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ROTENONE FISHERIES SURVEY OF THE GRAND RIVER

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SUMMARY

During the summer of 1978, the Michigan Department of Natural Resources surveyed the fishery resources of the Grand River using rotenone sampling techniques. The purpose of this survey was to evaluate the feasibility of rotenone sampling in large Michigan rivers and to estimate selected population parameters of this important aquatic resource. An electro-shocking survey of the Grand River made in 1970 served as a comparison for technique and water quality changes.

Although rotenone surveying, with downstream potassium permanganate detoxification was expensive, this technique provided large and apparently representative samples of fish from 23 stations throughout the river length. Rotenone surveying produced over 6.5 times the number of total fish, 1.6 times the number of total species, and 4.8 times the number of large sport fish compared to the 1970 electro-shocking survey.

Although mark and recapture methods were not employed in this survey, a downstream blocking net, small mesh subsamplers, and hand netting within the station appeared to remove the majority of fish. Conservative estimates of standing crop ranged from a low of 19 kg/hectare near a major metropolitan area to a high of 1288 kg/hectare in an unperturbed downriver rural area.

Coarse fish comprised 81 percent by weight and 67 percent by number of the catch. Of this coarse fish catch, carp and goldfish comprised 46 percent by weight and 16 percent by number, whereas, five species of redhorse suckers contributed 35 percent by weight and 51 percent by number to the total catch. Game species comprised 8 percent of the total catch by weight and 17 percent by number. Although coarse species of fish were more abundant, large sport fish were very common and appear to be under harvested. Growth of scale-sampled sport fish was extremely good and was consistently above state average growth values.

The primary management recommendation is for the continued improvement of water quality in the metropolitan areas. In addition, increased stocking of predator fish is warranted to more completely utilize the extensive forage base. Chemical treatment for carp removal would not appear to be a viable management alternative at this time because of the cost of chemicals for such a treatment and the prohibitively large number of fingerlings necessary to adequately establish desirable species in such a large river system.

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INTRODUCTION

The Grand River is located in the southern portion of Michigan's Lower Peninsula. Originating in the center of the state, it flows in a general northwesterly direction to Lake Michigan. The watershed comprises and area of 5,544 square miles and is second only to the Saginaw River watershed (Brown, 1944). The total main channel length of the Grand River is approximately 478 miles in length. Through much of this length it drains an area that possesses relatively few water resources for the nearly one million watershed residents. The upper one-half of the watershed is nearly devoid of inland lakes. The Grand River and its tributaries is therefore the most prominent water resource for this area.

In recent times, only a marginal fishery existed on the Grand River. This has primarily been caused by historically poor water quality, resulting in a fish community dominated by non-game species. Moreover, in many areas of the river, lack of public access has prevented the public from taking advantage of the fishery. However, a moderate improvement in the water quality of the Grand River over the last two decades has occurred. For example, summer average dissolved oxygen levels have shown a steady increase from approximately 3 mg/l in 1960 to 7 mg/l in 1980 at the Webster Road water quality sampling location below Lansing (STORET, 1981). A survey to evaluate the first response of the fish community to improved water quality was made in 1970. At that time, a comprehensive fishery survey was made of the entire Grand River by electro-shocking and netting.

The Grand River Salmon Plan was proposed in 1977 to improve the inland fishery resources and take advantage of improved water quality. The goal of the Grand River Salmon Plan is to increase fishing opportunities in the Grand River by extending spawning runs of salmon and steelhead to the upper river. This will be accomplished by constructing fish ladders at five dams between Grand Rapids and Lansing. Completion of this project is scheduled for the fall of 1981.

A comprehensive plan for the future management of the resident, warmwater fishery in the Grand River has yet to be developed. The purpose of this fishery survey was to provide the basis for the development of such a plan. Parameters of particular concern included species composition, standing crop estimates, and age and growth information. In addition, a secondary objective of this survey was to evaluate and develop chemical sampling procedures which would allow sampling of large river segments with more efficiency than is possible with the more traditional electro-fishing and netting techniques. Such chemical sampling has been shown to be effective for large river fishery surveys in Georgia (Johnson and Pasch, 1976).

METHODS

The Grand River was surveyed during the low flow period of July and August, 1978. Based on time and monetary considerations, 23 stations were chosen to represent the 478 mile main channel length (Figure 1 and Table 1). Tributaries were not

