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

The Lower Eastern Shore basin includes five major rivers and three embayments. This basin includes areas in Dorchester, Wicomico, Somerset and Worcester counties in Maryland, Kent and Sussex counties in Delaware, and Accomack County in Virginia (Figure 1). Land use is predominantly wetlands and agriculture (Table 1). Impervious surfaces covered approximately 6% of the Wicomico River watershed, 2% of the Nanticoke River watershed and less than 1% of the other watersheds in the basin (Table 1). Agriculture is the most important source of nitrogen, phosphorus and sediment loadings in the basin (Table 1).

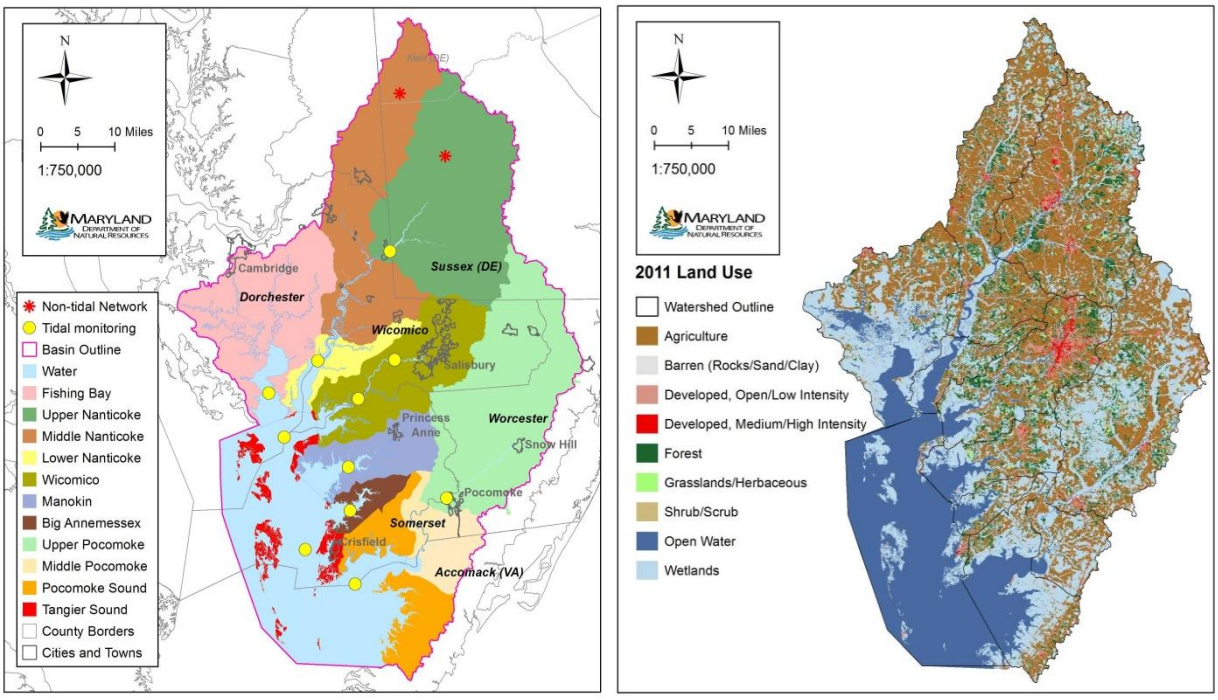

Figure 1. Lower Eastern Shore basin.
Left-side panel shows the individual watersheds and MD DNR sampling stations (tidal) and the Non-tidal Network stations in the basin where trends were determined for 2014. Right-side panel shows the land use throughout the basin for 2011.[1]

How healthy are the Lower Eastern Shore Rivers?

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

Table 1. Land Use and Loadings sources to the Lower Eastern Shore Basin.
Land Use columns include: dominant land use[1], percent of the watershed in each State, and percent impervious surfaces (MD only)[2] within each watershed. Dominant Loadings Sources[3] columns include TN (Total Nitrogen), TP (Total Phosphorus) and Sed (Sediment) loadings sources that are 20% or more of the total loadings to that river from each State. All values are in percent (%). Abbreviations include: Ag (Agriculture), Dev (Developed), Wetl (Wetlands), For (Forest); Storm (Stormwater), NT_D (NT_dep) and Urb (Urban).

Watershed	Land Use					Dominant Loading Sources (%) By State								
	Dominant land use	% of Watershed by State			% Impevious (MD only)	MD			DE			VA		
		MD	DE	VA		TN load	TP load	Sed. load	TN load	TP load	Sed. load	TN load	TP load	Sed. load
Fishing Bay	Wetl (56) Ag (24)	100			0.9	Ag (46) For (23) NT_D (23)	Ag (59) NT_D (21)	Ag (63) For (24)						
Upper Nanticoke	Ag (50) Wetl (22)	6	94		2.5	Ag (71)	Ag (78)	Ag (71)	Ag (69)	Ag (71)	Ag (57) Urb (33)			
Middle Nanticoke	Ag (49) Wetl (27)	67	33		2.5	Ag (72)	Ag (78)	Ag (79)	Ag (72)	Ag (78)	Ag (69)			
Lower Nanticoke	Wetl (45) Ag (24)	100			1.8	Ag (52) For (25)	Ag (65)	Ag (42) Urb (23) For (32)						
Wicomico	Ag (28) Wetl (27) Forest (19) Dev (17)	99	1		6.3	Ag (43)	Ag (56)	Ag (26) Urb (31) Storm (32)	Ag (60)	Ag (66)	Ag (31) Ag (25) Ag (39)			
Manokin	Wetl (47) Ag (24)	100			0.0	Ag (70)	Ag (80)	Ag (35) Urb (30) For (25)						
Big Annemessex	Wetl (54) Ag (23)	100			0.0	Ag (70)	Ag (80)	Ag (36) Urb (32) For (26)						
Upper Pocomoke	Wetl(46) Ag (33)	92	8		0.7	Ag (68)	Ag (79)	Ag (57) For (22)	Ag (75)	Ag (76)	Ag (57) Urb (29)			
Middle Pocomoke	Wetl(52) Ag (36)	52		48	0.0	Ag (80)	Ag (85)	Ag (56) Urb (26)				Ag (69)	Ag (83)	Ag (65)
Pocomoke Sound	Wetl(61) Ag (22)	42		58	0.0	Ag (71)	Ag (82)	Ag (45) Urb (22) For (32)				Ag (53)	Ag (74)	Ag (48) Urb (26) For (23)
Tangier Sound	Wetl (72)	93		7	0.0	Urb (19) For (26) NT_D (29)	Ag (24) Urb (20) NT_D (30)	Urb (66) For (28)				For (25) NT_D (64)	NT_D (64)	Urb (66) For (27)

Maryland DNR also participates in the Non-tidal Network, a partnership with the United States Geologic Survey (USGS), the Chesapeake Bay Program, and the other states in the basin, to measure non-tidal water quality using the same sampling and analysis methods. Two Non-tidal Network stations are located in the Nanticoke watershed by the State of Delaware (Figure 1). 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]

Table 2. Summary of non-tidal water quality trends.
Trends for nitrogen (N), phosphorus (P) and sediment (Sed). Trends at Non-tidal Network stations (columns labeled 'USGS') are determined by USGS for 2005-2014; analysis includes use of flow data.[4] Non-tidal Network stations include the corresponding USGS gage number; both stations are monitored by the State of Delaware. 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.

				USGS 2005-2014		
Watershed	**USGS Gage #**	**MD DNR Station**	**River/Creek**	**N**	**P**	**Sed**
Nanticoke	01487000		Nanticoke	Dec	Dec	
	01488500		Marshyhope Creek			

Fishing Bay: Water quality in Fishing Bay is good and phosphorus levels decreased (Table 3). Habitat quality for underwater grasses is fair but water clarity is poor. Underwater grass beds covered 99% of the restoration goal area during this period.[5] Summer bottom dissolved oxygen levels are good and improved, but bottom dwelling animals are unhealthy in some areas of Fishing Bay.

Nanticoke River: Non-tidal areas: Nitrogen and phosphorus levels in the non-tidal Nanticoke are decreasing when the effects of river flow are taken into account (Table 2). There are no trends at the station on Marshyhope Creek.

Tidal areas: Water quality in the tidal upper and lower Nanticoke River is poor due to high nitrogen and sediment levels. Phosphorus levels improved in the upper river. Habitat quality for underwater grasses is poor in the upper river and fair in the lower river. Algal densities in the upper river are too high and increased. Water clarity is poor in both the upper and lower river. No underwater grasses have been found in the Nanticoke. Summer bottom dissolved oxygen levels are good and increased in the upper river, but bottom dwelling animals are unhealthy in many areas of the river. Bottom dwelling organisms in the middle river were healthy in mid-1980s but are unhealthy in the recent period.

