Conesus Lake Tributaries
Summer 2010

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Conesus Lake Subwatersheds

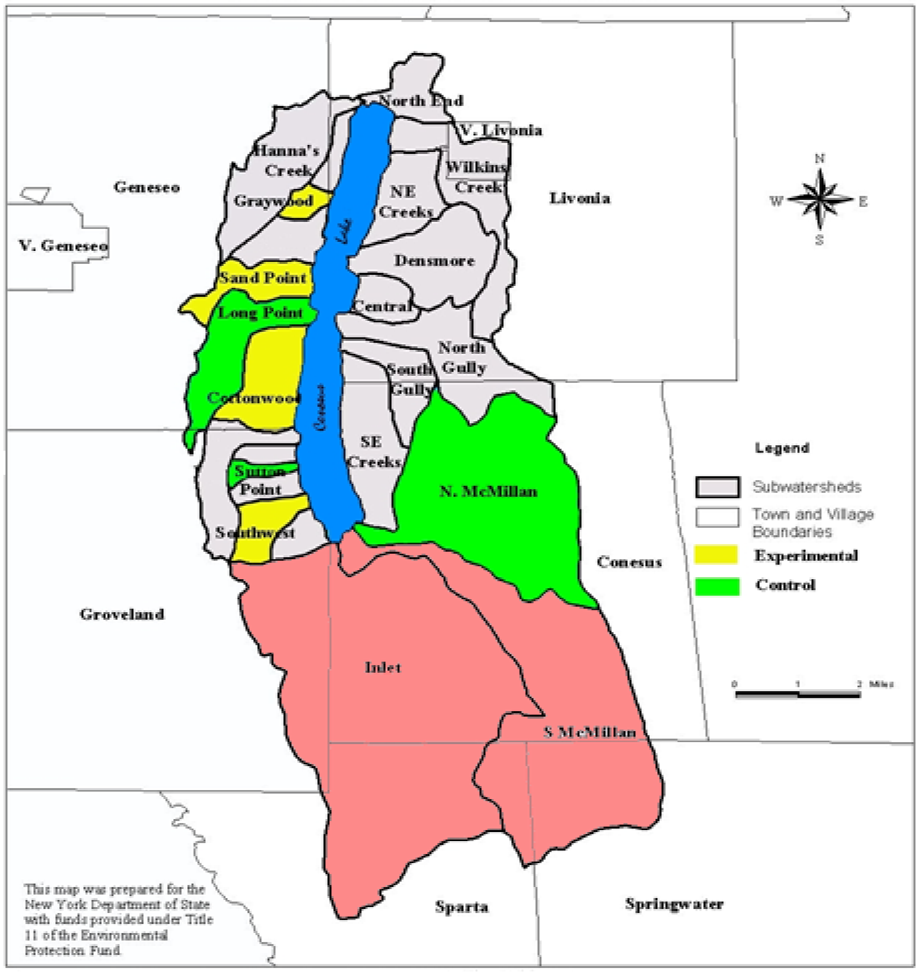

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Table of Contents

Summary………………………………………………………………………………..	2
Recommendations………………………………………………………………..……	3
Introduction……………………………………………………………………….....	4
Methods……………………………………………………………………………….	5
Quality Control……………………………………………………………………….	6
Results and Discussion…………………………………………………………….	6
References…..………………………………………………………………………	11
Tables 1-4……………………………………………………………………………..	12
Figures 1-15………………………………………………………………………….	18

Executive Summary

1. Monitoring of four of the so-called USDA streams (Graywood Gully, Cottonwood Gully, Long Point Gully, North McMillan Creek) continued during the summer of 2010.

2. It has been generally assumed that the impact of the Inlet and South McMillan watersheds was minimal since these watersheds were heavily forested and had only small amounts of agriculture associated with them. However, since no data existed on the influence of these watersheds, data were collected to verify this assumption.

3. To these ends, rating curves were developed allowing discharge to be calculated for the Inlet Creek and for South McMillan Creek. The determination of discharge allowed the calculation of the amount of nutrients and soil lost from these watersheds (sometimes called loading to the lake).

4. Concentrations of phosphorus and soil in water from the Inlet and South McMillan Creeks (e.g., average TP range=26.4 to 26.6 µg P/L) were lower that the concentrations from watersheds with land use heavily into agriculture (e.g., Graywood, Cottonwood, and Long Point Gullies; average TP range = 59.4 to 205.6 µg P/L) and slightly higher than the concentrations from North McMillan Creek (TP = 14.4 µg P/L). South McMillan Creek had relatively high losses of soil (61.9 kg/D) compared to other streams because of the large volume of water being discharged from the stream. Although losses from the watershed to the lake (loading) were high, concentrations were low. The elevated loads are due to the high discharge of water.

In these two watersheds, which are heavily dominated by forest, it is unlikely that any improvements in water quality would be realized by management.

5. A goal was to develop an assessment tool of watershed health utilizing the USDA data base. Such a tool would allow the county to evaluate the status of these watersheds; that is, are they improving, getting worse, or not changing. An evaluation tool of this type would allow further development and direction of the Conesus Lake Watershed Plan.

6. A statistical approach, analysis of covariance with discharge being the covariate, was the assessment tool developed to evaluate the 2003 to 2010 data base. The statistical approach provided a better interpretation of land use practices in watersheds than the concentration method and the simple calculation of nutrient load. This assessment method could be improved by collecting more data points during the summer and during hydrologic events. Such an approach would provide more statistical power to the analysis. With more data points for Graywood Creek, the increases observed in 2009 may become statistically significant. In retrospect, it probably would have been better to monitor the watersheds from March through June to capture the period of time when the agricultural community is actively tilling the land and planting crops, which the BMPs were designed to moderate, rather than during the dry summer period when stream flows are low and planted vegetation is actively taking up nutrients.

7. Since the implementation of best management plans (BMPs), adjusted losses from the USDA watersheds have generally not changed significantly. These data suggested that the BMPs instituted are indeed being maintained beyond the USDA program. However, there are some exceptions. At Cottonwood Gully, a significant increase in nitrate loss from the watershed was observed from 2008 to 2010. Also, a trend of increasing soluble reactive phosphorus and total Kjeldahl nitrogen was observed from 2007 to 2010. At Long Point Gully, a trend of increased losses of total phosphorus and soluble reactive phosphorus was observed in the summer of 2008 through 2010. At Graywood Gully in 2009, there was an increase in phosphorus loss from the watershed. However, it was not statistically significant.

Recommendations

1. If financially appropriate, monitoring of watersheds should continue as a mechanism to evaluate land use changes.

2. Consideration of increasing the sample size and the number of hydrologic events is suggested as a mechanism of developing data that is statistically defensible.

3. Discussion should occur on the advantages of monitoring during the spring period.

Introduction

After several years of a general decrease in "concentrations" of various nutrients from managed watersheds, substantial increases in the concentrations of nutrients and soil particles were observed in streams during the summer of 2009 (Makarewicz and Lewis 2009). At Graywood Gully, for example, concentrations of soil (TSS), total phosphorus (TP), soluble reactive phosphorus (SRP), total Kjeldahl nitrogen (TKN), and NO_3+NO_2 nitrate increased in the stream water. At Cottonwood Gully, after a 5-year decrease, concentrations of 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.

Several factors may have contributed to this observed increase in the concentration of dissolved and particulate material; some are natural (variation in rainfall amount and intensity) and others are affected by human actions (changes in land use or management practices). Although the increases observed in all the monitored streams may be 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 are 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; 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 watersheds in 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 concentration data only to evaluate temporal trends may be misinterpreted.

The three objectives of this summer's work were:

1) To reevaluate the stream concentration approach to assessment by converting the data in the amount of an analyte lost from a subwatershed and to apply a statistical approach that accounts for discharge;
2) To monitor nutrient and sediment input from selected watersheds; and,
3) To develop rating curves of discharge and evaluate nutrient loss from the Inlet and South McMillan Creeks.

Methods

Stream samples were taken at the former USDA monitoring sites (Makarewicz *et al.* 2009) at the base of the Graywood Gully, Long Point Gully, Cottonwood Gully, and the North McMillan Creek subwatersheds (Fig. 1). In addition, two tributaries that have never been monitored at the south end (South McMillan Creek and the Inlet, Fig. 2) of the lake were included in the sampling schedule. Water samples were taken every Tuesday morning from 18 May to 17 August 2010 irregardless of stream stage height; that is, water samples were taken on a Tuesday during hydrometeorologic events or nonevents. Water samples were taken, preserved, and analyzed using approved standard methods (USEPA 1979, APHA 1999).

Stream samples were analyzed for TP (APHA Method 4500-P-F), TKN (USEPA Method 351.2), 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), TKN (0.15 µg N/L), and TSS (0.2 mg/L). 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.

At South McMillan Creek (East Lake Road) and at the Inlet (Guiltner Road) (Figs. 2, 3 & 4), rating curves (Figs. 5 & 6) predicting stream discharge or flow (m^3/hour) were developed using the velocity-area method (Rantz 1982) and a calibrated Gurley current meter (Chow 1964). Each site was monitored weekly for velocity and stream depth. Streambed movement was verified weekly but was not observed.

Quality Control:

All water samples were analyzed at the Water Chemistry Laboratory at The College at Brockport, State University of New York (NELAC – EPA Lab Code # NY01449) within 24 h of collection. In general, this program includes biannual proficiency audits, annual inspections and documentation of all samples, reagents and equipment under good laboratory practices. All quality control (QC) measures are assessed and evaluated on an on-going basis. As required by NELAC and New York's ELAP certification process, method blanks, duplicate samples, laboratory control samples, and matrix spikes are performed at a frequency of one per batch of 20 or fewer samples. Field blanks (events and nonevents) are routinely collected and analyzed. 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. As part of the NELAC certification, the lab participates in biennial proficiency testing program (blind audits, Table 1) for each category of ELAP approval. If the lab fails the proficiency audit for an analyte, the lab director is required to identify the source and correct the problem to the certification agency.

