POTOMAC RIVER WATER QUALITY IN THE WASHINGTON REGION - DRAFT

January 2019

POTOMAC RIVER WATER QUALITY IN THE WASHINGTON REGION

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ABOUT COG

The Metropolitan Washington Council of Governments (COG) is an independent, nonprofit association that brings area leaders together to address major regional issues in the District of Columbia, suburban Maryland, and Northern Virginia. COG's membership is comprised of 300 elected officials from 24 local governments, the Maryland and Virginia state legislatures, and U.S. Congress.

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OVERVIEW

Progress, But More to be Done

The Metropolitan Washington Council of Government's (COG) assessment of water quality in the Potomac River from 1985 to 2016 shows that the billions of dollars invested by the Washington region's local governments and utilities on advanced wastewater treatment have yielded significant reductions in pollution resulting in water quality 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 number and extent of harmful algal blooms in the upper Potomac estuary has declined significantly. Populations of plants and animals that live in this portion of the river, such as submerged aquatic vegetation and American shad, have also 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.

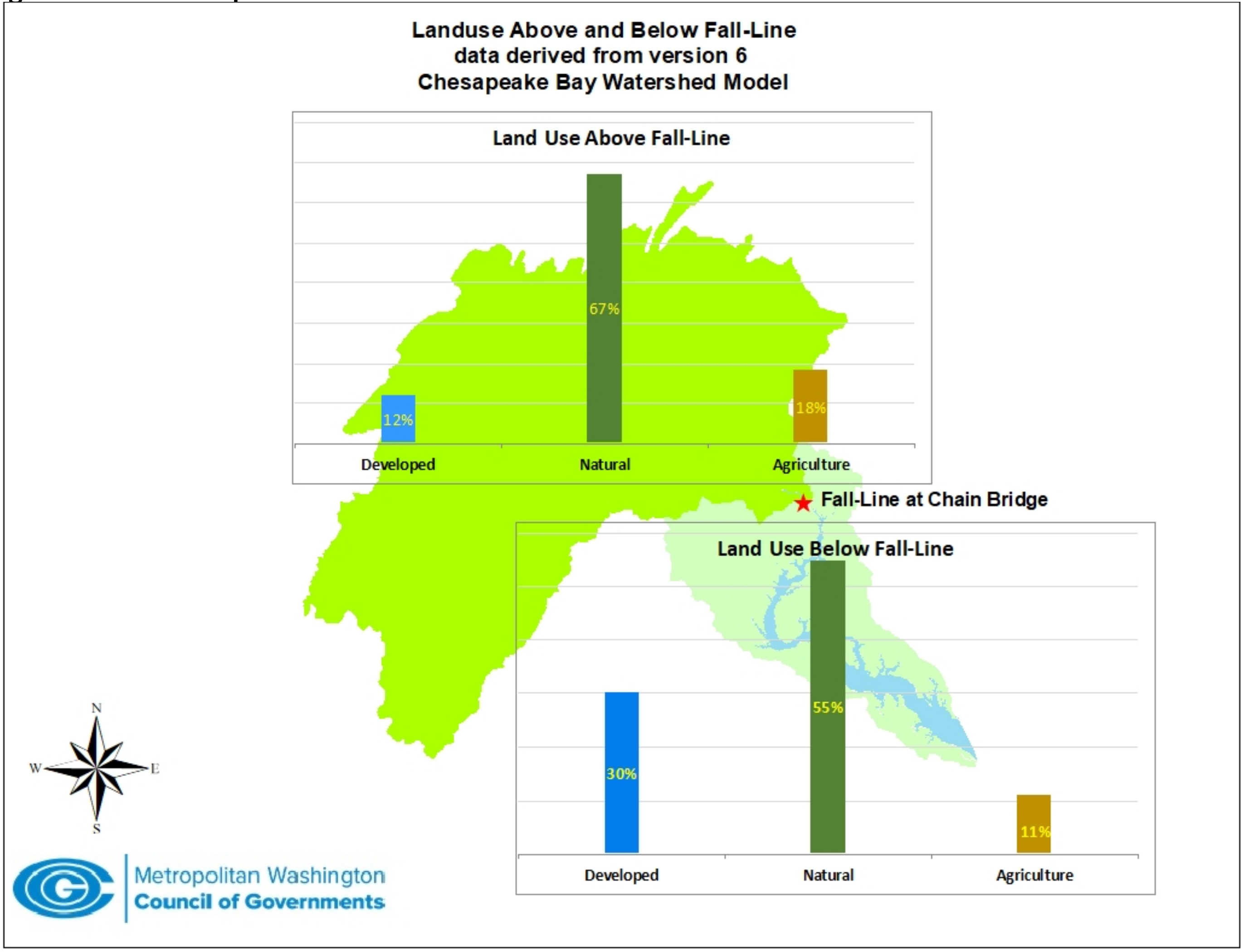
Report Focus

This report presents data collected by various entities and compiled by COG 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 both the key water quality parameters – dissolved oxygen, water clarity and chlorophyll-a -- and the major pollutants -- nitrogen, phosphorus and sediment -- that are targeted by the Chesapeake Bay Total Maximum Daily Load (TMDL). Almost all of the data in the report is trend data; that is, it shows the direction of change over time, either positive (improving) or negative (degrading) and it is designed to answer the question: are we making progress in our efforts to improve water quality.

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

- **WWTPs** - discharge from wastewater plants directly to the estuary.
- **Across the Fall Line** - the quality of the water flowing across the main Potomac River fall line at Chain Bridge. The watershed upstream of Chain Bridge has a higher percentage of agriculture than elsewhere in the watershed.
- **Below the Fall Line** - the quality of the water that drains to the river below Chain Bridge. A much larger percentage of the land draining to the river below Chain Bridge compared to above Chain Bridge is urbanized; here the quality of stormwater runoff is a critical factor.

Figure 1: Land Use Map of the Potomac Watershed



Source: Chesapeake Bay Watershed Model Phase 6

POTOMAC RIVER WATERSHED AT A GLANCE

LENGTH:	383 miles from origins in West Virginia to confluence with the Chesapeake Bay
AREA:	At 14,670 square 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 the COG region
LAND USE:	Primarily forested in the portion that drains above Chain Bridge, somewhat 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.

Section 1. Inputs to the Estuary - Regional Wastewater Treatment

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

Phosphorus was the first major nutrient of concern because it plays an important role in stimulating harmful algal blooms in the freshwater portion of the Potomac estuary. Area treatment plants began implementing phosphorus controls in the 1970s to meet what were then – and remain today – some of the most stringent discharge requirements in the country. These efforts, which pre-dated the first Chesapeake Bay Agreement in 1983, reduced the amount discharged by about 96 percent and these controls remain at limit-of-technology levels today.

The reduction in nutrient discharges from wastewater treatment plants is all the more impressive because it has been achieved despite increases in wastewater flow (depicted by blue lines in the accompanying charts) to the plants as a result of population and job growth in the region. The improvement in nutrient reduction efforts has given the region a cushion to accommodate future growth without exceeding the Bay TMDL's nutrient caps.

Beginning in the late 1980s, wastewater plants began to focus on reducing discharges of nitrogen. The first round of such reduction efforts, known as biological nutrient removal, reduced wastewater loadings 40 - 50 percent from previous levels. Since 2010, wastewater plants have been installing state of the art nitrogen removal technology that is producing significant further reductions.

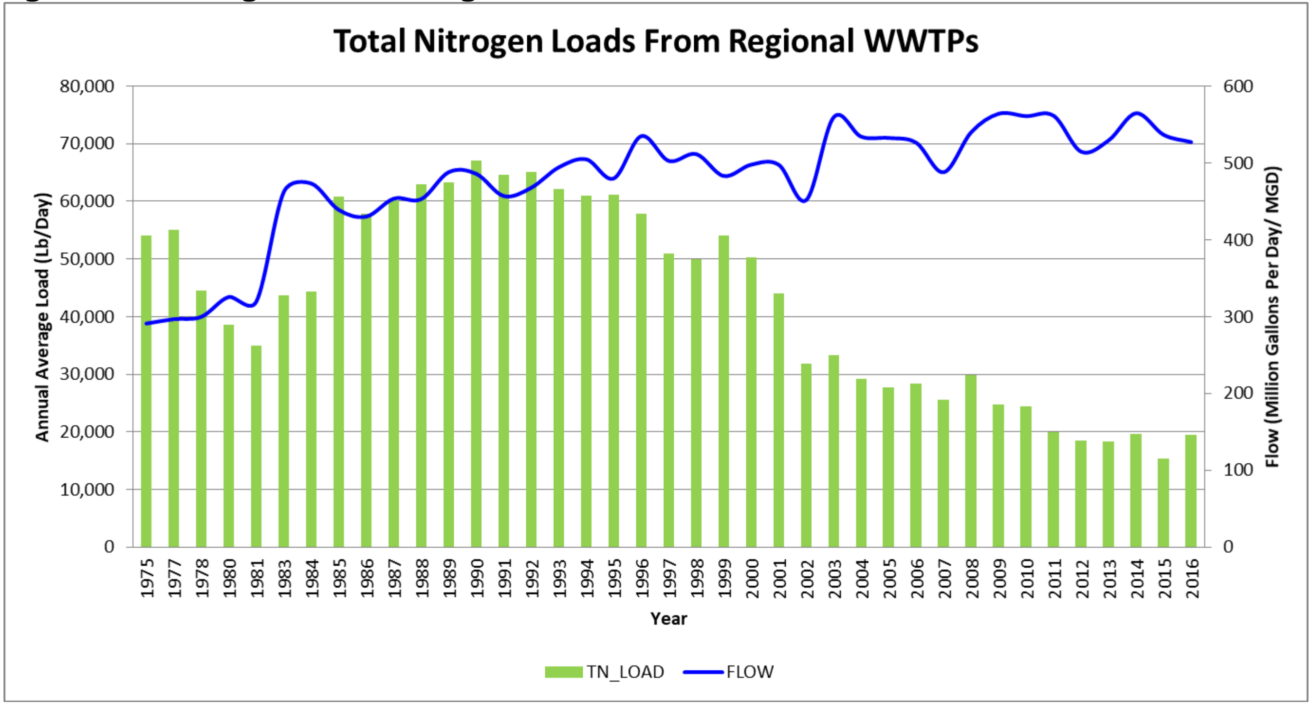
Reductions in wastewater nutrient loadings account for the most significant progress, by far, in the 35-year history of the Chesapeake Bay restoration effort. According to Chesapeake Bay Program (CBP) calculations, the wastewater sector accounts for about 75 percent of total reductions of nitrogen and phosphorus since 1985.

