Metropolitan Water Reclamation District of Greater Chicago

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BIOLOGICAL WATER QUALITY WITHIN THE CALUMET WATERWAY SYSTEM DURING 1988

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DISCLAIMER

Mention of proprietary equipment and chemicals in this report does not constitute endorsement by the Metropolitan Water Reclamation District of Greater Chicago.

EXECUTIVE SUMMARY

The deep draft portion of the Calumet River System, which includes the Calumet River, the Little Calumet River, and the Cal-Sag Channel, was studied during 1988. The studies were designed to determine the water quality within the system by examining populations of the indigenous biota, including selected bacterial indicators, benthic invertebrates, fish and periphyton. A summary of the major results of the biological sampling is shown in Figure 1.

Calumet River Water Quality

The 6.8 mile segment of the Calumet River, extending from the O'Brien Lock and Dam to Lake Michigan, must meet the General Use Water Quality Standards of the State of Illinois for fecal coliform bacteria (Title 35: Subtitle C: Chapter I: Part 302 B: § 302.209 Fecal Coliform). There are no General Use Water Quality Standards for benthic invertebrates, fish or periphyton.

The sanitary water quality of the Calumet River was good. All of the samples taken from Ewing Avenue and 130th Street for bacterial analysis during 1988 were less than the General Use Water Quality Standard of 400 fecal coliforms/100 mL (FC/100 mL).

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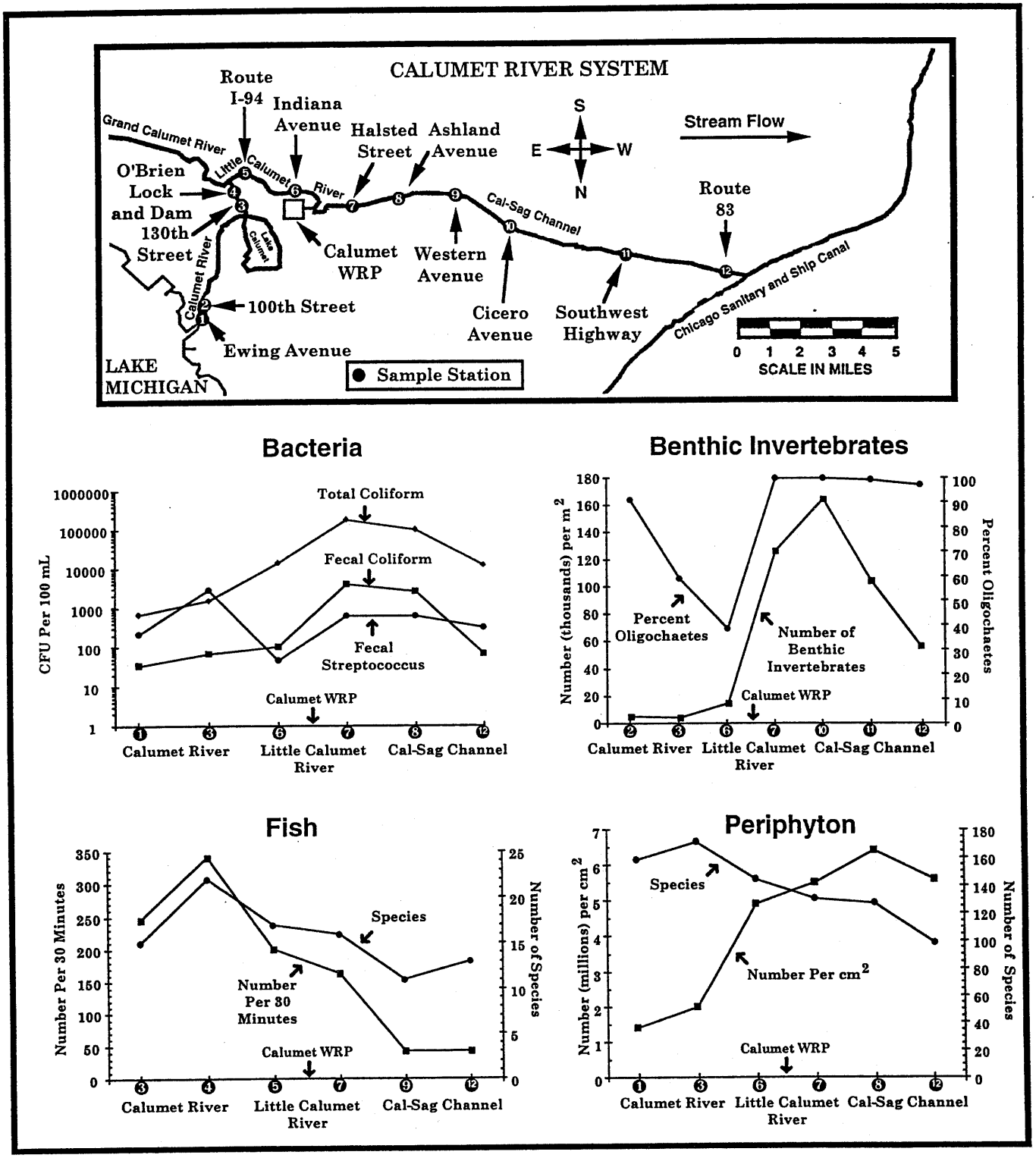
FIGURE 1

SUMMARY OF BIOLOGICAL SAMPLING RESULTS FROM THE ECOSYSTEMATIC STUDY OF THE CALUMET RIVER SYSTEM



The mean number of benthic invertebrates was about the same in the Calumet River, at 100th Street (5,133 organisms/m^2), and at 130th Street (4,265 organisms/m^2). There was an area of degraded sediment quality at the 100th Street Station with greater than 90% oligochaete worms. The sediment quality of the Calumet River at 130th Street was good.

More fish, fish species, and the greatest percent of game fish were found in the Calumet River than in the two waterways downstream. The chemical water quality for fish was good in the Calumet River. The Calumet River was a moderate aquatic resource with fair stream quality for fish.

The periphyton results also indicated water of good quality, and low in nutrient enrichment. The greatest numbers of periphyton species and the lowest numbers for total periphyton occurred in the Calumet River.

Little Calumet River Water Quality

The Little Calumet River, from its junction with the Grand Calumet River to the Cal-Sag Channel, is designated as a Secondary Contact water and must meet the Secondary Contact and Indigenous Aquatic Life Water Quality Standards of 35 Illinois Administrative Code 302, Subpart D. Secondary Contact waters are not required to meet the General Use Standards or the Public and Food Processing Water Supply Standards of Subparts B and C, Part 302. There are no water quality standards

for bacteria, benthic invertebrates, fish or periphyton included in the Illinois Administrative Code for Secondary Contact waters.

In comparison with the 130th Street Station on the Calumet River, an increase in bacterial counts at the Indiana Avenue Station, upstream of the Calumet WRP, was noticed. Total coliforms (TC) increased from 1,500 to 14,000 cfu/100 mL, fecal coliforms (FC) increased from 67 to 100 cfu/100 mL, Escherichia coli (EC) increased from 76 to 100 cfu/100 mL, and heterotrophic bacteria increased from 3,200 to 20,000 cfu/mL. These increases in bacterial counts suggested a discharge of wastewater upstream of the Calumet WRP outfall. This wastewater probably came from a WRP in Indiana discharging to the grand Calumet River, which joins the Little Calumet River upstream of the discharge of the Calumet WRP, or from combined sewer overflows.

The trend for the geometric means of the TC, FC, EC, and SPC densities increased at Halsted Street, below the Calumet WRP discharge. This reflected the input of treated, but unchlorinated, wastewater to the Little Calumet River by the Calumet WRP. Geometric means at Halsted Street were: 180,000 cfu/100 mL for TC, 3,900 cfu/100 mL for FC, 3,300 cfu/100 mL for EC, and 24,000 cfu/mL for Standard Plate Count (SPC). There are no water quality standards for TC, FC, EC, or SPC for the Little Calumet River.

The trend for the mean number of benthic invertebrates also indicated organic enrichment upstream of the Calumet WRP at Indiana Avenue, which suggested a discharge of wastewater upstream of the Calumet WRP outfall. The mean number of benthic invertebrates increased from 4,292 organisms/m^2 at the 130th Street Station in the Calumet River to 14,033 organisms/m^2 at the Indiana Avenue Station in the Little Calumet River.

The mean number of benthic invertebrates also increased at the Halsted Street Station (125,824 organisms/m^2) reflecting organic enrichment from the Calumet WRP effluent.

In comparison with the Calumet River, the number of fish, fish species, and percent game fish in the Little Calumet River decreased upstream of the Calumet WRP at Route I-94, which suggested a discharge of wastewater upstream of the Calumet WRP outfall. Analysis of the chemical water quality data also revealed that fish in the river at the Route I-94 Station had some exposure to acutely toxic water quality conditions from wastewater discharged upstream of the Calumet WRP. A fish kill occurred in this portion of the Little Calumet River in March 1988. District investigation of this fish kill clearly showed that wastewater flowing from Indiana was the source of such poor quality that dissolved oxygen concentrations in the Little Calumet River approached zero. These conditions continued throughout the spring of 1988.

The number of fish, fish species, and percent game fish remained relatively low at the Halsted Street Station. No fish were collected during a sample at this station in the spring of 1988 due to the deleterious impact of wastewater from a WRP in Indiana. Based on the Index of Biotic Integrity (IBI), the Little Calumet River was, in general, a limited aquatic resource with fair stream quality for fish.

When compared with the Calumet River Stations, the periphyton results also indicated water of degraded quality at the Indiana Avenue Station in the Little Calumet River, above the Calumet WRP discharge. In terms of both diatoms and total periphyton:

1. Average number of organisms increased at the Indiana Avenue Station, indicating nutrient enrichment from wastewater discharge upstream of the Calumet WRP.
2. Both average and total numbers of species decreased at the Indiana Avenue Station, indicating degraded water quality at this station.

In comparison with the Indiana Avenue Station, the periphyton values at the Halsted Street Station remained indicative of conditions of nutrient enrichment.

Cal-Sag Channel Water Quality

The Cal-Sag Channel is designated as a Secondary Contact water and must meet the water quality standards of 35 Illinois

Administrative Code 302, Subpart D. There are no water quality standards for bacteria, benthic invertebrates, fish or periphyton included in the Illinois Administrative Code for Secondary Contact waters.

The TC, FC, and EC densities at the Route 83 Station, 17 miles downstream of the Calumet WRP discharge, were similar to the values for these indicators upstream of the Calumet WRP, indicating that a natural reduction in the numbers of TC and FC occurred at this point in the Cal-Sag Channel. This natural die-off, downstream of the discharge from a WRP, was reported by Haas et al. (1).

The benthic invertebrate population was composed of almost 100% oligochaete worms at each Cal-Sag Channel station, indicating organic enrichment of the sediment throughout the length of the Cal-Sag Channel. In the Cal-Sag Channel the mean number of benthic invertebrates increased at the Western Avenue Bridge (164,325 organisms/m^2) then decreased at the Southwest Highway Bridge (94,785 organisms/m^2) and the Route 83 Bridge (56,441 organisms/m^2).

The number of fish and fish species were lower in the Cal-Sag Channel than in the other waterways. The percent of rough fish increased to 40% in the Cal-Sag Channel. The chemical water quality for fish was fair to poor, with a potential for exposure to stressful water quality conditions. As measured by the IBI, the Cal-Sag Channel is a limited aquatic

resource, with fair stream quality for fish. Habitat for fish in the Cal-Sag Channel is limited. The Cal-Sag Channel was not constructed to be a fishable stream with diverse habitat types. It was built for navigation and water reclamation. Natural habitat conditions in the Cal-Sag Channel are not conducive to sustaining sport fish.

The periphyton results also indicated nutrient enrichment in the Cal-Sag Channel.

INTRODUCTION

The Metropolitan Water Reclamation District of Greater Chicago (District) serves an area of 872 square miles. The area is highly urbanized and industrialized. The District treats a total domestic and nondomestic wastewater load that is equivalent to a population of 9.5 million people. Approximately 375 square miles of the District's area is served by combined sewers, with the remainder served by storm sewers or unsewered. The District presently owns approximately 537 miles of intercepting sewers and operates seven water reclamation plants (WRPs). The WRPs all utilize the conventional activated sludge process. The North Side, Stickney, Calumet, and Lemont WRPs together have 1,889 MGD of secondary capacity. The Hanover, Egan, and Kirie WRPs have a combined tertiary capacity of 114 MGD (2).

In order to protect the area's primary water supply, Lake Michigan, the flow of the Chicago River System was reversed in 1900, and the Calumet River System was reversed in 1922. Fifty-four miles of navigable canals were constructed and connected to existing river systems to form the 81 mile long Chicago Waterway System (Figure 2).

The District is responsible for the quality of the water in the streams and canals within its jurisdiction. The District established its Ecosystematic Study Program in 1975 (3),

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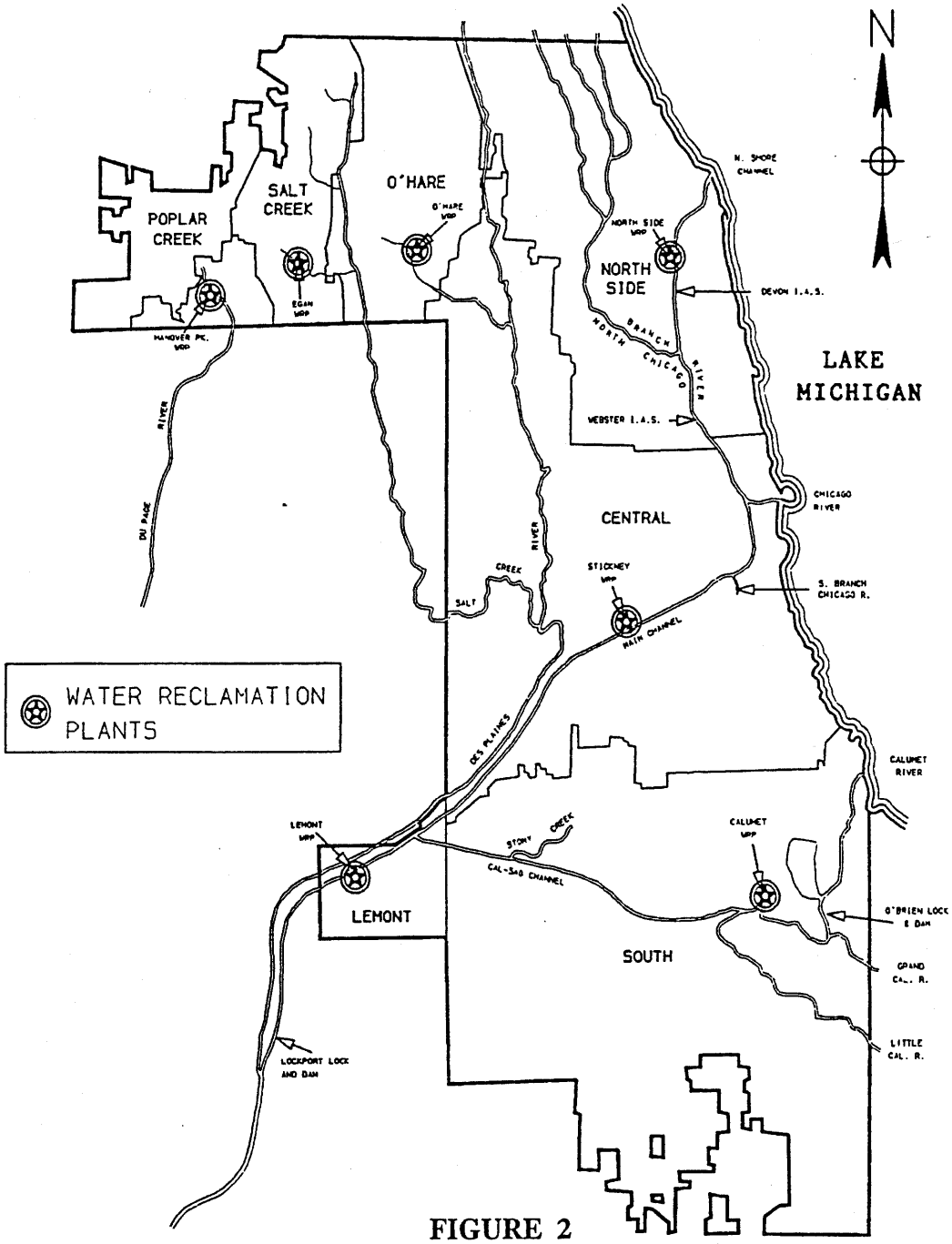

FIGURE 2

MAP OF MAJOR FACILITIES AND SERVICE AREAS

following preliminary sampling in 1974, to monitor these waterways on a regular basis using primarily biological parameters (Table 1).

The Calumet River System was monitored during 1988 for this report. It was previously monitored in 1974, 1975, and 1976.

The objective of this study was to sample the bacteria, benthic invertebrates, periphyton and fish of the Calumet River System, including the Calumet River, Little Calumet River, and Cal-Sag Channel, and to characterize the water quality of these waterways using metrics from these biological populations. Bacterial densities were measured in water samples because of the importance of bacteria as indicators of the sanitary quality of the water for human and animal health. Benthic invertebrates were sampled because they are indicators of the water and sediment quality for the bottom dwelling organisms. Periphyton were sampled as "quick response" indicators of water quality for these microscopic plants. Fish were sampled because they are good indicators of the water quality of the river. Chemical quality of the water was measured at the time of fish collections in order to determine the toxicity of the water to fish.

Study Area

The Calumet River System (Figure 1) is composed of three segments:

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TABLE 1

WATERWAYS MONITORED DURING THE ECOSYSTEMATIC STUDY
1975 THROUGH 1988

Years	Waterways
1975, 1976, and 1977	North Shore Channel North Branch of the Chicago River Chicago River South Branch of the Chicago River Chicago Sanitary and Ship Canal Calumet River Little Calumet River Cal-Sag Channel
1978 and 1979	Des Plaines River in Cook County
1980 and 1981	North Branch of the Chicago River including the West Fork, Middle Fork, and Skokie River
1982 and 1983	Little Calumet River and Thorn Creek
1984 and 1985	Wilmette, Chicago and Calumet Harbors
1986 and 1987	North Shore Channel North Branch Chicago River
1988	Calumet River Little Calumet River Cal-Sag Channel

1. The Calumet River is 7.73 miles long and 8.5 to 11.5 feet deep (2). The river flows from Calumet Harbor to the junction with the Grand Calumet River, just downstream of the O'Brien Lock and Dam.
2. The deep draft portion of the Little Calumet River is 6.55 miles long and 14 feet deep (2). The original Calumet WRP began operation on September 11, 1922. It was replaced by a conventional activated sludge plant in 1935 (4). The final effluent from the Calumet WRP flows into the Little Calumet River.
3. The Cal-Sag Channel is 15.98 miles long and 8.8 to 11.7 feet deep (2). The channel extends from its junction with the Little Calumet River to its junction with the Chicago Sanitary and Ship Canal.

As the Calumet River flows in a southerly direction away from Lake Michigan and joins with the Little Calumet River that connects with the Cal-Sag Channel, the water and sediment quality is markedly influenced by a combination of periodic discharges from urban storm water and combined sewer overflows both in the states of Indiana and Illinois, treated municipal and industrial wastewater from the state of Indiana, and the advanced secondary treated wastewater from the Calumet WRP.

Biological Samples

BACTERIA

TC, FC, and FS, are used by the District to indicate the sanitary quality of water. Analyses for these indicator bacteria have been performed routinely on all District waterways, including the Calumet River System, for many years.

The enterococcus group (ME) is a subgroup of the fecal streptococci that is a valuable bacterial indicator for determining the extent of fecal contamination of recreational surface waters. Studies at bathing beaches have shown that swimming associated gastroenteritis is related directly to the quality of the bathing water and that enterococci are efficient bacterial indicators of water quality.

Escherichia coli is an opportunistic intestinal pathogen and is a member of the fecal coliform group. EC is also a valuable indicator of bathing water quality.

Pseudomonas aeruginosa (PA) is a common inhabitant of soil and water and has a worldwide distribution. It is responsible for a number of infections in humans, particularly in debilitated or immunocompromised hosts.

Salmonella spp. (SAL) are enteric pathogens, some species of which occur naturally in the environment.

The SPC is used to estimate the total number of viable heterotrophic bacteria in water.

BENTHIC INVERTEBRATES

The benthic invertebrate community frequently has been used to assess the environmental quality of aquatic ecosystems. These organisms are sensitive to both physical and chemical changes in the environment and continually adjust to the water and sediment quality. They also have sufficiently long life cycles and low motility and, therefore, reflect both past and present environmental conditions.

An unstressed bottom community consists of a large number of different benthic groups with relatively few individuals within each group. Conversely, when a community is under stress, the number of benthic groups decreases and the number of individuals in the remaining tolerant groups increases.

FISH

Fish collections and analyses give the most meaningful index of water quality to the public. Fish occupy the upper levels of the aquatic food chain as the ultimate aquatic consumer. Therefore, changes in water quality that significantly affect the other organisms within the aquatic community will also affect the species composition and abundance of the fish population.

A knowledge of the assemblage of fish species in a stream, and the numerical relationships between these species provides an excellent biological picture of the watercourse and its well-being. When such information is available over a

long period of time, fish can be one of the most sensitive indicators of the quality of the aquatic environment (5).

PERIPHYTON

The periphyton assemblage (primarily algae) represents the primary producer trophic level, exhibits a different range of sensitivities, and will often indicate effects only indirectly observed in the benthic and fish communities. Algae generally have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts. As primary producers, algae are most directly affected by physical and chemical factors.

METHODS AND MATERIALS

Bacteria

Water samples for bacterial analyses were collected from bridges passing over the Calumet River, Little Calumet River, and Cal-Sag Channel as designated in Figure 1. These samples were placed in sterile four-liter containers with sufficient sodium thiosulfate to neutralize 15 mg chlorine/L, and transported, on ice, to the District's Research and Development Laboratory in Stickney, Illinois. Analyses were begun approximately 6 to 24 hours after sample collection began, and from 2 to 20 hours after the last sample was collected. The TC, FC, FS, and SPC analyses were performed according to Standard Methods for the Examination of Water and Wastewater (Standard Methods), 14th Edition (6). The SAL were estimated using a modification of the most probable number (MPN) technique described by Kenner and Clark (7). Presumptive *Salmonella* were identified biochemically utilizing the API 20® system for identification of enterobacteriaceae. Confirmation of these isolates was performed with polyvalent "O" antisera. The PA analyses were performed according to the tentative method in Standard Methods, 15th Edition (8). The EC were enumerated by the membrane filter procedure of Dufour et al. (9), and ME were enumerated using the membrane filter procedure of Dufour (10). Results were expressed as the geometric means of

samples collected four times during the year, as colony forming units (cfu)/100 mL, or cfu/mL.

