Stream Water Quality Assessment of Long Point Gully, Graywood Gully, and Sutton Point: Conesus Lake Tributaries 2015

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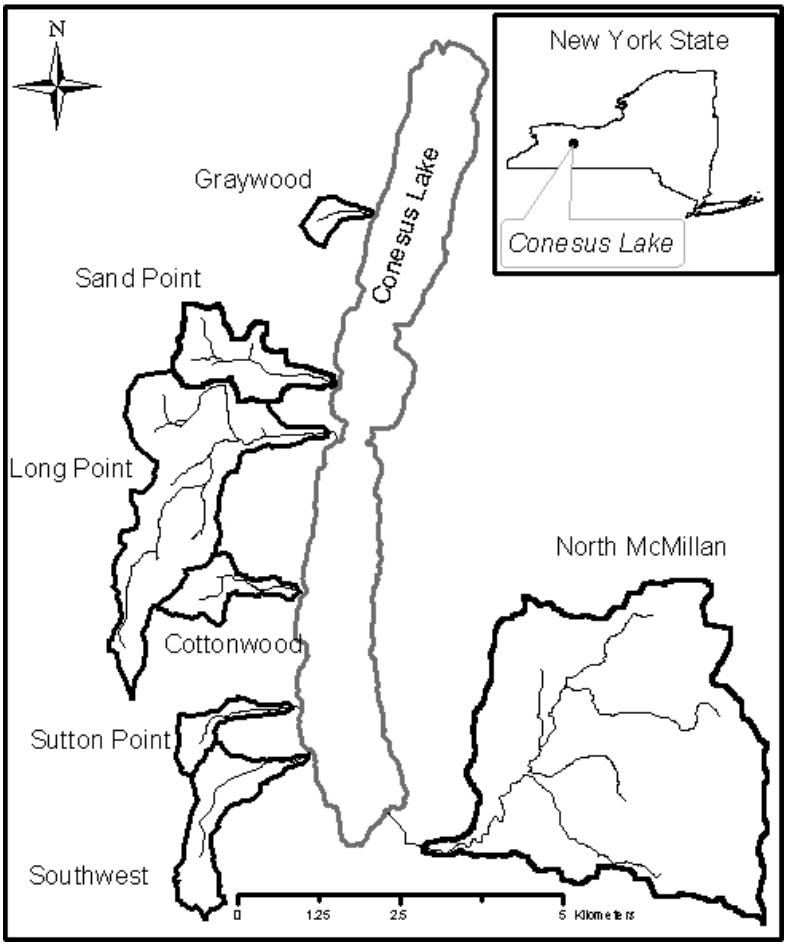

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Executive Summary

1. In 2011, Cottonwood Gully and North McMillan Creek were monitored to determine the status of these two watersheds of Conesus Lake using the newly developed Stream Water Index. In 2012, three additional watersheds (Long Point Gully, Sand Point Gully and Graywood Gully) were monitored using the assessment tool. In this study, we utilize the previously constructed Stream Water Quality Assessment Index for watershed health on three tributaries (Long Point Gully, Sutton Point and the Graywood Gully) of Conesus Lake where Best Management Practices (BMPs) were recently implemented. The implementation of this tool allows the county to evaluate the status of Conesus Lake watersheds over time; that is, are they improving, getting worse, or not changing. An evaluation using a tool of this type should provide further direction to the Conesus Lake Watershed Management Plan.

2. Long Point Gully, Sutton Point, and Graywood Gully were monitored from April to July 2015.

3. Graywood Gully was under BMP construction during the summer of 2015 while BMPs were implemented in the winter of 2014 in Long Point Gully and in the summer/fall of 2014 in Sutton Point spring of 2012 for stream discharge, nutrients, sodium, and soil loss.

4. Each stream was evaluated using the Stream Watershed Index previously developed for Conesus Lake's watersheds (Makarewicz *et al*. 2011, 2012).

5. In general, levels of total phosphorus, total suspended solids and nitrate showed improvements that may be attributed to the implementation of additional BMPs that were designed to control overland runoff and sediments. TP did not decrease in Graywood Gully

which may be due to the fact that the BMP implementation was not complete until the summer of 2015.

6. However, soluble reactive phosphorus increased in the number of red zone indicating degrading water quality for this parameter over historical values in all three watersheds in 2015.

7. Sodium, a component of deicing salt, was elevated in the stream water of Long Point Gully and Sutton Point.

Recommendations

1. Progress continues to be made in the management of the Conesus Lake watershed. This is especially true for nutrients that are associated with loss of particulate matter from the watershed as well as erosion itself.

2. BMPs that are designed specifically to control the soluble fraction of phosphorus should be considered a priority in the Conesus Lake watershed and the Soil and Water Conservation District.

3. The Stream Watershed Index appears to be a valuable tool in evaluating the watersheds of Conesus Lake, allowing comparisons with past data and thus assisting in decision making concerning watershed management.

4. The Stream Watershed Index also appears to be valuable in assessing the impact of additional BMPs implemented in the watersheds of Conesus Lake. If financially appropriate, monitoring of watersheds should continue as a mechanism to evaluate land-use practices, to advocate changes, evaluate additional BMP implementation and to assist in future planning.

