

Protecting Our Water Environment



Metropolitan Water Reclamation District of Greater Chicago

**RESEARCH AND DEVELOPMENT
DEPARTMENT**

REPORT NO. 92-30

*FISH AND MIDGE POPULATION CHANGES IN
CHICAGO WATERWAYS FOLLOWING
CESSATION OF WASTEWATER CHLORINATION*

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FOLLOWING CESSATION OF WASTEWATER CHLORINATION

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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.

SUMMARY AND CONCLUSIONS

It has long been known that chlorine, and the by-products of chlorination, such as chloramines, are very toxic to fish. Residual chlorine is the principal toxicant in most secondary effluents, and improvements in a stream fish community can occur after cessation of chlorination. Since concentrations of fecal coliform bacteria in river waters receiving unchlorinated effluent were found not to differ from concentrations in river waters receiving chlorinated effluent, at locations in secondary contact designated waters more than ten miles downstream of major water reclamation plant (WRP) outfalls of the Metropolitan Water Reclamation District of Greater Chicago (District), the cessation of effluent chlorination as a disinfection procedure seemed appropriate for the District.

In 1983, the Appellate Court of Illinois allowed cessation of chlorination for District WRPs which discharged into secondary contact and indigenous aquatic life waters. In 1983, the District filed a petition for variance before the Illinois Pollution Control Board (IPCB) requesting a variance from the water quality effluent standards for the Calumet WRP. This variance was granted for the period of August 1, 1983 through March 31, 1984. On March 21, 1984 the IPCB granted a variance beginning April 1, 1984 for all the District's major WRPs (Stickney, Calumet and North Side). The Calumet WRP, which discharges final effluent into the designated secondary contact

waters of the Little Calumet River, stopped chlorinating its effluent on August 1, 1983. The North Side WRP, which discharges final effluent into the designated secondary contact waters of the North Shore Channel stopped chlorinating on April 1, 1984. The Stickney WRP, which discharges final effluent into the designated secondary contact waters of the Chicago Sanitary and Ship Canal, also stopped chlorinating on April 1, 1984.

In order to monitor the effects of the cessation of effluent chlorination on the fish populations of the Metropolitan Chicago Waterway System, an electrofishing survey before and after the cessation of WRP effluent chlorination was carried out from 1974 through 1985.

Based on the results from this study, the following conclusions are made.

1. Cessation of effluent chlorination on April 1, 1984 at both the North Side and Stickney WRPs has led to increased fish populations below the North Side WRP outfall in the North Shore Channel, and North Branch of the Chicago River, and below the Stickney WRP outfall in the Chicago Sanitary and Ship Canal.

In the area below the North Side WRP outfall, the total number of fish species in the North Shore Channel increased from seven species in the period 1974 through 1977 to 13 species in October and November 1984 (following cessation of

effluent chlorination on April 1, 1984), and 18 species in 1985. Abundance of fish increased from an average of one fish per 30 minutes electrofishing during 1974 through 1977, to 93 fish per 30 minutes electrofishing in 1984 and 11 fish per 30 minutes electrofishing in 1985.

In the area below the Stickney WRP outfall, the total number of fish species in the Chicago Sanitary and Ship Canal increased from four species from 1974 through 1977, to 14 species in 1985 after cessation of effluent chlorination on April 1, 1984. Abundance of fish increased from an average of four fish per 30 minutes electrofishing from 1974 through 1977 to 20 fish per 30 minutes electrofishing in 1985.

2. These increased populations below the outfalls of the Stickney and North Side WRPs are apparently due to the absence of toxicity to fish following the removal of chlorine residual from these waterways when chlorination was discontinued at these WRPs. In 1985, without effluent chlorination, the bluegill toxicity index ranged from 0.04 to 0.57 in the North Shore Channel and North Branch of the Chicago River and from 0.05 to 0.65 in the Chicago Sanitary and Ship Canal.

Effluent chlorination, had it continued, would have added an additional component of toxicity of from 0.03 to 2.70 bluegill toxic units (BGTUs), depending on the total chlorine residual, to the existing toxicity in the waterway column within five miles of the chlorinated effluent source.

3. There have been no increases in the fish populations below the Calumet WRP outfall in the Little Calumet River or Cal-Sag Channel following cessation of effluent chlorination at the Calumet WRP on August 1, 1983. In the area below the Calumet WRP outfall, the total number of fish species was 12 species from 1974 through 1977 and 12 species during 1985. Abundance of fish also remained similar, with an average of seven fish per 30 minutes electrofishing collected from 1974 through 1977 and an average of six fish per 30 minutes collected during 1985.
4. The lack of change in the fish populations in the Little Calumet River and Cal-Sag Channel after cessation of chlorination at the Calumet WRP is apparently due to the toxicity in the area of the channel below the Calumet WRP outfall. Here the channel water was found to have a component toxicity sometimes exceeding one BGTU. Following

the August 1, 1983 cessation of effluent chlorination at the Calumet WRP, there were still five instances during 1985 in which the bluegill toxicity index was greater than one BGTU. Theoretically, these waters would be acutely toxic to fish in four days.

5. A secondary effect of the April 1, 1984 discontinuance of chlorination at the North Side WRP has been the reduction in the nuisance midge population along the North Shore Channel below the North Side WRP outfall. The number of adult midges collected from New Jersey insect light traps along the North Shore Channel decreased from a mean of 3,247 adults/trap/12-hr sampling period during June through August 1984 to a mean of 123 adults/trap/12-hr sampling period during the same three months in 1985. A similar decrease in the mean number of adult midges was observed during September through November 1985 (76 adults/trap/12-hr sampling period) compared to the same period in 1984 (113 adults/trap/12-hr sampling period).

As a consequence, the number of citizens complaining to the District regarding the swarming activity of adult midge flies declined

from 56 complaints from April through August 1984 to none from September 1984 through December 1985.

6. The decrease in the midge population is thought to be due to the establishment of a predatory fish population which feeds upon the midge larvae, pupae and emerging adults. Evidence of the effectiveness of fish as predators was obtained from the high percentage (67%) of fish collected during October and November 1984 from the North Shore Channel below the North Side WRP outfall in which midges were found in the digestive tract. Counts of midges (larvae and pupae) found in the digestive tracts of 139 fish ranged from one to 129 midges.

INTRODUCTION

Fish collections and analyses give the most meaningful index of water quality to the public. Citizens and legislators can better understand the effects of environmental degradation on fish than on other aquatic taxa (Hendricks et al., 1980). Results of studies in which fish were used as indicator species can often be directly related to the protection of aquatic biota as mandated by Congress (Karr et al., 1986). Fish are at the top of the aquatic food chain and therefore integrate the responses of the food chain to environmental stress (Hellowell, 1977).

A knowledge of the assemblage of fish species in a stream and the numerical relationships of 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, fishes can be one of the most sensitive indicators of the quality of the aquatic environment (Smith, 1971).

Fish surveys have been carried out on the waterways of the Metropolitan Chicago Waterway System since 1974 (Dennison et al., 1978, Dennison, 1978, Spielman et al., 1979, Dennison et al., 1984). The objective of these surveys was to estimate the success of the fish populations in these waterways as affected by ever improving methods of wastewater treatment. The distribution and relative abundance of the fish species in the waterways were the population parameters which have been routinely monitored.

It has long been known that chlorine, and the by-products of chlorination, such as chloramines, are very toxic to fish (W. A. Brungs, 1973; Roseboom and Richey, 1977). Residual chlorine is the principal toxicant in most secondary effluents (Tsai, 1973; Lewis et al., 1981), and improvements in a stream fish community can occur after the cessation of chlorination even in the presence of un-ionized ammonia-nitrogen concentrations as high as 0.11 mg/L (Paller et al., 1983).

Fecal coliform bacteria have been routinely used as indicators of the sanitary quality of river waters. Environmental monitoring results have shown that concentrations of fecal coliform bacteria in river water at waterway locations receiving chlorinated WRP effluent were not significantly different from the fecal coliform concentrations at the same locations following cessation of WRP effluent chlorination, at locations 10.5 to 17.3 miles downstream of major District WRP effluent outfalls (Sedita et al., 1987). Therefore, the cessation of effluent chlorination seemed appropriate for the District.

In 1983, the Appellate Court of Illinois allowed cessation of chlorination for District WRPs which discharge into secondary contact and indigenous aquatic life waters. In 1983, the District filed a petition for variance before the Illinois Pollution Control Board (IPCB) requesting a variance from the water quality effluent standards for the Calumet WRP. This variance was granted for the period of August 1, 1983 to March

31, 1984. On March 21, 1984 the IPCB granted a variance beginning April 1, 1984 for the District's major WRPs, including the Stickney, Calumet and North Side WRPs (Sedita et al., 1987). The Calumet WRP, which discharges final effluent into the designated secondary contact waters of the Little Calumet River, stopped chlorinating its effluent on August 1, 1983. The North Side WRP, which discharges final effluent into the designated secondary contact waters of the North Shore Channel stopped chlorinating on April 1, 1984. The Stickney WRP, which discharges final effluent into the designated secondary contact waters of the Chicago Sanitary and Ship Canal, also stopped chlorinating on April 1, 1984 (Sedita et al., 1987).

The Research and Development Department of the District decided to explore the question of whether or not fish would be more abundant below the North Side, Stickney and Calumet WRPs after the cessation of chlorination.

In October and November 1984, two locations below the North Side WRP outfall were sampled for fish with a boat electrofisher: (1) at Touhy Avenue (about one mile downstream of the North Side WRP outfall) and (2) at Peterson Avenue (about two miles downstream of the North Side WRP outfall).

The 1984 study was expanded in 1985 to include 17 locations throughout the deep draft metropolitan Chicago Waterway System. This system includes: the North Shore Channel, the North Branch of the Chicago River, the Chicago Sanitary and Ship Canal, the

Calumet River, the Little Calumet River, and the Cal-Sag Channel.

This paper describes changes in fish species composition, distribution and relative abundance in Chicago waterways after the District stopped chlorinating the secondary effluent at the Calumet WRP on August 1, 1983 and at the North Side and Stickney WRPs on April 1, 1984. This paper also describes changes in adult midge fly abundance in the North Shore Channel following the cessation of secondary effluent chlorination at the North Side WRP.

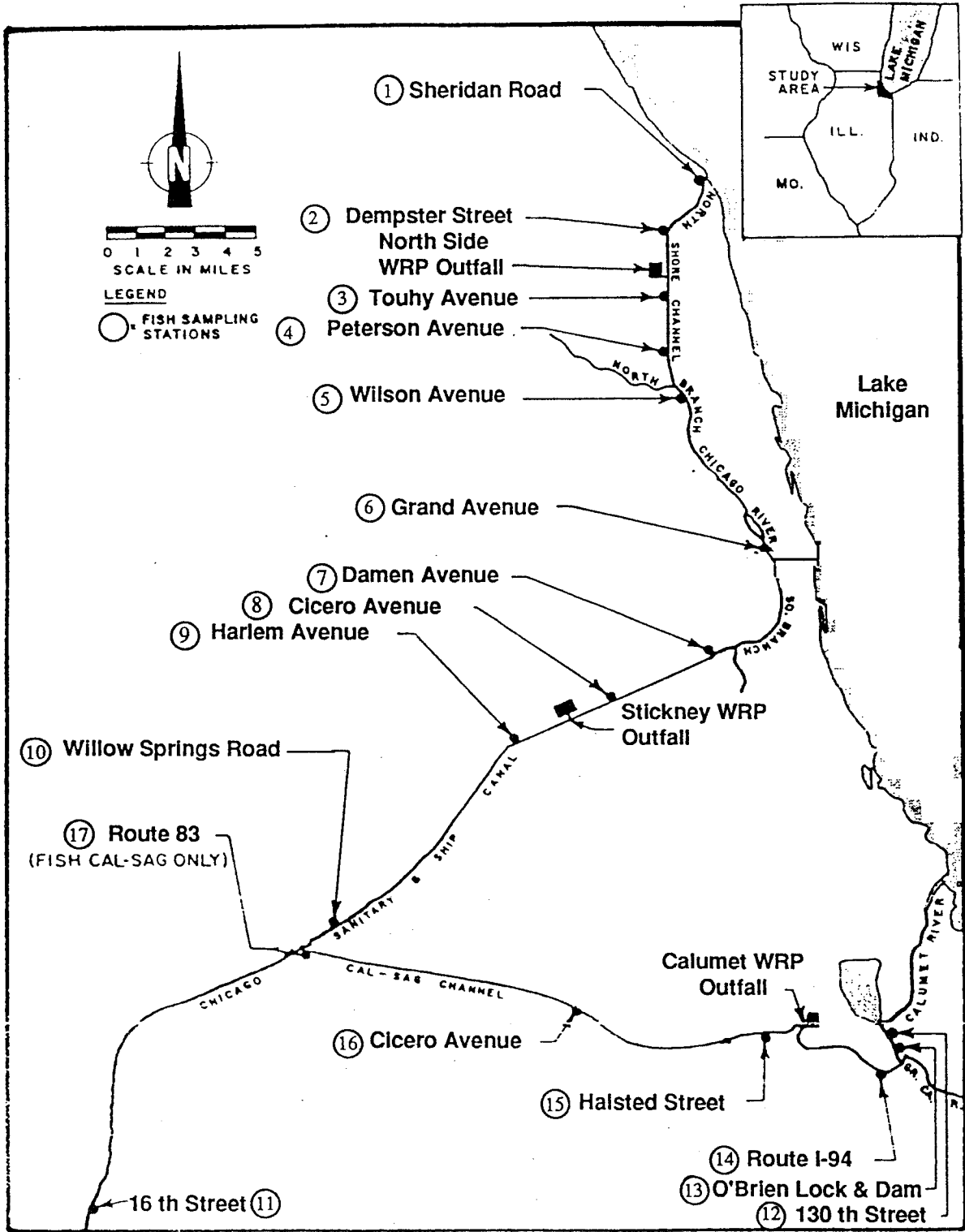
STUDY AREA

The study area is located in the Chicago metropolitan area in Northeastern Illinois (Figure 1). The Biology Section of the Research and Development Department collected fish by use of a boat electrofisher from 17 locations (Table 1) on the deep draft waterways in the metropolitan Chicago Waterway System during 1977 and 1985.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 1

