Lower Western Shore
Water Quality and Habitat Assessment
Overall Condition 2012-2014

The Lower Western Shore basin includes the Magothy, Severn, South, Rhode and West Rivers and area that drains directly to the mainstem Bay (Figure 1). This basin includes areas in Anne Arundel and Calvert counties in Maryland.

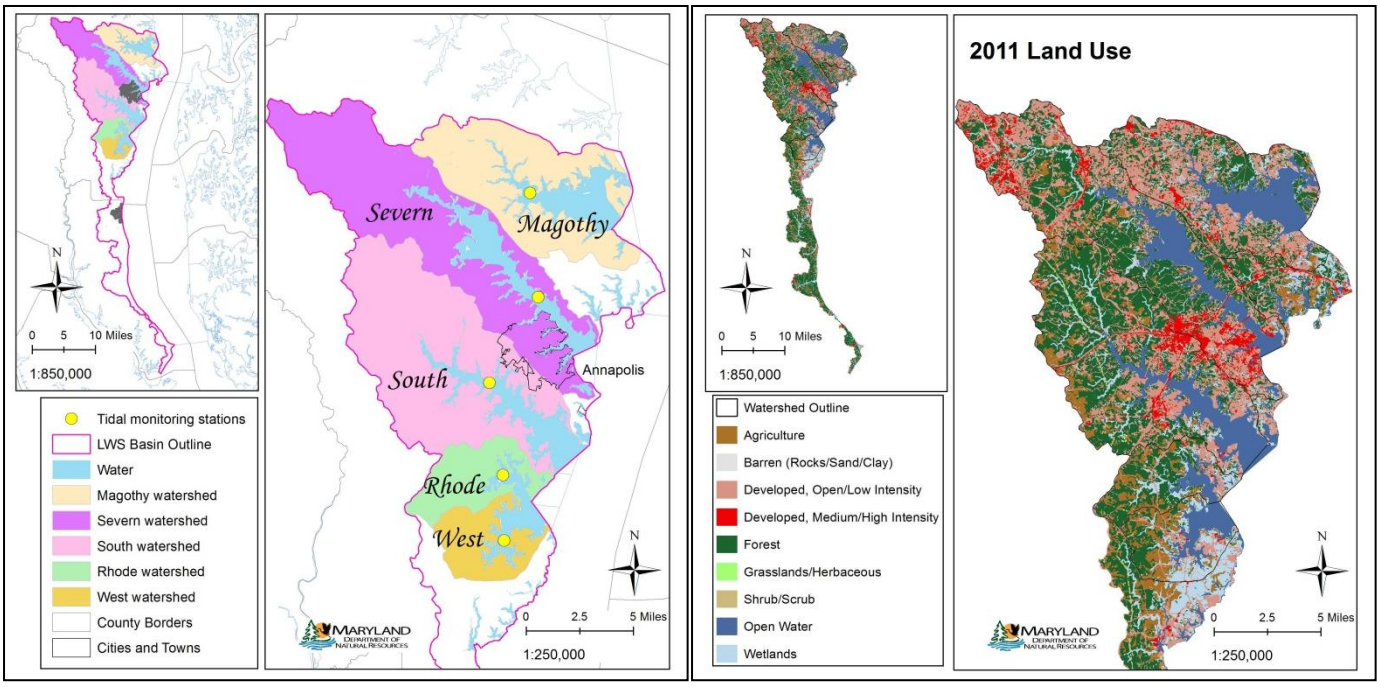

Figure 1 Lower Western Shore Basin.
Left-side panel shows the individual watersheds and locations of long-term non-tidal and tidal water quality monitoring stations. Smaller map shows entire basin .White areas of the basin drain to the mainstem Bay. Right-side panel shows the land use throughout the basin for 2011.[1]

In the Magothy River watershed, land use was estimated as 55% developed, 33% forested, and 1% agriculture (Figure 1).[1] Impervious surfaces covered 20% of the watershed.[2] Stormwater and septic are the most important sources of nitrogen loadings and stormwater is the largest source of phosphorus and sediment loadings.[3]

In the Severn River watershed, land use was estimated as 49% developed, 39% forested, and 4% agriculture. Impervious surfaces covered 19% of the watershed. Stormwater and wastewater are the largest sources of nitrogen and phosphorus loadings; stormwater is the largest source of sediment loadings.

