria usually turn the ammonia into nitrate. Pollutants such as sewage or manure contain much higher levels of nitrates. High levels of nitrate may get into groundwater or streams from fertilized fields, lawns, golf courses, septic system effluent, or storm water runoff.

Over 5 years, DIN concentrations for all sites meet SAV habitat requirements 80% of the time. Failure to meet the threshold level of 10 uMolar was found in 27% of samples from the St. Martin River and 54% of samples from Newport Bay. St. Martin River average of 31.98 uM is three times the habitat threshold, while Newport Bay revealed an average of 79.24 uM, nearly 8 times the standard!

Assawoman (5.3uM), Isle of Wight (6.27 uM), Sinepuxent (6.11 uM), and Chincoteague (5.81 uM) Bays were all found to be within the habitat requirements during the SAV growing season.

Dissolved Inorganic Phosphate:

Phosphorus is usually present in natural water as phosphate (PO_4). Organic phosphate is a part of living plants and animals, their by-products and their remains, while inorganic phosphate can be found attached to soil particles or present in laundry detergents. Phosphorous that has been introduced into the environment from human activities such as human and animal wastes, and disturbance to the land and vegetation, dwarfs the natural sources such as forest fires and volcanic eruptions.

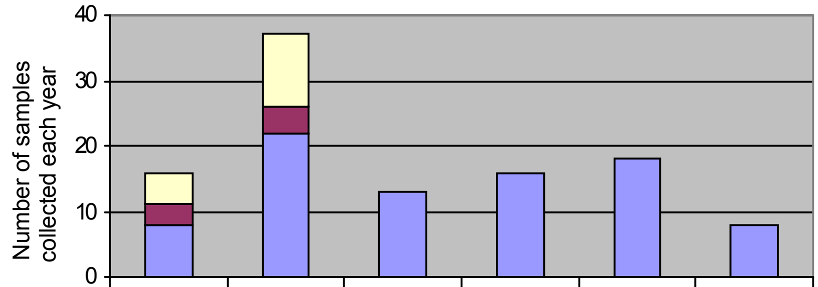
The SAV habitat requirement of 0.67 uMolar or less was found to mirror the Nitrogen trends. The St. Martin River was slightly high at 0.89 uM with 41% of the samples failing, while Newport Bay levels averaged 7.28 uM (54% failure)-nearly 11 times the threshold level!

Assawoman (0.32 uM), Isle of Wight (0.48 uM), Sinepuxent (0.60 uM), and Chincoteague (0.50 uM) Bays on average, all meet the habitat requirements during the growing season.

Goal 1: Collect data from at least 3 stations in each bay segment.

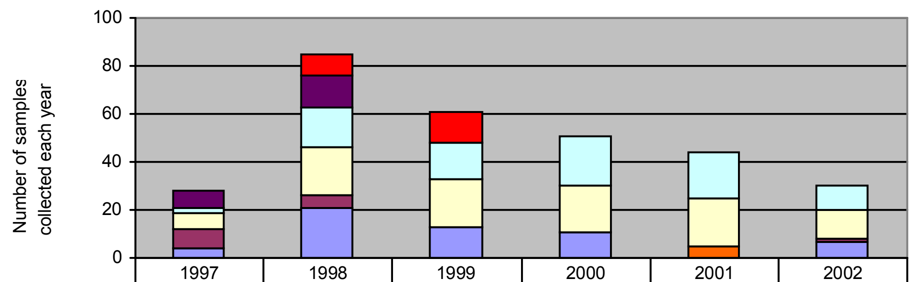
Only Fenwick Ditch, (Sandy Miller), has been consistently monitored for 5 years. Grey's Creek and Back Creek are two areas which MCBP would like to see monitored in the future.

Assawoman Bay



	1997	1998	1999	2000	2001	2002
#32 O.C. 79th St.	5	11				
#19 O.C. Caribbean St.	3	4				
#1 Fenwick Ditch	8	22	13	16	18	8

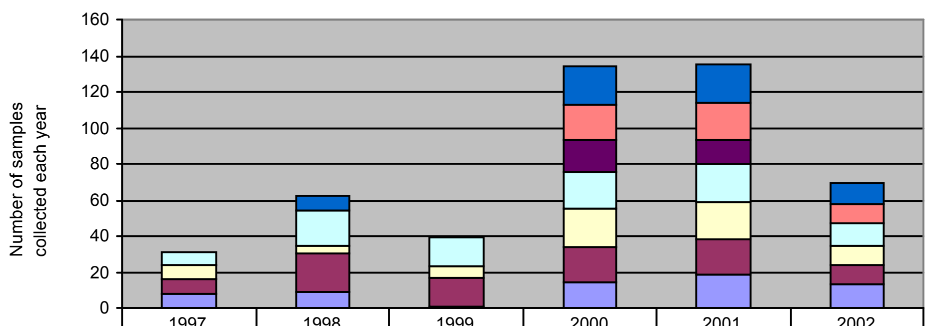
Saint Martin River



	1997	1998	1999	2000	2001	2002
# 26 Look Out Point		9	13			
#22 Piney Island	7	13				
#13 Holiday Harbor	2	17	15	21	19	10
#11 Bishopville Boat Ramp	7	20	20	19	20	12
#7 White Cove Circle	8	5			5	1
#3 White Horse Park	4	21	13	11		7

