Soil and Nutrient Loss from Sub-Watersheds in the Southwest Quadrant of Conesus Lake:

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Execuitve Summary

At least two of the "rivulets" draining sub-watersheds in the southwest quadrant of Conesus Lake are contributing excessive amount of soils, organic nitrogen, nitrate and phosphorus into Conesus Lake relative to similar nearby watersheds. The high loss of phosphorus will undoubtedly stimulate algae and macrophyte growth "locally" and could potentially cause the water quality of the entire lake to deteriorate. The high loss of soils from the watersheds are creating new land near the lake; that is, a delta is forming at least at one site due to the high losses of soils from the watershed. The large amount of material being lost from these small sub-watersheds is surprising when compared to larger nearby watersheds and suggests that a land-use practice in the watershed is the cause.

We believe the losses of materials and nutrients reported here from the sub-watersheds or rivulets is conservative. The late winter and spring of 1999 were fairly dry. With greater precipitation during this period, we believe losses from these watershed would be even higher than reported. In this sense, this study is limited by the unusually dry spring.

Introduction

The purpose of this study is to evaluate the loss of soil and nutrients from the upland area of four small watersheds or sub-watersheds located in the southwest quadrant of the Conesus Lake watershed. To accomplish this task, six streams draining sub-watersheds were sampled on eight sampling dates from 23 January to 16 April 1999. The sampling design included two precipitation events and six non-event periods. Of the six sub-watersheds, only two have been monitored previously, Long Point Gully (622.5 ha) and "No Name" Creek (415 ha)(Fig. 1 and 2). The other four sub-watersheds are drained by intermittent rivulets of small size (range 20.4 ha to 110 ha). These sub-watersheds are identified by the addresses of nearby homes on West Lake Road (#5301, #5341, #5413 and #5859)(Figs. 1 and 2). As a point of reference, site #5413 is the so-called "video" site, where a video of the rivulet was taken by a resident living along side the stream. The video captures a major event in the spring of 1998, showing discharge and turbidity conditions far exceeding any incurred during this short study.

Previous work in the late 1980s and early 1990s had estimated the loss of nutrients from Long Point Gully and "No Name" creek (Makarewicz et al. 1991). In this study, these larger watersheds are used for comparative purposes or a point of reference in evaluating soil and nutrient loss from the four smaller sub-watersheds of concern. If land use is similar, larger watersheds will generally lose more soil and nutrients than a smaller watershed. If we observe larger losses of nutrients and soils from the smaller watersheds or if we observe more loss per unit area of watershed in the smaller than the larger watershed, it would indicate a detrimental land practice in the watershed; that is, a land use that is causing excessive loss of soils and nutrients compared to other nearby watersheds of similar soil, geological formation and slope.

Methods

Because much of the loss of soils and nutrients occurs during precipitation events in any watershed, water samples were taken and stream discharge measured during two precipitation events as well as during six non-events (Table 1). Soil loss (as total suspended solids), nutrient loss (nitrate, dissolved phosphorus as soluble reactive phosphorus, total phosphorus), organic nitrogen plus ammonia as total Kjeldahl nitrogen and de-icing salt as sodium were measured as a function of stream discharge and concentration. Samples were taken manually and transported to SUNY Brockport for water chemistry analysis for total phosphorus (TP), soluble reactive phosphorus (SRP), total kjeldahl nitrogen (TKN), nitrate + nitrite, sodium and total suspended solids (TSS) (see detailed methods below).

All sampling bottles were pre-coded so as to ensure exact identification of the particular sample. All filtration units and other processing apparatus were cleaned routinely with phosphate-free RBS. Containers were rinsed prior to sample collection with the water being collected. In general, all procedures followed EPA standard methods (EPA 1979) or Standard Methods for the Analysis of Water and Wastewater (APHA 1999). Sample water for dissolved nutrient analysis (nitrate + nitrite and SRP) was filtered immediately with 0.45 µm MCI Magma Nylon 66 membrane filters and held at 4°C until analysis.

Water Chemistry:

Nitrate + Nitrite: Dissolved nitrate + nitrite nitrogen analyses were performed by the automated (Technicon Autoanalyser) cadmium reduction method (EPA 1979, APHA 1999).

Total Phosphorus and Soluble Reactive Phosphorus: For total phosphorus, the persulfate digestion procedure was used prior to analysis by the automated (Technicon autoanalyser) colorimetric ascorbic acid method (APHA 1999).

Total Kjeldahl Nitrogen: Analysis was performed using a modification of the Technicon Industrial Method 329-74W/B. The following modifications were performed:

1. In the sodium salicylate-sodium nitroprusside solution, sodium nitroferri-cyanide (0.4g) replaced the concentrated nitroprusside stock solution.
2. The reservoir of the autoanalyser was filled with 0.2M H_2SO_4 instead of distilled water.
3. Other reagents were made fresh prior to each analysis.

Total Suspended Solids: APHA (1999) Method 2540D was employed for this analysis.

Sodium: Sodium was determined by atomic absorption spectrophotometry (Perkin Elmer 3030) (APHA 1999) on filtered samples.

Physical Measurements:

Nutrient Loading: Daily nutrient and sediment loadings from the watershed were calculated by multiplying the discharge on the day of the sample by the concentration of the nutrient or solids from the appropriate water sample.

Stream Velocity: Stream velocity was measured at equally spaced locations in either a culvert or cement channel of a bridge under a road with a Gurley flow meter (Chow 1964). Locations of tributary monitoring sites and number of velocity measurements taken are presented in Appendix 1.

Stream Height and Cross-Sectional Area: Stream depth was measured as the difference between the vertical height of the culvert/bridge opening and the distance between the stream surface and upper portion of the culvert/bridge. Stream cross-sectional area for various stream heights was calculated by planimetry after measuring the cross-sectional dimensions of each stream monitored.

Quality Assurance Internal Quality Control: Multiple sample control charts (APHA 1999) were constructed for each parameter analyzed, except total suspended solids. A prepared quality control solution was placed in the analysis stream for each sampling date. If the control solution was beyond the set limits of the control chart, corrective action was taken and the samples re-run. **External Quality Control:** The Water Chemistry Laboratory at SUNY Brockport is certified through the New York State Department of Health's Environmental Laboratory Approval Program (ELAP - # 11439). This program includes biannual proficiency audits, annual inspections and good laboratory practices documentation of all samples, reagents and equipment.

Results and Discussion

Loading is the amount of nutrients and soil that is lost from the watershed and carried by the stream into Conesus Lake. Figures 3 to 8 demonstrate a commonly known fact for western New York watersheds. In general in non-forested watersheds, events contribute 70 - 90 percent of the annual losses of nutrients and soil. Also it is quite evident that soil loss (TSS), nutrient loss (soluble reactive phosphorus, total phosphorus, nitrate), and the loss of organic nitrogen plus ammonia from sites #5859 and #5341 are comparatively high to the other four watersheds sampled. Furthermore, by normalizing the losses from the watersheds to a unit area of watershed, it is quite evident that two small watersheds (#5859 and #5341) are delivering an excessive amount of materials into Conesus Lake. That is, their impact is much greater than would be expected based on the area of these small watersheds. It also should be noted that concentrations of organic nitrogen, phosphorus, nitrate and soils (TSS) for these small watersheds

(Table 2) are relatively high during events when compared to non-events and to the larger "No Name" and Long Point watersheds. This suggests that a land-use practice allows water to carry surficial materials during precipitation events out of the watershed and into Conesus Lake. The fact that these sub-watersheds are delivering such high levels of nutrients is of concern since it has been previously established that Long Point Gully and "No Name" watersheds were the major contributors of nitrate to Conesus Lake (Makarewicz and Lewis 1992). The high nitrate losses from the Long Point and "No Name" watersheds have been associated with agricultural practices in these watersheds, especially with fields planted in corn (Makarewicz and Lewis 1992).