In the South River watershed, land use was estimated as 33% developed, 47% forested, and 9% agriculture. Impervious surfaces covered 12% of the watershed. Stormwater and wastewater are the largest sources of nitrogen loadings; stormwater is the largest source of and phosphorus and sediment loadings.

In the Rhode River watershed, land use was estimated as 16% developed, 48% forested, and 5% agriculture. Impervious surfaces covered 5% of the watershed. Wastewater is the largest source of nitrogen; wastewater and stormwater are the largest sources of phosphorus; and stormwater and agriculture are the largest sources or sediment.

In the West River watershed, land use was estimated as 17% developed, 25% forested, and 28% agriculture. Impervious surfaces covered 6% of the watershed. Stormwater and agriculture are the largest source nitrogen, phosphorus and sediment.

How healthy are the Lower Western Shore Rivers?

Maryland Department of Natural Resources (MDDNR) measures water and habitat quality a long-term monitoring stations in the tidal areas of the major rivers (Figure 1). Current conditions are determined from the most recent three years of data; trends are determined from the 1999-2014 data.

Magothy River: Water quality in the Magothy River is good (Table 1). Habitat quality for underwater grasses is poor due to high algal densities and low water clarity. Very few underwater grass beds are found in the Magothy River.[4] Dissolved oxygen levels are very low in the summer so habitat quality for bottom dwelling animals is poor. Bottom dwelling animals are not healthy in all of the areas sampled during this period.

Severn River: Water quality in the Severn River is good and phosphorus levels have decreased. Habitat quality for underwater grasses is poor due to high algal densities and low water clarity. The Severn River has more underwater grasses than the other rivers in the basin; underwater grass beds covered about 40% of the area needed to meet the restoration goal during this period. Dissolved oxygen levels are very low in the summer so habitat quality for bottom dwelling animals is poor. Bottom-dwelling animal populations are not healthy in the areas randomly sampled during this period (but there were very few locations sampled during this period for the Severn River). Bottom dwelling animals were healthy at the single long-term station in the river.

South River: Water quality in the South River is good. Habitat quality for underwater grasses is poor. Very few underwater grass beds are found in the South River. Dissolved oxygen levels are very low in the summer so habitat quality for bottom dwelling animals is poor. Bottom dwelling animals are not healthy in the upper areas of the river sampled during this period, but were healthy in the main river near the mouth of the river.

Rhode River: Water quality in the Rhode River is good. Habitat quality for underwater grasses is poor due to high algal densities and low water clarity. Water clarity has also gotten worse. No underwater grass beds have been found in the Rhode River since 1978. Dissolved oxygen levels and habitat quality are fair to good for bottom dwelling animals.

West River: Water quality in the West River is good. Habitat quality for underwater grasses is poor due to high algal densities and low water clarity. No underwater grass beds have been found in the West River since 2004. Summer bottom dissolved oxygen levels are fair to good and bottom dwelling animals are healthy in most of the areas sampled during this period.

Table 1. 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.

	Water Quality			Habitat Quality		
River	**Nitrogen**	**Phosporus**	**Sediments**	**Algal Densities**	**Water Clarity**	**Summer Bottom DO**
Magothy	Meet	Meet	Meet	Fail	Fail	Fail
Severn	Meet	Decreasing Meet	Meet	Fail	Fail	Fail
South	Meet	Meet	Meet	Fail	Fail	Fail
Rhode	Meet	Meet	Meet	Fail	Decreasing Fail	Meet
West	Meet	Meet	Meet	Fail	Fail	Meet

How do the Lower Western Shore Rivers compare to other Maryland rivers?

The Magothy, Severn and South Rivers are in the 'Low Agriculture/High Developed' land use category. Nitrogen, phosphorus and sediment levels are similar in all three rivers and low compared with other high developed systems (Figure 2). Algal density is also similar in all three rivers and moderate compared to other rivers. Water clarity is better than in other high developed rivers, but summer bottom dissolved oxygen levels are low and summer bottom dissolved oxygen levels in the South River are among the worst of all Maryland rivers.

The Rhode River is in the 'Low Agriculture/Low Developed' land use category. Nitrogen levels are low compared to other high developed rivers and phosphorus, sediments and algal levels are moderate. Water clarity is lower than in the northern Lower Western Shore rivers, and summer bottom dissolved oxygen levels are much higher.

