

Patapsco River and Back River Water Quality and Habitat Assessment Overall Condition 2012-2014

The Patapsco River and Back River basin includes areas in Baltimore City, Baltimore County, Carroll County, Howard County and Anne Arundel County (Figure 1).

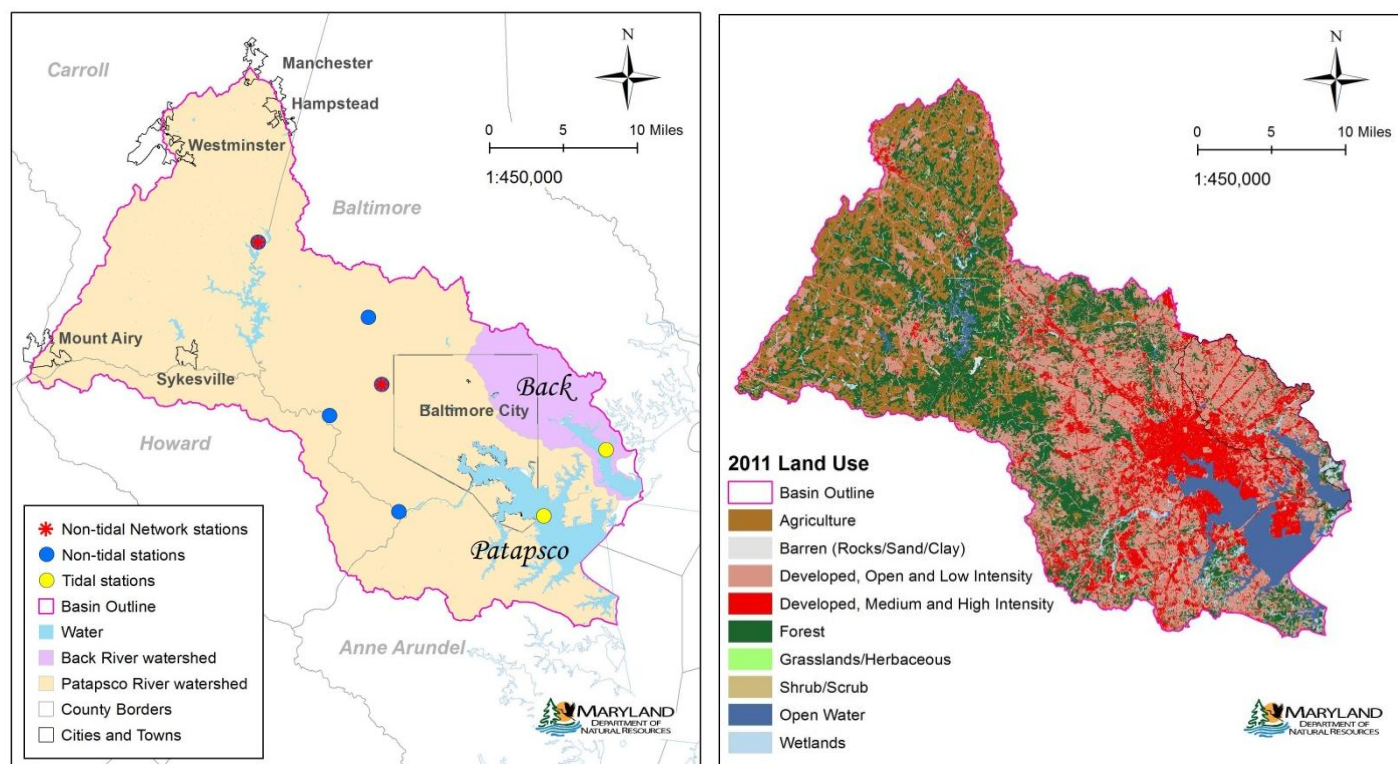


Figure 1 Patapsco and Back River basin.

Left-side panel shows the individual watersheds and locations of long-term non-tidal and tidal water quality monitoring stations. White areas of the basin drain to the mainstem Bay. Right-side panel shows the land use throughout the basin for 2011.¹ Black outline shows the Back River watershed.

Land use in the Patapsco River watershed was estimated as 46% developed, 29% forested, and 21% agriculture.¹ Impervious surfaces covered 20% of the watershed.² Point sources are the largest sources of nitrogen and phosphorus loadings, and urban run-off is the largest source of sediment loadings.³

Land use in the Back River watershed was estimated as 87% developed. Impervious surfaces covered 38% of the watershed. Point sources are the largest sources of nitrogen and phosphorus loadings, and urban run-off is the largest source of sediment loadings.

How healthy are the Patapsco River and the Back River?

Maryland Department of Natural Resources (MDDNR) measures water and habitat quality at five non-tidal long-term monitoring stations on the Patapsco River and at one tidal long-term monitoring station (Figure 1). Water quality is measured at one long-term tidal monitoring station in the Back River. Current conditions are determined from the most recent three years of data; trends are determined from the 1999-2014 data.