Introduction

Previous reports documented substantial increases in the concentrations of nutrients and soil particles in streams during the summer of 2009 and 2010 (Makarewicz and Lewis 2009, 2010). At Graywood Gully, for example, concentrations of soil (TSS), total phosphorus (TP), soluble reactive phosphorus (SRP), total Kjeldahl nitrogen (TKN), and nitrate increased in the stream water. After a 5-year decrease at Cottonwood Gully (Makarewicz *et al*. 2009), nitrate

concentration (NO_3+NO_2) increased to levels not observed since 2003. Similar increases were observed in the Southwest, Sand Point, North Gully, Sutton Point, and Long Point subwatersheds. This was of concern as a general decrease in “concentrations” of nutrients and soil from managed watersheds was evident prior to 2009 due to management plans adopted during the USDA study (Makarewicz *et al.* 2009).

Several factors may have contributed to this observed increase in the concentration of dissolved and particulate material, some were natural (variation in rainfall amount and intensity); but others were affected by human actions (changes in land use or management practices). Although the increases observed in all the monitored streams may have been related to new or changing farming practices, it could not be ruled out that the significant rainfalls in the spring and early summer of 2009 were not the cause. A limitation of the approach taken in 2008 and 2009 was that discharge was not measured as it was in the USDA study. Concentration of analytes is a function of discharge from streams in agricultural watersheds; that is, as discharge increases, concentrations increase as more material is washed from the land and more material is dissolved. The observed increases could simply be due to the higher than usual rainfalls in May and especially in June. For example, the daily rate of precipitation in June was twice the rate for any other previous year since 2002; May precipitation was the highest since 2003. Also, a visual inspection of these watersheds in the summer of 2009 ruled out any major changes in land use. The increase in nutrient loss from all of the USDA watersheds during the summer of 2009 suggests that the approach taken of using only averaged concentration data over time to evaluate temporal trends may have been misinterpreted.

In 2010, we reevaluated the stream concentration approach to assessment of stream water by converting the data in the amount of an analyte lost from a subwatershed and applying a statistical approach that accounts for discharge. This process adjusts or weights the mean concentration and load by discharge and produces an adjusted average loss from the watershed titled the marginal mean load. Increases in total phosphorus, soluble reactive phosphorus, total suspended solids (soil loss), and total Kjeldahl nitrogen were observed in

2009 using the summer data collected via the county sampling design. However, these increases were “not” statistically significant, which implies that we cannot be sure that the increases were not random effects.

The results from 2011 indicated that improvements in stream water quality observed during and after implementation of the USDA Best Management Plans were being maintained into 2011 for Cottonwood Gully and North McMillan Creek. Levels of total phosphorus, total suspended solids, total Kjeldahl nitrogen, sodium, and nitrate were at levels that indicate BMPs implemented earlier were successful. The results, however, for soluble reactive phosphorus, an element controlling phytoplankton growth in Conesus Lake, indicated that the loss of SRP from the watershed was often above historical concentrations from the 2003 to 2007 period – the period when BMPs were initiated. North McMillan Creek and its watershed are the most forested and had the least amount of agriculture of all the subwatersheds of Conesus Lake. This watershed was the control watershed used in the USDA study. In 2011, the spring data for TP, SRP, TKN, nitrate, and TSS indicated that the quality of the water leaving this watershed was not degraded and had not changed from the 2003 to 2007 period. The exception to this trend was sodium. Application of deicing salt on roads during the snow and ice period is quite common and expected by the public in the Finger Lakes Region.

The results from 2012 indicated that the levels of nutrients and soils losses from Graywood, Long Point, and Sand Point Gullies were generally at or below levels observed during baseline conditions during the 2002 to 2007 period. However, elevated levels of total phosphorus, soluble reactive phosphorus, nitrate and occasionally total Kjeldahl nitrogen were observed during rain events. Sodium, a component of deicing salt, was elevated in the stream water of Sand Point and Long Point Gullies.

The 2015 objective was:

to utilize the previously constructed Stream Water Quality Assessment Index for watershed health on three tributaries (Long Point Gully, Sutton Point and the Graywood Gully) of Conesus Lake where Best Management Practices (BMPs) were recently implemented. The implementation of this tool allows the county to evaluate the status of watersheds; that is, are they improving, getting worse, or not changing. In addition, these tools can be used to evaluate the impact of known changes in watersheds, such as BMPs, on water quality.