The West River is in the 'High Agriculture/High Developed' land use category. Nitrogen and phosphorus levels are low compared to other high developed rivers and sediments and algal levels are moderate. Water clarity is lower than in the northern Lower Western Shore rivers, and summer bottom dissolved oxygen levels are moderate.

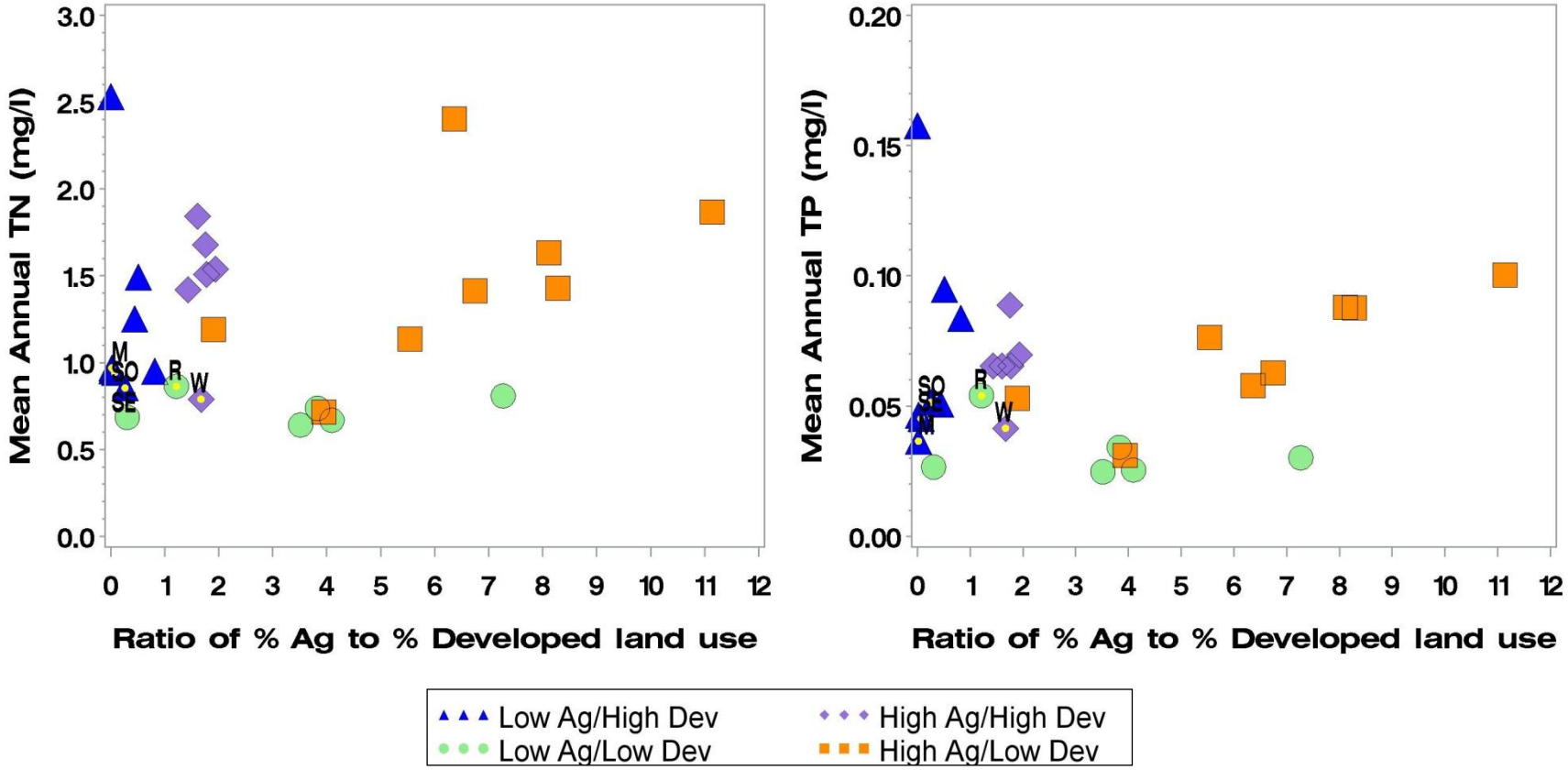

Figure 2. Water quality conditions versus land use.
Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as mean annual concentration (in mg/L) for total nitrogen (TN) and total phosphorus (TP). Rivers are color coded by their land use categories (see legend). Yellow dots highlight the data for the Magothy (M), Severn (SE), South (SO), Rhode (R) and West (W) rivers.

