

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO



**DEPARTMENT OF RESEARCH
AND DEVELOPMENT**

REPORT NO. 79-8-B

1977 ANNUAL SUMMARY REPORT

WATER QUALITY WITHIN THE WATERWAYS SYSTEM OF

THE METROPOLITAN SANITARY DISTRICT

OF GREATER CHICAGO

VOLUME 2

BIOLOGICAL

December 1979

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BIOLOGICAL

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SUMMARY

During 1977 the composition and distribution of bacteria, plankton, and bottom macroinvertebrates at eighteen sampling stations, and of fish near thirty-four sampling locations along the Chicago River and Calumet River Systems were studied. Sediment oxygen demand determinations were made at all bottom sampling stations where sufficient dissolved oxygen was available.

These data reveal that the areas of the man-made waterways closest to Lake Michigan have waters of better quality than the waters farther downstream (away from the Lake). The data show the greatest number of individual fish and species occur nearer to Lake Michigan, whereas, few or no fish were found in the waterways distant from Lake Michigan.

The phytoplankton species near Lake Michigan are a reflection of the lake's flora, while those farther downstream are representative of more polluted waters. In addition, the waters nearer Lake Michigan have much lower numbers of those bacteria considered to be of sanitary importance, including the indicators, TC, FC, and FS, and pathogens, than the waters farther downstream.

The greater variety of benthic macroinvertebrates were found near Lake Michigan, while only a few kinds were found downstream in the waterways. In general, Lake Michigan flora and fauna are present nearer to Lake Michigan and are replaced by other types farther downstream. The small number of clean water organisms nearer the lake make it doubtful if they reproduce in the water-

ways. Those present in the waterways apparently are replenished by individuals carried into the waterways from Lake Michigan.

CONCLUSION

This monitoring survey, covering 78 miles of the MSDGC major waterways system during 1977, shows that the quality of the water moving downstream from Lake Michigan becomes progressively lower. The present data were sufficient to show that waters leading from Lake Michigan are a reflection of the flora and fauna of Lake Michigan. However, sewage treatment plant effluents, combined sewer overflows, and other tributaries flowing into the system change these waters to those which are more representative of polluted waters. Pollution abatement resulting from construction of the Tunnel and Reservoir Plan (combined sewer overflow elimination), of the expanded and improved sewage treatment plants, and of the instream aeration project, should result in considerable improvement in water quality. Thereafter, the "clean" waters entering from the lake will not be altered as much as they are at the present time.

I. INTRODUCTION

The Metropolitan Sanitary District of Greater Chicago (MSDGC) is responsible for the quality of the water in the streams and canals within its jurisdiction. To monitor these waterways the MSDGC established a water quality study. The biological research activities under this monitoring program are provided by the Research and Development Department's Biology Research Section. For 1977, the field monitoring studies were handled by the following biology teams within the Biology Research Section: Analytical Microbiology, Aquatic Ecology, Aquatic Biology, and Fisheries. The 52 research stations, including 34 fish stations, in 1977 were selected to reflect general environmental conditions of the MSDGC main waterway systems.

The effects of pollutants on a waterway are reflected in the population density, species composition, and species diversity of natural aquatic communities. Therefore, information on all types of aquatic organisms present in a waterway is important in evaluating water quality. The long term water quality monitoring methods conducted by the MSDGC biology teams, as described in this report, are directed primarily toward sample collection and processing, organism identification and enumeration, and data reporting. This report summarizes the data obtained on the bacteria, plankton, benthic macroinvertebrate and fish communities during 1977. The 1975-1976 plankton data and the 1977 oxygen demands of the sediments have also been included.

II. WATER QUALITY MONITORING

Description of Waterways

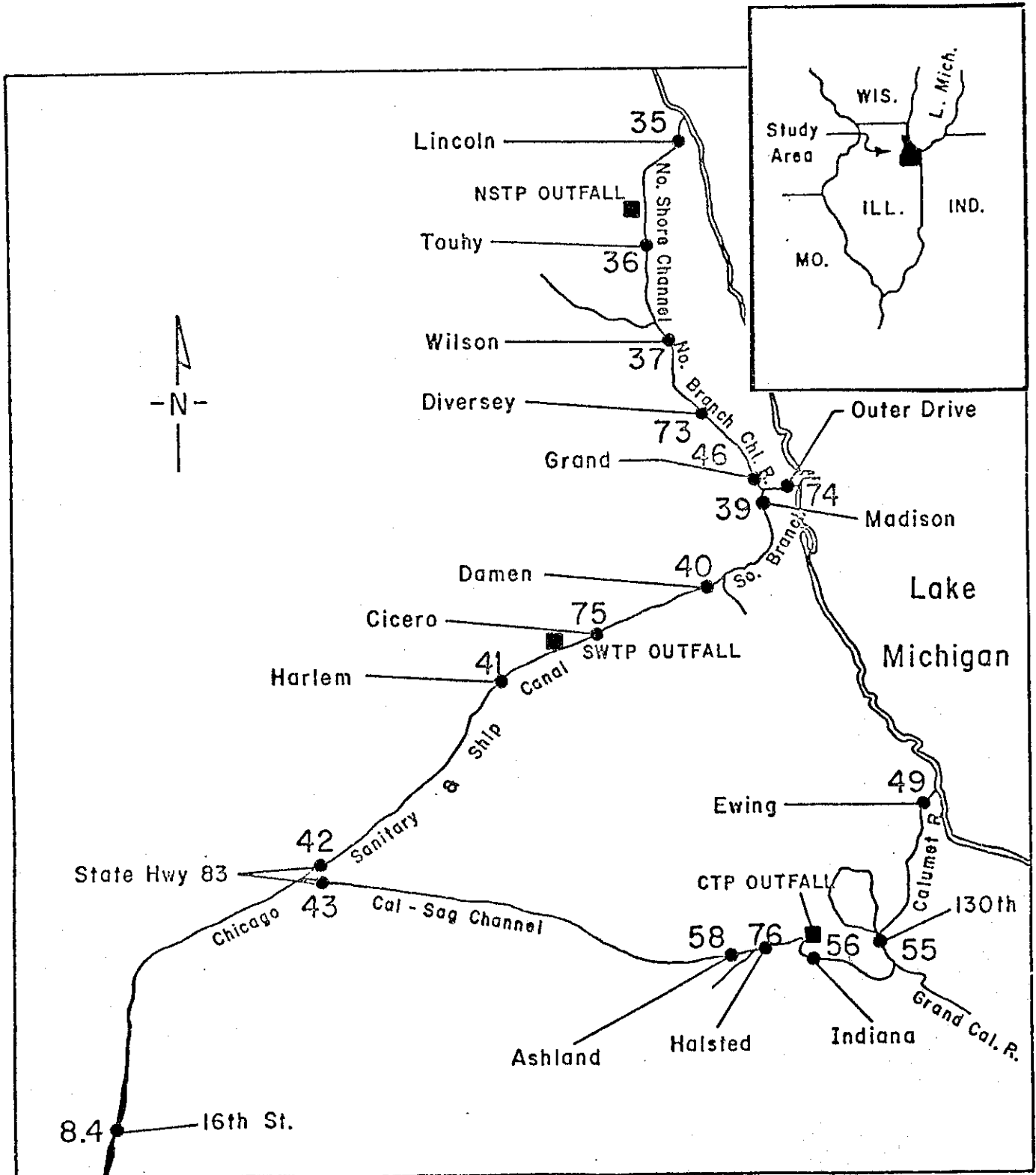
Principal man-made and controlled waterways in the Metropolitan Sanitary District system are the North Shore Channel, channelized portions of the North Branch, South Branch, and main stem of the Chicago River, the Sanitary and Ship Canal, channelized portions of the Calumet and Little Calumet Rivers, and the Cal-Sag Channel (Figure 1). The canal system functions to provide navigation for boats and barges and to serve as receiving waters for conveying the flows from tributary streams, sewage treatment plant effluents, combined sewer overflows, and storm water run-off to the Des Plaines River through the canal terminus at the Lockport Powerhouse.

Eighteen (18) sampling stations, for algae, bacteria and benthos, covering approximately 78 miles of the waterways were selected for study (Figure 1 , Table 1). Fish collections were made at 34 major locations throughout the MSD Waterways, and on other waterways (Figure 2).

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Figure 1

LOCATION OF 1977 SAMPLING STATIONS
FOR BACTERIA, ALGAE, AND BENTHOS



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TABLE 1

LIST OF STATIONS USED IN 1977 FOR
SAMPLING BACTERIA, ALGAE, AND BENTHOS

Station Number	Location ¹
<u>Chicago River System</u>	
35	Lincoln Street (NSC) ²
36	Touhy Avenue (NSC)
37	Wilson Avenue (NBCR)
73	Diversey Avenue (NBCR)
46	Grand Avenue (NBCR)
74	Outer Drive Bridge (Chicago River)
39	Madison Avenue (SBCR)
40	Damen Avenue (SBCR)
75	Cicero Avenue (CS & SC)
41	Harlem Avenue (CS & SC)
42	Route 83 (CS & SC)
8.4	16th Street (CS & SC)
<u>Calumet River System</u>	
49	Ewing Avenue (C-R) ²
55	130th Street (C-R)
56	Indiana Avenue (LC-R)
76	Halsted Street (LC-R)
58	Ashland Avenue (CS-C)
43	Route 83 (CS-C)

1 - Biological samples were taken from the upstream side of each bridge.

2 - NSC = North Shore Channel; NBCR = North Branch Chicago River; SBCR = South Branch Chicago River; CS & SC = Chicago Sanitary and Ship Canal; C-R = Calumet River; LC-R = Little Calumet River; CS-C = Cal-Sag Channel.

