POTOMAC RIVER WATER QUALITY IN THE WASHINGTON REGION

January 2014 - 1st Edition

Progress, But More to Be Done

The assessment of water quality in the Potomac River shows that the Washington region's huge investments in improving wastewater treatment have yielded significant improvements. Among the success stories: the amount of nitrogen and phosphorus discharged by wastewater plants in the Washington metropolitan region has declined dramatically since the 1980s and is on track for further reductions. As a result, the potential for harmful algal blooms in the upper Potomac estuary has declined significantly. And the populations of at least some of the plants and animals that live in this portion of the river, such as submerged aquatic vegetation and American shad, have rebounded.

But these improvements do not mean that either the river itself has fully recovered from the poor conditions of previous decades or that further efforts are unnecessary. In this, the river's situation mirrors that of the larger Chesapeake Bay watershed, of which it is an integral part.

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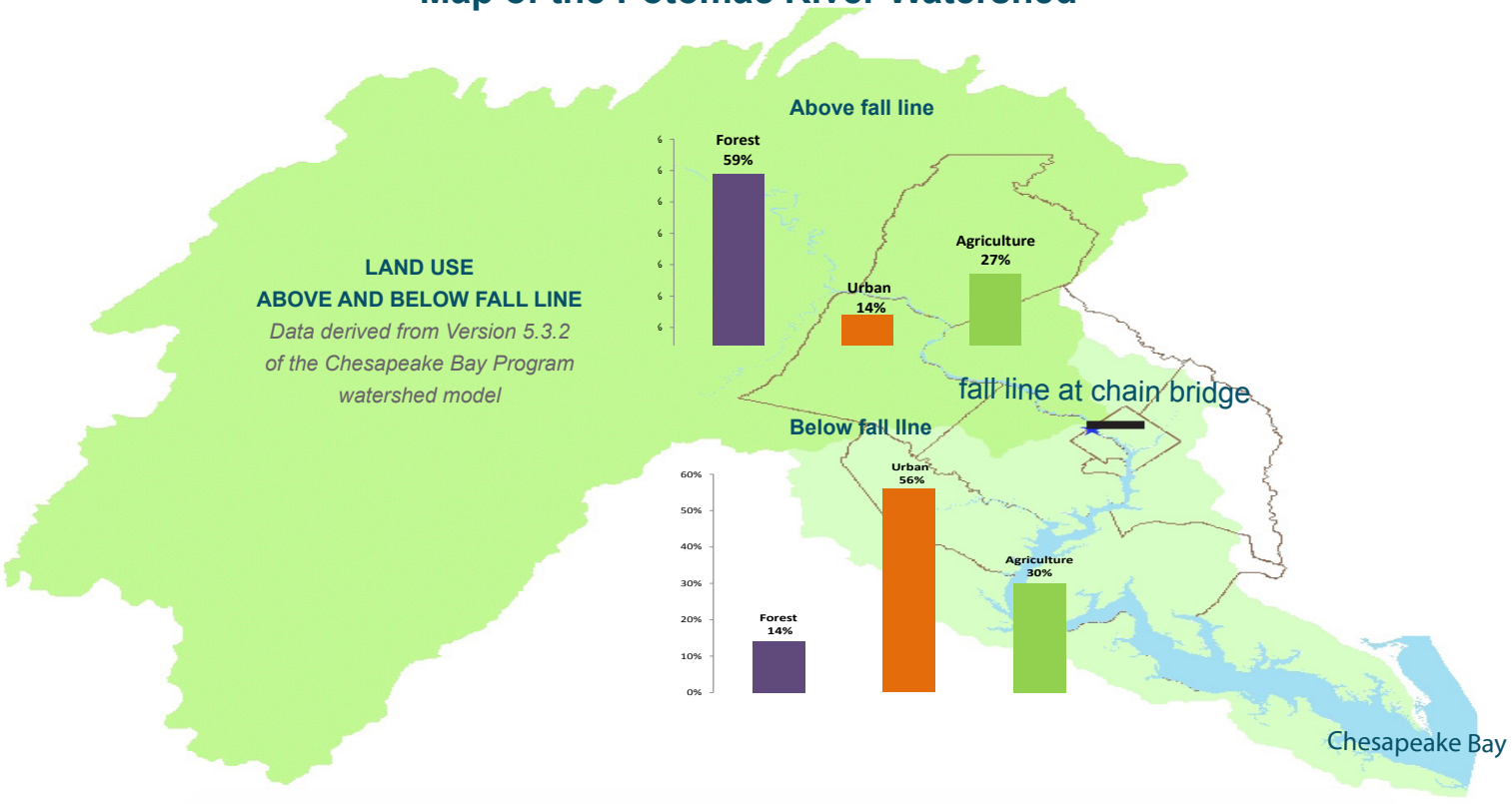
Fact Sheet Focus