Wicomico River: Water quality is poor in the middle Wicomico River due to high nitrogen and sediment levels. Water quality in the lower Wicomico River is fair due to high sediment levels. Nitrogen levels improved in the lower river. Habitat quality for underwater grasses is poor in the middle river due to high algal densities and poor water clarity. Habitat quality for underwater grasses in the lower river is fair but water clarity is poor. No underwater grass beds are found in the Wicomico River. Summer bottom dissolved oxygen levels are good in the lower river, but bottom dwelling animals are unhealthy in some areas of the river sampled during this period.

Manokin River: Water quality in the Manokin River is good. Nitrogen, phosphorus and sediment levels have improved. Habitat quality for underwater grasses is fair because water clarity is low, but water clarity improved. Bottom dissolved oxygen levels are good and also improved. Underwater grass beds covered 26% of the restoration goal area during this period. Bottom dwelling animals are healthy in the central portion of the lower river but are very unhealthy in areas closer to shore and in the upper river.

Table 3. 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	**River portion**	**Nitrogen**	**Phosporus**	**Sediments**	**Algal Densities**	**Water Clarity**	**Summer Bottom DO**
Fishing Bay		Meet	Decreasing Meet	Meet	Meet	Fail	Increasing Meet
Nanticoke	Upper	Fail	Decreasing Meet	Fail	Increasing Fail	Fail	Increasing Meet
	Lower	Fail	Meet	Fail	Meet	Fail	Meet
Wicomico	Middle	Fail	Meet	Fail	Fail	Fail	too shallow
	Lower	Decreasing Meet	Meet	Fail	Meet	Fail	Meet
Manokin		Decreasing Meet	Decreasing Meet	Decreasing Meet	Meet	Increasing Fail	Increasing Meet
Big Annemessex		Meet	Decreasing Meet	Meet	Meet	Meet	Increasing Meet
Pocomoke		Decreasing Fail	Fail	Meet	Meet	Fail	Fail
Pocomoke Sound		Meet	Meet	Meet	Meet	Fail	Meet
Tangier Sound	North	Fail	Meet	Meet	Meet	Meet	Meet
	South	Fail	Meet	Meet	Meet	Meet	Meet

Big Annemessex River: Water quality in the Big Annemessex River is good and phosphorus levels improved. Habitat quality for underwater grasses is good. Underwater grass beds covered 47% of the restoration goal area during this period. Summer bottom dissolved oxygen levels are good and improved. Bottom dwelling animals are unhealthy in some areas of the river.

Pocomoke River: Water quality in the Pocomoke River is poor due to high nitrogen and phosphorus levels. Nitrogen levels have improved. Habitat quality for underwater grasses is fair because water clarity is poor. Underwater grass beds are almost never found in the river. Summer bottom dissolved oxygen levels are poor.

Pocomoke Sound: Water and habitat quality in Pocomoke Sound is good. Habitat quality for underwater grasses is fair because water clarity is poor. Underwater grasses covered 25% of the restoration goal area in the Maryland portion of Pocomoke Sound during this period. Summer bottom dissolved oxygen levels are good.

Tangier Sound: Water and habitat quality is fair in both North Tangier Sound and South Tangier Sound. Nitrogen levels are too high in both areas. Habitat quality for underwater grasses is good in both North and South Tangier Sound. Underwater grasses covered 42% of the restoration goal area in the Maryland portion of Tangier Sound during this period. Summer bottom dissolved oxygen levels are good and bottom dwelling animals are healthy in most of the areas of Tangier Sound sampled during this period.

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

Fishing Bay is in the 'Low Agriculture/Low Developed' land use category. Total nitrogen, total phosphorus and sediment levels are low compared to other Maryland rivers. Algal densities are also low compared to other rivers. Water clarity and summer bottom dissolved oxygen are moderate.

Nanticoke River is a 'High Agriculture/Low Developed' river. Nitrogen levels are among the highest of all of Maryland's rivers. Phosphorus and sediment levels are high in comparison to the other rivers in Maryland. Algal densities are moderate, and water clarity is low. Summer bottom dissolved oxygen levels are high.

Wicomico River is the only 'High Agriculture/High Developed' river in the Lower Eastern Shore Basin. Nitrogen and sediment levels are high compared to other Maryland rivers. Phosphorus levels and algal densities are moderate within this land use category. Water clarity is low. Summer bottom dissolved oxygen levels are moderate.

Manokin River is in the 'Low Agriculture/Low Developed' land use category. Nitrogen and phosphorus levels and algal densities are low compared to all Maryland rivers. Sediment levels are moderate. Water clarity is moderate compared to similar rivers, and summer dissolved oxygen is high.

Big Annemessex is a 'Low Agriculture/Low Developed' river. Nitrogen, phosphorus and sediment levels and algal densities are low compared to other Maryland rivers and water clarity and summer bottom dissolved oxygen levels are high.

Pocomoke River/Sound is in the 'High Agriculture/Low Developed' category. Nitrogen levels are moderate but phosphorus levels are high compared to similar rivers. Sediment levels are low. Algal densities are low and water clarity is moderate. Summer bottom dissolved oxygen levels are moderate.

Tangier Sound is in the 'Low Agriculture/Low Developed' category. Nitrogen, phosphorus and sediment levels are low. Algal densities are low and water clarity is among the highest of all of Maryland's rivers and bays. Summer bottom dissolved oxygen levels are moderate.

