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Sediment Quality Analysis of the Little Rapids Area (St. Marys River, MI)

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ABSTRACT. *The International Joint Commission has identified the St. Marys River (MI/ON) as one of forty-two areas of concern within the Great Lakes Basin. The degradation of sediments is one of many environmental problems that have been recognized within this ecosystem. The majority of the riverbed has been sampled during stage I of the Remedial Action Plan process, but little is known about the sediment quality of the Little Rapids Area. Therefore, the ecological effects of a recently proposed Little Rapids habitat restoration project are of some concern. The objectives of this study were to test for Little Rapids sediment quality by analyzing the nutrients, physical conditions, and elemental content of sediment samples. Twenty-three samples were obtained, including eight reference samples from the river proper. The sediments were tested for porosity, grain size, total carbon, percent lost on ignition, total phosphorus, total nitrogen, and total elements. No significant difference was found for twenty different chemical and physical variables between the Little Rapids stations and reference stations elsewhere in the river (Mann-Whitney, $\alpha = 0.05$). Similarly, no significant difference was found when stations within the Little Rapids were grouped by location and overall depth (Kruskal-Wallis, $\alpha = 0.05$). With respect to the variables examined, the Little Rapids is very similar to the rest of the river. Additionally, individual site comparisons to the United States Environmental Protection Agency Sediment Quality Guidelines indicated that 80% of the sites within the Little Rapids were heavily polluted for at least one contaminant listed.*

INDEX WORDS: *sediments, St. Marys River, Little Rapids, contaminant, heterogeneity, restoration.*

INTRODUCTION

Forty-one areas of concern have been identified by the International Joint Commission as having contaminated sediments, including the St. Marys River. Contaminated sediments represent a continual threat to all trophic levels in aquatic ecosystems. Sediments are recognized as playing a crucial role in the physical partitioning and biological fate of contaminants (Great Lakes United 1988). They act as a repository for organic and inorganic pollutants, which can accumulate to potentially toxic concentrations.

Algoma Steel is a documented source of several contaminants to the St. Marys River. In 1988, Algoma Steel was the largest discharger of toxins into the air and water of the St. Marys watershed (Great Lakes United 1988). These contaminants included polycyclic aromatic hydrocarbons (PAH's) (Kauss and Hamdy 1991), iron, oils, phenols, and cyanide (OMOE 1992).

Remedial Action Plan (RAP) sediment sampling began in 1986 and continues today (OMOE 1992). Still, one portion of the river has been overlooked during this sampling process: the Little Rapids. The lack of sediment sampling in the Little Rapids has become a recent issue due to a habitat restoration project planned for the area. In 1997, a grassroots effort was developed by the Soo Area Sportsmen's Club in hopes of restoring the Little Rapids by adding

culverts to the St. Marys River causeway. The intention of this effort was to increase spawning habitat for target species of fish, such as walleye, *Stizostedion vitreum vitreum*. The ecological effects of these efforts are of some concern due to the lack of sediment sampling, particularly between Island I and Sugar Island.

Restoration of the Little Rapids, by the proposed increase in water flow, could potentially contaminate the river and produce harmful sedimentation effects on aquatic organisms located downstream. Sediment quality degradation in one location by contaminated sediments from another location is dependent upon the relative concentrations of contaminants at the locations. It is also dependent upon the wave and current re-suspension and transport of the sediments (Rosman 1995). Even without sediment transport, the rehabilitation of the Little Rapids could lure animals to an area of unknown habitat quality.

In response to the need for information on the quality and content of the Little Rapids sediments, samples were taken and tested for porosity, grain size, percent lost on ignition (%LOI), total nitrogen (TN), total carbon (TC), total phosphorus (TP), and total elements (K, Ca, Mg, Fe, Cu, Mn, Zn, Al, Na, S, Ni, Cd, and Pb). Reference sites throughout the St. Marys River were sampled and analyzed to provide a direct comparison for the Little Rapids sediment samples. This study was conducted in hopes to determine the present severity of sediment degradation in the Little Rapids and to direct attention to this RAP environmental concern.

METHODS

Sediment samples were collected from 23 sampling stations throughout the St. Marys River between December 4, 1998 and April 30, 1999 (figure 1). A total of 15 sediment samples were obtained directly from the Little Rapids (stations 2-16). Eight reference samples were acquired from the river proper (stations 1, 17-23). Each sampling station was characterized by Hydrolab™ measurements, such as maximum depth, temperature, dissolved oxygen, pH, and specific conductivity.

The size of the sample, recovered from a petite ponar grab, varied between the stations due to the differences in substrate. Upon retrieval, each sample was cored with a syringe to obtain a subsample for elemental analysis (K, Ca, Mg, Fe, Cu, Mn, Zn, Al, Na, S, Ni, Cd, and Pb). Once the remaining sediments were homogenized, two subsamples were taken for physical condition analyses (porosity, grain size) and nutrient content (TOC, TN, TP). All subsamples were preserved by freezing (prior to any analyses) in sealed, pre-weighed, plastic containers.