Maryland DNR also participates in the Non-tidal Network, a partnership with the United States Geological Survey (USGS), the Chesapeake Bay Program, and the other states in the Chesapeake Bay watershed, to measure non-tidal water quality using the same sampling and analysis methods. Two of Maryland's long-term non-tidal stations on the Patapsco River are also part of the Non-tidal Network (Figure 1, Table 2). USGS completes the trends analysis for all Non-tidal Network stations. USGS combines river flow data and the nutrient and sediment data for the most recent 10-year period. The USGS method accounts for changes in river flow so that underlying changes in nutrient and sediment levels can be determined.⁴

Patapsco River: Nontidal areas: Measured phosphorus levels in the water have decreased at all of the non-tidal monitoring locations in the Patapsco River watershed, and sediment levels have decreased at two monitoring locations (Table 1). Phosphorus levels at the Gwynns Falls station had still decreased when changes in river flow are accounted for.⁴

Tidal areas: Water quality in the tidal waters of the Patapsco River is fair because nitrogen levels are too high (Table 2). Sediment levels have improved. Habitat quality for underwater grasses is poor due to high algal densities and poor water clarity. Severe algal blooms are common in the Patapsco in the summer. Habitat quality for bottom dwelling animals is poor.

Underwater grasses have been very limited or not present in the Patapsco River during this period.⁵ Bottom dwelling animals are not healthy in about 60% of the areas sampled in the Patapsco River during this period. The health of the bottom dwelling animal populations has degraded at the long-term station in Middle Branch.

Back River: Water quality in the tidal waters of the Back River is poor because nitrogen and sediment levels are too high. However, nitrogen and phosphorus levels have improved. Habitat quality is poor for underwater grasses due to high algal densities and poor water clarity. Summer dissolved oxygen levels in Back River are good but indicate poor habitat quality due to excessive algal densities.

Underwater grasses have been very limited or not present in the Back River during this period. Bottom dwelling animals were healthy during this period in Back River at a long-term monitoring station. The health of the bottom dwelling animal population also improved at the long-term station.

Table 1. Summary of non-tidal water quality trends.

Trends for nitrogen (N), phosphorus (P) and sediment (Sed). Trends at MD DNR long-term non-tidal monitoring stations (columns labeled 'MDDNR') are determined for 1999-2014; analysis does not include use of flow data. Trends at Non-tidal Network stations (columns labeled 'USGS') are determined by USGS for 2005-2014 (at some stations there is no 2005 data); analysis includes use of flow data.⁴ Non-tidal Network stations include the corresponding USGS gage number. Stations in bold typeface are MD DNR long-term non-tidal monitoring stations that are also part of the Non-tidal Network. Decreasing trends ('Dec') are improving trends and shown with green typeface. Increasing trends ('Inc') are degrading trends and shown with red typeface. Blanks indicate no significant trend. Grey shading indicates that the station does not have data for that parameter. Stations are ordered from upstream to downstream.

Watershed	USGS Gage #	MD DNR Station	River/Creek	MDDNR 1999-2014 (without flow)			USGS 2005*-2014 (with flow)		
				N	P	Sed	N	P	Sed
Patapsco	01586000	NPA0165	North Branch Patapsco		Dec				
		PAT0285	Patapsco		Dec	Dec			
		PAT0176	Patapsco		Dec				
		JON0184	Jones Falls		Dec				
	0159300	GWN0115	Gwynns Falls		Dec	Dec		Dec	

Table 2. Summary of tidal water quality and habitat quality indicators.

Annual trends for 1999-2014 for nitrogen (total nitrogen), phosphorus (total phosphorus), sediment (total suspended solids), algal densities (chlorophyll *a*), and water clarity (Secchi depth). Summer bottom dissolved oxygen (DO) trends are for June through September data only. Trends are either 'Increasing' or 'Decreasing' if significant at $p \leq 0.01$; blanks indicate no significant trend. Improving trends are in green, degrading trends are in red. Nitrogen (dissolved inorganic nitrogen) levels below the level for nitrogen limitation 'Meet' criteria, otherwise 'Fail' criteria for 2012-2014 data. Phosphorus (dissolved inorganic phosphorus), sediment (total suspended solids), algal densities (chlorophyll *a*) and water clarity (Secchi depth) either 'Meet' or 'Fail' submerged aquatic vegetation (SAV) habitat requirements for 2012-2014 data. Summer (June through September) bottom dissolved oxygen levels either 'Meet' or 'Fail' EPA open-water 30-day dissolved oxygen criteria.

River	Water Quality			Habitat Quality		
	Nitrogen	Phosphorus	Sediments	Algal Densities	Water Clarity	Summer Bottom DO
Patapsco	Fail	Meet	Decreasing Meet	Fail	Fail	Fail
Back	Decreasing Fail	Decreasing Meet	Fail	Fail	Fail	Meet

How does the Patapsco River and the Back River compare to other rivers?

The Patapsco and Back rivers are in the ‘Low Agriculture/High Developed’ land use category. Patapsco River nitrogen, phosphorus and sediment levels and algal densities are low to moderate compared to other rivers, and water clarity is better than in other high developed rivers basins (Figure 2). However, summer bottom dissolved oxygen levels in the Patapsco River are the lowest of all rivers in Maryland and greatly degraded.

In many ways, Back River water and habitat quality is the worst of all Maryland rivers. Percent developed land use in the Back River watershed is the highest (and percent agriculture is the lowest) of all Maryland rivers. Nitrogen and phosphorus levels in the water and algal densities are also the highest, and water clarity is among the worst. Sediment levels are also among the highest of the high developed watershed rivers. Even though summer bottom dissolved oxygen levels are the highest of all Maryland rivers, this is an indication of poor habitat quality due to high nutrient levels and algal densities.

