Evaluation of a Chemical Reclamation and Restocking Program on the Huron River in the Detroit Metropolitan Area

Percy W. Laarman

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EVALUATION OF A CHEMICAL RECLAMATION AND RESTOCKING PROGRAM ON THE HURON RIVER IN THE DETROIT METROPOLITAN AREA[1]

By Percy W. Laarman

Abstract

About 40 miles of the Huron River, including seven impoundments (1215 ha) in Washtenaw and Wayne counties, were treated with 2 ppm of rotenone. Chemical treatment was done in three segments between October 1972 and October 1973. An estimated 1,016 metric tons of fish (95% carp) were eradicated and more than 17 million fish of desirable species were stocked to provide a sport fishery.

The major evaluation was done by post-treatment creel censuses on the three segments of the river. Post-treatment censuses were conducted during the open-water seasons from 1974-1976 on the upper section, 1974-1977 on Ford Lake, and 1975-1978 on Belleville Lake. Pre-treatment data were taken from a one-year census in 1972 on the upper section and from a mail survey in 1973 on Belleville Lake. On the upper segment of the river, no significant change in fishing pressure was evident after treatment. On Ford Lake and Belleville Lake during the post-treatment period, the mean annual increases in angler trips were 18,259 and 83,388, respectively. Based on an expanded 5-year pre- and post-treatment period and a recreational value of $8.99 per angler trip, the benefit:cost ratio was 4.1:1 (±5.3:1) on the upper segment, 5.7:1 (±1.0:1) on Ford Lake, and 25.3:1 (±4.5:1) on Belleville Lake. The benefit:cost ratio for the entire reclamation project was 13.9:1 (±2.2:1).

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[1] Contribution from Dingell-Johnson Project F-35-R, Michigan.

Introduction

The need exists to improve sport fishing opportunities near large population centers in Michigan. The part of the Huron River system which flows through Washtenaw and Wayne counties is close to the Detroit metropolitan area and therefore readily accessible to potentially large numbers of anglers.

The history of the sport fishery on the Huron River demonstrated the need for improvement. In 1938, a fisheries survey of the Huron River system indicated there was little doubt that a drastic reduction in the carp population would greatly benefit sport fishing (Brown and Funk 1945). Subsequent surveys confirmed that carp were very abundant in the river system.

Large chemical rehabilitation projects are expensive and evaluations of such projects are needed (Lennon et al. 1970). These authors reported there are very few unqualified successes in stream reclamations and that post-treatment evaluations are often sketchy or nonexistent. After critical review of the factors involved and after several public meetings, the decision was made by the Michigan Department of Natural Resources (MDNR) to conduct a large chemical rehabilitation project on about 40 miles of the Huron River including seven impoundments. The objectives of this study were to measure, by creel census, the fishing pressure and angler harvest following the treatment and restocking of desirable fish species and to compare the results with pre-treatment data.

Methods

Prior to chemical treatment, water levels in the impoundments were lowered to reduce the quantity of rotenone needed. Chemical treatment of the Huron River was started at Delhi Rapids (upstream from Barton Pond) and continued downstream to include Belleville Lake (Fig. 1). Rotenone (Pro-Noxfish) was used at a concentration of 2 ppm. The chemical was introduced by setting up drip stations in the lotic sections and by spraying,

boat balers, and helicopter in the lentic waters. Details on the treatment and removal of dead fish, especially for Belleville Lake, were reported by Spitler (1978).

The chemical treatment was divided into three segments. Barton, Argo, Geddes, and Superior impoundments (about 283 ha) in the upper section were treated in October 1972. Papermill (25.5 ha) and Ford (392 ha) impoundments were treated in May 1973, and Belleville (514 ha) was treated in October 1973.

Evaluation of the project was separated into the same three segments as the treatment. Creel census was conducted on all the treated waters except Papermill Pond and a section of the river flowing through the City of Ypsilanti. Spot checks showed very little fishing activity in these areas due to limited access. In general, creel censuses were conducted 40 hours per week according to pre-determined, statistically designed schedules to obtain data on fishing pressure, angler success, and residence of anglers. Since fishing pressure was usually greater on weekends than on weekdays, these data were analyzed separately and then combined to determine total fishing pressure and success. Information was obtained between 0600 and 2100 hours. On the upper section and Belleville Lake, one angler count per day was made. Two angler counts per day were made on Ford Lake. During the study, occasional modifications of the schedules were necessary to utilize available personnel as census clerks.

In the upper section, a pre-treatment creel census was conducted from April to September 1972. The post-treatment census was conducted April to October, 1974-1976. Winter fishing was nil on the treated waters. The 1972 and 1974 censuses included social-economic questions such as angler incomes, age and race, species of fish sought, species desired, and other questions to measure angler interest in the reclamation project. Results of this questionnaire were analyzed and reported by Carl (1976), but a brief summary of his analyses is included in this report to complete the evaluation of the entire reclamation project.