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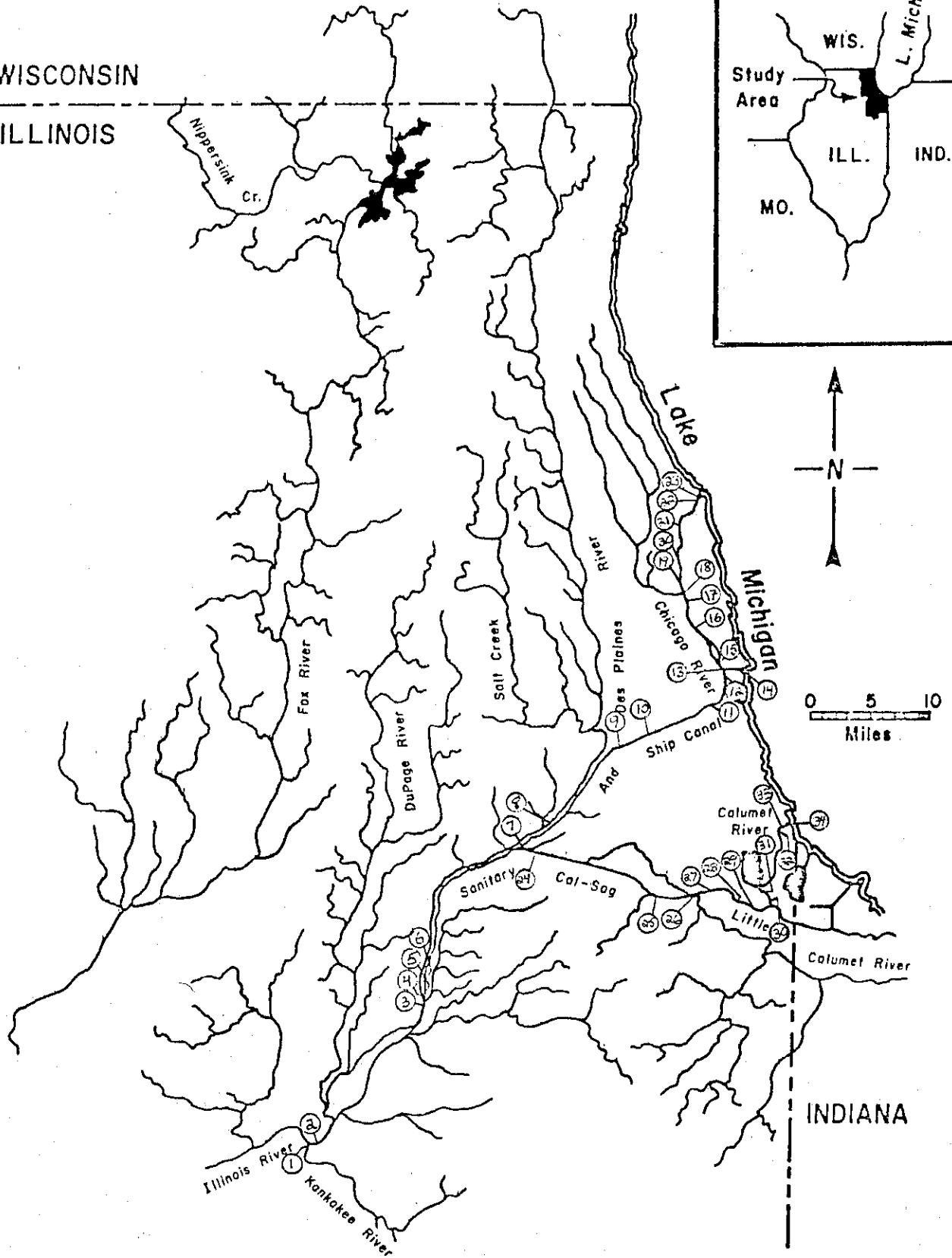


Figure 2 Location of 1977 Fish Sampling Stations (indicated by numbered circles)

Types of Biological Samples

Four kinds of biological samples were collected in these waterways during 1977 for water quality assessment:

(A) Algae, (B) Bacteria, (C) Benthos, and (D) Fish.

A. Algae

The objective of this part of the 1977 study was the identification and enumeration of that group of the biota collectively called the plankton, specifically the phytoplankton (the zooplankton represented mainly by Protozoa and Rotatoria, are present in much lower numbers) in the major waterways of the District. The plankton may be defined as those microscopic organisms suspended in the water with little or no powers of locomotion subject to distribution primarily through the action of waves or currents. The phytoplankton, as the principal primary producers in the waterways can serve as indicators of water quality. The phytoplankton studied belong to the following four groups:

1. The blue-green algae (Cyanophyta) - These are primitive forms (single celled, with nuclear material scattered throughout the center of the cell while green chlorophyll is diffused throughout the peripheral portion of the cell; has blue pigment and sometimes a red pigment), some of which produce "water blooms"; "pea soup" appearance; septic "pigpen" odors; impart a "fish taste"; and

cover rocks with slimy gelatinous masses.

2. Green algae (Chlorophyta) have pigments that are principally chlorophyll confined to chloroplasts or definite bodies. There is an organized nucleus, and the motile cells have flagelli.
3. Diatoms (Bacillariophyceae) have a greater proportion of yellow or brown pigment than chlorophyll and the cell wall is composed of silica.
4. Euglenoids (Euglenophyta) are chiefly one-celled aquatic flagellate plants.

B. Bacteria

Bacterial analyses, which give an indication of the bacteriological or sanitary quality of the water, have been performed routinely on waterways samples for several years. Coliform, and the more specific fecal coliform and fecal streptococcus tests are used extensively by MSDGC to determine the bacteriological quality of the water. In addition to these routine parameters several other analyses were included in this 1977 study:

1. Total Plate Count - This is a highly empirical procedure which gives an estimate of the total microbial populations.
2. Salmonella - The genus Salmonella contains a variety of species which are pathogenic for man or animals, and usually for both.
3. Pseudomonas aeruginosa - This organism is a causa-

tive agent of otitis media, otitis externa, chronic ulcerations of the skin and many wound and burn infections.

4. Staphylococcus aureus - The most common infections caused by Staph. aureus include pimples, boils, carbuncles, and food poisoning.

C. Benthos

In the waterways for 1977, the bottom macroinvertebrate communities were sampled for a third year to determine the composition and abundance of organisms. These organisms, having limited mobility and long life spans of a year or two, are sensitive to even subtle changes in water quality. Therefore, they can serve as excellent indicators, of pollution in the waterways of the District. Experience has shown that a diverse bottom fauna with no over-abundance of any one group indicates a water of good quality. Organic pollution, however, may restrict the variety of organisms while favoring the development of large numbers of organisms that tolerate these pollution conditions. In addition, pollution by toxic substances, may eliminate almost all benthic macroinvertebrates.

During 1977, there was also a need to quantify the oxygen demand characteristics of the bottom sediments in the deep draft waterways within the District. The importance of sediment oxygen demand (SOD) in the oxygen regime of lakes and rivers has been described by a number of in-

investigators (Baity, 1938; Fair, et al, 1941; Velz, 1958; and Owens and Edwards, 1963¹⁻⁴). Therefore, the Benthological Program included studying the degree and extent of the oxygen demand of the sediments.

D. Fish

Fish collections and analyses, which give the most meaningful index of water quality to the public, have been performed on the MSDGC waterways since 1974. Because fish occupy the upper levels of the aquatic food chain, any water quality conditions that significantly affect the other kinds of organisms within the aquatic community will also affect the species composition and abundance of the fish population.

Diversity indices are useful for measuring the water quality of the environment for a community of fish species. Their use is based on the generally observed phenomenon that relatively undisturbed environments support communities having large numbers of species with no individual species present in overwhelming abundance. If the species in such a community are ranked on the basis of their numerical abundance, there will be relatively few species with large numbers of individuals, and large numbers of species represented by only a few individuals. Many forms of stress tend to reduce diversity by making the environment unsuitable for some species or by giving other species a competitive advantage.

Throughout certain areas of MSDGC waterways where quality is poor and habitat suitable for fish is severely limited, the numbers of fish collected are so low (Spielman, et al , 1978)⁵ as to make diversity indices insensitive as measures of water quality. Samples containing less than 100 specimens should be evaluated with caution (Weber, 1973).⁶

Part of the water quality survey will lead to a qualitative description of which fish species inhabit which areas of each waterway, including canals and streams, as well as quantitative enumeration of the relative abundance of each major species within selected habitat - typical areas of each waterway.

Methods of Biological Analysis of Waterways

For 1975 during each month in each quarter, samples were collected from one of the three waterway segments, 1st month: North Shore Channel (NSC)/North Branch Chicago River (NBCR), including the main river stem (CR); 2nd month: South Branch Chicago River (SBCR) and the Chicago Sanitary and Ship Canal (CS & SC); 3rd month: Calumet River System including the Little Calumet River (LC-R) and the Cal-Sag Channel (CS-C). This sampling system was changed in 1976 to one where the Chicago River System, including the NSC, NBCR, CR, SBCR, and the CS & SC, was sampled in alternate months with the Calumet River System.

A. Algae

Samples were collected from bridges as surface grabs by the Industrial Waste Division samplers, placed into one-half gallon bottles containing 80 ml of Formalin (37-40% formaldehyde), and delivered iced to the laboratory. At the laboratory these samples were split into two aliquots, one for the analysis of diatoms and the other for the remaining organisms or non-diatoms. Diatoms were separated from other organisms and debris by nitric acid digestion of the sample. After digestion, the acid was diluted and the organisms concentrated by filtration onto a cellulose acetate membrane. After drying, a portion of the filter was cleared with immersion oil on a slide, and examined under the highest possible magnification for identification and counting.

The other aliquot, for non-diatom analysis, was allowed to settle in graduated cylinders after the addition of Ivory Liquid or similar detergent. Concentration of the original sample 200x was accomplished by stepwise settling into smaller cylinders. A tenth milliliter of this concentrate is then examined at the highest possible magnification and the organisms identified and counted.

B. Bacteria

Water samples for bacteriological analysis were collected in sterile one gallon containers with enough sodium thio-sulfate to neutralize 15 mg/l chlorine. All samples were taken one meter below the surface, in the center of the waterway, with a Kemmerer bottle, and transported on ice to the R&D Laboratory. Analyses were begun approximately twenty-four hours after collection. Total coliforms (TC) were estimated and verified according to membrane filter (MF) procedures outlined in Standard Methods for the Examination of Water and Wastewater (1975)⁷ fecal coliform (FC) determinations and verifications were carried out according to the MF technique described by Geldreich et al (1965)⁸. Fecal streptococci (FS) were determined and verified by a technique described by Kenner et al (1960)⁹.

Total plate counts were performed utilizing a MF procedure and plate count agar. Plates were incubated for 48 ± 3 hours at 35°C. Salmonellae were determined utilizing a MPN technique described by Kenner and Clark

(1974)¹⁰ using high temperature incubation (40°C) in Dulcitol Selenite Broth (DSE) for 48 hours. Positive tubes were subcultured to selective medium (Xylose Lysine Desoxycholate) and incubated at 40°C for 24 hours. Suspect colonies are transferred to triple sugar iron agar (TSI). TSI positives able to decarboxylate lysine and unable to deaminate phenylalanine or utilize malonate are considered presumptive Salmonella and are identified biochemically utilizing the API or R/B enteric systems. Confirmation of isolates is performed with polyvalent Salmonella "O" antisera. Verification and further serotyping or approximately 20% of the isolates were performed by the Illinois Department of Public Health.

Pseudomonas aeruginosa analyses were performed according to a MPN procedure in Standard Methods.⁷ Five 10 ml, five 1 ml and five 0.1 ml portions of sample are inoculated into tubes of asparagine enrichment broth. Tubes are incubated for 48 hours at 35°C, and positives are subcultured to acetamide agar and incubated at 35°C for 24-36 hours. Confirmed positives are those indicating acetamide utilization and were used to calculate a MPN.

Staphylococcus aureus were quantified using a MF procedure in Standard Methods.⁷ Samples were filtered and placed on mannitol salt agar. Colonies which ferment mannitol were verified by gram staining and coagulase testing.