Bishopville Boat Ramp, (Mike Evans) and Holiday Harbor, (Richard Mueller / Evelyn Adams) have been sampling since the program's inception. White Horse Park has recently been picked up by new volunteer, Joel Mitchell.

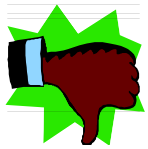
Isle of Wight



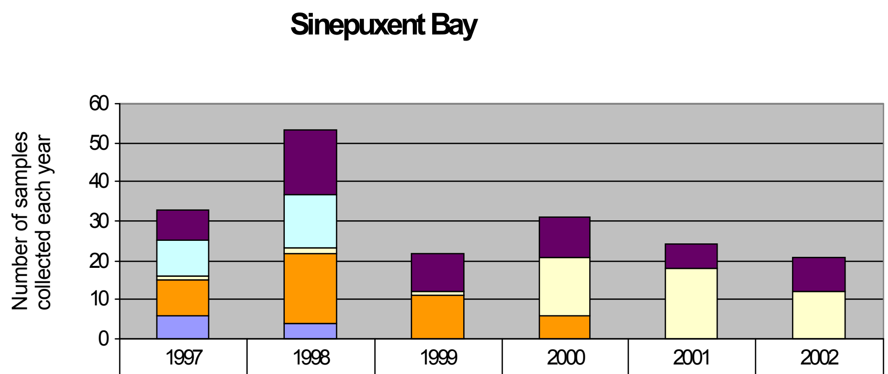
	1997	1998	1999	2000	2001	2002
#30 Turville Creek		8		21	21	11
#16 Manklin Creek				20	21	11
#9B OP Canal				17	13	
#9 OP Canal	7	19	16	21	21	12
#6 Herring Creek	8	5	6	21	21	11
#5 Butterfish Cove	8	21	16	20	19	11
#2 O.C. 36th St.	8	9	1	14	19	13

Butterfish Cove, (Joe O'Hara) and Wood Duck Canal (John McFalls) have provided 5 solid years of data for the Isle of Wight. Additionally, Bill Killinger has gone above and beyond by sampling Herring and Manklin Creeks, as well as collecting samples at Turville Creek and OP #9B Canal. Turville Creek is currently monitored by Chris & Liane McGillen. The MD Conservation Corps collects samples at Site 2 in Ocean City.

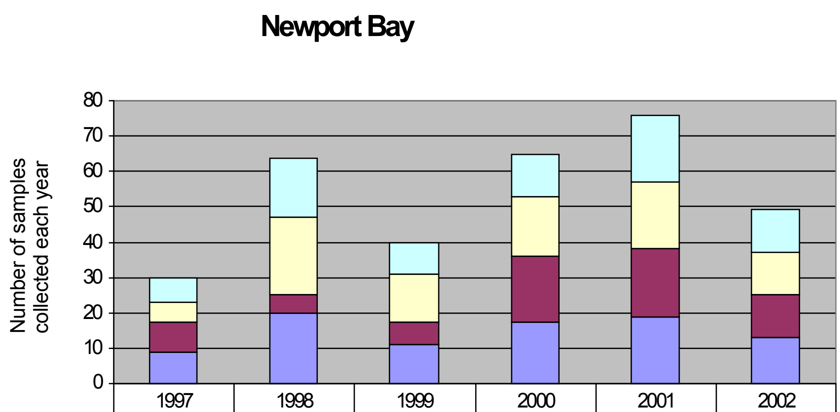
Goal 1:   Collect data from at least 3 stations in each bay segment.



Snug Harbor (Joe Smith) and South Point Landing (MD Conservation Corps) are providing data for Sinepuxent Bay. Previously, another South Point site was sampled by the Arentz family until 2000. This area would benefit with at least one additional volunteer.

