MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

Martin O'Malley, *Governor*
Anthony G. Brown, *Lt. Governor*
Joseph P. Gill, *Secretary*
Frank W. Dawson III, *Deputy Secretary*

Potomac River
Water and Habitat Quality Assessment

Maryland Department of Natural Resources
Tidewater Ecosystem Assessment

Tawes Building, D-2, 580 Taylor Avenue
Annapolis, MD 21401
http://dnr.maryland.gov

Toll Free in Maryland:
1-877-620-8DNR, ext: 8630
Out of state call: 410-260-8630
TTY users call via the MD Relay:
711 (within MD)
Out of state call: 1-800-735-2258

Martin O'Malley, Governor | Anthony G. Brown, Lt. Governor

Primary Author:

Renee Karrh rkarrh@dnr.state.md.us

Contributors:

Diana Domotor, Rebecca Golden, Lee Karrh, Brooke Landry, William Romano, Brian Smith, Ben Cole, Sherm Garrison, Thomas Parham, Mark Trice, Cathy Wazniak

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Acknowledgements:

Information on the water and habitat quality of Maryland's rivers and bays is available due to the hard work of many dedicated staff including:

- staff who are in the field collecting the samples year-round, sometimes under less than desirable weather conditions
- laboratory staff who perform the chemical tests to determine what exactly is in those water samples
- data management staff who collect the resulting information, confirm the accuracy and quality of the data, and organize and maintain the databases and
- analytical staff who interpret the data to answer the question 'how is the river/Bay doing?'

There are too many individuals to directly name from more than 25 years of monitoring, so we simply wish to commend all of them for their commitment to collecting high quality information and making it available and useful to the citizens of Maryland.

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Overall Condition

Healthy rivers and bays support a diverse population of aquatic life as well as recreational uses, such as swimming and fishing. To be healthy, rivers and bays need to have good water and habitat quality. High levels of nutrients and sediments lead to poor water quality. Poor water quality reduces habitat quality, including water clarity (how much light can get to the bottom) and the amount of dissolved oxygen in the water. In turn, habitat quality affects where plants and animals can live. The Maryland Department of Natural Resources (DNR) is responsible for monitoring water and habitat quality in the Chesapeake Bay and rivers, as well as the health of aquatic plants and animals. DNR staff use this information to answer common questions like "How healthy is my river?", "How does my river compare to other rivers?", "What needs to be done to make my river healthy?" and "What has already been done to improve water and habitat quality in my river?"

How healthy is the Potomac River?

The Potomac River is divided into three basins: the Upper Potomac, Middle Potomac and Lower Potomac.

Upper Potomac

The Potomac River in the Upper Potomac basin is all non-tidal. Land use is in Maryland is approximately 75% forest in the western half of the basin, and a mix of agriculture, forest and urban in the eastern half of the basin. Stream health varies from good (Savage River) to fair (Lower North Branch, Fifteen Mile Creek, Sidling Hill Creek, Upper Monocacy River) to poor (the rest of the area). Human population density is low to moderate.

Nutrient loadings and conditions differ between the western and eastern portion of the basin. In the western portion of the basin, nitrogen and phosphorus loadings from the Maryland streams decreased over the long-term. However, while nitrogen loadings decreased, phosphorus and sediment loadings increased in the recent period. Nitrogen levels in the river and streams decreased as well, and phosphorus levels have decreased in some main river locations. Sediment levels have increased at the two upstream main river stations and in Savage River and Georges Creek, but decreased in the most downstream main river station.

In the eastern portion of the basin, nitrogen and phosphorus loadings from Maryland tributaries decreased over the long-term, but only phosphorus loadings decreased in the recent period. Nitrogen levels increased in Conococheague Creek and Antietam Creek but decreased in the lower Monocacy River and in the main river at Point of Rocks. Phosphorus levels decreased throughout the basin, and sediment levels decreased in Conococheague Creek and Antietam Creek and maybe decreased in Catoctin Creek and Monocacy River.

While decreased nutrients indicate improvement overall, they do not necessarily indicate healthy stream habitat. Non-tidal river habitat is influenced by many issues beyond nutrient and sediment conditions (for example, acid mine drainage, pollutants, impervious surfaces, etc.), Also, newer concerns include algal blooms in this farthest upstream region of the Potomac River and the occurrence of invasive species such as *Didymo*.

Table 1. Summary of trends for non-tidal loadings (WY2002-2011) and non-tidal water quality parameters trends (1999-2012).
Map # corresponds to Figure 17 in main report. Annual trends ether 'Increase' or 'Decrease' if significant at $p \leq 0.01$ or 'Maybe Increase' or 'Maybe Decrease' at $0.01 < p < 0.05$; blanks indicate no significant trend. Improving trends are in green, degrading trends are in red. Gray boxes indicate there is no data to evaluate that component.

			Loadings			Water Quality		
	map#	Station	Nitrogen	Phosphorus	Sediments	Nitrogen	Phosphorus	Sediments
Western Upper Potomac	1	NBP0689				INCREASE		INCREASE
	2	SAV0000						INCREASE
	2	NBP0534						INCREASE
	3	GEO0009			INCREASE	DECREASE		INCREASE
	4	NBP0461				DECREASE	DECREASE	
	5	NBP0326				DECREASE	DECREASE	
	6	BDK0000				DECREASE		
	7	WIL0013	DECREASE	INCREASE		DECREASE		
	8	NBP0103				DECREASE	DECREASE	
	9	NBP0023				DECREASE	DECREASE	
	10	TOW0030				DECREASE		
	11	POT2766				DECREASE		
	12	POT2386				DECREASE		DECREASE
Eastern Upper Potomac	13	CON0180		DECREASE		INCREASE	DECREASE	Maybe Decrease
	14	CON0005				INCREASE	DECREASE	DECREASE
	15	POT1830					DECREASE	
	16	ANT0366				INCREASE		DECREASE
	17	ANT0203				INCREASE	DECREASE	DECREASE
	18	ANT0044				INCREASE	DECREASE	
	20	CAC0148		DECREASE			DECREASE	
	21	CAC0031					DECREASE	Maybe Decrease
	22	POT1596				DECREASE	DECREASE	
	23	POT1595					DECREASE	
Monocacy River	24	MON0528	DECREASE	DECREASE		Maybe Decrease	DECREASE	Maybe Decrease
	25	BPC0035					DECREASE	
	26	MON0269					DECREASE	
	27	MON0155				DECREASE	DECREASE	
	28	MON0020				DECREASE	DECREASE	
Middle Potomac	29	POT1472				Maybe Decrease	DECREASE	
	30	POT1471					DECREASE	
	31	SEN0008				DECREASE	DECREASE	
	32	CJB0005						
	33	RCM0111						
	34	POT1184					DECREASE	
	36	ANA0082					Maybe increase	INCREASE
	35	Potomac River at Chain Bridge, MD			INCREASE			

Middle Potomac

In the Middle Potomac basin, the river extends from downstream of the Monocacy River to downstream of Piscataway Creek. Land use in Maryland is 56% urban and 27% forest, and impervious surfaces covered between 10->20% of the sub-watersheds. Human population density in Maryland is high to very high. Stream health (on the Maryland side) is categorized as poor in all but the Seneca Creek sub-watershed which is categorized as fair.

Over the long-term, nitrogen levels decreased at all of the non-tidal stations, phosphorus levels decreased at most of the stations, and sediment levels decreased at the upstream main river stations. In the more recent period, phosphorous levels in the non-tidal main river decreased and nitrogen levels may have decreased at the upstream main river station. Nitrogen and phosphorus levels also decreased in Seneca Creek. However, phosphorus levels may have increased and sediment levels increased in the Anacostia River. Sediment loadings measured at the fall line increased.

Water quality in the tidal portions of the middle Potomac was fair to poor due to high nitrogen levels and poor water clarity. Piscataway Creek had fair water quality. Nitrogen levels decreased throughout the Middle Potomac, and phosphorus levels decreased in the recent period in most areas. Overall, phosphorus levels were good but sediment levels in shallow waters and algal densities in the main river were too high. Summer dissolved oxygen levels were good.

Underwater grass beds in the tidal fresh main river and in Piscataway Creek have decreased in the last several years. Underwater grass beds covered more than the area required to meet restoration goals from 2005-2010, but decreased to approximately 40% of the restoration goal area in 2012. Bottom animal populations were unhealthy at the long-term station and conditions have degraded.

Lower Potomac

In the Lower Potomac basin the river extends from downstream of Piscataway Creek to the mouth of the river at Point Lookout. Mattawoman Creek is a major tributary from the Maryland side of the river. Land use in Maryland is 51% forest, 24% urban and 19% agriculture, and impervious surfaces covered 4% of the watershed overall Human population density in Maryland is generally moderate. Stream health in the sub-watersheds surrounding the Lower Potomac River (on the Maryland side) is categorized as fair. All of the Lower Potomac sub-watersheds are Maryland Trust Fund low priority watersheds.

Water quality in the open tidal waters of the Lower Potomac was fair due to moderate nutrient levels but high algal densities and poor water clarity. Mattawoman Creek had good water quality. Nitrogen levels decreased throughout the Lower Potomac and phosphorus levels decreased in the upstream areas and in Mattawoman Creek. Sediment levels increased in the middle portion of the main river but decreased at the two downstream stations and in Mattawoman Creek. Algal densities and water clarity degraded in the main river but improved in Mattawoman Creek. Summer bottom dissolved oxygen in the Lower Potomac upper portion was fair to good, but in the lower portion summer bottom dissolved oxygen was almost always below 3 mg/l and very often less than 1 mg/l.

Underwater grass beds in the Lower Potomac have decreased in the last several years, especially in the lower portion of the river. In 2005, underwater grass beds in Maryland waters covered 80% of the area required to meet restoration goals in the middle portion of the Lower Potomac, but decreased to approximately 40% of the restoration goal area in 2012. In the lower portion of the river, underwater grass beds in Maryland waters covered 40% of the area required to meet restoration goals in 2005, but decreased to approximately 10% of the restoration goal area in 2012. Underwater grass beds in Mattawoman Creek covered areas close to or above restoration goals in recent years but decreased to 70% of the goal in 2012.

The health of algal populations degraded in the spring but may have improved in the upper section of the Lower Potomac in the summer. Blue green algal blooms have also become less frequent and/or less severe.

More than half of the habitat for bottom animals was degraded. The degraded locations were mostly within the deep channel of the lower river, where dissolved oxygen is almost always depleted during the summer months. Most of the locations where healthy benthic communities were found were upstream of this area or in shallower portions of the river.

How does the tidal Potomac River compare to other Maryland rivers?

The Middle Potomac and Lower Potomac River basins are in the 'High Urban, Low Agriculture' land use category, with Middle Potomac being among the most urbanized areas in Maryland (Figure 1). Nitrogen, phosphorus and sediment levels are higher in the Middle Potomac than in the Lower Potomac portion of the river (Figure 2). Algal densities are similar in both parts of the river, and water clarity is much better in the Lower Potomac than in the Middle Potomac portion.

The nitrogen and phosphorus levels in the Middle Potomac portion of the river are moderate relative to other high urban areas, but sediment levels are higher than in most other high urban areas. Summer bottom dissolved oxygen levels in the Middle Potomac are among the best of the high urban areas, but water clarity is among the worst of similar areas.

The nitrogen, phosphorus and sediment levels in the Lower Potomac portion of the river are among the lowest of the high urban areas, and water clarity is the best among similar areas. However, summer bottom dissolved oxygen levels are very poor and among the worst of all tidal waters in Maryland.

What needs to be done to make the Potomac River healthy?

The biggest water quality and habitat issues are moderate to high nutrient levels throughout the river and poor water clarity in the Middle Potomac and upper Lower Potomac River. Agriculture is a major source of nitrogen, phosphorus and sediment loadings from Maryland to all sections of the Potomac, so reductions in loadings from agricultural sources should be a priority. Upgrades to wastewater treatment plants will reduce nitrogen and phosphorus loadings, and these improvements are already in place or planned. Reducing sediment loadings from urban runoff should also be a priority. In heavily urbanized sub-watersheds, retrofitting existing structures with alternatives to conventional building materials and methods should be used to reduce the amount of impervious surfaces and prevent additional degradation of water quality.

By lowering nutrients and sediments, water clarity should improve which will improve habitat quality for underwater grasses. Reductions in nutrients will also lead to lower algal densities and further improve habitat quality. Reducing algal densities by reducing nutrients will improve dissolved oxygen conditions.

What has already been done in Maryland to improve water and habitat quality in the Potomac River?

To reduce loadings from agricultural sources, more than 81,000 acres of cover crops have been planted in between growing seasons to absorb excess nutrients and prevent sediment erosion. Fencing on more than 13,700 acres of farmland has been used to keep livestock out of streams and prevent streambank erosion. More than 1,250 containment structures have been built to store animal wastes to allow nutrients to be applied to the land in the most effective manner at the appropriate time, and more than 22,000.acres of stream buffers have been maintained, allowing areas next to streams to remain in a natural state with grasses, trees and wetlands.

Upgrades to all major wastewater treatment plants in Maryland are in progress and will be completed by 2020. Previous upgrades at the largest facility in the basin, Blue Plains Wastewater treatment plant, have already reduced nitrogen loadings to less than one-third the levels in the early to mid 1990s and also reduced phosphorus loadings to two-thirds the previous levels.

Stormwater retrofits have reduced nitrogen loadings from urban and suburban sources and prevented more than 41,000 pounds of nitrogen from entering streams. Also, almost 175 septic upgrades have been completed.

In addition, Maryland has a number of programs to reduce the impacts of continued development and increasing amounts of impervious surfaces in the Potomac River watershed. Program Open Space projects have conserved more than 10,400 acres of land for outdoor recreation opportunities. Rural Legacy Program projects have protected almost 18,400 acres, with special focus on areas with important cultural sites and natural resources and to ensure large areas of habitat. Maryland Environmental Trust projects have helped individual land owners protect almost 11,800 acres. Maryland Agricultural Land Preservation Program projects have preserved almost 11,350 acres of agricultural land from development.

The electronic version of the full report is available at
http://mddnr.chesapeakebay.net/eyesonthebay/tribsums.cfm

Table 2. Summary of tidal habitat quality and water quality indicators in main river. Algal densities, water clarity, inorganic phosphorus and sediments either 'Meet' or 'Fail' SAV habitat requirements. Dissolved nitrogen levels below the level for nitrogen limitation 'Meet' criteria, otherwise 'Fail' criteria. Summer bottom dissolved oxygen levels above 3 mg/l 'Meet' criteria, otherwise 'Fail' criteria. Annual trends for 1999-2012 ether 'Increase' or 'Decrease' if significant at $p \leq 0.01$ or 'Maybe Increase' or 'Maybe Decrease' at $0.01 < p < 0.05$; blanks indicate no significant trend. Improving trends are in green, degrading trends are in red. Nitrogen trends are for total nitrogen, phosphorus trends are for total phosphorus, water clarity trends are for Secchi depth. Data is from the long-term monitoring program (2010-2012). Gray boxes indicate there is no data to evaluate that component.

		Habitat Quality			Water Quality		
	Station	Algal densities	Water Clarity	Summer Bottom Dissolved Oxygen	Nitrogen	Phosphorus	Sediments
Middle Potomac	Upper Piscataway	MEET			FAIL DECREASING	FAIL	MEET
Middle Potomac	Lower Piscataway	FAIL	FAIL		FAIL DECREASING	MEET DECREASING	FAIL
Middle Potomac	Mouth of Piscataway	FAIL	FAIL	MEET IMPROVING	FAIL DECREASING	MEET DECREASING	MEET
Middle Potomac	Mouth of Dogue Creek	FAIL	FAIL	MEET	FAIL DECREASING	MEET DECREASING	MEET
Lower Potomac	Upper Mattawoman	MEET			FAIL Maybe Decreasing	MEET	MEET
Lower Potomac	Lower Mattawoman	MEET DECREASING	FAIL INCREASING		FAIL DECREASING	MEET DECREASING	MEET DECREASING
Lower Potomac	Indian Head	MEET Maybe Decreasing	FAIL	MEET DECREASING	FAIL DECREASING	MEET DECREASING	FAIL
Lower Potomac	Between Possom Pt and Moss Pt	MEET	FAIL	MEET	FAIL DECREASING	FAIL DECREASING	FAIL
Lower Potomac	Smith Point	MEET INCREASING	FAIL Maybe Decreasing	MEET	FAIL DECREASING	FAIL	MEET INCREASING
Lower Potomac	Maryland Point	MEET INCREASING	FAIL Maybe Decreasing	MEET Maybe Decreasing	FAIL DECREASING	FAIL	FAIL INCREASING
Lower Potomac	Morgantown	MEET Maybe Increasing	FAIL	MEET	FAIL DECREASING	FAIL	MEET Maybe Increasing
Lower Potomac	Ragged Point	FAIL	MEET	FAIL	MEET	MEET	MEET DECREASING
Lower Potomac	Point Lookout	MEET Maybe Increasing	MEET DECREASING	FAIL	MEET Maybe Decreasing	MEET	MEET Maybe Decreasing

Table 3. Summary of tidal habitat quality and water quality indicators in shallow water and tributaries to the main river.

Algal densities, water clarity, inorganic phosphorus and sediments either 'Meet' or 'Fail' SAV habitat requirements. Dissolved nitrogen levels below the level for nitrogen limitation 'Meet' criteria, otherwise 'Fail' criteria. Summer bottom dissolved oxygen levels above 3 mg/l 'Meet' criteria, otherwise 'Fail' criteria. Data is from the shallow water monitoring program (2007-2008). Gray boxes indicate there is no data to evaluate that component.

		Habitat Quality			Water Quality		
		Algal densities	Water Clarity	Summer Bottom Dissolved Oxygen	Nitrogen	Phosphorus	Sediments
Middle Potomac	Piscataway Creek	MEET	FAIL	MEET	FAIL	MEET	MEET
	Dogue Creek (VA)	MEET	FAIL	MEET	FAIL	MEET	MEET
	Pohick Bay (VA)	MEET	FAIL	MEET	FAIL	MEET	FAIL
	Occoquan Bay (VA)	MEET	MEET	MEET	FAIL	MEET	FAIL
	Neabsco Creek (VA)	FAIL	FAIL	MEET	FAIL	MEET	FAIL
	main river	MEET	MEET	MEET	FAIL	MEET	MEET
Lower Potomac	Matawoman Creek	MEET	MEET	MEET	FAIL	MEET	MEET
	Aquia Creek (VA)	MEET	FAIL	MEET	FAIL	MEET	MEET
	Potomac Creek (VA)	FAIL	FAIL	MEET	FAIL	MEET	FAIL
	Nanjemoy Creek	MEET	FAIL	MEET	FAIL	FAIL	FAIL
	Port Tobacco River	FAIL	FAIL	MEET	MEET	FAIL	FAIL
	Upper Machodoc Creek (VA)	FAIL	FAIL				FAIL
	Rosier Creek (VA)	FAIL	FAIL				FAIL
	Mattox Creek (VA)	FAIL	FAIL		FAIL	FAIL	FAIL
	Monroe Bay (VA)	FAIL	FAIL				FAIL
	Wicomico River	FAIL	FAIL	MEET	MEET	MEET	FAIL
	upper section of main river	MEET	FAIL	MEET	FAIL	FAIL	MEET
	Nomini Bay (VA)	FAIL	FAIL				FAIL
	St. Clements Bay	FAIL	FAIL	MEET	MEET	MEET	FAIL
	Breton Bay	MEET	MEET	MEET	MEET	MEET	FAIL
	Lower Machodoc Creek (VA)	FAIL	FAIL				FAIL
	St. Georges Creek	FAIL	FAIL	MEET	MEET	MEET	FAIL
	St. Marys River	MEET	MEET	MEET	MEET	MEET	MEET
	Smith Creek	MEET	MEET	MEET	MEET	MEET	MEET
	Yeocomico River (VA)	MEET	FAIL				MEET
	Coan River (Va)	FAIL	FAIL				FAIL
	lower section of main river	MEET	MEET	MEET	MEET	MEET	MEET

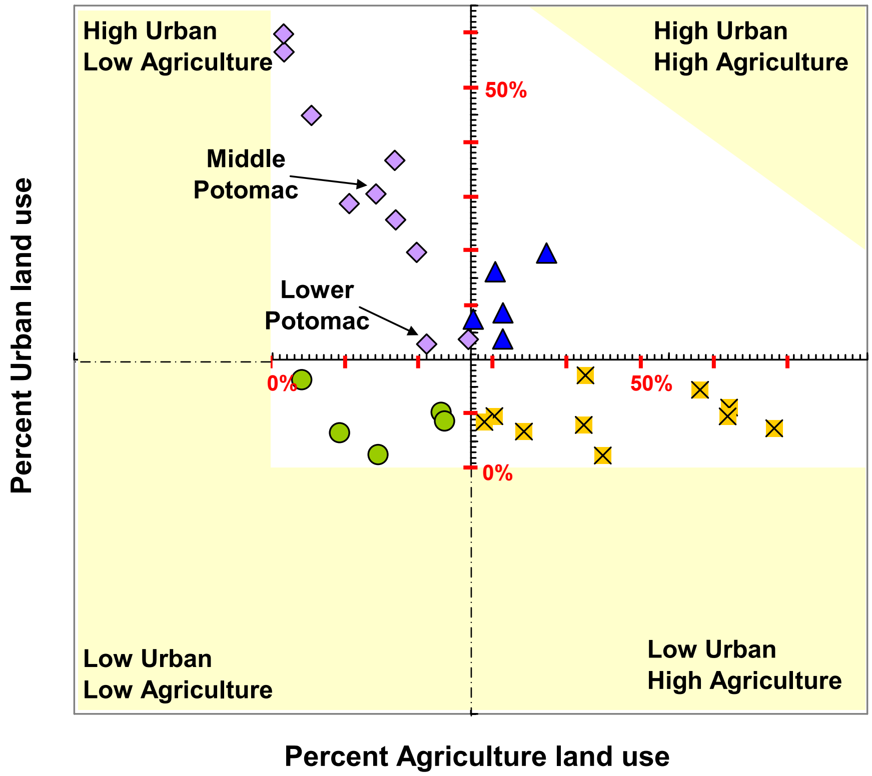

Figure 1. Classification of Maryland tidal tributaries using percent agriculture land use vs. percent urban land use.
The medians of all systems percent agriculture and percent urban land use are used to create a grid with four categories. Systems with percent urban less than the median are considered low urban. Systems with percent agriculture less than the median are considered low agriculture. Each system was categorized based on placement on the grid. Note that pale yellow areas are not mathematically possible (i.e. there is not a negative percent agriculture land use, and it is not possible for percent agriculture + percent urban to be greater than 100%). These groupings were used to evaluate each system relative to those other systems with similar land use characteristics.

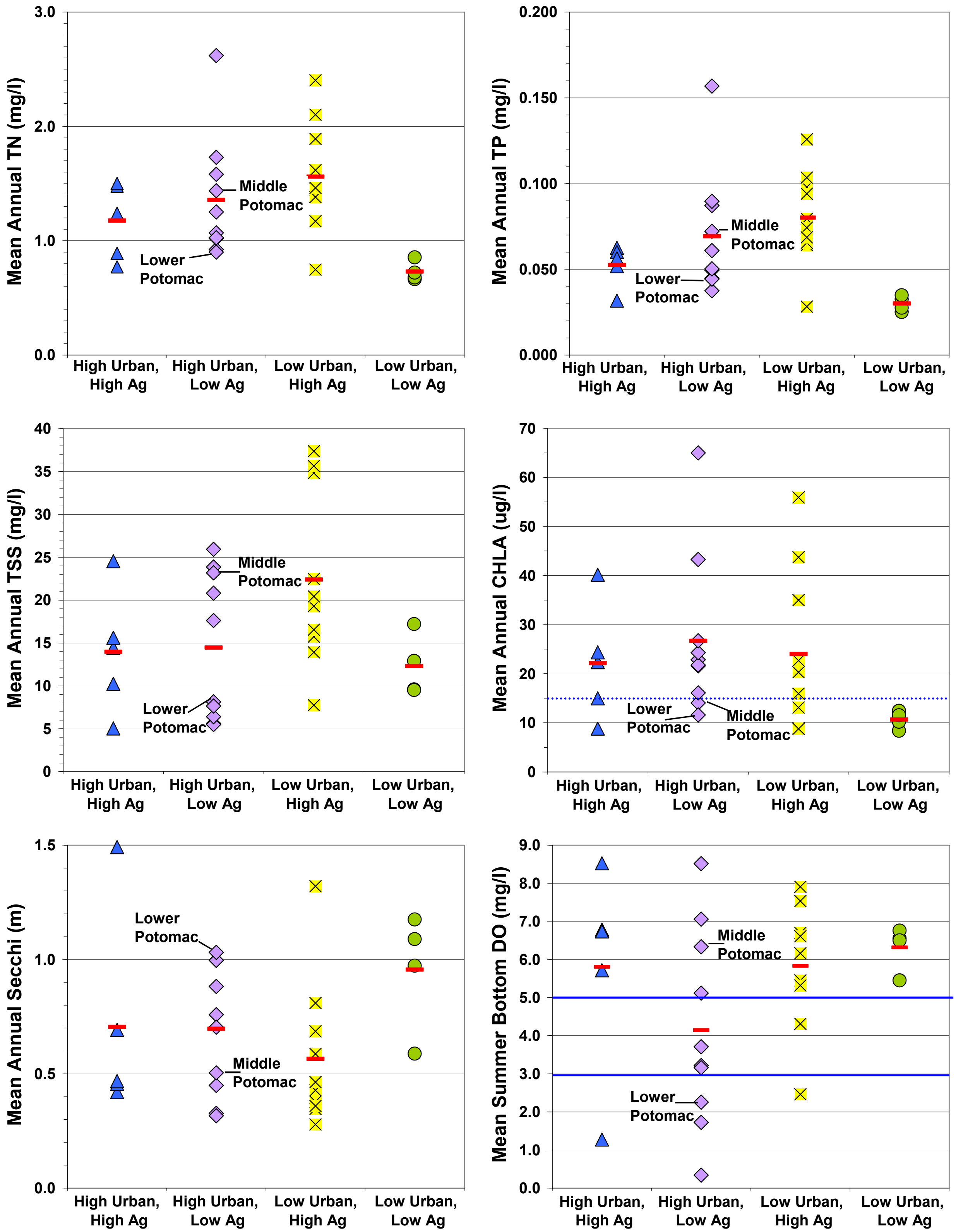

Figure 2. Comparison of the tidal Potomac to similar systems.
The mean annual concentration or depth (bottom dissolved oxygen is only summer) for 2010-2012 data. Total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), chlorophyll *a* (CHLA), Secchi depth and summer bottom dissolved oxygen (DO). Red bars indicate the mean of all systems within a category. Reference lines are included on the CHLA and summer bottom DO graphs.

Introduction

Water quality is measured as the level of nutrients and sediments in the water. Habitat quality is determined by how nutrients and sediments impact water clarity, algal populations and bottom dissolved oxygen levels. Habitat quality is also determined by salinity and water temperatures, but these measures are not changed by nutrients and sediments. Habitat quality determines if and where underwater grasses, fish and bottom dwelling animals can live. Reducing the levels of nutrients and sediments is a major focus of restoration efforts. The goal is to reduce nutrient and sediment levels so that habitat quality is improved and high quality habitat is expanded. Assessing water and habitat quality is an important first step in making decisions on what needs to be done to improve water and habitat quality.

Habitat quality can be assessed by looking at the health of the aquatic plants and animals that remain in the same location, such as underwater grasses and bottom dwelling animals. The health of these organisms depends on habitat that is suitable for growth and survival, so healthy organisms indicate healthy habitats. Changes in the populations of these plants and animals can often be linked to specific parts of habitat quality that are poor, such as water clarity or bottom dissolved oxygen. This additional information helps managers better pinpoint what needs to be changed to improve water and habitat quality.

Land use in a watershed is linked to the human population density. Rivers with high urban land uses have higher population densities and more impervious surfaces. Rivers with high agricultural land uses in rural areas have lower population densities and less impervious surfaces. Higher population densities are often linked to management of human wastes through wastewater treatment plants, while septic systems are more prevalent in areas with lower population density. Pollutant loadings from undeveloped lands such as forests are different from loadings from more developed areas. Information on human population and land use help managers decide the best methods for reducing nutrients and sediments going from the land into the water.

The Potomac River Water Quality and Habitat Assessment includes a variety of information. Land use data and census data are examined to understand how the watersheds are impacted by human uses. Loadings data is examined to identify how much nutrient and sediment is entering the non-tidal streams from the watershed. Data from long-term non-tidal and tidal water quality monitoring programs are examined for current water and habitat quality and changes over time. Data from monitoring in shallow water habitats are examined to determine water and habitat quality in the areas most important for underwater grasses and the organisms that live there. Data from monitoring of algal populations, underwater grasses and bottom dwelling organisms are examined to determine how well the resulting habitat quality supports healthy plant and animal populations.

Human Population and Land Use

Upper Potomac

The Upper Potomac watershed, which includes areas that drain to the Shenandoah and Monocacy Rivers, covers approximately 10,500 square miles in parts of Maryland, Pennsylvania, West Virginia and Virginia.[1] Larger cities include Cumberland, Hagerstown and Frederick. Overall, in 2010 there were approximately 1.5 million people living in the watershed (Figure 3).[2] Population density was low (10-100 people per square mile) in the western portion of the basin, with large areas of moderate population density (100-1,000 people per square mile) in the eastern portion of the basin and around Cumberland, MD, and high population density (>1,000 people per square mile) in cities.

In Maryland, the Upper Potomac basin includes 23 sub-watersheds in Garrett, Allegany, Washington, Frederick, Carroll and Montgomery counties (Figure 4). Land use differs between the western Upper Potomac (12 sub-watersheds) and eastern Upper Potomac (19 sub-watersheds). In 2010, approximately 75% of the land area in the western Upper Potomac basin in Maryland was forest, 13% was agriculture and 10% was urban.[3] In the eastern Upper Potomac Basin, land use was 44% agriculture, 29% forest and 22% urban. Between 2000 and 2010, land use in the western Upper Potomac was mostly unchanged, but in the eastern Upper Potomac urban land use increased by approximately 7% (Figure 5, Appendix 1). Urban land use increase was highest in the Catoctin Creek (13% increase) and Double Pipe Creek (8% increase) sub-watersheds. In 2010, impervious surface was greater than 5% in the sub-watersheds surrounding Tonoloway Creek (6%), Antietam Creek (6%), Lower Monocacy River (7%), Marsh Run (8%) and Conococheague Creek (10%) (Figure 6).

Stream health in most of the sub-watersheds in the Upper Potomac basin (on the Maryland side) is categorized as 'Poor' overall.[4] The exceptions are the Savage River sub-watershed which is categorized as 'Good' and the Potomac River Lower North Branch, Fifteen Mile Creek, Sideling Hill Creek and Upper Monocacy River sub-watersheds which are characterized as 'Fair'. A Watershed Restoration Action Strategy (WRAS) was developed in 2002 for the Georges Creek sub-watershed, in 2003 for the Lower Monocacy sub-watershed, and in 2004 for the Upper Monocacy sub-watershed.[5] Conococheague Creek and Lower Monocacy River sub-watersheds are Maryland Trust Fund medium priority watersheds.[6]

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[1] A portion of the Upper Potomac Tributary basin actually drains to the Middle Potomac River (see Figures 3 and 4). Population total for the Upper Potomac basin includes the approximately 40,000 people that live in Maryland in this section of the watershed.

[2] 2010 data from the U.S. Census Bureau available online at http://www2.census.gov/census_2010/04-Summary_File_1/

[3] Maryland Department of Planning data for 2010 available at http://www.planning.maryland.gov/OurWork/landuse.shtml

[4] Maryland Department of Natural Resources data available at www.streamhealth.maryland.gov/stream_health.asp

[5] Detailed reports are available at http://dnr.maryland.gov/watersheds/surf/proj/wras.html.

[6] For more information visit Baystat Trust Fund at www.baystat.maryland.gov/pdfs/2012workplan.pdf

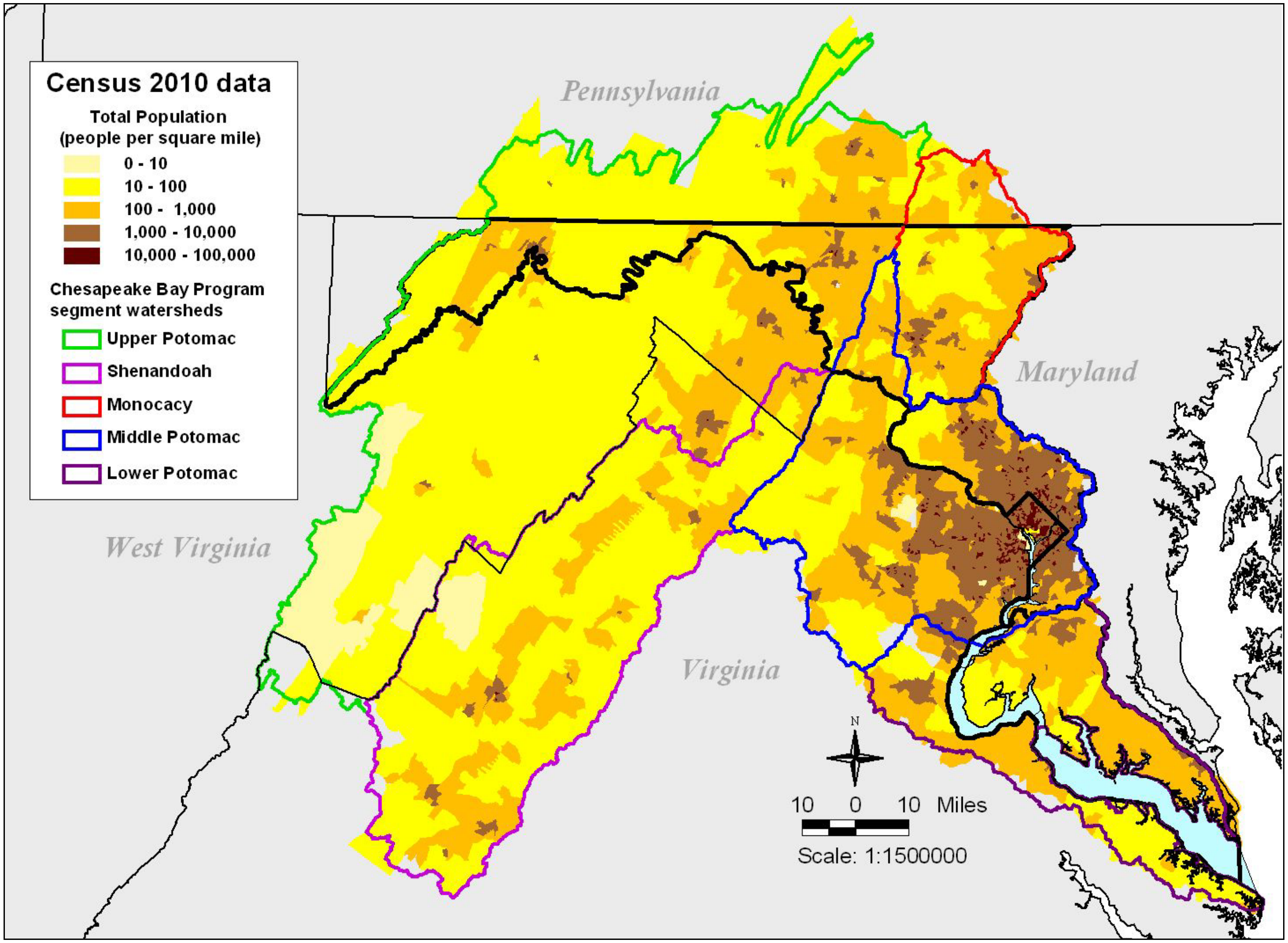

Figure 3. Entire Potomac basin 2010 Census data for total population by block group.
Total population per square mile is shown using a log scale. Pennsylvania, West Virginia and Virginia data are included for the corresponding watersheds that also drain to the Potomac (based on the Chesapeake Bay Program segment watersheds). Differences between the watershed boundaries and the Census bureau block groups' boundaries result in non-exact matching of the population data to the given watershed.

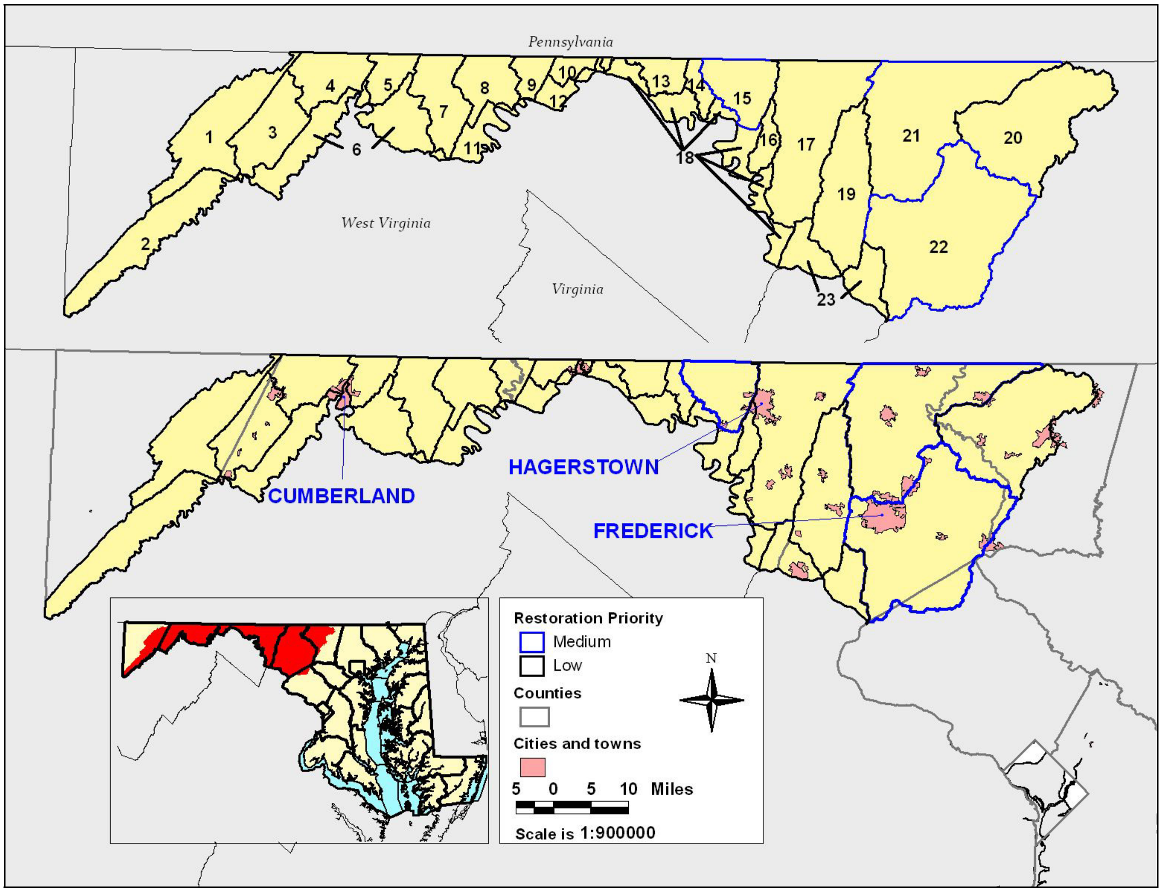

Figure 4. Upper Potomac watershed and sub-watersheds (8-digit).
Trust Fund Restoration Priority designation (medium, low) are shown in upper panel. Cities and towns and counties are shown in the bottom panel. Sub-watersheds (8-digit) in the Western Upper Potomac are: 1-Savage River, 2-Potomac River Upper North Branch, 3-Georges Creek, 4-Wills Creek, 5-Evitts Creek, 6-Potomac River Lower North Branch, 7-Town Creek, 8-Fifteen Mile Creek, 9-Sideling Hill Creek, 10-Little Tonoloway Creek, 11-Potomac River Allegany County, 12-Tonoloway Creek. Sub-watersheds in the Eastern Upper Potomac are: 13-Licking Creek, 14-Little Conococheague, 15-Conococheague Creek, 16-Marsh Run, 17-Antietam Creek, 18-Potomac River Washington County, 19-Catoctin Creek, 20-Double Pipe Creek, 21-Upper Monocacy River, 22-Lower Monocacy River, 23-Potomac River Frederick County.

Maryland has a number of programs in place to reduce the impacts of continued development and increasing amounts of impervious surfaces in the Upper Potomac River watershed.[7] Program Open Space projects have conserved 3,606 acres of land for outdoor recreation opportunities.[8] Rural Legacy Program projects have protected 11,222 acres, with special focus on areas with important cultural sites and natural resources and to ensure large areas of habitat. Maryland Environmental Trust projects have helped individual land owners protect 7,406 acres. Maryland Agricultural Land Preservation Program projects have preserved 7,483 acres of agricultural land from development.

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[7] For progress toward meeting restoration goals, see Maryland's BayStat website at http://www.baystat.maryland.gov/milestone_information.html. Data reported is through 2011 (updated 5/29/2013).
[8] Information on land conservation programs in Maryland is available at http://www.dnr.state.md.us/land/landconservation.asp

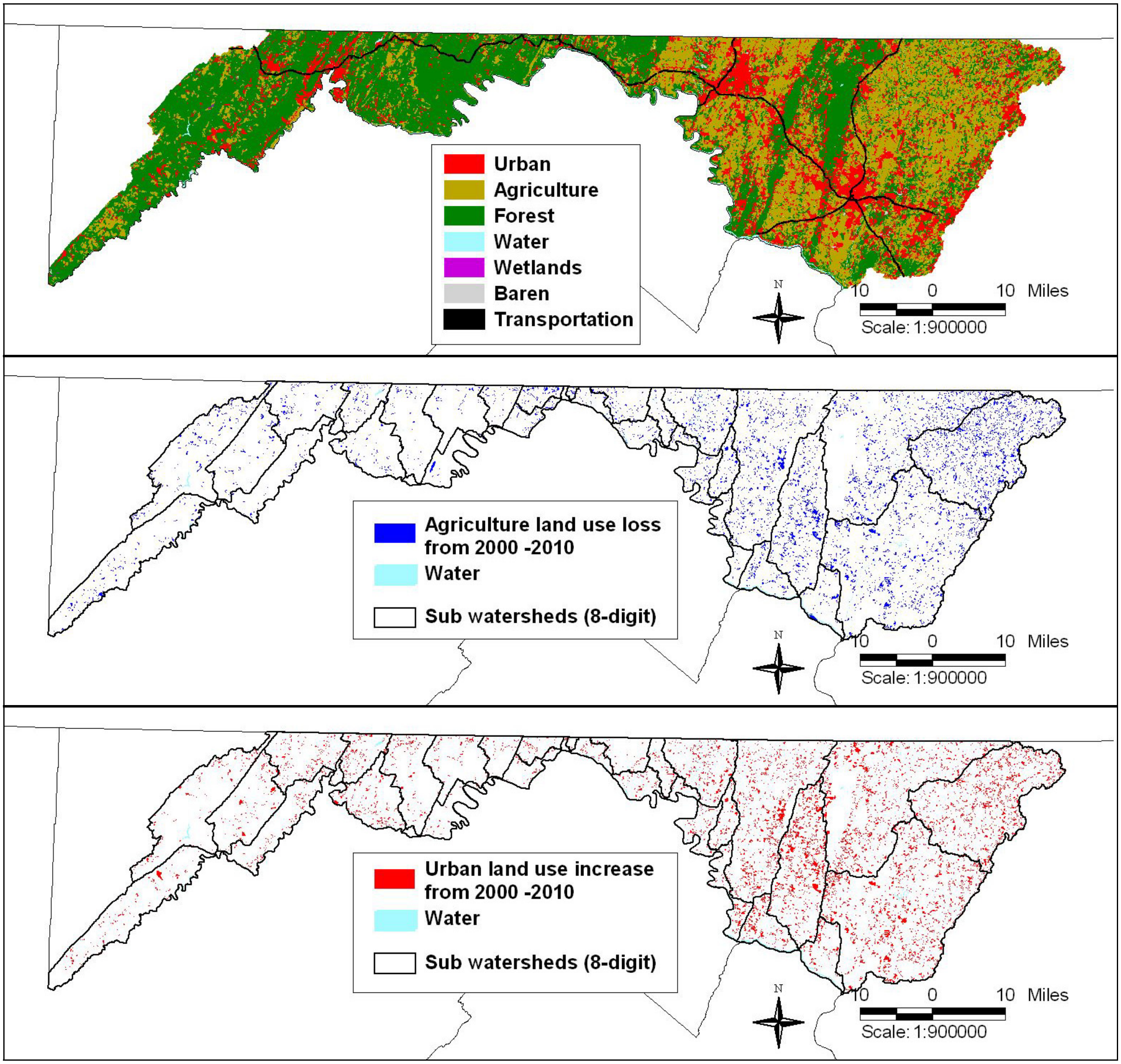

Figure 5. Upper Potomac land use/land cover data for 2010.
See Appendix 1 for detailed land use/land cover information. Top panel shows all land uses. Middle panel shows areas (in blue) that were in agriculture use in 2000 but no longer used for agriculture in 2010. Bottom panel shows areas (in red) that were not urban in 2000 but were converted to urban use by 2010.