What has already been done to improve water and habitat quality in the Patapsco River and the Back River?

Wastewater, Stormwater and Septic Loads

Wastewater treatment plant phosphorus loadings to the Patapsco River have been reduced by 53%, but nitrogen loadings have increased by 27%.⁶ Upgrades to the four largest wastewater treatment plants that discharge to the Patapsco River are under construction and scheduled to be completed by 2016.

Wastewater treatment plant nitrogen loadings to the Back River have been reduced by 50% and phosphorus loadings have been reduced by 87%. Upgrades to the largest wastewater treatment plant that discharges to the Back River (and some of the effluent is diverted to the Patapsco River) are scheduled to be complete by 2016.

Stormwater retrofits have reduced nitrogen loadings and prevented 77,118 pounds of nitrogen from entering the rivers since 2003, and 187 septic system retrofits were completed between 2008 and 2013.⁷

Agricultural Loads⁷

In 2014, cover crops were planted on 8,024 acres in between growing seasons to absorb excess nutrients and prevent sediment erosion. Fencing on 6,991 acres of farmland was used to keep livestock out of streams and prevent streambank erosion. A total of 140 containment structures had been built to store animal wastes and allow these nutrients to be applied to the land in the most effective manner at the appropriate time. Stream buffers were in place on 2,620 acres, allowing areas next to streams to remain in a natural state with grasses, trees and wetlands.

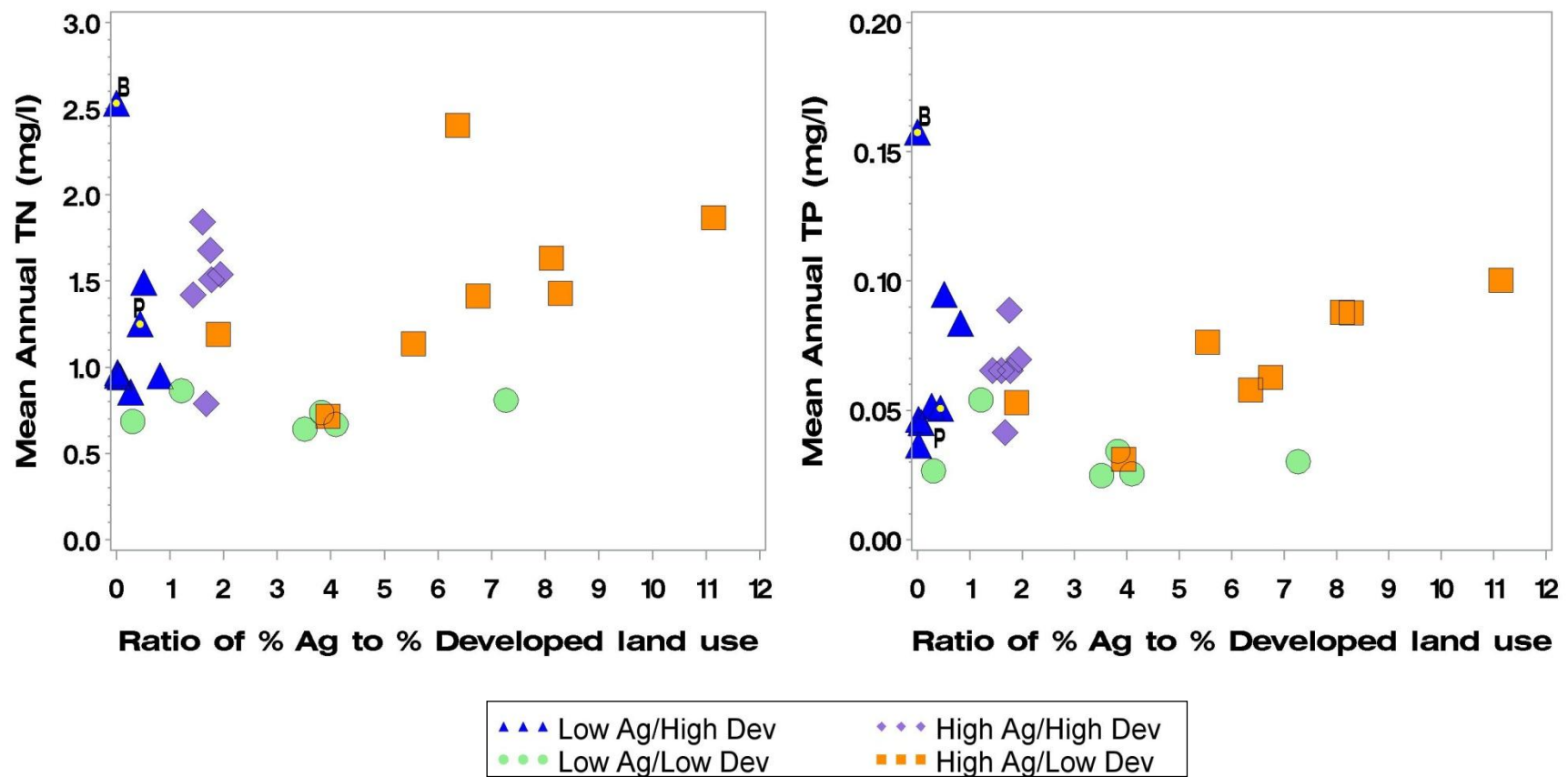


Figure 2. Water quality conditions versus land use.

Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as mean annual concentration (in mg/L) for total nitrogen (TN) and total phosphorus (TP). Rivers are color coded by their land use categories (see legend). Yellow dots highlight the data for the Patapsco (P) and Back (B) rivers.

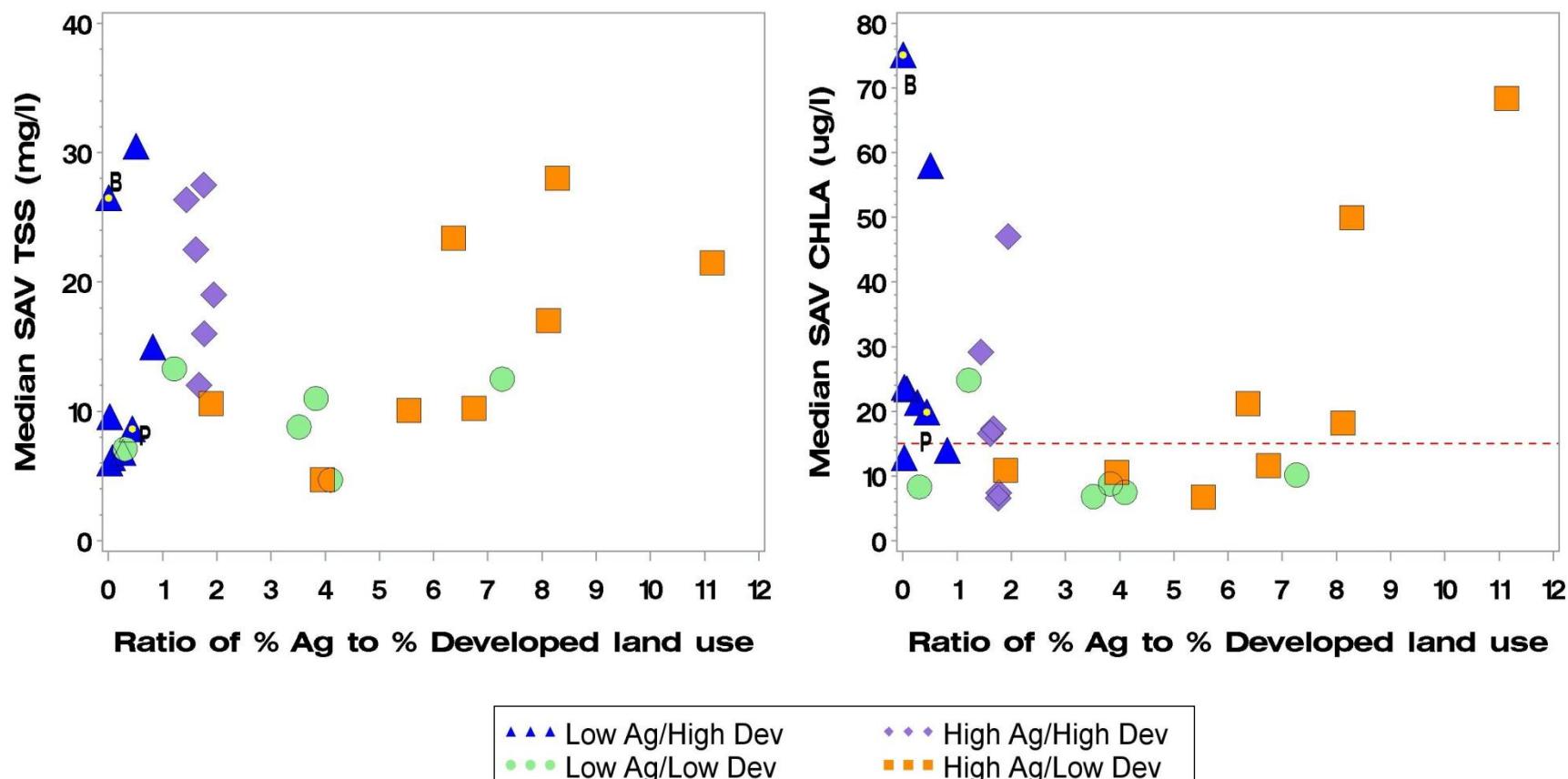


Figure 2 (cont.). Water quality conditions versus land use.

Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as submerged aquatic vegetation (SAV) growing season (April-October) median for total suspended solids (TSS, in mg/L), chlorophyll *a* (CHLA, in µg/L). Reference lines are included on the CHLA graph. Rivers are color coded by their land use categories (see legend). Yellow dots highlight the data for the Patapsco (P) and Back (B) rivers.