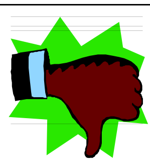


	1997	1998	1999	2000	2001	2002
#31 Snug Harbor	8	16	10	10	6	9
#17 Rum Point	9	14				
#10 S. Point Landing	1	1	1	15	18	12
#8 South Point	9	18	11	6		
#4 Green Creek	6	4				

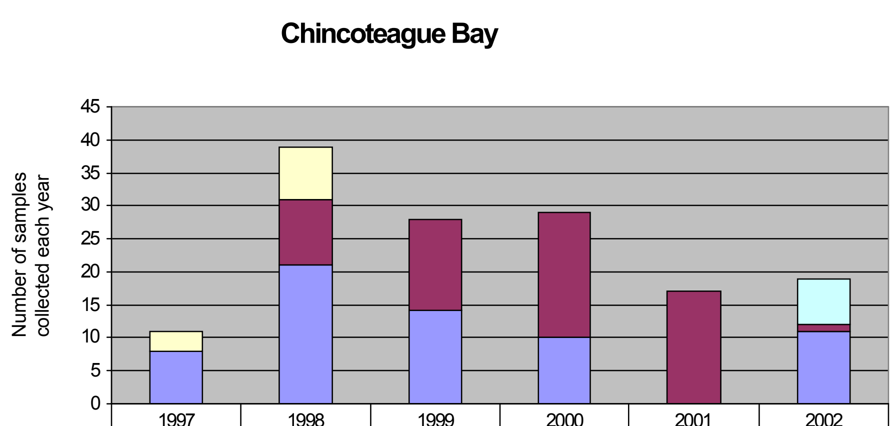


	1997	1998	1999	2000	2001	2002
#33 Ayres Creek	7	17	9	12	19	12
#23 Trappe Creek	6	22	14	17	19	12
#15 Newport Golf Course	8	5	6	19	19	12
#12 Mason Landing	9	20	11	17	19	13

All four sites within Newport Bay are being sampled by the Maryland Conservation Corps. Lead by Angela Baldwin of MD Dept. of Natural Resources, this program allows young people to earn college funds while supporting environmental stewardship projects. MCBP is deeply appreciative of their continued commitment.