This fact sheet presents data collected by COG and other entities to provide a broad overview of water quality conditions in the Potomac River, particularly the portion that flows through the Washington region. It focuses on the major pollutants – nitrogen, phosphorus and sediment -- that are targeted by the Chesapeake Bay Total Maximum Daily Load (TMDL). Subsequent fact sheets will explore the water quality data in more detail and also address other water quality issues in the river.

Map of the Potomac River Watershed



POTOMAC RIVER WATERSHED AT A GLANCE

Length:	383 miles from origins in West Virginia to confluence with the Chesapeake Bay
Area:	At 14,670 miles, the watershed comprises about 23 percent of the overall Bay watershed
Nature:	Free-flowing to the fall line at Chain Bridge; a tidally-influenced estuary for the rest of its length
Population:	About 6 million, 80 percent of whom live in COG region
Land use:	Primarily forested in the portion that drains above Chain Bridge; primarily urban in the portion that drains below Chain Bridge.

Determining how much pollution arises from the watershed's different land uses is key to understanding what management actions are necessary to further improve water quality.

Regional Wastewater Treatment - An Unparalleled Success Story

Starting in the early 1960s and continuing through today, the area's wastewater treatment plants have made many upgrades to increase the efficiency with which they remove nutrients and other sources of pollution from their effluent.

Originally, ***phosphorus*** was the major nutrient concern because of its role in stimulating harmful levels of algal bloom in the freshwater portion of the Potomac estuary. Together with a ban on phosphates in detergents, phosphorus controls at area treatment plants have reduced the amount discharged by about 96 percent. Those controls still achieve limit-of-technology levels today.

Beginning in the 1990s, the plants began to focus on reducing discharges of ***nitrogen.*** The first round of such reduction efforts, known as biological nutrient removal, reduced wastewater loadings by about 44 percent from previous levels. More recently, the plants have begun to install another round of nitrogen removal technology, which will result in significant further reductions and achieve limit-of-technology standards for nitrogen.

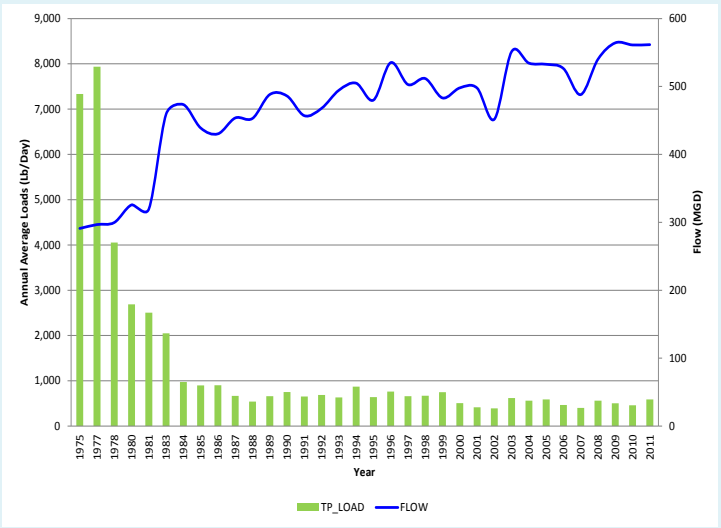
Impact on Bay Restoration

Reductions in wastewater nutrient loadings represent the greatest achievement in the 30-year history of the Chesapeake Bay restoration effort. To date, no other source of pollution has achieved anything close to the levels of nutrient reduction accomplished by wastewater plants. The success has derived from a funding partnership among all levels of government. Originally, federal grants helped local governments pay for phosphorus controls; today, local funds, supplemented by state and federal funds, are paying for nitrogen controls.

Although overall water quality remains mixed, it is possible to document the impact of these reductions in wastewater pollutants on improving water quality in the river, particularly in the upper Potomac estuary into which almost all of the Washington region's plants discharge their effluent. Monitoring efforts here have shown improvements in dissolved oxygen levels, a reduced incidence and severity of harmful algal blooms, and rebounding populations of several critical living resources, including submerged aquatic vegetation and American shad. (See "Success Stories" on pages 4-5.)