The grain size distribution subsamples were thawed, homogenized, and washed through a set of stacked microsieves containing a 710 µm and a 64 µm mesh screen. Each layer of specific sediment size was dried in the oven at 60°C to a constant weight. The percent grain size of each subsample was calculated by dividing the mass of the specific sediment size by the total mass of sediment.

$$(\text{Mass}_{\text{sediment size}} / \text{Total Mass}_{\text{all sediment sizes}}) \times 100 = \% \text{ Grain Size} \quad (1)$$

Porosity subsamples were thawed, homogenized, and dried in the oven at 60°C to a constant weight. The percent water of each subsample was calculated by using the difference between the wet and dry mass.

$$\frac{(\text{Pre-mass} - \text{Container mass}) - (\text{Post-mass} - \text{Container mass})}{(\text{Pre-mass} - \text{Container mass})} \times 100 = \% \text{ H}_2\text{O} \quad (2)$$

TOC subsamples were also thawed, homogenized, and dried in the oven at 60°C to a constant weight. Each dried subsample was ground by mortar and pestle. Between 0.1g and 0.2g of ground sediment were placed into pre-weighed crucibles and ignited in the muffle furnace at 550°C for at least one hour. The sediments were cooled in a dessicator. Total organic carbon was estimated by the percent lost on ignition, that is the difference between pre-and post-combustion subsample masses.

$$\frac{(\text{Pre-mass} - \text{Container mass}) - (\text{Post-mass} - \text{Container mass})}{(\text{Pre-mass} - \text{Container mass})} \times 100 = \% \text{ LOI} \quad (3)$$

Ground sediments from the TOC analysis were used in the TC, TN, and TP analyses. TC and TN were determined by instantaneous oxidation of each subsample (Iso-Mass Scientific Incorporated NA 2000) at the Canadian Forest Service Soil Lab (CFS). TP subsamples were digested using a persulfate digestion (Andersen 1976). Total phosphorus was determined by the United States Environmental Protection Agency (U.S. EPA) standard molybdate blue colorimetric procedure, reading absorbance at 880 nm (U.S. EPA SW 846 method 365.2).

$$\text{TP} = (\text{mg PO}_4\text{-P/L} \times 0.1\text{L})/\text{grams of digested sediment} \quad (4)$$

A microwave digestion for total elements was also performed on the previously ground sediment subsamples (U.S. EPA SW 846 method 3052). The subsamples were digested by the addition of nitric and hydrofluoric acid, followed by 29 minutes of 600 watt microwaves at 180°C. The filtrate of each subsample was run through the inductively coupled argon plasma spectrometer (Thermo Jerrell Ash ICAP 1100) at the CFS. The host computer determined the electrical currents characteristic of such elements as K, Ca, Mg, Fe, Cu, Mn, Zn, Al, Na, S, Ni, Pb, and Cd.

Various steps were taken throughout this study to ensure the accuracy of the analytical equipment and the precision of the results. In the TOC analysis, samples 1-11 were duplicated to affirm complete ashing. In the TP analysis, there were 7 duplicates analyzed in each of 2 sampling sets. Each sampling set also included duplicates of 4 different standards (0.1 mg PO₄-P/L, 0.5 mg PO₄-P/L, 1 mg PO₄-P/L, 2 mg PO₄-P/L). For the TC and TN analysis, a standard was run every 20 samples to create a standard curve. In the ICAP 1100 spectrometer analysis, 39 of the 46 samples were duplicated. Standards were run in the morning and periodically throughout this analysis. A sample was repeated after every 20 samples to assess stability.

Blanks were also used throughout the various analyses for quality control. In the TP analysis, 4 blanks were analyzed in a set of 23 samples. A blank was run through the NA 2000 every morning of the analysis. In the ICAP 1100 spectrometer analysis, 4 blanks total were analyzed in a set of 46 samples.

RESULTS

For the grain size distribution results, 12 out of 15 Little Rapids samples, and 6 out of 8 reference samples were found to have a grain size distribution of 64 μm – 200 μm (sand dominant). Sediment samples with high percentages of clays and silts yielded the maximum porosities, except for station 14 (figure 2). These samples showed the best ability to trap water. The porosities ranged from a maximum of 63.32% to a minimum of 20.21% in sediments taken from Little Rapids stations 5 and 7. The maximum and minimum porosities of the reference samples were 52.47% and 31.04%, stations 22 and 20.

The on-site description of the sediment sample taken from station 14 revealed that it had an abundance of organic matter. Stations 14 and 9 produced the maximum and minimum %LOI, %TC, and %TN in the Little Rapids, respectively (table 1 and figure 3). The %TC and %LOI data were made to approximate a normal distribution by an arc sine transformation. The %TC and %LOI were highly correlated, $r = 0.93$. The %LOI readings were higher than the %TC readings because the ignition procedure volatilized more than just organic carbon.

The TP samples that were analyzed colorimetrically had a less rigorous digestion procedure than those analyzed by the ICAP 1100 spectrometer. Therefore, the TP concentrations were not found to be the same (table 2). However, the results of the colorimetric analysis represent a measure of the TP in the Little Rapids that is more readily available to biological organisms. There was up to 20% error in the precision of the TP readings obtained by the colorimetric analysis.

Station 14, located adjacent to the causeway, yielded 5 of the highest elemental concentrations and 3 of the highest nutrient concentrations of all Little Rapids stations sampled (table 3). Station 9 was located just east of station 14 and it produced 8 of the lowest elemental concentrations and 3 of the lowest nutrient concentrations. For the reference samples, station 1 yielded 7 of the highest elemental concentrations and 1 of the highest nutrient concentrations. Both station 20 and 22 each produced 5 of the lowest elemental concentrations. Together, they produced 3 minimum nutrient concentrations.