In the case of TKN, basically organic nitrogen and ammonia, the high loss during rain events from watersheds #5859 and #5341 suggest that some type of organic materials, such as manure, is being washed off the landscape and into the lake. This could be confirmed further by looking for manure lagoons or manure spreading in the fields above the narrow "lake plain" or by testing for "coliform" bacteria. Similarly, the high loss of TSS (i.e., soils) and the associated particulate forms of phosphorus (TP) during events suggests that soil is being either eroded from the stream bank or that a land-use practice in the watershed (e.g., tillage) is the cause of this loss. Soil loss from the watershed is causing a new delta to form on Conesus Lake at a couple of locations (e.g., 5413 West Lake Road). It is also quite evident from the video of the stream at 5413 Lake Road from spring of 1998 that losses of soils and associated nutrients can be considerably higher than what was observed in this study. We believe the losses observed were conservative because of the low flows experienced due to the relatively dry spring.

This study monitored only four of the hundreds of rivulets entering Conesus Lake. It is not known at this time if all rivulets throughout the entire Conesus Lake watershed are as impacted by land-use as the southwest quadrant, but the results show that there is a potential that rivulets are having a significant impact on the water quality of Conesus Lake.

Literature Cited

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EPA. 1979. Methods for Chemical Analysis of Water and Wastes. Environmental Monitoring and Support Laboratory. Environmental Protection Agency. Cincinnati, Ohio. EPA-600/4-79-020.

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Makarewicz, J.C. and Lewis, T.W. 1992. Stress Stream Analysis of Two Sub-watersheds of Conesus Lake. Prepared for the Livingston County Planning Department, Mount Morris, NY. Available form Drake Memorial Library, SUNY Brockport, Brockport, NY.

Table 1. Dates of sampling and discharge (m^3/day) of rivulets draining watersheds in the Southwest Quadrant of Conesus Lake near Booher Hill (Figs. 1 and 2). Sites numbers are equivalent to house numbers on West Lake Road. NS = Not Sampled.

		Sites					
		#5301	#5341	#5413	#5859	Long Point	"No Name" #5577
01/23/99	Event	12039	64921	12919	139870	NS	NS
01/24/99	Baseline	983	8727	526	6306	NS	NS
02/17/99	Baseline	442	2058	235	6527	6810	10540
02/28/99	Baseline	552	1029	261	7999	25692	15434
03/25/99	Baseline	910	4133	783	9411	17519	23151
04/04/99	Baseline	373	2006	587	9474	14803	14116
04/12/99	Baseline	910	2526	2114	3670	15767	23151
04/16/99	Event	1581	1441	4404	12548	46196	49720

Table 2. Average concentrations of nutrients, sodium and soil in water draining streams from the Southwest Quadrant of Conesus Lake. Sites numbers are the house numbers on West Lake Road near the creek. TP = total phosphorus, SRP = soluble reactive phosphorus, TKN = total Kjeldahl nitrogen, Na = sodium, TSS = total suspended solids (soils).

		SRP (µg/L)	NO_3 (mg/L)	TKN (µg/L)	TP (µg/L)	NA (mg/L)	TSS (mg/L)
Sites							
#5301	event	125.6	3.99	680	1,009	2.19	54.8
	nonevent	56.6	6.6	223	128	3.81	7.7
#5341	event	130.6	3.07	3,055	1,007	9.88	995.1
	nonevent	69.9	4.36	341	90	14.97	6.7
#5413	event	97.6	2.55	2,780	561	13.24	933.5
	nonevent	45.4	3.81	198	58	14.9	8.6
#5859	event	134.6	3.45	2,560	550	18.21	372
	nonevent	58.2	4.9	400	77	20.04	7.7
Long Pt.	event	83.5	2.37	1,060	306	31.02	169.3
	nonevent	46.5	3.44	400	63	29.64	7.8
No Name	event	39.1	2.99	540	152	23.15	112.4
	nonevent	46.7	3.96	350	51	21.14	5.9

Table 3. Loss of soils and nutrients from watersheds in the southwest quadrant of Conesus Lake during the winter and spring of 1999. Sites numbers are equivalent to house numbers. TP = total phosphorus, SRP = soluble reactive phosphorus, TKN = total Kjeldahl nitrogen, NA = sodium, TSS = total suspended solids (soils).

	Area hectare		SRP (kg/d)	NO_3 (kg/d)	TKN (kg/d)	TP (kg/d)	NA (kg/d)	TSS (kg/d)
#5301	20.4	event	1.33	28.74	7.25	11.43	7.11	505.9
		nonevent	0.04	5.34	0.18	0.11	2.53	5.0
#5341	76	event	7.96	69.48	189.13	63.25	260.85	62,691.7
		nonevent	0.38	14.96	1.63	0.51	46.26	49.8
#5413	36.5	event	1.22	17.55	27.83	6.68	79.45	9993.6
		nonevent	0.03	3.09	0.12	0.04	12.13	7.1
#5859	110.1	event	17.55	308.06	318.60	71.46	756.18	48739.5
		nonevent	0.42	36.06	2.65	0.55	140.59	49.0
Long Pt.	622.5	event	3.86	109.49	48.97	14.14	1433.02	7821.0
		nonevent	0.71	53.89	6.07	1.01	462.31	122.5
"No Name"	415.0	event	1.94	148.66	26.85	7.54	1151.02	5588.5
		nonevent	0.84	70.04	5.84	0.90	365.01	93.2

Table 4. Event loss of materials from various sub-watersheds normalized by area of the watershed. TKN = total kjeldahl nitrogen, TP = total phosphorus, TSS = total suspended solids.

	TKN kg N/ha/d	TP kg P/ha/d	TSS kg/ha/d
#5301	0.36	0.56	24.8
#5341	2.49	0.83	825.9
#5413	0.76	0.18	273.8
#5859	2.89	0.65	442.7
Long Point	0.08	0.02	12.6
No Name	0.06	0.02	13.5

Appendix 1. Location and site descriptions of the Southwest Quadrant streams sampled during this study.