Results and Discussion

Objective 1: Evaluation of Stream Monitoring Approaches

In last year's work, we were not convinced that increases observed in various analytes (e.g., Fig. 7a) represented a true picture of events occurring in a watershed. The major concern was that the data was not adjusted for the effect of increasing discharge (flow) on stream concentrations: in general, the greater the discharge (m^3/day), the greater the concentration in streams around Conesus Lake. However, this relationship does not necessarily represent a change in land use practices. Examination of the phosphorus concentration (µg/L) data (Fig. 7a) from Graywood Gully demonstrates this point.

There was a decrease in phosphorus concentration from 2003 to 2007. This decrease coincides with the implementation of the many management plans on the Maxwell property (Herendeen and Glazier, 2009; Makarewicz *et al*. 2009). After 2007, however, there was an increase in phosphorus concentration (and SRP, nitrate, TKN, and TSS), suggesting that a new land use practice was occurring or that there was some relaxation of the BMPs implemented. However, a “windshield survey” revealed no new major operations and no indication of a relaxation of management protocols.

In Figure 7b the same concentration data are used, but the loss (concentration x discharge, kg/day) from the watershed or loading is calculated. This calculation is a function of discharge and will increase with increasing rainfall and discharge. A different trend is now observed. Since 2004 there has been a steady decrease in the amount of phosphorus loss from the Graywood Gully watershed that is directly correlated with stream discharge (Fig. 15a) during the summer.

In Figure 7c the same data are used again, but the effect of discharge is considered using a statistical process called Analysis of Covariance (ANCOVA). 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. An increase in TP, SRP, TKN, and TSS (soil loss) was observed in 2009 (Figs. 7c & f; 8c & f). However, these increases were “not” statistically significant. These data suggested that the BMPs instituted are indeed being maintained beyond the USDA project.

Generally, these summer data do not strongly mimic the large declines resulting from BMPs implemented in this watershed (Makarewicz *et al*. 2009). The reason for this difference has to do with the data being used. In Makarewicz *et al*. (2009), weekly data for an entire year were collected from each season of the year. Many, if not all, of the management plans implemented by the USDA project were designed to reduce nutrient and soil loss via water being lost directly from the watershed. That is, water carrying nutrients or soil was generally directed to buffer strips, de-watered, infiltrated into the soil, etc. Effects from BMPs would have a major effect during the winter and spring, generally during the wettest parts of the year. During the summer when flows are low, these impacts from BMPs would not necessarily be observed. Also, planted vegetation in the summer is actively taking up nutrients and serving to retain soil on the land.

Nevertheless, the statistical approach provides a better understanding of land use practices in watersheds than the concentration method and the simple calculation of nutrient load. The assessment could be improved by collecting more data points during the summer and during hydrologic events. Such an approach would provide more statistical power to the analysis. With more data points for Graywood Creek, the increases observed in 2009 may become statistically significant. In retrospect, it probably would have been better to monitor the watersheds from March through June to capture the period of time when the agricultural community is actively tilling the land and planting crops.

The rest of the analysis provided is based on the calculation of marginal mean loads; that is, the loss from the watershed is adjusted for the effect of discharge.

Objective 2: Monitoring Trends

Starting in September of 2002, the Conesus Lake Watershed Project monitored the chemistry of stream water in several creeks of the Conesus Lake watershed (Makarewicz *et al.* 2009). Six small, predominantly agricultural (>70%) watersheds (<325 ha) in the Conesus Lake catchment of New York State were selected to test the impact of BMPs on mitigation of nonpoint nutrient sources and soil loss from farms to downstream aquatic systems. Two other watersheds were added later in the study for a total of eight. The streams were monitored for the nutrients TP, SRP, TSS, TKN, and NO_3+NO_2. These are all measures that indicate how much “fertilizer” is in the water. Total Kjeldahl nitrogen (TKN) provides an indication of the amount of organic matter, such as manure, that is present in the water. Total suspended solids (TSS) provides a measure of the amount of erosion either from stream banks or from upland areas. Sodium is a measure of how much salt is in the water. Increases in these losses (kg/ha) or loading over a period of time would indicate that materials are being lost from the watersheds as a result of land use practices. Decreases in losses or loading would suggest improvements within a watershed; that is, materials are being kept within the watershed.

In 2010, four of the USDA streams (Graywood Gully, Long Point Gully, Cottonwood Gully, and North McMillan Creek) were monitored to determine if management practices were maintained after the USDA project ended, and to determine if new land use practices that may be affecting water quality have been adopted.

Graywood Gully (Table 3, Figs. 7c,f,i and 8c,f,i): The Maxwell Farm occurs in this watershed, and a myriad of BMPs were introduced here between 2003 and 2006. For example, the application of a full spectrum of management practices (fertilizer reduction, cover crops, contour strips, reduction in fall and winter manure spreading, various grass filters for runoff from bunker storage of silage and milk house wastes, cows and heifers fenced from the creek and pond) were implemented. Reductions in the limiting nutrient phosphorus (whether it be the dissolved fraction or the total fraction) decreased by over 50% since the implementation of BMPs. The loss of soil from the land also decreased by ~ 50% and NO_3+NO_2 by 75%, while organic nitrogen as TKN decreased by 40%. Clearly, management practices have led to a decrease in the amount of soil and nutrients being lost annually from the land and a reduction of such being delivered to Conesus Lake. After the USDA project had ended, this reduction observed from 2003 to 2007 was maintained into 2010 for NO_3+NO_2, TKN, TP, SRP, and TSS. Increases were observed in 2009 especially, but they were not statistically significant. It must be recognized that this observation is for the summer period and not for the wet, agriculturally active portion of the year (spring).

Long Point Gully (Table 3, Figs. 9c,f, i and 10c,f,i): Dairy cattle were removed from the Long Point Gully watershed in 2003, and a 37% reduction (76.7 ha) in crop acreage occurred by 2004. Here major reductions in NO_3+NO_2 (42%), TP (36%), and SRP (53%) concentrations were observed by 2007, 3 years after removal of cropland from production (Table 3) (Makarewicz *et al*. 2009). As expected, removing land from crop production reduced nonpoint nutrient sources and led to major reductions of nutrients from the watershed. However, losses of TP (Fig. 9c) and SRP (Fig. 9f) were observed to increase in the summer of 2008 through 2010. Similarly, there has been a gradual increase in nitrate loss from this watershed with losses now approaching 2003 and 2004 levels. However, they were not statistically significant. Some type of new land use activities may have occurred in this watershed starting in the summer of 2009. There are many possible reasons for this and could be simply a new crop planted in the watershed.

Cottonwood Gully (Table 3, Figs. 11c,f,i and 12c,f,i): In Cottonwood Gully where row crops predominate, BMPs were limited to two: construction of three water and sediment control basins (gully plugs) and strip cropping designed to retain soils. Previous to BMP introduction in this small watershed (98.8 ha), soil loss was high and conservatively estimated in the 1990s at 130 tons (metric) per year. Loading data suggest that the major BMP implemented "gully plugs" were still retaining soil on the land effectively (Fig.12f). A significant increase in nitrate loss from the watershed was observed from 2008 to 2010 (Fig. 11i). A trend of increasing SRP and TKN was also observed from 2007 to 2010 (Figs. 11f and 12c). Although this trend was not statistically significant, it is a watershed that should be monitored.

North McMillan Creek (Table 3, Figs. 13c,f,i and 14c,f,i): This watershed was the reference watershed for the USDA study. No BMPs were introduced here. No significant trends were observed in stream loading for any of the parameters from 2003 to 2010. There was a significant variability over time, but values were relatively low compared to other watersheds.

The Inlet and South McMillan Creek (Table 4): Concentrations of phosphorus and soil in water from the Inlet and South McMillan Creek (e.g., TP range=26.4 to 26.6 µg P/L) were lower than the concentrations from the watersheds with land use heavily into agriculture (e.g., Graywood, Cottonwood, and Long Point Gullies; TP range = 59.4 to

205.6 μg P/L) and slightly higher than the concentrations from North McMillan Creek (TP = 14.4 μg P/L (Table 4). Loss of phosphorus and soil from the South McMillan watersheds was surprisingly high (Table 4). For example, soil (TSS) lost during the summer was ~62 kg/D which was three times higher than from the Long Point Gully watershed, a watershed heavily into agriculture (Table 4), and from the adjacent North McMillan Creek (~27 kg/D). This result has to be viewed in context. Loss of soil/nutrients from a watershed is calculated by multiplying concentration times discharge from the watershed. South McMillan Creek had relatively high losses of soil because of the large volume of water being discharged from the stream. Concentrations were relatively low compared to the agriculturally land use dominated Graywood watershed.

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Table 1. Proficiency audit of the Water Quality Laboratory at The College at Brockport.

WADSWORTH CENTER
NEW YORK STATE DEPARTMENT OF HEALTH
ENVIRONMENTAL LABORATORY APPROVAL PROGRAM

Proficiency Test Report

Lab 11439 SUNY BROCKPORT EPA Lab ID NY01449 Page 1 of 1

WATER LAB LENNON HALL
BROCKPORT, NY 14420
USA

Shipment: 330 Non Potable Water Chemistry
Shipment Date: 19-Jan-2010

Analyte	Sample ID	Result	Mean/Target	Acceptance Limits	Method	Score
Approval Category: **Non Potable Water**						
Sample: **Residue**						
Solids, Total Suspended 180 passed out of 191reported results.	3002	43.9	44.5	33.9 – 51.4	SM18-20 2540D (97)	Satisfactory
Sample: **Organic Nutrients**						
Kjeldahl Nitrogen, Total 85 passed out of 87 reported results.	3004	17.2	15.5	10.3 – 20.0	EPA 351.2 Rev. 2.0	Satisfactory
Phosphorus, Total 98 passed out of 106 reported results.	3004	4.42	4.50	3.69 – 5.37	SM18-20 4500-PF	Satisfactory
Sample: **Inorganic Nutrients**						
Nitrate (as N) 113 passed out of 116 reported results.	3007	14.44	14.6	11.4 – 17.6	SM18-20 4500-NO3 F (00)	Satisfactory
Orthophosphate (as P) 87 passed out of 94 reported results.	3007	1.80	1.77	1.41 – 2.15	SM18-20 4500-PF	Satisfactory
Sample: **Minerals II**						
Sodium, Total 76 passed out of 77 reported results.	3037	88.4	85.2	72.3 – 97.6	SM 18-20 3111B (99)	Satisfactory
Sample: **Nitrite**						
Nitrite as N	3041	1.02	0.977	0.786 – 1.17	SM 18-20 4500-NO2 B	Satisfactory

Table 2. Latitude and longitude of stream sites sampled in summer of 2010.

