Missisquoi River Basin Association
Water Quality Monitoring Program
Summary of Results 2005-2012

Submitted for the Missisquoi River Basin Association
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Missisquoi River Basin Overview:

The Missisquoi River runs across the northwestern part of Vermont and into southern Quebec. The river begins in Lowell and flows approximately 80 miles into the Missisquoi Bay. The Missisquoi River watershed is comprised of forests, agricultural land, and some urban and suburban developments. At 25%, agriculture is the dominant non-forested land use land cover. The water quality in Missisquoi Bay is at risk due to the enrichment of nutrients from surrounding lands in the watershed and the toxic algae blooms that may result. The Missisquoi River watershed is currently the focus of several monitoring and restoration efforts by local, state and regional groups to identify nutrient sources and minimize nutrient input to the River and Bay.

Program Overview:

The Missisquoi River Basin Association (MRBA) is a non-profit organization focused on the restoration of the Missisquoi River and its tributaries. The Water Quality Monitoring program is a volunteer-run sampling program that takes place each summer throughout the Basin. Through partnership with the Vermont Department of Environmental Conservation's LaRosa Analytical Services Partnership Program, the MRBA has access to the State of Vermont's analytical laboratory to process and analyze the water samples taken in the field.

The goal of the monitoring project is multifaceted. This volunteer program allows community members to learn about the environment of the Missisquoi River Basin, conservation and restoration of this environment, and water quality sample collection with interpretation of the results. In addition, the program collects valuable data that may aid in the determination of specific problem areas at which to focus restoration efforts (and whether past restoration efforts are working).

Methods:

Trained citizen volunteers collect water samples biweekly at between 19 and 21 sites depending on the year. These sites are located throughout the Missisquoi River Basin, along the mainstem of the Missisquoi River and its tributaries. Refer to Table 1 for a list of sample sites and their corresponding site codes and sample years. Figures 1-3 show the location of each site labeled by their corresponding site code.

Table 1. List of MRBA sampling sites with site codes and sampling years.

Mainstem Sites	Code	Years
Westfield - Loop Rd - Below Mineral Springs Brook	M-WL	2005, 2006, 2007, 2008, 2009, 2010, 2011, ***2012***
Troy - Citizens Dam	M-TCD	2005, 2006, 2007
North Troy - Below Big Falls	M-NTBF	2005, 2006, 2007, 2008, 2009, 2010, 2011, ***2012***
East Richford - Near QC Border	M-ER	2005, 2006, 2007, 2008, 2009, 2010, 2011, ***2012***
Richford – below town, Davis Park	M-RDP	2005
Richford - Below North Branch Marvin Rd	M-RM	2006, 2007
East Berkshire - Below Trout River	M-EB	2005, 2006, 2007
Enosburg Falls - Lawyers Landing	M-ELL	2005
Enosburg Falls - Below Town	M-EF	2005, 2006, 2007, 2008, 2009, 2010, 2011, ***2012***
N.Sheldon - Above Black Creek - Kane Road	M-NS	2005, 2006, 2007
Sheldon Junction - Bridge	M-SJ	2005
Highgate - Dam at Highgate Falls	M-HD	2005, 2006, 2007
Swanton – above town Johns Bridge	M-SJB	2005
Swanton - Marble Mill - Below Dam	M-SMM	2005
Swanton - Monument Road	M-SMR	2005, 2006, 2007, 2008, 2009, 2010, 2011, ***2012***

Sites in blue averaged below 25 µg/L Phosphorus in 2012

Sites in green had the highest average concentrations of Phosphorus in 2012 (greater than 100 µg/L)

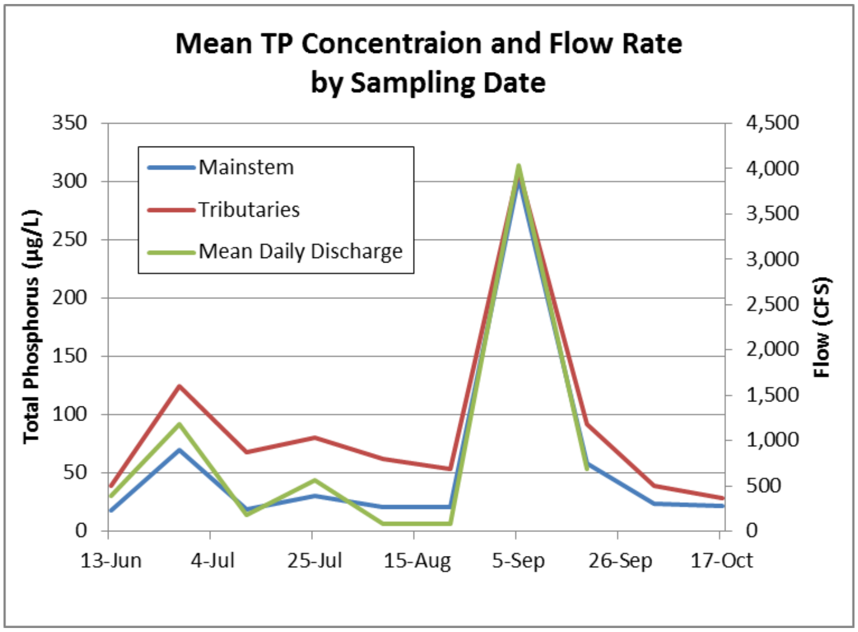
Sites in Red had a dramatic TP Increase from 2011

Tributary Sites	Code	Years
Lowell - Burgess Branch Route 58	T-LBB	2005, 2006, 2007, 2008, 2009, 2010, 2011, ***2012***
Troy - Jay Branch - Vielleux Road	T-TJB	2006, 2007, 2008, 2009, 2010, 2011, ***2012***
Newport Center - Mud Creek - Route 105	T-NCMC	2006, 2007, 2008, 2009, 2010, 2011, ***2012***
Newport Center – trib. to Mud Creek	T-NCTM	2008, 2009, 2010
North Troy - Mud Creek - Bear Mountain Road	T-NTMC	2005, 2006, 2007, 2008, 2009, 2010, 2011, ***2012***
Richford - North Branch - Pinnacle Road	T-RNB	2006, 2007, 2008, 2009, 2010, 2011, ***2012***
East Berkshire - Trout River - Near Mouth - Route 118	T-EBTR	2005, 2006, 2007, 2008, 2009, 2010, 2011, ***2012***
Enosburgh - Tyler Branch, Duffy Hill Road	T-ETBDH	2006, 2007, 2008, 2009, 2010, 2011, ***2012***
Enosburgh – Tyler Branch, Boston Post Rd.	T-ETYB	2008, 2009, 2010, 2011, ***2012***
Enosburgh – below Tyler Branch	T-EBTB	2005
Enosburgh – The Branch (Rt. 108)	T-ETB	2008, 2009, 2010, 2011, ***2012***
East Fairfield - Black Creek Ryan Rd.	T-EFBC	2007, 2008, 2009, 2010, 2011, ***2012***
Fairfield – Wanzer Brook	T-FFWZ	2008, 2009, 2010, 2011, ***2012***
Sheldon - Mouth of Black Creek - Bouchard Road	T-SBC	2005, 2006, 2007, 2008, 2009, 2010, 2011, ***2012***
Highgate - Hungerford Brook Route 207	T-HHB	2006, 2007
Sheldon – trib to Hungerford Bk Cook Rd.	T-SHCR	2008, 2009, 2010, 2011, ***2012***
Swanton – trib to Hungerford Woods Hill Rd.	T-THBW	2008, 2009, 2010, 2011, ***2012***, 2011, ***2012***
Swanton – Hungerford Bk Woods Hill Rd.	T-HBW	2008, 2009, 2010
Berkshire - Godin Brk Godin Rd	T-BGB	2011, ***2012***

Volunteers received training in accordance with the Quality Assurance Project Plan for taking grab samples for total phosphorus, total nitrogen, total suspended solids, and turbidity. Samples were kept cold during transport and storage before analysis. Samplers also completed a field data sheet at each site noting not only who took the sample and where and when the sample was taken, but also parameters such as flow and weather observations. The U.S. Environmental Protection Agency provided portable conductivity meters for volunteers to measure the conductivity at each site; the results were also recorded on the data sheet. In order to interpret the results from the State laboratory it was necessary to organize and manage the data using Microsoft Access® and Microsoft Excel®, which allowed for further geographic analysis in ESRI ArcGIS®.

Results and Discussion:

Figures 1-3 show sampling locations and results of the three water quality parameters measured (total phosphorus, total nitrogen and turbidity). The raw data for each parameter and sample event are presented in Appendix A. Figures 4-6 present mean values for the three parameters at each site ±1 standard error of the mean.



The data from 2012 that stand out the most are those from September 5th, when values for all three measured parameters were far above the normal variation seen in any typical year. The Sept. 5th sampling event coincided with the runoff events caused by Hurricane Isaac, which produced extremely high flows throughout the watershed on 9/5/12. The USGS gauge on the Missisquoi River in East Berkshire went from a mean discharge of 82 cubic feet per second (cfs) on September 4th, 2012 to a mean discharge of 4,040 cfs on September 5th, the day samples were taken. The figure above shows mean total phosphorus (TP) concentration of mainstem and tributary sites (µg/L, left axis) and flow rate (discharge in cubic feet per second, right axis) for the 2012 sampling season. The close correlation between TP values and flow in the Missisquoi River is evident here. Because of the unusually high flow rate due to Isaac, and the consequent anomalous results, the total phosphorus data is presented here both with and without the 9/5/12 data for comparison.

Even without data from September 5th, the samples taken in 2012 reflect high levels of nutrients in the Missisquoi Basin this year, as data showed increased levels of total phosphorus (TP, Figure 4), total nitrogen (TN, Figure 5), and turbidity (TURB, Figure 6). This result may be due to lingering effects of 2011 floods; many areas of the watershed were affected greatly by the spring floods of 2011 as well as the floods from Tropical Storm Irene at the end of August. There was a great deal of erosion from Irene, and many parts of the watershed remained free of vegetation through the winter and into the summer months. The high nutrient levels observed in 2012 seem to demonstrate that the watershed is still showing the effects of the large erosion and runoff events of 2011.

In 2012, only two sites (T-ETYB, T-LBB) showed overall mean phosphorus values below 25 µg/L, which is the standard for Missisquoi Bay in Lake Champlain. Both of these sites are low-order tributaries of the Missisquoi River. However, a number of sites showed TP values equal to or less than 25 µg/L on more than four discrete sampling occasions during the sampling season, both from the mainstem (M-EF, M-ER, M-NTBF, M-SMR, M-WL) and tributaries (T-EBTR, T-EFBC, T-ETBDH, T-FFWZ, T-ETB, T-ETYB, T-LBB, T-TJB).

The Missisquoi watershed is approximately 25% agricultural land and the Basin is the largest contributor of phosphorus to Lake Champlain among the all the lake's watersheds (Troy et al., 2007). The 2012 data show that the largest amounts of TP in the basin originate largely in the sub-watersheds of Mud Creek (T-NCMC, T-NTMC) and Hungerford Brook (T-SHCR, T-THBW, T-HBW), as well as a watershed represented by a single site, Godin Brook (T-BGB). Another area of note for high nutrient inputs is north of the mainstem in Berkshire and Richford; two sites here (T-RNB, T-BGB) showed moderate to high levels of both phosphorus and nitrogen. Average nutrient concentrations in the mainstem of the Missisquoi River were found to be lower than average concentrations in many of the tributaries.