No significant difference was found for twenty different chemical and physical variables (% sand, % clay/silt, %TN, %TC, %LOI, % water, P, %TP, K, Ca, Fe, Cu, Mn, Zn, Al, Na, S, Pb, Ni, and Cd) between the Little Rapids stations and reference stations elsewhere in the river (Mann-Whitney, $\alpha = 0.05$). Similarly, no significant difference was found when stations within the Little Rapids were grouped by location and overall depth (Kruskal-Wallis, $\alpha = 0.05$). The stations were grouped as follows:

1. stations adjacent to the causeway (13-16)
2. stations located in the deepest channel of the Little Rapids sampling area (2,4,6,7)
3. shallow stations located within the western Little Rapids (5, 8-12)

Although the statistical results indicated a lack of significant differences between the population medians in both tests, some interesting results were revealed when individual samples

were compared with the U.S. EPA Sediment Quality Guidelines (OMOE 1992). In 1984, all of the sediment samples taken from the St. Marys River were found to exceed the moderately polluted guidelines for at least one contaminant listed (OMOE 1992). In this study, 80% of the Little Rapids samples and 100% of the reference samples were found to be heavily polluted for at least one contaminant listed (table 4).

DISCUSSION

Sediments composed of silts and clays with diameters less than 62 μm can readily absorb organic and inorganic pollutants (International Joint Commission 1985). A higher degree of chemical attraction for toxins exists in fine sediments with organic matter, rather than coarser sediments or gravel (Great Lakes United 1988). The majority of the sediments collected and analyzed in this study were sand dominant. For example, the sediments taken from station 14 were found to be entirely composed of sand. Station 14 also produced a high percentage of water and the majority of the maximum elemental and nutrient concentrations within the Little Rapids. This implies that the nutrients and elements detected by this study were not completely adsorbed to the sediments. Furthermore, the disturbance of these sediments not only leads to the possibility of sediment transport and re-suspension, but also the release of these nutrients and elements. If the proposed restoration project is completed, the force and velocity of the water distributed from the culverts will determine the extent of sediment disturbance. This disturbance may go beyond the surficial sediments analyzed in this study, to the possible flushing of many layers of sediment. In this case, it would be beneficial to know the vertical distribution of sediment content in the Little Rapids.

Besides possible contamination and sedimentation effects, the Little Rapids habitat restoration project could lead to eutrophication. When the nitrogen to phosphorus ratio of the water column is low (<10:1), nitrogen is generally recognized as the limiting factor in algae and plant growth (OMOE 1992). In 1982 and 1983, this ratio always exceeded 10 (Liston et al. 1986), indicating that the St. Marys River was phosphorus limited. The nitrogen to phosphorus ratio produced by the Little Rapids and reference sediment samples was low (<10:1). The results of this study also show that 88% of the reference stations were heavily polluted with phosphorus. In the Little Rapids, 60% of the samples were heavily polluted with phosphorus and 27% of the samples were heavily polluted with nitrogen. Of particular interest are those areas of high concentrations of nitrogen and phosphorus in the Little Rapids. These areas (stations 4, 5, 6, and 14) appear to be possible depositional zones due to their deep locations. If these sediments are disturbed, the nitrogen to phosphorus ratio in the water column may be altered by the release of the nitrogen and phosphorus present in the sediments. This pollution may cause increased photosynthesis and plant growth. Eutrophication can create an anoxic hypolimnion, affecting the production and survival of the benthic community.

Overall, the results of this study show that contamination of the Little Rapids is of concern just as it is in the rest of the river. The 1985 RAP survey revealed only small, scattered areas of the riverbed to be moderately polluted with cadmium (OMOE 1992). Those areas included some of the reference sites sampled by this study, near Little Lake George. The RAP survey determined that the rest of the river was classified as non-polluted with respect to cadmium. The same survey of 1985 also found sediments to be moderately polluted with nickel in the vicinity of the Algoma Slip and depositional zones along the northwest shore of Sugar

Island, Little Lake George, Lake George, Lake Nicolet, and Munuscong Bay. As many as 34% of the samples collected by the U.S. EPA exceeded the moderately polluted guidelines for nickel. In this study, 100% of the reference samples and 80% of the Little Rapids samples exceeded the heavily polluted sediment quality guidelines for nickel and cadmium. Due to the results of this study, attention should be directed towards the heavy metal contamination of the river.

Fish communities are affected by contamination due to toxic effects and bioaccumulation (Krishka 1989). Direct effects of contamination are mutations and changes in fish behavior, growth, and performance. Heavy metals are known to specifically affect the survival of fish eggs and fry (Sprague 1971). Fish communities are indirectly affected by contamination influences on macrophage and aquatic invertebrate distribution. Even if the contamination concentrations are not lethal to fish or aquatic invertebrates, the accumulation of the contaminants throughout the food web may cause adverse effects in the wildlife (Upper Great Lakes Connecting Channels Study 1989). In addition, contamination can cause tainting of fish flavor and lead to future consumption advisories.

The St. Marys River supports an assortment of beneficial uses including fish and wildlife production and recreation. Yet an array of problems are created from competing uses of the river. The St. Marys River is used as an industrial and municipal water supply, a dispersal of municipal and industrial waste, and for navigation and hydropower production. Developments such as the navigation locks, flow control structures, and hydropower generating facilities have resulted in significant losses in the St. Marys River benthic invertebrate community and the fishery (Edsall and Gannon 1993).