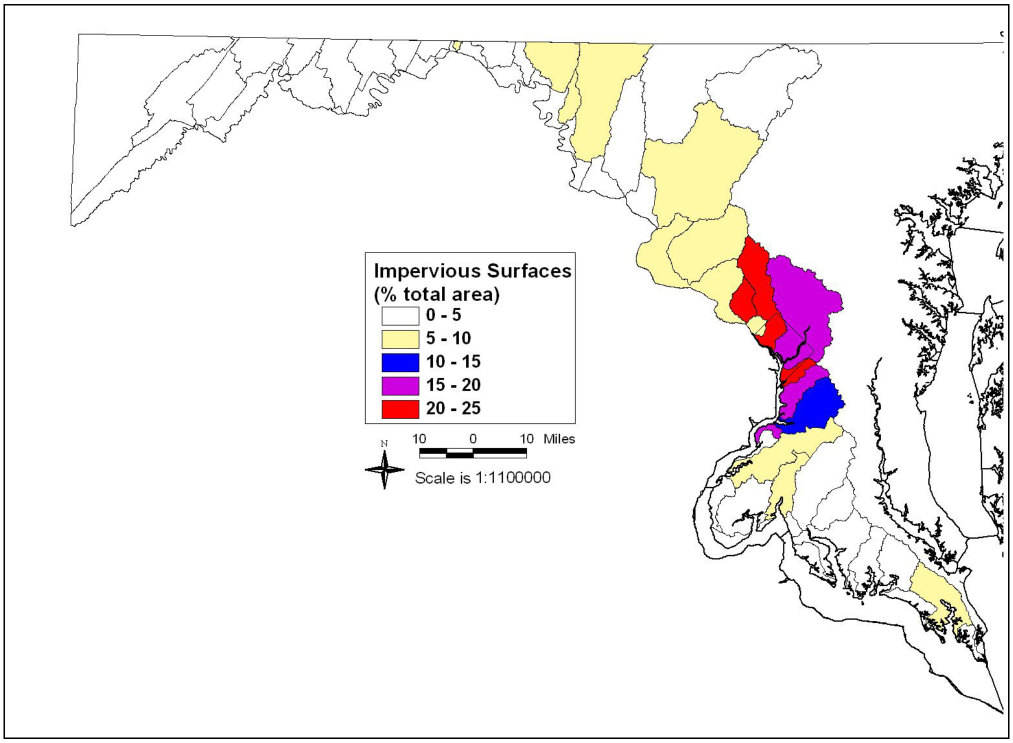

Figure 6. Percent Impervious Surfaces for the entire Potomac basin by sub-watershed for 2010. See Appendix 1 for detailed land use/land cover information.

Middle Potomac

The Middle Potomac watershed covers approximately 2,200 square miles in parts of Maryland and Virginia and includes all of the District of Columbia.[9] Overall, in 2010 there were approximately 4.3 million people living in the watershed. Population density was high (>1,000 people per square mile) or very high (>10,000 people per square mile) in the metropolitan areas, but moderate in some outer areas in Virginia (100-1,000 people per square mile).

In Maryland, the Middle Potomac basin includes 8 sub-watersheds in portions of Montgomery and Prince Georges counties (Figure 7). In 2010, nearly 56% of the land area in the middle Potomac Basin in Maryland was urban and 27% was forest.[10] In 2010 impervious surface was less than 10% in only the Seneca Creek sub-watershed (8%). Impervious surfaces covered between 10-20% in the Potomac River Montgomery County (10%), Piscataway Creek (12%) and Potomac River Upper tidal (18%) sub-watersheds. Impervious surfaces covered 20% or more of the Anacostia River (20%), Oxon Creek (21%), Rock Creek (21%) and Cabin John Creek (21%) sub-watersheds. Urban land use in the Anacostia River sub-watershed **decreased** from 2000 – 2010 by 10% (14 acres).

Stream health in the watersheds surrounding the middle Potomac River (on the Maryland side) is categorized as 'Poor' overall in all but the Seneca Creek sub-watershed which is categorized as

[9] See note 2 above. Population total for the Middle Potomac watershed does not include the approximately 40,000 people in Maryland that live in that section of the watershed
[10] Maryland Department of Planning data for 2010 available at http://www.planning.maryland.gov/OurWork/landuse.shtml

'Fair'.[11] All of the Middle Potomac sub-watersheds are Maryland Trust Fund high priority watersheds except Seneca Creek, which is a low priority watershed.[12]

Maryland has a number of programs in place to reduce the impacts of continued development and increasing amounts of impervious surfaces in the Middle Potomac River watershed.[13] Rural Legacy Program projects have protected 4,609 acres, with special focus on areas with important cultural sites and natural resources and to ensure large areas of habitat. Maryland Environmental Trust projects have helped individual land owners protect 81 acres. Maryland Agricultural Land Preservation Program projects have preserved 173 acres of agricultural land from development.

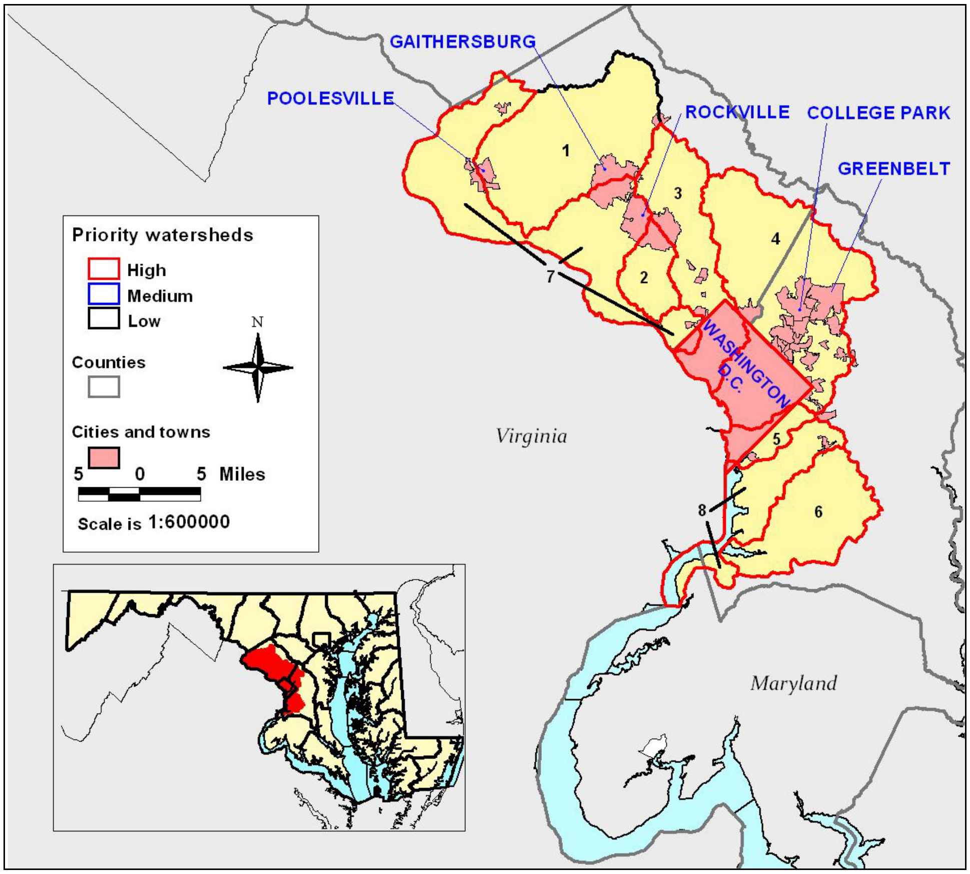

Figure 7. Middle Potomac watershed and sub-watersheds.
Trust Fund Restoration Priority designation (high, medium, low) and sub-watersheds (8-digit) are shown. Cities and towns and counties are also shown. Sub-watersheds are: 1- Seneca Creek, 2 - Cabin John Creek, 3- Rock Creek, 4- Anacostia River, 5- Oxon Creek, 6- Piscataway Creek, 7- Potomac River Montgomery County, 8- Potomac River Upper tidal. All sub-watersheds except Seneca Creek are High priority for restoration efforts.

[11] Maryland Department of Natural Resources data available at www.streamhealth.maryland.gov/stream_health.asp
[12] For more information visit Baystat Trust Fund at www.baystat.maryland.gov/pdfs/2012workplan.pdf
[13] For progress toward meeting restoration goals, see Maryland's BayStat website at http://www.baystat.maryland.gov/milestone_information.html. Data reported is through 2011 (updated 5/29/2013).

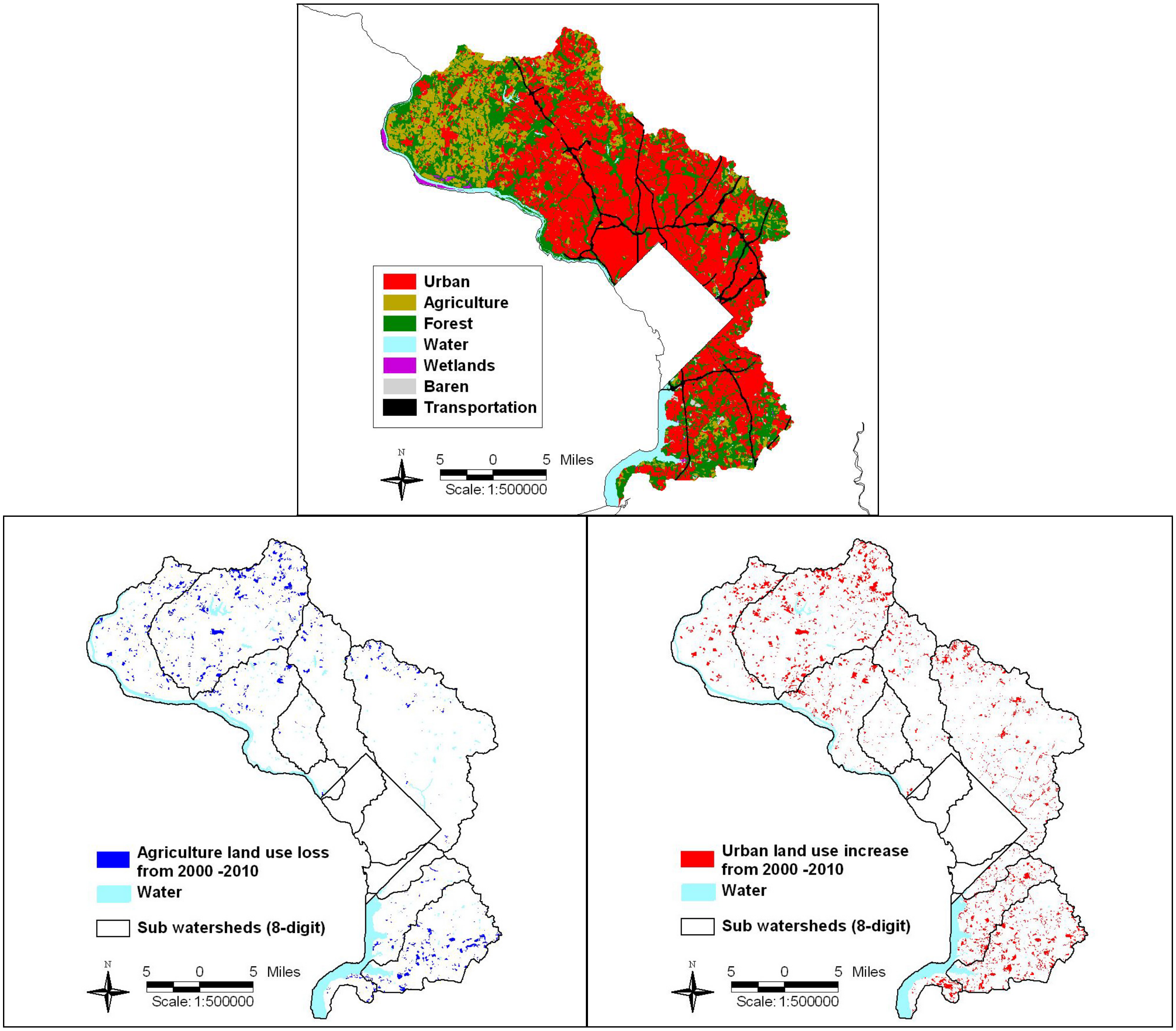

Figure 8. Middle Potomac land use/land cover data for 2010.
See Appendix 1 for detailed land use/land cover information. Top panel shows all land uses. Bottom left panel shows areas (in blue) that were in agriculture use in 2000 but no longer used for agriculture in 2010. Bottom right panel shows areas (in red) that were not urban in 2000 but were converted to urban use by 2010.

Lower Potomac

The Lower Potomac watershed covers approximately 1,400 square miles in parts of Maryland and Virginia. Overall, in 2010 there were approximately 430,000 people living in the watershed. Population density was moderate (100-1,000 people per square mile) in most of the Maryland side of the river, though some areas had low density (10-100 people per square mile) and some had high density (1,000-10,000 people per square mile).

In Maryland, the Lower Potomac River basin includes 10 sub-watersheds in portions of Charles, Saint Mary's and Prince Georges Counties (Figure 9). Larger cities in the basin include La Plata and Leonardtown.

In 2010, more than half of the land area in the Lower Potomac Basin in Maryland was forest. One-fourth of the basin was urban and one-fifth was agriculture.[14] Between 2000 and 2010, urban land-use increased by 9%, roughly half from forest and half from agricultural lands (Figure 10, Appendix 1). Transportation land use, though small in area covered, was 15 times larger in 2010 than in 2000, mostly in the Mattawoman and Port Tobacco watersheds. The increase in urban land use was greater than 10% in the watersheds surrounding St. Mary's River (14% increase), Breton Bay (14% increase), St. Clements Bay (11% increase), Gilbert Swamp (12% increase) and Port Tobacco River (11% increase). Impervious surface area in the entire basin increased from 3% to 4% from 2000 to 2010. In 2010 impervious surface was greater than 5% in the watershed surrounding the St. Mary's River (7%), Mattawoman Creek (8%) and Port Tobacco River (6%).

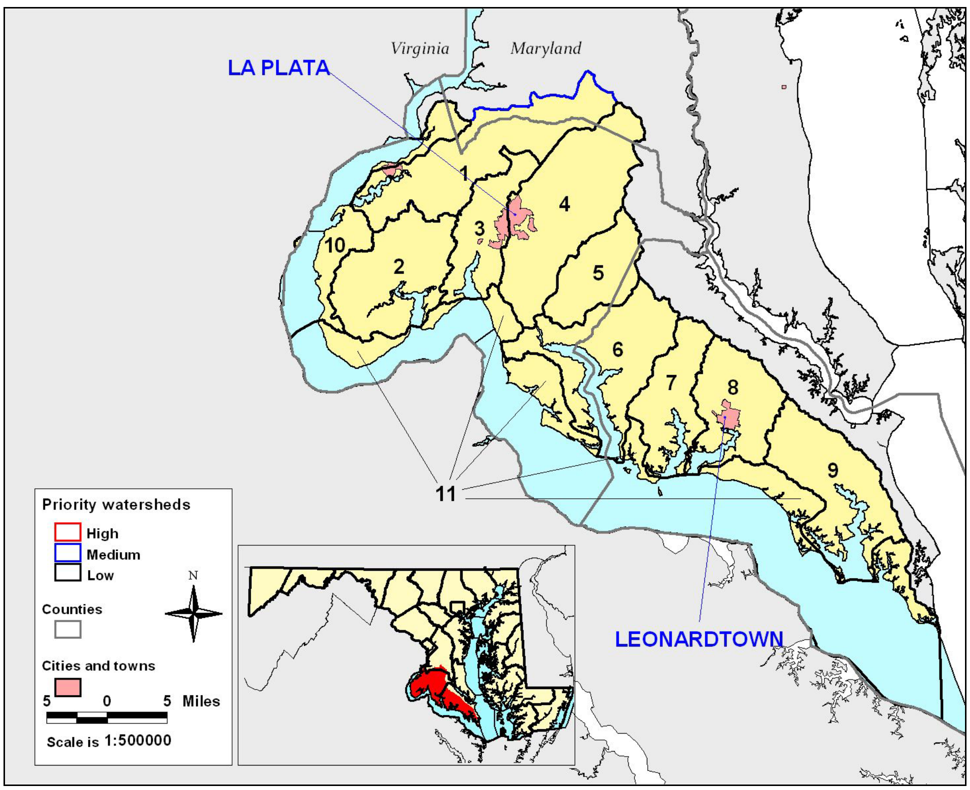

Figure 9. Lower Potomac basin sub-watersheds (8-digit).
Cities and counties are also shown. Sub-watersheds are: 1- Mattawoman Creek, 2-Nanjemoy Creek, 3- Port Tobacco River, 4- Zekiah Swamp, 5- Gilbert Swamp, 6- Wicomico River, 7- St. Clements Bay, 8- Breton Bay, 9- St. Mary's River, 10- Potomac River Middle tidal, 11- Potomac River Lower tidal.

[14] Maryland Department of Planning data for 2010 available at http://www.planning.maryland.gov/OurWork/landuse.shtml

Stream health in all of the sub-watersheds surrounding the Lower Potomac River (on the Maryland side) is categorized as 'Fair' overall.[15] A Watershed Restoration Action Strategy (WRAS) was developed in 2002 for the Breton Bay watershed and in 2006 for the Port Tobacco watershed.[16] All of the Lower Potomac sub-watersheds are Maryland Trust Fund low priority watersheds.[17]

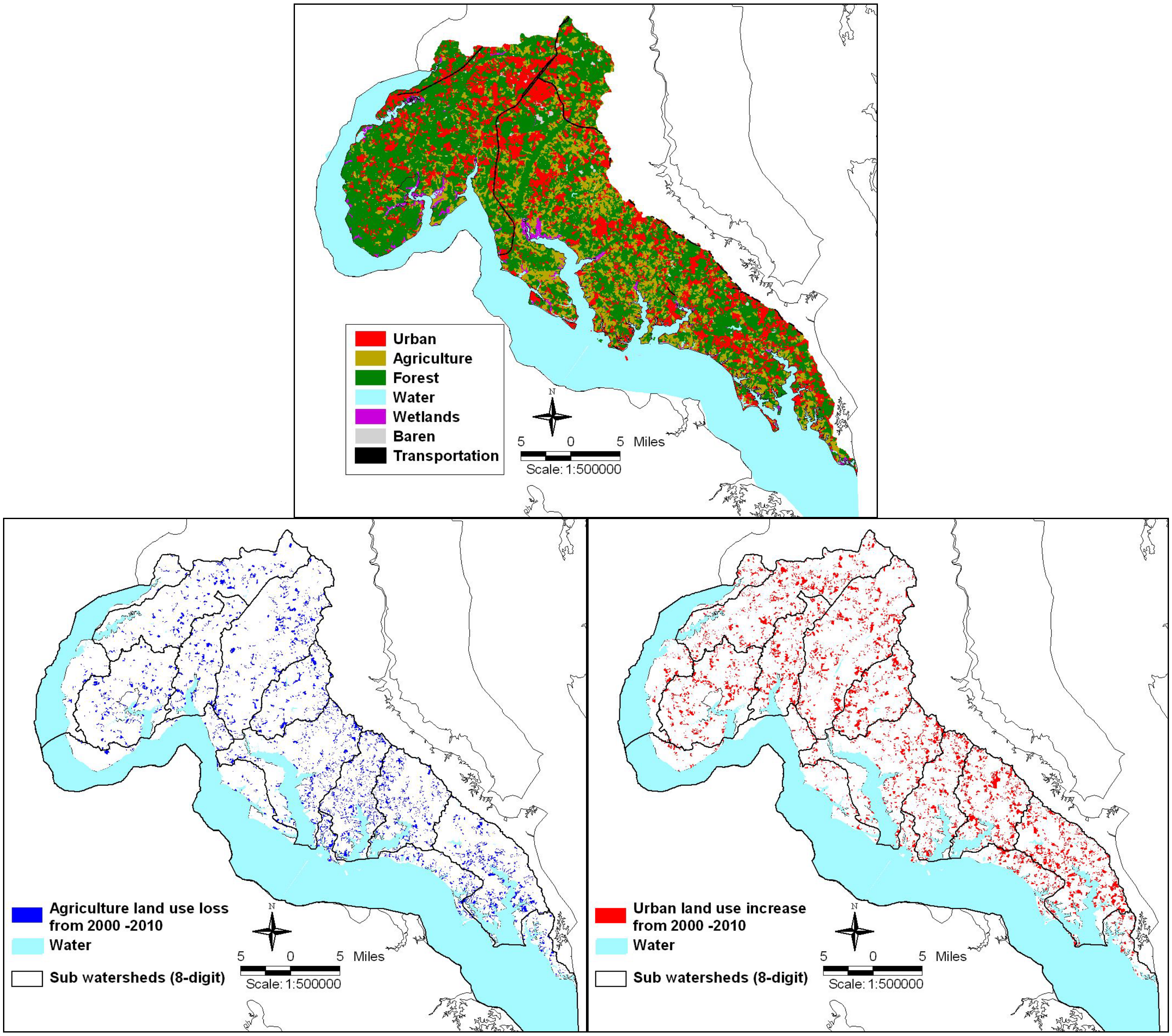

Figure 10. Lower Potomac land use/land cover data for 2010.
See Appendix 1 for detailed land use/land cover information. Top panel shows all land uses. Bottom left panel shows areas (in blue) that were in agriculture use in 2000 but no longer used for agriculture in 2010. Bottom right panel shows areas (in red) that were not urban in 2000 but were converted to urban use by 2010.

[15] Maryland. Department of Natural Resources data available at www.streamhealth.maryland.gov/stream_health.asp
[16] Detailed reports are available at http://dnr.maryland.gov/watersheds/surf/proj/wras.html.
[17] For more information visit Baystat Trust Fund at www.baystat.maryland.gov/pdfs/2012workplan.pdf

Maryland has a number of programs in place to reduce the impacts of continued development and increasing amounts of impervious surfaces in the lower Potomac River watershed.[18] Program Open Space projects have conserved 6,801 acres of land for outdoor recreation opportunities.[19] Rural Legacy Program projects have protected 2,566 acres, with special focus on areas with important cultural sites and natural resources and to ensure large areas of habitat. Maryland Environmental Trust projects have helped individual land owners protect more than 4,283 acres. Maryland Agricultural Land Preservation Program projects have preserved 3,690 acres of agricultural land from development.

Nutrient and Sediment Loadings

In accordance with the Chesapeake Bay Total Maximum Daily Load (TMDL), Maryland has developed a Watershed Implementation Plan (WIP) for making reductions in nitrogen, phosphorus and sediment loads to the Chesapeake Bay.[20] Maryland is required to reduce loads to Final Target loads by 2025. Maryland's Interim Target loads are set at 60% of the Final Target loads by 2017. Progress toward these Interim and Final Target loads is further broken into 2-year milestone loads.[21]

The Final Target Loads for the entire Potomac River are 15.29 million pounds per year of nitrogen, 0.94 million pounds per year of phosphorus and 731 million pounds per year of sediments. The information below is loadings in 2009. Loadings are estimated for each of the Chesapeake Bay Program tidal river segments only, so the tidal fresh Potomac segment captures loadings from the entire non-tidal region (Figure 11). The tidal fresh Potomac area includes all of the Upper and Middle Potomac basin, and part of the Lower Potomac basin. The oligohaline and mesohaline sections of the river are both in the Lower Potomac basin.

Tidal Fresh Potomac

The tidal fresh Potomac receives nitrogen, phosphorus and sediment loads from watershed areas in Maryland, Virginia, Pennsylvania, West Virginia and the District of Columbia (D.C.) (see Figure 11). As of 2009, the tidal fresh Potomac River received approximately 49.6 million lbs/yr of nitrogen from the watershed, with approximately 34% of the nitrogen load coming from Maryland and 36% of the nitrogen load coming from Virginia (Figure 12).[22] Approximately 43% of the nitrogen load from Maryland was from agriculture, and 21% was from wastewater treatment plants. Forest and urban runoff sources from Maryland were also important (approximately 17% and 14% of the nitrogen load, respectively). Nitrogen loadings sources

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[18] For progress toward meeting restoration goals, see Maryland's BayStat website at http://www.baystat.maryland.gov/milestone_information.html. Data reported is through 2011 (updated 5/29/2013).
[19] Information on land conservation programs in Maryland is available at http://www.dnr.state.md.us/land/landconservation.asp
[20] Maryland's Phase II Watershed Implementation Plan is online at www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Pages/FINAL_PhaseII_WIPDocument_Main.aspx
[21] Progress toward meeting the 2012-2013 milestones is available on BayStat at www.baystat.maryland.gov/milestone_information.html
[22] Pennsylvania, West Virginia and D.C. contributed approximately 12%, 12% and 6% of the nitrogen load to the tidal fresh Potomac, respectively. See Appendix 2 for more details.

from Virginia were similar: agriculture was approximately 44%, wastewater was 19%, forest was 20% and urban runoff was 15% of the nitrogen load from Virginia.

Phosphorus loadings to the tidal fresh Potomac totaled approximately 4.1 million lbs/yr, with loads from Virginia being the largest (44%), and smaller loads from Maryland (21%) and West Virginia (20%).[23] The largest source of phosphorus loadings from Maryland was agriculture (39%), and urban runoff and wastewater loadings were also important (26% and 22%, respectively). From Virginia, the largest source of phosphorus loadings was also agriculture (50%), and wastewater loadings (24%) and urban runoff (17%) were also important. From West Virginia, phosphorous loadings were from agriculture (57%), forest (21%) and wastewater (15%) sources.

Sediment loadings from the watershed to the tidal fresh Potomac totaled more than 2,400 million lbs/yr. Virginia was the largest contributor of sediment loadings to the tidal fresh Potomac (43% of the total sediment loadings). Maryland contributed 29% of the sediment loads.[24] The largest source of sediment loadings in Maryland was agriculture (61%), and urban runoff was also important (28%). Agriculture and urban runoff were also the largest sources of sediment loads in Virginia (69% and 19%, respectively).

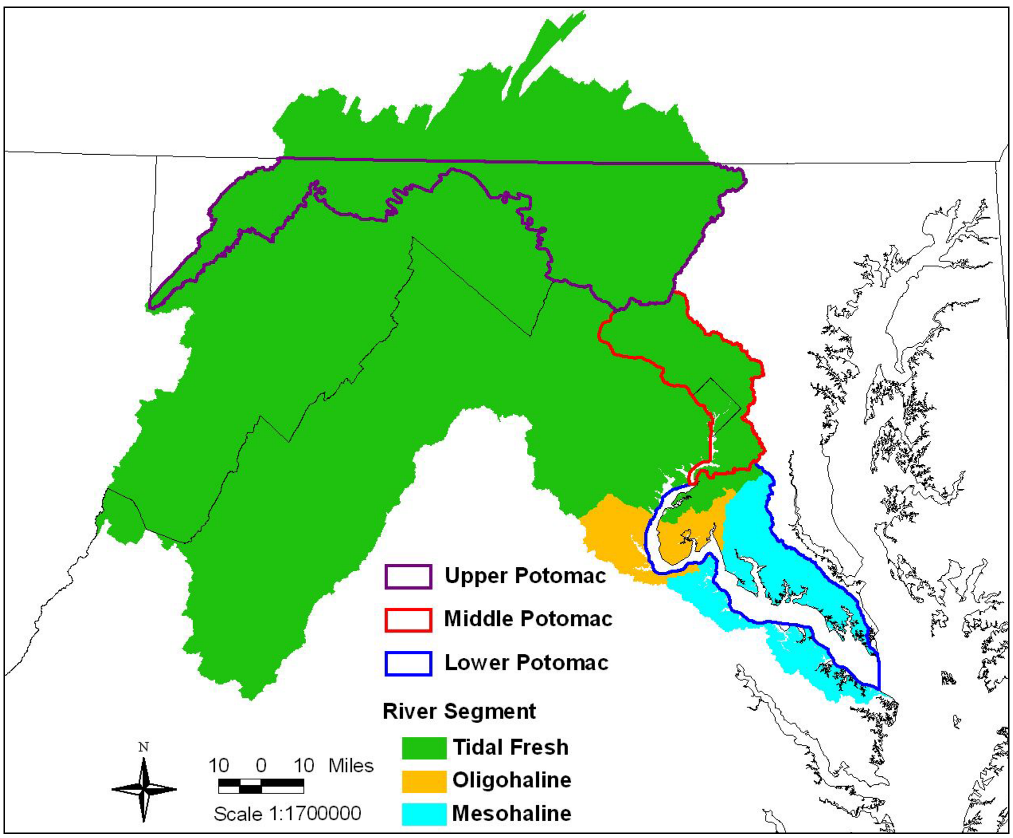

Figure 11. Watershed areas for the Potomac River by tidal river segment.
Note that the tidal fresh Potomac area includes all of the Upper and Middle Potomac basin, and part of the Lower Potomac basin. The oligohaline and mesohaline sections of the river are both in the lower Potomac basin. Loadings information is available by tidal river segment (tidal fresh, oligohaline, mesohaline).

[23] Pennsylvania and D.C. contributed approximately 13% and 2% of the phosphorus load to the tidal fresh Potomac, respectively.

[24] Pennsylvania, West Virginia and D.C. contributed 13%, 14% and 1% of the total sediment loads, respectively.

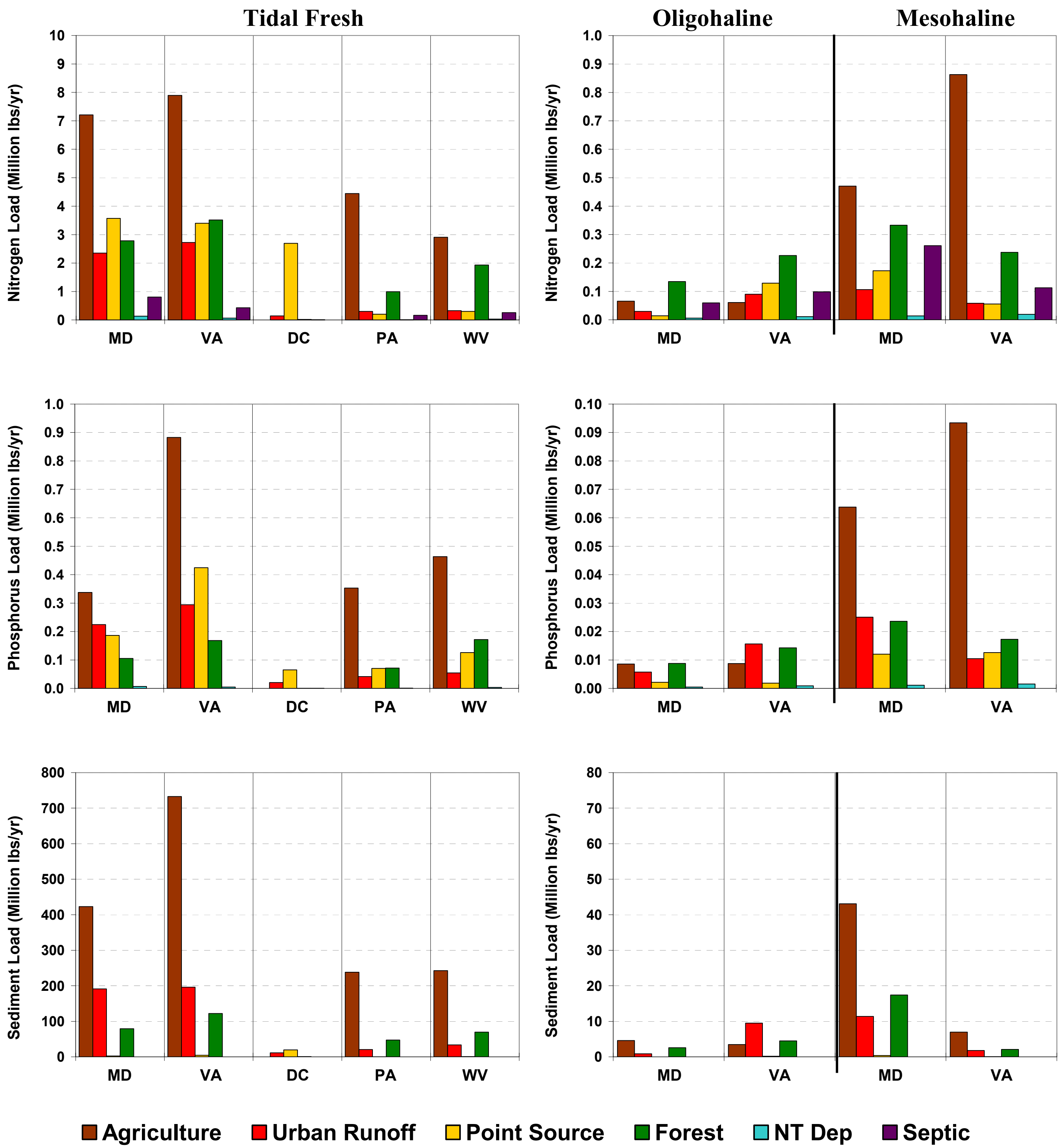

Figure 12. Nitrogen, phosphorus and sediment loadings per year.
Loadings are for 2009. Left-hand graphs show loadings to the tidal fresh area by state; right-hand graphs loadings to the oligohaline and mesohaline areas by state (refer to Figure 11 for areas). **Note that in the left-hand graphs, load scales are 10 times the right-hand graphs scale.** For more detailed information, see Appendix 2.

Oligohaline Potomac

The oligohaline Potomac receives nitrogen, phosphorus and sediment loads from watershed areas in Maryland and Virginia. As of 2009, the oligohaline Potomac River received approximately 1.0 million lbs/yr of nitrogen from the watershed, with approximately 40% of the nitrogen load coming from Maryland and 60% of the nitrogen load coming from Virginia. Approximately 38% of the nitrogen load from Maryland was from septic, and 33% was from forest. Agriculture sources from Maryland were also important (16%). Nitrogen loadings sources from Virginia were forest (37%), wastewater (21%), septic (16%) and urban runoff (15%).

Phosphorus loadings to the oligohaline Potomac totaled approximately 0.7 million lbs/yr, with loads from Virginia being the largest (62%), and smaller loads from Maryland (38%). The sources of phosphorus loadings from Maryland were forest (34%), agriculture (33%) and urban run-off (22%). From Virginia, the sources of phosphorus loadings were urban runoff (38%), forest (35%) and agriculture (21%).

Sediment loadings from the watershed to the oligohaline Potomac totaled almost 26 million lbs/yr. Virginia was the largest contributor of sediment loadings to the oligohaline Potomac (69% of the total sediment loadings). Maryland contributed 31% of the sediment loads. The largest source of sediment loadings in Maryland was agriculture (57%), and forest was also important (32%). Urban runoff, forest and agriculture were the largest sources of sediment loads in Virginia (54%, 26% and 20%, respectively).

Mesohaline Potomac

The mesohaline Potomac receives nitrogen, phosphorus and sediment loads from watershed areas in Maryland and Virginia. As of 2009, the mesohaline Potomac River received approximately 2.1 million lbs/yr of nitrogen from the watershed, with approximately 36% of the nitrogen load coming from Maryland and 64% of the nitrogen load coming from Virginia. Approximately 35% of the nitrogen load from Maryland was from agriculture, and forest, septic and wastewater sources were also important (25%, 19% and 13%, respectively). Nitrogen loadings sources from Virginia were agriculture (64%) and forest (18%).

Phosphorus loadings to the mesohaline Potomac totaled approximately 0.24 million lbs/yr, with loads from Virginia being the largest (57%), and smaller loads from Maryland (43%). The sources of phosphorus loadings from Maryland were agriculture (51%), urban runoff (20%) and forest (19%). From Virginia, the sources of phosphorus loadings were agriculture (69%) and forest (13%).

Sediment loadings from the watershed to the mesohaline Potomac totaled almost 66 million lbs/yr. Maryland was the largest contributor of sediment loadings to the mesohaline Potomac (83% of the total sediment loadings). Virginia contributed 17% of the sediment loads. The largest source of sediment loadings in Maryland was agriculture (60%), and forest (24%) and urban runoff (16%) were also important. Agriculture, forest and urban runoff were the largest sources of sediment loads in Virginia (64%, 19% and 16%, respectively).

Point Source Loads

Nutrient loadings from point sources (including wastewater treatment plants, WWTPs) are the easiest to measure. Point source loads are often the most cost-effective to manage. A major focus of management actions to reduce nutrient loads has been upgrades to WWTPs. In 2004 Maryland passed legislation creating the Chesapeake Bay Restoration Fund specifically to fund WWTP upgrades to enhanced nutrient removal (ENR).[25] The program is working to complete ENR upgrades to 67 major WWTPs, including 14 facilities in the Upper Potomac watershed, 5 facilities in the Middle Potomac watershed and 5 facilities in the Lower Potomac watershed.[26] As of 2012, 9 of the major WWTPs in the Potomac River Basin were operating ENR technology, and all but one (Blue Plains) are scheduled to be operating with ENR by 2016 (Figure 13).

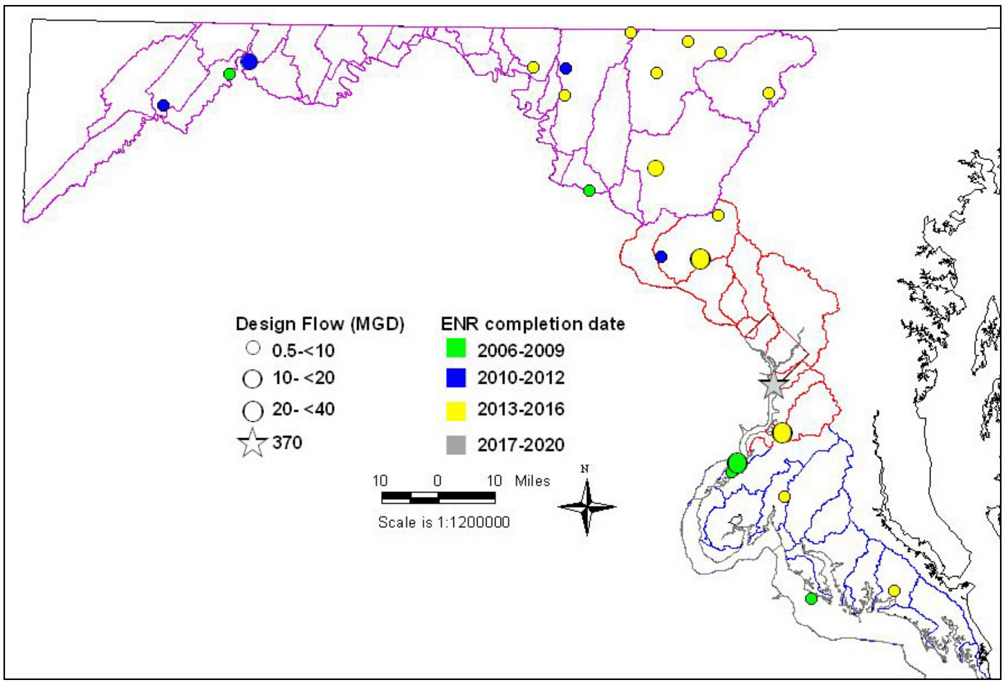

Figure 13. Wastewater treatment plant upgrades in the Potomac River Basin. Completion year of upgrades to Enhanced Nutrient Removal (ENR) at Maryland's major wastewater treatment plants in the Potomac Basin. Sub-watersheds in the Upper Potomac (purple lines), Middle Potomac (red lines) and Lower Potomac (blue lines) are also shown.

[25] The Chesapeake Bay Restoration Fund collects fees from wastewater treatment plant users to pay for the upgrades. A similar fee is paid by septic system users to upgrade onsite systems and implement cover crops to reduce nitrogen loading to the Bay. For more information on the Chesapeake Bay Restoration Fund see http://www.mde.state.md.us/programs/Water/BayRestorationFund/Pages/index.aspx.

[26] Major wastewater treatment plants (WWTP) are those with greater than 0.5 million gallons per day (MGD) design flow.

Through upgrades in technology at Blue Plains, TN and TP loads have dropped dramatically since 1985 (Figure 14). Between 1996-2000, Blue Plains upgraded to Biological Nutrient Removal (BNR) technology. In 2010, construction of upgrades to Enhanced Nutrient Removal (ENR) began at Blue Plains, and are scheduled to be completed by 2018.[27]

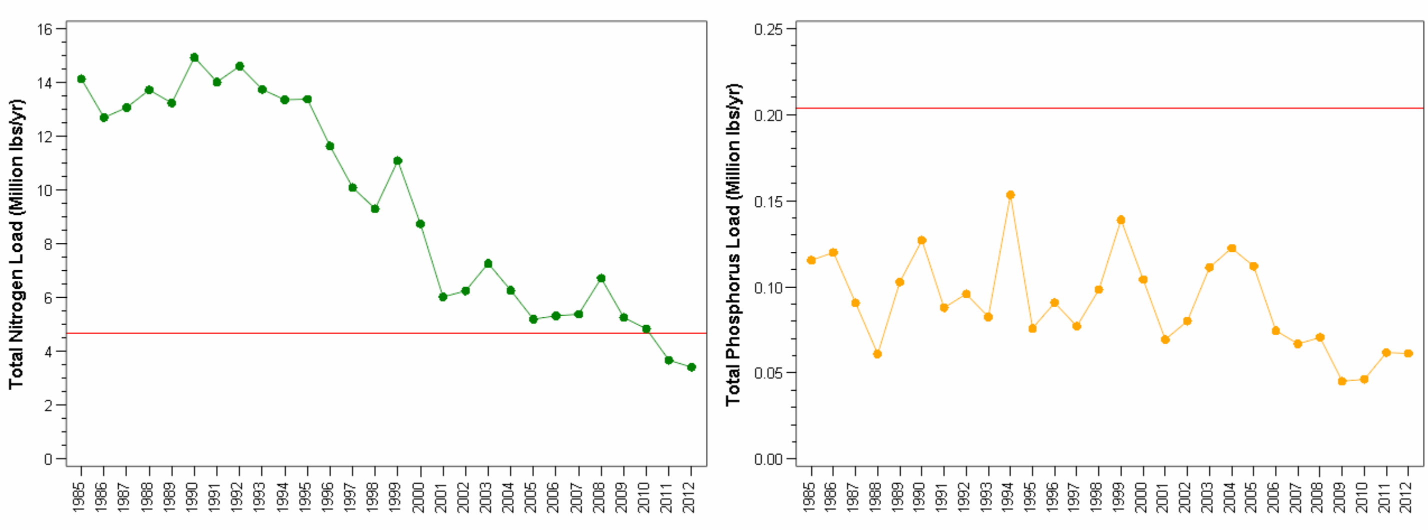

Figure 14. Annual total nitrogen and total phosphorus loadings from Blue Plains WWTP. Left graph is total nitrogen delivered load (million lbs/year) and right graph is total phosphorus load (million lbs/yr). Red horizontal line indicates the loading cap for the facility following implementation of Enhanced Nutrient Removal, scheduled to be completed by 2018.

The largest WWTPs in the Potomac River basin all discharge to the tidal fresh region of the river, including Blue Plains which is the largest advanced wastewater treatment plant in the **world**.[28,29] Blue Plains serves the District of Columbia and portions of Maryland and Virginia. The total design capacity is 370 MGD.

Four very large (greater than 10 MGD) WWTPs discharge to the Upper Potomac: Cumberland and Ballenger Creek in Maryland and North River and Opequon in Virginia (Figure 15). In the Middle Potomac, there are several very large facilities in addition to Blue Plains serving the District of Columbia and surrounding areas in Maryland and Virginia: Seneca Creek and Piscataway in Maryland and Leesburg, LCSA-Broad Run, Upper Occoquan S.A., Arlington Co., Alexandria S.A. and Fairfax Co.-Noman-Cole in Virginia. Two larger facilities discharge to the Lower Potomac River, Mattawoman in Maryland and PWCSA-H.L. Mooney in Virginia. Design flow and TN and TP loads from all of these largest facilities are shown in Figure 16. Overall, the single largest source of TN and TP delivered loads (in million lbs/year) is Blue Plains.

[27] BNR technology removes additional nitrogen than traditional methods, bringing nitrogen concentrations in effluent to below 8 mg/l. ENR reduces nitrogen concentrations to below 3 mg/l and phosphorus concentrations to below 0.3 mg/l in effluent.
[28] WWTPs that discharge to the Upper Potomac in West Virginia and Pennsylvania are all less than 10 MGD.
[29] For more information on Blue Plains, see http://www.dcwater.com/wastewater/blueplains.cfm.

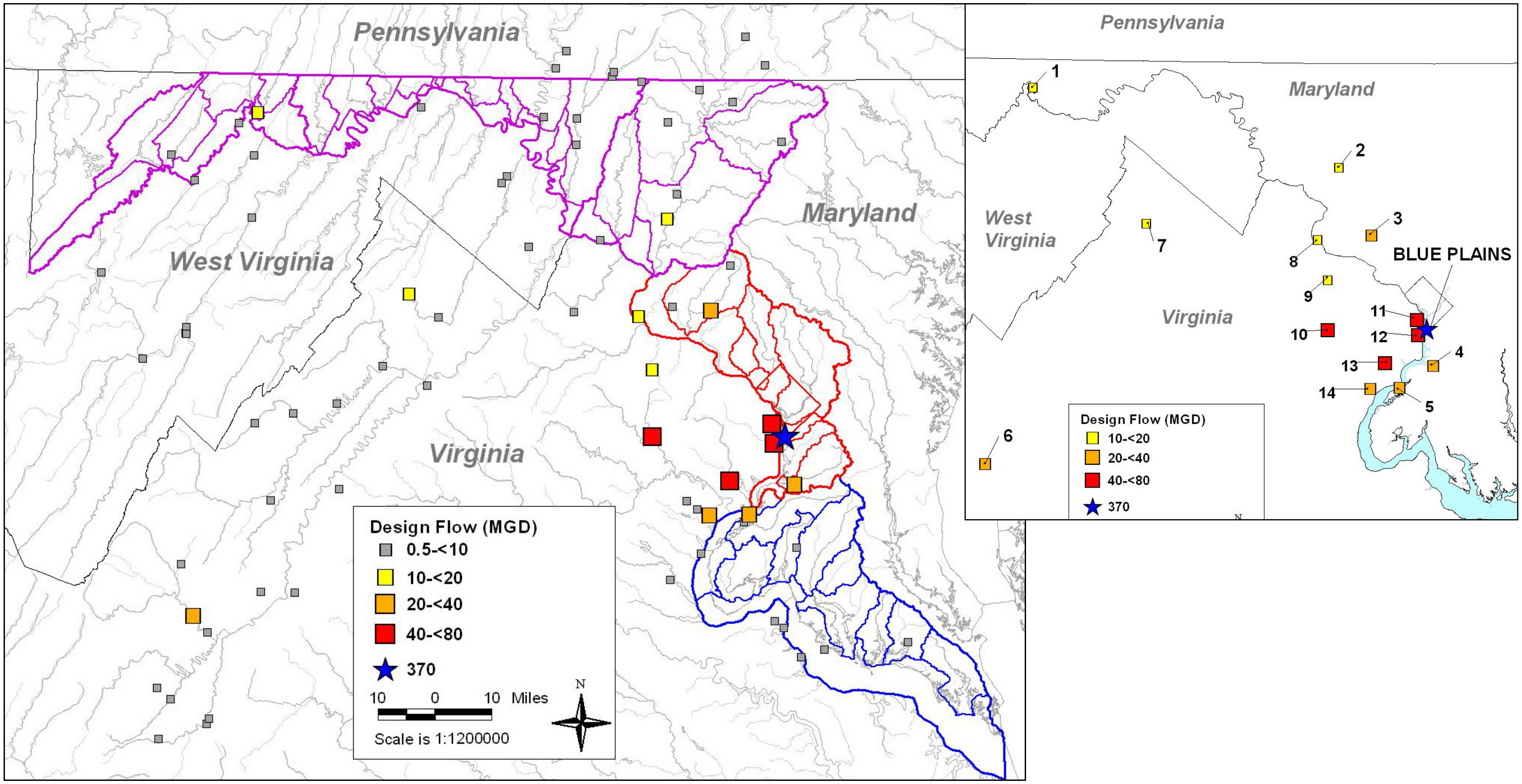

Figure 15. Largest wastewater treatment plants discharging to the Potomac River.
Main panel: Design flow (in million gallons per day, MGD) shown along with major tributaries (light grey lines) to the Potomac. Upper (purple lines), Middle (red lines) and Lower (blue lines) Potomac sub-watersheds in Maryland also shown. Blue Plains wastewater treatment plant (shown with blue star) is the largest single wastewater treatment plant discharging in the Potomac basin. Blue Plains serves Maryland, District of Columbia and Virginia. Insert panel: Maryland facilities greater than 10 MGD are: 1-Cumberland, 2-Ballenger Creek, 3-Seneca Creek, 4-Piscataway, and 5-Mattawoman. Virginia facilities greater than 10 MGD are: 6-HRRSA-North River, 7-Opequon, 8-Leesburg, 9-LCSA-Broad Run, 10-Upper Occoquan S.A., 11-Arlington Co., 12-Alexandria S.A., 13-Fairfax Co.-Noman-Cole, 14-PWCSA-H.L. Mooney.