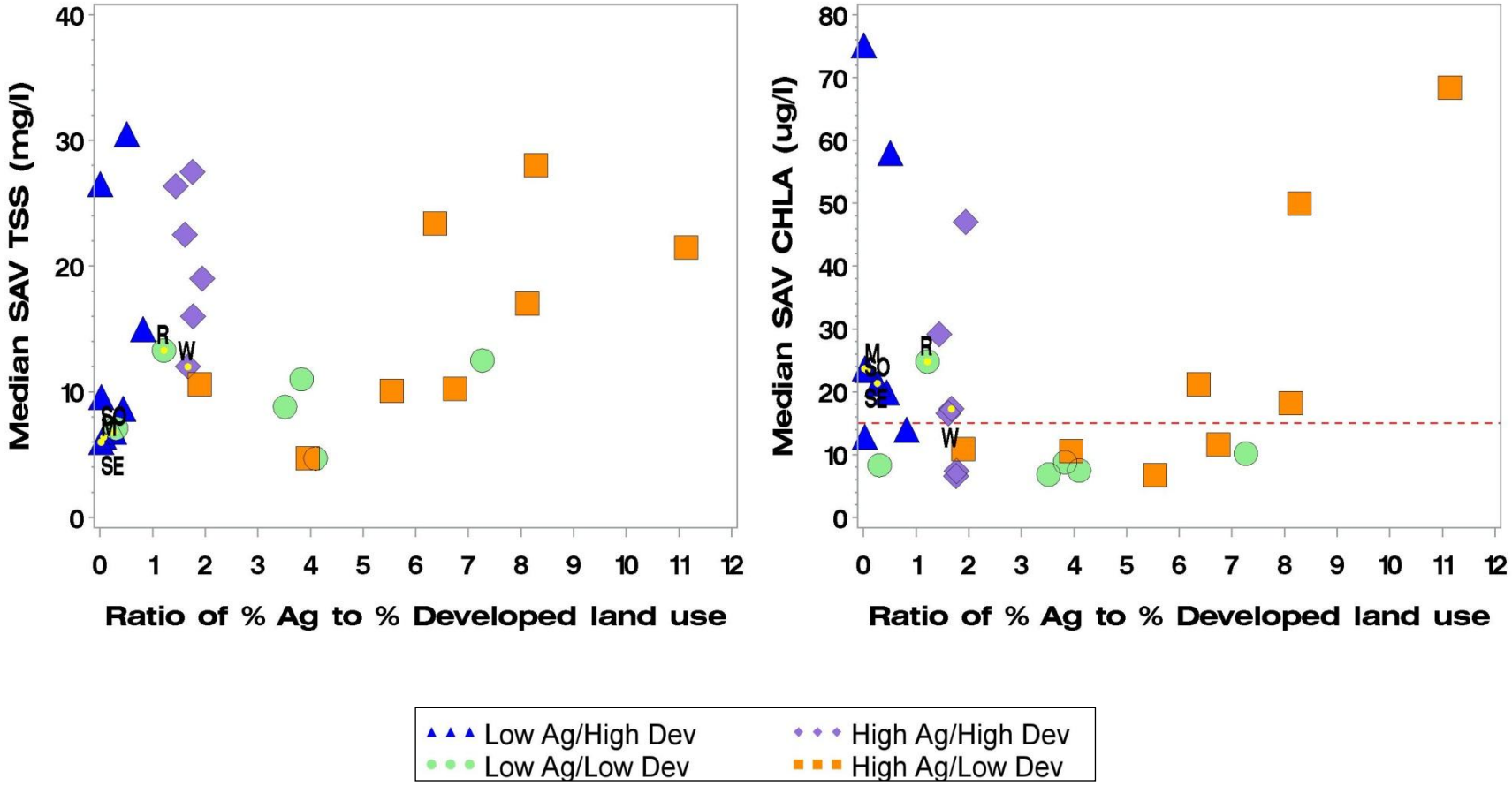

Figure 2 (cont.). Water quality conditions versus land use.
Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as submerged aquatic vegetation (SAV) growing season (April-October) median for total suspended solids (TSS, 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 Magothy (M), Severn (SE), South (SO), Rhode (R) and West (W) rivers.