Creek	Sample Location	Stream Height Measurement	Number of velocity measurements
Long Point Gully	Downstream side of bridge on West Lake Rd	Triangle on bottom half of upper bridge section	1
House #5301	Upstream side of bridge on West Lake Rd. Across from residential street address #5301	Center of culvert pipe	1
House #5341	Upstream side of bridge on West Lake Rd. Across from residential street address #5341	Center of culvert pipe	1
House #5413	Upstream side of bridge on West Lake Rd. Across from residential street address #5413	Center of culvert pipe	1
No Name Creek (#5577)	Upstream side of bridge on West Lake Rd.	Triangle on bottom half of upper bridge section	1
House #5859	Upstream side of bridge on West Lake Rd. Across from residential street address #5859	Triangle on bottom half of upper bridge section	1

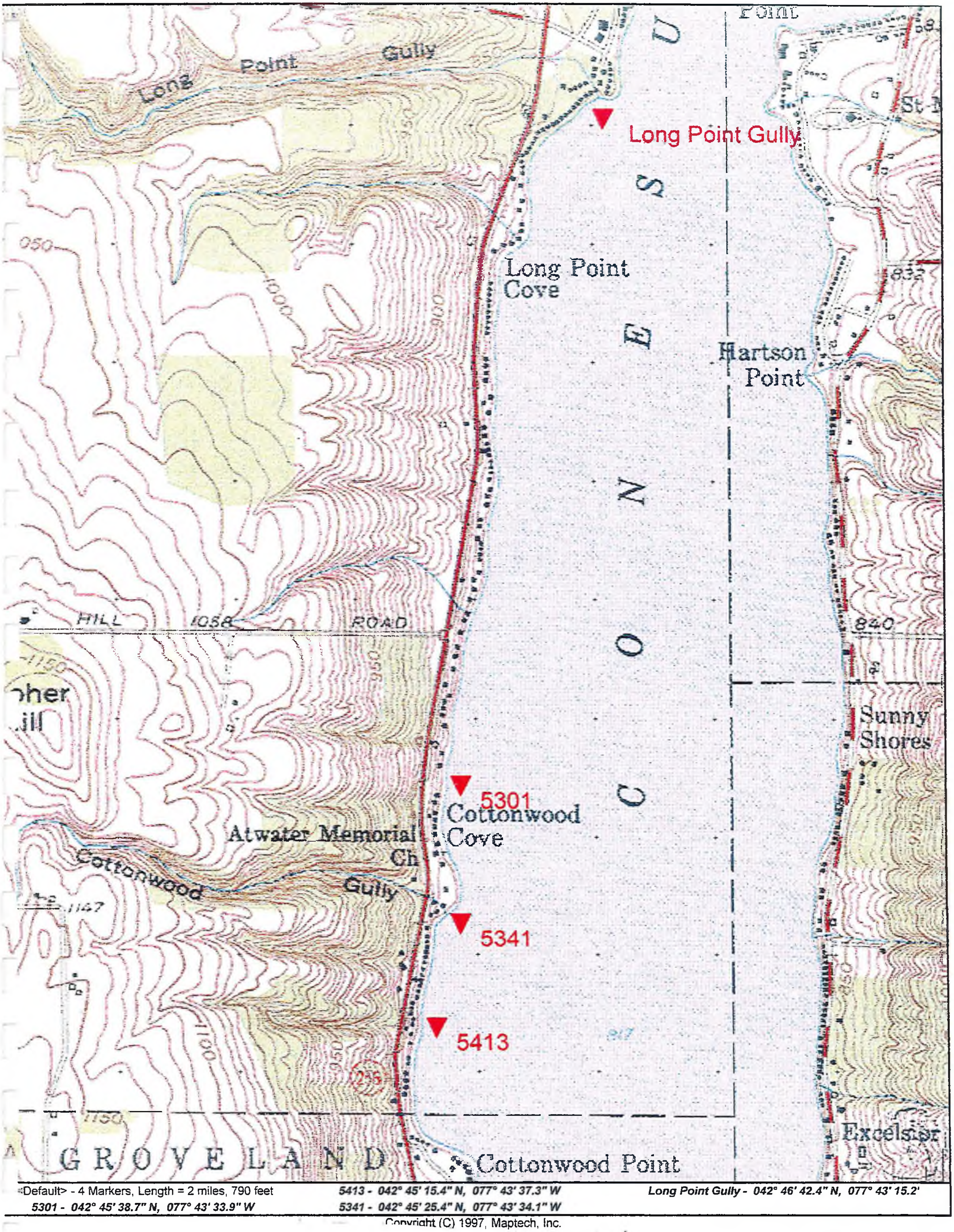

Figure 1. Southwest quadrant of Conesus Lake showing sub-watersheds sampled by red triangles.

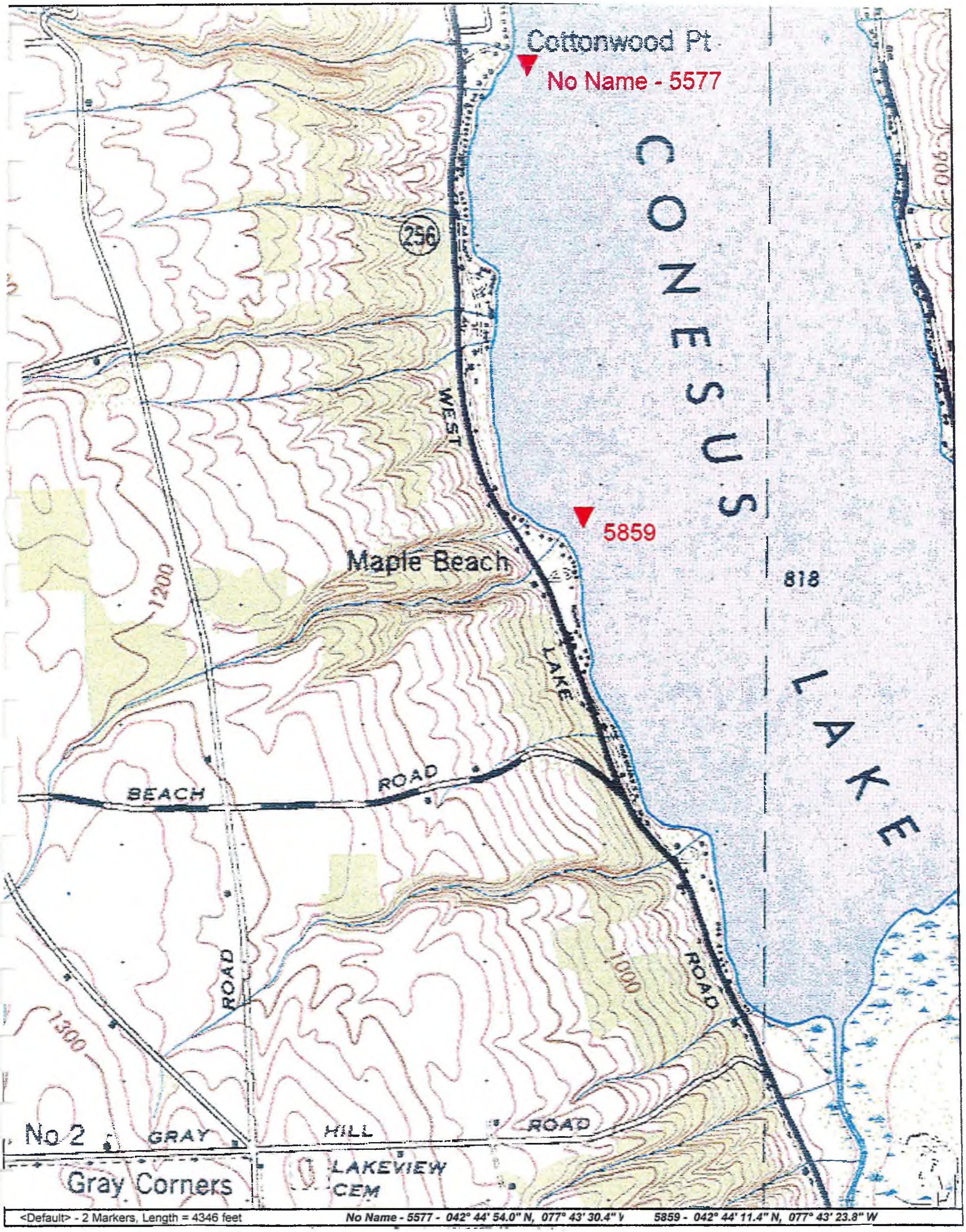

Figure 2. Southwest quadrant of Conesus Lake showing sub-watersheds sampled by red triangles.