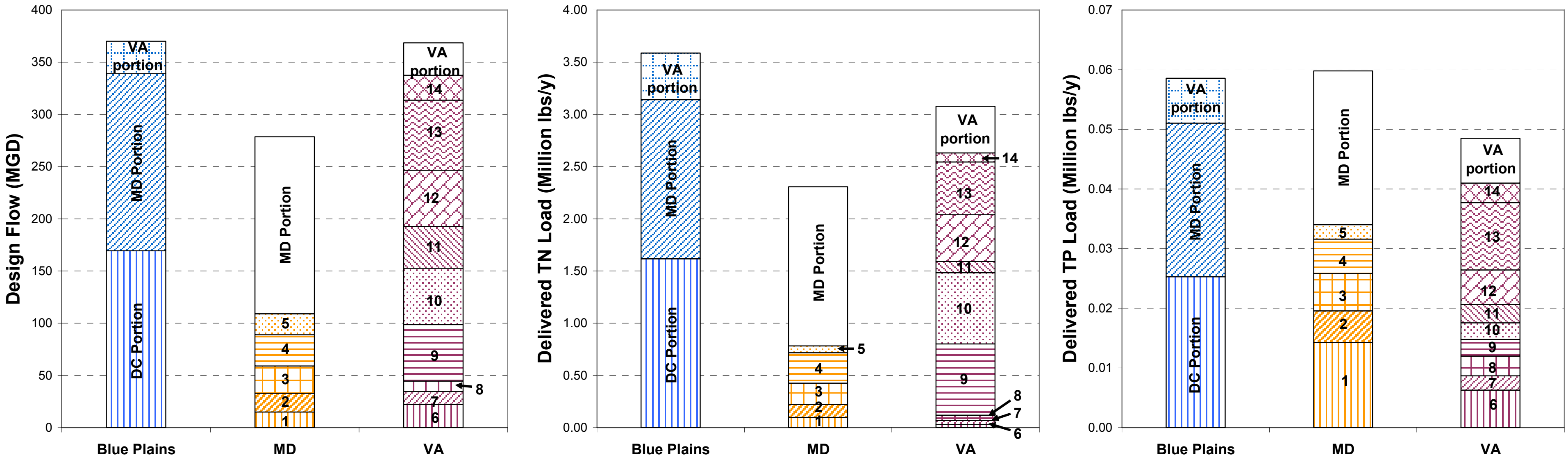

Figure 16. Relative comparison of TN and TP loadings to the Potomac River by state and facility for 2011.

Facility design flow (million gallons per day, left graph), delivered TN load (million lbs/yr, middle graph) and delivered TP load (million lbs/yr, right graph) for 2011 are shown. The largest facility, Blue Plains (blue bar to the left in each graph), serves District of Columbia (D.C.), Maryland (MD) and Virginia (VA). Maryland facilities greater than 10 MGD (middle bars in each graph) are: 1-Cumberland, 2-Ballenger Creek, 3-Seneca Creek, 4-Piscataway, and 5-Mattawoman. Virginia facilities greater than 10 MGD (right bars in each graph) are: 6-HRRSA-North River, 7-Opequon, 8-Leesburg, 9-LCSA-Broad Run, 10-Upper Occoquan S.A., 11-Arlington Co., 12-Alexandria S.A. , 13-Fairfax Co.-Noman-Cole, 14-PWCSA-H.L. Mooney (see Figure 13 for locations). Note that the Maryland and Virginia portions of Blue Plains loadings are also included at the top of the individual states bars (in white) to allow comparison between not only the relative contribution of Blue Plains to the rest of the wastewater treatment plants overall, but also the relative comparison of D.C., Maryland and Virginia loadings. D.C. and VA portions of Blue Plains loads are estimated from reported overall loads from Blue Plains (Quarterly Influent, Effluent and Biosolids Analysis reports provided by W. Bailey, District of Columbia Water and Sewer Authority), the Maryland portion loads reported by Maryland Dept. of the Environment (P. Pripali, Maryland Dept. of the Environment, personal communication), and the percentages allocated to each jurisdiction in the Blue Plains Intermunicipal Agreement of 2012 (http://www.mwcog.org/uploads/pub-documents/u15dVlc20130506094101.pdf). Virginia loadings information from Virginia Dept. of Environmental Quality (http://www.deq.virginia.gov/Programs/Water/PermittingCompliance/PollutionDischargeElimination/NutrientTrading.aspx).

Non-Point Source Loads

In 1998, Maryland passed the Water Quality Improvement Act, which requires farmers to reduce nitrogen and phosphorus loadings from agricultural lands.[30] Soil Conservation and Water Quality Plans (SCWQPs) are developed to determine what the appropriate actions, or best management plans (BMPs), are for a given area.[31] Each of Maryland's counties has a Soil Conservation District Office with staff to help farmers develop and implement SCWQPs. The total number of BMPs in place in the basin as a whole (not by individual farm) is used to measure progress.[32]

Agriculture is a major source of nitrogen, phosphorus and sediment loadings from Maryland to all sections of the Potomac, so BMPs that address agricultural sources are important.[33] In the Upper and Middle Potomac basins (corresponding to the tidal fresh region of the river), by 2011:

- More than 67,000 acres of cover crops were planted in between growing seasons to absorb excess nutrients and prevent sediment erosion.
- Fencing on more than 13,200 acres of farmland was used to keep livestock out of streams and prevent streambank erosion.
- More than 1,200 containment structures had been built to store animal wastes to allow these nutrients to be applied to the land in the most effective manner at the appropriate time.
- Almost 19,000 acres of stream buffers were in place, allowing areas next to streams to remain in a natural state with grasses, trees and wetlands.

In the Lower Potomac basin (corresponding to the oligohaline and mesohaline sections of the river):

- Almost 14,400 acres of cover crops were planted
- Fencing was used on more than 530 acres of farmland
- More than 50 containment structures had been built to store animal wastes
- Almost 3,300 acres of stream buffers were in place

Urban runoff is important to phosphorus and sediment loadings in the Upper and Middle Potomac basins, and septic sources are also important to nitrogen loads from Maryland in the Lower Potomac. Stormwater retrofits have reduced nitrogen loadings from urban and suburban sources and prevented more than 39,000 pounds of nitrogen in the Upper and Middle Potomac and almost 2,500 pounds of nitrogen in the Lower Potomac from entering streams. In the Lower Potomac almost 175 septic upgrades have been completed.

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[30] For more information, please see the Maryland Department of Agriculture website http://mda.maryland.gov/resource_conservation/Pages/nutrient_management.aspx

[31] For more information see http://mda.maryland.gov/resource_conservation/Documents/scwqplan.pdf

[32] Progress on different BMPs is available at http://www.baystat.maryland.gov/milestone_information.html Progress through 2011, as available 5/29/2013.

[33] Note that while loadings information is present by river segment (tidal fresh, oligohaline, mesohaline, see Figure 11), progress is tracked by river basin (Upper Potomac, Middle Potomac, Lower Potomac).

Water and Habitat Quality

Assessment methods are described in Appendix 4. For non-tidal and tidal stations, the following parameters were evaluated: total nitrogen (TN), total phosphorus (TP) and total suspended solids (TSS). For tidal stations, additional parameters were evaluated: dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (PO_4), algal abundance (as measured by chlorophyll *a*, CHLA), water clarity (as measured with a Secchi disc), summer bottom dissolved oxygen (BDO), salinity and water temperature.

Selected graphical results are included with the text. Non-tidal and tidal water quality trends results discussed in the text refer to the 1999-2012 trends. Significant trends for 1985-2012 (tidal) or 1986-2012 (non-tidal) are noted in the footnotes. Seasons for 1999-2012 tidal trends are: spring (March-May), summer (July-September)[34] and SAV growing season (Apr-October). In addition to trends, current conditions for 2010-2012 are described. Summary results are presented in Table 1 and Table 2 in the 'Overall Assessment' section. Detailed tabular results tabular results are included in Appendices 6, 7 and 8.

Non-tidal streams

Non-tidal water quality monitoring is done year-round at to characterize conditions in free-flowing freshwater. Maryland has thirty long-term non-tidal stations in the Upper Potomac watershed and six in the Middle Potomac watershed (Figure 17, Appendix 3). Samples are collected once a month. For these sites, only surface measurements are collected.

Stream gauges collect flow data at six stations in the Upper Potomac watershed in Maryland (GEO0009, WIL0013, CON0180, ANT0047 which is close to non-tidal station ANT0044, CAC0148, and MON0528) and one station in the Middle Potomac watershed in Maryland (USGS River Input Program station at Chain Bridge, Figure 17). The United States Geological Survey (USGS) uses the flow data and the nutrient data to calculate nitrogen, phosphorus and sediment loadings from the streams to the river.[35]

[34] For summer bottom dissolved oxygen analysis, the months used are June-September.

[35] For USGS methods see http://md.water.usgs.gov/publications/sir-2006-5178/index.html

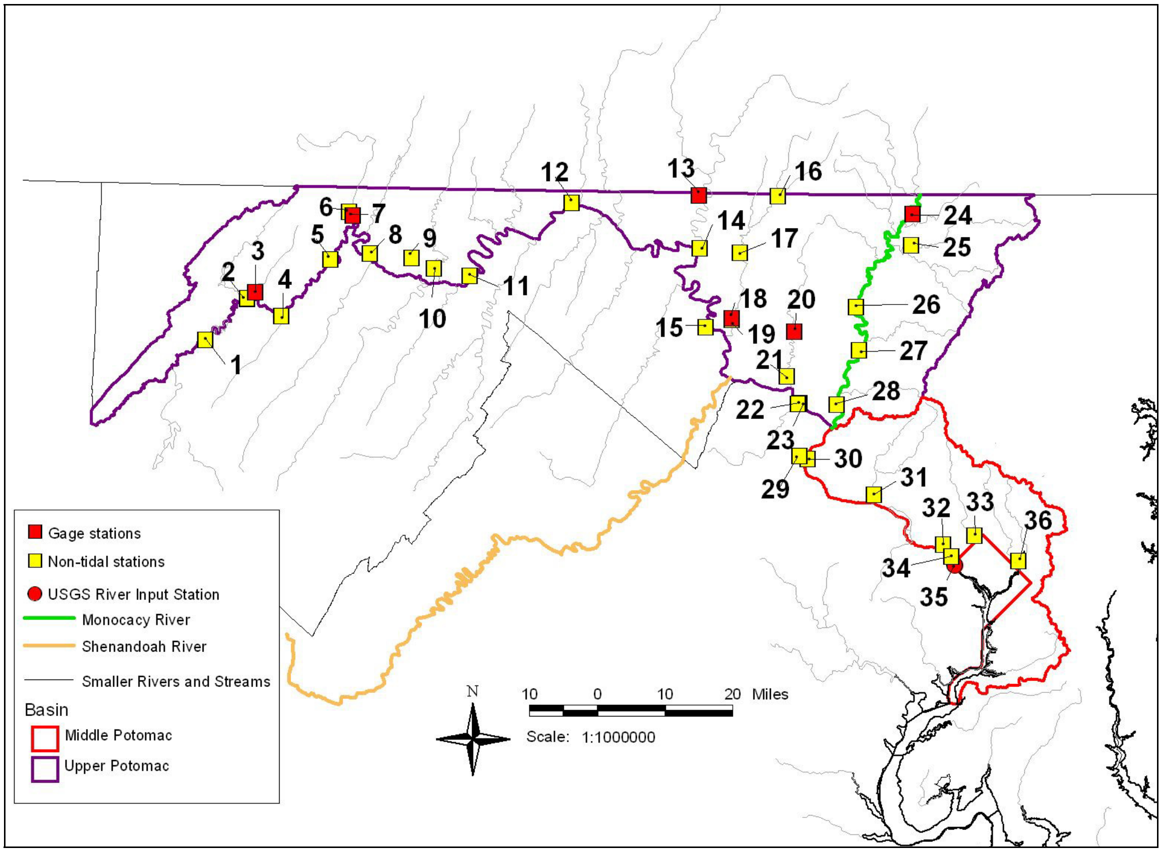


Figure 17. Long-term non-tidal water quality monitoring stations.
Stations are: 1) NBP0689, 2) NBP0534 and SAV0000, 3) **GEO0009** (USGS gage 01599000) , 4) NBP0461, 5) NBP0326, 6) BDK0000, 7) **WIL0013** (USGS gage 01601500), 8) NBP0103, 9) NBP0023, 10) TOW0030, 11) POT2766, 12) POT2386, 13) **CON0180** (UGSG gage 01614500), 14) CON0005, 15) POT1830, 16) ANT0366, 17) ANT0203, 18) **ANT0047** (USGS gage 01619500), 19) ANT0444, 20) **CAC0148** (USGS Gage 01637500), 21) CAC0031, 22) POT1596, 23) POT1595, 24) **MON0528** (UGSG gage 01639000), 25) BPC0035, 26) MON0269, 27) MON0155, 28) MON0020, 29) POT1472, 30) POT1471, 31) SEN0008, 32) CJB0005, 33) RCM0111, 34) POT1184, 35) USGS RIM station 01646580), 36) ANA0082. Stations in **BOLD** are USGS gage stations (red squares). See Appendix 3 for station description and information.

Upper Potomac

Western Upper Potomac

The western portion of the Upper Potomac basin includes thirteen non-tidal monitoring stations on the North Branch Potomac, Savage River, Georges Creek, Braddock Run, Wills Creek, Town Creek and the Potomac River downstream to US Rt.522 near Hancock, Maryland (stations 1-12 on Figure 17). Two USGS gage stations are also in the western Upper Potomac basin. Nitrogen levels decreased at ten of the thirteen stations, but increased at the most upstream station on the main North Branch Potomac (NBP0689) (Figure 18).[36] Nitrogen loadings at the USGS gage

[36] TN decreased at all thirteen stations in the western Upper Potomac from 1986-2012 but non linear trends at NBP0689 and SAV0000 indicate TN levels increased starting in the early to mid 2000s at those two stations.

station on Wills Creek (WIL0013) significantly decreased, but not at the station on Georges Creek (GEO0009) (Figure 19).[37]

Phosphorus levels decreased at the four downstream stations on the North Branch Potomac (NBP0461, NBP0326, NBP0103, NBP0023) but not in any of the tributaries to the main river.[38] However, phosphorus loadings at the Wills Creek USGS gage station significantly increased (Figure 20).[39] Sediment levels increased at the two upstream main river stations (NBP0689, NBP0534) at the mouth of Savage River (SAV0000) and in Georges Creek (GEO0009), but decreased at the most downstream main river station (POT2386).[40] Sediment loadings also increased at the Georges Creek station (Figure 21).[41]

Eastern Upper Potomac

The eastern portion of the Upper Potomac basin includes eleven non-tidal monitoring stations on Conococheague Creek, Antietam Creek, Catoctin Creek and the Potomac River downstream to the mouth of the Monocacy River (stations on Figure 13-23 on Figure 17). Three USGS gage stations are also in the eastern Upper Potomac basin. Nitrogen levels increased in Concocococheague Creek and Antietam Creek, but decreased at the main river the station on the Virginia side near Point of Rocks (POT1596).[42] There were no significant trends in nitrogen loadings.[43]

Phosphorus levels decreased at all non-tidal stations except one station on Antietam Creek (ANT0366).[44] Phosphorus loadings at the USGS gage station on Conococheague Creek and Catoctin Creek also decreased.[45] Sediment levels decreased in Conococheague Creek (CON0005) and Antietam Creek (ANT0366, ANT0203) and may have decreased in Catoctin Creek (CAC0031).[46] There were no significant trends in sediment loadings.[47]

[37] TN loadings decreased at both USGS gage stations in western Upper Potomac from WY1985-2011. Non-tidal loadings trends are from USGS (http://cbrim.er.usgs.gov/loads_query.html) and are analyzed by water year (WY), October-September.
[38] TP decreased at four main river stations (NBP0461, NBP0326, NBP0103, NBP0023) and in Georges Creek (GEO0009) in the western Upper Potomac from 1986-2012, and may have decreased at one more main river station (POT2386).
[39] TP loadings decreased at both USGS gage stations in western Upper Potomac from WY1985-2011.
[40] TSS levels decreased at NBP0326 and POT2386 and may have decreased at NBP0023 from 1986-2012, but a non-linear trend at NBP0534 indicates that TSS levels increased starting in the early 2000s.
[41] There were no long-term trends in sediment loadings at either of the western Upper Potomac stations.
[42] Non-linear trends at all but three stations in the eastern Upper Potomac indicate that TP levels increased starting in the early 2000s despite overall declines from 1986-2012. Only one station on Catoctin Creek (CAC0148) and the two stations at Point of Rocks (POT01596, POT01595) had decreasing TP trends for 1986-2012.
[43] Nitrogen loadings at all three USGS gage stations in the eastern Upper Potomac decreased from WY1985-2011.
[44] TP levels decreased at all non-tidal stations in the eastern Upper Potomac basin 1986-2012.
[45] Phosphorus loadings decreased at all three USGS gage stations from WY1985-2011.
[46] TSS levels decreased at ANT0366, ANT0203 and CAC0031, and may have decreased at CON0005 and ANT0044 from 1986-2012.
[47] Sediment loadings increased from WY1985-2011 at the USGS gage station on Catoctin Creek.

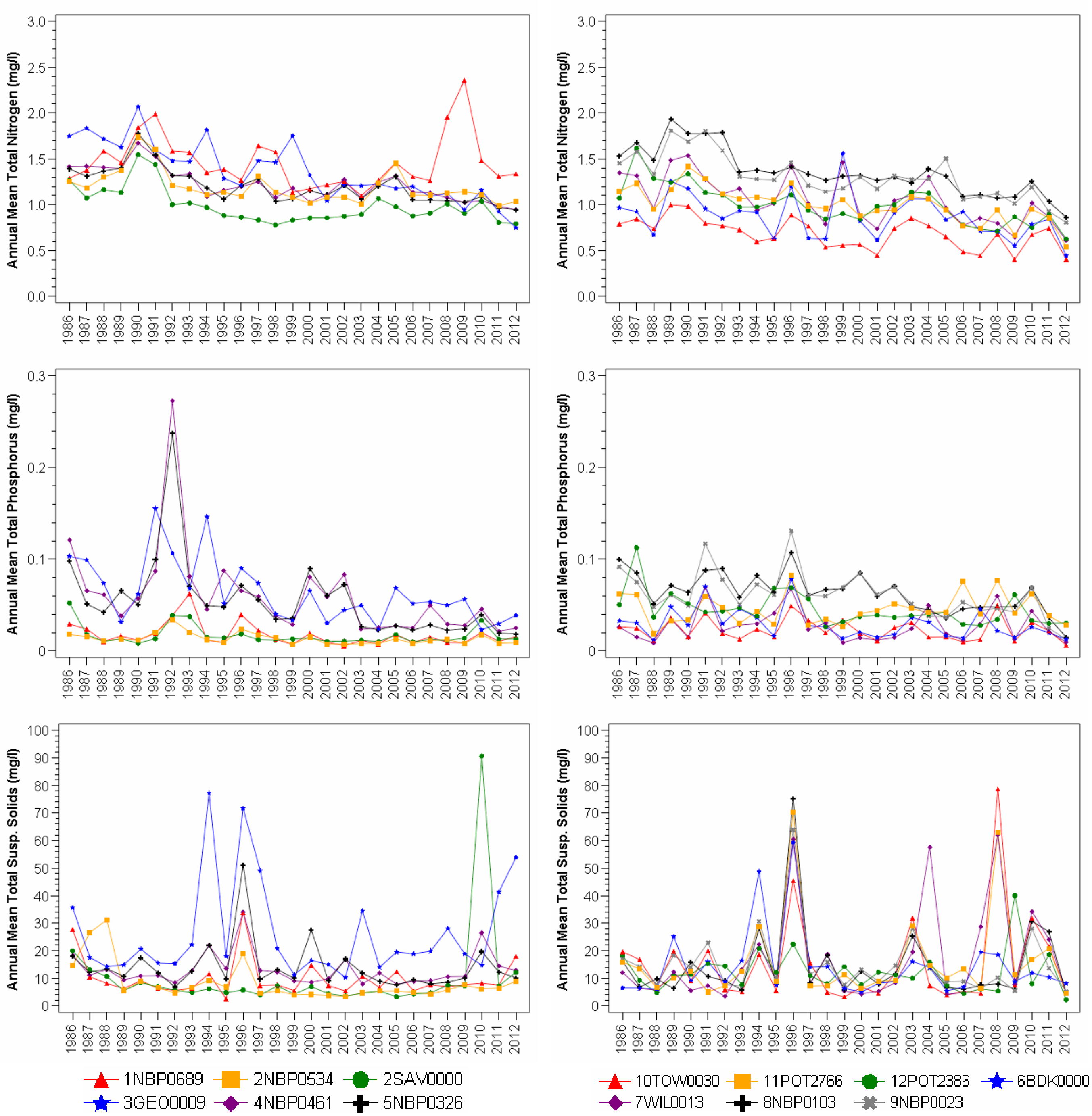


Figure 18. Annual means for total nitrogen, total phosphorus and total suspended solids in the western Upper Potomac basin non-tidal water quality monitoring stations.
Scales are the same on both graphs for each parameter: total nitrogen (top row), total phosphorus (middle row), total suspended solids (bottom row). Stations are the same in each column of graphs and legend for each column is at the bottom. Stations names shown in legends correspond to station labels in Figure 17.

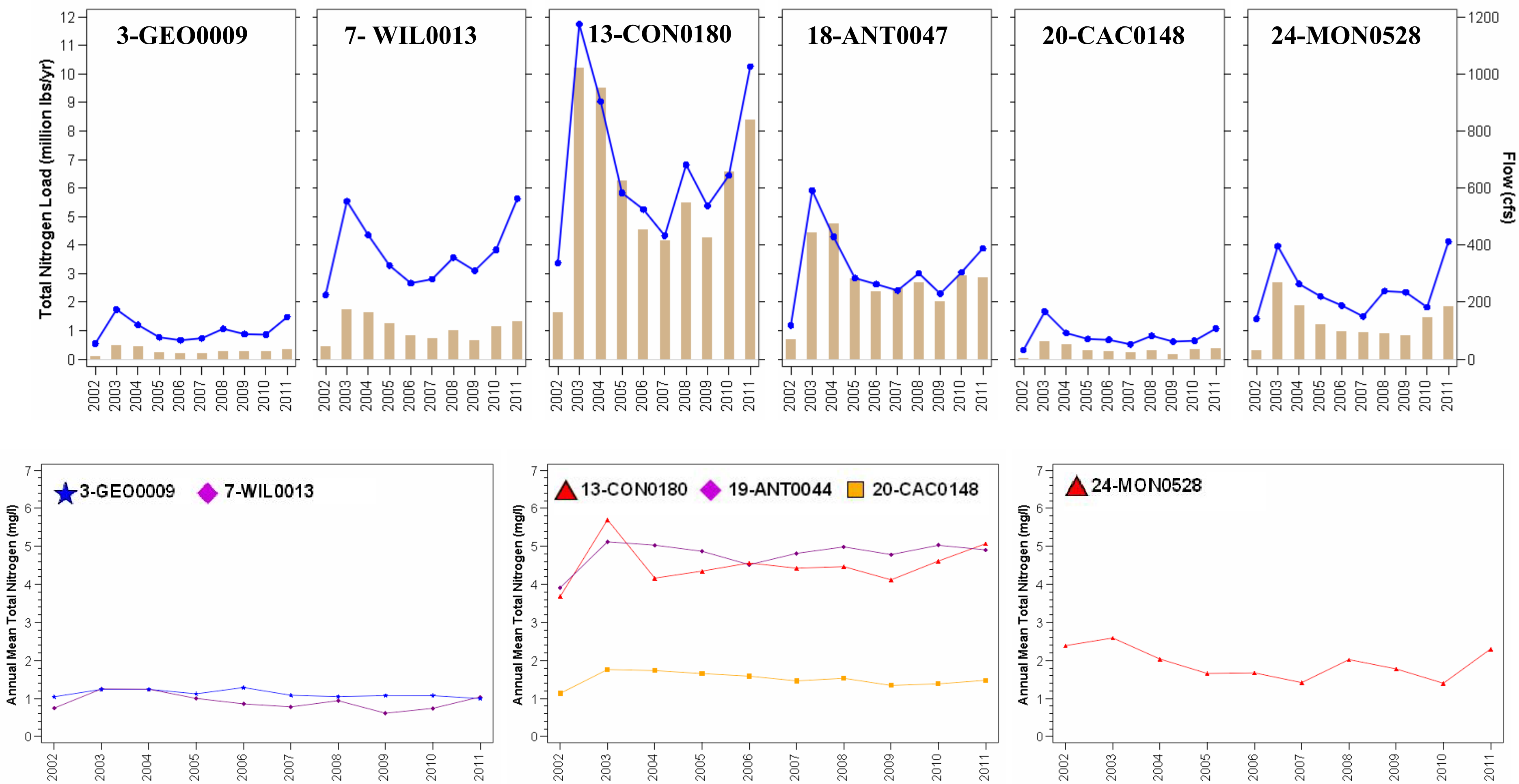


Figure 19. Annual nitrogen loadings to the Upper Potomac at USGS gage sites and water year means for TN at long-term non-tidal water quality monitoring stations.

Top graphs show annual nitrogen (tan bars, left axis) and flow (blue line, right axis) for each of the USGS gaging stations. Bottom graphs shows water year annual mean concentrations for total nitrogen for corresponding long-term non-tidal stations. Scales are the same on all of the loadings graphs and all of the annual concentrations graphs. Stations numbers correspond to station labels in Figure 17.

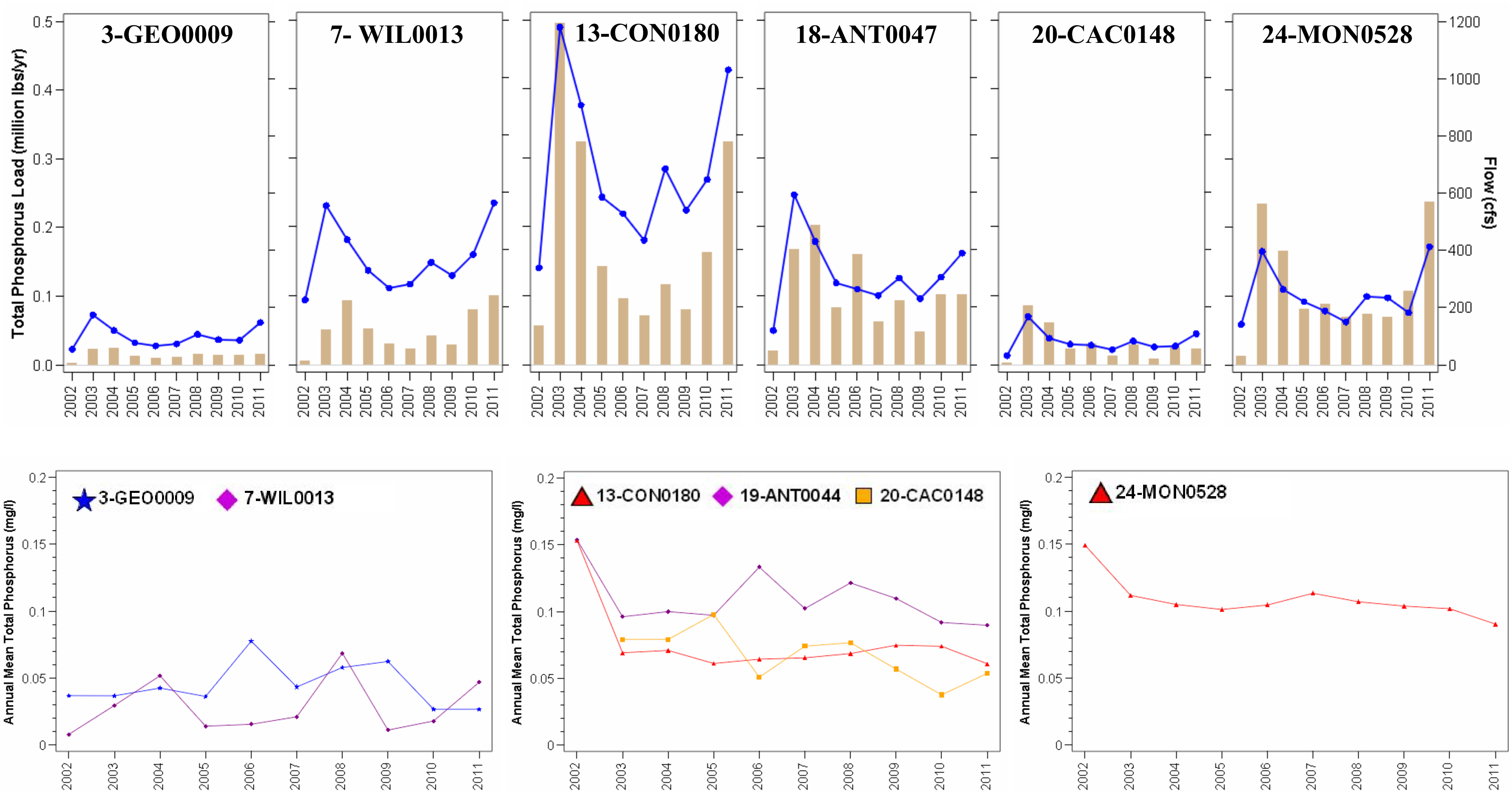


Figure 20. Annual phosphorus loadings to the Upper Potomac at USGS gage sites and water year means for TP at long-term non-tidal water quality monitoring stations.
Top graphs show annual phosphorus (tan bars, left axis) and flow (blue line, right axis) for each of the USGS gaging stations. Bottom graphs shows water year annual mean concentrations for total phosphorus for corresponding long-term non-tidal stations. Scales are the same on all of the loadings graphs and all of the annual concentrations graphs. Stations numbers correspond to station labels in Figure 17.

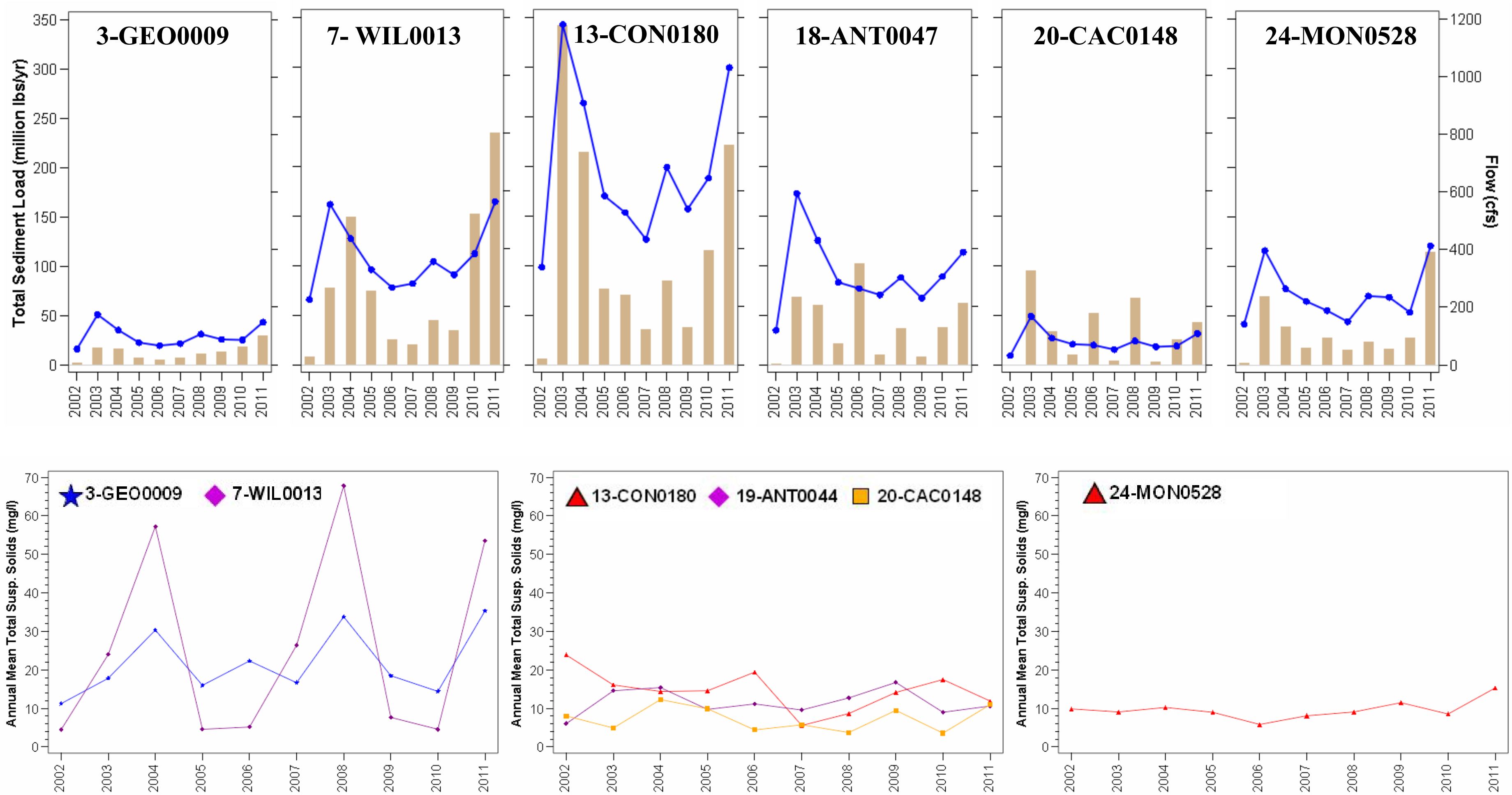


Figure 21. Annual sediment loadings to the Upper Potomac at USGS gage sites and water year means for TSS at long-term non-tidal water quality monitoring stations.
Top graphs show annual sediment (tan bars, left axis) and flow (blue line, right axis) for each of the USGS gaging stations. Bottom graphs shows water year annual mean concentrations for total suspended solids for corresponding long-term non-tidal stations. Scales are the same on all of the loadings graphs and all of the annual concentrations graphs. Stations numbers correspond to station labels in Figure 17.

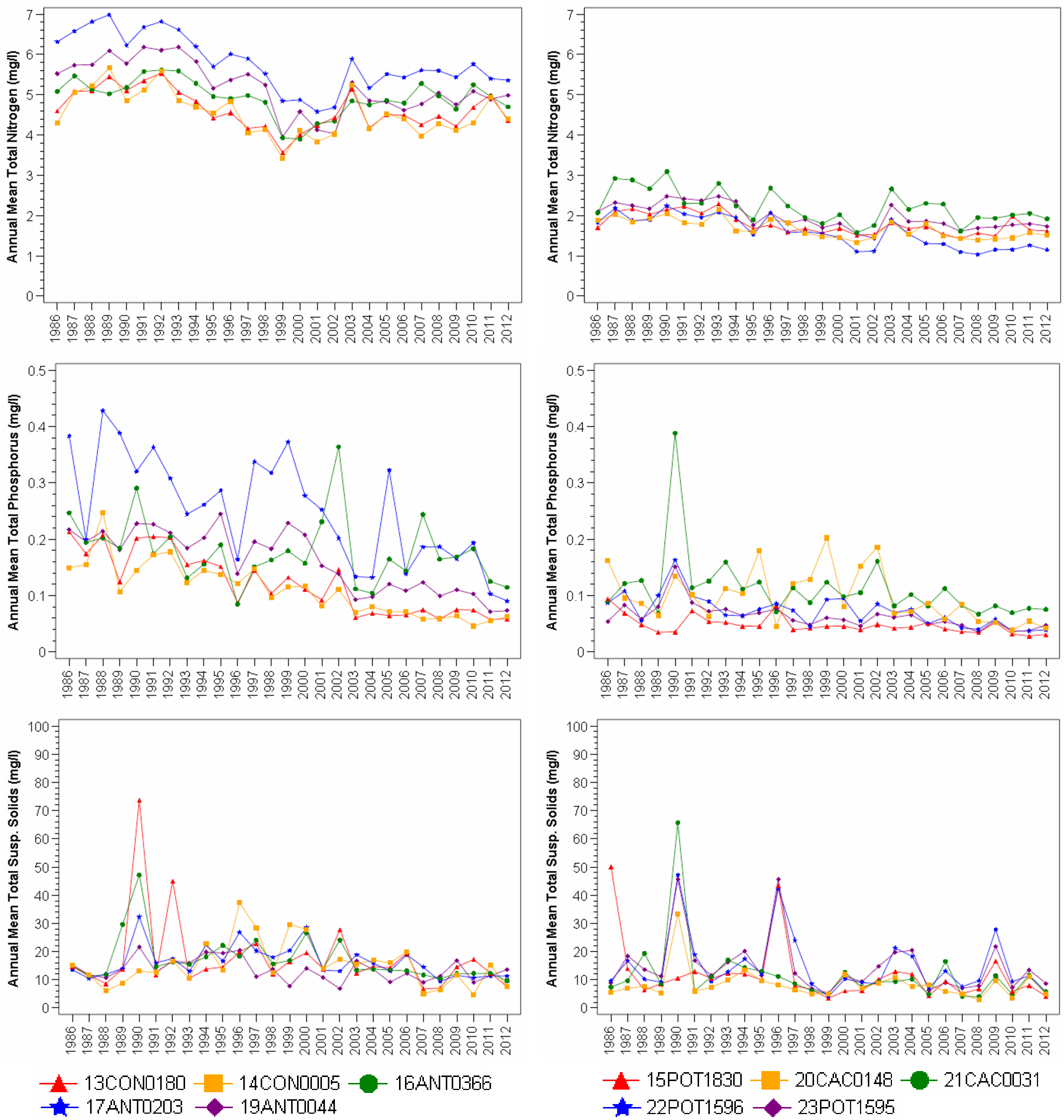


Figure 22. Annual means for total nitrogen, total phosphorus and total suspended solids in the eastern Upper Potomac basin non-tidal water quality monitoring stations.
Scales are the same on both graphs for each parameter: total nitrogen (top row), total phosphorus (middle row), total suspended solids (bottom row). Stations are the same in each column of graphs and legend for each column is at the bottom. Stations names shown in legends correspond to station labels in Figure 17.

Monocacy River

There are five non-tidal sampling locations on the Monocacy River (stations 24-28 on Figure 17). One of these non-tidal stations is also a USGS gage station. TN levels decreased at the two downstream stations (MON0155 and MON0020) and may have decreased at the upstream station (MON0528, gage station); nitrogen loadings decreased at the USGS gage station (Figure 23). [48] TP levels decreased at all five stations, and phosphorus loadings decreased.[49] TSS levels may have decreased at the upstream station, but there were no significant trends in TSS levels at the other stations or in sediment loadings.[50]

Middle Potomac

The Middle Potomac Basin includes seven non-tidal monitoring stations on Seneca Creek, Cabin John Branch, Rock Creek, Anacostia River and Potomac River from White's Ferry to above Little Falls (stations 29-36 on Figure 17). The USGS River Input station at Chain Bridge is also in the Middle Potomac Basin. TN levels decreased in Seneca Creek (SEN0008) and may have decreased in the main river at Whites Ferry (POT1472) (Figure 23).[51] TP levels decreased at the three main river stations (POT1472, POT1471, POT1184) and in Seneca Creek, but TP levels may have increased in the Anacostia River (ANA0082).[52] TSS levels significantly increased in the Anacostia River.[53] Sediment loadings also increased at the USGS River Input station at Chain Bridge, but nitrogen and phosphorus loadings had no significant trends (Figure 24).[54]

[48] TN levels decreased at all five of the Monocacy River stations from 1986-2012, and nitrogen loadings decreased at the Monocacy USGS gage station from WY1985-2011.
[49] TP levels decreased at all stations from 1986-2012 but a non-linear trend at the upstream station (MON0528) indicates that TP levels increased starting in the mid 2000s. Phosphorus loadings also decreased from WY1985-2011.
[50] TSS decreased at all five stations from 1986-2012 and sediment loadings decreased from WY1985-2011.
[51] TN levels decreased at all stations in the Middle Potomac from 1986-2012 but non-linear trends at POT1471 and ANA0082 indicate TN levels started to increase in the mid 2000s.
[52] TP levels decreased at all stations except RCM0111 and ANA0082 from 1986-2012. A non-linear trend at ANA0082 indicates TP levels started to increase around 2000.
[53] TSS level decreased at Whites Ferry (POT1472, POT1471) from 1986-2012, but a non-linear trend at ANA0082 indicates TSS levels started to increase in the mid 1990s.
[54] Nitrogen, phosphorus and sediment loadings all decreased at the USGS River Input station at Chain Bridge from WY1985-2011.

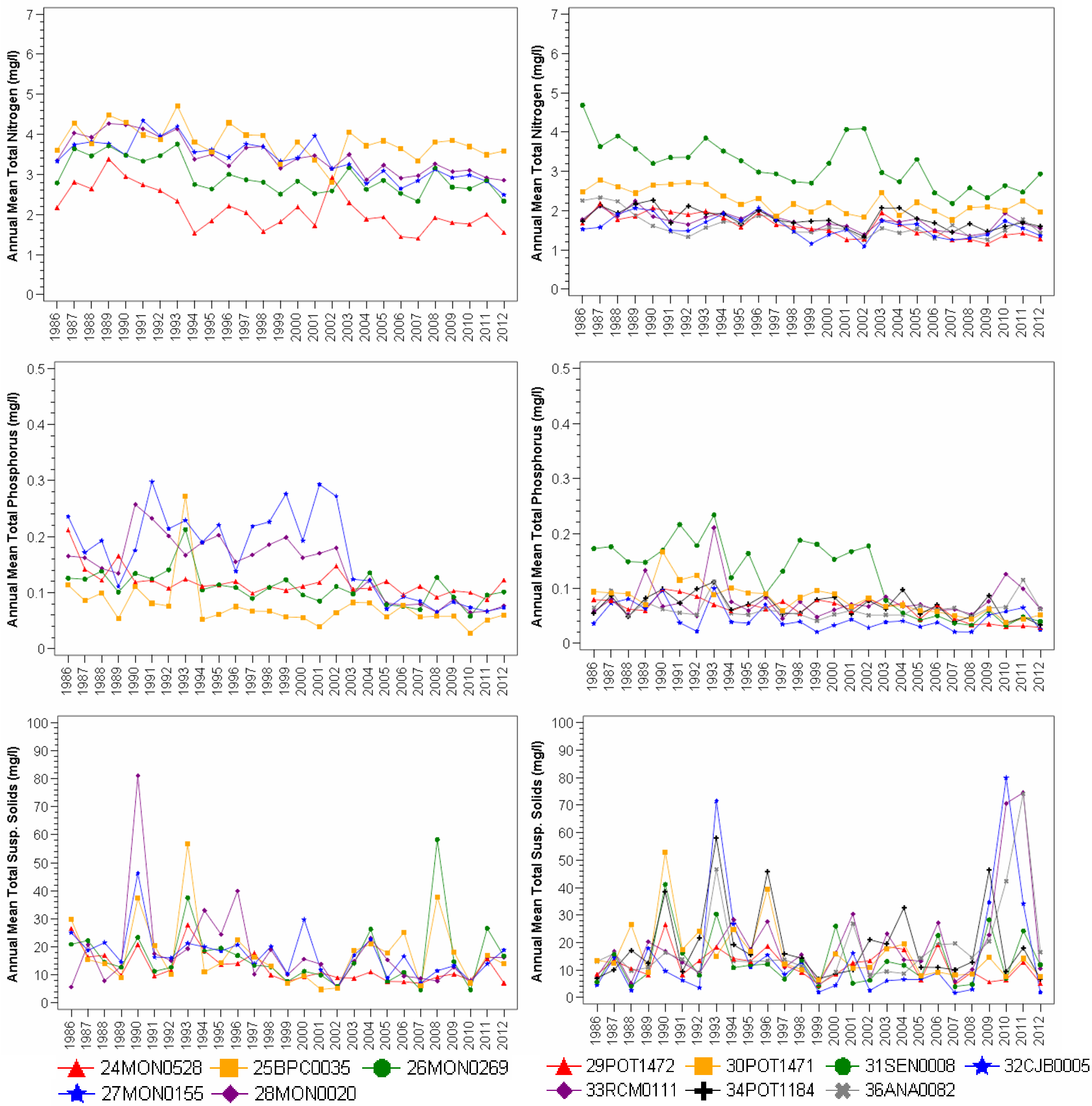
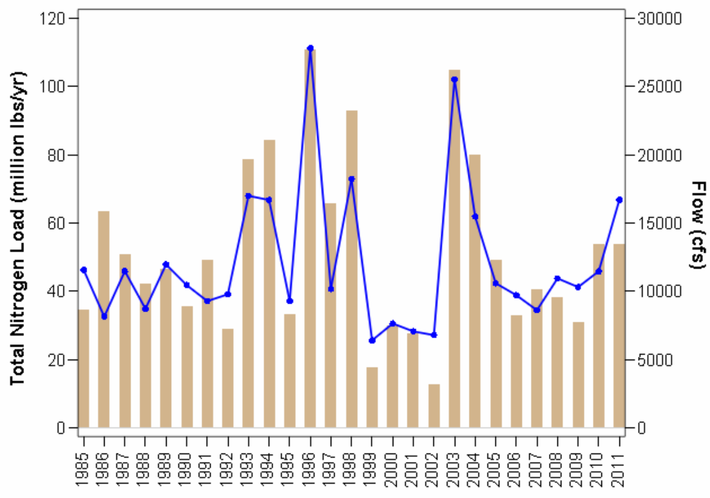
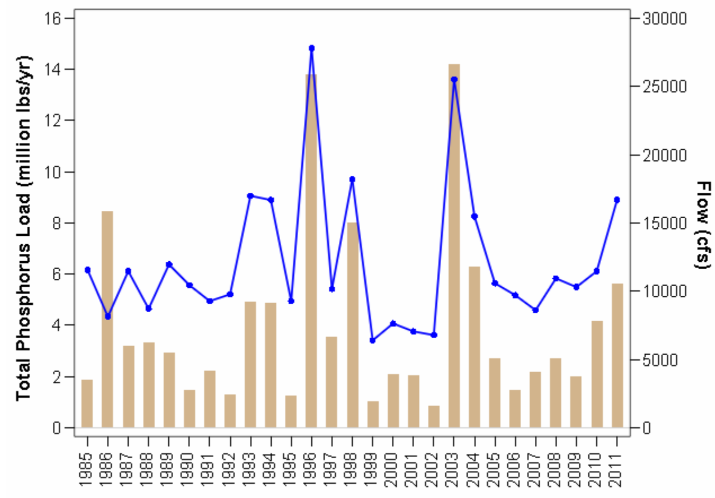


Figure 23. Annual means for total nitrogen, total phosphorus and total suspended solids in the Monocacy River and Middle Potomac non-tidal water quality monitoring stations.
Scales are the same on both graphs for each parameter: total nitrogen (top row), total phosphorus (middle row), total suspended solids (bottom row). Stations are the same in each column of graphs (Monocacy River on left, Middle Potomac on right) and legend for each column is at the bottom. Stations names shown in legends correspond to station labels in Figure 17.