Watershed	Latitude	Longitude	Road
Graywood	42.81058	-77.71516	Graywood Center Road
Long Point	42.78016	-77.72267	West Lake Road
Cottonwood	42.75808	-77.72704	West Lake Road
Inlet	42.68320	-77.70332	Guiltner Road
North McMillan	42.72320	-77.70240	East Lake Road
South McMillan	42.72183	-77.70244	East Lake Road

Table 3. Average summer concentration (May through September only) of stream water draining the Graywood, Sand Point, Long Point, Sutton Point, Southwest, North Gully, Cottonwood, and North McMillan Creek watersheds of Conesus Lake. Data from 2003 to 2007 are derived from the annual data of Makarewicz *et al.* 2009. See text for further explanation.

		TP (µg P/L)		Nitrate (mg N/L)		TSS (mg/L)		TKN (µg N/L)		Sodium (mg/L)		SRP (µg P/L)	
	Year	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean
Graywood	2003	247.9	71.5	8.09	1.21	8.8	1.4	539	42	65.53	5.15	116.6	15.4
	2004	241.9	25.2	8.14	1.20	14.8	2.7	558	35	52.58	2.12	120.8	13.1
	2005	163.3	10.6	3.63	.40	9.1	2.4	555	54	59.04	4.67	104.7	8.9
	2006	173.8	19.7	1.87	.19	7.1	1.5	384	52	70.72	4.82	105.5	13.5
	2007	96.3	21.1	2.22	.31	5.3	1.2	376	77	99.58	10.98	59.2	13.3
	2008	123.8	19.9	1.21	.31	5.4	1.0	303	44	102.03	5.26	99.1	16.2
	2009	236.9	43.1	3.79	1.26	19.4	4.6	768	135	60.38	3.85	171.5	36.0
	2010	205.6	33.0	4.52	1.17	18.4	6.8	546	64	91.32	12.72	159.5	27.0
Sand Point	2003	59.6	4.2	2.00	.50	5.5	1.3	569	75	44.01	3.38	39.2	5.0
	2004	111.4	44.4	.97	.13	46.8	41.1	719	217	23.74	1.72	37.0	9.1
	2005	75.5	8.7	1.65	.36	5.0	1.6	466	76	19.48	.95	50.3	6.8
	2006	86.8	13.5	1.17	.14	3.8	.6	539	104	16.95	.87	43.5	4.5
	2007	70.4	8.4	1.57	.66	2.5	.3	477	59	17.75	1.13	48.5	8.0
	2008	79.6	3.6	0.66	.04	4.5	1.1	505	40	21.48	1.83	54.3	4.0
	2009	80.4	8.4	2.44	0.80	15.8	90.9	654	90	24.52	2.28	50.3	4.3
	2010		No	Data									
Long Point	2003	102.3	22.6	4.99	.97	10.6	4.4	775	116	58.65	2.16	39.7	7.1
	2004	219.4	129.3	4.41	1.11	132.6	124.0	832	199	33.04	2.89	40.4	7.7
	2005	69.8	17.8	2.58	.58	8.7	4.2	568	54	31.04	1.09	34.4	8.5
	2006	60.7	14.9	2.23	.55	8.1	3.8	552	95	40.61	2.08	29.5	7.7
	2007	41.0	15.3	2.40	.96	3.4	.7	515	90	36.20	3.91	14.8	8.3
	2008	75.7	15.5	1.97	0.31	16.5	13.1	771	265	57.75	3.75	44.8	7.9
	2009	50.3	10.3	3.85	0.98	4.8	3.5	489	78	38.42	2.61	33.2	5.6
	2010	59.4	4.2	5.09	1.32	3.5	0.9	544	50	40.54	1.24	43.1	4.9

Table 3. Continued		TP (µg P/L)		Nitrate (mg N/L)		TSS (mg/L)		TKN (µg N/L)		Sodium (mg/L)		SRP (µg P/L)	
	Year	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean
Sutton Point	2003	45.5	4.7	1.93	.36	11.6	3.2	415	50	24.51	1.30	28.4	2.6
	2004	216.6	160.6	1.15	.10	13.7	7.3	413	56	18.09	1.37	26.5	3.7
	2005	46.6	5.0	1.28	.26	4.2	.7	318	38	15.87	.62	30.9	3.9
	2006	48.6	2.9	.98	.09	2.8	.9	352	86	21.14	1.18	28.9	2.9
	2007	38.0	3.2	1.57	.21	1.0	.1	305	83	19.40	1.21	25.0	4.1
	2008	46.6	2.1	1.32	.28	3.7	1.1	221	36	18.51	1.65	31.2	3.0
	2009	47.4	3.2	1.09	.10	5.3	2.1	483	85	28.82	1.31	35.9	2.2
	2010		No	Data									
Cottonwood	2003	68.0	6.0	2.83	.48	3.6	1.1	468	65	37.97	3.26	51.1	5.7
	2004	143.2	66.0	2.35	.60	69.4	58.3	568	86	18.16	1.01	53.0	6.6
	2005	97.3	23.3	2.30	.44	10.5	4.5	424	38	17.48	.50	57.5	6.0
	2006	68.8	6.4	1.64	.17	1.0	.3	393	37	21.46	.75	43.4	3.9
	2007	63.8	3.5	1.48	.13	2.5	.8	433	76	19.27	.33	45.8	3.7
	2008	84.7	9.9	1.12	.13	2.6	.8	381	46	25.02	2.34	57.7	3.9
	2009	72.5	3.7	2.79	0.28	3.9	1.2	518	82	23.43	1.07	58.8	3.2
	2010	73.6	6.2	3.86	0.72	6.6	2.2	559	66	22.22	0.96	59.7	1.9
Southwest	2003	83.2	5.0	3.54	.74	5.7	1.5	1054	527	37.01	1.26	63.1	7.2
	2004	179.1	47.9	1.63	.24	46.2	34.6	796	204	30.01	1.52	78.1	10.2
	2005	124.2	7.7	1.28	.39	10.8	3.5	486	61	32.28	1.02	69.1	7.7
	2006	97.9	6.4	1.03	.17	4.6	1.7	456	63	44.95	1.85	61.8	4.9
	2007	116.1	10.3	1.09	.11	7.1	3.6	469	100	35.02	.56	76.4	5.0
	2008	100.4	3.6	1.17	.14	3.0	0.8	297	33	45.50	2.67	69.5	5.3
	2009	127.6	8.5	1.17	0.10	8.9	4.3	633	76	46.08	2.81	100.5	7.5
	2010		No	Data									

Table 3. Continued

	Year	TP (µg P/L) Mean	TP Standard Error of Mean	Nitrate (mg N/L) Mean	Nitrate Standard Error of Mean	TSS (mg/L) Mean	TSS Standard Error of Mean	TKN (µg N/L) Mean	TKN Standard Error of Mean	Sodium (mg/L) Mean	Sodium Standard Error of Mean	SRP (µg P/L) Mean	SRP Standard Error of Mean
North McMillan	2003	10.9	2.3	.26	.05	2.7	1.3	265	41	35.05	1.77	4.4	.6
	2004	39.6	26.6	.14	.02	33.3	30.0	365	85	28.36	2.02	5.1	1.4
	2005	11.4	2.0	.24	.03	3.5	.8	276	39	30.04	.99	4.8	.6
	2006	10.5	1.5	.13	.03	1.7	.5	229	30	36.63	.65	3.7	.9
	2007	7.6	.9	.14	.02	2.0	.5	246	64	36.63	1.04	2.5	.3
	2008	13.8	7.0	.11	.02	2.3	.4	220	34	50.72	1.17	2.9	.5
	2009	27.4	8.8	.13	.01	70.3	67.1	455	96	36.90	2.16	9.1	4.3
	2010	14.4	3.8	.19	.04	1.8	.2	559	66	22.22	.96	59.7	1.9
North Gully	2004	33.0	16.6	0.41	0.15	5.1	6.3	413	203	22.63	3.46	15.7	14.3
	2005	34.9	25.7	0.71	0.90	4.8	5.2	312	212	21.19	2.69	17.0	14.7
	2006	28.3	18	0.31	0.17	5	15.7	366	153	25.6	3.33	13.5	9.5
	2007	28.7	15.2	0.2	0.15	5.7	7.44	273	171	20.92	2.9	15.2	8.7
	2008	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2009	39.7	10.5	0.33	0.07	15.1	6.5	370	54.	27.81	1.59	18.2	4.4
	2010		No	Data									
South McMillan	2010	26.4	3.2	.28	.04	3.5	.7	326	26	22.05	1.25	14.7	1.7
Inlet	2010	26.6	2.3	.54	.14	4.7	1.3	394	22	25.16	.91	6.8	1.0

Table 4. Concentrations and losses of soil and phosphorus (TP) in South McMillan and the Inlet compared to other watersheds in 2010.