The only pre-treatment data on fishing pressure available for Ford and Belleville impoundments were from a 1973 mail survey (Jamsen 1974)

for Belleville. The rate of increase in angler days from pre- to post-treatment observed for Belleville was used to predict pre-treatment fishing pressure on Ford Lake. On Ford, the post-treatment creel census was conducted from July to October 1974, and from April to October, 1975-1977. The post-treatment creel census on Belleville Lake was conducted from June to October 1975 and from April to October, 1976-1978. Pre- and post-treatment fish surveys were conducted with trap, fyke and gill nets to determine changes in the fish populations. Species composition from net collections and the anglers' creel were compared.

Benefit:cost ratios were determined on a 5-year basis; therefore, available creel census data were expanded to include the 5 years prior and following chemical treatment. In years when the post-treatment census did not include 7 months, the data on fishing pressure were expanded to 7 months. For example, the June to October 1975 census on Belleville was expanded to determine fishing pressure from April to October 1975.

Restocking began in all the impoundments as soon as the waters were non-toxic. Growth rate data on the stocked fish and their progeny were determined from scale samples collected by the census clerks and from netting surveys. For a point of reference on growth, the mean growth index by species was determined, which is the mean deviation in length from the statewide average growth rate. Only age groups represented by a minimum of five fish were used in determining the growth index.

Common names of fishes are used throughout this report.[2] In analyses of the data, hybrid sunfish are combined with pumpkinseed under the name of sunfish.

Results

Upper Section (Huron River; Barton, Argo, Geddes, and Superior impoundments)

At the time of chemical treatment in 1972, estimates of kilograms per hectare of fish removed were as follows: Argo, 166 (94% carp); Barton, 724 (99% carp); Geddes, 636 (99% carp); and Superior, 314 (93% carp).

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[2] A list of Common and Scientific Names of Fishes from the United States and Canada, third edition, 1970. American Fisheries Society Special Publication No. 6.

After treatment, 2,354,563 fish of 10 species were stocked of which 74% were walleye, northern pike and muskellunge fry (Table 1). Rainbow trout, most of which were catchable size, were stocked to provide an interim fishery.

No significant change in angler hours occurred between pre- and post-treatment years, although total harvest in numbers declined significantly after treatment (Table 2). The number of angler trips was greater in 1974 than in any other year. The catch per hour of 1.49 fish in 1972 before treatment was significantly greater than in the post-treatment years; however, the mean catch per hour of 0.59 fish after treatment apparently was sufficiently high to retain angler interest.

In general, the harvest changed primarily from crappie and carp before treatment to predominantly bluegills and sunfish combined 4 years after treatment (Table 3). Bluegills and sunfish together increased from 7% of the catch in 1972 to 64% in 1976. In 1972, 54% of the catch was crappies, but the percentage decreased to 6, 20 and 18 in the three post-treatment years. Carp made up 28% of the catch in 1972 but dropped to 7%, 4%, and 2% in 1974-1976, respectively. Bullheads comprised 1% of the catch in 1972, increased to 48% in 1974, and 32% in 1975, then decreased to 12% in 1976. Apparently survival of the stocked predators was low. Only about 2% of the catch in 1976 consisted of the larger predator species compared to 8% in 1972. Largemouth and smallmouth bass declined from 9% of the catch in 1972 to 1% of the catch in 1976. A limited number of channel catfish were harvested as a result of the stocking program.

Carp were as numerous in post-treatment as in pre-treatment net collections (Table 4). In 1972, 20% of the fish collected were carp as compared to 18% in 1975. During the post-treatment netting survey in 1973, Geddes Impoundment was found to be heavily infested with carp. Later in the same year a special effort was made to net the species and over 6,500 (862 kg) were removed.

The relative abundance of species in nets vs. creel was similar for some species and different for others (Table 5). In 1972, 56% of net-caught fish were crappies compared to 54% in the anglers' creel. The

relationship for crappies was also similar in 1975. Bluegills and sunfish were proportionately more abundant in nets than in the creel in 1972, but the reverse was true in 1975. Anglers' preference may be reflected in the data on carp since the relative abundance in nets and creel was similar in 1972, but in 1975 carp were five times more abundant in nets.

Growth rates for all species except northern pike were more rapid than the statewide average (Table 6). Since growth rates were similar in 1975 and 1976, the data were combined to determine mean growth indexes. Sufficient growth-rate data for 1972 were not available to make valid comparisons between pre- and post-treatment years. The mean length of 543 carp collected in the 1975 netting was 37 cm (range 23-56+ cm).

Comparisons between the 1972 and 1974 interviews indicated the majority of anglers appreciated the chemical rehabilitation, restocking, and park development (City of Ann Arbor) program on the Huron River. A complete description and analyses of the sociological aspects of the 1972 and 1974 censuses were reported by Carl (1976). The following is a summary of his analyses.

The ratio of black anglers to white anglers decreased from 1.12:1 in 1972 to 0.55:1 in 1974. In both years, 70% of the anglers indicated that a few large fish in the creel were more desirable than a "limit" catch of small fish. Twice as many anglers would fish for fun in 1974 than in 1972, although in both years most anglers intended to eat the fish they caught. The mean age of anglers in 1974 was 27.6 years; 37.3 years in 1972.

