Loading of Nutrients from North Shore Tributaries of Oneida Lake: Black, Crandell, Dakins, Little Bay and Threemile Creeks Oswego County, N.Y.

Joseph C. Makarewicz and Theodore W. Lewis
Department of Environmental Science and Biology
SUNY Brockport, Brockport, NY

Oswego County Soil and Water Conservation District
3095 State Route 3
Fulton, NY 13069

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Executive Summary

1. The 2002 Oneida Lake tributary monitoring program of the Oswego County Soil and Water Conservation District is an expansion of the monitoring program that took place in the southern region tributaries of Oneida Lake from 1999 to 2000 by the Central New York Regional Planning Board (CNYRPB). Currently, Phase I of the 2002-2003 program of the CNYRPB involves sampling at the base of the primary tributaries flowing into Oneida Lake (including Big Bay, Scriba, East Branch of Fish, Lower Fish, Wood, Oneida, Cowaselon, Canaseraga, Chittenango, Limestone, and Butternut Creeks). As an extension of the Oneida Lake Watershed Monitoring Program, the Oswego County SWCD is using the same procedures and methodology to monitor an additional five smaller, northwest shore tributaries in the Oswego County portion of the Oneida Lake watershed. The sampling sites are summarized below:

   Little Bay Creek at NYS Route 49 crossing
   Threemile Creek at Lower Road crossing
   Dakins Creek at Johnson Road crossing
   Crandell Creek just West of the County Route 17 crossing
   Black Creek at Gale Road crossing.

2. The addition of the north shore tributaries to the monitoring strategy allows a better evaluation and prioritization of the subwatersheds in terms of nutrient and suspended solids (soil) loss to the lake from tributaries. That is, the goal of monitoring program is to document nutrient and sediment loading to the lake and to prioritize the streams according to problem severity allowing direction on potential restoration and protection initiatives in affected sub-watersheds. Also, these results will be used to augment the on-going study of major tributaries into Oneida Lake due to be completed by the Central New York Regional Planning Board in spring of 2003.

3. For the 14 sampling dates, the average highest non-event (26,302 m^3/day) and event (187,065 m^3/day) flows were observed at Black and Little Bay Creek, respectively.

4. In general, the low pH and low specific conductance at all sites reflect the small size of the watersheds and land use.

5. Oxygen concentrations of Little Bay Creek during non-events (mean = 6.28 mg/L) were 3 to 4 mg/L lower than other creeks. These values may represent daily high values because samples were always taken during the day when oxygen concentration would typically be at their highest. Although still suitable for supporting fish populations, oxygen concentrations should be monitored during the evening to establish the diel variability. Oxygen concentrations in the

evening may fall below suitable levels to support desireable fish life. This result suggests a source of organic material in the watershed.

6. Non-event losses of nutrients from the watersheds are generally low compared to event losses on a per day basis; that is losses from the watersheds are greatest during hydrometeorological events. Generally, daily losses from the watersheds during events are two to 15 times higher than the baseline losses for total suspended solids (soils), total phosphorus, nitrate and total Kjeldahl nitrogen. The lowest increase from non-event to events was in the Crandell Creek sub-watershed. Here event losses were generally only twice as high as non-event losses. The greatest loss from non-events to events was observed in the Little Bay Creek sub-watershed. Events losses of phosphorus, total Kjeldahl nitrogen, nitrate, chloride and total suspended solids ranged from 3 to 15 times higher than non-event losses.

7. In Little Bay Creek, the concentration (mg/L) of chloride and loss of chloride (g Cl/ha/d) was significantly higher during events. The high loading of salt from Little Bay Creek is probably associated with deicing salt operations on NYS Route 49 where the sampling site is located.

8. Baseline losses of phosphorus from each subwatershed was variable (0.22 to 0.56 g P/ha/day), but much lower than event losses (0.75 to 8.77 g P/ha/day). Considering daily areal loading, Little Bay Creek at Route 49 delivered substantially more phosphorus (8.77 g P/ha/day) to downstream habitats than any other watershed during events. Threemile Creek at Lower Road also had high event losses (2.80 g P/ha/d) of total phosphorus relative to the other subwatersheds studied. Average total phosphorus loading (kg/day) was highly correlated with average event discharge from the studied watersheds ($r=0.91$, $P<.03$, ANOVA). This suggests that the phosphorus in the particulate form (soil) was being washed off the landscape or eroded from stream banks during periods of high water flow. In fact, 44% of the phosphorus being lost from these subwatersheds can be accounted for by soil loss.

9. Nitrate is a measure of the soluble forms of nitrogen that are used readily by plants for growth. The largest amount of nitrate loss to downstream habitats during events in descending order were: Little Bay Creek (12.2 g N/ha/day), Black Creek (10.1 g N/ha/day), Crandell Creek (8.6 g N/ha/day), Threemile Creek (8.5 g N/ha/day) and Dakins Creek (5.1 g N/ha/ day). In general, the losses of nitrate-nitrogen from these watersheds were generally low. The low loss of nitrate during both events and non-events reflects the makeup of soils in this area and land use, which is decidedly not agricultural.

10. In descending order, the greatest event areal loss of total Kjeldahl nitrogen from the watershed to downstream systems was: Little Bay Creek, Threemile Creek, Black Creek, Dakins Creek and Crandell Creek. Average event total Kjeldahl nitrogen loss from sub-watersheds was highly correlated with average event discharge from tributaries from Sandy Pond during events ($r=0.96$, $P<0.01$,

ANOVA) and with average event TSS losses (r=0.83). This suggests that nitrogen, in the particulate from, is being washed off the landscape.

11. Loss of soil from the five sub-watersheds was correlated with event discharge (r=0.76). Except for Crandell Creek where the percentage increase in loss of soil was only 114% from non-events to events, the percentage increase in total suspended losses (soil) from non-events to events exceeded 500% (Black Creek = 942%, Threemile Creek = 795%, Little Bay Creek = 664% and Dakins Creek =594%). The largest losses of soil of the studied creeks were from Little Bay Creek and Black Creek at the rate of ~1500 lbs per event day. In contrast, Crandell Creek was delivering only 95 lbs of soil per event day.

12. Compared to the south shore tributaries of Oneida Lake recently studied by the Central New York Regional Planning Board, the losses of nutrients and soils from the five sub-watersheds studied on the north shore are minimal relative to Oneida, Canaseraga, Cowaselon and Limestone Creeks. Nevertheless, the losses of phosphorus from the Little Bay Creek watershed represent levels above background observed in the other studied sub-watersheds making up the northern watershed of Oneida Lake. This suggests a source exists in this sub-watershed. Losses of phosphorus were particularly high in March and May, a period associated with cultivation of the land. This is reinforced by the high losses of chloride, organic nitrogen and relatively high losses of total suspended solids. However, other possibilities exist in this sub-watershed as sources. Two trailer parks and a strip mall have functioning leach fields exist in this sub-watershed. Also the Village of Central Square and a new Super Wal-Mart exist in the watershed. Only a segment analysis would help locate sources.

13. With the possible exception of Little Bay Creek, Black, Crendell, Dakins and Threemile Creeks are not losing an unusual amount of soil or nutrients from their watersheds.

Recommendations

1. **The current sampling scheme provides a "snapshot" for an instant in time.** We have 14 snapshots (i.e., sample dates) or instances in time where samples were taken, which is a good representation of likely conditions over a one-year period of time. Because only one year was sampled and it was an exceptionally dry summer, consideration should be given to monitoring for one more year. 2002 may not been a typical year.

2. Little Bay Creek, which had the highest areal loading of the tributaries studied, was delivering 24.6 lbs of phosphorus per storm event day. This sub-watershed is delivering the largest amounts of phosphorus on areal basis and non-areal basis during events and non-events. **Since phosphorus is generally considered to be the limiting nutrient of phytoplankton growth in freshwater lakes, any remedial program to protect the water quality of Oneida Lake should**

develop a phosphorus reduction strategy considering Little Bay Creek.

3. Stressed stream analysis or segment analysis is a technique that identifies the sources of pollutants within a watershed by subdividing the impacted watershed into small distinct geographical units. Samples are taken at the beginning and end of each stream unit to determine if a nutrient (or other contaminant) source occurs within that reach. We have found this technique very useful in identifying point and non-point sources that are not always obvious. Identified sources can then be targeted for remediation and best management practices.

   There are several reasons that a stressed stream analysis should be completed on Little Bay Creek. These include: the high amounts of phosphorus, total Kjeldahl nitrogen and soil lost from this sub-watershed, the relatively low dissolved oxygen concentrations and the low pH of the stream water. The low oxygen concentrations suggest an organic source that is depleting oxygen levels through bacterial degradation. During the evening levels of oxygen may be low enough not to support desirable fish life.

