Choptank Basin Rivers
Water Quality and Habitat Assessment
Overall Condition 2012-2014

Three rivers are included in the Choptank Basin: the Choptank, Little Choptank and Honga rivers (Figure 1). The Choptank River is divided into four regions- upper, middle, lower and outer. This basin includes areas in Queen Anne's, Caroline, Talbot and Dorchester counties in Maryland and Kent County in Delaware.

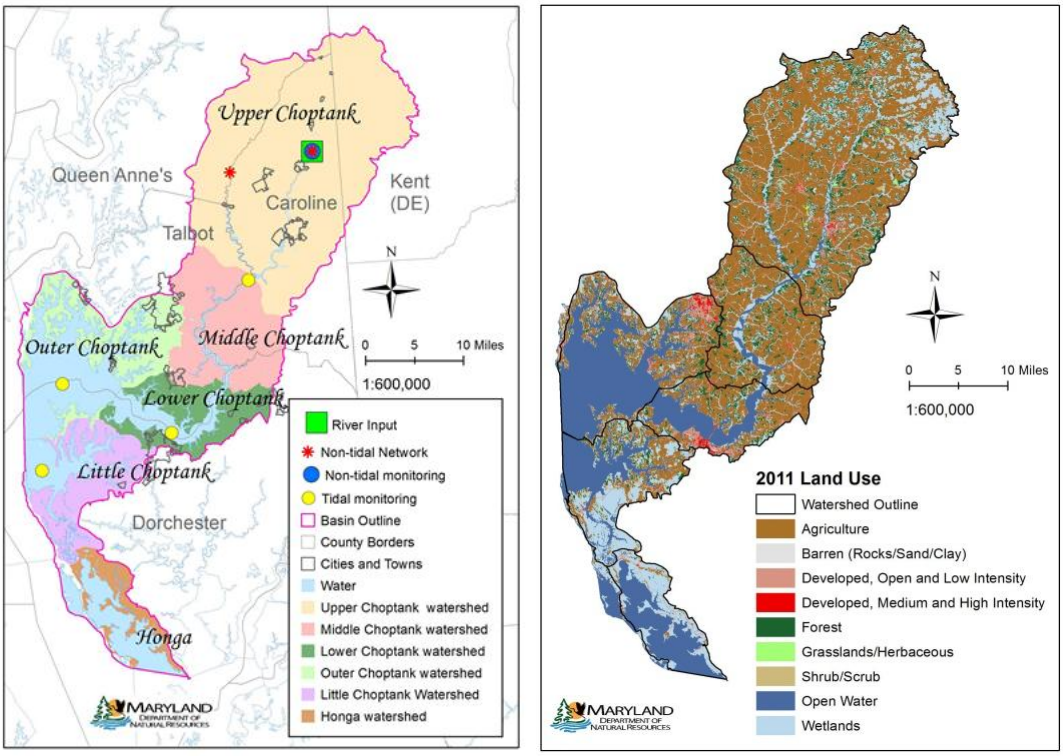

Figure 1 Choptank, Little Choptank and Honga River basin.
Left-side panel shows the individual watersheds and MD DNR sampling stations (non-tidal and tidal) and the Non-tidal Network stations in the basin where trends were determined for 2014. The River Input station for loadings trends is also shown. Right-side panel shows the land use throughout the basin for 2011.[1]

Land use in the upper Choptank River watershed was estimated to be 60% agriculture and 20% wetlands; 25% of the watershed is in Delaware. [1] Impervious surfaces cover 3% of the upper river watershed. [2] Agriculture is the largest source of nitrogen, phosphorus and sediment loadings in upper river.[3]

Land use in the middle Choptank River watershed was estimated to be 65% agriculture and 12% forest. Impervious surfaces cover 3% of the middle river watershed. Agriculture is the largest source of nitrogen, phosphorus and sediment loadings in middle river.

Land use in the lower Choptank River watershed was estimated to be 49% agriculture, 17% developed and 16% wetlands. Impervious surfaces cover 5% of the lower river watershed. Agriculture is the largest source of nitrogen, phosphorus and sediment loadings. Urban land is also a large source of sediment loadings in the lower river.

Land use in the outer Choptank River watershed was estimated to be 49% agriculture, 17% developed and 16% wetlands. Impervious surfaces cover 7% of the outer river watershed. Agriculture is the largest source of nitrogen, phosphorus and sediment loadings. Urban land is also a large source of nitrogen, phosphorus and sediment loadings in the outer river.

Land use in the Little Choptank River watershed was estimated to be 50% wetlands and 26% agriculture. Impervious surfaces cover 1.5% of the watershed. Agriculture is the largest source of nitrogen, phosphorus and sediment loadings. Forest lands are also a large source of nitrogen loadings to the Little Choptank River.

