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CONTAMINATED SEDIMENT ASSESSMENT BENTHIC MACROINVERTEBRATE COMMUNITY - STUDY

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Contaminated Sediment Assessment
Macroinvertebrate Community Structure Study
of
Wisconsin Great Lakes Coastal Harbors and Tributaries

Christin K. Campbell
Linda M. Talbot

Wisconsin Department of Natural Resources
Bureau of Water Resources Management

DRAFT

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THE WISCONSIN COASTAL MANAGEMENT PROGRAM, part of the Wisconsin Department of Administration, and overseen by the **WISCONSIN COASTAL MANAGEMENT COUNCIL**, was established in 1978 to preserve, protect and manage the resources of the Lake Michigan and Lake Superior coastline for this and future generations.

INTRODUCTION

Wisconsin's Great Lakes coasts contain Areas of Concern (AOCs), identified by the International Joint Commission, where much of the point source pollution has been abated, and contaminated sediments are now a significant source of pollution to the aquatic system. These areas are so designated because of the impairment of uses that have been identified, for example: restrictions on dredging, degradation of benthos (bottom dwelling biota and habitat), loss of fish and wildlife habitat, and advisories on fish consumption. Sediment and water quality monitoring and assessments have become necessary tools in obtaining information on which to base remedial action decisions for these areas.

The Wisconsin Department of Natural Resources' (WDNR) Sediment Management and Remediation Techniques (SMART) program has the task of helping to guide sediment quality assessment, monitoring and remediation activities within the state. This requires that the best methods available for sediment quality assessment be sought out and reviewed for use by the WDNR with regard to the inherent heterogeneity of contaminated site characteristics around the state. To this end, the SMART program is implementing the use of the Sediment Quality Triad as an approach (Chapman 1986; Chapman 1990) for sediment assessments in Areas of Concern (AOCs) and other contaminated sites around the state. This approach allows sediment quality assessments based on a "weight of evidence" strategy which utilizes three measurable aspects of a sediment: bulk chemistry, toxicity and *in situ* effects. The *in situ* effects are often measured by assessing benthic invertebrate communities and impacts on them.

This study was conducted to assess the benthic invertebrate community structures at coastal sites where bulk chemistry, toxicity and bioaccumulation data have already been gathered. In 1991 and 1992, the WDNR conducted studies funded by the Wisconsin Coastal Management Program (WCMP) examining sediment deposits with likely or known contamination at 18 sites in Lake Superior, Green Bay and Lake Michigan (WDNR, 1992; WDNR, 1993). Sediments from these sites were sampled for bulk chemistry, then used in laboratory tests of bioaccumulation and acute and chronic toxicity for the 1991 study (WDNR, 1992). The following year (WDNR 1993), *in situ* bioaccumulation tests using caged fathead minnows (*Pimephales promelas)* were performed to compare *in situ* and laboratory bioaccumulation tests.

In this study, we have returned to 14 of these sites to conduct benthic invertebrate community surveys in an attempt to measure biological impact or community differences at each site. Although the benthic invertebrate data from this study will not be evaluated in conjunction with the other Triad data for these sites in this report, these data will provide the third component of the Triad to complement with the other studies' data, and will allow for the additional assessment of these sites using the Triad approach.

METHODS

Site Descriptions

The fourteen sites chosen for this study contain soft sediment deposits and were sampled in previous years for bulk chemistry, and toxicity and bioaccumulation tests (WDNR 1992; WDNR 1993). The sites are located in 1) the St. Louis River Harbor in Lake Superior, 2) the Menominee River in Green Bay, and 3) Kenosha, Port Washington and Kewaunee Harbors in Lake Michigan (Table 1).

Table 1 - Site Descriptions - St. Louis River, Lake Superior

Site	Description	Depth
ALZ	Allouez Bay, near middle - reference site.	5-6 ft
NWC	Near 21st Ave. NW Channel, northeast of the WLSSD outfall.	7 ft
MPL	Northeast of the northernmost Minn. Power and Light Co. dock.	6 ft
STR	Southeast quadrant of Stryker Embayment.	4.5 ft

@ A list of the other sites will be added when these data are fully received and analyzed.

Field Collection

Sampling was conducted during April, May and June of 1993. Five benthic core samples and five artificial substrate samples, were taken at each site in the St. Louis River and Menominee River. Only core samples were obtained at the Lake Michigan harbors. Sediment cores, fifteen centimeters deep, were obtained with a 3" diameter polycarbonate piston corer and gently sieved in a #60 mesh (250 um openings) wash bucket (Wildco, Michigan). Samples were placed in polyethylene jars and preserved with 10 % formalin for at least two hours to preserve oligochaetes before replacing the formalin with 70%-80% ethanol preservative.

Modified Hester-Dendy type multiple plate artificial substrate samplers (Klemm et al. 1990) were placed at each site at the time of core collection. Samplers were suspended less than a foot above the sediment on a subsurface styrofoam buoy anchored to a cement brick. Each set of five samplers were attached to a surface buoy or shoreline tree for retrieval purposes. Artificial substrates were retrieved as carefully as possible after six weeks and were placed directly into a plastic jar with 70%-80% ethanol preservative.