The Little Rapids habitat restoration project is an attempt to restore the reduced fishery habitat. This project consists of the addition of 30 culverts to the St. Marys River causeway (Edison Sault and Acres International 1997). It is assumed that the discharge from these culverts will expose the substrate that historically provided spawning and nursery habitat for several species of sport fish. However, the Little Rapids physical and chemical heterogeneity poses a problem for this habitat restoration attempt (figure 4). The flushing of certain portions of the Little Rapids sediments (such as station 14) could be detrimental to the present fish populations in the Little Rapids and downstream from this area.

Future studies of the Little Rapids sediments would be beneficial in determining the overall quality of the habitat and the potential effects of the restoration project. One possibility is the examination of more sediment samples for a wider variety of contaminants. Other sediment studies of the St. Marys River included testing for chloride, silica, phenol, ammonia, cyanide, polycyclic aromatic hydrocarbons (PAH's), oil, grease, vanadium, cobalt, chromium, arsenic, mercury, polychlorinated biphenyls (PCB's), and dichlorodiphenyldichloroethane (DDT) (Pope and Kauss 1995). Samples of benthic invertebrates could also contribute to the determination of the quality of the Little Rapids habitat. The biodiversity of benthic invertebrates can be used as an indicator of sediment quality (Pope 1990).

Further studies may call for the remediation of the Little Rapids sediments. Contaminated sediment remediation is the primary focus of the Clean-up Restoration Task Team for the St. Marys River (OMOE 1994). This team has prioritized 13 contaminated sediment sites for remediation, based on information from the Stage I RAP, and data from recent studies

conducted since the completion of the Stage I RAP. Recommendations of remedial actions for contaminated sediment sites have yet to be specified in the Stage II RAP. Possible remedial actions may include the removal of sediments by dredging, the on site treatment of sediments, or the capping of sediments to prevent further re-entry of toxins (Great Lakes Science Advisory Board 1988).

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FIGURES

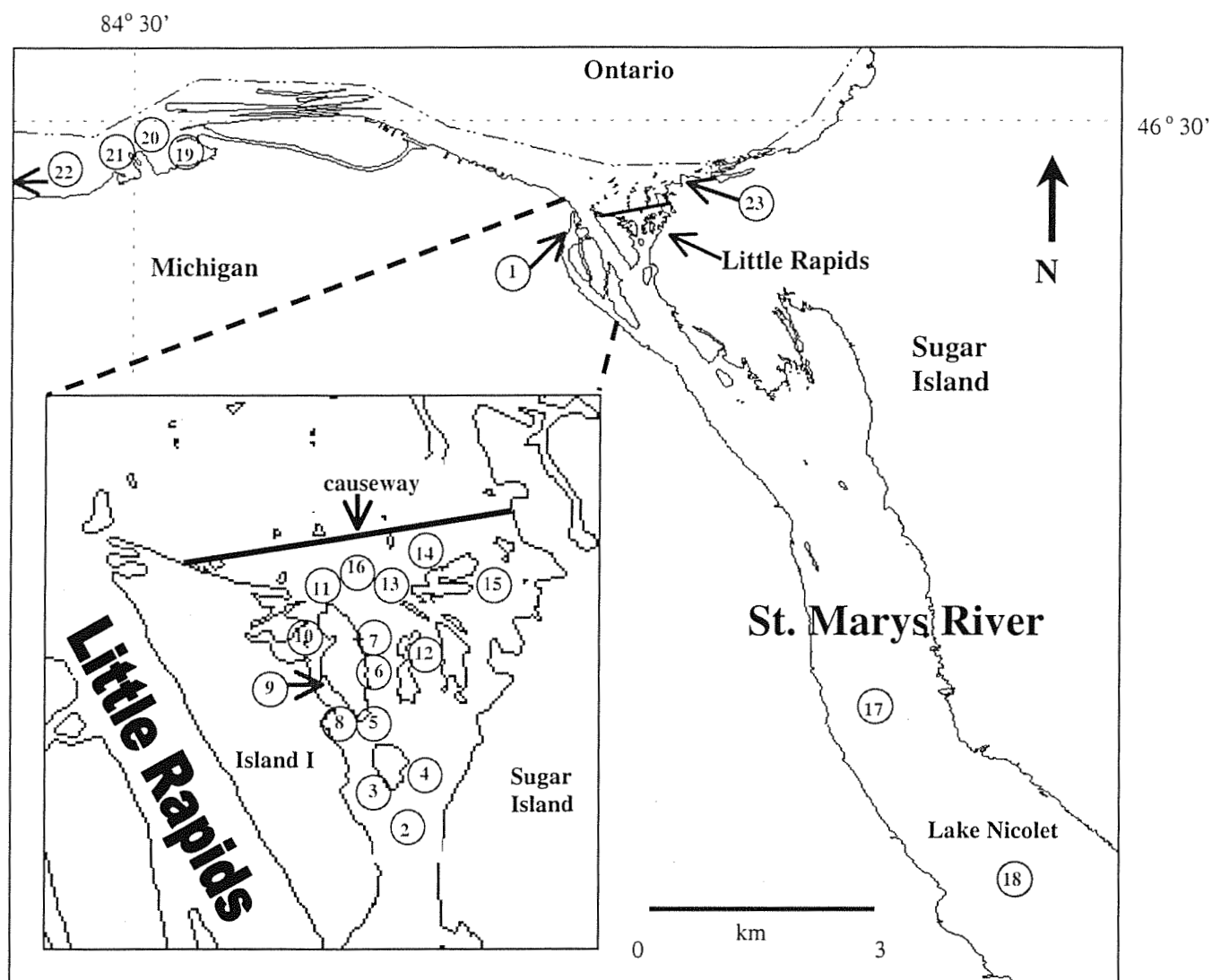


Figure 1. Sampling site locations throughout the St. Marys River (1, 17-23) and the Little Rapids (2-16).