The success in reducing pollution is derived from a funding partnership among wastewater utilities and all levels of government. Federal grants helped utilities and local governments pay for capital improvements needed in the original round of phosphorus controls; local, state and federal funds are also helping to pay now for capital improvements to achieve further nitrogen controls and ongoing costs to operate and maintain wastewater infrastructure are all paid by utilities and local governments.

Although indicators of water quality remain mixed, it is possible to document the impact of reductions in wastewater pollutants on improving water quality in the Potomac River, particularly in the upper estuary into which almost all of the metropolitan Washington region's plants discharge their effluent. Water quality 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.

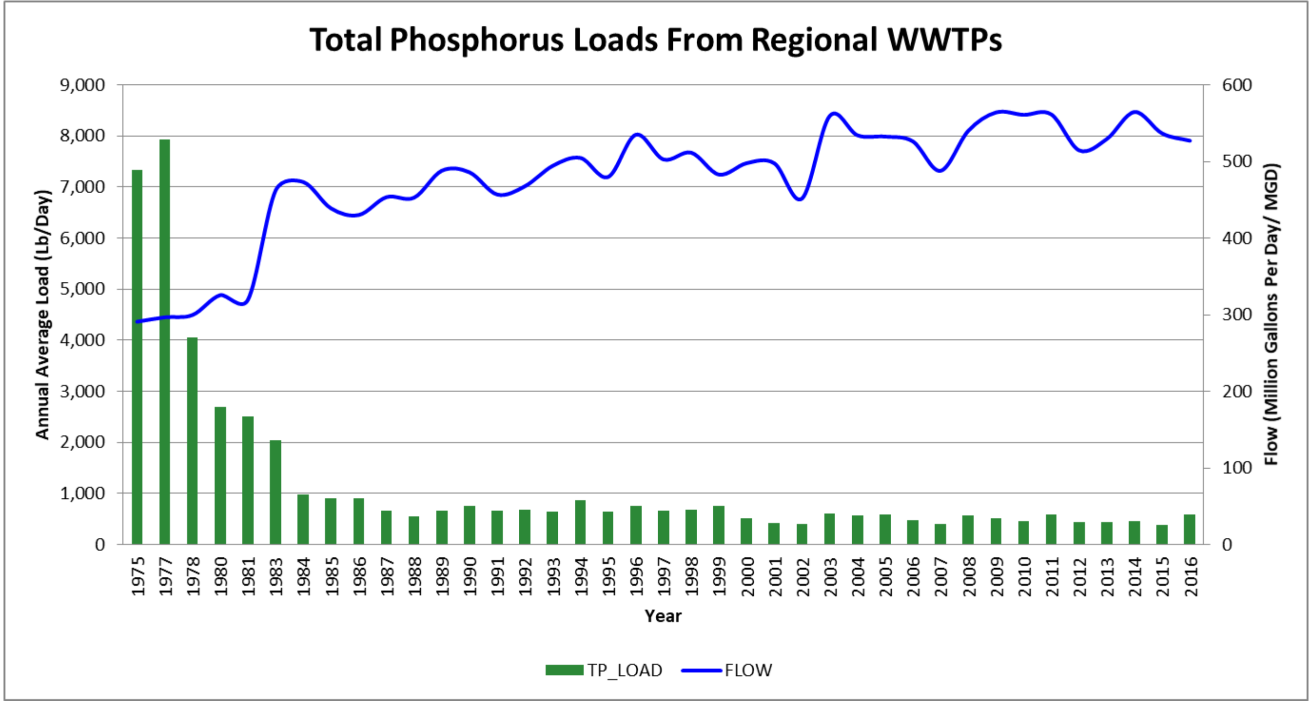
Source: Blue Plains WWTP

Figure 2: Total Nitrogen Loads from Regional WWTPs



Source: COG

Figure 3: Total Phosphorus Loads from Regional WWTPs



Source: COG

Section 2. Inputs to the Estuary - Monitoring Pollutant Loads at Chain Bridge

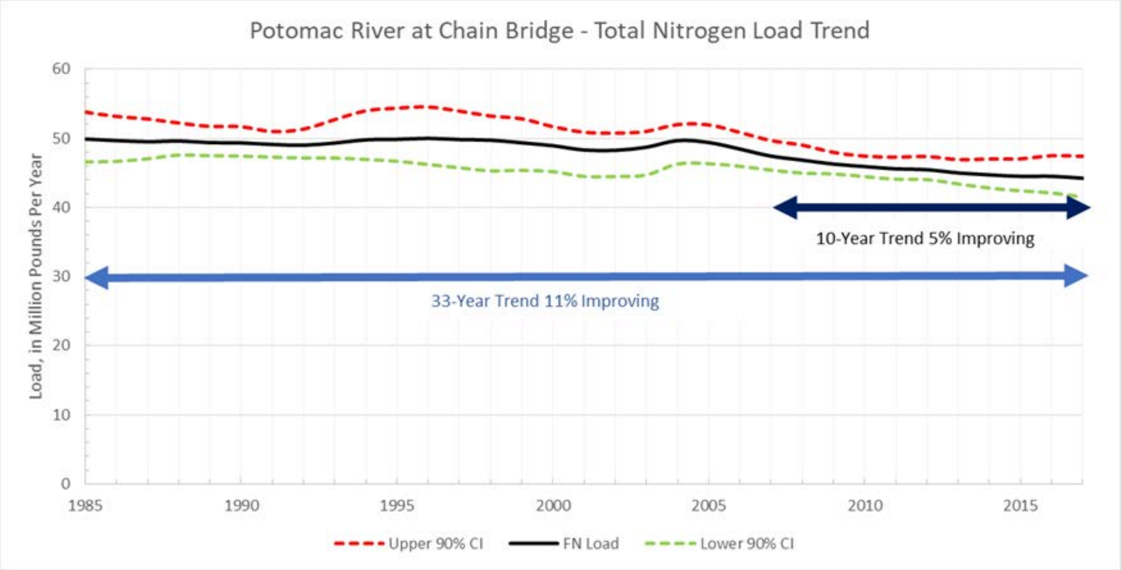
The U.S. Geological Survey has maintained a Potomac River fall line monitoring station at Chain Bridge since 1985, one of a series of river input monitoring stations that analyze water quality flowing into the Bay from its major tributaries. Data in this section is drawn from the USGS Chain Bridge station and addresses the three major pollutants regulated by the Bay TMDL: total nitrogen, total phosphorus and total sediment.

We would like to know from this data if the Bay Program's pollution reduction efforts are working, that is, whether the trend for these parameters is increasing or decreasing. (It's important to note that almost all of the wastewater effluent from plants in the COG region is discharged into the river below Chain Bridge; water quality at Chain Bridge reflects some impacts from upstream wastewater plants, but it is more affected by nonpoint sources, particularly agriculture.)

However, this task is complicated by several factors. Foremost of these is the variability created by changing weather patterns. On a year-to-year basis, the total amount, or load, of these pollutants will fluctuate with the flows resulting from differing patterns of precipitation. To discern water quality trends impacted only by human activities, the USGS has developed a method for estimating flow-normalized loads and trends in load. This method (known by its acronym, as WRTDS) produced the data shown in this section[i]; it also provides some of the data used to establish loads for the Bay TMDL and to calibrate the CBP watershed model.