Land use in the Honga River watershed was estimated to be 80% wetlands. Impervious surfaces cover 1% of the watershed. Forest lands are the largest source of nitrogen loadings. Forest, agriculture and deposition from the air are the largest sources of phosphorus loadings. Forest land is the largest source of sediment loadings in the Honga River.

How healthy are the Choptank and Little Choptank Rivers?

Maryland Department of Natural Resources (MDDNR) measures water and habitat quality at one non-tidal long-term monitoring stations and at three tidal long-term monitoring stations in the Choptank River (Figure 1) and one long-term station in the Little Choptank Rivers; there is not a long-term water quality monitoring station in the Honga 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 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. Maryland's long-term non-tidal station on the Choptank is also part of the Non-tidal Network (Figure 1, Table 1); a second station on Tuckahoe Creek is part of the Non-tidal Network. 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] Trends results from the Non-tidal Network stations from the other states are included below because of the consistency in monitoring and analysis methods.

USGS and MDDNR also measure the nutrient and sediment loadings at the fall-line station (River Input station on Figure 1) to determine trends in loadings at this station.[4]

Choptank River: Non-tidal areas: Nitrogen, phosphorus and sediment loads from the watershed to the non-tidal waters of the Choptank have increased.[4] Nitrogen and phosphorus levels in the water have increased when the effect of flow is accounted for (Table 1). There were no trends at the Non-tidal Network station on Tuckahoe Creek.

Tidal areas: Water quality in the tidal upper Choptank is poor. Nitrogen, phosphorus and sediment levels are too high (Table 2). Habitat quality for underwater grasses is poor because algal densities are too high and water clarity is poor. No underwater grass beds were found in the upper Choptank.[5] Bottom dwelling animal populations are healthy in this portion of the river.

There are no long-term water quality monitoring stations in the middle Choptank River. No underwater grass beds were found in the middle Choptank during this time period. Bottom dwelling animal populations are generally healthy in this portion of the river.

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. The River Input Station (fall-line station) is highlighted in yellow. 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.

				MDDNR 1999-2014 (without flow)			USGS 2005*-2014 (with flow)		
Watershed	**USGS Gage #**	**MD DNR Station**	**River/Creek**	**N**	**P**	**Sed**	**N**	**P**	**Sed**
Upper Chopank	01491000	ET5.0	**Choptank**				Inc	Inc	
	01491500	TUK0181	Tuckahoe Creek						

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.

		Water Quality			Habitat Quality		
River	**River portion**	**Nitrogen**	**Phosporus**	**Sediments**	**Algal Densities**	**Water Clarity**	**Summer Bottom DO**
Choptank	Upper	Fail	Fail	Fail	Fail	Fail	Meet
	Lower	Fail	Meet	Meet	Meet	Fail	Meet
	Outer	Fail	Meet	Meet	Increasing Meet	Meet	Meet
Little Choptank		Meet	Meet	Meet	Increasing Meet	Meet	Fail

Water quality in the lower Choptank is fair but nitrogen levels are high. Habitat quality for underwater grasses is fair because water clarity is too low. Underwater grass beds covered only 1% of the area needed to meet the restoration goal during this period. Bottom dwelling animal populations are generally healthy.

Water quality in the outer Choptank is fair due to low phosphorus and sediment levels but high nitrogen levels. Algal densities are low but have increased. Water clarity is good. Underwater grass beds covered 48% of the area needed to meet the restoration goal during this period. Summer bottom dissolved oxygen levels are good.

Bottom dwelling animal populations are healthy in the tributaries to the main river, but bottom dwelling animals are unhealthy in the central portion of the outer Choptank.

Little Choptank: Water quality in the Little Choptank is currently good due to low nitrogen, phosphorus and sediment levels. Habitat quality for underwater grasses is good but algal densities have increased. Underwater grass beds covered less than 7% of the area needed to meet the restoration goal during this period. Summer bottom dissolved oxygen is unhealthy and often below 2 mg/l.

How do the Choptank and Little Choptank Rivers compare to other Maryland rivers?

The Choptank River is in the 'High Agriculture/ Low Developed' land use category. In the Choptank River overall, nitrogen and phosphorus levels are moderate compared with other high agricultural systems. Sediment and algal densities are low compared to other high agricultural systems. Water clarity is high and summer bottom dissolved oxygen levels are moderate compared with other high agricultural systems (Figure 2).

The Little Choptank River is in the 'Low Agriculture/ Low Developed' land use category. The nitrogen, phosphorus and sediment levels, algal densities and water clarity in the Little Choptank River are among the best in all of the Maryland rivers and bays. However, summer bottom dissolved oxygen levels are extremely low and one the worst of Maryland's rivers and bays.

What has been done to improve water and habitat quality in the Choptank Basin Rivers?