C. Benthos

Bottom samples were collected with a 23x23 cm (9x9") Ponar grab at the 18 stations on the three District, major deep draft, waterways (Figure 1). Three replicates were taken at each station and were used to calculate organism numbers per square meter. (The area of the grab was converted to a square meter by taking the number in the Ponar sample times 19.) In the field, these samples were screened immediately with a large U.S. #30 mesh bucket sieve. The debris, including the macroinvertebrates, were placed in gallon containers and transported to the laboratory. There the organisms were removed for sorting and analysis. In situations where large numbers of organisms were collected, estimates of their abundance were made by analyzing aliquots. To measure the sediment oxygen demands in situ at the benthic Stations, a bottom sampler (see Figure 3) similar to the steel chamber (24" long, 14" wide, and 10" deep) designed by the Illinois State Water Survey (Butts, 1974)¹¹ was used. This chamber has a volume of 30.27 liters and covers a bottom area of 0.22 square meters. With 100 feet of 3/4" rubber garden hose and five feet of clear flexible plastic tubing attached, the total volume of water contained within the system is 41.4 liters. The oxygen demand of the sediments was computed using the procedures of the Illinois State Water Survey in Peoria,

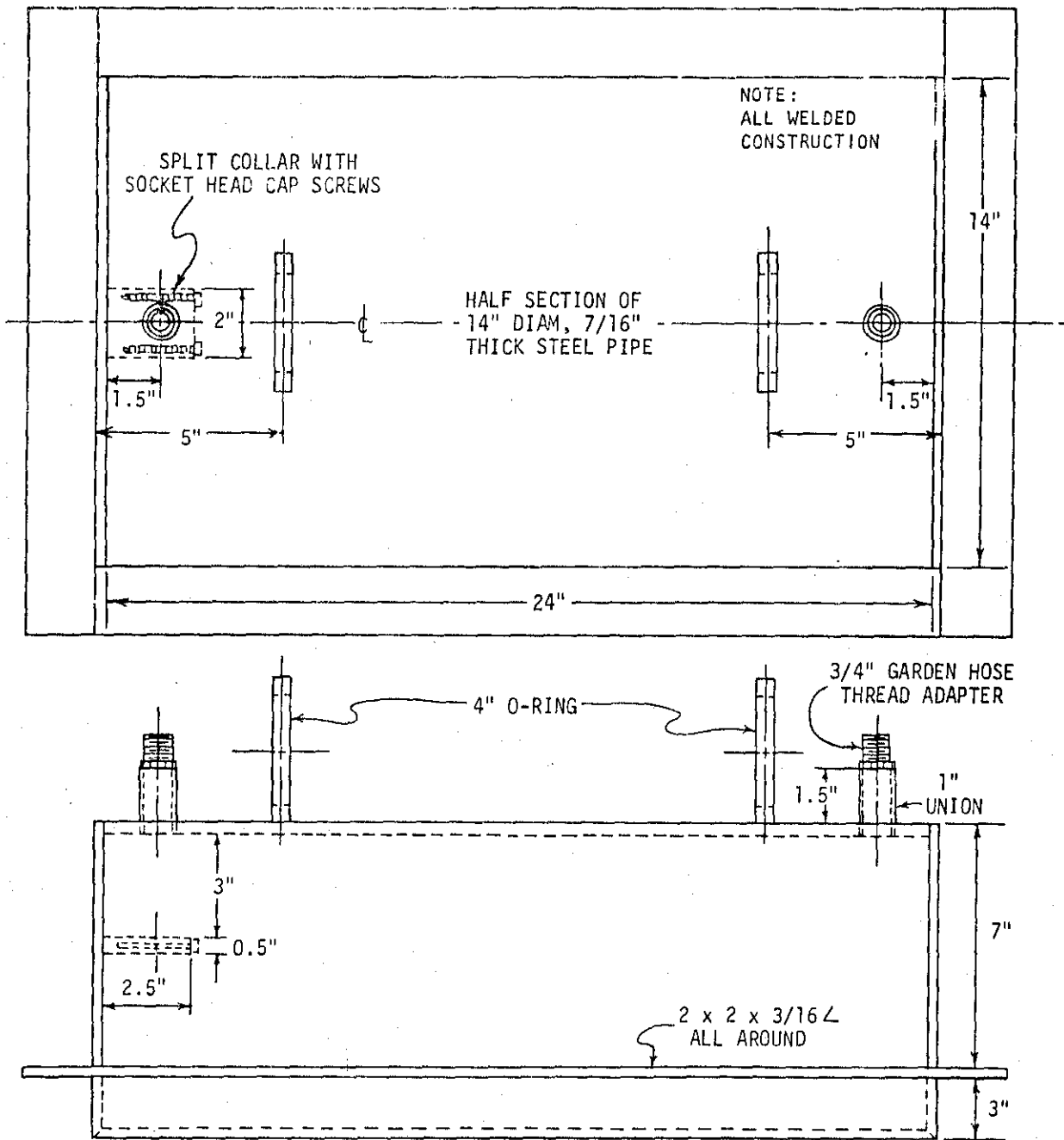


Figure 3 - Sediment oxygen demand bottom sampler (From Butts, 1974)

and reported as grams oxygen per square meter per day ($\text{g m}^{-2} \text{d}^{-1}$) (Butts, 1974)¹¹.

D. Fish

During 1977 all fish were collected by use of a 230 volt alternating current, boat mounted, boom electrofisher followed by a backup boat. The stunned fish were collected with dip nets.

Generally, a 400 meter section of stream was marked off by use of an optical range finder and fish were shocked on both sides of the stream for a total of 800 meters of shoreline. Electrofishing time was noted for all samples.

All large fish collected were identified to species, weighed to the nearest gram, and measured for total length to the nearest millimeter. They were then returned to the stream of capture. Most small fish (less than 80 millimeters total length) were preserved in 10-15% formalin and identified, weighed and measured in the laboratory.

The species diversity index used was that developed by Shannon.¹² It is labeled \bar{d} in this report. Species diversity indices were compared statistically by use of a "t" test¹³ for diversity indices. Numbers of fish species as well as numbers of individuals were compared by use of chi-square evaluation.

RESULTS AND DISCUSSION OF WATERWAYS QUALITY CONDITIONS

Algae

The primary objective of this portion of the study was to define the waterways of the greater Chicago area in terms of the plankton inhabiting them.

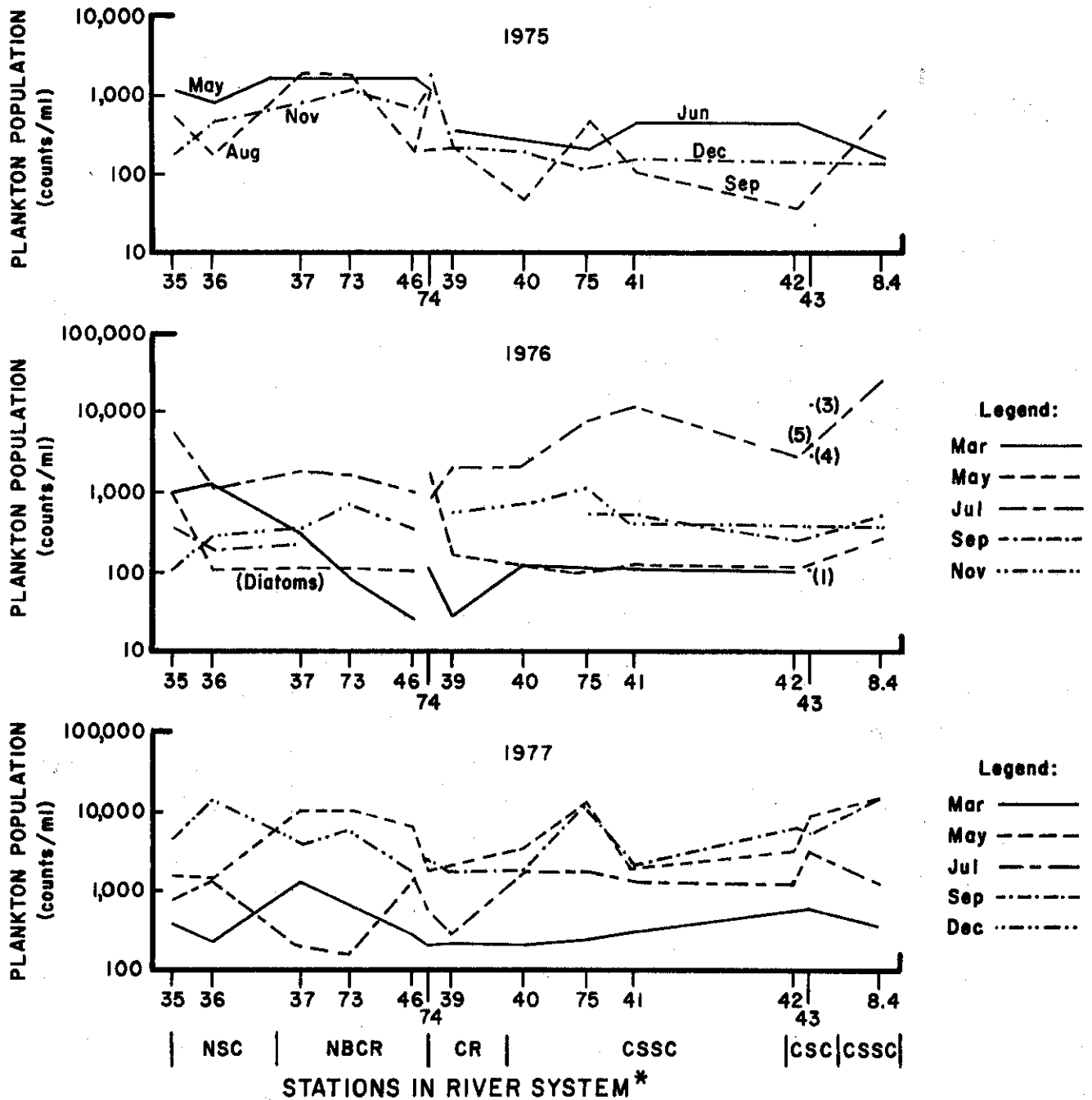
Figures 4 and 5 show variations in average total plankton counts/ml for each month the waterways were sampled. These variations were analyzed by Analysis of Variance (ANOV) and it was shown that no significant differences occur between waterways or between stations along a waterway. A significant difference at the 0.05 level ($F=3.46$ for the North Shore Channel - North Branch Chicago River; $F=4.26$ for the Chicago River - Sanitary and Ship Canal; $F=9.89$ for the Calumet River - Cal-Sag Channel system), however, was demonstrated for mean plankton populations between seasons sampled within each year.

The plankton found in these artificial systems reflect the plankton numbers and species variation found in Lake Michigan.