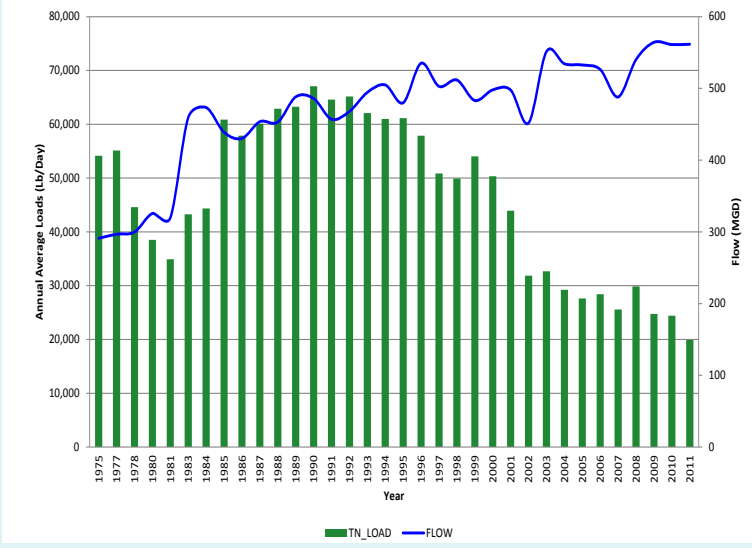
Amounts of Nutrients Discharged by Wastewater Plants in the COG region

Total Phosphorus



The reduction in nutrient discharges from wastewater treatment plants is all the more impressive because it has been achieved despite increases in wastewater flow (blue lines in the accompanying charts) to the plants as a result of population growth in the region. The installation of advanced nutrient reduction technologies, coupled with having added more flow capacity at the region's wastewater plants (based on growth predictions) will allow the region to accommodate future growth without exceeding the Bay TMDL nutrient caps.

Total Nitrogen



Inputs to the Potomac River Estuary

In broad terms, water quality in the estuary is determined by three major inputs:

- Discharge from wastewater plants directly to the estuary see page 2
- The quality of the water flowing across the fall line at Chain Bridge see graphs on this page
- The quality of the water that drains to the river below Chain Bridge Because much of the land draining to the river below Chain Bridge is urbanized, the quality of stormwater runoff is a critical factor. Monitoring efforts designed to evaluate the effectiveness of the stormwater best management practices that are now being used throughout the region are still in their infancy. Future installments of this fact sheet will address what that monitoring is telling us about the success of urban stormwater controls.

Monitoring Pollutant Loads at Chain Bridge

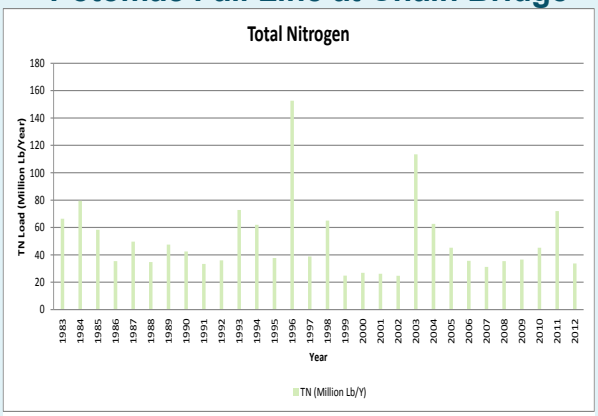
COG has contracted with the Occoquan Watershed Monitoring Laboratory (OWML) of Virginia Tech to monitor water quality at the Potomac River fall line at Chain Bridge since 1983. Fall line monitoring provides a convenient point from which to assess the impact of land use changes and management actions on the portion of the watershed draining upstream of Chain Bridge.

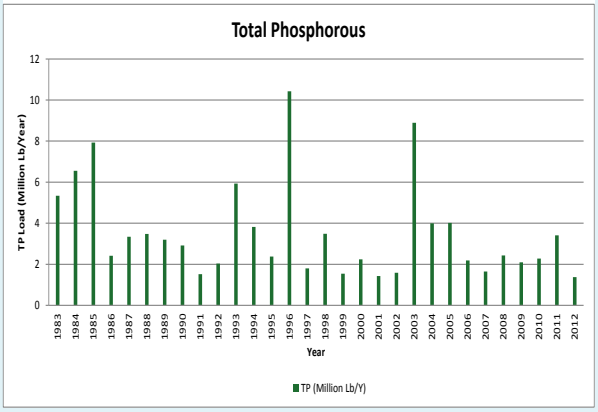
OWML measures a number of parameters at Chain Bridge, but this fact sheet notes the results for only the three major pollutants regulated by the Bay TMDL: total nitrogen, total phosphorus and total sediment.