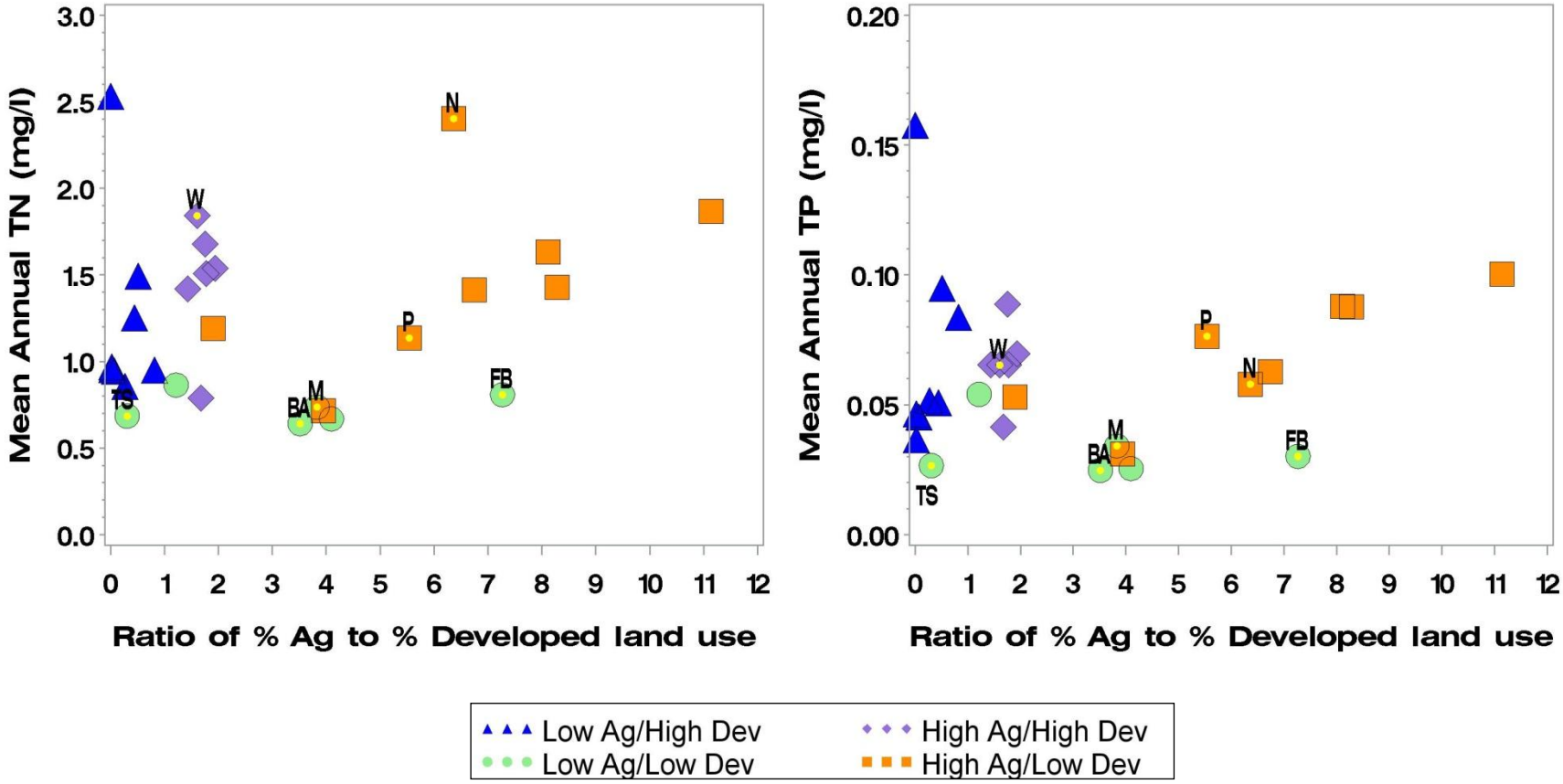

Figure 2. Water quality conditions versus land use.
Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as mean annual concentration (in mg/L) for total nitrogen (TN) and total phosphorus (TP). Rivers are color coded by their land use categories (see legend). Yellow dots highlight the data for the Fishing Bay (FB), Nanticoke (N), Wicomico (W), Manokin (M), Big Annemessex (BA) rivers, Pocomoke River/Sound (P) and Tangier Sound (TS).

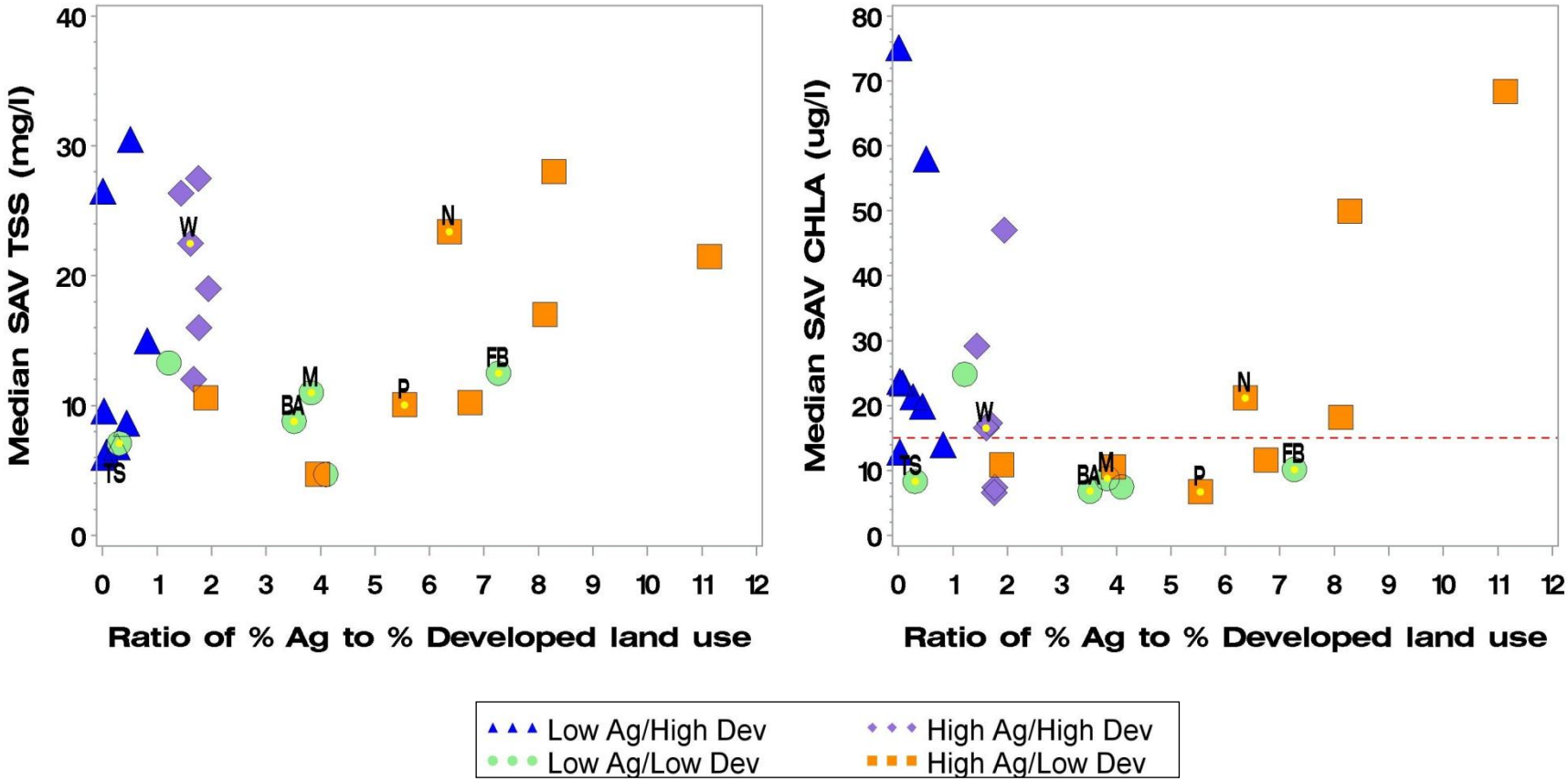

Figure 2 (cont.). Water quality conditions versus land use.
Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as submerged aquatic vegetation (SAV) growing season (April-October) median for total suspended solids (TSS, 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 Fishing Bay (FB), Nanticoke (N), Wicomico (W), Manokin (M), Big Annemessex (BA) rivers, Pocomoke River/Sound (P) and Tangier Sound (TS).

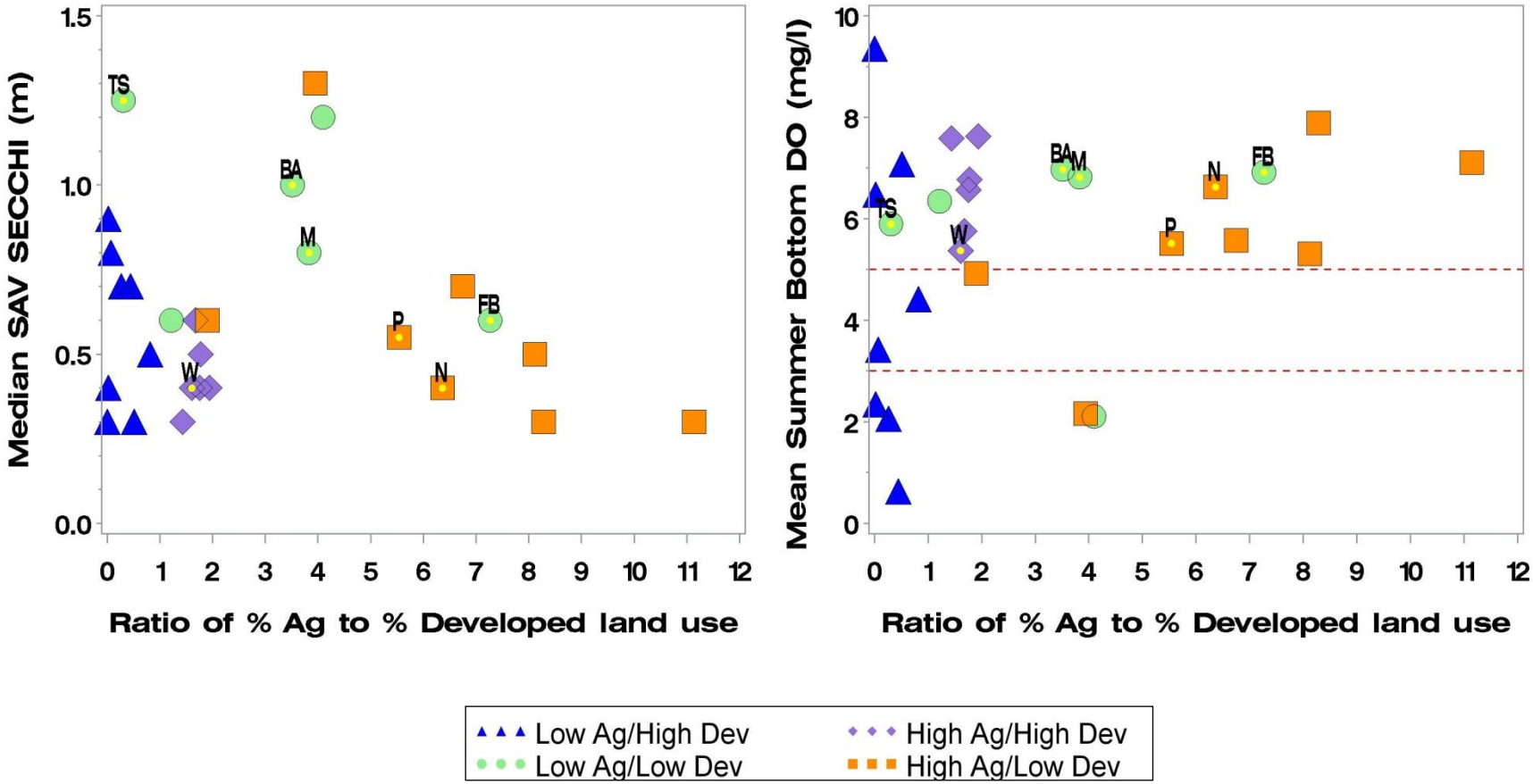

Figure 2 (cont.). Water quality conditions versus land use.
Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as submerged aquatic vegetation (SAV) growing season (April through October) median for Secchi depth (in m) and 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 Fishing Bay (FB), Nanticoke (N), Wicomico (W), Manokin (M), Big Annemessex (BA) rivers, Pocomoke River/Sound (P) and Tangier Sound (TS).