Methods

Stream samples were taken at three former USDA monitoring sites (Makarewicz et al. 2009) at the base of the Long Point Gully, Sutton Point and the Graywood Gully sub-watersheds (Fig. 1). Water samples were taken weekly from 29 April to 14 July 2015. In addition, discharge measurements were taken using measured stream levels at the time of sampling. These levels were converted to discharge using rating curves and statistical relationships developed during the five years of intensive stream monitoring from 2002 to 2006. A total of fourteen sets of water samples were taken 6 of which were under event conditions, samples were preserved, and analyzed using approved standard methods (APHA 1999). Sample water for dissolved nutrient analysis (SRP, NO_3+ NO_2) was filtered immediately on site with 0.45-µm MCI Magna Nylon 66 membrane filters and held at 4°C until analysis the following day. Stream samples were analyzed for TP (APHA Method 4500-P-F), TN (APHA Method 4500-N-C), NO_3+ NO_2 (APHA Method 4500-NO_3-F), and TSS (APHA Method 2540D). Except for TSS, analyses were performed on a Technicon AutoAnalyser II. Method Detection limits were as follows: SRP (0.48 µg P/L), TP (0.38 µg P/L), NO_3+ NO_2 (0.005 mg N/L), TN (0.15 µg N/L), and TSS (0.2 mg/L).
In previous iterations of the Stream Water Quality Index, total Kjeldahl nitrogen was used. Our laboratory has discontinued this parameter due to the hazardous nature of the waste stream and is now measuring total nitrogen. Total nitrogen is reported in this study but there is not enough data to construct an index for this parameter yet.

Quality Control:

All water samples were analyzed at the Water Chemistry Laboratory at The College at Brockport, State University of New York within approved sample handling times. All quality control (QC) measures are assessed and evaluated on an on-going basis. Method blanks, duplicate samples, laboratory control samples, and matrix spikes are performed at a frequency of one per batch of 20 or fewer samples. Analytical data generated with QC samples that fall within prescribed acceptance limits indicate the test method was in control. For example, QC limits for laboratory control samples and matrix spikes are based on the historical mean recovery plus or minus three standard deviations. QC limits for duplicate samples are based on the historical mean relative percent difference plus or minus three standard deviations. Data generated with QC samples that fall outside QC limits indicate the test method was out of control. These data are considered suspect and the corresponding samples are reanalyzed.

Results and Discussion

Use of a Stream Watershed Index

Some of this material has been included in previous reports but it is included here for completeness and context. In 2011, we developed a graphical index of discharge versus concentration based on spring data from 2002 to 2006 (Makarewicz *et al.* 2011). Figure 2 shows the Cottonwood Gully data grouped by regression lines using the Pre-BMP and Post-BMP data from the USDA work of Makarewicz *et al.* (2009). From this graphic, it is evident analyte concentration varied over time and with discharge - in general, the higher the discharge the higher the analyte concentration. Also, concentration was higher early in the USDA study period prior to BMP introduction and was reduced after the BMPs were implemented.

This approach was further modified in Figure 3. This figure represents the regression line of all measurements at Cottonwood Gully made during the spring period of 2003 to 2007. The curved lines below and above the middle line represent the 99% confidence interval. If an analyte concentration is in the dark red area and above the upper 99% confidence interval, the water quality of this stream discharging into Conesus Lake would be considered degraded or

having a reduction in water quality compared to the 2003-2007 period. If the analyte concentration was below the lower 99% confidence interval and in the green area, water quality of the stream discharging into Conesus Lake is improving. If analyte concentrations fall within the 99% confidence interval, there is no certainty whether the stream water is improving or degrading. For example, the data for spring 2011 are plotted as triangles. The preponderance of the points is in the green area of the graph suggesting the loss of total phosphorus from the Cottonwood watershed is below the Pre-BMP period; thus the water quality of the stream is better than it was historically and therefore improving. This approach provides a mechanism to evaluate trends, improving, not changing, or degrading, in a given watershed over time as compared to the 2003-2007 baseline periods.

Monitoring Trends

Graywood Gully

As part of the USDA project, extensive BMPs were applied to this watershed dominated by agriculture in 2002 and 2003. Major decreases in all nutrient and soil losses were observed when the BMPs were initiated. In 2015, a majority of both SRP (86%) and TP (57%) concentrations were in the red or degrading conditions zone. This is a reversal from the spring of 2012, where less than 36% of the stream phosphorus samples were in the red zone. Nitrate, TSS and sodium all improved from 2012 with all readings except TSS during the event on 8 June 2015 in the no change to improving zones.

During the summer of 2015, a low profile water and sediment basin or terrace outlet diversion was installed in the Greywood subwatershed. The basin was sized to handle storm water runoff from a 25 year storm event (Robert Stryker, Livingston County SWCD, personal communication). It is possible that the pre-construction for this BMP affected some of the phosphorus concentrations and the single high TSS concentration but the results of the other parameters suggest continued success from BMPs implemented in the early 2000's.

Long Point Gully

Dairy cattle were removed from the Long Point Gully watershed in 2002, and there was a 37% reduction in crop acreage by 2003. Major reductions in nitrate (42%), TP (36%), and SRP (53%) concentrations were observed within a year of implementation.

A series of three larger low profile water and sediment basin or terrace outlet diversions, sized to handle a 10 year storm event, were installed in the Long Point subwatershed during the summer/fall of 2014 (Robert Stryker, Livingston County SWCD, personal communication).