The lowest average concentration in 2012 was found at site T-LBB (12.55 ± 2.87 µg/L) and the site with the highest average concentration, for the second year in a row, was T-SHCR (204.31 ± 48.94 µg/L). Site M-SMR, located at the mouth of the Missisquoi before it flows into Missisquoi Bay, had an average phosphorus concentration of 32.00 ± 4.44 µg/L in 2012, which is nearly 5 µg/L lower than the average observed in 2011. The individual samples taken from M-SMR varied from 21.3 µg/L (June 13, 2012) to 67.5 µg/L (September 5, 2012).

There is no State water quality standard for total nitrogen (only for nitrate nitrogen: 5 mg/L NO_3^- in most state waters), so comparing these Missisquoi nitrogen data to established criteria is not possible. In general, portions of the watershed showing increased concentrations of total nitrogen coincide with locations showing increased levels of phosphorus (Figs. 1, 2). This result, both nutrients increasing proportionately, seem to indicate that the source of nutrient enrichment in the watershed is likely agricultural runoff, rather than urban development or wastewater treatment plant effluent alone, because these point sources tend to increase nitrogen dramatically more than phosphorous alone.

As with nutrients, average turbidity values in the watershed were found to be generally higher in 2012 than in 2011. Six sites were found to have an average value for the season that exceeded the 25 NTU standard for warm water fisheries (M-WL, T-HBW, T-TJB, M-NTBF, T-NTMC, M-ER). Two sites were between 20 and 25 NTU (M-EF, T-THBW), and the rest of the sites had average turbidity values less than 10 NTU, the standard for cold water fisheries. The Missisquoi River mainstem below

Enosburg Falls is a designated warm-water fishery, but no sites along this stretch of river exceeded the 25 NTU standard for this designation.

Figures 4-6 show the overall averages of all samples taken in the previous years. The graphs represent mean values for each parameter at each site ±1 standard error of the mean. These figures show that, for many sites, water quality has remained relatively stable (M-ER, M-SMR, T-LBB, T-RNB) or improved (T-ETBDH, T-EFBC, T-ETB) from previous years of data collection. Despite this, many sites increased in mean TP concentrations in 2012. This was reflected in the data even when results from the September 5th sampling event were excluded (Figures 4c, 4d). The sites M-EF, M-NTBF, M-WL, T-BGB, T-HBW, T-NCMC, T-NTMC, T-SHCR, T-THBW and T-TJB all show increases in TP from previous years. Perhaps the most drastic increases from 2011 are seen in the sites M-WL, T-BGB, T-HBW, T-NCMC, T-SCHR and T-TJB.

Often the median value (mid-point) of a set of data is described because it is less susceptible to being skewed towards one or two outliers in a dataset (i.e. being pulled one way or another by results from extreme sampling conditions such as data from the September 5th sampling event of 2012). In order to look at the MRBA data in this slightly different way, the yearly median TP values for all sites with data from the last seven years are presented in Figure 7. These graphs show the central tendency (represented by the data point) of TP values in each sampling year, with bars that show the extent of the 25th (low) and 75th (high) percentile values from each year. This way of looking at results may be helpful for identifying long-term trends in data with high variability such as the field measurements of water quality. It can be seen in the Figure 7 graphs that many of the long-term sampling sites are generally stable, despite some year-to year variability (M-ER, M-NTBF, M-SMR, M-WL,T-ETBDH, T-LBB, T-RNB, T-SBC, T-TJB). Other sites show increasing TP levels within the last couple of years (M-EF, T-NCMC). T-EBTR has been relatively stable over the initial seven sampling years, but shows an increasing trend in TP since 2010.

Conclusion

The MRBA sampling program has proven to be a great success over the past six years not only with data collection but education and outreach as well. Numerous samples have been collected and analyzed by over two dozen volunteers who sample every two weeks throughout the summer. These data have been very useful to MRBA and other organizations that target sites in need of water quality improvement projects due to high concentrations of nutrients and sediment. Some of these projects are already underway in the Missisquoi River Basin. The MRBA Water Quality Monitoring Program hopes to continue collaboration with the Vermont DEC in 2013 to produce useful information relevant for both entities.

References:

Troy, A., D. Wang, D. Capen, J. O'Neil-Dunne and S. MacFaden. 2007. Updating the Lake Champlain Basin Land Use Data to Improve Prediction of Phosphorus Loading Lake Champlain Basin Program. Lake Champlain Basin Program, Grand Isle, VT.

Vermont Department of Environmental Concentration. Biomonitoring database. Accessed February 24, 2011.

Vermont Water Quality Standards; Vt. Code R. 12 004 052; State of Vermont Natural Resources Board, Water Resources Panel. Effective December 30th, 2011. http://www.nrb.state.vt.us/wrp/publications/wqs.pdf

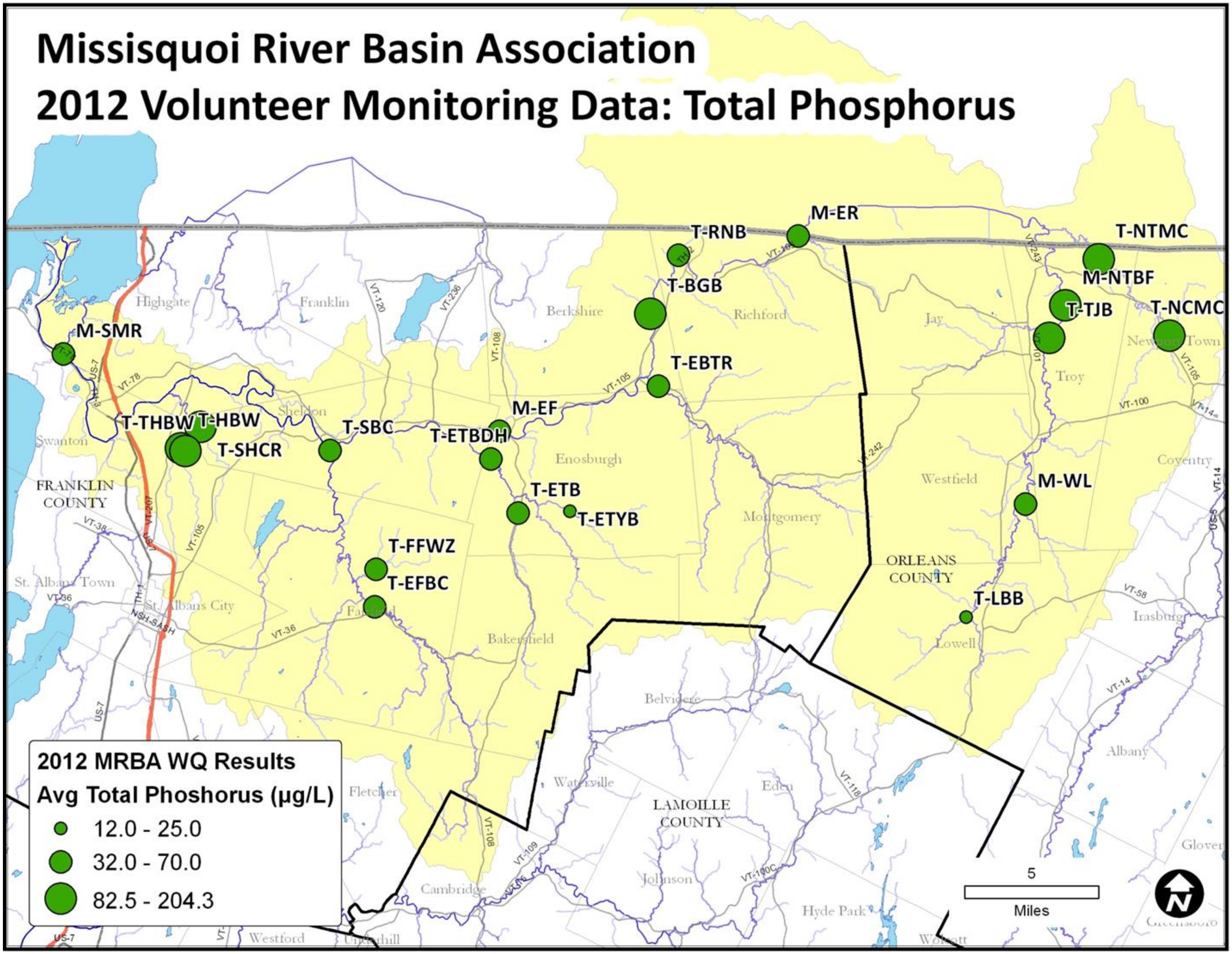


Figure 1: 2012 averages for total phosphorus (µg/L) at each sampling site. Larger dots indicate higher levels of nutrients. See Table 1 for site code names.

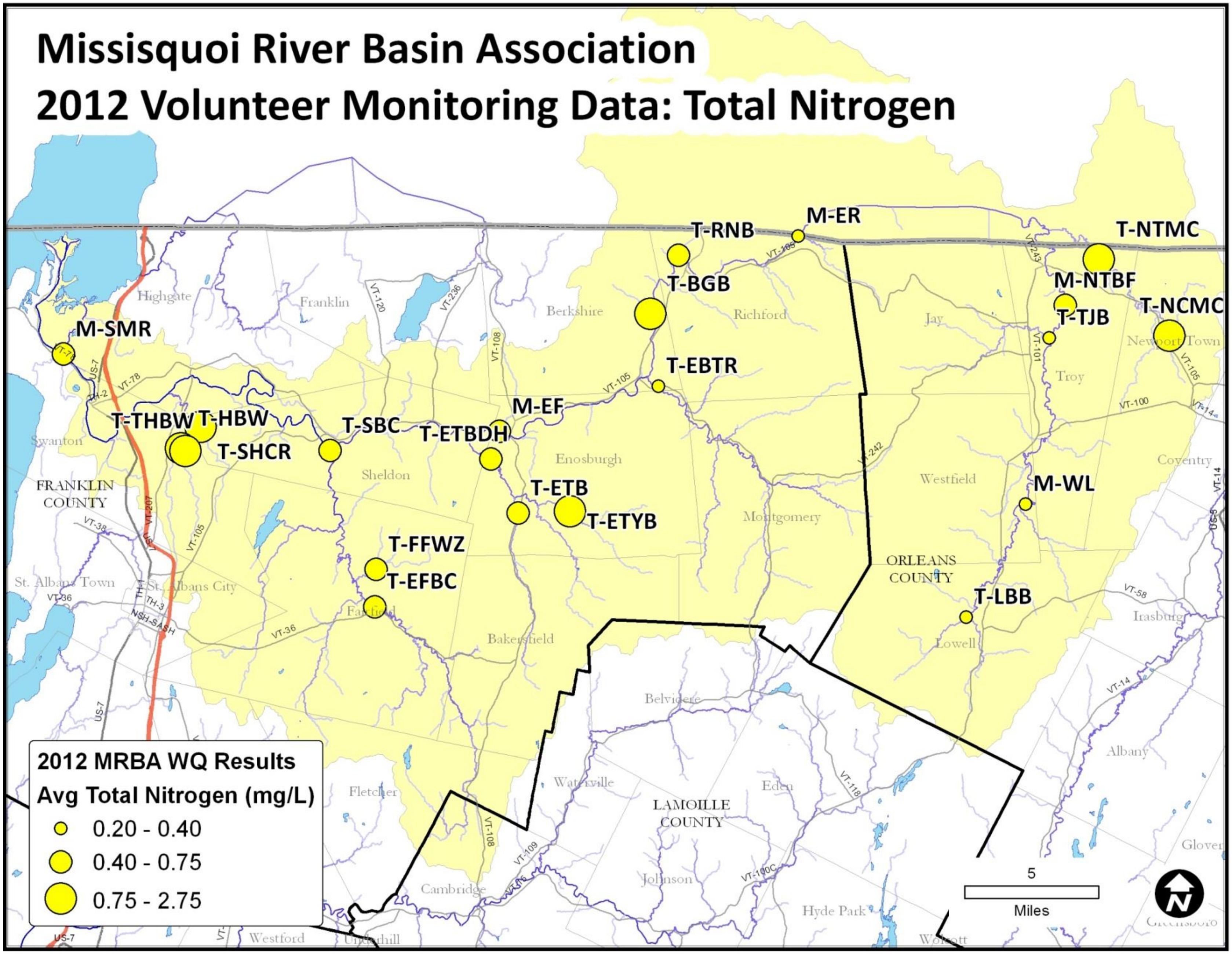


Figure 2: 2012 averages for total nitrogen (mg/L) at each sampling site.