LOCATION OF SAMPLING STATIONS FOR FISH



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 1

WATERWAY FISH SAMPLING STATIONS

Fish Sampling Station Number and Location	Township, Range and Section	Miles from Water Reclamation Plant (WRP) Outfall	River Mile ^a
<u>North Shore Channel</u>		<u>Miles from North Side WRP</u>	
1. Sheridan Road	T42N/R13E/S35 NW	6.3 Upstream	342.6
2. Dempster Street	T41N/R13E/S14 SE	1.7 Upstream	339.0
3. Touhy Avenue	T41N/R13E/S35 SE	1.0 Downstream	335.6
4. Peterson Avenue	T40N/R13E/S01 NW	2.7 Downstream	334.6
<u>North Branch Chicago River</u>			
5. Wilson Avenue	T40N/R13E/S13 NE	3.8 Downstream	332.5
6. Grand Avenue	T39N/R14E/S09 NW	10.3 Downstream	326.0
<u>Chicago Sanitary and Ship Canal</u>		<u>Miles from Stickney WRP</u>	
7. Damen Avenue	T38N/R13E/S30 SW	5.2 Upstream	321.0
8. Cicero Avenue	T37N/R13E/S03 NW	1.2 Upstream	317.0
9. Harlem Avenue	T38N/R13E/S12 NW	1.8 Downstream	314.0
10. Willow Springs Road	T37N/R12E/S32 SE	7.9 Downstream	307.9
11. 16th Street, Lockport	T36N/R10E/S22 SE	23.7 Downstream	292.1

Table continued on the following page.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 1 (Continued)

WATERWAY FISH SAMPLING STATIONS

Fish Sampling Station Number and Location	Township, Range and Section	Miles from Water Reclamation Plant (WRP) Outfall	River Mile ^a
<u>Calumet River</u>		<u>Miles from Calumet WRP</u>	
12. 130th Street	T37N/R14E/S36 NE	5.6 Upstream	327.0
13. O'Brien Lock and Dam	T37N/R14E/S36 SE	5.0 Upstream	326.4
<u>Little Calumet River</u>			
14. Route I-94	T36N/R14E/S02 NE	3.3 Upstream	324.7
15. Halsted Street	T37N/R14E/S32 NE	1.3 Downstream	320.1
<u>Cal-Sag Channel</u>			
16. Cicero Avenue	T37N/R13E/S33 NE	6.6 Downstream	314.8
17. Route 83	T37N/R11E/S14 NE	17.2 Downstream	304.2

^aDistance along the Illinois Waterway from Grafton, Illinois, which is at the confluence of the Illinois River with the Mississippi River.

MATERIALS AND METHODS

The biological changes monitored during this study included changes in fish species composition, distribution and relative abundance in Chicago waterways after the District stopped chlorinating the secondary effluent at the Calumet WRP on August 1, 1983 and at the North Side and Stickney WRPs on April 1, 1984, as well as changes in adult midge fly abundance in the North Shore Channel following the cessation of effluent chlorination at the North Side WRP.

Fish Collections

Fish were collected at a scheduled frequency of four times a year at each of 17 locations (Table 1) during 1985. The gear used to collect the fish was a boat mounted electrofisher. The electrofisher was powered by a 230-volt, 3,000-watt, 180-cycle, 3-phase, alternating-current Homelite® generator. The water was electrified with 8 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. A backup boat followed the electrofishing boat so that another netter could pick up those fish which rose to the surface behind the electrofishing boat.

In most cases, the section of canal sampled extended for 400 meters. Whenever possible, both sides of this canal section were electrofished. 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 total catch per unit of effort (CPUE). In the present study, this total catch was the number of fish collected per 30 minutes of electrofishing effort.

Bluegill Toxicity Index

Water samples were collected at the same location and on the same day as the fish collections for those samples collected during 1985. During 1977, water samples were either collected on the same day as the fish collections or data were obtained from samples collected during routine District "bridge run" waterway collections by the Industrial Waste Division. Samples were analyzed by the Quality Control Division of the Research and Development Department according to Standard Methods for the Examination of Water and Wastewater or other approved methods (Research and Development Department, 1986).

The Bluegill Toxicity Index was calculated from the results of chemical analyses for various toxic components of the water. Toxic constituents included in the Bluegill Toxicity Index 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 considered. A component toxicity, expressed in bluegill toxic units (BGTUs), was calculated for

each toxicant by dividing the environmental concentration of the toxicant by its 96 hour LC₅₀ to bluegill. The 96 hour LC₅₀ is the concentration of toxicant which is lethal to 50 percent of the test fish in 96 hours. The component toxicities were then summed to yield the toxicity index (also in BGTUs). A sample of canal water with a toxicity of 1.0 BGTU, for example, would be lethal, by definition, to 50 percent of the bluegills exposed to it for 96 hours (Lubinski and Sparks, 1981).

An example of the calculation of a Bluegill Toxicity Index for a water sample is given in Table 2. Values for the Bluegill Toxicity Index used for classification of stream water toxicity to fish are listed in Table 3.

Adult Midge Collections

Four New Jersey[®] insect light traps were used to study the prevalence of adult midge flies along the North Shore Channel. The insect traps were fitted with 25-watt, white bulbs and were equipped with photoelectric switches. The traps were placed approximately one-half mile apart on channel front business property or government facilities, covering a two mile reach of the North Shore Channel. Each trap was hung three to five feet above the ground.

Adult midge collections from the four traps were made daily, except weekends, from May through November during 1984 and 1985. In the laboratory, adult midges were separated from other insects and counted.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 2

AN EXAMPLE OF THE CALCULATION OF A BLUEGILL TOXICITY INDEX FOR A WATER SAMPLE FROM THE LITTLE CALUMET RIVER AT HALSTED STREET, ON MARCH 28, 1985

Water Quality Constituent	Concentration	Toxicity (BGTUs)
<u>Limiting Factors</u>		
Temperature (°C)	11.5	
Hardness (mg/L as CaCO ₃)	254	
Dissolved Oxygen (mg/L)	1.4	
pH (Units)	6.96	
Total Ammonia Nitrogen (mg/L)	8.4	
<u>Toxicant</u>		
Un-ionized Ammonia (mg/L)	0.02	0.11
Arsenic (mg/L)	<0.2	0.00
Cadmium (mg/L)	<0.02	0.00
Total Residual Chlorine (mg/L)	<0.01	0.00
Chromium (mg/L)	<0.02	0.00
Copper (mg/L)	0.04	0.01
Total Cyanide (mg/L)	0.13	0.74
Fluoride (mg/L)	0.7	0.02
Iron (mg/L)	0.9	0.03
MBAS (mg/L)	0.22	0.65
Lead (mg/L)	<0.02	0.00
Manganese (mg/L)	0.14	0.00
Mercury (µg/L)	<0.02	0.00
Nickel (mg/L)	<0.2	0.00
Nitrite + Nitrate (mg/L)	0.5	0.00
Phenol (mg/L)	0.038	0.01
Silver (mg/L)	0.001	0.01
Zinc (mg/L)	<0.2	<u>0.00</u>
Bluegill Toxicity Index		
Sum of Toxicities		1.58

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 3

CLASSIFICATION OF STREAM WATER TOXICITY TO FISH BASED ON THE
BLUEGILL TOXICITY INDEX

Bluegill Toxicity Index (BGTUs)	Classification of Water Toxicity (Toxic Levels for Fish)*
< 0.2	Acceptable
0.2 to 0.4	Marginal
> 0.4 to < 1.0	Stressful
≥ 1.0	Lethal

*Based on information in Lubinski and Sparks, 1981.

Fish Digestive Tract Analysis

Fish were preserved in 10 percent, volume to volume (v/v), formalin in the field and transferred to 40 percent (v/v) propanol in the laboratory prior to being identified to species, weighed to the nearest gram and measured to the nearest millimeter for standard and total length.

The entire digestive tract (stomach and intestine) was removed from the fish, and weighed. The digestive tract was then opened, and the contents were flushed into a container with 40 percent 2-propanol, and the empty digestive tract was weighed again.

The preserved digestive tract contents were then mailed to a consultant (Mr. Michael Winnell, Freshwater Benthic Services, Petoskey, Michigan) for taxonomic identification.

RESULTS AND DISCUSSION

Waterway Fish Collections

NORTH SHORE CHANNEL AND NORTH BRANCH OF THE CHICAGO RIVER

In the fall of 1984, two locations below the North Side WRP outfall were sampled for fish with a boat electrofisher: (1) at Touhy Avenue (about one mile downstream of the North Side WRP outfall), and (2) at Peterson Avenue (about two miles downstream of the North Side WRP outfall). The results of these two 1984 collections below the North Side WRP outfall are listed in Tables 4 and 5 along with the numbers of fish collected from 1974 through 1980, and in 1985. There were considerably more fish in these areas in the fall of 1984 than had been collected in previous surveys during the period from 1974 through 1980. One hundred fifteen fish (44 CPUE) were collected from the Touhy Avenue Station and 366 fish (141 CPUE) were collected from the Peterson Avenue Station in 1984. Previously, not more than seven individual fish (8 CPUE) had been collected from either of these North Shore Channel locations on any one sampling trip. During 1985, numbers of fish collected from these two locations ranged from nine to 62 (4 to 21 CPUE) at Touhy Avenue and from 16 to 53 fish (6 to 20 CPUE) at Peterson Avenue.

Total numbers of each species of fish collected from the North Shore Channel and North Branch of the Chicago River

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 4

FISH COLLECTED BETWEEN TOUHY AVENUE AND DEVON AVENUE (0.66 TO 1.66 MILES
DOWNSTREAM OF THE NORTH SIDE WATER RECLAMATION PLANT) 1975 THROUGH 1985

Fish Species	Date Sampled and Number of Fish Collected											
	10/29 1975	6/17 1976	7/22 1977	11/4 1977	5/31 1979	7/25 1979	11/5 1980	11/5 1984	4/11 1985	6/4 1985	8/22 1985	10/30 1985
Alewife	0	0	0	0	0	0	0	0	2	12	0	0
Goldfish	1	0	0	0	0	0	0	1	0	9	11	1
Carp	0	2	0	0	3	0	0	2	4	13	3	2
Carp x goldfish hybrid	1	0	0	0	0	0	0	0	1	0	5	0
Spottail shiner	0	1	0	0	0	0	0	0	0	0	0	0
Bluntnose minnow	0	0	0	0	0	0	0	12	0	0	0	0
Fathead minnow	0	0	0	0	0	0	1	70	2	11	0	0
Longnose dace	0	0	0	0	0	0	0	2	0	3	0	0
White sucker	0	0	0	0	0	0	0	0	0	0	1	0
Black bullhead	0	0	0	0	0	0	0	1	0	6	2	7
Brook stickleback	0	0	0	0	0	0	0	18	0	6	0	4
Green sunfish	4	0	0	0	2	0	5	7	0	0	1	2
Pumpkinseed	0	0	0	0	0	0	0	0	0	1	0	0
Bluegill	1	0	0	0	0	0	0	0	0	0	0	1
Largemouth bass	0	0	0	0	0	0	0	0	0	0	0	1
Yellow perch	0	0	0	0	0	0	0	2	0	1	0	0
Total Number	7	3	0	0	5	0	6	115	9	62	23	18

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 5

FISH COLLECTED BETWEEN PETERSON AVENUE AND BRYN MAWR AVENUE (2.08 TO 2.54 MILES
DOWNSTREAM OF THE NORTH SIDE WATER RECLAMATION PLANT) 1974 THROUGH 1985

Fish Species	Date Sampled and Number of Fish Collected										
	10/17 1974	7/22 1977	11/4 1977	5/31 1979	7/26 1979	10/31 1980	10/30 1984	4/12 1985	6/5 1985	8/23 1985	11/6 1985
Alewife	0	0	0	0	0	0	0	0	5	0	0
Goldfish	0	0	0	0	0	0	7	2	4	3	3
Carp	0	0	0	2	0	1	8	12	1	6	8
Carp x goldfish hybrid	0	0	0	1	0	3	0	4	0	1	3
Golden shiner	0	0	0	0	0	0	1	0	0	0	0
Bigmouth shiner	0	0	0	0	0	0	1	0	0	0	0
Spottail shiner	0	0	0	0	0	0	1	0	0	0	0
Bluntnose minnow	0	0	0	0	0	0	99	1	0	0	0
Fathead minnow	0	0	0	0	0	0	171	26	6	0	0
Longnose dace	0	0	0	0	0	0	6	0	0	0	0
White sucker	0	0	0	0	0	0	0	0	0	0	1
Black bullhead	0	0	0	0	0	0	0	0	1	0	1
Brook stickleback	0	0	0	0	0	0	68	0	3	0	0
Green sunfish	0	0	0	4	0	0	0	8	4	5	29
Bluegill	0	0	0	0	0	0	2	0	0	0	2
Largemouth bass	0	0	0	0	0	0	0	0	0	0	1
Yellow perch	0	0	0	0	0	0	2	0	0	1	0
Total Number	0	0	0	7	0	4	366	53	24	16	48

upstream and downstream of the North Side WRP effluent outfall during the period 1974 through 1977 (those years when all the District deep draft waterways were sampled for fish), and during 1985 are listed in Tables 6 and 7. A total of 2,030 fish (21 species) were collected from the two locations (Sheridan Road and Dempster Street) upstream of the North Side WRP from 1974 through 1977, and 7,623 fish (23 species) were collected from the same locations during 1985. From 1974 through 1977, 18 fish (seven species) were collected from the four locations downstream of the North Side WRP, 481 fish (13 species) were collected from the two locations downstream of the North Side WRP at Touhy Avenue and Peterson Avenue in 1984, and 453 fish (18 species) were collected from the four downstream locations during 1985.