Introduction

The 2002 Oneida Lake and tributary monitoring program of the Oswego Soil and Water Conservation District (SCWD) is an expansion of the monitoring program that took place in the southern region tributaries of Oneida Lake from 1999 to 2000 by the Central New York Regional Planning Board (CNYRPB)(See Makarewicz and Lewis 2000a, 2003). Phase I of the 2002-2003 program of the CNYRPB involved sampling at the base of the primary tributaries flowing into Oneida Lake (including Big Bay, Scriba, East Branch of Fish, Lower Fish, Wood, Oneida, Cowaselon, Canaseraga, Chittenango, Limestone, and Butternut Creeks). As an extension of the Oneida Lake Watershed Monitoring Program, the Oswego County SWCD is using the same procedures and methodology to monitor an additional five smaller northwest shore tributaries in the Oswego County portion of the Oneida Lake watershed. The sampling sites are summarized below (Figure 1):

1. Little Bay Creek at NYS Route 49 crossing
2. Threemile Creek at Lower Road crossing
3. Dakins Creek at Johnson Road crossing
4. Crandell Creek just West of the County Route 17 crossing
5. Black Creek at Gale Road crossing.

The addition of the north shore tributaries to the monitoring strategy allows a better evaluation and prioritization of the subwatersheds in terms of nutrient and suspended solids (soil) loss to the lake from tributaries. That is, the goal of monitoring program goal is to document nutrient and sediment loading to the lake and to prioritize the streams according to problem severity allowing direction on potential restoration and protection initiatives in affected subwatersheds.

Definitions

Total Phosphorus- A measure of all forms of the element phosphorus. Phosphorus is an element required for plant growth on land or in water. In lakes, phosphorus is often the limiting factor of phytoplankton growth and is the cause of eutrophication, or overproduction, of lakes. Phosphorus may enter a watershed in soluble or organic form from several sources including sewage, heavy-duty detergents, fertilizer and agricultural waste. Some forms of phosphorus are more available to, and cause more immediate activity in, plants.

Nitrate + Nitrite- A measure of the soluble forms of nitrogen used readily by plants for growth. Sources of nitrates in the environment are many and include barnyard waste and fertilizer.

Total Kjeldahl Nitrogen- The Kjeldahl method is a convenient method of analysis for nitrogen but cannot be used for all types of nitrogen compounds. It is, however, a good measure of organic nitrogen, including ammonia. Manure, for example, contains a large amount of organic nitrogen.
Chloride- A measure of the mineral, most commonly found as sodium chloride (NaCl), dissolved in water. NaCl naturally occurs in deep layers of local bedrock. Mined, it is stored and spread as a de-icing agent on roads and other pavements.
Total Suspended Solids - A measure of the loss of soil and other materials suspended in the water from a watershed. Water-borne sediments act as an indicator, facilitator and agent of pollution. As an indicator, they add color to the water. As a facilitator, sediments often carry other pollutants, such as nutrients and toxic substances. As an agent, sediments smother organisms and clog pore spaces used by some species for spawning.

Methods

Site Locations

Selection of monitoring sites were by the Oswego County Soil and Water Conservation District (Figures 1, 4, 5 and 6).

Sampling Dates

Tributary sampling was conducted from January to December 2002. Non-event samples were generally collected once a month while five event samples were collected during the 12-month period. Non-event Sampling Days were:

- 10 January 2002
- 19 April 2002
- 12 June 2002
- 24 July 2002
- 8 August 2002
- 12 September 2002
- 9 October 2002
- 21 November 2002
- 12 December 2002

All "event" samples were taken on the same day and within a three-hour time period. An "event" is defined as a period of heavy precipitation or significant snowmelt that results in a substantial increase in the volume of water flowing down a tributary. Listed below are the event samples by date. Note that no event samples were taken during the summer due to the lack of precipitation in an unusually dry summer.

- 7 February 2002
- 5 March 2002
- 14 May 2002
- 17 October 2002
- 7 November 2002

Water Sampling

One water sample was collected per stream for each sampling date because the streams being sampled are small and shallow (generally less than a foot in depth) and the flow of water is sufficient to mix the water column entirely. Samples were placed in pre-cleaned polyethylene bottles provided by LSL, Inc. of Syracuse N.Y. Analysis for chloride, soluble reactive phosphorus, total phosphorus, total Kjeldahl nitrogen, nitrate and total suspended solids were performed by LSL, Inc according to Standard Procedures and preservation techniques (Tables 1 and 2).

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-type flow meter (Chow 1964). The number of velocity reading is proportional to the width of the stream.

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 were calculated by planimetry after measuring the cross-sectional dimensions of each stream monitored.

Discharge: Discharge was calculated using standard USGS protocol following Measurement and Computation of Streamflow by Rantz *et al*. (1982). In general, the area-velocity method was used where cross-sectional area and velocity are physically measured during each sampling trip across the width of the streambed.

Watershed Area: Subwatershed areas were estimated from USGS topographic maps by SWCD.

Nutrient Loading: Daily nutrient and soil loss 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.

Consistency In Sampling

To ensure consistent sampling procedures with tributary samples taken by the Central New York Regional Planning & Development Board at several other sites on Oneida Lake (Makarewicz and Lewis 2003), Oswego SWCD personnel took a training session conducted by the author including a review of the equipment, sampling handling and storage, and field sampling procedures. Each participant worked with the flow probes and HydroLabs.

Sample Handling and Custody Requirements:

Chain of custody forms were signed by the sampling personnel upon release of the samples and are signed by the individual accepting samples for the laboratory.

Quality Assurance

LSL. Inc is a NELAC certified laboratory. To ensure analytical quality control, the following were completed.
Method Blanks were performed at a frequency of one per batch of samples per matrix type per sample extraction or preparation test method. The results of these samples are used to determine batch acceptance. Method blank detections ten times the reporting limit will require repeat analysis of the associated batch.

Laboratory Control Samples were analyzed at a minimum of 1 per batch of 20 or fewer samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available (e. g. total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen, or turbidity). The results of these samples are used to determine batch acceptance.

Matrix Spikes (MS) were performed at a frequency of one in 20 samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as, total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The sample(s) selected for spiking are rotated among received samples so that various matrix problems may be noted and/or addressed. Poor performance in a matrix spike generally indicates a problem with the sample composition, and not the laboratory analysis, and is reported to assist in data assessment. The analyst will not repeat batch processing due to poor matrix spike recovery.

Laboratory Duplicates were analyzed at a minimum of 1 in 20 samples per matrix type per sample extraction or test method. The selected sample(s) are rotated among received samples so that various matrix problems may be noted and/or addressed.

Results and Discussion

Physical Measurements and Concentration of Analytes

Temperature:

Average stream temperatures were not significantly different between the five streams sampled entering Oneida Lake during the study period. Average seasonal non-event temperatures measured by SWCD personnel ranged from 52.4 to 56.4 ^{o}F, while event average seasonal temperatures were slightly lower (range = 39.2 to 41.4^{o}F) (Table 3). Event temperatures are lower because hydrometeorlogical events tend to occur during the winter and spring.

pH:

pH is a measure of the hydrogen ion concentration or acidity of the water. Average seasonal pH at all sites was basic during non-events (range = 7.10 to 7.31) except at Little Bay Creek where stream pH was slightly acidic (6.60). For events, stream pH was more acidic reflecting the fact that precipitation in the region is acidic (range = 5.07 to 6.78) (Table 3). pH of Little Bay Creek was a whole pH unit lower than other creeks during events

Specific Conductance:

Specific conductance is a measure of the ability of an aqueous solution to carry an electric current. The greater the amount of dissolved solids in the water, the greater the electrical current that can be carried by the water. Average seasonal non-event specific conductance ranged from a high of 465.1 mS/cm at Little Bay Creek to a low of 91.2 mS/cm at Black Creek (Table 3). Average event seasonal specific conductance was significantly lower than non-event specific conductance (Table 3) ranging from a low of 59.2 mS/cm at Black Creek to a high of 292.5 mS/cm at Little Bay Creek. The significantly lower event values suggest dilution of baseline runoff by precipitation containing little or no inorganic dissolved substances. In general, the low pH and low specific conductance at all sites probably reflect the small size of the watersheds. Bedrock in the study area is sedimentary. Only the northeast corner of Oswego County is part of the Tug Hill Plateau.

Total Suspended Solids:

Total suspended solids (TSS) is a measure of materials suspended in the water column. The suspended materials could be soil, microscopic organisms called phytoplankton, zooplankton, and bacteria. Average seasonal event TSS was generally low (range = 2.0 to 12.0 mg/L) in all streams and only slightly different from non-event concentrations (Table 3).