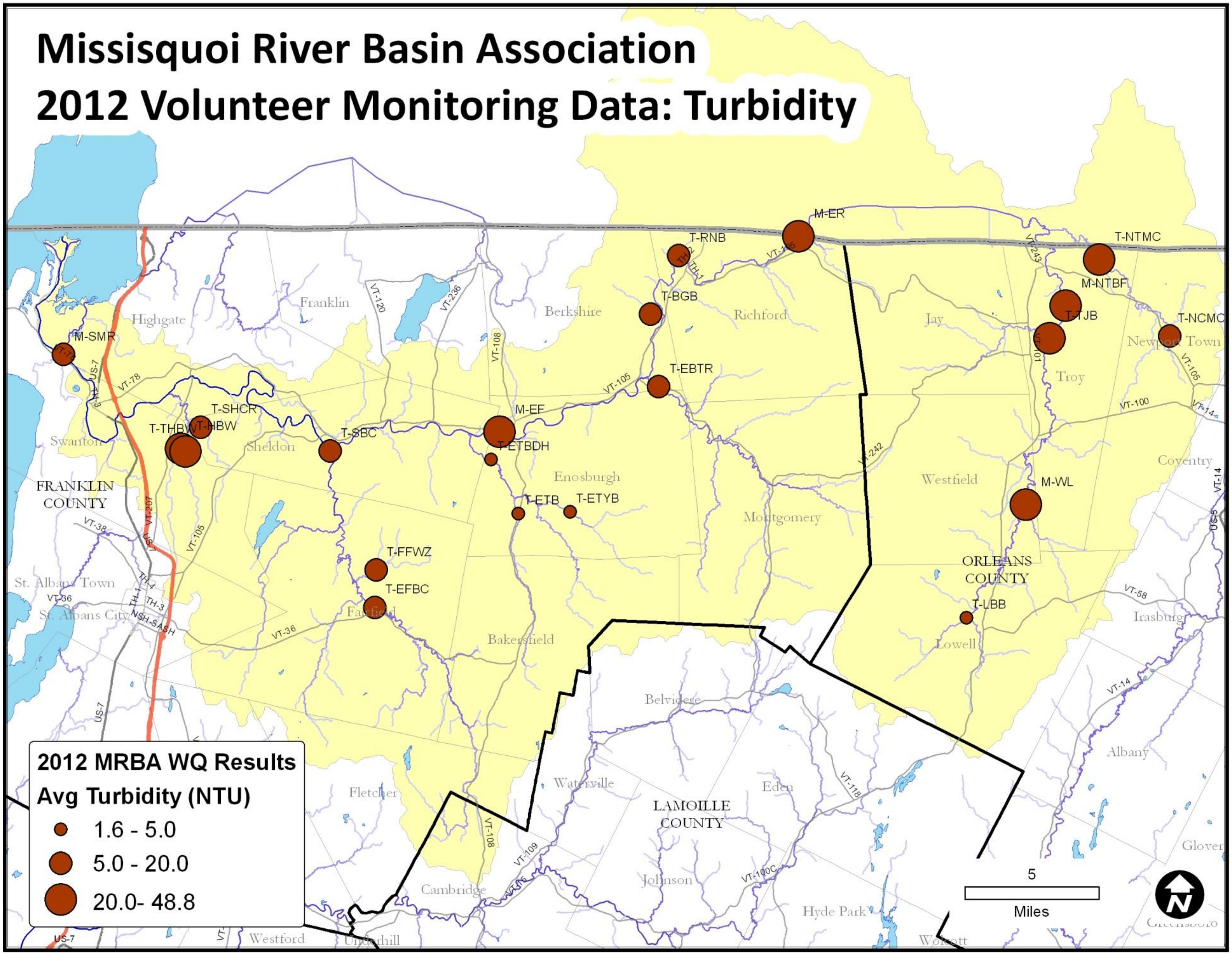


Figure 3: 2012 turbidity averages (NTU).

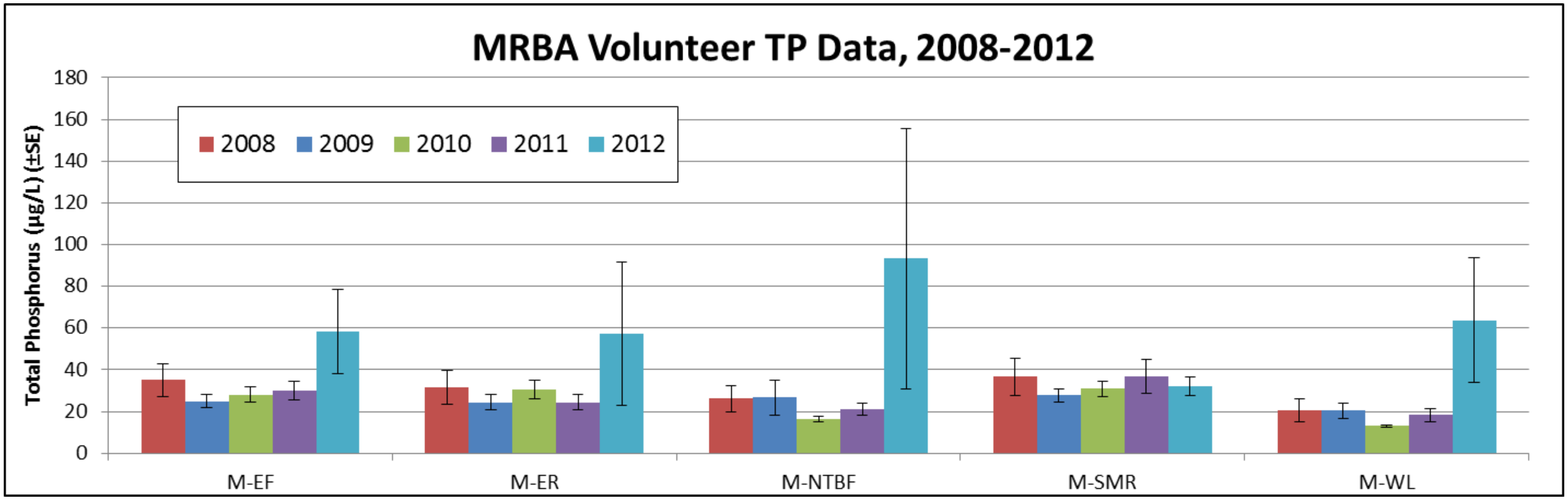


Figure 4a: Mainstem Missisquoi River averages for total phosphorus concentration in µg/L (±1 standard error of the mean) from 2008 to 2012.

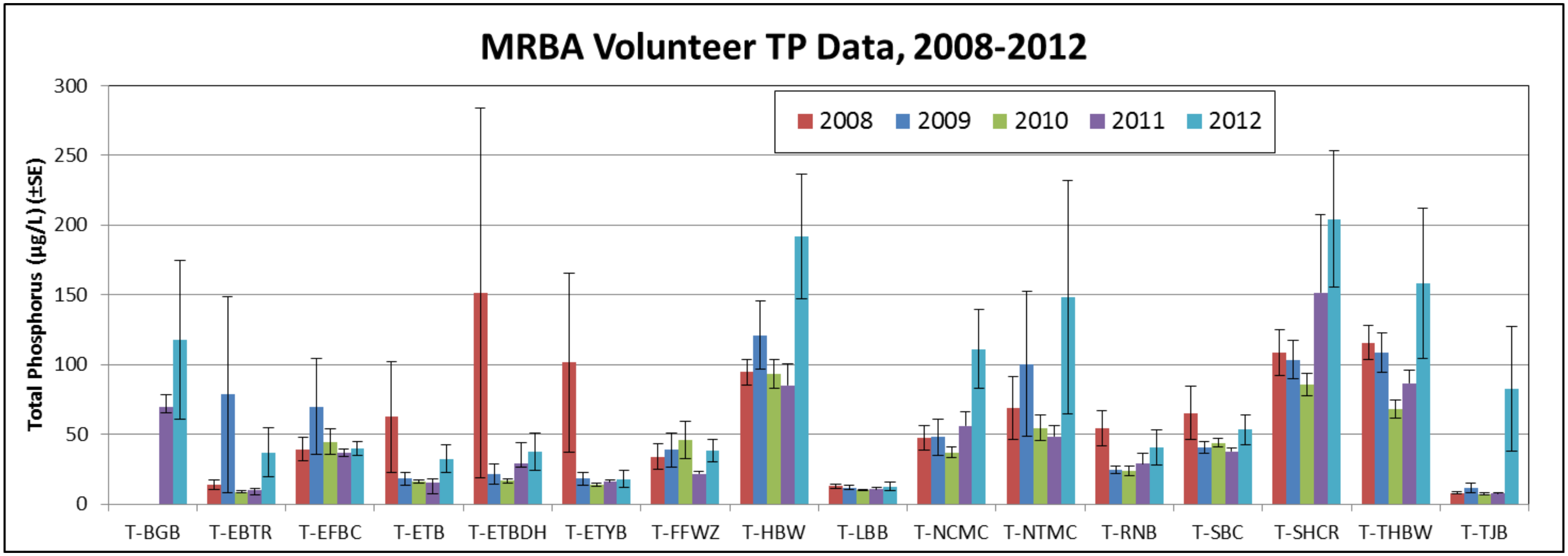


Figure 4b: Missisquoi River Tributary averages for total phosphorus concentration in µg/L (±1 standard error) from 2008 to 2012.