Total numbers of fish collected per 30 minutes electrofishing effort from the North Shore Channel, and North Branch of the Chicago River, during the period 1974 through 1977 and during 1985, are shown in Figure 2 and listed in Appendix I, Tables AI-1 through AI-6 (CPUE for each species).

For purpose of comparison among waterway locations before and after cessation of WRP effluent chlorination, average numbers of fish collected per 30 minutes electrofishing, and total numbers of fish species collected upstream and downstream of the North Side WRP outfall are listed in Tables 6 and 7. For the North Shore Channel and North Branch of the Chicago

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 6

ABUNDANCE OF FISH FROM THE NORTH SHORE CHANNEL UPSTREAM OF THE
NORTH SIDE WRP FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	<u>Total Number</u>		<u>Catch Per 30 Minutes</u>	
	1974-1977	1985	1974-1977	1985
Alewife	447	247	19	8
Gizzard shad	2	0	<1	0
Rainbow trout	1	4	<1	<1
Brown trout	8	0	1	0
Coho salmon	1	0	<1	0
Chinook salmon	0	1	0	<1
Rainbow smelt	1	1,410	<1	48
Goldfish	542	105	16	4
Carp	204	67	5	3
Carp x goldfish hybrid	84	34	4	1
Golden shiner	2	41	<1	2
Emerald shiner	0	14	0	<1
Spottail shiner	30	88	1	4
Bluntnose minnow	487	1,090	22	50
Fathead minnow	23	1,844	2	70
White sucker	1	19	<1	1
Black bullhead	0	84	0	3
Brook stickleback	0	535	0	22
Ninespine stickleback	1	0	<1	0
Rock bass	3	1	<1	<1
Green sunfish	27	544	2	20
Pumpkinseed	3	42	<1	2
Orangespotted sunfish		18	0	1
Bluegill	41	29	2	2
Largemouth bass	2	4	<1	<1
White crappie	1	0	<1	0
Black crappie	0	7	0	<1
Green sunfish x pumpkinseed hybrid	2	2	<1	<1
Yellow perch	117	1,392	3	70
Mottled sculpin	0	1	0	<1
Total	2,030	7,623	78	312
Number of Species	21	23		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 7

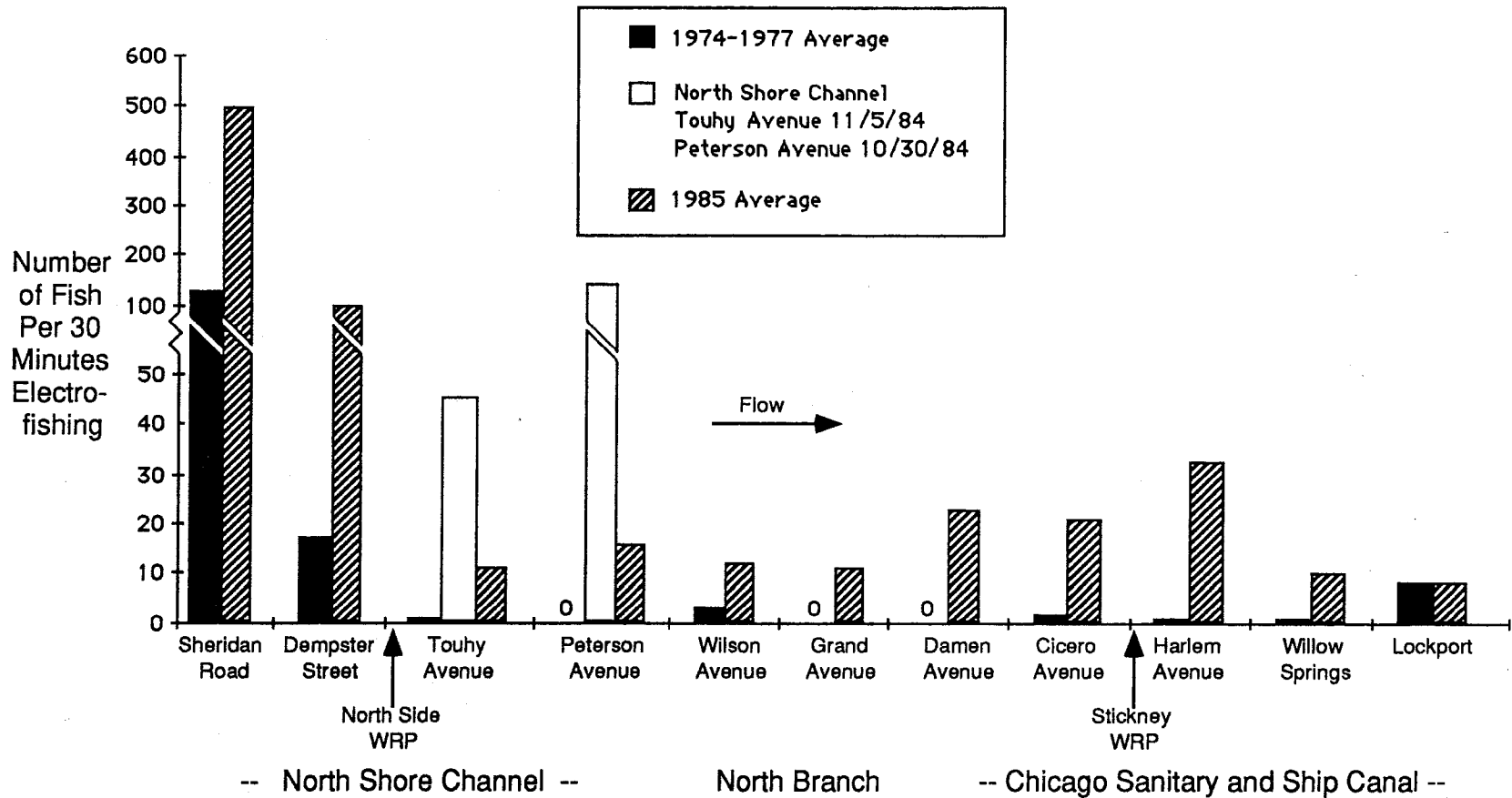
ABUNDANCE OF FISH FROM THE NORTH SHORE CHANNEL AND THE NORTH BRANCH OF THE CHICAGO RIVER DOWNSTREAM OF THE NORTH SIDE WRP FROM 1974 THROUGH 1977 AND IN 1984 AND 1985

Fish Species	Total Number			Catch Per 30 Minutes		
	1974- 1977	1984	1985	1974- 1977	1984	1985
Alewife	0	0	21	0	0	<1
Gizzard shad	0	0	5	0	0	<1
Rainbow smelt	0	0	1	0	0	<1
Goldfish	3	8	61	<1	2	1
Carp	5	10	86	<1	2	2
Carp x goldfish hybrid	1	0	19	<1	0	<1
Golden shiner	0	1	1	0	<1	<1
Bigmouth shiner	0	1	0	0	<1	0
Spottail shiner	1	1	1	<1	<1	<1
Bluntnose minnow	0	111	1	0	21	<1
Fathead minnow	0	241	65	0	47	2
Longnose dace	0	8	0	0	2	0
White sucker	0	0	5	0	0	<1
Black bullhead	1	1	29	<1	<1	1
Brook stickleback	0	86	19	0	17	<1
Green sunfish	4	7	76	<1	1	2
Pumpkinseed	0	0	1	0	0	<1
Orangespotted sunfish	0	0	2	0	0	<1
Bluegill	2	2	6	<1	<1	<1
Largemouth bass	0	0	3	0	0	<1
Black crappie	1	0	0	<1	0	0
Yellow perch	0	4	51	0	1	1
Total	18	481	453	1	93	11
Number of Species	7	13	18			

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 2

NUMBER OF FISH COLLECTED PER 30 MINUTES ELECTROFISHING FROM THE NORTH SHORE CHANNEL, NORTH BRANCH OF THE CHICAGO RIVER AND CHICAGO SANITARY AND SHIP CANAL FROM 1974 THROUGH 1977, AND DURING 1984 AND 1985



River, there was an increase in abundance of fishes both upstream (1974 through 1977, 78 CPUE and 1985, 312 CPUE) and downstream (1974 through 1977, 1 CPUE and 1985, 11 CPUE) of the North Side WRP from the period of effluent chlorination to no chlorination. However, total number of fish species collected remained about the same upstream of the North Side WRP from 1974 through 1977 (21 species), and in 1985 (23 species), whereas total numbers of fish species more than doubled (from 7 to 18) downstream of the North Side WRP. This suggested that there was a definite positive response by the stream fishes to the absence of chlorine, allowing twice as many species to live downstream of the WRP. This is evidence that the increase in abundance of downstream fishes was related to an absence of chlorine rather than being just an overflow of fishes from the upstream area of the waterway to the downstream area.

CHICAGO SANITARY AND SHIP CANAL

Total numbers of each species of fish collected electrofishing from the Chicago Sanitary and Ship Canal between the period 1974 through 1977, and during 1985 are listed in Tables 8 and 9. Twenty-two fish (four species) were collected from the two stations (Damen Avenue and Cicero Avenue) upstream of the Stickney WRP during the period 1974 through 1977. In 1985, 342 fish (14 species) were collected from these same two locations. Ninety-three fish (four species) were collected from the three stations (Harlem Avenue, Willow Springs Road and 16th

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 8

ABUNDANCE OF FISH FROM THE CHICAGO SANITARY AND SHIP CANAL
UPSTREAM OF THE STICKNEY WRP FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Alewife	2	5	<1	<1
Gizzard shad	0	1	0	<1
Rainbow trout	0	1	0	<1
Rainbow smelt	0	28	0	2
Goldfish	7	142	<1	9
Carp	8	77	1	5
Carp x goldfish hybrid	4	7	<1	1
Golden shiner	0	1	0	<1
Spottail shiner	0	1	0	<1
Bluntnose minnow	0	2	0	<1
Fathead minnow	0	10	0	1
Black bullhead	0	29	0	2
Green sunfish	0	8	0	1
Bluegill	0	5	0	<1
Black crappie	1	0	<1	0
Yellow perch	0	22	0	2
Total	22	339	1	23
Number of Species	4	14		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 9

ABUNDANCE OF FISH FROM THE CHICAGO SANITARY AND SHIP CANAL
DOWNSTREAM OF THE STICKNEY WRP FROM 1974 THROUGH 1977 AND 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Gizzard shad	0	1	0	<1
Rainbow smelt	0	4	0	<1
Central mudminnow	0	2	0	<1
Grass pickerel	0	1	0	<1
Goldfish	41	301	1	11
Carp	41	132	2	5
Carp x goldfish hybrid	6	16	<1	1
Spottail shiner	0	3	0	<1
Bluntnose minnow	0	3	0	<1
Fathead minnow	0	2	0	<1
Black bullhead	4	8	<1	<1
Green sunfish	0	4	0	<1
Bluegill	0	3	0	<1
Black crappie	1	1	<1	<1
Yellow perch	0	44	0	2
Total	93	525	4	20
Number of Species	4	14		

Street, Lockport) downstream of the Stickney WRP effluent outfall from 1974 through 1977. Five hundred twenty-five fish (14 species) were collected from these same locations in 1985.

Total numbers of fish collected per 30 minutes electrofishing effort from the Chicago Sanitary and Ship Canal, during the period 1974 through 1977 and during 1985, are listed in Figure 2, and in Appendix AI, Tables AI-7 through AI-11.

As shown in Tables 8 and 9, fish numbers increased from 1 to 23 CPUE upstream of the Stickney WRP and 4 to 20 CPUE downstream of the Stickney WRP between the period 1974 through 1977 and 1985. Numbers of fish species increased from 4 to 14 fish species upstream of the Stickney WRP and from 4 to 14 fish species downstream of the Stickney WRP between the period 1974 through 1977 and 1985. This is strong evidence that the fishes were responding positively to the absence of chlorine during 1985, keeping in mind that the waterway upstream of the Stickney WRP is also downstream of the North Side WRP.

CALUMET WATERWAY

Numbers of each species of fish collected electrofishing from the Calumet Waterway, during the period 1974 through 1977 and during 1985, are listed in Tables 10 and 11. Total numbers of fish collected from the three stations (130th Street, O'Brien Lock and Dam, and Route I-94) upstream of the Calumet WRP effluent outfall were 2,673 (17 species) during 1974 through 1977 and 3,735 (23 species) in 1985. Total numbers of fish

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 10

ABUNDANCE OF FISH FROM THE CALUMET RIVER AND THE LITTLE CALUMET RIVER UPSTREAM OF THE CALUMET WRP FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	<u>Total Number</u>		<u>Catch Per 30 Minutes</u>	
	1974-1977	1985	1974-1977	1985
Bowfin	0	1	0	<1
Alewife	6	6	<1	<1
Gizzard shad	539	231	19	13
Rainbow smelt	0	1	0	<1
Goldfish	109	30	6	20
Carp	194	151	9	12
Carp x goldfish hybrid	27	7	1	1
Golden shiner	8	12	<1	<1
Emerald shiner	475	20	17	2
Common shiner	1	0	<1	0
Spottail shiner	3	10	<1	1
Sand shiner	0	3	0	<1
Bluntnose minnow	1,083	2,701	53	166
Fathead minnow	1	37	<1	2
White sucker	0	1	0	<1
Black bullhead	0	3	0	<1
Channel catfish	0	1	0	<1
White perch	0	1	0	<1
Green sunfish	49	52	2	3
Pumpkinseed	13	37	1	2
Orangespotted sunfish	2	36	<1	2
Bluegill	7	3	<1	<1
Largemouth bass	83	34	4	2
Black crappie	1	6	<1	<1
Yellow perch	71	349	2	19
Freshwater drum	0	2	0	<1
Total	2,672	3,735	116	229
Number of Species	17	23		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 11

ABUNDANCE OF FISH FROM THE LITTLE CALUMET RIVER AND CAL-SAG CHANNEL DOWNSTREAM OF THE CALUMET WRP FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Gizzard shad	27	24	1	1
Rainbow trout	0	1	0	<1
Central mudminnow	2	1	<1	<1
Goldfish	21	9	1	<1
Carp	16	22	1	1
Carp x goldfish hybrid	3	8	<1	<1
Golden shiner	1	0	<1	0
Emerald shiner	1	0	<1	0
Fathead minnow	0	20	0	1
Creek chub	2	0	<1	0
White sucker	1	0	<1	0
Black bullhead	5	11	<1	1
Mosquitofish	4	0	<1	0
Green sunfish	87	35	2	2
Bluegill	13	3	1	<1
Largemouth bass	0	3	0	<1
Green sunfish x pumpkinseed hybrid	1	0	<1	0
Pumpkinseed x orangespotted hybrid	0	1	0	<1
Yellow perch	0	1	0	<1
Total	184	139	7	6
Number of Species	12	12		

collected downstream of the Calumet WRP outfall were 184 fish (12 species) from 1974 through 1977, and 139 fish (12 species) in 1985.

