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**ELECTROFISHING SURVEY OF THE GREAT MIAMI RIVER
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ANNUAL REPORT**

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EXECUTIVE SUMMARY

Fish were collected, using electroshocking techniques, from three sites in the Great Miami River (GMR) (September 07 and 08, 1995) as part of an annual survey for Fernald Environmental Restoration Management Corporation (FERMCO). The objective was to collect fish fillets for uranium analysis and examine the health of the fish community in comparison to data collected during the past eleven years. Samples were taken from upstream (river mile = RM; RM 38) and downstream (RM 19) of the Fernald site as well as from near the Fernald effluent line (RM 24). RM 38 is isolated from upstream fish migration by two dams located near Hamilton, Ohio and fish collected from this site should not be influenced by processes at the downstream sites. Samples of 549 fish from 29 species belonging to nine families provided seventy-two samples for uranium analysis by an independent laboratory. Chemical analysis of water samples collected at each site was used to determine the effect of chemical parameters on the fish community. This study focused on comparison of the density, biomass and diversity of the fish community between sites and between years.

The fish community in 1995 was separated ecologically by physical habitat differences rather than by water quality differences between sites. The average biomass of fish caught was highest at RM 24 and lowest at RM 38. The fish community at RM 24 was dominated by large freshwater drum, typical of rapid flowing water in mid-sized streams. Small fish species were excluded from this channelized site by the rapid current. The ponded site at RM 19 was dominated by young of the year (YOY) gizzard shad and YOY bluegill. Small species and YOY are usually common in ponded sites where they do not have to contend with a rapid

current. The pooled site at RM 38 was diagnostically separated from the other sites by YOY golden redhorse and gizzard shad in addition to a large number of bluntnose minnows.

Diversity of the fish community was inversely related to biomass. Diversity was highest at RM 38, lowest at RM 19 and the intermediate site was RM 24. The high diversity at RM 38 resulted from the occurrence of several small species at this site: bluntnose minnows, YOY gizzard shad and YOY golden redhorse. The low diversity found at RM 19 resulted from the dominance of this site by YOY gizzard shad and bluegill. The intermediate diversity at RM 24 was indicative of the fact that the rapid current excludes many small species from this site. Since the downstream and upstream communities were not very similar in terms of biomass and diversity, it appears that the Hamilton dams were sufficient to prevent fish migration upstream.

Improved species richness and density in 1995 was consistent with a fish community that has recovered from the conditions that caused low density and diversity in previous years. Species richness in 1995 was significantly different from 1987, 1990 and 1992. Species richness was lower during the years 1987, 1990 and 1992 than during any other years of this study. In 1995 there were 20 species found at RM 38, 15 at RM 24 and 19 at RM 19. The number of fish caught per hour in 1995 was significantly different from 1987, 1989, 1990, 1991 and 1993. The higher number of fish caught per hour in 1995 indicated that the density of fish per unit area in 1995 was higher than in previous years.

Changes in water chemistry showed highest concentrations of phosphate and chlorophyll at RM 24 while sulfate and nitrate concentrations were highest at RM 19. The

downstream increase in phosphate from RM 38 to RM 24 was indicative of a point source of pollution, possibly sewage effluent from upstream of the Fernald site. Increased chlorophyll at RM 24 suggested that the excess phosphate was being incorporated into algal biomass. Nitrate and sulfate both increased downstream. Sulfur normally accumulates downstream because it is not used in the metabolic activities of stream organisms. The increased nitrate was probably from non-point sources such as run-off from fertilized areas. Oxygen concentration was lowest at RM 24. Temperature increased with time of day.

The fish community in 1995 was healthy at all sites sampled. No diseased or otherwise unhealthy fish were found. Changes in the fish community reflected changes in the physical habitat rather than chemical parameters of the stream. No evidence was found to suggest that water quality, habitat or fish community were adversely affected by pollutants. Species diversity, density and biomass per site as well as adult and YOY fish found in this study indicated that the Great Miami River (between RM 38 and RM 19) was a clean system in 1995. The presence and sometimes abundance of YOY fish indicated that the fish community was reproducing.