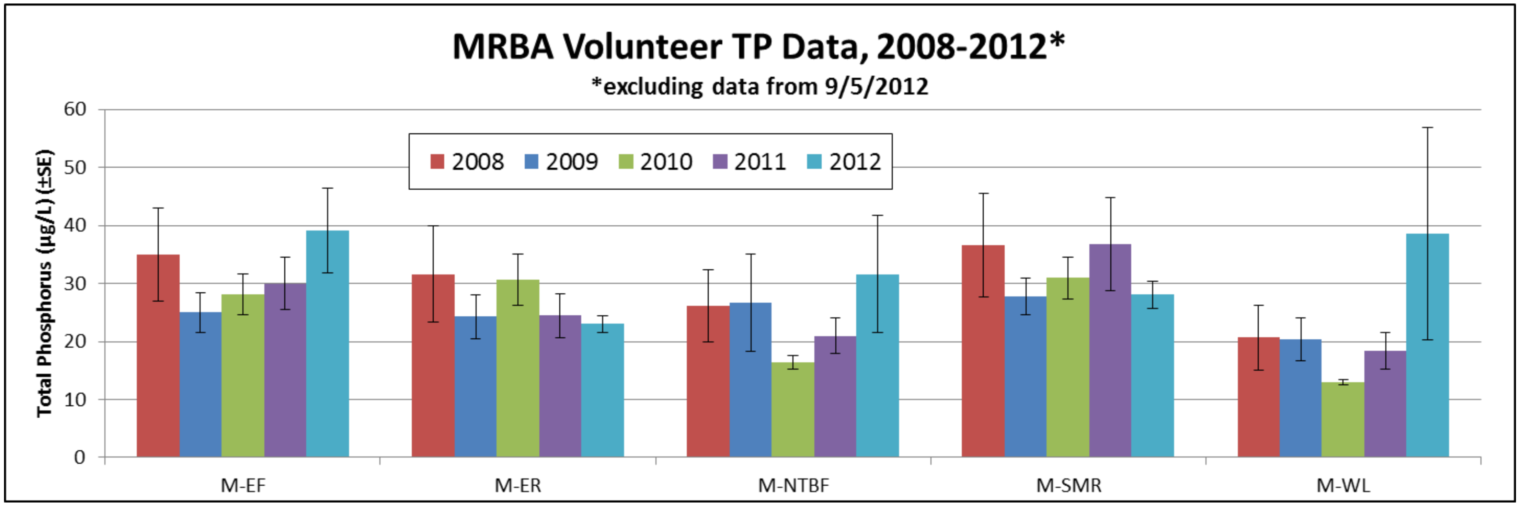


Figure 4c: Mainstem Missisquoi River averages for total phosphorus concentration in µg/L (± standard error) from 2008 to 2012, excluding sample data from 9/5/2012.

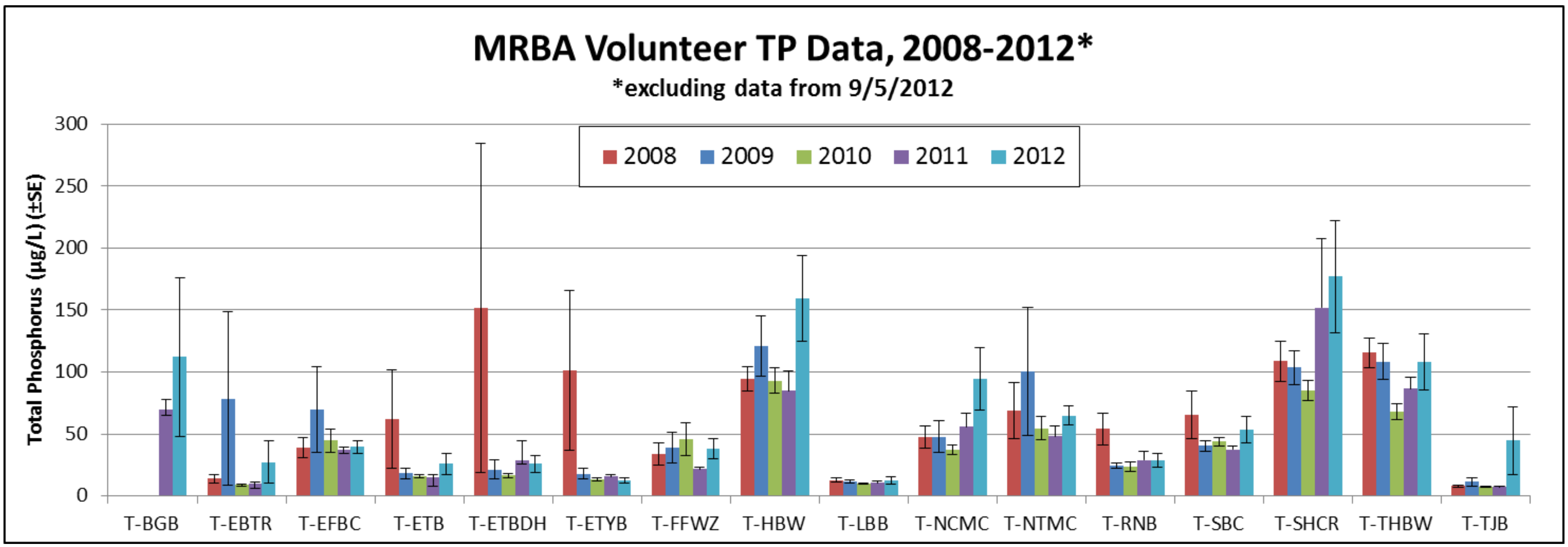


Figure 4b: Missisquoi River Tributary averages for total phosphorus concentration in µg/L (± standard error) from 2008 to 2012, excluding sample data from 9/5/2012.

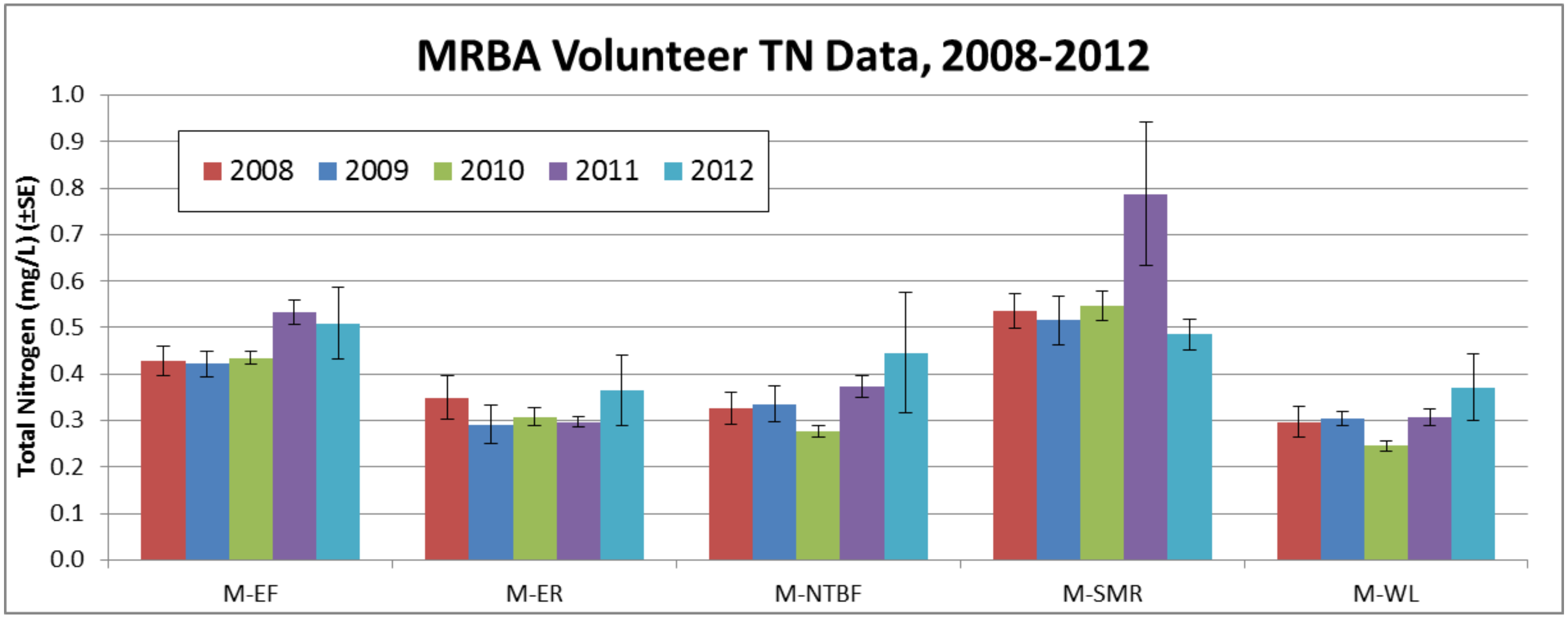


Figure 5a: Mainstem Missisquoi River averages for total nitrogen concentration in mg/L (± standard error) from 2008 to 2012.

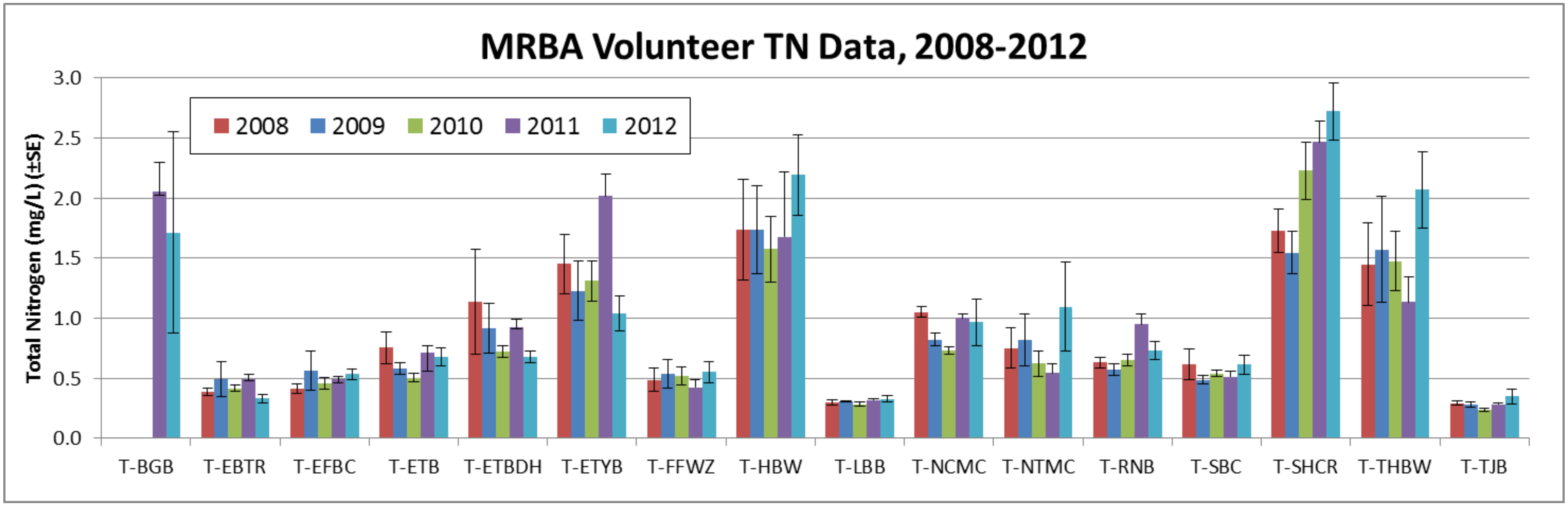


Figure 5b: Missisquoi River Tributary averages for total nitrogen concentration in mg/L (± standard error) from 2008 to 2012.