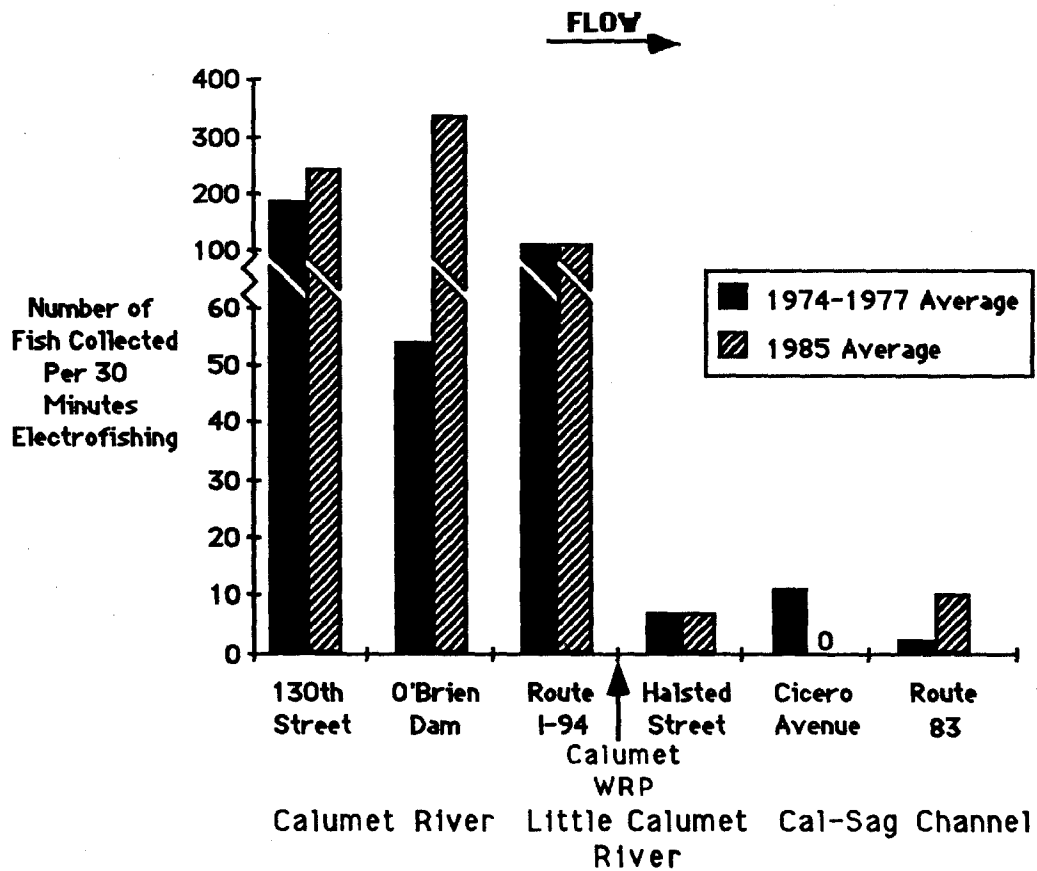
Total numbers of fish collected per 30 minutes electrofishing effort from the Calumet River, Little Calumet River and Cal-Sag Channel, between the period 1974 through 1977 and during 1985, are listed in Figure 3, and in Appendix AI, Tables AI-12 through AI-17. CPUEs from the three upstream locations were 54 to 184 fish from 1974 through 1977, and 106 to 338 fish during 1985. CPUE downstream from the Calumet WRP ranged from 2 to 11 fish from 1974 through 1977, and from 0 to 12 fish during 1985.

Average CPUE data and total number of fish species upstream and downstream of the Calumet WRP between the period of effluent chlorination and no effluent chlorination are shown in Tables 10 and 11. Fish numbers increased from 116 CPUE to 229 CPUE and numbers of fish species increased from 17 to 23 species between the period 1974 through 1977 and during 1985. However, there was no increase in either fish numbers (7 CPUE during 1974 through 1977; 6 CPUE in 1985) or number of fish species (12 species during 1974 through 1977; 12 species in 1985) at the locations downstream of the Calumet WRP in the Little Calumet River and the Cal-Sag Channel. No evidence was present for any positive response by the downstream fish populations to the absence of chlorine in the Calumet WRP effluent.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 3

NUMBER OF FISH COLLECTED PER 30 MINUTES ELECTROFISHING FROM THE CALUMET WATERWAY (CALUMET RIVER, LITTLE CALUMET RIVER AND CAL-SAG CHANNEL) FROM 1974 THROUGH 1977 AND DURING 1985



Bluegill Toxicity Index

NORTH SHORE CHANNEL AND NORTH BRANCH OF THE CHICAGO RIVER

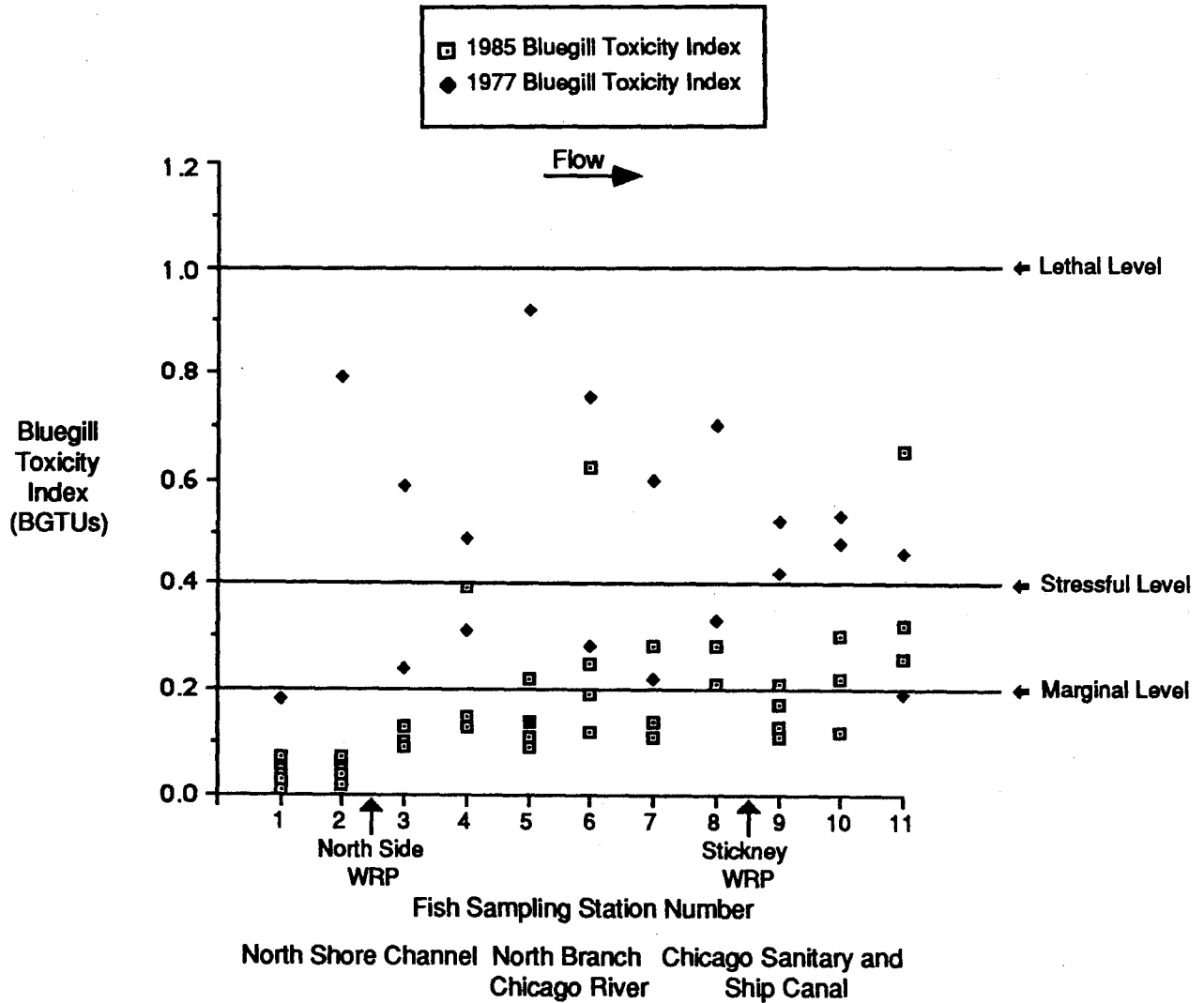
Bluegill Toxicity Indices calculated for chemical data collected from the North Shore Channel and North Branch of the Chicago River during 1977 and during 1985 at the time of the District fish collections are shown in Figure 4. The Bluegill Toxicity Index ranged from 0.18 to 0.79 BGTUs upstream of the North Side WRP effluent outfall during the 1977 fish collections and ranged from 0.02 to 0.07 BGTUs during the 1985 fish collections. Downstream of the North Side WRP the Bluegill Toxicity Index ranged from 0.24 to 0.92 BGTUs during the 1977 fish collections and from 0.09 to 0.62 BGTUs during the 1985 fish collections.

Average concentrations of water quality constituents and Bluegill Toxicity Indices for the North Shore Channel and North Branch of the Chicago River comparing data from 1977 with 1985 upstream and downstream of the North Side WRP are listed in Tables 12 and 13. Stream toxicity classifications resulting from these indices are shown in Figure 5. The toxicity to fish of water from the North Shore Channel and the North Branch of the Chicago River has clearly decreased from 1977 through 1985 both upstream and downstream of the North Side WRP. For the North Shore Channel and North Branch of the Chicago River, there was a decrease in average Bluegill Toxicity Index both upstream (from 0.5 BGTUs in 1977 to 0.05 BGTUs in 1985) and downstream

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 4

BLUEGILL TOXICITY INDEX FOR THE NORTH SHORE CHANNEL
NORTH BRANCH OF THE CHICAGO RIVER AND THE CHICAGO
SANITARY AND SHIP CANAL DURING 1977 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 12

AVERAGE WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES
FOR THE NORTH SHORE CHANNEL UPSTREAM OF THE NORTH SIDE WATER
RECLAMATION PLANT OUTFALL DURING 1977 AND 1985

Water Quality Constituent	Concentration ^a		Bluegill Toxic Units ^a	
	1977	1985	1977	1985
Temperature (°C)	15	12	-	-
Hardness (mg/L as CaCO ₃) ^b	200	129	-	-
Dissolved				
Oxygen (mg/L)	3.45	10.01	-	-
pH (units)	7.35	7.64	-	-
Total NH ₃ -N (mg/L)	2.50	0.34	-	-
Un-ionized				
Ammonia (mg/L)	0.017	0.005	0.09	0.01
Arsenic (mg/L)	<0.2	<0.2	0.00	0.00
Cadmium (mg/L)	<0.02	<0.02	0.00	0.00
Total Residual				
Chlorine (mg/L)	NA ^c	<0.01	NA	0.00
Chromium (mg/L)	<0.02	<0.02	0.00	0.00
Copper (mg/L)	<0.02	<0.02	0.00	0.00
Cyanide (mg/L)	0.006	0.002	0.03	0.01
Fluoride (mg/L)	0.29	0.16	0.01	0.00
Iron (mg/L)	NA	0.38	NA	0.01
MBAS (mg/L)	0.200	0.003	0.35	0.00
Lead (mg/L)	0.03	<0.08	0.00	0.00
Manganese (mg/L)	NA	0.01	NA	0.00
Mercury (µg/L)	0.2	<0.3	0.00	0.00
Nickel (mg/L)	NA	<0.2	NA	0.00
NO ₂ +NO ₃ (mg/L)	4.65	0.26	0.00	0.00
Phenol (mg/L)	0.006	0.001	0.00	0.00
Silver (mg/L)	NA	<0.002	NA	0.01
Zinc (mg/L)	<0.2	<0.2	0.00	0.00
Bluegill Toxicity Index			0.48	0.04

^aAverage of two samples from 1977 and of nine samples from 1985.

^bHardness estimated as 200 mg/L for samples from 1977.