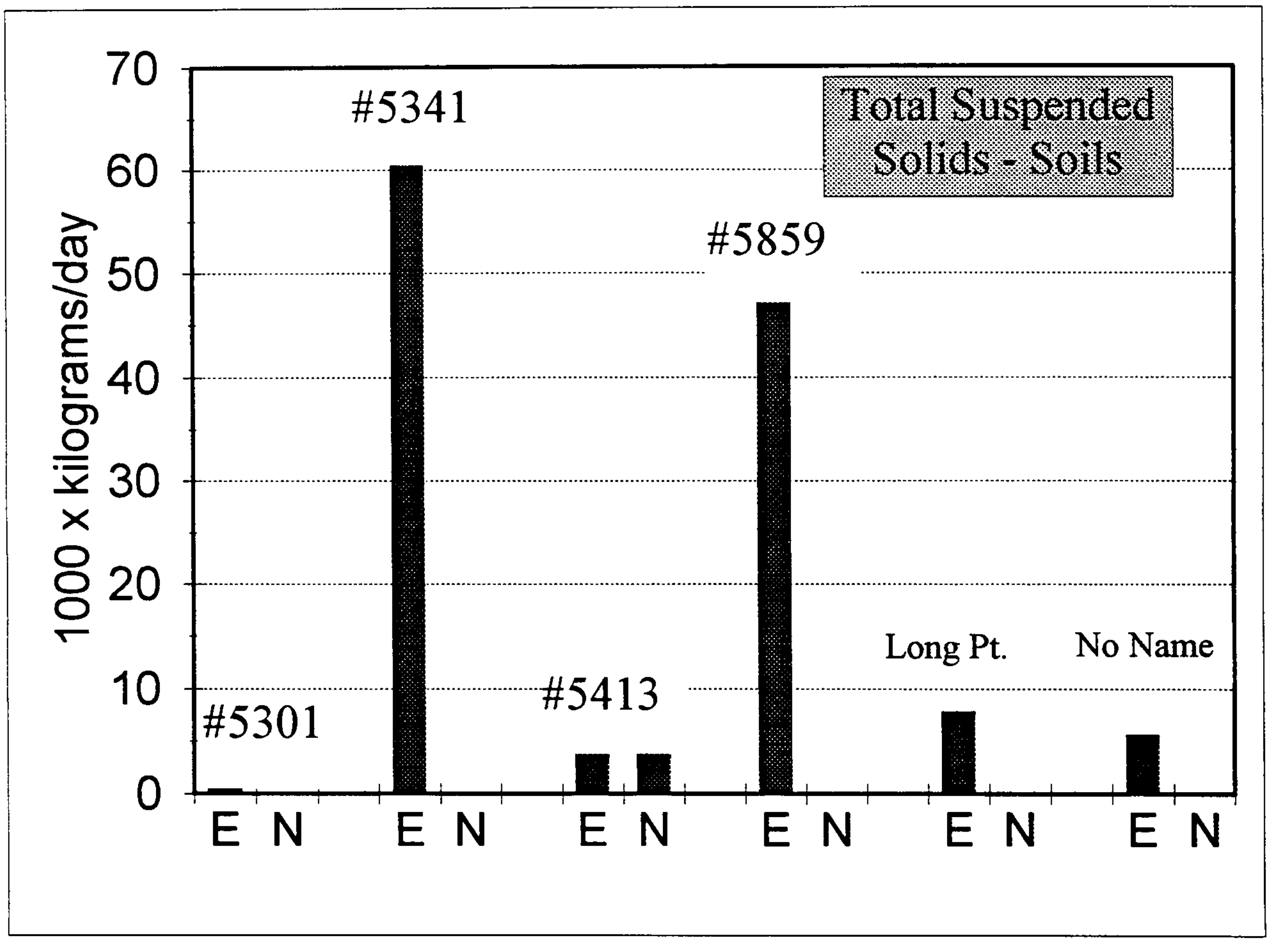

Figure 3. Event and non-event losses of total suspended solids from sub-watersheds in the southwest quadrant of Conesus Lake during the winter and spring of 1999.

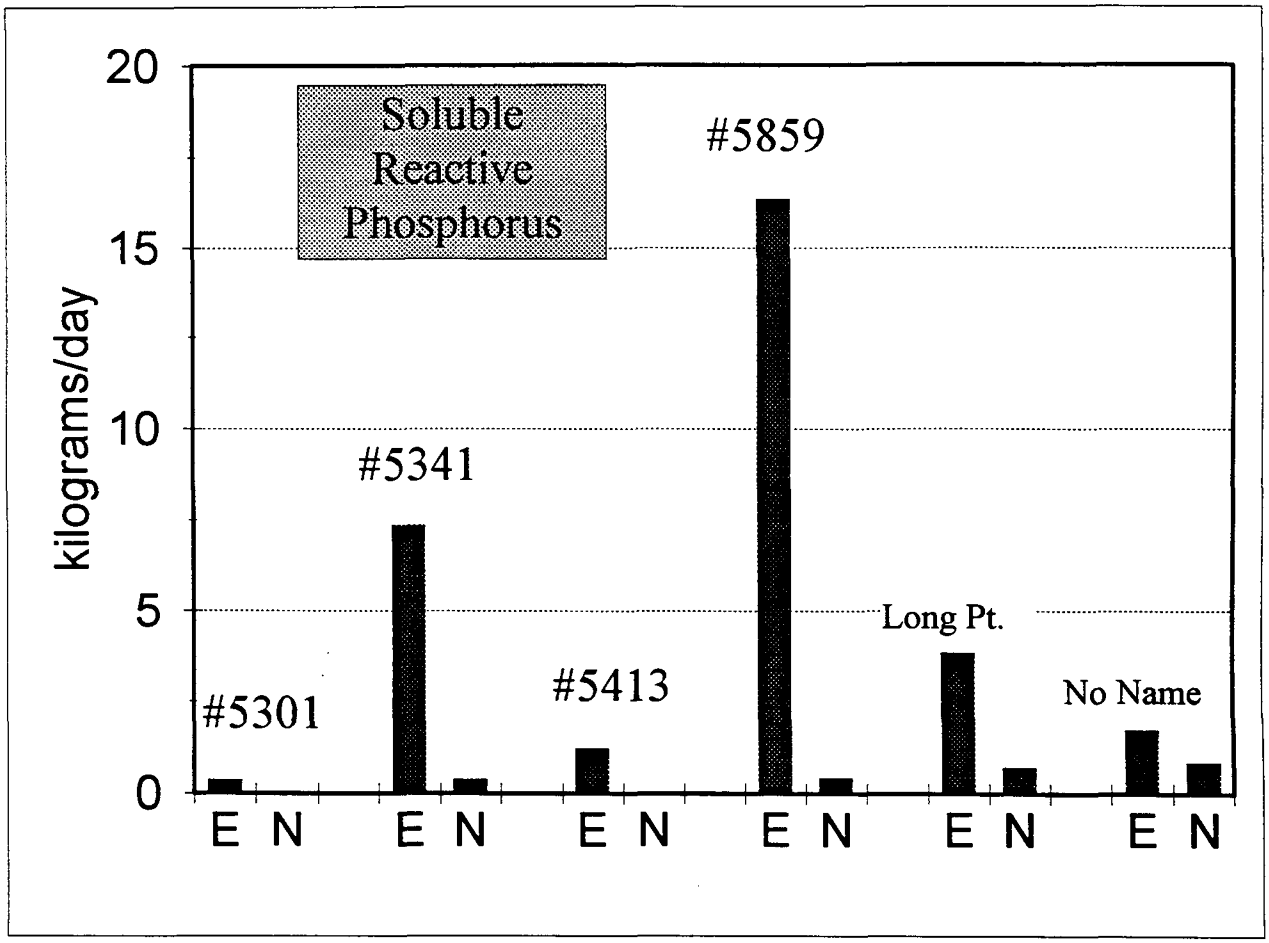

Figure 4. Event and non-event losses of soluble reactive phosphorus from sub-watersheds in the southwest quadrant of Conesus Lake during the winter and spring of 1999.

