

RECENT WATER QUALITY IN THE GRAND CALUMET RIVER AS MEASURED BY BENTHIC INVERTEBRATES

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INTRODUCTION

The Grand Calumet River system in northwestern Indiana flows through one of the most highly industrialized areas of the country. Most of the flow in the river is composed of industrial and municipal wastewater, and water quality has been severely degraded for many years. Low dissolved oxygen and high ammonia, phenol, cyanide, metal, polycyclic aromatic hydrocarbon (PAH's), polychlorinated biphenyl (PCB's), and volatile organic compound (VOC's) concentrations have been detected in water and/or sediments in the river (Hydroqual, 1984). This study was undertaken to measure the biological effect of this degradation, to help identify particular water quality problems, and to provide baseline data to document any changes that may occur in the future. Monitoring benthic invertebrates proved useful in this study, because these animals are relatively immobile and, therefore, sensitive to local conditions.

METHODS

During the summers of 1986-1988, macroinvertebrates were collected on Hester-Dendy artificial substrate samplers (Fullner, 1971) suspended from bridges or other stationary objects at six sites in the Grand Calumet River system (Figure 1). Two or three samplers were set approximately one meter below the surface in the area of most rapid current velocity (0 to 30 cm/sec) at each site. Most samplers were set in mid-June or early July and retrieved 5 to 8 weeks later, although the 1987 samplers had an 18 week exposure period. Crayfish were also collected at each site in basket traps baited with meat. The basket traps were set in June or July each year, left overnight at each site, and checked the next day for captured animals. All macroinvertebrate samples were preserved in the field and sorted, identified, and enumerated in the laboratory. Everything was identified to the genus or species level, except the oligochaetes, which were identified only to order.

Several biometrics commonly used to assess water quality were applied to the data (EPA, 1983). The number of genera observed in a sample (generic richness) was calculated by treating oligochaetes as a single genus and omitting genera represented by only one individual. Percent similarity to a reference site (see below) was measured with a Jaccard Similarity Coefficient, using the taxonomic order level to compare similarity between sites. The Shannon-Weaver Diversity Index was also calculated using order level identifications at each site. Dominant genera, as discussed in the text, included those groups which constituted at least 25% of all individuals in a sample.

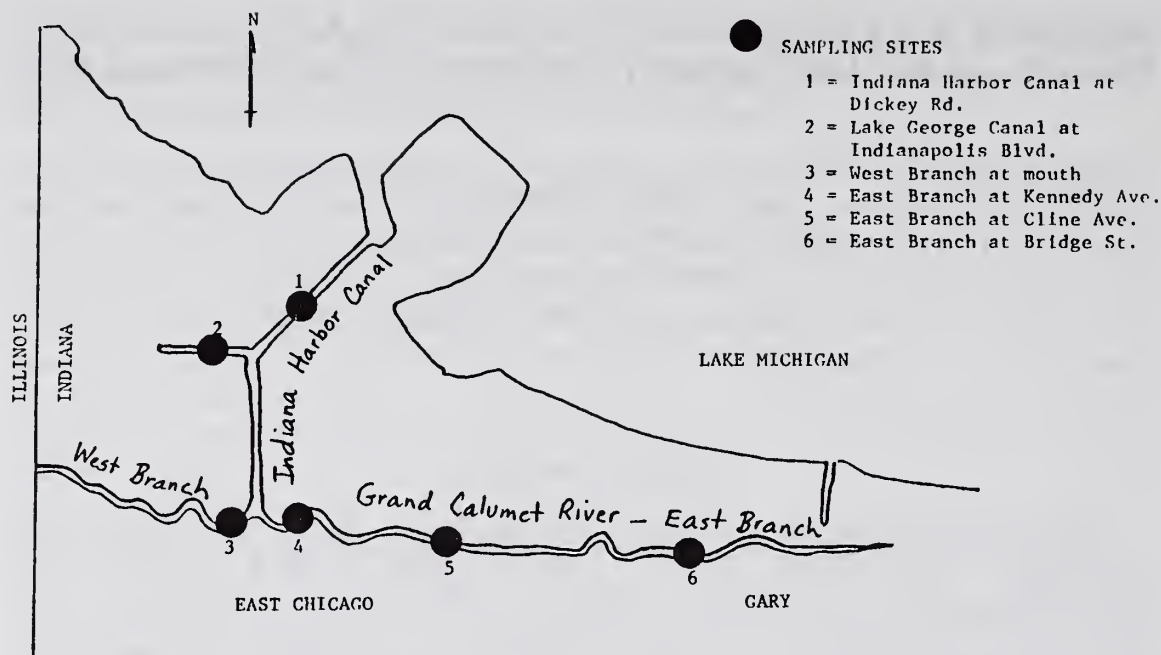


FIGURE 1. Location of macroinvertebrate sampling sites within the Grand Calumet River Basin.

RESULTS AND DISCUSSION

The macroinvertebrate groups present at the six sampling sites are summarized in Table 1. Five main groups of macroinvertebrates were present at every site. The most obvious common characteristic of this assemblage is the tolerance of each group to moderate organic pollution, especially reduced dissolved oxygen concentrations. No "intolerant" species were present at any of the sites. However, the presence of many "facultative" organisms (especially odonates and certain midges and snails) indicates that severe oxygen depletions do not occur.