Samples from the St. Louis River sites were sorted and identified at the Lake Superior Research Institute, University of Wisconsin-Superior. All other samples were

processed at the University of Wisconsin-Stevens Point. All samples were fully sorted and counted and identified to species if possible unless sample size was prohibitive in which case subsamples were used following QA/QC rules.

Data Analysis

@ Methods for data analysis will be added upon completion of data analysis.

RESULTS

St. Louis River

The water temperatures near the sediment surface ranged between 7.5°c and 9.8°c during the collection of benthic grab samples and placement of the artificial substrates in May. Temperatures ranged from 14.5°c and 17°c and dissolved oxygen between 7.2 and 9.3 mg/l during artificial substrate collection six weeks later. Secchi depth readings ranged from 0.5 ft to 2.3 ft. Turbidity was greatest at the reference site ALZ compared to all other sites in the St. Louis River.

The artificial substrate samplers were partially entangled with each other at some sites indicating that the samplers had been disturbed during the six weeks, possibly by wind and wave action. Tangled samplers were noted and care was taken to keep samples legitimately separate and prevent the loss of organisms from the samplers during collection.

St. Louis River

Benthic invertebrate core samples

Total abundance. The total abundance of organisms (total number of organisms found) ranged from 70 at STR to 461 at NWC (Figure 1). NWC was the only site significantly different than the reference site ALZ (93 organisms). This could possibly be due to organic enrichment without serious oxygen depletion at the NWC site from the nearby sewage treatment plant discharge.

Biomass. Measured biomass was highest at the reference site ALZ (63.3 mg), but it did not differ significantly compared to the other sites (11.9 mg-24.1 mg) because of high variability between sites. The total biomass of organisms from each site did not correlate with total abundance. This can be easily explained by the existence of various sized organisms at each site.

Percent contribution by dominant taxa. The reference site, ALZ (33%), had the lowest percent contribution by the dominant taxa compared to the other sites NWC (45%), MPL (57%), and STR (53%).

Species richness. Species richness (number of taxa identified) was highest at ALZ (18 taxa identified), and lowest at NWC and STR (12), but not significantly different between sites.

Taxa Diversity. The Shannon-Wiener diversity index (d) at ALZ (3.3), as calculated from the total count at the site (as if samples were composited), was obviously greater than at the other sites (range 2.2 - 2.4). Statistical analysis (ANOVA) of the replicate sample data (means were compared, n=5) revealed no difference between sites.

Artificial substrate samples

Total abundance. Invertebrate abundances were similar at sites ALZ (1109) and STR (1141) (Figure 2). NWC and MPL had higher total abundances of 2234 and 2432 respectively.

Percent contribution by dominant taxa. All sites were similarly dominated by a single taxon ranging from 33 to 40 percent contribution.

Species richness. The number of species identified at each site was higher from the artificial substrates than the core samples, and ranged from 36 at NWC to 50 at MPL.

Taxa Diversity. The Shannon-Wiener diversity index (d) from a composited total was highest at MPL (3.3) and STR (3.2). Diversity index values at ALZ and NWC were 2.6 and 2.2 respectively.

@ Further data analysis will be completed.

Table 1 - Community measures

	ALZ	NWC	MPL	STR

Table - Top five most abundant taxa from core samples - **St. Louis River**

Family	Abundance			
	ALZ	**NWC**	**MPL**	**STR**
Chironomidae	33	29	24	18
Nematoda	31	40	18	6
Naididae	2	207	3	2
Tubificidae	16	90	70	37
Polychaeta	0	90	4	4

Most abundant = total from all four sites.

Table - Ten most abundant Families from artificial substrate samples - **St. Louis River**

Order	Family	Abundance			
		ALZ	**NWC**	**MPL**	**STR**
Oligochaeta	Naididae	435	807	805	200
Diptera	Chironomidae	85	249	870	755
Nematoda	Nematoda (Order)	2	515	597	24
Gastropoda	Valvatidae	0	661	27	35
Hydroida	Hydridae	339	3	4	0
Amphipoda	Gammaridae	198	1	3	54
Ephemeroptera	Caenidae	21	3	45	25
Trichoptera	Polycentropdidae	1	18	35	18
Gastropoda	Physidae	0	61	0	2
Acari	Acari (Order)	0	8	19	3

DISCUSSION

The Allouez Bay reference site contained more noticeable detritus and partially decomposed plant material on the sediment surface. It is possible that the greater diversity and species richness (although not significant) observed in the core samples at ALZ is a result of a greater diversity of habitat available compared to the other three sites where no detritus was evident during any of the sampling, and only soft sediment was available for invertebrate habitat. This observation was further born out by

@ Further discussion will be presented once the data from UW-Stevens Point is analyzed. All data from both contract labs was received late, with the UW-SP data being received in mid-December.

REFERENCES

Wisconsin Department of Natural Resources. 1992. Contaminated sediment bioassay (toxicity tests) study of Wisconsin Great Lakes coastal harbors and tributaries.

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@ Further references will be added once the discussion is developed.

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