Colony confirmations for TC, FC, FS, EC, ME, and PA are presented in Table 2. The confirmation rates for typical TC, FC, FS, EC, ME, and PA colonies were 87.5%, 83.1%, 75.6%, 75.8%, 71.8%, and 86.3%, respectively. These data demonstrate that the analyses were recovering high and acceptable percentages of the indicated populations.

Benthic Invertebrates

Seven sampling stations were selected for the benthic survey (Figure 1), with two stations in the Calumet River, two in the Little Calumet River, and three stations in the Cal-Sag Channel. A linear transect was established at each of the seven sampling stations. Two sites (center and right or left bank) were located on each transect. A description of each of the 14 sampling sites is presented in Table 3.

Triplicate sediment samples were collected with a petite Ponar Grab (0.023 m^2) during April and May, July and August, and October and November 1988 from 14 sampling sites (two sites at each of seven stations) in the Calumet River System Table 3. The sediment samples were sieved in the field using a field sieving bucket with 250 micrometer (μm) openings. The sieved material was placed in one-gallon plastic containers and returned to the laboratory for analysis. All samples were stored at 4°C until processed.

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TABLE 2

TOTAL COLIFORM (TC), FECAL COLIFORM (FC), FECAL STREPTOCOCCUS (FS), *ESCHERICHIA COLI* (EC), ENTEROCOCCI (ME), AND *PSEUDOMONAS AERUGINOSA* (PA) COLONY CONFIRMATIONS FOR THE CALUMET RIVER, LITTLE CALUMET RIVER, AND CAL-SAG CHANNEL DURING 1988

Parameter	TC		FC		FS		EC		ME		PA	
	T[1]	AT[2]	T	AT	T	AT	T	AT	T	AT	T	AT
Number of Colonies Tested	96	20	89	24	78	8	95	23	85	19	51	23
Number Confirmed	84	2	74	0	59	3	72	0	61	3	44	3
Percent Confirmed	87.5	10	83.1	0	75.6	37.5	75.8	0	71.8	15.8	86.3	13.0

[1]T = Typical colonies.
[2]AT = Atypical colonies.

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TABLE 3

DESCRIPTION OF BENTHIC INVERTEBRATE SAMPLING SITES
IN THE CALUMET RIVER SYSTEM

Station Location	Description of Sampling Site[1]
100th Street Calumet River	Chicago Skyway bridge in the center of the river; 1.5 miles below Lake Michigan; 10.4 miles above the Calumet WRP outfall and 100 feet above the 100th Street bridge along right bank of the river; 1.6 miles below Lake Michigan; 10.3 miles above the Calumet WRP outfall.
130th Street Calumet River	1000 feet below the 130th Street bridge in the center and along right bank of the river 5.3 miles above the Calumet WRP outfall.
Indiana Avenue Little Calumet River	300 feet above the Indiana Avenue bridge in the center and along right bank of the river; 3.5 miles below junction with the Grand Calumet River; 0.9 miles above the Calumet WRP outfall.
Halsted Street Little Calumet River	500 feet above the Halsted Street bridge in the center and along right bank of the river; 1.3 miles below the Calumet WRP outfall.
Western Avenue Cal-Sag Channel	300 feet above the Western Avenue bridge in the center and along right bank of the channel; 1.7 miles below junction with the Little Calumet River; 3.4 miles below the Calumet WRP outfall.
Southwest Highway Cal-Sag Channel	300 feet below the Southwest Highway bridge in the center and along right bank of the channel; 10.7 miles below the Calumet WRP outfall.
Route 83 Cal-Sag Channel	400 feet above the Route 83 bridge in the center and along right bank of the channel; 17.3 miles below the Calumet WRP outfall.

[1] Sampling site facing upstream in the waterway.

In the laboratory, the sediment samples were washed and screened through a U.S. Standard Number 60 mesh sieve (250 μm openings). The sieved material was examined using a stereomicroscope at 7 to 30 x magnification. All invertebrates were removed from the finer residual material, sorted into major taxonomic groups, and counted within one to three days of collection. In situations where there were large numbers of benthic organisms in the sample, estimates of their abundance were made by employing a subsampling device (11). The organisms were identified to a variety of taxonomic levels using the following taxonomic references: Merritt and Cummins (12), and Pennak (13).

The community characteristics determined were the identification and enumeration of the organisms (organisms/m^2), percent composition of major taxonomic groups, and seasonal trends.

Fish

SAMPLE COLLECTION

Fish were collected four times during the year at each of the seven locations on the Calumet River, Little Calumet River, and Cal-Sag Channel. A list of waterway fish sampling stations, including the distance of each station upstream or downstream from the Calumet WRP, is shown in Table 4. A map of the stations is shown in Figure 1.

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TABLE 4

FISH SAMPLING STATIONS IN THE CALUMET RIVER SYSTEM DURING 1988

Fish Sampling Station Location	Township, Range and Section	Miles from WRP Outfall	River Mile[1]
Calumet River			
130th Street	T37N/R14E/S36 NE	5.6 Upstream	327.0
O'Brien Lock and Dam	T37N/R14E/S36 SE	4.8 Upstream	326.2
Little Calumet River			
Route I-94	T36N/R14E/S02 NE	3.3 Upstream	324.7
Halsted Street	T37N/R14E/S32 NE	1.3 Downstream	320.1
Cal-Sag Channel			
Cicero Avenue	T37N/R13E/S33 NE	6.5 Downstream	314.9
Route 83	T37N/R11E/S14 NE	17.2 Downstream	304.2

[1] Distance along the Illinois Waterway from Grafton, Illinois, which is at the confluence of the Illinois River and the Mississippi River.

A boat mounted electrofisher was used to collect fish. The electrofisher was powered by a 230-volt, 3,000-watt, 180-cycle, 3-phase, alternating-current generator. The water was electrified with eight to 15 amps of current. Stunned fish were picked out of the water with long handled dip nets by either of two netters who were positioned on the bow of the boat. In most cases, the section of canal sampled extended 400 meters. Whenever possible, both sides of this canal section were electrofished.

All large fish were identified to species, weighed to the nearest gram or ounce, and measured for standard and total length to the nearest millimeter. Generally, large fish were identified, weighed, and measured at the sampling site and returned alive to the canal. Small fish were preserved in 10% (v/v) formalin, and processed later in the laboratory. They were processed similar to the large fish, except that the small fish were weighed to the nearest 0.01 gram.

ABUNDANCE OF FISH

Catch per unit of effort (CPUE) by electrofishing is a useful, easily obtained index to the abundance of the populations of many fish species. This relative measure is more useful when applied to adult fish because of size selectivity. Data regarding the relative abundance of small fish are probably biased too low, but trends in the abundance of young fish

can be monitored if electrofishing equipment and procedures are evaluated with this objective in mind (14).

Total time of electrofishing (the time, in minutes, that the current was actually on) was noted for each collection so that the collection results could be presented as CPUE. In the present study, the CPUE was the number or weight of fish collected per 30 minutes of electrofishing effort.

INDEX OF BIOTIC INTEGRITY (IBI)

Fish populations integrate both chemical and physical perturbations which affect stream quality. Stream quality for fish is affected by the chemical and physical quality of the water, the quality of the physical habitat, and the variability of stream flow.

The IBI assesses the health of a fish community using 12 fish community measures, or metrics, which fall into three broad categories: (1) species composition, (2) trophic composition, and (3) fish abundance and condition. The Illinois Department of Conservation (IDOC) and the Illinois Environmental Protection Agency (IEPA) have used the IBI to develop a five-tiered stream classification system predicated largely on the type and condition of the fishery resource (15, 16). This five-tiered classification system will be used in this report to describe the stream quality of the Chicago Waterway System.

The five categories of the stream classification system developed by the IDOC and the IEPA which describe stream quality as a function of IBI are:

1. Good, a unique aquatic resource: excellent stream quality for fish, IBI of 51 to 60, comparable to the best situations without human disturbance.
2. Good, a highly valued aquatic resource: good stream quality for fish, IBI of 41 to 50, a good sport fishery.
3. Fair, a moderate aquatic resource: IBI of 31 to 40, a bullhead, sunfish, and carp fishery.
4. Fair, a limited aquatic resource: IBI of 21 to 30, carp or other less desirable species support fishery.
5. Poor, a restricted use aquatic resource: IBI less than or equal to 20, no sport fishery, few fish of any species present.

The calculation procedure for the IBI in this study was obtained from the IEPA (Robert Schacht, personal communication). An example of the calculation of the IBI is given in Table 5.

CHEMICAL ANALYSIS AND BLUEGILL TOXICITY INDEX (BTI)

Water samples were collected at the same location and on the same day as the fish collections for those samples

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TABLE 5

AN EXAMPLE OF SCORING FOR CALCULATION OF THE INDEX OF BIOTIC INTEGRITY (IBI) METRICS FOR A FISH COLLECTION FROM THE LITTLE CALUMET RIVER AT HALSTED STREET ON AUGUST 11, 1988

IBI Metric	Sample Value	Score[1]
Total Number of Species	7	3
Number of Sucker Species	0	1
Number of Sunfish Species	2	3
Number of Darter Species	0	1
Number of Intolerant Species	0	1
Percent of Total As Green Sunfish	0.4	5
Percent of Individuals As Hybrids	1.4	1
Percent of Individuals Diseased or Abnormal	2.2	1
Percent of Omnivores	97.1	1
Percent of Insectivorus Cyprinids	0.0	1
Percent of Carnivores	0.0	1
Number of Fish Caught per Hour	348	3
IBI		22

[1] Scores based on sample value ranges listed in Hite and Bertrand, 1989 (16).

collected during 1988. Samples were analyzed by the Quality Control Division (now known as the Analytical Laboratories Division) of the Research and Development Department according to Standard Methods, 16th Edition (17) or other approved methods.

The BTI was calculated from the results of chemical analyses for various toxic components of the water from which the fish were collected. Toxic constituents included in the BTI were: un-ionized ammonia, arsenic, cadmium, total residual chlorine, chromium, copper, cyanide, fluoride, iron, methylene blue active substances (MBAS), lead, manganese, mercury, nickel, nitrite plus nitrate, phenol, silver, and zinc. Effects of temperature, total hardness, dissolved oxygen, and pH on the toxicity of these constituents were also taken into consideration. A component toxicity, expressed in bluegill toxic units (BGTUs) was calculated for each toxicant by dividing the environmental concentration of the toxicant by the 96-hour LC_{50} to bluegill. The 96-hour LC_{50} is the concentration of toxicant which is lethal to 50% of the test fish in 96 hours. The component toxicities were then summed to yield the toxicity index. A sample of canal water with a toxicity of 1.0 BGTU, for example, would be lethal, by definition, to 50% of the bluegills exposed to it for 96 hours (18).

An example of the calculation of the BTI for a water sample is given in Table 6. Values for the BTI used for classification of stream water quality for fish are listed in Table 7.

Periphyton

The periphyton were sampled by providing artificial substrates (microscope slides) for them to colonize at the six locations designated in Figure 1. They were collected at two week intervals, protected from auto-oxidation by wrapping them in aluminum foil, kept viable at 4°C, and transported to the laboratory. For diatoms, the allotted slides were covered with 30% hydrogen peroxide overnight, scraped with a rubber spatula, and then the sample was completely oxidized using potassium dichromate. The sample was allowed to stand to concentrate the diatom frustules, and then washed with sterile distilled or deionized water. After removing all of the dichromate (yellow color), the sample volume was adjusted to concentrations that would provide readable slides (10 to 50 diatom frustules) when two mL were dried on a 22 x 50 mm cover slip. This residue was mounted in a high refractive index medium (Hyrax®), and 500 organisms or 300 fields were identified and counted. A minimum of 15 fields was counted.

The nondiatom portion of the algae sample was scraped from the slides, and preserved with 0.5% glutaraldehyde. The gelatinous matrix surrounding some organisms was dissolved

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 6

AN EXAMPLE OF THE CALCULATION OF THE BLUEGILL TOXICITY INDEX (BTI) FOR A WATER SAMPLE FROM THE LITTLE CALUMET RIVER AT HALSTED STREET ON AUGUST 11, 1988

Water Quality Constituent	Concentration	BGTUs[1]
Limiting Factors		
Temperature (°C)	27	
Hardness (mg/L as $CaCO_3$)	218	
Dissolved Oxygen (mg/L)	2.0	
pH (units)	6.7	
Total Ammonia Nitrogen (mg/L)	1.3	
Toxicants		
Un-ionized Ammonia (mg/L)	0.01	0.0016
Arsenic (mg/L)	<0.2	0.0000
Cadmium (mg/L)	<0.02	0.0000
Total Residual Chlorine (mg/L)	NA[2]	NA
Chromium (mg/L)	<0.02	0.0000
Copper (mg/L)	<0.02	0.0000
Total Cyanide (mg/L)	0.034	0.4258
Fluoride (mg/L)	0.74	0.0167
Iron (mg/L)	0.3	0.0091
MBAS (mg/L)	0.055	0.1400
Lead (mg/L)	<0.08	0.0000
Manganese (mg/L)	0.06	0.0015
Mercury (μg/L)	<0.3	0.0000
Nickel (mg/L)	<0.2	0.0000
Nitrite + Nitrate-N (mg/L)	3.0	0.0015
Phenol (mg/L)	0.001	0.0003
Silver (mg/L)	0.001	0.0143
Zinc (mg/L)	<0.2	0.0000
BTI (Sum of Toxicities)		0.6108

[1]Bluegill toxic units.
[2]NA = No analysis.

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TABLE 7

WATER QUALITY FOR FISH BASED ON THE BLUEGILL TOXICITY INDEX (BTI)

BTI	Toxicant Concentrations	Water Quality[1]
< 0.2	Acceptable	Good
0.2 to 0.4	Marginal	Fair
> 0.4 to < 1.0	Stressful	Poor
> 1.0	Lethal	Very Poor

[1]Based on information in Lubinski and Sparks, 1981 (18).

with Triton N-101®, a wetting agent. The sample was allowed to settle in the refrigerator in the dark for a minimum of four hours to allow the preservative to penetrate and harden the organisms. Serial sedimentation was used to concentrate the organisms, and wet mounts of 0.1 mL of the concentrate were made on a 22 x 50 mm cover slip. Five hundred organisms or 300 fields were counted and identified with a minimum of 15 fields observed.

RESULTS

Bacteria

The geometric means of four quarterly samples for the bacterial population densities of TC, FC, FS, ME, SPC, EC, PA, and SAL are presented in Table 8 for each of the six stations on the Calumet River/Cal-Sag Channel System.

CALUMET RIVER

The geometric mean TC and FC densities in the Calumet River System in 1988 were lowest at Ewing Avenue on the Calumet River at 670 cfu/100 mL and 34 cfu/100 mL, respectively. The stream reach from the O'Brien Lock and Dam to Lake Michigan is defined as a General Use Water, and is subject to the General Use Water Quality Standard for fecal coliform of 400 cfu/100 ml based upon a geometric mean of at least five samples collected over a 30-day period (Title 35: Subtitle C: Chapter I: Part 302 B:§302.209 Fecal Coliform). Based on the results of one sample collected per month, we speculate that any number of samples collected would contain less than 400 cfu/100 ml (19). All of the samples from the Ewing Avenue and 130th Street stations on the Calumet River during 1988 were in compliance with the General Use Water Quality Standard of the state of Illinois for FC of 400 cfu/100 mL.

The geometric mean EC densities follow the trend shown by the FC of which they are a subset. The EC density in the

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 8

BACTERIAL DENSITIES[1] IN THE CALUMET WATERWAY SYSTEM DURING 1988

Station Location[2]	TC[3]	FC[3]	FS[3]	ME[3]	SPC[3]	EC[3]	PA[3]	SAL[3]
Ewing Avenue Calumet River	670	34	220	78	1,100	45	3.9	<0.16
130th Street Calumet River	1,500	67	2,800	1,200	3,200	76	414	<0.15
Indiana Avenue Little Calumet River	14,000	100	46	49	20,000	160	7	0.17
Halsted Street Little Calumet River	180,000	3,900	630	450	24,000	3,300	120	0.57
Ashland Avenue Cal-Sag Channel	100,000	2,600	610	420	11,000	4,800	62	0.47
Route 83 Cal-Sag Channel	12,000	67	320	150	15,000	98	20	<0.16

[1] All densities are given in colony forming units per 100 mL (cfu/100 mL), except SPC which is in cfu/mL, and SAL which is in most probable number per 100 mL (MPN/100 mL).

[2] Figure 1.

[3] TC = Total Coliform; FC = Fecal Coliform; FS = Fecal Streptococcus; ME = Enterococcus; SPC = Standard Plate Count; EC = *Escherichia coli*; PA = *Pseudomonas aeruginosa*; SAL = *Salmonella* spp. Values shown are the geometric means of results of analyses of four samples taken March 7, May 2, August 1, and October 3, 1988.

Calumet River System was lowest at Ewing Avenue at 45 cfu/100 mL.

The geometric mean FS and ME densities in the Calumet River System during 1988 were highest 5.6 miles upstream of the Calumet WRP at 130th Street on the Calumet River at 2,800 cfu/100 mL and 1,200 cfu/100 mL, respectively. The ME are a subset of the FS, and are found mostly in the human intestinal tract. The agreement in numbers between FS and ME densities indicates that the majority of the FS were of human origin.

The SPC is a measure of the total heterotrophic bacterial population, i.e., those microorganisms requiring organic compounds for energy and growth. The geometric mean SPC density in the Calumet River System was lowest at Ewing Avenue at 1,100 cfu/mL, the station closest to Lake Michigan.

The PA density in the Calumet River System was lowest at Ewing Avenue on the Calumet River at 4 cfu/100 mL, and highest upstream of the Calumet WRP at 130th Street with 414 cfu/100 mL.

The geometric mean density of SAL in the Calumet River System was lowest at 130th Street at <0.15 MPN/100 mL.

LITTLE CALUMET RIVER

The Little Calumet River, from its junction with the Grand Calumet River to the Cal-Sag Channel, is designated as a Secondary Contact water. There are no bacterial water quality standards for Secondary Contact waters.

The geometric mean TC and FC densities in the Calumet River System were highest at Halsted Street with 180,000 TC cfu/100 mL and 3,900 FC cfu/100 mL. The Halsted Street Station on the Little Calumet River and the Ashland Avenue Station on the Cal-Sag Channel consistently had the highest FC levels measured in the Calumet River System during 1988.

The geometric mean FS and ME densities in the Calumet River System were lowest at Indiana Avenue at 46 cfu/100 mL and 49 cfu/100 mL, respectively.

The geometric mean SPC heterotrophic bacteria density in the Calumet River System was highest at Halsted Street at 24,000 cfu/mL.

The second highest mean PA density in the Calumet River System was 120 cfu/100 mL at Halsted Street.

The geometric mean density of SAL in the Calumet River System was highest at Halsted Street at 0.57 MPN/100 mL.

CAL-SAG CHANNEL

The Cal-Sag Channel is designated as a Secondary Contact water. There are no bacterial standards for Secondary Contact waters.

The Ashland Avenue Station on the Cal-Sag Channel, with a geometric mean TC density of 100,000 cfu/100 mL, and a mean FC density of 2,600 cfu/100 mL, along with Halsted Street on the Little Calumet River, consistently had the highest TC and FC levels measured in the Calumet River System.

The geometric mean EC densities in the Calumet River System followed the trend shown by the FC of which they are a subset. The EC densities were highest at Ashland Avenue at 4,800 cfu/100 mL. The EC are associated primarily with the intestinal tract of humans and, as such, they are the more specific indicators of sewage contamination. The agreement in numbers between the FC and EC indicates that few, if any, of the FC present were not of human origin.

Benthic Invertebrates

CALUMET RIVER

Overall, oligochaete worms, chironomid midges, fingernail clams, leeches, and amphipods accounted for 76.3%, 20.7%, 1.9%, 0.5%, and 0.5%, respectively, of the total benthos collected during 1988 from the Calumet River (Table 9). The estimated mean faunal density for the four sampling sites was 4,710/m^2. During the spring, summer, and fall of 1988, the estimated mean abundance for benthic invertebrates was 6,667, 2,463, and 4,999/m^2, respectively.

Detailed sample statistics for each Calumet River sample are listed in Appendix Tables AII-1 and AII-2.