Wastewater, Stormwater and Septic Loads

Wastewater treatment plant nitrogen loadings to the upper Choptank River have been reduced by 67% and phosphorus loadings have been reduced by 90%.[6] Upgrades to the two largest wastewater treatment plants that discharge to the upper Choptank were complete by 2012.

Wastewater treatment plant nitrogen loadings to the lower Choptank River have been reduced by 80% and phosphorus loadings have been reduced by 91%.[5] Upgrades to the largest wastewater treatment plant that discharges to the lower Choptank were complete by 2013 (but loadings data is only available through 2012).

No major wastewater treatment plants discharge to the Little Choptank River or the Honga River.

In the entire basin, almost 380 septic system retrofits were completed between 2008 and 2013, and stormwater retrofits have reduced nitrogen loadings and prevented 2,562 pounds of nitrogen from entering the rivers since 2003.[7]

Agricultural Loads[7]

In 2014, there were 78,896 acres of cover crops planted in between growing seasons to absorb excess nutrients and prevent sediment erosion. Fencing on 504 acres of farmland was used to keep livestock out of streams and prevent streambank erosion. A total of 279 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 20,784 acres, allowing areas next to streams to remain in a natural state with grasses, trees and wetlands.

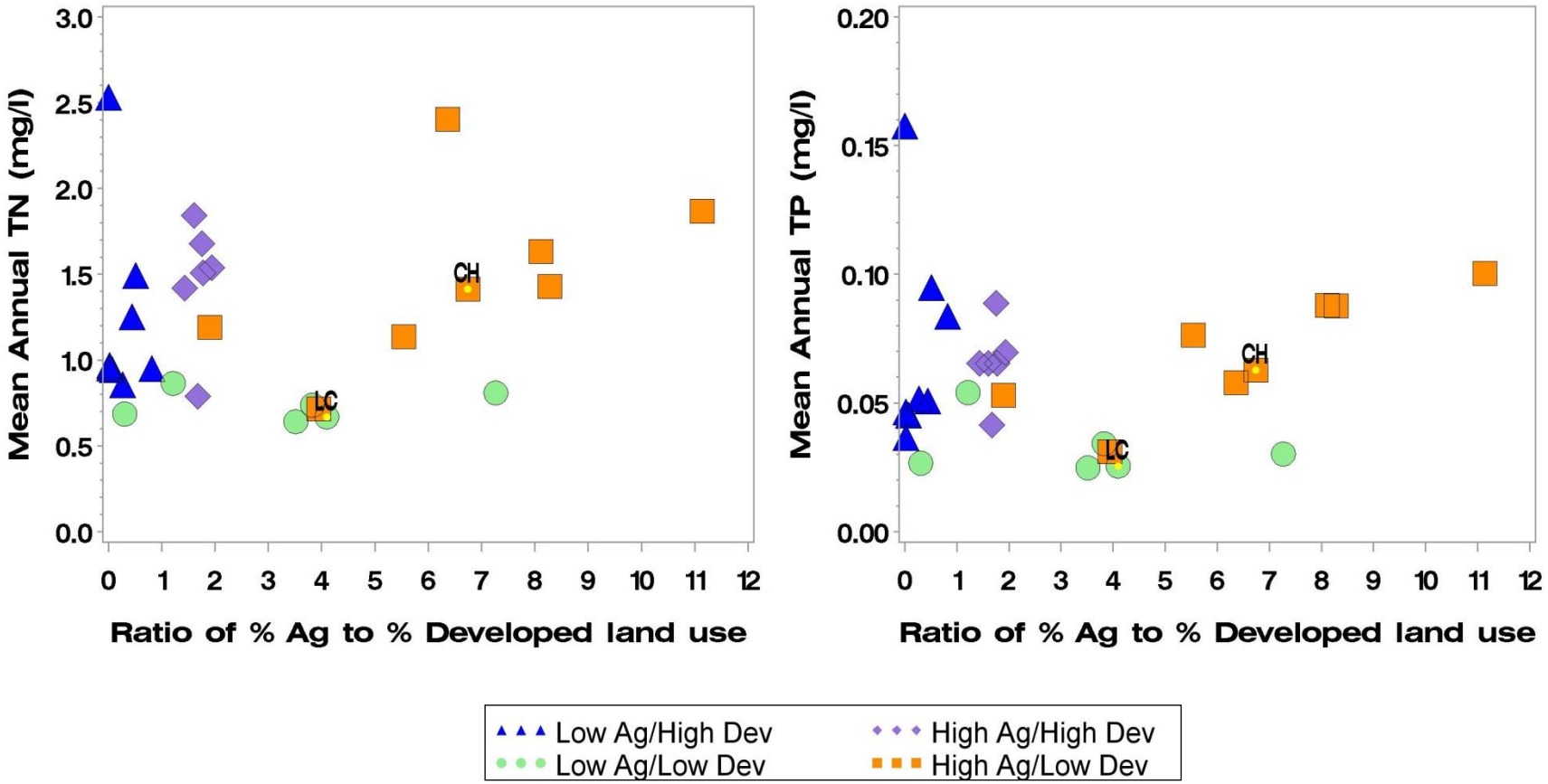

Figure 2. Water quality conditions versus land use.
Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as mean annual concentration (in mg/L) for total nitrogen (TN) and total phosphorus (TP). Rivers are color coded by their land use categories (see legend). Yellow dots highlight the Choptank (CH) and Little Choptank (LC) river data.