Anglers showed a preference for catching bass in 1972 and 1974. In both years about 30% indicated that bass was their first choice. Fewer anglers wanted to fish for crappie in 1974 than in 1972. In 1974, more anglers wanted to catch trout and northern pike, indicating the stocking program had influenced angler preference.

Apprehension by anglers about the proposed chemical treatment in 1972 was evident. Sixty-three percent wanted the river stocked but not treated. In 1974, after treatment, about 70% felt the program was good or very good but 20% indicated the program was poor.

The income of fishermen using the Huron River changed over the 2-year period. More low- and high-income and fewer mid-income people were fishing in 1974 than in 1972. The no-income group increased from 5% to 20%. Anglers with incomes from $8,000-$11,000 decreased by a factor of two. The number of anglers with incomes over $17,000 increased from 1% in 1972 to 11% in 1974.

Ford Lake

An estimated 852 kg/ha of fish (99% carp) were removed from Ford Lake when it was treated in May 1973. Fish-kill estimates were based on all fish found in 0.4-ha parcels at 10 different representative areas. A pre-treatment sample of 1,541 fish was taken in October 1972 with trap, fyke and gill nets, of which about 62% were carp, suckers, and bullheads.

From 1973 to 1977, 7,037,836 fish were stocked in the lake (Table 7). About 58% of the total number stocked were walleye fry. Yearling and fingerling rainbow trout were stocked to provide an interim fishery.

Post-treatment estimates of fishing pressure and of total catch are given in Table 8. Fishing pressure was similar in 1974 and 1975, consisting of slightly more than 10,000 angler hours per month. In 1976 and 1977, fishing pressure declined to 5,925 and 6,842 angler hours per month, respectively. The total estimated catch increased from 2,805 fish per month in 1974 to 6,774 fish per month in 1975. In 1976, catch declined to 2,163 fish per month and increased to 7,008 in 1977. If the 1974 census results (July-October) are expanded to include April-October for direct comparison, angler hours per hectare are 185, 185, 106, and 121 for 1974 to 1977, respectively. The catch of 1.02 fish per hour in 1977 was significantly greater than in 1974 and 1976.

When the post-treatment creel censuses were ended, the fisheries in the upper section of the study area (previously described) and Ford Lake were similar. In both areas, the relative abundance of carp in the creel was low and bluegills and sunfish were predominant. About 90% of the

total number of fish stocked in Ford Lake were largemouth bass, smallmouth bass, walleye, northern pike, and tiger muskellunge; however, the total harvest in 1977 consisted of less than 2% of these species. Bluegills and sunfish ranged from 55% of the catch in 1974 to 88% in 1975 and remained at a high level of 81% in 1977 (Table 9). Carp ranged from 7% of the catch in 1974 to 1% in 1977. Bullheads comprised 15% of the catch in 1977. Smallmouth and largemouth bass steadily declined from 27% in 1974 to 2% in 1977. The stocking of channel catfish contributed very little to the fishery.

A reduction of carp is reflected in the net collections in 1972 and 1975 (Table 10). Carp comprised 30% of the catch in 1972 and 6% in 1975. Bullheads increased from 18% in 1972 to 35% in 1975. Bluegills and sunfish increased from 10% in 1972 to 48% in 1975.

A comparison between species composition in the 1975 net collections and creel census is given in Table 11. Bluegills and sunfish were the most numerous in net collections and also in the creel. Walleye, largemouth, and smallmouth bass were more abundant in the creel than in nets. Conversely, carp and bullheads comprised 41% of the catch in nets, but only 14% in the anglers' creel.

Growth rates remained constant from 1975 to 1977; consequently, scale samples collected during these years were combined to determine the mean growth indexes (Table 12). All species were growing at a faster rate than the statewide average.

Belleville Lake

An estimated 897 kg/ha of fish (95% carp) were removed from Belleville Lake when it was treated. Ninety-two percent of the 8,291,322 fish stocked were walleye and northern pike fry (Table 13). Adult and yearling rainbow trout were stocked to provide an immediate fishery.

No significant change in fishing pressure occurred during the 4 years of post-treatment creel census (Table 14). Expanding the 5 months of census data in 1975 into 7 months to make it directly comparable to subsequent years indicated that fishing pressure ranged from 573 angler

hours per hectare in 1975 to 492 in 1978. Based on the pre-treatment 1973 mail survey, an average of 83,388 angler trips per year was generated by the treatment and stocking program. Harvest per month was significantly higher in 1975 and 1978 than in 1976 and 1977. The catch of 1.1 fish per hour in 1978 was significantly greater than in the preceding years.

Black crappie was the predominant species in the anglers' creel, ranging from 46% to 84% of the total catch (Table 15). Bluegills and sunfish together ranged from 8% to 40%. Walleyes declined from 11% of the catch in 1975 to 2% in 1976 and remained at a low level. The decline of walleyes in 1976 may have been due to a change in the minimum size limit from 33 cm in 1975 to 38 cm in subsequent years; however, an expected increase in catch during 1977 and 1978 did not occur. Carp represented less than 1% of the catch in all years. The introduction of 146 adult white bass was successful; beginning in 1976, more than 3,000 per year were harvested. Channel catfish were caught in sufficient numbers to provide some interest to anglers.