At the 100th Street Station, 91.1% of the benthic community was composed of oligochaete worms (Table 10). Chironomid midges, fingernail clams, leeches, amphipods, and snails accounted for the remainder of the benthos. The estimated mean density at Station 13 in the Calumet River during 1988 was

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 9

NUMBER OF BENTHIC INVERTEBRATES PER SQUARE METER (N/m^2) AND PERCENTAGE COMPOSITION (%) OF EACH TAXONOMIC GROUP IN EACH WATERWAY IN THE CALUMET RIVER SYSTEM DURING 1988

Waterway and Taxonomic Group	Spring		Summer		Fall		Annual Mean	
	N/m^2	%	N/m^2	%	N/m^2	%	N/m^2	%
Calumet River								
Hirudinea (leeches)	55	0.82	4	0.14	13	0.26	24	0.50
Oligochaeta (worms)	4867	72.99	1464	59.44	4456	89.14	3595	76.34
Amphipoda (amphipods)	7	0.10	57	2.31	4	0.07	23	0.48
Chironomidae (midges)	1634	24.51	865	35.13	425	8.50	975	20.70
Odonata (dragon flies)	0	0.00	4	0.14	0	0.00	1	0.02
Psychodidae (filter flies)	0	0.00	0	0.00	0	0.00	0	0.00
Gastropoda (snails)	7	0.10	0	0.00	0	0.00	2	0.05
Pelecypoda (clams)	99	1.48	70	2.84	102	2.03	90	1.91
Total	6669	100.00	2464	100.00	5000	100.00	4710	100.00
Little Calumet River								
Hirudinea (leeches)	4	0.00	0	0.00	0	0.00	1	0.00
Oligochaeta (worms)	104485	99.66	44315	93.11	47952	82.50	65584	93.44
Amphipoda (amphipods)	0	0.00	0	0.00	0	0.00	0	0.00
Chironomidae (midges)	73	0.07	1278	2.69	601	1.03	651	0.93
Odonata (dragon flies)	0	0.00	0	0.00	32	0.06	11	0.02
Psychodidae (filter flies)	0	0.00	0	0.00	0	0.00	0	0.00
Gastropoda (snails)	0	0.00	0	0.00	0	0.00	0	0.00
Pelecypoda (clams)	288	0.27	1998	4.20	9538	16.41	3941	5.61
Total	104850	100.00	47591	100.00	58123	100.00	70188	100.00

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 9 (Continued)

NUMBER OF BENTHIC INVERTEBRATES PER SQUARE METER (N/m^2) AND PERCENTAGE COMPOSITION (%) OF EACH TAXONOMIC GROUP IN EACH WATERWAY IN THE CALUMET RIVER SYSTEM DURING 1988

Waterway and Taxonomic Group	Spring		Summer		Fall		Annual Mean	
	N/m^2	%	N/m^2	%	N/m^2	%	N/m^2	%
Cal-Sag Channel								
Hirudinea (leeches)	0	0.00	0	0.00	0	0.00	0	0.00
Oligochaeta (worms)	166672	100.00	55909	97.23	99663	98.78	107415	99.13
Amphipoda (amphipods)	0	0.00	0	0.00	0	0.00	0	0.00
Chironomidae (midges)	2	0.00	1571	2.73	1011	1.00	861	0.79
Odonata (dragon flies)	0	0.00	0	0.00	0	0.00	0	0.00
Psychodidae (filter flies)	0	0.00	0	0.00	4	0.00	1	0.00
Gastropoda (snails)	0	0.00	0	0.00	0	0.00	0	0.00
Pelecypoda (clams)	0	0.00	21	0.04	219	0.22	80	0.08
Total	166674	100.00	57501	100.00	100897	100.00	108357	100.00

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 10

NUMBER OF BENTHIC INVERTEBRATES PER SQUARE METER (N/m^2) AND PERCENTAGE COMPOSITION (%) OF EACH TAXONOMIC GROUP AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Sample Location, Waterway and Taxonomic Group	Spring		Summer		Fall		Annual Mean	
	N/m^2	%	N/m^2	%	N/m^2	%	N/m^2	%
100th Street Calumet River								
Hirudinea (leeches)	7	0.1	0	0.0	7	0.1	5	0.1
Oligochaeta (worms)	7010	88.4	1584	91.6	5422	94.8	4672	91.1
Amphipoda (amphipods)	7	0.1	0	0.0	7	0.1	5	0.1
Chironomidae (midges)	779	9.8	108	6.2	197	3.4	361	7.0
Odonata (dragon flies)	0	0.0	0	0.0	0	0.0	0	0.0
Psychodidae (filter flies)	0	0.0	0	0.0	0	0.0	0	0.0
Gastropoda (snails)	13	0.2	0	0.0	0	0.0	4	0.1
Pelecypoda (clams)	114	1.4	38	2.2	89	1.6	80	1.6
Total	7930	100.0	1730	100.0	5722	100.0	5127	100.0
130th Street Calumet River								
Hirudinea (leeches)	102	1.9	7	0.2	19	0.4	43	1.0
Oligochaeta (worms)	2723	50.4	1343	42.0	3490	81.6	2519	58.7
Amphipoda (amphipods)	7	0.1	114	3.6	0	0.0	40	0.9
Chironomidae (midges)	2489	46.1	1622	50.8	653	15.3	1588	37.0
Odonata (dragon flies)	0	0.0	7	0.2	0	0.0	2	0.1
Psychodidae (filter flies)	0	0.0	0	0.0	0	0.0	0	0.0
Gastropoda (snails)	0	0.0	0	0.0	0	0.0	0	0.0
Pelecypoda (clams)	83	1.5	102	3.2	114	2.7	100	2.3
Total	5404	100.0	3195	100.0	4276	100.0	4292	100.0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 10 (Continued)

NUMBER OF BENTHIC INVERTEBRATES PER SQUARE METER (N/m^2) AND PERCENTAGE COMPOSITION (%) OF EACH TAXONOMIC GROUP AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Sample Location, Waterway and Taxonomic Group	Spring		Summer		Fall		Annual Mean	
	N/m^2	%	N/m^2	%	N/m^2	%	N/m^2	%
Indiana Avenue, Little Calumet River								
Hirudinea (leeches)	7	0.4	0	0.0	0	0.0	2	0.0
Oligochaeta (worms)	1096	60.0	7290	54.7	8326	29.3	5571	38.4
Amphipoda (amphipods)	0	0.0	0	0.0	0	0.0	0	0.0
Chironomidae (midges)	146	8.0	2033	15.3	993	3.5	1057	7.3
Odonata (dragon flies)	0	0.0	0	0.0	0	0.0	0	0.0
Psychodidae (filter flies)	0	0.0	0	0.0	0	0.0	0	0.0
Gastropoda (snails)	0	0.0	0	0.0	0	0.0	0	0.0
Pelecypoda (clams)	576	31.6	3996	30.0	19075	67.2	7882	54.3
Total	1825	100.0	13319	100.0	28394	100.0	14512	100.0
Halsted Street, Little Calumet River								
Hirudinea (leeches)	0	0.0	0	0.0	0	0.0	0	0.0
Oligochaeta (worms)	207873	100.0	81339	99.4	87578	99.7	125597	99.8
Amphipoda (amphipods)	0	0.0	0	0.0	0	0.0	0	0.0
Chironomidae (midges)	0	0.0	523	0.6	209	0.2	244	0.2
Odonata (dragon flies)	0	0.0	0	0.0	64	0.1	21	0.0
Psychodidae (filter flies)	0	0.0	0	0.0	0	0.0	0	0.0
Gastropoda (snails)	0	0.0	0	0.0	0	0.0	0	0.0
Pelecypoda (clams)	0	0.0	0	0.0	0	0.0	0	0.0
Total	207873	100.0	81862	100.0	87851	100.0	125862	100.0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 10 (Continued)

NUMBER OF BENTHIC INVERTEBRATES PER SQUARE METER (N/m^2) AND PERCENTAGE COMPOSITION (%) OF EACH TAXONOMIC GROUP AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Sample Location, Waterway and Taxonomic Group	Spring		Summer		Fall		Annual Mean	
	N/m^2	%	N/m^2	%	N/m^2	%	N/m^2	%
Western Avenue, Cal-Sag Channel								
Hirudinea (leeches)	0	0.0	0	0.0	0	0.0	0	0.0
Oligochaeta (worms)	266760	100.0	90571	99.4	134544	99.7	163958	99.8
Amphipoda (amphipoda)	0	0.0	0	0.0	0	0.0	0	0.0
Chironomidae (midges)	0	0.0	496	0.5	448	0.3	315	0.2
Odonata (dragon flies)	0	0.0	0	0.0	0	0.0	0	0.0
Psychodidae (filter flies)	0	0.0	0	0.0	13	0.0	4	0.0
Gastropoda (snails)	0	0.0	0	0.0	0	0.0	0	0.0
Pelecypoda (clams)	0	0.0	64	0.1	0	0.0	21	0.0
Total	266760	100.0	91131	100.0	135005	100.0	164298	100.0
Southwest Highway, Cal-Sag Channel								
Hirudinea (leeches)	0	0.0	0	0.0	0	0.0	0	0.0
Oligochaeta (worms)	111537	100.0	49023	98.2	149868	98.9	103476	99.2
Amphipoda (amphipods)	0	0.0	0	0.0	0	0.0	0	0.0
Chironomidae (midges)	0	0.0	919	1.8	1672	1.1	864	0.8
Odonata (dragon flies)	0	0.0	0	0.0	0	0.0	0	0.0
Psychodidae (filter flies)	0	0.0	0	0.0	0	0.0	0	0.0
Gastropoda (snails)	0	0.0	0	0.0	0	0.0	0	0.0
Pelecypoda (clams)	0	0.0	0	0.0	7	0.0	2	0.0
Total	111537	100.0	49942	100.0	151547	100.0	104342	100.0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 10 (Continued)

NUMBER OF BENTHIC INVERTEBRATES PER SQUARE METER (N/m^2) AND PERCENTAGE COMPOSITION (%) OF EACH TAXONOMIC GROUP AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Sample Location, Waterway and Taxonomic Group	Spring		Summer		Fall		Annual Mean	
	N/m^2	%	N/m^2	%	N/m^2	%	N/m^2	%
Route 83, Cal-Sag Channel								
Hirudinea (leeches)	0	0.0	0	0.0	0	0.0	0	0.0
Oligochaeta (worms)	121720	100.0	28133	89.5	14576	90.3	54810	97.1
Amphipoda (amphipods)	0	0.0	0	0.0	0	0.0	0	0.0
Chironomidae (midges)	7	0.0	3297	10.5	912	5.7	1405	2.5
Odonata (dragon flies)	0	0.0	0	0.0	0	0.0	0	0.0
Psychodidae (filter flies)	0	0.0	0	0.0	0	0.0	0	0.0
Gastropoda (snails)	0	0.0	0	0.0	0	0.0	0	0.0
Pelecypoda (clams)	0	0.0	0	0.0	649	4.0	216	0.4
Total	121727	100.0	31430	100.0	16137	100.0	56431	100.0

5,127/m^2. The oligochaete worms were the numerically predominant benthic group during all three seasons. During the spring, summer, and fall sampling periods, the estimated mean number of organisms collected at Station 13 were 7,930, 1,730, and 5,722/m^2, respectively.

At the 130th Street Station, the most abundant invertebrate groups were the oligochaete worms (58.7%), and chironomid midges (37.0%). The remaining 4.3% of the benthic fauna was composed of fingernail clams, leeches, amphipods, and a unidentified odonate insect. The estimated mean abundance of benthic invertebrates at Station 14 was 4,292/m^2. The benthic community was quite different during the spring and summer of 1988 than in the fall (Table 10). During the spring and summer, oligochaete worms and chironomid midges accounted for most of the fauna. In the spring the worms and midges were 50.4% and 46.1%, and in the summer 42.0% and 50.8%, respectively. In the fall, the worms and midges comprised 81.6% and 15.3%, respectively, of the benthos. The estimated mean density of invertebrates was similar at Station 14 during the spring, summer, and fall seasons; 5,404/m^2, 3,195/m^2, and 4,276/m^2, respectively.

LITTLE CALUMET RIVER

The most abundant benthic invertebrate groups during the 1988 survey in the Little Calumet River were the oligochaete worms (93.4%), fingernail clams (5.6%) and chironomid midges

(0.9%) as shown in Table 9. Estimated mean invertebrate abundance was 70,187/m^2. The estimated mean number of benthic organisms during the spring, summer, and fall of 1988 was 104,849/m^2, 47,591/m^2, and 58,123/m^2, respectively.

Detailed sample statistics for each Little Calumet River sample are listed in Appendix Tables AII-3 and AII-4.

Overall, the benthic community at the Indiana Avenue Station was composed of fingernail clams (54.3%), oligochaete worms (38.4%), and chironomid midges (7.3%). In 1988, the estimated mean density was 14,512/m^2. The percent composition of benthic invertebrate groups varied from one season to another (Table 10). During the spring, oligochaetes were the predominate benthic organisms (60.1%) followed by the fingernail clams (31.6%). In the fall, the clams accounted for 67.2% of the benthos, and the aquatic worms 29.3%. The estimated mean density varied considerably during the spring, summer, and fall of 1988 at 1,825/m^2, 13,319/m^2, and 28,394/m^2, respectively.

At the Halsted Street Station, the benthos was dominated numerically by the oligochaete worms (99.8%). The only other benthic organisms collected at this sampling station were chironomid midges, accounting for only 0.2% of the population. The estimated mean abundance of invertebrates was 125,824/m^2. Overall, the worms were the predominant benthic group during all three sampling seasons (Table 10). The estimated mean

numbers of invertebrates collected at Halsted Street in April, August, and November 1988 were 207,873/m^2, 81,862/m^2, 87,851/m^2, respectively.

CAL-SAG CHANNEL

The benthic invertebrate community collected and identified during 1988 from the Cal-Sag Channel was composed of oligochaete worms (99.1%), chironomid midges (0.8%), and fingernail clams (0.1%), as shown in Table 9. Overall, the estimated mean faunal density for the six sampling sites was 108,357/m^2. The estimated mean abundance of invertebrates was higher during the spring (166,675/m^2) and fall seasons (100,896/m^2), than in the summer (57,501/m^2).

Detailed sample statistics for each Cal-Sag Channel sample are listed in Appendix Tables AII-5 to AII-7.

Oligochaete worms accounted for 99.8% of the benthic invertebrate community at the Western Avenue Station. The remaining 0.2% of the benthos were chironomid midges and fingernail clams. Estimated mean invertebrate abundance was 164,298/m^2. As shown in Table 10 the worms were the predominate benthic group collected at Western Avenue in the Cal-Sag Channel during all three sampling periods. The estimated mean density varied considerably during April, August, and November 1988 at 266,760/m^2, 91,131/m^2, and 135,005/m^2, respectively.

The most abundant benthic invertebrates collected at the Southwest Highway Station were the oligochaete worms (99.2%). Chironomid midges and fingernail clams accounted for the rest of the benthos. The estimated mean density at the Southwest Highway Station in the Cal-Sag Channel was 104,342/m^2. Overall, the benthic community was dominated by the worms, comprising 99.2% of the fauna during all three seasons (Table 10). During the spring, summer, and fall of 1988, the estimated mean abundances of benthic invertebrates were 111,537/m^2, 49,942/m^2, and 151,547/m^2, respectively.

At the Route 83 Station, the oligochaete worms were the dominant benthic group during the 1988 survey (97.1%). The remaining 2.9% of the bottom fauna was composed of chironomid midges and fingernail clams. The estimated mean number of invertebrates at the Route 83 Station in the Cal-Sag Channel was 56,431/m^2. Worms predominated at all times during 1988 (Table 10). The estimated mean density was highest in the spring (121,727/m^2), and lowest during the summer (31,430/m^2) and fall (16,137/m^2) seasons.

Fish

CALUMET RIVER

A total of 2,840 fish composed of 24 species were collected during 8 electrofishing samples from the Calumet River during 1988, as shown in Table 11. Total weight of the

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 11

NUMBER (N) AND PERCENTAGE COMPOSITION (%) OF THE ANNUAL CATCH OF FISH FROM THE CALUMET RIVER DURING 1988

Fish Species	Sample Station: 130th Street N	130th Street %	Sample Station: O'Brien Dam N	O'Brien Dam %	Combined Total N	Combined Total %
Forage Fish						
Alewife	0	0.00	7	0.49	7	0.25
Gizzard shad	506	35.84	798	55.88	1304	45.92
Central stoneroller	0	0.00	1	0.07	1	0.04
Golden shiner	0	0.00	4	0.28	4	0.14
Emerald shiner	18	1.27	88	6.16	106	3.73
Spottail shiner	0	0.00	2	0.14	2	0.07
Bluntnose minnow	555	39.31	191	13.38	746	26.27
Fathead minnow	1	0.07	2	0.14	3	0.11
Total Forage Fish	1080	76.49	1093	76.54	2173	76.53
Game Fish						
Rainbow trout	0	0.00	1	0.07	1	0.04
Chinook salmon	0	0.00	1	0.07	1	0.04
Grass pickerel	1	0.07	0	0.00	1	0.04
White sucker	2	0.14	0	0.00	2	0.07
Channel catfish	0	0.00	1	0.07	1	0.04
White perch	20	1.42	26	1.82	46	1.62
Green sunfish	36	2.55	44	3.08	80	2.82
Pumpkinseed sunfish	27	1.91	55	3.85	82	2.89
Orangespotted sunfish	18	1.27	27	1.89	45	1.58
Bluegill	30	2.12	31	2.17	61	2.15
Largemouth bass	85	6.02	23	1.61	108	3.80
Black crappie	0	0.00	1	0.07	1	0.04
Hybrid sunfish	2	0.14	5	0.35	7	0.25
Yellow perch	62	4.39	32	2.24	94	3.31
Total Game Fish	283	20.03	247	17.29	530	18.69

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 11 (Continued)

NUMBER (N) AND PERCENTAGE COMPOSITION (%) OF THE ANNUAL CATCH OF FISH FROM THE CALUMET RIVER DURING 1988

Fish Species	Sample Station: 130th Street N	130th Street %	Sample Station: O'Brien Dam N	O'Brien Dam %	Combined Total N	Combined Total %
Rough Fish						
Goldfish	4	0.28	4	0.28	8	0.28
Carp	45	3.19	83	5.81	128	4.51
Freshwater drum	0	0.00	1	0.07	1	0.04
Total Rough Fish	49	3.47	88	6.16	137	4.83
Grand Total Fish	1412	100.00	1428	100.00	2840	100.00
Number of Species	15		22		24	

Calumet River catch was 317.8 kilograms (698 pounds). Forage fish species made up 77% of the catch, primarily gizzard shad, bluntnose minnows and emerald shiners. Game fish made up 19% of the catch, primarily largemouth bass and other sunfish, yellow perch, and white perch. Rough fish, mostly carp, made up 5% of the catch.

At the 130th Street Station, a total of 1,412 fish composed of 15 species were collected. The catch was composed of 76% forage fish species, 20% game fish, and 3% rough fish. At the station immediately downstream of the O'Brien Lock and Dam, a total of 1,428 fish composed of 22 species were collected. The catch was composed of 77% forage fish species, 17% game fish species, and 6% rough fish species.

The number of fish species per sample ranged from 10 to 13 at 130th Street and from 9 to 16 at the O'Brien Lock and Dam, as shown in Figure 3. The CPUE ranged from 120 to 410 fish (average of 246 fish) at 130th Street and from 133 to 591 fish (average of 340 fish) at the O'Brien Lock and Dam, as shown in Figure 4.

Detailed catch statistics for each sample collected from the Calumet River are listed in Appendix Tables AIII-1 and AIII-2.

The IBI was calculated for each sample at 130th Street and at the O'Brien Lock and Dam. These indices are shown in Figure 5. The range of IBI for the Calumet River was 26 to 36, with an average IBI for each station of 32, indicating that

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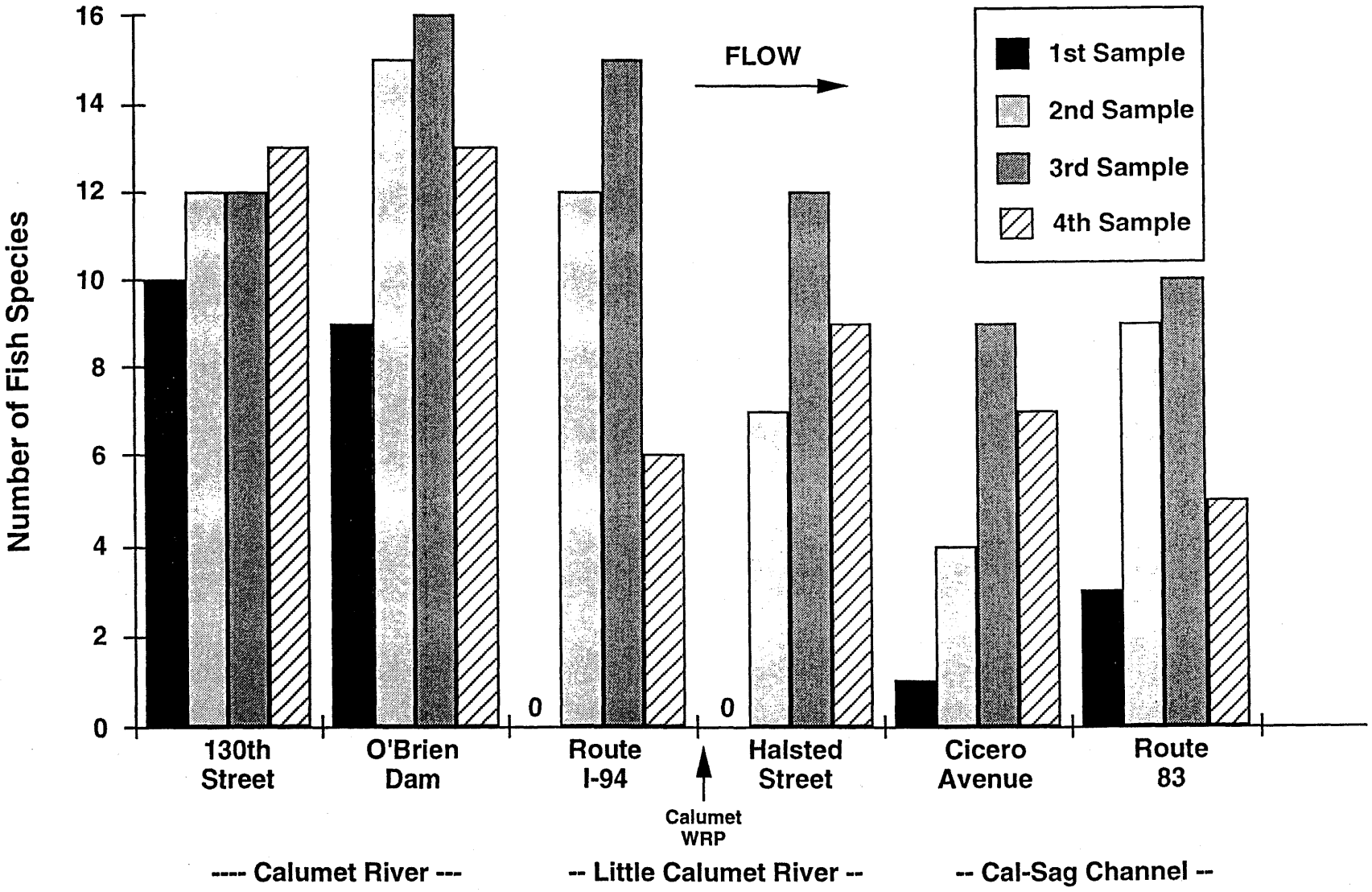
FIGURE 3