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AVERAGE PLANKTON POPULATIONS FOR EACH MONTH THE NORTHERN ARTIFICIAL WATERWAYS WERE SAMPLED BY YEAR 1975-1977

Figure 4

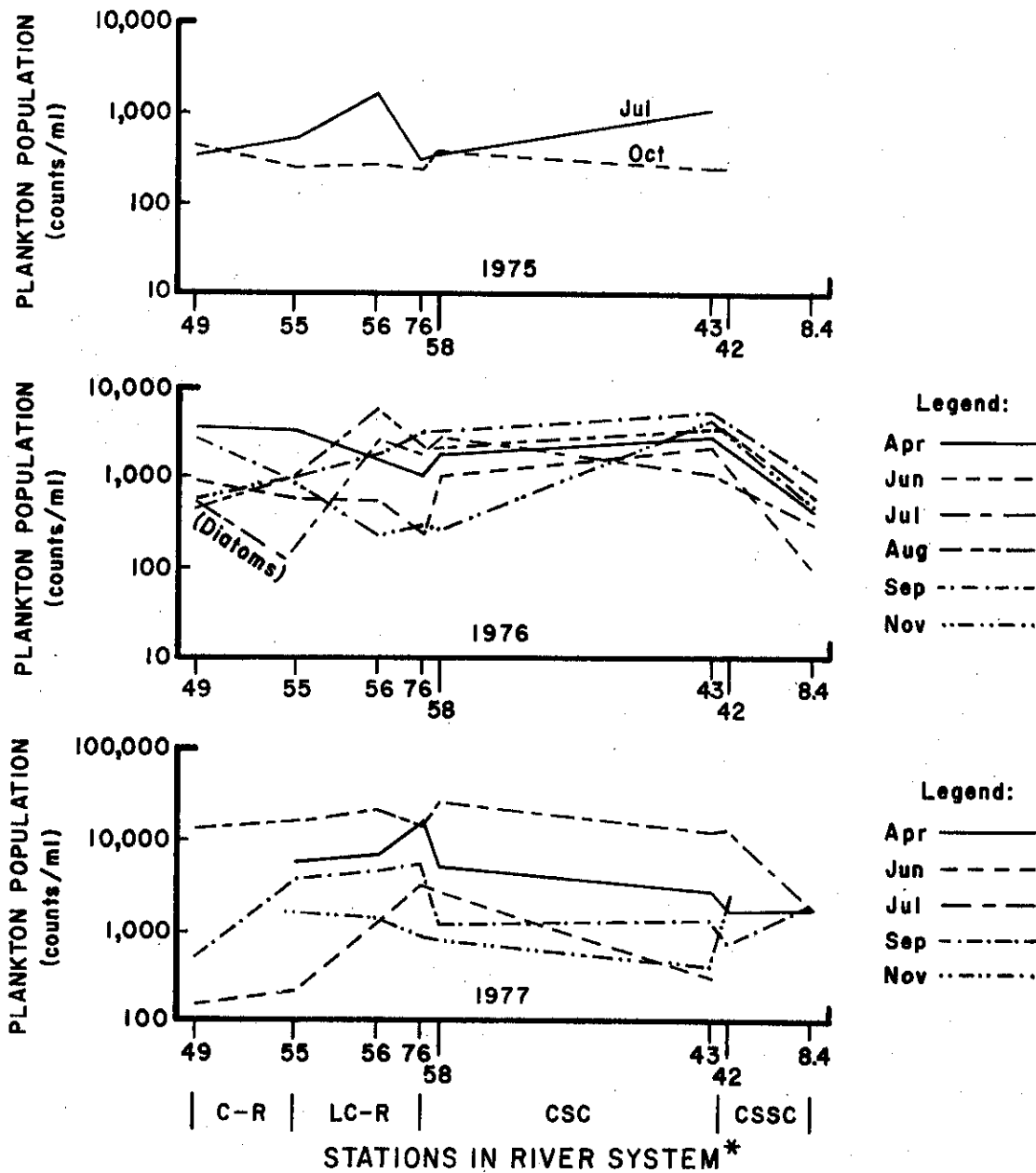


* NSC=North Shore Channel; NBCR=North Branch Chicago River; CR=Chicago River; CSSC=Chicago Sanitary and Ship Canal; CSC=Cal-Sag Channel.

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AVERAGE PLANKTON POPULATIONS FOR EACH MONTH THE SOUTHERN ARTIFICIAL WATERWAYS WERE SAMPLED BY YEAR 1975-1977

Figure 5



* C-R=Calumet River; LC-R=Little Calumet River; CSC=Cal-Sag Channel; CSSC=Chicago Sanitary and Ship Canal.

Bacteria

Geometric means of the various bacteriological parameters monitored during 1977 on the North Shore Channel and North Branch of Chicago River, Chicago River, Sanitary and Ship Canal, and the Calumet River are presented in Tables 2 , 3 and 4 . Stations were sampled three or four times during the year with the exception of Station 46 Grand Avenue which was sampled only once on three occasions. Chicago Avenue was sampled instead of Grand Avenue.

Among the indicators, fecal coliform, fecal streptococcus and total plate count demonstrated a general increase with distance from Lake Michigan in the three waterways sampled. These increases represent a trend and not necessarily an increase from individual stations. This trend was interrupted on the North Shore Channel by discharge from the North Side Sewage Treatment Plant, FC, FS and TPC counts in the effluent being lower than that in the channel upstream of the plant. This decrease in counts immediately downstream of the NSTP was also noted in 1975 and 1976. Total coliform indicated no general trend in the NSC-NBCR, but in the Calumet-Cal-Sag and the Chicago River- Sanitary and Ship Canal it indicated a general tendency to increase with increasing distance from the lake.

Staphylococcus aureus data did not indicate a trend in any of the waterways. Pseudomonas aeruginosa data in the NBCR-NSC showed an increase with distance from Lake Michigan, and a slight decrease due to the dilution from the discharge of the NSTP. In the

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TABLE 2

BACTERIAL COUNTS PER 100 ML GEOMETRIC AVERAGE OF
3/24/77, 6/7/77, 9/8/77, AND 12/6/77

Sample Runs - North Shore Channel and North Branch of Chicago River

Station	TC	FC	FS	TPC	P. aeruginosa	S. aureus	Salmonella
35	2.6×10^4	4.7×10^2	4.1×10^2	1.6×10^6	8.6×10^2	2.3×10^3	$< 5.6 \times 10^{-2}$
36	3.2×10^3	3.4×10^1	9.7×10^1	4.4×10^5	3.4×10^2	$< 2.2 \times 10^2$	$< 6.0 \times 10^{-2}$
37	7.7×10^4	1.0×10^3	1.2×10^3	5.1×10^6	6.9×10^3	$< 7.3 \times 10^1$	$< 1.0 \times 10^{-1}$
73	9.3×10^4	1.2×10^3	2.6×10^3	6.2×10^6	3.9×10^3	6.9×10^2	$< 6.0 \times 10^{-2}$
46	3.0×10^3	2.5×10^2	1.3×10^2	3.8×10^7	$\geq 2.4 \times 10^5$	$< 1.0 \times 10^2$	8.0×10^{-2}

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TABLE 3

BACTERIAL COUNTS PER 100 ML GEOMETRIC AVERAGE OF
1/25/77, 4/19/77, 7/6/77, AND 10/18/77

Sampling Runs - Chicago River and Sanitary and Ship Canal

Station	TC	FC	FS	TPC	P.aeruginosa	S.aureus	Salmonella
74	1.2×10^3	6.5×10^1	5.2×10^1	9.1×10^5	2.3×10^2	$< 2.2 \times 10^2$	$< 1.0 \times 10^{-1}$
39	4.1×10^4	1.2×10^3	4.8×10^3	1.3×10^7	1.4×10^4	$< 7.0 \times 10^2$	$< 1.6 \times 10^{-1}$
40	8.3×10^4	3.3×10^3	5.4×10^3	2.1×10^7	1.1×10^4	6.4×10^3	5.9×10^{-1}
22 75	1.5×10^5	1.9×10^3	1.7×10^4	1.8×10^7	1.5×10^4	$< 2.5 \times 10^3$	2.5×10^{-1}
41	8.7×10^4	2.6×10^3	7.1×10^3	1.6×10^7	1.8×10^4	2.1×10^3	5.7×10^{-1}
42	$> 1.2 \times 10^6$	9.5×10^4	2.8×10^3	1.6×10^8	1.9×10^4	$< 4.6 \times 10^1$	8.1×10^{-2}
8.4	5.3×10^4	1.6×10^3	5.5×10^2	7.8×10^6	1.3×10^4	$< 1.3 \times 10^2$	2.7×10^{-1}

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TABLE 4

BACTERIAL COUNTS PER 100 ML GEOMETRIC AVERAGE OF
2/17/77, 6/21/77, 9/20/77, 11/15/77

<u>Sampling Runs - Calumet River</u>							
Station	TC	FC	FS	TPC	P.aeruginosa	S.aureus	Salmonella
49	1.3×10^3	5.0×10^1	9.9×10^2	2.9×10^5	1.3×10^3	$< 9.6 \times 10^1$	5.0×10^{-2}
55	1.3×10^3	1.0×10^2	3.0×10^2	3.1×10^6	6.5×10^2	$< 1.8 \times 10^2$	$< 7.5 \times 10^{-2}$
56	6.5×10^4	3.8×10^3	2.5×10^3	1.1×10^8	5.7×10^3	$< 5.1 \times 10^2$	2.3×10^{-1}
Σ 76	$> 1.3 \times 10^5$	1.6×10^4	1.3×10^4	1.3×10^7	1.6×10^4	2.1×10^3	1.4×10^{-1}
58	3.7×10^5	5.2×10^3	2.8×10^3	2.1×10^7	9.7×10^3	$< 2.3 \times 10^3$	1.0×10^{-1}
43	1.3×10^5	6.1×10^3	8.2×10^2	1.0×10^6	1.3×10^4	$< 2.7 \times 10^1$	2.0×10^{-1}

Chicago River - Sanitary and Ship Canal Pseudomonas aeruginosa increased approximately 2 orders of magnitude between Station 74 (Outer Drive) and Station 39 (Madison) and remained relatively stable downstream of that station. Pseudomonas aeruginosa counts demonstrated no trend in the Calumet River.

Salmonella was recovered in 6 of 19 samples on the NBCR-NSC, 18 of 26 samples on the CR-CS&SC and 18 of 23 samples on the CR-CSC system. Concentrations were in all cases low, nowhere exceeding a geometric mean of 5.9×10^{-1} /100 ml. Results of Salmonella serotyping by the Illinois Public Health Department are shown in Table 5. Sixty-eight percent of the isolates were among the ten most commonly isolated from clinical samples in 1977. Similar results were obtained in 1975 and 1976.

Confirmation data for the indicators are presented in Table 6. Of the 355 typical total coliform colonies picked for confirmation 227 confirmed for a confirmation rate of 64%. This compares with a rate of 68% in 1975 and 75% in 1976. These results are typical for total coliforms and indicate that approximately 60-70% of all typical total coliform colonies are indeed total coliforms. Of the 361 fecal coliform colonies picked 341 confirmed for a confirmation rate of 94%. This compared with 91% and 94% for 1975 and 1976 respectively. Of the 315 fecal streptococcus colonies picked for confirmation a total of 280, or 89%, confirmed. This compares to rates of 86% in 1975 and 99% in 1976. The 1977 fecal coliform and fecal streptococcus confirmation rates are typical although the fecal streptococcus rate (89%) is a little lower than usually reported (95-99%).

METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 5

1977 WATERWAYS BACTERIOLOGICAL STUDY
SALMONELLA SEROTYPING RESULTS

Serotype	Number Isolated
Agona	12
Enteritidis	12
Newport	6
Infantis	4
Tennessee	3
Havana	2
Saint Paul	2
Bovismorbiticans	2
Simsbury	2
Derby	2
Chester	1
Uphill	1
Ohio	1
Thomson	1
Typhimurium	1
Dry pool	1
Java	1
Heidelberg	1
Untyped	1
Total	56

METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 6

1977 WATERWAYS BACTERIOLOGY STUDY
COLONY CONFIRMATIONS

	<u>Colonies Confirmed</u> <u>Colonies Picked</u>	% Confirmed
Total Coliform	227/355	64
Fecal Coliform	341/361	94
Fecal Streptococcus	280/315	89

Benthos

The 1977 benthic data are reported herein on a station-by-station basis Tables 7, 8 and 9 .

CHICAGO RIVER SYSTEM

As this waterway proceeds downstream, the influence of the cleaner waters from Lake Michigan are rapidly nullified by the wastewaters from tributaries and combined sewer overflows. The variety of benthic macroinvertebrates found at the upstream stations decreases until only oligochaetes, mainly tubificids, are present. When these pollution tolerant organisms are present in large numbers and/or make-up more than 80 percent of the total population, heavy pollution is indicated.

Station 35, Lincoln Street (North Shore Channel)

Lincoln Street is located in the North Shore Channel 0.88 miles downstream of the sluice gate at Wilmette. The bottom is composed of debris and sludge. Four taxa were found at this station: oligochaetes, midges, isopods and snails. Seventy-five percent of the total were oligochaetes (Table 8). This particular balance among the benthic macroinvertebrate community indicates a poor water quality.

Station 36, Touhy Avenue (North Shore Channel)

Touhy is located 0.56 miles downstream from the discharge of the North Side Sewage Treatment Plant and four miles downstream of Lincoln Street. The bottom is composed of sand, clay, and sludge. Four taxa were collected at this station: oligochaetes, midges, isopods, and mothflies. Ninety-nine percent of the speci-

METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 7

ABUNDANCE OF BENTHIC MACROINVERTEBRATES
AT STATIONS ON THE NORTH SHORE CHANNEL,
NORTH BRANCH OF THE CHICAGO RIVER,
AND THE CHICAGO RIVER FOR 1977

Station Name	Number	River System	Benthic Macroinvertebrates Per Square Meter							%Oligochaeta
			Oligochaeta (aquatic worms)	Hirudinea (leeches)	Chironomidae (midges)	Amphipoda (scuds)	Isopoda (sow bugs)	Pelecypoda (clams)	Other	
Lincoln Street	35	Channel	15,000		5,000		10	38	6 ¹	75
-----NSTP Outfall-----										
Touhy Avenue	36	Channel	250,000		300		2,600		65 ²	99
Wilson Avenue	37	North Branch	160,000		300		70		266 ¹	>99
Diversey Avenue	73	North Branch	99,000		67		95			>99
Grand Avenue	46	North Branch	50,000		16		3			>99
Outer Drive	74	Chicago	1,600	25	230	10	3	70	6 ¹	82

1 Gastropoda (snails)

2 Psychodidae (mothflies)

METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 8

ABUNDANCE OF BENTHIC MACROINVERTEBRATES
AT STATIONS ON THE SOUTH BRANCH OF THE CHICAGO RIVER
AND THE CHICAGO SANITARY AND SHIP CANAL FOR 1977

Station		River System	Benthic Macroinvertebrates Per Square Meter				
Name	Number		Oligochaeta (aquatic worms)	Chironomidae (midges)	Psychodidae (sewage flies)	Pelecypoda (clams)	%Oligochaeta
Madison Avenue	39	South Branch	110,000	3		86	>99
Damen Avenue	40	Chicago Sanitary	3,900				100
Cicero Avenue	75	Chicago Sanitary	110,000		3		>99
-----SWTP Outfall-----							
Harlem Avenue	41	Chicago Sanitary	350,000				100
Route 83	42	Chicago Sanitary	9,100				100
16th Street	8.4	Chicago Sanitary	26,000				100

METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 9

ABUNDANCE OF BENTHIC MACROINVERTEBRATES
AT STATIONS ON THE CALUMET RIVER,
LITTLE CALUMET RIVER, AND THE CAL-SAG CHANNEL FOR 1977

Station		River System	Benthic Macroinvertebrates Per Square Meter						
Name	Number		Oligochaeta (aquatic worms)	Hirudinea (leeches)	Chironomidae (midges)	Psychodidae (sewage flies)	Amphipoda (scuds)	Pelecypoda (clams)	%Oligochaeta
Ewing Avenue	49	Calumet	78,000	220	10		3	92	>99
Norfolk&Western Ry	(55) *	Calumet	540	10	32				93
Indiana Avenue	56	Little Calumet	4,000	6	2,300		3	1,300	53
-----CTP Outfall-----									
Halsted Street	76	Little Calumet	59,000						100
Ashland Avenue	58	Cal-Sag Channel	160,000		26	3			>99
Route 83	43	Cal-Sag Channel	48,000						100

* Upstream of 130th St. (Station #55).

mens collected were aquatic worms (Table 7). This community domination by aquatic worms indicates a response to moderate organic enrichment. At Station 36, the mean total density of organisms for the two sampling dates (June and September) was more than 250,000 per square meter, the largest number present in this area.

Station 37, Wilson Avenue (North Branch, Chicago River)

This station, located four miles below the North Side outfall and 0.7 miles downstream from the junction of the channel and North Branch, also supported a depressed benthic macroinvertebrate community. The bottom here is composed of sand with some sludge and debris present. The four taxa collected at this station, oligochaetes, midges, isopods and snails, are considered to be highly tolerant of organic enrichment. More than 99% of these specimens were aquatic worms. The mean total density of these macroinvertebrates from the two sampling dates (June and September) amounted to 160,000 organisms per square meter (Table 7).

Station 73, Diversey Avenue (North Branch, Chicago River)

Diversey is located 3.3 miles downstream of the Junction. The bottom is composed of mainly sludge. Three kinds of benthic macroinvertebrates were collected at this point; aquatic worms, midges, and isopods. More than 99% of the organisms found were pollution-tolerant aquatic worms. The mean total density of organisms for the three sampling periods was 99,000 per square meter (Table 7). The high number of oligochaetes and the low

number of taxa suggest a highly stressed community.

Station 46, Grand Avenue (North Branch, Chicago River)

The bottom here consists of sludge and debris. The benthic macroinvertebrate community at this station was similar in numbers and kinds to the Diversey Station above. Only aquatic worms (50,000 organisms per square meter), chironomids, and isopods were present (Table 7), indicating an area under heavy stress.

Station 74, Outer Drive (Chicago River)

The "Outer Drive" is located near the MSDGC Lock 0.2 miles from Lake Michigan. Here the bottom consists of clay with a large number of empty fingernail clam (Sphaerium sp.) shells. Six taxa of macroinvertebrates were present here: aquatic worms, leeches, midges, isopods, amphipods, and clams, indicating an acceptable water quality. This was the only station of the six sampled in which amphipods and clams were present. The mean total density for the two sampling dates (June and September) was more than 1,900 organisms per square meter, 82% of which were aquatic worms (Table 7).

Station 39, Madison (South Branch, Chicago River)

Madison is located on the South Branch of the Chicago River near the Chicago downtown area. The bottom is composed of mostly black, oily sludge with some sand, debris, and numerous empty fingernail clam (Sphaerium sp.) shells. The oligochaetes (aquatic worms), 110,000 organisms per square meter, made up more than 99 percent of the benthic macroinvertebrate community. A few (live) clams and midges were present (Table 8).

Station 40, Damen (Chicago Sanitary & Ship Canal)

Damen is about four miles downstream from Madison on the South Branch of the Chicago River. The bottom is mostly black sludge and clay with some vegetative debris. The benthic macroinvertebrate community was greatly reduced from the previous station. No clams or midges were found during the summer run. Only oligochaetes were present numbering 3,900 organisms per square meter (Table 8).

Station 75, Cicero (Chicago Sanitary & Ship Canal)

Cicero is located four miles downstream of Station 40 (Damen) on the Chicago Sanitary and Ship Canal. The bottom is composed of black sludge with some sand, charcoal and much vegetative debris. Anaerobic conditions were especially noticeable because of the extensive bubbling action present. Only tubificids (110,000 organisms per square meter) and three sewage flies ($3/m^2$) were found present here (Table 8).

Station 41, Harlem (CS & SC)

This station, Harlem, is located on the Chicago Sanitary and Ship Canal about 15 miles downstream of the West-Southwest Treatment Plant outfall. This treatment plant effluent represents a very sizeable quantity of water entering the system. On the bottom in this area organic material is present in the form of extensive black sludge beds, apparently providing enough food to support a large standing crop of worms. Only the worms were present numbering 350,000 organisms per square meter (Table 8).

Station 42, Route 83 (CS & SC)

Route 83 is about 10 miles downstream of Station 41 (Harlem) on the Chicago Sanitary and Ship Canal. The bottom is composed of mostly rock, gravel, and sand darkened by oily material. Because of the hard bottom material some difficulty in collecting samples was experienced. The tubificids were the only benthic macroinvertebrates present. Their numbers were considered low at 9,100 organisms per square meter (Table 8).

Station 8.4, 16th Street (CS & SC)

This station, 16th Street, is approximately 11 miles downstream of Cal-Sag Junction, the confluence of the Chicago and Calumet River Systems, and one mile upstream of the locks at Lockport on the Chicago Sanitary and Ship Canal. The bottom is composed of black sludge with clay. Very little residue remains from a sample screened through a U.S. Number 30 sieve. The aquatic worms were the only benthic macroinvertebrates present, numbering 26,000 organisms per square meter (Table 8).

As can be seen from the data from individual stations, the influence of the cleaner waters from Lake Michigan on the Chicago River Systems are rapidly nullified by the wastewaters from tributaries and combined sewer overflows. The variety of benthic macroinvertebrates found at the upstream stations decreases until only oligochaetes, mainly tubificids, are present. When these pollution tolerant organisms are present in large numbers and/or make up more than 80 percent of the total population, heavy pollution is indicated.

Station 49, Ewing (Calumet River)

Ewing is located near the mouth of Calumet Harbor on the Calumet River. The bottom is composed mostly of clay with some gravel and rocks, making sampling difficult. Aquatic worms numbered 78,000 organisms per square meter, making up more than 99% of the benthic macroinvertebrates present. Other organisms present were the leeches and the fingernail clams, Sphaerium sp. (Table 9).

(Station 55), Norfolk & Western Ry. (Calumet River)

This station, Norfolk & Western Ry. is located about one-half mile upstream of the O'Brien Lock on the Calumet River. The bottom consists of mostly clay and mud with numerous clam shells. The oligochaetes made up 93 percent of the benthic macroinvertebrate community during this time (August and November 1977). Leeches and midges were also present, but in small numbers (Table 9).

Station 56, Indiana (Little Calumet River)

Indiana Station is located on the Little Calumet River about 4 miles downstream of the O'Brien Lock. The bottom is composed of mostly gray clay. The oligochaetes, 4,000 organisms per square meter, made up 53 percent of the benthic macroinvertebrate community in this area at the times (August and November 1977) sampled. In addition to the worms, there were midges, leeches, fingernail clams, and amphipods present in the area (Table 9).