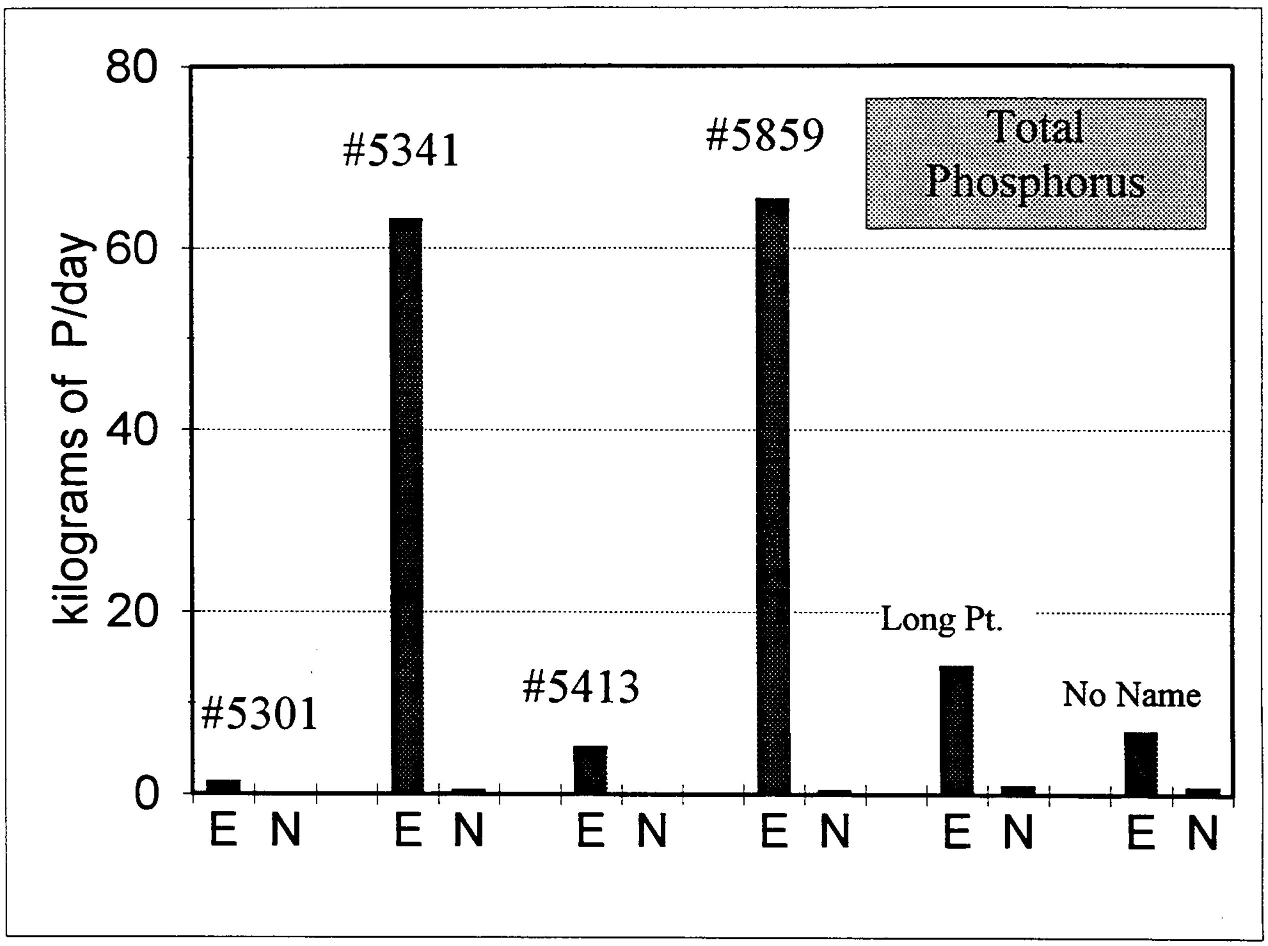

Figure 5. Event and non-event losses of total phosphorus from sub-watersheds in the southwest quadrant of Conesus Lake during the winter and spring of 1999.