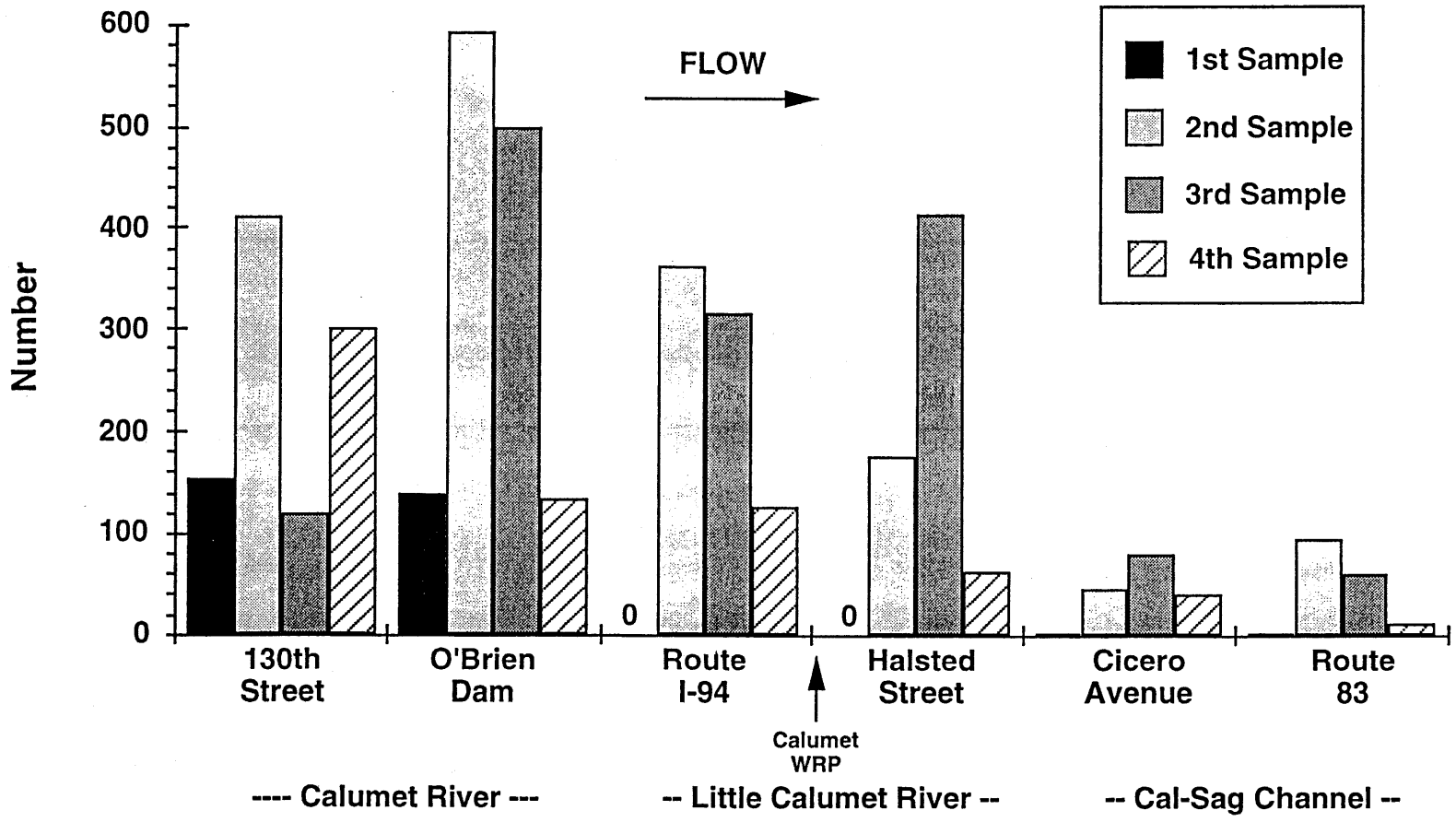
NUMBER OF FISH SPECIES COLLECTED PER SAMPLE FROM THE CALUMET RIVER, LITTLE CALUMET RIVER, AND CAL-SAG CHANNEL DURING 1988



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 4

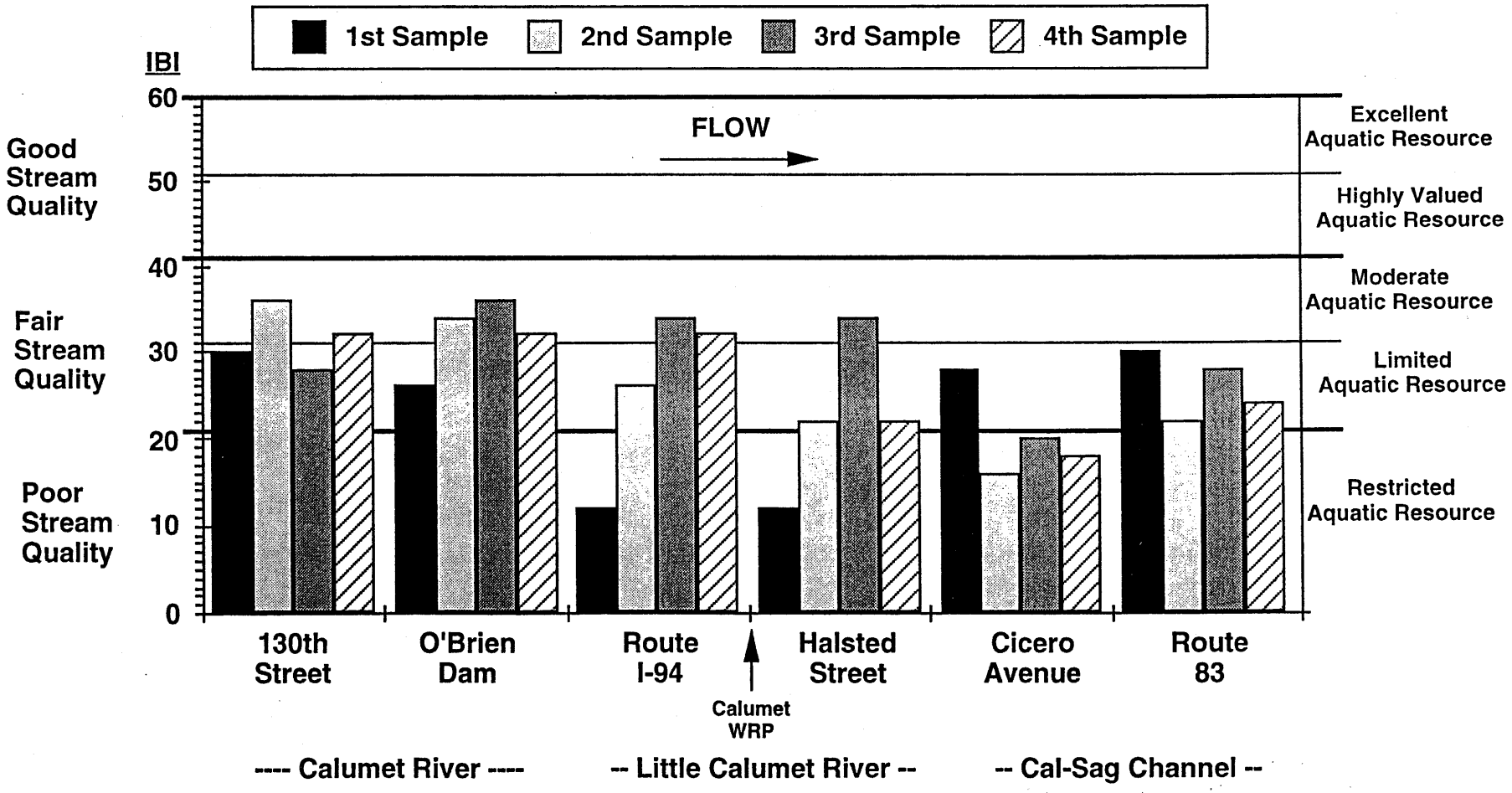
NUMBER OF FISH COLLECTED PER 30 MINUTES ELECTROFISHING FROM THE CALUMET RIVER, LITTLE CALUMET RIVER, AND CAL-SAG CHANNEL DURING 1988



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 5

INDEX OF BIOTIC INTEGRITY (IBI) FOR FISH COLLECTIONS FROM THE CALUMET RIVER, LITTLE CALUMET RIVER, AND CAL-SAG CHANNEL DURING 1988



this portion of the Calumet River was a moderate aquatic resource with fair stream quality for fish. Metrics used in the calculation of the IBI for each fish sample at 130th Street and at the O'Brien Lock and Dam in the Calumet River during 1988 are listed in Appendix Tables AIII-7 and AIII-8.

The BTI was calculated from the results of the chemical analysis of each water sample collected at the time of fish collections at 130th Street, and at the O'Brien Lock and Dam. These indices are shown in Figure 6. The BTI at 130th Street was less than 0.1 BGTU, indicating good water quality. The BTI at the O'Brien Lock and Dam ranged from <0.1 to 0.4 BGTU, with an average of 0.1 BGTU, indicating generally good water quality, with a potential for some exposure to degraded water quality.

Water quality constituents and BTIs for each sample collected at 130th Street and at the O'Brien Lock and Dam in the Calumet River during 1988 are listed in Appendix Tables AIII-13 and AIII-14.

LITTLE CALUMET RIVER

A total of 2,209 fish composed of 19 species were collected during 8 electrofishing samples from the Little Calumet River during 1988, as shown in Table 12. Total weight of the Little Calumet River catch was 160.9 kilograms (355 pounds). Forage fish species made up 59% of the catch, primarily gizzard shad and emerald shiners. Game fish made up 8% of the

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 6

BLUEGILL TOXICITY INDEX (BTI) FOR FISH COLLECTIONS FROM THE CALUMET RIVER, LITTLE CALUMET RIVER, AND CAL-SAG CHANNEL DURING 1988

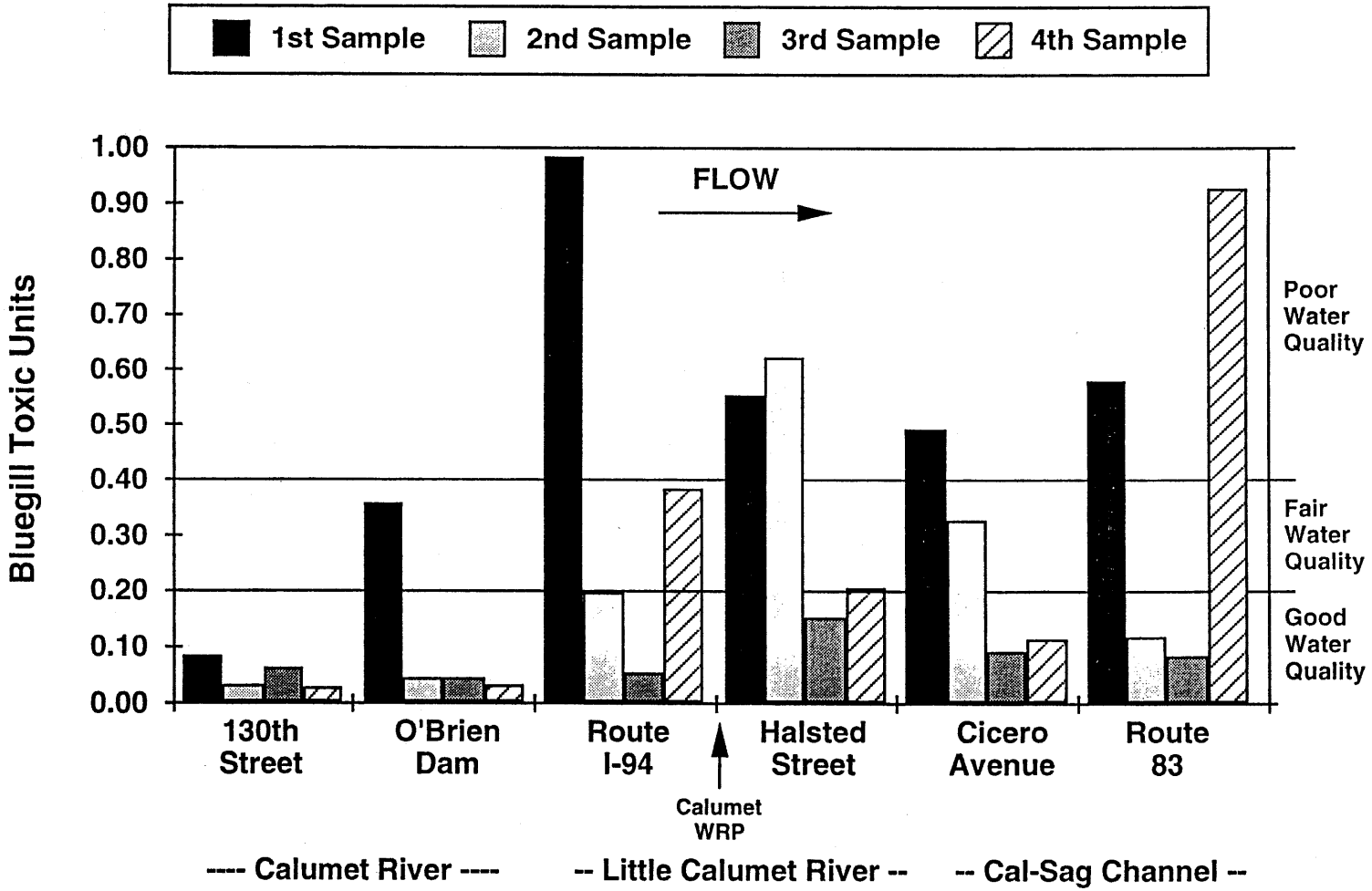


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TABLE 12

NUMBER (N) AND PERCENTAGE COMPOSITION (%) OF THE ANNUAL CATCH OF FISH FROM THE LITTLE CALUMET RIVER DURING 1988

Fish Species	Sample Station: Route I-94 N	Route I-94 %	Halsted Street N	Halsted Street %	Combined Total N	Combined Total %
Forage Fish						
Alewife	7	0.73	3	0.24	10	0.45
Gizzard shad	370	38.38	240	19.28	610	27.61
Golden shiner	2	0.21	31	2.49	33	1.49
Emerald shiner	167	17.32	440	35.34	607	27.48
Spottail shiner	8	0.83	0	0.00	8	0.36
Bluntnose minnow	8	0.83	4	0.32	12	0.54
Fathead minnow	3	0.31	19	1.53	22	1.00
Total Forage Fish	565	58.61	737	59.20	1302	58.93
Game Fish						
Chinook salmon	0	0.00	1	0.08	1	0.05
Black bullhead	1	0.10	0	0.00	1	0.05
White perch	71	7.37	9	0.72	80	3.62
Green sunfish	0	0.00	10	0.80	10	0.45
Pumpkinseed sunfish	19	1.97	2	0.16	21	0.95
Orangespotted sunfish	12	1.24	1	0.08	13	0.59
Bluegill	18	1.87	12	0.96	30	1.36
Largemouth bass	7	0.73	1	0.08	8	0.36
Black crappie	1	0.10	0	0.00	1	0.05
Yellow perch	10	1.04	2	0.16	12	0.54
Total Game Fish	139	14.42	38	3.04	177	8.02
Rough Fish						
Goldfish	202	20.95	327	26.27	529	23.95
Carp	52	5.39	134	10.76	186	8.42
Carp x goldfish hybrid	6	0.62	9	0.72	15	0.68
Total Rough Fish	260	26.96	470	37.75	730	33.05
Grand Total Fish	964	100.00	1245	100.00	2209	100.00
Number of Species	17		16		19	

catch, primarily white perch and sunfish species. Rough fish, mostly goldfish and carp, made up 33% of the catch.

At the Route I-94 Station, a total of 964 fish composed of 17 species were collected. The catch was composed of 59% forage fish species, 14% game fish, and 27% rough fish. At the Halsted Street Station, a total of 1,245 fish composed of 16 species were collected. The catch was composed of 59% forage fish, 3% game fish and 38% rough fish species.

The number of fish species per sample ranged from 0 to 15 at Route I-94 and from 0 to 12 at Halsted Street, as shown in Figure 3. The CPUE ranged from 0 to 362 fish (average of 201 fish) at Route I-94 and from 0 to 412 fish (average of 163 fish) at Halsted Street, as shown in Figure 4.

Detailed catch statistics for each sample from the Little Calumet River are listed in Appendix Tables AIII-3 and AIII-4.

The IBI was calculated for each sample at Route I-94 and at Halsted Street. These indices are shown in Figure 5. The range of IBI for the Little Calumet River was 12 to 34, with an average IBI of 26 at Route I-94 and an average IBI of 23 at Halsted Street, indicating that this portion of the Little Calumet River was a limited aquatic resource with generally fair stream quality for fish. Metrics used in the calculation of the IBI for each fish sample at Route I-94 and at Halsted Street in the Little Calumet River during 1988 are listed in Appendix Tables AIII-9 and AIII-10.

The BTI was calculated from the results of the chemical analysis of each water sample collected at the time of fish collections at Route I-94 and at Halsted Street. These indices are shown in Figure 6. The BTI at Route I-94 ranged from <0.1 BGTU to approximately 1.0 BGTU, with an average of 0.4 BGTU, indicating poor water quality. The BTI at Halsted Street ranged from 0.2 to 0.6, with an average of 0.4, indicating generally poor water quality, with a potential for some exposure to acutely toxic water. For example, no fish were collected while boat electrofishing from either location on the Little Calumet River during May 1988 at the time of a reported fish kill in this area.

Water quality constituents and BTIs for each sample collected at Route I-94 and at Halsted Street in the Little Calumet River during 1988 are listed in Appendix Tables AIII-15 and AIII-16.

CAL-SAG CHANNEL

A total of 462 fish composed of 16 species were collected during 8 electrofishing samples from the Cal-Sag Channel during 1988, as shown in Table 13. Total weight of the Little Calumet River catch was 51.0 kilograms (113 pounds). Forage fish species made up 51% of the catch, primarily gizzard shad. Game fish made up 9% of the catch, primarily green sunfish. Rough fish, mostly carp and goldfish, made up 40% of the catch.

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TABLE 13

NUMBER (N) AND PERCENTAGE COMPOSITION (%) OF THE ANNUAL CATCH OF FISH FROM THE CAL-SAG CHANNEL DURING 1988

Fish Species	Sample Station				Combined Total	
	Cicero Avenue		Route 83			
	N	%	N	%	N	%
Forage Fish						
Gizzard shad	107	49.08	100	40.98	207	44.81
Golden shiner	1	0.46	4	1.64	5	1.08
Emerald shiner	12	5.50	3	1.23	15	3.25
Bluntnose minnow	3	1.38	1	0.41	4	0.87
Fathead minnow	0	0.00	3	1.23	3	0.65
Creek chub	1	0.46	0	0.00	1	0.22
Total Forage Fish	124	56.88	111	45.49	235	50.88
Game Fish						
Black bullhead	3	1.38	0	0.00	3	0.65
Green sunfish	4	1.83	19	7.79	23	4.98
Pumpkinseed sunfish	0	0.00	1	0.41	1	0.22
Bluegill	1	0.46	4	1.64	5	1.08
Largemouth bass	0	0.00	5	2.05	5	1.08
White crappie	1	0.46	0	0.00	1	0.22
Black crappie	0	0.00	1	0.41	1	0.22
Hybrid sunfish	1	0.46	0	0.00	1	0.22
Yellow perch	0	0.00	2	0.82	2	0.43
Total Game Fish	10	4.59	32	13.12	42	9.10
Rough Fish						
Goldfish	22	10.09	18	7.38	40	8.66
Carp	59	27.06	76	31.15	135	29.22
Carp x goldfish hybrid	3	1.38	7	2.87	10	2.16
Total Rough Fish	84	38.53	101	41.40	185	40.04
Grand Total Fish	218	100.00	244	100.00	462	100.00
Number of Species	11		13		16	

At the Cicero Avenue Station, a total of 218 fish composed of 11 species were collected. The catch was composed of 57% forage fish species, 5% game fish, and 39% rough fish. At the Route 83 Station, a total of 244 fish composed of 13 species were collected. The catch was composed of 45% forage fish, 13% game fish, and 41% rough fish species.

The number of fish species per sample ranged from 1 to 9 at Cicero Avenue and from 3 to 10 at Route 83, as shown in Figure 3. The CPUE ranged from 1 to 80 fish (average of 42 fish) at Cicero Avenue and from 2 to 96 fish (average of 42 fish) at Route 83, as shown in Figure 4.

Detailed catch statistics for each sample are listed in Appendix Tables AIII-5 and AIII-6.

The IBI was calculated for each sample collected at Cicero Avenue and at Route 83. These indices are shown in Figure 5. The range of IBI for the Cal-Sag Channel was 16 to 30, with an average IBI of 21 at Cicero Avenue and 27 at Route 83, indicating that this portion of the Cal-Sag Channel was a limited aquatic resource with generally fair stream quality for fish. Metrics used in the calculation of the IBI for each fish sample at Cicero Avenue and at Route 83 in the Cal-Sag Channel during 1988 are listed in Appendix Tables AIII-11 and AIII-12.

The BTI was calculated from the results of the chemical analysis of each water sample collected at the time of fish collections at Cicero Avenue and at Route 83. These indices

are shown in Figure 6. The BTI at Cicero Avenue ranged from 0.1 to 0.5, with an average of 0.3 BGTUs, indicating generally fair water quality, with a potential for some exposure to stressful toxicity. The BTI at Route 83 ranged from 0.1 to 0.9, with an average of 0.4 BGTUs, indicating generally poor water quality, with a potential for some exposure to stressful toxicity.

Water quality constituents and BTIs for each sample collected at Route I-94 and at Halsted Street in the Little Calumet River during 1988 are listed in Appendix Tables AIII-17 and AIII-18.

Periphyton

CALUMET RIVER

The average diatom populations in the Calumet River System during 1988 (Table 14) were lowest at the O'Brien Lock and Dam at 94,000 organisms/cm^2. The average and total number of diatom species, 29 and 127 species, respectively, at Ewing Avenue were higher than at any other station in the Calumet River System (i.e., Calumet River, Little Calumet River, and Cal-Sag Channel).

The average periphyton populations (Table 15) in the Calumet River System were lowest at Ewing Avenue at 1.4 million organisms/cm^2. The average number of periphyton species of 35 at Ewing Avenue, and the total periphyton species of 171

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TABLE 14

DIATOMS AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Waterway and Sample Location	Number of Samples	Average Number (Thousands Per cm^2)	Number of Species	
			Average	Total
Calumet River				
Ewing Avenue	13	99	29	123
O'Brien Lock and Dam	14	94	28	127
Little Calumet River				
Indiana Avenue	15	236	21	93
Halsted Street	13	470	20	73
Cal-Sag Channel				
Ashland Avenue	14	728	20	76
Route 83	12	990	18	62

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TABLE 15

PERIPHYTON AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Waterway and Sample Location	Number of Samples	Average Number (Millions Per cm^2)	Number of Species	
			Average	Total
Calumet River				
Ewing Avenue	13	1.4	35	158
O'Brien Lock and Dam	14	2.0	33	171
Little Calumet River				
Indiana Avenue	15	4.9	29	144
Halsted Street	13	5.5	30	130
Cal-Sag Channel				
Ashland Avenue	13	6.4	28	127
Route 83	10	5.6	24	98

at the O'Brien Lock and Dam, were greater than at any other station in the Calumet River System.

LITTLE CALUMET RIVER

The total periphyton and diatom numbers in the Little Calumet River were about three and four times higher, respectively, than in the Calumet River (Tables 14 and 15).

CAL-SAG CHANNEL

The total periphyton and diatom numbers in the Cal-Sag Channel were four and nine times higher, respectively, than in the Calumet River, indicating nutrient enrichment (Table 14). The average and total number of diatom species, were lowest at Route 83 (18 and 62 species, respectively) than at any other station in the Calumet River System.

The average total periphyton populations (Table 15) in the Calumet River System were highest at Ashland Avenue with 6.4 million organisms/cm^2. The average (24 species) and total number (98 species) of periphyton species were lowest at Route 83 than at any other station in the Calumet River System.

DISCUSSION

Bacteria

CALUMET RIVER

The Calumet River is a General Use Waterway and must meet the General Use Water Quality Standards for the state of Illinois for FC. All of the samples taken from the Ewing Avenue and 130th Street Stations on the Calumet River for bacterial analysis during 1988 were less than the General Use Water Quality Standard of 400 FC/100 mL. Thus, 100% of the samples taken for this study were in compliance with the General Use Water Quality Standard of the state of Illinois.