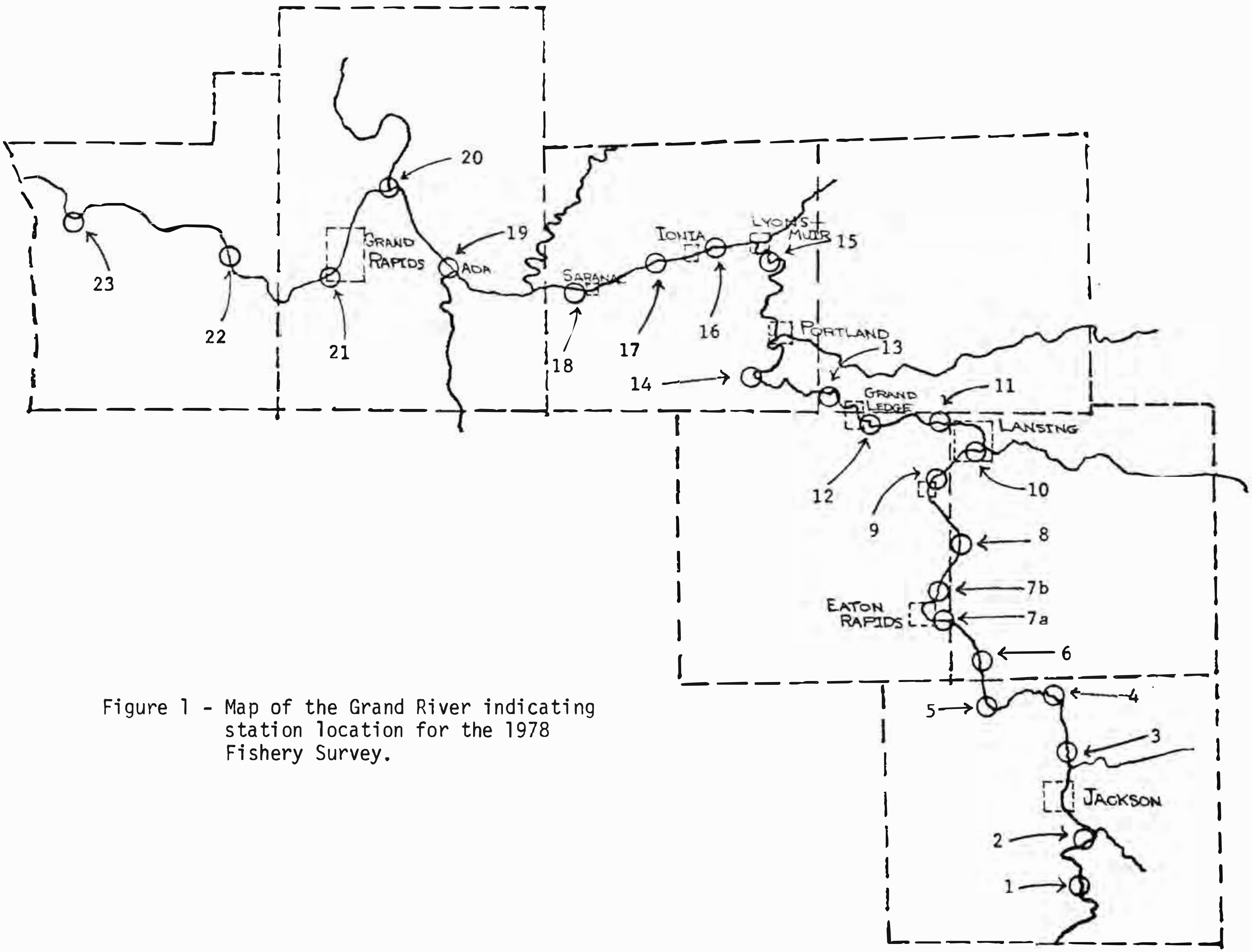


Figure 1 - Map of the Grand River indicating station location for the 1978 Fishery Survey.

Table 1 - Station Locations for the 1978 Grand River Fishery Survey

Station	County	Location	Upstream Limit - Description
1	Jackson	T4S, R1W, Sec. 1	0.3 miles downstream from Loomis Rd.
2	Jackson	T3S, R1W, Sec. 13 T3S, R1E, Sec. 18	At Meridian Rd.
3	Jackson	T2S, R1W, Sec. 2	0.6 miles downstream from confluence with Portage River
4	Jackson	T1S, R1W, Sec. 10	0.4 miles upstream from State Rd.
5	Jackson	T1S, R2W, Sec. 15	0.3 miles upstream from Tompkins Rd.
6	Ingham	T1N, R2W, Sec. 28 & 33	0.6 miles upstream from Plank Rd. (at Onondaga)
7a	Eaton	T1N, R3W, Sec. 2	Smithville Dam (at Smithville Rd.)
7b	Eaton	T2N, R3W, Sec. 26	100 feet upstream from Petrieville Hwy.
8	Ingham	T2N, R2W, Sec. 6	0.9 miles downstream from Columbia Rd.
9	Eaton	T3N, R3W, Sec. 15	100 yds. below Diamondale Dam
10	Ingham	T4N, R2W, Sec. 21	100 yds. below Moores Park Dam
11	Eaton	T4N, R3W, Sec. 1	0.6 miles downstream from Waverly Rd. (Grand Woods Park)
12	Eaton	T4N, R4W, Sec. 12	0.5 miles upstream from Grand Ledge bridge
13	Clinton	T5N, R4W, Sec. 29 & 30	0.1 miles upstream from Jones Rd.
14	Ionia	T5N, R5W, Sec. 18	700 feet upstream from confluence of Sebewa Creek (end of Erdman Rd.)
15	Ionia	T7N, R5W, Sec. 29	0.3 miles downstream from site of old Waggar Dam
16	Ionia	T7N, R6W, Sec. 22 & 23	Off end of Quarry Rd. (private property)
17	Ionia	T7N, R7W, Sec. 27	600 feet upstream from Sessions Creek
18	Ionia	T6N, R8W, Sec. 10	1.5 miles downstream from Saranac bridge
19	Kent	T7N, R10W, Sec. 27	0.5 miles downstream from Ada bridge
20	Kent	T8N, R11W, Sec. 23	0.1 miles downstream from Plainfield bridge
21	Kent	T7N, R12W, Sec. 35	At confluence with Plaster Creek 0.6 miles upstream from I-196 bridge
22	Ottawa	T6N, R13W, Sec. 32	2.0 miles upstream from Lake Michigan Drive (M-45), on north side of island
23	Ottawa	T8N, R16W, Sec. 36	Grand Haven State Game Area, at end of 144th St. (150 yds. down from upstream end of Indian Channel)

sampled. Stations were evenly spaced, when possible, throughout the river length. Station location was based on such criteria as depth, channel morphology, ease of access, and degree of habitat similarity between station and river segment. The 1970 survey stations were duplicated when feasible, although the geographical limits of this earlier electro-shocking survey were greater than the present study. The 1970 survey emphasized sites above and below major metropolitan areas, however, the 1978 sampling effort placed less emphasis on metropolitan sites and placed additional effort on river segments between cities.

At each selected site, physical measurements were taken to describe station morphology and to provide data for the calculation of chemical requirements. Station length was generally 183 meters (600 feet). Longer and shorter lengths were sometimes used to accommodate unusual channel morphology or habitat. Generally, seven transects were made at each station to calculate the average cross sectional profile area. Average velocity through the station was measured with fluorescein dye. Instantaneous velocities for calculating station discharge values were based on the Embody float technique. Chemical requirements were based on these station discharge values.

Rotenone was applied at a concentration of 3 parts per million by various methods. The application method used to apply the rotenone was determined by water depth at the upstream limit of the station. At locations where the river was too shallow for boating and easily wadable, rotenone was applied by spraying with one or more gasoline driven pumps depending on the width of the stream. If water depths were sufficient to allow the use of a boat with an outboard motor, rotenone was gravity fed into the outboard back wash while the boat made consecutive transects across the river. Toxic levels were maintained at each station for an exposure time of 45 minutes.