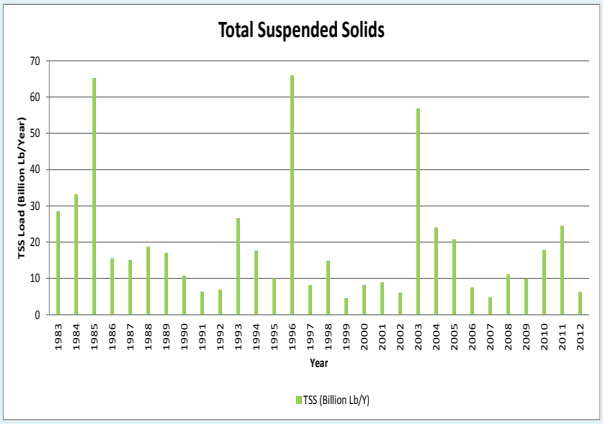
The region's water quality managers would like to know from this data how well pollution reduction efforts occurring upstream are working, that is, whether the amount of nutrients and sediment in the river is increasing or decreasing. However, this task is complicated by several factors, including the variability created by changing patterns of precipitation and the time lag between the installation of practices and when their impact shows up in surface waters.

The U.S. Geological Survey (USGS) has also calculated various trends for both the concentrations and the overall amounts or annual loads of these pollutants. The results from these two types of trends appear to point in different directions, raising questions about the effectiveness of pollution control efforts. COG has asked OWML to examine the USGS trend information in more detail and to compute its own trends in load for the free-flowing Potomac. These results and what they say about the effectiveness of upstream pollution control efforts will be presented in a future fact sheet.

Annual Amounts of Nitrogen, Phosphorus and Sediment at the Potomac Fall Line at Chain Bridge







Success Stories - Submerged Aquatic Vegetation

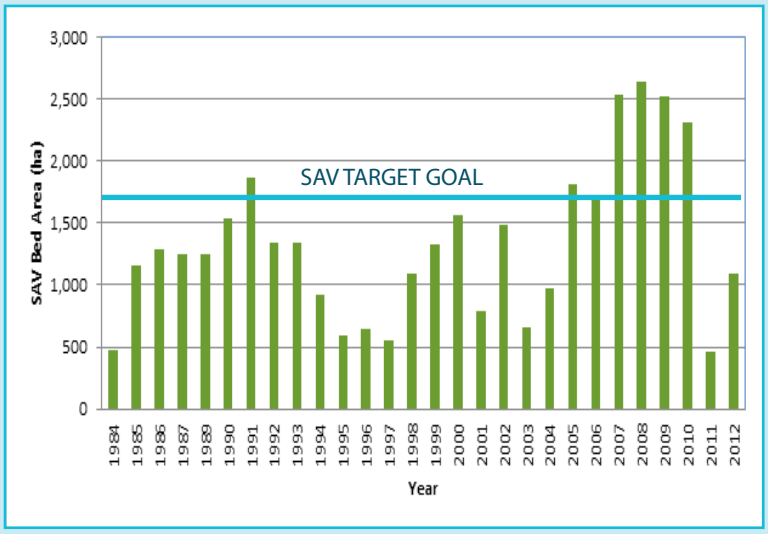
Although water quality in the river does not fully meet the water quality goals established under the Clean Water Act, there are success stories where concerted action has led to significant improvements in some conditions and where in recent years the populations of certain species of plants or animals have rebounded from previously low levels. Most of the Potomac's successes, which include submerged aquatic vegetation (SAV) and a number of fish species, derive largely from the reductions of nutrients from wastewater plants in the Washington region and show up most clearly in the predominately freshwater portion of the Potomac estuary, which stretches from the river's fall line at Chain Bridge in Washington, D.C., downriver to the mouth of Mattawoman Creek.