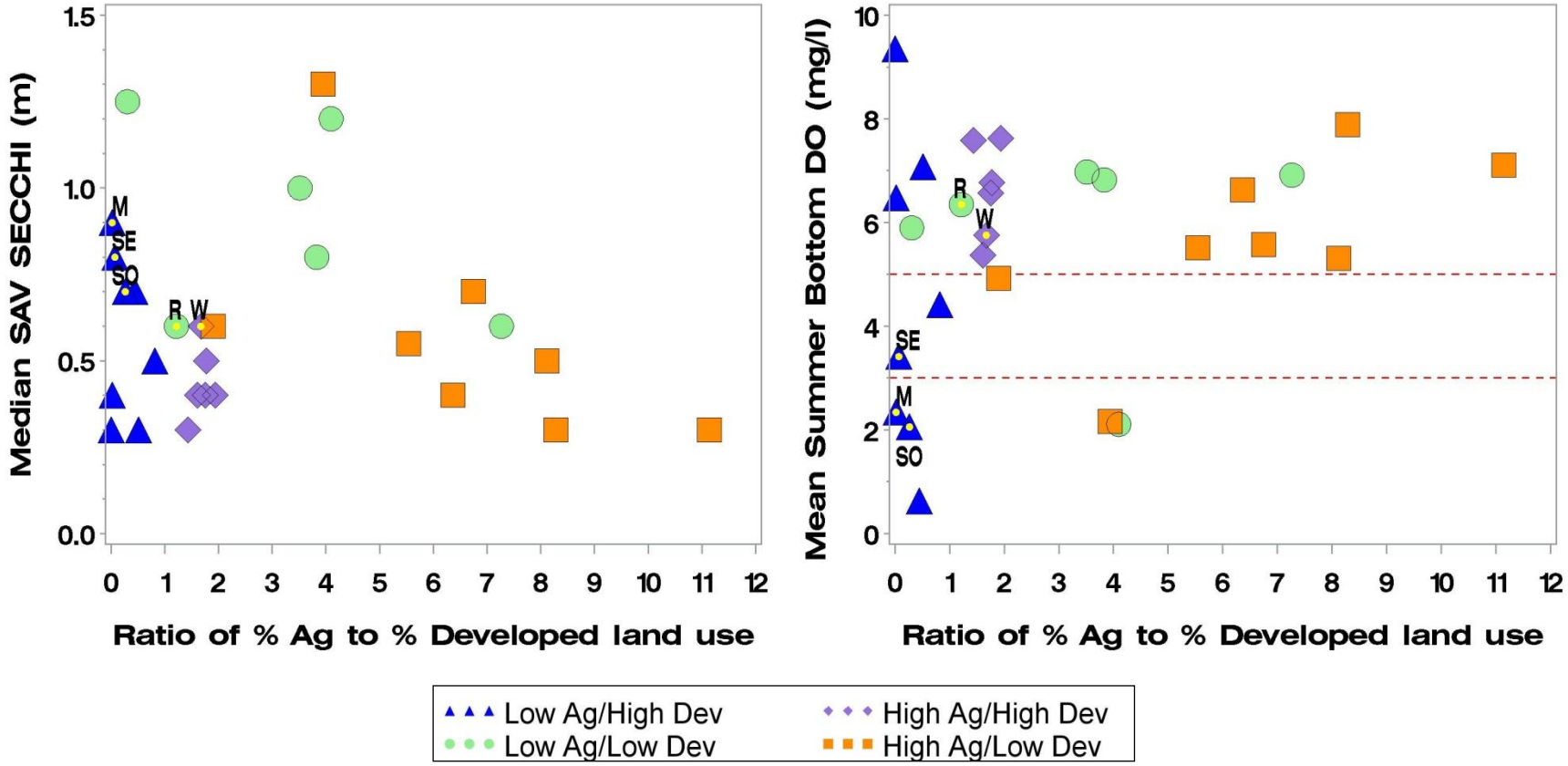

Figure 2 (cont.). Water quality conditions versus land use.
Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as submerged aquatic vegetation (SAV) growing season (April through October) median for Secchi depth (in m) and 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 Magothy (M), Severn (SE), South (SO), Rhode (R) and West (W) rivers.

What has been done to improve water and habitat quality in the Lower Western Shore Rivers?