	Discharge	Total Phosphorus		Total Suspended solids	
	m^3/Day	µg P/L	kg P/D	mg/L	kg/D
Inlet	3,489	26.6±2.3	0.08±0.02	4.7±1.3	9.06±2.85
South McMillan	12,474	26.4±3.2	0.42±0.17	3.5±0.7	61.86±27.96
North McMillan	14,059	14.4±3.8	0.25±0.10	1.8±0.2	27.54±7.71
Graywood Gully	212	205.6±33.0	0.06±0.02	18.4±6.8	5.04±3.09
Cottonwood Creek	2,025	73.6±6.2	0.14±0.02	6.6±2.2	9.85±2.67
Long Point	6,170	59.4±4.2	0.39±0.16	3.5±0.9	20.83±9.15

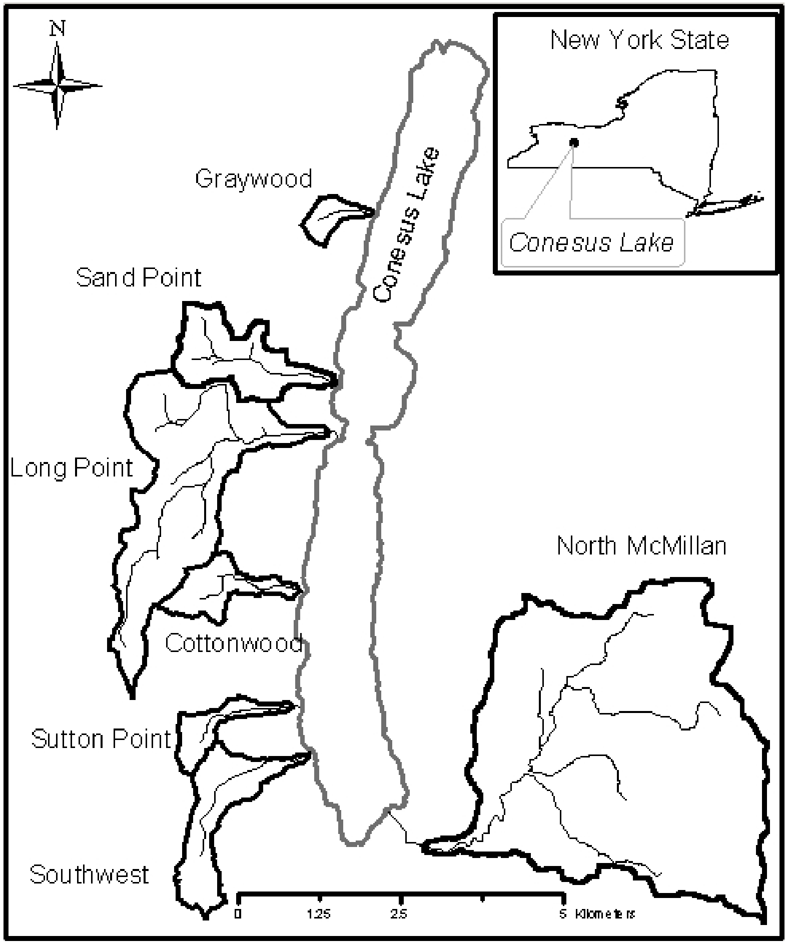


Figure 1. USDA sampling sites of Makarewicz *et a*l. (2009).

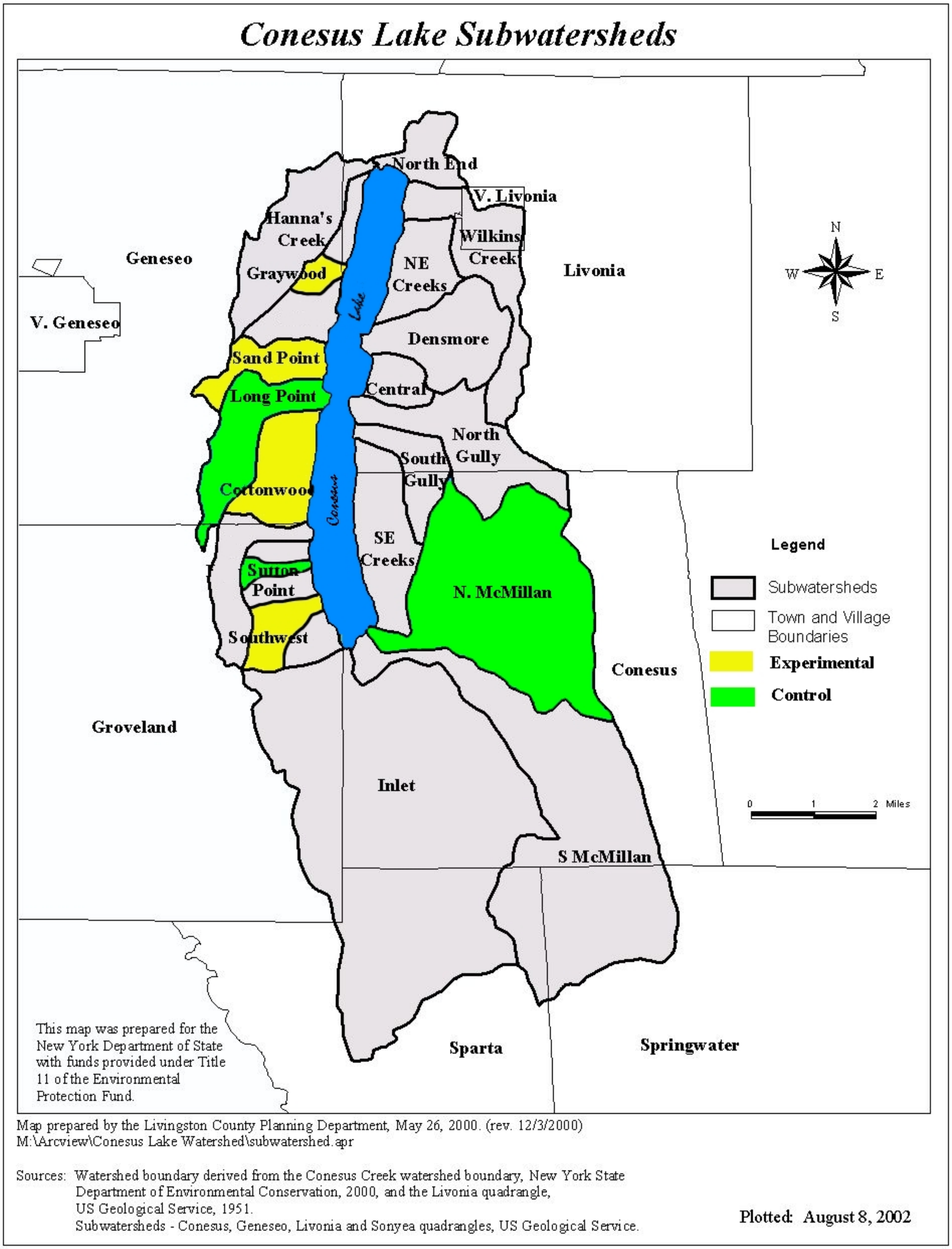
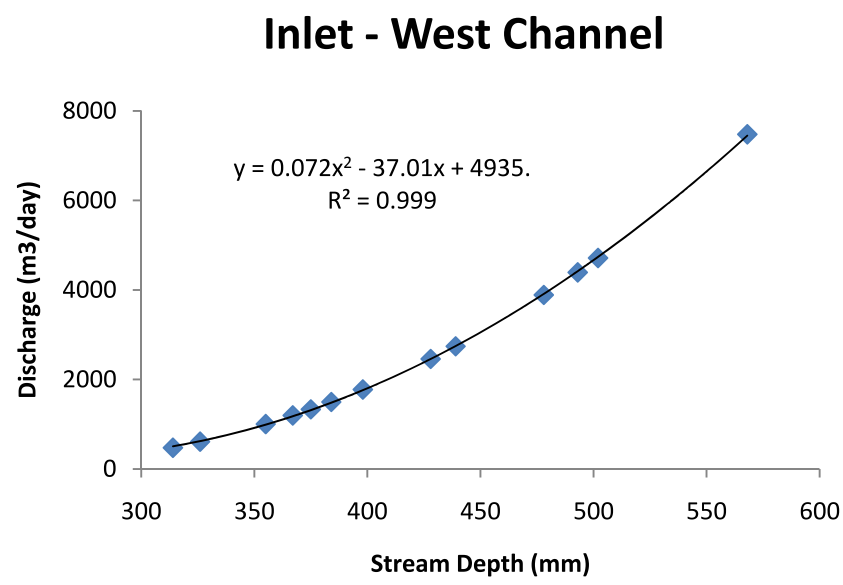


Figure 2. The Conesus Lake watershed showing the South McMillan and Inlet sub-basins.

Figure 3. Bridge at the Inlet, summer 2010.

Figure 4. Bridge at South McMillan Creek, summer 2010.



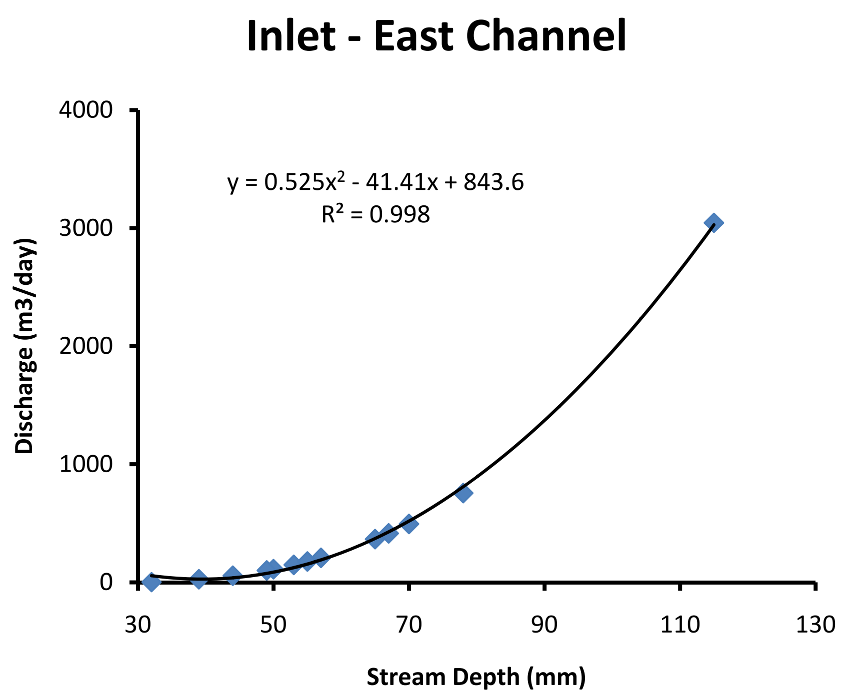


Figure 5. Rating curve for the Inlet (east and west Channels) of Conesus Lake. Developed during the summer of 2010.