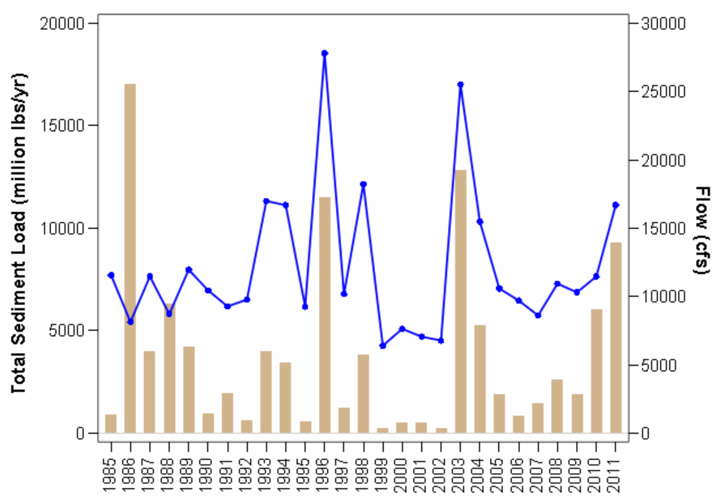


Figure 24. Annual nitrogen, phosphorus and sediment loadings to the USGS River Input site at Chain Bridge, Potomac.
TN (top left), TP (top right) and sediments (bottom middle) loadings (tan bars, left axis) and flow (blue line, right axis). See Figure 17 for station location. Flow data is from USGS station 01646500 (Little Falls).

Tidal Potomac

Tidal water quality monitoring is done year-round at thirteen stations that have been monitored since 1985 (Figure 25, Appendix 3). Samples are collected once a month.

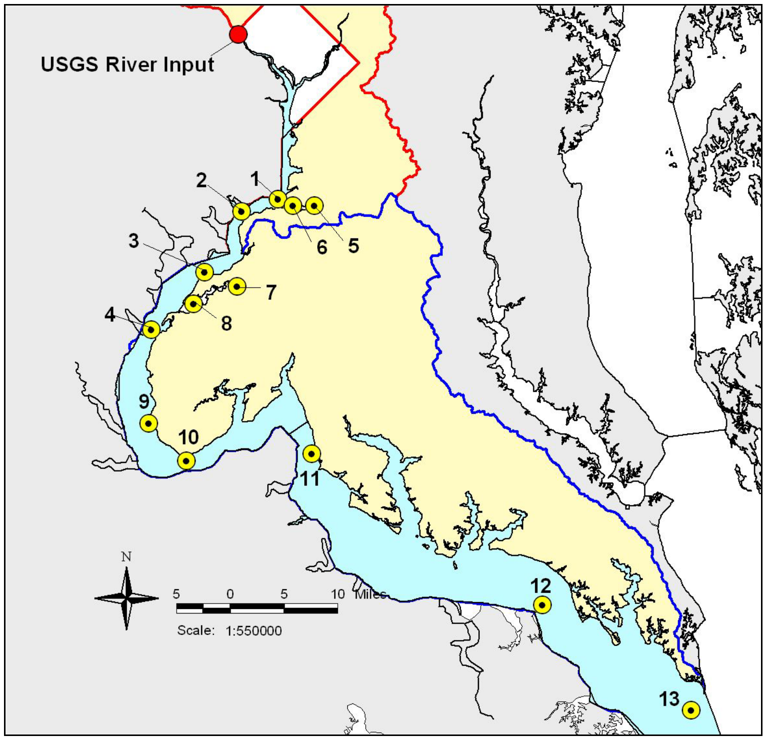


Figure 25. Long-term tidal water quality monitoring stations.
Stations (yellow circles) are 1) TF2.1, 2) TF2.2, 3) TF2.3, 4) TF2.4, 5) PIS0033, 6) XFB1986, 7) MAT0078, 8) MAT0016, 9) RET2.1, 10) RET2.2, 11) RET2.4, 12) LE2.2, 13) LE2.3. See Appendix 3 for station description and information. USGS River Input Monitoring station at Chain Bridge is also shown (red circle).

Total nitrogen (TN) levels dramatically declined throughout the Potomac River, and TN levels improved or may have improved at all stations annually except Ragged Point (Figure 26).[55] TN levels were relatively good in the upper Piscataway Creek, Mattawoman Creek (both stations), Smith Point, Maryland Point and Point Lookout. TN levels were relatively poor in the main river off Dogue Creek and Morgantown Bridge.[56] TN levels at the remaining stations were relatively fair. Dissolved inorganic nitrogen (DIN) levels also improved or may have improved annually at most stations, with only the lowest two stations near the mouth of the river not showing a significant trend. DIN levels were relatively poor in most locations, but DIN levels were relatively good in the upper Piscataway Creek, Mattawoman Creek (both stations), at

[55] TN trends for all stations except Ragged Point improved for 1985-2012. A non-linear trend at the upper Mattawoman station indicates that while concentrations had decreased from 1985 to 2006, levels have since begun to increase. TN trends for 1985-1997 improved at all stations from Piscataway Creek down to Smith Point.
[56] Relative status is determined by salinity zone (see Appendix 4 for methods references), so while TN levels are lower at the mesohaline station at Morgantown than at the oligohaline station at Maryland Pt, status is 'poor' at Morgantown Bridge and 'good' at Maryland Pt.

Ragged Point and at Point Lookout. DIN levels were not low enough for nitrogen limitation to occur at most stations, but nitrogen limitation may have occurred in Mattawoman Creek in summer and fall, and may have occurred at Ragged Point and Point Lookout in summer, fall and winter (Figure 27).

Total phosphorus (TP) levels improved annually in the lower Piscataway and lower Mattawoman Creeks and in the Middle and Lower Potomac upper main river sections (Figure 28).[57] TP also improved in the summer and SAV growing season at Smith Point and in the summer at Point Lookout. TP levels were relatively good throughout the river except at Morgantown Bridge, where TP levels were relatively poor. Dissolved inorganic phosphorus (PO_4) levels improved annually in the lower Piscataway Creek, upper Mattawoman Creek, the main river in the upper Middle Potomac and at Smith Point and Maryland Point. PO_4 levels also may have improved annually at the upper Piscataway station. However PO_4 levels degraded in the summer and may have degraded in the SAV growing season in the lower Mattawoman Creek. PO_4 levels were relatively good at all stations. PO_4 levels met the SAV habitat requirement except in the upper Piscataway Creek, and the main river from between Possum Point and Moss Point downstream to Morgantown (Figure 29).[58]

Total suspended solids (TSS) levels improved annually in the lower Mattawoman and at Ragged Point and may have improved annually at Point Lookout (Figure 28). TSS levels degraded annually at Smith Point and Maryland Point and may have degraded annually at Morgantown.[59] TSS levels were relatively good in Mattawoman Creek, upper Piscataway Creek, Smith Point, Maryland Point, Ragged Point and Point Lookout, and relatively fair in the main river at the mouth of Piscataway Creek and in the lower Piscataway Creek. TSS levels were relatively poor in the main river from the mouth of Dogue Creek down to between Possum Point and Moss Point and at Morgantown.[60] TSS levels met the habitat requirement in most areas, but failed to meet the requirement at the lower Piscataway and in the main river at Indian Head, between Possum Point and Moss Point, and at Maryland Point (Figure 29).[61]

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[57] TP levels degraded or may have degraded in most areas from 1985-1997.
[58] PO_4 median values for 2010-2012 compared to the SAV habitat requirement.
[59] TSS levels degraded or may have degraded at all stations from 1985-1997 except at lower Mattawoman and at Point Lookout.
[60] Even through TSS levels were relatively poor at Morgantown, levels were lower than at the upstream stations where TSS levels were relatively good.
[61] TSS median values for 2010-2012 compared to the SAV habitat requirement.

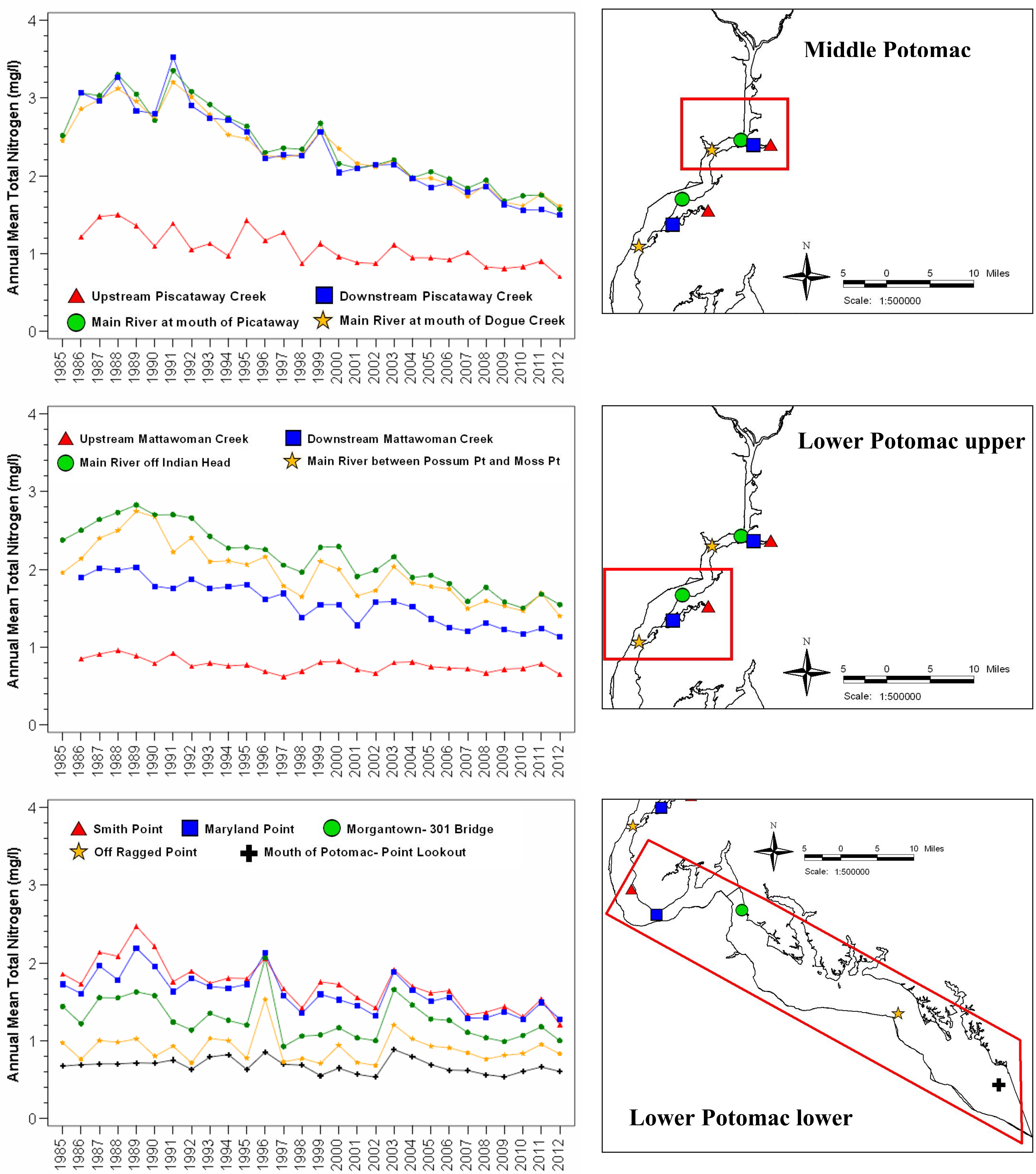

Figure 26. Annual means for total nitrogen in the Potomac tidal portion, 1985-2012. Maps to the right indicate station locations.

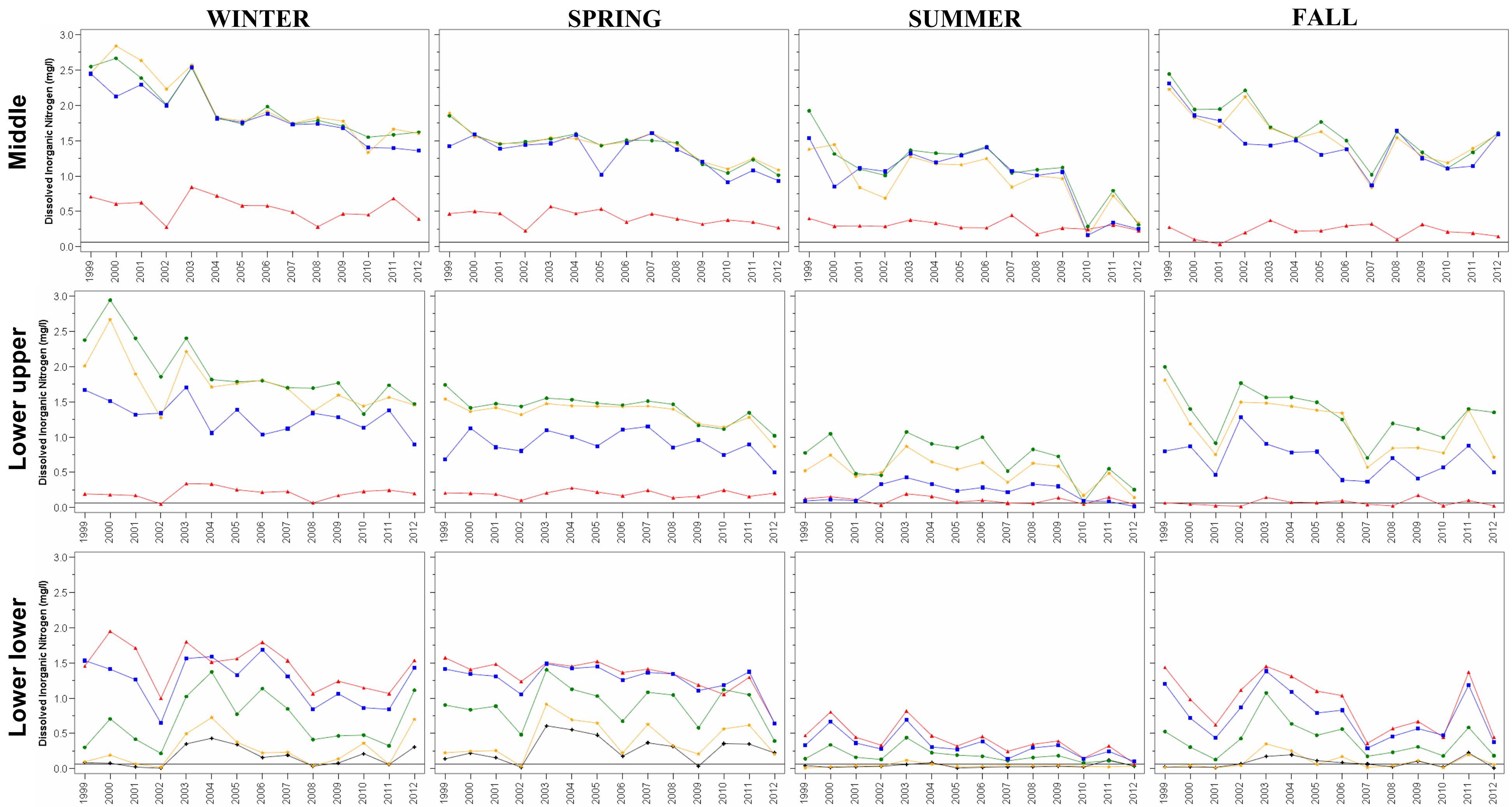

Figure 27. Nitrogen limitation by season in the Potomac tidal portion.
Seasonal mean DIN levels are shown for 1999-2012. The black line indicates the threshold for nitrogen limitation (0.07 mg/l DIN). Winter season includes December (of the previous year), January and February. Spring season includes March-May. Summer season includes July-August (June is a transition month and not included). Fall season includes October and November. Biological nutrient removal of nitrogen at WWTPs is most effective in warmer months, and seasonal changes in phytoplankton populations (blooms in spring and fall) reduce DIN. See Figure 26 for map of station locations and graph legends. Top row is Middle Potomac stations; middle row is Lower Potomac upper stations; bottom row is Lower Potomac lower stations.

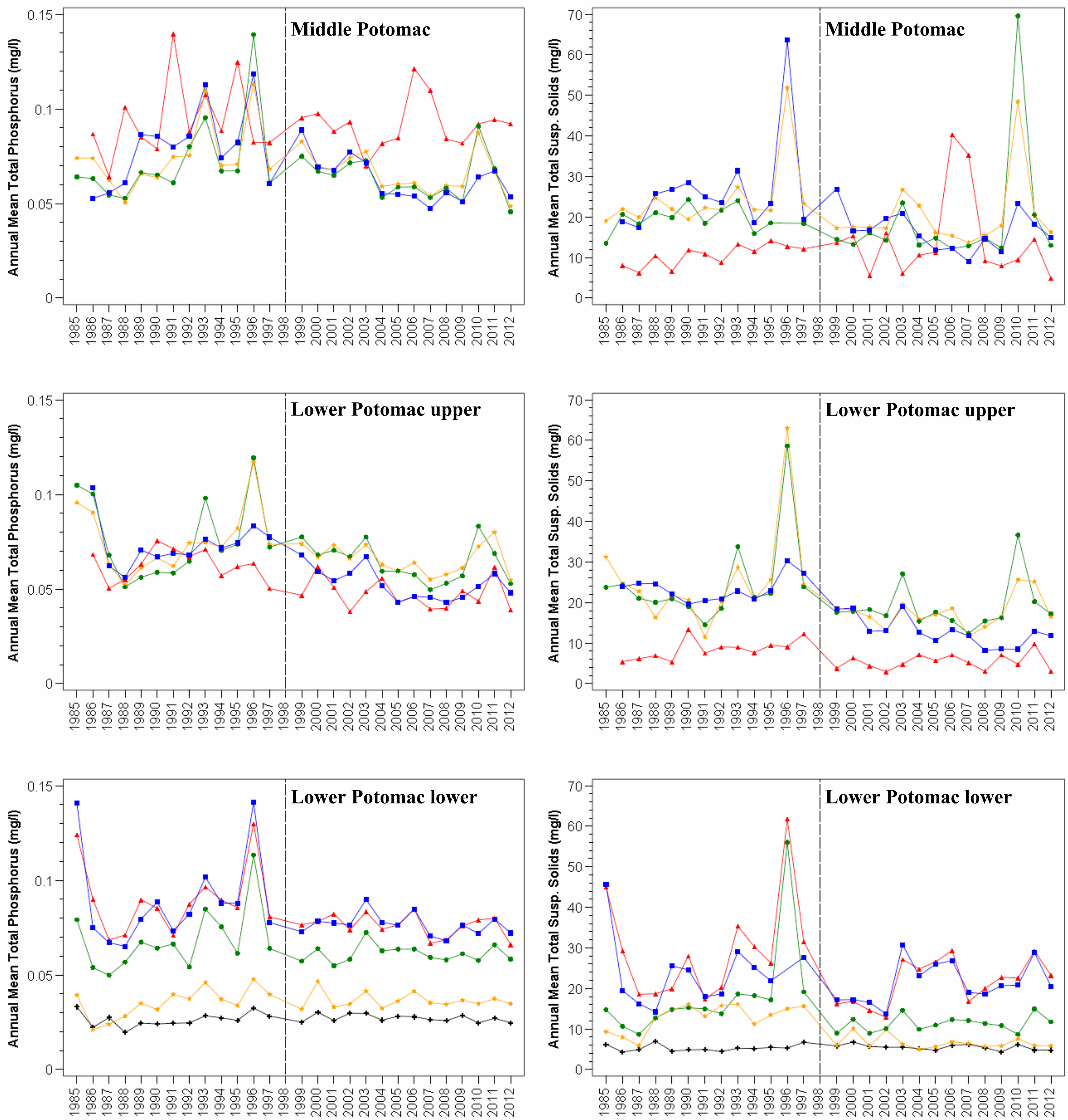

Figure 28. Annual total phosphorus and total suspended solids in the Potomac tidal portion, 1985-2012.

TP on left, TSS on right. See Figure 26 for station locations and graph legends. Dotted line (1998) indicates when the lab change occurred that may have impacted TP and TSS. Caution should be used in making comparisons of before to after the lab change. Top row is Middle Potomac stations; middle row is Lower Potomac upper stations; bottom row is Lower Potomac lower stations.

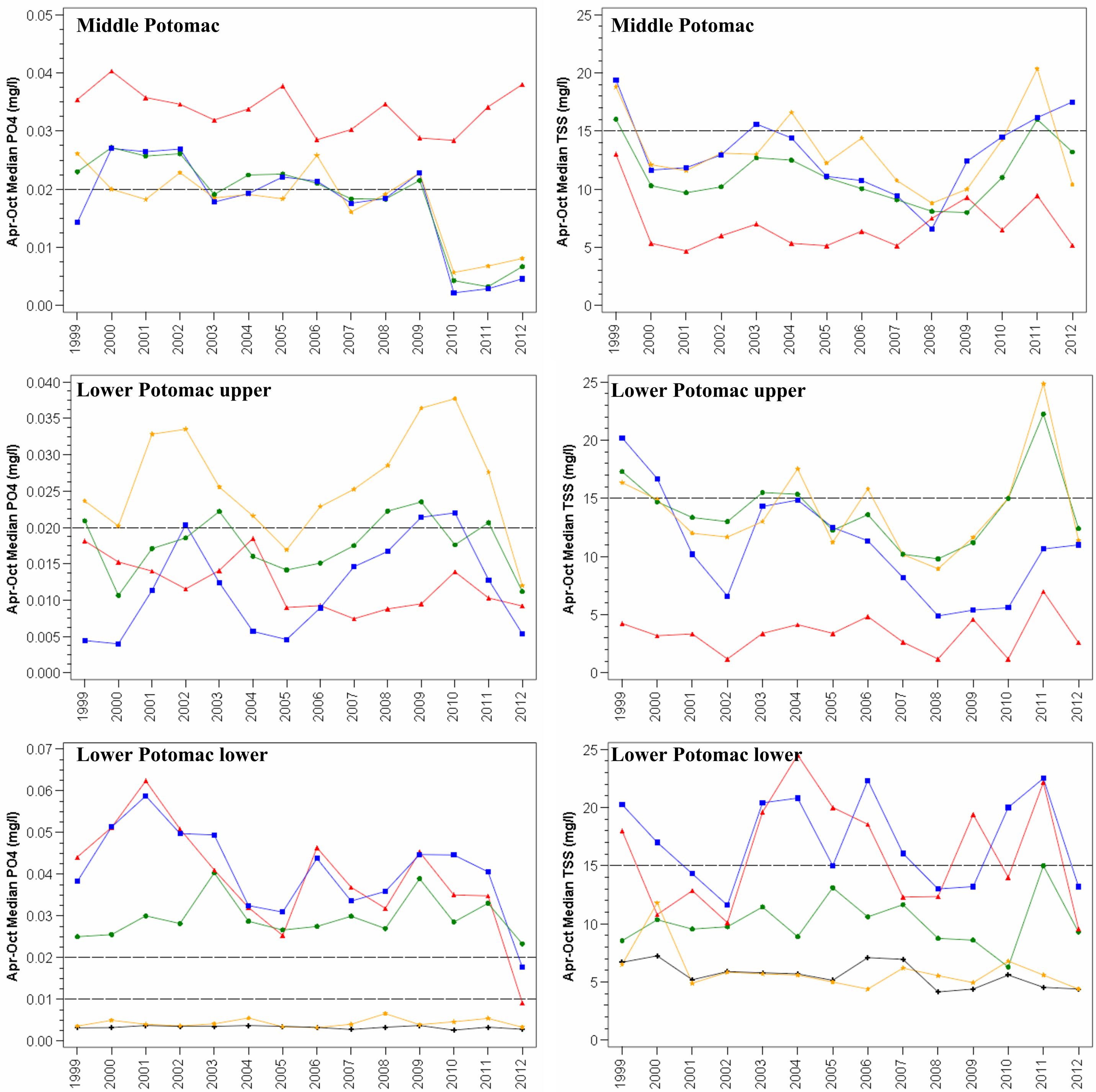

Figure 29. PO_4 and TSS levels compared to SAV habitat requirements, 1999-2012. SAV growing season (April-October) median values for PO_4 (left) and TSS (right). See Figure 26 for station locations and graph legends. Top row is Middle Potomac stations; middle row is Lower Potomac upper stations; bottom row is Lower Potomac lower stations. Threshold values (shown with dashed lines) are based on salinity zone (Appendix 5). To meet or pass the habitat requirements, levels of PO_4 and TSS must be lower than the threshold. Middle Potomac and Lower Potomac upper stations are in the tidal fresh/oligohaline zone. Lower Potomac lower stations are in different salinity zones and are compared to different thresholds (see Figure 30 for salinity zone information).

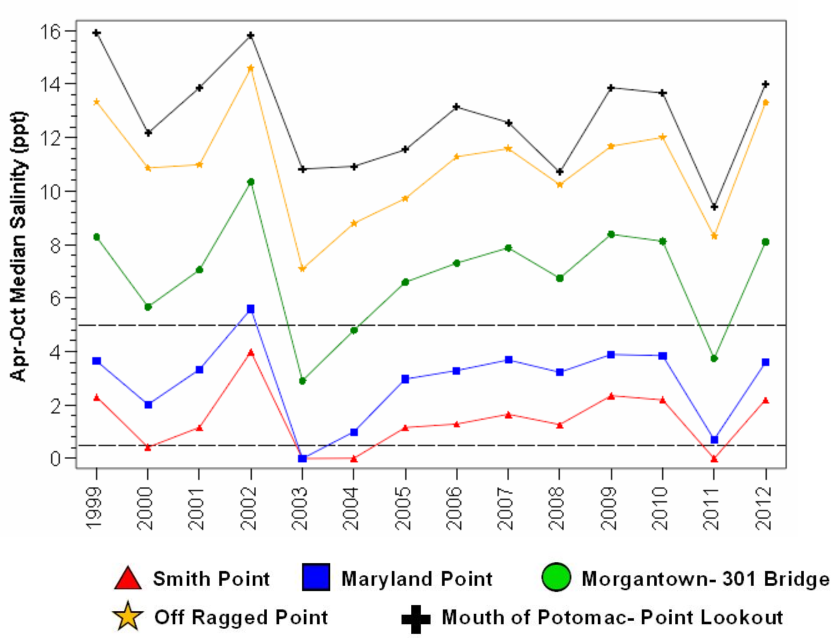

Figure 30. Salinity zone in the Lower Potomac River lower portion, 1999-2012.
SAV growing season (April-October) median values for salinity. Salinity zone ranges are shown with dashed lines: tidal fresh 0 – 0.5ppt; oligohaline 0.5-5 ppt; mesohaline 5-18 ppt. See Figure 26 for station locations.

Algal abundance levels improved annually in the lower Mattawoman Creek, and may have improved annually at Indian Head.[62] Algal abundance may also have improved in the spring in the upper Piscataway and upper Mattawoman. However, algal abundance degraded at Smith Point and Maryland Point annually and may have degraded at Morgantown and Point Lookout annually.[63] CHLA levels were relatively poor at most stations, but were relatively good at upper Piscataway, upper Mattawoman, Smith Point and Maryland Point, and relatively fair at Point Lookout. CHLA levels met the SAV habitat requirement in all but the lower Piscataway and the main river at the mouth of the Piscataway, mouth of Dogue Creek and Ragged Point (Figure 31).

Water clarity improved annually in the lower Mattawoman, but degraded at Point Lookout and may have degraded at Smith Point and Maryland Point.[64] Water clarity was relatively poor in most locations, but was relatively good in lower Mattawoman and in the main river at the mouth of Piscataway Creek, Maryland Point and Point Lookout, and was relatively fair at Ragged Point. Water clarity failed to meet the SAV habitat requirement in most locations, but met the requirement at upper Mattawoman, Ragged Point and Point Lookout (Figure 31).

[62] CHLA levels improved from 1985-2012 in the lower Mattawoman but degraded from 1985-2012 at all six main river stations from between Possum Point and Moss Point downstream to Point Lookout.
[63] CHLA levels degraded from 1985-1997 at the lower Piscataway and the main river stations at the mouth of Piscataway, mouth of Dogue Creek, Smith Point and may have degraded between Possum Point and Moss Point and at Morgantown.
[64] Secchi depth improved from 1985-2012 at lower Piscataway and lower Mattawoman, but degraded Maryland Point, Morgantown and Point Lookout. Secchi depth also degraded from 1985-1997 at Smith Point, Maryland Point, Morgantown and Point Lookout and may have degraded between Possum Point and Moss Point.

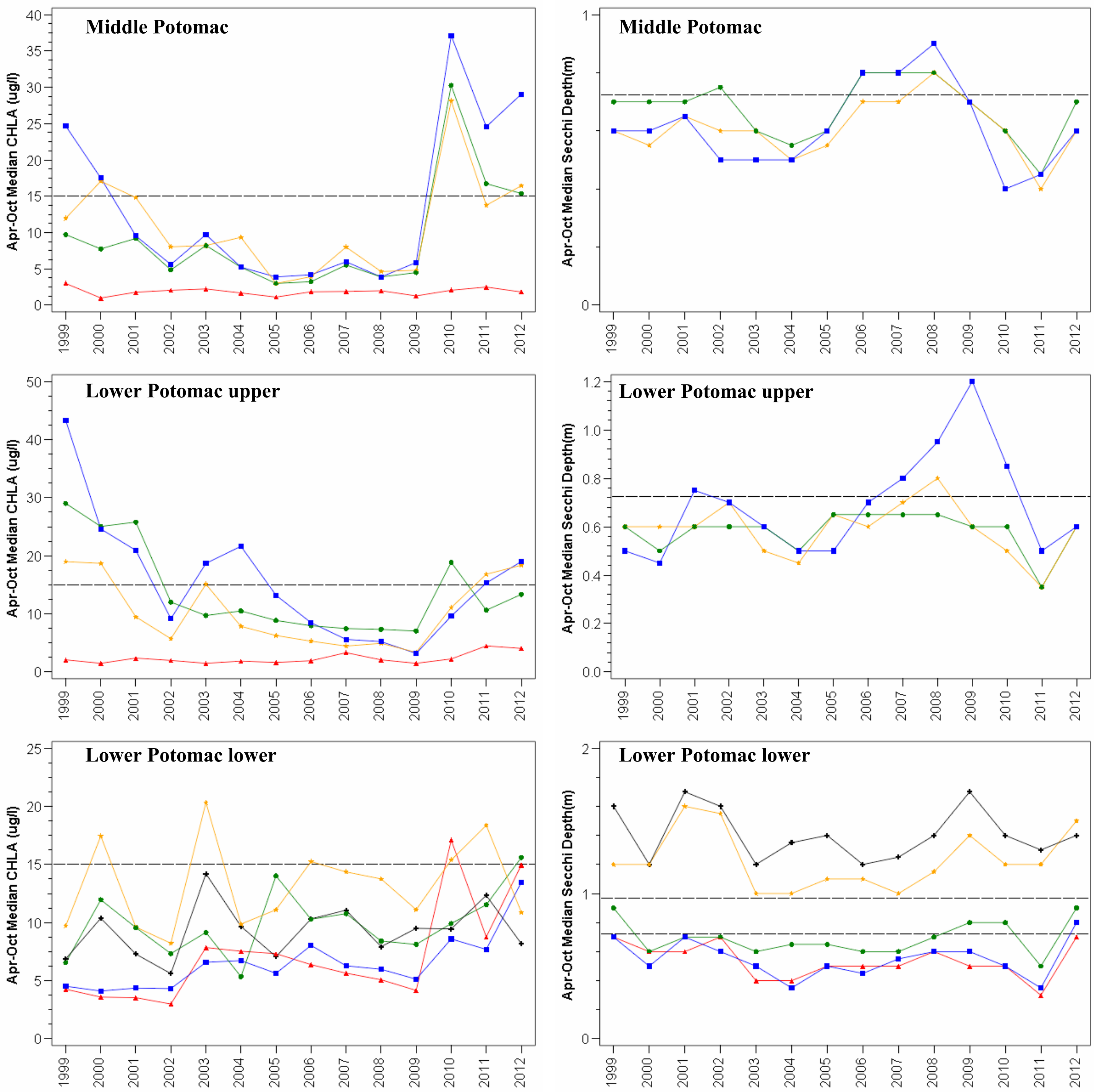

Figure 31. CHLA levels and Secchi depth compared to SAV habitat requirements, 1999-2012. SAV growing season (April-October) median values for CHLA (left) and Secchi depth (right). See Figure 26 for station locations and graph legends. Top row is Middle Potomac stations; middle row is Lower Potomac upper stations; bottom row is Lower Potomac lower stations. Threshold values (shown with dashed lines) are based on salinity zone (Appendix 5). To meet or pass the habitat requirements, levels CHLA need to be lower than the threshold and Secchi depth needs to be above the threshold. Middle Potomac and Lower Potomac upper stations are in the tidal fresh/oligohaline zone. Lower Potomac lower stations are in different salinity zones and are compared to different thresholds (see Figure 30 for salinity zone information).

Summer bottom dissolved oxygen (BDO) levels degraded in the main river at Indian Head and may have degraded at Maryland Point.[65] Summer BDO was good at all of the upper river stations, fair at Morgantown and poor at Ragged Point and Point Lookout. Summer BDO in the Middle Potomac and Lower Potomac upper portions rarely fell below 5 mg/l (Figure 32).[66] At Maryland Point, summer BDO often fell below 5 mg/l (Figure 33). At Morgantown, summer BDO was almost always below 5 mg/l from June-August, and often fell below 3 mg/l. At Ragged Point and Point Lookout, summer BDO was almost always below 3 mg/l and very often less than 1 mg/l.

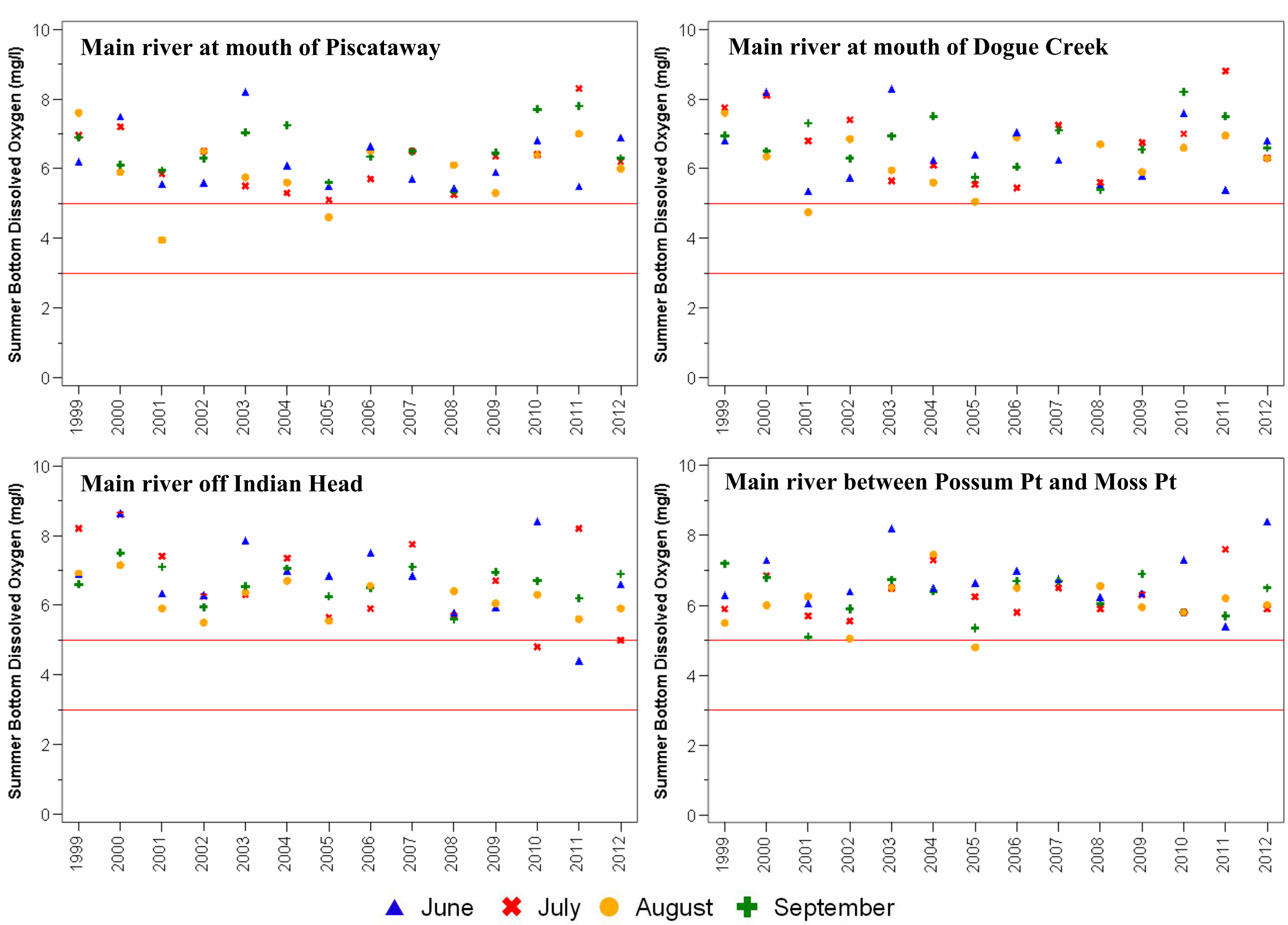

Figure 32. Summer bottom dissolved oxygen levels in the Middle and Lower Potomac upper portions.
Monthly bottom dissolved oxygen levels with threshold values of 5 mg/l and 3 mg/l shown with red reference lines.

[65] Summer BDO improved at Morgantown from 1985-2012 but non linear trends indicate conditions degraded at Indian Head, Smith Point and Maryland Point starting in the late 1990s. Summer BDO improved from 1985-1997 in the main river at the mouth of Piscataway Creek and may have improved at the mouth of Dogue Creek, between Possum Point and Moss Creek, and Maryland Point.
[66] Bottom dissolved oxygen is not measured in Mattawoman or Piscataway Creeks due to shallow water depth.

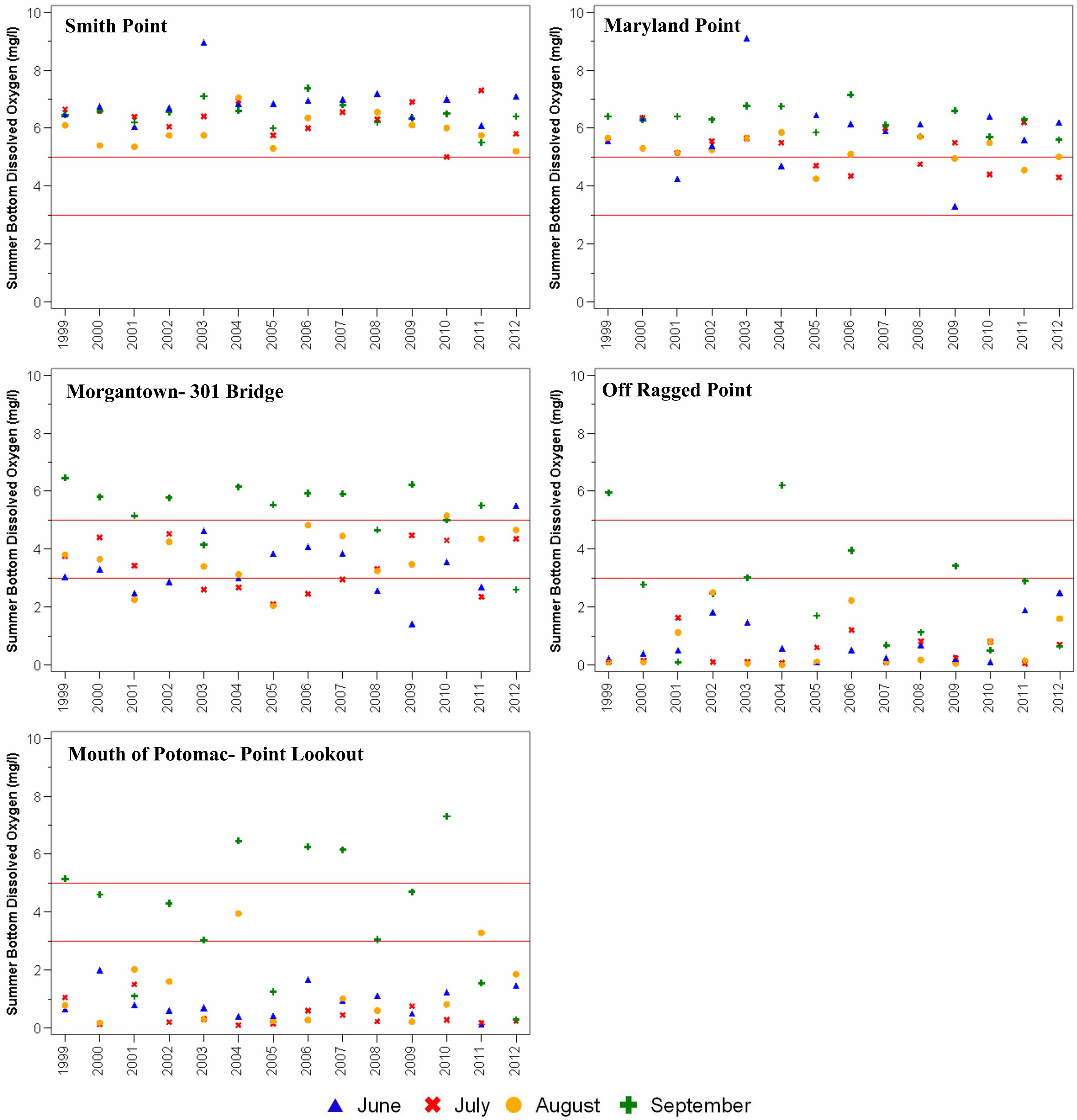

Figure 33. Summer bottom dissolved oxygen levels in the Lower Potomac River lower portion. Monthly bottom dissolved oxygen levels with threshold values of 5 mg/l and 3 mg/l shown with red reference lines.

Salinity decreased annually at Ragged Point and may have decreased at Point Lookout.[67] Water temperature may have increased annually at the upper Piscataway and both Mattawoman Creek stations.[68] Water temperature increased or may have increased at almost all stations in summer and SAV growing season.

Shallow water

The tidal long-term monitoring program samples at a fixed point that is generally in the center channel and deeper waters of a river. Sampling is usually done once or twice a month. The strength of this type of monitoring is that the repetition of sampling over many years (more than two decades) measures how water quality has changed over time and in response to management actions, land use changes, etc. However, conditions at the long-term monitoring station may not adequately capture water quality conditions in shallow waters, the river as a whole or on short time scales. The shallow water monitoring program is designed to measure conditions in the areas closest to land that are critical habitat areas, especially in the areas with underwater grass beds. Sampling in a river is done for a 3-year period to determine short-term changes in water quality that occur due to weather, such as between a year with very high rainfall and a year with low rainfall. Some shallow water stations have been monitored for longer periods.

The first part of the shallow water monitoring program uses instruments that stay in the water for extended periods (usually April-October) and collect information every 15 minutes; this is called the continuous monitoring program. Instead of the one or two samples a month typical of the long-term monitoring program, the continuous monitoring program can collect more than 2,800 samples a month.[69] This type of monitoring 1) measures water quality changes that occur between night and day, between days and at longer times spans; 2) determines how long water quality problems persist, such as algal blooms or low oxygen water; and 3) measures water quality changes that occur related to weather events such as storms.

The second part of the monitoring program samples all of the shallow waters of a river (or river segment in larger rivers) once a month from April-October; this is the water quality mapping program. Data is collected nearly constantly as a boat moves along the entire shoreline, so changes in water quality can be measured from one part of the river to another. This data captures water quality in very localized areas and can identify places with better or worse water quality than the river overall. This monitoring is also able to capture changes in water quality related to events that occur in only part of the river such as algal blooms or in response to localized nutrient sources.

Maryland conducted an intensive monitoring and assessment study of the Potomac River during the years 2006-2008.[70,71] (Figure 34, Appendix 3). Virginia conducted an intensive monitoring

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[67] Salinity decreased from 1985-2012 at Ragged Point and Point Lookout. Salinity decreased from 1985-1997 at all of the main river stations from Smith Point to Point Lookout.