In 2015, TP and nitrate showed marked improvement over values measured in 2012. The percentage of TP measurements in the degrading (red) zone decreased from 36% in 2012 to 14% in 2015. Similarly, red zone nitrate levels decreased from over 50% in 2012 to 0% in 2015. The percentage of degrading zone readings for TSS stayed the same for both years but in 2015 an extremely high TSS concentration of 5345 mg/L was recorded from the event on 8 June 2015. The percentage of SRP red zone readings increased from 2012 (29%) to 2015 (71%). With the exception of the single very high TSS concentration observed, the results are indicative of water quality improvements from that type of BMP implementation. That is, a BMP that is designed to reduce overland runoff and sediment. There appears that there is work still to be done to address the loss of the soluble form of phosphorus in this watershed.

Over 72% of the sodium stream samples taken were in the red zone (degrading conditions) for sodium.

<u>Sutton Point</u>

Sutton Point is a small watershed that is 76% in agriculture. During the USDA study no physical infrastructure improvements were implemented in Sutton Point. However, the progressive conversion of large portions of cropland in this watershed to a long-term vegetative type crop (60.3% as alfalfa-grass hay by 2007) was related to major reductions in TSS (72%), TKN (33%), and NO3 (39%) (Makarewicz et al. 2009).

A series of seven similar low profile water and sediment basin or terrace outlet diversions, sized to handle a 10 year storm event, were installed in the Sutton Point subwatershed in late

December 2014. This was implemented to address runoff concerns on 90 acres of prime farmland (Robert Stryker, Livingston County SWCD, personal communication).

This is the first time that Sutton Point has been evaluated after the Stream Water Quality Assessment Index was developed. The two parameters associated with erosion and particulate matter, TP and TSS were reduced from historical levels in that only 29% of the TP and 21% of the TSS readings were in the red zone or degrading category. Similarly, nitrate had only 7% of its readings in the red zone. These results may be due to the implementation of the BMPs in 2014. Conversely, SRP had 64% and sodium had 71% of their readings in the red zone in 2015.

Conclusions/Limitations

Much of the following has been discussed previously (Makarewicz *et al*. 2011). The preferred approach to evaluate the streams is to sample the entire year during nonevents and events as was done during the USDA project (Makarewicz *et al*. 2009). However, the cost of this approach is beyond the means of Livingston County. As an alternate approach, the Stream Water Quality Assessment Index was developed and appears to be a viable tool for evaluating changes in the water quality of the USDA streams. The Water Quality Assessment Indices also seem to be a reasonable way to evaluate the impacts of additional BMP implementations. Any decisions on water quality should be based on the preponderance of sampling results (points) for a given period of time. The larger the number of sampling points over various flow or discharge regimes, the better this tool will be for evaluating status of the streams.

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Table1. Data collected from 29 March to 14 July 2015 at the Graywood Gully watershed of Conesus Lake. TP=total phosphorus, TSS=total suspended solids, TN= total nitrogen, SRP=soluble reactive phosphorus.

Date		Discharge (m^3/d)	TP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	Sodium (mg/L)	SRP (µg P/L)	TN (mg N/L)
4/29/2015	Non-event	745	266.5	0.14	2.6	34.13	177.1	2.74
5/7/2015	Non-event	254	192.8	0.97	2.6	35.41	24.1	2.02
5/14/2015	Non-event	745	294.4	1.26	5.3	30.41	113.7	2.52
5/20/2015	Non-event	1,153	402.6	1.01	11.2	46.52	370.9	2.15
5/27/2015	Non-event	184	384.6	0.27	2.4	63.38	252.0	0.99
6/1/2015	Event	2,542	381.5	3.49	37.0	26.02	381.5	6.59
6/4/2015	Non-event	1,389	567.0	3.63	11.5	41.32	356.4	6.39
6/8/2015	Event	1,736	646.4	3.86	1000.0	23.10	388.6	6.50
6/9/2015	Event	1,736	823.4	2.33	36.5	41.46	256.7	2.96
6/15/2015	Event	3,002	387.4	4.36	32.0	32.83	307.2	5.43
6/24/2015	Non-event	745	319.7	5.96	11.1	47.56	165.0	8.49
7/1/2015	Event	5,376	505.5	2.50	33.8	27.04	245.3	3.27
7/7/2015	Non-event	218	375.8	2.86	6.4	48.35	269.3	3.33
7/14/2015	Event	5,537	335.2	1.09	54.4	40.13	195.6	1.54

Table 2. Data collected from 29 March to 14 July 2015 at the Long Point Gully watershed of Conesus Lake. TP=total phosphorus, TSS=total suspended solids, TN= total nitrogen, SRP=soluble reactive phosphorus.