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

Wastewater, Stormwater and Septic Loads

Upgrades to six of the eight largest wastewater treatment plants in the basin were completed between 2006 and 2014. Wastewater treatment plant nitrogen loadings have been reduced to Nanticoke River (two facilities, total 75%), Manokin River (72%), Pocomoke River/Sound (two facilities, total of 5%) and Tangier Sound (64%) since 1985.[5] Also, since 1985, wastewater treatment phosphorus loadings have been reduced to Nanticoke River (94%), Manokin River (99%), Pocomoke River/Sound (71%) and Tangier Sound (93%).

Nitrogen loads from the three wastewater treatment plants that discharge to the Wicomico River increased 23% since 1985. Wastewater treatment plant phosphorus loads to the Wicomico River decreased 78% for that period. Upgrades to one of the facilities were completed in 2012. Upgrades at the other two facilities are scheduled for completion in 2016 and 2018.

Almost 1,100 septic system retrofits were completed from 2008 to 2013, and stormwater retrofits have reduced nitrogen loadings and prevented 1,080 pounds of nitrogen from entering the rivers since 2003.[6]

Agricultural Loads[6]

In 2014 there were 87,013 acres of cover crops planted in between growing seasons to absorb excess nutrients and prevent sediment erosion. Fencing on 464 acres of farmland was used to keep livestock out of streams and prevent streambank erosion. A total of 1,050 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 also in place on 32,287 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 Eastern 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] 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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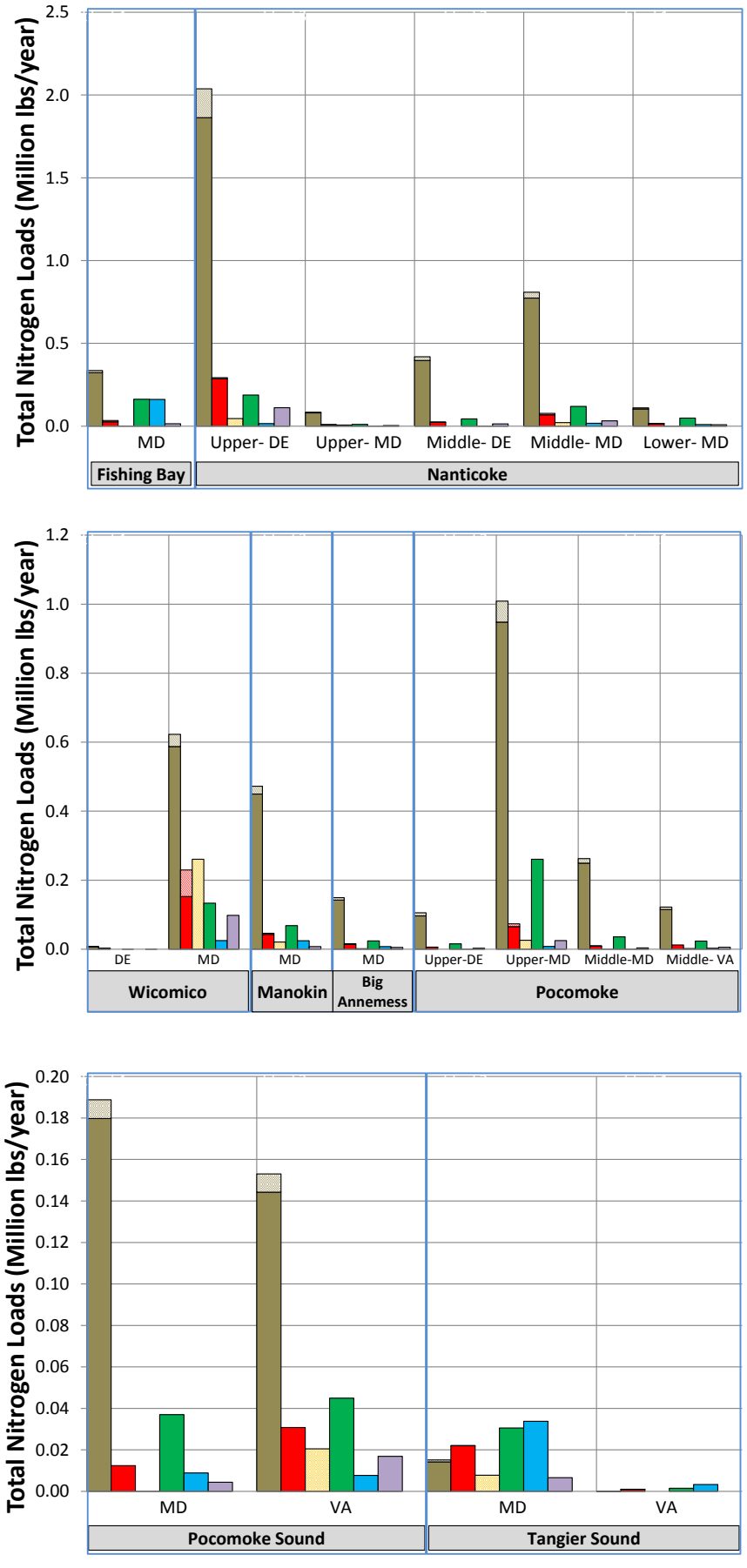
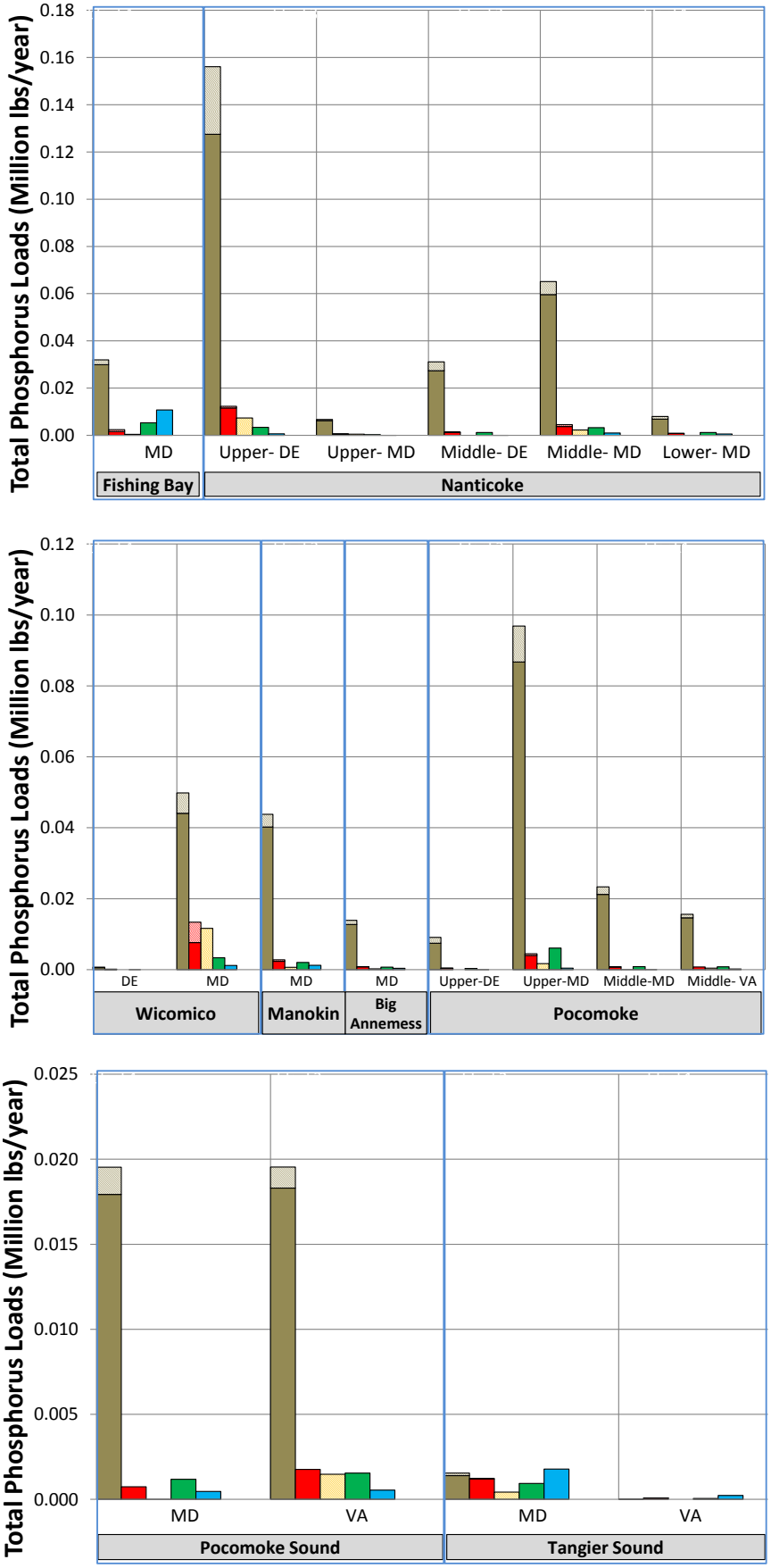