[68] Water temperature increased from 1985-2012 at Morgantown.

[69] Nutrient samples are collected twice a month instead of continuously.

[70] An interactive map of all continuous monitoring stations and complete archived data are available at http://mddnr.chesapeakebay.net/newmontech/contmon/archived_results.cfm.

[71] Interpolated maps for all water quality mapping cruises are available on the Maryland Department of Natural Resources "Eyes on the Bay" website http://mddnr.chesapeakebay.net/sim/dataflow_data.cfm

and assessment study of the Potomac River during the years 2007-2009.[72] Maryland and Virginia coordinated their sampling efforts in the overlap years (2007-2008), and some of Maryland's water quality mapping (WQM) calibration stations were co-located with the Virginia monitoring stations. Following Maryland's three-year assessment period, three continuous monitoring stations were also maintained from 2009 to the present.

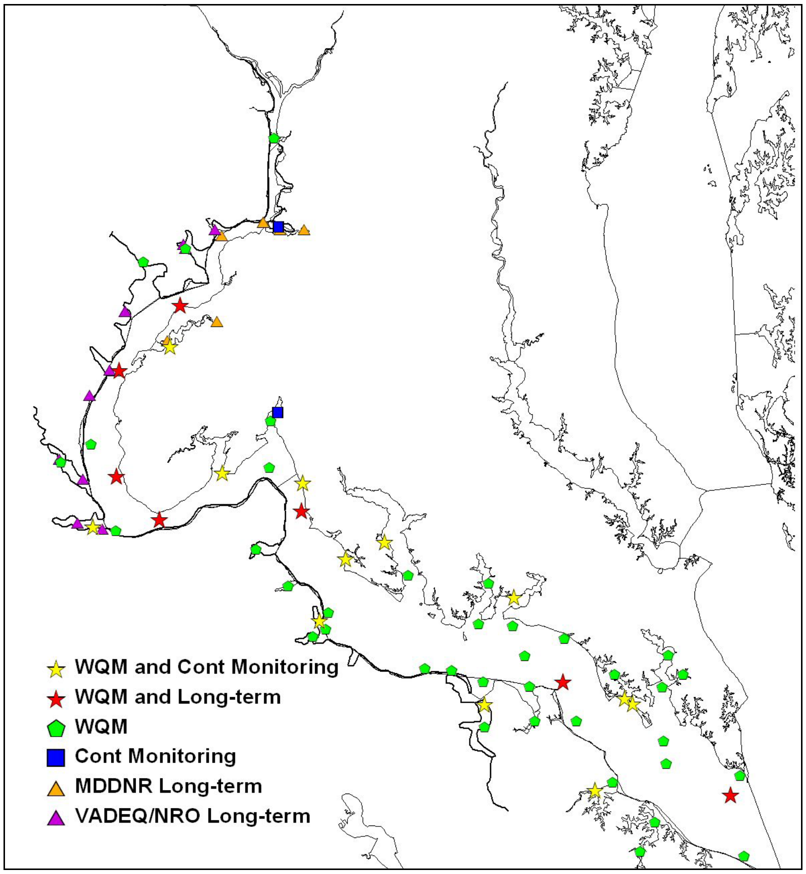


Figure 34. Shallow water monitoring locations for 2007-2008 in the Potomac River.
See Appendix 3 for station names and coordinates.

Temporal conditions

High temporal frequency data from the Maryland continuous monitoring program were used to determine how often water quality met conditions needed for healthy habitats. Percent failures are defined as the percent of values in each year that did not meet the water quality thresholds (see Appendix 4 for methods). Data for the years 2004-2012 were used. Chlorophyll and turbidity measurements collected during the SAV growing season (April through October) and summer dissolved oxygen values (June through September) were included in the analysis. The percent failures for all Maryland stations are shown in Table 4.

Most stations exceeded the 15 µg/l chlorophyll threshold between 5% and 30% of the time. Comparatively, the Fenwick and Pope's Creek stations had the lowest percentage of chlorophyll values greater than the 15 µg/l threshold, with less than a 10% failure rate for all years. With

[72] For more information on Virginia's shallow water monitoring program, please see http://www3.vims.edu/vecos/.

slightly more frequent failures, Mattawoman, Indian Head, Sage Point, St. Mary's College, and Blossom Point all had percent failures greater than 10% for just two years or fewer. The largest percentage of chlorophyll values greater than 15 µg/l occurred at Wicomico Beach and Port Tobacco, with each station having between 25% and 50% of chlorophyll values exceed the 15 µg/l threshold.

For turbidity, several stations had a large percentage of values in excess of the 7 NTU threshold. Observations at Wicomico Beach, Blossom Point, Port Tobacco, and Popes Creek exceeded the turbidity threshold more than 90% of the time for all monitoring years. Swan Point and Piscataway had a greater than 50% failure rate for turbidity for all years. Piney Point, Sage Point, Breton Bay, and St. Mary's College had the least number of observations greater than the threshold value, with less than a 20% failure rate for all years.

For dissolved oxygen, the stations with the greatest number of observations below the 3.2 mg/l threshold were St. Mary's College and Breton Bay. The station with the greatest percentage of values below 3.2 mg/l was St. Mary's College, with almost 50% of dissolved oxygen values below 3.2 mg/l in 2008. For Breton Bay, dissolved oxygen levels below 3.2 mg/l were observed approximately 10%-25% of the time. At the Mattawoman and Piscataway stations, more than 10% of dissolved oxygen observations were below 3.2 mg/l during at least one year of monitoring. The remaining stations in the Potomac all showed less than 10% (and most showed less than 5%) failure of the 3.2 mg/l dissolved oxygen threshold.

Table 4. . Shallow water dissolved oxygen, chlorophyll and turbidity levels in 2004-2012
The percent of instantaneous values in each year that did not meet the thresholds:
dissolved oxygen > 3.2 mg/l, chlorophyll *a* < 15 µg/l, turbidity < 7 NTU.

Station	Location	Year	Dissolved Oxygen Threshold	Chlorophyll Threshold	Turbidity Threshold
			% < 3.2 mg/l	% > 15 ug/l	% > 7 NTU
XFB2184	Piscataway	2004	10.90	22.06	79.82
		2005	7.61	24.31	61.57
		2006	0.85	34.05	74.93
		2007	0.80	16.15	52.97
		2008	0.84	7.53	69.18
XFB0231	Fenwick	2004	0.00	3.89	60.74
		2005	0.12	0.22	43.94
		2006	0.26	0.17	29.69
		2007	0.00	1.41	26.44
		2008	0.00	0.43	35.56
XEB5404	Indian Head	2009	0.31	0.00	3.78
		2010	0.71	8.06	34.85
		2011	1.57	12.41	52.38
		2012	1.92	13.98	38.94
XEA3687	Mattawoman	2004	0.36	31.26	90.58
		2005	2.96	8.57	55.93
		2006	1.17	6.40	31.72
		2007	0.57	6.80	33.68
		2008	0.05	0.79	23.52
		2009	6.06	2.62	4.31
		2010	23.24	6.01	17.42
		2011	4.07	4.75	54.70
		2012	0.12	16.31	72.80

< 10 % failure
10 - 40 % failure
40 - 70 % failure
> 70 % failure

Table 4 (continued). Shallow water dissolved oxygen, chlorophyll and turbidity levels in 2004-2012
The percent of instantaneous values in each year that did not meet the thresholds:
dissolved oxygen > 3.2 mg/l, chlorophyll *a* < 15 µg/l, turbidity < 7 NTU.

Station	Location	Year	Dissolved Oxygen Threshold	Chlorophyll Threshold	Turbidity Threshold
			% < 3.2 mg/l	% > 15 ug/l	% > 7 NTU
XDB4544	Blossom Point	2006	0.07	17.27	99.85
		2007	0.00	9.01	99.81
		2008	0.03	9.52	99.67
XDB8884	Port Tobacco	2007	2.11	50.85	99.62
		2008	1.60	38.01	94.82
XDC3807	Popes Creek	2006	1.88	5.31	91.86
		2007	4.23	4.54	88.91
		2008	4.10	7.42	89.88
XCC8346	Swan Point	2006	1.75	32.32	85.83
		2007	0.89	29.16	75.91
		2008	0.39	19.12	66.61
XCC9680	Wicomico Beach	2006	1.24	41.44	95.99
		2007	0.12	42.01	95.25
		2008	0.17	26.73	94.47
XCD5599	Breton Bay	2006	12.40	15.09	9.85
		2007	13.74	31.91	13.67
		2008	22.64	22.26	13.71
		2009	4.98	10.66	4.65
XBE8396	Piney Point	2004	0.67	12.49	9.93
		2005	3.01	14.32	3.27
		2006	7.15	9.82	7.56
		2007	2.01	18.94	20.54
		2008	2.50	15.90	11.73
XBF7904	St. George's Creek	2006	1.92	15.78	27.48
		2007	2.41	20.74	27.87
		2008	7.75	18.25	19.36
		2009	1.13	4.61	5.08
		2010	0.04	4.93	19.78
		2011	0.42	21.66	27.52
		2012	0.16	10.15	21.63
XCF1440	St. Mary's College	2008	46.44	19.11	17.51
		2009	26.82	5.38	13.46
XBF6843	Sage Point	2004	0.46	6.67	17.43
		2005	2.26	16.16	10.09

< 10 % failure
10 - 40 % failure
40 - 70 % failure
> 70 % failure

The percent failure analysis determines how often dissolved oxygen levels were below healthy levels, but not how long at any one time dissolved oxygen levels were dangerously low. This is important because most benthic animals and fish can survive in low dissolved oxygen for short periods but not extended periods. To examine duration of low dissolved oxygen conditions, a special study was done of the continuous monitoring data from Maryland rivers for 2004-2010 and included the data for five shallow water stations in the Potomac River: Piscataway Creek (XFB2184, 2004-2008), Indian Head (XEB5404, 2009-2010), Mattawoman Creek (XEA3687, 2004-2010), Fenwick (XFB0231, 2004-2008) and St. Georges Creek (XBF7904, 2006-2008). This study found that periods of dissolved oxygen levels below 3.2 mg/l at different locations throughout the Bay lasted from as little as 15 minutes to as long as 5.7 days.[73] Mattawoman

[73] Boynton et al (2011) available online at http://www.gonzo.cbl.umces.edu/documents/water_quality/Level1Report28.pdf

Creek had the longest continuous period of extremely low dissolved oxygen for the Potomac River stations examined, a period of 25 hours (in 2010); in other years the maximum duration varied from 1-15 hours. The longest continuous period of extremely low dissolved oxygen per year at the station in Piscataway Creek varied from 3-16 hours. For Indian Head, the longest measured continuous period of extremely low dissolved oxygen was 4 hours. At Fenwick, the maximum duration of extremely low dissolved oxygen levels varied from 0-3 hours, and at St. Georges Creek varied from 4-15 hours.

Spatial Conditions

Spatial differences in water quality and habitat conditions were evaluated using the nutrient data collected from 2007-2008 at continuous monitoring and water quality mapping calibration stations from stations in Maryland and Virginia.[74] Data from the long-term monitoring stations in Maryland and Virginia were also included in the analyses. All calibration data for a station (water quality mapping and continuous monitoring) were used to calculate a monthly median. Note that some shallow water monitoring stations were co-located with long-term stations; medians for those stations include data from long-term and shallow water calibration sampling. Monthly medians for April-October were used to calculate the overall SAV growing season median, which was compared to habitat requirements (Appendix 5). See Appendix 9 for tables of results by station.

DIN levels were highest in the tidal fresh and oligohaline portions of the main river, and all stations in these regions were above the threshold for nitrogen limitation (Figure 35). Stations in the upper mesohaline region (down to Swan Point) were also above the nitrogen limitation threshold. All stations in the lower mesohaline region had DIN levels below this threshold, so nitrogen limitation may have occurred in these areas. Tributaries to the main river followed the same pattern with the exception that Port Tobacco River in Maryland and Potomac Creek in Virginia were below the threshold for nitrogen limitation.

PO_4 levels failed to meet the SAV habitat requirement in the middle section of the main river, from between Moss Point and Possum Point downstream to Morgantown (Figure 36) and at the stations on the Virginia side of the river across from Swan Point and in Monroe Bay (VA). PO_4 levels met the requirement in the upper and lower sections of the river. Only one tributary station failed the PO_4 requirement (upper Piscataway Creek long-term station).

Patterns of failure of the TSS SAV habitat requirement were not as consistent as the nutrient levels. TSS levels failed to meet the SAV habitat requirement in the main river near Smith Point, Blossom Point, Popes Creek and the mouth of St. Clements Bay, as well as in several Maryland tributaries (Port Tobacco River, Wicomico River, Breton Bay, St. Georges Creek and St. Mary's River). TSS levels also failed in may Virginia tributaries (Gunston Cove, Pohick Bay, Occoquan Bay, Neabsco Creek, Potomac Creek, Upper Machodoc Creek, Rosier Creek, Monroe Bay, Mattox Creek, Nomini Creek, Lower Machodoc Creek and Coan River).

CHLA levels generally met the SAV habitat requirement in the main river but failed to meet the requirement in some of the tributaries. CHLA levels failed to meet the habitat requirement in

[74] Virginia shallow water monitoring data retrieved from Chesapeake Bay Program databases (http://www.chesapeakebay.net/data/downloads/cbp_water_quality_database_1984_present)

Maryland tributaries to the middle river including Port Tobacco River, Wicomico River, St. Clements Bay and St. Georges Creek. CHLA levels failed to meet the habitat requirement in Virginia tributaries throughout the river including Occoquan Bay, Neabsco Creek, Potomac Creek, Upper Machodoc Creek, Rosier Creek, Monroe Bay, Mattox Creek, Nomini Creek, Nomini Bay, Lower Machodoc Creek and Coan River.

Secchi depth failed to meet the SAV habitat requirement in most of the upper and middle river, from the mouth of Dogue Creek downstream to the mouth of St. Clements Bay and in most of the tributaries. Secchi depth met the requirement in only a few tributaries, including Mattawoman Creek, the lower Wicomico River, Breton Bay and St. Mary's River in Maryland and Pohick Bay in Virginia.

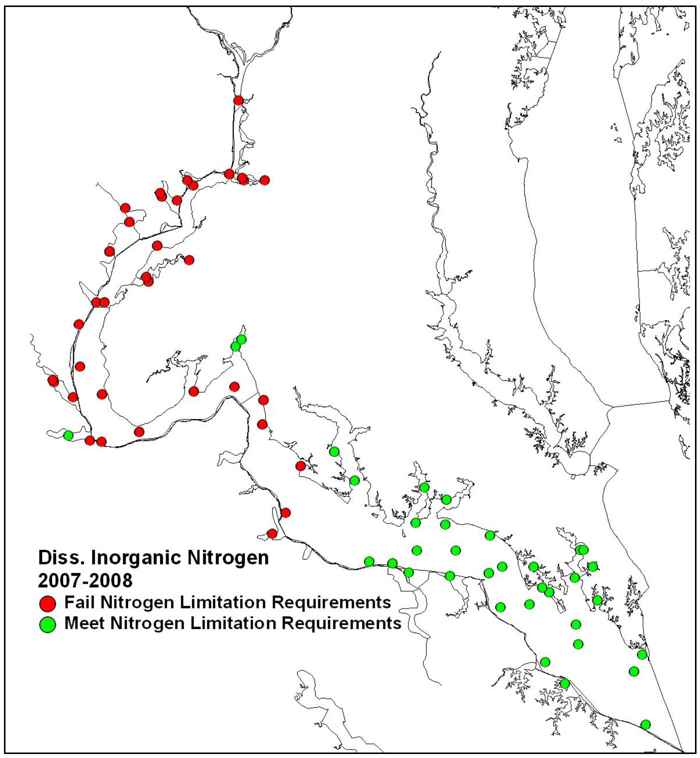


Figure 35. Shallow water monitoring DIN data compared to the Nitrogen Limitation threshold 2007-2008.

DIN levels below 0.07 mg/l meet the nitrogen limitation threshold. All calibration data for a station (water quality mapping and continuous monitoring) were used to calculate a monthly median. Monthly medians for April-October were used to calculate the SAV growing season median, which was compared to habitat requirements (Appendix 5). Note that the long-term stations include data from long-term and water quality mapping calibration sampling. See Appendix 9 for tables of results by station.

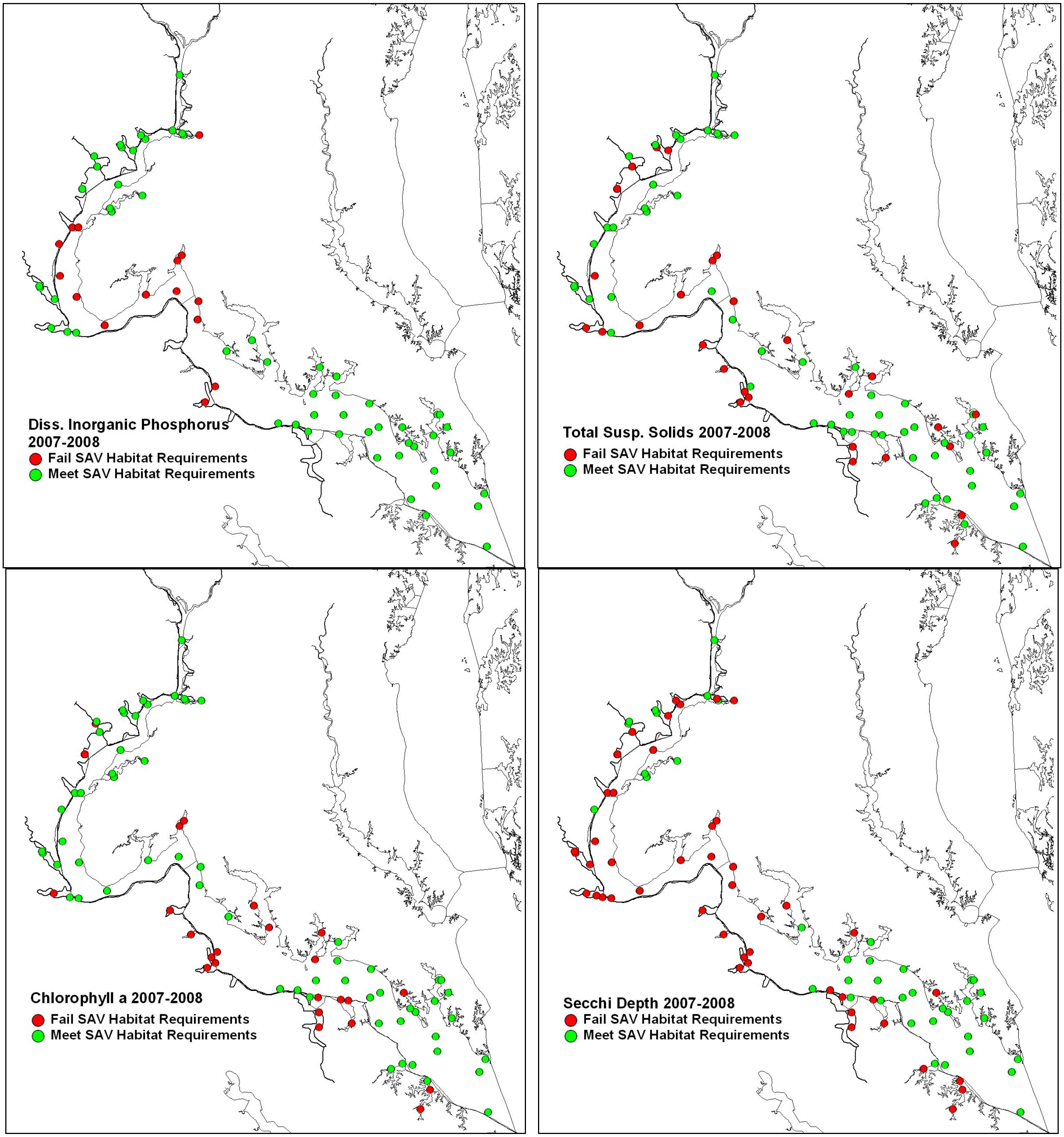


Figure 36. Shallow water monitoring data compared to the SAV Habitat Requirements for 2007-2008.
PO_4 (top left), TSS (top right), CHLA (bottom left), Secchi depth (bottom right). All calibration data for a station (water quality mapping and continuous monitoring) were used to calculate a monthly median. Monthly medians for April-October were used to calculate the SAV growing season median, which was compared to habitat requirements (Appendix 5). Note that the long-term stations include data from long-term and water quality mapping calibration sampling. See Appendix 9 for tables of results by station.

Health of Key Plants and Animals

Phytoplankton

Phytoplankton (generally algae) are the primary producers in the Chesapeake Bay and rivers and the base of the food chain. Routine samples collected in the long-term tidal and shallow water monitoring programs estimate the abundance of algae but can not determine the health of the population overall. As part of a supplemental program, the overall phytoplankton community was sampled at three of the long-term tidal water quality stations in the Lower Potomac (Indianhead, Maryland Point and Ragged Point) in spring and summer. The phytoplankton index of biotic integrity (PIBI) assesses the health of the community. [75] A PIBI score of greater than 3 is considered meeting the goal for phytoplankton community health criteria.[76] From 1985-2010, PIBI scores at Indianhead may have degraded in the spring but improved in the summer. PIBI scores at Maryland Point degraded in the spring and may have degraded in the summer as well. The Ragged Point PIBI scores also degraded in the spring. Spring PIBI scores at all stations did not meet the goal for most years. Summer PIBI scores also did not meet the goal in most years at the Indianhead and Ragged Point stations, but summer PIBI met the goal in more than half of the years at Maryland Point. Summer PIBI scores at Indianhead were the worst measured in the Potomac from 1993-2003, but in recent years had improved to meeting the goal in several years.

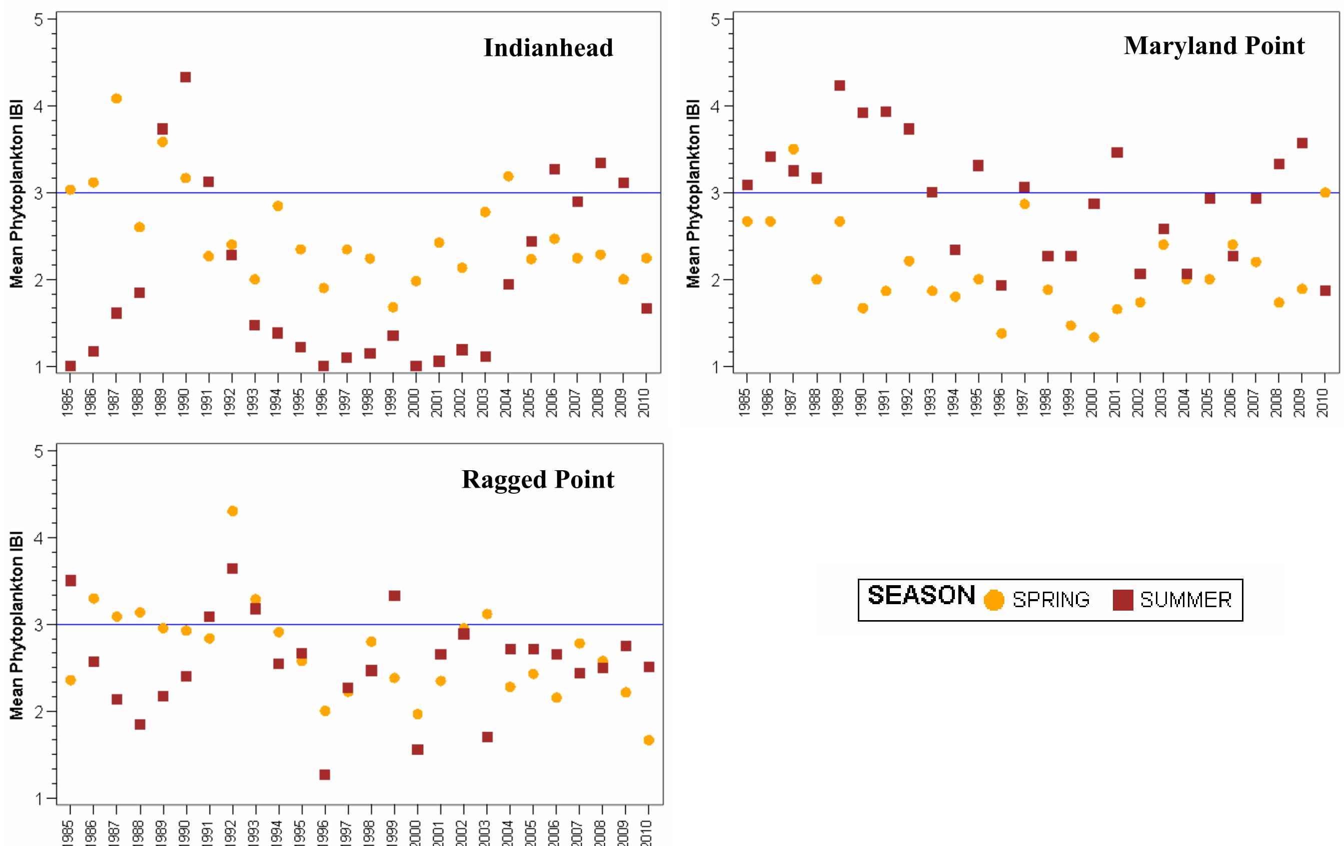


Figure 37. Spring and summer Phytoplankton Index of Biotic Integrity (PIBI) scores 1985-2010.

[75] Methods for calculation of the PIBI are available at http://www.chesapeakebay.net/images/indicators/5387/indicator_survey_phyto_ibi_2012_final.docx

[76] PIBI scores calculated by J. Johnson, Interstate Commission on the Potomac River Basin/Chesapeake Bay Program.

Harmful Algal Blooms (HABs)

High algal density (algal blooms) can degrade habitat quality. Blooms of certain species of phytoplankton (harmful algae) can also degrade habitat quality. When a bloom occurs, samples are taken to test for the presence and levels of toxins, which can be released by some types of harmful algae. Fortunately, of the more than 700 species of algae in Chesapeake Bay, less than 2% of them are believed to have the ability to produce toxic substances.[77]

Blue-green algae are generally smaller cells and not as nutritious and edible to small animals (zooplankton). Blooms of blue-green algae look like blue-green paint floating at or near the water surface (Figure 38). Blue-green algae can only live in low salinity waters. Some species of blue-green algae (*Microcystis* and *Anabaena*) can produce a toxin that is released into the water. Contact with or ingestion of water containing high toxin levels can cause human health impacts (skin irritation, gastrointestinal discomfort), and can be harmful or even fatal to livestock and pets. The Potomac main river from Indian Head to Morgantown and Mattawoman Creek has historically had significant to severe blue-green algal blooms (*Microcystis aeruginosa, Anabaena and Aphanizomenon*), though the severity of these blooms has generally lessened as nutrient levels have decreased (Figure 39).[78]

Blooms of some species of algae called dinoflagellates are known as 'mahogany tides' because the color of the algae and the density of algae in the bloom make the water appear brown or reddish-brown (Figure 40). These conditions are most often caused by blooms of *Prorocentrum minimum*. While *Prorocentrum* frequently blooms in the spring, blooms have been observed in Maryland waters in all seasons. These algae do not produce a toxin, but the magnitude of the bloom can harm fish and shellfish by replacing more nutritious algae, depleting oxygen in the water column or clogging gills. The darkened waters can also reduce the light reaching underwater grasses. The tidal Potomac river has recurrent mahogany tides (*Prorocentrum minimum*), usually in the area from Morgantown to the mouth of the river and into the mainstem Bay; some bloom events have been associated with fish kills. The lower Potomac also has had occasional blooms of *Dinophysis accuminata,* including a bloom in February-March 2002 which led to temporary closing of oyster beds to harvesting to prevent illness in humans.[79]

[77] Information on Harmful Algal Blooms is available at http://mddnr.chesapeakebay.net/eyesonthebay/habs.cfm
[78] For more information on blue-green algae blooms, see DNR's Eyes on the Bay website: http://mddnr.chesapeakebay.net/eyesonthebay/habs.cfm

[79] For more information on the 2002 bloom, see http://mddnr.chesapeakebay.net/hab/news_2_25_02.cfm and http://mddnr.chesapeakebay.net/hab/news_3_4_02.cfm

Figure 38. Blue-green algal scum accumulating along the shoreline of the Potomac River, Route 301 bridge at Morgantown, MD.
Photo by MD DNR's Laura Fabian, September 2, 2003.

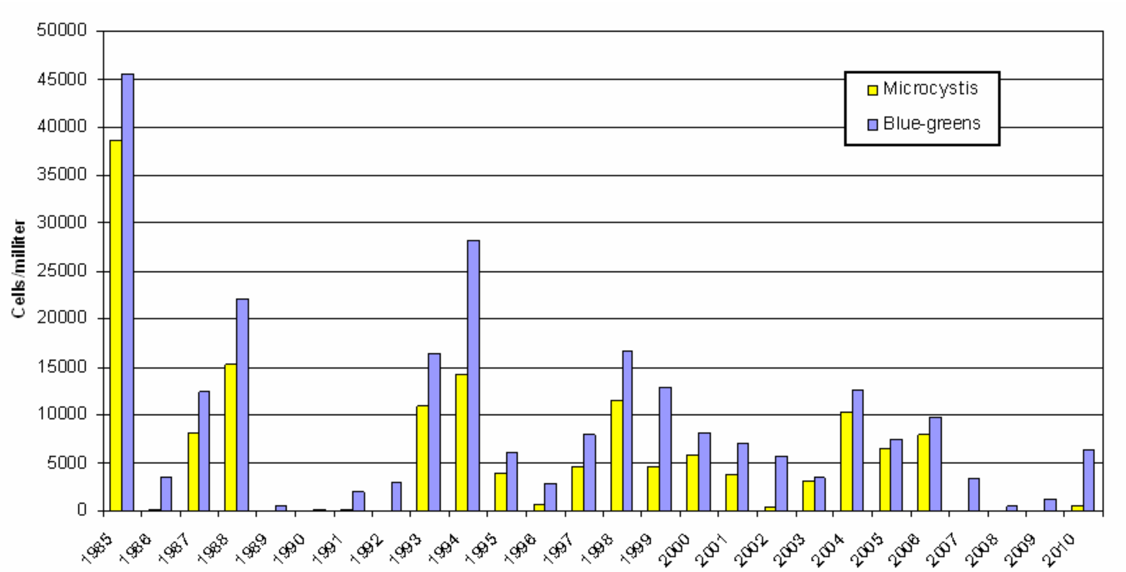


Figure 39. Historical time series (1985-2010) for summer mean concentration of blue-greens in the Potomac River at Indian Head.
Density of all blue greens (blue bar) and *Microcystis* (yellow bar), including filaments, colony counts plus cells/ml. Summer includes July, August and September.

Figure 40. 'Mahogany tide' harmful algal bloom.

Didymo, sometimes called 'rock snot' due to its appearance, is another harmful algal species first detected in the basin in 2009 in the Savage River, a tributary to the Upper Potomac. *Didymo* is not a human health risk, but the dense mats of algae may negatively impact bottom dwellers such as crayfish, mayflies and stoneflies.[80] *Didymo* can bloom into enormous numbers resulting in a yellow-brown mass that may dominate sections of a river. Over time, dramatic changes in stream biology are probable, and the thick mats of algae make fishing virtually impossible.

In a soon to be published DNR study, numerous longtime Upper Potomac River anglers/guides were surveyed about their experiences on the river and how the river has changed over their lifetimes fishing the river. A common thread was the mention of large amounts of algae on rocks and in the water column present in summer months from approximately Harper's Ferry down river down river to at least Point of Rocks. Most responses suggested that the increases in algae have occurred since the late 1990's. Algal growth was so heavy that guides and other fisherman would avoid these areas during these algal blooms due to the noxious smell and poor quality of fishing. Currently DNR is investigating the extent of the blooms, species involved and the causes for these algal blooms

Figure 41. *Didymo* mats.
Didymo, sometimes called 'rock snot' due to its appearance, forms dense mats that may negatively impact bottom dwellers such as crayfish, mayflies and stoneflies.

[80] For more information on *Didymo,* please see http://dnr.maryland.gov/dnrnews/pressrelease2011/031711.asp

Underwater grasses

Water quality determines the distribution and abundance of underwater grasses (submerged aquatic vegetation, SAV). For this reason, SAV communities are good barometers of the health of the tidal rivers and bays. SAV beds are also a critical nursery habitat for many bay animals. Similarly, several species of waterfowl are dependant on SAV as food when they over-winter in the Chesapeake region. SAV distribution is determined through the compilation of aerial photography directed by the Virginia Institute of Marine Science (VIMS).[81]

Maryland's tidal fresh portion of the Potomac River has had highly variable SAV coverage. In 1999-2004, SAV coverage in the Maryland tidal fresh Potomac was between approximately 860 to 1860 acres (40% to 87% of the Maryland goal of 2,142 acres, Figure 42).[82] SAV abundances were higher in 2005-2010 and were close to or above the restoration goal. SAV abundances in the Maryland tidal fresh waters peaked at approximately 3,073 acres (143% of goal) in 2008. Since then, coverage has declined, and in 2012 was approximately 867 acres (40% of goal, Figure 44).[83] Hydrilla, coontail and water milfoil were the most frequently reported of the species found during ground-truthing by citizens and the U. S. Geological Survey. SAV coverage in Virginia's tidal fresh portion followed a similar pattern and peaked at 3,778 acres in 2010 (181% of VA goal of 2,142 acres) but also declined in 2012 to 85% of the VA goal. SAV coverage in the District of Columbia section of the tidal fresh Potomac was highest in the 1999-2002 period and met the D.C. goals, but has since dropped to less than 15% of the D.C. goal.

SAV acreage in the Maryland portion of the oligohaline Potomac River has been declining since 1999, when coverage was 2,531 acres (90% of the MD goal of 2,802 acres, Figure 42). In 2012, SAV area met 39% of the MD goal. Conversely, SAV beds in the Virginia portion of the oligohaline segment generally increased from 1999-2010, exceeding the VA restoration goal in most years. SAV beds in the Virginia portion covered approximately 1,480 acres (98% of the VA goal) in 2012.

Piscataway Creek SAV acreage has been highly variable over the past few decades. However, dense SAV beds in 2005-2008 covered close to the restoration goal of 789 acres (Figure 43). In 2012, Piscataway Creek SAV coverage had dropped to 252 acres (32% of goal).

Bay grass coverage in Mattawoman Creek was close to or exceeded its 792 acre restoration goal in 2005-2010 (Figure 43). Mattawoman Creek coverage declined in 2012 and only met 68% of the SAV restoration acreage goal. The dense SAV beds in Mattawoman Creek provide critical habitat and spawning areas for several recreationally important finfish.

[81] Reports detailing methodology and annual SAV coverage are available at www.vims.edu/bio/sav . Details on species of SAV discussed in this report can be found at www.dnr.maryland.gov/bay/sav/key
[82] Goals are set for each state for each river segment.
[83] 2012 data are preliminary.

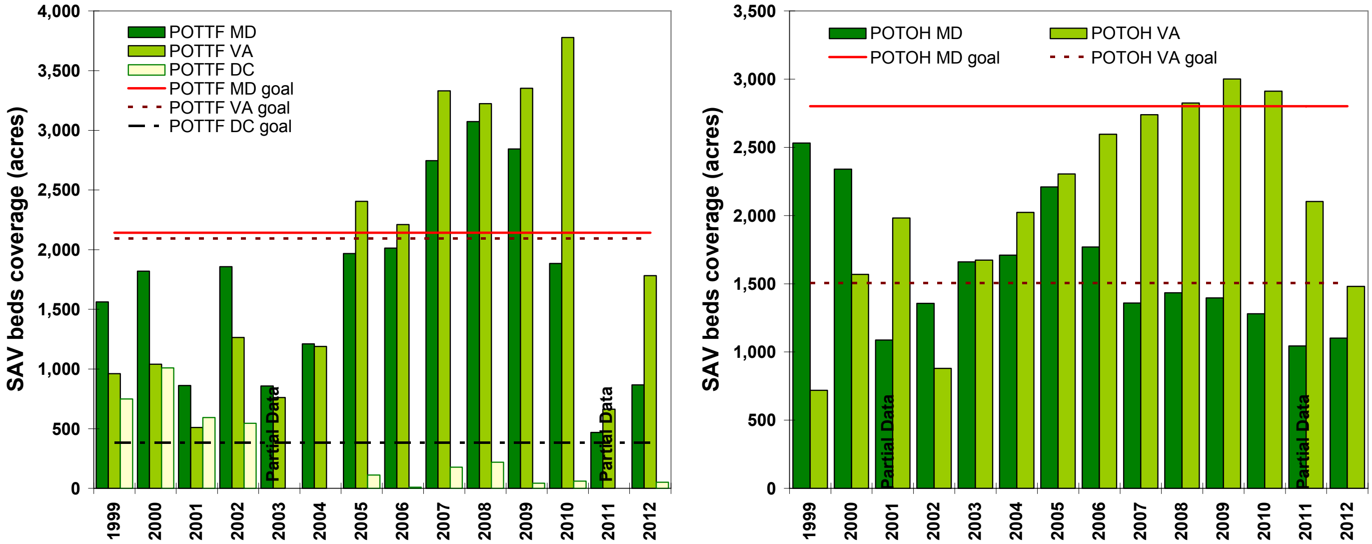


Figure 42. SAV total area in the tidal fresh and oligohaline Potomac by state for 1999-2012. Data provided by VIMS; 2012 data is preliminary. Tidal fresh segment (TF) of the main river is shown in the left panel. Oligohaline segment (OH) of the main river is shown in the right panel. SAV acreage restoration goals for each state are shown as indicated in legend.

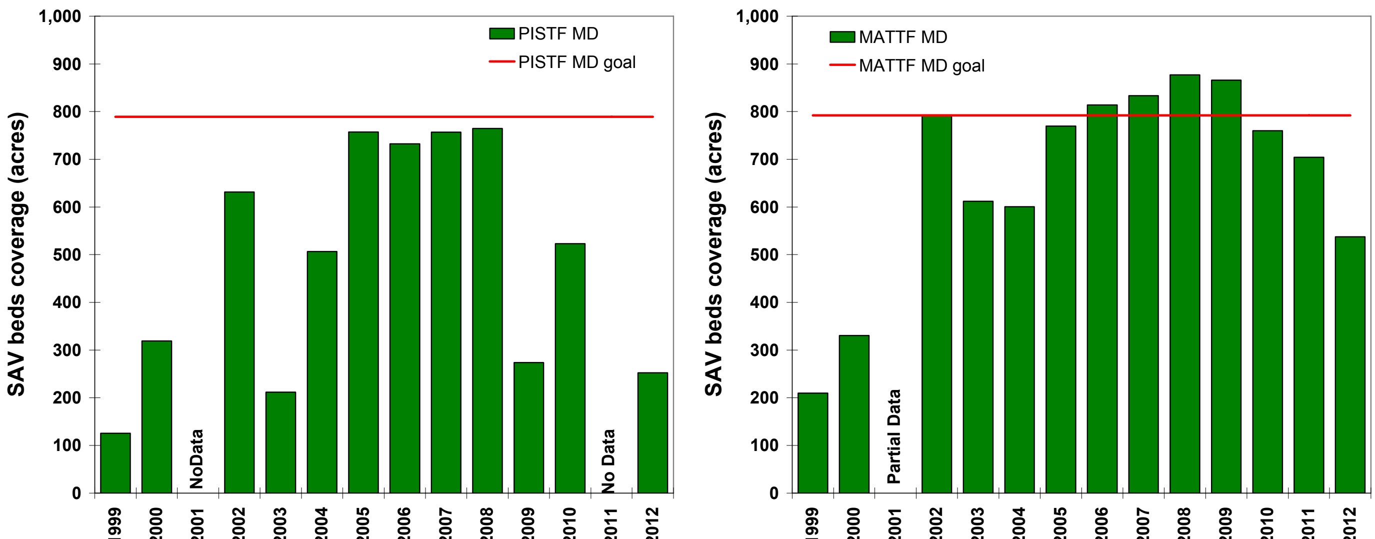


Figure 43. SAV total area in the Piscataway and Mattawoman Creeks for 1999-2012. Data provided by VIMS; 2012 data is preliminary. Piscataway Creek data are shown in the left panel. Mattawoman Creek data are shown in the top right panel. SAV acreage restoration goal is shown with red line.

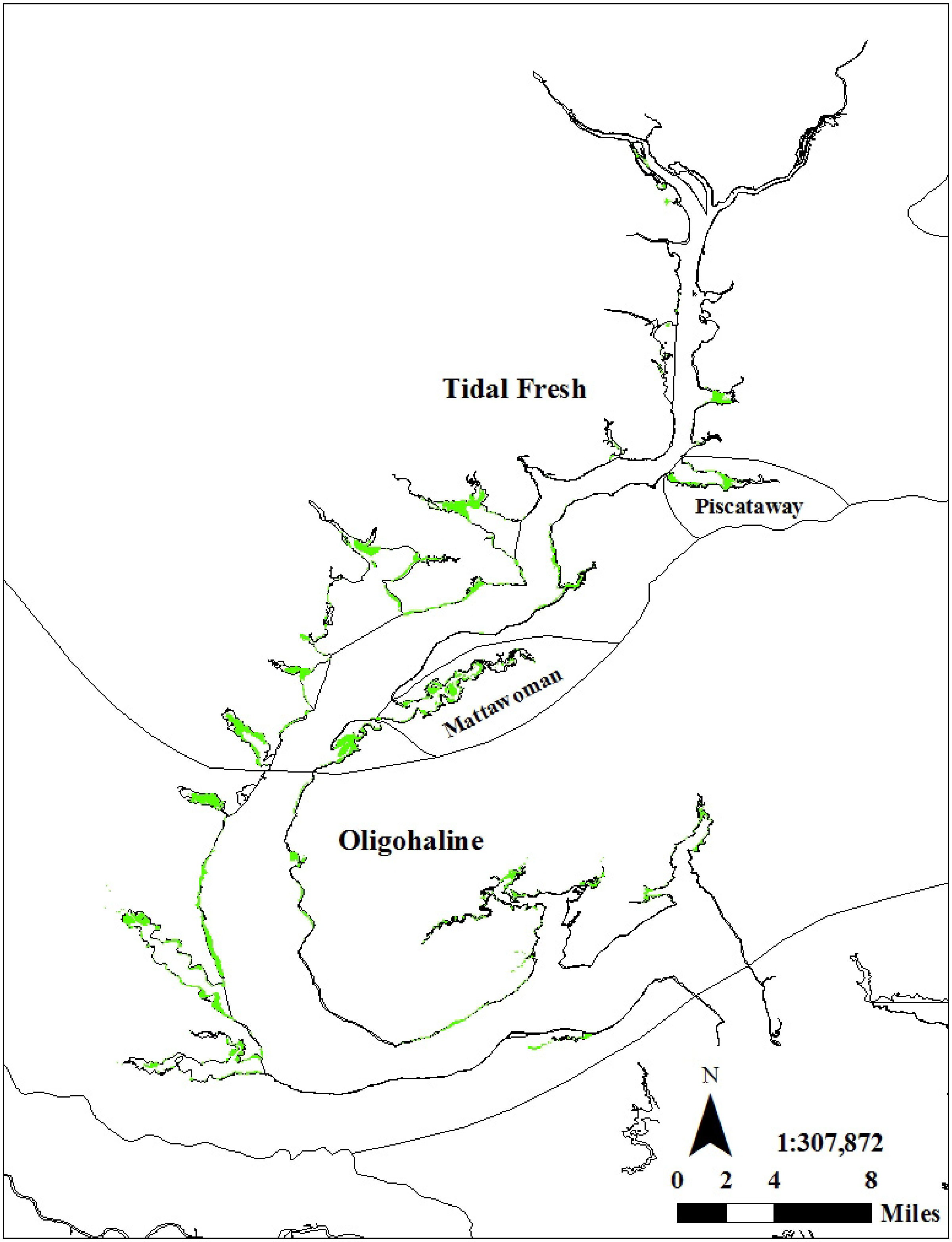


Figure 44. SAV beds in the tidal fresh and oligohaline Potomac in 2012.
Data provided by VIMS; data is preliminary. Green areas indicate location of SAV beds. Piscataway Creek and Mattawoman Creek segments also shown

In the Maryland portion of the mesohaline Potomac, SAV coverage has dropped dramatically from higher levels in 2002-2006, when acreages ranged from 1,663 to 3,062 acres (23% to 43% of the restoration goal of 7,088 acres, Figure 45). From 2007-2012, SAV beds in Maryland waters covered less than 10% of the area need to meet the Maryland restoration goal. In 2012, beds were extremely sparse (Figure 46). In the Virginia portion of the mesohaline Potomac, little to no SAV coverage has been measured since 2006. Historically, the lower Potomac River was dominated by several species of SAV, including horned pondweed (*Zannichellia palustris*), eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*). Natural populations of horned pondweed and widgeon grass remain primarily in the St. Mary's River and St. Georges Creek. Several acres of eelgrass have been successfully restored since 2004 near St. Georges Island.

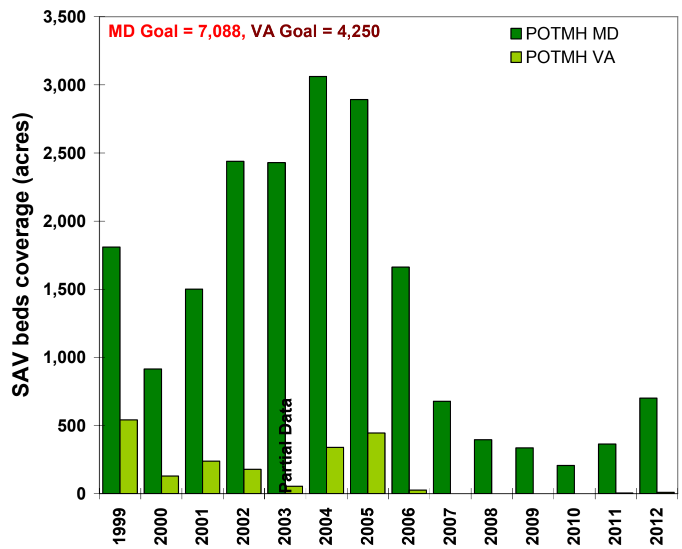


Figure 45. SAV total area in the mesohaline Potomac by state for 1999-2012.
Data provided by VIMS; 2012 data is preliminary. SAV acreage restoration goals for each state are outside the scale of the graph and indicated at top.