Station 76, Halsted (Little Calumet River)

This station, Halsted, is located 1-1/2 miles downstream of the Calumet Treatment Plant outfall on the Little Calumet River. The bottom here consists mostly of clay. The aquatic worms (oligochaetes) were the only organisms present, numbering 59,000 organisms per square meter (Table 9).

Station 58, Ashland (Cal-Sag Channel)

Ashland Station is located one mile downstream of Station 76 (Halsted) at the Junction on the Cal-Sag Channel. The bottom is composed mostly of sludge and debris (coal, etc.) In addition to the 160,000 aquatic worms per square meter found here, only one midge (3 per square meter) was present (Table 9).

Station 43, Route 83 (Cal-Sag Channel)

This station, Route 83, is located near Sag Junction, the confluence with the Chicago Sanitary and Ship Canal (Station 42). The bottom consists mostly of sludge. The numbers of aquatic worms present in this location were much lower than at the previous site. The worms numbered 48,000 organisms per square meter (Table 9).

The Calumet Waterway System starts near the mouth of the Calumet Harbor and flows past numerous steel, oil, and other large industrial concerns before meeting at Sag Junction with the Chicago Sanitary and Ship Canal. The flow in the Calumet River System, is low in both volume and velocity. As can be seen from the individual station data, tubificids (oligochaetes) were the most abundant macroinvertebrates throughout the system. They comprised 53 - 100% of the invertebrates (Table 9). Also present,

METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 10

1977 WATERWAYS SEDIMENT OXYGEN DEMAND VALUES

Station	Date	Water Temp (°C)	DO (mg/l)	SOD g/m ² /day
Lincoln (NSC)	7/22/77	20.5	7.4	8.90
Touhy (NSC)	8/2/77	23.0	5.4	5.11
Wilson (NBCR)	7/19/77	25.0	3.0	8.91
Diversey (NBCR)	7/28/77	24.0	2.0	8.97
Grand (NBCR)	11/16/77	14.5	3.6	9.33
Jackson (SBCR)	7/26/77	23.5	1.4	-*
Damen (CSSC)	11/17/77	13.0	1.7	-*
Cicero (CSSC)	11/18/77	15.5	3.0	2.59
Harlem (CSSC)	8/11/77	25.5	2.6	12.98
Rt. 83 (CSSC)	10/24/77	18.5	0.6	-*
16th St. (CSSC)	10/25/77	18.5	2.6	8.29
Ewing (CR)	9/27/77	17.5	6.6	4.97
N & WRR (CR)	8/19/77	24.5	4.2	6.11
Indiana (LCR)	9/30/77	19.5	5.3	7.17
Ashland (CSC)	9/28/77	20.0	1.4	-*
Rt. 83 (CSC)	10/20/77	15.0	1.1	-*

* Initial DO was too low to determine an in situ SOD.

although in small numbers, were the midges, fingernail clams, leeches, and amphipods.

Sediment Oxygen Demand

Six successful in situ SOD runs were made during the summer months and five during the fall (Table 10). The D.O. was above 5.0 mg/l at only 2 of the stations examined during the summer runs (Lincoln/Touhy) and 2 during the fall runs (Ewing/Indiana). The summer water temperatures ranged from 20.5 to 25.5°C while the fall water temperatures ranged from a low 13.0°C to a high 20.0°C. The highest SOD ($12.989 \text{ m}^{-2}\text{d}^{-1}$) occurred during the summer at Harlem on the Chicago Sanitary & Ship Canal. Grand Avenue with a SOD rate of $9.33 \text{ mg}^{-2}\text{d}^{-1}$ had the highest for those stations examined during the fall.

Fish

During 1977 fish were sampled from the Chicago Channel System including the Northshore Channel, North and South Branches of the Chicago River, the Chicago River, the Sanitary and Ship Canal, the Calumet-Sag Channel, the Little Calumet and Calumet River, as well as from the Lower Des Plaines River and Kankakee River (see Figure 2).

Two separate collections were made throughout the system, one in late spring and early summer and one in the fall. Results of these collections in terms of the number of individuals of each species collected per 30 minutes electro-fishing, as well as total numbers and weight of catch per 30 minutes electrofishing, are listed in Tables 11 - 16. Station numbers corresponding

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 11

NUMBER OF FISH COLLECTED WITHIN THE KANKAKEE RIVER, DES PLAINES RIVER
AND CHICAGO SANITARY AND SHIP CANAL DURING 1977

Species Collected	WATERWAY AND RIVER MILE											
	Kankakee River		Des Plaines River				Sanitary and Ship Canal ³					
	RM 274 ¹		RM 274		RM 288.7		RM 290.1		RM 290.1		RM 292.1	
	(Wilmington)		(Dresden Hts.)		(Joliet)		(Lockport)		(Lockport)		(16th St.)	
	(1) ²	(2)	(2)	(3) Date Collected	(4)	(5)	(6)					
	Jul.11	Oct.26	Jul.11	Oct.26	Jul.14	Oct.31	Jul.14	Oct.31	Jul.15	Oct.31	Jul.15	Oct.24
Skipjack herring	1.38	-	1.27	-	-	-	-	-	-	-	-	-
Gizzard shad	229.82	74.22	27.89	9.24	-	2.03	-	8.88	-	-	-	-
Goldfish	1.38	0.49	12.68	7.12	1.37	6.10	24.48	-	-	-	0.51	0.74
Carp	22.02	3.93	34.23	11.30	16.43	12.20	50.84	12.22	-	-	9.67	-
Carp x goldfish hybrid	1.38	0.49	8.87	6.16	6.84	2.03	0.94	6.66	-	-	-	-
Hornyhead chub	-	0.49	-	-	-	-	-	-	-	-	-	-
Emerald shiner	-	10.32	10.14	61.61	-	-	0.94	1.11	-	-	-	-
Spotfin shiner	1.38	1.48	-	-	-	-	-	-	-	-	-	-
Sand shiner	-	0.98	-	-	-	-	-	-	-	-	-	-
Bluntnose minnow	-	3.93	-	-	-	-	7.53	7.77	-	-	-	-
Bullhead minnow	16.51	6.39	-	-	-	-	-	-	-	-	-	-
Quillback	5.51	1.97	-	1.03	-	-	-	-	-	-	-	-
Whitesucker	-	-	-	1.03	-	-	-	1.11	-	-	-	-
Northern redhorse	6.88	10.32	-	6.16	-	-	-	-	-	-	-	-
Channel catfish	1.38	-	-	-	-	-	-	-	-	-	-	-
Trout-perch	-	0.49	-	-	-	-	-	-	-	-	-	-
Rock bass	4.13	-	-	-	-	-	-	-	-	-	-	-
Green sunfish	-	0.98	-	-	-	-	2.82	1.11	-	-	-	-
Pumpkinseed sunfish	4.13	-	-	-	-	-	-	-	-	-	-	-
Orangespotted sunfish	1.38	3.44	-	-	-	-	-	-	-	-	-	-
Bluegill	2.75	3.44	-	-	-	-	-	-	-	-	-	-

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 11 continued

NUMBER OF FISH COLLECTED WITHIN THE KANKAKEE RIVER, DES PLAINES RIVER
AND CHICAGO SANITARY AND SHIP CANAL DURING 1977

Species Collected	WATERWAY AND RIVER MILE											
	Kankakee River		Des Plaines River				Sanitary and Ship Canal 3					
	RM 274 ¹ (Wilmington) (1) ²	RM 274 (Dresden Hts.) (2)	RM 288.7 (Joliet)	(3) Date Collected (4)		RM 290.1 (Lockport)	RM 290.1 (Lockport)	(5)		RM 292.1 (16th St.) (6)		
Jul.11	Oct.26	Jul.11	Oct.26	Jul.14	Oct.31	Jul.14	Oct.31	Jul.15	Oct.31	Jul.15	Oct.24	
Northern longear sunfish	4.13	3.93	-	-	-	-	-	-	-	-	-	-
Smallmouth bass	-	3.93	-	-	-	-	-	-	-	-	-	-
Largemouth bass	1.38	5.90	-	-	-	-	-	-	-	-	-	-
White crappie	-	0.49	-	-	-	-	-	-	-	-	-	-
Black crappie	-	0.49	-	-	-	-	-	-	-	-	-	-
Log perch	-	0.49	-	-	-	-	-	-	-	-	-	-
Total catch per 30 minutes shocking	305.51	138.61	95.07	103.71	24.64	22.37	87.55	38.87	0.00	0.00	10.18	0.74
Total weight of catch per 30 minutes shocking in kilograms	21.81	11.96	14.21	10.09	5.32	2.17	25.55	10.99	0.00	0.00	0.15	0.09

1. River miles from confluence of Illinois waters with the Mississippi River at Grafton, Ill. (Corps of Engineers milepoint designations).
2. Sample Station Numbers are listed in parantheses.
3. To mile 303.5, The Cal-Sag/Sag-Ship Canal junction.
4. Number of fish taken per 30 minutes of electrofishing (boat shocker - 230 volt AC)

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 12

NUMBER OF FISH COLLECTED WITHIN THE SANITARY AND SHIP CANAL
AND SOUTH BRANCH OF THE CHICAGO RIVER DURING 1977

Species Collected	WATERWAY AND RIVER MILE											
	Sanitary and Ship Canal						So. Br. Chicago River					
	RM 304 ¹ (Rt.83)		RM 307.9 (Willow Springs Rd.)		RM 314 (Harlem Ave.)		RM 317 (Cicero Ave.)		RM 321 (Damen Ave.)		RM 325.3 (Madison St.)	
	(7) ²		(8)		(9) Date Collected		(10)		(11)		(12)	
Jun.20	Oct.27	Jun.20	Oct.27	Jul.27	Nov.2	Jul.27	Nov.2	Jul.21	Nov.2	Jul.21	Nov.2	
Goldfish	-	-	1.18 ³	-	-	-	-	-	-	-	-	-
Carp	-	-	2.35	-	-	2.52	5.60	-	-	-	-	-
Total catch per 30 minutes shocking	0.00	0.00	3.53	0.00	0.00	2.52	5.60	0.00	0.00	0.00	0.00	0.00
Total weight of catch per 30 minutes shocking in kilograms	0.00	0.00	0.68	0.00	0.00	1.64	0.65	0.00	0.00	0.00	0.00	0.00

1. River miles from confluence of Illinois Waterway with the Mississippi River at Grafton, Ill. (Corps of Engineers milepoint designations).
2. Sample station numbers are listed in parentheses.
3. Number of fish taken per 30 minutes of electrofishing (boat shocker - 230 volt AC).