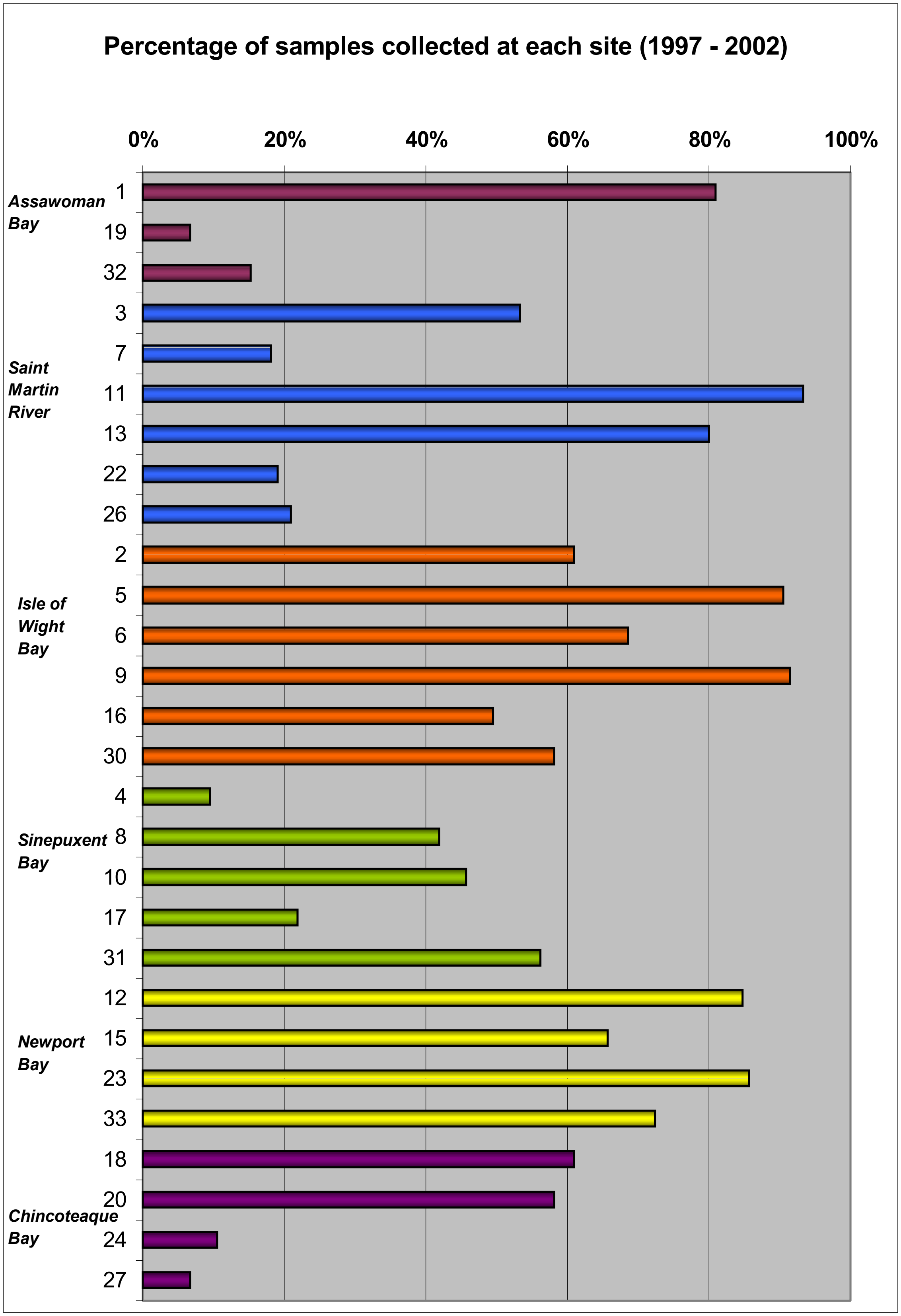


Public Landing is the longest maintained site for the Chincoteague Bay thanks to Alice Tweedy. Currently, she has switched to Figg's Landing which is closer to home, thus relieving Jeff Figgs to whom we are grateful for his past participation. Public Landing does now however, need a new champion to continue the data set. The newest, and southernmost, collection site to the program is at George Island Landing near Stockton which is being monitored by John Clifton.



	1997	1998	1999	2000	2001	2002
#27 George Island						7
#24 Kelly Point	3	8				
#20 Public Landing		10	14	19	17	1
#18 Figgs Landing	8	21	14	10		11

Goal #2: Collect 80% of scheduled samples from each site



From a five year perspective, only one quarter (25%) of the original sampling sites meet the 80% goal. **This illustration does not properly reflect the efforts of volunteers who have adopted unattended sites or began monitoring in new areas.** MCBP's lack of timely feedback to volunteers is most likely the cause of withdrawal from the program and the resulting gaps in data. The Program recognizes this deficiency and is working to resolve the problem.

Goal #3: Determine the number of stations meeting SAV habitat requirements

This graphic uses color coding to illustrate the number of areas meeting submerged aquatic vegetation habitat requirements.

Overall:
7% met turbidity thresholds, 54% met Chlorophyll-a requirements, 67 % met Phosphorus limits, and 80% met Nitrogen limits.

The Saint Martin River and Newport Bay show the greatest amount of stress. **(See page 16)**

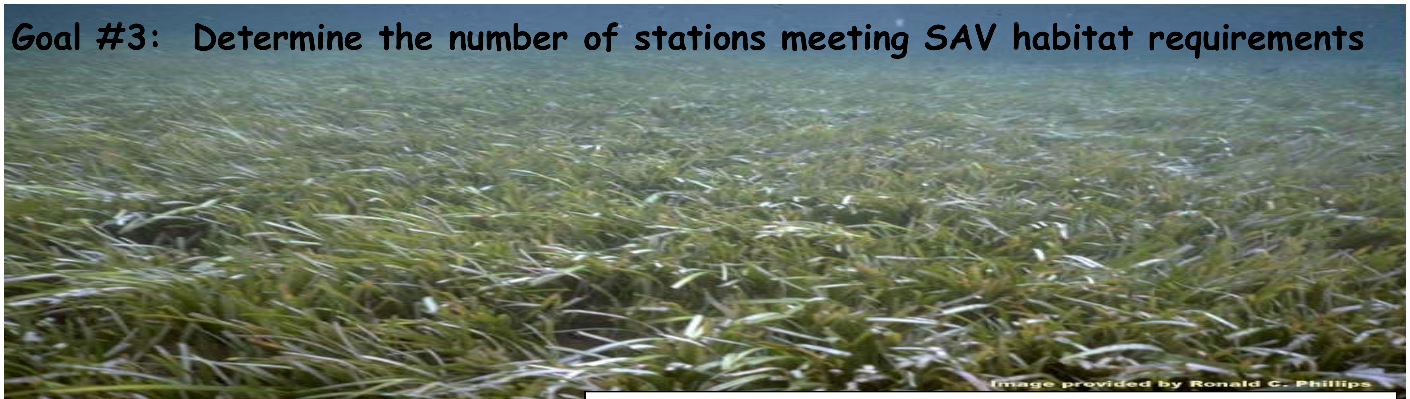
Note that the vast majority of light attenuation coefficient (a measure of turbidity), indicate sufficient light is available less than 24% of the time. This may be misleading due to the difficulties in acquiring secchi measurements in shallow waters. Other considerations to keep in mind for the four parameters measured by MCBP include: the length of participation by the volunteer (thus a larger data set to draw conclusions from), the number of recoverable samples at the lab, and also recall that not all sites collected samples for nutrient analysis.