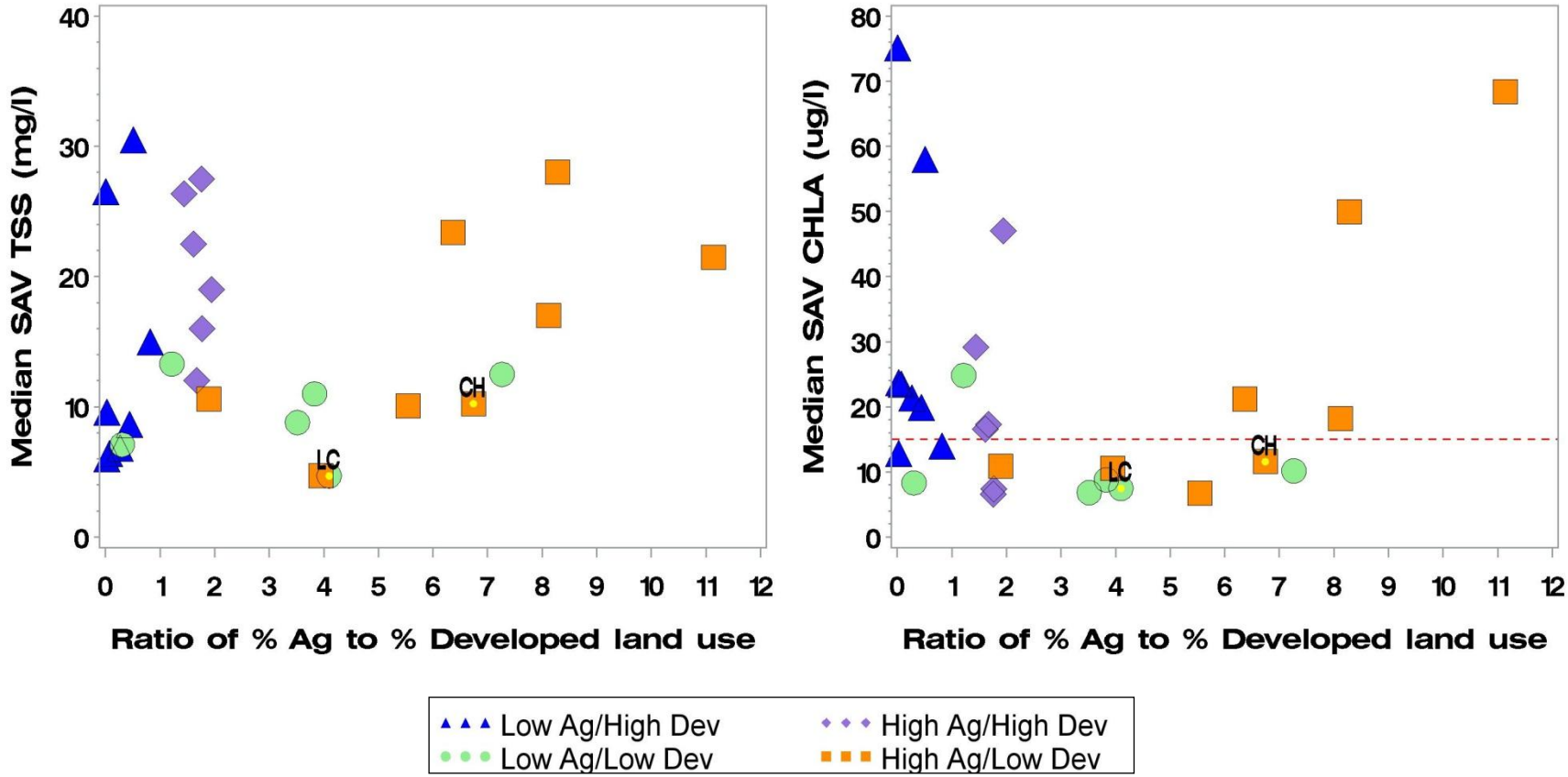

Figure 2 (cont.). Water quality conditions versus land use.
Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as submerged aquatic vegetation (SAV) growing season (April-October) median for total suspended solids (TSS, 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 Choptank (CH) and Little Choptank (LC) river data.