^cNA indicates no analysis.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 13

AVERAGE WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES
FOR THE NORTH SHORE CHANNEL AND NORTH BRANCH OF THE CHICAGO
RIVER DOWNSTREAM OF THE NORTH SIDE WATER RECLAMATION PLANT
OUTFALL DURING 1977, 1984 AND 1985

Water Quality Constituent	Concentration ^a			Bluegill Toxic Units ^a		
	1977	1984	1985	1977	1984	1985
Temperature (°C)	20	16	16	-	-	-
Hardness (mg/L as CaCO ₃) ^b	200	187	178	-	-	-
Dissolved						
Oxygen (mg/L)	4.55	8.30	6.71	-	-	-
pH (units)	6.96	7.65	7.05	-	-	-
Total NH ₃ -N (mg/L)	4.00	0.40	1.96	-	-	-
Un-ionized						
Ammonia (mg/L)	0.023	0.006	0.008	0.07	0.01	0.02
Arsenic (mg/L)	<0.2	<0.2	<0.2	0.00	0.00	0.00
Cadmium (mg/L)	<0.02	<0.02	<0.02	0.00	0.00	0.00
Total Residual						
Chlorine (mg/L)	NA ^c	NA	<0.01	NA	NA	0.00
Chromium (mg/L)	0.01	<0.02	<0.02	0.00	0.00	0.00
Copper (mg/L)	<0.02	<0.02	0.01	0.00	0.00	0.00
Cyanide (mg/L)	0.018	0.004	0.013	0.18	0.02	0.08
Fluoride (mg/L)	0.63	0.66	0.57	0.01	0.01	0.01
Iron (mg/L)	0.15	0.10	0.36	0.00	0.00	0.01
MBAS (mg/L)	0.257	0.015	0.044	0.22	0.01	0.05
Lead (mg/L)	0.02	0.01	0.01	0.00	0.00	0.00
Manganese (mg/L)	0.03	<0.02	0.02	0.00	0.00	0.00
Mercury (µg/L)	0.01	<0.3	<0.3	0.00	0.00	0.00
Nickel (mg/L)	<0.2	<0.2	<0.2	0.00	0.00	0.00
NO ₂ +NO ₃ (mg/L)	2.77	5.90	2.13	0.00	0.00	0.00
Phenol (mg/L)	0.001	0.001	0.002	0.00	0.00	0.00
Silver (mg/L)	<0.001	0.001	<0.002	0.00	0.01	0.01
Zinc (mg/L)	<0.2	<0.2	<0.2	0.00	0.00	0.00
Bluegill Toxicity Index				0.48	0.06	0.18

^aAverages of seven samples from 1977, two from 1984, and nine from 1985.

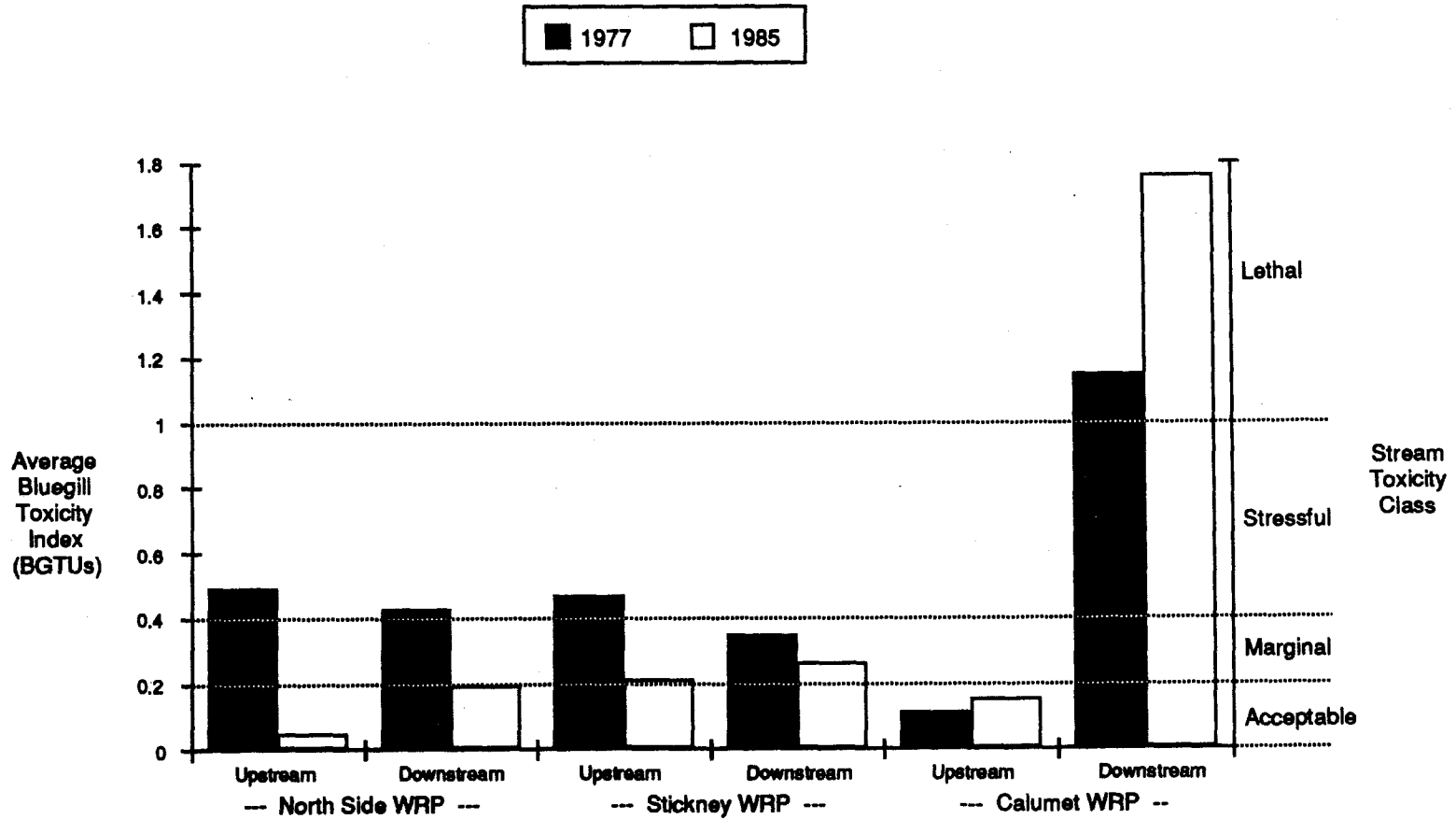
^bHardness estimated as 200 mg/L for samples from 1977.

^cNA indicates no analysis.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 5

BLUEGILL TOXICITY INDEX UPSTREAM AND DOWNSTREAM OF WRP OUTFALLS BEFORE (1977) AND AFTER (1985) CESSATION OF EFFLUENT CHLORINATION



(from 0.4 BGTUs in 1977 to 0.2 BGTUs in 1985) of the North Side WRP from "chlorination" to "no chlorination periods." This decrease in toxicity index may help to explain why the abundance of fishes was higher downstream of the North Side WRP during 1985 than during 1977.

It is important to note that total chlorine residual was not measured at the time of fish collections for samples collected from the waterways before 1985. The Bluegill Toxicity Index component due to total chlorine residual is not included in the calculation for any Bluegill Toxicity Indices for years prior to 1985. The concentration of total residual chlorine was measured in 1985 (during the period after the cessation of effluent chlorination). No total residual chlorine was detected in any waterway sample during 1985.

CHICAGO SANITARY AND SHIP CANAL

Bluegill Toxicity Indices calculated for chemical data collected from the Chicago Sanitary and Ship Canal during 1977 and during 1985 at the time of the District fish collections are shown in Figure 4. The Bluegill Toxicity Index ranged from 0.22 to 0.70 BGTUs upstream of the Stickney WRP effluent outfall during the 1977 fish collections, and from 0.11 to 0.28 BGTUs during 1985. Downstream of the Stickney WRP, the Bluegill Toxicity Index ranged from 0.19 to 0.53 BGTUs during the 1977 fish collections, and from 0.11 to 0.65 BGTUs during the 1985 fish collections.

Average water quality constituents and Bluegill Toxicity Indices for the Chicago Sanitary and Ship Canal comparing data from 1977 with 1985 upstream and downstream of the Stickney WRP are listed in Tables 14 and 15. Stream toxicity classifications resulting from these indices are shown in Figure 5. The toxicity to fish of water from the Chicago Sanitary and Ship Canal has clearly decreased between 1977 and 1985 both upstream and downstream of the Stickney WRP. There was a decrease in average Bluegill Toxicity Index upstream (from 0.5 BGTUs in 1977 to 0.2 BGTUs in 1985) and downstream (from 0.4 BGTUs in 1977 to 0.3 BGTUs in 1985) of the Stickney WRP from "chlorination" to "no chlorination periods". This would indicate that water quality conditions were better for fish both upstream and downstream of the Stickney WRP during 1985 as compared to 1977.

CALUMET WATERWAY

Bluegill Toxicity Indices calculated for Calumet Waterway chemical data collected during 1977 and during 1985 at the time of the District fish collections are shown in Figure 6. The Bluegill Toxicity Index ranged from 0.04 to 0.19 BGTUs during the 1977 fish collections, and from 0.03 to 0.44 BGTUs during the 1985 fish collections. Downstream of the Calumet WRP effluent outfall, the Bluegill Toxicity Index ranged from 0.67 to 1.63 BGTUs during the 1977 fish collections and from 0.23 to 5.72 BGTUs during the 1985 fish collections.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 14

AVERAGE WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES FOR THE CHICAGO SANITARY AND SHIP CANAL UPSTREAM OF THE STICKNEY WATER RECLAMATION PLANT OUTFALL DURING 1977 AND 1985

Water Quality Constituent	Concentration ^a		Bluegill Toxic Units ^a	
	1977	1985	1977	1985
Temperature (°C)	24	14	-	-
Hardness (mg/L as CaCO ₃) ^b	200	176	-	-
Dissolved				
Oxygen (mg/L)	0.97	4.26	-	-
pH (units)	7.10	6.79	-	-
Total NH ₃ -N (mg/L)	3.43	1.69	-	-
Un-ionized				
Ammonia (mg/L)	0.025	0.003	0.09	0.01
Arsenic (mg/L)	<0.2	<0.2	0.00	0.00
Cadmium (mg/L)	<0.02	<0.02	0.00	0.00
Total Residual				
Chlorine (mg/L)	NAC ^c	<0.01	NA	0.00
Chromium (mg/L)	<0.02	<0.02	0.00	0.00
Copper (mg/L)	<0.02	0.01	0.00	0.00
Cyanide (mg/L)	0.009	0.014	0.07	0.09
Fluoride (mg/L)	0.50	0.39	0.01	0.01
Iron (mg/L)	0.13	0.36	0.00	0.01
MBAS (mg/L)	0.097	0.034	0.28	0.07
Lead (mg/L)	0.01	0.01	0.00	0.00
Manganese (mg/L)	0.04	0.02	0.00	0.00
Mercury (µg/L)	<0.3	<0.3	0.00	0.00
Nickel (mg/L)	<0.2	<0.2	0.00	0.00
NO ₂ +NO ₃ (mg/L)	1.34	0.99	0.00	0.00
Phenol (mg/L)	0.003	0.001	0.00	0.00
Silver (mg/L)	<0.001	0.001	0.00	0.01
Zinc (mg/L)	<0.2	<0.2	0.00	0.00
Bluegill Toxicity Index			0.46	0.20

^aAverage of four samples from 1977 and of seven samples from 1985.

^bHardness estimated as 200 mg/L for samples from 1977.

^cNA indicates no analysis.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 15

AVERAGE WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES
FOR THE CHICAGO SANITARY AND SHIP CANAL DOWNSTREAM OF THE
STICKNEY WATER RECLAMATION PLANT OUTFALL DURING 1977 AND 1985

Water Quality Constituent	Concentration ^a		Bluegill Toxic Units ^a	
	1977	1985	1977	1985
Temperature (°C)	24	17	-	-
Hardness (mg/L as CaCO ₃) ^b	200	199	-	-
Dissolved				
Oxygen (mg/L)	2.14	4.18	-	-
pH (units)	7.10	6.77	-	-
Total NH ₃ -N (mg/L)	2.77	2.46	-	-
Un-ionized				
Ammonia (mg/L)	0.023	0.006	0.10	0.02
Arsenic (mg/L)	<0.2	<0.2	0.00	0.00
Cadmium (mg/L)	<0.02	<0.02	0.00	0.00
Total Residual				
Chlorine (mg/L)	NAC ^c	<0.01	NA	0.00
Chromium (mg/L)	0.02	<0.02	0.00	0.00
Copper (mg/L)	<0.02	0.01	0.00	0.00
Cyanide (mg/L)	0.013	0.010	0.16	0.08
Fluoride (mg/L)	2.39	0.58	0.05	0.01
Iron (mg/L)	0.25	0.39	0.01	0.01
MBAS (mg/L)	0.062	0.079	0.11	0.11
Lead (mg/L)	0.02	0.01	0.00	0.00
Manganese (mg/L)	0.02	0.03	0.00	0.00
Mercury (µg/L)	0.05	<0.3	0.00	0.00
Nickel (mg/L)	<0.2	<0.2	0.00	0.00
NO ₂ +NO ₃ (mg/L)	3.41	3.27	0.00	0.00
Phenol (mg/L)	0.013	0.005	0.00	0.00
Silver (mg/L)	<0.001	0.001	0.00	0.01
Zinc (mg/L)	0.02	<0.2	0.00	0.00
Bluegill Toxicity Index			0.44	0.25

^aAverage of six samples from 1977 and of ten samples from 1985.