INTRODUCTION

During August or September of each year from 1984 to the present, the fish community of the Great Miami River has been examined at three or four sites as part of a survey of uranium content of fish fillets (1984-1990, 1993 and 1994) and whole fish (1991 and 1992) for FERMCO (Figures 1-4). Prior to 1980 when the Ohio Environmental Protection Agency (OEPA) began surveying the streams, rivers and lakes in Ohio to determine compliance with clean water standards, the fish community in the river had been studied only sporadically. The surveying effort necessitated the development of a new set of indices and standardized sampling methods for fish and macroinvertebrates (OEPA, 1988). Since multiple sites have been monitored annually for an extended number of years using similar methods and sample sizes, comparison to OEPA's surveys (1980, 1987, and 1990) over the length of the river is warranted (Rankin *et al.*, 1990). OEPA repeated their study in 1995 during the same week that this survey was conducted. Moreover, the OEPA established a series of high quality reference streams in the state by ecoregion, province of similar soils, bedrock, morphometry, and drainage that allows comparison of biological health between equal-sized bodies of water courses.

The fish communities of the GMR near the Fernald site are affected by the Ohio River as well as upstream processes. The Ohio River and the many tributary streams of the GMR serve as a source and a refugium for biotic diversity. Between 1957 and 1959, fish sampling in the middle Ohio River identified 83 species of fish in lock and dam rotenone studies conducted in the fall (Pearson and Krumholz, 1984; Krumholz, 1981). Additional studies on Ohio River tributaries have found more species; 108 species in 1962 (ORSANCO, 1980) and by 1970 the

cumulative species list of the fish for the Ohio River (983 miles) was 120. Between 1974 and 1986, an average of 22 species of fish were found in single day samples from the GMR (n=2100 to 3700 individuals). Hence, approximately one quarter of the cumulative fish species can be found in a single day's sample. The remaining species are globally rare, restricted to unique micro-habitats, associated with tributary streams, accidentally washed-in from reservoirs, or only temporal residents of the river. The diversity in middle-sized rivers is determined in part by migration of fish species such as the white bass, sauger, mooneye, hybrid striped bass, gizzard shad and carp from big rivers. It is also determined in part by migration of smaller stream species into larger rivers: minnows, darters, northern hognose suckers, white sucker and other fish. Mid-sized rivers have a high diversity of lithophils belonging to true river fish species: suckers, buffalos, carpsuckers, and redhorses (Catostomidae) and catfishes (Ictaluridae). Washout from upstream reservoirs and ponds may contribute species of fish such as largemouth bass, sunfishes, and YOY gizzard shad.

The diversity of fish in a given reach of stream is a function of the water quality (chemical variables), size of the stream (stream order, discharge), habitat structure (riparian zone), energy base (allochthonous or autochthonous), flow regime (riffle or pool), and biotic interactions (competition and predation risk) (Karr, 1981). The OEPA has coded a system of assessing habitat quality: the Quality Habitat Environmental Index (QHEI). This index includes current velocity, bank stability, canopy, riparian vegetation, in-stream cover, gradient, channel morphology, channel width, and channel depth (OEPA, 1988). The standardization of electroshocking methods and the use of multicomponent indices, such as the Index of Biotic

Integrity (IBI) and the Index of Well-Being (Iwb) (Gammon, 1976b), has allowed the OEPA to characterize the water quality of the GMR and its tributary streams over the past decade (OEPA, 1990).

The GMR is a multi-stressed river receiving significant industrial and domestic sewage pollution from sites near Dayton, OH (Yoder *et al.*, 1976; Beckett, 1978, 1977; Moller, 1986). Rankin *et al.* (1990) summarized the factors that degrade Ohio's running waters; these factors include municipal and industrial point sources and agricultural and non-point sources. Municipal and industrial point sources affect the most river miles. Most point source dischargers have had sewage treatment facilities upgraded in past decades. Agricultural and non-point sources cause channelization and siltation which lead to habitat modification. These are the two most serious contributors to non-point habitat impairment.

The GMR headwaters have exceptional water quality as assessed by the multicomponent indices for fish and for macroinvertebrates called the Index of Community Integrity (ICI). Headwater reference sites have 19-21 species and clean tributaries have 17 to 30 species of fish sampled in a single day (Table 1).