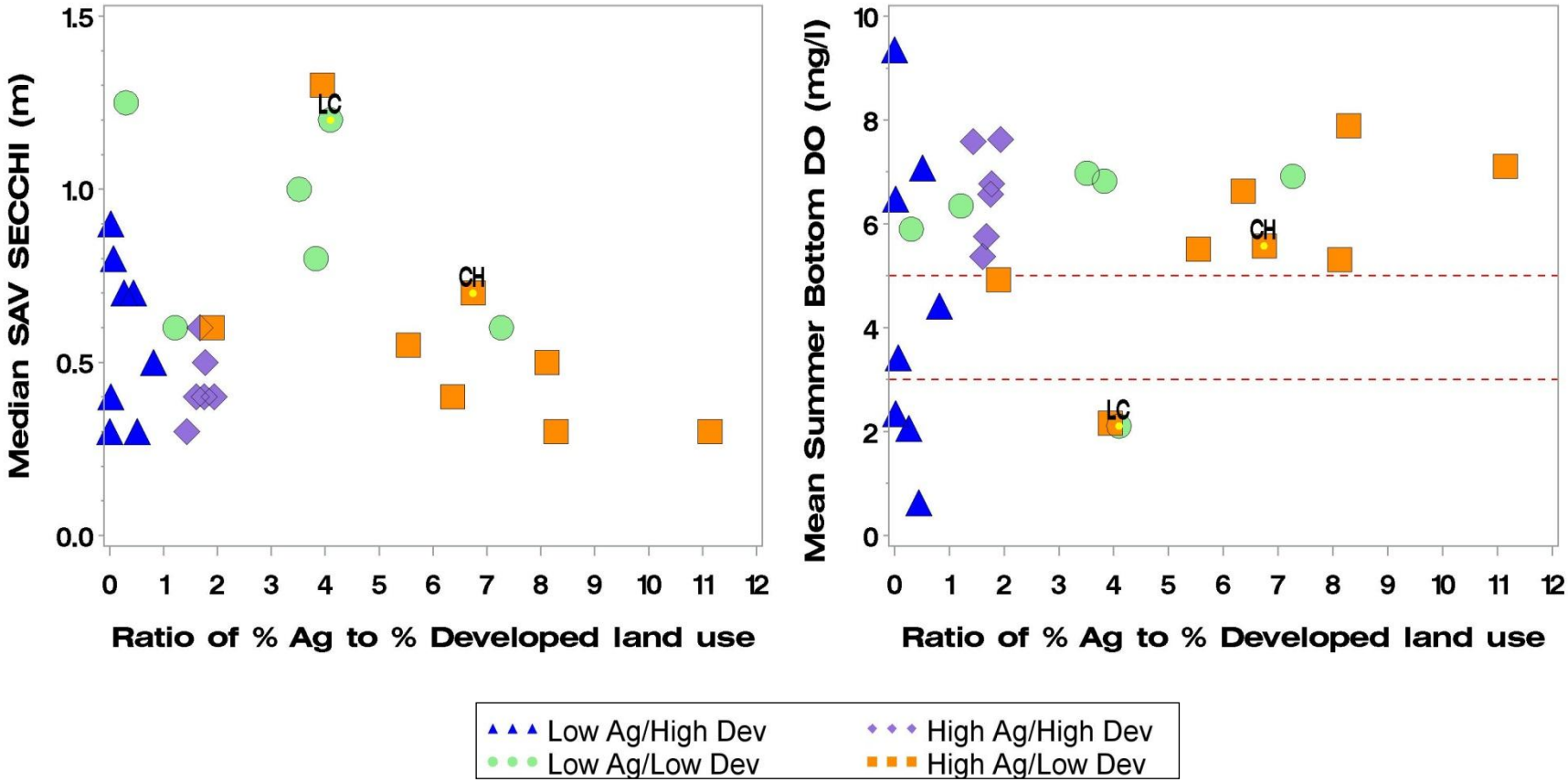

Figure 2 (cont.). Water quality conditions versus land use.
Water quality is shown relative to the ratio of % Agriculture (Ag) to % Developed (Dev) land use. Data for 2012-2014 are summarized as submerged aquatic vegetation (SAV) growing season (April through October) median for Secchi depth (in m) and 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 Choptank (CH) and Little Choptank (LC) river data.

For more information

An integrative assessment of the water and habitat quality of the Choptank Basin river 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. The Upper Choptank River watershed includes areas in Delaware but data for impervious surfaces for this area is not included.

[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 loadings trends results are through WY2014 from USGS website http://cbrim.er.usgs.gov/summary.html for Short-term period (WY2005-WY2014) accessed February 4, 2016.
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). Data for calendar year available for 1985-2012. Changes in loadings determined from the difference of the average of the first three and last three years of data.