Percent samples <u>meeting</u> SAV habitat requirements during the April – October growing season = **<u>\# of samples within acceptable limits</u> / total # of samples collected**

Green	**75 – 100 % Met**
Yellow	**50 – 74 % Met**
Orange	**25 – 49 % Met**
Red	**0 – 24 % Met**

	Site #	SAV Habitat Requirements:	Light Attenuation Coefficient **<1.5 m^{-1}**	Chlorophyll a **<15 ug/L**	Dissolved Inorganic Phosphorus **<0.67uM**	Dissolved Inorganic Nitrogen **<10 uM**	Total Suspended Solids **<15 mg/L**
Assawoman Bay	1	Fenwick Ditch	12 % (6/50)	45 % (26/58)	96 % (48/50)	86 % (38/44)	ND = No Data
	19	Caribbean Street, Ocean City	17 % (1/6)	50 % (3/6)	ND	ND	ND
	32	79th Street, Ocean City	ND	50 % (5/10)	63 % (5/8)	80 % (4/5)	ND
St. Martin River	3	White Horse Park	0 % (0/33)	28 % (11/39)	83 % (29/35)	81 % (25/31)	ND
	7	Ocean Pines at White Cover Circle	20 % (2/10)	20 % (2/10)	100 % (2/2)	100 % (2/2)	ND
	11	Bishopville Boat Ramp	0 % (0/37)	9 % (6/65)	48 % (28/58)	67 % (39/58)	ND
	13	Holiday Harbor	0 % (0/32)	21 % (12/57)	33 % (4/12)	75 % (9/12)	ND
	22	Piney Island Shingle Landing	0 % (0/13)	23 % (3/13)	54 % (7/13)	82 % (9/11)	ND
	26	Look Out Point	0 % (0/5)	25 % (4/16)	ND	ND	ND
Isle of Wight Bay	2	36th Street, Ocean City	18 % (2/11)	85 % (33/39)	38 % (6/16)	94 % (15/16)	ND
	5	Butterfish Cove, Ocean City	43 % (20/47)	97 % (64/66)	47 % (8/17)	100 % (15/15)	ND
	6	Herring Creek	8 % (3/39)	50 % (24/48)	85 % (39/46)	95 % (42/44)	ND
	9	Ocean Pines Wood Duck Canal (West)	9 % (4/46)	54 % (35/65)	61 % (37/61)	89 % (54/61)	ND
	9 B	Ocean Pines Wood Duck Canal (East)	0 % (0/7)	91 % (21/23)	87 % (20/23)	91 % (21/23)	ND
	16	Manklin Creek	0 % (0/24)	60 % (21/35)	91 % (32/35)	97 % (34/35)	ND
	30	Turville Creek	0 % (0/26)	28 % (11/39)	85 % (29/34)	73 % (24/33)	ND
Sinepuxent Bay	8	South Point	11 % (2/18)	71 % (20/28)	ND	ND	ND
	10	South Point Landing	5 % (1/22)	80 % (24/30)	60 % (9/15)	93 % (14/15)	ND
	17	Rum Point Pier	0 % (0/8)	59 % (10/17)	54 % (7/13)	100 % (10/10)	ND
	31	Snug Harbor	10 % (2/20)	95 % (38/40)	51 % (18/35)	90 % (28/31)	ND
Newport Bay	12	Mason Landing	2 % (1/52)	26 % (15/57)	80 % (39/49)	49 % (24/49)	ND
	15	Newport Golf Course	0 % (0/24)	44 % (20/45)	61 % (11/18)	82 % (14/17)	ND
	23	Trappe Creek	0 % (0/19)	76 % (45/59)	4 % (2/54)	2 % (1/50)	ND
	33	Ayres Creek	2 % (1/47)	17 % (9/52)	64 % (30/47)	75 % (36/48)	ND
Chincoteague Bay	18	Figg's Landing	3 % (1/32)	80 % (35/44)	59 % (22/37)	82 % (28/34)	ND
	20	Public Landing	5 % (1/21)	80 % (33/41)	74 % (29/39)	95 % (37/39)	ND
	24	Kelly Point	0 % (0/9)	0 % (0/9)	ND	ND	ND
	27	George Island Landing	0 % (0/5)	71 % (5/7)	71 % (5/7)	100 % (7/7)	ND