The SAV Success Story

The amount of SAV growing in the upper estuary fluctuates annually because of changes in weather conditions and other factors, but overall it has increased significantly in recent years as nutrient levels in the water have decreased. Fewer nutrients leads to less algal growth, which in turn increases the amount of light that reaches underwater grasses. In addition to greater overall SAV growth, the upper estuary also has seen the diversity of underwater grasses increase in recent years. Hydrilla, an invasive exotic species that was the first type of SAV to recolonize shallow water habitat in the estuary, now comprises less than 10 percent of total SAV abundance in most years.

The SAV success story is still somewhat limited, however. The Chesapeake Bay Program has established initial targets for the extent of SAV acreage in different parts of the Bay and the tidal waters of its tributaries, including the Potomac. SAV growth in the tidal freshwater portion of the Potomac estuary mostly met this target in recent years, but did not do so in 2011 and 2012. The underwater grass populations in the river remain sensitive to environmental disturbance. Weather conditions that favored greater algal growth in 2011 and 2012 also saw fewer acres of underwater grasses in the upper estuary. Moreover, SAV growth tends to drop off in the lower, saltier portions of the estuary, where the amount of SAV acreage has not yet met any of the initial Bay Program targets. And even where SAV growth has met the initial restoration targets, it remains far short of the ultimate goal: underwater grasses growing in all of the shallow water habitat of the Bay and the tidal waters of its tributaries.

Upper Potomac Estuary Submerged Aquatic Vegetation (SAV)



The extent of SAV growing each year in the freshwater portion of the upper Potomac estuary. The line indicates the Bay Program's initial habitat target for this key living resource. (Data compiled from annual surveys conducted by the Virginia Institute of Marine Sciences)

SAV near Aquia Creek in Virginia

PHOTO credit: Brian LeCouteur, COG Staff

Rebounding Fish Populations

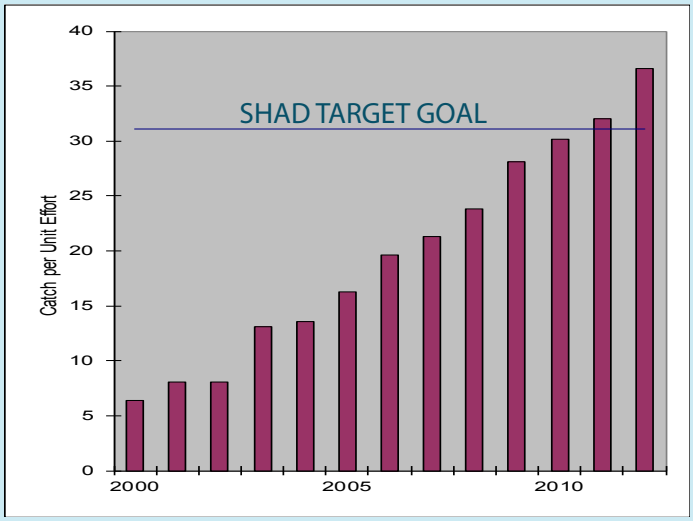
The increase in SAV acres has been good news for other living resources -- such as anadramous fish species that live mostly in saltwater but spawn in freshwater -- that inhabit the upper Potomac estuary. One example is American shad (*Alosa sapidissima*), which has staged a major comeback in the Potomac in recent years; populations are estimated to have increased more than five-fold between 2000 and 2012. The numbers exceed the Bay Program's target for this species, making the Potomac the only river basin in the Bay system to achieve this goal. Populations of other fish species, such as smallmouth bass and rockfish, also have increased.

Decreasing Incidents of Major Algal Blooms

Another success story, albeit somewhat limited, has been the extent to which the explosive growth in algal populations in the estuary -- known as algal blooms -- has been kept in check in recent years. In the 1960s and 1970s, a series of major summertime algal blooms blanketed large portions of the upper estuary, creating waters resembling pea soup that were unhealthy for boaters and swimmers and harmful to fish and other species. The prime culprit in these blooms was a blue-green algal species, *Microcystis aeruginosa,* responding to the high levels of nutrients, particularly phosphorus, in the waters.