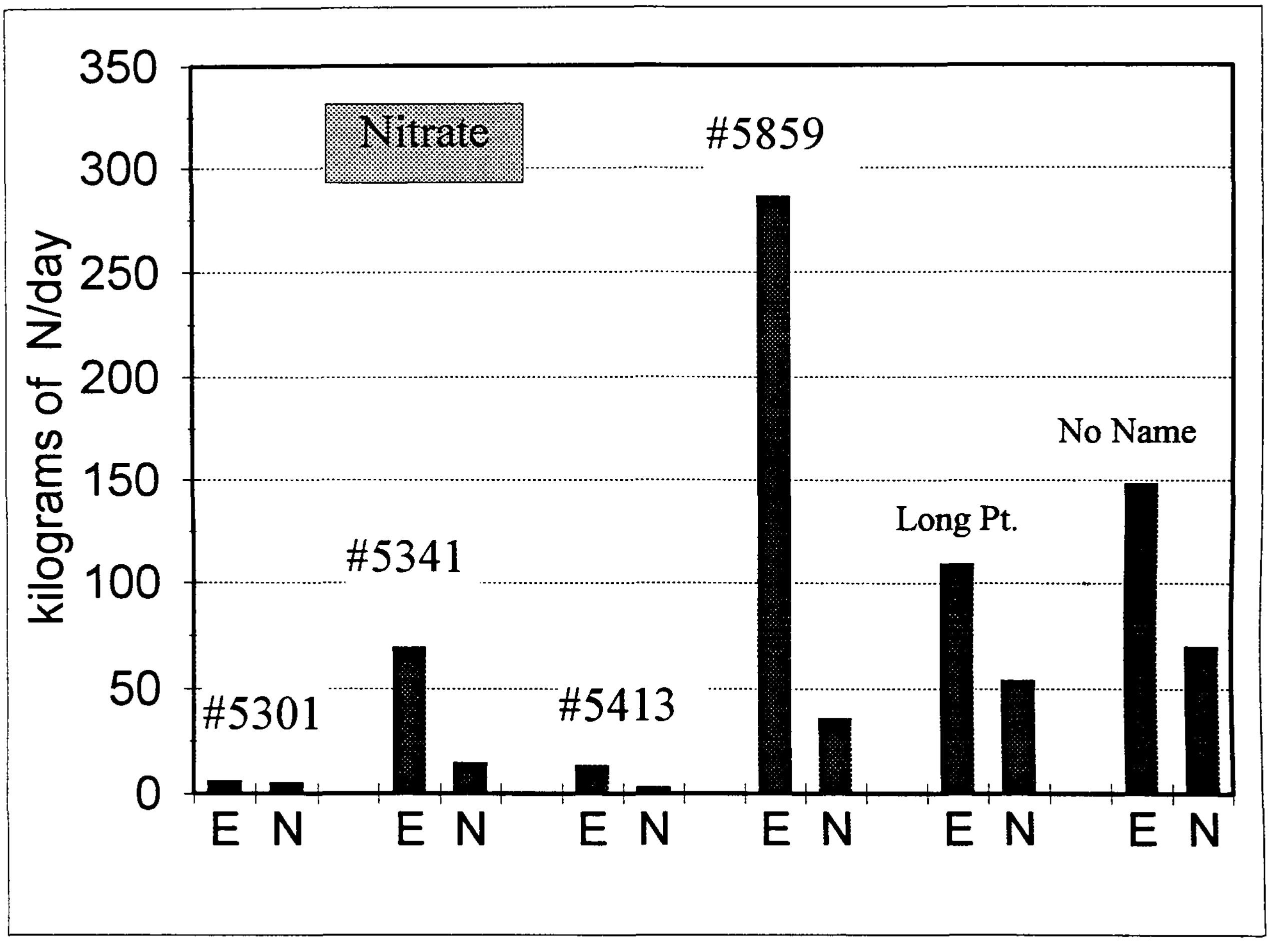

Figure 6. Event and non-event losses of nitrate from sub-watersheds in the southwest quadrant of Conesus Lake during the winter and spring of 1999.

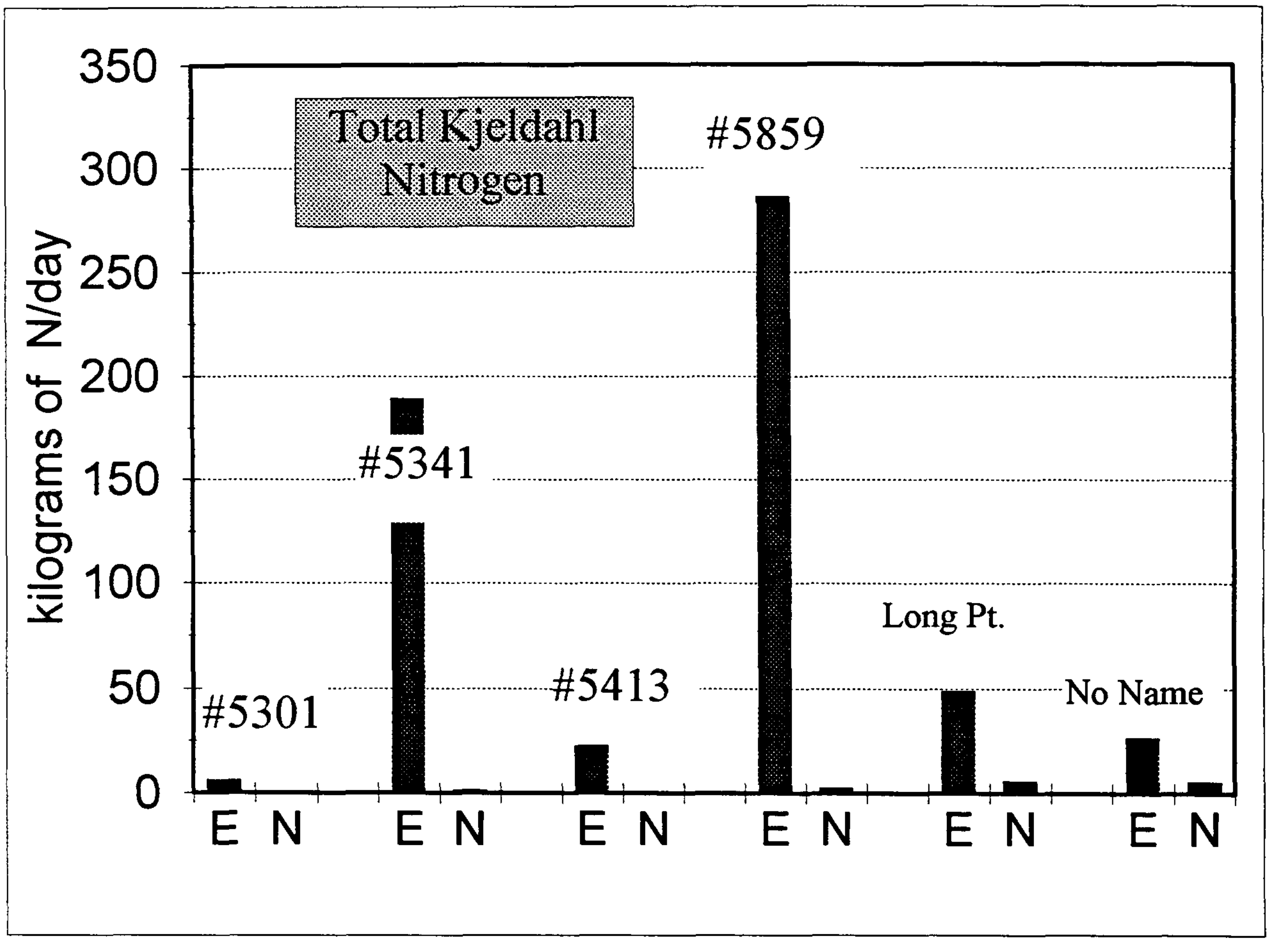

Figure 7. Event and non-event losses of total Kjeldahl nitrogen from sub-watersheds in the southwest quadrant of Conesus Lake during the winter and spring of 1999.