Goal #3: Determine the number of stations meeting SAV habitat requirements



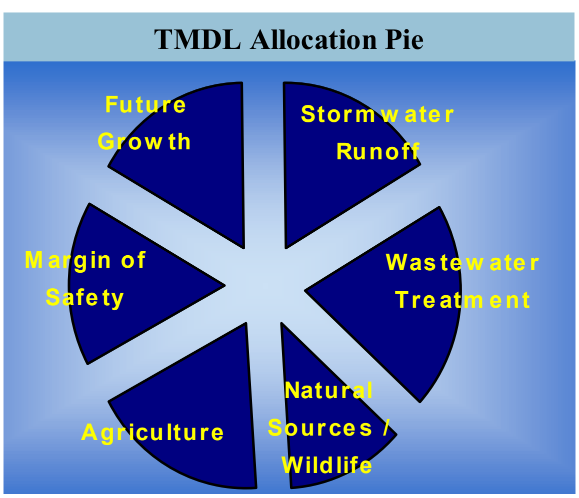
The federal **Clean Water Act** (1972) mandates that each state must protect and restore its waterbodies. The general framework of this Act includes four key requirements: develop water quality standards, determine the use of the water body, submit a list of all waters failing to meet minimum standards, and implement a program for restoration.

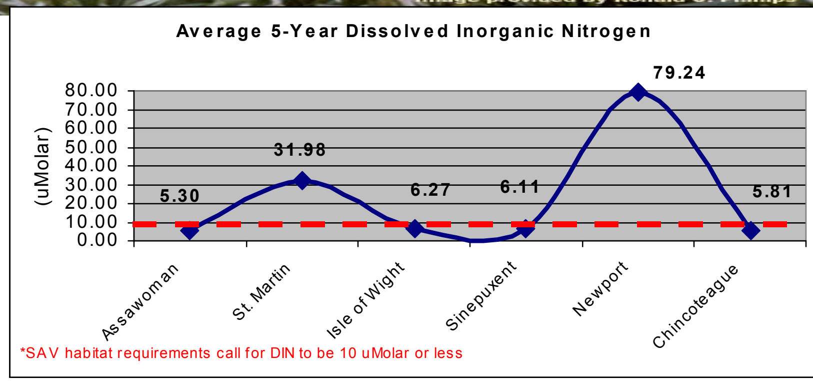
In 1996, all of the Coastal Bays were placed on the State of Maryland's 303(d) ***Impaired Surface Water List***, due to low dissolved oxygen conditions and excessive nutrients and fecal coliform bacteria.

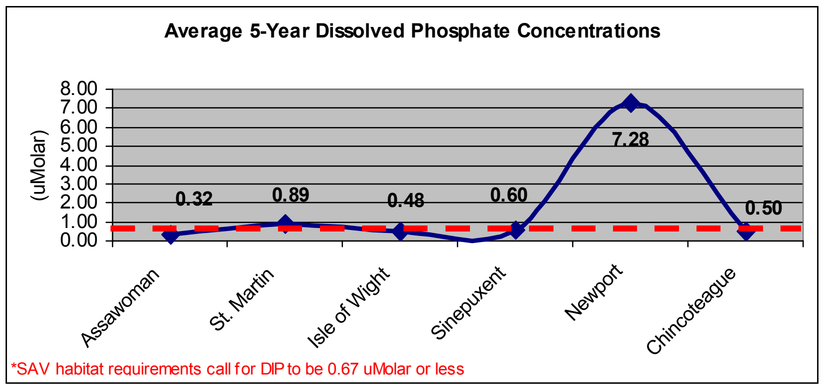
To restore the bays to healthy conditions, the State of Maryland is implementing a series of Total Maximum Daily Load (**TMDL**) assessments. A TMDL is basically a pollution budget which specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. In essence it is a measure to protect human health and aquatic life by limiting the amount of pollutants entering waters from such sources as industrial plants, sewage treatment facilities, storm drains, and runoff from urban and rural areas.

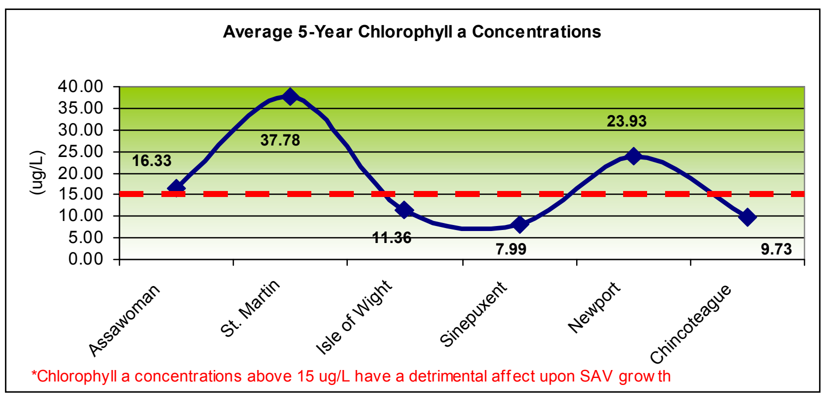
To date TMDL's have been established in portions of the Northern Bays for nitrogen and phosphorus. Generally speaking, the goal here is to reduce loads of phosphorus by 20% and nitrogen by 30% to the Saint Martin River and to reduce Herring and Turville Creeks nutrient load by 18% phosphorus and 30% nitrogen.