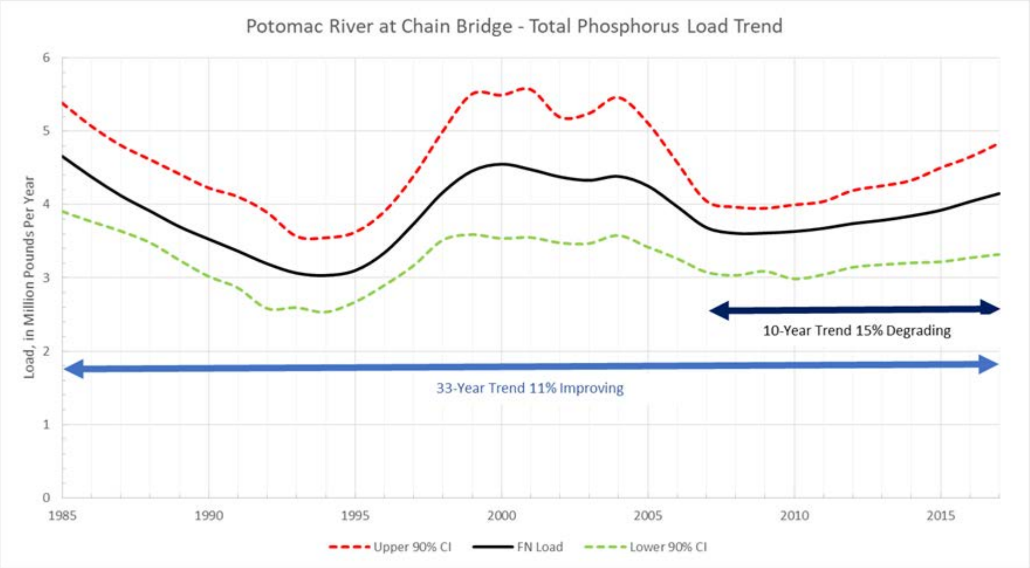
These charts show the trends in flow-normalized loads of the major Bay pollutants measured at the Potomac fall line at Chain Bridge by USGS. Total nitrogen and total phosphorus are shown in millions of pounds/year; total sediment; in billions of pounds/year.

Figure 4: Potomac River at Chain Bridge – Total Nitrogen Load Trend



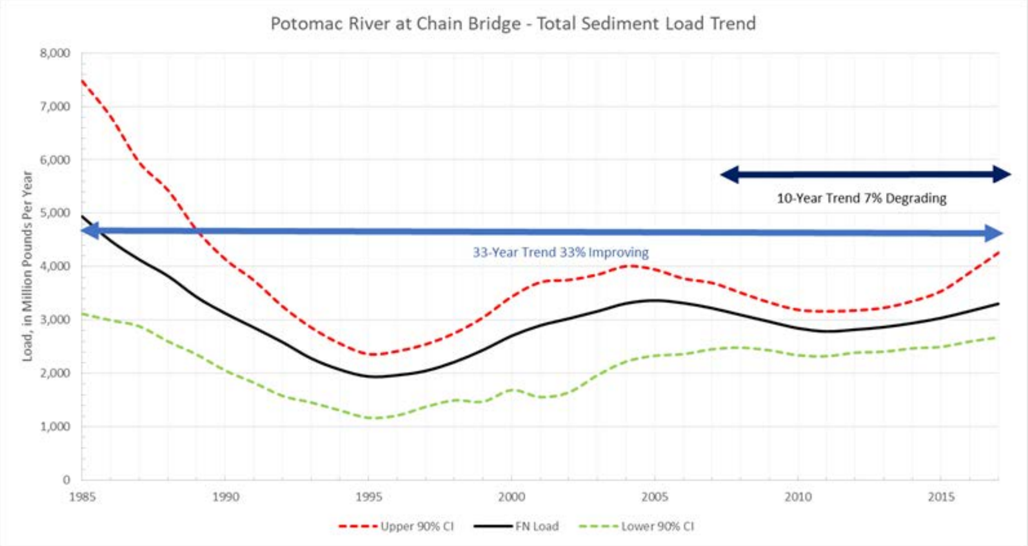
Source: USGS

Figure 5: Potomac River at Chain Bridge – Total Phosphorus Load Trend



Source: USGS

Figure 6: Potomac River at Chain Bridge – Total Sediment Load Trend



Source: USGS

The USGS data shows that loads of the three major pollutants at the Potomac fall line are lower now than in 1985, most likely due to nutrient reduction efforts in this portion of the watershed. However, the patterns differ between nitrogen (TN) on the one hand and both phosphorus (TP) and sediment (TS) on the other. Observed loads of TN have been flat to steadily declining over the 33-year span of the USGS monitoring data. Observed TP and TS loads over the same period have gone up and down and in both cases show increases (i.e. degrading trends) in the most recent 10 years. There is not a definitive explanation for the drivers of these observed changes in loads. Reductions in nutrients from wastewater plants and from agriculture probably account for most of the progress. In the case of the recent increases in flow-normalized TP and TS loads, it is thought that increases in animal agriculture and the resulting manure in certain portions of the watershed and increases in the amount of developed land above the Chain Bridge fall line have contributed to these degrading trends.

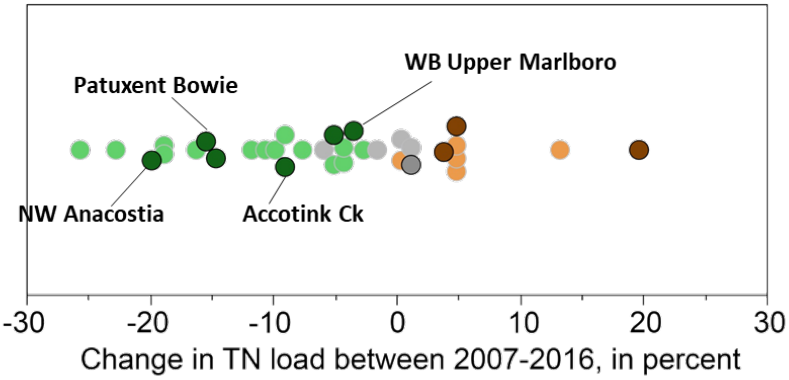
USGS uses statistical techniques to remove most of the variability in actual loads introduced by fluctuating hydrology. The resulting flow-normalized loads provide an illustration of how nutrient and sediment loads have altered because of man-made changes.

Section 3. Inputs to the Estuary - Nonpoint Source Loads from below the Fall Line

Efforts to reduce nutrient and sediment loads from urban landscapes are still in their infancy compared to wastewater nutrient reduction efforts. COG member jurisdictions with Municipal Separate Storm Sewer System (MS4) permits for their stormwater conveyance systems only began to focus on pollutant reductions from BMPs in permit cycles that began between 2005 and 2010. Moreover, controlling pollution across the urban landscape and ramping up the necessary program resources, both financial and otherwise, to accomplish this have been major challenges.

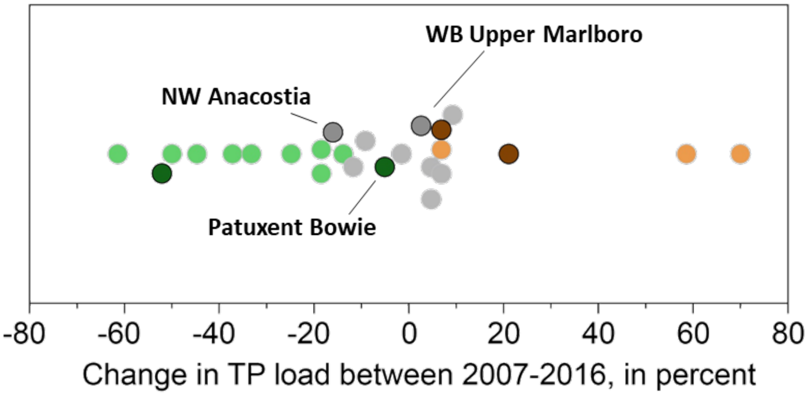
Nevertheless, some signs have emerged of progress in reducing nutrient loads from urban stormwater in portions of the COG region. The following charts show TN and TP load data from all of the USGS nontidal monitoring stations in the Potomac and Patuxent watersheds in the 10 years from 2007 - 2016. (*See Figure 9 for a map of where these stations are located.*) Improving load trends (shown as green circles) indicate pollution reduction progress; brown circles indicate degrading load trends. The stations at Northwest Anacostia, Patuxent Bowie, Accotink Creek, and Western Branch Upper Marlboro (all of which drain primarily urban areas, although not all of the watersheds are in the Potomac basin) all show improving trends for TN and Patuxent Bowie and Northwest Anacostia also show improving trends for TP. However, these trends are not definitive and there are other COG stations that drain urban watersheds that still show degrading trends.