The benthic fauna at all six sites also appeared to be stressed by toxic chemicals. In every sample, *Cricotopus bicinctus* and/or *Parachironomus abortivus* were the dominant midge larvae, both of which are found most abundantly in waters affected by toxic wastes (Simpson and Bode, 1980). Also, each of the samples was missing important faunal elements occurring in similar but unstressed habitats. For example, artificial substrate samples from Burns Ditch, a similar habitat about 30 kilometers east of the Grand Calumet River, regularly included amphipods, caddisflies (Psychomyiidae), bryozoans, and several genera of heavy-bodied midge larvae in the subfamily Chironomini (IDEM, unpublished data). These groups are generally tolerant of mild organic pollution but can be quite sensitive to certain toxic chemicals (Hart and Fuller, 1974; Mayer and Ellersieck, 1986). All were rare or absent in the Grand Calumet River samples.

Table 1 also shows the results of several common biometrics used to assess water quality at each of the six Grand Calumet River sites as well as at a reference site (Burns Ditch). Taxa richness, percent similarity to the reference station, and the diversity index all generally increase as water quality improves (EPA, 1983). According to Table 1, the most biologically stressed site in the Grand Calumet River was at Bridge Street, immediately downstream from the outfalls of a large steel mill and several combined sewer overflows from the City of Gary. This site had lower taxa richness, lower diversity, less similarity to the reference site, and was often dominated by the toxics-tolerant midge, *Cricotopus bicinctus*.

TABLE 1. Average of all samples during the study period. Numbers beside each macroinvertebrate group are proportions of that group in the total sample (+ = < 1% of total sample; Gam = *Gammarus*; Dicro = *Dicrotendipes*; Crico = *Cricotopus*; oligo = oligochaetes; bryo = bryozoa).

	Reference	Bridge	Cline	Kennedy	Branch West	IHC	Lake George Canal
Oligochaetes	+	.21	.25	.47	.66	.92	.38
Leeches	+	.02	.04	.28	.05	.01	.04
Snails	.13	.51	.20	.04	.08	.03	.40
Midges	.52	.24	.49	.20	.18	.03	.10
Odonates	.05	.02	.02	.01	.03	.01	.08
Others	.30	+	+	+	+	+	+
Generic Richness	18	7	9	9	8	8	12
Percent Similarity to Reference	100	39	52	45	55	55	52
Diversity Index	1.25	1.14	1.22	1.22	1.02	0.39	1.30
Dominant Genera	Gam Dicro	Physa Crico	Crico oligo	oligo	oligo	oligo bryo	oligo bryo Physa

TABLE 2. Biometrics applied to Indiana Harbor Canal samples, 1979-1988 (oligo = oligochaetes and bryo = bryozoa).

	Year							
	79	80	81	82	84	86	87	88
Generic Richness	1	5	1	6	6	9	8	7
Percent Similarity to Reference	9	36	9	55	55	64	45	45
Diversity Index	0	0.04	0	0.06	0.06	1.08	0.24	0.20
Dominant Taxa	oligo	oligo	oligo	oligo	oligo bryo	sponge bryo	oligo	oligo

By evaluating the environmental requirements and sensitivities of the species present, it is possible to narrow the range of chemicals responsible for toxic-related stress. For example, most metals can be ruled out as a primary cause of stress in the system because the snail, *Physa*, which is quite sensitive to many metals (Nebeker, 1986), was present and sometimes dominant at all sites. In addition, no metals in potentially toxic concentrations have been detected in any recent water samples from the Grand Calumet River and Indiana Harbor Canal (Indiana Department of Environmental Management, 1985). PCB-related stress was also

not evident from these results. Crayfish (*Procambarus acutus* and/or *Cambarus diogenes*) appeared to be equally abundant at most sites, including Bridge Street, where the highest PCB concentrations in sediments were located (Hydroqual, 1984). Although the amount of available toxicity data is limited, crayfish seem to be at least as sensitive as most other organisms tested for PCB toxicity (EPA, 1980a).

There is some evidence that cyanide and/or PAH's may be responsible for the toxic-related stress observed in the Grand Calumet River system. Sediment concentrations of both these chemical groups were highest at Bridge Street (Hydroqual, 1984), which was also the most biologically depressed site. The absence of amphipods from a habitat where they should be numerically dominant could be at least partially attributed to cyanide toxicity, since amphipods are among the most cyanide-sensitive invertebrates known (EPA, 1984). They are also taxonomically and ecologically similar to mysid shrimp, which are the most PAH-sensitive organism tested to date (EPA, 1980b).

Table 2 summarizes recent annual changes that have occurred in the benthic fauna of the Indiana Harbor Canal and includes previously unpublished data collected by the Indiana Department of Environmental Management from the site between 1979 and 1984. All of the biometrics applied to this data indicate that water quality in the Canal was highest in 1986 and has declined somewhat since then. Water levels in Lake Michigan reached historic highs in 1986 (Indiana Department of Natural Resources, 1986), and the improved benthic fauna that year may have been caused more by lake water dilution than by wastewater treatment improvements in the basin. Nevertheless, recent water quality in the Canal, as measured by benthic invertebrate community structure, has improved markedly since 1979.

SUMMARY

Benthic invertebrates were collected on artificial substrate samplers from the Grand Calumet River system during the summers of 1986-88 to determine recent water quality. The benthic communities observed each year indicated stress from both low dissolved oxygen and toxic substances. Although the sediments are highly contaminated with metals, stress from metals toxicity was not apparent in this study. Toxicity from cyanides and/or polycyclic aromatic hydrocarbons is more likely. The most biologically depressed site was at Bridge Street in Gary. This site receives wastewater from a large steel mill as well as several combined sewer overflows and has the most highly contaminated sediments for most chemical parameters. Overall, the benthic community appeared least stressed in 1986, when Lake Michigan water levels were at historic highs. Similar studies done since 1979 show that water quality in the Grant Calumet River system has improved markedly since that time.

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