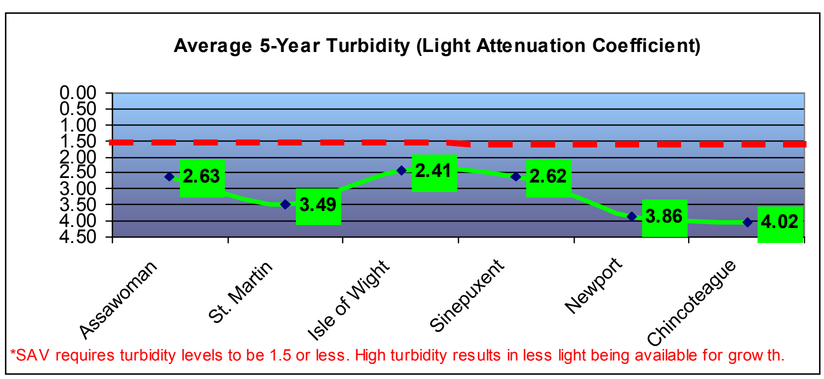
Currently a draft TMDL has been prepared for a 45% reduction in phosphorus to Newport Bay and summertime oxygen demand for Kitts Branch.











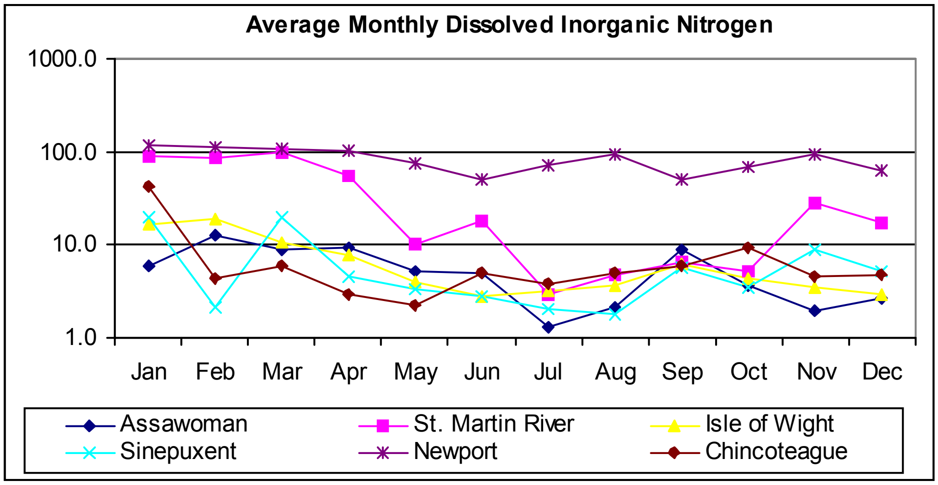
A Typical Year
(adapted from www.dnr.state.md.us)

Winter (Dec., Jan., Feb.)
Fresh water flow over the land and into the streams and tributaries is low during the winter months. Water temperatures are at the lowest for the year, are well mixed, and have slightly higher salinities, and increased dissolved oxygen levels.

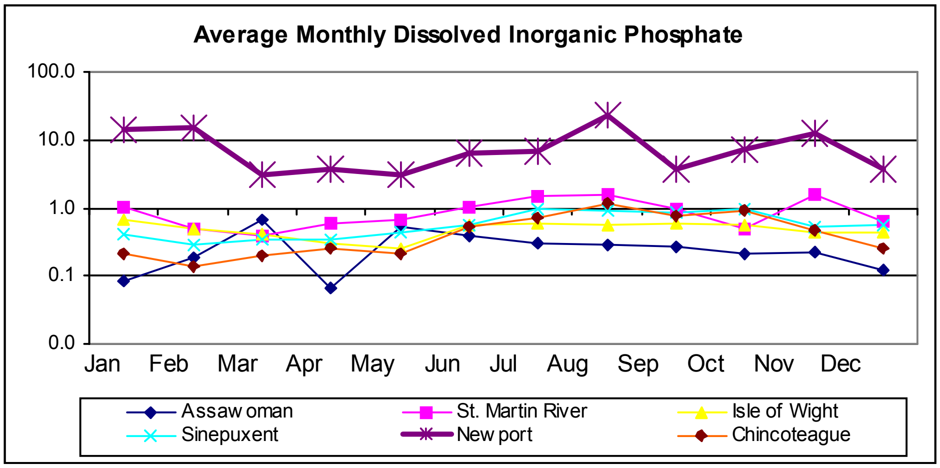
Spring (March, April, May)
Longer days with increased sunlight and warmer temperatures begin to warm the water. Snow melt and spring rains result in increased fresh water flow to streams and tributaries. The fresh water increases mixing and oxygenation while lowering salinities. The runoff carries with it the vital nutrients necessary to fuel algae growth which forms the base of the food web. Excessive nutrients and sediments cloud the water, disrupt the natural balance, and perpetuate eutrophication.