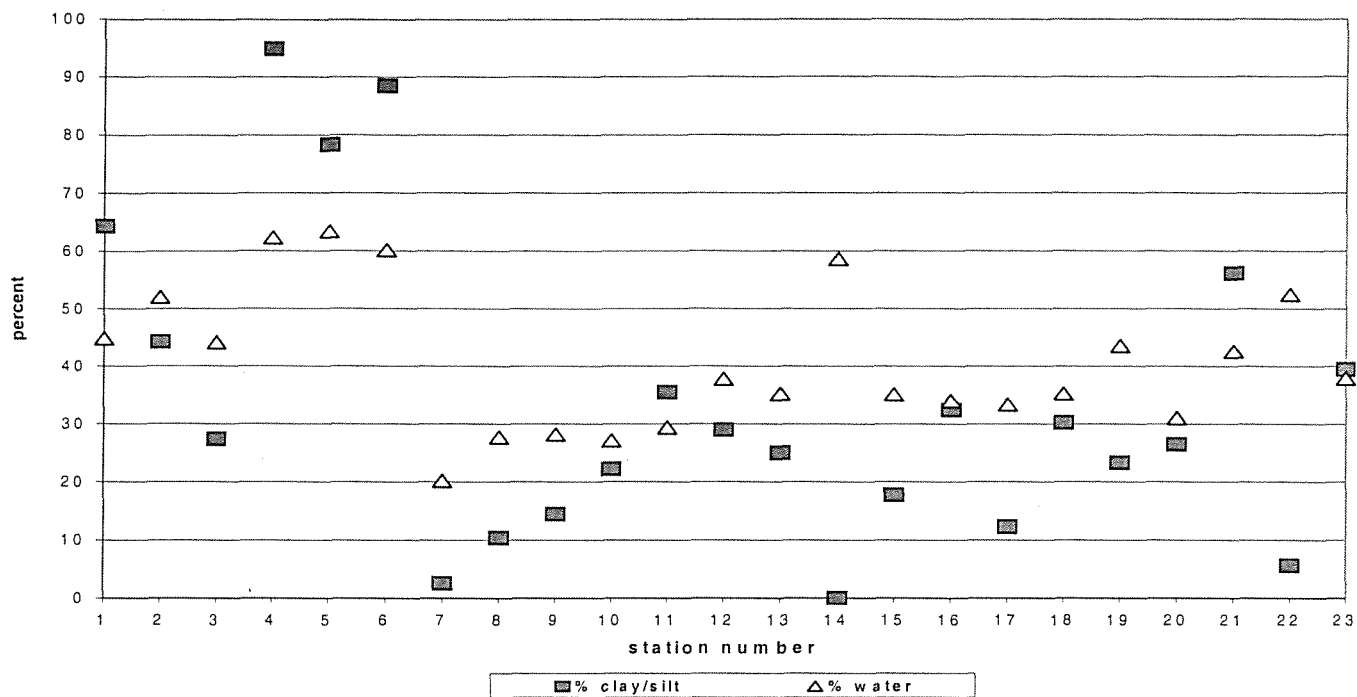


Figure 2. The % water and % clay/silt results of the reference (stations 1, 17-23) and Little Rapids samples (stations 2-16).