Figure 7: USGS Nontidal Monitoring Station – Change in Total Load 2007-2016



Source: USGS

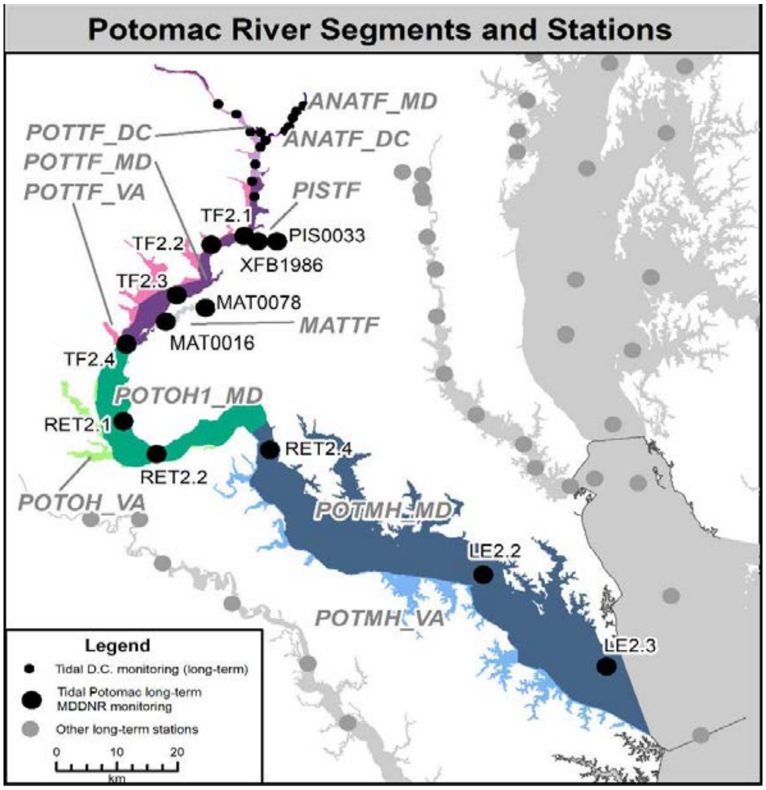
Figure 8: USGS Nontidal Monitoring Station – Change in Total Load 2007-2016



Source: USGS

Section 4. Estuarine Water Quality

Figure 9: Map of Water Quality Monitoring Stations in the Potomac Watershed



Source: Chesapeake Bay Program

Water quality data gathered in the Potomac River estuary and the Chesapeake Bay since 1985 provides a mixed picture of progress, with certain parameters showing signs of improvement while others have degraded. The data in the following charts is derived from the Chesapeake Bay Program's (CBP) tidal monitoring program, under which the Maryland Department of Natural Resources (MDDNR) and Virginia Department of Environmental Quality (VADEQ) in collaboration with the CBP collect water quality samples from the Bay and its tidal tributaries (Most of these charts are a subset of the larger CBP 2016 tidal trends release provided courtesy of R. Murphy, UMCES-CBP {CBP 2017[ii]}.) At most stations, samples are collected twice a month in the warmer months, when living resources are most active and environmental stresses are most acute, and monthly in the winter. The data is analyzed and presented in the same way across all the stations, allowing for uniform assessments of the degree to which the water is meeting water quality standards.

Water quality standards are regulatory provisions that describe the desired condition of a water body and the means by which that condition will be protected or achieved. For example, meeting the desired condition for aquatic resources in the deep channel habitat of the mainstem of the Chesapeake Bay requires dissolved oxygen levels of 1 milligram/liter or higher.

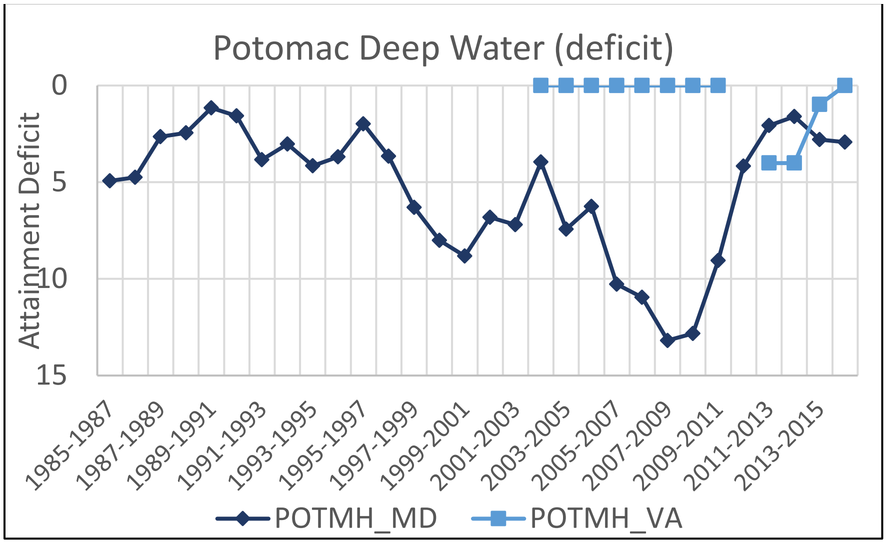
There are three official water quality parameters for assessing attainment of Chesapeake Bay water quality standards: dissolved oxygen, water clarity and chlorophyll-a (a measure of algal abundance). The Bay Program provided guidance to the states in selecting threshold values or criteria for each of these based on different habitat zones within the Bay. The different segments into which the Bay and its tidal tributaries have been divided are designated as in or out of attainment based on a criteria assessment procedure that uses the monitoring data (USEPA 2003[iii]; USEPA 2010[iv]).

Estuarine water quality is a complex phenomenon and the data we use to measure it depicts a mixed picture. For example, there are sections in the river where there is sufficient dissolved oxygen to meet water quality standards, but the trends over time are degrading. In general, dissolved oxygen levels meet their criteria in the upper portion of the estuary, but fail to do so in the deeper waters of the lower estuary, which is a similar pattern to what we see in the Chesapeake Bay as a whole. Thus, improving dissolved oxygen levels in the lower estuary are the main drivers for the level of nutrient reductions necessary to return the river to full health. Even in the upper estuary, further reductions in pollutants are necessary to reverse degrading trends and achieve all the conditions to meet water quality standards.

Because a simple in- or out-of-attainment metric does not convey the extent of non-attainment nor lend itself to an assessment of progress, Bay Program analysts have developed other ways of evaluating the data. One of these is "attainment deficit," which incorporates estimates of the volume of water and the amount of time that a particular tidal water segment is determined to be out of attainment for a particular parameter during the critical summer months when environmental stresses tend to be most severe (Zhang et al. 2018[v]).

The following charts are all based on attainment deficits for summer (i.e. June- September) dissolved oxygen levels, a key water quality endpoint for which the Bay TMDL was designed. They are calculated for rolling three-year periods. Values at "0" in these charts means the segment is in attainment. The degree to which a segment is out of attainment is the distance from the measured values for each three-year period (the dark blue or light blue lines in the charts) to the zero line; the greater the distance, the more the extent of non-attainment.

Figure 10: Attainment Deficit for the Potomac Deep Channel Stations in MD and VA

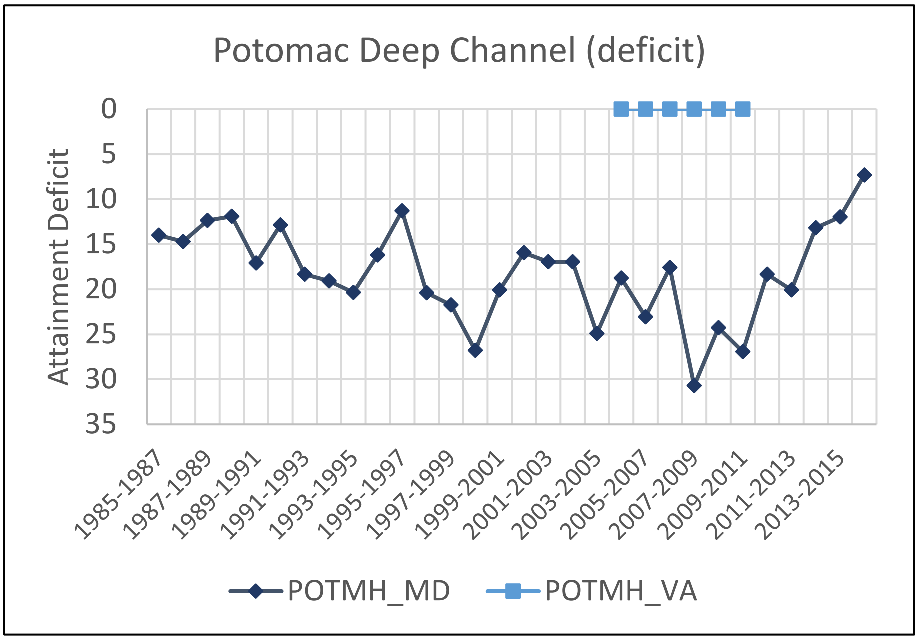


Source: Chesapeake Bay Program

The two charts show attainment deficit for the deep channel and the adjacent deeper waters in the lower portion, or mesohaline section, of the Potomac estuary. POTMH-MD represents the Maryland portion of these waters, which comprise the bulk of the mainstem; POTMH-VA comprises Virginia's portion, which includes a number of embayments on its side of the river. There is much less data for these Virginia waters and its water quality does not necessarily correspond to conditions in the main part of the estuary.

Although the charts show deficits in the range of 5 – 15 percent on a time- and volume-weighted basis for these segments (which means they actually are in attainment most of the time), it does appear that water quality degradation bottomed out in the 2007-2009 period and has been improving since then, which analysts attribute largely to reductions in wastewater nutrients. And there is other data that provides evidence of recent improvement in water quality in the Potomac estuary.