Upstream of the Fernald site, major sources of pollutants exist that may affect the biological water quality down river. These include the cities of Dayton (RM 50) and Hamilton (RM 38). Toxins, excess nutrients, sewage, bacteria, and thermal enrichments are contaminants generated by urban and industrial centers. Sites below Dayton have shown IBI, Iwb, and ICI values in the poor to very poor range between 1985 and 1989 (Rankin *et al.*, 1990). The concentrations of all pollutants appear to drop in the area of the river near the Fernald site. This

could be due to the enforcement of water pollution laws and the construction of sewage plants along the GMR. However, low-flow pollution loading and elevated temperatures have combined to cause large fish kills. During the 1988 drought, approximately 261,000 fish were enumerated in a major kill caused by high temperatures near Hamilton (Rankin et al., 1990).

IBI results, used by the Ohio Department of Natural Resources (ODNR) for fish communities, range from 20 (poor or degraded) to 40 (good) for various sample sites from the Ohio River to Dayton. Between 1980 and 1989, no site between RM 19 and RM 38 reached an IBI of greater than 33 (fair to moderate impact) (Rankin *et al.*, 1990). The Iwb is a composite index of numbers and weights calculated as Shannon Indices. The modified Iwb ranged from 7.7 to 8.1 in the Fernald site reach in 1989 on a scale of 1 to 10, ten being the best (OEPA, 1990). The ICI ranged from 40 to 50 in the area of the Fernald site; classified as good or enriched to exceptional (OEPA, 1988). Only at Hamilton and Dayton does the ICI show degradation to the fair or impacted level. The habitat quality of the GMR is the most variable, QHEI of 50-80, between RM 19 and RM 38 (OEPA, 1988). The lowest quality of habitat was found in Hamilton (Fig. 2). Thus the extensive surveys of the OEPA and ODNR over the past decade show an upriver source of enrichment from Dayton and Hamilton sewage treatment plants and a degraded river downstream of the Fernald site from gravel dredging. OEPA and ODNR results indicate that the system has recently been recovering from the upstream enrichment.

OBJECTIVE

The purpose of this study is to analyze the fish community of the GMR as part of an annual survey for FERMCO. This annual survey consists of collection, processing and shipping

of fish samples for uranium analysis. In the process, data collected concerning the biomass, density, diversity and health of the fish community, as well as measurement of chemical parameters of the water quality are used to determine the overall health of the GMR fishery between RM 38 and RM 19. In an effort to determine the impact of the Fernald effluent line located at RM 24 on the overall health of the GMR, this study focuses on areas upstream of the Fernald site effluent line, at the effluent line and downstream of the effluent line. The upstream site is used as a control site because of its isolation from the downstream sites by two dams that prevent upstream fish migration.

This report emphasizes the comparison of the fish community among the years (1984 to 1995), sites and subsamples in terms of density, biomass, health, and species richness. With the twelve year database, changes or trends in the status of the river biota can be followed. If abnormal changes occurred at a given site or year, they may be apparent as deviations of species composition or evenness, changes in mean or modal length and weight, and/or changes in condition as observed in length-weight distributions among sites.

The survey of fish community status and fish radionuclide concentrations around the Fernald site attempts to analyze and document changes in water quality, fish community structure and habitat quality in response to effluent coming from the Fernald site. The sites used in this study may be affected by upriver sewage treatment plants: Dayton and Hamilton. Dams and channel modification by gravel dredging have limited the migration probabilities of fish. The limited migration upstream of the Fernald site provides a method of separating the affects of sewage treatment plants from the affects of Fernald site effluent.

METHODS

Electrofishing: Fishing with electricity has become a commonly used method of collecting fish in a variety of habitats. Pulsed direct current (DC) electrofishing is often the chosen method because it has a wider range of use than unmodified DC (Reynolds, 1983) and is less likely to cause injury or death to fish than alternating current (AC) (Fisher and Brown, 1993). Pulsed DC is effective for collecting unbiased samples of stream fishes with respect to species and size (Fisher and Brown, 1993; Gammon, 1976a). Fish located near the anode are temporarily stunned and can be captured with a net (Reynolds, 1983). The effect of electrical shock varies with size and species of fish. Larger fish are more susceptible to immobilization at lower frequencies because their muscle fibers are longer and are therefore less likely to relax between pulses (Reynolds, 1983; Sternin et al, 1976; Vibert, 1967). Fish species respond differently to the shock depending on their behavior, habitat preferences and swimming abilities (Reynolds, 1983; Sternin et al, 1976; Vibert, 1967). However, with a frequency of 60 cycles per second most stream dwelling fishes are adequately immobilized including bottom dwellers (Vibert, 1967) and the stronger swimmers (Reynolds, 1983).