Figure 3. Nitrogen Loads to the Lower Eastern Shore rivers. Loads (in million lbs/year) are summarized by Chesapeake Bay Program model segment and by source category. Data for Progress 2014 model run downloaded on November 16, 2015 from http://baytas.chesapeakebay.net/. Source categories from BayTas 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.
Note that y-axis scale differs between graphs.



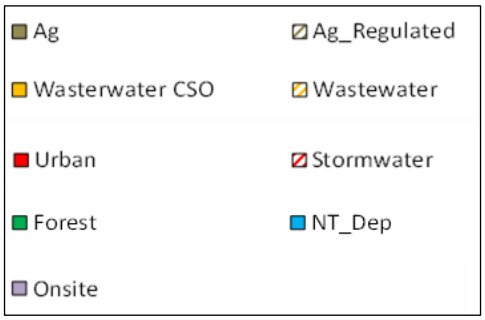


Figure 4. Phosphorus Loads to the Lower Eastern Shore rivers. Loads (in million lbs/year) are summarized by Chesapeake Bay Program model segment and by source category. Data for Progress 2014 model run downloaded on November 16, 2015 from http://baytas.chesapeakebay.net/. Source categories from BayTas 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.
Note that y-axis scale differs between graphs.

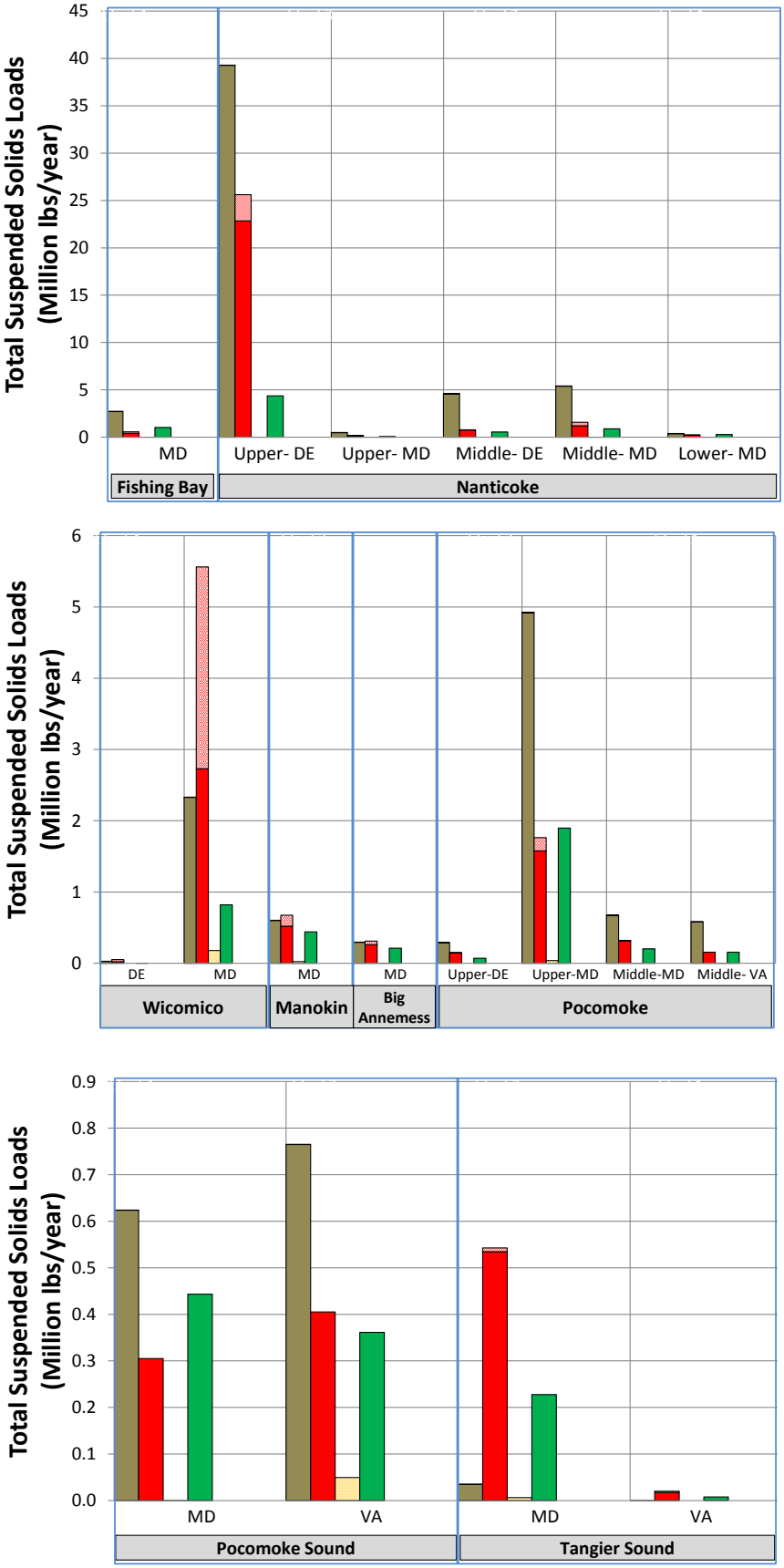


Figure 5. Sediment Loads to the Lower Eastern Shore rivers. Loads (in million lbs/year) are summarized by Chesapeake Bay Program model segment and by source category. Data for Progress 2014 model run downloaded on November 16, 2015 from http://baytas.chesapeakebay.net/. Source categories from BayTas 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.

Note that y-axis scale differs between graphs.

Table 4. Nitrogen, phosphorus and sediment loads to Lower Eastern 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.