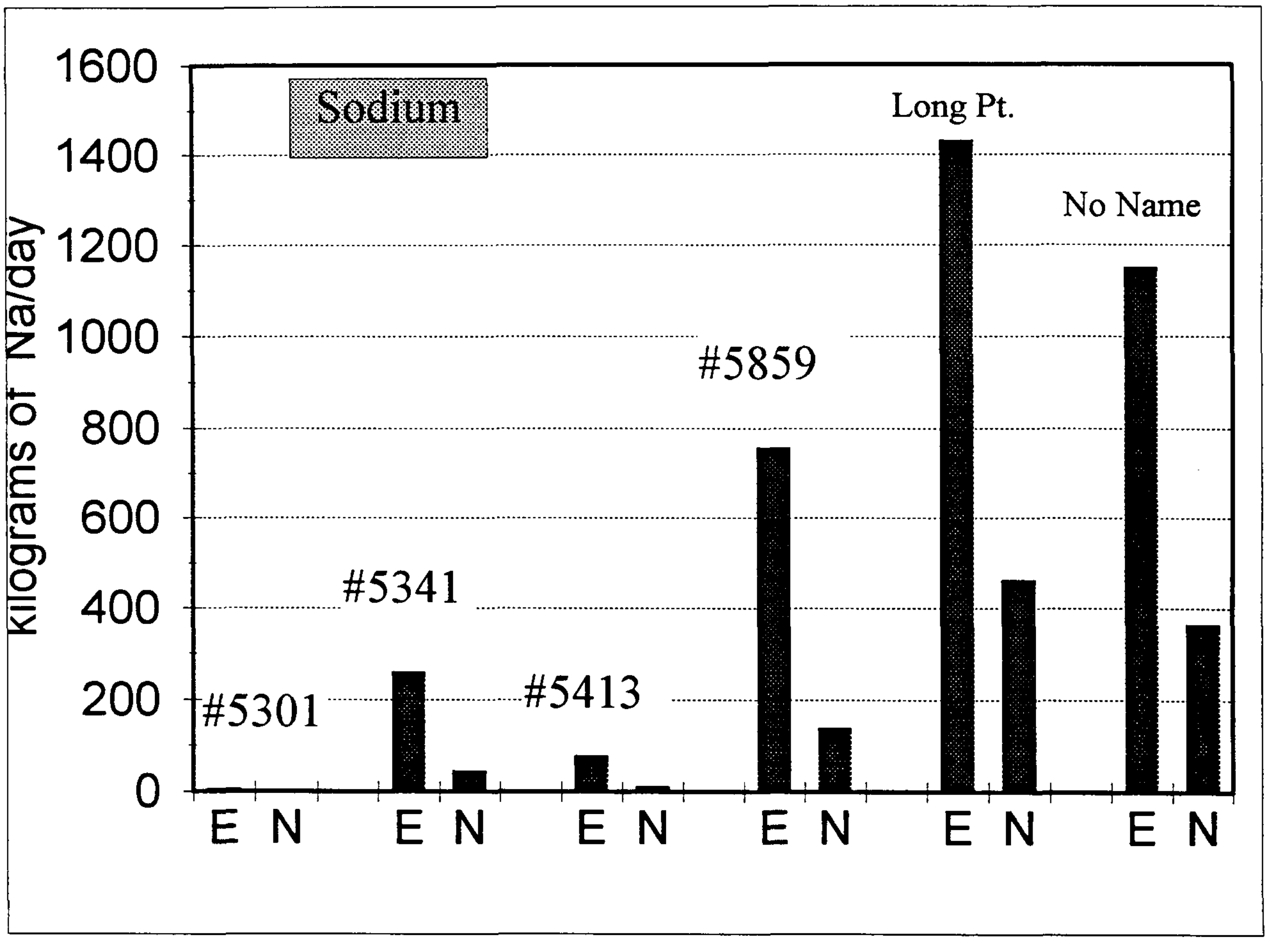

Figure 8. Event and non-event losses of sodium from sub-watersheds in the southwest quadrant of Conesus Lake during the winter and spring of 1999.

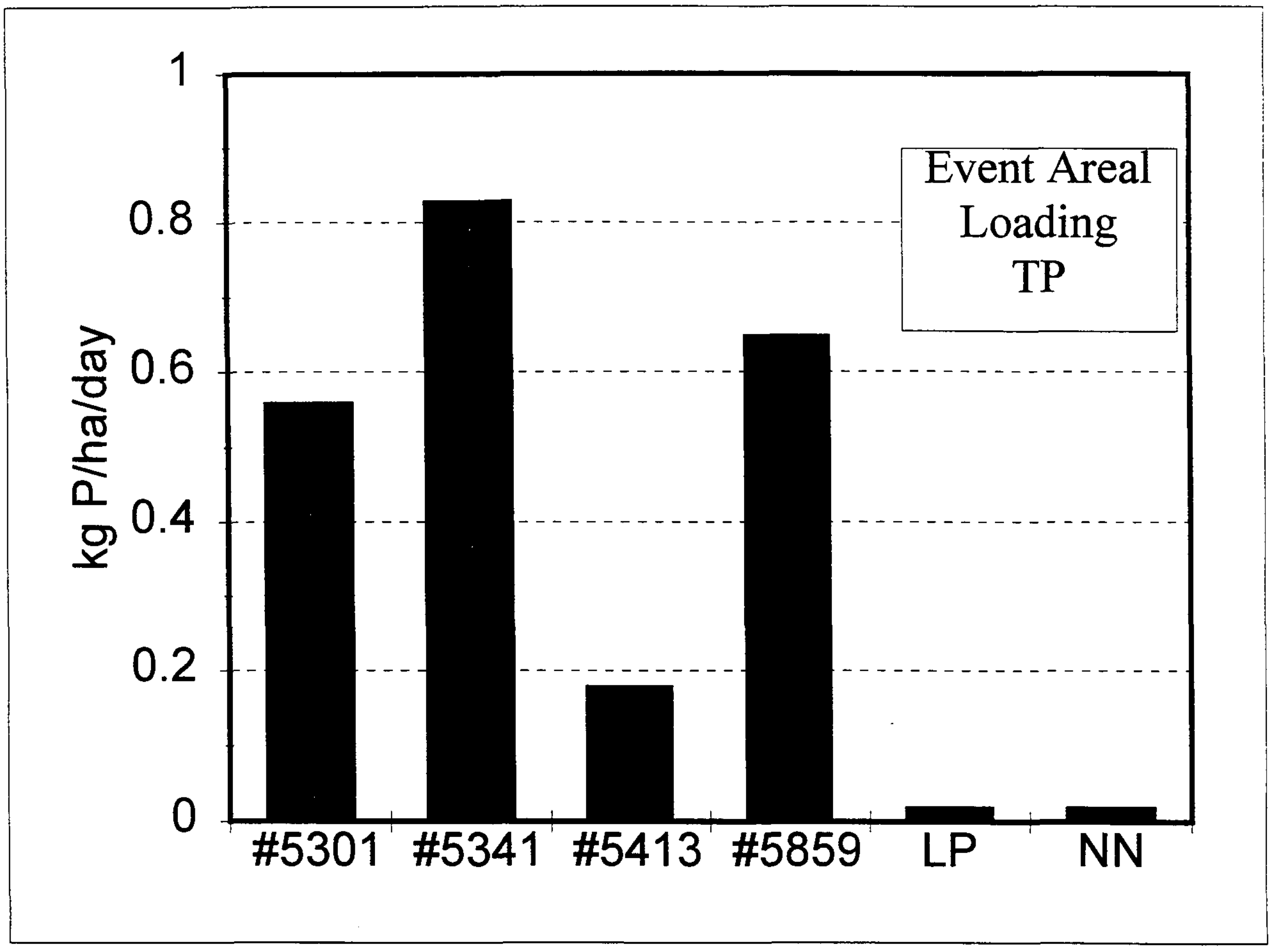

Figure 9. Areal event losses of total phophorus from sub-watersheds in the southwest quadrant of Conesus Lake during the winter and spring of 1999. LP = Long Point Gully, NN = "No Name" Creek.