Dissolved Oxygen:

Dissolved oxygen is required by fish to live in water. Oxygen concentrations were typically high (> 9.0 mg/L) at all sites (Table 3) and support fish life. Event oxygen levels were higher than during non-events. Event water represents rain that is often near oxygen saturation for a given temperature. Oxygen concentrations of Little Bay Creek during non-events (mean = 6.28) were 3 to 4 mg/L lower than other creeks. These values may represent high values because samples were always taken during the day when oxygen concentration would typically be at their highest. Although still suitable for supporting fish populations, oxygen concentrations should be monitored during the evening to establish the diel variability. Oxygen concentrations during the evening may drop into a range that would make these waters unsuitable for desirable fish life.

Total Kjeldahl Nitrogen:
Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen plus ammonia. In all cases, average seasonal baseline TKN concentrations (range = 0.27 to 0.61 mg N/L) were generally higher, but not statistically significant, than event concentrations (range = 0.21 to 0.41 mg N/L) for all streams but Little Bay Creek (Table 3). For Little Bay Creek, event TKN concentrations were 50% lower than during non-events. This was a surprising result and suggests that a source of organic nitrogen exists in this watershed that is steadily being lost during non-events.

Nitrate +Nitrite:
Nitrate is a measure of the soluble forms of nitrogen used readily by plants for growth. Sources of nitrates in the environment are many and include barnyard waste and fertilizer. Mean non-event nitrate concentrations (range = 0.17 to 0.28 mg N/L) were higher, but generally not significantly higher, than events (range = 0.15 to 0.20 mg N/L) for each respective stream (Table 3).

Total Phosphorus:
Phosphorus is considered the limiting nutrient to growth of microscopic plants (i.e., algae) and macrophytes (i.e., weeds). It is a fertilizer and excessive amounts will stimulate the growth of plants. Except for Little Bay and Crandell Creek, average seasonal event (18 to 32 µg P/L) total phosphorus concentrations were higher than non-events (range= 13 to 23 µg P/L) (Table 3). In Little Bay Creek and Crandell Creek, non-event concentrations were higher, but not significantly, than events. Total phosphorus concentrations during events and non-events for Little Bay Creek were high during both events and non-events.

Chloride
Chloride is a measure of the mineral, most commonly found as sodium chloride (NaCl), dissolved in water. Concentrations were generally low and not significantly different between events and non-events. Only Little Bay Creek displayed a high loss of chloride during both events and non-events (Table 3) probably dud to its proximity to Route 49.

LOSS OF MATERIALS AND NUTRIENTS FROM THE WATERSHED

Although concentration of pollutants are a useful piece of information in evaluating streams, these data are limited and may lead to an inaccurate conclusion. The total loss of a pollutant from a watershed or loading to downstream systems is a better measurement of a watershed's impact because it considers the volume of water in addition to the concentration of the nutrient in that water. A stream with a high concentration of a nutrient but a low discharge will have less of an impact on downstream systems than a stream with high discharge and a moderate concentration of a nutrient.

The current sampling scheme provides a “snapshot” for an instant in time. We have 14 snapshots (i.e. sample dates) or instances in time where samples were taken, which is a good representation of likely conditions over a one-year period of time. Because the number of years of sampling is low (n=1) and because it was an exceptionally dry summer, the results may not be representative of a typical year. Consideration should be given to monitoring for one more year. Because flow or discharge was not monitored continuously, time trend analysis within the study period or into the future is not possible. However, prioritization of subwatersheds based on the amount of nutrients and materials lost from a subwatershed is possible and has been done below. It should be noted that these rankings may change as more sampling dates are added to the data base

Direct comparisons of watersheds using areal losses (loss per watershed area) are used in this report (Table 4, Fig. 2), although non-weighted nutrient losses are also presented (Table 5, Fig. 3). By calculating the loss per unit area of watershed, we normalize the results so that subwatersheds of different sizes can be effectively compared. A watershed with a high loss of nutrients per unit area compared to another would suggest that a non-point or point source of nutrients exists in this watershed. Also by considering areal loading, prioritization or ranking of watersheds for remedial action is possible. The data is separated into events and non-events reflecting the design of the sampling strategy whereby samples were taken during hydrometeorological events and non-events.

Average Daily Losses During Events and Baseline Conditions:

Each bar graph in this series of graphs (Fig. 2) represents the nutrient or material losses from a tributary and its associated watershed. The blue bar (lighter bar) is average daily event areal loading; the red bar (darker bar) represents the average daily baseline or non-event areal loading to Onieda Creek from the five sub-watersheds.

Discharge (Tables 4 and 5, Figure 2a)

For the 14 sampling dates, the average highest non-event (26,302 m^3/day) and event (187,065 m^3/day) flows were observed at Black and Little Bay Creek, respectively. The lowest flows were observed at Dakins Creek (baseline: 7,827 m^3/day) and Threemile Creek (8,475 m^3/day) during non-events. Except for Crandell Creeks, where flow increased by only 115% from baseline conditions, all the other sampling locations experienced significantly higher event flows ranging as high as 1,150% (Little Bay Creek) and 482 % (Threemile Creek) over baseflow.

Phosphorus (Tables 4 and 5, Figure 2b):

The loss of total phosphorus during events from the five subwatersheds was always higher than baseline losses. Baseline losses from each subwatershed were variable (0.22 to 0.56 g P/ha/day), but much lower than event losses (0.75 to 8.77 g P/ha/day). Considering daily areal loading, Little Bay Creek at Route 49 delivered substantially more phosphorus (8.77 g P/ha/day) to downstream habitats than any other watershed during events (Fig. 2b). Threemile Creek at Lower Road also had high event losses (2.80 g P/ha/d) of total phosphorus relative to the other subwatersheds studied. Average total phosphorus loading (kg/day) was highly correlated with average event discharge from the studied watersheds ($r=0.91$, $P<.03$, ANOVA). This suggests that the phosphorus in the particulate form (soil) was being washed off the landscape or eroded from stream banks during periods of high water flow. In fact, 44% (r^2) of the phosphorus being lost from these subwatersheds can be accounted for by soil loss.

By considering the total loading of a subwatershed (not normalized by area of the subwatershed), a better sense of the amounts of phosphorus being delivered into Oneida Lake by a subwatershed is possible. For example, Little Bay Creek, which had the highest areal loading of the tributaries studied, was delivering 24.6 lbs of phosphorus per storm event day. Since phosphorus is generally considered to be the limiting nutrient of phytoplankton growth in freshwater lakes, any remedial program to protect the water quality of Oneida Lake should develop a phosphorus reduction strategy considering Little Bay Creek. This subwatershed is delivering the largest amounts of phosphorus on areal basis and non-areal basis during events and non-events (Tables 4 and 5) of the five tributaries investigated.

Nitrate (Tables 4 and 5, Figure 2c)

Nitrate is a measure of the soluble forms of nitrogen that are used readily by plants for growth. The largest amount of nitrate loss to downstream habitats during events in descending order were: Little Bay Creek (12.2 g N/ha/day), Black Creek (10.1 g N/ha/day), Crandell Creek (8.6 g N/ha/day), Threemile Creek (8.5 g N/ha/day) and Dakins Creek (5.1 g N/ha/ day). Little Bay Creek also had relatively high losses of total phosphorus from the upstream watershed. However, losses of nitrate-nitrogen from these watersheds are low. For example, loss of nitrate nitrogen during events for roughly the same period of time and year in Sandy Pond, which is 26 miles due north of Little Bay Creek is substantially higher [Skinner Creek (67.5 g N/ha/day), Little Sandy Creek Creek (40.0 g N/ha/day), Lindsey Creek (31.5 g N/ha/day), Blind Creek (28.0 g N/ha/day) and Mud Creek (24.8 g N/ha/ day)] (Makarewicz *et al*. 2002). Losses of nitrate from the sub-watersheds during non-events was also low. The low loss of nitrate during both events and non-events reflects the makeup of soils in this area and land use, which is decidedly not agricultural.

Total Suspended Solids (Tables 4 and 5, Figure 2d)

The loss of suspended solids is a measurement of the loss of soil and other materials suspended in the water from a watershed and can be used as a measure of soil erosion. In general, soil erosion is one of the major sources of nutrient loss from watersheds and is often positively correlated with total phosphorus and TKN loss as in the southern Oneida Lake tributaries and Sandy Pond in Oswego County (Makarewicz and Lewis 2000a, Makarewicz *et al*. 2002). Loss of phosphorus and TKN from Little Bay, Threemile, Dakins and Crandell and Black Creeks was highly correlated with loss of soil (r = 0.66 and 0.63, respectively) and discharge (r=0.91 and r=0.96, respectively). Loss of soil from the five sub-watersheds was correlated with event discharge (r=0.76). Another way of interpreting this result is that ~58% of the variability in the soil loss can be explained by the increasing discharge. Several watersheds were losing suspended materials at higher areal levels compared to other watersheds. In descending order, loss of soil from subwatershed was: Dakins Creek, Little Bay Creek, Black Creek, Threemile Creek and Crandell Creek. Except for Crandell Creek where the percentage increase in loss of soil was only 114% from non-events to events, the percentage increase in total suspended losses (soil) from non-events to events exceeded 500% (Black Creek = 942%, Threemile Creek = 795%, Little Bay Creek =664% and Dakins Creek =594%).