At the downstream end of the station, a barrier net was placed across the river. Nets of several lengths and depths were used to accommodate the various station morphologies encountered. The mesh size of these nets ranged from 22-25 mm (7/8 - 1 inch). The float line of this barrier net was attached to a head rope which had previously been set across the river and pulled taut. Braided dacron line was used for this head rope at most stations, however, steel aircraft cable was substituted at Stations 21 and 23 due to river width and velocity. The lead line of the net was held in place with trap net anchors. In high velocity situations, it was sometimes necessary to attach additional lines to the head rope. These lines were directed upstream and helped to prevent downstream sag of the net. In practice, the lead line was not anchored until treatment was ready to begin. This prevented the build up of debris in the net which tended to pull the float line under the water's surface.

The toxicant was neutralized by adding potassium permanganate to the river at a rate of 4 parts per million immediately downstream from the barrier net. Three parts per million was necessary to neutralize the rotenone and one additional part per million was necessary to compensate for the potassium permanganate demand of the river. Potassium permanganate was sprayed into the river with gasoline driven pumps after having been dissolved in steel barrels containing river water. Because of the relative insolubility of potassium permanganate, it was necessary to pump a slurry of the mixture and add additional pumping units. Potassium permanganate application was continued for 55 minutes to insure that all rotenone had been neutralized.

Dead and distressed fish were removed from the study area with hand nets as soon as was possible. Dead fish that accumulated on the barrier net were allowed to remain. Several sweeps of the entire study area were made by boat and wading to remove fish that had been washed ashore or had become lodged in obstructions. When no additional dead fish accumulated on the barrier net, the net was lifted and the fish were removed. To estimate the number of small fish that passed through the barrier net, two to three sub-sampler nets were placed just downstream from the barrier net. These sub-sampler nets were constructed of knotless nylon with a maximum diagonal opening of 4.8 mm (3/16 inch).

Generally, data from fish larger than 10 cm total length was recorded in the field. Fish species were identified, measured, and weighed to the nearest 1/10 of a pound in aggregate by species. Redhorse suckers were identified to genus only. In cases where more than 100 individuals of a given species were collected, the collection was sub-sampled for length-frequency analysis by measuring the first 100 fish. Sport fish were randomly scale sampled by size group for age determination. Pectoral spines were sampled from catfish. Small fish, including minnows and young-of-year, were preserved by freezing and were later identified and enumerated by the staff of the Fishery Section of the University of Michigan Museum. Size range by species was established, and the total sample (by station) was weighed. For additional information on methods used, consult Nelson and Smith (1980).

RESULTS

In general, rotenone sampling, with neutralization, proved to be an excellent method for sampling fish. This was particularly true when river discharge values were in the range of 100 to 1000 cfs. Population estimates in the small upper river stations (less than 100 cfs) were probably not improved over the 1970 electrofishing survey estimates. Sampling efficiency was lower at the two most downstream stations (22 and 23) than at other stations. At stations 22 and 23 only half of the station width was sampled at island locations because of the large river widths. Moreover, at Station 23, the depth was so great that the chemicals may not have reached the bottom. Trap and fyke netting at this station for two nights with three nets produced a larger collection of fish. It is possible, however, that a portion of these fish were migrants.

Since an upstream blocking net in combination with mark and recapture methods was not employed, it was not possible to estimate the percentage of fish removed from a given station. When the riverbed configuration was relatively simple with no large pools and eddies, and stream velocities ranged from 2.5 to 4.5 feet per second, it was believed that harvest approached 100 percent. Such stations, however, usually have a minimum of cover and habitat which tends to reduce the standing crop of fish. Large pools and eddies within a station made the uniform application of rotenone more difficult, and slowed the movement of fish downstream to the blocking net. When such pools were associated with deep, slow water, fish recovery was probably impaired. Stations with good cover and habitat generally produced larger catches of fish. When water velocities were very high (greater than six feet per second) at the blocking net, debris tended to accumulate on the net causing a hydraulic head which forced the float line under the water's surface. This occurred at two stations and caused a minor escapement of dead fish.

Neutralization of the rotenone with potassium permanganate proved adequate. Excessive downstream fish mortalities were limited. The only downstream mortalities of significance were those associated with mechanical failure of the permanganate pumping units. Since more pumping units were required in the lower river and the probability of pump malfunction was greater, several fish mortalities occurred in the lower river. Moreover, as a result of incomplete mixing with the river, rotenone levels were not always matched with permanganate levels and several minor fish mortalities occurred. In addition, each station required a mixing zone before complete neutralization occurred, and very minor mortalities were always observed in this zone. A more sophisticated potassium permanganate distribution system such as the use of a perforated pipe spanning the river would be more efficient. However, the cost would be prohibitive. Excellent news coverage of the survey and the cooperation of other DNR field personnel mitigated unfavorable public comments directed at the minor mortalities.

Although this survey produced excellent results, the survey was very cost and labor intensive. A total of 375 ten hour man days were required to complete the project. The five largest stations required a minimum work force of 15 people. Chemical cost for the rotenone and potassium permanganate amounted to $11,600 for the total project.

Seventy species of fish from 18 different families were sampled in the 1978 survey (Table 2). This compares to 146 species from 28 families known to occur in Michigan as listed in "Names of Michigan Fishes," (Fisheries Division, MDNR, 1975).

The fish community differed from the headwaters to the downstream areas. Headwaters contained such species as sticklebacks, mud minnows and darters. Whereas, locations near to the mouth contained such species as alewife, gizzard shad, quillback, and freshwater drum. Most species, however, were represented throughout the river. Only the ubiquitous bluntnose minnow occurred at every station. Carp were present at all but one station, although their abundance at many stations was very low. The most commonly occurring large sport species were northern pike, smallmouth bass, and channel catfish. These species occurred at 92, 71, and 71 percent of the stations respectively.

Several rare species were also collected. The river redhorse (*M. carinatum*) is designated as threatened on Michigan's endangered and threatened species list. Two specimens of this fish were collected at Station 23 and were identified by the staff of the University of Michigan Museum. Since large redhorse were not routinely identified to species, it is quite possible that other specimens were also collected. This is only the second record of this species in Michigan.