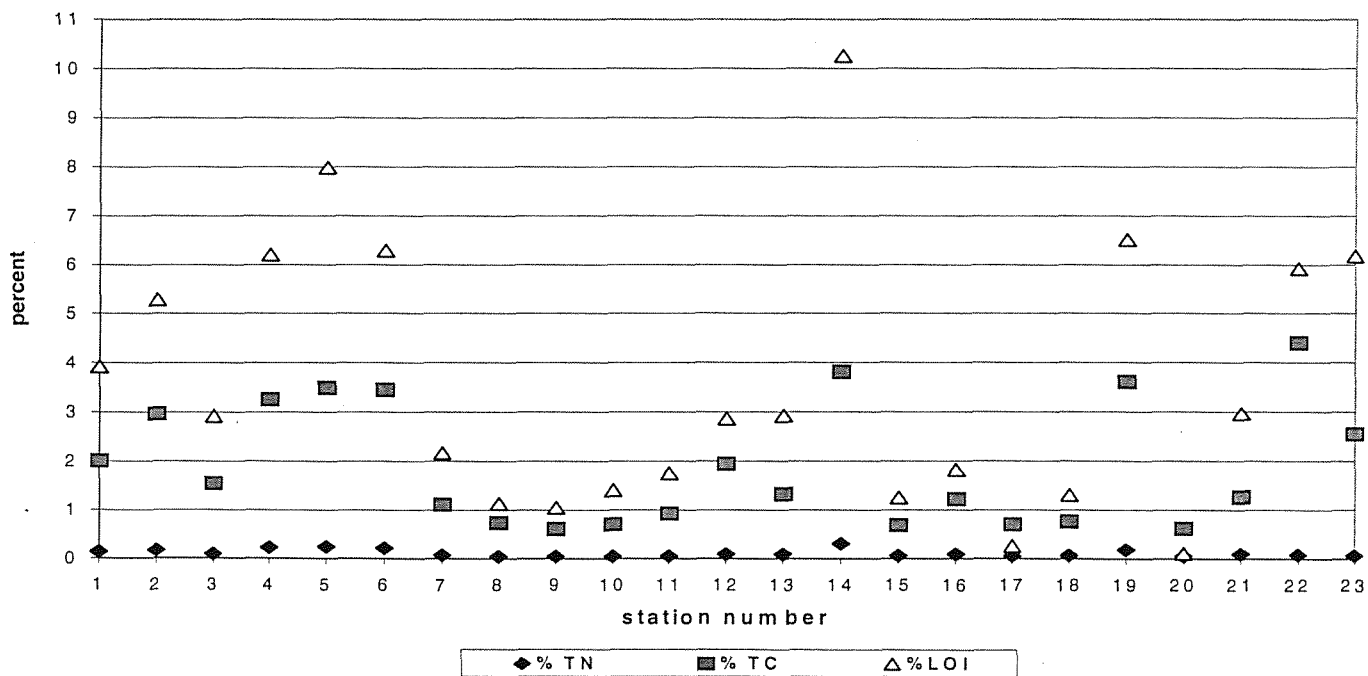


Figure 3. The % TN, % TC, % LOI results of the reference (stations 1, 17-23) and Little Rapids samples (stations 2-16).

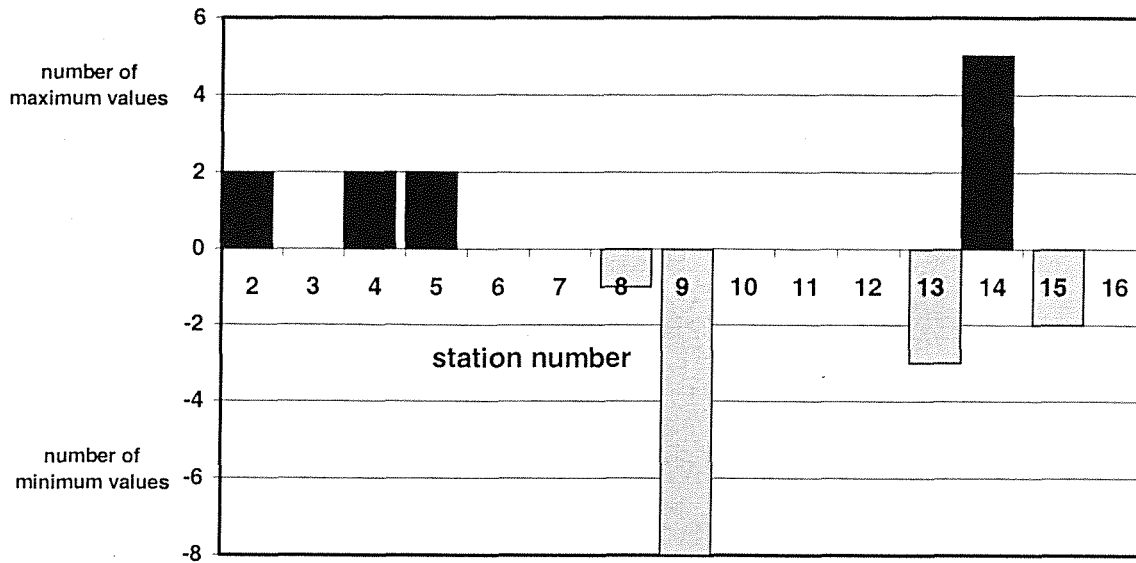


Figure 4. The number of minimum and maximum elemental concentrations held by each station within the Little Rapids.

TABLES

Table 1. %LOI, %TC, %TN of the Little Rapids sediment samples.

	%LOI	%TC	%TN	station #'s
MAXIMUM	10.26	3.82	0.31	14, 14, 14
MEDIAN	2.87	1.33	0.09	13, 13, 12
MINIMUM	1.05	0.82	0.04	9, 9, 9

Table 2. TP ranges in the Little Rapids and reference sediment samples as determined by both the colorimetric and elemental analyses. All values are in mg P/g sediment.

	MINIMUM	MEDIAN	MAXIMUM
TP _{colorimeter}	0.11	0.24	0.71
Station #	15	16	4
TP _{ICAP 1100}	0.35	0.09	1.27
Station #	9	6	14

Table 3. Nutrient, physical condition, and elemental analysis results of the Little Rapids (LR) and reference (Ref) samples.