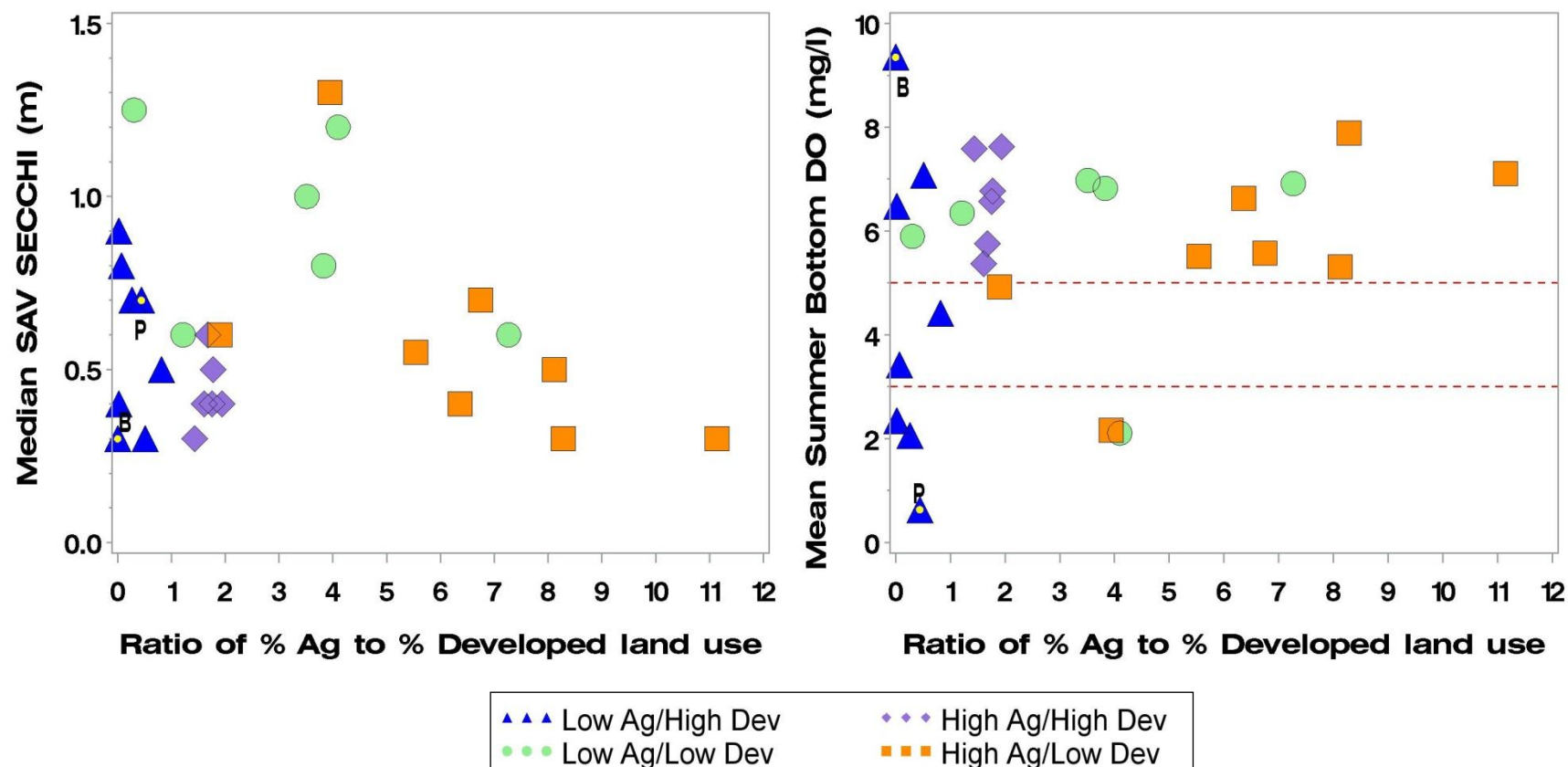


Figure 2 (cont.). Water quality conditions versus land use.

Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as submerged aquatic vegetation (SAV) growing season (April through October) median for Secchi depth (in m) and as mean for summer (June through September) bottom dissolved oxygen (DO, in mg/L). Reference lines are included on the DO graph. Rivers are color coded by their land use categories (see legend). Yellow dots highlight the data for the Patapsco (P) and Bush (B) rivers.

For more information

An integrative assessment of the water and habitat quality of the Patapsco and Back Rivers for 1985-2010 is available online at <http://eyesonthebay.dnr.maryland.gov/eyesonthebay/tribsums.cfm>. Current water and habitat quality information is also available from Maryland DNR's Eyes on the Bay website www.eyesonthebay.net.

References and Data Sources

Data not collected and/or analyzed by the Maryland Department of Natural Resources include:

¹ Land use by basin determined from 2011 National Land Cover Database (NLCD).

Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing*, v. 81, no. 5, p. 345-354
GIS layer downloaded on 11/24/2015 from http://www.mrlc.gov/nlcd11_data.php

² Impervious surfaces data downloaded from Maryland Department of the Environment (MDE) website on 12/1/2015
http://www.mde.state.md.us/programs/Water/TMDL/DataCenter/Pages/phase6_development.aspx

³ Nutrient and sediment loads data for Progress 2014 model run downloaded on November 16, 2015 from <http://baytas.chesapeakebay.net/>. Source categories from BayTas website were renamed to conform to those used on the ChesapeakeStat website http://stat.chesapeakebay.net/?q=node/130&quicktabs_10=1 as follows: Agriculture = Ag; Agriculture_Regulated = Ag_Reg; Non Regulated Stormwater = Urban; Regulated Stormwater = Stormwater; WasteWater-CSO = CSO; PS = Wastewater; Forest = Forest; Non-Tidal Water Deposition = NT_Dep; Septic = Onsite.