Figure 11: Attainment Deficit for the Potomac Deep Channel Stations in MD and VA

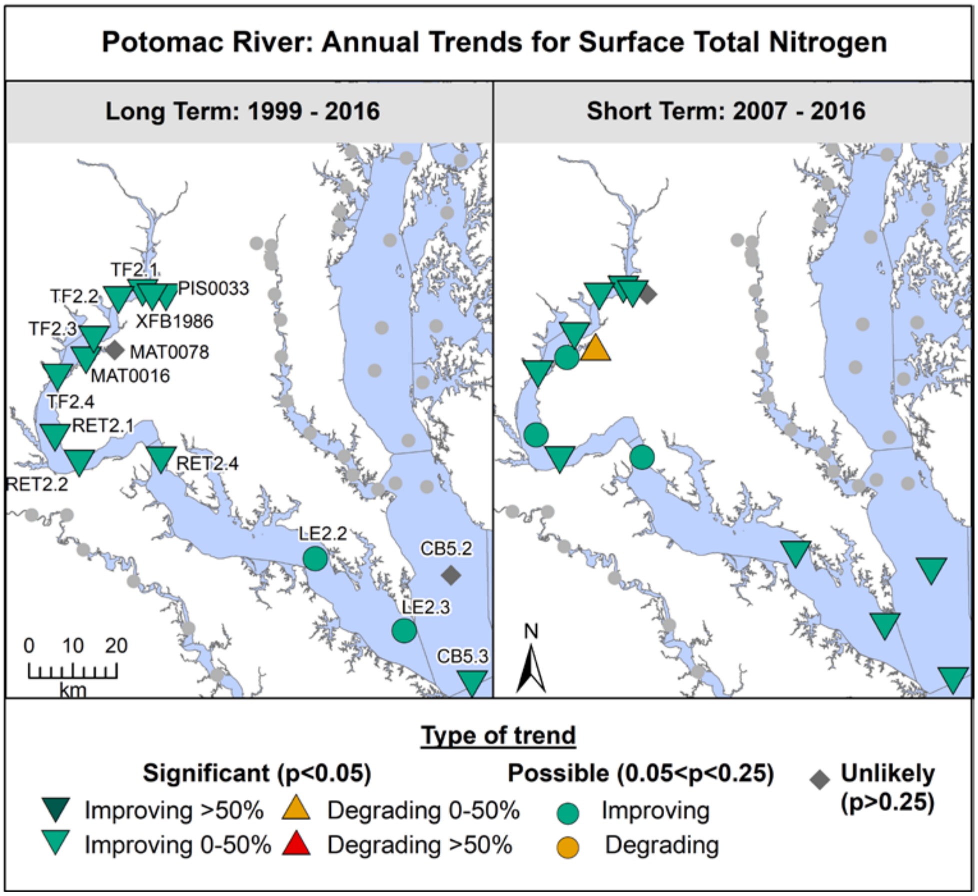


Source: Chesapeake Bay Program

Assessing Trends

Working in concert with analysts for the Maryland Department of Natural Resources, Bay Program staff has begun using a new implementation of a statistical technique known as Generalized Additive Models (or GAMs) to discern trends and other patterns in the data over time (Murphy et al. in review[vi]). In the following charts, GAM-based trend results are shown for both the long-term and short-term data records for multiple parameters.

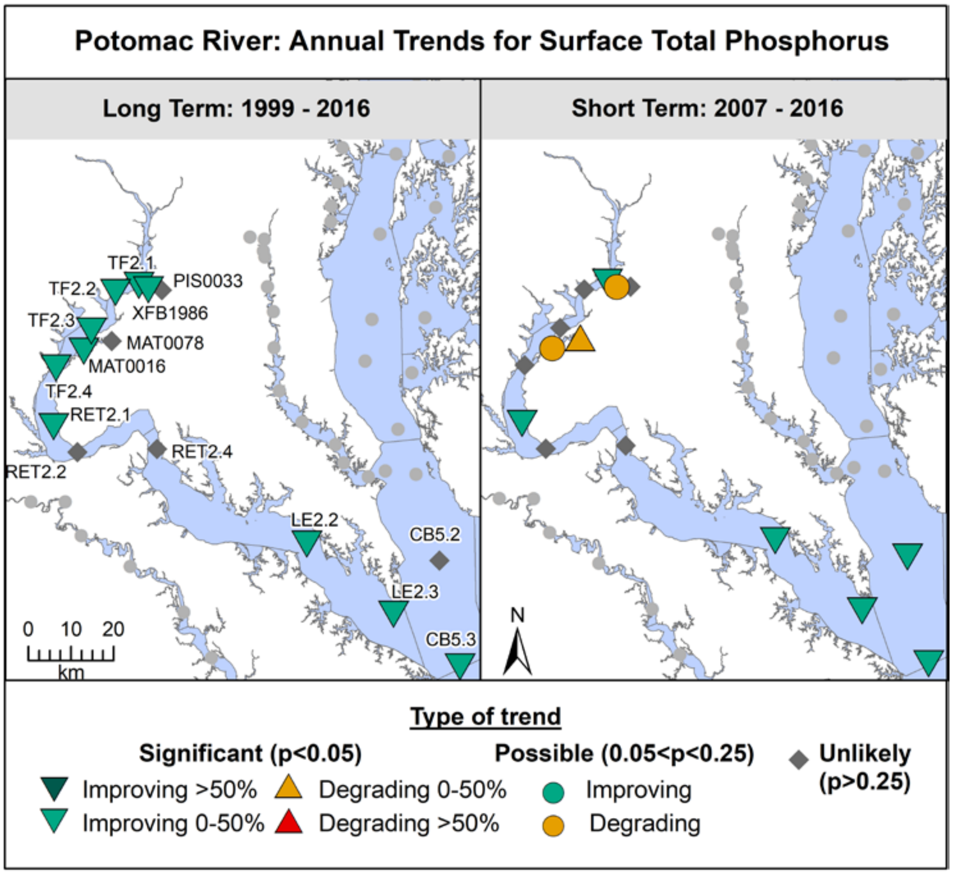
Figure 12: Potomac River Annual Trends for Surface Total Nitrogen



Source: Chesapeke Bay Program "Tidal Trends in Water Quality: Potomac River 2016 Tributary Summary."

The charts show trends for a variety of water quality parameters measured by the tidal water monitoring program. They all employ the same visual symbols, indicating whether the trends are improving (in green arrows or circles), degrading (in either red or yellow arrows or circles) or not significant (grey diamonds). Darker green indicates a more significant improving trend (more than 50 percent), just as red indicates a more significant degrading trend (more than 50 percent).

Figure 13: Potomac River Annual Trends for Surface Total Phosphorus



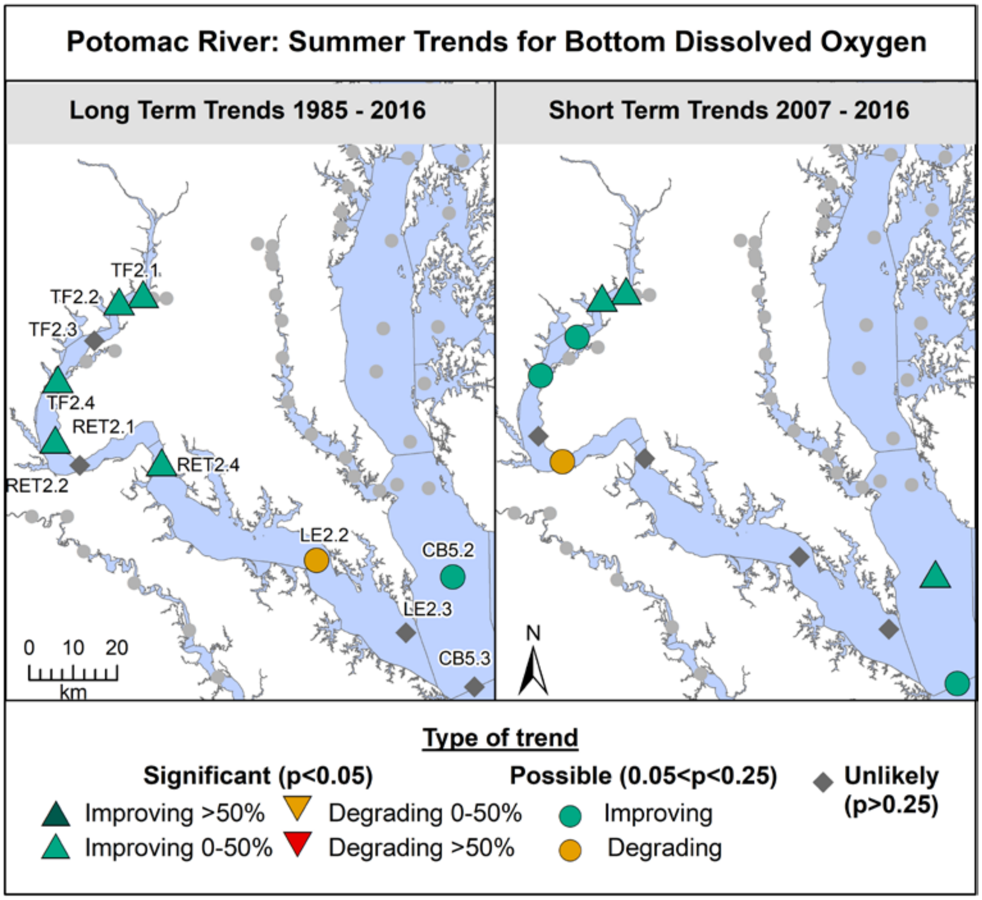
Source: Chesapeke Bay Program "Tidal Trends in Water Quality: Potomac River 2016 Tributary Summary."