Although not considered threatened within its natural range, the black buffalo (*I. niger*) is extremely uncommon in Michigan. One specimen of this species was collected in the Grand River at Station 22, and identified by the staff of the University of Michigan Museum. This constitutes only the fourth known record of capture of this species in Michigan.

The percent of catch, by weight and number, for selected species and taxa is presented in Table 3. Carp and redhorse made up 81.0 and 61.7 percent of the total catch by weight and number respectively. Sport species comprised only 8.1 percent of the catch by weight and 16.5 percent by number.

Table 2 - List of Species Captured at Each Station During the 1978 Grand River Survey

Species	1	2	3	4	5	6	7A	7B	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Chestnut lamprey (Ichthyomyzon castaneus)																	X							
Amer. brook lamprey (Lampetra lamottei)																		X						
Spotted gar (Lepisosteus productus)																		X	X					
Longnose gar (Lepisosteus osseus)																	X				X	X	X	
Bowfin (Amia calva)																								X
Brown trout (Salmo trutta)																		X						
Chinook salmon (Oncorhynchus tshawytscha)																	X							
Alewife (Alosa pseudoharengus)																								X
Gizzard shad (Dorosoma cepedianum)																						X	X	X
Central mudminnow (Umbra limi)	X	X		X	X								X					X						
Mud pickerel (Esox americanus)			X	X	X	X	X																	
Northern pike (Esox lucius)	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X
Black buffalo (Ictiobus niger)																							X	
Quillback (Carpiodes cyprinus)																X	X	X	X	X	X	X	X	X
Redhorse spp. (Moxostoma spp.)	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Black redhorse (Moxostoma duquesnei)									X															
Golden redhorse (Moxostoma erythrurum)		X			X	X								X	X	X	X	X	X	X		X		X
Silver redhorse (Moxostoma anisurum)																						X		
Northern redhorse (M. macrolepidotum)																X			X	X		X		X
Greater redhorse (Moxostoma valenciennesi)								X	X	X		X			X									
River redhorse (Moxostoma carinatum)																								X
Hog sucker (Hypentelium nigricans)	X	X			X	X	X	X	X	X	X	X			X	X	X	X		X	X			
White sucker (Catostomus commersoni)	X		X	X	X	X	X	X	X		X	X	X	X	X				X			X	X	X
Spotted sucker (Minytrema melanops)											X								X			X		
Carp (Cyprinus carpio)	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Goldfish (Carassius auratus)														X	X	X						X		
Golden shiner (Notemigonus crysoleucas)														X	X									X
Creek chub (Semotilus atromaculatus)	X		X			X		X				X			X			X						
Hornyhead chub (Nocomis bigattata)			X	X	X			X																
River chub (Nocomis micropogon)	X																			X				
Blacknose dace (Rhinichthys atratulus)																		X						
Emerald shiner (Notropis atherinoides)																	X					X	X	X
Rosyface shiner (Notropis rubellus)															X			X	X					
Common shiner (Notropis cornutus)	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X			
Blackchin shiner (Notropis heterodon)	X																							

Table 2 - Continued

	1	2	3	4	5	6	7A	7B	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Spottail shiner (Notropis hudsonius)														X	X		X	X	X	X	X	X	X	X
Spotfin shiner (Notropis spilopterus)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	
Striped shiner (Notropis chrysocephalus)		X	X	X	X			X		X		X							X	X				
Sand shiner (Notropis stramineus)						X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	
Bluntnose minnow (Pimephales notatus)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Stoneroller (Campostoma anomalum)								X																
Bullhead spp. (Ictalurus spp.)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X
Black bullhead (Ictalurus melas)																	X							
Brown bullhead (Ictalurus nebulosus)				X	X	X							X	X										
Yellow bullhead (Ictalurus natalis)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X
Channel catfish (Ictalurus punctatus)					X	X	X			X	X		X	X	X	X	X	X	X	X	X	X	X	X
Flathead catfish (Pylodictis olivaris)																	X	X	X	X		X	X	
Tadpole madtom (Noturus gyrinus)																								X
Blackstripe topminnow (Fundulus notatus)	X	X																						
Burbot (Lota lota)																				X		X		
Trout-perch (Percopsis omiscomaycus)																								X
Brook silverside (Labidesthes sicculus)	X										X								X		X			
Smallmouth bass (Micropterus dolomieui)	X	X					X	X	X	X				X	X	X	X	X	X	X	X	X	X	X
Largemouth bass (Micropterus salmoides)	X		X		X	X	X				X	X	X	X							X	X	X	X
Warmouth (Lepomis gulosus)							X																	
Green sunfish (Lepomis cyanellus)		X	X		X	X	X			X	X		X	X	X		X	X	X	X		X		
Pumpkinseed (Lepomis gibbosus)	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X
Bluegill (Lepomis macrochirus)	X	X	X	X	X	X	X	X		X	X	X	X		X			X	X	X		X	X	X
Longear sunfish (Lepomis megalotis)	X	X	X				X	X						X	X		X	X	X					
Rock bass (Ambloplites rupestris)	X	X		X	X	X	X	X	X		X		X		X	X	X	X	X	X	X	X	X	
White crappie (Pomoxis annularis)																			X	X			X	
Black crappie (Pomoxis nigromaculatus)		X	X	X	X	X	X			X	X		X	X	X	X	X	X	X	X		X	X	X
Walleye (Stizostedion vitreum)																	X	X	X	X	X	X		
Yellow perch (Perca flavescens)	X	X	X	X	X	X	X												X			X	X	X
Blackside darter (Percina maculata)	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X		X			
Logperch (Percina caprodes)	X	X								X	X				X	X	X	X	X	X	X	X		
Channel darter (Percina copelandi)											X													
Johnny darter (Etheostoma nigrum)	X	X	X		X	X	X	X	X		X	X	X		X		X	X	X		X		X	X
Greenside darter (Etheostoma blennioides)	X																							
Rainbow darter (Etheostoma caeruleum)	X					X		X	X															
Freshwater drum (Aplodinotus grunniens)																						X	X	X
Brook stickleback (Culaea inconstans)		X																						

Table 3 - The Percent of Catch by Weight and Number for Each Taxon Collected in the 1978 Grand River Survey for Fish Larger Than 10 cm.