⁴ Nutrient and sediment non-tidal concentrations trends results are through WY2014 from USGS website http://cbrim.er.usgs.gov/trends_query.html file dated 2/02/2016, downloaded 2/4/2016. Trends are determined using the Weighted Regressions on Time, Discharge, and Season (WRTDS) model, Hirsch and others, *Environmental Modelling & Software* 2015, <http://www.sciencedirect.com/science/article/pii/S1364815215300220>. Results are reported in the text if the trend was 'Extremely Likely' (Likelihood values ≥ 0.95) or 'Very Likely' (Likelihood values $0.95 > p \geq 0.90$).

⁵ Underwater grasses (submerged aquatic vegetation, or SAV) data are available from the Virginia Institute of Marine Sciences SAV in Chesapeake Bay and Coastal Bays webpage, Tables tab <http://web.vims.edu/bio/sav/SegmentAreaTable.htm#>.

⁶ WWTP loadings data were downloaded from the Chesapeake Bay Program Nutrient Point Source Database website on 10/14/2015 (http://www.chesapeakebay.net/data/downloads/bay_program_nutrient_point_source_database). Changes in loadings determined from the difference of the average of the first three and last three years of data. Data for calendar year available for 1985-2012.

⁷ Data are from Maryland's 2014 - 2015 Milestone Goals and Progress Report website <http://baystat.maryland.gov/solutions-map/>.

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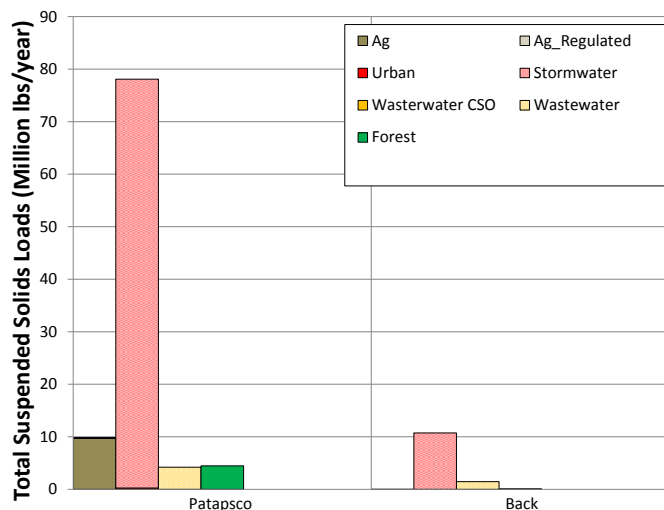
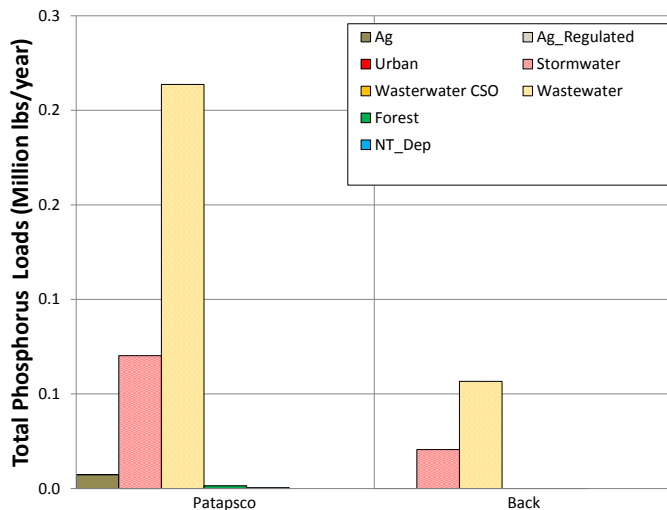
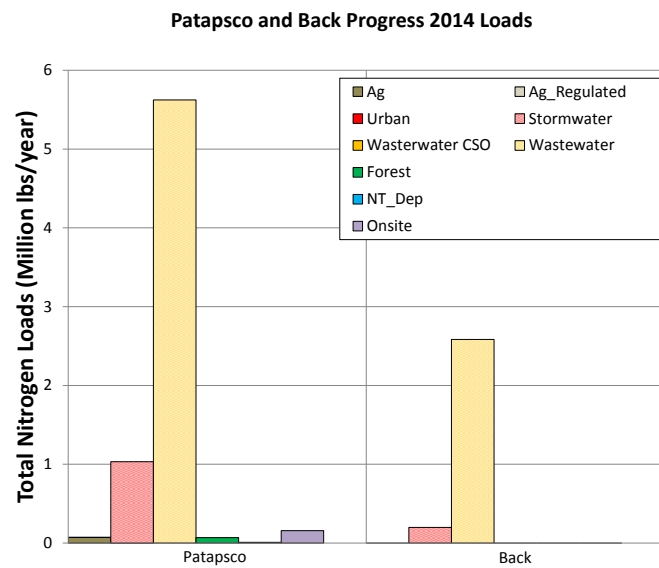


Figure 3. Nitrogen, phosphorus and sediment loads to the Patapsco and Back rivers. Loads (in million lbs/year) are summarized by Chesapeake Bay Program model segment and by source category. Data for Progress 2014 model run downloaded on November 16, 2015 from <http://baytas.chesapeakebay.net/>. Source categories from BayTas website were renamed to conform to those used on the ChesapeakeStat website http://stat.chesapeakebay.net/?q=node/130&quicktabs_10=1 as follows: Agriculture = Ag; Agriculture_Regulated = Ag_Reg; Non Regulated Stormwater = Urban; Regulated Stormwater = Stormwater; WasteWater-CSO = CSO; PS = Wastewater; Forest = Forest; Non-Tidal Water Deposition = NT_Dep; Septic = Onsite.