Another way of gauging the impact of a watershed is to consider the total loading from the watershed - that is not normalizing the data for area. For Little Bay Creek and Black Creek, about 1500 pounds of soil per storm event day were washed into the lake. In contrast, Crandell Creek was delivering only 95 pounds of soil per event per day.

Total Kjeldahl Nitrogen (Tables 4 and 5, Figure 3d)

Total Kjeldahl nitrogen (TKN) is a measure of the organic nitrogen and ammonia loss from the watershed. For example, cow manure would contain a large amount of organic nitrogen. In descending order, the greatest event areal loss of total Kjeldahl nitrogen from the watershed to downstream systems was: Little Bay Creek, Threemile Creek, Black Creek, Dakins Creek and Crandell Creek. Average event total Kjeldahl nitrogen loss from sub-watersheds was highly correlated with average event discharge from tributaries from Oneida Lake during events ($r=0.96$, $P<0.01$, ANOVA) and with average event TSS losses ($r=0.83$). This suggests that nitrogen, in the particulate from, is being washed off the landscape.

Chloride (Tables 4 and 5, Figure 3e)

Chloride is a component of deicing salt. Unlike the other chemical analytes discussed where the highest concentration often occurred during hydrometeorologic events, concentrations of chloride were often similar between events and non-events with exception of Little Bay Creek. In Little Bay Creek, concentration (mg/L) of chloride and loss of chloride (g Cl/ha/d) was significantly higher during events (Table 4). The high loading of salt from Little Bay Creek is associated with deicing salt operations on NYS Route 49 where the sampling site is located.

Comparison to Other Watersheds

Comparison to watersheds with various land uses in western and central New York suggest phosphorus loss from tributaries in the five-studied small, northwest sub-watersheds of Oneida Lake are low. Similarly during events, losses from the monitored tributaries are generally low compared to watersheds known to have high losses from the watershed due to land use practices (Table 6). For example, event losses of phosphorus from Limestone Creek (LS1, 24.6 g P/ha/d), Cowaselon Creek (CW1)(31.3 g P/ha/d), Canaseraga Creek (CN1) (24. 8 g P/ha/ d) and Oneida Creek (ON1) (14.4 g P/ha/d), all sub-watersheds of Oneida Lake, are substantially higher than event losses from Threemile Creek (2.8 g P/ha/d), Dakins Creek (1.3 g P/ha/d), Crandell Creek (0.8 g P/ha/d), and Black Creek (1.3 g P/ha/d). Similarly, average annual daily losses from Sheldon Creek (27.4 g P/ha/d), a sub-watershed of Lake Neatahwanta, are substantially higher than any of the five sub-watersheds studied (Makarewicz and Lewis, 1998a). These Oneida Lake and Lake Neatahwanta tributaries with high losses of phosphorus are either in agriculture or have sewage treatment plants located within the watershed. Event and non-event losses from the five studied subwatersheds, with the exception of Little Bay Creek, are more in line with tributaries from Canandaigua Lake and Sandy Pond (Table 6). Many of these tributaries are forested. These comparisons between watersheds suggest that losses of nutrients from northern Oneida Lake sub-watersheds are not excessively high.

Little Bay Creek is a small watershed entering the northwestern portion of Oneida Lake. Event losses of phosphorus from Little Bay Creek averaged 8.8 g P/ha/d. This value is not as high as losses from other known areas of large losses from sub-watersheds. However, it is clear that losses from phosphorus from the Little Bay Creek watershed represent levels above background observed in the other studied sub-watersheds making up the northern watershed of Oneida Lake. This suggests a source exists in this sub-watershed. Losses were particularly high in March and May (Table 6), a period associated with cultivation of the land. This is reinforced by the high losses of chloride, organic nitrogen and relatively high losses of total suspended solids. However, other possibilities exist in this sub-watershed as sources. Two trailer parks and a strip mall have functioning leach fields exist in this sub-watershed. Also the Village of Central Square and a new Super Wal-Mart exist in the watershed. Only a segment analysis would help locate sources.

Acknowledgements

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Table 1. Analytical methodology employed by LSL, Inc.

Analyte	Method	Volume/Container	Preservative	*Holding Time*	Reporting Limit
Chloride	EPA 300	250ml/plastic	cool 4°C	28 days	0.04 mg/l
Nitrate/nitrite	EPA 353.1	250ml/plastic	cool 4°C	48 hours	0.02 mg/l
TKN	EPA 351.2	250ml/plastic	H_2SO_4, cool 4°C	28 days	0.002 mg/l
TSS	EPA 160.2	250ml/plastic	cool 4°C	7 days	4 mg/l
Total Phosphorus	EPA 365.3	250ml/plastic	cool 4°C	28 days	0.002 mg/l

*****From time of collection.

Table 2. LSL, Inc. quality assurance acceptable limits for nonpoint water samples. LCS = Laboratory Control Sample, RPD=Relative Percent Deviation, MS=Matrix Spike.

Analyte	Method	LCS - % Rec.	Duplicate RPD	MS - % Rec
Chloride	EPA 300	+/- 10%	<20%	no limit
Nitrate/nitrite	EPA 353.1	+/- 10%	<20%	no limit
TKN	EPA 351.2	+/- 10%	<20%	no limit
TSS	EPA 160.2	NA	<20%	no limit
Total Phosphorus	EPA 365.3	+/- 10%	<20%	no limit

Table 3. Average concentrations in selected Oneida Lake tributaries during events and nonevents that occured between 10 January 2002 to 12 December 2002. B+E refers to the average for hydrometerological events and baseline (nonevents) conditions. Mean = average concentration, S.E. = standard error, TP = total phosphorus, TKN = total Kjeldahl nitrogen, TSS = total suspended solids, Temp. = water temperature, DO = dissolved oxygen, Turb. = Turbidity, SC = specific conductance, N.D. = no data available.

		TP (mg/l)		Nitrate (mg/l)		TKN (mg/l)		Chloride (mg/l)		TSS (mg/l)		Temp (°F)		DO (mg/l)		pH		Turb (NTU)		SC mS/cm	
Creek		Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Little Bay	Baseline	0.086	0.013	0.22	0.03	0.61	0.05	72.4	7.71	11.0	2.9	53.9	5.3	6.28	1.28	6.60	0.30	32.3	19.3	465.1	41.4
Creek	Event	0.078	0.020	0.20	0.05	0.41	0.07	44.6	9.11	3.4	0.9	39.7	3.8	9.42	0.88	5.07	0.76	7.1	3.2	292.5	51.7
	B+E	0.083	0.010	0.21	0.03	0.54	0.05	62.5	6.81	8	2.1	48.8	4.0	7.40	0.95	6.05	0.37	23.3	12.6	403.5	38.7
Threemile	Baseline	0.023	0.002	0.23	0.02	0.48	0.05	7.2	0.39	5.4	2.0	52.8	4.9	9.33	0.73	7.22	0.14	21.0	9.0	139.4	14.8
Creek	Event	0.032	0.009	0.16	0.04	0.39	0.05	7.2	0.73	2.0	0.0	40.2	4.0	12.53	1.98	6.72	0.24	5.2	2.2	91.5	18.8
	B+E	0.026	0.004	0.20	0.02	0.45	0.04	7.2	0.34	4.2	1.3	48.3	3.8	10.48	0.90	7.04	0.14	15.4	6.1	122.3	12.9
Dakins	Baseline	0.023	0.004	0.25	0.01	0.27	0.02	7.9	0.30	8.7	2.7	52.4	4.4	10.27	0.72	7.31	0.13	12.4	4.2	131.5	9.3
Creek	Event	0.031	0.007	0.17	0.06	0.30	0.05	7.3	0.69	12.1	7	39.6	3.7	11.48	0.76	6.78	0.20	44.4	30.2	95.3	17.5
	B+E	0.026	0.004	0.23	0.02	0.28	0.02	7.7	0.31	10.3	2.8	47.8	3.5	10.70	0.54	7.12	0.13	23.8	11.2	118.6	9.5
Crandell	Baseline	0.017	0.002	0.17	0.01	0.31	0.02	6.1	0.18	2.0	0.0	56.4	6.0	9.36	1.29	7.10	0.11	1.9	1.5	102.0	5.9
Creek	Event	0.016	0.003	0.15	0.05	0.21	0.03	5.4	0.53	2.0	0.0	41.4	3.7	12.14	1.20	6.70	0.20	2.2	1.4	85.7	7.9
	B+E	0.016	0.002	0.17	0.02	0.27	0.02	5.9	0.23	2.0	0.0	50.6	4.4	10.43	0.97	6.94	0.11	2.0	1.1	95.7	5.1
Black Creek	Baseline	0.013	0.001	0.28	0.02	0.28	0.03	5.6	0.23	2.0	0.0	53.5	5.3	9.84	0.99	7.13	0.09	7.0	2.4	91.2	8.1
	Event	0.018	0.003	0.15	0.05	0.24	0.06	4.8	0.41	3.8	1.4	39.2	3.5	12.83	1.21	6.65	0.23	3.4	1.6	59.2	10.6
	B+E	0.015	0.001	0.24	0.02	0.27	0.03	5.3	0.22	2.6	0.5	48.0	4.0	10.99	0.85	6.94	0.12	5.6	1.6	78.9	7.6