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

This project has been funded in part by the United States Environmental Protection Agency under assistance agreement (CB-97390101) to Maryland Department of Natural Resources. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

Chesapeake Bay Program
A Watershed Partnership

Figure 3. Nitrogen, phosphorus and sediment loads to Choptank Basin 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 scales are different between left and right side graphics.

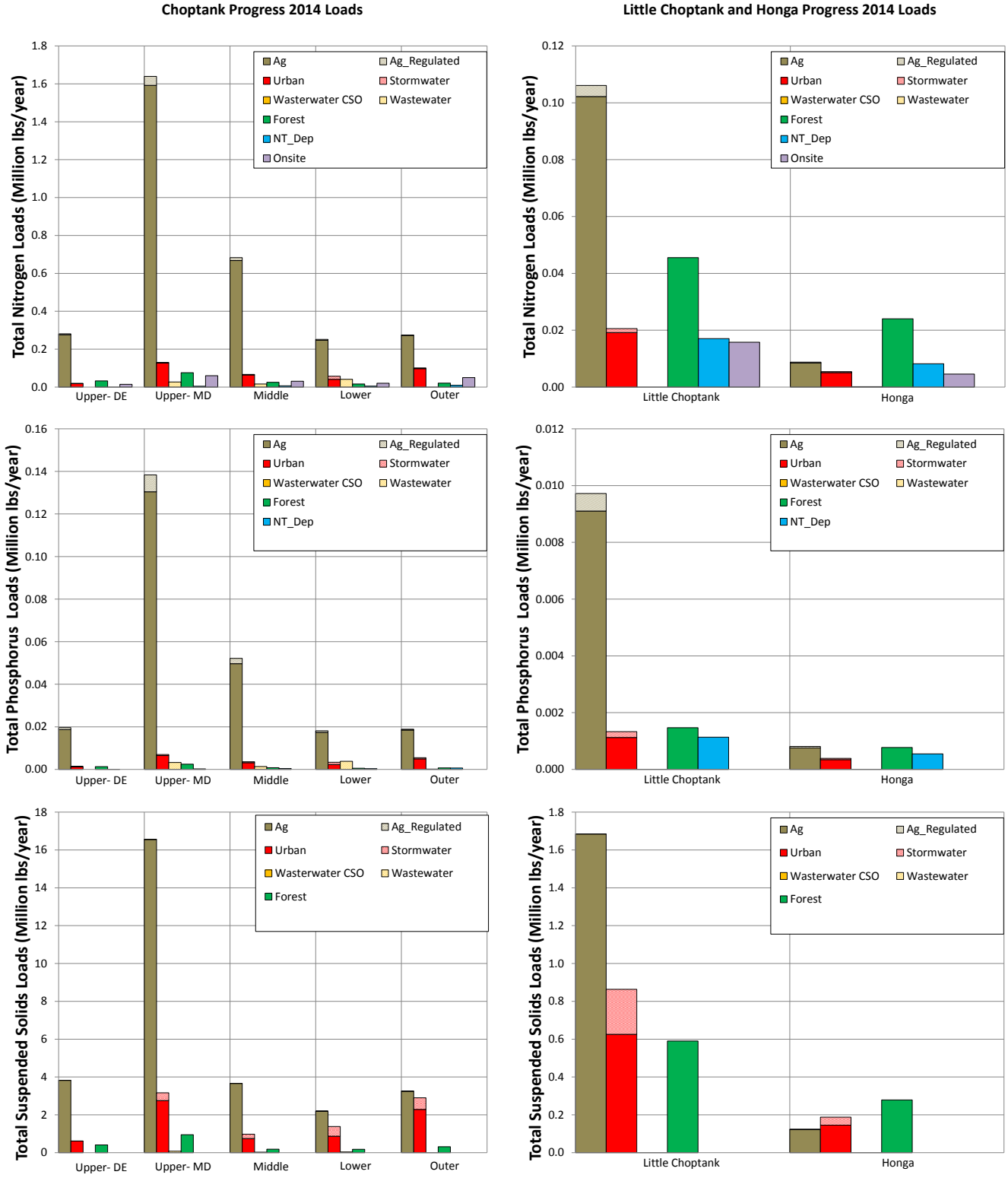

Table 3. Nitrogen, phosphorus and sediment loads to Choptank Basin rivers. Loads (in million lbs/year) are summarized by Chesapeake Bay Program model segment and by source category. Data for Progress 2014 model run downloaded on November 16, 2015 from http://baytas.chesapeakebay.net/. Source categories 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
Upper Choptank	CHOTF	DE	Ag	0.276	79.7%	0.0187	84.1%	3.82	78.9%
			Ag_Reg	0.005	1.4%	0.0009	4.2%	0.00	0.0%
			Urban	0.018	5.3%	0.0013	5.8%	0.61	12.6%
			Stormwater	0.000	0.0%	0.0000	0.0%	0.00	0.0%
			CSO		0.0%		0.0%		0.0%
			Wastewater		0.0%		0.0%		0.0%
			Forest	0.033	9.4%	0.0013	5.8%	0.41	8.4%
			NT_Dep	0.000	0.1%	0.0000	0.1%		0.0%
			Onsite	0.014	4.2%		0.0%		0.0%
			Total Load	**0.346**		**0.0222**		**4.85**	
Upper Choptank	CHOTF	MD	Ag	1.592	82.2%	0.1304	86.2%	16.56	79.8%
			Ag_Reg	0.047	2.4%	0.0079	5.2%	0.00	0.0%
			Urban	0.126	6.5%	0.0065	4.3%	2.75	13.3%
			Stormwater	0.004	0.2%	0.0005	0.3%	0.41	2.0%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.027	1.4%	0.0032	2.1%	0.08	0.4%
			Forest	0.076	3.9%	0.0024	1.6%	0.95	4.6%
			NT_Dep	0.004	0.2%	0.0002	0.1%		0.0%
			Onsite	0.060	3.1%		0.0%		0.0%
			Total Load	**1.936**		**0.1512**		**20.75**	
Middle Choptank	CHOOH	MD	Ag	0.668	80.6%	0.0497	85.4%	3.66	75.5%
			Ag_Reg	0.016	1.9%	0.0025	4.2%	0.00	0.0%
			Urban	0.064	7.7%	0.0032	5.4%	0.75	15.5%
			Stormwater	0.003	0.4%	0.0004	0.7%	0.23	4.7%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.016	1.9%	0.0013	2.3%	0.03	0.6%
			Forest	0.025	3.0%	0.0008	1.3%	0.18	3.8%