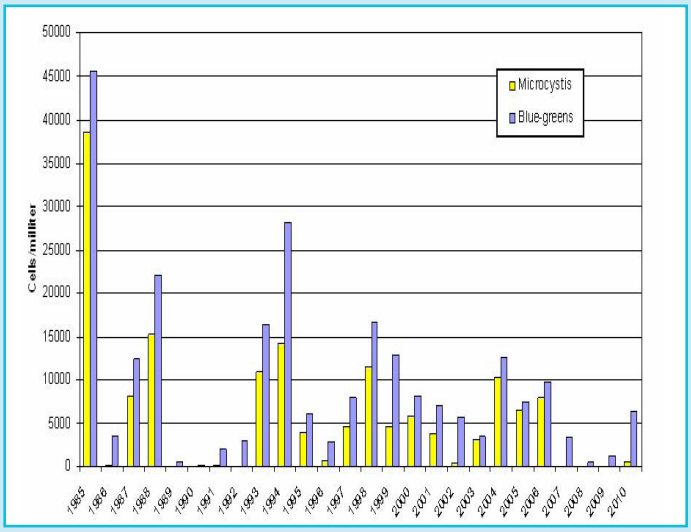
These blooms were the original catalyst for phosphrous reduction efforts by the region's wastewater treatment plants, which began in the late 1970s and predate the earliest Chesapeake Bay Program restoration efforts. Reductions in phosphorus discharge have dampened the re-occurrence of the super blooms of the 1960s and 1970s in the Potomac. However, nutrient concentrations in the upper Potomac estuary -- which also reflect inputs from the upper portions of the watershed flowing across Chain Bridge, as well as runoff from the largely urban landscape draining below Chain Bridge – are still high enough to support unhealthy levels of algal growth and smaller-scale, more localized blooms still occur.

American Shad in Potomac



Shad populations in the Potomac River estimated by the Virginia Institute of Marine Sciences, as reported in the Maryland DNR's 2013 "Potomac Assessment." The size of the population is compared to a target for the Potomac set by the Chesapeake Bay Program.

Blue Green Algal Blooms



Average summertime blue-green algal concentrations in the Potomac River estuary, as measured at Indian Head and reported in the Maryland DNR's 2013 "Potomac Assessment." The blue bar shows all blue-green algal species combined; the yellow bar, just *Microcystis*.

A Mixed Picture

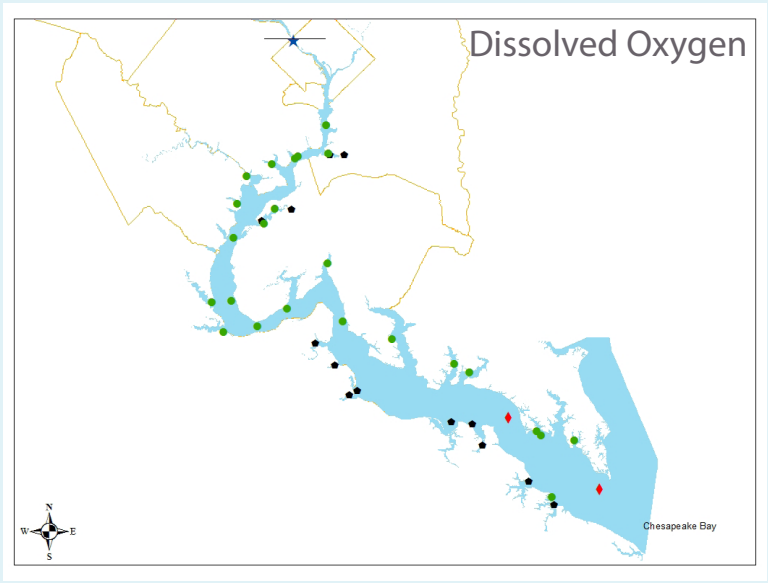
Water quality data gathered in the Potomac River estuary over the past 10-15 years paints a picture that defies a simple explanation. There are places in the river where current water quality conditions meet the habitat requirements for living resources, but the trends in these same conditions are worsening. There are other places where water quality conditions do not meet the habitat requirements, but the trends are improving.