River	Segment	State	Source	TN Load (delivered)	% TN load	TP Load (delivered)	% TP load	Sed. Load (delivered)	% Sed. Load
Fishing Bay	FSBMH	MD	Ag	0.323	45.6%	0.0299	58.9%	2.70	63.0%
			Ag_Reg	0.012	1.8%	0.0020	4.0%	0.00	0.0%
			Urban	0.026	3.7%	0.0016	3.2%	0.40	9.4%
			Stormwater	0.008	1.1%	0.0008	1.6%	0.15	3.6%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.001	0.1%	0.0004	0.8%	0.00	0.1%
			Forest	0.162	22.9%	0.0053	10.4%	1.02	23.9%
			NT_Dep	0.161	22.7%	0.0107	21.1%		0.0%
			Onsite	0.014	2.0%		0.0%		0.0%
			Total Load	**0.709**		**0.0507**		**4.28**	
Upper Nanticoke	NANTF	DE	Ag	1.863	69.2%	0.1275	71.0%	39.27	56.7%
			Ag_Reg	0.174	6.5%	0.0286	15.9%	0.01	0.0%
			Urban	0.286	10.6%	0.0116	6.4%	22.84	33.0%
			Stormwater	0.007	0.2%	0.0007	0.4%	2.78	4.0%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.046	1.7%	0.0073	4.1%	0.01	0.0%
			Forest	0.188	7.0%	0.0034	1.9%	4.36	6.3%
			NT_Dep	0.016	0.6%	0.0006	0.3%		0.0%
			Onsite	0.112	4.1%		0.0%		0.0%
			Total Load	**2.692**		**0.1796**		**69.27**	
Upper Nanticoke	NANTF	MD	Ag	0.080	71.2%	0.0062	77.5%	0.46	71.0%
			Ag_Reg	0.003	3.0%	0.0005	6.7%	0.00	0.0%
			Urban	0.008	7.1%	0.0004	5.5%	0.13	19.4%
			Stormwater	0.000	0.0%	0.0000	0.0%	0.00	0.1%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.007	6.0%	0.0005	6.3%	0.00	0.5%
			Forest	0.010	9.0%	0.0003	3.6%	0.06	9.1%
			NT_Dep	0.000	0.3%	0.0000	0.3%		0.0%
			Onsite	0.004	3.4%		0.0%		0.0%
			Total Load	**0.113**		**0.0080**		**0.65**	
Middle Nanticoke	NANOH	DE	Ag	0.397	79.3%	0.0273	81.4%	4.57	77.8%
			Ag_Reg	0.022	4.5%	0.0038	11.2%	0.00	0.0%
			Urban	0.023	4.7%	0.0013	3.7%	0.75	12.8%
			Stormwater	0.000	0.0%	0.0000	0.0%	0.02	0.3%
			CSO		0.0%		0.0%		0.0%
			Wastewater		0.0%		0.0%		0.0%
			Forest	0.044	8.8%	0.0012	3.6%	0.53	9.1%
			NT_Dep	0.000	0.1%	0.0000	0.0%		0.0%
			Onsite	0.014	2.8%		0.0%		0.0%
			Total Load	**0.500**		**0.0336**		**5.87**	
Middle Nanticoke	NANOH	MD	Ag	0.774	71.9%	0.0596	78.4%	5.39	68.5%
			Ag_Reg	0.034	3.2%	0.0055	7.2%	0.00	0.0%
			Urban	0.068	6.3%	0.0037	4.9%	1.20	15.3%
			Stormwater	0.009	0.9%	0.0008	1.0%	0.36	4.6%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.021	2.0%	0.0022	2.9%	0.03	0.4%
			Forest	0.120	11.1%	0.0032	4.2%	0.88	11.2%
			NT_Dep	0.018	1.6%	0.0010	1.3%		0.0%
			Onsite	0.032	3.0%		0.0%		0.0%
			Total Load	**1.077**		**0.0760**		**7.87**	

River	Segment	State	Source	TN Load (delivered)	% TN load	TP Load (delivered)	% TP load	Sed. Load (delivered)	% Sed. Load
Lower Nanticoke	NANMH	MD	Ag	0.104	**53.4%**	0.0068	**65.2%**	0.36	**42.2%**
			Ag_Reg	0.007	3.6%	0.0011	10.8%	0.00	0.0%
			Urban	0.015	7.8%	0.0008	7.2%	0.20	**23.1%**
			Stormwater	0.000	0.2%	0.0000	0.4%	0.02	2.1%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.001	0.8%	0.0000	0.0%	0.00	0.1%
			Forest	0.048	**25.0%**	0.0012	11.2%	0.28	**32.5%**
			NT_Dep	0.010	5.1%	0.0005	5.2%		0.0%
			Onsite	0.008	4.3%		0.0%		0.0%
			Total Load	**0.194**		**0.0105**		**0.86**	
Wicomico	WICMH	DE	Ag	0.007	**60.3%**	0.0005	**65.6%**	0.03	**31.4%**
			Ag_Reg	0.001	6.8%	0.0001	17.8%	0.00	0.0%
			Urban	0.001	10.4%	0.0000	6.0%	0.02	**24.6%**
			Stormwater	0.001	12.2%	0.0001	9.0%	0.03	**39.3%**
			CSO		0.0%		0.0%		0.0%
			Wastewater		0.0%		0.0%		0.0%
			Forest	0.001	5.6%	0.0000	1.6%	0.00	4.7%
			NT_Dep		0.0%		0.0%		0.0%
			Onsite	0.001	4.8%		0.0%		0.0%
			Total Load	**0.012**		**0.0008**		**0.08**	
Wicomico	WICMH	MD	Ag	0.587	**42.9%**	0.0441	**55.6%**	2.33	**26.2%**
			Ag_Reg	0.035	2.6%	0.0057	7.3%	0.00	0.0%
			Urban	0.153	11.2%	0.0076	9.6%	2.73	**30.7%**
			Stormwater	0.077	5.6%	0.0057	7.2%	2.83	**31.9%**
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.260	19.0%	0.0116	14.7%	0.18	2.0%
			Forest	0.133	9.7%	0.0033	4.2%	0.82	9.2%
			NT_Dep	0.025	1.8%	0.0011	1.4%		0.0%
			Onsite	0.098	7.2%		0.0%		0.0%
			Total Load	**1.368**		**0.0793**		**8.89**	
Manokin	MANMH	MD	Ag	0.449	**70.4%**	0.0402	**79.6%**	0.60	**34.6%**
			Ag_Reg	0.023	3.5%	0.0036	7.1%	0.00	0.0%
			Urban	0.043	6.7%	0.0024	4.7%	0.52	**30.0%**
			Stormwater	0.003	0.5%	0.0004	0.8%	0.15	8.8%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.020	3.2%	0.0007	1.3%	0.02	1.3%
			Forest	0.068	10.7%	0.0020	4.0%	0.44	**25.3%**
			NT_Dep	0.024	3.8%	0.0012	2.4%		0.0%
			Onsite	0.007	1.2%		0.0%		0.0%
			Total Load	**0.639**		**0.0505**		**1.73**	
Big Annemessex	BIGMH	MD	Ag	0.142	**70.4%**	0.0127	**79.7%**	0.29	**36.0%**
			Ag_Reg	0.007	3.5%	0.0011	7.1%	0.00	0.0%
			Urban	0.015	7.3%	0.0008	4.8%	0.26	**31.9%**
			Stormwater	0.000	0.2%	0.0001	0.4%	0.05	6.2%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.001	0.6%	0.0002	1.3%	0.00	0.1%
			Forest	0.024	11.8%	0.0007	4.4%	0.21	**25.9%**
			NT_Dep	0.007	3.6%	0.0004	2.3%		0.0%
			Onsite	0.005	2.5%		0.0%		0.0%
			Total Load	**0.202**		**0.0160**		**0.81**	

River	Segment	State	Source	TN Load (delivered)	% TN load	TP Load (delivered)	% TP load	Sed. Load (delivered)	% Sed. Load
Upper Pocomoke	POCTF	DE	Ag	0.097	**74.8%**	0.0074	**76.3%**	0.29	**56.9%**
			Ag_Reg	0.009	6.9%	0.0017	17.1%	0.00	0.0%
			Urban	0.006	4.4%	0.0003	3.5%	0.15	**28.8%**
			Stormwater	0.000	0.0%	0.0000	0.0%	0.00	0.5%
			CSO		0.0%		0.0%		0.0%
			Wastewater		0.0%		0.0%		0.0%
			Forest	0.015	11.8%	0.0003	3.1%	0.07	13.8%
			NT_Dep	0.000	0.0%	0.0000	0.0%		0.0%
			Onsite	0.003	2.0%		0.0%		0.0%
			Total Load	**0.129**		**0.0097**		**0.50**	
Upper Pocomoke	POCTF	MD	Ag	0.948	**67.7%**	0.0867	**79.3%**	4.92	**57.0%**
			Ag_Reg	0.061	4.3%	0.0101	9.2%	0.01	0.1%
			Urban	0.065	4.7%	0.0040	3.7%	1.58	18.3%
			Stormwater	0.008	0.6%	0.0004	0.4%	0.19	2.2%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.026	1.8%	0.0017	1.5%	0.04	0.4%
			Forest	0.261	18.6%	0.0061	5.5%	1.90	**22.0%**
			NT_Dep	0.008	0.5%	0.0004	0.4%		0.0%
			Onsite	0.025	1.8%		0.0%		0.0%
			Total Load	**1.401**		**0.1094**		**8.62**	
Middle Pocomoke	POCOH	MD	Ag	0.249	**79.6%**	0.0212	**84.7%**	0.67	**56.3%**
			Ag_Reg	0.013	4.2%	0.0021	8.4%	0.00	0.0%
			Urban	0.009	2.9%	0.0007	3.0%	0.32	**26.5%**
			Stormwater	0.000	0.0%	0.0000	0.0%	0.00	0.2%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.000	0.0%	0.0000	0.0%	0.00	0.0%
			Forest	0.036	11.4%	0.0008	3.4%	0.20	16.9%
			NT_Dep	0.002	0.7%	0.0001	0.5%		0.0%
			Onsite	0.004	1.1%		0.0%		0.0%
			Total Load	**0.313**		**0.0250**		**1.19**	
Middle Pocomoke	POCOH	VA	Ag	0.115	**68.8%**	0.0146	**82.6%**	0.58	**65.0%**
			Ag_Reg	0.007	4.2%	0.0010	5.6%	0.00	0.0%
			Urban	0.012	7.3%	0.0007	4.1%	0.16	17.4%
			Stormwater		0.0%		0.0%		0.0%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.002	1.0%	0.0004	2.2%	0.00	0.3%
			Forest	0.023	13.9%	0.0008	4.5%	0.15	17.3%
			NT_Dep	0.003	1.5%	0.0002	1.0%		0.0%
			Onsite	0.005	3.2%		0.0%		0.0%
			Total Load	**0.167**		**0.0177**		**0.89**	