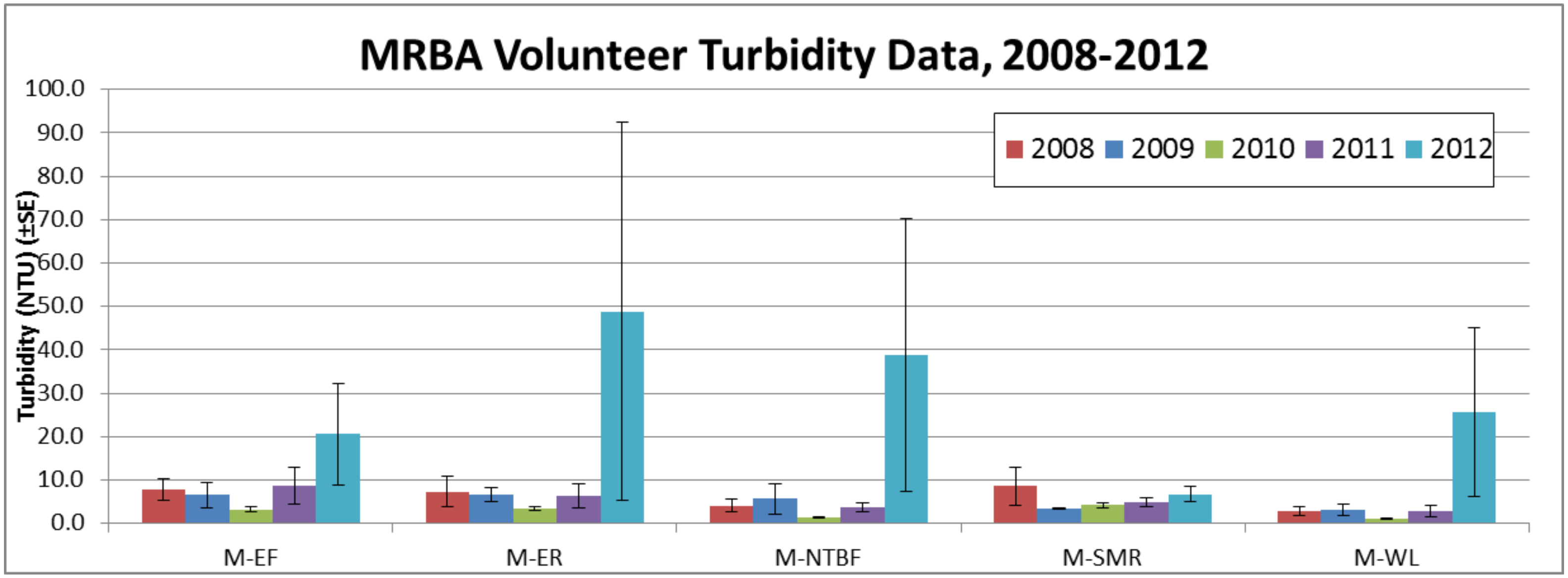


Figure 6a: Mainstem Missisquoi River averages for turbidity in NTU (± standard error) from 2008 to 2012.

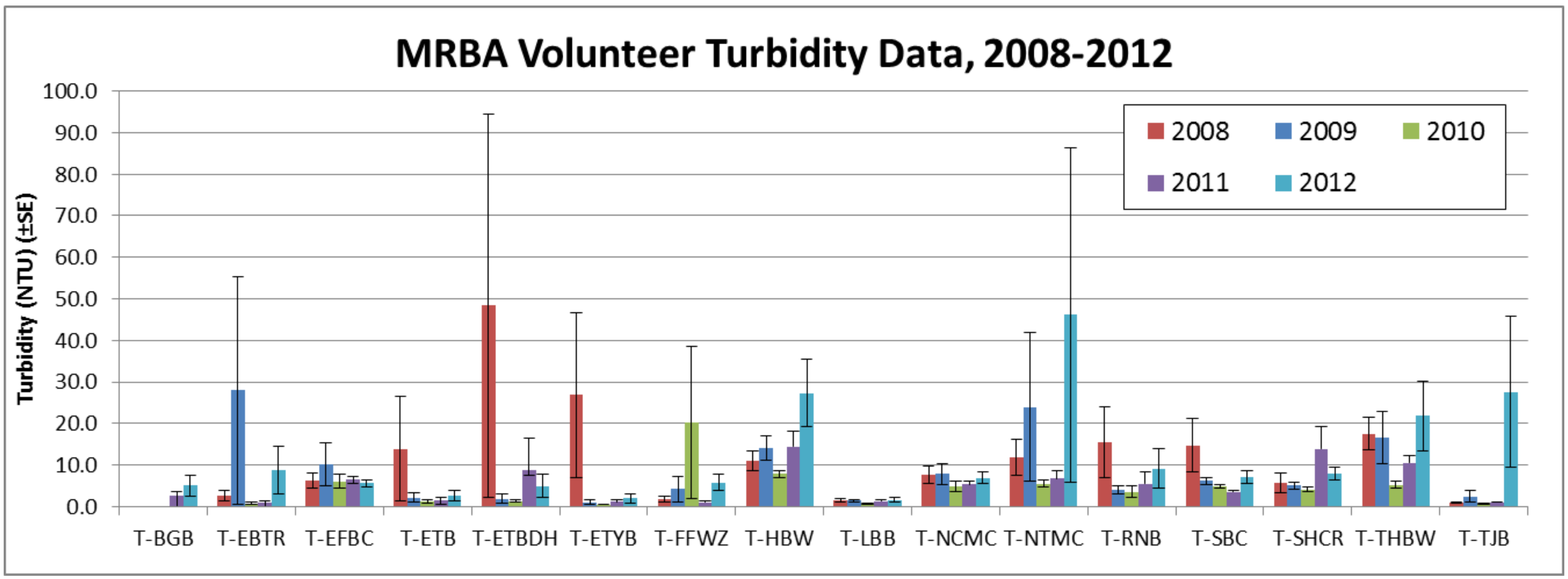


Figure 6b: Missisquoi River Tributary averages for turbidity in NTU (± standard error) from 2008 to 2012.

Figure 7 (a-m). Yearly median total phosphorus values for 13 MRBA volunteer water quality monitoring sites with at least 7 years of data. Error bars indicate the 25th and 75th percentile distribution of the yearly data. M site are mainstem and T sites are tributaries. Note that the scales vary between each graph.

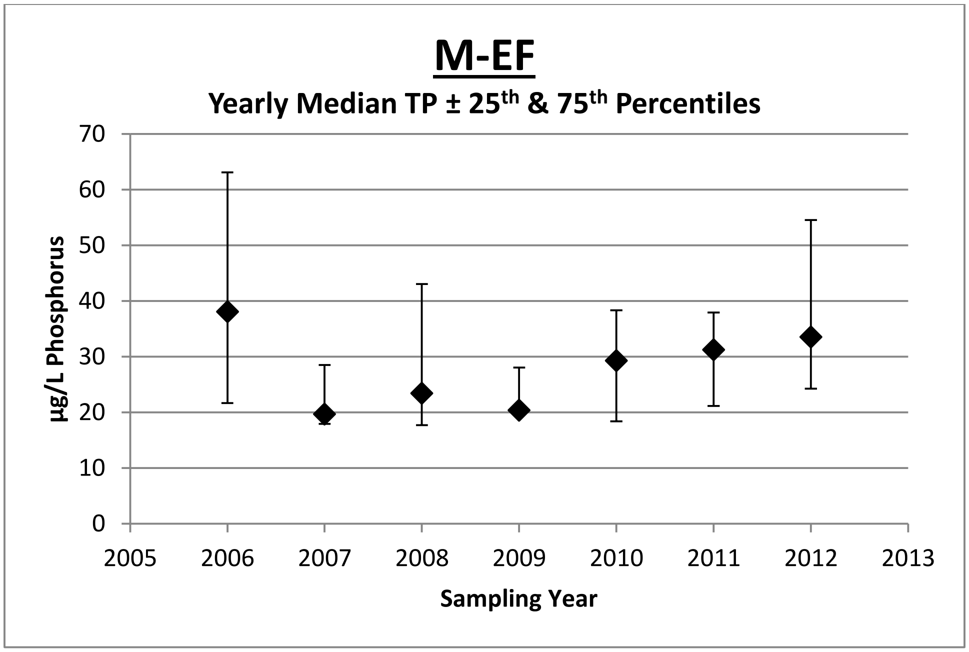


Fig 7a.

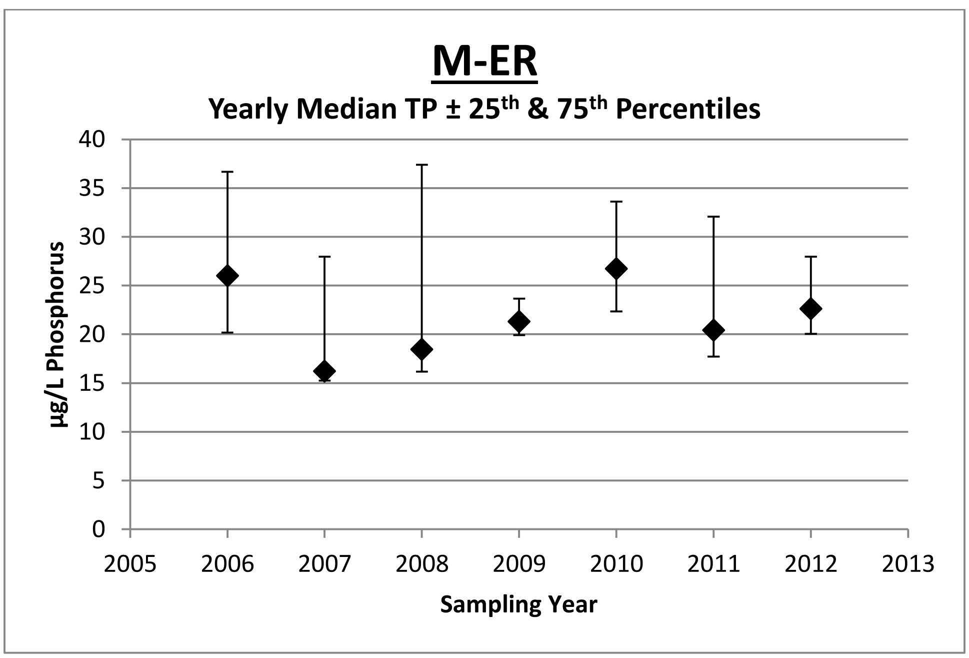


Fig 7b.