Table 4. Areal nutrient loss (g/ha/day) and discharge (m^3/day) from Oswego County Oneida Lake watersheds during events and non-events (NE). TP=total phosphorus, TSS=total suspended solids, Cl=Chloride, TKN=Total Kjeldahl nitrogen.

	Discharge (m^3/day)		TP (g P/ha/d)		Nitrate (g N/ha/d)		TSS (g/ha/d)		TKN (g N/ha/d)		Cl^- (g/ha/d)	
	Event	Non-Event	Event	Non-Event	Event	Non-Event	Event	Non-Event	Event	Non-Event	Event	Non-Event
Little Bay Creek	187,065	14,967	8.77	0.56	12.2	2.8	489	64	48.7	5.5	3,600	651
ThreemileCreek	49,328	8,475	2.80	0.34	8.5	2.8	166	34	37.5	6.9	540	111
Dakins Creek	27,499	7,827	1.32	0.24	5.1	2.5	639	92	12.5	3.0	244	78
Crandell Creek	21,586	10,034	0.75	0.35	8.6	3.7	90	42	8.6	7.0	242	128
Black Creek	113,435	26,302	1.33	0.22	10.1	4.1	323	31	16.6	5.0	292	82

Table 5. Nutrient loss (g and kg/day) and discharge rom Oswego County Oneida Lake watersheds during events and non-events. TP=total phosphorus, TSS=total suspended solids, Cl=Chloride, TKN=Total Kjeldahl nitrogen.

	Discharge (m^3/day)		TP (g P/d)		Nitrate (kg NO_3-N/d)		TSS (kg/d)		TKN (kg N/d)		Cl^- (kg/d)	
	Event	Non-Event	Event	Non-Event	Event	Non-Event	Event	Non-Event	Event	Non-Event	Event	Non-Event
Little Bay Creek	187,065	14,967	12,302	785	17.1	3.9	686	90	68.3	7.7	5,050	913
ThreemileCreek	49,328	8,475	1,665	202	5.0	1.7	99	20	22.3	4.1	321	66
Dakins Creek	27,499	7,827	1,011	183	3.9	1.9	488	70	19.5	2.3	186	60
Crandell Creek	21,586	10,034	362	167	4.1	1.8	43	20	4.1	3.4	116	62
Black Creek	113,435	26,302	2,261	373	17.2	7.0	547	53	27.8	8.5	494	139

Table 6. Comparison of average daily event and non-event phosphorus loading from tributaries of Oneida Lake, Sandy Pond, Lake Neatahwanta and Canandaigua Lake. Oneida Lake and Canandaigua Lake data are from Makarewicz and Lewis (2000a, 1998b, 2002) Oneida and Canandaigua Lake data represents the daily average for events and nonevents.

Subbasin or Creek	Watershed	Land Use	Total Phosphorus Loading (g P/ha/d)	
			Non-event	Event
			1999-2000	
Chittenango Creek (CH2)	Oneida Lake	Agriculture	0.6	9.0
Chittenango Creek(CH1)	Oneida Lake	Agriculture	0.8	4.8
Limestone Creek (LS2)	Oneida Lake		0.7	6.0
Limestone Creek (LS1)	Oneida Lake		0.1	24.6
Butternut Creek (BN1)	Oneida Lake	Urban?	0.1	3.8
Cowaselon Creek (CW1)	Oneida Lake	Agriculture, STP	0.3	31.3
Cowaselon Creek (CW2)	Oneida Lake	Agriculture, STP	0.5	18.8
Canastota Creek (CT1)	Oneida Lake		1.2	3.6
Canaseraga Creek (CN1)	Oneida Lake		1.8	24.8
Clockville Creek (CK1)	Oneida Lake		0.6	3.2
Oneida Creek (ON1)	Oneida Lake	Agriculture, STP	1.0	14.4
			1999-2002	
Little Sandy Creek	Sandy Pond		0.3	2.9
Blind Creek	Sandy Pond		0.1	1.9
Mud Creek	Sandy Pond		0.4	1.9
Lindsey Creek	Sandy Pond		0.5	1.3
Skinner Creek	Sandy Pond		0.5	2.1
			2002	
Little Bay Creek	Oneida Lake		0.6	8.8
Threemile Creek	Oneida Lake		0.3	2.8
Dakins Creek	Oneida Lake		0.2	1.3
Crandell Creek	Oneida Lake		0.4	0.8
Black Creek	Oneida Lake		0.2	1.3
			1997-1999	
T1 Fallbrook	Canandaigua Lake		0.79	2.58
T2 Deep Run	Canandaigua Lake		0.37	2.45
T3 Gauge Gully	Canandaigua Lake		0.10	0.86
T4 Fisher Gully	Canandaigua Lake		0.07	0.22
T6 Lower Vine Valley	Canandaigua Lake		0.37	2.00
T8 Lower West River	Canandaigua Lake		2.72	1.33
T9 Clark Gully	Canandaigua Lake		0.14	1.11
T10 Parish Gully	Canandaigua Lake		0.16	3.70
T11 Upper Naples Creek	Canandaigua Lake		0.16	3.48
T13 Cooks Point	Canandaigua Lake		0.50	24.54
T14 Hicks Point	Canandaigua Lake		0.15	5.44
T15 Seneca Point Gully	Canandaigua Lake		0.20	1.11
T16 Barnes Gully	Canandaigua Lake		0.08	2.06
T17 Menteth	Canandaigua Lake		0.03	1.15
T18 Tichenor Gully	Canandaigua Lake		0.30	3.58
TSB - Sucker Brook - grabs	Canandaigua Lake		0.09	1.95
T24 Tannery Creek	Canandaigua Lake		0.05	0.92
T25 Eelpot Creek	Canandaigua Lake		0.10	1.94
T26 Reservoir Creek	Canandaigua Lake		0.12	10.8
T27 Grimes Creek	Canandaigua Lake		0.22	1.06

Table 7. Event and non-event areal nutrient and suspended solids losses from subwatersheds of Oneida Lake. TP = Total Phosphorus, TKN = Total Kjeldahl Nitrogen, TSS = Total Suspended Solids.

Little Bay Creek @ NYS Route 49 (43^o 17' 07N, 76^o 08' 14W)				**Watershed Area: 1403 ha**		
Date	Discharge (m^3/d)	TP (g/ha/d)	Nitrate (g/ha/d)	TSS (g/ha/d)	TKN (g/ha/d)	Chloride (g/ha/d)
EVENTS						
2/7/2002	85,324	1.9	16.4	121.7	18.3	2798.5
3/5/2002	141,806	14.2	19.2	202.2	27.3	3943.3
5/14/2002	580,863	22.0	4.1	1863.7	153.2	6212.5
10/17/2002	24,140	1.9	5.7	111.9	11.7	1222.1
11/7/2002	103,195	4.0	15.5	147.2	33.1	3826.1
Average	187065	8.7	12.2	489.3	48.7	3600.5
S.E.	100263	4.0	3.0	343.9	26.4	815.2
NON-EVENTS						
1/10/2002	36,570	0.8	8.9	130.4	13.3	1929.5
4/19/2002	11,521	0.8	1.3	221.8	3.9	271.1
6/12/2002	5,681	0.6	0.8	60.8	2.5	218.8
7/24/2002	1,894	0.2	0.3	27.0	1.1	109.4
8/8/2002	1,337	0.1	0.0	15.3	0.8	95.4
9/12/2002	1,337	0.1	0.2	8.6	0.7	95.4
10/9/2002	2,274	0.1	0.4	7.3	1.0	149.1
11/21/2002	54,586	1.8	8.6	77.8	20.6	2101.7
12/12/2002	19,503	0.6	4.9	27.8	5.4	890.0
Average	14967	0.6	2.8	64.1	5.5	651.2
S.E.	6301	0.2	1.2	23.8	2.3	271.1

Table 7 (Cont). Event and non-event areal nutrient and suspended solids losses from subwatersheds of Oneida Lake. TP = Total Phosphorus, TKN = Total Kjeldahl Nitrogen, TSS = Total Suspended Solids.