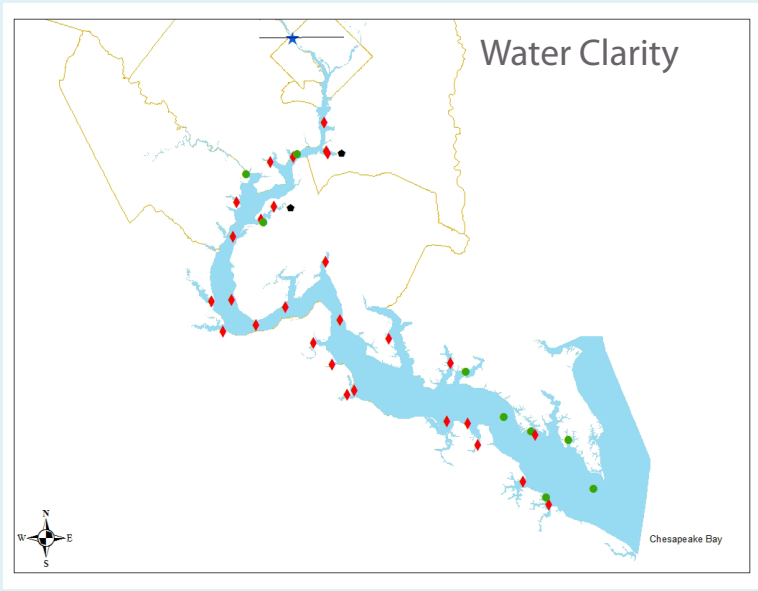
The maps of the estuary in this section show assessments of current water quality conditions done by the Maryland Department of Natural Resources (DNR). DNR used the most recent data collected either from long-term monitoring stations located in deeper waters along the main stem of the river (2010 – 2012) or from shallow waters in the river itself or its tributaries (2007 – 2008). The three parameters shown in the maps – algal density, water clarity and dissolved oxygen (DO) levels found in bottom waters in the summer – correspond to the three major water quality criteria used for the Bay TMDL and the meet/fail distinction indicates whether the waters would or would not meet the applicable water quality standard at that particular station for that particular criteria.

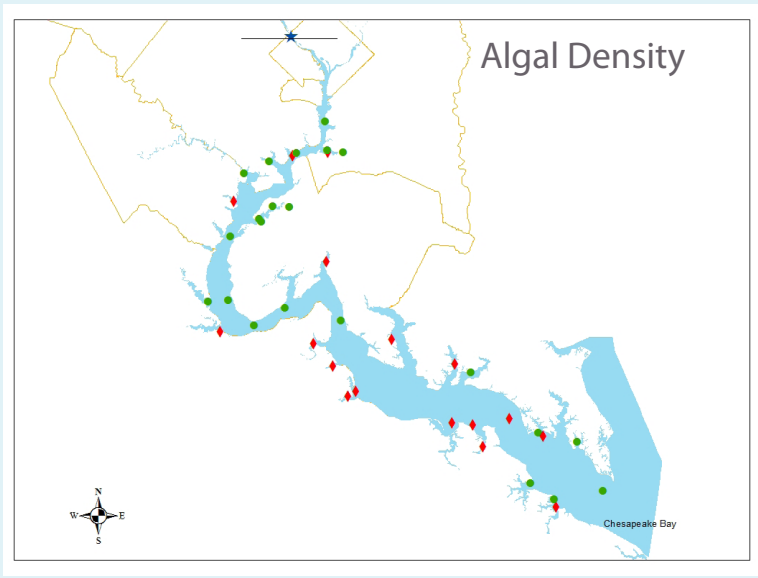
Assessment Challenges

Assessing water quality in the Potomac River estuary is a complex undertaking. Tidal effects and fluctuating salinity levels are important factors in how living resources respond to their environment and must be accounted for in water quality assessments.

Various state and local agencies monitor water quality in different portions of the estuary on a coordinated basis. Although much of the biological activity in the estuary occurs during the warmer months, when living resources are most active and environmental stresses are most acute, monitoring occurs over the entire year. Data in this section were compiled and analyzed by staff from Maryland DNR and issued in its 2013 report, “Potomac River Water and Habitat Quality Assessment.”







Legend

- FAIL
- MEET
- No Data

Assessing Trends

Maryland DNR also has assessed trends for these particular criteria as well as whether trends in the concentrations of total nitrogen (TN), total phosphorus (TP) and total suspended solids (TSS) are improving or degrading at the deeper water stations for the period from 1999 to 2012. (Data shown in adjacent table.)

On the basis of this data, it appears that water quality in the estuary mostly meets the dissolved oxygen (DO) criteria with the exception of waters around the confluence of the river with the Bay, where water from the Bay itself is mixing with water from the Potomac. However, several deeper water stations show degrading trends for DO and only one (Mouth of Piscataway) shows an improving trend.

For algal density, results are mixed, with about half the stations meeting the criteria and half not meeting. There are negative trends in the lower part of the estuary but positive ones farther upstream.

For water clarity, the results are the most disappointing, with few of either the deeper water or shallow water stations meeting the criteria. Here, the few trends that can be detected tend to be negative.