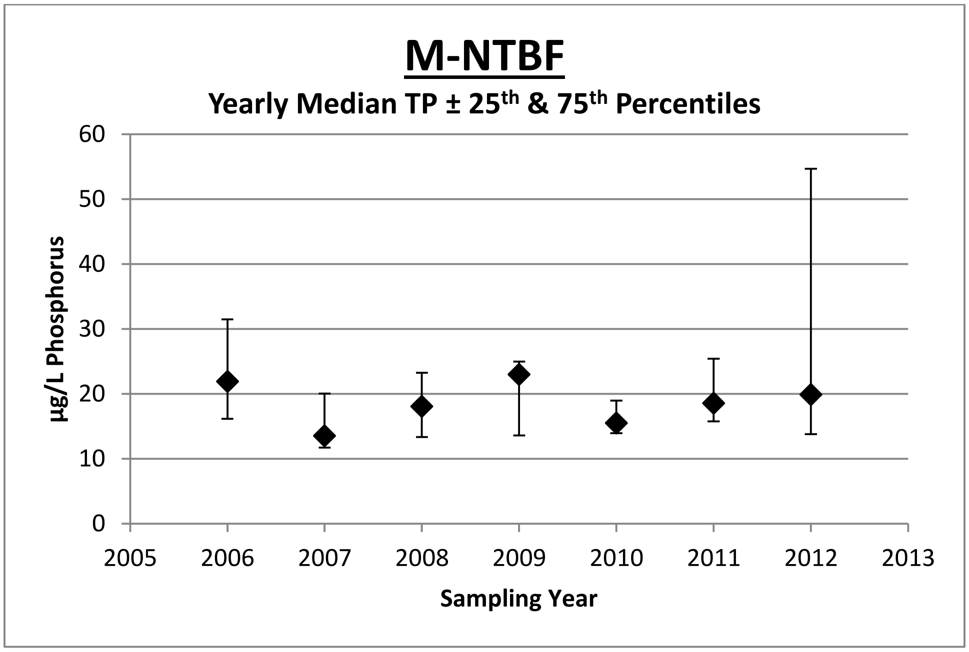

M-NTBF
Yearly Median TP ± 25th & 75th Percentiles
µg/L Phosphorus
0
10
20
30
40
50
60
2005
2006
2007
2008
2009
2010
2011
2012
2013
Sampling Year

Fig 7c.

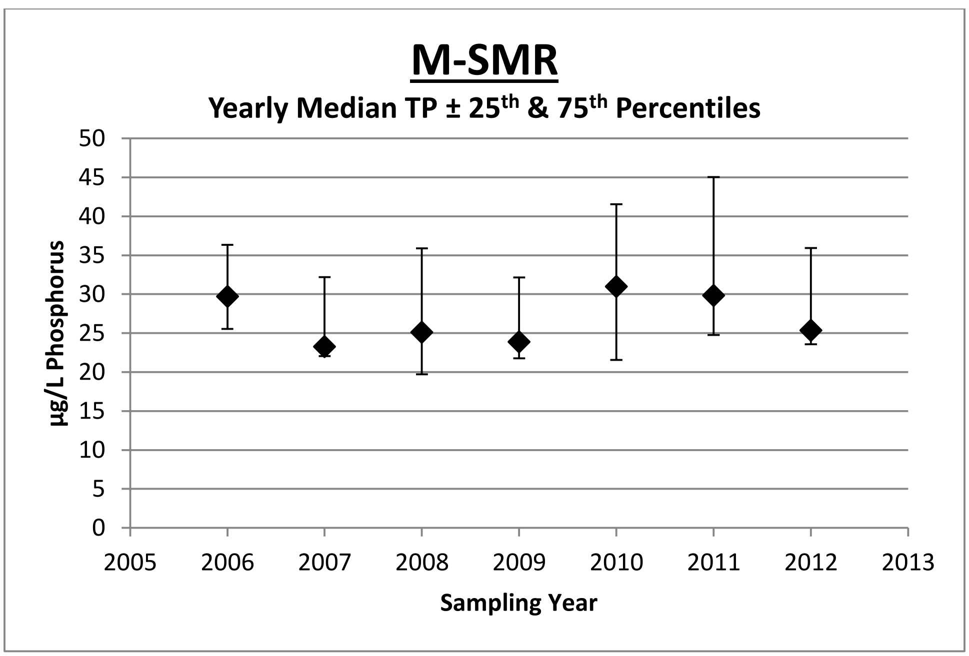

M-SMR
Yearly Median TP ± 25th & 75th Percentiles
µg/L Phosphorus
0
5
10
15
20
25
30
35
40
45
50
2005
2006
2007
2008
2009
2010
2011
2012
2013
Sampling Year

Fig 7d.

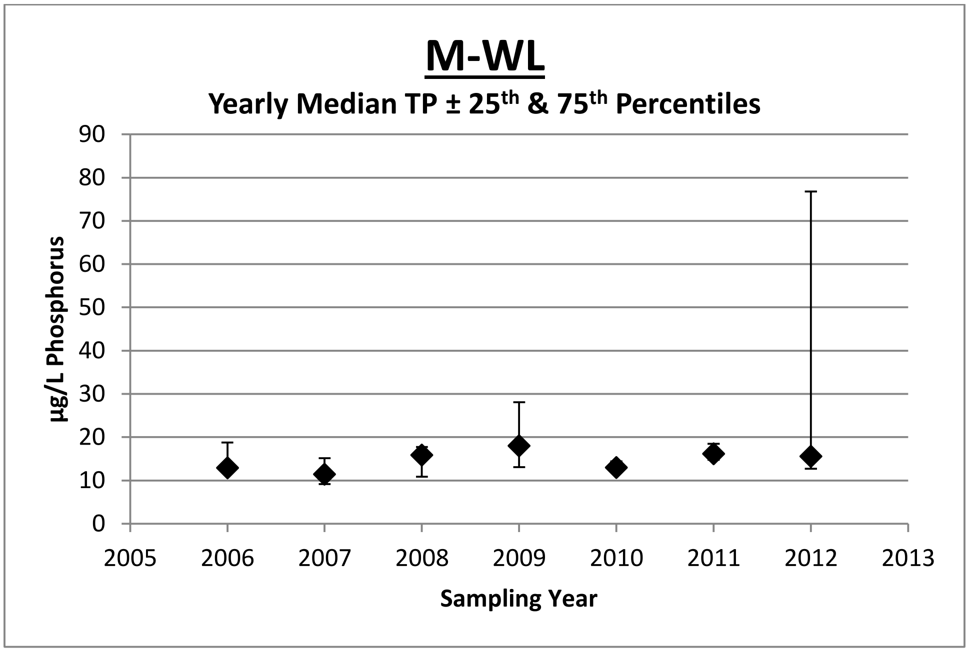

M-WL
Yearly Median TP ± 25th & 75th Percentiles
µg/L Phosphorus
0
10
20
30
40
50
60
70
80
90
2005
2006
2007
2008
2009
2010
2011
2012
2013
Sampling Year

Fig 7e.

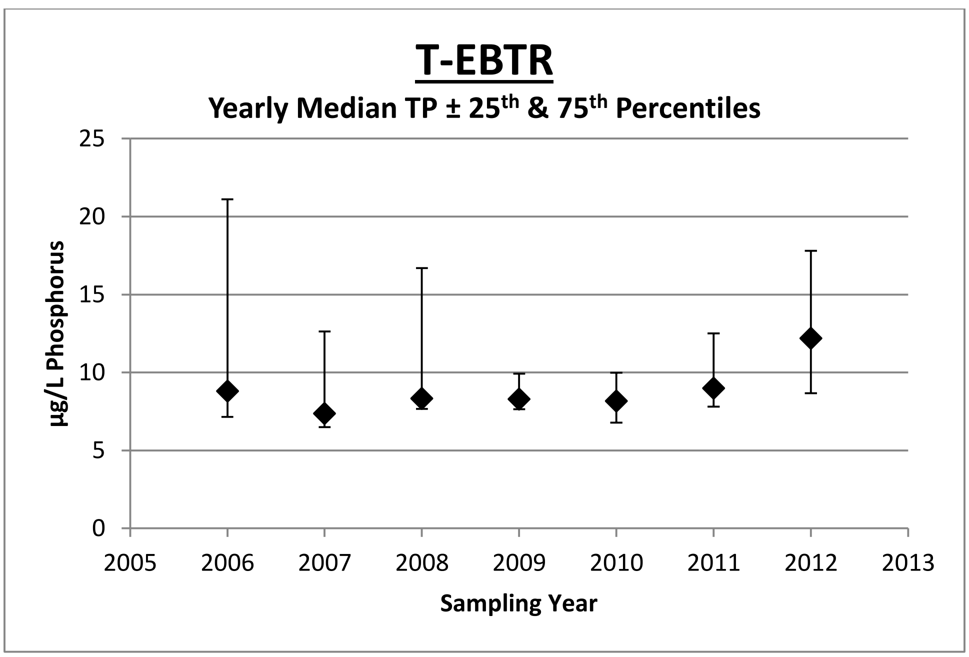

T-EBTR
Yearly Median TP ± 25th & 75th Percentiles
µg/L Phosphorus
0
5
10
15
20
25
2005
2006
2007
2008
2009
2010
2011
2012
2013
Sampling Year

Fig 7f.

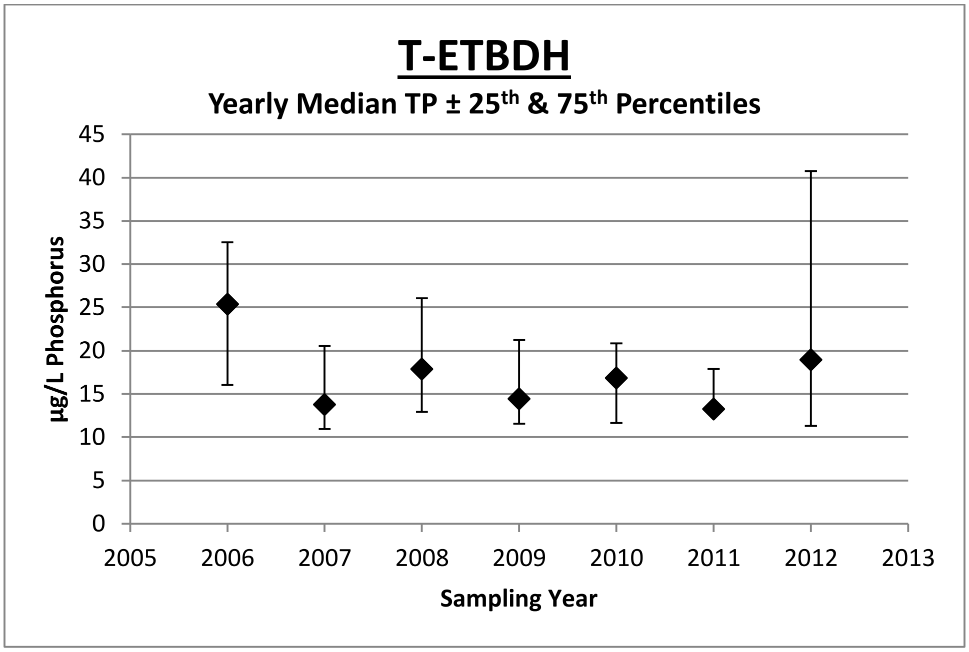

T-ETBDH
Yearly Median TP ± 25th & 75th Percentiles
µg/L Phosphorus
45
40
35
30
25
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
Sampling Year

Fig 7g.