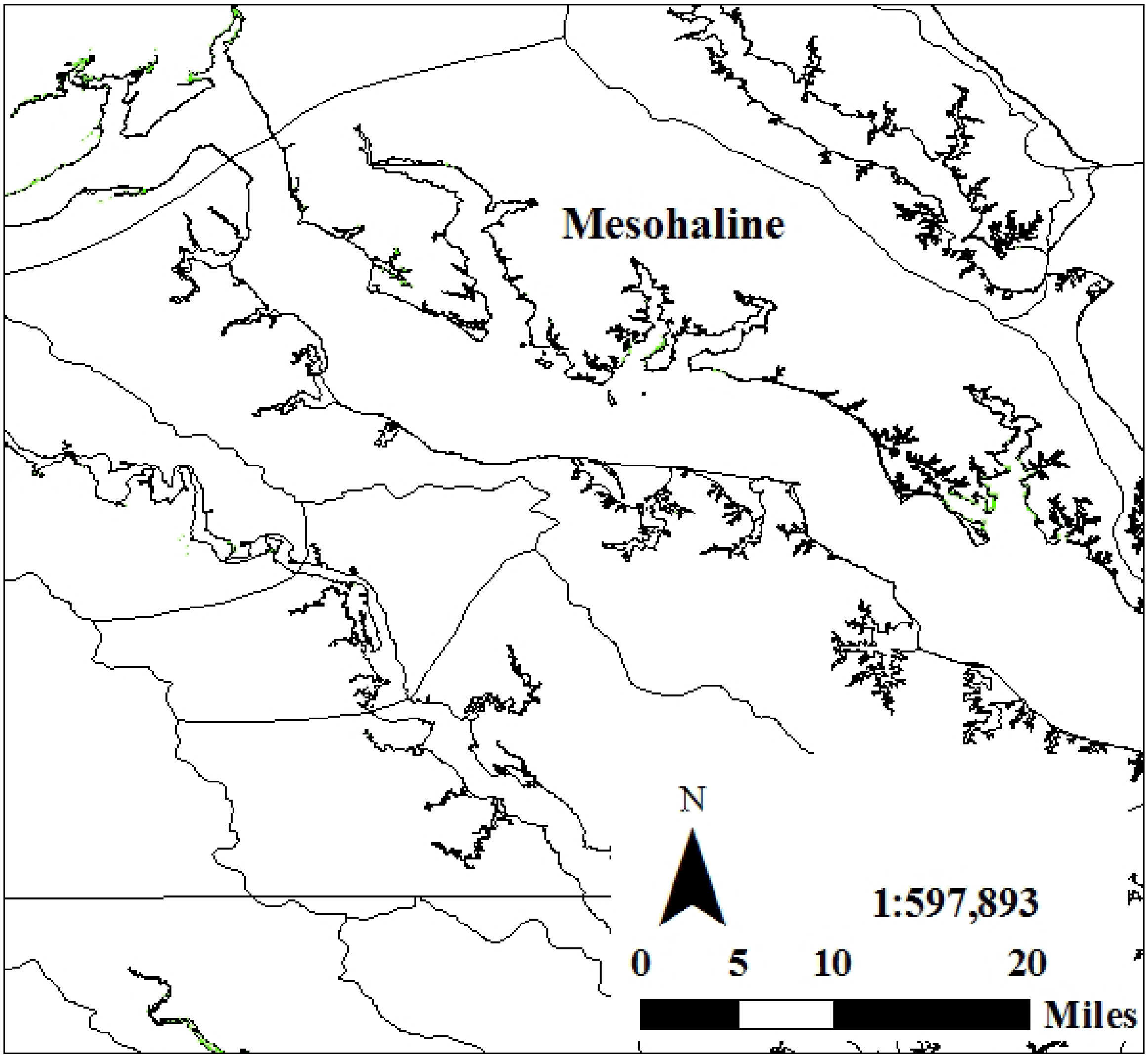


Figure 46. SAV beds in the mesohaline Potomac in 2012.
Data provided by VIMS; data is preliminary. Green areas indicate location of SAV beds.

Benthos

Benthic animals are the animals that live in or on the bottom of the bay. To determine the health of benthic communities, samples are collected in the summer at seven long-term benthic monitoring stations in the Potomac River. The Potomac River stations have been monitored since 1984. The benthic index of biotic integrity (BIBI) assesses the health of the benthic community.[84] A BIBI score of greater than 3 is considered meeting the goal for benthic community health.

The health of benthic communities in the upper tidal fresh river (near the mouth of Broad Creek) has gotten worse from 1985-2012; conditions at this location met goals in 1985-1987, but conditions were degraded for 2010-2012. Benthic communities near Maryland Point met goals. The benthic community in shallow water upstream of Morgantown met goals, but the community in deeper water was severely degraded and significantly worsened from 1985-2012. The station downstream of Morgantown met goals. There are two stations in the main river between St. Clements Bay and Nomini Bay; benthic communities at the northern station were degraded and at the southern station were severely degraded.

Starting in 1996, samples were also collected each year from randomly selected locations. The tidal Potomac is sampled as a single area for the Benthic Monitoring Program, so both the Middle and Lower Potomac Basins are combined for estimating the amount of area that is degraded. Twenty-five samples are randomly selected from the entire Potomac River each year, but there are not a fixed number of samples each year sampled in the Middle versus Lower Potomac basin. Because each spot in the Potomac has an equal chance of being selected each year, the larger lower river ends up with more samples collected over time.

Over the entire 1996-2012 period, the Potomac has been sampled in 425 locations (25 samples per year). Only 14 were collected in the Middle Potomac; 411 (about 97% of the total samples) were collected in the Lower Potomac. Degraded or Severely Degraded conditions were found in 21% of samples in Middle and 71% of samples in Lower Potomac. Only 3 samples were collected in the Middle Potomac from 2010-2012: 2 met goals and one was degraded (Figure 47). For the 2010-2012 period, 72 samples were collected in the Lower Potomac river: 32 (44%) were severely degraded, 20 (28%) were degraded, 7 (10%) were marginal and 13 (18%) met or exceeded restoration goals. The degraded locations were mostly within the deep channel of the lower river, where dissolved oxygen is almost always depleted (hypoxic or anoxic) during the summer months. Most of the locations where healthy benthic communities were found were upstream of this area or in shallower portions of the river.

On average, the area of bottom habitat that was degraded or severely degraded was 888 km^2 (70%). In seven years (1998, 2001, 2003, 2005-2007, 2011) more than 75% of the total area (969-1122 acres) was degraded or severely degraded. In 2010 the area failing was 64%, in 2011 it was 76%, and in 2012 it was 72%.

[84] Methods for calculation of the BIBI are available at http://www.baybenthos.versar.com/DsgnMeth/Analysis.htm

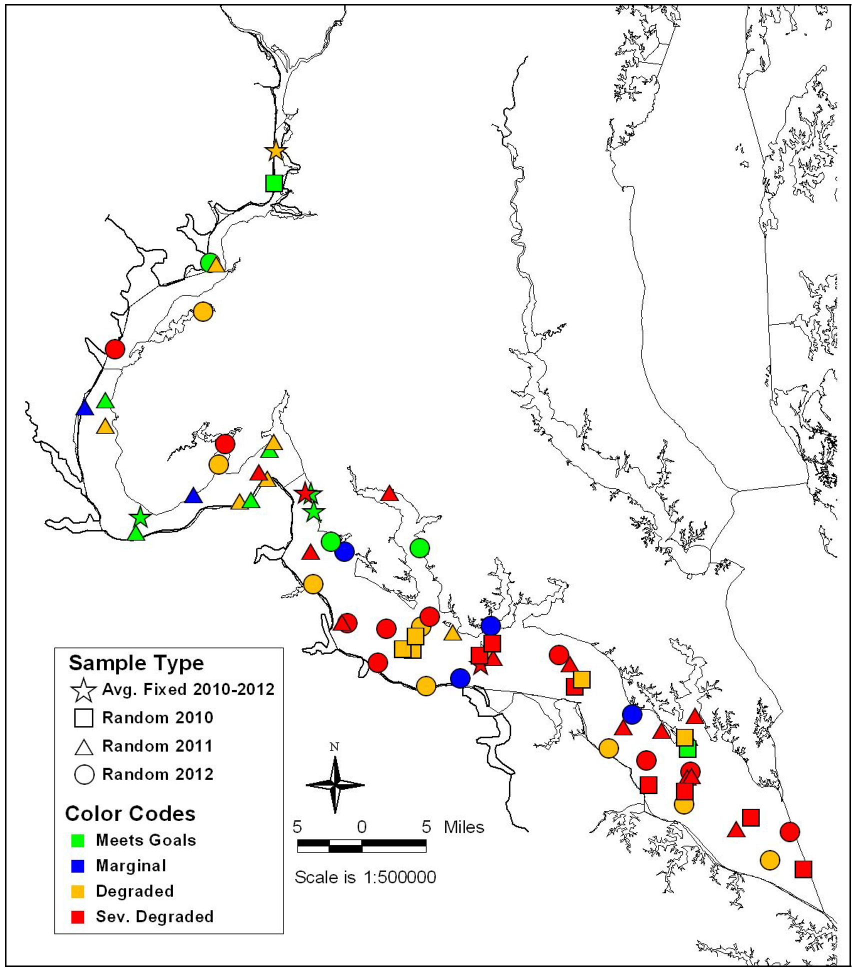


Figure 47. Benthic Index of Biotic Integrity (BIBI) results for the Potomac for 2010-2012. Random samples were collected in 75 locations in 2010-2012. A BIBI score of 3 or greater Meets Goals. BIBI scores of 2.7-2.9 are Marginal, 2.1-2.6 are Degraded and less than 2.1 are Severely Degraded.

Summary of Water and Habitat Quality Conditions

Information on current water and habitat quality and the changes through time is needed to assess the health of a river. Many types of information are needed to most completely understand the current conditions. In some instances the assessment is straight forward and all of the information indicates both good water quality and healthy habitats. Most often, some aspects of the overall picture indicate good conditions and other aspects indicate poor conditions. The summary presented here is intended to best represent an overall condition. This is a simplified version and cannot capture all the detail presented in the previous sections of this report. Informing the public about the overall health of a river is often best done with a summary of all of the data. Management decisions can benefit from both the summarized and the detailed information.

The Potomac River watershed in Maryland is divided into three basins: the Upper Potomac, Middle Potomac and Lower Potomac. Due to both the size of the basin and the difference in land use and human population, the Upper Potomac is further divided into the western Upper Potomac and the eastern Upper Potomac.

Western Upper Potomac

The Potomac River in the western Upper Potomac basin is all non-tidal. The main portion of the river is the North Branch Potomac and the Potomac River downstream to US Rt.522 near Hancock, Maryland. Maryland tributaries to the main river include Savage River, Georges Creek, Braddock Run, Wills Creek and Town Creek. Land use in Maryland is approximately 75% forest, and stream health varies from good (Savage River) to fair (Lower North Branch, Fifteen Mile Creek, Sidling Hill Creek) to poor (the rest of the area). Human population density is low to moderate.

Nitrogen and phosphorus loadings from the Maryland streams have decreased over the long-term. However, while nitrogen loadings decreased in the recent period, phosphorus and sediment loadings have increased. Nitrogen levels in the river and streams have decreased as well, and some main river locations have decreased phosphorus levels. Sediment levels have increased at the two upstream main river stations and in Savage River and Georges Creek, but decreased in the most downstream main river station.

While decreased nutrients indicate improvement overall, they do not necessarily indicate healthy stream habitat. Non-tidal river habitat is influenced by many issues beyond nutrient and sediment conditions (for example, acid mine drainage, pollutants, impervious surfaces, etc.), Also, newer concerns include algal blooms in this farthest upstream region of the Potomac River and the occurrence of invasive species such as *Didymo*.

Eastern Upper Potomac

The Potomac River in the eastern Upper Potomac basin is all non-tidal. The main river in this section extends from downstream of Hancock, Maryland to the mouth of the Monocacy River. Maryland tributaries to the main river include Conococheague Creek, Antietam Creek, Catoctin Creek and the Monocacy River; the Shenandoah River also enters the Potomac River from the West Virginia/Virginia side of the river. Land use in Maryland is a mix of agriculture, forest and urban. Between 2000 and 2010, urban land use increased by approximately 7%, and was highest in the Catoctin Creek and Double Pipe Creek sub-watersheds. Impervious surfaces covered more than 5% of the Tonoloway Creek, Antietam Creek, Lower Monocacy River, Marsh Run and Conococheague Creek sub-watersheds. Stream health is poor in most of the basin with the exception of being fair in the Upper Monocacy River sub-watershed. Conococheague Creek and Lower Monocacy River sub-watersheds are Maryland Trust Fund medium priority watersheds.

Nitrogen and phosphorus loadings from Maryland have decreased over the long-term, but only phosphorus loadings have decreased in the recent period. Nitrogen levels have increased in Conococheague Creek and Antietam Creek but decreased in the lower Monocacy River and in the main river at Point of Rocks. Phosphorus levels have decreased throughout the basin, and sediment levels have decreased in Conococheague Creek and Antietam Creek and maybe decreased in Catoctin Creek and Monocacy River.

Middle Potomac

The Potomac River in the Middle Potomac basin is both non-tidal and tidal fresh and extends from downstream of the Monocacy River to downstream of Piscataway Creek. Maryland tributaries to the non-tidal portion of the river include Seneca Creek, Cabin John Branch, Rock Creek and the Anacostia River. Piscataway Creek enters the river below the fall line. Land use in Maryland is 56% urban and 27% forest. Human population density in Maryland is high to very high. Impervious surfaces covered between 10-20% in the Potomac River Montgomery County, Piscataway Creek and Potomac River Upper tidal sub-watersheds and more than 20% in the Anacostia River, Oxon Creek, Rock Creek and Cabin John Creek sub-watersheds.

Stream health in the watersheds surrounding the middle Potomac River (on the Maryland side) is categorized as poor in all but the Seneca Creek sub-watershed which is categorized as fair. All of the middle Potomac sub-watersheds are Maryland Trust Fund high priority watersheds except Seneca Creek, which is a low priority watershed.

Over the long-term, nitrogen levels have decreased at all of the non-tidal stations, phosphorus levels have decreased at most of the stations, and sediment levels have decreased at the upstream main river stations. Nitrogen, phosphorus and sediment loadings at the river input station (fall line) at Chain Bridge have also decreased over the long-term period.

In the more recent period, phosphorous levels in the non-tidal main river decreased and nitrogen levels may have decreased at the upstream main river station. Nitrogen and phosphorus levels have also decreased in Seneca Creek. However, phosphorus levels may have increased and sediment levels have increased in the Anacostia River, and overall sediment loadings measured at the fall line have increased.

Water quality in the open tidal portions of the middle Potomac was fair to poor due to high nitrogen and poor water clarity. Piscataway Creek had fair water quality. Nitrogen levels have decreased throughout the Middle Potomac, and phosphorus levels have decreased in the recent period in most areas. DIN levels were not low enough for nitrogen limitation to occur. PO_4 levels met the SAV habitat requirements except in the upper Piscataway Creek, while TSS levels met the habitat requirement except in the lower Piscataway. Algal densities only met the habitat requirement in the upper Piscataway and water clarity failed to meet the requirement in all locations. Summer dissolved oxygen levels were good.

Water quality in the shallow waters of the Middle Potomac main river met the SAV habitat requirements, but nitrogen levels were too high for nutrient limitation. Water quality in the tributaries to the Middle Potomac met the SAV habitat requirements for phosphorus, and most met the requirements for algal densities but failed to meet water clarity requirements. Sediments were too high in some of the shallow water areas.

In the tidal fresh areas of the main river, SAV abundances in 2005-2010 and were close to or above the restoration goal. Since then, coverage has declined, and in 2012 was approximately 867 acres (40% of goal). In Piscataway Creek, SAV beds in 2005-2008 covered close to the restoration goal, but in 2012, coverage had dropped to 252 acres (32% of goal).

Bottom animal populations were unhealthy at the long-term station and conditions have degraded.

Lower Potomac

The Potomac River in the Lower Potomac basin is all tidal and extends from downstream of Piscataway Creek to the mouth of the river at Point Lookout. Mattawoman Creek is a major tributary from the Maryland side of the river. Land use in Maryland is 51% forest, 24% urban and 19% agriculture. Human population density in Maryland is generally moderate. Impervious surfaces covered 4% of the watershed overall.

Stream health in the watersheds surrounding the Lower Potomac River (on the Maryland side) is categorized as fair. All of the Lower Potomac sub-watersheds are Maryland Trust Fund low priority watersheds.

Water quality in the open tidal waters of the Lower Potomac was fair due to moderate nutrient levels but high algal densities and poor water clarity. Mattawoman Creek had good water quality. Nitrogen levels have decreased throughout the Lower Potomac and phosphorus levels decreased in the upstream areas and in Mattawoman Creek. Sediment levels increased in the middle portion of the main river but decreased at the two downstream stations and in Mattawoman Creek. Algal densities and water clarity degraded in the main river but improved in Mattawoman Creek. DIN levels were not low enough for nitrogen limitation to occur at most stations, but nitrogen limitation may have occurred in Mattawoman Creek in summer and fall, and may have occurred at the downstream stations in summer, fall and winter. PO_4 and TSS levels failed to meet the SAV habitat requirements in the main river in the upstream and middle portion. Algal densities met the SAV habitat requirement except at Ragged Point, but water clarity failed in all areas except the two downstream stations. Summer BDO in the Lower Potomac upper portions rarely fell below 5 mg/l, but BDO often fell below 5 mg/l at Maryland Point. At Morgantown, summer BDO was almost always below 5 mg/l from June-August, and often fell below 3 mg/l. At Ragged Point and Point Lookout, summer BDO was almost always below 3 mg/l and very often less than 2 mg/l.

Water quality in the shallow waters of the upper portion of the main Lower Potomac generally met the habitat requirements for algal densities and sediment levels, but failed for phosphorus and water clarity and the nitrogen levels were too high. In the lower portion of the main river water quality met all of the SAV habitat requirements.

Shallow water areas in the tributaries to the upper portion of the lower Potomac River generally failed to meet habitat requirements for algal densities, water clarity and sediments. Nutrients were not measured during the shallow water monitoring program at many stations; in tributaries where nutrients were measured, upstream tributaries generally failed for phosphorus but had lower nitrogen levels, while downstream tributaries met for phosphorus but had higher nitrogen levels. In the tributaries to the lower portion of the Lower Potomac River where nutrients were measured, phosphorus levels met the requirements and nitrogen levels were lower. Algal densities and water clarity failed to meet requirements in about half of the tributaries, and sediments failed to meet requirements in the more upstream tributaries.

SAV acreage in the Maryland portion of the oligohaline Potomac River has been declining since 1999, when coverage was 90% of the goal. In 2012, SAV area met 39% of the goal. Bay grass coverage in Mattawoman Creek and was close to or exceeded the restoration goal in 2005-2010, but declined in 2012 and only met 68% of the SAV restoration acreage goal. In the Maryland portion of the mesohaline Potomac, SAV coverage has dropped dramatically from higher levels in 2002-2006, when acreages ranged from 23% to 43% of the restoration goal. From 2007-2012, SAV beds in Maryland waters covered less than 10% of the area need to meet the Maryland restoration goal.

The health of algal populations degraded in the spring but may have improved in the upper section of the Lower Potomac in the summer. Blue green algal blooms have also become less frequent and/or less severe. More than half of the habitat for bottom animals was degraded. The degraded locations were mostly within the deep channel of the lower river, where dissolved oxygen is almost always depleted (hypoxic or anoxic) during the summer months. Most of the locations where healthy benthic communities were found were upstream of this area or in shallower portions of the river.

Appendix 1

Land use/land cover for 2000 and 2010 and Amount of Impervious Surface

Land-use/land-cover 2000 and 2010 from the Maryland Department of Planning. 2010 data is available at www.planning.maryland.gov/OurWork/landUse.shtml. 2000 data is available from Maryland Department of Planning, Planning Data Services, (410) 767-4450. Use codes are from the Maryland Department of Planning Land Use/ Land Cover Classification Definitions (http://www.planning.maryland.gov/PDF/OurWork/landUse/AppendixA_LandUseCategories.pdf). Impervious surface calculated from definitions in Cappiella and Brown, Urban Cover and Land Use in the Chesapeake Bay watershed, Center for Watershed Protection, 2001, as referenced in Table 4.1 of a User's Guide to Watershed Planning in Maryland http://dnr.maryland.gov/watersheds/pubs/userguide.html

Basin Overall Summary

Loadings ≥ 20% shown in **BOLD**

Region	Land use/ Land cover	Area in 2000 (sqr miles)	%Total in 2000	Area in 2010 (sqr miles)	%Total in 2010	Area Change (sqr miles)	%Total Area change
WESTERN UPPER POTOMAC	AGRICULTURE	93.96	13%	90.36	12%	3.60	1%
	BARREN LAND	0.64	0%	0.66	0%	-0.03	0%
	FOREST	550.01	**76%**	541.79	**75%**	8.23	1%
	TRANSPORTATION	0.00	0%	2.12	0%	-2.12	0%
	URBAN	63.21	9%	73.10	10%	-9.89	-1%
	WETLANDS	0.54	0%	0.42	0%	0.12	0%
	IMPERVIOUS	11.89	2%	14.75	2%	-2.86	0%
EASTERN UPPER POTOMAC	AGRICULTURE	675.19	**49%**	610.47	**44%**	64.72	5%
	BARREN LAND	0.60	0%	2.02	0%	-1.42	0%
	FOREST	438.07	**32%**	398.23	**29%**	39.83	3%
	TRANSPORTATION	0.00	0%	5.04	0%	-5.04	0%
	URBAN	217.43	16%	310.83	**22%**	-93.40	-7%
	WETLANDS	0.48	0%	0.46	0%	0.02	0%
	IMPERVIOUS	51.52	4%	62.24	4%	-10.71	-1%
MIDDLE POTOMAC	AGRICULTURE	100.75	14%	92.38	13%	68.00	1%
	BARREN LAND	1.88	0%	3.29	0%	1.17	0%
	FOREST	167.58	**24%**	166.03	**24%**	36.85	0%
	TRANSPORTATION	4.44	1%	6.13	1%	1.61	0%
	URBAN	334.52	**48%**	341.24	**49%**	-95.63	-1%
	WETLANDS	2.58	0%	2.56	0%	-7.24	0%
	IMPERVIOUS	91.38	13%	90.23	13%	-10.72	0%
LOWER POTOMAC	AGRICULTURE	175.08	**23%**	143.59	19%	31.48	4%
	BARREN LAND	2.07	0%	3.98	1%	-1.91	0%
	FOREST	428.44	**57%**	388.57	**51%**	39.87	6%
	TRANSPORTATION	0.09	0%	1.39	0%	-1.30	0%
	URBAN	113.62	15%	182.10	**24%**	-68.48	-9%
	WETLANDS	13.44	2%	13.37	2%	0.07	0%
	IMPERVIOUS	24.89	3%	32.46	4%	-7.57	-1%

By Sub-watershed

Loadings ≥ 20% shown in **BOLD**

	Sub-watershed	Land use/ Land cover	Area in 2000 (sqr miles)	%Total in 2000	Area in 2010 (sqr miles)	%Total in 2010	Area Change (sqr miles)	%Total Area change
NORTH BRANCH POTOMAC RIVER	Savage River	AGRICULTURE	16.82	14%	14.97	13%	1.84	2%
		BARREN LAND	0.02	0%	0.02	0%	0.00	0%
		FOREST	95.16	**82%**	95.47	**82%**	-0.31	0%
		TRANSPORTATION	0.00	0%	0.09	0%	-0.09	0%
		URBAN	4.01	3%	5.57	5%	-1.57	**-1%**
		WETLANDS	0.42	0%	0.29	0%	0.13	0%
		IMPERVIOUS	0.50	0%	0.63	1%	-0.12	0%
	Potomac River Upper North Branch	AGRICULTURE	16.04	15%	19.13	18%	-3.09	-3%
		BARREN LAND	0.58	1%	0.50	0%	0.08	0%
		FOREST	78.55	**75%**	78.07	**74%**	0.48	0%
		TRANSPORTATION	0.00	0%	0.00	0%	0.00	0%
		URBAN	10.06	10%	7.53	7%	2.53	**2%**
		WETLANDS	0.08	0%	0.08	0%	0.00	0%
		IMPERVIOUS	0.75	1%	0.71	1%	0.04	0%
	Georges Creek	AGRICULTURE	9.42	13%	10.23	14%	-0.81	-1%
		BARREN LAND	0.00	0%	0.06	0%	-0.06	0%
		FOREST	53.76	**72%**	52.41	**70%**	1.34	2%
		TRANSPORTATION	0.00	0%	0.14	0%	-0.14	0%
		URBAN	11.62	16%	11.95	16%	-0.33	**0%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	1.86	2%	2.07	3%	-0.21	0%
	Wills Creek	AGRICULTURE	5.45	9%	5.15	9%	0.29	0%
		BARREN LAND	0.00	0%	0.01	0%	-0.01	0%
		FOREST	44.17	**73%**	43.18	**72%**	0.98	2%
		TRANSPORTATION	0.00	0%	0.24	0%	-0.24	0%
		URBAN	10.61	18%	11.64	19%	-1.03	**-2%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	2.61	4%	3.05	5%	-0.43	-1%
	Evitts Creek	AGRICULTURE	4.32	14%	3.79	12%	0.52	2%
		BARREN LAND	0.00	0%	0.02	0%	-0.02	0%
		FOREST	20.81	**67%**	20.37	**66%**	0.44	1%
		TRANSPORTATION	0.00	0%	0.36	1%	-0.36	-1%
		URBAN	5.68	18%	6.44	**21%**	-0.75	**-2%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	1.17	4%	1.52	5%	-0.35	-1%
	Potomac River Lower North Branch	AGRICULTURE	12.98	11%	12.00	11%	0.99	1%
		BARREN LAND	0.00	0%	0.00	0%	0.00	0%
		FOREST	84.41	**75%**	81.54	**72%**	2.87	3%
		TRANSPORTATION	0.00	0%	0.07	0%	-0.07	0%
		URBAN	15.52	14%	19.27	17%	-3.75	**-3%**
		WETLANDS	0.03	0%	0.03	0%	0.00	0%
		IMPERVIOUS	3.97	4%	4.45	4%	-0.49	0%

	Sub-watershed	Land use/ Land cover	Area in 2000 (sqr miles)	%Total in 2000	Area in 2010 (sqr miles)	%Total in 2010	Area Change (sqr miles)	%Total Area change
UPPER POTOMAC RIVER	Town Creek	AGRICULTURE	13.21	19%	12.42	18%	0.79	1%
		BARREN LAND	0.00	0%	0.00	0%	0.00	0%
		FOREST	53.35	**78%**	51.98	**76%**	1.37	2%
		TRANSPORTATION	0.00	0%	0.20	0%	-0.20	0%
		URBAN	1.53	2%	3.45	5%	-1.92	**-3%**
		WETLANDS	0.01	0%	0.01	0%	0.00	0%
		IMPERVIOUS	0.21	0%	0.50	1%	-0.29	0%
	Fifteen Mile Creek	AGRICULTURE	2.82	5%	2.24	4%	0.58	1%
		BARREN LAND	0.00	0%	0.00	0%	0.00	0%
		FOREST	48.24	**93%**	46.94	**90%**	1.31	3%
		TRANSPORTATION	0.00	0%	0.37	1%	-0.37	-1%
		URBAN	1.00	2%	2.49	5%	-1.48	**-3%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	0.16	0%	0.58	1%	-0.41	-1%
	Sideling Hill Creek	AGRICULTURE	3.91	18%	3.60	16%	0.30	1%
		BARREN LAND	0.02	0%	0.00	0%	0.02	0%
		FOREST	17.48	**79%**	17.10	**77%**	0.38	2%
		TRANSPORTATION	0.00	0%	0.29	1%	-0.29	-1%
		URBAN	0.75	3%	1.17	5%	-0.42	**-2%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	0.11	0%	0.39	2%	-0.29	-1%
	Little Tonoloway Creek	AGRICULTURE	3.77	**24%**	2.86	18%	0.92	6%
		BARREN LAND	0.01	0%	0.00	0%	0.01	0%
		FOREST	10.39	**67%**	10.60	**68%**	-0.21	-1%
		TRANSPORTATION	0.00	0%	0.33	2%	-0.33	-2%
		URBAN	1.28	8%	1.68	11%	-0.40	**-3%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	0.25	2%	0.53	3%	-0.28	-2%
	Potomac River Allegany County	AGRICULTURE	4.84	10%	3.71	8%	1.13	2%
		BARREN LAND	0.00	0%	0.00	0%	0.00	0%
		FOREST	42.35	**88%**	42.71	**89%**	-0.37	-1%
		TRANSPORTATION	0.00	0%	0.00	0%	0.00	0%
		URBAN	0.82	2%	1.59	3%	-0.77	**-2%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	0.18	0%	0.20	0%	-0.02	0%
	Tonoloway Creek	AGRICULTURE	0.39	19%	0.25	12%	0.13	6%
		BARREN LAND	0.00	0%	0.05	2%	-0.05	-2%
		FOREST	1.37	**66%**	1.43	**69%**	-0.06	-3%
		TRANSPORTATION	0.00	0%	0.03	1%	-0.03	-1%
		URBAN	0.32	16%	0.32	16%	0.00	**0%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	0.12	6%	0.12	6%	0.00	0%
	Licking Creek	AGRICULTURE	4.88	18%	4.32	16%	0.56	2%
		BARREN LAND	0.00	0%	0.01	0%	-0.01	0%
		FOREST	21.81	**79%**	22.01	**79%**	-0.21	-1%
		TRANSPORTATION	0.00	0%	0.01	0%	-0.01	0%
		URBAN	1.07	4%	1.42	5%	-0.35	**-1%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	0.17	1%	0.18	1%	-0.01	0%
	Little Conococheague	AGRICULTURE	8.04	**48%**	8.02	**48%**	0.02	0%
		BARREN LAND	0.00	0%	0.00	0%	0.00	0%
		FOREST	6.90	**41%**	6.54	**39%**	0.36	2%
		TRANSPORTATION	0.00	0%	0.12	1%	-0.12	-1%
		URBAN	1.83	11%	2.08	12%	-0.25	**-2%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	0.32	2%	0.43	3%	-0.12	-1%

	Sub-watershed	Land use/ Land cover	Area in 2000 (sqr miles)	%Total in 2000	Area in 2010 (sqr miles)	%Total in 2010	Area Change (sqr miles)	%Total Area change
UPPER POTOMAC RIVER	Conococheague Creek	AGRICULTURE	35.37	**55%**	32.97	**51%**	2.40	4%
		BARREN LAND	0.37	1%	0.46	1%	-0.09	0%
		FOREST	12.78	20%	10.65	16%	2.14	3%
		TRANSPORTATION	0.00	0%	0.82	1%	-0.82	-1%
		URBAN	16.26	**25%**	19.82	**31%**	-3.57	**-6%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	5.18	8%	6.72	10%	-1.54	-2%
	Marsh Run	AGRICULTURE	11.97	**57%**	11.58	**55%**	0.39	2%
		BARREN LAND	0.03	0%	0.04	0%	-0.01	0%
		FOREST	4.13	20%	3.35	16%	0.78	4%
		TRANSPORTATION	0.00	0%	0.06	0%	-0.06	0%
		URBAN	4.96	**24%**	6.06	**29%**	-1.10	**-5%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	1.31	6%	1.61	8%	-0.31	-1%
	Antietam Creek	AGRICULTURE	90.42	**49%**	82.71	**44%**	7.71	4%
		BARREN LAND	0.03	0%	0.33	0%	-0.30	0%
		FOREST	53.11	**29%**	48.86	**26%**	4.25	2%
		TRANSPORTATION	0.00	0%	0.47	0%	-0.47	0%
		URBAN	42.50	**23%**	53.69	**29%**	-11.20	**-6%**
		WETLANDS	0.02	0%	0.02	0%	0.00	0%
		IMPERVIOUS	10.92	6%	11.91	6%	-0.99	-1%
	Potomac River Washington County	AGRICULTURE	30.60	**36%**	28.90	**34%**	1.70	2%
		BARREN LAND	0.07	0%	0.07	0%	0.00	0%
		FOREST	42.24	**50%**	40.55	**48%**	1.69	2%
		TRANSPORTATION	0.00	0%	0.64	1%	-0.64	-1%
		URBAN	11.36	13%	14.12	17%	-2.76	**-3%**
		WETLANDS	0.07	0%	0.07	0%	0.00	0%
		IMPERVIOUS	1.88	2%	2.57	3%	-0.69	-1%
MIDDLE POTOMAC RIVER	Catoctin Creek	AGRICULTURE	65.12	**53%**	57.04	**47%**	8.08	7%
		BARREN LAND	0.00	0%	0.00	0%	0.00	0%
		FOREST	44.79	**36%**	33.94	**28%**	10.85	9%
		TRANSPORTATION	0.00	0%	0.48	0%	-0.48	0%
		URBAN	13.62	11%	29.37	**24%**	-15.75	**-13%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	2.50	2%	4.14	3%	-1.64	-1%
	Double Pipe Creek	AGRICULTURE	133.40	**69%**	113.65	**59%**	19.75	10%
		BARREN LAND	0.03	0%	0.17	0%	-0.14	0%
		FOREST	37.43	19%	40.34	**21%**	-2.91	-2%
		TRANSPORTATION	0.00	0%	0.01	0%	-0.01	0%
		URBAN	22.38	12%	38.61	20%	-16.22	**-8%**
		WETLANDS	0.25	0%	0.28	0%	-0.02	0%
		IMPERVIOUS	4.00	2%	5.25	3%	-1.26	-1%
	Upper Monocacy River	AGRICULTURE	124.36	**51%**	113.92	**47%**	10.43	4%
		BARREN LAND	0.00	0%	0.07	0%	-0.07	0%
		FOREST	97.45	**40%**	89.63	**37%**	7.82	3%
		TRANSPORTATION	0.00	0%	0.69	0%	-0.69	0%
		URBAN	23.32	10%	40.07	16%	-16.75	**-7%**
		WETLANDS	0.06	0%	0.02	0%	0.04	0%
		IMPERVIOUS	5.29	2%	6.81	3%	-1.52	-1%
	Lower Monocacy River	AGRICULTURE	142.75	**47%**	129.15	**42%**	13.60	4%
		BARREN LAND	0.08	0%	0.71	0%	-0.63	0%
		FOREST	92.53	**30%**	81.45	**27%**	11.07	4%
		TRANSPORTATION	0.00	0%	1.55	1%	-1.55	-1%
		URBAN	69.44	**23%**	91.19	**30%**	-21.75	**-7%**
		WETLANDS	0.07	0%	0.07	0%	0.00	0%
		IMPERVIOUS	16.99	6%	19.85	7%	-2.86	-1%

	Sub-watershed	Land use/ Land cover	Area in 2000 (sqr miles)	%Total in 2000	Area in 2010 (sqr miles)	%Total in 2010	Area Change (sqr miles)	%Total Area change
MIDDLE POTOMAC RIVER	Potomac River Frederick County	AGRICULTURE	28.29	**44%**	28.21	**44%**	0.08	0%
		BARREN LAND	0.00	0%	0.17	0%	-0.17	0%
		FOREST	24.90	**39%**	20.93	**33%**	3.97	6%
		TRANSPORTATION	0.00	0%	0.18	0%	-0.18	0%
		URBAN	10.71	17%	14.40	**23%**	-3.69	**-6%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	2.96	5%	2.76	4%	0.21	0%
WASHINGTON METROPOLITAN	Seneca Creek	AGRICULTURE	44.69	**35%**	38.36	**30%**	6.33	5%
		BARREN LAND	0.02	0%	0.18	0%	-0.16	0%
		FOREST	42.32	**33%**	39.14	**30%**	3.18	2%
		TRANSPORTATION	0.00	0%	0.47	0%	-0.47	0%
		URBAN	41.54	**32%**	50.38	**39%**	-8.85	**-7%**
		WETLANDS	0.08	0%	0.08	0%	0.00	0%
		IMPERVIOUS	9.56	7%	10.90	8%	-1.34	-1%
	Cabin John Creek	AGRICULTURE	0.20	1%	0.20	1%	0.01	0%
		BARREN LAND	0.00	0%	0.02	0%	-0.02	0%
		FOREST	3.25	13%	3.26	13%	-0.01	0%
		TRANSPORTATION	0.00	0%	0.53	2%	-0.53	-2%
		URBAN	22.27	**87%**	21.72	**84%**	0.55	**2%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	5.67	22%	5.97	**23%**	-0.29	-1%
	Rock Creek	AGRICULTURE	4.52	5%	3.86	6%	0.65	1%
		BARREN LAND	0.04	0%	0.02	0%	0.02	0%
		FOREST	10.99	13%	10.51	17%	0.48	1%
		TRANSPORTATION	0.01	0%	0.66	1%	-0.64	-1%
		URBAN	45.76	**55%**	46.28	**75%**	-0.52	**-1%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	12.27	15%	12.86	**21%**	-0.60	-1%
	Anacostia River	AGRICULTURE	3.44	2%	9.10	6%	-5.66	-4%
		BARREN LAND	0.23	0%	0.72	0%	-0.49	0%
		FOREST	24.09	13%	32.72	**23%**	-8.64	-6%
		TRANSPORTATION	2.92	2%	2.37	2%	0.55	0%
		URBAN	114.05	**63%**	99.73	**69%**	14.32	**10%**
		WETLANDS	0.00	0%	0.05	0%	-0.05	0%
		IMPERVIOUS	34.41	19%	29.20	**20%**	5.21	4%
	Oxon Creek	AGRICULTURE	0.04	0%	0.32	3%	-0.28	-3%
		BARREN LAND	0.17	1%	0.09	1%	0.08	1%
		FOREST	1.83	10%	2.22	**21%**	-0.38	-4%
		TRANSPORTATION	0.31	2%	0.21	2%	0.11	1%
		URBAN	8.32	**45%**	7.84	**73%**	0.48	**4%**
		WETLANDS	0.00	0%	0.00	0%	0.00	0%
		IMPERVIOUS	2.51	14%	2.23	**21%**	0.27	3%
	Piscataway Creek	AGRICULTURE	9.91	15%	6.79	10%	3.11	5%
		BARREN LAND	0.34	1%	1.13	2%	-0.79	-1%
		FOREST	30.02	**44%**	27.55	**40%**	2.48	4%
		TRANSPORTATION	0.30	0%	0.52	1%	-0.22	0%
		URBAN	27.52	**40%**	32.09	**47%**	-4.57	**-7%**
		WETLANDS	0.17	0%	0.17	0%	0.01	0%
		IMPERVIOUS	7.81	11%	8.50	12%	-0.69	-1%
	Potomac River Montgomery County	AGRICULTURE	35.48	**27%**	32.17	**25%**	3.31	3%
		BARREN LAND	0.00	0%	0.08	0%	-0.08	0%
		FOREST	39.98	**30%**	38.03	**29%**	1.95	2%
		TRANSPORTATION	0.00	0%	0.60	0%	-0.60	0%
		URBAN	51.32	**39%**	55.89	**43%**	-4.57	**-4%**
		WETLANDS	2.18	2%	2.18	2%	0.00	0%
		IMPERVIOUS	11.87	9%	12.77	10%	-0.90	-1%

	Sub-watershed	Land use/ Land cover	Area in 2000 (sqr miles)	%Total in 2000	Area in 2010 (sqr miles)	%Total in 2010	Area Change (sqr miles)	%Total Area change
WASHINGTON METROPOLITAN	Potomac River Upper tidal	AGRICULTURE	2.48	6%	1.57	4%	0.91	2%
		BARREN LAND	1.07	2%	1.04	2%	0.04	0%
		FOREST	15.10	**34%**	12.60	**29%**	2.50	6%
		TRANSPORTATION	0.90	2%	0.78	2%	0.12	0%
		URBAN	23.75	**54%**	27.31	**63%**	-3.57	**-8%**
		WETLANDS	0.15	0%	0.10	0%	0.05	0%
		IMPERVIOUS	7.29	17%	7.80	18%	-0.52	-1%
LOWER POTOMAC RIVER	Mattawoman Creek	AGRICULTURE	11.72	12%	8.84	9%	2.88	3%
		BARREN LAND	0.13	0%	0.94	1%	-0.81	-1%
		FOREST	56.64	**60%**	50.98	**54%**	5.66	6%
		TRANSPORTATION	0.08	0%	0.45	0%	-0.37	0%
		URBAN	25.15	**27%**	32.31	**34%**	-7.16	**-8%**
		WETLANDS	0.93	1%	1.07	1%	-0.13	0%
		IMPERVIOUS	6.30	7%	7.79	8%	-1.49	-2%
	Nanjemoy Creek	AGRICULTURE	11.37	16%	9.10	12%	2.28	3%
		BARREN LAND	0.03	0%	0.07	0%	-0.04	0%
		FOREST	53.70	**73%**	50.29	**69%**	3.41	5%
		TRANSPORTATION	0.00	0%	0.00	0%	0.00	0%
		URBAN	5.21	7%	10.79	15%	-5.57	**-8%**
		WETLANDS	2.92	4%	2.99	4%	-0.08	0%
		IMPERVIOUS	0.82	1%	1.03	1%	-0.21	0%
	Port Tobacco River	AGRICULTURE	8.99	**20%**	6.98	16%	2.01	5%
		BARREN LAND	0.10	0%	0.19	0%	-0.09	0%
		FOREST	24.87	**56%**	21.94	**50%**	2.93	7%
		TRANSPORTATION	0.00	0%	0.23	1%	-0.23	-1%
		URBAN	9.69	**22%**	14.33	**33%**	-4.64	**-11%**
		WETLANDS	0.37	1%	0.35	1%	0.02	0%
		IMPERVIOUS	2.28	5%	2.80	6%	-0.52	-1%
	Zekiah Swamp	AGRICULTURE	24.26	**22%**	19.78	18%	4.48	4%
		BARREN LAND	1.15	1%	1.36	1%	-0.21	0%
		FOREST	63.62	**58%**	59.46	**54%**	4.16	4%
		TRANSPORTATION	0.00	0%	0.28	0%	-0.28	0%
		URBAN	19.92	18%	28.46	**26%**	-8.54	**-8%**
		WETLANDS	0.30	0%	0.23	0%	0.07	0%
		IMPERVIOUS	3.74	3%	5.03	5%	-1.29	-1%
	Gilbert Swamp	AGRICULTURE	14.45	**33%**	12.10	**28%**	2.35	5%
		BARREN LAND	0.11	0%	0.34	1%	-0.23	-1%
		FOREST	22.87	**53%**	19.87	**46%**	2.99	7%
		TRANSPORTATION	0.00	0%	0.04	0%	-0.04	0%
		URBAN	5.70	13%	10.81	**25%**	-5.11	**-12%**
		WETLANDS	0.06	0%	0.05	0%	0.01	0%
		IMPERVIOUS	1.00	2%	1.38	3%	-0.38	-1%
	Wicomico River	AGRICULTURE	26.93	**35%**	24.44	**32%**	2.50	3%
		BARREN LAND	0.04	0%	0.04	0%	0.00	0%
		FOREST	38.87	**50%**	34.69	**45%**	4.18	5%
		TRANSPORTATION	0.00	0%	0.08	0%	-0.08	0%
		URBAN	7.97	10%	14.54	19%	-6.57	**-8%**
		WETLANDS	3.57	5%	3.52	5%	0.04	0%
		IMPERVIOUS	1.46	2%	2.11	3%	-0.64	-1%
	St. Clements Bay	AGRICULTURE	18.03	**39%**	14.63	**31%**	3.40	7%
		BARREN LAND	0.01	0%	0.04	0%	-0.03	0%
		FOREST	23.87	**51%**	22.18	**47%**	1.69	4%
		TRANSPORTATION	0.00	0%	0.03	0%	-0.03	0%
		URBAN	4.42	9%	9.50	**20%**	-5.07	**-11%**
		WETLANDS	0.38	1%	0.40	1%	-0.02	0%
		IMPERVIOUS	0.79	2%	1.20	3%	-0.40	-1%

	Sub-watershed	Land use/ Land cover	Area in 2000 (sqr miles)	%Total in 2000	Area in 2010 (sqr miles)	%Total in 2010	Area Change (sqr miles)	%Total Area change
LOWER POTOMAC RIVER	Breton Bay	AGRICULTURE	13.89	**25%**	11.21	**20%**	2.67	5%
		BARREN LAND	0.16	0%	0.36	1%	-0.20	0%
		FOREST	32.75	**59%**	27.09	**49%**	5.66	10%
		TRANSPORTATION	0.00	0%	0.10	0%	-0.10	0%
		URBAN	8.08	15%	16.08	**29%**	-8.00	**-14%**
		WETLANDS	0.38	1%	0.40	1%	-0.02	0%
		IMPERVIOUS	1.58	3%	2.50	5%	-0.91	-2%
	St. Mary's River	AGRICULTURE	15.45	**22%**	10.95	15%	4.50	6%
		BARREN LAND	0.15	0%	0.37	1%	-0.23	0%
		FOREST	40.82	**58%**	34.90	**49%**	5.92	8%
		TRANSPORTATION	0.00	0%	0.10	0%	-0.10	0%
		URBAN	13.68	19%	23.86	**34%**	-10.19	**-14%**
		WETLANDS	0.73	1%	0.68	1%	0.05	0%
		IMPERVIOUS	3.58	5%	4.98	7%	-1.40	-2%
	Potomac River Middle tidal	AGRICULTURE	2.42	7%	1.90	6%	0.52	2%
		BARREN LAND	0.04	0%	0.05	0%	-0.01	0%
		FOREST	25.41	**78%**	24.21	**74%**	1.20	4%
		TRANSPORTATION	0.00	0%	0.02	0%	-0.02	0%
		URBAN	3.74	11%	5.52	17%	-1.78	**-5%**
		WETLANDS	1.02	3%	0.93	3%	0.09	0%
		IMPERVIOUS	0.89	3%	0.83	3%	0.06	0%
	Potomac River Lower tidal	AGRICULTURE	27.57	**32%**	23.67	**28%**	3.90	5%
		BARREN LAND	0.14	0%	0.21	0%	-0.06	0%
		FOREST	45.02	**53%**	42.95	**50%**	2.07	2%
		TRANSPORTATION	0.00	0%	0.06	0%	-0.06	0%
		URBAN	10.06	12%	15.90	19%	-5.85	**-7%**
		WETLANDS	2.78	3%	2.74	3%	0.03	0%
		IMPERVIOUS	2.44	3%	2.82	3%	-0.38	0%