Black crappie were numerous in pre-treatment (1972) and post-treatment (1976) net collections (Table 16). Bluegills and sunfish together increased from 22% of the net collection in 1972 to 39% in 1976. The relative abundance of carp and white sucker was 47% in 1972, but declined to 10% in 1976.

The species composition of fish collected in nets and the creel for 1976 is compared in Table 17. Black crappie were most abundant in both nets and the creel. Bluegill, sunfish, and crappie represented 80% of the catch in nets and 82% in the creel. Carp represented 7% of the catch in nets but only 0.3% of the creel.

Growth rates for 1975 and 1976 combined and for 1977 and 1978 combined are given in Tables 18 and 19, respectively. To evaluate changes in growth rates, the mean growth indexes were determined (Table 20). Growth rates of bluegills and sunfish were rapid and remained constant during the post-treatment years. Crappie, largemouth and smallmouth bass were also growing rapidly, but a decline is suggested in 1977 and 1978. The growth rate of walleyes has slowed considerably from a mean index of +9.4 in

1975-76, to +0.8 in 1977-78. Additional evidence of the decline in growth of walleyes is apparent from scale samples collected in April 1976, 1977, and 1978 on the spawning run at the upper end of Belleville Lake. Mean indexes for the three respective years were +1.5, +0.5, and -3.0. Numbers of scale samples examined were 204 (1976), 128 (1977), and 69 (1978).

Discussion

Evaluation of a reclamation project requires putting a post-treatment time limit for which benefits are realized. Hooper et al. (1964) made a detailed evaluation of lake and stream reclamations in the United States and Canada. The authors reported that fish eradication is usually incomplete even under the best of conditions, but stated that reclamations that result in improved fishing for 3 years or more are worth the investment. A complete eradication of fish in the treated waters was not obtained, but neither was it expected; however, the data show that benefits were realized for at least 5 years after treatment on Ford and Belleville impoundments. Using a 5-year, pre- and post-time period and a value of $8.99 per angler trip for warmwater anglers (calculated from data presented in the National Survey of Hunting, Fishing and Wildlife, U.S. Dep. Int. 1975), the benefit:cost ratio for the entire project was 13.9:1 (Table 21). The mean increase of 4,889 angler trips per year on the upper section was not significant. However, significant increases of 18,259 angler trips per year on Ford and 83,388 on Belleville were realized. The 5-year benefit:cost ratios with 95% confidence limits for the upper section, Ford and Belleville were 4.1:1 (±5.3:1), 5.7:1 (±1.0:1), and 25.3:1 (±4.5:1) respectively. Though the kill of undesirable fish species was not complete, treatment of the upper section probably delayed rapid re-infestation of carp downstream into Ford and Belleville impoundments.

Although the number of stocked predators harvested was rather low, all species of planted fish except muskellunge were observed in the creel. An estimated 0.7% of the stocked tiger muskellunge were caught by anglers. Largemouth and smallmouth bass represented about 4% of the total harvest. Approximately 3% of the fish caught by anglers were walleyes. The

predominant species in the creel were crappie, bluegills, and sunfish. The introduction of channel catfish and white bass provided two new species for the angler to catch.

The goal of improving fishing opportunities and success near a large metropolitan area was accomplished through the reclamation and restocking program. About 98% of the anglers interviewed were local people from Washtenaw and Wayne counties. Although publicity given the project probably attracted many anglers initially, it seems reasonable to assume that angler interest would have soon dissipated if post-treatment fishing success had been poor.

Acknowledgments

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Table 1.--Fish stocked between 1972-1976 in Barton, Argo, Geddes, and Superior impoundments, after chemical treatment.

Species	Number	Size[a]
Bluegill × green hybrid	31,338	F
Redear × green hybrid	43	A
	227,238	F
Largemouth bass	30	Y
	166,783	F
Smallmouth bass	140	Y
	84,072	F
Walleye	199	A
	1,003	F
	1,509,000	Fry
Northern pike	16	A
	8	Y
	194,000	Fry
Muskellunge	40,000	Fry
Tiger muskellunge	117	F
Rainbow trout	4,076	A
	13,000	Y
Channel catfish	58,500	F
	25,000	Fry
Total	2,354,563	

[a] A = adult; Y = yearling from 10.2 to 20.3 cm; F = fingerling up to 15.2 cm; Fry = newly hatched fish.

Table 2--Estimated fishing pressure and total numbers of fish caught in the Huron River and Barton, Argo, Geddes, and Superior impoundments (± 2 standard errors).

Date	Angler hours	Angler trips	Total catch	Catch per hour
(April-Sep) 1972[a]	75,646 ±3,469	29,536 ±1,220	112,630 ±19,147	1.49 ±0.26
(April-Oct) 1974	85,157 ±9,720	44,590 ±6,888	36,796 ±6,256	0.43 ±0.09
(April-Oct) 1975	80,264 ±11,481	34,445 ±5,279	49,661 ±10,661	0.62 ±0.16
(April-Oct) 1976	70,561 ±14,561	39,008 ±7,585	53,569 ±22,313	0.76 ±0.35

[a] Pre-treatment year.