Most of the trends in both surface nitrogen and surface phosphorus concentrations in all portions of the estuary show significant improvement (i.e. reductions) in both the short- (10 years) and long-term (20 years). Reductions in the nutrients discharged from wastewater plants are likely the major cause for this improvement, although reductions from other sources also contributed to the trends.

However, improvements in other water quality parameters are harder to discern, both because such improvements tend to lag behind reductions in the pollutants that are the root cause of degradation and because other factors come into play in the complex estuarine environments.

For example, dissolved oxygen has shown a significant long-term improving trend at almost all of the upstream stations since 1985 and at ones in the uppermost tidal fresh portion of the estuary since 2007. However, the lowermost stations – LE2.2 and LE2.3 – have mostly shown no trends or degrading trends during these same periods. However, these stations represent the deepest waters in the Potomac estuary, typically where low oxygen conditions are hardest to overcome, and also are more influenced by water quality in the mainstem of the Bay than the other Potomac stations.

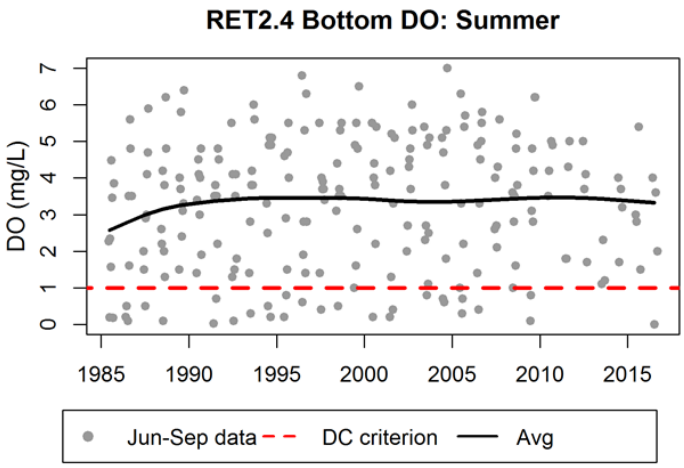
Figure 14: Summer Trends for Bottom Dissolved Oxygen



Source: Chesapeke Bay Program "Tidal Trends in Water Quality: Potomac River 2016 Tributary Summary."

Even where overall statistical analysis shows no signs of improvement, analysts believe they can pick out smaller signs that progress is being made. At the RET 2.4 station near the Route 301 Bridge, for example, the monitoring data from recent years has only 1 value below the deep channel instantaneous criterion of of 1 milligram/liter.

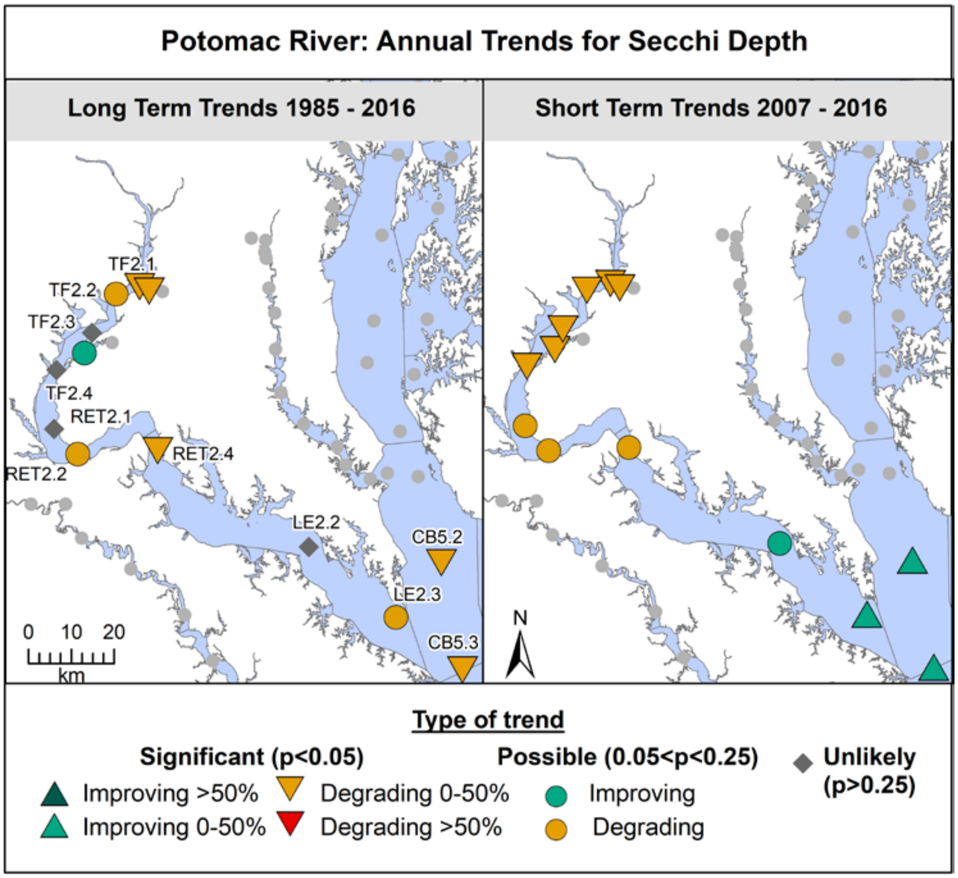
Figure 15: Bottom Dissolved Oxygen: Summer for station RET2.4



Source: Chesapeke Bay Program "Tidal Trends in Water Quality: Potomac River 2016 Tributary Summary."

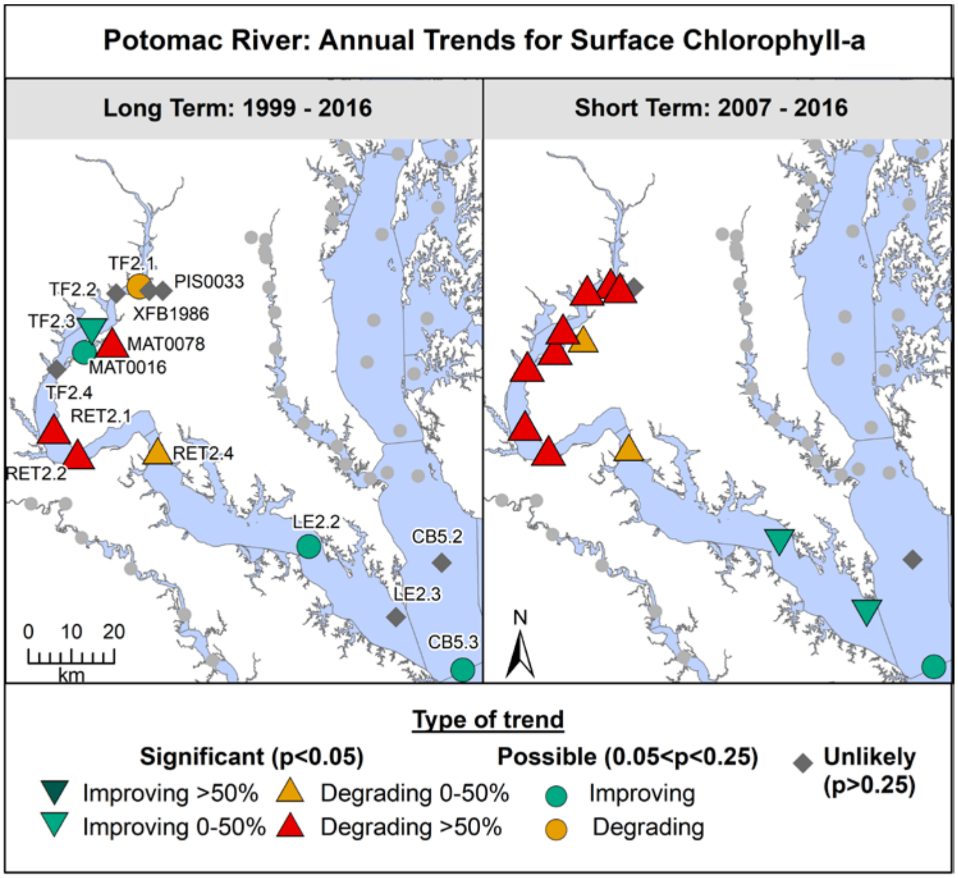
The trends for Secchi disk depth (a measure of water clarity) and chlorophyll-a (a measure of algal amounts) also are mostly degrading, especially in the upper portion of the estuary where the impact of wastewater nutrient reduction should be the greatest. Because estuaries are such dynamic systems, it is typically hard to determine cause-and-effect relationships. Researchers are currently examining the reasons for these seemingly contradictory trends.

Figure 16: Annual Trends for Secchi Disk Depth



Source: Chesapeke Bay Program "Tidal Trends in Water Quality: Potomac River 2016 Tributary Summary."

Figure 17: Long and Short Term Annual Trends for Chlorophyll-a



Source: Chesapeake Bay Program "Tidal Trends in Water Quality: Potomac River 2016 Tributary Summary."