Taxons	% By Weight	% By Number
Alewife	0.0	0.1
Gizzard shad	0.5	2.5
Northern pike	0.7	0.8
Quillback carpsucker	4.4	2.2
White sucker	1.2	1.3
Hog sucker	3.0	3.8
Redhorse sp.	35.4	51.7
Carp and Goldfish	45.6	16.0
Bullhead	1.5	5.5
Channel catfish	3.3	3.3
Flathead catfish	0.8	0.2
Smallmouth bass	1.6	5.0
Largemouth bass	0.2	0.5
Sunfish	0.2	1.9
Rock bass	0.2	1.0
Crappies	0.5	3.2
Walleye	0.6	0.5
Yellow perch	0.0	0.1
Freshwater drum	0.1	0.1
Other	0.2	0.3

Catch data, standardized by surface area, for sport species and other selected important species is presented in the Appendix in Tables A-1 through A-23. Tables A-1 through A-23 are appended to the original report only contained in the Fisheries Division files. Weights were not taken by species for the small specimens sent to the University of Michigan Museum for identification. Instead, the total weight of the small fish collection, as well as the extrapolated sub-sample data, is included in the total station weight. When available, the catch by number for the small specimen collection is included with the enumerated table values. The values for average total length, percent catchable, and average weight are based only on those fish, 10 cm or larger, that were identified in the field. For those species with no legal size, the catchable size is considered to be 15 cm (6 inches) for bluegills, rock bass, and sunfish; 20 cm (8 inches) for crappie and yellow perch; and 25 cm (10 inches) for catfish. Individual length frequencies for each species, at each station, are not included in this report due to space limitations. This information is available and will be maintained in DNR files.

Since large percentages of fish were removed from each station by this survey method, the total weight of fish per hectare per station can be used as a conservative estimate of standing crop. This estimate, however, is extremely variable. Values ranged from a low of 19.1 kg/hectare at Station 11 to a high of 1288.3 kg/hectare at Station 16. There was, however, a general trend for the standing crop to increase as the survey progressed downstream. This trend probably relates to increased static water volume per unit of surface area, increased cover provided by increased water depths, and more varied habitat.

In general, standing crop estimates were reduced below each of the major metropolitan areas. This reduction is probably caused by decreased water quality in these areas. The fact that these reductions were less severe in downstream areas would indicate that increased river discharges and/or static water volumes mitigate the impact of man's activity in the watershed.

The likely explanation for the variability observed between stations, other than that caused by water quality is sampling error, average weight differences, and habitat differences. The average weight of carp and redhorse is graphed in Figure 2. These weights differed between stations and caused variability in the total station weight when the catch of carp and redhorse was large. Since these species were not scale sampled, it is impossible to suggest a mechanism for the cause of this weight variability. It should also be noted that small carp, less than 25 cm, were rarely captured. The difference between stations for habitat and cover was in many instances very great and, other than water quality, it was probably the single most important cause for the observed variation in catch. Since no attempt was made to quantify habitat at each station, the catch results cannot be standardized for this factor. When selecting stations, it was often necessary to compromise the habitat considerations for other considerations such as river width, depth, flow characteristics, or accessibility. A graphic illustration of catch, by weight, is presented in Figure 3. Also included is the percent of total catch, by weight, for carp, redhorse, and game species.

The relatively low catch values for Stations 17, 18, 19, and 20 are probably not adequate estimators of standing crop. Stations 17 and 18 were chosen primarily for ease of access to the river. At both of these stations, channel morphologies were very routine with no deep holes or cover. Shifting sand comprised 80 percent

Figure 3. The percent of catch, by weight, for carp, redhorse, gamefish captured at each station of the 1978 Grand River survey. The solid line represents the total weight of all fish taken.