LITTLE CALUMET RIVER

The Little Calumet River is a designated Secondary Contact water and is not required to meet the General Use Water Quality Standards or the Public and Food Processing Water Supply Standards of the state of Illinois. The District's Calumet WRP, a conventional activated sludge Publicly Owned Treatment Works, is authorized by the U. S. Environmental Protection Agency to discharge its unchlorinated final effluent to the Little Calumet River, as specified in its National Pollutant Discharge Elimination System (NPDES) permit.

During 1988, an increase in the densities of TC, FC, EC, and heterotrophic bacteria upstream of the Calumet WRP at Indiana Avenue suggested a discharge of wastewater upstream of the Calumet WRP outfall. This wastewater might have come from

a WRP in Indiana discharging to the Grand Calumet River, which joins the Little Calumet River upstream of the discharge of the Calumet WRP, or from combined sewer overflows. As reported in the *Chicago Tribune* (July 6, 1988): "In some cases, raw sewage bypasses treatment in Hammond (Indiana) and flows into the Grand Calumet River, said Tom Williams, an environmental engineer in the U.S. Environmental Protection Agency's Chicago office. Depending on water levels, the sewage flows west to the Little Calumet River in Illinois or east into Lake Michigan."

CAL-SAG CHANNEL

The TC, FC and EC counts at the Route 83 Station, 17 miles downstream of the Calumet WRP discharge, were similar to the values upstream of the Calumet WRP, indicating that a natural bacterial reduction had occurred to this point in the Calumet River System. The reduction in bacterial densities in this waterway corroborates the conclusion of Haas et al. (1) that beyond 15 miles below a WRP discharge, treated but unchlorinated receiving water bacterial concentrations show no adverse effect upon the microbial water quality.

Benthic Invertebrates

CALUMET RIVER

As seen in Table 10, two sampling stations (100th Street and 130th Street) in the Calumet River yielded the lowest mean

abundance (5,133/m^2 and 4,265/m^2, respectively). The lower mean abundance of invertebrates indicated less organic enrichment in the Calumet River compared to the Little Calumet River and the Cal-Sag Channel. Stations at 100th Street and 130th Street in the Calumet River are approximately 1.6 and 6.5 miles, respectively, below Lake Michigan and 10.3 and 5.3 miles, respectively, above the final effluent outfall from the Calumet WRP. The area above these two sampling stations receives some dilution water from Lake Michigan, a small amount of urban and industrial storm water, and discharges from six combined sewers. The 100th Street and 130th Street Stations were established as controls with which to compare downstream stations.

There are no General Use Water Quality Standards for benthic invertebrates in the state of Illinois. The mean abundance of benthic invertebrates and the percent oligochaete worms are used by the District as estimates of the water and sediment quality as reflected by these benthic invertebrates, but these measurements are not water quality standards.

LITTLE CALUMET RIVER

The abundance of benthic invertebrates at the Indiana Avenue Station (mean of 14,033/m^2) was greater than at stations upstream in the Calumet River. The increase in the mean abundance of invertebrates indicates organic enrichment at the Indiana Avenue Station.

In Indiana, overflows from separate and combined sewers, and treated municipal and industrial effluents discharge into the Grand Calumet River, upstream of the Calumet WRP. The western portion of the Grand Calumet River flows into Illinois, eventually merging with the Calumet and Little Calumet Rivers. The Indiana Avenue Station in the Little Calumet River is approximately 3.5 miles below the junction with the Grand Calumet River. The raw sewage bypasses from Hammond, Indiana probably caused the organic enrichment of the sediment at the Indiana Avenue Station, upstream of the Calumet WRP.

A change in the percent composition of the major benthic groups (Table 10) also occurred at Indiana Avenue, in comparison with the upstream Calumet River Stations. Overall, the fingernail clams accounted for 56.2%, of the benthic fauna at Indiana Avenue, compared to 1.6% and 2.3%, respectively, upstream at the 100th Street and 130th Street Stations. Similarly, the worms had been reduced to 36.3% of the benthic community, compared with 91.1% and 59.0%, respectively, at the two upstream stations. Since fingernail clams are generally thought to be intolerant of turbidity, this suggests that the raw sewage bypasses from Hammond, Indiana were not constant, but were dependent on water levels in the Grand Calumet River.

Flow in the Little Calumet River is augmented 1.7 miles above its junction with the Cal-Sag Channel by the secondary effluent from the Calumet WRP. Also entering the system below the Calumet WRP outfall are periodic discharges from numerous

combined and separate storm sewers. The treated effluent from the Calumet WRP and the periodic overflows affected the benthic community downstream at the Halsted Street Station in the Little Calumet River. The mean number of benthic organisms collected at the Halsted Street Station increased greatly, and the benthic community at the Halsted Street Station was composed almost entirely of oligochaete worms.

CAL-SAG CHANNEL

The number of benthic organisms was highest at the Western Avenue Station and gradually decreased at the Southwest Highway and Route 83 Stations (Figure 1 and Table 10). These benthic invertebrates were made up of more than 95% pollution tolerant aquatic oligochaete worms. This indicated organic enrichment in the Cal-Sag Channel.

Fish

CALUMET RIVER

More fish (2,840 fish), fish species (24 species) and greatest percent game fish (19%) occurred in the Calumet River than in the two waterways which are downstream of it (Table 11). Based on the BTI, the chemical water quality for fish was good in the Calumet River, especially upstream of the O'Brien Lock and Dam. Based on the IBI, the Calumet River was a moderate aquatic resource with fair stream quality for fish.

There are no General Use Water Quality Standards for fish in the state of Illinois. The BTI and the IBI are used by the

District in this report as estimates of chemical water quality and stream quality for fish, respectively, but these indices are not water quality standards.

LITTLE CALUMET RIVER

Discharges of untreated sewage from Indiana by the Hammond Sanitary District were blamed for a Little Calumet River fish kill that occurred in March 1988 (*Chicago Tribune*, July 6, 1988).

In comparison with the 130th Street Station (Table 11) on the Calumet River, the number of fish, fish species, and percent game fish decreased at the Route I-94 Station (Table 12), upstream of the Calumet WRP, on the Little Calumet River, while the percent of pollution tolerant rough fish increased at the Route I-94 Station. Based on the BTI (Table 7), which is not a water quality standard, the chemical water quality at the Route I-94 Station, upstream of the Calumet WRP, was very poor. A BTI of 1.0 BGTUs indicated that fish in this portion of the river were exposed to acutely toxic water quality conditions. This toxic condition was caused by raw sewage bypasses from the Hammond, Indiana WRP entering the Grand Calumet River and flowing into the Little Calumet River.

No fish were collected during a sample at the Halsted Street Station, downstream of the Calumet WRP, in the spring of 1988, due to the deleterious impact of wastewater from the Hammond, Indiana WRP. More fish were collected at the Halsted

Street Station (Table 12) than at the upstream Route I-94 Station during 1988, though the percent game fish decreased at Halsted Street.

Based on the IBI (15, 16), which is not a water quality standard, the Little Calumet River was a limited aquatic resource with fair stream quality for fish.

CAL-SAG CHANNEL

The numbers of fish and fish species were lower in the Cal-Sag Channel (Table 13) than in the Calumet River (Table 11) or Little Calumet River (Table 12). The percent game fish was about the same as in the Little Calumet River (9% for the combined total, 5% at Cicero Avenue, and 13% at Route 83) but the percent rough fish increased to 40% in the Cal-Sag Channel. Based on the BTI (Table 7), which is not a water quality standard, the chemical water quality for fish was fair to poor. Based on the IBI (15, 16), which is not a water quality standard, the Cal-Sag Channel was a limited aquatic resource, with fair stream quality for fish.

Periphyton

CALUMET RIVER

Total numbers of both diatom and periphyton species were greatest and total numbers of diatoms and periphyton were least in the Calumet River as compared to the Little Calumet River and Cal-Sag Channel downstream, as seen in Tables 14 and 15. This indicated relatively good water quality and low

nutrient enrichment in the Calumet River as compared with the Little Calumet River and Cal-Sag Channel.

There are no General Use Water Quality Standards for periphyton in the state of Illinois. Total numbers of diatoms and periphyton, and the average and total numbers of diatom and periphyton species, are used by the District as estimates of the extent of nutrient enrichment in a waterway, but these measurements are not water quality standards.

LITTLE CALUMET RIVER

In comparison with the Calumet River Stations, average and total numbers of both diatoms and periphyton species decreased and total numbers of diatoms and periphyton increased at the Indiana Station on the Little Calumet River, upstream of the Calumet WRP, as seen in Tables 14 and 15. This indicated a degradation of water quality with nutrient enrichment, which was caused by raw sewage bypasses by the Hammond, Indiana WRP into the Grand Calumet River, which flows into the Little Calumet River.

In comparison with the Indiana Avenue Station, the periphyton values at the Halsted Street Station remained indicative of conditions of nutrient enrichment.

CAL-SAG CHANNEL

In comparison with the Little Calumet River Stations, numbers of diatom and periphyton species remained relatively low, and total numbers of diatoms and periphyton remained

relatively high, at the Ashland Avenue and Route 83 Stations in the Cal-Sag Channel, as seen in Tables 14 and 15. This indicated nutrient enrichment in the Cal-Sag Channel.

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APPENDIX AI

RESULTS OF BACTERIAL TESTING OF THE CALUMET RIVER SYSTEM DURING 1988

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-1

BACTERIAL DENSITIES[1] IN THE CALUMET RIVER SYSTEM DURING 1988

Sample Site[2]	Sample Date	TC[3]	FC[3]	EC[3]	FS[3]	ME[3]	SPC[3]	PA[3]	SAL[3]
Ewing Avenue	3/7/88	220	33	24	16	7	72	<1	<.15
	5/2/88	430	6	8	<1	2	126	<1	<.15
	8/1/88	2800	350	600	77000	2200	84000	12	<.15
	10/3/88	780	19	37	2000	1200	2100	20	0.2
130th Street	3/7/88	28000	10	28	1400	15000	1200	<2	<.15
	5/2/88	540	200	420	8100	2000	1190	<1	<.15
	8/1/88	1100	300	50	50000	410	71000	18	<0.15
Indiana Ave.	3/7/88	170000	380	740	390	270	7500	30	0.2
	5/2/88	36000	150	250	<10	10	10300	10	0.2
	8/1/88	6300	200	180	60	70	150000	<1	<0.15
	10/3/88	1100	10	20	20	30	13000	<10	<0.15
Halsted Street	3/7/88	24000	110	130	10	30	1600	10	<.15
	5/2/88	250000	4500	4100	190	180	12000	130	0.75
	8/1/88	220000	5100	6	5000	3800	120000	150	0.2
	10/3/88	760000	90000	36000	3400	2000	14000	910	4.6
Ashland Ave.	3/7/88	20000	60	280	10	50	2500	10	<.15
	5/2/88	58000	2800	4100	2000	170	400	20	2.15
	8/1/88	170000	8000	15000	9700	1600	120000	160	0.2
	10/3/88	60000	34000	31000	7200	2400	140000	470	0.75
Route 83	3/7/88	34000	<10	30	60	91	3400	10	<.15
	5/2/88	3500	30	50	<10	9	3900	<10	<.15
	8/1/88	26000	110	130	21000	1000	110000	10	0.2
	10/3/88	6000	600	470	870	700	40000	160	<0.15

[1] All Densities in Colony Forming Units Per 100 mL (cfu/100 mL) except SPC (cfu/mL) and SAL which is in Most Probable Number Per 100 mL (MPN/100 mL).

[2] Figure 1

[3] TC = Total coliform, FC = Fecal coliform, FS = Fecal streptococci, EC = *Escherichia coli*, ME = Enterococci, SPC = Standard Plate Count, PA = *Pseudomonas aeruginosa*, SAL = *Salmonella*.

APPENDIX AII

RESULTS OF BENTHIC INVERTEBRATE SAMPLING OF THE CALUMET RIVER SYSTEM DURING 1988

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-1

NUMBER OF BENTHIC INVERTEBRATES IN THE CALUMET RIVER AT 100th STREET DURING 1988[1]

Taxonomic Group	Season	Bank	Number of Benthic Organisms Per Square Meter: Grab Sample 1	Grab Sample 2	Grab Sample 3	Mean
Annelida Oligochaeta (worms)	Spring	Right	1330	414	0	581
		Center	18088	15884	6346	13439
	Summer	Right	2394	2014	3458	2622
		Center	228	1292	114	545
	Fall	Right	76	570	266	304
		Center	7334	12540	11742	10539
Annelida Hirudinea (leeches)	Spring	Right	0	0	0	0
		Center	0	38	0	13
	Summer	Right	0	0	0	0
		Center	0	0	0	0
	Fall	Right	0	0	0	0
		Center	0	38	0	13
Crustacea Amphipoda	Spring	Right	0	0	0	0
		Center	0	38	0	13
	Summer	Right	0	0	0	0
		Center	0	0	0	0
	Fall	Right	38	0	0	13
		Center	0	0	0	0
Insecta Diptera Chironomidae (midges)	Spring	Right	0	0	0	0
		Center	2356	494	1824	1558
	Summer	Right	38	152	76	89
		Center	76	266	38	127
	Fall	Right	0	0	0	0
		Center	646	418	114	393

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-1 (Continued)

NUMBER OF BENTHIC INVERTEBRATES IN THE CALUMET RIVER AT 100th STREET DURING 1988[1]

Taxonomic Group	Season	Bank	Number of Benthic Organisms Per Square Meter: Grab Sample 1	Grab Sample 2	Grab Sample 3	Mean
Mollusca Gastropoda (snails)	Spring	Right	0	0	0	0
		Center	0	76	0	25
	Summer	Right	0	0	0	0
		Center	0	0	0	0
	Fall	Right	0	0	0	0
		Center	0	0	0	0
Mollusca Pelecypoda (clams)	Spring	Right	0	0	0	0
		Center	380	152	152	228
	Summer	Right	190	0	0	63
		Center	0	38	0	13
	Fall	Right	0	0	0	0
		Center	38	0	494	177

[1]Facing upstream in the waterway.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-2

NUMBER OF BENTHIC INVERTEBRATES IN THE CALUMET RIVER AT 130th STREET DURING 1988[1]

Taxonomic Group	Season	Bank	Number of Benthic Organisms Per Square Meter — Grab Sample 1	Grab Sample 2	Grab Sample 3	Mean
Annelida Oligochaeta (worms)	Spring	Right	4864	1748	5434	4015
		Center	1178	380	2736	1431
	Summer	Right	3306	2166	1292	2255
		Center	608	684	0	431
	Fall	Right	4788	3686	836	3103
		Center	5168	2432	4028	3876
Annelida Hirudinea (leeches)	Spring	Right	0	0	608	203
		Center	0	0	0	0
	Summer	Right	0	0	0	0
		Center	0	38	0	13
	Fall	Right	0	0	0	0
		Center	0	38	76	38
Crustacea Amphipoda	Spring	Right	38	0	0	13
		Center	0	0	0	0
	Summer	Right	38	380	228	215
		Center	38	0	0	13
	Fall	Right	0	0	0	0
		Center	0	0	0	0
Insecta Diptera Odonata (dragon flies)	Spring	Right	0	0	0	0
		Center	0	0	0	0
	Summer	Right	0	38	0	13
		Center	0	0	0	0
	Fall	Right	0	0	0	0
		Center	0	0	0	0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-2 (Continued)

NUMBER OF BENTHIC INVERTEBRATES IN THE CALUMET RIVER AT 130th STREET DURING 1988[1]

Taxonomic Group	Season	Bank	Number of Benthic Organisms Per Square Meter: Grab Sample 1	Grab Sample 2	Grab Sample 3	Mean
Insecta Diptera Chironomidae (midges)	Spring	Right	2736	7486	1482	3901
		Center	114	114	3002	1077
	Summer	Right	2280	4408	3040	3243
		Center	0	0	0	0
	Fall	Right	1672	456	1178	1102
		Center	266	228	114	203
Mollusca Pelecypoda (clams)	Spring	Right	114	114	0	76
		Center	228	0	38	89
	Summer	Right	304	38	0	114
		Center	76	190	0	89
	Fall	Right	152	342	152	215
		Center	38	0	0	13

[1]Facing upstream in the waterway.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-3

NUMBER OF BENTHIC INVERTEBRATES IN THE CALUMET RIVER AT INDIANA AVENUE DURING 1988[1]

Taxonomic Group	Season	Bank	Number of Benthic Organisms Per Square Meter: Grab Sample 1	Grab Sample 2	Grab Sample 3	Mean
Annelida Oligochaeta (worms)	Spring	Right	494	608	570	557
		Center	1748	1064	2090	1634
	Summer	Right	7638	9576	5624	7613
		Center	3990	1102	15808	6967
	Fall	Right	7486	2470	1520	3825
		Center	506	17261	20710	12826
Annelida Hirudinea (leeches)	Spring	Right	0	0	0	0
		Center	38	0	0	13
	Summer	Right	0	0	0	0
		Center	0	0	0	0
	Fall	Right	0	0	0	0
		Center	0	0	0	0
Insecta Diptera Chironomidae (midges)	Spring	Right	190	76	38	101
		Center	304	38	228	190
	Summer	Right	1976	1786	2394	2052
		Center	2546	1064	2432	2014
	Fall	Right	1330	266	1444	1013
		Center	380	1206	1330	972
Mollusca Pelecypoda (clams)	Spring	Right	494	760	874	709
		Center	456	874	0	443
	Summer	Right	608	304	304	405
		Center	8284	11514	2964	7587
	Fall	Right	16226	8512	6080	10273
		Center	37962	32555	13110	27876

[1]Facing upstream in the waterway.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-4

NUMBER OF BENTHIC INVERTEBRATES IN THE CALUMET RIVER AT HALSTED STREET DURING 1988[1]

Taxonomic Group	Season	Bank	Number of Benthic Organisms Per Square Meter: Grab Sample 1	Grab Sample 2	Grab Sample 3	Mean
Annelida Oligochaeta (worms)	Spring	Right	410400	408500	282467	367122
		Center	45779	80370	19722	48624
	Summer	Right	43320	126160	10374	59951
		Center	51680	83600	172900	102727
	Fall	Right	161500	142500	1178	101726
		Center	72770	18316	129200	73429
Insecta Diptera Odonata (dragon flies)	Spring	Right	0	0	0	0
		Center	0	0	0	0
	Summer	Right	0	0	0	0
		Center	0	0	0	0
	Fall	Right	0	0	0	0
		Center	0	0	380	127
Insecta Diptera Chironomidae (midges)	Spring	Right	0	0	0	0
		Center	0	0	0	0
	Summer	Right	1045	380	570	665
		Center	0	380	760	380
	Fall	Right	380	0	0	127
		Center	0	114	760	291

[1]Facing upstream in the waterway.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-5

NUMBER OF BENTHIC INVERTEBRATES IN THE CALUMET RIVER AT WESTERN AVENUE DURING 1988[1]

Taxonomic Group	Season	Bank	Number of Benthic Organisms Per Square Meter: Grab Sample 1	Grab Sample 2	Grab Sample 3	Mean
Annelida Oligochaeta (worms)	Spring	Right	286140	197600	262200	248647
		Center	53200	379620	421800	284873
	Summer	Right	101485	98800	150480	116922
		Center	58140	57190	77330	64220
	Fall	Right	157700	236740	319960	238133
		Center	24244	53010	15611	30955
Insecta Diptera Psychodidae	Spring	Right	0	0	0	0
		Center	0	0	0	0
	Summer	Right	0	0	0	0
		Center	0	0	0	0
	Fall	Right	0	0	0	0
		Center	76	0	0	25
Insecta Diptera Chironomidae (midges)	Spring	Right	0	0	0	0
		Center	0	0	0	0
	Summer	Right	886	1140	0	675
		Center	0	570	380	317
	Fall	Right	0	0	0	0
		Center	912	1330	444	895
Mollusca Pelecypoda (clams)	Spring	Right	0	0	0	0
		Center	0	0	0	0
	Summer	Right	0	0	380	127
		Center	0	0	0	0
	Fall	Right	0	0	0	0
		Center	0	0	0	0

[1]Facing upstream in the waterway.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-6

NUMBER OF BENTHIC INVERTEBRATES IN THE CALUMET RIVER AT SOUTHWEST HIGHWAY DURING 1988[1]

Taxonomic Group	Season	Bank	Number of Benthic Organisms Per Square Meter: Grab Sample 1	Grab Sample 2	Grab Sample 3	Mean
Annelida Oligochaeta (worms)	Spring	Right	85310	95760	332500	171190
		Center	60230	89300	6118	51883
	Summer	Right	8056	23750	1786	11197
		Center	191285	28978	40280	86848
	Fall	Right	76051	615600	179360	290337
		Center	13756	2470	11970	9399
Insecta Diptera Chironomidae (midges)	Spring	Right	0	0	0	0
		Center	0	0	0	0
	Summer	Right	1330	1596	1064	1330
		Center	760	380	380	507
	Fall	Right	3417	0	2280	1899
		Center	1140	798	2394	1444
Mollusca Pelecypoda (clams)	Spring	Right	0	0	0	0
		Center	0	0	0	0
	Summer	Right	0	0	0	0
		Center	0	0	0	0
	Fall	Right	0	0	0	0
		Center	0	38	0	13

[1]Facing upstream in the waterway.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-7

NUMBER OF BENTHIC INVERTEBRATES IN THE CALUMET RIVER AT 100th STREET DURING 1988[1]

Taxonomic Group	Season	Bank	Number of Benthic Organisms Per Square Meter: Grab Sample 1	Grab Sample 2	Grab Sample 3	Mean
Annelida Oligochaeta (worms)	Spring	Right	183160	182020	91580	152253
		Center	28842	84740	159980	91187
	Summer	Right	28728	11970	5320	15339
		Center	86260	20710	15808	40926
	Fall	Right	3154	52534	13680	23123
		Center	8626	4104	5358	6029
Insecta Diptera Chironomidae (midges)	Spring	Right	0	0	0	0
		Center	0	0	38	13
	Summer	Right	2584	2736	2660	2660
		Center	2850	4465	4484	3933
	Fall	Right	1482	2470	456	1469
		Center	988	0	76	355
Mollusca Pelecypoda (clams)	Spring	Right	0	0	0	0
		Center	0	0	0	0
	Summer	Right	0	0	0	0
		Center	0	0	0	0
	Fall	Right	190	475	76	247
		Center	38	1140	1976	1051

[1]Facing upstream in the waterway.