River	Segment	State	Source	TN Load (delivered)	% TN load	TP Load (delivered)	% TP load	Sed. Load (delivered)	% Sed. Load
Pocomoke Sound	POCMH	MD	Ag	0.180	**71.5%**	0.0179	**81.8%**	0.62	**45.4%**
			Ag_Reg	0.009	3.6%	0.0016	7.3%	0.00	0.0%
			Urban	0.012	4.9%	0.0007	3.4%	0.30	**22.2%**
			Stormwater		0.0%		0.0%		0.0%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.000	0.0%	0.0000	0.0%	0.00	0.0%
			Forest	0.037	14.7%	0.0012	5.4%	0.44	**32.3%**
			NT_Dep	0.009	3.5%	0.0005	2.1%		0.0%
			Onsite	0.004	1.7%		0.0%		0.0%
			Total Load	**0.251**		**0.0219**		**1.37**	
Pocomoke Sound	POCMH	VA	Ag	0.144	**52.7%**	0.0183	**73.7%**	0.76	**48.4%**
			Ag_Reg	0.009	3.2%	0.0012	5.0%	0.00	0.0%
			Urban	0.031	11.2%	0.0017	7.0%	0.41	**25.6%**
			Stormwater		0.0%		0.0%		0.0%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.020	7.5%	0.0015	5.9%	0.05	3.1%
			Forest	0.045	16.4%	0.0015	6.2%	0.36	**22.9%**
			NT_Dep	0.008	2.8%	0.0005	2.2%		0.0%
			Onsite	0.017	6.2%		0.0%		0.0%
			Total Load	**0.274**		**0.0248**		**1.58**	
Tangier Sound	TANMH	MD	Ag	0.014	12.3%	0.0014	**23.7%**	0.03	4.2%
			Ag_Reg	0.001	0.8%	0.0001	2.4%	0.00	0.0%
			Urban	0.022	19.0%	0.0012	**20.4%**	0.53	**65.9%**
			Stormwater	0.000	0.1%	0.0000	0.2%	0.01	1.0%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.008	6.7%	0.0004	7.2%	0.01	0.8%
			Forest	0.031	**26.3%**	0.0009	15.8%	0.23	**28.1%**
			NT_Dep	0.034	**29.2%**	0.0018	**30.3%**		0.0%
			Onsite	0.007	5.7%		0.0%		0.0%
			Total Load	**0.116**		**0.0059**		**0.81**	
Tangier Sound	TANMH	VA	Ag	0.000	1.2%	0.0000	2.6%	0.00	1.5%
			Ag_Reg	0.000	0.1%	0.0000	0.2%	0.00	0.0%
			Urban	0.001	15.7%	0.0001	18.2%	0.02	**62.0%**
			Stormwater	0.000	0.5%	0.0000	1.4%	0.00	9.5%
			CSO		0.0%		0.0%		0.0%
			Wastewater		0.0%		0.0%		0.0%
			Forest	0.001	**25.4%**	0.0000	14.0%	0.01	**27.1%**
			NT_Dep	0.003	**57.0%**	0.0002	**63.7%**		0.0%
			Onsite		0.0%		0.0%		0.0%
			Total Load	**0.006**		**0.0004**		**0.03**	

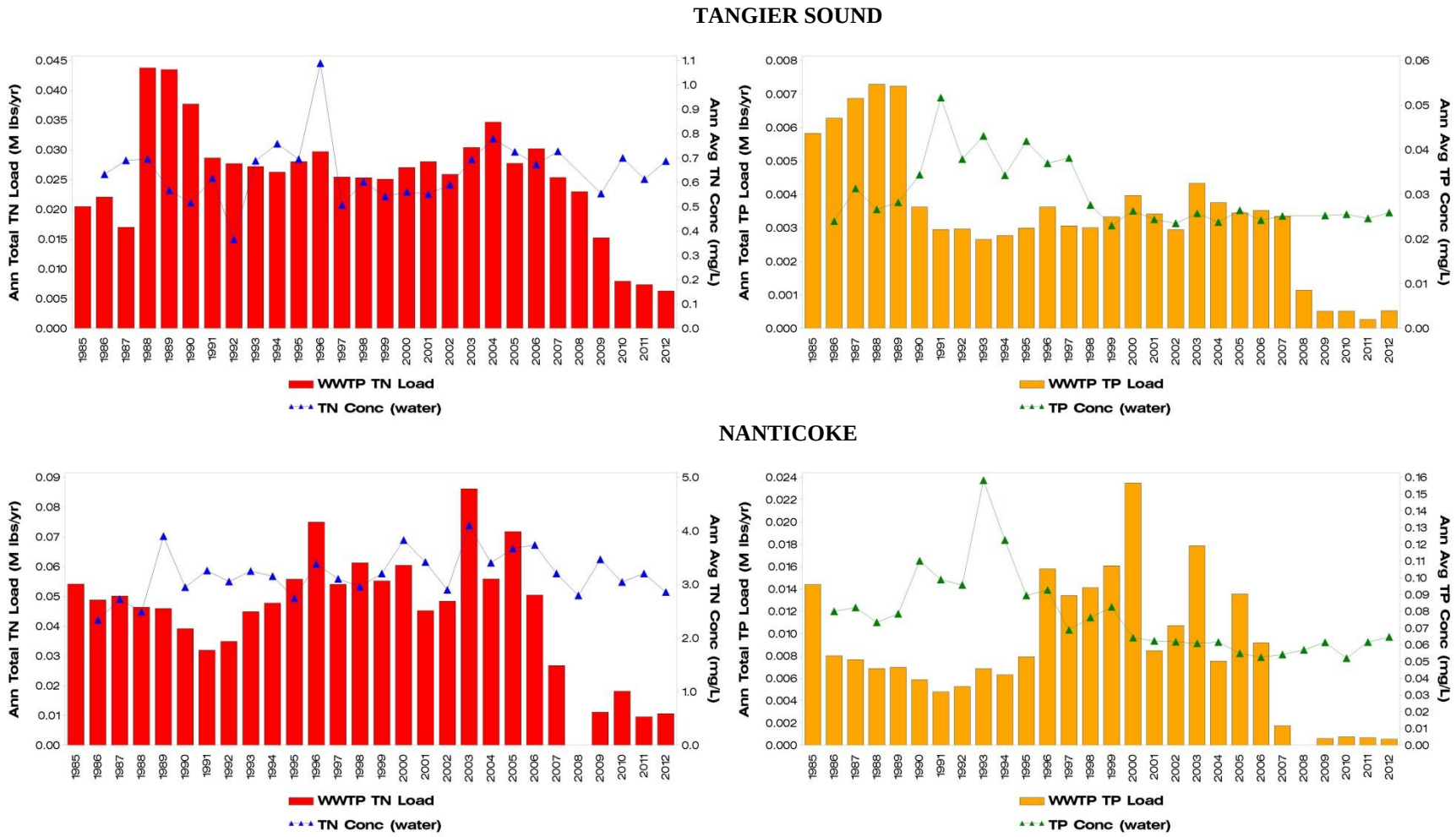


Figure 6. Total Wastewater Treatment Plant loads versus water quality. Loads from the major wastewater treatment plant (in million pounds per year, M lbs/yr) that discharges into Tangier Sound (top graphs) and the sum of the loads of the two facilities that discharge to the Nanticoke River (bottom graphs) compared to annual mean nutrient concentrations (in mg/L) at the closest long-term monitoring site in each river. 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).