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 13

NUMBER OF FISH COLLECTED WITHIN THE BRANCHES
AND MAIN CHANNEL OF THE CHICAGO RIVER DURING 1977

Species Collected	WATERWAY AND RIVER MILE											
	SBCR/NBCR ¹ RM 325.5 ² (Kinzie St.)		CR Locks RM 327		North Branch Chicago River						NBCR/NSC RM 333.5 (Junction)	
	(13)		(14)		RM 326 (Grand Ave.)		RM 330 (Diversey Ave.)		RM 332.5 (Wilson Ave.)		(18)	
	Jul.28	Nov.10	Jul.21	Nov.2	(15) Date Collected		(16)		(17)		Jul.28	Nov.4
Rainbow trout	-	-	-	0.93 ⁴	-	-	-	-	-	-	-	-
Chinook salmon	-	-	-	0.93	-	-	-	-	-	-	-	-
Goldfish	2.42	-	-	-	-	-	1.90	-	1.21	-	25.31	10.55
Carp	2.42	-	1.54	5.58	-	-	-	-	3.62	-	3.89	1.32
Carp x goldfish hybrid	-	-	-	-	-	-	-	-	-	-	-	1.32
Golden shiner	-	-	-	-	-	-	-	-	-	-	0.97	-
Bluntnose minnow	-	-	4.63	-	-	-	-	-	-	-	-	-
Bullhead minnow	-	-	-	-	-	-	-	-	-	-	0.97	-
Black bullhead	-	-	3.09	-	-	-	-	-	-	-	6.81	-
Rock bass	-	-	14.66	-	-	-	-	-	-	-	-	-
Green sunfish	-	-	-	-	-	-	-	-	-	-	5.84	-
Pumpkinseed sunfish	-	-	-	-	-	-	-	-	-	-	2.92	-
Orangespotted sunfish	-	-	2.32	-	-	-	-	-	-	-	23.36	-
Bluegill	-	-	-	-	-	-	-	-	-	-	5.84	-

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 13 continued

NUMBER OF FISH COLLECTED WITHIN THE BRANCHES
AND MAIN CHANNEL OF THE CHICAGO RIVER DURING 1977

Species Collected	WATERWAY AND RIVER MILE											
	SBCR/NBCR ¹ RM 325.5 ² (Kinzie St.)		CR Locks RM 327		North Branch Chicago River						NBCR/NSC RM 333.5 (Junction)	
	(13)		(14)		RM 326 (Grand Ave.)		RM 330 (Diversey Ave.)		RM 332.5 (Wilson Ave.)		(18)	
	Jul.28	Nov.10	Jul.21	Nov.2	Jul.21	Nov.4	Jul.28	Nov.4	Jul.28	Nov.4	Jul.28	Nov.4
Largemouth bass	-	-	-	-	-	-	-	-	-	-	1.95	-
Black crappie	-	-	0.77	-	-	-	-	-	-	-	-	-
Total catch per 30 minutes shocking	4.84	0.00	27.01	7.44	0.00	0.00	1.90	0.00	4.83	0.00	77.86	13.19
Total weight of catch per 30 minutes shocking in kilograms	0.85	0.00	7.85	29.60	0.00	0.00	0.23	0.00	1.93	0.00	8.98	1.54

1. SBCR - South Branch Chicago River; NBCR - North Branch Chicago River; CR - Chicago River; NSC - North Shore Channel
2. River Miles from confluence of Illinois Waterway with The Mississippi River at Grafron, Ill. (Corps of Engineers milepoint designations).
3. Sample station numbers are listed in parenthesis.
4. Number of fish taken per 30 minutes of electrofishing (boat shocker - 230 volt AC).

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 14

NUMBER OF FISH COLLECTED WITHIN
THE NORTH SHORE CHANNEL DURING 1977

Species Collected	NORTH SHORE CHANNEL									
	RM 334.6 ¹ (Peterson Ave.) (19) ²		RM 335.6 (Touhy Ave.) (20)		RM 339 (Dempster St.) (21)		RM 342 (Lincoln St.) (22)		RM 342.6 (Wilmette Lock) (23)	
	Jul.28	Nov.4	Jul.22	Nov.4	Jul.29	Nov.3	Jul.29	Nov.3	Jul.29	Nov.3
Alewife	-	-	-	-	-	-	-	-	-	38.54 ³
Brown trout	-	-	-	-	-	-	-	-	-	9.07
Goldfish	-	-	-	-	10.08	-	4.98	67.55	1.82	21.54
Carp	-	-	-	-	4.03	-	4.98	3.65	-	-
Carp x goldfish hybrid	-	-	-	-	-	-	3.32	1.83	3.64	-
Golden shiner	-	-	-	-	-	-	-	-	1.82	1.13
Spotfin shiner	-	-	-	-	-	-	-	-	1.82	-
Green sunfish	-	-	-	-	-	-	1.66	-	1.82	-
Orangespotted sunfish	-	-	-	-	-	-	1.66	1.83	-	-
Total catch per 30 minutes shicking	0.00	0.00	0.00	0.00	14.11	0.00	16.60	74.86	10.92	70.28
Total weight of catch per 30 minutes shicking in kilograms	0.00	0.00	0.00	0.00	2.90	0.00	9.30	6.99	0.74	5.34

1. River miles from confluence of Illinois Waterway with The Mississippi River at Grafton, Ill. (Corps of Engineers milepoint designations).
2. Sample station numbers are listed in parentheses.
3. Number of fish taken per 30 minutes of electrofishing (boat shocker - 230 volt AC).

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 15

NUMBER OF FISH COLLECTED WITHIN THE CAL-SAG CHANNEL
AND THE LITTLE CALUMET RIVER DURING 1977

Species Collected	WATERWAY AND RIVER MILE											
	RM 304.2 ¹ (Rt. 83)		Cal-Sag Channel RM 314.8 (Cicero Ave.) (25)		RM 319.0 (Ashland Ave.) (26)		RM 320.1 (Halsted Ave.) (27)		Little Calumet River RM 322.5 (Indiana Ave.) (28)		RM 324.7 (Calumet Ave.) (29)	
	Jun.20	Oct.27	Jun.17	Oct.25	Jun.16	Oct.17	Jun.16	Oct.17	Jun.16	Oct.20	Jun.23	Oct.13
Gizzard shad	-	-	-	1.83 ³	-	-	-	-	-	31.31	-	14.31
Goldfish	-	2.88	-	3.65	-	-	-	1.70	14.98	1.03	3.69	1.38
Carp	-	-	-	1.83	-	-	-	0.57	26.63	17.96	6.16	12.00
Carp x goldfish hybrid	-	-	-	-	-	-	-	-	1.66	0.51	1.23	3.69
Emerald shiner	-	-	-	-	-	-	-	-	-	1.54	1.23	14.31
Bluntnose minnow	-	-	-	-	-	-	-	-	-	2.57	-	6.46
Fathead minnow	-	-	-	-	-	-	-	-	-	0.51	-	-
White sucker	-	-	-	1.83	-	-	-	-	-	-	-	-
Black bullhead	-	-	-	-	-	-	-	0.57	-	0.51	-	-
Green sunfish	-	1.44	-	-	-	-	-	3.40	-	5.65	-	-

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 15 continued

NUMBER OF FISH COLLECTED WITHIN THE CAL-SAG CHANNEL
AND THE LITTLE CALUMET RIVER DURING 1977

Species Collected	WATERWAY AND RIVER MILE											
	RM 304.2 ¹ (Rt. 83) (24) ²		Cal-Sag Channel RM 314.8 (Cicero Ave.) (25)		RM 319.0 (Ashland Ave.) (26)		RM 320.1 (Halsted Ave.) (27)		Little Calumet River RM 322.5 (Indiana Ave.) (28)		RM 324.7 (Calumet Ave.) (29)	
	Jun.20	Oct.27	Jun.17	Oct.25	Jun.16	Oct.17	Jun.16	Oct.17	Jun.16	Oct.20	Jun.23	Oct.13
Bluegill	-	1.44	-	-	0.59	-	-	2.26	-	-	-	-
Largemouth bass	-	-	-	-	-	-	-	-	0.83	0.51	-	1.85
Total catch per 30 minute shocking	0.00	5.76	0.00	9.14	0.59	0.00	0.00	8.50	44.10	61.08	12.31	54.00
Total weight of catch per 30 minutes shocking in kilograms	0.00	0.02	0.00	0.14	0.01	0.00	0.00	0.03	54.55	41.28	8.60	7.53

1. River miles from confluence of Illinois Waterway with the Mississippi River at Grafton, Ill. (Corps of Engineers milepoint designations).
2. Sample station numbers are listed in parentheses.
3. Number of fish taken per 30 minutes of electrofishing (boat shocker - 230 volt AC).

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 16

NUMBER OF FISH COLLECTED WITHIN
THE CALUMET RIVER DURING 1977

Species Collected	CALUMET RIVER								
	RM 326.4 ¹ (O'Brien Lock&Dam) (30) ²		RM 327.0 (130th St.) (31)		RM 330.2 (Wisconsin Steel) (32)		RM 332.6 (Ewing Ave.) (33)		RM 333.3 (Cal. R. Mouth) (34)
	Jun.24	Oct.13	Jun.23	Oct.20	Jun.27	Jun.27	Nov.7	Jun.27	
Alewife	-	7.20 ³	-	2.99	-	5.77	-	59.82	
Rainbow trout	-	-	-	-	-	1.15	-	-	
Goldfish	-	-	5.17	1.80	-	-	-	1.76	
Carp	-	7.20	3.88	7.19	-	2.31	-	-	
Carp x goldfish hybrid	-	3.00	-	0.60	-	-	-	-	
Golden shiner	-	-	1.29	0.60	-	-	-	-	
Emerald shiner	-	0.60	1.29	3.59	-	-	-	-	
Spottail shiner	-	-	3.88	-	-	-	-	-	
Bluntnose minnow	-	21.00	-	35.93	-	18.45	-	-	
Longnose dace	-	-	-	-	-	1.15	-	-	
Green sunfish	-	17.40	-	1.20	-	-	-	-	
Pumpkinseed	1.42	3.60	-	-	-	-	-	-	
Orangespotted sunfish	-	0.60	-	0.60	-	-	-	-	

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 16 continued

NUMBER OF FISH COLLECTED WITHIN
THE CALUMET RIVER DURING 1977

Species Collected	CALUMET RIVER								
	RM 326.4 ¹ (O'Brien Lock&Dam) (30)		RM 327.0 (130th St.) (31)		RM 330.2 (Wisconsin Steel) (32)		RM 332.6 (Ewing Ave.) (33)		RM 333.3 (Cal. R. Mouth) (34)
	Jun.24	Oct.13	Jun.23	Oct.20	Jun.27	Jun.27	Nov.7	Jun.27	
Bluegill	-	3.60	-	-	-	-	-	-	
Largemouth bass	1.42	-	-	1.20	-	-	-	-	
Yellow perch	-	-	2.59	1.20	-	-	-	21.11	
Total catch per 30 minute shocking	2.84	65.40	18.10	56.90	0.00	28.83	0.00	82.69	
Total weight of catch per 30 minutes shocking in kilograms	0.17	9.40	21.17	14.69	0.00	9.72	0.00	3.36	

1. River miles from confluence of Illinois Waterway with the Mississippi River at Grafton, Ill. (Corps of Engineers milepoint designations).
2. Sample station numbers listed in parentheses.
3. Number of fish taken per 30 minutes of electrofishing within the Calumet River during 1977.

to those in Figure 2 are listed in parentheses next to River Mile in Tables 11 - 16. Throughout this discussion carp x goldfish hybrids will be treated as a separate species.