ThreemileCreek @ Lower Road (43° 16' 02N, 76° 02' 47W) **Watershed Area: 594 ha**

Date	Discharge (m^3/d)	TP (g/ha/d)	Nitrate (g/ha/d)	TSS (g/ha/d)	TKN (g/ha/d)	Chloride (g/ha/d)
EVENTS						
2/7/2002	43,834	1.4	14.0	147.6	22.9	627.2
3/5/2002	38,819	4.4	11.1	130.7	20.3	496.6
5/14/2002	120,133	6.5	2.0	404.4	113.2	970.6
10/17/2002	9,126	0.2	3.1	30.7	4.8	96.8
11/7/2002	34,729	1.5	12.3	116.9	26.3	508.6
Average	49328.1	2.8	8.5	166.1	37.5	539.9
S.E.	18686.0	1.1	2.5	62.9	19.3	140.1
NON-EVENTS						
1/10/2002	17,728	0.63	6.31	59.6	16.1	250.6
4/19/2002	17,507	0.74	4.65	58.9	13.6	200.4
6/12/2002	3,888	0.18	1.62	42.5	5.4	33.4
7/24/2002	190	0.01	0.10	0.6	0.2	2.2
8/8/2002	137	0.01	0.06	2.5	0.1	1.8
9/12/2002	968	0.02	0.44	3.3	0.5	11.1
10/9/2002	707	0.03	0.21	22.6	0.4	7.4
11/21/2002	21,530	1.05	7.25	72.5	17.4	293.6
12/12/2002	13,620	0.41	4.59	45.9	8.7	201.7
Average	8475	0.34	2.8	34.3	6.9	111.4
S.E.	2982	0.13	0.97	9.2	2.4	40.8

Table 7 (Cont). Event and non-event areal nutrient and suspended solids losses from subwatersheds of Oneida Lake. TP = Total Phosphorus, TKN = Total Kjeldahl Nitrogen, TSS = Total Suspended Solids.

Dakins Creek @ Johnson Road (43° 15' 13N, 75° 57' 34W) **Watershed Area: 764 ha**

Date	Discharge (m^3/d)	TP (g/ha/d)	Nitrate (g/ha/d)	TSS (g/ha/d)	TKN (g/ha/d)	Chloride (g/ha/d)
EVENTS						
2/7/2002	14,051	0.4	4.8	36.8	3.5	130.6
3/5/2002	26,619	0.9	8.0	418.3	7.3	240.5
5/14/2002	51,319	3.9	0.7	2486.5	32.9	342.7
10/17/2002	18,395	0.8	ND	180.7	7.7	224.0
11/7/2002	27,113	0.7	6.7	71.0	11.0	280.5
Average	27499	1.3	5.0	638.6	12.5	243.7
S.E.	6450	0.7	1.6	466.8	5.3	34.9
NON-EVENTS						
1/10/2002	9,769	0.2	3.6	70.4	3.1	98.5
4/19/2002	11,045	0.4	3.0	202.5	6.1	94.0
6/12/2002	6,567	0.3	2.3	197.8	2.5	58.5
7/24/2002	1,775	0.0	0.7	4.7	0.6	21.6
8/8/2002	4,361	0.1	1.3	11.4	1.3	49.7
9/12/2002	2,975	0.0	0.9	7.8	0.7	33.1
10/9/2002	4,074	0.2	1.2	50.7	1.3	44.8
11/21/2002	20,170	0.6	5.5	52.8	8.5	203.4
12/12/2002	9,704	0.3	4.1	228.7	3.2	97.8
Average	7827	0.2	2.5	91.9	3.0	77.9
S.E.	1892	0.06	0.6	30.5	0.9	18.4

Table 7 (Cont). Event and non-event areal nutrient and suspended solids losses from subwatersheds of Oneida Lake. TP = Total Phosphorus, TKN = Total Kjeldahl Nitrogen, TSS = Total Suspended Solids.

Crandell Creek @ County Route 17 (43° 15' 18N, 75° 55' 00W) **Watershed Area: 480 ha**

Date	Discharge (m^3/d)	TP (g/ha/d)	Nitrate (g/ha/d)	TSS (g/ha/d)	TKN (g/ha/d)	Chloride (g/ha/d)
EVENTS						
2/7/2002	27,330	0.6	14.2	113.8	9.7	324.4
3/5/2002	34,350	1.8	15.0	143.0	9.3	400.5
5/14/2002	17,852	0.7	0.4	74.3	8.2	204.4
10/17/2002	11,839	0.3	ND	49.3	5.7	162.7
11/7/2002	16,559	0.4	4.8	69.0	10.0	117.2
Average	21584	0.8	8.6	89.9	8.6	241.8
S.E.	4063	0.3	3.6	16.9	0.8	52.5
NON-EVENTS						
1/10/2002	26,557	0.7	10.5	110.6	23.8	376.0
4/19/2002	17,773	0.6	5.9	74.0	9.6	196.1
6/12/2002	13,733	0.7	5.1	57.2	10.6	151.5
7/24/2002	6,184	0.3	2.8	25.8	4.9	86.3
8/8/2002	202	0.0	0.1	0.8	0.1	2.6
9/12/2002	1,470	0.0	0.5	6.1	0.7	18.4
10/9/2002	2,913	0.2	0.9	12.1	1.9	38.2
11/21/2002	14,596	0.5	5.5	60.8	7.9	194.5
12/12/2002	6,878	0.1	2.4	28.6	3.7	90.2
Average	10034	0.4	3.8	41.9	7.0	128.2
S.E.	2918	0.09	1.1	12.2	2.4	39.1

Table 7 (Cont). Event and non-event areal nutrient and suspended solids losses from subwatersheds of Oneida Lake. TP = Total Phosphorus, TKN = Total Kjeldahl Nitrogen, TSS = Total Suspended Solids.

Black Creek @ Gale Road Crossing (43^{o} 14’ 50N, 75^{o} 52’ 34W) **Watershed Area: 1695 ha**

Date	Discharge (m^3/d)	**TP** (g/ha/d)	Nitrate (g/ha/d)	TSS (g/ha/d)	TKN (g/ha/d)	Chloride (g/ha/d)
EVENTS						
2/7/2002	110,044	0.8	14.9	259.7	10.4	305.1
3/5/2002	161,259	2.4	19.0	190.3	8.2	418.6
5/14/2002	197,076	2.7	1.2	1046.4	48.8	406.9
10/17/2002	44,242	0.4	ND	52.2	5.7	154.0
11/7/2002	54,556	0.4	5.5	64.4	9.7	173.8
Average	113435	1.3	10.2	323	16.6	291.7
S.E.	29622	0.5	4.1	185.1	8.1	55.9
NON-EVENTS						
1/10/2002	59,185	0.5	9.8	69.8	14.7	188.6
4/19/2002	35,921	0.5	4.9	42.4	9.1	97.5
6/12/2002	30,964	0.3	6.2	36.5	6.2	96.8
7/24/2002	12,376	0.1	2.5	14.6	1.9	47.5
8/8/2002	10,841	0.1	2.1	12.8	1.3	41.6
9/12/2002	8,808	0.1	1.6	10.4	1.2	31.2
10/9/2002	16,011	0.1	2.3	18.9	2.6	53.8
11/21/2002	44,569	0.3	5.0	52.6	6.3	123.6
12/12/2002	18,041	0.1	2.7	21.3	1.7	56.4
Average	26301.84	0.22	4.11	31.03	5.00	81.9
S.E.	5824.29	0.06	0.88	6.87	1.53	16.8