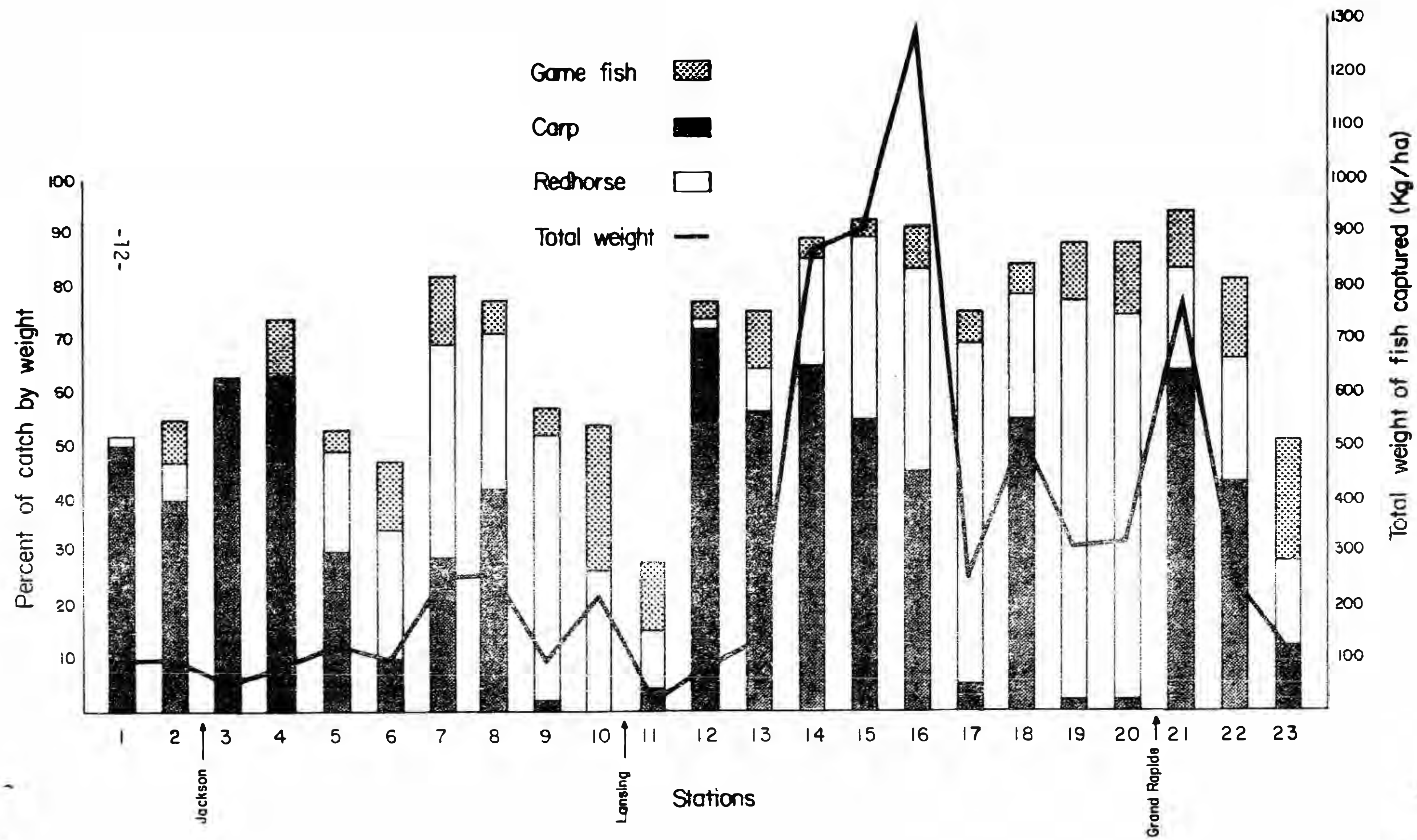
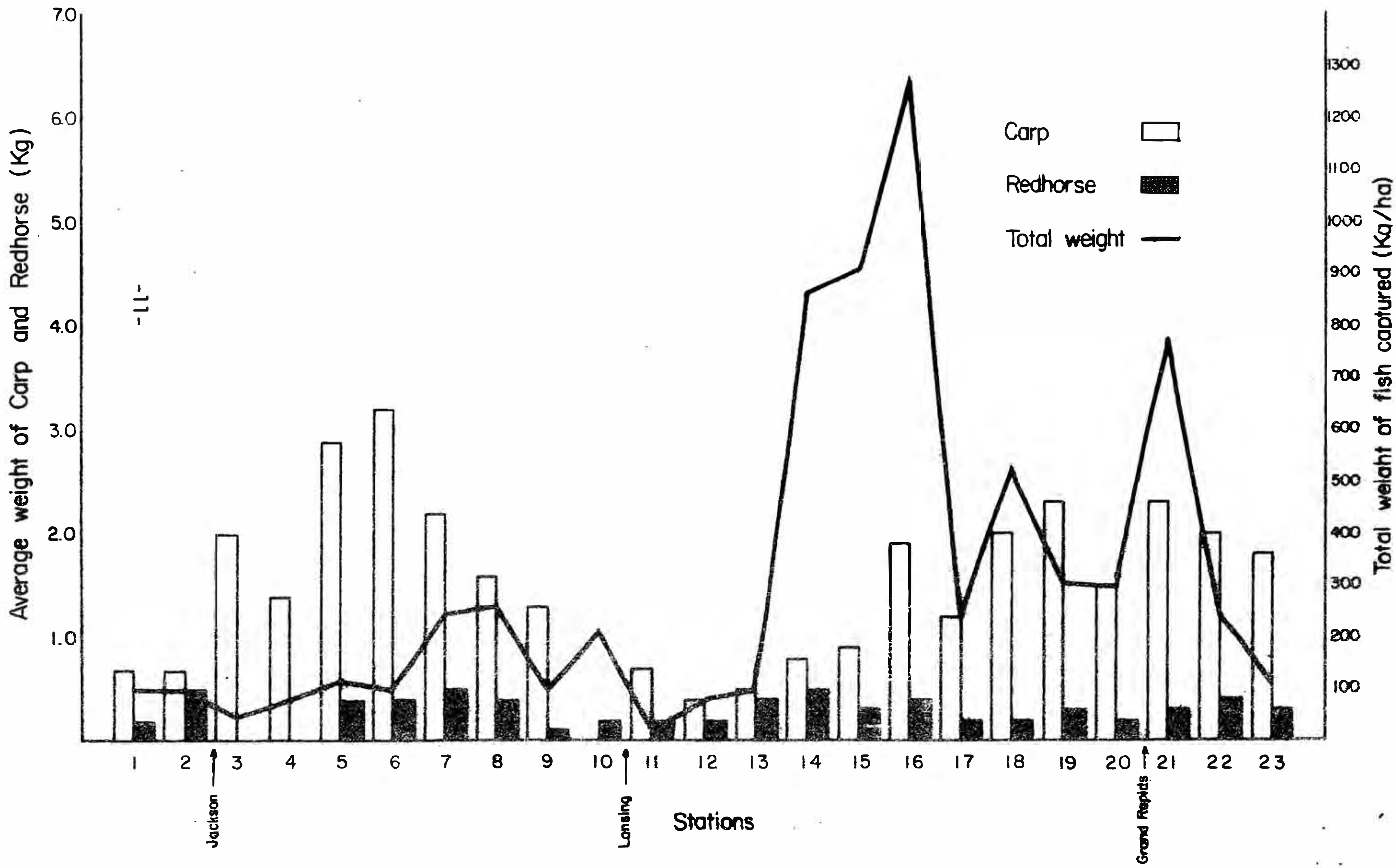


Figure 2. The average weight of carp and redhorse individuals and total weight of all fish by station collected during the 1978 Grand River survey.



of the bottom material. Although most fish were probably removed from these stations, lack of cover did not make them representative of the river in this area. Heavy rains in the Grand Rapids-Ionia area just prior to the treatment of Stations 19 and 20 caused postponement of the survey for one week. When these stations were finally surveyed, river discharge rates and water velocities were still substantially above normal. Increased depths, velocities, and debris in the water caused the float line of the blocking net to submerge and subsequent loss of fish at both stations. As much as 50 percent of the sample was estimated to have been lost at Station 19. Loss of fish at Station 20 was probably less severe, but substantial numbers floated downstream.