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River	Segment	State	Source	TN Load (delivered)	% TN load	TP Load (delivered)	% TP load	Sed. Load (delivered)	% Sed. Load
Patapsco	PATMH	MD	Ag	0.071	1.0%	0.0073	2.5%	9.74	10.1%
			Ag_Reg	0.000	0.0%	0.0000	0.0%	0.01	0.0%
			Urban	0.001	0.0%	0.0001	0.0%	0.26	0.3%
			Stormwater	1.032	14.8%	0.0701	23.9%	77.83	80.6%
			CSO		0.0%		0.0%		0.0%
			Wastewater	5.623	80.8%	0.2137	72.9%	4.22	4.4%
			Forest	0.068	1.0%	0.0015	0.5%	4.46	4.6%
			NT_Dep	0.008	0.1%	0.0004	0.1%		0.0%
			Onsite	0.157	2.3%		0.0%		0.0%
			Total Load	6.959		0.2932		96.52	
Back	BACOH	MD	Ag	0.001	0.0%	0.0001	0.1%	0.03	0.2%
			Ag_Reg	0.000	0.0%	0.0000	0.0%	0.00	0.0%
			Urban		0.0%		0.0%		0.0%
			Stormwater	0.198	7.1%	0.0206	26.6%	10.72	87.3%
			CSO		0.0%		0.0%		0.0%
			Wastewater	2.583	92.6%	0.0567	73.1%	1.46	11.9%
			Forest	0.004	0.1%	0.0001	0.1%	0.07	0.6%
			NT_Dep	0.002	0.1%	0.0001	0.1%		0.0%
			Onsite	0.001	0.0%		0.0%		0.0%
			Total Load	2.788		0.0776		12.28	

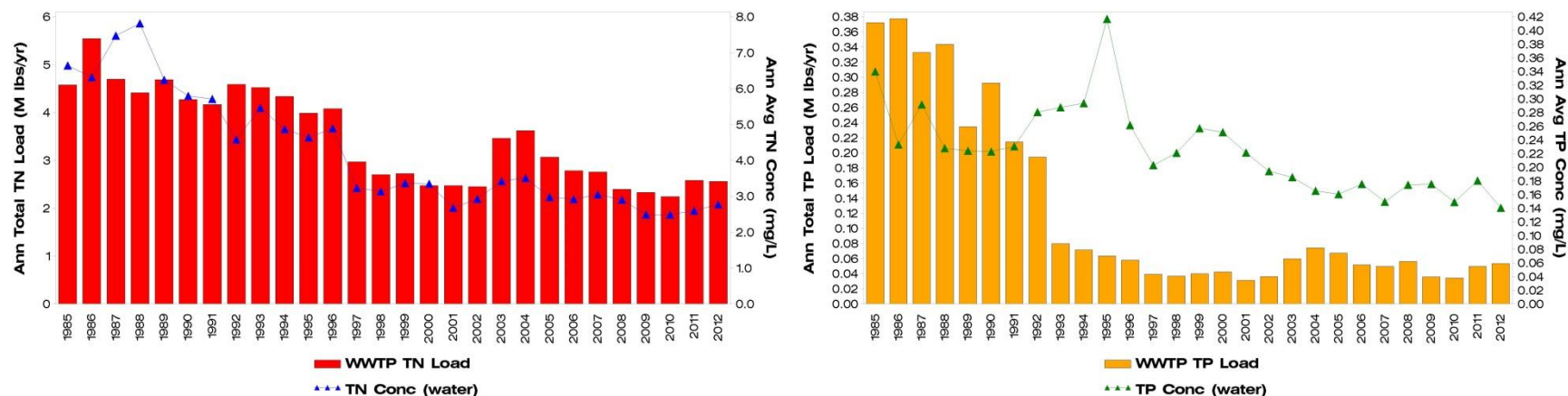


Figure 4. Back River Total Wastewater Treatment Plant loads versus water quality. Loads from the Back River wastewater treatment plant (in million pounds per year, M lbs/yr) that discharges into the Back River compared to annual mean nutrient concentrations (in mg/L) at the long-term monitoring site. Total nitrogen loads (red bars) compared to total nitrogen concentrations (blue triangles) are shown in the left side graphs; total phosphorus (orange bars) compared to total phosphorus concentrations (green triangles) are shown in the right side graphs. Full calendar year loadings data is only available through 2012, and was downloaded from the Chesapeake Bay Program Nutrient Point Source Database website on 10/14/2015 (http://www.chesapeakebay.net/data/downloads/bay_program_nutrient_point_source_database). Note that some of the effluent from the Back River facility is diverted to be used as cooling tower water for the industrial facility at Sparrow's Pt. and then is discharged to the Patapsco River. See graphs in Figure 5 for Sparrow's Pt. loads to the Patapsco River. Also note that the Back River, Sparrow's Pt. and Patapsco River facilities are all part of the same sewer system, so flows are diverted to different facilities at different times and impact the loadings between the Back River and the Patapsco River.