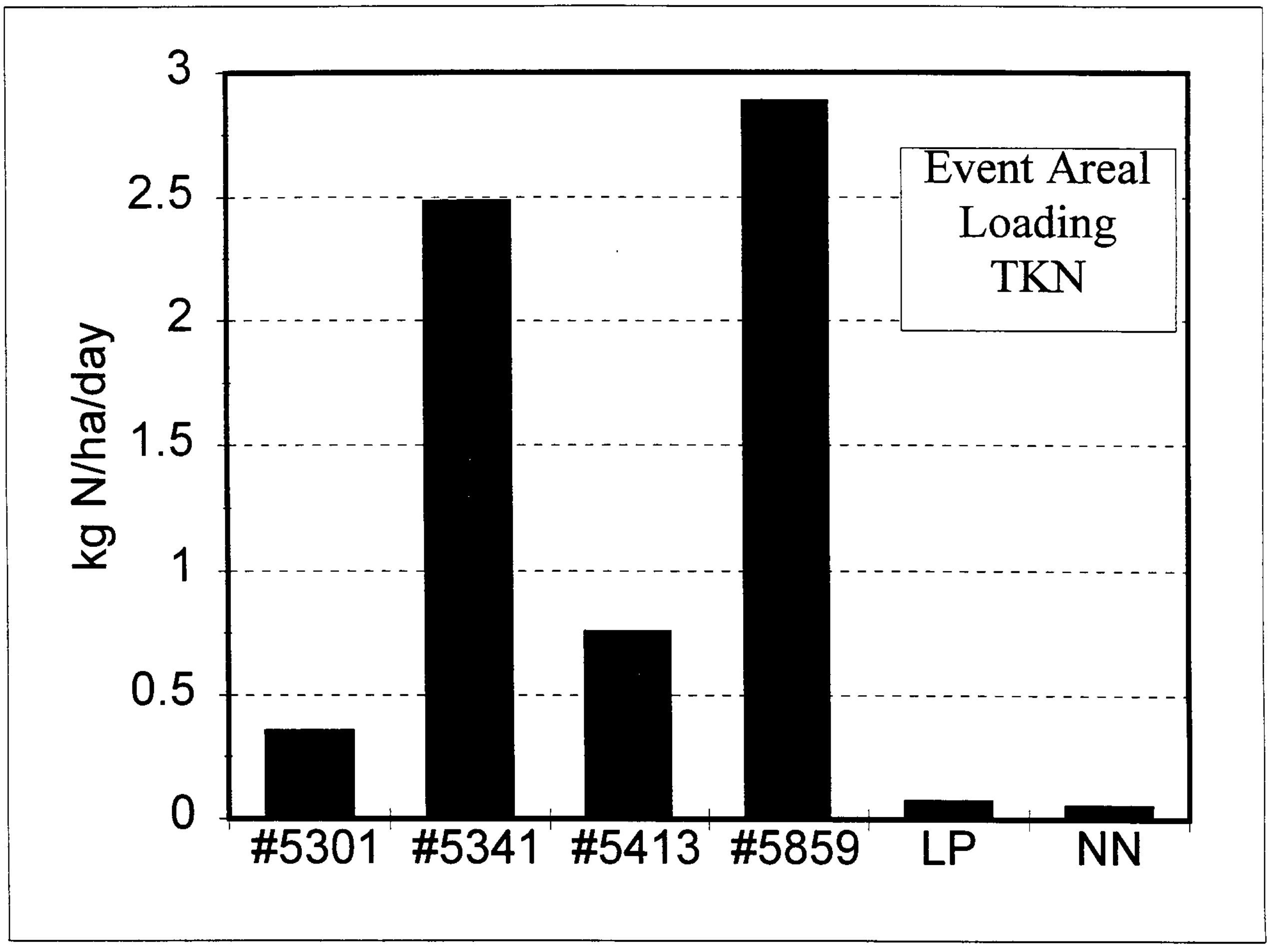

Figure 10. Areal event losses of total kjeldahl nitrogen from sub-watersheds in the southwest quadrant of Conesus Lake during the winter and spring of 1999. LP = Long Point Gully, NN = "No Name" Creek.

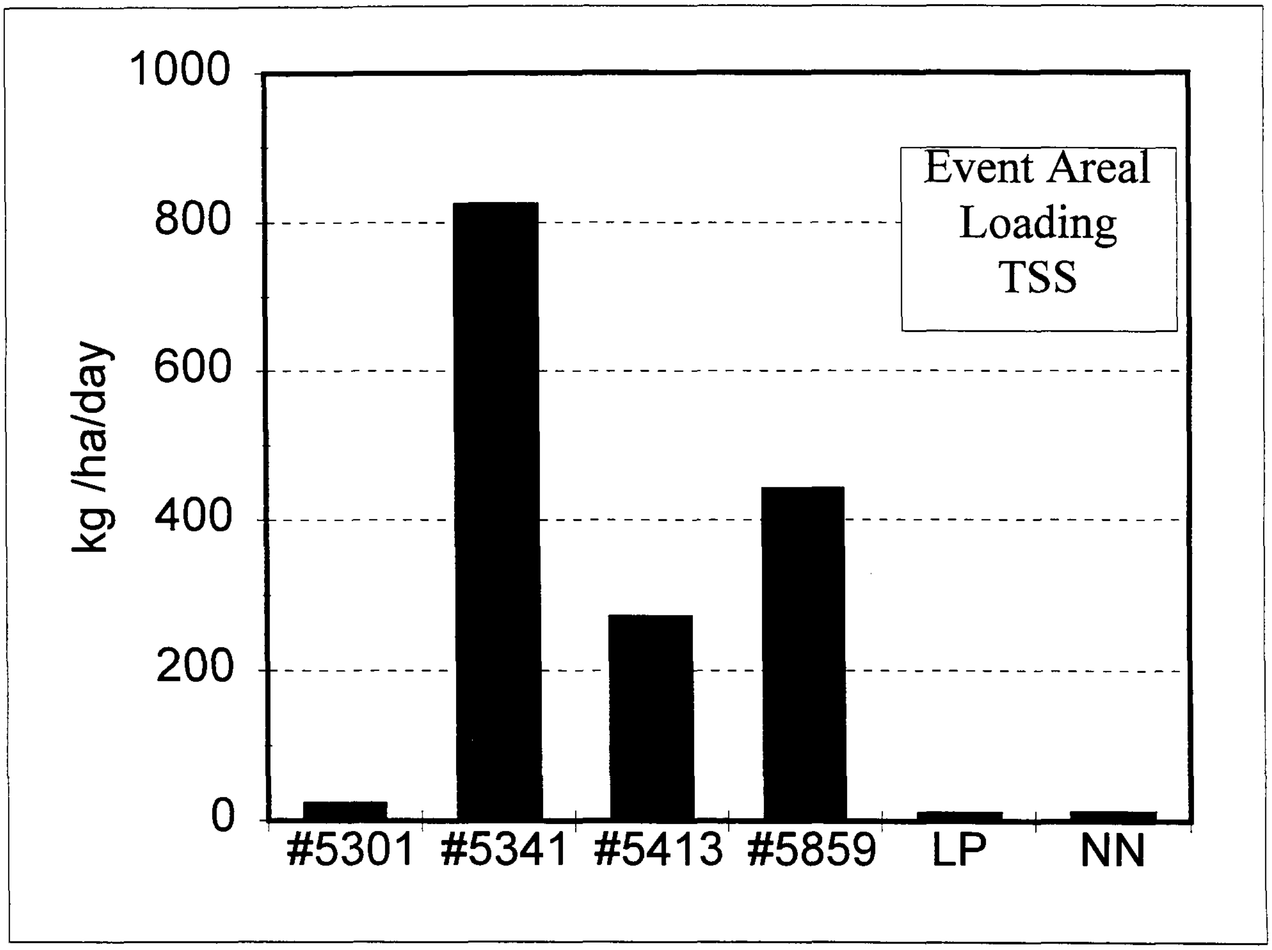

Figure 11. Areal event losses of total suspended solids from sub-watersheds in the southwest quadrant of Conesus Lake during the winter and spring of 1999. LP = Long Point Gully, NN = "No Name" Creek.