Kankakee and Des Plaines Rivers

The Kankakee River (Station 1) near its junction with the Des Plaines River (Table 11) yielded a greater number of species (26) than any other station, with more species being collected in the fall (22) than in the summer (16). Both the Illinois Natural History Survey and the Illinois Conservation Department ceased routine sampling of fish at this point. By beginning our sampling here we are able to have a continuous picture of fish distribution throughout the Illinois waterway and adjacent waterways (see Figure 2). The lower Des Plaines River decreased in numbers of species, going northeastward, with 9 species at Station 3. Eight species were collected at Station 4 (River Mile 290.1) in the Des Plaines River just above its junction with the Sanitary and Ship Canal, while no fish were collected at the corresponding River Mile (Station 5) in the San-Ship Canal itself.

Sanitary and Ship Canal, Chicago River and North Shore Channel

For the next 49 miles of channel (Tables 11 - 14) including the Sanitary and Ship Canal, the South and North Branches of the Chicago River (excluding the North Shore Channel junction) and the North Shore Channel to Dempster Street (Station 21, River Mile 339) only occasional carp and goldfish were collected.

More species of fish were collected at those areas near openings to Lake Michigan. These stations are number 14 (Table 13) at the Chicago River Locks (8 species), and numbers 22 and 23 (Table 14) near Wilmette on the North Shore Channel (9 species). Ten species of fish were collected at the junction of the North Shore Channel and North Branch of the Chicago River (Table 13).

Concentrations of fish, at the mouths of incoming streams, was noticed for a number of tributaries of the Chicago Channel System during 1976. Since few fish were collected below this junction of the North Branch and the North Shore Channel (2 species at Station 17), and none in the North Shore Channel above it (Stations 19 and 20) until Dempster Street, the fish are apparently avoiding other areas of the channel. They cannot travel up the North Branch itself because of the elevation of the incoming water flow.

Total numbers of fish collected per 30 minutes electro-fishing were significantly greater during the summer than in the fall at Stations 1, 4, 6, 10, 13, 14, 17, 18 and 21 and, conversely, greater during the fall than in the summer at the Wilmette Stations (22 and 23).

Cal-Sag Channel, Little Calumet and Calumet Rivers

In general, numbers of fish and total weight of catch were less in the Cal-Sag Channel and Little Calumet River (Table 15) from Halsted Street (River Mile 322.5, Station 28) to Route 83 (River Mile 304.2, Station 24) than at those stations closer to

Lake Michigan in the Little Calumet and Calumet Rivers (Tables 15 and 16), i.e. Station 28 at Indiana Avenue and above. However, collections at Ewing Avenue near the mouth with Lake Michigan were erratic with 29 fish per 30 minutes being collected in the summer, and no fish collected in the fall.

Conversely, significantly greater numbers of fish were collected during the fall than during the summer at Stations 24, 25, 27, 29, 30 and 31.

Species Diversity

Values of species diversity, \bar{d} , for areas of the Chicago Channel System above and below major treatment plants are listed in Table 17. These values are based on data collected between 1974 and 1977, inclusive, listed in Table 18. These data were combined in order to approach total numbers of 100 individuals recommended by the USEPA when calculating diversity indices. Species diversity was not different above and below these plants. The number of species was greater above the North Side Plant. The number of fish per 30 minutes, that is, the density of individuals, was higher above both the North Side and Calumet Treatment Plants than below these plants.

This suggests that the quality of the water below treatment plant outfalls is deleterious to all species of fish not allowing any one species to overpopulate the area. Thus the proportion of species remained similar and the density was greatly decreased below the plants.

Since the area above the West-Southwest Plant is itself

below the North Side Plant outfall as well as below many combined sewer outfalls, neither fish species diversity index number of species or density of fish (all listed in Table 17) are different from each other above this treatment plant. That is, water quality is poor in both areas for fish life.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 17

RESULTS OF STATISTICAL COMPARISONS OF SPECIES DIVERSITY (\bar{d}),
SPECIES NUMBER AND NUMBER OF FISH PER 30 MINUTES ABOVE
AND BELOW MAJOR CHICAGO SEWAGE TREATMENT PLANTS

Number	Locality Description	\bar{d}	Number of Species	Fish per 30 Minutes
	Northside Treatment Plant			
	Above Outfall	1.88	23	120
	Below Outfall	1.78	9*	7*
	Calumet Treatment Plant			
	Above Outfall	1.83	16	128
	Below Outfall	1.77	15	7*
	West-Southwest Treatment Plant			
	Above Outfall	1.21	4	2
	Below Outfall	1.08	5	4

Significant difference (Probability ≤ 0.05 that the parameters come from the same populations) above and below the indicated sewage treatment plant outfall.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 18

NUMBER OF FISH TAKEN IN THE CHICAGO CHANNEL SYSTEM DURING 1974 - 1977
 PRIMARILY WITH SEINES AND ELECTROFISHING GEAR

Species	Locality ^a														Total
	1	2	3	4	5	6	7 ^b	8	9 ^b	10	11	12 ^b	13 ^b	14 ^b	
Skipjack herring	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
Alewife	0	444	0	56	0	0	0	0	9	2	0	0	0	0	571
Gizzard shad	1	2	0	15	0	0	0	855	21	649	60	5	2	0	1610
Rainbow trout	0	1	0	1	0	0	0	0	7	0	0	0	0	0	9
Brown trout	0	8	0	0	0	0	0	0	0	0	0	0	0	0	8
Coho salmon	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Chinook salmon	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
American smelt	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Central mudminnow	0	0	0	0	0	0	0	0	0	0	2	5	5	0	12
Stoneroller	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Goldfish	73	535	10	33	7	41	11	187	22	128	38	56	37	0	1178
Carp	43	199	5	32	8	41	1	427	55	212	17	39	26	0	1105
Carp x goldfish hybrid	10	62	1	4	4	6	0	27	2	29	3	6	1	0	155
Hornyhead chub	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
Golden shiner	1	4	0	8	0	0	0	0	4	6	1	8	0	0	32
Emerald shiner	0	0	0	0	0	0	0	231	60	447	1	0	0	0	739
Striped shiner	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Common shiner	0	0	0	0	0	0	0	8	0	1	0	0	0	0	9
Bigmouth shiner	0	0	2	0	0	0	0	26	0	0	0	0	0	0	28
Spottail shiner	0	30	0	0	0	0	0	0	3	0	0	0	0	0	33
Spotfin shiner	0	0	0	0	0	0	0	9	0	0	0	0	0	0	9
Sand shiner	0	0	0	1	0	0	0	2	0	0	0	0	0	0	3
Suckermouth minnow	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Bluntnose minnow	0	510	0	235	0	0	0	221	993	259	0	36	3	0	2257
Fathead minnow	40	23	0	1	0	0	1	0	2	2	0	0	1	0	70

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 18 continued

NUMBER OF FISH TAKEN IN THE CHICAGO CHANNEL SYSTEM DURING 1974 - 1977
 PRIMARILY WITH SEINES AND ELECTROFISHING GEAR

Species	Locality ^a														Total
	1	2	3	4	5	6	7 ^b	8	9 ^b	10	11	12 ^b	13 ^b	14 ^b	
Bullhead minnow	0	0	0	0	0	0	0	29	0	0	0	0	0	0	29
Longnose dace	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Creek chub	0	0	0	0	0	0	0	0	0	0	2	95	189	0	286
Quillback	0	0	0	0	0	0	0	12	0	0	0	0	0	0	12
White sucker	0	1	0	0	0	0	0	13	0	0	1	3	4	0	22
Northern redhorse	0	0	0	0	0	0	0	32	0	0	0	0	0	0	32
Black bullhead	23	0	1	5	0	4	1	3	0	0	5	14	0	0	56
Channel catfish	0	0	0	0	0	0	0	1	0	0	0	1	0	0	2
Tadpole madtom	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Trout-perch	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Mosquitofish	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4
Brook silverside	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Nine-spine stickleback	0	1	0	2	0	0	0	0	0	0	0	0	0	0	3
White bass	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Yellow bass	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
Rock bass	0	3	0	82	0	0	0	5	2	0	0	0	0	0	92
Green sunfish	100	27	12	3	0	0	20	291	16	35	87	43	19	0	653
Pumpkinseed sunfish	10	3	0	4	0	0	0	10	8	9	0	2	0	0	46
Orangespotted sunfish	26	43	0	3	0	0	0	14	1	1	0	0	0	0	88
Bluegill	45	0	2	6	0	0	3	47	3	7	14	74	6	0	207
Northern longear sunfish	0	0	0	0	0	0	0	13	0	0	0	0	0	0	13
Redear sunfish	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Smallmouth bass	0	0	0	0	0	0	0	11	0	0	0	0	0	0	11
Largemouth bass	8	2	0	10	0	0	0	16	95	44	0	8	2	0	185

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 18 continued

NUMBER OF FISH TAKEN IN THE CHICAGO CHANNEL SYSTEM DURING 1974 - 1977
 PRIMARILY WITH SEINES AND ELECTROFISHING GEAR

Species	Locality ^a														Total
	1	2	3	4	5	6	7 ^b	8	9 ^b	10	11	12 ^b	13 ^b	14 ^b	
White crappie	0	1	0	0	0	0	0	1	0	0	0	0	0	0	2
Black crappie	2	0	2	2	1	1	0	1	1	0	1	2	0	0	13
Green x pumpkinseed hybrid	0	1	0	0	0	0	0	3	0	0	1	1	0	0	6
Green x bluegill hybrid	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Green x longear hybrid	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Yellow perch	0	118	1	0	0	0	0	0	24	55	0	0	0	0	198
Logperch	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Freshwater drum	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
Mottled sculpin	0	0	0	2	0	0	0	0	1	0	0	0	0	0	3

a - See Table 19 for explanation.
 b - Fish collected during 1976 only.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 19

LOCALITIES - FISH SAMPLING AREAS
IN THE CHICAGO CHANNEL SYSTEM

1. North Branch Chicago River to and including its junction with the North Shore Channel.
2. North Shore Channel above Northside Treatment Plant outfall.
3. North Shore Channel and North Branch Chicago River below Northside Treatment Plant outfall.
4. Chicago River, including the junction of the North and South branches.
5. South Branch Chicago River and Sanitary and Ship Canal above West-Southwest Treatment Plant outfall.
6. Sanitary and Ship Canal below West-Southwest Treatment Plant outfall.
7. Shell Drainage Ditch including mouth to Sanitary and Ship Canal.
8. Des Plaines River, Brandon and Dresden Pools, including the Kankakee River near Wilmington, Illinois.
9. Calumet River above O'Brien Lock & Dam, including Calumet Harbor.
10. Little Calumet River above Calumet Treatment Plant outfall.
11. Calumet Sag Channel and Little Calumet River below Calumet Treatment Plant outfall.
12. Calumet Sag Channel tributaries and mouths to Channel.
13. Little Calumet River below junction with Calumet Sag Channel, including tributaries.
14. Grand Calumet River.

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