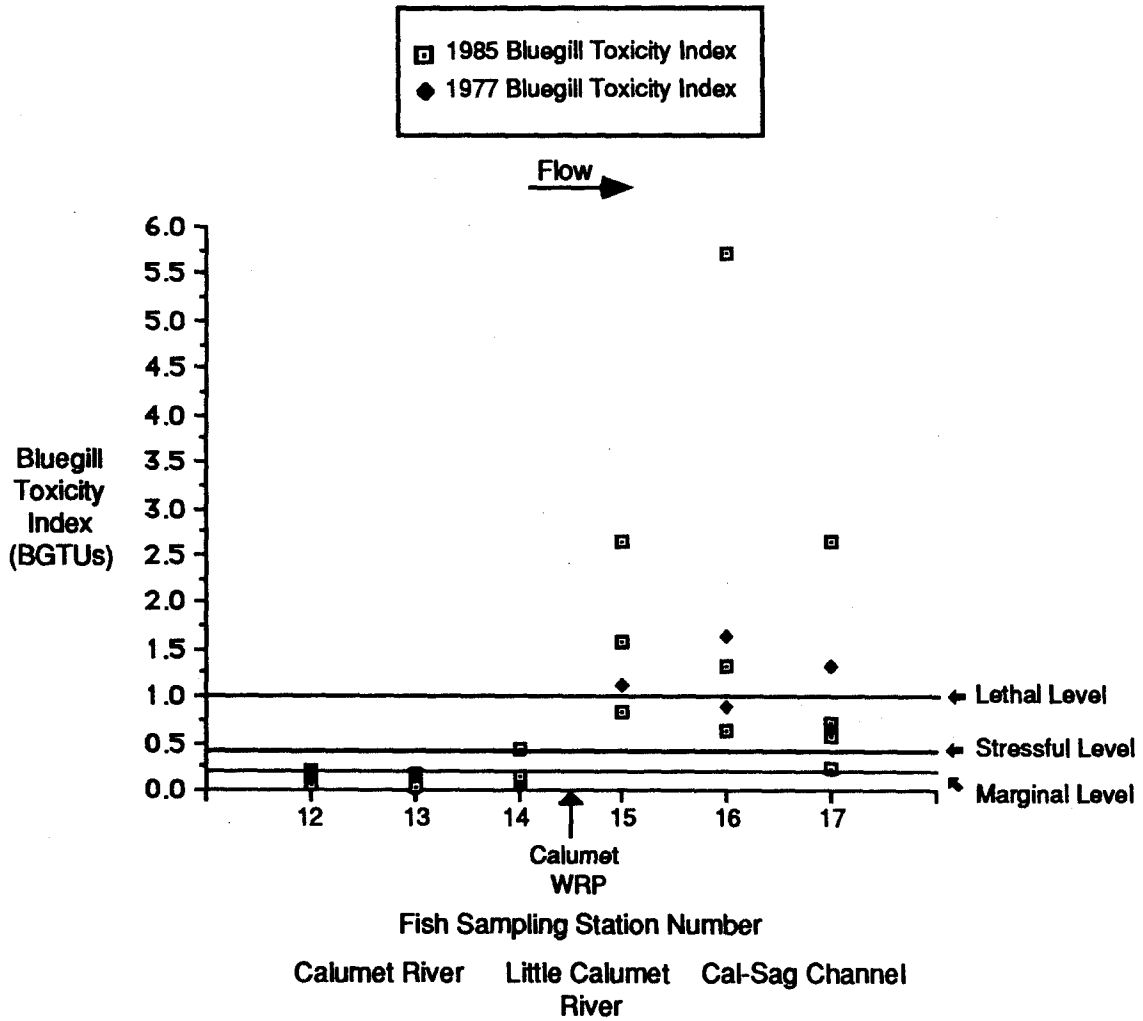
^bHardness estimated as 200 mg/L for samples from 1977.

^cNA indicates no analysis.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 6

BLUEGILL TOXICITY INDEX FOR THE CALUMET RIVER, LITTLE CALUMET RIVER AND CAL-SAG CHANNEL DURING 1977 AND 1985



Average water quality constituents and Bluegill Toxicity Indices for the Calumet River, Little Calumet River and Cal-Sag Channel comparing data from 1977 with 1985 upstream and downstream of the Calumet WRP are listed in Tables 16 and 17. Stream toxicity classifications resulting from these indices are shown in Figure 5. In the Calumet River and Little Calumet River upstream of the Calumet WRP effluent, average Bluegill Toxicity Index remained about the same during "chlorination" and "no chlorination" years, 0.1 BGTU in 1977 and also in 1985. The channel water in this upstream portion of the Calumet Waterway appears to be, in general, relatively nontoxic to fish. However, there was an increase in average Bluegill Toxicity Index from 1977 (1.2 BGTUs) to 1985 (1.8 BGTUs) at the locations downstream of the Calumet WRP in the Little Calumet River and the Cal-Sag Channel. The Calumet Waterway below the Calumet WRP was often, theoretically, acutely toxic and lethal to 50 percent of the fish exposed to it for 96 hours.

The lack of change in the fish populations in the Little Calumet River and Cal-Sag Channel is apparently due to the toxicity in that area of the channel below the Calumet WRP outfall. Here the channel water was found to have a component toxicity sometimes exceeding one BGTU. There were five instances during 1985 in which the Bluegill Toxicity Index was greater than one BGTU. Theoretically, these waters should have been acutely toxic to fish in four days.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 16

AVERAGE WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES FOR THE CALUMET RIVER AND LITTLE CALUMET RIVER UPSTREAM OF THE CALUMET WATER RECLAMATION PLANT OUTFALL DURING 1977 AND 1985

Water Quality Constituent	Concentration ^a		Bluegill Toxic Units ^a	
	1977	1985	1977	1985
Temperature (°C)	18	17	-	-
Hardness (mg/L as CaCO ₃) ^b	202	138	-	-
Dissolved				
Oxygen (mg/L)	7.18	7.44	-	-
pH (units)	7.60	7.45	-	-
Total NH ₃ -N (mg/L)	1.23	3.02	-	-
Un-ionized				
Ammonia (mg/L)	0.025	0.007	0.05	0.02
Arsenic (mg/L)	<0.2	<0.2	0.00	0.00
Cadmium (mg/L)	<0.02	<0.02	0.00	0.00
Total Residual				
Chlorine (mg/L)	NA ^c	<0.01	NA	0.00
Chromium (mg/L)	<0.02	<0.02	0.00	0.00
Copper (mg/L)	<0.02	0.02	0.00	0.00
Cyanide (mg/L)	0.003	0.013	0.02	0.06
Fluoride (mg/L)	0.51	0.30	0.01	0.01
Iron (mg/L)	0.75	0.57	0.02	0.02
MBAS (mg/L)	0.060	0.049	0.03	0.03
Lead (mg/L)	0.02	<0.02	0.00	0.00
Manganese (mg/L)	0.07	0.04	0.00	0.00
Mercury (µg/L)	0.2	<0.3	0.00	0.00
Nickel (mg/L)	<0.2	<0.2	0.00	0.00
NO ₂ +NO ₃ (mg/L)	0.82	0.51	0.00	0.00
Phenol (mg/L)	0.005	0.001	0.00	0.00
Silver (mg/L)	<0.001	<0.001	0.00	0.00
Zinc (mg/L)	<0.2	<0.2	0.00	0.00
Bluegill Toxicity Index			0.13	0.15

^aAverage of four samples from 1977 and of nine samples from 1985.

^bHardness estimated as 200 mg/L for samples from 1977.

^cNA indicates "no analysis."

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 17

AVERAGE WATER QUALITY CONSTITUENTS AND BLUEGILL TOXICITY INDICES FOR THE LITTLE CALUMET RIVER AND CAL-SAG CHANNEL DOWNSTREAM OF THE CALUMET WATER RECLAMATION PLANT OUTFALL DURING 1977 AND 1985

Water Quality Constituent	Concentration ^a		Bluegill Toxic Units ^a	
	1977	1985	1977	1985
Temperature (°C)	19	17	-	-
Hardness (mg/L as CaCO ₃) ^b	200	211	-	-
Dissolved				
Oxygen (mg/L)	1.53	2.26	-	-
pH (units)	7.35	7.04	-	-
Total NH ₃ -N (mg/L)	7.07	5.98	-	-
Un-ionized				
Ammonia (mg/L)	0.076	0.029	0.39	0.14
Arsenic (mg/L)	<0.2	<0.2	0.00	0.00
Cadmium (mg/L)	<0.02	<0.02	0.00	0.00
Total Residual				
Chlorine (mg/L)	NA ^c	<0.01	NA	0.00
Chromium (mg/L)	<0.02	<0.02	0.00	0.00
Copper (mg/L)	<0.02	0.02	0.00	0.01
Cyanide (mg/L)	0.020	0.130	0.21	1.22
Fluoride (mg/L)	0.85	0.64	0.02	0.01
Iron (mg/L)	0.60	1.07	0.02	0.03
MBAS (mg/L)	0.177	0.092	0.48	0.25
Lead (mg/L)	0.02	0.01	0.00	0.00
Manganese (mg/L)	0.10	0.07	0.00	0.00
Mercury (µg/L)	<0.3	<0.3	0.00	0.00
Nickel (mg/L)	0.25	<0.2	0.01	0.00
NO ₂ +NO ₃ (mg/L)	1.10	0.82	0.00	0.00
Phenol (mg/L)	0.001	0.013	0.00	0.00
Silver (mg/L)	<0.001	0.001	0.00	0.01
Zinc (mg/L)	<0.2	0.02	0.00	0.00
Bluegill Toxicity Index			1.13	1.68

^aAverage of six samples from 1977 and of ten samples from 1985.

^bHardness estimated as 200 mg/L for samples from 1977.

^cNA indicates "no analysis."

CHLORINE RESIDUAL

In order to estimate what the Bluegill Toxicity Index would have been in these waterways if the total chlorine residual had been measured during the years prior to 1985, data from a 1972 study (Harper and Lue-Hing, 1974) are presented for the North Shore Channel and North Branch of the Chicago River. At this time, a series of total chlorine residual determinations were made for the North Shore Channel, and North Branch of the Chicago River up to five miles downstream of the North Side WRP effluent outfall. Another set of total chlorine residual determinations was made during 1982 for locations along the North Shore Channel.

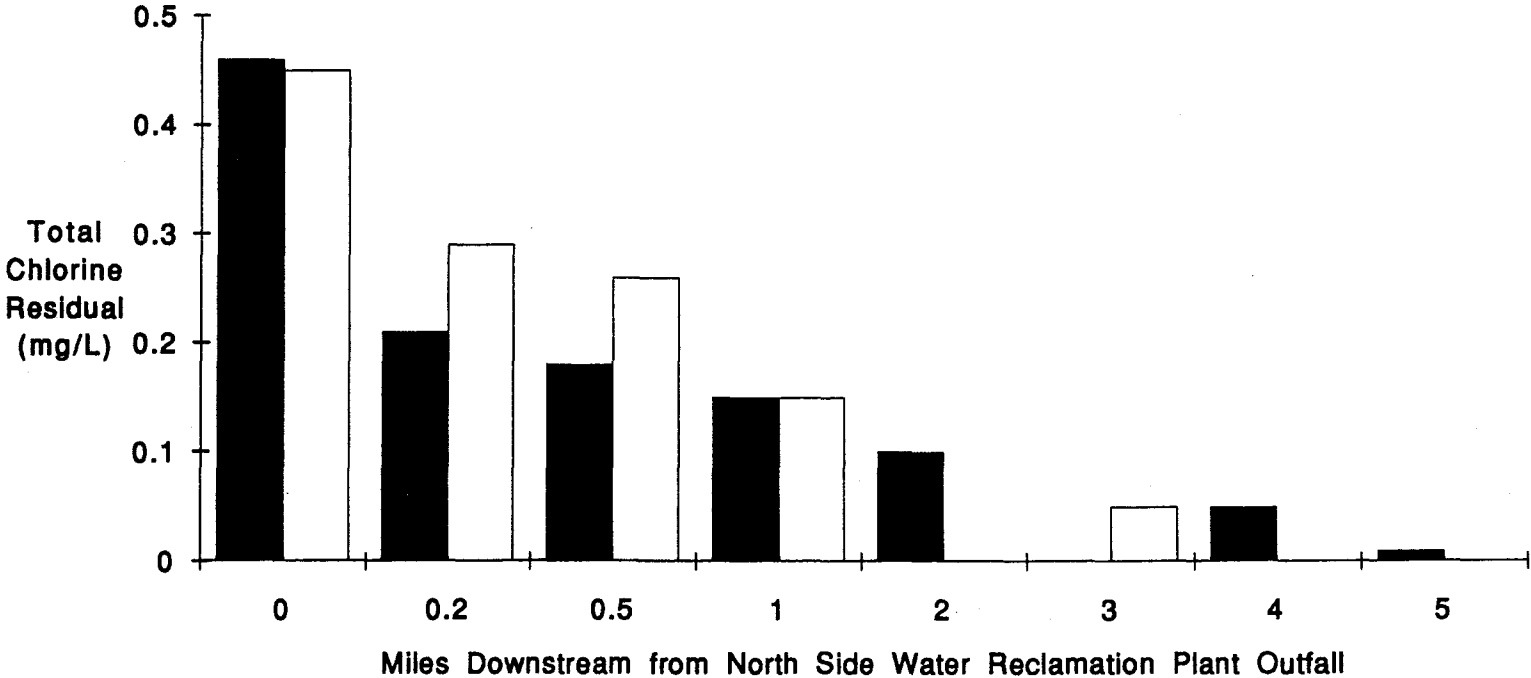
Data from the 1972 and 1982 studies are presented in Figure 7. Depending on location in the waterway, effluent chlorination could have added a component toxicity of 0.03 to 2.7 BGTUs (using the range of total chlorine residuals listed in the previous studies) to the existing toxic fraction in the water within five miles of a chlorinated effluent source. An addition to the Bluegill Toxicity Index by the total chlorine residual at each location as depicted in Figures 4 and 5 may have been equal to or greater than 1.0 BGTU. Theoretically, such conditions would then have been acutely toxic and lethal to 50 percent of the fish (specifically, to the bluegill sunfish) at most of the North Shore Channel and North Branch of the Chicago River fish collection locations downstream of the North Side WRP (the source of the total chlorine residual) within

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FIGURE 7

TOTAL CHLORINE RESIDUAL IN THE NORTH SHORE CHANNEL AND NORTH BRANCH OF THE CHICAGO RIVER

■ May to Sept. 1972 □ Sept. 1982



96-hours. This would help to explain the low numbers of fish, in the years prior to 1985, downstream of the North Side WRP and Stickney WRP.

Theoretically, the toxicity of the water below the Calumet WRP outfall (Figures 5 and 6) was acutely toxic to fish both before (1977) and after (1985) the cessation of effluent chlorination, with or without the toxicity due to the total chlorine residual taken into consideration.

Reduction in Midge Population Along the North Shore Channel

HISTORICAL REVIEW OF MIDGE CONTROL

Nonbiting larval midges are one of the most common and abundant organisms in inland natural or man-made aquatic ecosystems. Adult midge flies emerging in large numbers from lakes and rivers often create a nuisance for people living or working near midge larval breeding sources (Ali, 1980). Many species emerge in the dark with peak emergences occurring within two to four hours after sunset. The adult midges are attracted to lights around which they swarm. The swarming activity gradually subsides after midnight. Even though the adult midges do not bite or transmit any diseases, massive swarms entering homes and businesses necessitates control of both larval and adult populations.