Date		Discharge (m^3/d)	TP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	Sodium (mg/L)	SRP (µg P/L)	TN (mg N/L)
4/29/2015	Non-event	11,388	11.7	0.48	2.8	38.00	11.7	1.03
5/7/2015	Non-event	3,203	32.2	0.22	17	33.27	0.0	0.22
5/14/2015	Non-event	6,803	25.3	0.65	2.5	48.43	3.5	1.02
5/20/2015	Non-event	935	58.1	0.40	2.6	46.34	36.6	2.15
5/27/2015	Non-event	0	DRY	DRY	DRY	DRY	DRY	DRY
6/1/2015	Event	18,000	146.8	3.50	52.0	30.27	66.3	6.59
6/4/2015	Non-event	7,626	52.7	1.14	2.6	34.23	49.4	3.12
6/8/2015	Event	14,701	1618.2	1.90	5345.0	21.89	85.6	2.53
6/9/2015	Event	14,701	240.1	1.82	100.0	44.47	139.5	2.72
6/15/2015	Event	36,349	97.8	2.26	41.5	14.54	84.0	2.43
6/24/2015	Non-event	11,046	89.9	1.64	9.8	31.87	40.9	2.12
7/1/2015	Event	35,737	284.5	1.27	296.0	23.23	65.9	1.97
7/7/2015	Non-event	1,629	73.1	1.33	2.5	31.67	58.7	1.33
7/14/2015	Event	3,776	88.7	0.94	27.6	31.17	39.8	1.06

Table 3. Data collected from 29 March to 14 July 2015 at the Sutton Point watershed of Conesus Lake. TP=total phosphorus, TSS=total suspended solids, TN= total nitrogen, SRP=soluble reactive phosphorus.

Date		Discharge (m^3/d)	TP (µg P/L)	Nitrate (mg N/L)	TSS (mg/L)	Sodium (mg/L)	SRP (µg P/L)	TN (mg N/L)
4/29/2015	Non-event	959	16.8	0.44	2.3	23.98	6.2	0.62
5/7/2015	Non-event	389	27.2	0.29	11.4	21.19	3.7	0.29
5/14/2015	Non-event	959	21.1	0.36	1.4	23.55	7.9	0.37
5/20/2015	Non-event	1,462	41.6	0.30	9.7	28.32	37.3	0.50
5/27/2015	Non-event	0	DRY	DRY	DRY	DRY	DRY	DRY
6/1/2015	Event	3,645	66.3	3.46	15.0	22.62	27.5	6.73
6/4/2015	Non-event	1,777	43.4	1.15	3.5	20.98	43.4	3.04
6/8/2015	Event	2,278	66.3	1.87	28.8	18.47	50.1	2.45
6/9/2015	Event	2,278	94.6	2.20	67.0	24.58	30.5	2.26
6/15/2015	Event	4,562	148.1	2.05	127.3	21.28	45.8	2.36
6/24/2015	Non-event	959	48.4	1.79	3.9	21.27	41.6	1.96
7/1/2015	Event	11,082	169.3	1.43	214.0	19.26	18.2	1.65
7/7/2015	Non-event	346	49.0	1.28	7.8	16.48	49.0	1.48
7/14/2015	Event	11,638	92.4	1.06	57.2	18.76	35.2	1.17

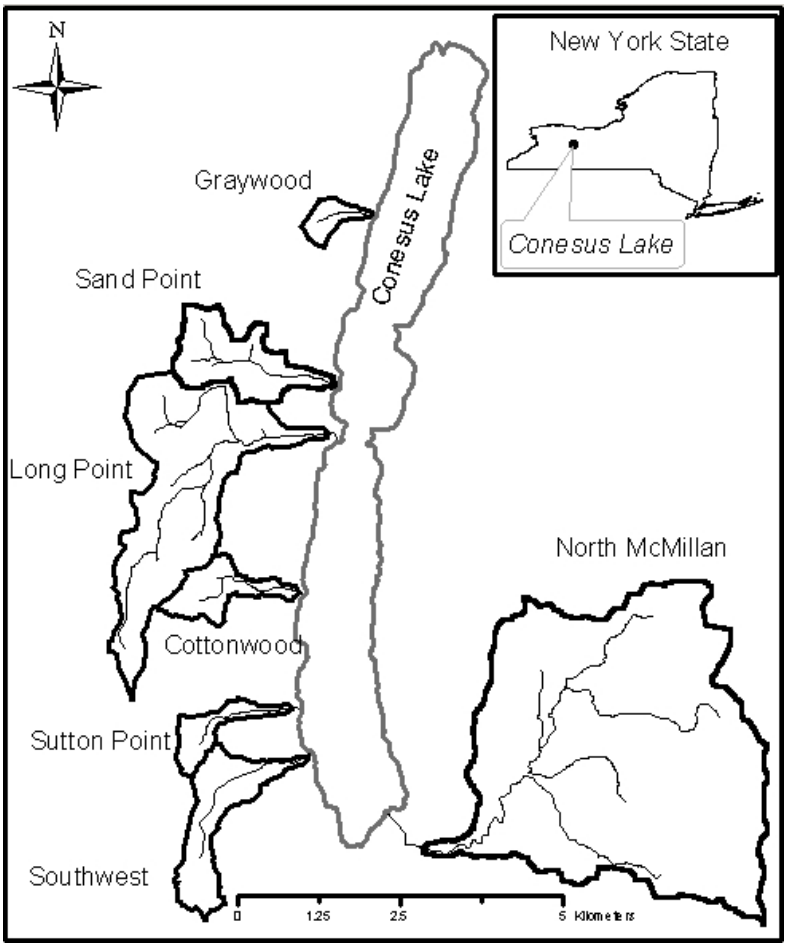

Figure 1. USDA sampling sites of Makarewicz *et al*. (2009).