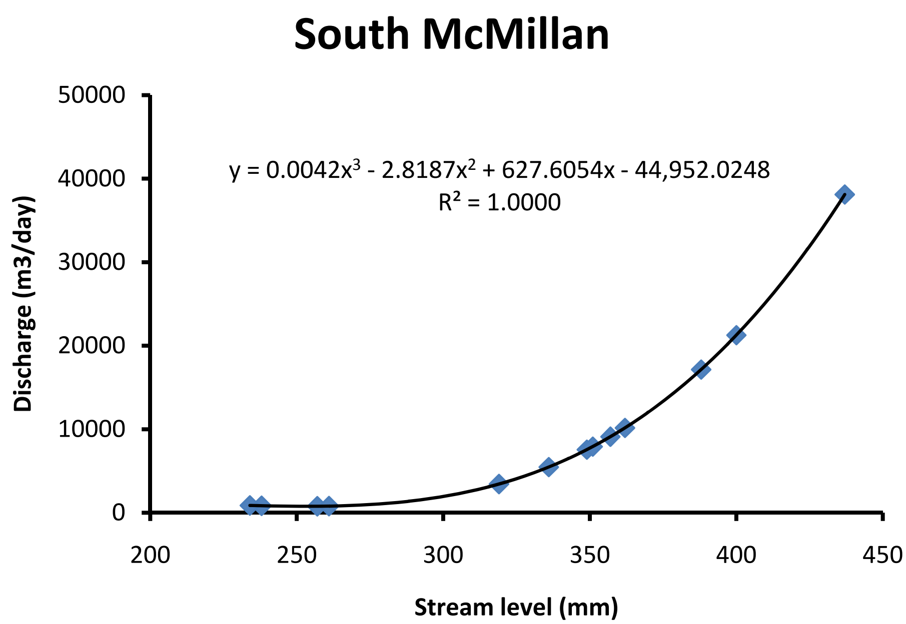


Figure 6. Rating curve for South McMillan Creek. Developed in the summer of 2010.

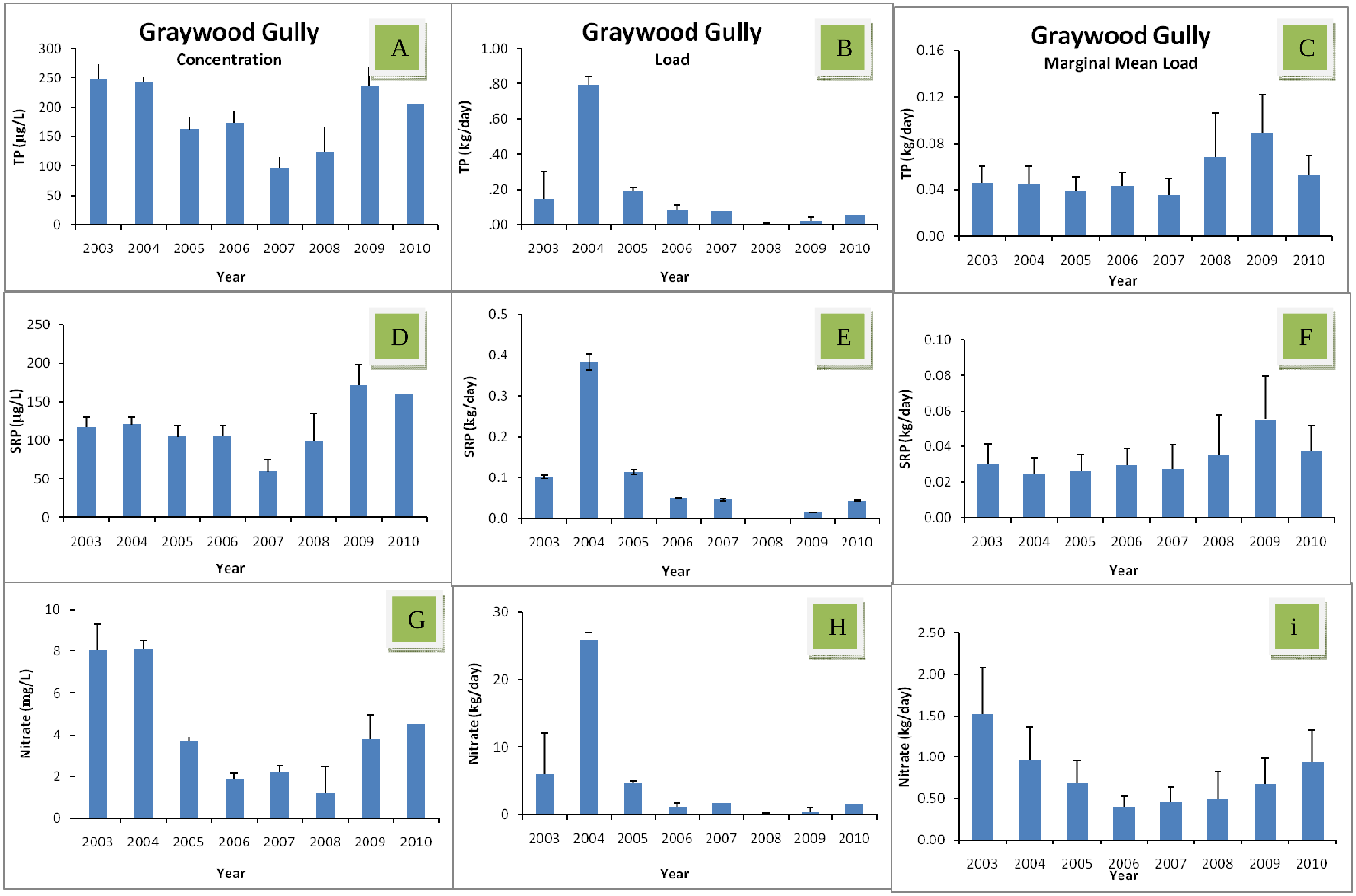


Figure 7. Average (+SE) concentrations, average nutrient load, and marginal mean load adjusted for discharge (May through August) of total phosphorus (TP), soluble reactive phosphorus (SRP), and nitrate in Graywood Gully from 2003 to 2010. S.E.=standard error.

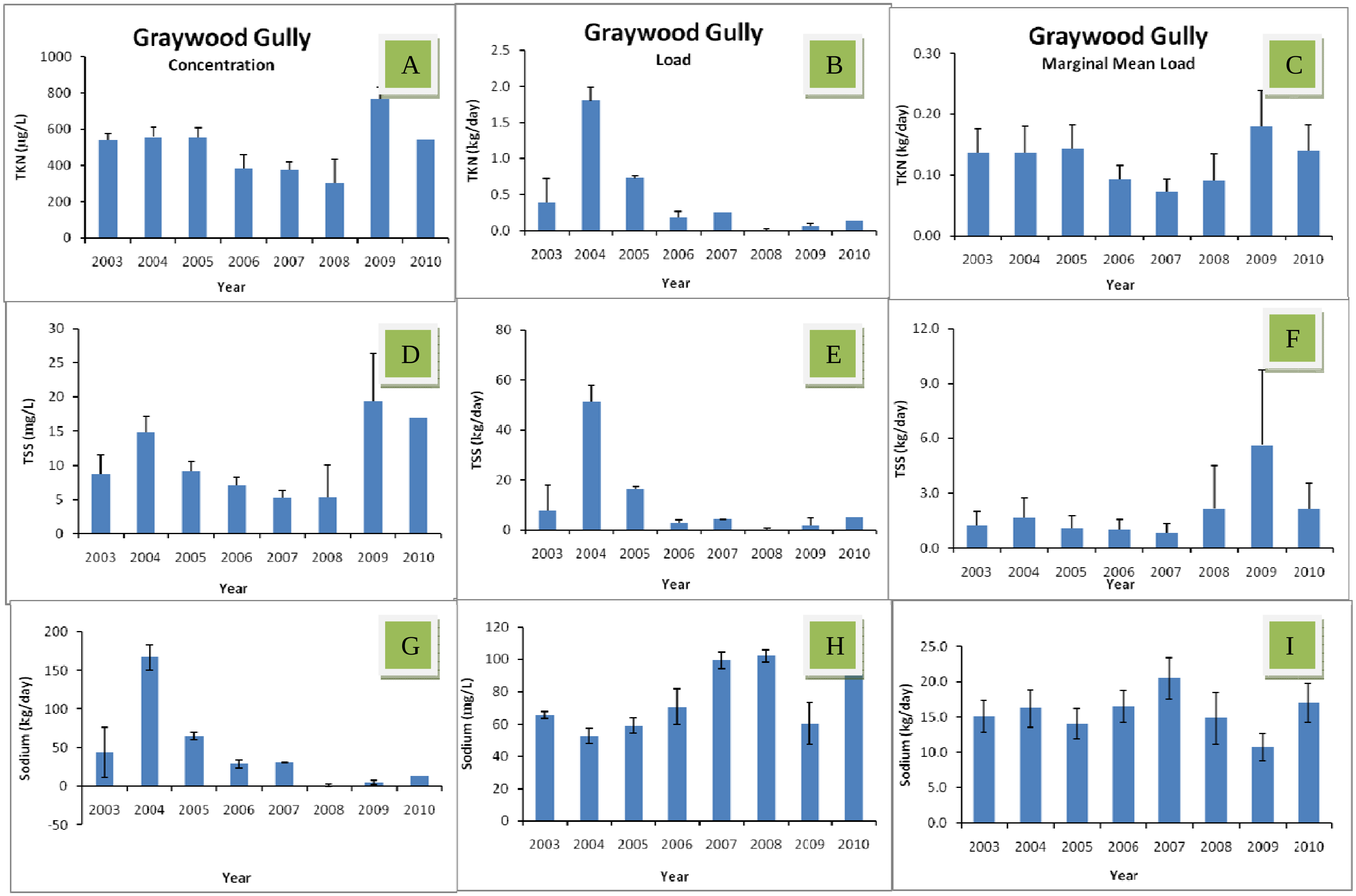


Figure 8. Average (+SE) concentrations, average nutrient load, and marginal mean load adjusted for discharge (May through August) of total Kjeldahl nitrogen (TKN), total suspended solids (TSS), and sodium at Graywood Gully from 2003 to 2010. S.E.=standard error.