Analysis	LR max	station #	LR min	station #	Ref max	station #	Ref min	station #	units
sand	97	7	4	4	94	22	36	1	%
clay/silt	94	4	0	14	64	1	6	22	%
water	63	5	20	7	52	22	31	20	%
TN	0.30	14	0.04	9	0.20	19	0.05	17	%
LOI	10.3	14	1.0	9	6.5	19	0.1	20	%
TC	3.8	14	0.6	9	4.4	22	0.6	20	%
TP _{colorimeter}	0.7	4	0.1	15	0.4	1	0.2	22	mg/g
TP _{ICAP 1100}	1.30	14	0.40	9	0.14	18	0.05	15	mg/g
K	2.2	2	0.7	8	2.1	1	1.2	18	%
Ca	0.8	14	0.4	7	1.1	21	0.3	22	%
Mg	0.20	2	0.02	9	0.09	23	0.03	21	%
Fe	32,353	14	11,317	15	27,486	23	8,802	20	mg/kg
Cu	52	14	16	15	39	22	17	20	mg/kg
Mn	393	4	162	9	291	21	212	22	mg/kg
Zn	169	4	35	9	115	1	38	20	mg/kg
Al	15,743	5	1,471	9	10,224	1	3,411	20	mg/kg
Na	20,096	5	4,890	15	18391	1	7422	22	mg/kg
S	0.20	14	0.02	9	0.09	22	0.04	20	%
Pb	143	14	30	13	152	1	40	17	mg/kg
Ni	240	5	29	13	202	1	64	22	mg/kg
Cd	19	5	3	13	49	1	8	22	mg/kg

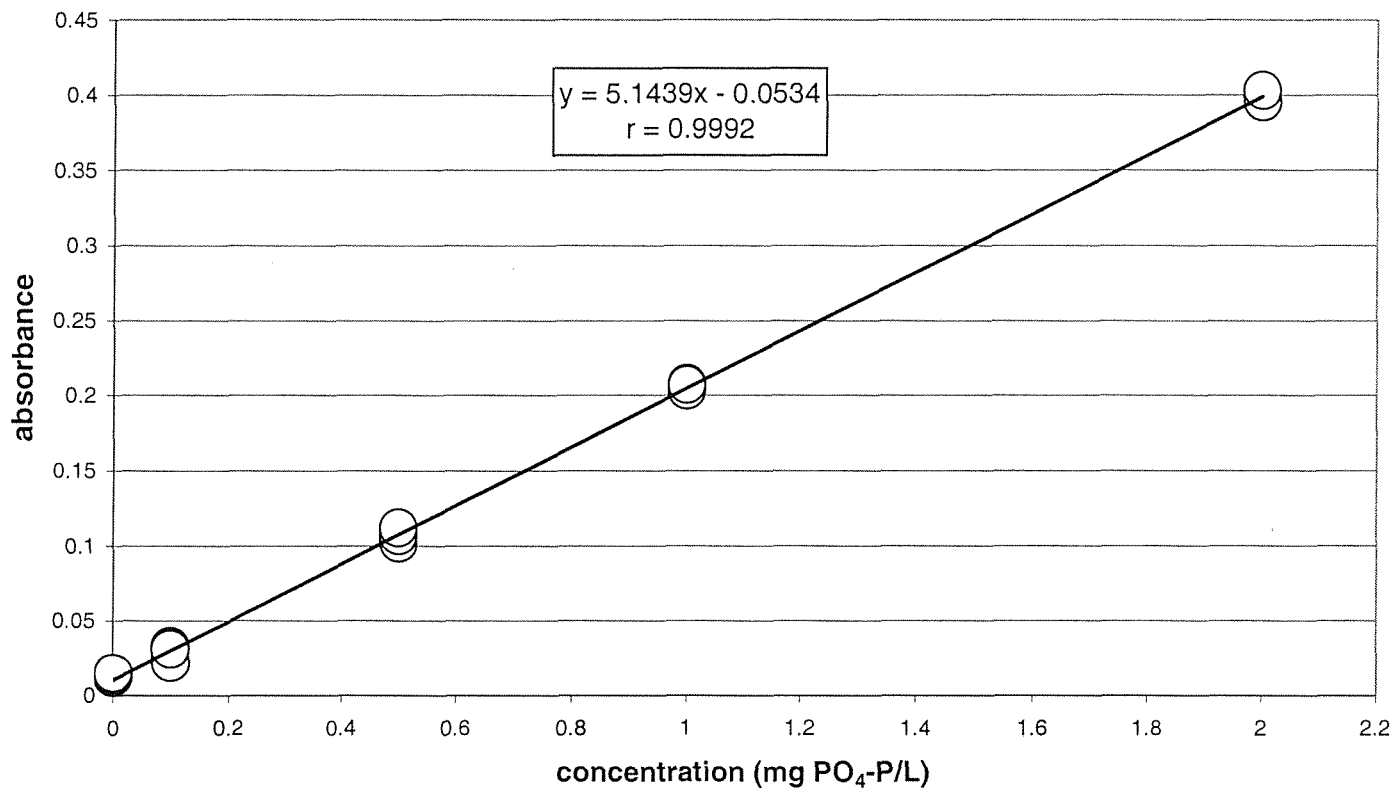
Table 4. Percent of heavily polluted samples taken from the Little Rapids (n=15) and reference sites (n=8), according to U.S. EPA Sediment Quality Guidelines.

	Cd	P	N	Fe	Cu	Pb	Ni
% of Little Rapids samples	80	60	27	27	7	67	80
% of Reference samples	100	88	0	13	0	50	100

APPENDIX B

This is one of the standard curves used to determine TP colorimetrically in each of the sediment samples.