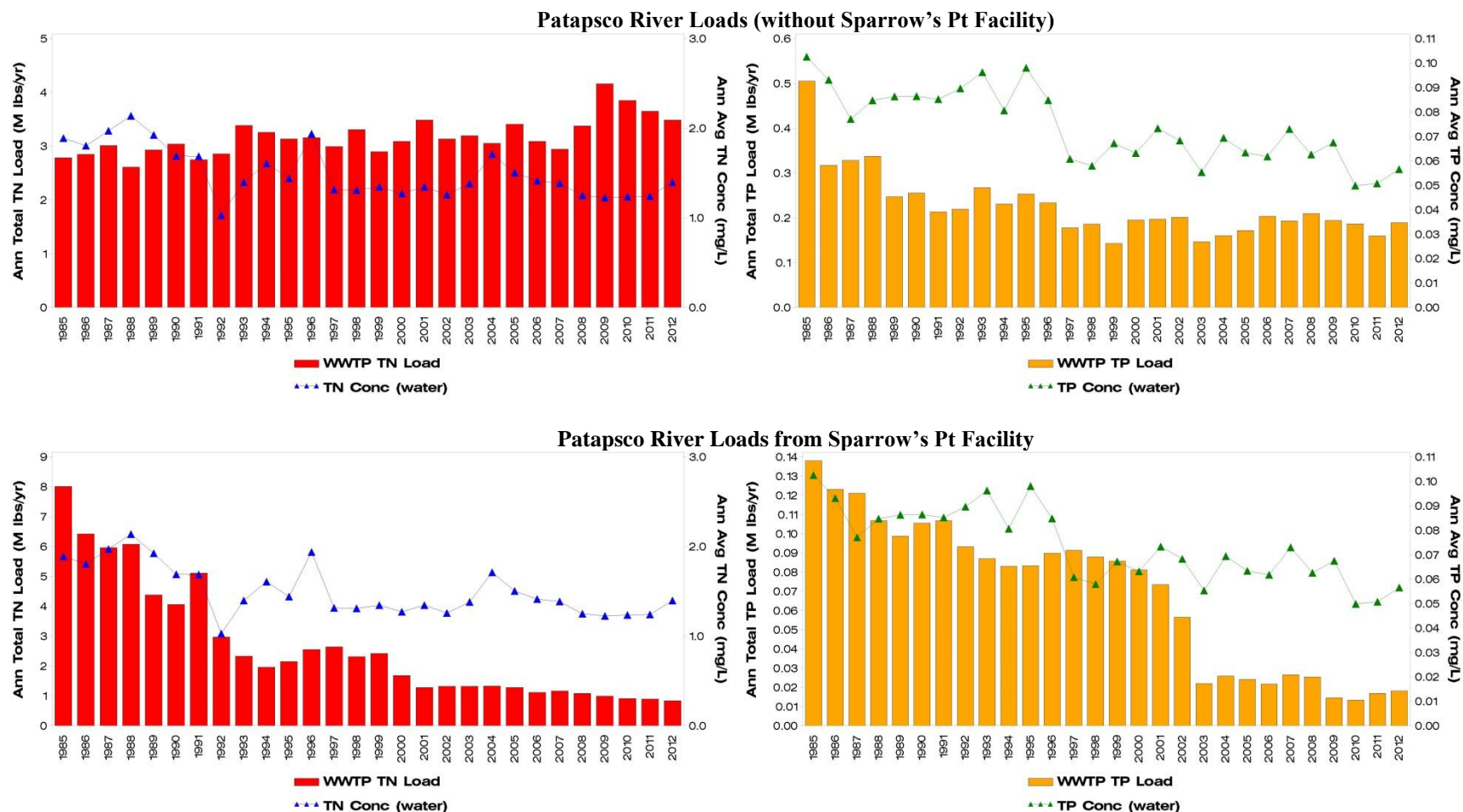


Figure 5. Patapsco River Total Wastewater Treatment Plant loads versus water quality. Summed total of loads from four of the major wastewater treatment plants (in million pounds per year, M lbs/yr) that discharge to the Patapsco River (top graphs) and for the major wastewater treatment plant at Sparrow's Pt. (bottom graphs) compared to annual mean nutrient concentrations (in mg/L) at the long-term monitoring site. Total nitrogen loads (red bars) compared to total nitrogen concentrations (blue triangles) are shown in the left side graphs; total phosphorus (orange bars) compared to total phosphorus concentrations (green triangles) are shown in the right side graphs. Full calendar year loadings data is only available through 2012, and was downloaded from the Chesapeake Bay Program Nutrient Point Source Database website on 10/14/2015 (http://www.chesapeakebay.net/data/downloads/bay_program_nutrient_point_source_database). Note that some of the effluent from the Back River facility is diverted to be used as cooling tower water for the industrial facility at Sparrow's Pt. and then is discharged to the Patapsco River as part of the total load from that facility. Also note that the Back River, Sparrow's Pt. and Patapsco River facilities are all part of the same sewer system, so flows are diverted to different facilities at different times and impact the loadings between the Back River and the Patapsco River.