Appendix 2

Delivered Loads to the Potomac River

Phase 5.3 2009 Progress Run 8/25/2010

Chesapeake Bay Program. Accessed January 10, 2012 from
http://www.chesapeakebay.net/watershedimplementationplantools.aspx?menuitem=52044
File
(ftp://ftp.chesapeakebay.net/Modeling/phase5/Phase53_Loads-Acres-BMPs/MD/
Load_Acres_MDWIP_08252010.xls)

LOADINGS TO THE TIDAL FRESH POTOMAC

State	category	Cbseg	N load (Million lbs per yr)	% Total N Load	P load (Million lbs per yr)	% Total P Load	Sed load (Million lbs per yr)	% Total Sed Load
MD	Agriculture	ANATF_DC	0.000	0.0%	0.0000	0.0%	0.02	0.0%
		ANATF_MD	0.035	0.5%	0.0035	1.0%	15.17	3.6%
		MATTF	0.018	0.3%	0.0028	0.8%	2.63	0.6%
		PISTF	0.022	0.3%	0.0031	0.9%	2.55	0.6%
		POTTF_DC	0.011	0.2%	0.0006	0.2%	3.51	0.8%
		POTTF_MD	7.123	**98.8%**	0.3277	**97.0%**	399.24	**94.4%**
		Total	**7.209**		**0.3377**		**423.12**	
	Urban Runoff	ANATF_DC	0.047	2.0%	0.0104	4.6%	1.52	0.8%
		ANATF_MD	0.321	13.7%	0.0519	**23.2%**	85.87	**44.9%**
		MATTF	0.038	1.6%	0.0094	4.2%	2.59	1.4%
		PISTF	0.067	2.8%	0.0145	6.5%	2.56	1.3%
		POTTF_DC	0.116	4.9%	0.0126	5.6%	18.86	9.9%
		POTTF_MD	1.759	**74.9%**	0.1255	**56.0%**	79.94	**41.8%**
		Total	**2.348**		**0.2243**		**191.34**	
	Wastewater	ANATF_DC	0.000	0.0%	0.0000	0.0%	0.00	0.1%
		ANATF_MD	0.006	0.2%	0.0017	0.9%	0.04	1.4%
		MATTF	0.014	0.4%	0.0039	2.1%	0.01	0.5%
		PISTF	0.292	8.2%	0.0047	2.5%	0.03	1.0%
		POTTF_DC	2.168	**60.7%**	0.0322	17.3%	0.04	1.6%
		POTTF_MD	1.092	**30.6%**	0.1441	**77.2%**	2.57	**95.3%**
		Total	**3.571**		**0.1866**		**2.70**	
	Forest	ANATF_DC	0.006	0.2%	0.0003	0.3%	0.08	0.1%
		ANATF_MD	0.086	3.1%	0.0044	4.1%	10.30	13.0%
		MATTF	0.063	2.3%	0.0044	4.1%	1.63	2.1%
		PISTF	0.051	1.8%	0.0030	2.9%	1.05	1.3%
		POTTF_DC	0.025	0.9%	0.0009	0.9%	2.78	3.5%
		POTTF_MD	2.551	**91.7%**	0.0925	**87.7%**	63.17	**79.9%**
		Total	**2.783**		**0.1055**		**79.02**	
	NT Water Dep.	ANATF_DC	0.000	0.0%	0.0000	0.0%		
		ANATF_MD	0.001	1.1%	0.0001	1.4%		
		MATTF	0.001	1.0%	0.0001	1.6%		
		PISTF	0.001	0.4%	0.0000	0.5%		
		POTTF_DC	0.001	0.7%	0.0001	1.1%		
		POTTF_MD	0.128	**96.9%**	0.0066	**95.4%**		
		Total	**0.132**		**0.0069**			
	Septic	ANATF_DC	0.000	0.1%				
		ANATF_MD	0.051	6.3%				
		MATTF	0.062	7.7%				
		PISTF	0.030	3.7%				
		POTTF_DC	0.017	2.1%				
		POTTF_MD	0.646	**80.2%**				
		Total	**0.805**					
	Agriculture Total		7.209	**42.8%**	0.3377	**39.2%**	423.12	**60.8%**
	Urban Runoff Total		2.348	13.9%	0.2243	**26.1%**	191.34	**27.5%**
	Wastewater Total		3.571	**21.2%**	0.1866	**21.7%**	2.70	0.4%
	Forest Total		2.783	16.5%	0.1055	12.3%	79.02	11.4%
	NT Water Dep Total.		0.132	0.8%	0.0069	0.8%		
	Septic Total		0.805	4.8%				
	OVERALL TOTAL		**16.848**		**0.8610**		**696.18**	

LOADINGS TO THE TIDAL FRESH POTOMAC

State	category	Cbseg	N load (Million lbs per yr)	% Total N Load	P load (Million lbs per yr)	% Total P Load	Sed load (Million lbs per yr)	% Total Sed Load
VA	Agriculture	POTTF_DC	0.000	0.0%	0.0000	0.0%	0.01	0.0%
		POTTF_MD	7.710	**97.7%**	0.8583	**97.2%**	718.82	**98.1%**
		POTTF_VA	0.185	2.3%	0.0243	2.7%	14.08	1.9%
		Total	**7.895**		**0.8826**		**732.91**	
	Urban Runoff	POTTF_DC	0.113	4.2%	0.0111	3.8%	6.02	3.1%
		POTTF_MD	1.777	**65.3%**	0.1906	**64.8%**	117.86	**60.1%**
		POTTF_VA	0.831	**30.5%**	0.0926	**31.5%**	72.30	**36.9%**
		Total	**2.721**		**0.2943**		**196.17**	
	Waste-water	POTTF_DC	0.753	**22.2%**	0.0189	4.4%	0.00	0.0%
		POTTF_MD	0.506	14.9%	0.3452	**81.3%**	1.38	**30.6%**
		POTTF_VA	2.138	**62.9%**	0.0605	14.3%	3.14	**69.3%**
		Total	**3.398**		**0.4245**		**4.52**	
	Forest	POTTF_DC	0.011	0.3%	0.0003	0.2%	0.36	0.3%
		POTTF_MD	3.190	**90.7%**	0.1555	**92.3%**	111.29	**91.3%**
		POTTF_VA	0.314	8.9%	0.0127	7.5%	10.30	8.4%
		Total	**3.516**		**0.1685**		**121.94**	
	NT Water Dep.	POTTF_DC	0.001	1.6%	0.0001	1.2%		
		POTTF_MD	0.051	**75.2%**	0.0039	**75.9%**		
		POTTF_VA	0.016	**23.1%**	0.0012	**22.9%**		
		Total	**0.068**		**0.0051**			
	Septic	POTTF_DC	0.000	0.0%				
		POTTF_MD	0.401	**93.4%**				
		POTTF_VA	0.029	6.6%				
		Total	**0.430**					
	Agriculture Total		7.895	**43.8%**	0.8826	**49.7%**	732.91	**69.4%**
	Urban Runoff Total		2.721	15.1%	0.2943	16.6%	196.17	18.6%
	Wastewater Total		3.398	18.8%	0.4245	**23.9%**	4.52	0.4%
	Forest Total		3.516	19.5%	0.1685	9.5%	121.94	11.6%
	NT Water Dep Total.		0.068	0.4%	0.0051	0.3%		
	Septic Total		0.430	2.4%				
	OVERALL TOTAL		**18.026**		**1.7750**		**1055.55**	

LOADINGS TO THE TIDAL FRESH POTOMAC

State	category	Cbseg	N load (Million lbs per yr)	% Total N Load	P load (Million lbs per yr)	% Total P Load	Sed load (Million lbs per yr)	% Total Sed Load
DC	Agriculture	ANATF_DC	0.000		0.0000		0.00	
		ANATF_MD	0.000		0.0000		0.00	
		POTTF_DC	0.000		0.0000		0.00	
		POTTF_MD	0.000		0.0000		0.00	
		Total	**0.000**		**0.0000**		**0.00**	
	Urban Runoff	ANATF_DC	0.056	**39.4%**	0.0114	**55.5%**	3.13	**27.4%**
		ANATF_MD	0.013	9.2%	0.0027	13.1%	0.61	5.3%
		POTTF_DC	0.055	**38.8%**	0.0057	**27.6%**	7.12	**62.2%**
		POTTF_MD	0.018	12.6%	0.0008	3.9%	0.59	5.1%
		Total	**0.143**		**0.0206**		**11.45**	
	Wastewater	ANATF_DC	0.069	2.6%	0.0156	**24.0%**	1.56	8.0%
		ANATF_MD	0.000	0.0%	0.0000	0.0%	0.00	0.0%
		POTTF_DC	2.440	**90.7%**	0.0289	**44.3%**	0.61	3.1%
		POTTF_MD	0.182	6.8%	0.0206	**31.6%**	17.43	**88.9%**
		Total	**2.691**		**0.0652**		**19.60**	
	Forest	ANATF_DC	0.002	16.4%	0.0001	**35.2%**	0.05	6.0%
		ANATF_MD	0.000	1.8%	0.0000	3.8%	0.00	0.5%
		POTTF_DC	0.010	**69.4%**	0.0002	**54.3%**	0.69	**90.1%**
		POTTF_MD	0.002	12.4%	0.0000	6.7%	0.03	3.4%
		Total	**0.015**		**0.0004**		**0.77**	
	NT Water Dep.	ANATF_DC	0.003	**71.5%**	0.0002	**75.6%**		
		ANATF_MD	0.000	0.0%	0.0000	0.0%		
		POTTF_DC	0.001	**24.8%**	0.0000	**22.6%**		
		POTTF_MD	0.000	3.7%	0.0000	1.8%		
		Total	**0.004**		**0.0002**			
	Septic	ANATF_DC	0.000					
		ANATF_MD	0.000					
		POTTF_DC	0.000					
		POTTF_MD	0.000					
		Total	**0.000**					
	Agriculture Total		0.000	0.0%	0.0000	0.0%	0.00	0.0%
	Urban Runoff Total		0.143	5.0%	0.0206	**23.8%**	11.45	**36.0%**
	Wastewater Total		2.691	**94.3%**	0.0652	**75.4%**	19.60	**61.6%**
	Forest Total		0.015	0.5%	0.0004	0.5%	0.77	2.4%
	NT Water Dep Total.		0.004	0.1%	0.0002	0.3%		
	Septic Total		0.000	0.0%				
	OVERALL TOTAL		**2.853**		**0.0864**		**31.81**	
PA	Agriculture	POTTF_MD	4.442	**72.7%**	0.3531	**65.7%**	238.46	**77.7%**
	Urban Runoff	POTTF_MD	0.300	4.9%	0.0416	7.7%	20.74	6.8%
	Wastewater	POTTF_MD	0.205	3.3%	0.0701	13.1%	0.36	0.1%
	Forest	POTTF_MD	0.994	16.3%	0.0715	13.3%	47.48	15.5%
	NT Water Dep.	POTTF_MD	0.008	0.1%	0.0009	0.2%		
	Septic	POTTF_MD	0.163	2.7%				
	OVERALL TOTAL		**6.112**		**0.537**		**307.04**	
WV	Agriculture	POTTF_MD	2.907	**50.5%**	0.4632	**56.5%**	242.61	**69.9%**
	Urban Runoff	POTTF_MD	0.325	5.6%	0.0548	6.7%	33.92	9.8%
	Wastewater	POTTF_MD	0.299	5.2%	0.1259	15.4%	0.86	0.2%
	Forest	POTTF_MD	1.931	**33.6%**	0.1719	**21.0%**	69.46	**20.0%**
	NT Water Dep.	POTTF_MD	0.029	0.5%	0.0034	0.4%		
	Septic	POTTF_MD	0.260	4.5%				
	OVERALL TOTAL		**5.751**		**0.8191**		**346.85**	
	OVERALL TOTAL	**MD**	16.848	**34.0%**	0.8610	**21.1%**	696.18	**28.6%**
		VA	18.026	**36.3%**	1.7750	**43.5%**	1055.55	**43.3%**
		DC	2.853	5.8%	0.0864	2.1%	31.81	1.3%
		PA	6.112	12.3%	0.5370	13.2%	307.04	12.6%
		WV	5.751	11.6%	0.8191	**20.1%**	346.85	14.2%
		Total	**49.591**		**4.0786**		**2437.43**	

LOADINGS TO THE OLIGOHALINE POTOMAC

State	category	Cbseg	N load (Million lbs per yr)	% Total N Load	P load (Million lbs per yr)	% Total P Load	Sed load (Million lbs per yr)	% Total Sed Load
MD	Agriculture	POTOH1_M	0.013	19.8%	0.0017	19.8%	1.12	**24.3%**
		POTOH2_M	0.024	**36.6%**	0.0031	**36.0%**	1.53	**33.0%**
		POTOH3_M	0.029	**43.6%**	0.0038	**44.2%**	1.97	**42.6%**
		Total	**0.066**		**0.0086**		**4.62**	
	Urban Runoff	POTOH1_M	0.002	8.0%	0.0007	11.4%	0.16	17.6%
		POTOH2_M	0.021	**70.0%**	0.0037	**64.9%**	0.52	**58.6%**
		POTOH3_M	0.006	**22.0%**	0.0014	**23.7%**	0.21	**23.9%**
		Total	**0.030**		**0.0058**		**0.89**	
	Wastewater	POTOH1_M	0.000	0.0%	0.0000	0.0%	0.00	0.0%
		POTOH2_M	0.014	**100.0%**	0.0021	**100.0%**	0.01	**100.0%**
		POTOH3_M	0.000	0.0%	0.0000	0.0%	0.00	0.0%
		Total	**0.014**		**0.0021**		**0.01**	
	Forest	POTOH1_M	0.030	**22.4%**	0.0019	**21.6%**	0.64	**25.0%**
		POTOH2_M	0.038	**28.2%**	0.0024	**27.2%**	0.60	**23.2%**
		POTOH3_M	0.066	**49.3%**	0.0045	**51.1%**	1.33	**51.7%**
		Total	**0.135**		**0.0088**		**2.57**	
	NT Water Dep.	POTOH1_M	0.002	**29.3%**	0.0001	**29.1%**		
		POTOH2_M	0.001	8.9%	0.0000	8.9%		
		POTOH3_M	0.004	**61.7%**	0.0003	**62.0%**		
		Total	**0.006**		**0.0005**			
	Septic	POTOH1_M	0.007	11.6%				
		POTOH2_M	0.038	**63.7%**				
		POTOH3_M	0.015	**24.7%**				
		Total	**0.059**					
	Agriculture Total		0.066	16.2%	0.0086	**33.4%**	4.62	**57.1%**
	Urban Runoff Total		0.030	7.3%	0.0058	**22.4%**	0.89	11.0%
	Wastewater Total		0.014	3.6%	0.0021	8.2%	0.01	0.1%
	Forest Total		0.135	**33.2%**	0.0088	**34.1%**	2.57	**31.8%**
	NT Water Dep Total.		0.006	1.5%	0.0005	1.8%		
	Septic Total		0.155	**38.3%**				
	OVERALL TOTAL		**0.405**		**0.0258**		**8.09**	

LOADINGS TO THE OLIGOHALINE POTOMAC

State	category	Cbseg	N load (Million lbs per yr)	% Total N Load	P load (Million lbs per yr)	% Total P Load	Sed load (Million lbs per yr)	% Total Sed Load
VA	Agriculture	POTOH1_M	0.005	7.5%	0.0008	9.7%	0.07	2.0%
		POTOH_VA	0.056	**92.5%**	0.0079	**90.3%**	3.38	**98.0%**
		Total	**0.061**		**0.0087**		**3.45**	
	Urban Runoff	POTOH1_M	0.008	8.9%	0.0014	9.0%	0.20	2.1%
		POTOH_VA	0.082	**91.1%**	0.0143	**91.0%**	9.33	**97.9%**
		Total	**0.090**		**0.0157**		**9.52**	
	Wastewater	POTOH1_M	0.000	0.0%	0.0000	0.0%	0.00	0.0%
		POTOH_VA	0.129	**100.0%**	0.0018	**100.0%**	0.18	**100.0%**
		Total	**0.129**		**0.0018**		**0.18**	
	Forest	POTOH1_M	0.013	5.5%	0.0008	5.5%	0.11	2.4%
		POTOH_VA	0.214	**94.5%**	0.0135	**94.5%**	4.40	**97.6%**
		Total	**0.226**		**0.0143**		**4.51**	
	NT Water Dep.	POTOH1_M	0.000	4.0%	0.0000	4.4%		
		POTOH_VA	0.011	**96.0%**	0.0009	**95.6%**		
		Total	**0.011**		**0.0009**			
	Septic	POTOH1_M	0.007	7.3%				
		POTOH_VA	0.091	**92.7%**				
		Total	**0.099**					
	Agriculture Total		0.061	9.9%	0.0087	**21.1%**	3.45	19.6%
	Urban Runoff Total		0.090	14.6%	0.0157	**37.9%**	9.52	**53.9%**
	Wastewater Total		0.129	**20.9%**	0.0018	4.4%	0.18	1.0%
	Forest Total		0.226	**36.7%**	0.0143	**34.5%**	4.51	**25.5%**
	NT Water Dep Total.		0.011	1.9%	0.0009	2.2%		
	Septic Total		0.099	16.0%				
	OVERALL TOTAL		**0.617**		**0.0414**		**17.66**	

LOADINGS TO THE OLIGOHALINE POTOMAC

OVERALL TOTAL	MD	0.405	**39.7%**	0.0258	**38.4%**	8.09	**31.4%**
	VA	0.617	**60.3%**	0.0414	**61.6%**	17.66	**68.6%**
	Total	**1.022**		**0.0671**		**25.75**	

LOADINGS TO THE MESOHALINE POTOMAC

State	category	Cbseg	N load (Million lbs per yr)	% Total N Load	P load (Million lbs per yr)	% Total P Load	Sed load (Million lbs per yr)	% Total Sed Load
MD	Agriculture	POTMH_MD	0.470	**34.6%**	0.0638	**50.8%**	43.07	**59.6%**
	Urban Runoff	POTMH_MD	0.107	7.9%	0.0251	20.0%	11.41	15.8%
	Wastewater	POTMH_MD	0.173	12.7%	0.0120	9.6%	0.37	0.5%
	Forest	POTMH_MD	0.333	**24.5%**	0.0236	18.8%	17.43	**24.1%**
	NT Water Dep.	POTMH_MD	0.014	1.0%	0.0011	0.9%		
	Septic	POTMH_MD	0.261	19.2%				
		Overall total	**1.358**		**0.126**		**72.28**	
VA	Agriculture	POTMH_MD	0.046	5.3%	0.0048	5.2%	0.38	5.5%
		POTMH_VA	0.817	**94.7%**	0.0886	**94.8%**	6.59	**94.5%**
		Total	**0.863**		**0.0934**		**6.97**	
	Urban Runoff	POTMH_MD	0.005	9.1%	0.0009	8.8%	0.17	9.6%
		POTMH_VA	0.053	**90.9%**	0.0095	**91.2%**	1.62	**90.4%**
		Total	**0.059**		**0.0104**		**1.79**	
	Wastewater	POTMH_MD	0.000	0.0%	0.0000	0.0%	0.00	0.0%
		POTMH_VA	0.056	**100.0%**	0.0126	**100.0%**	0.06	**100.0%**
		Total	**0.056**		**0.0126**		**0.06**	
	Forest	POTMH_MD	0.015	6.5%	0.0011	6.3%	0.13	6.3%
		POTMH_VA	0.222	**93.5%**	0.0162	**93.7%**	1.98	**93.7%**
		Total	**0.237**		**0.0173**		**2.11**	
	NT Water Dep.	POTMH_MD	0.003	16.1%	0.0002	15.9%		
		POTMH_VA	0.016	**83.9%**	0.0013	**84.1%**		
		Total	**0.019**		**0.0015**			
	Septic	POTMH_MD	0.008	6.7%				
		POTMH_VA	0.105	**93.3%**				
		Total	**0.113**					
	Agriculture Total		0.863	**64.1%**	0.093	**69.1%**	6.97	**63.8%**
	Urban Runoff Total		0.059	4.3%	0.010	7.7%	1.79	16.4%
	Wastewater Total		0.056	4.2%	0.013	9.3%	0.06	0.5%
	Forest Total		0.237	17.6%	0.017	12.8%	2.11	19.3%
	NT Water Dep Total.		0.019	1.4%	0.002	1.1%		
	Septic Total		0.113	8.4%				
	OVERALL TOTAL		**1.347**		**0.1353**		**10.92**	

Overall Total	MD	0.750	**35.8%**	0.1009	**42.7%**	54.86	**83.4%**
	VA	1.347	**64.2%**	0.1353	**57.3%**	10.92	16.6%
	Overall Total	**2.096**		**0.2361**		**65.78**	

Appendix 3

Station names, locations and descriptions

Long-term non-tidal water quality stations

Map # refers to Figure 17 in Report

map #	Station name	Station Description	Latitude / Longitude (NAD83m)
1	NBP0689	North Branch Potomac River downstream of MD Route 38	39° 23' 21.64430" 79° 10' 45.68819"
2	SAV0000	Savage River at MD Route 135	39° 28' 50.15752" 79° 4' 5.03062"
2	NBP0534	North Branch Potomac River at Bloomington Upstream of Confluence/Savage Road	39° 28' 45.21734" 79° 4' 4.88618"
3	GEO0009	Georges Creek right bank at Franklin 1 mile north of Westernport	39° 29' 37.09849" 79° 2' 40.91654"
4	NBP0461	North Branch Potomac at bridge on MD Route 220	39° 26' 41.66372" 78° 58' 18.29118"
5	NBP0326	North Branch Potomac River Gage station near Western Maryland Railroad at Pinto USGS	39° 34' 0.38510" 78° 50' 20.09296"
6	BDK0000	Braddock Run US 40 and Braddock station bridge	39° 40' 13.71954" 78° 47' 26.92324"
7	WIL0013	Wills Creek Gage station downstream from Confluence or Braddock Run	39° 39' 42.66256" 78° 46' 49.04738"
8	NBP0103	North Branch Potomac River West of Intersection of Mooreshollow Road and MD Route 51	39° 34' 57.64206" 78° 43' 53.24102"
9	NBP0023	North Branch Potomac toll bridge at Oldtown	39° 34' 28.08012" 78° 36' 55.33560"
10	TOW0030	Towns Creek at Gage station near bridge on Oldtown Road	39° 33' 10.92996" 78° 33' 12.19720"
11	POT2766	Potomac River Bridge on MD Route 51 near Paw Paw West Virginia	39° 32' 19.13590" 78° 27' 16.17340"
12	POT2386	Potomac River at gage station, 0.5 miles below bridge on US Route 522	39° 41' 50.71139" 78° 10' 34.68907"
13	CON0180	Conococheague Creek at Gage station 0.7 mile above bridge on Fairview Road	39° 42' 57.76304" 77° 49' 30.19404"
14	CON0005	Conococheague Creek at MD Route 68 bridge	39° 36' 11.66306" 77° 49' 17.77994"
15	POT1830	Potomac River at gage station below bridge on MD Route 34	39° 26' 6.27835" 77° 48' 9.56934"
16	ANT0366	Antietam Creek at Gage station west of MD Route 60 at Rocky Forgetendsville	39° 42' 57.55720" 77° 36' 29.61292"
17	ANT0203	Antietam Creek at bridge on Proffenburger Road near Funkstown	39° 35' 40.65349" 77° 42' 38.85509"
18	ANT0044	Antietam Creek at Gage station below Burnside Bridge near Shappsburg	39° 27' 1.31782" 77° 43' 53.95012"
20	CAC0148	Catoctin Creek near bridge on MD Route 17 at Gage station	39° 25' 32.81315" 77° 33' 32.40666"
21	CAC0031	Catoctin Creek near mouth at bridge on MD Route 464	39° 19' 54.41596" 77° 34' 48.64429"
22	POT1596	Potomac River Virginia Side Point of Rocks	39° 16' 19.50172" 77° 32' 52.44029"
23	POT1595	Potomac River East End of Bridge, U.S. Route 15	39° 16' 24.51461" 77° 32' 37.21927"
24	MON0528	Monocacy River at Bridgeport Bridge on MD Route 97 USGS gage station	39° 40' 45.00095" 77° 14' 5.57884"

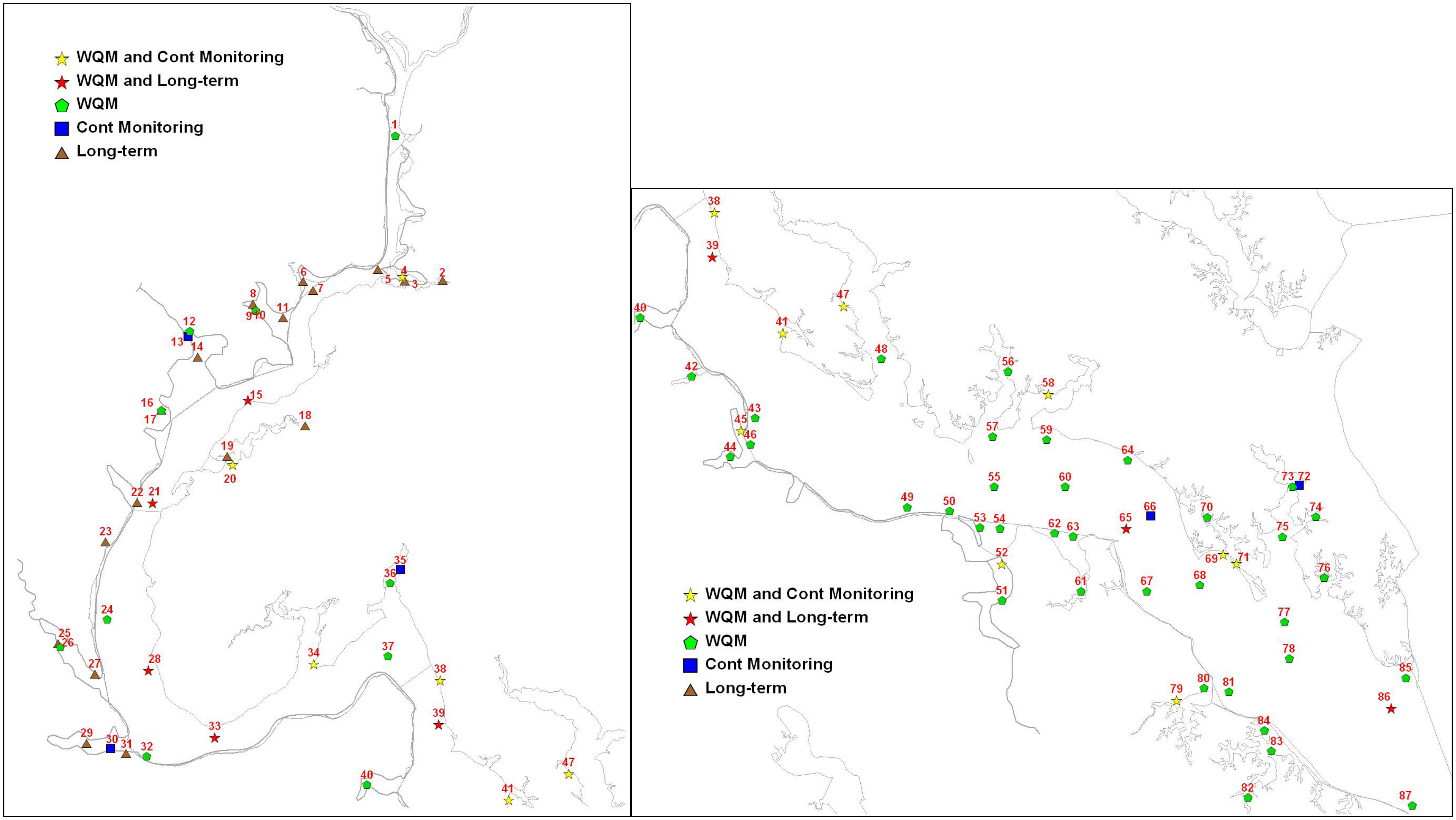
map #	Station name	Station Description	Latitude / Longitude (NAD83m)
25	BPC0035	Big Pipe Bridge on Biggs Ford Road	39° 36' 43.84087" 77° 14' 17.54959"
26	MON0269	Monocacy River Bridge on Biggs Ford Road	39° 28' 48.99338" 77° 23' 21.78848"
27	MON0155	Monocacy River Bridge on Reels Mill Road	39° 23' 16.01682" 77° 22' 51.93732"
28	MON0020	Monacacy River Bridge on Maryland Route 28	39° 16' 18.15283" 77° 26' 29.67792"
29	POT1472	Potomac River West Terminus of Whites Ferry	39° 9' 19.84662" 77° 31' 20.34127"
30	POT1471	Potomac River Terminus of Whites Ferry	39° 9' 15.91002" 77° 31' 16.50385"
31	SEN0008	Seneca Creek Bridge on Maryland Route 112	39° 4' 46.49844" 77° 20' 22.68949"
32	CJB0005	Cabin John at bridge on Macarthur Blvd.	38° 58' 24.41604" 77° 8' 55.81000"
33	RCM0111	Rock Creek 1.5 miles above mouth of Creek	38° 59' 34.87751" 77° 3' 46.90444"
34	POT1184	Potomac River Gage station above Little Falls Dam	38° 56' 53.5691" 77° 7' 38.40557"
36	ANA0082	Anacostia River Bridge on Bladenburg Road	38° 56' 20.16431" 76° 56' 36.40819"

Long-term tidal water quality stations

Map # refers to Figure 25 in Report

map #	Station name	Station Description	Latitude / Longitude (NAD83m)	Characterizes
1	TF2.1	At FL Buoy 77 off month of Piscataway Creek	38° 42' 23.91833" 77° 2' 55.52822"	Tidal fresh zone
2	TF2.2	Buoy 67 off mouth of Dogue Creek	38° 41' 26.43076" 77° 6' 39.99524"	Tidal fresh zone
3	TF2.3	Buoy N 54 mid-channel off Indianhead	38° 36' 29.60330" 77° 10' 26.29859"	Tidal fresh zone
4	TF2.4	Buoy 44 between Possum Point and Moss Point	38° 31' 48.24516" 77° 15' 55.32361"	Tidal fresh/transition zone
5	PIS0033	Piscataway Creek Bridge on Maryland Route 210	38° 41' 54.29872" 76° 59' 12.23830"	Tidal fresh zone
6	XFB1986	Piscataway Creek at Ft. Was. Mar. at Day Marker 6	38° 41' 52.31548" 77° 1' 23.42413"	Tidal fresh zone
7	MAT0078	Mattawoman Creek Bridge on Maryland Route	38° 35' 18.68244" 77° 7' 7.128770"	Tidal fresh zone
8	MAT0016	Mattawoman Creek at Black Day Beacon 1	38° 33' 54.29707" 77° 11' 36.42662"	Tidal fresh zone
9	RET2.1	Buoy 27 Southwest of Smith Point, 8m	38° 24' 12.50834" 77° 16' 8.70996"	Transition zone
10	RET2.2	Buoy 19 mid-channel off Maryland Point, 11m	38° 21' 9.11531" 77° 12' 18.29581"	Transition zone
11	RET2.4	Mid-channel at Morgantown Bridge (U.S. Route 301), 19 m	38° 21' 45.35784" 76° 59' 26.26120"	Lower estuarine zone
12	LE2.2	Potomac River off Ragged Point at buoy 51B; 10m	38° 9' 27.37962" 76° 35' 52.89245"	Lower estuarine zone
13	LE2.3	Mouth of Potomac River (1.6 nm from Pt Lookout on Hdg 240, 0.5 nm NW of Whistle A); 19.8 m	38° 0' 51.16144" 76° 20' 46.13158"	Lower estuarine zone

Shallow water monitoring locations and dates



map#	Segment	Source	Station	Sample type	Latitude	Longitude	Location	years
1	POTTF	MDDNR	XFB8408	WQM	38.80790	-77.03210	main river	2006-2008
2	PISTF	MDDNR	PIS0033	long-term	38.69842	-76.98673	Piscataway Creek	2006-2008
3	PISTF	MDDNR	XFB1986	long-term	38.69786	-77.02317	Piscataway Creek	2006-2008
4	PISTF	MDDNR	XFB2184	CMON, WQM	38.70156	-77.02593	Piscataway Creek	2006-2008
5	POTTF	MDDNR	TF2.1	long-term	38.70664	-77.04876	main river, mouth of Piscataway	2006-2008
6	POTTF	VADEQ/NRO	1ADOU000.60	long-term	38.69778	-77.12111	Dogue Creek (VA)	2007-2008
7	POTTF	MDDNR	TF2.2	long-term	38.69067	-77.11111	main river, Mouth of Dogue Creek	2006-2008
8	POTTF	VADEQ/NRO	1APOH002.32	long-term	38.68028	-77.16917	Pohick Bay (VA)	2007-2008
9	POTTF	VADEQ/NRO	1APOH002.10	long-term	38.67589	-77.16642	Pohick Bay (VA)	2007-2008
10	POTTF	MDDNR	XFB0500	WQM	38.67580	-77.16630	Pohick Bay (VA)	2006-2008
11	POTTF	VADEQ/NRO	1APOH000.93	long-term	38.67000	-77.14000	Pohick Bay (VA)	2007-2008
12	POTTF	MDDNR	XEA8467	WQM	38.66000	-77.23000	Occoquan Bay (VA)	2007-2008
13	POTTF	MDDNR	XEA9461	CMON	38.65590	-77.23210	Occoquan Bay (VA)	2006
14	POTTF	VADEQ/NRO	1AOCC002.47	long-term	38.64028	-77.22222	Occoquan Bay (VA)	2007-2008
15	POTTF	MDDNR	TF2.3	long-term, WQM	38.60820	-77.17390	main river, Indianhead	2006-2008
16	POTTF	MDDNR	XEA6046	WQM	38.60000	-77.25700	Neabsco Creek (VA)	2006
16	POTTF	VADEQ/NRO	1ANEA000.40	long-term	38.60000	-77.25694	Neabsco Creek (VA)	2007-2008
17	POTTF	VADEQ/NRO	1ANEA000.57	long-term	38.60000	-77.25692	Neabsco Creek (VA)	2007-2008
18	MATTF	MDDNR	MAT0078	long-term	38.58852	-77.11864	Matawoman Creek	2006-2008
19	MATTF	MDDNR	MAT0016	long-term	38.56508	-77.19345	Matawoman Creek	2006-2008
20	MATTF	MDDNR	XEA3687	CMON, WQM	38.55925	-77.18870	Matawoman Creek	2006-2008
21	POTTF	MDDNR	TF2.4	long-term, WQM	38.53010	-77.26540	main river, between Possum Pt and Moss Pt	2006-2008
22	POTTF	VADEQ/NRO	1AQUA000.43	long-term	38.53000	-77.28000	Aquia Creek (VA)	2007-2008
23	POTMH	VADEQ/NRO	1ACHO000.47	long-term	38.50000	-77.31000	unknown (VA)	2007-2008
24	POTOH	MDDNR	XDA6515	WQM	38.44170	-77.30830	main river	2006-2008
25	POTMH	VADEQ/NRO	1AAUA003.71	long-term	38.42305	-77.35528	Aquia Creek (VA)	2007-2008
26	POTOH	MDDNR	AQU0037	WQM	38.42050	-77.35320	Aquia Creek (VA)	2006-2008
27	POTMH	VADEQ/NRO	1AAUA001.39	long-term	38.40000	-77.32000	Aquia Creek (VA)	2007-2008
28	POTOH	MDDNR	RET2.1	long-term, WQM	38.40350	-77.26910	main river, Smith Point	2006-2008
29	POTMH	VADEQ/NRO	1APOM002.41	long-term	38.34750	-77.32750	Potomac Creek (VA)	2007-2008
30	POTOH	VIMS	POM000.97	CMON	38.34360	-77.30485	Potomac Creek (VA)	2007-2008
31	POTMH	VADEQ/NRO	1APOM000.60	long-term	38.34000	-77.29000	Potomac Creek (VA)	2007-2008
32	POTOH	MDDNR	XDA0338	WQM	38.33830	-77.27000	main river	2006-2008
33	POTOH	MDDNR	RET2.2	long-term, WQM	38.35250	-77.20510	main river, Maryland Pt	2006-2008
34	POTOH	MDDNR	XDB4544	CMON, WQM	38.40840	-77.11030	mouth Nanjemoy Creek- Blossom Point	2006-2008
35	POTOH	MDDNR	XDB8884	CMON	38.47963	-77.02748	Port Tobacco River	2007-2008
36	POTOH	MDDNR	XDB8278	WQM	38.46970	-77.03710	Port Tobacco River	2006-2008
37	POTOH	MDDNR	XDB4877	WQM	38.41420	-77.03910	main river	2006-2008
38	POTMH	MDDNR	XDC3807	CMON, WQM	38.39600	-76.98910	main river- Pope's Creek	2006-2008
39	POTMH	MDDNR	RET2.4	long-term, WQM	38.36260	-76.99063	main river, Morgantown	2006-2008
40	POTMH	VIMS	UMC001.78	WQM	38.31697	-77.05922	Upper Machodoc Creek (VA)	2007-2008

map#	Segment	Source	Station	Sample type	Latitude	Longitude	Location	years
41	POTMH	MDDNR	XCC8346	CMON, WQM	38.30540	-76.92390	main river- Swan Point	2006-2008
42	POTMH	VIMS	ROS001.10	WQM	38.27273	-77.01050	Rosier Creek (VA)	2007-2008
43	POTMH	MDDNR	XCC4530	WQM	38.24150	-76.95030	main river	2006-2008
44	POTMH	VIMS	MAO001.05	WQM	38.21255	-76.97378	Mattox Creek (VA)	2007-2008
45	POTMH	VIMS	MON000.18	CMON, WQM	38.23197	-76.96372	Monroe Bay (VA)	2007-2008
46	POTMH	VIMS	POT040.14	WQM	38.22160	-76.95442	Monroe Bay (VA)	2007-2008
47	POTMH	MDDNR	XCC9680	CMON, WQM	38.32550	-76.86600	Wicomico River- Wicomico Beach	2006-2008
48	POTMH	MDDNR	XCD7202	WQM	38.28590	-76.83000	Wicomico River	2006-2008
49	POTMH	MDDNR	XCD0517	WQM	38.17440	-76.80560	main river	2006-2008
50	POTMH	MDDNR	XCD0340	WQM	38.17150	-76.76560	main river- mouth of Nomini Bay	2007-2008
51	POTMH	VIMS	NOM004.69	WQM	38.10398	-76.71592	Nomini Bay (VA)	2007-2008
52	POTMH	VIMS	NOM002.36	CMON, WQM	38.13160	-76.71618	Nomini Bay (VA)	2007-2008
53	POTMH	MDDNR	XBD9558	WQM	38.15880	-76.73680	Nomini Bay (VA)	2006
54	POTMH	VIMS	NOM000.81	WQM	38.15818	-76.71787	Nomini Bay (VA)	2007-2008
55	POTMH	MDDNR	XCD1466	WQM	38.18960	-76.72310	main river	2007-2008
56	POTMH	MDDNR	XCD6674	WQM	38.27600	-76.70950	St. Clements Bay	2006-2008
57	POTMH	MDDNR	XCD3765	WQM	38.22720	-76.72470	main river; mouth of St Clements Bay	2006-2008
58	POTMH	MDDNR	XCD5599	CMON, WQM	38.25900	-76.67130	Breton Bay	2006-2008
59	POTMH	MDDNR	XCD3596	WQM	38.22460	-76.67320	main river	2006-2008
60	POTMH	MDDNR	XCE1407	WQM	38.18940	-76.65560	main river	2006-2008
61	POTMH	VIMS	LOW003.42	WQM	38.11082	-76.64082	Lower Machodoc Creek (VA)	2007-2008
62	POTMH	MDDNR	XBE9300	WQM	38.15430	-76.66590	Lower Machodoc Creek (VA)	2006
63	POTMH	VIMS	POT022.86	WQM	38.15212	-76.64825	Lower Machodoc Creek (VA)	2007-2008
64	POTMH	MDDNR	XCE2643	WQM	38.20920	-76.59600	main river	2006-2008
65	POTMH	MDDNR	LE2.2	long-term, WQM	38.15760	-76.59800	main river, Ragged Pt	2006-2008
66	POTMH	MDDNR	XCE0055	CMON	38.16667	-76.57500	main river	2008
67	POTMH	MDDNR	XBE6753	WQM	38.11060	-76.57850	main river	2006-2008
68	POTMH	MDDNR	XBE6983	WQM	38.11500	-76.52830	main river	2007-2008
69	POTMH	MDDNR	XBE8396	CMON, WQM	38.13780	-76.50580	main river, Piney Point	2006-2008
70	POTMH	MDDNR	SGC0041	WQM	38.16600	-76.52100	St. Georges Creek	2006-2008
71	POTMH	MDDNR	XBF7904	CMON, WQM	38.13110	-76.49340	St. Georges Creek	2006-2008
72	POTMH	MDDNR	XCF1440	CMON	38.18930	-76.43390	St. Marys River	2008
73	POTMH	MDDNR	XCF1336	WQM	38.18870	-76.43980	St. Marys River	2006-2008
74	POTMH	MDDNR	XBF9949	WQM	38.16570	-76.41770	St. Marys River	2006-2008
75	POTMH	MDDNR	XBF9130	WQM	38.15100	-76.44950	St. Marys River	2006-2008
76	POTMH	MDDNR	XBF0956	WQM	38.12000	-76.41000	Smith Creek	2007
76	POTMH	MDDNR	XBF7254	WQM	38.12000	-76.41000	Smith Creek	2008
77	POTMH	MDDNR	XBF5231	WQM	38.08670	-76.44830	main river	2006-2008
78	POTMH	MDDNR	XBF3534	WQM	38.05950	-76.44400	main river	2006-2008
79	POTMH	VIMS	WES000.18	CMON, WQM	38.02855	-76.55090	Yeocomico River (VA)	2007-2008
80	POTMH	VIMS	YEO000.45	WQM	38.03765	-76.52498	Yeocomico River (VA)	2007-2008
81	POTMH	MDDNR	XBE2100	WQM	38.03480	-76.50120	main river	2006
82	POTMH	VIMS	COA004.28	WQM	37.95500	-76.48378	Coan River (Va)	2007-2008
83	POTMH	VIMS	COA000.63	WQM	37.99002	-76.46122	Coan River (Va)	2007-2008
84	POTMH	MDDNR	XBF0320	WQM	38.00560	-76.46790	Coan River (Va)	2006
85	POTMH	MDDNR	XBG2601	WQM	38.04430	-76.33340	main river	2006-2008
86	POTMH	MDDNR	LE2.3	long-term, WQM	38.02150	-76.34770	main river, Point Lookout	2006-2008
87	POTMH	MDDNR	XBF6903	WQM	37.94830	-76.32830	main river	2006-2008

Appendix 4

Water and Habitat Quality Data Assessment Methods

Loadings
For USGS methods see http://md.water.usgs.gov/publications/sir-2006-5178/index.html

Current condition- Status
Tidal station nutrient concentrations and physical properties were evaluated to determine the current health of the rivers (status). Relative status was determined for total nitrogen (TN), dissolved inorganic nitrogen (DIN), total phosphorus (TP), dissolved inorganic phosphorus (PO_4), total suspended solids (TSS), algal abundance (as measured by chlorophyll *a*, CHLA) and water clarity (as measured with a Secchi disc) for the 2010-2012 period. For status calculation methods see http://mddnr.chesapeakebay.net/eyesonthebay/documents/ICPRB09-4_StatusMethodPaperMolson2009.pdf.

Results for some parameters are compared with established threshold values to evaluate habitat quality. Summer bottom dissolved oxygen (BDO) is compared to US EPA Chesapeake Bay dissolved oxygen criteria for deep-water seasonal designated use (June- September). Summer dissolved oxygen is considered healthy if levels are 5 mg/l or greater and impaired if levels are less than 3 mg/l. For more details see www.chesapeakebay.net/content/publications/cbp_13142.pdf. DIN is compared to a nitrogen limitation threshold value of less than 0.07 mg/l (Fisher and Gustafson 2002, available online at http://www.hpl.umces.edu/gis_group/Resource%20Limitation/2002_report_27Oct03.htm#es). Submerged aquatic vegetation (SAV) growing season median concentrations for 2010-2012 for PO_4, TSS, CHLA and Secchi depth are compared to SAV habitat requirements (Appendix 5) using the methods of Kemp et al. (2004) available online at http://archive.chesapeakebay.net/pubs/sav/savreport.pdf

Change over time- Trends

Nutrient levels and physical properties were evaluated to determine progress toward improved water quality (trends). For trends calculation methods see http://mddnr.chesapeakebay.net/eyesonthebay/documents/stat_trend_hist.pdf. For non-tidal water quality stations, concentrations of TN, TP and TSS were evaluated. For tidal water quality stations, the following parameters were evaluated: TN, DIN, TP, PO_4, TSS, algal abundance (as measured by chlorophyll *a*, CHLA), water clarity (as measured with a Secchi disc), summer BDO, salinity and water temperature. In order to understand results in the primary parameters, additional parameters were examined including nitrate-nitrite (NO_{23}), ammonium (NH_4) and ratios of nutrient concentrations (TN:TP, DIN:PO_4) that may explain more about nutrient use by aquatic plants and limitations of available nutrients.

Non-tidal water quality data was tested for linear trends for 1999-2012 and 1986-2012. Tidal water quality data were tested for linear trends for 1985-1997, 1999-2012 and 1985-2012. Tests for non-linear trends were also done for 1985-2012 with the tidal water quality data. Trends are significant if $p \leq 0.01$; also included in the discussion are trends that 'may be' significant when $0.01 < p < 0.05$. Due to a laboratory change in 1998 that affects the tidal water quality data, a step trend may occur for TP, PO_4 and TSS. For these parameters, trends are determined for 1985-1997 and 1999-2012 only.

In addition to annual trends for the various time ranges above, tidal water quality data was tested for seasonal trends for 1999-2012. Seasons tested were spring (March-May), summer (July-September) and SAV growing season (April-October).