Wastewater, Stormwater and Septic Loads

Upgrades to the six major wastewater treatment plants in this basin are under construction and will be completed by 2016. Only one of these facilities discharges to a tributary (the Mayo WWTP discharges to the Rhode River); the other five facilities discharge directly to the Mainstem Bay. Phosphorus loadings from the Mayo WWTP have been reduced by 41% but nitrogen loadings continue to increase; upgrades at this facility are scheduled to be completed by the end of 2016.[5]

Stormwater retrofits have reduced nitrogen loadings and prevented more than 10,200 pounds of nitrogen from entering the rivers since 2003, and almost 720 septic system retrofits were completed between 2008 and 2013.[6]

Agricultural Loads[6]

In 2014 there were cover crops planted on 1,552 acres in between growing seasons to absorb excess nutrients and prevent sediment erosion. Fencing on 776 acres of farmland was used to keep livestock out of streams and prevent streambank erosion. Stream buffers were also in place on 400 acres, allowing areas next to streams to remain in a natural state with grasses, trees and wetlands.

For more information

An integrative assessment of the water and habitat quality of the Lower Western Shore 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] 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#.

[5] 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, but for Mayo WWTP only available starting in 1990.

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

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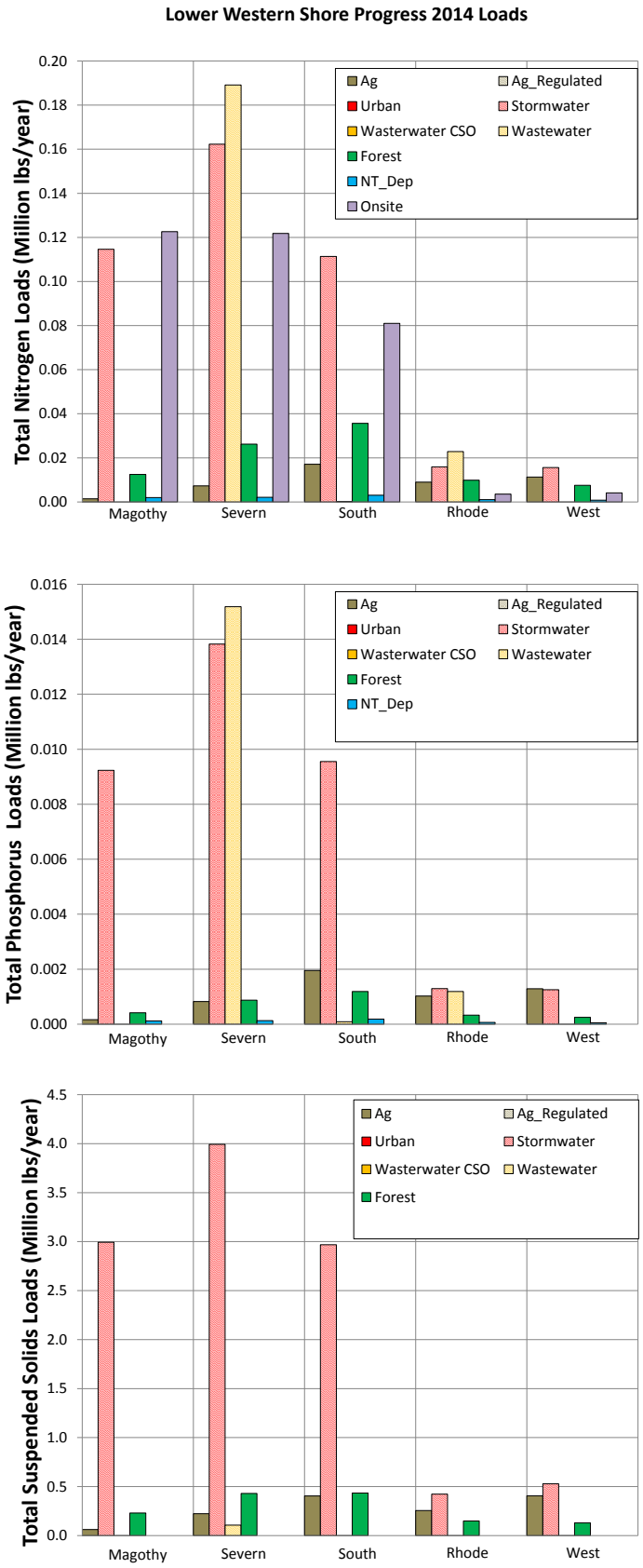