Section 5. Success Stories – Submerged Aquatic Vegetation (SAV)

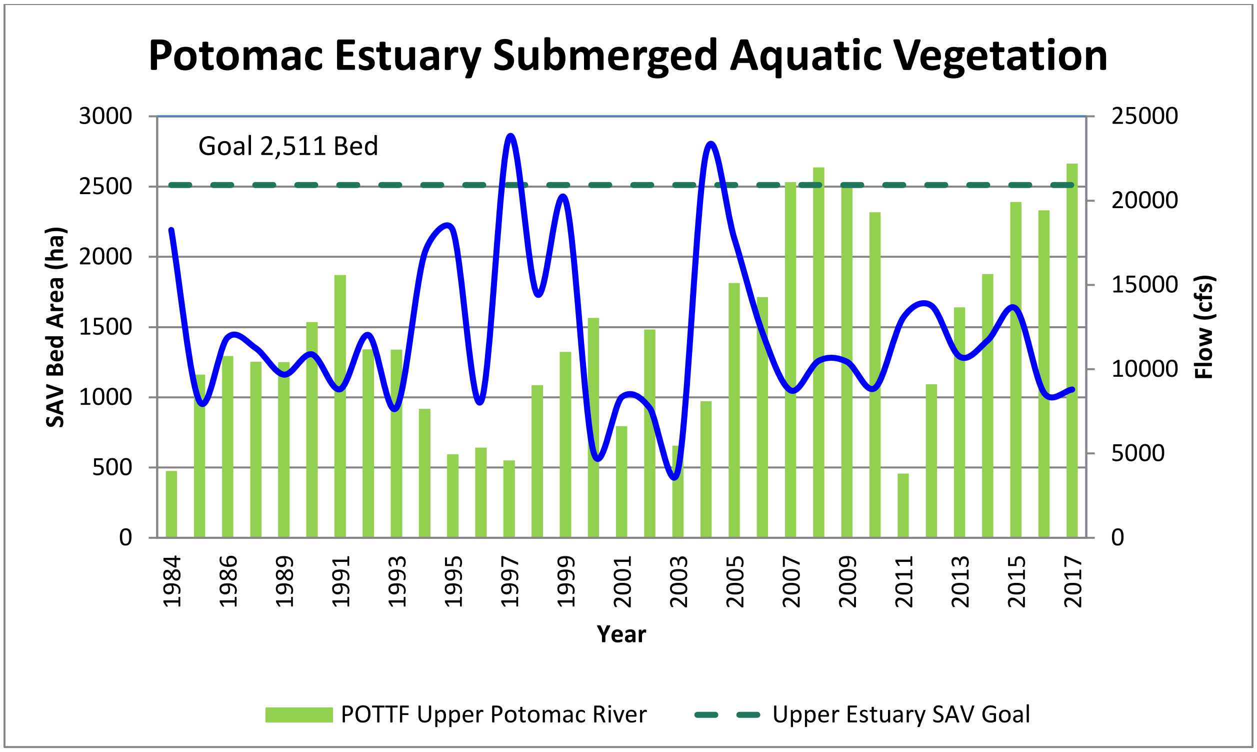
Source: Brian LeCouteur, COG Staff

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 more acres of submerged aquatic vegetation (SAV) and increases in the numbers of certain fish species, derive largely from the reductions of nutrients from wastewater plants in the Washington region. These improvements show up most clearly in the 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 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 tends to lead 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 verticillata*, 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, compared t0 80 percent in the 1990s. In addition to *Hydrilla*, the estuary now has populations of 12 different species of SAV.

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 consistently met this target in recent years, except for 2011 and 2012. The underwater grass populations in the river remain sensitive to environmental disturbance and in 2011 and 2012, weather conditions that favored greater algal growth resulted in 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. While some areas like the Upper Potomac Estuary have met initial restoration targets, the entire Chesapeake Bay 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.

Figure 18: Potomac Estuary SAV (Upper Portion) and Flow at Chain Bridge



Local Water Quality in Gunston Cove – A Case Study

Figure 19. Watershed Draining to Gunston Cove

National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

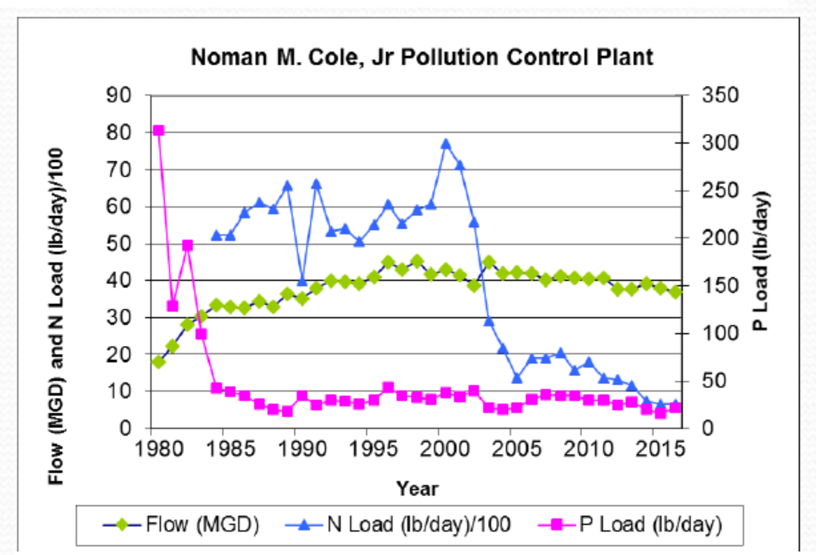
Although restoration of the Chesapeake Bay has been the main driver behind many of the water quality improvement efforts undertaken in the region, the improvement of water quality in smaller, localized water bodies is also an important reason for action. Local streams, many of which have been degraded by decades of urbanization, are targeted for a variety of restoration measures by local government stormwater management programs. Where wastewater discharges occur into local rivers or Potomac River embayments, reductions in the discharge of nutrients and other pollutants can have a major impact on improving local water quality conditions.

Information in Section 3,”Nonpoint Source Loads from below the Fall Line,” indicated that smaller tributary watersheds in the COG region present a mixed picture of progress; some have improving trends and others have degrading trends for nutrients and sediment. Despite improvements in some local streams, almost all of the smaller watersheds in the region are at most only partly restored and will require decades of further work to return to fully fishable and swimmable conditions.

Perhaps the most encouraging case study of how restoration efforts can improve local waters is provided by Gunston Cove, a Potomac River embayment on the edge of Fairfax County, into which the county’s Noman M. Cole Jr Wastewater Plant discharges its effluent. Water quality in the cove has been extensively studied for decades by a research team from George Mason University led by Dr. Chris Jones. Data in this section is derived from this research[vii].

Historically, water quality and living resources in Gunston Cove experienced the same overall response pattern as have tidal waters throughout the Bay. As water quality continued to decline in response to increasing pollution, living resources were increasingly stressed, and in some cases, disappeared. By the mid-20th Century, summer conditions in the embayment came to be dominated by algal blooms, stimulated by an excess of nutrients. The surface-growing algae decreased light to the SAV, which disappeared entirely from Gunston Cove by the 1960s and 1970s.

Figure 20. Flow and Loads at Noman Cole Plant



Source: George Mason University

Gunston Cove's road to recovery began with a ban on phosphates in detergents in the 1980s and the implementation of phosphorus controls at all of the major wastewater plants discharging to the estuary in the late 1970s and early 1980s, including the Noman Cole plant in Fairfax County. These were followed by controls on nitrogen discharges in successive periods from 2000-2005 and again since 2015. (*See Figure 20.*)

Noman M. Cole Jr. WWTP

Between 1980 and 1985, the amount of phosphorus discharged into the lower Pohick Creek by the Noman Cole plant decreased by about 85 percent and the amount of phosphorus leaving the plant has remained at the same low level despite increases in the flow of wastewater to the plant. The discharge of nitrogen continued to increase until 2000-2005, when Noman Cole implemented its first round of biological nitrogen removal, achieving reductions of about 85 percent. Noman Cole implemented its second round of nitrogen reductions in 2013.

The water quality response can be seen in *figures 21, 22 and 23* - a small amount of SAV growth was seen in the wake of the initial reductions in wastewater phosphorus. However, summertime levels of chlorophyll-A, a measure of the amount of algal growth, remained elevated and, correspondingly, water clarity, as measured by Secchi disk depth, remained relatively poor through 2000. Then, at various points between 2001 and 2005, chlorophyll-A levels declined dramatically – indicating a major reduction in algal populations – and water clarity improved. These are believed to be major factors in the significant expansion of SAV acreage subsequently seen in Gunston Cove.

Although the general pattern of nutrient reductions leading to water quality improvements seems clear and has been observed in other parts of the Bay, water quality scientists are not certain of all the details and there are individual differences at play as well. Jones believes that the chlorophyll-A, water clarity and SAV acreage changes in Gunston Cove were triggered by the phosphorus reductions at Noman Cole, even though several decades elapsed between these two sets of events. He attributes this response lag to the persistence of phosphorus in bottom sediments in the cove; it is only when this phosphorus reservoir was depleted that the algal populations declined and the SAV rebounded.