In 1969 and 1970, residents began complaining to the District regarding adult midge fly swarms emanating from a three mile reach of the North Shore Channel below the outfall from the

North Side WRP. A program to chemically control midge larvae in the North Shore Channel was initiated during 1971 with the use of chlorpyrifos (Dursban®) insecticide. Applications in 1972 and 1973 resulted in excellent control of midge larvae (Polls, et al., 1975). During 1974, the chemical lost effectiveness, and the larvae were demonstrated to have developed a resistance to the insecticide.

From 1979 through 1981, the District used temephos (Abate®) insecticide in the North Shore Channel for midge larval control. Temephos similarly became ineffective against the midge larvae during 1981. As was the case with chlorpyrifos, the midge larvae had developed a resistance to temephos. Ali and Mulla (1977, 1978) have shown that the repeated, and prolonged, use of insecticides may result in the build-up of a cross resistance within the organophosphorus group of pesticides by midge larvae. The District discontinued using chemicals for midge larval control in the channel during 1982. Since then, the principal means for controlling midges has been adulticiding in the evenings during the midge breeding season (June through November) using ultra low volume (ULV) applicators.

ADULT MIDGE REDUCTION

A monitoring program was developed in 1981 to determine the prevalence and number of adult midge flies along the North Shore Channel below the North Side WRP outfall. Four New Jersey[®] insect light traps, placed approximately one-half mile apart, were used to collect adult midge flies. In June through August 1984, the mean number of adult midges collected daily, except weekends, from the four light traps were 3,247 adults/trap/12-hr sampling period. Compared to June through August 1984, a significant decrease ($p < 0.01$) in the mean number of adult midges (Figure 8) occurred during the same three months in 1985 (mean = 123 adults/trap/12-hr sampling period).

As a consequence of the reduction in the number of adult midge flies along the North Shore Channel, the number of citizens complaining to the District regarding the swarming activity of adult midge flies declined also from 56 complaints during the period of April through August 1984, to none from September 1984 through December 1985 (Table 18).

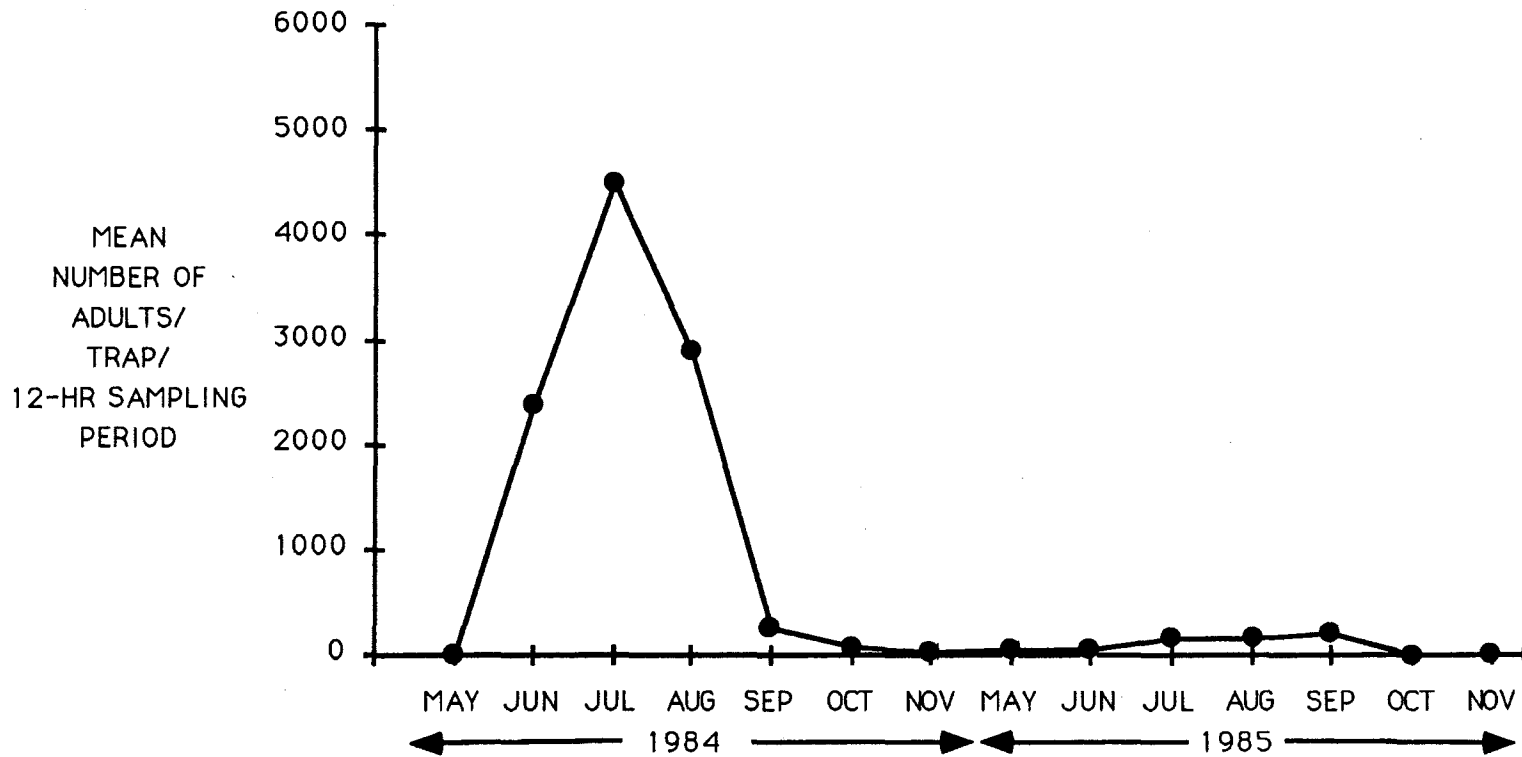
PREDATORY FISH

The decrease in the midge population is thought to be due to the establishment of a predatory fish population which feeds upon the midge larvae, pupae, and emerging adults. As discussed previously, compared to the period from 1974 through 1977, the

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 8

MEAN NUMBER OF ADULT MIDGE FLIES COLLECTED FROM NEW JERSEY
INSECT LIGHT TRAPS ALONG THE NORTH SHORE CHANNEL DURING
1984 AND 1985



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TABLE 18

NUMBER OF CITIZENS COMPLAINING TO THE DISTRICT REGARDING ADULT
MIDGE FLY SWARMS ALONG THE NORTH SHORE CHANNEL DURING 1984 AND
1985

Month	1984	1985
March	0	0
April	14	0
May	7	0
June	13	0
July	11	0
August	11	0
September	0	0
October	0	0
November	0	0
December	0	0

mean abundance of fish collected in the North Shore Channel below the outfall from the North Side WRP increased from one fish/30 minutes of electrofishing, to 93 and 11 fish/30 minutes of electrofishing during 1984 and 1985, respectively. Coincident total numbers of fish species increased also from seven fish species during the period 1974 through 1977, to 13 and 18 species of fish in 1984 and 1985, respectively.

Several investigators (Bay and Anderson, 1965; Bay and Anderson, 1966; Kimball, 1968) have shown that midge larvae and pupae form a significant part of the diet of freshwater fish including bullheads, carp, goldfish, and mosquitofish.

Evidence for the effectiveness of fish as predators of midges was obtained by examining the digestive tracts of 206 fish (predominantly bluntnose and fathead minnows, and brook sticklebacks) collected in the North Shore Channel below the North Side WRP outfall during October and November 1984. Of these 206 digestive tracts, 139 (67%) contained from one to 129 midges (Table 19). Carp had the greatest average midge count of these 139 fish (77 midges/tract). The green sunfish and the yellow perch had an average of 25 midges in their digestive tracts.

It is, therefore, concluded that fish extensively fed upon midges (biological control), so that no chemical controls were necessary for midge abatement along the North Shore Channel during the period from September 1984 through December 1985.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 19

DIGESTIVE TRACT ANALYSIS OF FISH COLLECTED FROM THE NORTH SHORE CHANNEL BELOW THE NORTH SIDE WATER RECLAMATION PLANT OUTFALL DURING OCTOBER AND NOVEMBER 1984

Fish Species	Number of Digestive Tracts Examined	Number of Fish in Which Midges Were Found in the Digestive Tract	Range of Midge Counts Per Tract	Average Midge Count Per Tract	Average Fish Total Length (inches)
Black bullhead	1	1		15	7
Bluegill	2	2	2 - 10	6	2
Bluntnose minnow	41	18	1 - 31	5	2
Brook stickleback	71	67	1 - 16	5	2
Carp	5	5	1 - 129	77	5
Fathead minnow	65	31	1 - 12	4	2
Goldfish	7	4	1 - 10	4	2
Green sunfish	4	4	10 - 43	25	4
Carp x goldfish hybrid	4	3	2 - 60	22	3
Longnose dace	2	1		13	2
Yellow perch	4	3	19 - 37	25	4
Total	206	139			

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APPENDIX AI

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-1

ABUNDANCE OF FISH FROM THE NORTH SHORE CHANNEL AT STATION
NUMBER 1 (SHERIDAN ROAD) UPSTREAM OF THE NORTH SIDE WRP FROM
1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Alewife	447	238	37.3	14.5
Gizzard shad	2	0	0.1	0.0
Rainbow trout	1	4	<0.1	0.3
Brown trout	8	0	1.8	0.0
Chinook salmon	0	1	0.0	0.3
Coho salmon	1	0	0.1	0.0
Rainbow smelt	1	1,407	0.2	85.5
Goldfish	494	62	23.1	4.5
Carp	195	55	7.9	4.1
Carp x goldfish hybrid	57	19	3.9	1.5
Golden shiner	2	37	0.6	3.0
Emerald shiner	0	14	0.0	0.9
Spottail shiner	30	85	1.9	6.3
Bluntnose minnow	487	1,086	43.7	89.8
Fathead minnow	22	1,420	3.9	95.7
White sucker	1	16	<0.1	1.0
Black bullhead	0	61	0.0	3.9
Brook stickleback	0	512	0.0	38.0
Ninespine stickleback	1	0	0.2	0.0
Rock bass	3	1	0.4	0.1
Green sunfish	26	481	3.3	31.2
Pumpkinseed	3	38	0.4	4.1
Orangespotted sunfish	0	18	0.0	1.4
Bluegill	41	10	5.0	3.2
Largemouth bass	2	4	0.1	0.7
White crappie	1	0	0.1	0.0
Black crappie	0	3	0.0	0.2
Green sunfish x pumpkinseed hybrid	2	1	0.4	0.1
Yellow perch	117	919	5.0	92.2
Mottled sculpin	0	1	0.0	0.1
Total	1,944	6,508	139.2	482.6
Number of species	21	23		
Number of hybrids	2	2		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-2

ABUNDANCE OF FISH FROM THE NORTH SHORE CHANNEL AT STATION
NUMBER 2 (DEMPSTER STREET) UPSTREAM OF THE NORTH SIDE WRP FROM
1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Alewife	0	9	0.0	0.8
Rainbow trout	0	0	0.0	0.3
Rainbow smelt	0	3	0.0	0.4
Goldfish	48	43	9.6	3.9
Carp	9	12	2.4	1.1
Carp x goldfish hybrid	27	15	4.8	1.3
Golden shiner	0	4	0.0	0.4
Spottail shiner	0	3	0.0	0.3
Bluntnose minnow	0	4	0.0	0.3
Fathead minnow	1	424	0.3	37.2
White sucker	0	3	0.0	0.3
Black bullhead	0	23	0.0	2.9
Brook stickleback	0	23	0.0	2.0
Green sunfish	1	63	0.2	5.6
Pumpkinseed	0	4	0.0	0.3
Bluegill	0	4	0.0	0.4
Black crappie	0	4	0.0	0.4
Green sunfish.x pumpkinseed hybrid	0	1	0.0	0.1
Yellow perch	0	473	0.0	41.3
Total	86	1,115	17.3	99.3
Number of species	4	17		
Number of hybrids	1	2		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-3

ABUNDANCE OF FISH FROM THE NORTH SHORE CHANNEL AT STATION
NUMBER 3 (TOUHY AVENUE) DOWNSTREAM OF THE NORTH SIDE WRP FROM
1974 THROUGH 1977 AND IN 1984 AND 1985

Fish Species	Total Number			Catch Per 30 Minutes		
	1974- 1977	1984	1985	1974- 1977	1984	1985
Alewife	0	0	12	0.0	0.0	1.0
Goldfish	1	1	21	0.1	0.4	1.9
Carp	2	2	22	0.4	0.8	1.9
Carp x goldfish hybrid	1	0	6	0.1	0.0	0.6
Spottail shiner	1	0	0	0.2	0.0	0.0
Bluntnose minnow	0	12	0	0.0	4.7	0.0
Fathead minnow	0	70	13	0.0	27.3	1.1
Longnose dace	0	2	0	0.0	0.8	0.0
White sucker	0	0	4	0.0	0.0	0.4
Black bullhead	0	1	17	0.0	0.4	1.4
Brook stickleback	0	18	10	0.0	7.0	0.8
Green sunfish	4	7	3	0.5	2.7	0.3
Pumpkinseed	0	0	1	0.0	0.0	0.1
Bluegill	1	0	1	0.1	0.0	0.1
Largemouth bass	0	0	1	0.0	0.0	0.1
Yellow perch	0	2	1	0.0	0.8	0.1
Total	10	115	112	1.4	44.9	9.8
Number of species	5	9	12			
Number of hybrids	1	0	1			

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-4

ABUNDANCE OF FISH FROM THE NORTH SHORE CHANNEL AT STATION
NUMBER 4 (PETERSON AVENUE) DOWNSTREAM OF THE NORTH SIDE WRP FROM
1974 THROUGH 1977 AND IN 1984 AND 1985