Figure 3. Nitrogen, phosphorus and sediment loads to Lower Western Shore rivers. Loads (in million lbs/year) are summarized by Chesapeake Bay Program model segment and by source category. Data for Progress 2014 model run downloaded on November 16, 2015 from http://baytas.chesapeakebay.net/. Source categories 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
Magothy	MAGMH	MD	Ag	0.001	0.6%	0.0002	1.6%	0.06	1.9%
			Ag_Reg		0.0%		0.0%		0.0%
			Urban		0.0%		0.0%		0.0%
			Stormwater	0.115	**45.3%**	0.0092	**93.0%**	2.99	**91.1%**
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.000	0.0%	0.0000	0.0%	0.00	0.0%
			Forest	0.012	4.9%	0.0004	4.2%	0.23	7.0%
			NT_Dep	0.002	0.8%	0.0001	1.2%		0.0%
			Onsite	0.123	**48.4%**		0.0%		0.0%
			Total Load	**0.253**		**0.0099**		**3.29**	
Severn	SEVMH	MD	Ag	0.007	1.4%	0.0008	2.7%	0.22	4.7%
			Ag_Reg		0.0%		0.0%		0.0%
			Urban		0.0%		0.0%		0.0%
			Stormwater	0.162	**31.9%**	0.0138	**44.8%**	3.99	**84.0%**
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.189	**37.2%**	0.0152	**49.3%**	0.11	2.2%
			Forest	0.026	5.2%	0.0009	2.8%	0.43	9.0%
			NT_Dep	0.002	0.4%	0.0001	0.4%		0.0%
			Onsite	0.122	**23.9%**		0.0%		0.0%
			Total Load	**0.509**		**0.0308**		**4.75**	
South	SOUMH	MD	Ag	0.017	6.9%	0.0020	15.1%	0.40	10.6%
			Ag_Reg		0.0%		0.0%		0.0%
			Urban		0.0%		0.0%		0.0%
			Stormwater	0.111	**44.9%**	0.0096	**73.7%**	2.97	**78.0%**
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.000	0.1%	0.0001	0.7%	0.00	0.0%
			Forest	0.036	14.4%	0.0012	9.1%	0.43	11.4%
			NT_Dep	0.003	1.2%	0.0002	1.4%		0.0%
			Onsite	0.081	**32.6%**		0.0%		0.0%
			Total Load	**0.248**		**0.0130**		**3.81**	
Rhode	RHDMH	MD	Ag	0.009	14.4%	0.0010	**26.2%**	0.26	**30.9%**
			Ag_Reg		0.0%		0.0%		0.0%
			Urban		0.0%		0.0%		0.0%
			Stormwater	0.016	**25.6%**	0.0013	**33.2%**	0.42	**51.0%**
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.023	**36.7%**	0.0012	**30.5%**	0.00	0.2%
			Forest	0.010	15.9%	0.0003	8.4%	0.15	17.9%
			NT_Dep	0.001	1.7%	0.0001	1.7%		0.0%
			Onsite	0.004	5.7%		0.0%		0.0%
			Total Load	**0.062**		**0.0039**		**0.83**	
West	WSTMH	MD	Ag	0.011	**28.8%**	0.0013	**45.4%**	0.41	**38.1%**
			Ag_Reg		0.0%		0.0%		0.0%
			Urban		0.0%		0.0%		0.0%
			Stormwater	0.016	**39.7%**	0.0013	**44.2%**	0.53	**49.6%**
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.000	0.0%	0.0000	0.0%	0.00	0.2%
			Forest	0.008	19.2%	0.0003	8.8%	0.13	12.1%
			NT_Dep	0.001	2.0%	0.0000	1.7%		0.0%
			Onsite	0.004	10.4%		0.0%		0.0%
			Total Load	**0.039**		**0.0028**		**1.06**	