Shallow water Temporal Assessment (Percent failure analysis)

Continuous monitoring data were compared to water quality thresholds. Measurements of dissolved oxygen taken during the months of June through September were compared to the US EPA threshold value of 3.2 mg/l for shallow water bay grass use (instantaneous minimum). This time period was used because the summer months typically experience the lowest dissolved oxygen levels and are the most critical for living resources. Chlorophyll and turbidity measurements collected during the SAV growing season of April through October were compared to threshold levels of 15 µg/l and 7 NTU, respectively. Values above these levels can inhibit light penetration through the water column and impact growth of underwater grasses. Percent failures are defined as the percent of values in each year that did not meet the water quality thresholds.

Shallow water Spatial Assessment

Algal density, sediment and nutrient samples were collected from calibration sites on water quality mapping cruises, some of which were also at continuous monitoring sites. In addition, samples were collected at the continuous monitoring sites when the equipment was serviced (approximately every two weeks). All data for a station (water quality mapping calibration and continuous monitoring calibration) were used to calculate a monthly median. Monthly medians for April-October were used to calculate the SAV growing season median. Note that the long-term stations include data from long-term and water quality mapping sampling. The median CHLA, TSS, PO_4 and DIN levels and Secchi depths for the April-October SAV growing season were compared to the habitat requirements in the same manner as the long-term tidal data (Appendix 5).

Appendix 5

Submerged Aquatic Vegetation Habitat Requirements

Submerged Aquatic Vegetation (SAV) habitat requirements by salinity regime (from Habitat Requirements for Submerged Aquatic Vegetation in Chesapeake Bay: Water Quality, Light Regime, and Physical-Chemical Factors. W. M. Kemp, R. Batiuk, R. Bartleson, P. Bergstrom, V. Carter, C. L. Gallegos, W. Hunley, L. Karrh, E. W. Koch, J. M. Landwehr, K. A. Moore, L. Murray, M. Naylor, N. B. Rybicki, J. C. Stevenson and D. J. Wilcox. Estuaries. 2004. 27:363–377 available online at http://archive.chesapeakebay.net/pubs/sav/savreport.pdf.).

SAV growing season for all three regimes in Maryland is from April-October. Median seasonal values are compared to the listed habitat requirement to determine if water quality is suitable for SAV growth and survival. Note that the dissolved inorganic nitrogen (DIN) requirement for mesohaline waters exceeds the 0.07 mg/l level where nitrogen limitation of algal growth likely occurs. The more stringent nitrogen limitation DIN level is used for interpretation of habitat quality instead. Due to issues with the model calibration, instead of Percent light at leaf (PLL) water clarity is assessed with percent light through water (PLW) at 1.0 meter depth (L. Karrh, personal communication). PLW can be calculated for the long-term stations that were sampled from 1985-2012. For all stations, Secchi depth can also be used to estimate PLW (L. Karrh, personal communication).

Salinity Regime (ppt)	**Water Column Light Requirement (PLW) (%) or Secchi Depth (m)**	**Total Suspended Solids (mg/l)**	**Plankton Chlorophyll-*a* (µg/l)**	**Dissolved Inorganic Nitrogen (mg/l)**	**Dissolved Inorganic Phosphorus (mg/l)**
Tidal Fresh <0.5 ppt	>13% or 0.725 m	< 15	< 15	Not applicable	< 0.02
Oligohaline 0.5-5 ppt	>13% or 0.725 m	< 15	< 15	Not applicable	< 0.02
Mesohaline 5-18 ppt	>22% or 0.97 m	< 15	< 15	< 0.15 (Nitrogen Limitation < 0.07)	< 0.01

Appendix 6

Annual trends results from the non-tidal water quality stations.
Trend results from 1999-2012 and 1986-2012

Data is from the surface layer. Red colored results indicate degrading conditions. Green colored results indicate improving conditions. Grey shading of the 1986-2012 Linear Trend results indicates the non-linear trend is significant and the linear trend results should not be reported. For trends significant at $p \leq 0.01$, results are abbreviated as INC (increasing), DEC (decreasing), U (u-shaped non-linear trend) and INV-U (inverse u-shaped non-linear trend). For trends significant at $0.01 < p < 0.05$, NT (no trend) precedes the abbreviation. NT alone indicates trend is not significant at $p < 0.05$.

		map#	STATION	1999 2012 Linear	1986 2012 Linear	1986 2012 Non Linear	1986-2012 NLN inflection
TN	Western Upper Potomac	1	NBP0689	INC	NT-DEC	U	Nov-99
		2	SAV0000	NT	DEC	U	Aug-05
		2	NBP0534	NT	DEC		
		3	GEO0009	DEC	DEC		
		4	NBP0461	DEC	DEC		
		5	NBP0326	DEC	DEC		
		6	BDK0000	DEC	DEC		
		7	WIL0013	DEC	DEC		
		8	NBP0103	DEC	DEC		
		9	NBP0023	DEC	DEC		
		10	TOW0030	DEC	DEC		
		11	POT2766	DEC	DEC		
		12	POT2386	DEC	DEC		
	Eastern Upper Potomac	13	CON0180	INC	DEC	U	Jul-03
		14	CON0005	INC	DEC	U	Apr-04
		15	POT1830	NT	DEC	U	Jul-09
		16	ANT0366	INC	DEC	U	Sep-02
		17	ANT0203	INC	DEC	U	Aug-05
		18	ANT0044	INC	DEC	U	Apr-07
		20	CAC0148	NT	DEC		
		21	CAC0031	NT	DEC	U	Nov-07
		22	POT1596	DEC	DEC		
		23	POT1595	NT	DEC	DEC_to_As	Oct-13
	Monocacy River	25	MON0528	NT-DEC	DEC		
		26	BPC0035	NT	DEC		
		27	MON0269	NT	DEC		
		28	MON0155	DEC	DEC	INV-U	Feb-88
		29	MON0020	DEC	DEC		
	Middle Potomac	30	POT1472	NT-DEC	DEC		
		31	POT1471	NT	DEC	U	Jul-07
		32	SEN0008	DEC	DEC		
		33	CJB0005	NT	DEC		
		34	RCM0111	NT	DEC		
		35	POT1184	NT	DEC		
		37	ANA0082	NT	DEC	U	Sep-04

		map#	STATION	1999 2012 Linear	1986 2012 Linear	1986 2012 Non Linear	1986-2012 NLN inflection
TP	Western Upper Potomac	1	NBP0689	NT	NT		
		2	NBP0534	NT	NT		
		2	SAV0000	NT	NT		
		3	GEO0009	NT	DEC		
		4	NBP0461	DEC	DEC		
		5	NBP0326	DEC	DEC		
		6	BDK0000	NT	NT-SLOPE = 0		
		7	WIL0013	NT	NT		
		8	NBP0103	DEC	DEC		
		9	NBP0023	DEC	DEC	INV-U	Sep-92
		10	TOW0030	NT	NT		
		11	POT2766	NT	NT		
		12	POT2386	NT	NT-DEC		
	Eastern Upper Potomac	13	CON0180	DEC	DEC		
		14	CON0005	DEC	DEC		
		15	POT1830	DEC	DEC		
		16	ANT0366	NT	DEC		
		17	ANT0203	DEC	DEC		
		18	ANT0044	DEC	DEC	DEC_from_As	Oct-85
		20	CAC0148	DEC	DEC	INV-U	Jun-95
		21	CAC0031	DEC	DEC		
		22	POT1596	DEC	DEC		
		23	POT1595	DEC	DEC		
	Monocacy River	25	MON0528	DEC	DEC	U	Sep-05
		26	BPC0035	DEC	DEC		
		27	MON0269	DEC	DEC		
		28	MON0155	DEC	DEC	INV-U	Jun-94
		29	MON0020	DEC	DEC	INV-U	Feb-92
	Middle Potomac	30	POT1472	DEC	DEC	INV-U	Jan-92
		31	POT1471	DEC	DEC		
		32	SEN0008	DEC	DEC	INV-U	Dec-88
		33	CJB0005	NT	DEC		
		34	RCM0111	NT	NT		
		35	POT1184	DEC	DEC	INV-U	Mar-93
		37	ANA0082	NT-INC	NT	U	Sep-99

.

		map#	STATION	1999 2012 Linear	1986 2012 Linear	1986 2012 Non Linear	1986-2012 NLN inflection
TSS	Western Upper Potomac	1	NBP0689	**INC**	NT		
		2	NBP0534	**INC**	NT	**U**	Mar-03
		2	SAV0000	**INC**	NT		
		3	GEO0009	**INC**	NT		
		4	NBP0461	NT	NT-SLOPE = 0		
		5	NBP0326	NT	**DEC**		
		6	BDK0000	NT	NT		
		7	WIL0013	NT	NT		
		8	NBP0103	NT	NT		
		9	NBP0023	NT	NT-DEC		
		10	TOW0030	NT	NT		
		11	POT2766	NT	NT		
		12	POT2386	**DEC**	**DEC**		
	Eastern Upper Potomac	13	CON0180	NT-DEC	NT		
		14	CON0005	**DEC**	NT-DEC	**INV-U**	Oct-98
		15	POT1830	NT	NT-SLOPE = 0		
		16	ANT0366	**DEC**	**DEC**		
		17	ANT0203	**DEC**	**DEC**	**INV-U**	Jul-97
		18	ANT0044	NT	NT-DEC		
		20	CAC0148	NT	NT		
		21	CAC0031	NT-DEC	**DEC**		
		22	POT1596	NT	NT		
		23	POT1595	NT	NT		
	Monocacy River	25	MON0528	NT-DEC	**DEC**		
		26	BPC0035	NT	**DEC**		
		27	MON0269	NT	**DEC**		
		28	MON0155	NT	**DEC**		
		29	MON0020	NT	**DEC**		
	Middle Potomac	30	POT1472	NT	**DEC**		
		31	POT1471	NT	**DEC**		
		32	SEN0008	NT	NT		
		33	CJB0005	NT	NT		
		34	RCM0111	NT	NT		
		35	POT1184	NT	NT		
		37	ANA0082	**INC**	NT-INC	**U**	May-96

Appendix 7

Current status and annual trends results from the tidal water quality stations.
Trend results from 1985-1997, 1999-2012 and 1985-2012

Data is from the surface layer with the exception of dissolved oxygen, which is from the bottom and the dissolved oxygen trends are for summer only (June-September). Red colored status and trends results indicate poor or degrading conditions. Green colored status and trends results indicate good or improving conditions. Blue colored status indicates fair status. Blue colored trends indicate decreasing trends where a qualitative assessment (improving or degrading) is not applicable; purple colored trends indicate increasing trends in the same parameters. Grey shading of the 1985-2012 Linear Trend results indicates the non-linear trend is significant and the linear trend results should not be reported. For trends significant at $p \leq 0.01$, results are abbreviated as IMP (improving), DEG (degrading), INC (increasing), DEC (decreasing), U (u-shaped non-linear trend) and INV-U (inverse u-shaped non-linear trend). For trends significant at $0.01 < p \leq 0.05$, NT (no trend) precedes the abbreviation. NT alone indicates trend is not significant at $p < 0.05$. * indicates too much of the data was below detection limits to calculate the trend.

PARAM	River portion	Station	2010-2012 Median	2010-2012 Status	1985-1997 Linear Trend	1999-2012 Linear Trend	1985-2012 Linear Trend	1985-2012 Non-Linear Trend	1985-2012 NLN Inflection
TN	Middle Potomac	PIS0033	0.85	GOOD	IMP	IMP	IMP		
		XFB1986	1.50	FAIR	IMP	IMP	IMP		
		TF2.1	1.56	FAIR	IMP	IMP	IMP		
		TF2.2	1.65	POOR	IMP	IMP	IMP		
	Lower Potomac upper	MAT0078	0.73	GOOD	IMP	NTIMP	IMP	U	2006
		MAT0016	1.09	GOOD	IMP	IMP	IMP		
		TF2.3	1.49	FAIR	IMP	IMP	IMP		
		TF2.4	1.57	FAIR	IMP	IMP	IMP		
	Lower Potomac lower	RET2.1	1.37	GOOD	IMP	IMP	IMP		
		RET2.2	1.30	GOOD	NT	IMP	IMP		
		RET2.4	1.00	POOR	NT	IMP	IMP		
		LE2.2	0.80	FAIR	NT	NT	NT		
		LE2.3	0.59	GOOD	NT	NTIMP	IMP	INV-U	1993
DIN	Middle Potomac	PIS0033	0.282	GOOD	IMP	IMP	Not analyzed due to lab change		
		XFB1986	0.994	POOR	IMP	IMP			
		TF2.1	1.107	POOR	IMP	IMP			
		TF2.2	1.139	POOR	IMP	IMP			
	Lower Potomac upper	MAT0078	0.155	GOOD	NT	NTIMP	Not analyzed due to lab change		
		MAT0016	0.534	GOOD	NT	NTIMP			
		TF2.3	1.110	POOR	IMP	IMP			
		TF2.4	0.942	POOR	IMP	IMP			
	Lower Potomac lower	RET2.1	0.785	POOR	NTIMP	IMP	Not analyzed due to lab change		
		RET2.2	0.696	POOR	NT	IMP			
		RET2.4	0.266	POOR	NT	IMP			
		LE2.2	0.068	GOOD	NT	NT			
		LE2.3	0.086	GOOD	NT	NT	SLOPE=0		
TP	Middle Potomac	PIS0033	0.078	GOOD	NT	NT	Not analyzed due to lab change		
		XFB1986	0.056	GOOD	DEG	IMP			
		TF2.1	0.051	GOOD	DEG	IMP			
		TF2.2	0.055	GOOD	NTDEG	IMP			
	Lower Potomac upper	MAT0078	0.040	GOOD	NT	NT	Not analyzed due to lab change		
		MAT0016	0.049	GOOD	NTDEG	IMP			
		TF2.3	0.056	GOOD	NT	IMP			
		TF2.4	0.063	GOOD	NTDEG	IMP			
	Lower Potomac lower	RET2.1	0.076	GOOD	NT	NT	Not analyzed due to lab change		
		RET2.2	0.074	GOOD	NT	NT			
		RET2.4	0.060	POOR	DEG	NT			
		LE2.2	0.036	GOOD	DEG	NT			
		LE2.3	0.024	GOOD	DEG	NT	SLOPE=0		
PO4	Middle Potomac	PIS0033	0.0220	GOOD	Not analyzed due to lab change	NTIMP	Not analyzed due to lab change		
		XFB1986	0.0045	GOOD		IMP			
		TF2.1	0.0062	GOOD		IMP			
		TF2.2	0.0082	GOOD		IMP			
	Lower Potomac upper	MAT0078	0.0090	GOOD	Not analyzed due to lab change	IMP	Not analyzed due to lab change		
		MAT0016	0.0102	GOOD		NT			
		TF2.3	0.0130	GOOD		NT			
		TF2.4	0.0183	GOOD		NT			
	Lower Potomac lower	RET2.1	0.0255	GOOD	Not analyzed due to lab change	IMP	Not analyzed due to lab change		
		RET2.2	0.0280	GOOD		IMP			
		RET2.4	0.0206	GOOD		NT			
		LE2.2	0.0036	GOOD		NT			
		LE2.3	0.0026	GOOD	*	NT	*		

PARAM	River portion	Station	2010-2012 Median	2010-2012 Status	1985-1997 Linear Trend	1999-2012 Linear Trend	1985-2012 Linear Trend	1985-2012 Non-Linear Trend	1985-2012 NLN Inflection
TSS	Middle Potomac	PIS0033	5.6	GOOD	DEG	NT	Not analyzed due to lab change		
		XFB1986	14.5	FAIR	DEG	NT			
		TF2.1	13.8	FAIR	NTDEG	NT			
		TF2.2	16.0	POOR	DEG	NT			
	Lower Potomac upper	MAT0078	3.5	GOOD	DEG	*	Not analyzed due to lab change		
		MAT0016	10.9	GOOD	NT	IMP			
		TF2.3	16.5	POOR	NTDEG	NT			
		TF2.4	21.0	POOR	DEG	NT			
	Lower Potomac lower	RET2.1	20.4	GOOD	DEG	DEG	Not analyzed due to lab change		
		RET2.2	20.5	GOOD	DEG	DEG			
		RET2.4	11.1	POOR	DEG	NTDEG			
		LE2.2	5.2	GOOD	DEG	IMP			
		LE2.3	4.8	GOOD	NT	NTIMP	SLOPE=0		
CHLA	Middle Potomac	PIS0033	2.3	GOOD	NT	NT	NT		
		XFB1986	17.6	POOR	DEG	NT	NT		
		TF2.1	13.5	POOR	DEG	NT	NT		
		TF2.2	12.3	POOR	DEG	NT	NT		
	Lower Potomac upper	MAT0078	2.0	GOOD	NT	NT	NT		
		MAT0016	11.5	POOR	NT	IMP	IMP	INV-U	1989
		TF2.3	10.7	POOR	NT	NTIMP	NT	INV-U	1998
		TF2.4	9.8	POOR	NTDEG	NT	DEG		
	Lower Potomac lower	RET2.1	8.7	GOOD	DEG	DEG	DEG		
		RET2.2	6.6	GOOD	NT	DEG	DEG		
		RET2.4	11.8	POOR	NTDEG	NTDEG	DEG		
		LE2.2	13.0	POOR	NT	NT	DEG		
		LE2.3	10.0	FAIR	NT	NTDEG	DEG		
SECCHI	Middle Potomac	XFB1986	0.5	POOR	NT	NT	IMP	U	1993
		TF2.1	0.6	GOOD	NT	NT	NT		
		TF2.2	0.5	POOR	NT	NT	NT		
	Lower Potomac upper	MAT0016	0.6	GOOD	NT	IMP	IMP	U	1990
		TF2.3	0.5	POOR	NT	NT			
		TF2.4	0.5	POOR	NTDEG	NT	SLOPE=0		
	Lower Potomac lower	RET2.1	0.4	POOR	DEG	NTDEG	SLOPE=0		
		RET2.2	0.5	GOOD	DEG	NTDEG	DEG		
		RET2.4	0.6	POOR	DEG	NT	DEG		
		LE2.2	1.2	FAIR	NT	NT	NT		
		LE2.3	1.4	GOOD	DEG	DEG	DEG		
Summer Bottom DO	Middle Potomac	TF2.1	6.6	GOOD	IMP	NT	NT		
		TF2.2	6.9	GOOD	NTIMP	NT	NT		
	L Potomac upper	TF2.3	6.3	GOOD	NT	DEG	NT	INV-U	1997
		TF2.4	6.0	GOOD	NTIMP	NT	NT		
	Lower Potomac lower	RET2.1	6.1	GOOD	NT	NT	NT	INV-U	1998
		RET2.2	5.6	GOOD	NTIMP	NTDEG	NT	INV-U	1998
		RET2.4	4.2	FAIR	NT	NT	IMP		
		LE2.2	0.8	POOR	NT	NT	NT		
		LE2.3	0.7	POOR	NT	NT	NT		

PARAM	River portion	Station	1985-1997 Linear Trend	1999-2012 Linear Trend	1985-2012 Linear Trend	1985-2012 Non-Linear Trend	1985-2012 NLN Inflection
SALINITY	Lower Potomac upper	MAT0078	NT	NT	NT		
		MAT0016	SLOPE=0	NT	NT		
		TF2.3	SLOPE=0	NT	NT		
		TF2.4	SLOPE=0	NT	NT		
	Lower Potomac lower	RET2.1	**DEC**	NT	NT	**U**	1999
		RET2.2	**DEC**	NT	NT		
		RET2.4	**DEC**	NT	NT	**U**	1999
		LE2.2	**DEC**	**DEC**	**DEC**		
		LE2.3	**DEC**	NTDEC	**DEC**		
WTEMP	Middle Potomac	PIS0033	NT	NTINC	NT		
		XFB1986	NT	NT	NT		
		TF2.1	NT	NT	NT		
		TF2.2	NT	NT	NT		
	Lower Potomac upper	MAT0078	NT	NTINC	NT		
		MAT0016	NT	NTINC	NT		
		TF2.3	NT	NT	NT		
		TF2.4	NT	NT	NT		
	Lower Potomac lower	RET2.1	NT	NT	NT		
		RET2.2	NT	NT	NT		
		RET2.4	NT	NT	**INC**		
		LE2.2	NT	NT	NT		
		LE2.3	NT	NT	NT		

PARAM	River portion	Station	1985-1997 Linear Trend	1999-2012 Linear Trend	1985-2012 Linear Trend	1985-2012 Non-Linear Trend	1985-2012 NLN Inflection
TN:TP	Middle Potomac	PIS0033	**DEC**	**DEC**	**Not analyzed due to lab change**		
		XFB1986	**DEC**	NT			
		TF2.1	**DEC**	NT			
		TF2.2	**DEC**	NT			
	Lower Potomac upper	MAT0078	**DEC**	NT	**Not analyzed due to lab change**		
		MAT0016	**DEC**	NT			
		TF2.3	**DEC**	NT			
		TF2.4	**DEC**	**DEC**			
	Lower Potomac lower	RET2.1	NT	**DEC**	**Not analyzed due to lab change**		
		RET2.2	NT	NTDEC			
		RET2.4	**DEC**	**DEC**			
		LE2.2	**DEC**	NT			
		LE2.3	**DEC**	NT	SLOPE=0		
DIN:PO4	Middle Potomac	PIS0033		NT	**Not analyzed due to lab change**		
		XFB1986		NT			
		TF2.1		NTINC			
		TF2.2		NT			
	Lower Potomac upper	MAT0078		NT	**Not analyzed due to lab change**		
		MAT0016		**DEC**			
		TF2.3		**DEC**			
		TF2.4		NT			
	Lower Potomac lower	RET2.1		NT	**Not analyzed due to lab change**		
		RET2.2		NT			
		RET2.4		**DEC**			
		LE2.2		NT			
		LE2.3	*	NT	*		
NH4	Middle Potomac	PIS0033	**IMP**	NT	**Not analyzed due to lab change**		
		XFB1986	**IMP**	**IMP**			
		TF2.1	**IMP**	**IMP**			
		TF2.2	**IMP**	**IMP**			
	Lower Potomac upper	MAT0078	*	NTIMP	**Not analyzed due to lab change**		
		MAT0016	*	NT			
		TF2.3	**IMP**	**IMP**			
		TF2.4	**IMP**	**IMP**			
	Lower Potomac lower	RET2.1	**IMP**	**IMP**	**Not analyzed due to lab change**		
		RET2.2	**IMP**	**IMP**			
		RET2.4	NT	**IMP**			
		LE2.2	*	NT			
		LE2.3	*	NT	*		
NO23	Middle Potomac	PIS0033	NTIMP	**IMP**	**Not analyzed due to lab change**		
		XFB1986	**IMP**	**IMP**			
		TF2.1	NTIMP	**IMP**			
		TF2.2	NTIMP	**IMP**			
	Lower Potomac upper	MAT0078	NT	NT	**Not analyzed due to lab change**		
		MAT0016	NT	NTIMP			
		TF2.3	NT	**IMP**			
		TF2.4	NT	**IMP**			
	Lower Potomac lower	RET2.1	NT	**IMP**	**Not analyzed due to lab change**		
		RET2.2	NT	**IMP**			
		RET2.4	NT	**IMP**			
		LE2.2	NT	NT			
		LE2.3	NT	NT	SLOPE=0		

Appendix 8

Seasonal trends results for long-term tidal water quality data

Seasonal trends results for surface data from 1999-2012. Color codes and abbreviations are the same as used in Appendix 7.

param	River portion	Station	ANNUAL Jan-Dec	SPRING Mar-May	SUMMER Jun-Sep	SAV Apr-Oct
TN	Middle Potomac	PIS0033	**IMP**	**IMP**	**IMP**	**IMP**
		XFB1986	**IMP**	**IMP**	**IMP**	**IMP**
		TF2.1	**IMP**	**IMP**	**IMP**	**IMP**
		TF2.2	**IMP**	**IMP**	**IMP**	**IMP**
	Lower Potomac upper	MAT0078	NTIMP	NT	NTIMP	NTIMP
		MAT0016	**IMP**	**IMP**	**IMP**	**IMP**
		TF2.3	**IMP**	**IMP**	**IMP**	**IMP**
		TF2.4	**IMP**	**IMP**	**IMP**	**IMP**
	Lower Potomac lower	RET2.1	**IMP**	**IMP**	**IMP**	**IMP**
		RET2.2	**IMP**	NTIMP	**IMP**	**IMP**
		RET2.4	**IMP**	NT	**IMP**	**IMP**
		LE2.2	NT	NT	NT	NT
		LE2.3	NTIMP	NT	**IMP**	**IMP**
DIN	Middle Potomac	PIS0033	**IMP**	NTIMP	NTIMP	**IMP**
		XFB1986	**IMP**	**IMP**	**IMP**	**IMP**
		TF2.1	**IMP**	**IMP**	**IMP**	**IMP**
		TF2.2	**IMP**	**IMP**	**IMP**	**IMP**
	Lower Potomac upper	MAT0078	NTIMP	NT	NTIMP	NTIMP
		MAT0016	NTIMP	NT	NT	NT
		TF2.3	**IMP**	**IMP**	**IMP**	**IMP**
		TF2.4	**IMP**	**IMP**	**IMP**	**IMP**
	Lower Potomac lower	RET2.1	**IMP**	**IMP**	**IMP**	**IMP**
		RET2.2	**IMP**	**IMP**	**IMP**	**IMP**
		RET2.4	**IMP**	NT	**IMP**	**IMP**
		LE2.2	NT	NT	NT	NT
		LE2.3	NT	NT	NT	NT
TP	Middle Potomac	PIS0033	NT	NT	NT	NT
		XFB1986	**IMP**	NTIMP	NT	**IMP**
		TF2.1	**IMP**	NTIMP	**IMP**	**IMP**
		TF2.2	**IMP**	NTIMP	**IMP**	**IMP**
	Lower Potomac upper	MAT0078	NT	NT	NTIMP	NTIMP
		MAT0016	**IMP**	**IMP**	**IMP**	**IMP**
		TF2.3	**IMP**	**IMP**	**IMP**	**IMP**
		TF2.4	**IMP**	NT	**IMP**	**IMP**
	Lower Potomac lower	RET2.1	NT	NT	**IMP**	**IMP**
		RET2.2	NT	NT	NT	NT
		RET2.4	NT	NT	NT	NT
		LE2.2	NT	NT	NT	NT
		LE2.3	NT	**IMP**	NT	NT
PO4	Middle Potomac	PIS0033	NTIMP	NTIMP	NT	NT
		XFB1986	**IMP**	NTIMP	**IMP**	**IMP**
		TF2.1	**IMP**	NTIMP	**IMP**	**IMP**
		TF2.2	**IMP**	**IMP**	**IMP**	**IMP**
	Lower Potomac upper	MAT0078	**IMP**	NTIMP	**IMP**	**IMP**
		MAT0016	NT	NT	**DEG**	NTDEG
		TF2.3	NT	NT	NT	NT
		TF2.4	NT	NT	NT	NT
	Lower Potomac lower	RET2.1	**IMP**	**IMP**	**IMP**	**IMP**
		RET2.2	**IMP**	NTIMP	NT	**IMP**
		RET2.4	NT	NT	NT	NT
		LE2.2	NT	NT	NT	NT
		LE2.3	NT	NT	NT	NT

param	River portion	Station	ANNUAL Jan-Dec	SPRING Mar-May	SUMMER Jun-Sep	SAV Apr-Oct
TSS	Middle Potomac	PIS0033	NT	NT	NT	NT
		XFB1986	NT	NT	NT	NT
		TF2.1	NT	NT	NT	NT
		TF2.2	NT	NT	NT	NT
	Lower Potomac upper	MAT0078	*	NT		*
		MAT0016	**IMP**	**IMP**	**IMP**	**IMP**
		TF2.3	NT	NT	NT	NT
		TF2.4	NT	NT	NT	NT
	Lower Potomac lower	RET2.1	**DEG**	NTDEG	NT	NT
		RET2.2	**DEG**	NT	NT	NT
		RET2.4	NTDEG	NT	NT	NT
		LE2.2	**IMP**	NT	**IMP**	**IMP**
		LE2.3	NTIMP	**IMP**	NTIMP	**IMP**
CHLA	Middle Potomac	PIS0033	NT	NTIMP	NT	NT
		XFB1986	NT	NT	NT	NT
		TF2.1	NT	NT	NT	NT
		TF2.2	NT	NT	NT	NT
	Lower Potomac upper	MAT0078	NT	NTIMP	NT	NT
		MAT0016	**IMP**	NTIMP	**IMP**	**IMP**
		TF2.3	NTIMP	NT	NTIMP	**IMP**
		TF2.4	NT	NT	NT	NT
	Lower Potomac lower	RET2.1	**DEG**	NT	NTDEG	**DEG**
		RET2.2	**DEG**	NT	NTDEG	**DEG**
		RET2.4	NTDEG	NT	NTDEG	**DEG**
		LE2.2	NT	NT	NT	NT
		LE2.3	NTDEG	NT	NT	NT
SECCHI	Middle Potomac	XFB1986	NT	NT	NT	NT
		TF2.1	NT	NT	NT	NT
		TF2.2	NT	NT	NT	NT
	Lower Potomac upper	MAT0016	**IMP**	NT	**IMP**	**IMP**
		TF2.3	NT	NT	NT	NT
		TF2.4	NT	NT	NT	NT
	Lower Potomac lower	RET2.1	NTDEG	NT	NT	NT
		RET2.2	NTDEG	NT	NT	NT
		RET2.4	NT	NT	NT	NT
		LE2.2	NT	NT	NT	NT
		LE2.3	**DEG**	NT	NT	NTDEG
SALINITY	Lower Potomac upper	MAT0078	NT		NT	NT
		MAT0016	NT	NT	NT	NT
		TF2.3	NT		NT	NT
		TF2.4	NT	NT	NT	NT
	Lower Potomac lower	RET2.1	NT		NT	NT
		RET2.2	NT	NT	NT	NT
		RET2.4	NT	NT	NT	NT
		LE2.2	**DEC**	**DEC**	NT	NT
		LE2.3	NTDEC	**DEC**	NT	NT
WTEMP	Middle Potomac	PIS0033	NTINC	NT	NT	**INC**
		XFB1986	NT	NT	NT	NT
		TF2.1	NT	NT	NT	NT
		TF2.2	NT	NT	NTINC	NTINC
	Lower Potomac upper	MAT0078	NTINC	NT	NTINC	**INC**
		MAT0016	NTINC	NT	NTINC	NTINC
		TF2.3	NT	NT	NTINC	NTINC
		TF2.4	NT	NT	**INC**	NTINC
	Lower Potomac lower	RET2.1	NT	NT	NTINC	NTINC
		RET2.2	NT	NT	**INC**	**INC**
		RET2.4	NT	NT	NTINC	NTINC
		LE2.2	NT	NT	NT	NT
		LE2.3	NT	NT	NTINC	NT

Appendix 9

Shallow water monitoring water and habitat quality

Spatial Assessment

Shallow water monitoring data compared to SAV habitat requirements.
All 2007-2008 data for a station (water quality mapping and continuous monitoring) were used to calculate a monthly median. Monthly medians for April-October were used to calculate the SAV growing season median, which was compared to habitat requirements (Appendix 5). Note that the some long-term stations include data from long-term and water quality mapping sampling (long-term only stations are included for comparisons). Some Virginia stations did not include DIN or PO_4 sampling.

map#	Station	Sample type	Location	years	CHLA		TSS		DIN		PO4		SECCHI		Salinity	Salzone
1	XFB8408	WQM	main river	2007-2008	6.0	MEET	14.0	MEET	1.344	FAIL	0.0179	MEET	0.75	MEET	0.00	TF
2	PIS0033	long-term	Piscataway Creek	2007-2008	2.0	MEET	5.0	MEET	0.275	FAIL	0.0325	FAIL			0.00	TF
3	XFB1986	long-term	Piscataway Creek	2007-2008	5.5	MEET	10.1	MEET	1.230	FAIL	0.0185	MEET	0.90	MEET	0.00	TF
4	XFB2184	CMON, WQM	Piscataway Creek	2007-2008	8.1	MEET	13.6	MEET	0.762	FAIL	0.0111	MEET	0.60	FAIL	0.00	TF
5	TF2.1	long-term	main river, mouth of Piscataway	2007-2008	5.3	MEET	9.1	MEET	1.223	FAIL	0.0194	MEET	0.75	MEET	0.00	TF
6	1ADOU000.60	long-term	Dogue Creek (VA)	2007-2008	14.0	MEET	14.0	MEET	0.940	FAIL	0.0108	MEET	0.50	FAIL	0.14	OH
7	TF2.2	long-term	main river, Mouth of Dogue Creek	2007-2008	4.4	MEET	13.2	MEET	1.131	FAIL	0.0191	MEET	0.70	FAIL	0.00	TF
8	1APOH002.32	long-term	Pohick Bay (VA)	2007-2008	10.9	MEET	7.0	MEET	1.476	FAIL	0.0055	MEET	0.90	MEET	0.22	OH
9	1APOH002.10	long-term	Pohick Bay (VA)	2007-2008	12.4	MEET	22.0	FAIL	1.632	FAIL	0.0040	MEET	0.73	MEET	0.26	OH
10	XFB0500	WQM	Pohick Bay (VA)	2007-2008	16.9	FAIL	13.4	MEET	0.968	FAIL	0.0027	MEET	0.60	FAIL	0.00	TF
11	1APOH000.93	long-term	Pohick Bay (VA)	2007-2008	14.7	MEET	17.5	FAIL	0.895	FAIL	0.0125	MEET	0.50	FAIL	0.19	OH
12	XEA8467	WQM	Occoquan Bay (VA)	2007-2008	9.3	MEET	9.3	MEET	0.150	FAIL	0.0038	MEET	0.85	MEET	0.00	TF
14	1AOCC002.47	long-term	Occoquan Bay (VA)	2007-2008	8.6	MEET	30.0	FAIL	0.655	FAIL	0.0080	MEET	0.53	FAIL	0.16	OH
15	TF2.3	long-term, WQM	main river, Indianhead	2007-2008	8.4	MEET	12.3	MEET	1.144	FAIL	0.0184	MEET	0.70	FAIL	0.00	TF
16	1ANEA000.40	long-term	Neabsco Creek (VA)	2007-2008	21.8	FAIL	26.5	FAIL							0.17	OH
17	1ANEA000.57	long-term	Neabsco Creek (VA)	2007-2008	17.8	FAIL	31.5	FAIL	0.435	FAIL	0.0048	MEET	0.30	FAIL	0.21	OH
18	MAT0078	long-term	Matawoman Creek	2007-2008	2.5	MEET	3.0	MEET	0.109	FAIL	0.0093	MEET	0.80	MEET	0.00	TF
19	MAT0016	long-term	Matawoman Creek	2007-2008	6.7	MEET	9.5	MEET	0.369	FAIL	0.0098	MEET	0.80	MEET	0.00	TF
20	XEA3687	CMON, WQM	Matawoman Creek	2007-2008	6.0	MEET	6.8	MEET	0.207	FAIL	0.0095	MEET	1.10	MEET	0.00	TF
21	TF2.4	long-term, WQM	main river, between Possum Pt and Moss Pt	2007-2008	5.2	MEET	11.7	MEET	1.009	FAIL	0.0270	FAIL	0.60	FAIL	0.00	TF
22	1AQUA000.43	long-term	Aquia Creek (VA)	2007-2008	3.6	MEET	12.0	MEET	0.375	FAIL	0.0268	FAIL	0.68	FAIL	1.12	OH
23	1ACHO000.47	long-term	unknown (VA)	2007-2008	5.3	MEET	10.3	MEET	0.294	FAIL	0.0235	FAIL	0.75	MEET	1.44	OH
24	XDA6515	WQM	main river	2007-2008	6.4	MEET	17.6	FAIL	0.891	FAIL	0.0306	FAIL	0.50	FAIL	0.05	TF
25	1AAUA003.71	long-term	Aquia Creek (VA)	2007-2008	5.6	MEET	13.0	MEET	0.207	FAIL	0.0050	MEET	0.60	FAIL	0.30	OH
26	AQU0037	WQM	Aquia Creek (VA)	2007-2008	6.5	MEET	10.0	MEET	0.282	FAIL	0.0045	MEET	0.60	FAIL	0.08	OH
27	1AAUA001.39	long-term	Aquia Creek (VA)	2007-2008	3.3	MEET	10.3	MEET	0.390	FAIL	0.0138	MEET	0.68	FAIL	1.10	OH
28	RET2.1	long-term, WQM	main river, Smith Point	2007-2008	6.5	MEET	13.2	MEET	0.675	FAIL	0.0381	FAIL	0.50	FAIL	1.94	OH
29	1APOM002.41	long-term	Potomac Creek (VA)	2007-2008	21.9	FAIL	21.0	FAIL	0.009	MEET	0.0048	MEET	0.30	FAIL	0.50	OH
30	POM000.97	CMON	Potomac Creek (VA)	2007-2008									0.45	FAIL		MH
31	1APOM000.60	long-term	Potomac Creek (VA)	2007-2008	12.7	MEET	18.0	FAIL	0.072	FAIL	0.0058	MEET	0.40	FAIL	1.84	OH
32	XDA0338	WQM	main river	2007-2008	6.0	MEET	8.0	MEET	0.481	FAIL	0.0158	MEET	0.60	FAIL	1.01	OH
33	RET2.2	long-term, WQM	main river, Maryland Pt	2007-2008	6.6	MEET	17.5	FAIL	0.502	FAIL	0.0349	FAIL	0.50	FAIL	3.73	OH
34	XDB4544	CMON, WQM	mouth Nanjemoy Creek- Blossom Point	2007-2008	9.5	MEET	31.0	FAIL	0.204	FAIL	0.0286	FAIL	0.30	FAIL	4.20	OH
35	XDB8884	CMON	Port Tobacco River	2007-2008	18.7	FAIL	41.0	FAIL	0.058	MEET	0.0183	FAIL	0.33	FAIL	5.26	MH
36	XDB8278	WQM	Port Tobacco River	2007-2008	17.6	FAIL	18.0	FAIL	0.028	MEET	0.0105	FAIL	0.50	FAIL	6.12	MH
37	XDB4877	WQM	main river	2007-2008	7.5	MEET	11.0	MEET	0.358	FAIL	0.0294	FAIL	0.60	FAIL	7.43	MH
38	XDC3807	CMON, WQM	main river- Pope's Creek	2007-2008	5.6	MEET	18.4	FAIL	0.228	FAIL	0.0329	FAIL	0.60	FAIL	6.99	MH
39	RET2.4	long-term, WQM	main river, Morgantown	2007-2008	11.7	MEET	10.7	MEET	0.209	FAIL	0.0275	FAIL	0.70	FAIL	7.62	MH
40	UMC001.78	WQM	Upper Machodoc Creek (VA)	2007-2008	32.4	FAIL	31.7	FAIL					0.30	FAIL		MH

map#	Station	Sample type	Location	years	CHLA		TSS		DIN		PO4		SECCHI		Salinity	Salzone
41	XCC8346	CMON, WQM	main river- Swan Point	2007-2008	12.3	MEET	14.1	MEET	0.086	FAIL	0.0079	MEET	0.70	FAIL	8.77	MH
42	ROS001.10	WQM	Rosier Creek (VA)	2007-2008	27.1	FAIL	31.8	FAIL					0.35	FAIL		MH
43	XCC4530	WQM	main river	2007-2008	16.7	FAIL	11.6	MEET	0.183	FAIL	0.0156	FAIL	0.60	FAIL	8.63	MH
44	MAO001.05	WQM	Mattox Creek (VA)	2007-2008	39.6	FAIL	28.6	FAIL	0.432	FAIL	0.0276	FAIL	0.36	FAIL		MH
45	MON000.18	CMON, WQM	Monroe Bay (VA)	2007-2008	30.5	FAIL	36.7	FAIL					0.40	FAIL		MH
46	POT040.14	WQM	Monroe Bay (VA)	2007-2008	23.7	FAIL	22.6	FAIL					0.45	FAIL		MH
47	XCC9680	CMON, WQM	Wicomico River- Wicomico Beach	2007-2008	15.7	FAIL	30.7	FAIL	0.025	MEET	0.0069	MEET	0.40	FAIL	9.51	MH
48	XCD7202	WQM	Wicomico River	2007-2008	18.7	FAIL	12.5	MEET	0.034	MEET	0.0044	MEET	1.00	MEET	11.28	MH
49	XCD0517	WQM	main river	2007-2008	11.1	MEET	5.3	MEET	0.058	MEET	0.0069	MEET	1.00	MEET	9.40	MH
50	XCD0340	WQM	main river- mouth of Nomini Bay	2007-2008	10.6	MEET	7.2	MEET	0.022	MEET	0.0045	MEET	0.90	FAIL	9.50	MH
51	NOM004.69	WQM	Nomini Bay (VA)	2007-2008	38.1	FAIL	21.0	FAIL					0.48	FAIL		MH
52	NOM002.36	CMON, WQM	Nomini Bay (VA)	2007-2008	20.0	FAIL	15.0	FAIL					0.65	FAIL		MH
54	NOM000.81	WQM	Nomini Bay (VA)	2007-2008	21.2	FAIL	6.3	MEET					1.08	MEET		MH
55	XCD1466	WQM	main river	2007-2008	11.0	MEET	4.7	MEET	0.060	MEET	0.0061	MEET	1.20	MEET	9.76	MH
56	XCD6674	WQM	St. Clements Bay	2007-2008	16.8	FAIL	12.0	MEET	0.042	MEET	0.0043	MEET	0.80	FAIL	10.50	MH
57	XCD3765	WQM	main river; mouth of St Clements Bay	2007-2008	18.5	FAIL	26.0	FAIL	0.039	MEET	0.0040	MEET	1.00	MEET	11.15	MH
58	XCD5599	CMON, WQM	Breton Bay	2007-2008	15.0	MEET	19.3	FAIL	0.027	MEET	0.0038	MEET	1.00	MEET	11.13	MH
59	XCD3596	WQM	main river	2007-2008	8.5	MEET	4.0	MEET	0.038	MEET	0.0030	MEET	1.20	MEET	11.74	MH
60	XCE1407	WQM	main river	2007-2008	9.0	MEET	4.4	MEET	0.054	MEET	0.0036	MEET	1.20	MEET	10.30	MH
61	LOW003.42	WQM	Lower Machodoc Creek (VA)	2007-2008	27.9	FAIL	17.3	FAIL					0.60	FAIL		MH
63	POT022.86	WQM	Lower Machodoc Creek (VA)	2007-2008	17.9	FAIL	5.8	MEET					1.15	MEET		MH
64	XCE2643	WQM	main river	2007-2008	8.4	MEET	4.3	MEET	0.057	MEET	0.0036	MEET	1.10	MEET	11.41	MH
65	LE2.2	long-term, WQM	main river, Ragged Pt	2007-2008	11.4	MEET	5.5	MEET	0.044	MEET	0.0037	MEET	1.30	MEET	10.50	MH
66	XCE0055	CMON	main river	2008	12.9	MEET	4.5	MEET	0.034	MEET	0.0061	MEET	1.30	MEET	7.27	MH
67	XBE6753	WQM	main river	2007-2008	11.2	MEET	3.6	MEET	0.038	MEET	0.0045	MEET	1.20	MEET	11.41	MH
68	XBE6983	WQM	main river	2007-2008	8.8	MEET	3.6	MEET	0.043	MEET	0.0032	MEET	1.60	MEET	11.48	MH
69	XBE8396	CMON, WQM	main river, Piney Point	2007-2008	8.1	MEET	9.3	MEET	0.053	MEET	0.0036	MEET	1.20	MEET	12.90	MH
70	SGC0041	WQM	St. Georges Creek	2007-2008	16.1	FAIL	37.5	FAIL	0.032	MEET	0.0032	MEET	0.50	FAIL	13.19	MH
71	XBF7904	CMON, WQM	St. Georges Creek	2007-2008	9.3	MEET	24.4	FAIL	0.036	MEET	0.0035	MEET	1.00	MEET	13.10	MH
72	XCF1440	CMON	St. Marys River	2008	12.0	MEET	55.7	FAIL	0.042	MEET	0.0055	MEET	1.40	MEET	10.99	MH
73	XCF1336	WQM	St. Marys River	2007-2008	9.5	MEET	10.2	MEET	0.031	MEET	0.0034	MEET	1.20	MEET	13.19	MH
74	XBF9949	WQM	St. Marys River	2007-2008	9.3	MEET	9.2	MEET	0.026	MEET	0.0030	MEET	1.10	MEET	13.06	MH
75	XBF9130	WQM	St. Marys River	2007-2008	8.6	MEET	8.3	MEET	0.053	MEET	0.0034	MEET	1.40	MEET	12.99	MH
76	XBF0956	WQM	Smith Creek	2007	11.2	MEET	13.3	MEET	0.017	MEET	0.0022	MEET	1.10	MEET	12.40	MH
76	XBF7254	WQM	Smith Creek	2008	7.5	MEET	14.8	MEET	0.011	MEET	0.0023	MEET	1.05	MEET	10.56	MH
77	XBF5231	WQM	main river	2007-2008	9.9	MEET	3.2	MEET	0.031	MEET	0.0031	MEET	1.50	MEET	12.53	MH
78	XBF3534	WQM	main river	2007-2008	8.5	MEET	11.2	MEET	0.015	MEET	0.0033	MEET	1.70	MEET	11.28	MH
79	WES000.18	CMON, WQM	Yeocomico River (VA)	2007-2008	14.6	MEET	8.7	MEET					0.83	FAIL		MH
80	YEO000.45	WQM	Yeocomico River (VA)	2007-2008	11.0	MEET	7.5	MEET					1.15	MEET		MH
82	COA004.28	WQM	Coan River (Va)	2007-2008	27.7	FAIL	15.7	FAIL					0.55	FAIL		MH
83	COA000.63	WQM	Coan River (Va)	2007-2008	15.1	FAIL	11.9	MEET					0.80	FAIL		MH
85	XBG2601	WQM	main river	2007-2008	7.0	MEET	12.0	MEET	0.012	MEET	0.0030	MEET	1.60	MEET	12.33	MH
86	LE2.3	long-term, WQM	main river, Point Lookout	2007-2008	10.0	MEET	9.5	MEET	0.022	MEET	0.0031	MEET	1.40	MEET	12.59	MH
87	XBF6903	WQM	main river	2007-2008	11.4	MEET	12.0	MEET	0.012	MEET	0.0026	MEET	1.30	MEET	11.61	MH