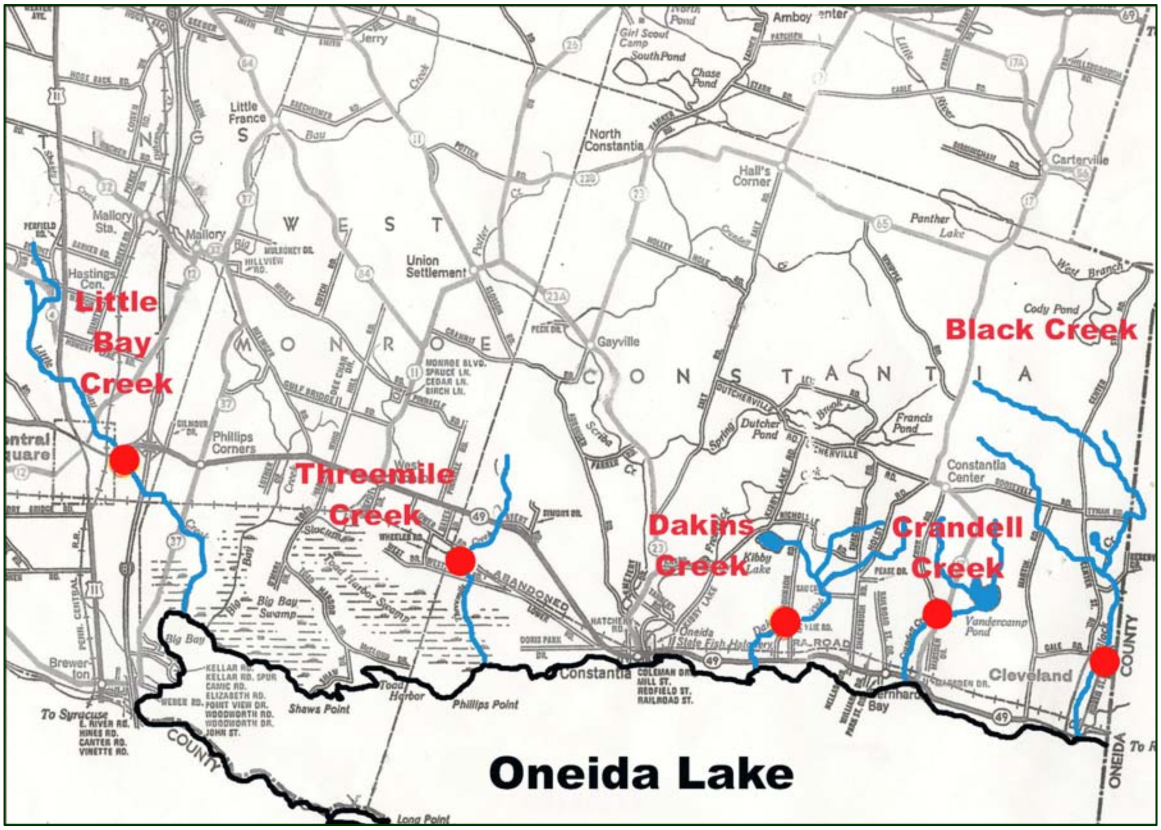

Figure 1. Oswego Soil and Water Conservation District Sampling sites on tributaries to Oneida Lake in 2002.

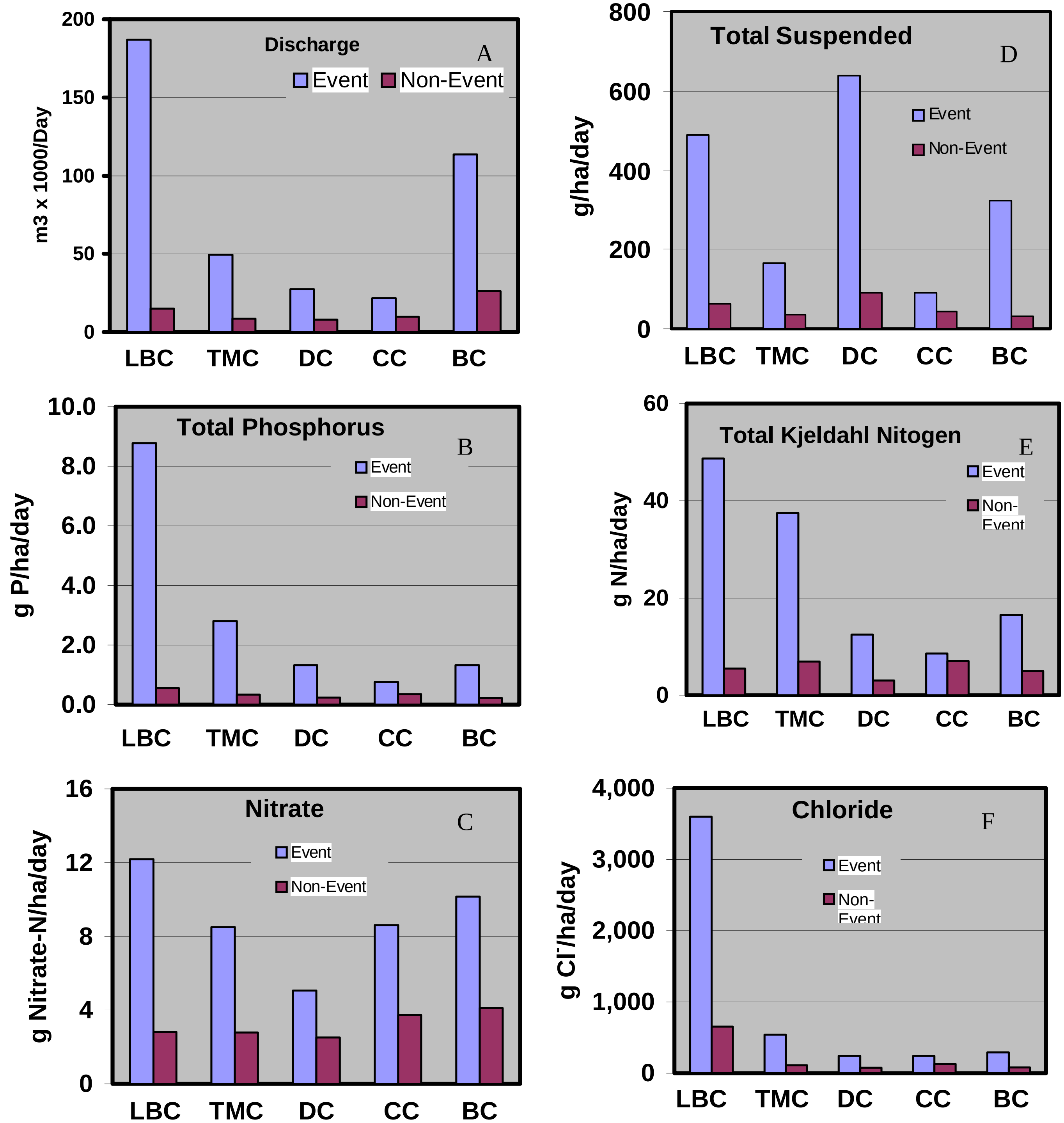

Figure 2. Average daily areal event and non-event loss of selected parameters from Little Bay Creek (LBC), Threemile Creek (TMC), Dakins Creek (DC), Crandell Creek (CC) and Black Creek.