Figure 21. SAV Extent in Gunston Cove in 2005

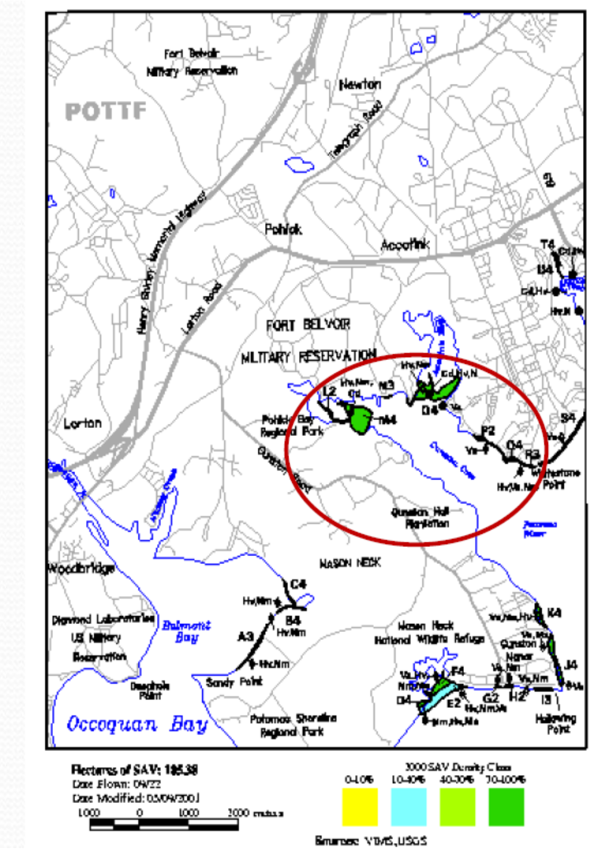
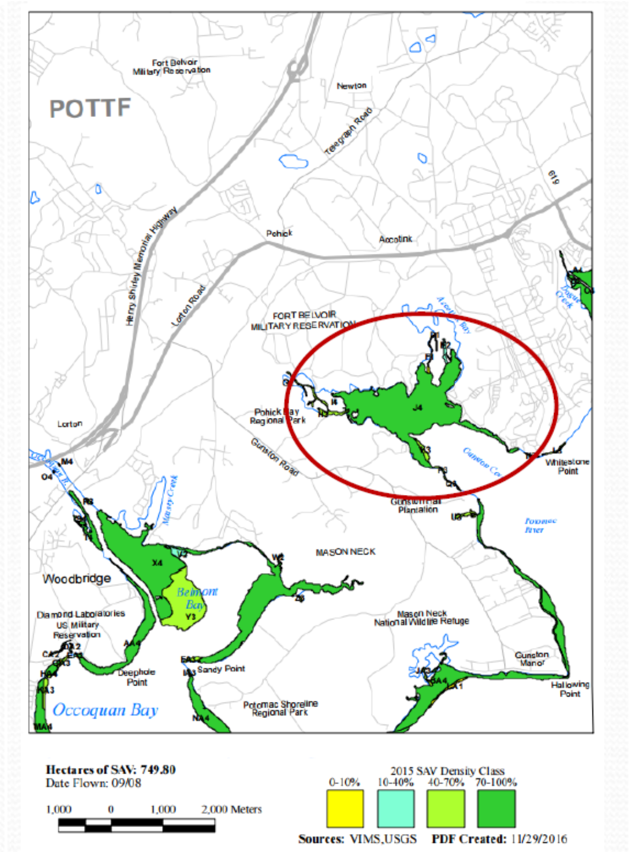
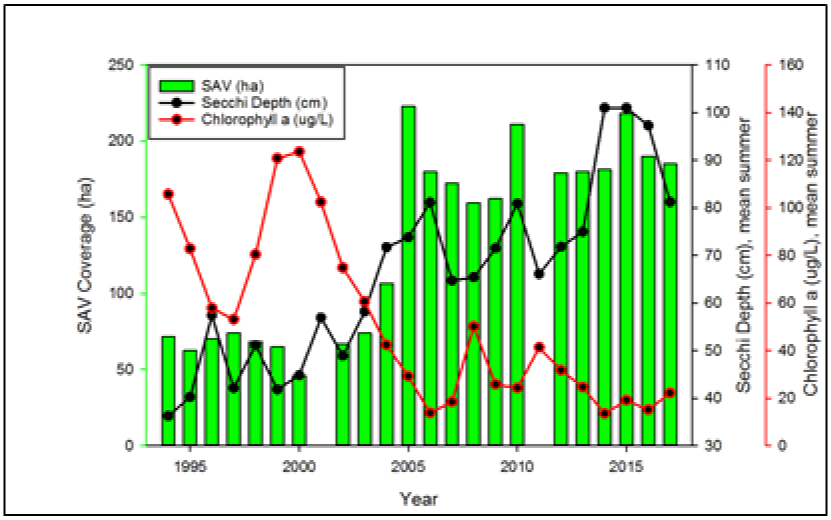


Figure 22. SAV Extent in Gunston Cove in 2015



Source: George Mason University

Figure 23. Various Water Quality Parameters in Gunston Cove



Source: George Mason University

Section 6: Other Issues

This report is focused on the major pollutants that are the focus of the Chesapeake Bay TMDL and also drive much of the water quality dynamics in the Potomac estuary: nitrogen, phosphorus and sediment. However, there are a number of other water quality issues in the Potomac caused both by these pollutants and other factors. These include harmful algal blooms above the Chain Bridge fall line that release toxins of concern to drinking water providers and toxic man-made chemicals that may cause intersex fish and other problems.

The rapid spurts in algal populations known as blooms have been a common occurrence in the Potomac estuary, but they also can occur in upstream portions of the river. The main driver of such harmful algal populations is excessive nutrients, just as it is in tidal waters. Maryland DNR staff is currently gathering data on the production of toxins by cyanobacteria in the free-flowing portion of the river and whether the levels are of concern to the drinking water intakes for the metropolitan Washington region.

Monitoring has detected the presence of a number of toxic chemical contaminants in the Potomac River, ranging from various types of metals to organic compounds. These include mercury, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), pesticides and pharmaceuticals and personal care products that have been linked to reproductive disruptions in fish and other species.

Intersex characteristics in fish, particularly smallmouth bass, were discovered in the South Branch of the Potomac River by USGS scientists more than 10 years ago. The condition is thought to be linked to the presence of endocrine disrupting compounds that originate from a variety of human and animal-waste sources.[viii]

Another water quality issue that has prompted increasing concern in the last few years is the poresence of salts, particularly sodium chloride, in the watershed. Although the levels of such salts tend to be highest in smaller streams in the watershed, data from Potomac monitoring shows increasing concentrations in the free-flowing river, which is a concern for the region's drinking water providers.

Summary

Local governments and utilities in the COG region have made great progress in reducing the amount of nutrients discharged from wastewater plants in the region. As a result, harmful algal blooms have been reduced, submerged aquatic vegetation has returned, and the populations of several fish and waterfowl species have rebounded. There also has been some progress, albeit smaller, in achieving reductions from other nutrient sources in the Potomac watershed.

But these reductions are not yet enough to completely achieve water quality standards. Researchers are investigating to what extent nutrient and sediment concentrations must decline further to achieve the standards, but the calculation is not a simple linear relationship. It is complicated by dynamic processes on the land and in the water that are affected by more than just nutrients and sediment. Additional issues such as toxics and chemical contaminants, intersex fish, and climate change also have major impacts on water quality. This complexity underlies some of the mixed signals presented by water quality data in the Potomac estuary, with both improving and degrading trends.

Because wastewater has essentially already achieved state-of-the art levels of nutrient reduction, further progress in improving water quality conditions depends on further efforts to reduce nutrients and sediment from nonpoint sources, such as agriculture and urban runoff. Here, too, there is uncertainty and mixed signals, with many improving trends but some degrading ones as well. Scientists are still interpreting the effects of time lags, for instance, in the flow of nitrate-enhanced groundwater that gradually feeds surface waters and the ability of BMPs to reduce extensive phosphorus reservoirs in certain soils. What is certain is that additional efforts to reduce nutrients and sediment from these nonpoint sources will be needed to achieve the Potomac River's long-term water quality goals.

For More Information

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

(need to add web references)

Endnotes

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[i] Moyer, D.L., Chanat, J.G., Yang, Guoxiang, Blomquist, J.D., and Langland, M.J., 2017, Nitrogen, phosphorus, and suspended-sediment loads and trends measured at the Chesapeake Bay Nontidal Network stations: Water years 1985-2014: U.S. Geological Survey data release, https://doi.org/10.5066/F7XK8D2R.

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[iii] U.S. Environmental Protection Agency (2003a). Ambient water quality criteria for dissolved oxygen, water clarity and chlorophyll-a for the Chesapeake Bay and its tidal tributaries. USEPA Region III Chesapeake Bay Program Office EPA 903-R-03-002. Annapolis, Maryland. https://www.chesapeakebay.net/content/publications/cbp_13142.pdf

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https://www.chesapeakebay.net/content/publications/cbp_51366.pdf.

[v] Zhang, Q, P.J. Tango, R.R. Murphy, M.K. Forsyth, R. Tian, J. Keisman, and E.M. Trentacoste. 2018. Chesapeake Bay Dissolved Oxygen Criterion Attainment Deficit: Three Decades of Temporal and Spatial Patterns. Frontiers in Marine Science. doi: 10.3389/fmars.2018.00422

[vi] Murphy, R.R., E. Perry, J. Harcum, and J. Keisman. A Generalized Additive Model approach to evaluating water quality in Chesapeake Bay. In Review at Environmental Modelling and Software.

[vii] (need citation for Jones' work)

[viii] https://toxics.usgs.gov/highlights/edcs_bass_nests.html