Table 3.--Estimated numbers caught, by species, from the Huron River and Barton, Argo, Geddes, and Superior impoundments.

Species	Year			
	1972	1974	1975	1976
Bluegill	7,221	...	6,641	6,942
Sunfish	555	7,821	11,444	27,467
Rock bass	...	...	495	168
Black crappie	60,820	2,052	10,047	9,489
Yellow perch	139	...	514	317
Largemouth bass	...	...	338	16
Smallmouth bass	10,415[a]	3,551[a]	812	396
Walleye	139	...	288	276
Northern pike	...	392	507	468
Tiger muskellunge	...	...	14	...
Channel catfish	...	727	369	284
Carp	31,536	2,487	1,744	956
Bullhead	972	17,831	15,710	6,259
White sucker	555	...	728	531
Bowfin	...	...	10	...
Others	278	1,935	...	...
Totals	112,630	36,796	49,661	53,569

[a] Includes largemouth bass.

Table 4.--Numbers of fish collected by survey gear from Barton, Argo, Geddes, and Superior impoundments in pre- (1972) and post-treatment years.

Species	Year		
	1972[a]	1973[b]	1975[c]
Bluegill	354	52	316
Sunfish	25	58	203
Rock bass	...	5	6
Black crappie	1,169	144	974
Yellow perch	19	1	...
Largemouth bass	5	17	12
Smallmouth bass	18	13	15
Walleye	8	1	3
Northern pike	3	10	30
Tiger muskellunge	...	6	...
Channel catfish	...	...	12
Carp	423	2,067	545
Bullhead sp.	3	21	774
White sucker	46	35	80
Bowfin	1	1	3
Longnose gar	...	...	3
Goldfish	0	0	9
Total	2,074	2,431	2,985

[a] Electrofishing, gill and fyke nets between April 6 and June 27.

[b] Gill and fyke nets between June 24 and August 15.

[c] Fyke and trap nets between June 10 and July 30.

Table 5.--Percentage species composition of the catch by nets and anglers for Barton, Argo, Geddes, and Superior impoundments, 1972 and 1975.

Species	1972		1975	
	Creel	Nets	Creel	Nets
Bluegill	6.4	17.1	13.4	10.6
Sunfish	0.5	1.2	23.0	6.8
Black crappie	54.0	56.4	20.2	32.7
Yellow perch	0.1	0.9	1.0	...
Largemouth bass	...	...	0.7	0.4
Smallmouth bass	9.2[a]	1.1[a]	1.6	0.5
Walleye	0.1	0.4	0.6	0.1
Northern pike	...	0.1	1.0	1.0
Tiger muskellunge	...	...	<0.1	...
Channel catfish	...	...	0.7	0.4
Carp	28.0	20.4	3.5	18.3
Bullhead	0.9	0.1	31.6	26.0
White sucker	0.5	2.2	1.5	2.7
Bowfin	...	<0.1	<0.1	0.1
Longnose gar	...	...	...	<0.1
Goldfish	...	...	...	0.3
Total number of fish	112,630[b]	2,074	49,661[b]	2,978

[a] Includes largemouth bass.

[b] Estimated total catch.

Table 6.--Mean lengths (cm) at capture for four age groups of fishes from Barton, Argo, Geddes, and Superior impoundments.[a] Mean growth indexes are presented for point of reference. Numbers of fish in parentheses.

Species	Age group				Mean growth index[b]
	I	II	III	IV	
Bluegill	14.5 (11)	15.0 (124)	18.5 (27)	21.3 (3)	+4.8
Sunfish	11.9 (3)	14.5 (86)	15.7 (44)	17.3 (7)	+2.8
Rock bass	...	14.7 (7)	...	...	+3.3
Black crappie	13.7 (13)	17.0 (142)	21.6 (51)	24.6 (22)	+0.8
Largemouth bass	...	23.9 (10)	34.3 (6)	32.8 (1)	+4.6
Smallmouth bass	15.2 (1)	27.9 (24)	30.7 (3)	34.0 (2)	+4.6
Walleye	30.2 (3)	38.6 (3)	44.2 (2)	...	...
Northern pike	39.4 (2)	49.3 (25)	69.1 (4)	...	0

[a] Samples from the 1975 and 1976 census were combined with those from the 1975 netting.

[b] Deviations from statewide average growth rates (see Methods).

Table 7.--Fish stocked in Ford Lake between 1973-1977, after chemical treatment.

Species	Number	Size[a]
Bluegill	639	A
	48,048	F
Redear × green hybrid	110,821	F
Black crappie	1,663	A
Largemouth bass	233	Y
	254,038	F
Smallmouth bass	107,940	F
Walleye	19	Y
	14,400	F
	4,100,000	Fry
Northern pike	1,784,000	Fry
Tiger muskellunge	5,832	F
	89,193	Fry
Rainbow trout	92,510	Y
	100,000	F
Channel catfish	241,000	F
	87,500	Fry
Total	7,037,836	

[a] A = adult; Y = yearling from 10.2 to 20.3 cm; F = fingerling up to 15.2 cm; Fry = newly hatched fish.

Table 8.--Estimated fishing pressure and total numbers of fish caught in Ford Lake, 1974-1977 (± 2 standard errors).