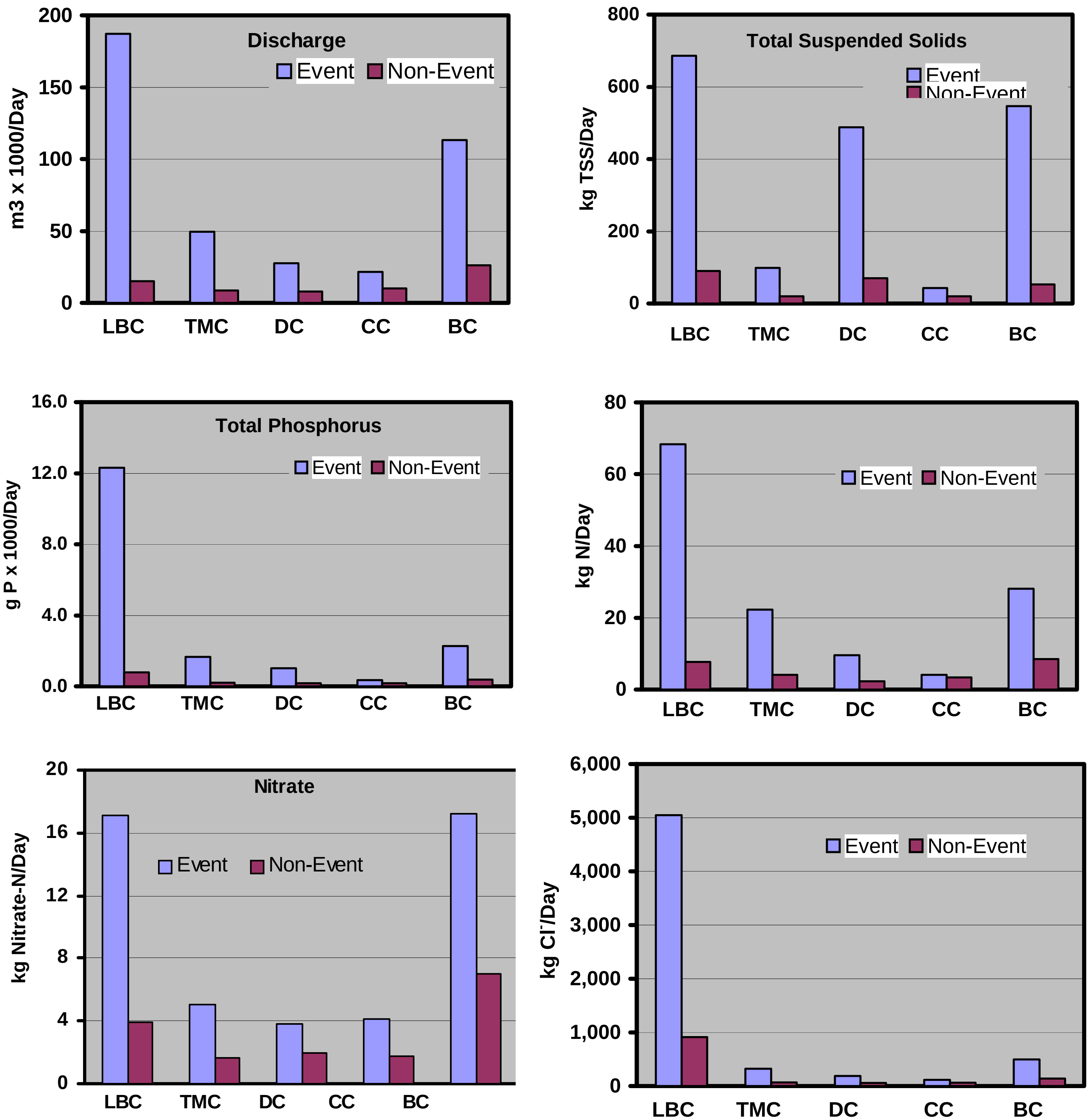

Figure 3. Average daily event and non-event loss of selected parameters from Little Bay Creek (LBC), ThreemileCreek (TMC), Dakins Creek (DC) and Crandell Creek (CC) and Black Creek (BC)..

Figure 4. Sampling sites on Oswego County Oneida Lake tributaries.

Figure 5. Sampling sites on Oswego County Oneida Lake tributaries.

Figure 6 . Sampling sites on Oswego County Oneida Lake tributaries.

Appendix A. Raw data from each sampling day. * Signifies storm events; NA = data not available.

Little Bay Creek			Little Bay Creek			
Date	Discharge	NO_3	TP	TKN	TSS	Chloride
	(m^3/d)	(mg/L)	(ug/L)	(ug/L)	(mg/L)	(mg/L)
1/10/2002	36570	0.34	31	510	5	74
2/7/2002*	85324	0.27	31	300	<4	46
3/5/2002*	141806	0.19	140	270	<4	39
4/19/2002	11521	0.16	92	470	27	33
5/14/2002*	580863	<0.02	53	370	4.5	15
6/12/2002	5681	0.19	140	620	15	54
7/24/2002	1894	0.2	120	780	20	81
8/8/2002	1337	<0.1	110	890	16	100
9/12/2002	1337	0.23	100	700	9	100
10/9/2002	2274	0.23	90	610	4.5	92
10/17/2002*	24140	0.33	110	680	6.5	71
11/7/2002*	103195	0.21	54	450	<4	52
11/21/2002	54586	0.22	47	530	<4	54
12/12/2002	19503	0.35	41	390	<4	64
Mean	76,431	0.24	82.8	540.7	11.9	62.5
S.E.	42,070	0.02	10.9	50.6	2.8	7.1

ThreemileCreek			ThreemileCreek			
Date	Discharge	NO_3	TP	TKN	TSS	Chloride
	(m^3/d)	(mg/L)	(ug/L)	(ug/L)	(mg/L)	(mg/L)
1/10/2002	17728	0.21	21	540	<4	8.4
2/7/2002*	43834	0.19	19	310	<4	8.5
3/5/2002*	38819	0.17	67	310	<4	7.6
4/19/2002	17507	0.16	25	460	<4	6.8
5/14/2002*	120133	<0.02	32	560	<4	4.8
6/12/2002	3888	0.24	28	820	6.5	5.1
7/24/2002	190	0.33	30	600	<4	7
8/8/2002	137	0.28	24	420	11	7.8
9/12/2002	968	0.27	9.7	300	<4	6.8
10/9/2002	707	0.18	22	350	19	6.2
10/17/2002*	9126	0.2	16	310	<4	6.3
11/7/2002*	34729	0.21	26	450	<4	8.7
11/21/2002	21530	0.2	29	480	<4	8.1
12/12/2002	13620	0.2	18	380	<4	8.8
Mean	23,065	0.22	26.2	449	12.2	7.21
S.E.	8,766	0.01	3.7	41	4.5	0.36

Appendix A. Raw data from each sampling day. * Signifies storm events; NA = data not available.

Dakins Creek			Dakins Creek			
Date	Discharge	NO_3	TP	TKN	TSS	Chloride
	(m^3/d)	(mg/L)	(ug/L)	(ug/L)	(mg/L)	(mg/L)
1/10/2002	9769	0.28	14	240	5.5	7.7
2/7/2002*	14051	0.26	20	190	<4	7.1
3/5/2002*	26619	0.23	<50	210	12	6.9
4/19/2002	11045	0.21	28	420	14	6.5
5/14/2002*	51319	<0.02	58	490	37	5.1
6/12/2002	6567	0.27	32	290	23	6.8
7/24/2002	1775	0.29	14	260	<4	9.3
8/8/2002	4361	0.23	13	220	<4	8.7
9/12/2002	2975	0.24	9.5	180	<4	8.5
10/9/2002	4074	0.23	45	240	9.5	8.4
10/17/2002*	18395	NA	32	320	7.5	9.3
11/7/2002*	27113	0.19	20	310	<4	7.9
11/21/2002	20170	0.21	23	320	<4	7.7
12/12/2002	9704	0.32	24	250	18	7.7
Mean	14,853	0.25	25.6	281	15.8	7.685714
S.E.	3,716	0.01	4.0	24	3.9	0.32

Crandell Creek			Crandell Creek			
Date	Discharge	NO_3	TP	TKN	TSS	Chloride
	(m^3/d)	(mg/L)	(ug/L)	(ug/L)	(mg/L)	(mg/L)
1/10/2002	26557	0.19	13	430	<4	6.8
2/7/2002*	27330	0.25	9.7	170	<4	5.7
3/5/2002*	34350	0.21	<50	130	<4	5.6
4/19/2002	17773	0.16	17	260	<4	5.3
5/14/2002*	17852	<0.02	18	220	<4	5.5
6/12/2002	13733	0.18	24	370	<4	5.3
7/24/2002	6184	0.22	20	380	<4	6.7
8/8/2002	202	0.15	13	280	<4	6.2
9/12/2002	1470	0.15	12	230	<4	6
10/9/2002	2913	0.15	27	310	<4	6.3
10/17/2002*	11839	NA	14	230	<4	6.6
11/7/2002*	16559	0.14	12	290	<4	3.4
11/21/2002	14596	0.18	16	260	<4	6.4
12/12/2002	6878	0.17	10	260	<4	6.3
Mean	14,160	0.18	15.8	273	<4	5.864286
S.E.	2,849	0.01	1.5	22	<4	0.241447

Appendix A. Raw data from each sampling day. * Signifies storm events; NA = data not available.

Black Creek			Black Creek			
Date	Discharge	NO_3	TP	TKN	TSS	Chloride
	(m^3/d)	(mg/L)	(ug/L)	(ug/L)	(mg/L)	(mg/L)
1/10/2002	59185	0.28	13	420	<4	5.4
2/7/2002*	110044	0.23	13	160	4	4.7
3/5/2002*	161259	0.2	<50	86	<4	4.4
4/19/2002	35921	0.23	22	430	<4	4.6
5/14/2002*	197076	<0.02	23	420	9	3.5
6/12/2002	30964	0.34	18	340	<4	5.3
7/24/2002	12376	0.34	15	260	<4	6.5
8/8/2002	10841	0.33	8.9	200	<4	6.5
9/12/2002	8808	0.31	13	230	<4	6
10/9/2002	16011	0.24	11	280	<4	5.7
10/17/2002*	44242	NA	16	220	<4	5.9
11/7/2002*	54556	0.17	11	300	<4	5.4
11/21/2002	44569	0.19	12	240	<4	4.7
12/12/2002	18041	0.25	7.5	160	<4	5.3
Mean	57,421	0.26	14.11	268	6.50	5.28
S.E.	16,208	0.02	1.34	29	3.54	0.23