Growth of scale sampled sport species was extremely good. Growth indices are presented in Table 4 by species and station. The growth index reported is the weighted difference, pooled across age groups, between average size at time of capture and average state growth values. Since no average state values are available for channel catfish, this species was compared to average values of channel catfish collected by the MDNR, Lake St. Clair Great Lakes Fisheries Station from Lake Erie, Lake St. Clair, and southern Lake Huron. Although food studies were not undertaken in this survey, these excellent growth values indicate that the present population of sport fish in the Grand River is not limited by available food. In fact, an underutilized forage base may well be present as indicated by the large numbers of redhorse suckers, white suckers, and hog suckers.

DISCUSSION

Comparison With Past Surveys

Detailed comparison of the 1978 Grand River survey to the 1970 survey is not particularly meaningful because the methods of fish capture were different; the station location does not always correspond; and weights of fish were not recorded in 1970. However, for the purpose of comparing the relative catch of the two different methods, total numbers of fish and total number of species captured are of interest. In 1970, 3158 total fish representing 17 species were captured by electrofishing. In 1978, using rotenone, 24,356 large fish and 70 different species were captured.

The percentage of gamefish captured in 1978 was smaller than 1970 and is contrary to what would be expected in view of water quality improvements. The primary reason for this difference is that rotenone captured larger fish such as carp and redhorse suckers much better than electrofishing in 1970.

Standing crop estimates ranged from 10 kg/hectare near a major metropolitan area to 1288 kg/hectare in an unperturbed downriver rural area. The mean of all stations was 318 kg/hectare. The standing crop range was large and brackets nearly all published standing crop estimates. Selected standing crop estimates reported in the literature are provided below for comparison:

Courtois Creek, Missouri	62-101 kg/hectare, Fajen, 1975
Midwestern River Backwater and Oxbows	560 kg/hectare, Carlander, 1955
Midwestern Reservoirs	448 kg/hectare, Carlander, 1955
Midwestern Warmwater Lakes	150-168 kg/hectare, Carlander, 1955
Upper Mississippi Backwater Areas	252-329 kg/hectare, Christensen & Smith, 1965
Small Indiana Streams	51-1050 kg/hectare, Gerking, 1949
Alabama Rivers	51-1730 kg/hectare, Swingle, 1954

Table 4 - Growth Indicies (in mm) of Important Sport Fish Collected in the 1978 Grand River Survey. Growth Index Represents the Weighted Difference, Pooled Across Age Groups, Between Average Length at Time of Capture and Average State Length. The Number of Fish Sampled is in parenthesis.

	Northern Pike	Channel Catfish	Bluegill	Pumpkinseed	Black Crappie	Rock Bass	Smallmouth Bass	Largemouth Bass	Walleye
7	+10.1 (20)		+18.0 (1)	+12.4 (11)	+21.4 (18)	+44.0 (5)	-5.9 (39)		
8	+67.3 (7)			+19.4 (8)		+34.1 (7)	+53.8 (4)		
9	-29.0 (1)						-12.4 (8)		
10			+33.8 (11)					+22.4 (37)	
12	+70.0 (1)		+15.5 (2)	+15.7 (14)	+2.0 (1)			+32.2 (4)	
13							+40.9 (21)	+27.7 (3)	
14	+16.0 (2)						+47.3 (18)		
15	+16.0 (3)						-6.0 (40)		
16	-17.0 (3)	+20.3 (7)					+18.7 (13)		+77.9 (46)
17	+21.0 (2)	-2.0 (1)					+19.1 (20)		+60.1 (17)
18	+28.0 (1)				+71.0 (1)		+55.0 (3)		+66.1 (13)
19	+87.0 (2)				+6.4 (8)		+21.2 (22)		+91.0 (10)
20	+7.0 (1)	-16.1 (7)					+0.5 (30)		+120.0 (3)
21	+113.8 (5)				+2.7 (34)		+18.4 (25)		
22	+206.0 (1)	+26.0 (8)						-19.5 (25)	
23	+83.3 (7)	+13.4 (35)	+24.8 (65)		+9.6 (73)			+14.1 (15)	

Critical Areas

Water quality in the large metropolitan areas along the river was the major limiting factor upon gamefish populations in 1970. Although water quality has improved since 1970, the effects of Jackson, Lansing, and Grand Rapids are still visible.

The European carp, a very tolerant coarse fish, is present throughout the river. However, its presence (as measured by percent of the total community), is higher below major metropolitan areas. The various redhorse sucker species, a less tolerant coarse fish than the carp, are present throughout the river. Where carp are dominant, redhorse are not and vice versa. Figure 4 compares the percentage of carp and redhorse in the total population between the 1970 and 1978 surveys.

It is believed that where redhorse suckers are dominant, water quality is improved and that where carp are dominant, water quality is still a problem. Overall, redhorse suckers are the dominant fish in the Grand River as they were in 1970. However, their abundance seems to be increasing with improvements in water quality. Carp seem to be decreasing or stabilizing in numbers.

By 1981, fish passage by ladder will be possible upstream to North Lansing. This will benefit upstream seasonal migration by coho and chinook salmon and steelhead.

Lack of suitable public access is a problem in many places along the river. However, the Grand River Salmon Plan, to be fully implemented by the early 1980's, plans support facilities such as boat launch, shore fishing areas, and sanitary facilities. This situation will be much improved in the future.

RECOMMENDATIONS AND MANAGEMENT ALTERNATIVES

Fisheries Improvements

With continued water quality improvements near municipalities, the fish population in the Grand River will continue to improve. A gradual shift in the game fish:non-gamefish ratio would be expected to occur.