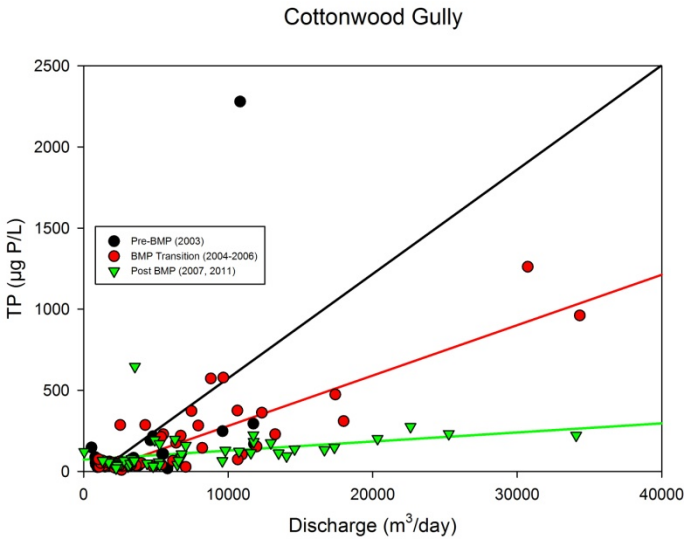

Figure 2. Cottonwood Gully spring discharge versus total phosphorus (TP) concentration for the 2003 to 2006 and 2011 period. Lines plotted are regression lines for the Pre-BMP period, Post-BMP period, and the transition period.

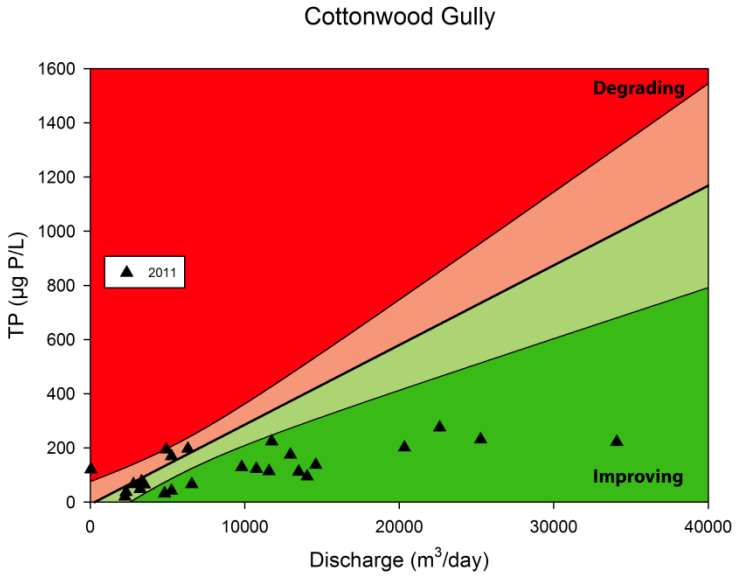

Figure 3. Cottonwood Gully Stream Water Quality Assessment Index. The triangles represent samples taken in 2011. See text for further explanation of the graph. TP=total phosphorus.