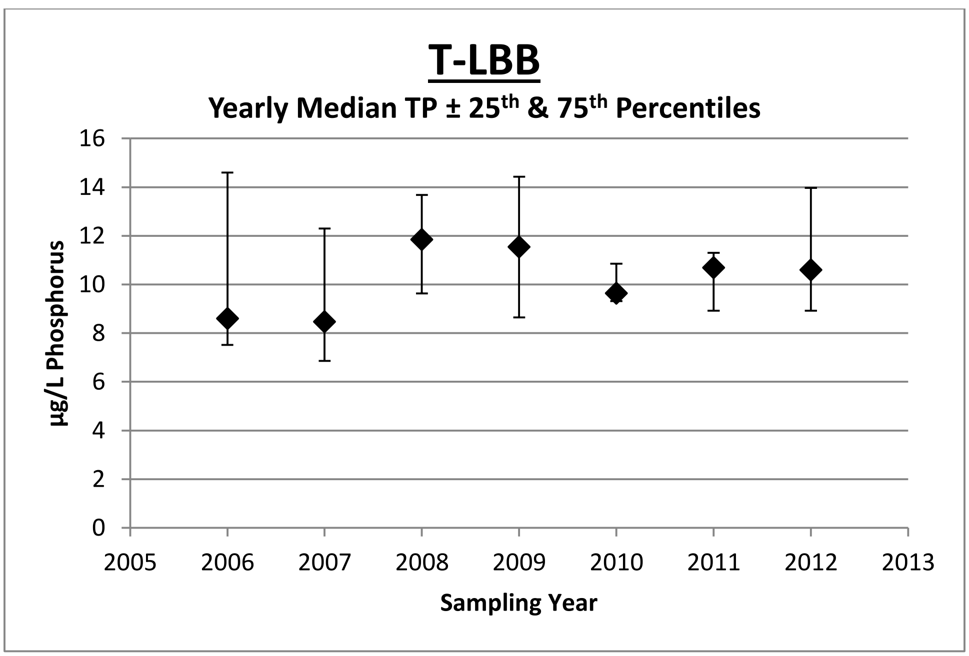

T-LBB
Yearly Median TP ± 25th & 75th Percentiles
µg/L Phosphorus
16
14
12
10
8
6
4
2
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
Sampling Year

Fig 7h.

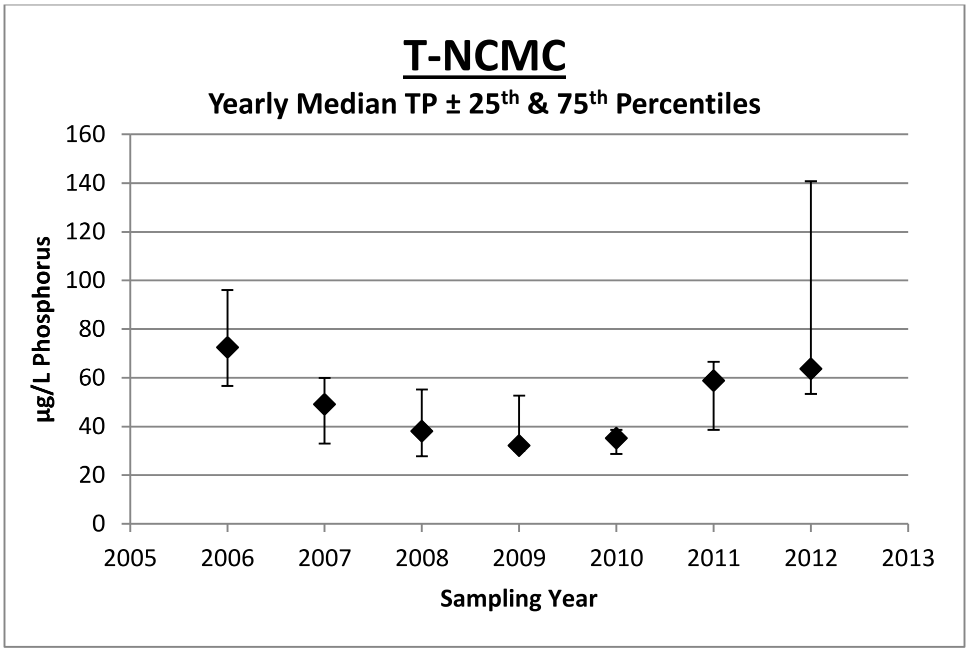

T-NCMC
Yearly Median TP ± 25th & 75th Percentiles
160
140
120
100
80
60
40
20
0
µg/L Phosphorus
2005
2006
2007
2008
2009
2010
2011
2012
2013
Sampling Year

Fig 7i.

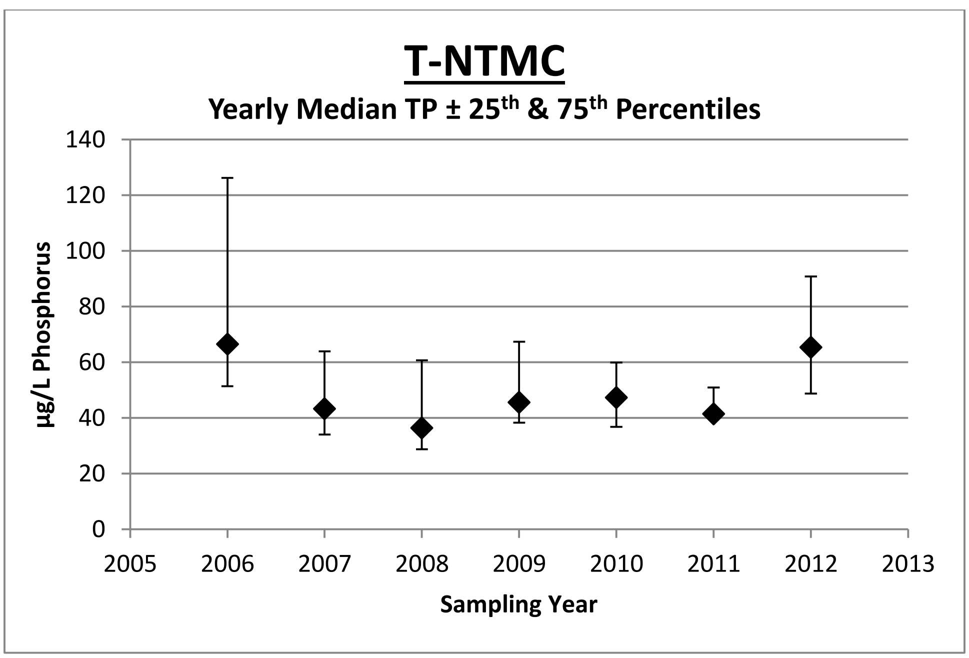

T-NTMC
Yearly Median TP ± 25th & 75th Percentiles
140
120
100
80
60
40
20
0
µg/L Phosphorus
2005
2006
2007
2008
2009
2010
2011
2012
2013
Sampling Year

Fig 7j.

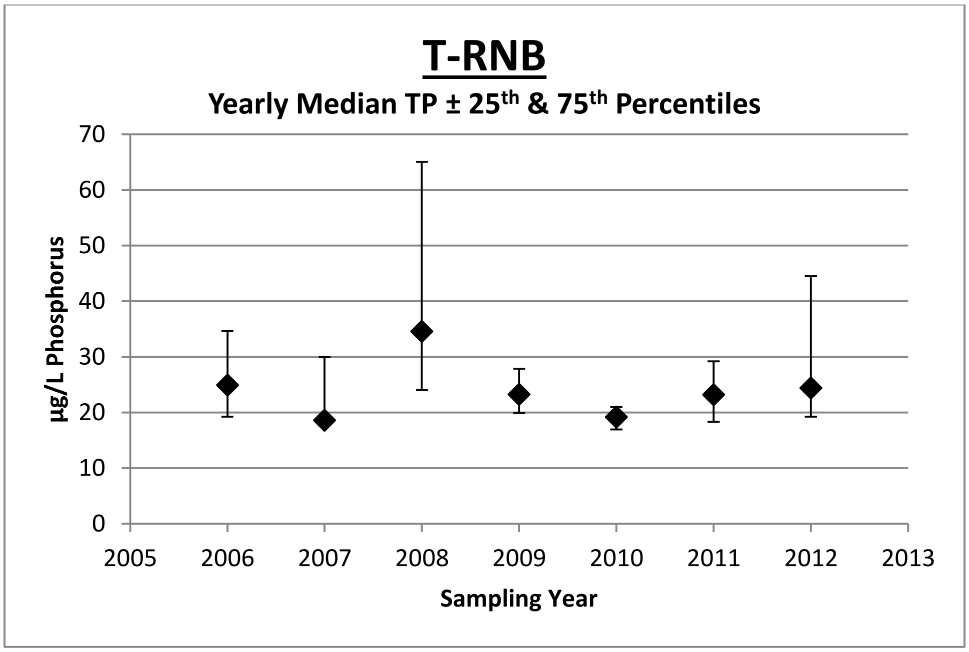

T-RNB
Yearly Median TP ± 25th & 75th Percentiles
µg/L Phosphorus
70
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
Sampling Year

Fig 7k.

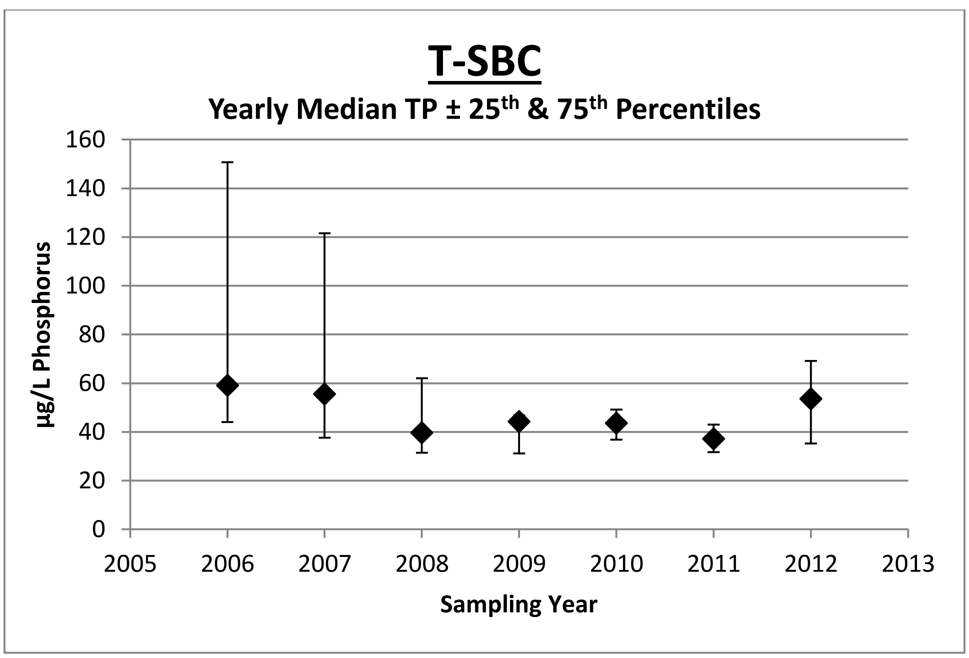

T-SBC
Yearly Median TP ± 25th & 75th Percentiles
µg/L Phosphorus
160
140
120
100
80
60
40
20
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
Sampling Year

Fig 7l.