Standard Curve (Concentration v. Absorbance) for Samples 1-11



APPENDIX C

Raw data from the physical condition and nutrient analyses of each sediment sample.

station	sand	clay/silt	N	C	LOI	water	max depth	P
#	%	%	%	%	%	%	m	mg/g
1	35	64	0.14	2.01	3.93	44	4.1	0.377
2	55	44	0.17	2.98	5.29	52	6.6	0.367
3	72	27	0.09	1.55	2.93	44	1.9	0.300
4	5	94	0.22	3.28	6.20	62	6.7	0.707
5	21	78	0.25	3.50	7.98	63	4.2	0.456
6	11	88	0.21	3.46	6.29	60	6.0	0.438
7	97	2	0.07	1.12	2.17	20	4.5	0.172
8	89	10	0.05	0.74	1.14	27	0.4	0.169
9	85	14	0.04	0.62	1.05	28	0.5	0.154
10	77	22	0.05	0.71	1.41	27	0.3	0.176
11	64	35	0.06	0.94	1.75	29	0.5	0.226
12	70	29	0.09	1.95	2.87	37	3.2	0.223
13	75	25	0.09	1.33	2.93	35	0.8	0.212
14	100	0	0.31	3.82	10.26	58	1.2	0.135
15	82	17	0.06	0.69	1.26	35	0.3	0.111
16	67	32	0.09	1.23	1.83	34	0.7	0.241
17	87	12	0.05	0.70	0.26	33	1.4	0.283
18	69	30	0.07	0.77	1.31	35	8.4	0.245
19	76	23	0.18	3.62	6.51	43	6.2	0.373
20	73	26	0.05	0.62	0.11	31	1.9	0.235
21	43	56	0.10	1.27	2.97	42	4.7	0.265
22	94	5	0.08	4.41	5.92	52	2.0	0.212
23	60	39	0.07	2.56	6.18	37	8.0	0.278

APPENDIX D

Raw data from the elemental analysis of each sediment sample.

station	P	K	Ca	Mg	Fe	Cu	Mn	Zn	Al	Na	S	Pb	Ni	Cd
#	%	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg
1	0.097	2.100	0.491	0.085	15619	38.38	275.8	114.50	10224	18391	0.077	152.00	201.80	48.88
2	0.091	2.171	0.503	0.164	23028	44.02	329	158.80	12412	16315	0.104	112.10	199.10	46.30
3	0.077	1.791	0.556	0.126	16159	25.11	308.5	102.60	11687	15638	0.054	69.80	191.20	44.62
4	0.097	1.592	0.683	0.159	25830	49.03	392.9	169.40	13767	17622	0.087	133.20	195.80	44.86
5	0.105	1.744	0.636	0.156	25844	45.71	370.6	156.60	15743	20096	0.099	30.78	238.60	48.81
6	0.090	1.612	0.705	0.161	24914	47.82	389.3	164.60	12977	15109	0.075	66.56	188.80	40.77
7	0.055	1.481	0.356	0.157	12400	21.89	212.7	86.84	7814	11147	0.039	75.42	164.00	38.65
8	0.037	0.664	0.540	0.037	13510	17.00	188.63	37.56	1817	5939	0.026	30.24	33.66	4.99
9	0.035	0.701	0.501	0.024	11610	18.27	161.67	34.86	1471	5190	0.023	31.65	29.35	4.60
10	0.058	0.974	0.576	0.034	12602	24.67	220.02	48.27	3403	7227	0.035	34.47	50.67	10.25
11	0.079	0.977	0.779	0.067	17796	29.13	258.88	56.54	7837	7769	0.045	64.86	75.75	12.24
12	0.103	0.921	0.796	0.092	25153	46.94	305.31	99.01	9204	9464	0.078	70.13	103.10	17.67
13	0.040	0.707	0.417	0.046	15417	21.53	216.77	57.75	3883	5820	0.051	29.52	28.69	3.14
14	0.127	0.768	0.819	0.141	32353	52.00	374.38	158.30	11758	9466	0.152	143.00	109.00	16.78
15	0.051	0.843	0.378	0.030	11317	16.34	162.39	39.31	2500	4890	0.041	72.42	54.03	10.84
16	0.118	0.717	0.452	0.102	16326	26.70	209.89	65.38	5277	9633	0.059	61.63	83.85	11.03
17	0.142	1.188	0.390	0.054	12781	18.52	228.05	46.27	5215	9773	0.054	40.25	76.35	11.85
18	0.144	1.161	0.339	0.057	12357	35.27	167.15	45.84	7494	12119	0.071	43.71	110.20	13.99
19	0.136	1.198	0.640	0.044	17153	27.86	214.70	55.20	5501	9513	0.112	47.32	82.86	11.18
20	0.098	1.864	0.507	0.030	8802	17.16	184.85	38.07	3411	9917	0.039	51.80	71.88	12.31
21	0.086	1.347	1.054	0.027	22804	34.57	290.97	62.93	5302	9785	0.052	68.69	80.73	12.43
22	0.059	1.179	0.305	0.035	17921	38.61	211.94	73.64	3787	7422	0.089	67.16	63.64	7.62
23	0.087	1.394	0.676	0.086	27486	37.24	312.90	92.39	7555	11945	0.063	107.90	148.30	19.29
BLANK 1	0.000	0.000	0.000	0.000	1	0.08	0.06	0.07	28	46	0.001	0.35	0.19	0.02
BLANK 2	0.000	0.000	0.000	0.000	1	0.08	0.07	0.09	30	46	0.000	0.14	0.21	0.01