Date	Angler hours	Angler trips	Total catch	Catch per hour
(July-Oct) 1974	41,454 ±9,151	14,245 ±3,179	11,221 ±4,169	0.27 ±0.10
(April-Oct) 1975	72,945 ±5,813	24,724 ±2,572	47,417 ±13,911	0.65 ±0.20
(April-Oct) 1976	41,474 ±5,400	16,026 ±2,559	15,140 ±5,596	0.37 ±0.13
(April-Oct) 1977	47,893 ±4,159	17,746 ±2,200	49,034 ±9,672	1.02 ±0.22

Table 9.--Estimated numbers caught by species from Ford Lake, 1974-1977.

Species	Year			
	1974	1975	1976	1977
Bluegill	2,272	11,893	12,379	29,385
Sunfish	3,883	19,459	941	10,461
Rock bass	...	...	37	...
Black crappie	65	2,828	94	475
Yellow perch	11	...	11	130
Largemouth bass	1,444	2,190	204	36
Smallmouth bass	1,650	1,955	181	508
Walleye	...	1,874	118	161
Northern pike	354	18	11	133
Tiger muskellunge	53	256	23	40
Channel catfish	...	46	24	37
Carp	773	680	323	269
Bullhead	716	6,218	794	7,399
Total	11,221	47,417	15,140	49,034
± 2 standard errors	±4,169	±13,911	±5,596	±9,672

Table 10.--Numbers of fish collected with nets from Ford Lake in 1972 (pre-treatment) and 1975 (post-treatment).

Species	Year	
	1972[a]	1975[b]
Bluegill	48	451
Sunfish	100	321
Rock bass	3	...
Black crappie	233	133
Yellow perch	49	2
Largemouth bass	4	1
Smallmouth bass	1	15
Walleye	36	1
Northern pike	...	7
Tiger muskellunge	...	3
Channel catfish	...	2
Carp	419	101
Bullhead	276	553
White sucker	263	1
Longnose gar	4	...
Golden shiner	121	4
Total	1,557	1,595

[a] Gill, fyke, and trap nets, October 11-November 1.

[b] Fyke and trap nets, May 20-22.

Table 11.--Percentage species composition of the catch by nets and by anglers from Ford Lake in 1975.

Species	1975	
	Creel	Nets
Bluegill	25.1	28.3
Sunfish	41.0	20.1
Black crappie	6.0	8.3
Yellow perch	...	0.1
Largemouth bass	4.6	<0.1
Smallmouth bass	4.1	0.9
Walleye	4.0	<0.1
Northern pike	<0.1	0.4
Tiger muskellunge	0.5	0.2
Channel catfish	0.1	0.1
Carp	1.4	6.3
Bullhead	13.1	34.7
White sucker	...	<0.1
Golden shiner	...	0.3
Total number of fish	47,417[a]	1,595

[a] Estimated total catch.

Table 12.--Mean lengths (cm) at capture for four age groups of fishes from Ford Lake.[a] Mean growth indexes are presented for reference point. Number of fish in parentheses.

Species	Age group I	Age group II	Age group III	Age group IV	Mean growth index[b]
Bluegill	15.5 (1)	16.0 (161)	18.0 (22)	19.3 (53)	+3.8
Sunfish	12.7 (3)	13.7 (90)	14.7 (13)	18.0 (5)	+2.3
Black crappie	...	18.0 (21)	22.1 (3)	24.9 (6)	+1.3
Largemouth bass	25.4 (3)	28.2 (29)	33.3 (13)	34.0 (3)	+6.4
Smallmouth bass	...	28.7 (38)	33.3 (24)	35.1 (1)	+5.1
Walleye	20.6 (1)	39.4 (12)	40.6 (14)	49.8 (5)	+4.6
Northern pike	...	65.5 (11)	66.0 (1)	72.4 (3)	+16.3
Tiger muskellunge	...	77.5 (11)	90.2 (1)	94.0 (4)	...

[a] Combined data of 1975-1977.

[b] Deviation from statewide average growth rates (see Methods).

Table 13.--Fish stocked in Belleville Lake between 1973-1977, after chemical treatment.

Species	Number	Size[a]
Bluegill	321	A
	80,323	F
Pumpkinseed	300	F
Bluegill × green hybrid	1,750	F
Black crappie	1,642	A
	1,500	F
Largemouth bass	179,180	F
Smallmouth bass	5,779	F
Walleye	16,568	F
	4,350,000	Fry
Northern pike	3,300,359	Fry
Tiger muskellunge	5,024	F
	51,428	Fry
Rainbow trout	722	A
	127,759	Y
White bass	146	A
Channel catfish	138	A
	116,383	F
Fathead minnows	52,000	Y
Total	8,291,322	

[a] A = adult; Y = yearling from 10.2 to 20.3 cm; F = fingerling up to 15.2 cm; Fry = newly hatched fish.

Table 14.--Estimates (± 2 standard errors) of fishing pressure and total catch for Belleville Lake, in 1973 and 1975-1978.