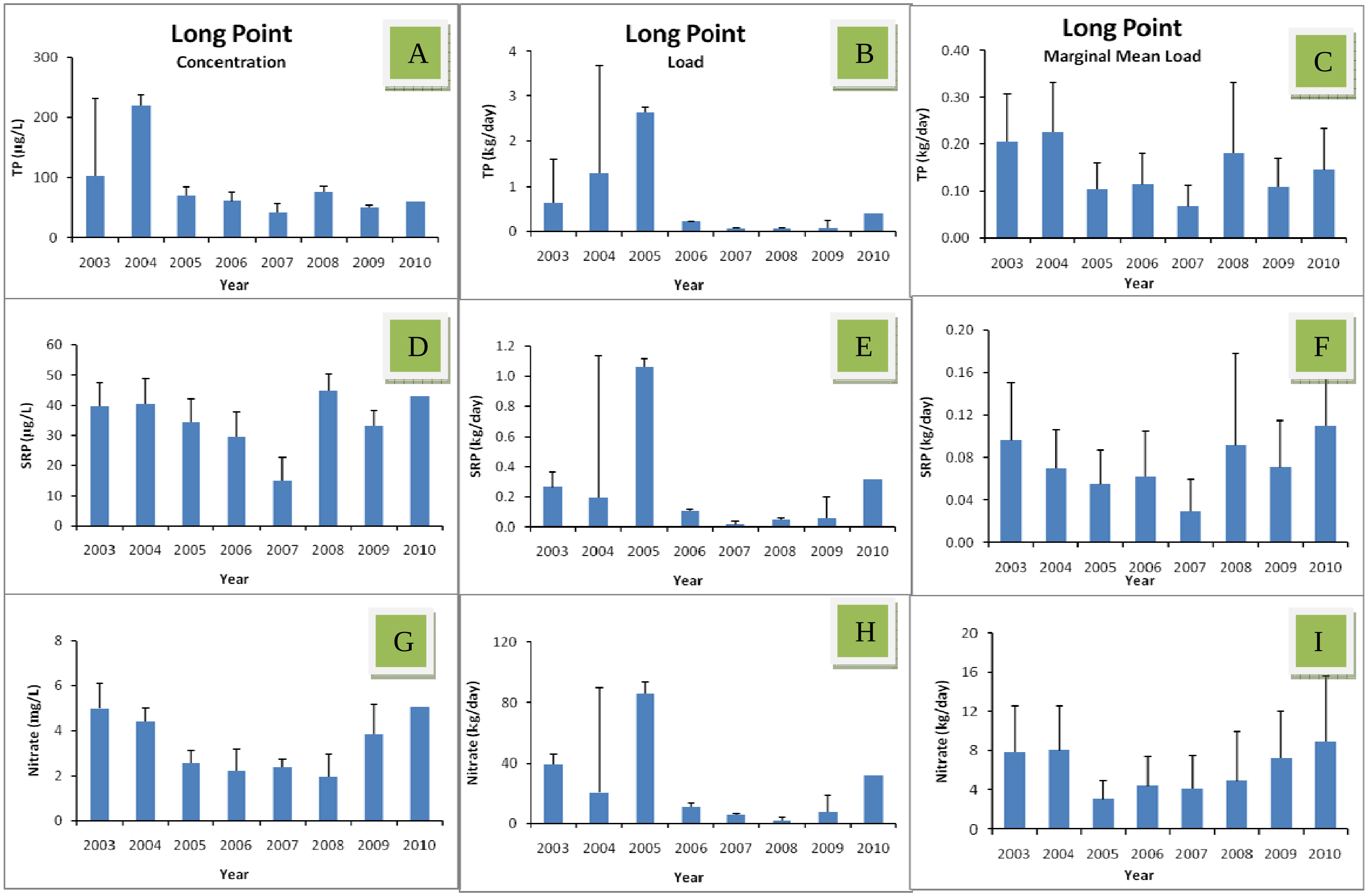


Figure 9. Average (+SE) concentrations, average nutrient load, and marginal mean load adjusted for discharge (May through August) of total phosphorus (TP), soluble reactive phosphorus (SRP), and nitrate in Long Point Gully from 2003 to 2010. S.E.=standard error.

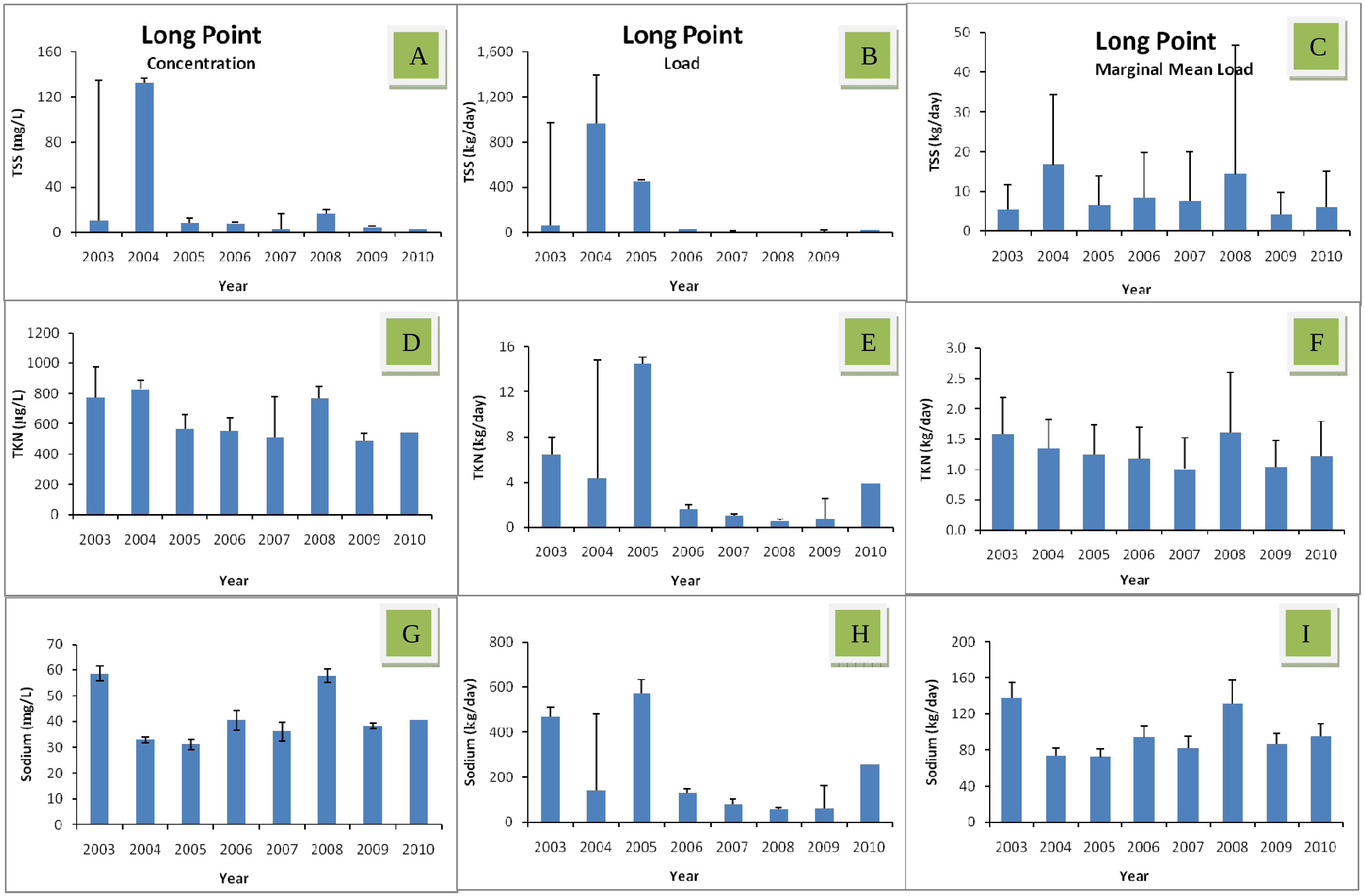


Figure 10. Average (+SE) concentrations, average nutrient load, and marginal mean load adjusted for discharge (May through August) of total suspended solids (TSS), total Kjeldahl nitrogen (TKN), and sodium in Long Point Gully from 2003 to 2010. S.E.=standard error