The Maryland DNR assessment does indicate that the trends for nutrient and sediment concentrations are almost all positive (i.e. the concentrations are decreasing). This would appear to reflect both the reductions in the amount of nutrients discharged by wastewater treatment plants (as noted on page 2) and, less certainly, reductions in nutrients and perhaps sediment from other sources. It is likely that improvements in habitat criteria lag somewhat behind improvements in nutrients and sediment. If that is the case, then these particular trends portend future, further improvements in living resources.

Water Quality Trends in Potomac Estuary 1999 – 2012

Station		Habitat Criteria			Major Pollutants		
		Algal Densities (Chlorophyll-*a* data)	Water Clarity (Secchi disc data)	Dissolved Oxygen Summer Bottom (concentration data)	Nitrogen (concentration data)	Phosphorus (concentration data)	Sediment (concentration data)
Middle Potomac	Upper Piscataway	-			↗	-	-
	Lower Piscataway	-	-		↗	↗	-
	Mouth of Piscataway	-	-	↗	↗	↗	-
	Mouth of Dogue Creek	-	-	-	↗	↗	-
Lower Potomac	Upper Mattawoman	-			↗	-	-
	Lower Mattawoman	↗	↗		↗	↗	↗
	Indian Head	↗	-	↘	↗	↗	-
	Possum Pt./Moss Pt.	-	-	-	↗	↗	-
	Smith Point	↘	↘	-	↗	-	↘
	Maryland Point	↘	↘	↘	↗	-	↘
	Morgantown	↘	-	-	↗	-	↘
	Ragged Point	-	-	-	-	-	↗
	Point Lookout	↘	↘	-	↗	-	↗

↗ = **improving** trend@ 99% significance; ↗ = **improving** trend @ 95% significance; ▢ = no data available

↘ = **degrading** trend @99% significance; ↘ = **degrading** trend @ 95% significance; - = no trend

Derived from MD DNR's "Potomac River Water and Habitat Quality Assessment"

A Job Not Finished

From a management perspective, the assessment of water quality in the Potomac indicates that the initial efforts to improve water quality have succeeded to a point, but that reductions in the amount of pollutants in wastewater discharges are not, in themselves, sufficient to achieve water quality standards under the Clean Water Act nor to have the abundance of living resources we seek.

Declines in the amount of nutrients and sediment entering the estuary from upriver appear to have stalled and may in some cases be headed in the wrong direction. While some water quality indicators have improved in the upper part of the estuary, many of them, particularly water clarity and the amount of algal growth, still do not meet habitat requirements throughout the estuary as a whole. The level of dissolved oxygen, while currently sufficient to support aquatic life, appears to be in decline at some spots in the estuary.

The success of efforts to reduce nutrients and sediment that wash off urban or agricultural land with stormflow – or nutrients that enter the groundwater and gradually re-emerge into surface waters – is still uncertain. The Chain Bridge fall line data are difficult to interpret and may be complicated by significant lag times between when pollutants originally leave the land surface and when they show up in surface waters. What is certain is that additional effort to reduce these nonpoint sources will be needed to achieve the river's long-term water quality goals.

Future Fact Sheets

COG staff will explore aspects of water quality in the Potomac in more detail in additional and future updates to this fact sheet. This will include a more in-depth examination of water quality dynamics in the estuary, more detailed data on SAV and fall-line monitoring results, the status of emerging contaminants, the impact of climate change, and the connection between water quality in local streams and in the Potomac.

For More Information

More in-depth information is available from the following sources:

The Maryland Department of Natural Resources' 2013 report, "Potomac River Water and Habitat Quality Assessment." http://mddnr.chesapeakebay.net/eyesonthebay/tribsums.cfm

The Chesapeake Bay Program's Potomac water quality monitoring data: http://www.chesapeakebay.net/about/programs/monitoring

The U.S. Geological Survey's assessment of SAV trends in the Potomac: http://water.usgs.gov/nrp/highlights/potomac.html

Region Forward Greater Washington 2050

As part of COG's Region Forward sustainability goal, a target has been set to achieve 100% of the Chesapeake Bay Program's Water Quality Implementation Goals by 2025. Visit www.mwcog.org for more information.

COG's Water Resources

The Department of Environmental Programs (DEP), Water Resources Program assist COG's local government members, and affiliated wastewater treatment and drinking water utilities, with protecting, restoring, and conserving the region's water resources as well as addressing the policy and technical implications of various state and federal initiatives that have water quality impacts. Visit our Web Site for additional information about our program and regional activities.

Potomac River at Chain Bridge