Summer (June, July, August)
Air and water temperatures increase, while fresh water flow decreases. Also, warmer temperatures result in more evaporation of surface waters. Salinities reach their maximum at this time. Bottom waters are cooler and heavier with salt which diminishes mixing. The algae that bloomed during the spring die and sink to the bottom. As the algae decompose they release nutrients and use up the oxygen in the bottom waters. Other species of algae take advantage of the free nutrients and result in another bloom.

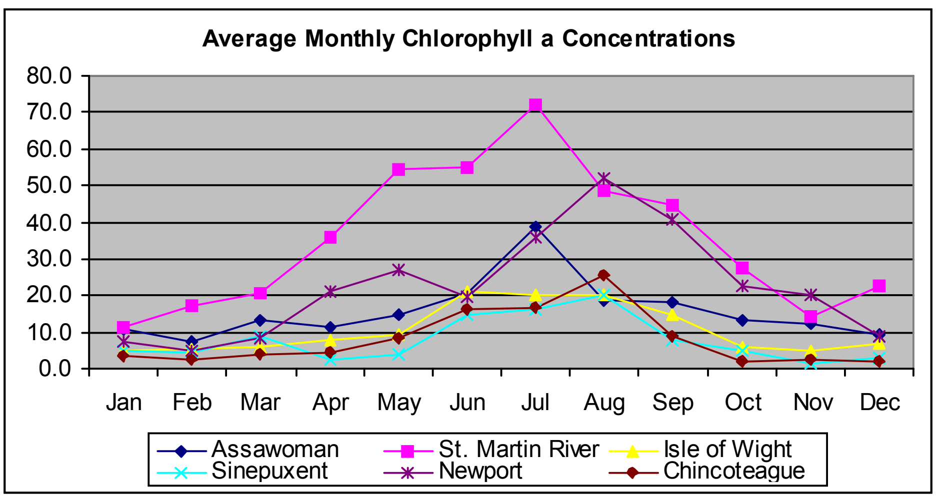
Fall (Sept., Oct., Nov.)
Air and water temperatures begin to cool. Low precipitation and fresh water inflow increases salinities. As the water temperature drops the density difference between the bottom and surface water decreases, allowing the two layers to mix again. This helps to replenish bottom water dissolved oxygen levels. Decreased fresh water inflow also results in less sediments and nutrients being delivered and thus higher water clarity.



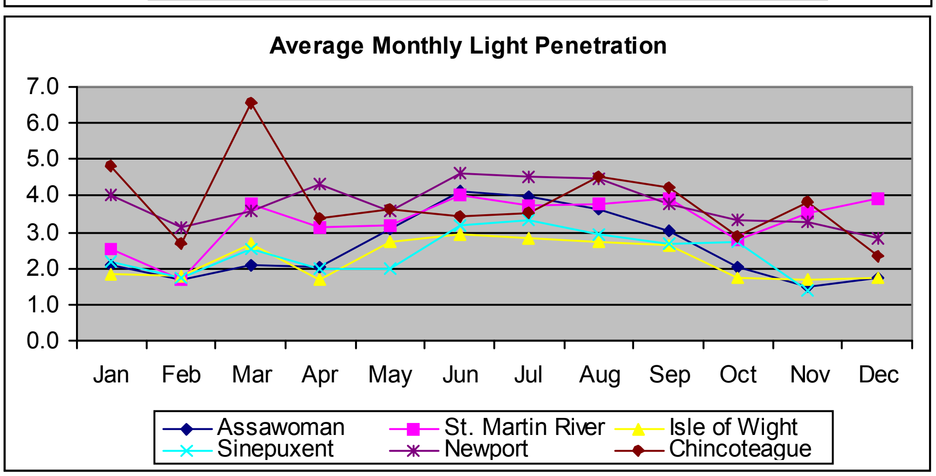
Average Monthly Dissolved Inorganic Nitrogen



Average Monthly Dissolved Inorganic Phosphate



Average Monthly Chlorophyll a Concentrations



Average Monthly Light Penetration