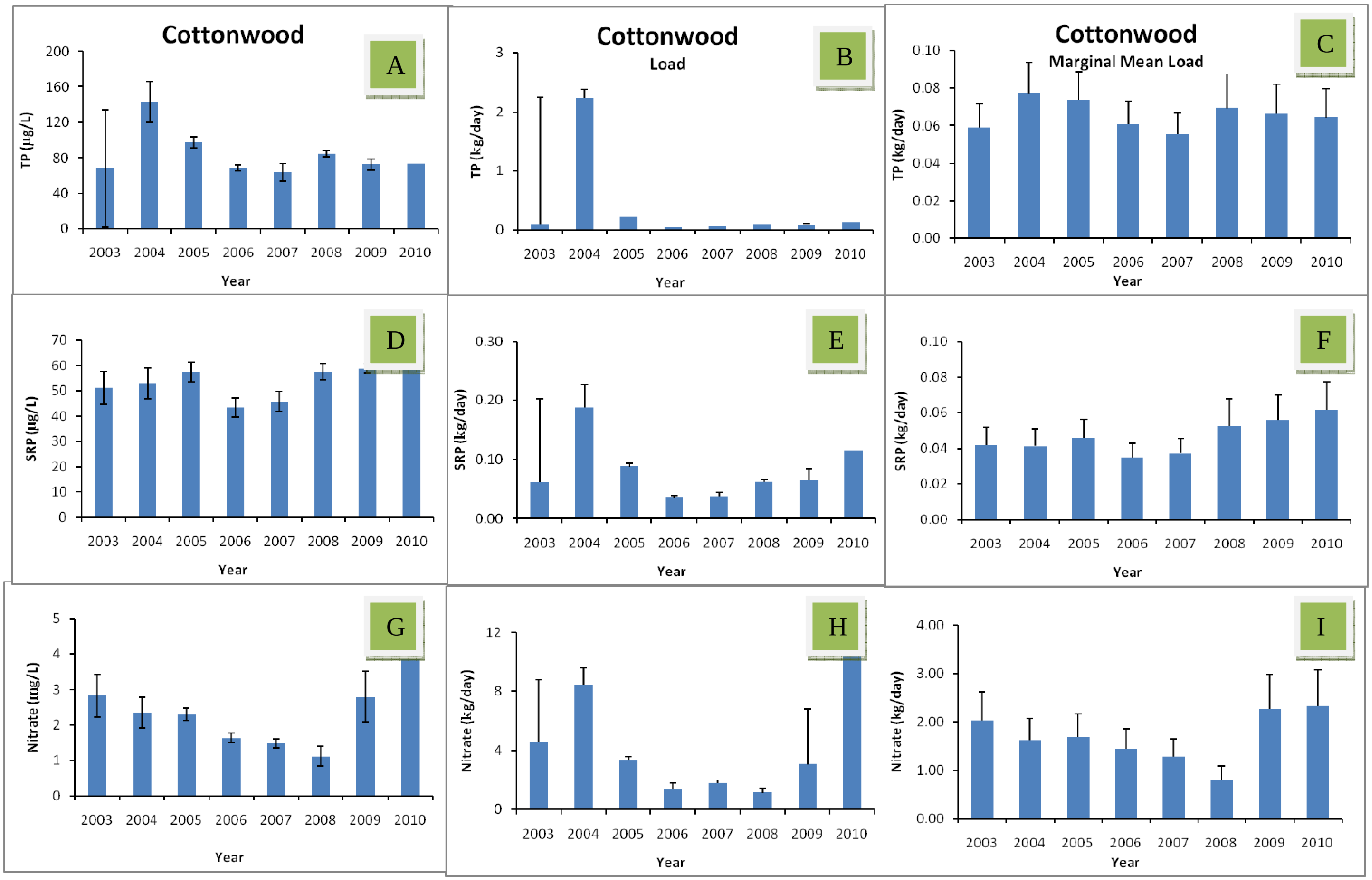


Figure 11. Average (+SE) concentrations, average nutrient load, and marginal mean load adjusted for discharge (May through August) of total phosphorus (TP), soluble reactive phosphorus (SRP), and nitrate at Cottonwood Gully from 2003 to 2010. S.E.=standard error.

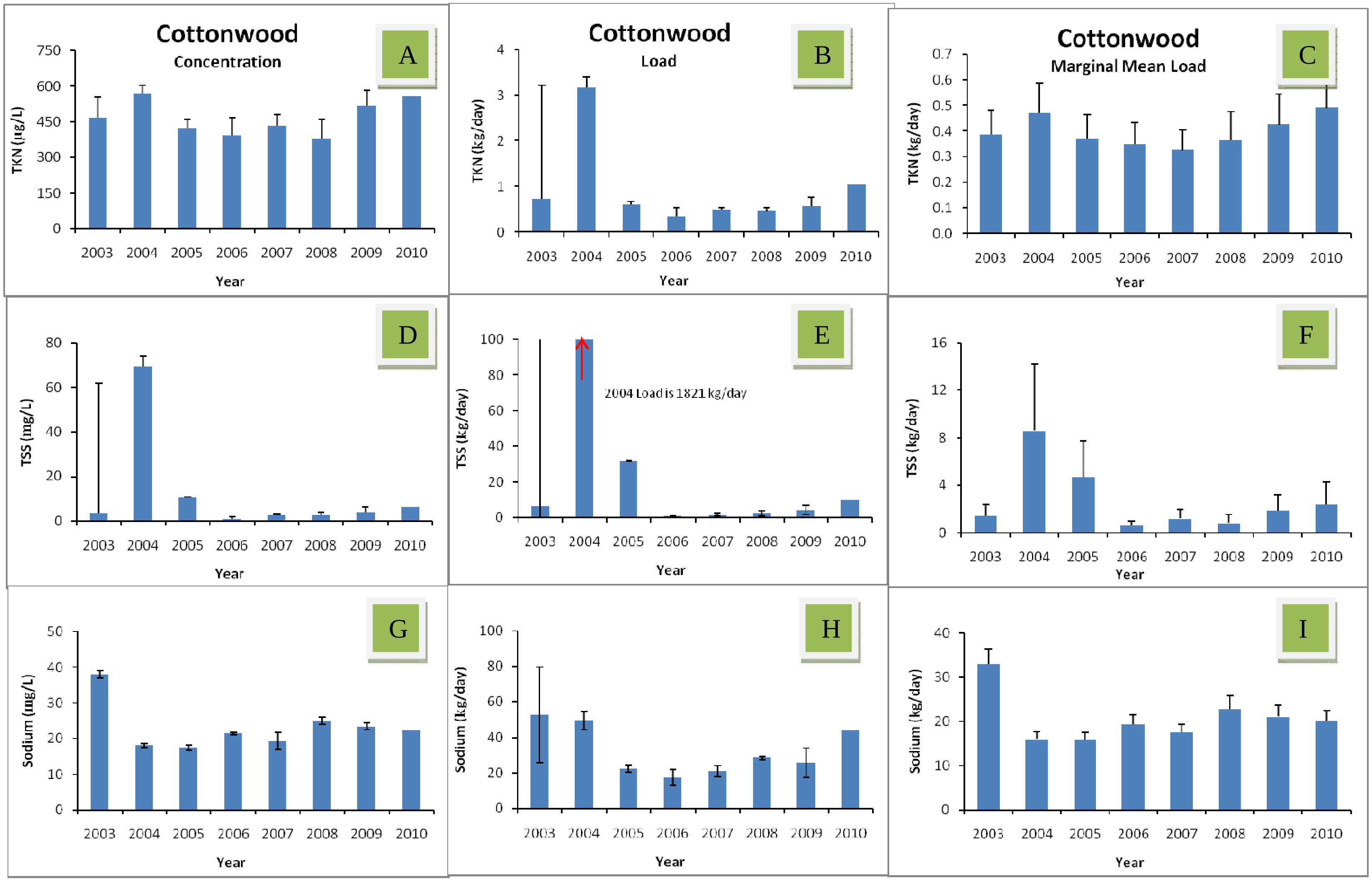


Figure 12. Average (±SE) concentrations, average nutrient load, and marginal mean load adjusted for discharge (May through August), total suspended solids (TSS), total Kjeldahl nitrogen (TKN), and sodium at Cottonwood Creek from 2003 to 2010. S.E.=standard error.