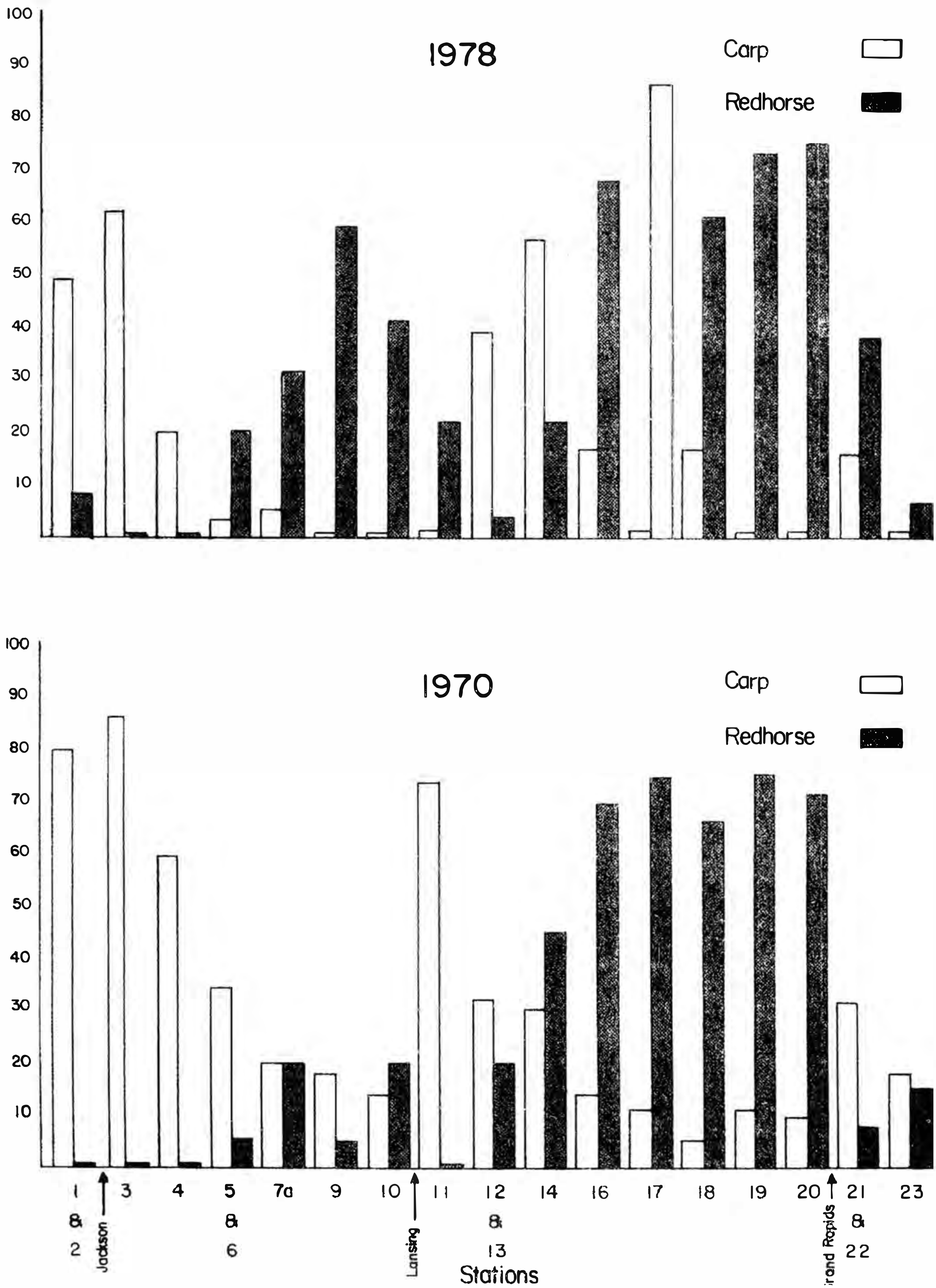
A carp eradication program has been a consideration for a number of years. It appears from the 1978 fisheries survey that the carp population is linked to water quality and has been stabilized since 1970. It seems that with the present abundance of gamefish and an apparent stabilization of the carp population, a chemical carp removal program would not be in the best interest at this time.

Perhaps the best management technique to improve the fish population would be a predator gamefish stocking program to take advantage of the large forage base.

Water Management

Expansion of walleye stocking by means of an extensive walleye rearing pond operation centrally located along the river is recommended. It is estimated that 100,000 to 200,000 fingerlings stocked annually would be desirable. This would especially benefit the Lansing to Grand Haven portions of the River because

Figure 4. Comparison of percent carp and redhorse by station during the 1970 and 1978 Grand River surveys.



of habitat conditions and the fact that walleyes were once plantiful in this portion of the river.

Northern pike populations in the upper river particularly seem to be doing very well. Efforts to expand the pike fishery do not appear to be necessary at this time.

Smallmouth bass are presently abundant in the Grand River. There would seem to be little need for supplemental stocking in the near future.

A northern muskellunge or tiger muskellunge stocking program would be beneficial particularly from Jackson to Lansing in the slower waters. One or the other of these species would provide a valuable trophy warmwater fish as well as a desirable predator fish on the large sucker population.

In addition to the gamefish species listed above, black crappies, rock bass, channel catfish, and flathead catfish are abundant in the Grand River. Also, largemouth bass, bluegills, pumpkinseeds, and bullheads are abundant in the bayous and lower river stream environment. These species are capable of sustaining their numbers without additional management.

Rough fish species, particularly redhorse suckers, can best be utilized as forage for the expanding gamefish populations. Consideration should be given to opening a limited commercial fishery for the numerous carp and suckers. This program would allow a controlled harvest of underutilized species in the Grand River.

Anadromous Management

With the implementation of the Grand River Salmon Plan, the future of the anadromous fishery on the Grand River looks very bright. By 1981, fish passage ladders and additional support facilities will provide an additional 150,000 angler days by steelhead and salmon fishermen. This additional fishery will occur in the relatively lakeless Ionia to Lansing portion of the watershed. If this program is successful and water quality improvements continue upstream from Lansing, there is the possibility of expansion to Eaton Rapids and eventually Jackson.

Additional Surveys

Selected survey stations should be sampled again in the future to monitor changes in the fishery. This future sampling would be important to evaluate future fisheries management activities. Fisheries changes due to improved water quality could be measured by sampling above and below municipalities.

Rotenone sampling in other rivers in the state could be a valuable fisheries management tool.

The following suggestions could be utilized in future rotenone fish sampling projects:

1. Use an upstream net as well as a downstream blocking net to better confine fish within the area to be sampled.

2. Use mark and recapture methods prior to sampling to evaluate the completeness of the sample.

3. Standardize the fish catch to static water volume, habitat and cover instead of surface area. Better comparison of different habitat areas would be possible in this manner.

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