			NT_Dep	0.007	0.8%	0.0004	0.6%		0.0%
			Onsite	0.031	3.7%		0.0%		0.0%
			Total Load	**0.828**		**0.0582**		**4.84**	
Lower Choptank	CHOMH2	MD	Ag	0.247	63.2%	0.0174	66.6%	2.19	57.9%
			Ag_Reg	0.005	1.2%	0.0008	2.9%	0.00	0.0%
			Urban	0.041	10.5%	0.0023	8.7%	0.87	22.9%
			Stormwater	0.016	4.2%	0.0011	4.1%	0.51	13.5%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.041	10.5%	0.0038	14.5%	0.04	1.0%
			Forest	0.016	4.1%	0.0005	2.0%	0.18	4.7%
			NT_Dep	0.005	1.2%	0.0003	1.2%		0.0%
			Onsite	0.020	5.1%		0.0%		0.0%
			Total Load	**0.391**		**0.0261**		**3.79**	
Outer Choptank	CHOMH1	MD	Ag	0.272	59.6%	0.0185	71.7%	3.25	50.2%
			Ag_Reg	0.002	0.5%	0.0004	1.4%	0.00	0.0%
			Urban	0.097	21.3%	0.0049	19.2%	2.29	35.3%
			Stormwater	0.004	0.8%	0.0005	2.1%	0.61	9.5%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.001	0.2%	0.0002	0.6%	0.01	0.1%
			Forest	0.021	4.5%	0.0007	2.6%	0.31	4.8%
			NT_Dep	0.010	2.1%	0.0006	2.4%		0.0%
			Onsite	0.050	11.0%		0.0%		0.0%
			Total Load	**0.457**		**0.0258**		**6.47**	

Table 3 (cont). Nitrogen, phosphorus and sediment loads to Choptank Basin 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
Little Choptank	LCHMH	MD	Ag	0.102	**49.9%**	0.0091	**66.6%**	1.68	**53.7%**
			Ag_Reg	0.004	1.9%	0.0006	4.5%	0.00	0.0%
			Urban	0.019	9.3%	0.0011	8.2%	0.63	19.9%
			Stormwater	0.001	0.7%	0.0002	1.5%	0.24	7.6%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.000	0.0%	0.0000	0.0%	0.00	0.0%
			Forest	0.046	**22.2%**	0.0015	10.8%	0.59	18.8%
			NT_Dep	0.017	8.3%	0.0011	8.3%		0.0%
			Onsite	0.016	7.7%		0.0%		0.0%
			Total Load	**0.205**		**0.0137**		**3.14**	
Honga	HNGMH	MD	Ag	0.008	16.5%	0.0008	**30.0%**	0.12	**20.7%**
			Ag_Reg	0.000	0.6%	0.0001	2.1%	0.00	0.0%
			Urban	0.005	10.0%	0.0003	13.6%	0.15	**24.6%**
			Stormwater	0.000	0.6%	0.0000	1.9%	0.04	7.2%
			CSO		0.0%		0.0%		0.0%
			Wastewater	0.000	0.2%	0.0000	0.2%	0.00	0.1%
			Forest	0.024	**47.0%**	0.0008	**30.6%**	0.28	**47.3%**
			NT_Dep	0.008	16.0%	0.0005	**21.6%**		0.0%
			Onsite	0.005	9.0%		0.0%		0.0%
			Total Load	**0.051**		**0.0025**		**0.59**	