Rhode River

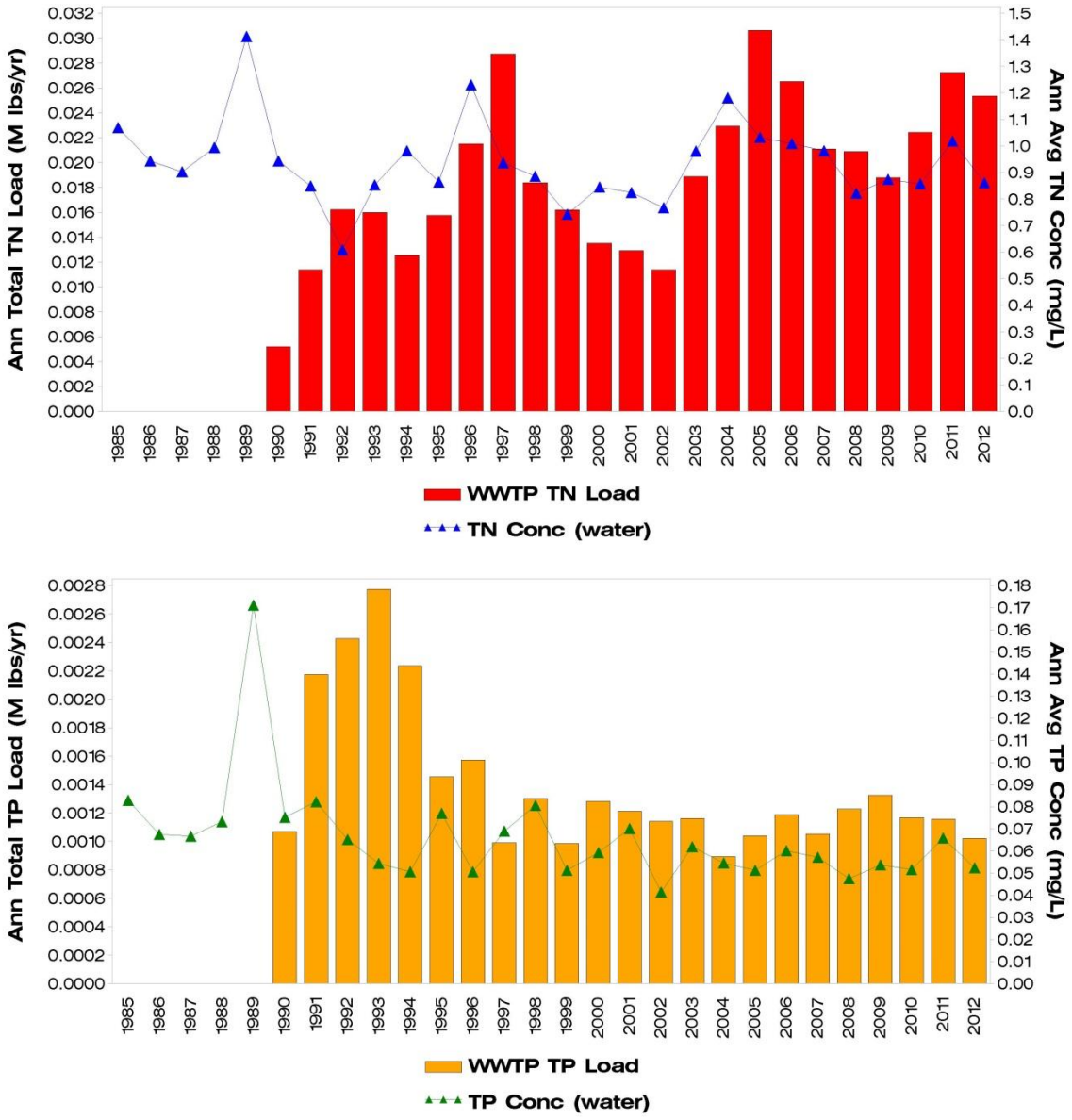

Figure 4. Rhode River Wastewater Treatment Plant load versus water quality. Total loads from the single major wastewater treatment plant (in million pounds per year, M lbs/yr) that discharges into the Rhode River (Mayo WWTP) compared to annual mean nutrient concentrations (in mg/L) at the long-term monitoring site. Total nitrogen loads (red bars) compared to total nitrogen concentrations (blue triangles) are shown in the top graphs; total phosphorus (orange bars) compared to total phosphorus concentrations (green triangles) are shown in the bottom graphs. Full calendar year loadings are available starting in 1990. Full calendar year loadings data is only available through 2012, and was downloaded from the Chesapeake Bay Program Nutrient Point Source Database website (http://www.chesapeakebay.net/data/downloads/bay_program_nutrient_point_source_database) on 10/14/2015. The remaining major wastewater treatment plants in the Lower Western Shore basin discharge to the Mainstem Bay.