APPENDIX AIII

RESULTS OF FISH SAMPLING OF THE CALUMET RIVER SYSTEM DURING 1988

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-1

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE 130th STREET STATION ON THE CALUMET RIVER DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
5/13/88 Sample				
Bluntnose minnow	35	33.95	105.45	102.06
Carp	16	15.52	52,190.00	50,506.48
Emerald shiner	1	0.97	5.55	5.37
Gizzard shad	86	83.42	5,957.71	5,765.50
Goldfish	1	0.97	460.00	445.16
Green sunfish	1	0.97	15.38	14.88
Largemouth bass	5	4.85	133.69	129.37
Pumpkinseed	4	3.88	111.17	107.59
White perch	9	8.73	657.59	636.38
Yellow perch	1	0.97	24.81	24.01
Totals for 5/13/88	159	154.23	59,661.35	57,736.80
8/16/88 Sample				
Bluegill	4	3.44	3.68	3.16
Bluntnose minnow	66	56.76	91.16	78.11
Carp	8	6.88	21,971.00	18,832.30
Emerald shiner	2	1.72	7.40	6.35
Gizzard shad	319	274.34	9,811.15	8,409.53
Goldfish	3	2.58	586.00	502.29
Grass pickerel	1	0.86	13.51	11.58
Largemouth bass	11	9.46	2,330.19	1,997.32
Orangespotted sunfish	1	0.86	43.80	37.54
Pumpkinseed	6	5.16	243.68	208.86
White perch	2	1.72	81.17	69.57
Yellow perch	54	46.44	326.41	279.76
Totals for 8/16/88	477	410.22	35,509.15	30,436.37

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-1 (Continued)

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE 130th STREET STATION ON THE CALUMET RIVER DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
9/28/88 Sample				
Bluegill	13	6.37	321.93	158.34
Bluntnose minnow	71	34.79	261.82	128.78
Carp	11	5.39	18,221.10	8,961.20
Emerald shiner	7	3.43	34.98	17.21
Gizzard shad	87	42.63	8,109.14	3,988.10
Green sunfish x pumpkinseed	1	0.49	57.30	28.18
Green sunfish	8	3.92	93.36	45.90
Largemouth bass	21	10.29	2,762.44	1,358.57
Pumpkinseed	11	5.39	505.19	248.46
White sucker	1	0.49	804.00	395.41
White perch	8	3.92	517.66	254.59
Yellow perch	4	1.96	88.10	43.33
Orangespotted sunfish	1	0.49	4.72	2.32
Totals for 9/28/88	244	119.56	31,781.74	15,630.39
11/2/88 Sample				
Bluegill	13	7.41	123.33	69.80
Bluntnose minnow	383	218.31	229.94	130.29
Carp	10	5.7	23,283.20	13,179.18
Emerald shiner	8	4.56	22.73	12.87
Fathead minnow	1	0.57	1.77	1.00
Gizzard shad	14	7.98	873.79	494.61
Green sunfish x pumpkinseed	1	0.57	86.00	48.68
Green sunfish	27	15.39	506.47	286.68
Largemouth bass	48	27.36	1,416.41	801.73
Orangespotted sunfish	16	9.12	64.64	36.60
Pumpkinseed	6	3.42	38.24	21.65
White sucker	1	0.57	1,344.00	760.75
White perch	1	0.57	78.80	44.60
Yellow perch	3	1.71	11.24	6.36
Totals for 11/2/88	532	303.24	28,080.56	15,894.80

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-2

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE O'BRIEN LOCK AND DAM STATION ON THE CALUMET RIVER DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
5/12/88 Sample				
Alewife	1	1	23.93	23.93
Bluntnose minnow	21	21	112.45	112.45
Carp	28	28	63,035.90	63,035.90
Emerald shiner	2	2	6.58	6.58
Fathead minnow	1	1	1.33	1.33
Gizzard shad	66	66	4,393.06	4,393.06
Pumpkinseed	3	3	34.04	34.04
White perch	13	13	596.49	596.49
Yellow perch	3	3	7.55	7.55
Totals for 5/12/88	138	138	68,211.33	68,211.33
8/15/88 Sample				
Alewife	4	4	7.47	7.47
Bluegill	8	8	158.67	158.67
Bluntnose minnow	22	22	27.71	27.71
Carp	5	5	7,294.80	7,294.80
Emerald shiner	4	4	7.48	7.48
Fathead minnow	1	1	1.59	1.59
Freshwater drum	1	1	972.00	972.00
Gizzard shad	508	508	6,657.92	6,657.92
Golden shiner	4	4	7.85	7.85
Goldfish	2	2	24.42	24.42
Green sunfish	14	14	196.91	196.91
Largemouth bass	6	6	653.79	653.79
Orangespotted sunfish	2	2	24.64	24.64
Pumpkinseed	2	2	153.82	153.82
Yellow perch	8	8	185.70	185.70
Totals for 8/15/88	591	591	16,374.77	16,374.77

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-2 (Continued)

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE O'BRIEN LOCK AND DAM STATION ON THE CALUMET RIVER DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
9/27/88 Sample				
Alewife	2	1.76	108.96	96.14
Black crappie	1	0.88	6.99	6.17
Bluegill	22	19.36	139.71	123.28
Bluegill x orangespotted	3	2.64	8.70	7.68
Bluegill x pumpkinseed	2	1.76	9.26	8.17
Bluntnose minnow	143	125.84	212.78	187.72
Carp	5	4.40	12,557.80	11,080.41
Emerald shiner	82	72.16	526.89	464.89
Gizzard shad	206	181.28	7,841.61	6,919.13
Goldfish	2	1.76	114.50	101.03
Green sunfish	15	13.20	115.58	101.98
Largemouth bass	15	13.20	4,692.64	4,140.57
Large scale stoneroller	1	0.88	5.67	5.00
Orangespotted sunfish	5	4.40	35.52	31.34
Pumpkinseed	30	26.40	258.09	227.74
Spottail shiner	2	1.76	21.57	19.04
White perch	11	9.68	639.91	564.64
Yellow perch	19	16.72	150.45	132.77
Totals for 9/27/88	566	498.08	27,446.63	24,217.70

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-2 (Continued)

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE
O'BRIEN LOCK AND DAM STATION ON THE CALUMET RIVER DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
11/9/88 Sample				
Bluegill	1	1	32.14	32.14
Bluntnose minnow	5	5	3.95	3.95
Carp	45	45	108,364.00	108,364.00
Channel catfish	1	1	6.20	6.20
Chinook salmon	1	1	5,004.60	5,004.60
Gizzard shad	18	18	728.45	728.45
Green sunfish	15	15	127.83	127.83
Largemouth bass	2	2	94.80	94.80
Orangespotted sunfish	20	20	64.73	64.73
Pumpkinseed	20	20	37.86	37.86
Rainbow trout	1	1	3,334.40	3,334.40
Yellow perch	2	2	5.10	5.10
White perch	2	2	167.30	167.30
Totals for 11/9/88	133	133	117,971.36	117,971.36

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-3

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE ROUTE I-94 STATION ON THE LITTLE CALUMET RIVER DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
5/13/88 Sample				
No Fish	0	0	0	0
8/12/88 Sample				
Alewife	7	6.79	6.02	5.82
Black bullhead	1	0.97	208.20	201.48
Bluntnose minnow	1	0.97	0.28	0.27
Carp	14	13.58	2,737.21	2,648.93
Carp x goldfish	2	1.94	435.00	420.97
Emerald shiner	4	3.88	30.75	29.76
Gizzard shad	225	218.25	3,505.28	3,392.19
Golden shiner	1	0.97	22.1	21.39
Goldfish	98	95.06	1,998.77	1,934.29
Largemouth bass	1	0.97	74.7	72.29
Spottail shiner	6	5.82	46.74	45.22
White perch	11	10.67	249.07	241.04
Yellow perch	3	2.91	91.94	88.97
Totals for 8/12/88	374	362.78	9,406.06	9,102.62
9/27/88 Sample				
Black crappie	1	0.71	13.69	9.78
Bluegill	18	12.78	95.41	68.13
Bluntnose minnow	7	4.97	8.44	6.03
Carp	33	23.43	77,027.03	55,019.32
Carp x goldfish	4	2.84	2,769.37	1,978.13
Emerald shiner	82	58.22	510.61	364.75
Fathead minnow	3	2.13	8.66	6.19
Gizzard shad	90	63.90	1,901.10	1,357.94
Golden shiner	1	0.71	6.54	4.67
Goldfish	104	73.84	6,066.57	4,333.23
Largemouth bass	4	2.84	1,149.50	821.07
Orangespotted sunfish	9	6.39	18.70	13.36
Pumpkinseed	19	13.49	256.98	183.54

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-3 (Continued)

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE ROUTE I-94 STATION ON THE LITTLE CALUMET RIVER DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
Spottail shiner	2	1.42	22.66	16.18
White perch	60	42.60	2,758.80	1,970.60
Yellow perch	6	4.26	83.09	59.36
Totals for 9/27/88	443	314.53	92,697.15	66,212.28
11/8/88 Sample				
Carp	5	4.30	7,765.5	6,656.14
Emerald shiner	81	69.66	195.48	167.57
Gizzard shad	55	47.30	475.23	407.33
Largemouth bass	2	1.72	56.6	48.52
Orangespotted sunfish	3	2.58	13.71	11.75
Yellow perch	1	0.86	2.80	2.40
Totals for 11/8/88	147	126.42	8,509.32	7,293.71

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-4

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE HALSTED STREET STATION ON THE LITTLE CALUMET RIVER DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
5/11/88 Sample				
No Fish	0	0	0	0
8/11/88 Sample				
Alewife	3	1.89	127.43	79.64
Bluegill	3	1.89	2.06	1.29
Carp	41	25.83	6,270.24	3,918.93
Carp x goldfish	4	2.52	2,613.11	1,633.19
Fathead minnow	3	1.89	2.69	1.69
Gizzard shad	41	25.83	291.93	182.49
Goldfish	182	114.66	2,132.8	1,333.15
Green sunfish	1	0.63	0.23	0.14
Totals for 8/11/88	278	175.14	11,440.49	7,150.52
9/26/88 Sample				
Bluegill	9	4.32	14.53	7.02
Bluntnose minnow	2	0.96	2.64	1.28
Carp	63	30.24	10,351.21	5,008.67
Carp x goldfish	2	0.96	2,685.00	1,299.20
Emerald shiner	429	205.92	1,155.75	559.40
Fathead minnow	16	7.68	39.60	19.18
Gizzard shad	155	74.40	1,858.47	899.37
Golden shiner	31	14.88	207.59	100.44
Goldfish	134	64.32	4,333.51	2,096.88
Green sunfish	4	1.92	21.57	10.43
Pumpkinseed	2	0.96	12.17	5.89
White perch	9	4.32	66.65	32.24
Yellow perch	2	0.96	65.13	31.52
Totals for 9/26/88	858	411.84	20,813.82	10,071.52

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-4 (Continued)

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE HALSTED STREET STATION ON THE LITTLE CALUMET RIVER DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
11/3/88 Sample				
Bluntnose minnow	2	1.16	1.12	0.64
Carp	30	17.40	10,000.20	5,769.38
Carp x goldfish	3	1.74	2,894.80	1,670.07
Chinook salmon	1	0.58	3,759.20	2,168.77
Emerald shiner	11	6.38	38.63	22.29
Gizzard shad	44	25.52	416.66	240.37
Goldfish	11	6.38	817.84	471.84
Green sunfish	5	2.90	16.05	9.26
Largemouth bass	1	0.58	51.70	29.83
Orangespotted sunfish	1	0.58	3.68	2.12
Totals for 11/3/88	109	63.22	17,999.88	10,384.57

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-5

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE CICERO AVENUE STATION ON THE CAL-SAG CHANNEL DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
5/4/88 Sample				
Carp x goldfish	1	0.73	9.74	7.13
White crappie	1	0.73	22.10	16.17
Totals for 5/4/88	2	1.46	31.84	23.30
7/27/88 Sample				
Black bullhead	2	1.76	163.30	144.09
Carp	4	3.52	4,339.15	3,828.67
Carp x goldfish	1	0.88	15.08	13.31
Gizzard shad	30	26.40	504.64	445.28
Goldfish	15	13.20	143.61	126.71
Totals for 7/27/88	52	45.76	5,165.78	4,558.06
9/22/88 Sample				
Black bullhead	1	0.75	115.00	86.25
Bluegill	1	0.75	1.00	0.75
Bluntnose minnow	1	0.75	0.35	0.26
Carp	23	17.25	2,049.22	1,536.94
Carp x goldfish	1	0.75	61.80	46.35
Emerald shiner	11	8.25	42.90	32.19
Gizzard shad	62	46.50	343.73	257.87
Golden shiner	1	0.75	9.69	7.27
Goldfish	4	3.00	90.19	67.64
Green sunfish	1	0.75	3.64	2.73
Green x pumpkinseed	1	0.75	1.40	1.05
Totals for 9/22/88	107	80.25	2,718.92	2,039.30

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-5 (Continued)

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE CICERO AVENUE STATION ON THE CAL-SAG CHANNEL DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
11/1/88 Sample				
Bluntnose minnow	2	1.46	3.82	2.79
Carp	32	23.36	6,730.04	4,924.43
Creek chub	1	0.73	21.60	15.80
Emerald shiner	1	0.73	8.58	6.28
Gizzard shad	15	10.95	326.01	238.54
Goldfish	3	2.19	64.56	47.24
Green sunfish	3	2.19	5.40	3.95
Totals for 11/1/88	57	41.61	7,160.01	5,239.03

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-6

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE ROUTE 83 STATION ON THE CAL-SAG CHANNEL DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
5/2/88 Sample				
Black crappie	1	0.79	37.00	29.21
Green sunfish	1	0.79	2.30	1.82
Yellow perch	1	0.79	18.30	14.45
Totals for 5/2/88	3	2.37	57.60	45.48
7/27/88 Sample				
Bluegill	1	0.73	30.66	22.43
Carp	61	44.53	22,398.81	16,389.38
Carp x goldfish	7	5.11	6,153.30	4,502.40
Emerald shiner	2	1.46	12.41	9.08
Fathead minnow	1	0.73	0.55	0.40
Gizzard shad	41	29.93	2,599.29	1,901.92
Goldfish	12	8.76	760.74	556.63
Green sunfish	3	2.19	22.47	16.44
Largemouth bass	2	1.46	84.97	62.17
Yellow perch	1	0.73	27.60	20.20
Totals for 7/27/88	131	95.63	32,090.80	23,481.05
9/23/88 Sample				
Bluegill	3	1.92	85.91	54.84
Carp	9	5.76	2,368.44	1,511.77
Emerald shiner	1	0.64	4.54	2.90
Fathead minnow	2	1.28	6.50	4.15
Gizzard shad	54	34.56	204.68	130.68
Golden shiner	4	2.56	49.38	31.52
Goldfish	6	3.84	455.13	290.52
Green sunfish	10	6.40	85.98	54.89
Largemouth bass	2	1.28	216.30	138.06
Pumpkinseed	1	0.64	8.30	5.30
Totals for 9/23/88	92	58.88	3,485.16	2,224.63

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-6 (Continued)

NUMBER AND WEIGHT OF TOTAL FISH CATCH FROM THE ROUTE 83 STATION ON THE CAL-SAG CHANNEL DURING 1988

Date of Sample and Fish Species Collected	Number of Fish		Weight (grams)	
	Total Catch	Per 30 Minutes	Total Catch	Per 30 Minutes
10/27/88 Sample				
Bluntnose minnow	1	0.67	2.58	1.72
Carp	6	4.02	179.45	119.63
Gizzard shad	5	3.35	32.25	21.50
Green sunfish	5	3.35	63.76	42.51
Largemouth bass	1	0.67	3.44	2.29
Totals for 10/27/88	18	12.06	281.48	187.65

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-7

METRICS USED IN THE CALCULATION OF THE INDEX OF BIOTIC INTEGRITY (IBI) FOR THE 130th STREET STATION ON THE CALUMET RIVER DURING 1988

IBI Metric	Date of Collection			
	5/13/88	8/16/88	9/28/88	11/2/88
Number Species Per Sample	10	12	12	13
Number Sucker Species	0	0	1	1
Number Sunfish Species	2	3	4	4
Number Darter Species	0	0	0	0
Number Intolerant Species	0	0	0	0
Percent Green Sunfish	0.63	0.00	3.28	5.08
Percent Hybrids	0.00	0.00	0.41	0.19
Percent Disease	6.90	0.84	2.90	1.50
Percent Omnivores	86.79	83.02	69.26	76.69
Percent Insectivorus Cyprinids	0.63	0.42	2.87	1.50
Percent Carnivores	9.43	14.26	13.52	9.77
Total Number of Fish	159	477	244	532
Electrofishing time (minutes)	31	35	61	53
Stream Order	3	3	3	3
Stream Basin	2	2	2	2
Species Metric Factor	3	3	3	5
Sucker Metric Factor	1	1	1	1
Sunfish Metric Factor	3	5	5	5
Darter Metric Factor	1	1	1	1
Intolerant Metric Factor	1	1	1	1
Green Sunfish Metric Factor	5	5	5	3
Hybrid Metric Factor	5	5	3	3
Disease Metric Factor	1	3	1	1
Omnivore Metric Factor	1	1	1	1
Insectivore Metric Factor	1	1	1	1
Carnivore Metric Factor	5	5	5	5
Abundance Metric Factor	3	5	1	5
IBI (Sum of Metric Factors)	30	36	28	32

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-8

METRICS USED IN THE CALCULATION OF THE INDEX OF BIOTIC INTEGRITY (IBI) FOR THE STATION IMMEDIATELY DOWNSTREAM OF THE O'BRIEN LOCK AND DAM ON THE CALUMET RIVER DURING 1988

IBI Metric	Date of Collection 5/12/88	8/15/88	9/27/88	11/9/88
Number Species Per Sample	9	15	16	13
Number Sucker Species	0	0	0	0
Number Sunfish Species	1	4	5	4
Number Darter Species	0	0	0	0
Number Intolerant Species	0	0	1	2
Percent Green Sunfish	0.00	2.37	2.65	11.28
Percent Hybrids	0.00	0.00	0.88	0.00
Percent Disease	13.80	1.20	0.35	20.30
Percent Omnivores	84.78	92.39	63.25	51.13
Percent Insectivorus Cyprinids	1.45	0.68	14.84	0.00
Percent Carnivores	11.59	2.37	8.13	6.02
Total Number of Fish	138	591	566	133
Electrofishing time (minutes)	30	30	34	30
Stream Order	3	3	3	3
Stream Basin	2	2	2	2
Species Metric Factor	3	5	5	5
Sucker Metric Factor	1	1	1	1
Sunfish Metric Factor	1	5	5	5
Darter Metric Factor	1	1	1	1
Intolerant Metric Factor	1	1	1	3
Green Sunfish Metric Factor	5	5	5	3
Hybrid Metric Factor	5	5	3	5
Disease Metric Factor	1	1	3	1
Omnivore Metric Factor	1	1	1	1
Insectivore Metric Factor	1	1	1	1
Carnivore Metric Factor	5	3	5	5
Abundance Metric Factor	1	5	5	1
IBI (Sum of Metric Factors)	26	34	36	32

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-9

METRICS USED IN THE CALCULATION OF THE INDEX OF BIOTIC INTEGRITY (IBI) FOR THE STATION AT ROUTE I-94 ON THE LITTLE CALUMET RIVER DURING 1988

IBI Metric	Date of Collection			
	5/13/88	8/12/88	9/27/88	11/8/88
Number Species Per Sample	0	12	16	6
Number Sucker Species	0	0	0	0
Number Sunfish Species	0	0	5	1
Number Darter Species	0	0	0	0
Number Intolerant Species	0	0	0	0
Percent Green Sunfish	0.00	0.00	0.00	0.00
Percent Hybrids	0.00	0.53	0.90	0.00
Percent Disease	0.00	3.20	2.90	0.00
Percent Omnivores	0.00	92.51	53.72	40.82
Percent Insectivorus Cyprinids	0.00	2.67	18.96	55.10
Percent Carnivores	0.00	4.01	16.03	2.04
Total Number of Fish	0	374	443	147
Electrofishing time (minutes)	30	31	42	35
Stream Order	3	3	3	3
Stream Basin	2	2	2	2
Species Metric Factor	1	3	5	1
Sucker Metric Factor	1	1	1	1
Sunfish Metric Factor	1	1	5	1
Darter Metric Factor	1	1	1	1
Intolerant Metric Factor	1	1	1	1
Green Sunfish Metric Factor	1	5	5	5
Hybrid Metric Factor	1	3	3	5
Disease Metric Factor	1	1	1	5
Omnivore Metric Factor	1	1	1	3
Insectivore Metric Factor	1	1	1	5
Carnivore Metric Factor	1	3	5	3
Abundance Metric Factor	1	5	5	1
IBI (Sum of Metric Factors)	12	26	34	32

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-10

METRICS USED IN THE CALCULATION OF THE INDEX OF BIOTIC INTEGRITY (IBI) FOR THE STATION AT HALSTED STREET ON THE LITTLE CALUMET RIVER DURING 1988

IBI Metric	Date of Collection 5/11/88	8/11/88	9/26/88	11/3/88
Number Species Per Sample	0	7	12	9
Number Sucker Species	0	0	0	0
Number Sunfish Species	0	2	3	2
Number Darter Species	0	0	0	0
Number Intolerant Species	0	0	0	1
Percent Green Sunfish	0.00	0.36	0.47	4.59
Percent Hybrids	0.00	1.44	0.23	2.75
Percent Disease	0.00	2.20	1.40	8.30
Percent Omnivores	0.00	97.12	46.74	79.82
Percent Insectivorus Cyprinids	0.00	0.00	50.00	10.09
Percent Carnivores	0.00	0.00	1.28	1.83
Total Number of Fish	0	278	858	109
Electrofishing time (minutes)	33	48	62	52
Stream Order	3	3	3	3
Stream Basin	2	2	2	2
Species Metric Factor	1	3	3	3
Sucker Metric Factor	1	1	1	1
Sunfish Metric Factor	1	3	5	3
Darter Metric Factor	1	1	1	1
Intolerant Metric Factor	1	1	1	1
Green Sunfish Metric Factor	1	5	5	5
Hybrid Metric Factor	1	1	3	1
Disease Metric Factor	1	1	1	1
Omnivore Metric Factor	1	1	1	1
Insectivore Metric Factor	1	1	5	1
Carnivore Metric Factor	1	1	3	3
Abundance Metric Factor	1	3	5	1
IBI (Sum of Metric Factors)	12	22	34	22

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-11

METRICS USED IN THE CALCULATION OF THE INDEX OF BIOTIC INTEGRITY (IBI) FOR THE STATION AT CICERO AVENUE ON THE CAL-SAG CHANNEL DURING 1988