Date	Angler hours	Angler trips	Total catch	Catch per hour
(Open water) 1973[a]	...	8,280	18,180	...
(June-Oct) 1975	210,282 ±21,231	66,747 ±7,849	149,642 ±36,046	0.71 ±0.19
(April-Oct) 1976	256,983 ±34,728	91,123 ±28,814	80,206 ±49,973	0.31 ±0.20
(April-Oct) 1977	275,267 ±25,165	98,199 ±12,825	126,040 ±18,885	0.46 ±0.08
(April-Oct) 1978	253,162 ±20,991	83,902 ±7,680	286,612 ±50,137	1.13 ±0.22

[a] Pre-treatment data from mail survey (see Methods).

Table 15. --Estimated numbers caught by species from Belleville Lake, 1975-1978.

Species	Year			
	1975	1976	1977	1978
Bluegill	18,608	11,307	19,370	21,544
Sunfish	4,800	3,357	30,954	2,188
Rock bass	234	101	35	383
Black crappie	92,511	50,658	58,113	239,487
Yellow perch	1,035	397	467	...
Largemouth bass	6,537	1,700	1,859	1,710
Smallmouth bass	2,511	47	1,209	701
Walleye	16,436	1,550	1,952	1,580
Northern pike	136	...	8	147
Tiger muskellunge	460	...	61	109
Rainbow trout	1,169	...	...	...
White bass	...	3,488	3,680	3,205
Channel catfish	1,093	1,130	1,788	2,064
Carp	248	205	264	39
Bullhead	3,864	4,848	5,821	2,811
White sucker	...	1,418	459	10,644
Total	149,642	80,206	126,040	286,612
± 2 standard errors	±36,042	±49,973	±18,885	±50,137

Table 16.--Numbers of fish collected with nets from Belleville Lake in 1972 (pre-treatment) and 1976 (post-treatment).

Species	Year	
	1972[a]	1976[b]
Bluegill	122	348
Sunfish	56	15
Black crappie	199	373
Yellow perch	...	2
Smallmouth bass	...	19
Walleye	8	12
Northern pike	...	3
Tiger muskellunge	...	1
Channel catfish	...	39
Carp	156	67
Bullhead	28	20
White sucker	223	26
Longnose gar	2	...
Goldfish	...	1
Golden shiner	4	...
Total	798	926

[a] Trap and fyke nets, June 14-16.

[b] Fyke nets, July 21-23.

Table 17.--Percentage species composition of the catch by nets and anglers from Belleville Lake in 1976.

Species	1976	
	Creel	Nets
Bluegill	14.1	37.6
Sunfish	4.2	1.6
Rock bass	0.1	...
Black crappie	63.2	40.3
Yellow perch	0.5	0.2
Largemouth bass	2.1	...
Smallmouth bass	<0.1	2.1
Walleye	1.9	1.3
Northern pike	...	0.3
Tiger muskellunge	...	0.1
White bass	4.4	...
Channel catfish	1.4	4.2
Carp	0.3	7.2
Bullhead	6.0	2.2
White sucker	1.8	2.8
Goldfish	...	0.1
Total number of fish	80,206[a]	926

[a] Estimated total catch.

Table 18.--Mean lengths (cm) at capture for four age groups of fishes from Belleville Lake, 1975 and 1976. Number of fish in parentheses.

Species	Age group			
	0	I	II	III
Bluegill	...	15.5 (18)	17.5 (102)	19.0 (6)
Sunfish	...	13.5 (24)	14.7 (18)	...
Rock bass	...	14.2 (1)	15.2 (1)	20.6 (1)
Black crappie	...	17.5 (176)	22.4 (62)	...
Yellow perch	...	22.1 (10)	22.4 (2)	...
Largemouth bass	...	26.2 (38)	28.7 (51)	31.8 (4)
Smallmouth bass	...	23.1 (8)	29.7 (23)	...
Walleye	...	34.5 (87)	42.2 (39)	46.0 (1)
Northern pike	...	56.9 (1)	...	...
Tiger muskellunge	...	...	81.8 (4)	...
Rainbow trout	...	29.2 (6)	43.2 (1)	...
White bass	17.5 (5)	...	...	...

Table 19.--Mean lengths (cm) at capture for four age groups of fishes from Belleville Lake, 1977 and 1978. Number of fish in parentheses.

Species	Age group			
	I	II	III	IV
Bluegill	16.5 (22)	17.8 (52)	19.3 (31)	20.3 (11)
Sunfish	13.2 (10)	16.3 (22)	16.5 (30)	...
Black crappie	18.0 (64)	20.1 (251)	23.1 (101)	24.6 (10)
Yellow perch	...	23.1 (3)	27.4 (1)	...
Largemouth bass	15.5 (9)	29.0 (9)	33.8 (13)	36.8 (1)
Smallmouth bass	...	28.2 (10)	34.3 (8)	...
Walleye	...	34.8 (19)	42.2 (15)	41.1 (7)
White bass	22.1 (51)	...	...	...
White sucker	...	...	39.1 (20)	...