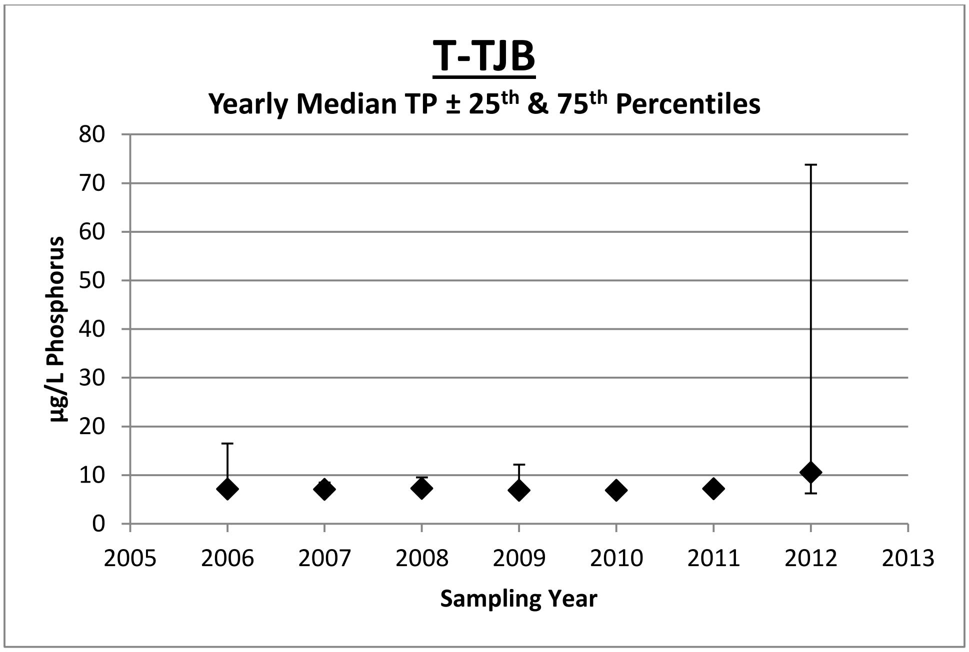

T-TJB
Yearly Median TP ± 25th & 75th Percentiles
µg/L Phosphorus
0
10
20
30
40
50
60
70
80
2005
2006
2007
2008
2009
2010
2011
2012
2013
Sampling Year

Fig 7m.

Appendix A. 2012 MRBA Volunteer Water Quality Data

Total Phosphorus (µg/L)

SiteCode	13-Jun	27-Jun	11-Jul	25-Jul	8-Aug	22-Aug	5-Sep	19-Sep	3-Oct	17-Oct	Average
M-EF	20.2	87.7	23.7	36.8	24.1	24.8	230.0	57.0	30.4	47.3	**58.2**
M-ER	17.9	28.4	21.9	26.7	19.9	18.7	367.0	29.6	23.3	20.5	**57.4**
M-NTBF		54.7	14.1	34.5	19.9	13.6	587.0	91.4	13.8	11.0	**93.3**
M-SMR	21.3	25.0	22.2	33.9	25.8	24.7	67.5	36.6	39.8	23.2	**32.0**
M-WL	12.7	154.0	13.7	19.1	15.6		264.0	76.8	9.2	7.6	**63.6**
T-LBB	11.2	25.4		10.0	8.6			14.9		5.2	**12.6**
T-ETYB	13.8	26.6	8.5	13.7	7.5	7.8	67.3	18.6	9.5	6.5	**18.0**
T-ETB	60.1	77.7	10.0	22.6	10.3	11.5	91.5	16.8	10.8	13.4	**32.5**
T-EBTR	12.2	146.0	9.4	8.5	12.3	8.7	111.0		17.8	5.0	**36.8**
T-ETBDH	19.9	42.3	12.3	74.0	10.9	18.0	143.0	36.1	11.0	8.0	**37.6**
T-FFWZ	21.3	63.3	14.6	59.0	19.3	19.3		84.0	38.1	24.3	**38.1**
T-EFBC	35.4	51.8	27.5	54.6	35.5	46.4		62.6	25.7	17.5	**39.7**
T-RNB	24.0	61.7	17.9	23.3	24.9	27.9	147.0	50.1	15.5	14.5	**40.7**
T-SBC	40.5	72.7	32.9	126.0	24.4	37.5		65.7	53.6	27.8	**53.5**
T-TJB	10.6	228.0	5.9	7.7	5.0	20.5	385.0	73.8	6.2		**82.5**
T-NCMC	39.8	61.0	51.5	274.0	59.1	42.6	260.0	153.0	104.0	66.5	**111.2**
T-BGB	65.6	560.0	36.3	58.1	48.6	35.8	160.0		65.0	28.5	**117.5**
T-NTMC	65.4	96.8	48.8	80.7	45.6	50.5	816.0		41.7	90.9	**148.5**
T-THBW	61.3	80.9	115.0	117.0	178.0	105.0	610.0	242.0	50.9	24.0	**158.4**
T-HBW	83.9	166.0	137.0	175.0	382.0	240.0	482.0	153.0	61.5	38.0	**191.8**
T-SHCR	65.3	228.0	497.0	179.0	125.0	135.0	450.0	228.0	75.5	60.3	**204.3**
Averages:											
Mainstem	18.0	70.0	19.1	30.2	21.1	20.5	303.1	58.3	23.3	21.9	**60.9**
Tributaries	39.4	124.3	68.3	80.2	62.3	53.8	310.2	92.2	39.1	28.7	**82.7**

Total Nitrogen (mg/L)

SiteCode	13-Jun	27-Jun	11-Jul	25-Jul	8-Aug	22-Aug	5-Sep	19-Sep	3-Oct	17-Oct	*Average*
M-EF	0.36	0.83	0.41	0.5	0.4	0.37	1.06	0.52	0.29	0.35	**0.5**
M-ER	0.26	0.38		0.4	0.21	0.22	0.94	0.22	0.28	0.37	**0.4**
M-NTBF		0.45	0.33	0.44	0.27	0.21	1.32	0.35	0.19		**0.4**
M-SMR	0.35	0.57	0.52	0.61	0.43	0.4	0.41	0.64	0.54	0.38	**0.5**
M-WL	0.24	0.44	0.28	0.4	0.29		0.87	0.46	0.18	0.18	**0.4**
T-BGB	1	8.33	1.08	0.8	0.5	0.35	1.62		0.81	0.94	**1.7**
T-EBTR	0.31	0.46	0.41	0.33	0.33	0.3	0.5		0.18	0.16	**0.3**
T-EFBC	0.49	0.56	0.46	0.62	0.4	0.38		0.84	0.46	0.6	**0.5**
T-ETB	0.65	0.82	0.86	0.61	0.99	0.86	0.9	0.38	0.36	0.39	**0.7**
T-ETBDH	0.78	0.82	0.81	0.64	0.71	0.68	0.9	0.51	0.44	0.53	**0.7**
T-ETYB	0.99	0.97	1.66	0.95	1.59	1.75	0.83	0.56	0.5	0.63	**1.0**
T-FFWZ	0.58	1.05	0.39	0.64	0.29	0.28		0.87	0.5	0.36	**0.6**
T-HBW	0.97	3.16	1.12	3.87	1.83	1.46	3.23	1	2.82	2.49	**2.2**
T-LBB	0.31	0.41	0.35	0.36	0.38			0.29		0.2	**0.3**
T-NCMC	0.94	0.99	0.69	1.52	0.44	0.4	2.34	1.23	0.48	0.63	**1.0**
T-NTMC	0.84	0.66	0.59	0.63	0.51	0.62	3.93		0.54	1.54	**1.1**
T-RNB	0.53	0.83	0.8	0.65	1.01	0.96	1.05	0.7	0.38	0.39	**0.7**
T-SBC	0.5	0.48	0.66	1.21	0.51	0.43		0.69	0.52	0.55	**0.6**
T-SHCR	2.09	3.31	4.31	1.73	2.79	2.22	3.13	2.2	2.89	2.56	**2.7**
T-THBW	0.99	1.69	1.11	3.35	1.63	0.86	2.65	3.69	1.99	2.73	**2.1**
T-TJB	0.27	0.47	0.31	0.29	0.31	0.24	0.78	0.35	0.12		**0.3**
Averages:											
Mainstem	*0.30*	*0.53*	*0.39*	*0.47*	*0.32*	*0.30*	*0.92*	*0.44*	*0.30*	*0.32*	***0.44***
Tributaries	*0.77*	*1.56*	*0.98*	*1.14*	*0.89*	*0.79*	*1.82*	*1.02*	*0.87*	*0.98*	***1.03***

Turbidity (NTU)

SiteCode	13-Jun	27-Jun	11-Jul	25-Jul	8-Aug	22-Aug	5-Sep	19-Sep	3-Oct	17-Oct	*Average*
M-EF	3.16	15.1	4.22	10.4	3.95	2.77	123	30.1	5.85	7.45	**20.6**
M-ER	1.76	6.38	2.71	8.92	3.97	3.19	441	11.5	4.71	3.82	**48.8**
M-NTBF		12	1.44	7.76	2.49	1.04	289	31.4	2.41	1.18	**38.7**
M-SMR	3.37	2.55	4	11.5	4.21	4.63	20.6	5.83	7.43	3.7	**6.8**
M-WL	2.25	7.43	1.93	3.32	2.14		179	31.9	1.07	0.82	**25.5**
T-BGB	2.42	9.5	1.12	1.61	0.64	0.49	6.22		23	0.71	**5.1**
T-EBTR	1.54	17.7	1.25	1.32	0.54	0.68	52.3		4.37	0.26	**8.9**
T-EFBC	4.2	7.42	3.25	10.3	4.47	4.75		8.64	5.58	1.99	**5.6**
T-ETB	1.3	4.1	0.71	1.87	0.8	0.74	13.6	1.61	0.69	0.64	**2.6**
T-ETBDH	1.56	7.27	1.52	3.31	0.9	1.06	29.3	2.69	0.84	0.61	**4.9**
T-ETYB	1.09	1.39	0.57	0.9	0.34	0.25	12.8	1.39	0.47	0.25	**1.9**
T-FFWZ	10.2	7.98	0.61	18.8	1.02	1.15		7.72	2.47	2.2	**5.8**
T-HBW	10.9	14.8	13.7	34.8	36.7	25.9	92.8	29.3	7.51	7.05	**27.3**
T-LBB	2.84	3.73	0.54	0.74	0.48			2.64		0.39	**1.6**
T-NCMC	3.14	5.33	4.42	12.3	9.45	4.97	6.1	16.5	4.39	2.06	**6.9**
T-NTMC	4.53	8.12	3.73	10.6	2.84	6.37	368		5.13	6.54	**46.2**
T-RNB	1.85	10.7	2.32	3.74	4.21	4.79	51.2	9.66	1.96	1.36	**9.2**
T-SBC	3.88	7.22	3.98	17	2.64	3.78		10.8	9.53	5.34	**7.1**
T-SHCR	3.13	5.6	12.7	10.6	8.63	6.47	13.3	14	2.57	1.81	**7.9**
T-THBW	5.87	10.6	15.4	16	17.3	8.47	77.5	63.7	1.72	1.74	**21.8**
T-TJB	1.56	56.8	0.21	1.02	0.3	0.2	182	31.7	1.25	0.84	**27.6**
Averages:											
Mainstem	*2.64*	*8.69*	*2.86*	*8.38*	*3.35*	*2.91*	*210.52*	*22.15*	*4.29*	*3.39*	***28.08***
Tributaries	*3.75*	*11.14*	*4.13*	*9.06*	*5.70*	*4.67*	*75.43*	*15.41*	*4.77*	*2.11*	***11.90***

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