IBI Metric	Date of Collection			
	5/4/88	7/27/88	9/22/88	11/1/88
Number Species Per Sample	1	4	9	7
Number Sucker Species	0	0	0	0
Number Sunfish Species	1	0	2	1
Number Darter Species	0	0	0	0
Number Intolerant Species	0	0	0	0
Percent Green Sunfish	0.00	0.00	0.93	5.26
Percent Hybrids	50.00	1.92	1.87	0.00
Percent Disease	0.00	3.80	4.70	10.50
Percent Omnivores	0.00	94.23	85.05	91.23
Percent Insectivorus Cyprinids	0.00	0.00	10.28	3.51
Percent Carnivores	50.00	0.00	0.00	0.00
Total Number of Fish	2	52	107	57
Electrofishing time (minutes)	41	34	40	41
Stream Order	4	4	4	4
Stream Basin	2	2	2	2
Species Metric Factor	1	1	3	1
Sucker Metric Factor	1	1	1	1
Sunfish Metric Factor	1	1	3	1
Darter Metric Factor	1	1	1	1
Intolerant Metric Factor	1	1	1	1
Green Sunfish Metric Factor	5	5	5	3
Hybrid Metric Factor	1	1	1	5
Disease Metric Factor	5	1	1	1
Omnivore Metric Factor	5	1	1	1
Insectivore Metric Factor	1	1	1	1
Carnivore Metric Factor	5	1	1	1
Abundance Metric Factor	1	1	1	1
IBI (Sum of Metric Factors)	28	16	20	18

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-12

METRICS USED IN THE CALCULATION OF THE INDEX OF BIOTIC INTEGRITY (IBI) FOR THE STATION AT ROUTE 83 ON THE CAL-SAG CHANNEL DURING 1988

IBI Metric	Date of Collection			
	5/2/88	7/27/88	9/23/88	10/27/88
Number Species Per Sample	3	9	11	5
Number Sucker Species	0	0	0	0
Number Sunfish Species	2	2	3	1
Number Darter Species	0	0	0	0
Number Intolerant Species	0	0	0	0
Percent Green Sunfish	33.33	2.29	10.75	27.78
Percent Hybrids	0.00	5.34	0.00	0.00
Percent Disease	0.00	15.30	0.00	0.00
Percent Omnivores	0.00	87.79	80.65	66.67
Percent Insectivorus Cyprinids	0.00	1.53	1.08	0.00
Percent Carnivores	66.67	2.29	2.15	5.56
Total Number of Fish	3	131	93	18
Electrofishing time (minutes)	38	41	47	45
Stream Order	4	4	4	4
Stream Basin	2	2	2	2
Species Metric Factor	1	3	3	1
Sucker Metric Factor	1	1	1	1
Sunfish Metric Factor	3	3	3	1
Darter Metric Factor	1	1	1	1
Intolerant Metric Factor	1	1	1	1
Green Sunfish Metric Factor	1	5	3	1
Hybrid Metric Factor	5	1	5	5
Disease Metric Factor	5	1	5	5
Omnivore Metric Factor	5	1	1	1
Insectivore Metric Factor	1	1	1	1
Carnivore Metric Factor	5	3	3	5
Abundance Metric Factor	1	1	1	1
IBI (Sum of Metric Factors)	30	22	28	24

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-13

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION AT 130th STREET ON THE CALUMET RIVER DURING 1988

Water Quality Constituent	Sample Date			
	5/13/88	8/16/88	9/28/88	11/2/88
	Concentration			
Temperature (°C)	17	27	19	9.5
Hardness (mg/L as $CaCO_3$)	190	174	192	158
Dissolved Oxygen (mg/L)	9.2	7.27	8.11	10.28
pH (Units)	8.1	7.6	8	7.5
Total Ammonia Nitrogen (mg/L)	0.7	0.3	0.1	0.2
Un-ionized Ammonia-N (mg/L)	0.03	0.01	0.00	0.00
Arsenic (mg/L)	<0.2	<0.2	<0.2	<0.2
Cadmium (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Residual Chlorine (mg/L)	<0.01	NA	NA	NA
Chromium (mg/L)	<0.02	<0.02	<0.02	<0.02
Copper (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Cyanide (mg/L)	0.001	0.001	0.003	0.004
Fluoride (mg/L)	0.32	0.17	0.15	0.21
Iron (mg/L)	0.4	0.2	0.3	<0.2
MBAS (mg/L)	0.013	0.010	<0.001	<0.001
Lead (mg/L)	<0.08	<0.08	<0.08	<0.08
Manganese (mg/L)	<0.02	0.04	0.02	<0.02
Mercury (µg/L)	<0.3	<0.3	<0.3	<0.3
Nickel (mg/L)	<0.2	<0.2	<0.2	<0.2
Nitrite + Nitrate-N (mg/L)	1.6	1.0	0.2	0.4
Phenol (mg/L)	<0.001	<0.001	<0.001	<0.001
Silver (mg/L)	<0.001	<0.001	0.001	<0.001
Zinc (mg/L)	<0.2	<0.2	<0.2	<0.2

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-13 (Continued)

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION AT 130th STREET ON THE CALUMET RIVER DURING 1988

Water Quality Constituent	Sample Date			
	5/13/88	8/16/88	9/28/88	11/2/88
	--------Bluegill Toxic Units (BGTUs)-------			
Un-ionized Ammonia-N	0.0510	0.0062	0.0075	0.0023
Arsenic	0.0000	0.0000	0.0000	0.0000
Cadmium	0.0000	0.0000	0.0000	0.0000
Total Residual Chlorine	0.0000	0.0000	0.0000	0.0000
Chromium	0.0000	0.0000	0.0000	0.0000
Copper	0.0000	0.0000	0.0000	0.0000
Total Cyanide	0.0047	0.0105	0.0250	0.0190
Fluoride	0.0072	0.0038	0.0034	0.0047
Iron	0.0122	0.0061	0.0091	0.0000
MBAS (LAS)	0.0057	0.0043	0.0000	0.0000
Lead	0.0000	0.0000	0.0000	0.0000
Manganese	0.0000	0.0010	0.0005	0.0000
Mercury	0.0000	0.0000	0.0000	0.0000
Nickel	0.0000	0.0000	0.0000	0.0000
Nitrite + Nitrate-N	0.0008	0.0005	0.0001	0.0002
Phenol	0.0000	0.0000	0.0000	0.0000
Silver	0.0000	0.0000	0.0143	0.0000
Zinc	0.0000	0.0000	0.0000	0.0000
Toxicity Index (Sum of Toxicities)	0.0815	0.0324	0.0599	0.0262

NA = No analysis.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-14

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION DOWNSTREAM OF THE O'BRIEN LOCK AND DAM ON THE CALUMET RIVER DURING 1988

Water Quality Constituent	Sample Date			
	5/12/88	8/15/88	9/27/88	11/9/88
	Concentration			
Temperature (°C)	16.8	27	20	8
Hardness (mg/L as $CaCO_3$)	243	172	190	174
Dissolved Oxygen (mg/L)	5.8	7.19	8.14	10.4
pH (Units)	7.4	7.6	7.5	7.5
Total Ammonia Nitrogen (mg/L)	8.7	0.2	0.5	0.4
Un-ionized Ammonia-N (mg/L)	0.08	0.01	0.00	0.00
Arsenic (mg/L)	<0.2	<0.2	<0.2	<0.2
Cadmium (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Residual Chlorine (mg/L)	<0.01	NA	NA	NA
Chromium (mg/L)	<0.02	<0.02	<0.02	<0.02
Copper (mg/L)	<0.02	<0.02	<0.02	0.03
Total Cyanide (mg/L)	0.004	0.002	0.003	0.001
Fluoride (mg/L)	0.36	0.17	0.18	0.25
Iron (mg/L)	0.3	0.3	0.3	0.2
MBAS (mg/L)	0.095	0.008	<0.001	0.013
Lead (mg/L)	<0.08	<0.08	<0.08	<0.08
Manganese (mg/L)	0.05	0.04	0.02	<0.02
Mercury (µg/L)	<0.3	<0.3	<0.3	<0.3
Nickel (mg/L)	<0.2	<0.2	<0.2	<0.2
Nitrite + Nitrate-N (mg/L)	1.0	0.1	0.4	0.6
Phenol (mg/L)	0.004	0.001	<0.001	<0.001
Silver (mg/L)	<0.001	<0.001	<0.001	<0.001
Zinc (mg/L)	<0.2	<0.2	<0.2	<0.2

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-14 (Continued)

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION DOWNSTREAM OF THE O'BRIEN LOCK AND DAM ON THE CALUMET RIVER DURING 1988

Water Quality Constituent	Sample Date			
	5/12/88	8/15/88	9/27/88	11/9/88
	Bluegill Toxic Units (BGTUs)			
Un-ionized Ammonia-N	0.2524	0.0042	0.0076	0.0041
Arsenic	0.0000	0.0000	0.0000	0.0000
Cadmium	0.0000	0.0000	0.0000	0.0000
Total Residual Chlorine	0.0000	0.0000	0.0000	0.0000
Chromium	0.0000	0.0000	0.0000	0.0000
Copper	0.0000	0.0000	0.0000	0.0057
Total Cyanide	0.0212	0.0211	0.0255	0.0048
Fluoride	0.0081	0.0038	0.0041	0.0056
Iron	0.0091	0.0091	0.0091	0.0061
MBAS (LAS)	0.0635	0.0035	0.0000	0.0057
Lead	0.0000	0.0000	0.0000	0.0000
Manganese	0.0013	0.0010	0.0005	0.0000
Mercury	0.0000	0.0000	0.0000	0.0000
Nickel	0.0000	0.0000	0.0000	0.0000
Nitrite + Nitrate-N	0.0005	0.0001	0.0002	0.0003
Phenol	0.0003	0.0001	0.0000	0.0000
Silver	0.0000	0.0000	0.0000	0.0000
Zinc	0.0000	0.0000	0.0000	0.0000
Toxicity Index (Sum of Toxicities)	0.3564	0.0428	0.0470	0.0323

NA = No analysis.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-15

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION AT ROUTE I-94 ON THE LITTLE CALUMET RIVER DURING 1988

Water Quality Constituent	Sample Date			
	5/13/88	8/12/88	9/27/88	11/8/88
	Concentration			
Temperature (°C)	18	27	20.5	7.5
Hardness (mg/L as $CaCO_3$)	243	195	192	174
Dissolved Oxygen (mg/L)	0.5	1.5	8.2	6.42
pH (Units)	7.2	6.9	7.5	7.1
Total Ammonia Nitrogen (mg/L)	3.5	0.4	0.3	1.2
Un-ionized Ammonia-N (mg/L)	0.02	0.00	0.00	0.00
Arsenic (mg/L)	<0.2	<0.2	<0.2	<0.2
Cadmium (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Residual Chlorine (mg/L)	<0.01	NA	NA	NA
Chromium (mg/L)	<0.02	<0.02	<0.02	<0.02
Copper (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Cyanide (mg/L)	0.006	0.003	0.002	0.006
Fluoride (mg/L)	0.51	0.22	0.16	0.44
Iron (mg/L)	0.6	0.4	0.3	0.7
MBAS (mg/L)	0.259	0.045	<0.001	0.407
Lead (mg/L)	0.02	<0.08	<0.08	<0.08
Manganese (mg/L)	0.10	0.04	0.02	0.04
Mercury (µg/L)	<0.3	<0.3	<0.3	<0.3
Nickel (mg/L)	<0.2	<0.2	<0.2	<0.2
Nitrite + Nitrate-N (mg/L)	0.1	<0.1	0.4	1.1
Phenol (mg/L)	0.003	0.003	<0.001	<0.001
Silver (mg/L)	<0.001	<0.001	0.001	<0.001
Zinc (mg/L)	<0.2	<0.2	<0.2	<0.2

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-15 (Continued)

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION AT ROUTE I-94 ON THE LITTLE CALUMET RIVER DURING 1988

Water Quality Constituent	Sample Date			
	5/13/88	8/12/88	9/27/88	11/8/88
	--------Bluegill Toxic Units (BGTUs)--------			
Un-ionized Ammonia-N	0.1291	0.0056	0.0077	0.0101
Arsenic	0.0000	0.0000	0.0000	0.0000
Cadmium	0.0000	0.0000	0.0000	0.0000
Total Residual Chlorine	0.0000	0.0000	0.0000	0.0000
Chromium	0.0000	0.0000	0.0000	0.0000
Copper	0.0000	0.0000	0.0000	0.0000
Total Cyanide	0.0574	0.0376	0.0172	0.0325
Fluoride	0.0115	0.0050	0.0036	0.0099
Iron	0.0182	0.0122	0.0091	0.0213
MBAS (LAS)	0.7618	0.1324	0.0000	0.3082
Lead	0.0001	0.0000	0.0000	0.0000
Manganese	0.0025	0.0010	0.0005	0.0010
Mercury	0.0000	0.0000	0.0000	0.0000
Nickel	0.0000	0.0000	0.0000	0.0000
Nitrite + Nitrate-N	0.0001	0.0000	0.0002	0.0006
Phenol	0.0008	0.0008	0.0000	0.0000
Silver	0.0000	0.0000	0.0143	0.0000
Zinc	0.0000	0.0000	0.0000	0.0000
Toxicity Index (Sum of Toxicities)	0.9814	0.1945	0.0526	0.3836

NA = No analysis.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-16

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION AT HALSTED STREET ON THE LITTLE CALUMET RIVER DURING 1988

Water Quality Constituent	Sample Date			
	5/11/88	8/11/88	9/26/88	11/3/88
	Concentration			
Temperature (°C)	19.2	27	21.5	15
Hardness (mg/L as $CaCO_3$)	317	218	241	261
Dissolved Oxygen (mg/L)	2.8	1.95	6.7	5.98
pH (Units)	6.9	6.7	7	6.9
Total Ammonia Nitrogen (mg/L)	1.1	1.3	0.8	0.9
Un-ionized Ammonia-N (mg/L)	0.00	0.01	0.00	0.00
Arsenic (mg/L)	<0.2	<0.2	<0.2	<0.2
Cadmium (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Residual Chlorine (mg/L)	NA	NA	NA	NA
Chromium (mg/L)	<0.02	<0.02	<0.02	<0.02
Copper (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Cyanide (mg/L)	0.031	0.034	0.012	0.019
Fluoride (mg/L)	1.08	0.74	0.57	1.12
Iron (mg/L)	0.7	0.3	0.3	0.4
MBAS (mg/L)	0.099	0.055	0.017	0.029
Lead (mg/L)	<0.08	<0.08	<0.08	<0.08
Manganese (mg/L)	0.13	0.06	0.04	0.06
Mercury (µg/L)	<0.3	<0.3	<0.3	<0.3
Nickel (mg/L)	<0.2	<0.2	<0.2	<0.2
Nitrite + Nitrate-N (mg/L)	4.2	3.0	4.2	10.7
Phenol (mg/L)	0.011	0.001	<0.001	0.007
Silver (mg/L)	<0.001	0.001	<0.001	0.001
Zinc (mg/L)	<0.2	<0.2	<0.2	0.2

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-16 (Continued)

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION AT HALSTED STREET ON THE LITTLE CALUMET RIVER DURING 1988

Water Quality Constituent	Sample Date			
	5/11/88	8/11/88	9/26/88	11/3/88
	Bluegill Toxic Units (BGTUs)			
Un-ionized Ammonia-N	0.0223	0.0116	0.0092	0.0073
Arsenic	0.0000	0.0000	0.0000	0.0000
Cadmium	0.0000	0.0000	0.0000	0.0000
Total Residual Chlorine	0.0000	0.0000	0.0000	0.0000
Chromium	0.0000	0.0000	0.0000	0.0000
Copper	0.0000	0.0000	0.0000	0.0000
Total Cyanide	0.3062	0.4258	0.1115	0.1008
Fluoride	0.0243	0.0167	0.0128	0.0252
Iron	0.0213	0.0091	0.0091	0.0122
MBAS (LAS)	0.1703	0.1400	0.0086	0.0195
Lead	0.0000	0.0000	0.0000	0.0000
Manganese	0.0033	0.0015	0.0010	0.0015
Mercury	0.0000	0.0000	0.0000	0.0000
Nickel	0.0000	0.0000	0.0000	0.0000
Nitrite + Nitrate-N	0.0021	0.0015	0.0021	0.0054
Phenol	0.0029	0.0003	0.0000	0.0005
Silver	0.0000	0.0143	0.0000	0.0143
Zinc	0.0000	0.0000	0.0000	0.0189
Toxicity Index (Sum of Toxicities)	0.5526	0.6207	0.1543	0.2056

NA = No analysis.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-17

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION AT CICERO AVENUE ON THE CAL-SAG CHANNEL DURING 1988

Water Quality Constituent	Sample Date			
	5/4/88	7/27/88	9/22/88	11/1/88
	Concentration			
Temperature (°C)	18	28	20	11
Hardness (mg/L as $CaCO^3$)	392	260	215	333
Dissolved Oxygen (mg/L)	2	3.42	5.77	6.52
pH (Units)	7.1	7.1	7	7
Total Ammonia Nitrogen (mg/L)	3.2	1.5	0.6	0.8
Un-ionized Ammonia-N (mg/L)	0.02	0.02	0.00	0.00
Arsenic (mg/L)	<0.2	<0.2	<0.2	<0.2
Cadmium (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Residual Chlorine (mg/L)	<0.01	<0.01	NA	NA
Chromium (mg/L)	<0.02	<0.02	<0.02	<0.02
Copper (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Cyanide (mg/L)	0.013	0.016	0.007	0.010
Fluoride (mg/L)	1.00	0.66	0.40	0.87
Iron (mg/L)	0.5	0.2	0.3	0.7
MBAS (mg/L)	0.078	0.064	<0.001	0.014
Lead (mg/L)	<0.08	<0.08	<0.08	<0.08
Manganese (mg/L)	0.13	0.06	0.03	0.07
Mercury (µg/L)	<0.3	<0.3	<0.3	<0.3
Nickel (mg/L)	<0.2	<0.2	<0.2	<0.2
Nitrite + Nitrate-N (mg/L)	3.3	3.6	2.2	7.5
Phenol (mg/L)	0.002	<0.001	0.001	0.002
Silver (mg/L)	<0.001	<0.001	<0.001	<0.001
Zinc (mg/L)	<0.2	<0.2	<0.2	<0.2

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-17 (Continued)

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION AT CICERO AVENUE ON THE CAL-SAG CHANNEL DURING 1988

Water Quality Constituent	Sample Date			
	5/4/88	7/27/88	9/22/88	11/1/88
	Bluegill Toxic Units (BGTUs)			
Un-ionized Ammonia-N	0.0938	0.0319	0.0081	0.0060
Arsenic	0.0000	0.0000	0.0000	0.0000
Cadmium	0.0000	0.0000	0.0000	0.0000
Total Residual Chlorine	0.0000	0.0000	0.0000	0.0000
Chromium	0.0000	0.0000	0.0000	0.0000
Copper	0.0000	0.0000	0.0000	0.0000
Total Cyanide	0.1244	0.2064	0.0651	0.0530
Fluoride	0.0225	0.0149	0.0090	0.0196
Iron	0.0152	0.0061	0.0091	0.0213
MBAS (LAS)	0.2294	0.0655	0.0000	0.0094
Lead	0.0000	0.0000	0.0000	0.0000
Manganese	0.0033	0.0015	0.0008	0.0017
Mercury	0.0000	0.0000	0.0000	0.0000
Nickel	0.0000	0.0000	0.0000	0.0000
Nitrite + Nitrate-N	0.0017	0.0018	0.0011	0.0038
Phenol	0.0005	0.0000	0.0001	0.0001
Silver	0.0000	0.0000	0.0000	0.0000
Zinc	0.0000	0.0000	0.0000	0.0000
Toxicity Index (Sum of Toxicities)	0.4908	0.3280	0.0932	0.1150

NA = No analysis.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-18

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION AT ROUTE 83 ON THE CAL-SAG CHANNEL DURING 1988

Water Quality Constituent	Sample Date			
	5/2/88	7/27/88	9/23/88	10/27/88
	Concentration			
Temperature (°C)	16.8	29.5	20.5	11
Hardness (mg/L as $CaCO_3$)	351	251	215	251
Dissolved Oxygen (mg/L)	2.58	13.19	5.3	3.53
pH (Units)	7.2	8	7	6.9
Total Ammonia Nitrogen (mg/L)	6.7	0.3	0.5	1.1
Un-ionized Ammonia-N (mg/L)	0.04	0.03	0.00	0.00
Arsenic (mg/L)	<0.2	<0.2	<0.2	<0.2
Cadmium (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Residual Chlorine (mg/L)	<0.01	<0.01	NA	NA
Chromium (mg/L)	<0.02	<0.02	<0.02	<0.02
Copper (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Cyanide (mg/L)	0.024	0.006	0.004	0.009
Fluoride (mg/L)	0.89	0.54	0.30	0.75
Iron (mg/L)	0.5	0.2	0.8	0.6
MBAS (mg/L)	0.082	0.039	0.005	0.510
Lead (mg/L)	<0.08	<0.08	<0.08	<0.08
Manganese (mg/L)	0.11	0.03	0.03	0.07
Mercury (µg/L)	<0.3	<0.3	<0.3	0.5
Nickel (mg/L)	<0.2	<0.2	<0.2	<0.2
Nitrite + Nitrate-N (mg/L)	2.8	2.9	1.7	0.6
Phenol (mg/L)	0.005	<0.001	<0.001	0.003
Silver (mg/L)	<0.001	<0.001	<0.001	0.001
Zinc (mg/L)	<0.2	<0.2	<0.2	0.2

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-18 (Continued)

WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES (BTI) FOR THE STATION AT ROUTE 83 ON THE CAL-SAG CHANNEL DURING 1988

Water Quality Constituent	Sample Date			
	5/2/88	7/27/88	9/23/88	10/27/88
	Bluegill Toxic Units (BGTUs)			
Un-ionized Ammonia-N	0.2261	0.0146	0.0079	0.0120
Arsenic	0.0000	0.0000	0.0000	0.0000
Cadmium	0.0000	0.0000	0.0000	0.0000
Total Residual Chlorine	0.0000	0.0000	0.0000	0.0000
Chromium	0.0000	0.0000	0.0000	0.0000
Copper	0.0000	0.0000	0.0000	0.0000
Total Cyanide	0.1363	0.0680	0.0384	0.0511
Fluoride	0.0200	0.0122	0.0068	0.0169
Iron	0.0152	0.0061	0.0243	0.0182
MBAS (LAS)	0.1747	0.0170	0.0034	0.7916
Lead	0.0000	0.0000	0.0000	0.0000
Manganese	0.0028	0.0008	0.0008	0.0017
Mercury	0.0000	0.0000	0.0000	0.0001
Nickel	0.0000	0.0000	0.0000	0.0000
Nitrite + Nitrate-N	0.0014	0.0015	0.0009	0.0003
Phenol	0.0013	0.0000	0.0000	0.0003
Silver	0.0000	0.0000	0.0000	0.0143
Zinc	0.0000	0.0000	0.0000	0.0189
Toxicity Index (Sum of Toxicities)	0.5778	0.1199	0.0824	0.9254

NA = No analysis.