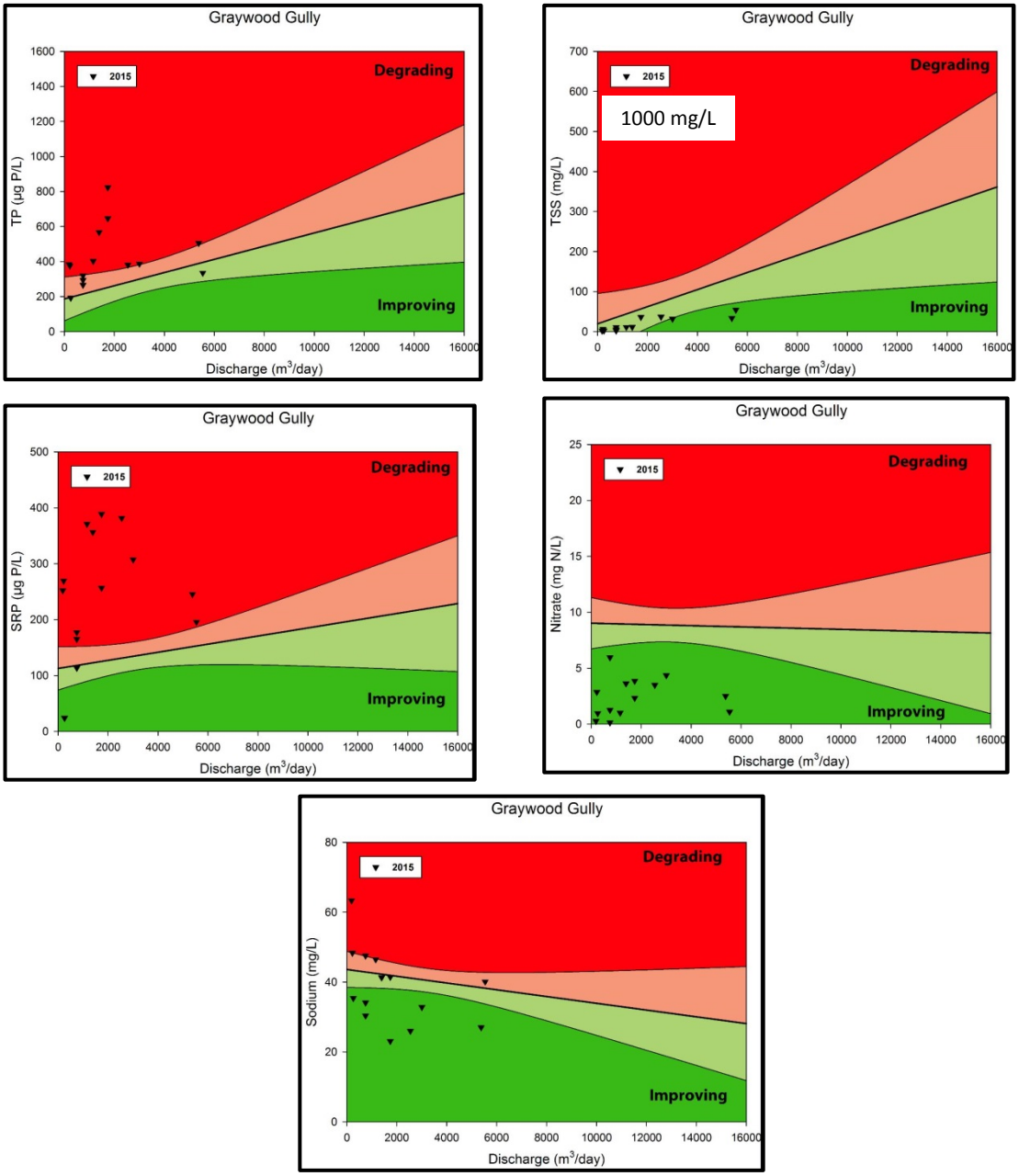

Figure 4. Graywood Gully Stream Water Quality Assessment Index for total phosphorus, soluble reactive phosphorus (TP), total suspended solids (TSS), nitrate, and sodium.