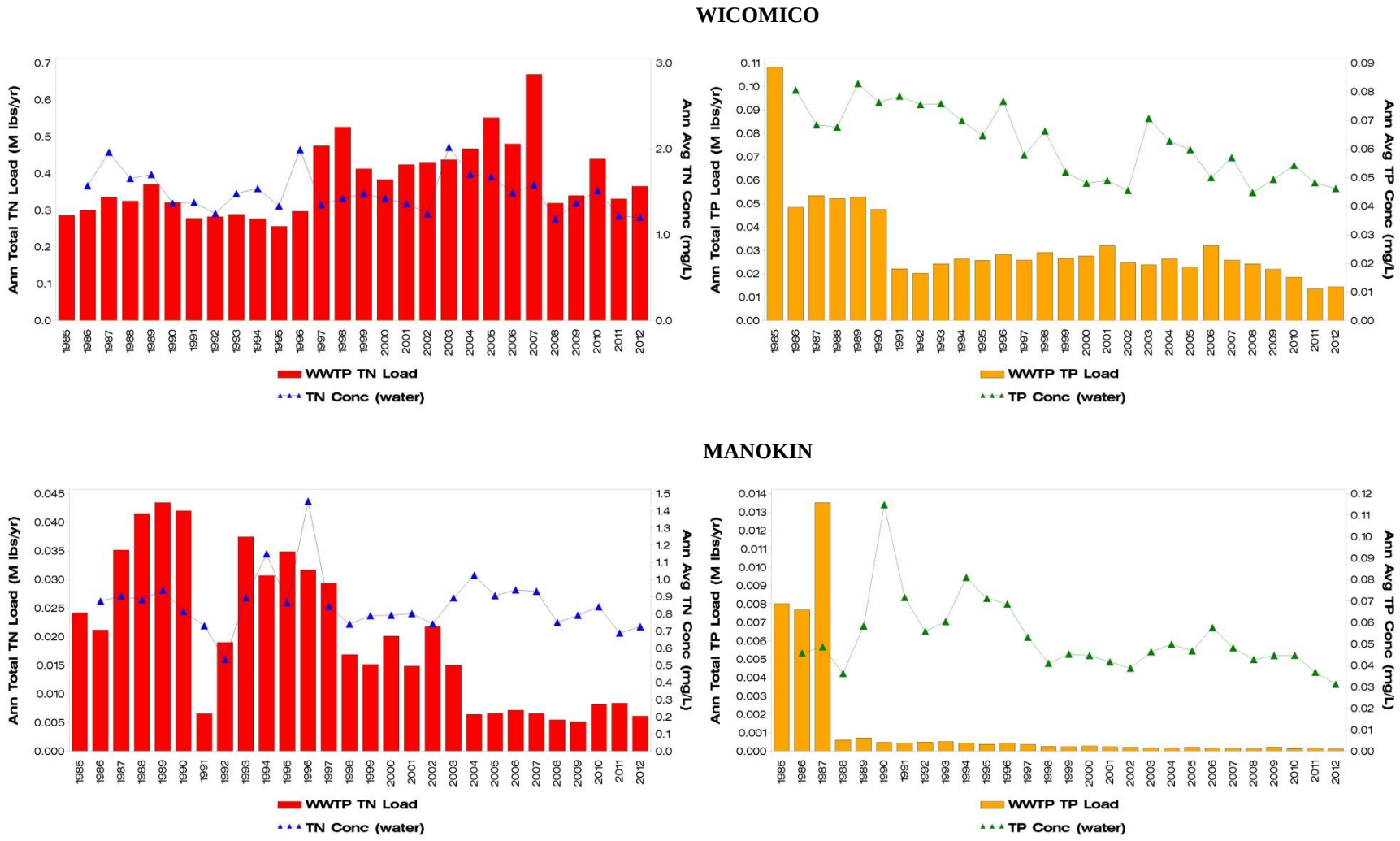


Figure 6. Total Wastewater Treatment Plant loads versus water quality. Sum of the loads from the three major wastewater treatment plants (in million pounds per year, M lbs/yr) that discharge into the Wicomico River (top graphs) and the load from the single facility that discharges to the Manokin River (bottom graphs) compared to annual mean nutrient concentrations (in mg/L) at the closest long-term monitoring site in each river. 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).

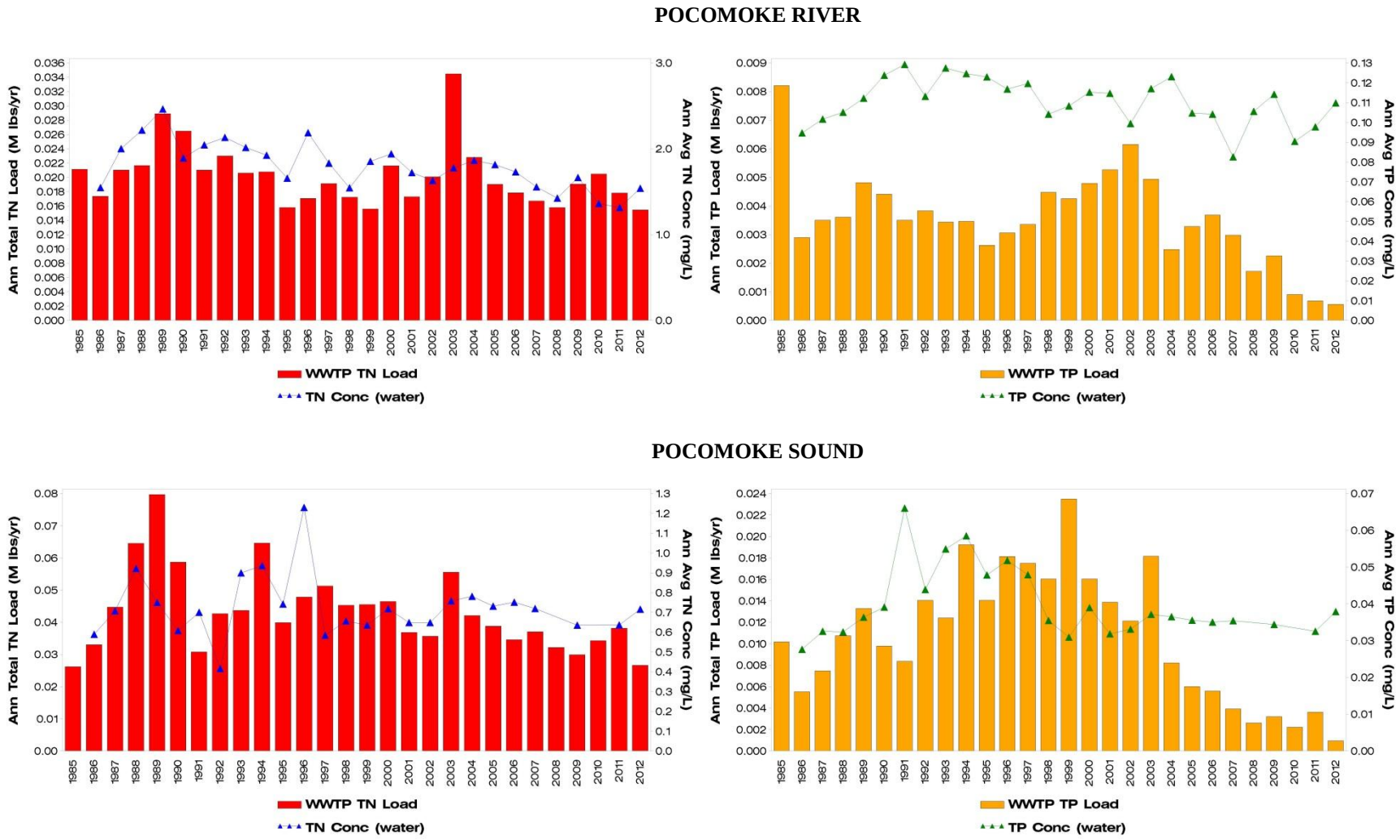


Figure 6. Total Wastewater Treatment Plant loads versus water quality. Loads from the major wastewater treatment plant (in million pounds per year, M lbs/yr) that discharges into the upper Pocomoke River (top graphs) and the sum of loads from the two facilities that discharge to the Pocomoke Sound (bottom graphs) compared to annual mean nutrient concentrations (in mg/L) at the closest long-term monitoring site in each river. 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).