Fish Species	Total Number			Catch Per 30 Minutes		
	1974- 1977	1984	1985	1974- 1977	1984	1985
Alewife	0	0	5	0.0	0.0	0.5
Goldfish	0	7	13	0.0	2.7	1.2
Carp	0	8	27	0.0	3.1	2.5
Carp x goldfish hybrid	0	0	7	0.0	0.0	0.6
Golden shiner	0	1	0	0.0	0.4	0.0
Bigmouth shiner	0	1	0	0.0	0.4	0.0
Spottail shiner	0	1	0	0.0	0.4	0.0
Bluntnose minnow	0	99	1	0.0	38.1	0.1
Fathead minnow	0	171	32	0.0	65.8	3.0
Longnose dace	0	6	0	0.0	2.3	0.0
White sucker	0	0	1	0.0	0.0	0.1
Black bullhead	0	0	2	0.0	0.0	0.2
Brook stickleback	0	68	3	0.0	26.2	0.3
Green sunfish	0	0	46	0.0	0.0	4.1
Bluegill	0	2	2	0.0	0.8	0.2
Largemouth bass	0	0	1	0.0	0.0	0.1
Yellow perch	0	2	1	0.0	0.8	0.1
Total	0	366	141	0	141.0	13.0
Number of species	0	11	12			
Number of hybrids	0	0	1			

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-5

ABUNDANCE OF FISH FROM THE NORTH BRANCH OF THE CHICAGO RIVER AT
STATION NUMBER 5 (WILSON AVENUE) DOWNSTREAM OF THE NORTH SIDE
WRP FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Alewife	0	4	0.0	0.4
Goldfish	2	22	0.8	2.2
Carp	3	22	1.2	2.2
Carp x goldfish hybrid	0	5	0.0	0.5
Spottail shiner	0	1	0.0	0.1
Fathead minnow	0	18	0.0	1.9
Black bullhead	1	3	0.4	0.3
Brook stickleback	0	6	0.0	0.6
Green sunfish	0	25	0.0	2.5
Orangespotted sunfish	0	2	0.0	0.2
Bluegill	1	1	0.4	0.1
Black crappie	1	0	0.4	0.0
Yellow perch	0	2	0.0	0.2
Total	8	111	3.2	11.2
Number of species	5	11		
Number of hybrids	0	1		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-6

ABUNDANCE OF FISH FROM THE NORTH BRANCH OF THE CHICAGO RIVER AT STATION NUMBER 6 (GRAND AVENUE) DOWNSTREAM OF THE NORTH SIDE WRP FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Gizzard shad	0	5	0.0	0.7
Rainbow smelt	0	1	0.0	0.1
Goldfish	0	5	0.0	0.7
Carp	0	15	0.0	2.0
Carp x goldfish hybrid	0	1	0.0	0.2
Golden shiner	0	1	0.0	0.2
Fathead minnow	0	2	0.0	0.3
Black bullhead	0	7	0.0	0.9
Green sunfish	0	2	0.0	0.2
Bluegill	0	2	0.0	0.2
Largemouth bass	0	1	0.0	0.1
Yellow perch	0	47	0.0	4.8
Total	0	89	0.0	10.4
Number of species	0	11		
Number of hybrids	0	1		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-7

ABUNDANCE OF FISH FROM THE CHICAGO SANITARY AND SHIP CANAL AT
STATION NUMBER 7 (DAMEN AVENUE) UPSTREAM OF THE STICKNEY WRP
FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	<u>Total Number</u>		<u>Catch Per 30 Minutes</u>	
	1974-1977	1985	1974-1977	1985
Alewife	0	5	0.0	0.6
Gizzard shad	0	1	0.0	0.1
Rainbow trout	0	1	0.0	0.1
Rainbow smelt	0	23	0.0	2.6
Goldfish	0	58	0.0	6.7
Carp	0	41	0.0	4.9
Carp x goldfish hybrid	0	5	0.0	0.6
Golden shiner	0	1	0.0	0.1
Spottail shiner	0	1	0.0	0.1
Bluntnose minnow	0	5	0.0	0.6
Fathead minnow	0	7	0.0	0.8
Black bullhead	0	24	0.0	2.8
Green sunfish	0	6	0.0	0.7
Bluegill	0	5	0.0	0.6
Yellow perch	0	22	0.0	2.7
Total	0	205	0	24.0
Number of species	0	14		
Number of hybrids	0	1		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-8

ABUNDANCE OF FISH FROM THE CHICAGO SANITARY AND SHIP CANAL AT STATION NUMBER 8 (CICERO AVENUE) UPSTREAM OF THE STICKNEY WRP FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Alewife	2	0	0.2	0.0
Rainbow smelt	0	5	0.0	0.7
Goldfish	7	84	0.6	13.2
Carp	8	36	1.4	5.9
Carp x goldfish hybrid	4	2	0.3	0.5
Fathead minnow	0	3	0.0	0.7
Black bullhead	0	5	0.0	1.2
Green sunfish	0	2	0.0	0.4
Black crappie	1	0	0.1	0.0
Total	22	137	2.6	22.6
Number of species	4	6		
Number of hybrids	1	1		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-9

ABUNDANCE OF FISH FROM THE CHICAGO SANITARY AND SHIP CANAL AT STATION NUMBER 9 (HARLEM AVENUE) DOWNSTREAM OF THE STICKNEY WRP FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Gizzard shad	0	1	0.0	0.1
Rainbow smelt	0	3	0.0	0.3
Central mudminnow	0	2	0.0	0.2
Goldfish	0	238	0.0	19.7
Carp	3	103	0.9	9.8
Carp x goldfish hybrid	0	12	0.0	1.0
Spottail shiner	0	3	0.0	0.4
Bluntnose minnow	0	1	0.0	0.1
Fathead minnow	0	2	0.0	0.2
Black bullhead	0	2	0.0	0.2
Green sunfish	0	3	0.0	0.3
Bluegill	0	1	0.0	0.1
Yellow perch	0	41	0.0	4.4
Total	3	412	0.9	36.8
Number of species	1	12		
Number of hybrids	0	1		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-10

ABUNDANCE OF FISH FROM THE CHICAGO SANITARY AND SHIP CANAL AT
STATION NUMBER 10 (WILLOW SPRINGS ROAD) DOWNSTREAM OF THE
STICKNEY WRP FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Rainbow smelt	0	1	0.0	0.2
Goldfish	2	52	0.4	8.8
Carp	3	5	0.7	1.0
Black bullhead	0	1	0.0	0.2
Yellow perch	0	1	0.0	0.2
Total	5	60	1.1	10.4
Number of species	2	5		
Number of hybrids	0	0		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-11

ABUNDANCE OF FISH FROM THE CHICAGO SANITARY AND SHIP CANAL AT STATION NUMBER 11 (16TH STREET, LOCKPORT) DOWNSTREAM OF THE STICKNEY WRP FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Grass pickerel	0	1	0.0	0.2
Goldfish	39	11	3.7	1.8
Carp	35	24	4.0	3.6
Carp x goldfish hybrid	6	4	0.6	0.6
Bluntnose minnow	0	2	0.0	0.4
Black bullhead	4	5	0.4	0.9
Green sunfish	0	1	0.0	0.1
Bluegill	0	2	0.0	0.3
Black crappie	0	1	0.0	0.2
White crappie	1	0	0.4	0.0
Yellow perch	0	2	0.0	0.4
Total	85	53	9.1	8.5
Number of species	4	9		
Number of hybrids	1	1		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-12

ABUNDANCE OF FISH FROM THE CALUMET RIVER AT STATION NUMBER 12
(130TH STREET) UPSTREAM OF THE CALUMET WRP FROM 1974 THROUGH
1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Alewife	4	0	0.7	0.0
Gizzard shad	21	47	3.7	6.1
Rainbow smelt	0	1	0.0	0.1
Goldfish	13	1	3.3	0.1
Carp	37	14	7.4	2.0
Carp x goldfish hybrid	1	0	0.2	0.0
Golden shiner	2	12	0.6	1.4
Emerald shiner	58	0	10.1	0.0
Spottail shiner	3	9	1.3	2.0
Sand shiner	0	3	0.0	0.4
Bluntnose minnow	844	1,521	142.7	197.9
Fathead minnow	0	15	0.0	1.8
White sucker	0	1	0.0	0.2
Black bullhead	0	2	0.0	0.4
Channel catfish	0	1	0.0	0.1
White perch	0	1	0.0	0.2
Green sunfish	16	29	2.7	3.4
Pumpkinseed	4	23	0.7	2.9
Orangespotted sunfish	1	23	0.2	3.3
Bluegill	0	1	0.0	0.1
Largemouth bass	43	20	7.2	2.5
Black crappie	1	1	0.2	0.1
Green sunfish x pumpkinseed hybrid	0	0	0.0	0.0
Yellow perch	16	153	3.3	18.3
Totals	1,064	1,878	184.3	243.3
Number of species	14	20		
Number of hybrids	1	0		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-13

ABUNDANCE OF FISH FROM THE CALUMET RIVER AT STATION NUMBER 13
(TAILRACE OF THE O'BRIEN LOCK AND DAM) UPSTREAM OF THE CALUMET
WRP FROM 1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Bowfin	0	1	0.0	0.2
Alewife	2	6	0.2	1.2
Gizzard shad	220	25	11.7	5.7
Goldfish	11	2	0.6	0.5
Carp	83	92	6.8	27.1
Carp x goldfish hybrid	8	6	0.9	2.0
Golden shiner	5	0	0.2	0.0
Emerald shiner	168	20	9.1	4.8
Common shiner	1	0	0.1	0.0
Spottail shiner	0	1	0.0	0.2
Bluntnose minnow	220	882	13.2	250.7
Fathead minnow	0	13	0.0	3.7
Green sunfish	32	23	4.5	6.6
Pumpkinseed	8	7	1.3	1.7
Orangespotted sunfish	1	12	0.2	2.8
Bluegill	4	1	0.4	0.3
Largemouth bass	25	11	2.0	2.6
Black crappie	0	5	0.0	1.2
Yellow perch	55	104	3.5	24.8
Freshwater drum	0	2	0.0	0.4
Totals	843	1,213	54.7	336.5
Number of species	14	17		
Number of hybrids	1	1		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-14

ABUNDANCE OF FISH FROM THE LITTLE CALUMET RIVER AT STATION
NUMBER 14 (ROUTE I-94) UPSTREAM OF THE CALUMET WRP FROM 1974
THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Gizzard shad	298	159	41.8	26.1
Goldfish	85	27	13.1	4.5
Carp	74	45	12.4	7.8
Carp x goldfish hybrid	18	1	3.1	0.2
Golden shiner	1	0	0.1	0.0
Emerald shiner	249	0	32.1	0.0
Bluntnose minnow	19	298	2.8	49.1
Fathead minnow	1	9	0.1	1.5
Black bullhead	0	1	0.0	0.2
Green sunfish	1	0	0.2	0.0
Pumpkinseed sunfish	1	7	0.2	1.2
Orangespotted	0	1	0.0	0.2
Bluegill	3	0	0.4	0.0
Largemouth bass	15	3	1.8	0.5
Yellow perch	0	92	0.0	15.3
Totals	765	643	108.1	106.6
Number of species	11	10		
Number of hybrids	1	1		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-15

ABUNDANCE OF FISH FROM THE LITTLE CALUMET RIVER AT STATION
NUMBER 15 (HALSTED STREET) DOWNSTREAM OF THE CALUMET WRP FROM
1974 THROUGH 1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Gizzard shad	26	23	1.3	2.5
Central mudminnow	1	0	0.1	0.0
Goldfish	4	6	0.4	0.7
Carp	5	11	0.3	1.2
Carp x goldfish hybrid	3	6	0.2	0.7
Fathead minnow	0	8	0.0	1.2
Black bullhead	2	1	0.2	0.2
Mosquitofish	4	0	0.2	0.0
Green sunfish	61	0	3.5	0.0
Orangespotted sunfish	0	1	0.0	0.1
Bluegill	7	0	0.6	0.0
Totals	113	56	6.8	6.6
Number of species	8	6		
Number of hybrids	1	1		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-16

ABUNDANCE OF FISH FROM THE CAL-SAG CHANNEL AT STATION NUMBER 16
(CICERO AVENUE) DOWNSTREAM OF THE CALUMET WRP FROM 1974 THROUGH
1977 AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Gizzard shad	1	0	0.6	0.0
Goldfish	14	0	2.9	0.0
Carp	11	0	2.0	0.0
Golden shiner	1	0	0.1	0.0
Emerald shiner	1	0	0.1	0.0
Creek chub	2	0	0.3	0.0
White sucker	1	0	0.6	0.0
Black bullhead	3	0	0.4	0.0
Green sunfish	25	0	3.4	0.0
Bluegill	5	0	0.7	0.0
Green sunfish x pumpkinseed hybrid	1	0	0.1	0.0
Totals	65	0	11.2	0.0
Number of species	10	0		
Number of hybrids	1	0		

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AI-17

ABUNDANCE OF FISH FROM THE CAL-SAG CHANNEL AT STATION NUMBER 17
(ROUTE 83) DOWNSTREAM OF THE CALUMET WRP FROM 1974 THROUGH 1977
AND IN 1985

Fish Species	Total Number		Catch Per 30 Minutes	
	1974-1977	1985	1974-1977	1985
Gizzard shad	0	1	0.0	0.1
Rainbow trout	0	1	0.0	0.1
Central mudminnow	1	1	0.2	0.1
Goldfish	3	3	1.2	0.3
Carp	0	11	0.0	1.2
Carp x goldfish hybrid	0	2	0.0	0.2
Fathead minnow	0	12	0.0	1.6
Black bullhead	0	10	0.0	1.4
Green sunfish	1	35	0.5	4.0
Bluegill	1	3	0.5	0.3
Largemouth bass	0	3	0.0	0.3
Yellow perch	0	1	0.0	0.1
Totals	6	83	2.4	9.7
Number of species	4	11		
Number of hybrids	0	1		