Table 20.--Mean growth indexes (cm) for fishes from Belleville Lake. [a]

Species	Years	
	1975-1976	1977-1978
Bluegill	+6.1	+6.1
Sunfish	+4.3	+4.3
Black crappie	+4.8	+3.0
Largemouth bass	+8.6	+4.6
Smallmouth bass	+7.1	+5.1
Walleye	+9.4	+0.8

[a] Deviations from statewide average growth rates (see Methods).

Table 21. --Five-year benefit:cost ratios of the reclamation project, based on a value of $8.99 per angler trip (± 2 standard errors).

Impoundment	Increase in angler trips	Value of increase	Total cost [a]	B:C
Upper section	24,445 ±31,807	$219,761 ±285,944	$53,753 [b]	4.1:1 ±5.3:1
Ford	91,295 ±15,225	$820,742 ±136,873	$143,207 [c]	5.7:1 ±1.0:1
Belleville	416,940 ±74,426	$3,748,290 ±669,090	$148,432	25.3:1 ±4.5:1
Totals	532,680 ±82,357	$4,788,793 ±740,310	$345,392	13.9:1 ±2.2:1

[a] Includes treatment and restocking costs.

[b] City of Ann Arbor contributed $3,000 for rotenone.

[c] Joint Ypsilanti Recreation Organization (JYRO) contributed $27,464 for rotenone.

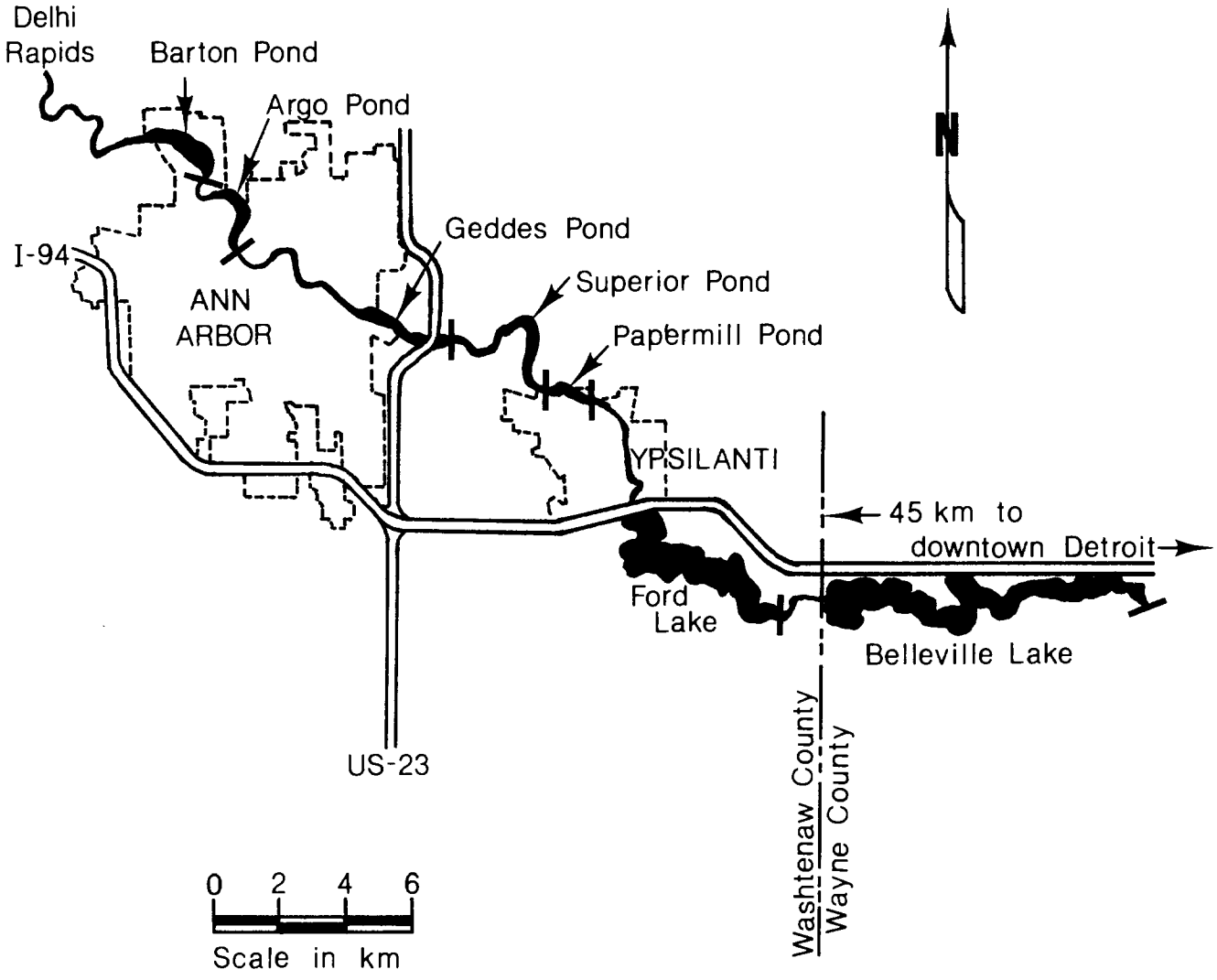

Figure 1.--Portion of the Huron River and impoundments treated with rotenone.

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Report approved by W. C. Latta

Typed by M. S. McClure