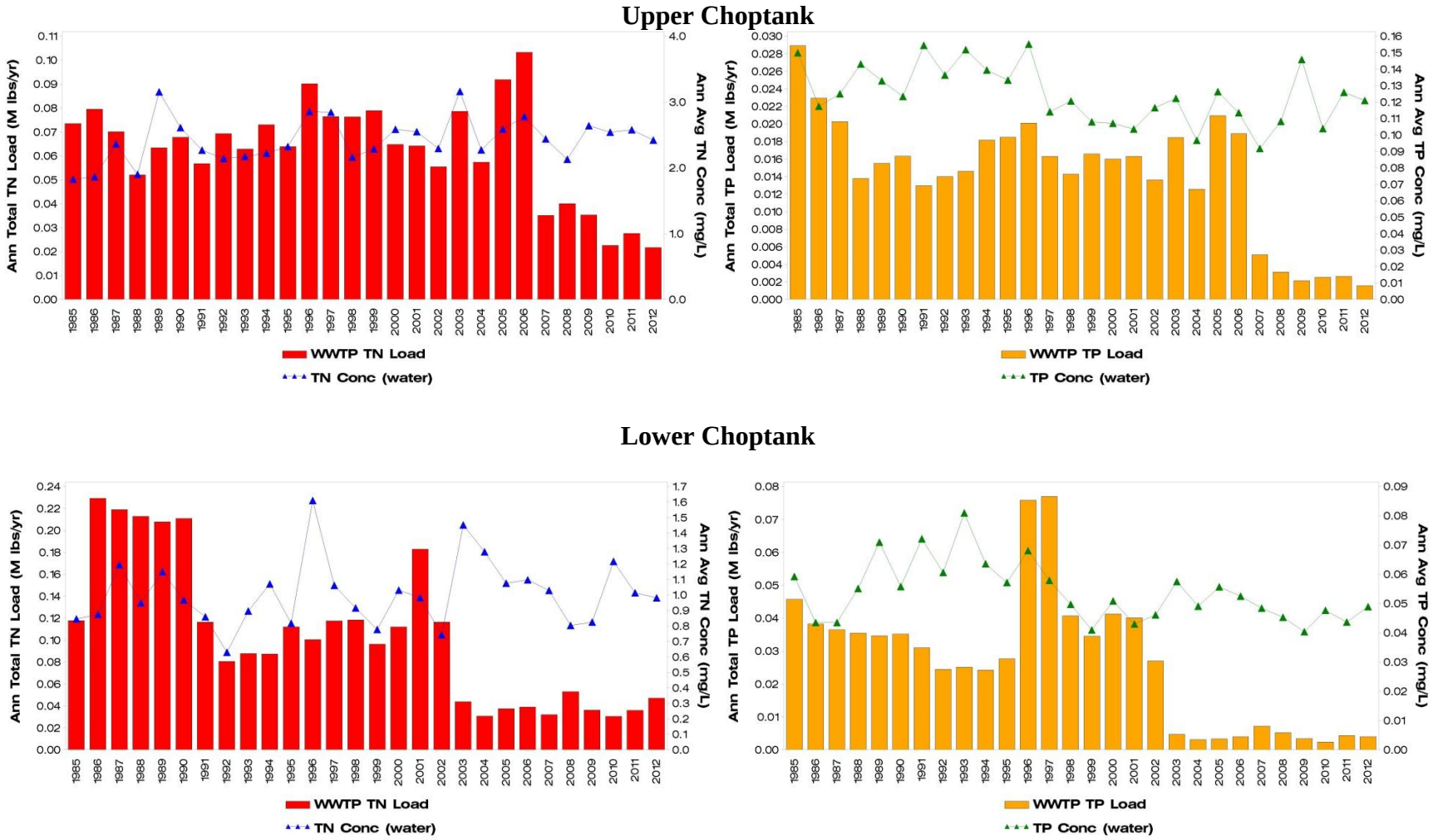

Figure 4. Total Wastewater Treatment Plant loads versus water quality. Summed total of loads from two major wastewater treatment plants (in million pounds per year, M lbs/yr) that discharge into the Upper Choptank (top graphs) and the single facility that discharges to the Lower Choptank (bottom graphs) compared to annual mean nutrient concentrations (in mg/L) at the long-term monitoring site in each section of the 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). No major wastewater treatment plants discharge to the Lower Choptank River, the Little Choptank River or the Honga River.