APPENDIX AIV

RESULTS OF PERIPHYTON SAMPLING OF THE CALUMET RIVER SYSTEM DURING 1988

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Bacillariophyceae	Number Per Square Centimeter					
Achnanthes affinis	284	0	0	0	0	0
Achnanthes haukiana	4	94	0	0	0	0
Achnanthes lanceolata	26233	165	18493	23575	14541	8430
Achnanthes linearis	13	0	0	0	20	0
Achnanthes linearis var. curta	0	0	0	0	20	0
Achnanthes minutissima	13	576034	0	0	0	0
Achnanthes stewardii	0	0	954	0	0	0
Amphipleura pellucida	4588	305	0	0	0	0
Amphora coffeiformis	298	0	1	0	0	0
Amphora ovalis	198	149	42	795	0	0
Amphora ovalis var. affinis	99	0	0	0	0	0
Amphora ovalis var. pediculus	0	0	0	795	0	0
Amphora perpusilla	0	24	0	118	397	0
Amphora submontana	48	0	0	0	0	0
Amphora veneta	0	11	662	0	0	0
Asterionella formosa	5217	11	174	26	0	0
Caloneis silicula var. truncatula	0	0	0	0	1491	0
Carpartogramma crucicula	0	433	0	0	0	0
Cocconeis diminuta	0	4258	0	0	0	0
Cocconeis klamathenis	19	0	0	0	0	0
Cocconeis pediculus	1686	2683	0	0	0	0
Cocconeis placentula	4666	41070	20353	30353	176419	11262
Cocconeis placentula var. euglypta	581	0	2567	1294	25387	0
Cocconeis placentula var. lineata	3481	19723	2403	10425	65288	6647
Cocconeis rugosa	15730	5542	0	0	0	0
Coscinodiscus lacustris	0	3158	3460	2514	8585	12508
Coscinodiscus rothii	0	0	271	800	0	0
Cyclotella antigua	3332	596	256	0	0	0
Cyclotella bodanica	306	353	12	0	0	0
Cyclotella comta	1205	149	4227	3128	2385	0
Cyclotella glomerata	99971	31990	80261	116283	150949	96665
Cyclotella kuetzingiana	994	0	70	12	0	0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1 (Continued)

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Bacillariophyceae (cont.)						
	Number Per Square Centimeter					
Cyclotella meneghiniana	142	12825	17203	15392	34748	73278
Cyclotella michiganiana	35926	7086	2194	2322	10883	1610
Cyclotella ocellata	381	142	704	0	0	0
Cyclotella stelligera	1638	750	734	12	0	0
Cyclotella striata	0	298	14	401	60	0
Cymatopleura affinis	0	245	0	0	0	0
Cymatopleura elliptica	72	16	0	0	0	0
Cymatopleura elliptica var. constricta	0	8	0	0	0	0
Cymatopleura solea	279	322	0	0	0	0
Cymbella cuspidata	199	0	0	0	0	0
Cymbella cymbiformis	72	0	0	0	0	0
Cymbella hustedii	0	305	0	0	0	0
Cymbella lunata	224	0	0	0	0	0
Cymbella mexicana	0	8	0	0	0	0
Cymbella microcephala	0	322	0	0	0	0
Cymbella minuta	102570	21851	10645	0	795	0
Cymbella minuta f. latens	284	0	0	0	0	0
Cymbella minuta var. silesiaca	102152	20842	4618	0	795	0
Cymbella penstexta	99	149	0	0	0	0
Cymbella prostrata	283	4790	0	0	0	0
Cymbella prostrata var. auerswaldii	0	4790	0	0	0	0
Cymbella protracta	0	179	0	0	0	0
Cymbella pusilla	0	402	0	0	0	0
Cymbella tumida	0	26012	0	0	0	0
Cymbella ventricosa	0	447	0	372	0	0
Diatoma anceps	498002	82291	24716	41029	140455	348406
Diatoma heimale	0	7602	0	0	1788	2484
Diatoma heimale var. mesodon	0	0	0	0	1788	2484
Diatoma tenue	7350	3711	7561	41367	166091	213212
Diatoma tenue var. elongatum	7342	3711	7561	41367	166091	213212
Diatoma vulgare	34932	29365	19903	913	3825	1240
Diatoma vulgare var. breve	358	3383	0	0	0	0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1 (Continued)

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Bacillariophyceae (cont.)	Number Per Square Centimeter					
Diatoma vulgare var. grande	0	280	0	0	0	0
Diatoma vulgare var. ovalis	94	0	0	0	0	0
Diatoma vulgare var. products	0	8	0	0	0	0
Diploneis smithii	0	47	0	0	0	0
Epithemia adnata	0	0	414	0	0	0
Epithemia argus var. alpestris	0	36	0	0	0	0
Epithemia turgida	0	0	0	12	0	0
Epithemia zebra var. parcellus	0	0	477	0	0	0
Eunotia curvata	0	0	12	0	0	0
Fragilaria brevistriata	35874	264	1	6658	5008	0
Fragilaria capucina	10732	0	0	7	2924	0
Fragilaria construens	16	8	537	3975	0	0
Fragilaria construens var. subsalina	16	0	537	0	0	0
Fragilaria crotonensis	487	47	705	0	0	0
Fragilaria leptostauron	365	94	0	0	0	0
Fragilaria leptostauron var. dubia	221	47	0	0	0	0
Fragilaria pinnata	2762	257	250	1231	0	2385
Fragilaria pinnata var. lancettula	0	0	0	795	0	0
Fragilaria vaucheria	152640	4930	6571	22844	18352	21666
Fragilaria virescens	13	213	24	0	0	0
Gomphonema affine	0	0	2683	0	0	0
Gomphonema angustissima	0	0	0	0	0	1490
Gomphonema bedinii	0	47	0	0	0	0
Gomphonema dichotomum	0	80	0	0	0	0
Gomphonema gibba	0	0	0	0	1258	0
Gomphonema olivaceum	92443	115196	32816	33285	129163	180042
Gomphonema olivaceum var. calcarea	2717	3624	8066	10463	17640	13116
Gomphonema parvulum	16551	144272	2839381	4945060	8000365	9198184
Gomphonema subclavatum	0	0	0	12	0	1192
Gomphonema subclavatum var. communtatum	0	0	0	12	0	0
Gomphonema truncatum	142	36	537	0	0	0
Gomphonema truncatum var. capitatum	0	1503	537	0	0	0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1 (Continued)

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Bacillariophyceae (cont.)	Number Per Square Centimeter					
Gyrosigma acuminatum	596	825	43	0	0	0
Gyrosigma attenuatum	88	72	0	0	0	0
Gyrosigma spencerii	0	11	0	0	0	0
Gyrosigma spencerii var. curvata	183	0	0	0	0	0
Hantzschia amphioxys	0	0	0	0	795	0
Melosira ambigua	71	149	3	0	0	0
Melosira granulata	0	0	0	318	0	0
Melosira ikapoensis var. procera	45	0	0	0	0	0
Melosira islandica	2396	1625	4311	1669	7708	4742
Melosira italica	706	498	0	431	0	0
Melosira nyassensis	18	0	1	0	0	0
Melosira pyxis	0	0	12	0	0	0
Melosira varians	0	1505	1997	60796	69499	110283
Navicula aikenensis	298	0	0	0	0	391
Navicula arvensis	0	0	0	0	8088	35947
Navicula bacillum	0	47	0	0	0	0
Navicula beigenensis	0	0	21	0	0	0
Navicula bicephala	0	176	0	0	0	0
Navicula canalis	1341	291	0	805	1787	0
Navicula capitata	0	174	0	0	0	0
Navicula cincta	0	0	0	0	93445	83078
Navicula contraria	0	0	0	0	1065	0
Navicula cryptocephala	2667	31865	89179	6104	12851	22511
Navicula cryptocephala var. veneta	142	0	12	0	0	0
Navicula cuspidata	284	0	698	0	0	0
Navicula decussis	0	149	0	0	0	0
Navicula elginensis	0	0	0	1987	1491	497
Navicula exigua	0	11	142	795	0	0
Navicula exigua var. capitata	0	11	0	0	0	0
Navicula gastrum	0	72	0	0	0	0
Navicula graciles	99	0	0	0	0	0
Navicula graciloides	142	0	0	24	0	0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1 (Continued)

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Bacillariophyceae (cont.)	Number Per Square Centimeter					
Navicula gynsingensis	99	0	0	0	0	196
Navicula halophila	142	0	4554	596	0	0
Navicula halophila var. tenuirostris	142	0	0	0	0	0
Navicula heufleri	13	0	0	8119	33288	0
Navicula integra	0	70	0	0	0	0
Navicula lanceolata	0	24	0	0	0	179
Navicula laterostrata	0	596	0	0	0	0
Navicula menisculus var. upsaliensis	0	776	309	0	0	0
Navicula minima	0	0	537	0	0	0
Navicula mutica	0	0	3228	25868	23015	34886
Navicula mutica var. cohnii	0	0	414	0	0	0
Navicula mutica var. stigma	0	0	0	2385	0	0
Navicula mutica var. tropica	0	0	0	0	0	1192
Navicula placentula	0	1192	0	0	417	0
Navicula protracta	0	810	526	0	0	0
Navicula pseudoreinhardtii	0	0	308	0	0	0
Navicula pupula var. elliptica	0	269	0	0	0	0
Navicula pupula var. mutata	0	149	0	0	397	0
Navicula pupula var. rectangularis	0	8	21	0	0	0
Navicula pygmaea	0	16	0	0	0	0
Navicula radiosa	596	769	1034	1590	1232	0
Navicula radiosa var. tenella	0	628	868	1590	397	0
Navicula rhynchocephala var. germanii	0	0	954	0	0	0
Navicula rhyncocephala	298	0	0	0	0	0
Navicula simula	0	894	0	0	0	0
Navicula species #22	0	0	1	0	0	0
Navicula species #4	142	0	0	0	0	0
Navicula species #6	0	0	0	0	80	0
Navicula species #7	0	0	0	0	2981	0
Navicula tripunctata	690	2786	523	36985	16689	0
Navicula viridula var. avenacea	0	0	0	0	397	778
Nitzschia acicularis	0	126	0	0	0	537

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1 (Continued)

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Bacillariophyceae (cont.)	Number Per Square Centimeter					
Nitzschia acuta	13	194	1052	0	0	0
Nitzschia amphibia	0	22	0	648	537	4183
Nitzschia angustata var. acuta	0	11	0	0	0	0
Nitzschia communis	0	0	0	0	9838	0
Nitzschia commutata	0	0	0	0	0	107
Nitzschia dissipata	5414	18627	903	718	745	1192
Nitzschia elliptica	0	0	0	0	20	0
Nitzschia filiformis	642	16378	13441	38355	239810	211730
Nitzschia fonticola	1669	888	2405	386	5016	1906
Nitzschia hantzschiana	142	0	0	0	0	0
Nitzschia hungarica	0	0	0	0	20847	0
Nitzschia ignorata	0	0	0	795	0	0
Nitzschia palea	16366	44683	174982	314463	297574	244471
Nitzschia paleacea	993	56	0	0	1669	5962
Nitzschia parvula	17	0	1	0	0	0
Nitzschia recta	298	188	0	0	0	4770
Nitzschia romana	0	0	0	7155	835	3575
Nitzschia stagnorum	0	0	0	4020	20	0
Nitzschia sublinearis	0	0	537	795	0	0
Nitzschia thermalis	1132	440	817	795	1511	5522
Nitzschia tryblionella	0	668	21	268	0	0
Nitzschia tryblionella var. debilis	0	400	0	268	0	0
Opephora martyi	803	0	0	819	5323	391
Pinnularia appendieulata	0	0	0	0	0	17886
Pinnularia microstauron	0	0	0	795	0	0
Pinnularia subcapitata	1703	0	21	0	0	0
Pinnularia subcapitata var. paucistriata	0	0	21	0	0	0
Rhoicosphenia curvata	12725	2832	0	0	1661	537
Stephanodiscus astraea	3665	6247	10380	5509	14111	6068
Stephanodiscus binderanus	0	0	23	0	0	215
Stephanodiscus dubius	771	433	11238	20004	0	0
Stephanodiscus invisitatus	199	0	12	0	0	0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1 (Continued)

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Bacillariophyceae (cont.)	Number Per Square Centimeter					
Stephanodiscus tenuis	358	168	1	7	596	0
Surirella angustata	19	70	12	0	2756	3383
Surirella ovalis	0	0	0	0	596	0
Surirella ovata	328	1493	2027	3253	26992	30537
Surirella ovata var. apiculata	0	0	0	0	0	3577
Surirella ovata var. pinnata	72	165	537	2782	0	1299
Surirella ovata var. salina	149	729	1431	459	0	1555
Surirella ovata var. apiculata	0	8	0	0	0	0
Surirella straitula	715	0	0	0	0	0
Synedra acus	426	168	2187	11606	3996	7003
Synedra amphicephala	4	309	0	0	0	0
Synedra amphicephala var. austriaca	4	298	0	0	0	0
Synedra demerare	13	0	0	0	20	0
Synedra famelica	0	0	0	353	0	0
Synedra fasciculata	64	2289	4402	92186	94111	246070
Synedra fasciculata var. truncata	0	1016	3297	0	2405	994
Synedra nana	0	0	0	0	0	994
Synedra pulchella	355	25907	6795	25636	45051	111459
Synedra pulchella var. lanceolata	0	0	0	0	1192	497
Synedra radians	30	116	537	0	2696	5962
Synedra rumpens	13	458	0	0	2696	5392
Synedra rumpens var. familliaris	0	458	0	0	2696	0
Synedra rumpens var. fragilaroides	13	0	0	0	0	0
Synedra ulna	5638	1108	51895	135289	257831	497888
Synedra ulna var. contracta	0	0	0	0	4017	1192
Synedra ulna var. longissima	16	0	0	0	0	0
Synedra ulna var. ramesi	0	0	0	0	0	358
Tabellaria fenestrata	53360	14156	40129	6156	13725	4133
Tabellaria floculosa	1614	285	1744	1089	1661	0
Tabellaria quadrisepta	6108	1123	10169	3474	770	0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1 (Continued)

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Chlorophyceae	Number Per Square Centimeter					
Actinastrum hantzschii	0	0	0	0	0	30556
Ankistrodesmus falcatus	21998	15402	97924	60721	62185	83315
Ankistrodesmus falcatus var. acicularis	17424	0	0	4390	0	0
Ankistrodesmus falcatus var. mirabilis	4574	15402	63809	56331	62185	83315
Botryococcus protuberens var. minor	0	0	47545	0	0	0
Characium acuminatum	0	0	0	10565	4285	100618
Characium ambiguum	13	0	5233	0	3122	0
Characium curvatum	0	0	30000	0	0	0
Characium limneticum	0	1821	0	0	0	14721
Characium obtusum	0	0	0	0	0	126044
Characium pringsheimii	0	0	8119	0	0	0
Chlamydomonas angulosa	0	1771	0	0	0	0
Chlamydomonas cienkowski	0	0	29011	0	0	0
Chlamydomonas globosa	49520	24620	2210027	577487	245303	276351
Chlamydomonas pseudopertyi	0	1060	0	0	0	0
Chlamydomonas sphagnicola	0	0	3691	0	0	0
Closteriopsis longissima var. tropica	0	0	959	0	0	0
Closterium sp.	0	0	3170	0	0	0
Coelastrum sphaerium	0	0	62794	0	0	0
Coleochaete soluta	0	0	0	0	658732	0
Cosmarium sp.	0	3776	0	0	0	4490
Crucigenia quadrata	0	0	24421	20177	0	0
Excentrospheria viridis	0	0	0	0	0	3820
Franceia droescheri	0	0	3170	0	0	0
Gleocystis gigas	0	0	0	40354	0	28340
Gleocystis major	0	906	21099	0	31376	3820
Gleocystis vesiculosa	0	177327	739877	122667	0	0
Kirchneriella contorta	590696	236970	369804	912145	847082	1867578
Kirchneriella elongata	0	0	0	0	21951	0
Kirchneriella lunaris	0	0	0	0	0	10901
Kirchneriella obesa	0	0	0	6211	13279	0
Lagerheimia quadriseta	0	5515	246902	37162	8166	25622

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1 (Continued)

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Chlorophyceae (cont.)			Number Per Square Centimeter			
Lagerheimia subsalsa	0	0	30863	0	0	0
Micractinium pusillum	0	0	0	15133	0	0
Microspora pachyderma	5588	0	0	0	0	0
Microspora stagnorum	0	1311	0	49691	0	0
Mougeotia abnormis	61642	0	0	10089	0	0
Mougeotia parvula	57323	70058	959	0	39561	0
Mougeotia pulchella	3002	0	0	0	0	0
Mougeotia quadrangulata	13552	0	0	0	0	0
Mougeotia scalaris	3073	0	0	0	0	0
Mougeotia virescens	0	0	0	0	7967	0
Mougeotiopsis calospora	0	0	0	0	0	56681
Mouqeotia tumidula	1689	0	0	0	0	0
Oedogonium plusiosporum	33374	0	0	0	0	0
Palmella mucosa	0	0	146524	20177	0	0
Pediastrum boryanum	0	14500	97682	0	42493	0
Pediastrum duplex var. clathratum	0	0	50714	0	0	0
Pediastrum obtusum	0	0	24421	16564	0	0
Planctonema lauterbornii	327685	475588	2047772	2287058	477958	17681
Protococcus viridis	0	0	0	0	113722	0
Rhizoclonium hieroglyphicum	0	0	0	0	15825	175318
Scenedesmus abundans	0	0	0	16564	10623	0
Scenedesmus abundans var. brevicauda	0	0	0	16564	0	0
Scenedesmus acuminatus	0	5437	0	105882	0	0
Scenedesmus acuminatus var. tetradesmoides	0	1812	0	0	0	0
Scenedesmus bernardii	0	0	6105	4141	0	0
Scenedesmus bijuga	0	0	0	12423	0	0
Scenedesmus dimorphus	0	0	0	64824	102699	0
Scenedesmus incassatalus	0	0	16301	0	52683	0
Scenedesmus incassatalus var. mononae	0	0	0	0	52683	0
Scenedesmus longus var. minutus	0	8341	0	40354	0	0
Scenedesmus opoliensis	0	8341	0	0	0	0
Scenedesmus quadricauda	0	59363	359605	196692	176963	146088

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1 (Continued)

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Chlorophyceae (cont.)			Number Per Square Centimeter			
Scenedesmus quadricauda var. longispina	0	25869	339490	0	47571	0
Scenedesmus quadricuada var. parvus	6146	0	0	63506	0	0
Schizomeris leibleinii	0	0	0	706791	0	309593
Selenastrum gracile	1537	886	6105	15545	9088	0
Spirogyra borysthenica	0	0	0	9366	97301	0
Spirogyra daedoleoides	0	0	0	0	29214	0
Spirogyra triplicata	0	20854	0	0	21951	0
Spiroqyra webil	3144	0	0	0	0	0
Stigeoclonium lubricum	0	33561	10466	869204	74552	9818863
Stigeoclonium nanum	0	201931	4270574	972787	187737	576714
Stigeoclonium subsecundum	0	0	0	0	59341	0
Stigeoclonium tenue	0	0	0	680488	854517	0
Tetraedron caudatum	0	0	0	5192	0	0
Tetraedron regulare var. incus	0	0	0	0	2656	0
Tetrastrum staurogeniaeforme	0	0	0	8282	0	0
Treubaria sp.	0	0	0	0	0	4490
Trochiscia reticularis	0	0	2637	0	0	0
Ulothrix aequalis	108376	0	0	0	57841	0
Ulothrix cylindricum	57366	0	0	63320	118923	0
Ulothrix subconstricta	0	0	12466	677077	94946	270773
Ulothrix subtillisima	53399	0	13659	92647	395718	0
Ulothrix tenerrima	0	0	0	38454	201889	0
Ulothrix tenuissima	0	0	0	376976	0	0
Ulothrix variablis	87000	173085	788375	94208	485921	0
Ulothrix zonata	96802	0	0	0	0	0
Myxophyceae						
Aphanothece castagnei	0	0	0	6797559	36666	0
Aphanothece microspora	0	0	0	47718	0	0
Aphanothece nidulans	13614622	19211259	47814803	43817963	51943733	39443034
Chroococcus dispersus	277878	639148	1307041	239727	2904313	120008

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1 (Continued)

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Myxophyceae (cont.)	Number Per Square Centimeter					
Chroococcus dispersus var. minor	25756	118938	0	51161	224097	28340
Chroococcus limeticus	0	0	0	22775	0	0
Chroococcus minor	0	12468	123200	94439	35727	0
Chroococcus minutus	11727	125854	453240	122324	34276	214855
Chroococcus pallidus	0	0	0	32000	0	0
Cylindrospermum licheniforme	0	351512	184011	424636	498849	57293
Cylindrospermum minutissima	0	0	0	0	197561	0
Cylindrospermum minimum	0	19395	97431	147135	0	77398
Gleocapsa aeruginosa	0	0	0	50443	0	87207
Gleocapsa punctata	18578	0	10927	60264	0	0
Gomphosphaeria lacustric var. compacta	0	0	98587	0	0	0
Lyngbya epiphytica	96802	178219	0	0	0	338936
Merismopedia elegans	2168	0	0	0	0	0
Merismopedia glauca	4336	100963	0	0	0	0
Merismopedia puncata	0	0	0	0	0	56681
Merismopedia tennuissima	51	53698	0	0	77122	0
Microcystis aeruginosa	0	0	7912	0	304620	0
Microcystis incerta	0	80593	0	0	0	0
Microystis aeruginosa	0	0	0	561951	0	0
Nostoc linckia	0	0	0	242647	0	0
Oscillatoria acutissima	0	0	589554	0	0	0
Oscillatoria ameona	0	21073	0	0	0	0
Oscillatoria amphibia	0	0	0	0	31870	0
Oscillatoria angustata	0	0	0	0	0	63529
Oscillatoria angustissima	1689373	373878	1443337	1282149	744007	553777
Oscillatoria articulata	0	30205	0	0	0	0
Oscillatoria lacustris	0	0	5366	0	0	0
Oscillatoria limnetica	589334	1299789	493324	810251	8078877	846029
Oscillatoria sancta	137728	0	0	0	0	0
Oscillatoria tenuis	0	157456	0	0	0	481259
Oscillatoria tenuis var. natans	0	75073	0	0	0	0
Oscillatoria tenuis var. tergistina	0	15610	0	0	0	0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIV-1 (Continued)

PERIPHYTON SPECIES COLLECTED AT EACH STATION IN THE CALUMET RIVER SYSTEM DURING 1988

Family and Species	Ewing Avenue	O'Brien Lock and Dam	Indiana Avenue	Halsted Street	Ashland Avenue	Route 83
Myxophyceae (cont.)	Number Per Square Centimeter					
Phormidium minnesotense	0	0	0	0	0	112979
Phormidium mucicola	33008	44723	0	280362	18465	467796
Phormidium tenue	34171	0	0	0	0	0
Spirulina laxa	0	0	0	0	4390	0
Spirulina laxissima	0	0	75238	0	0	0
Spirulina nordstedtii	0	0	671	0	0	0
Total	19543848	25873935	68471235	70649505	81411039	69120351