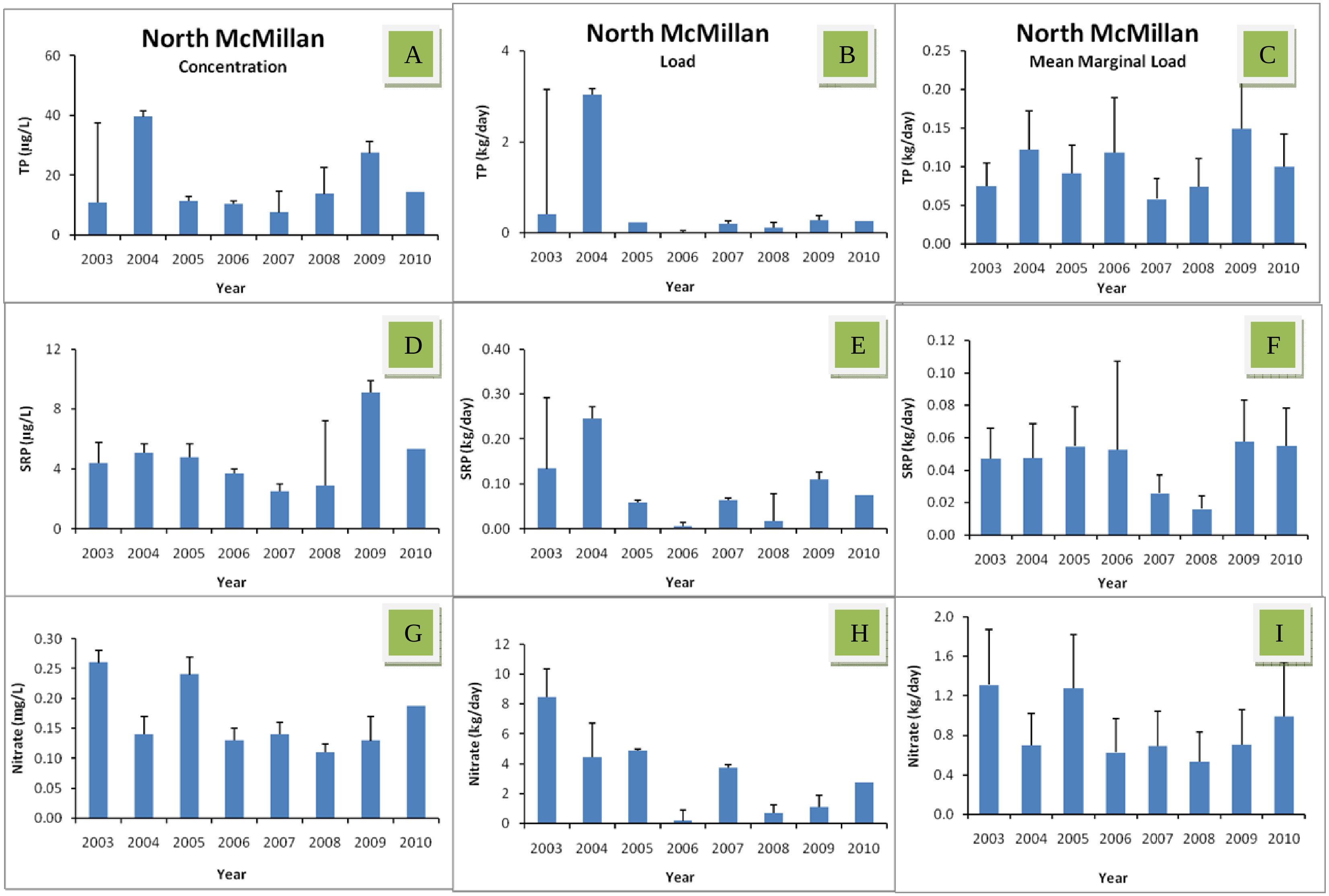


Figure 13. Average (+SE) concentrations, average nutrient load, and marginal mean load adjusted for discharge (May through August) of total phosphorus (TP), soluble reactive phosphorus (SRP), and nitrate at North McMillan Creek from 2003 to 2010. S.E.=standard error.

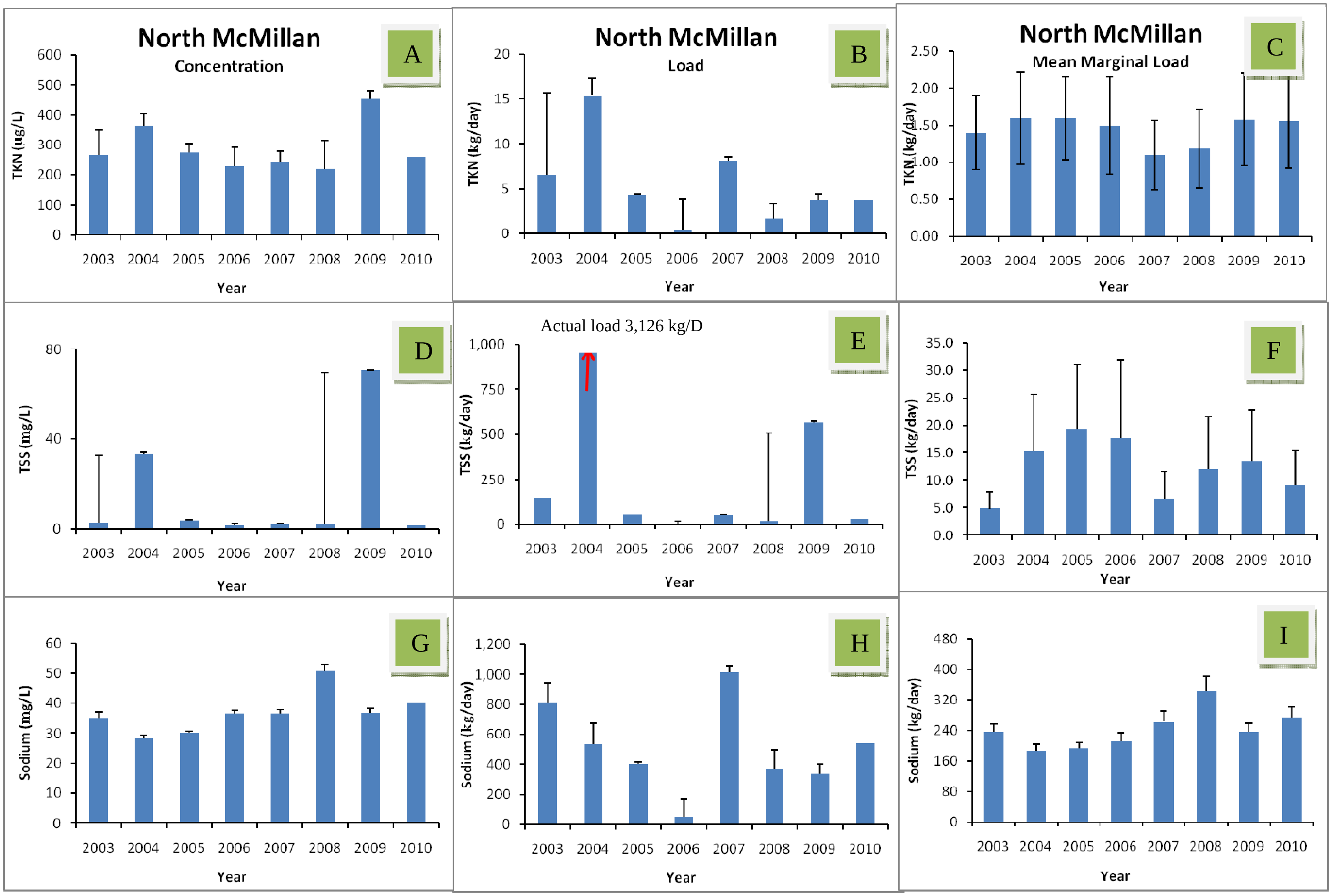


Figure 14. Average (±SE) concentrations, average nutrient load, and marginal mean load adjusted for discharge (May through August) total suspended solids (TSS), total Kjeldahl nitrogen (TKN),and sodium at North McMillan Creek from 2003 to 2010. S.E.=standard error.

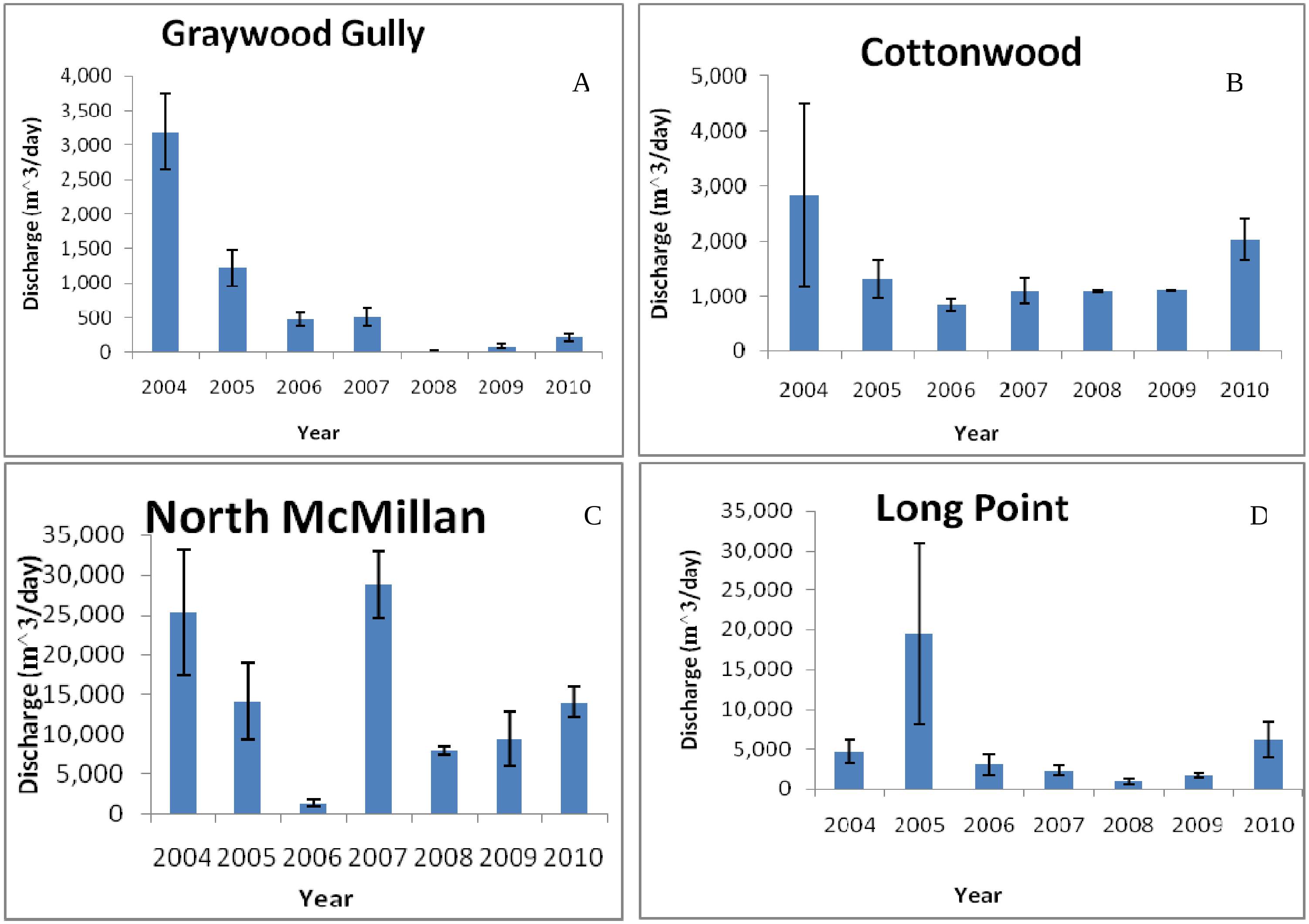


Figure 15. Average daily discharge during the summer of 2003 to 2010.