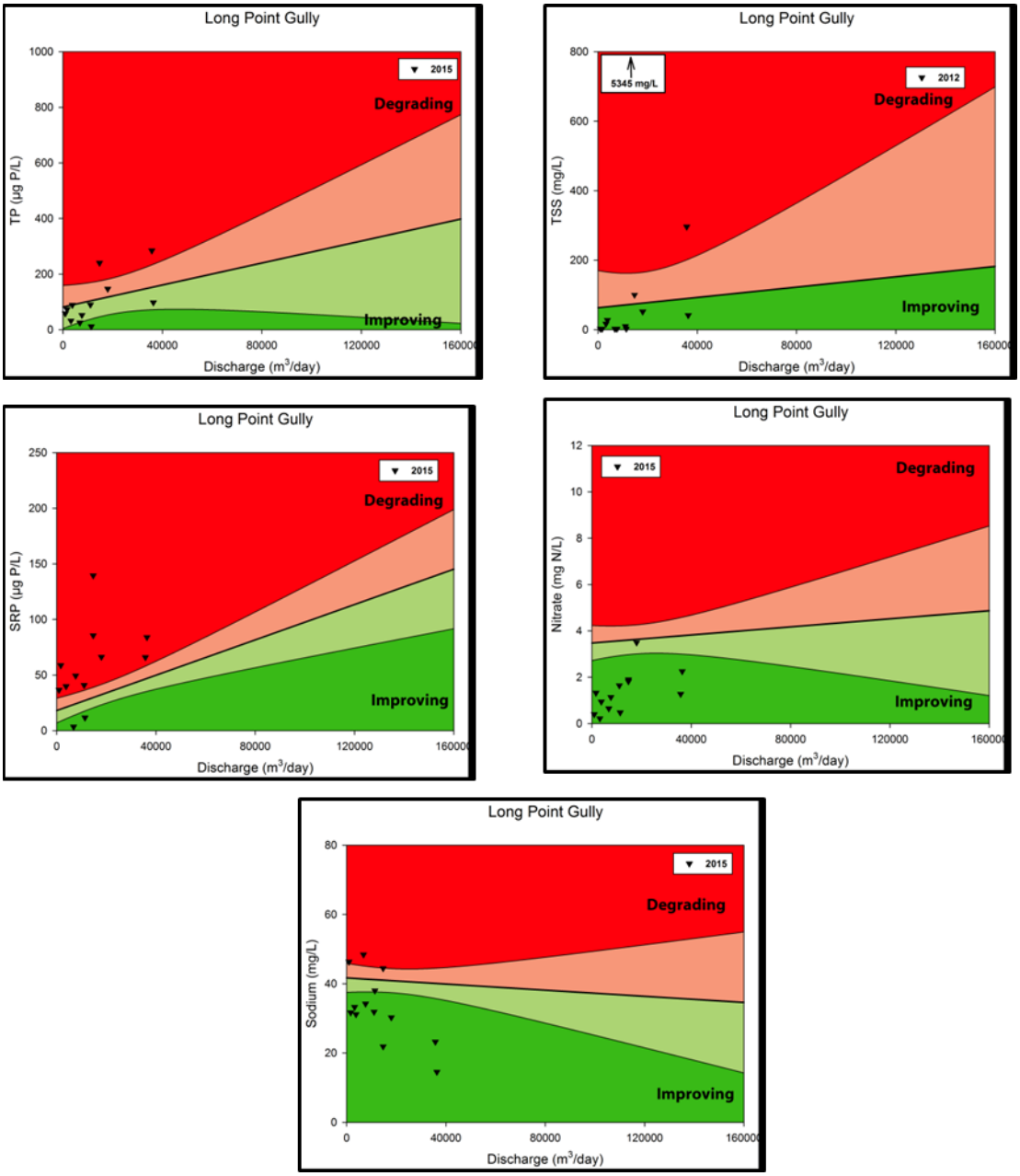

Figure 5. Long Point Gully Stream Water Quality Assessment Index for total phosphorus (TP), soluble reactive phosphorus (SRP), total suspended solids (TSS), nitrate, and sodium.

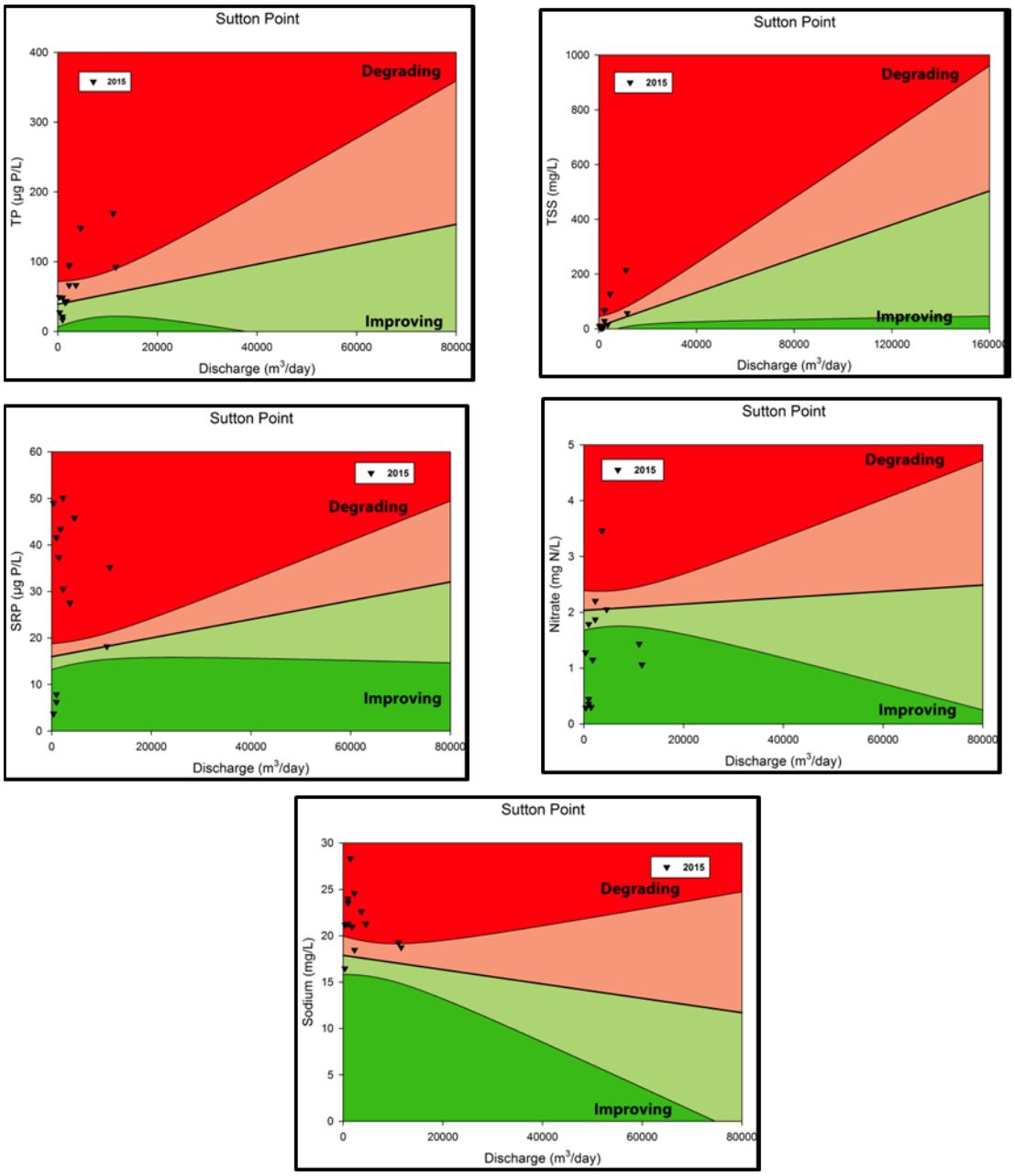

Figure 6. Sutton Point Stream Water Quality Assessment Index for total phosphorus, soluble reactive phosphorus (SRP), total suspended solids (TSS), nitrate, and sodium.