Sample collection: For this study, fish were electroshocked using a portable electrofisher (5.0 GPP) made by Smith-Root, Inc., Vancouver, WA. The anodes (one on each front corner) were extended 2.0 meters from the front of a 5.0 meter flat bottom aluminum boat by a movable boom constructed of PVC pipe. Each umbrella shaped anode consists of four small diameter stainless steel cables that extend 30 cm below the surface of the water. Small

flexible anode cables and movable boom allow greater maneuverability and sampling efficiency along shorelines and in shallow water. A pulsed DC current of 60 cycles per second was delivered to the anodes by a 240V transformer powered by a gasoline operated, 5,000 Watt, 120V AC Briggs and Stratton generator.

A four person crew operated the boat and electrofishing equipment. Two individuals with long handled (3m) dip nets were positioned at the front of the boat, behind a safety railing, to collect stunned fish. One of the netters controlled the electricity by use of a "deadman" switch. Electricity was delivered to the water only while the "deadman" switch was pressed. A time recorder on the transformer recorded the time in seconds the "deadman" switch was pressed, corresponding to total shocking time. A third crew member positioned at the center of the boat operated the generator and transformer and kept track of total shocking time for each subsample. A fourth person operated the outboard motor located at the back of the boat. Location of the anode at the front of the boat with the motor situated at the back greatly reduces fright bias associated with noise of outboard motors (Sternin et al, 1976).

Electrofishing was conducted during a period of two days: 07 September and 08 September 1995. River Mile 38 was sampled on 07 September while RM 24 and RM 19 were sampled on 08 September. At two of the three sampling sites (RM 24 and RM 19) four subsamples were collected, each consisting of approximately 7 minutes (420 seconds) total shocking time. At the upstream site (RM 38) biomass yield appeared low after the fourth subsample was taken. Therefore, a fifth subsample was collected at RM 38 to ensure that we had enough biomass to fill at least 20 bags with 200-500 grams (wet weight) of fish fillets per bag for

this site. Subsamples were intended to analyze different microhabitats within each selected site (RM) and were not meant to be replicate samples. This type of sampling results in a more complete analysis of the site and more accurately assesses the fish biodiversity in a given site. Fish diversity and density varies with habitat complexity, including topography of the shore, the depth of the pool, nature of the current and the amount of vegetation in and over the water (Gammon et al., 1983; Yoder and Gammon, 1976; OEPA, 1988).

The catch from each subsample was placed in large plastic bags, labeled with site and subsample information and stored on ice in padlocked coolers. The area sampled, for each subsample, was identified on a topographic map (Figs. 2-4) and documented in the field. Later, a Silva type 40 Map Measure was used to trace the distances on the maps and determine distance shocked for each site and subsample (Table 4).

Sample Preparation: At the end of each sampling day fish were taken back to a radionuclide-free laboratory at the University of Cincinnati, removed from the padlocked coolers, one site at a time, and completely processed. Fish were identified to species and weight (g) and length (cm) measurements were recorded directly into a QUATTRO-PRO spreadsheet (Clay, 1975; Pfeiffer, 1975; Smith, 1979; Trautman, 1981; Boschung *et al.*, 1983; Page and Burr, 1991). Abnormalities such as injuries, deformities or diseases were noted. Fish tails, dorsal fins, heads and guts were removed and fillets were taken from either side of the body. Fillets from small fish contained some bone, skin and scales while those from larger fish were mostly meat and scales. Collected fish fillets were placed in zip lock bags and labeled with species or feeding group, total bag weight (at least 200 g wet weight whenever possible) and bag

identification number. Bag numbers were sequential within each site. Smaller fish such as gizzard shad (*Dorosoma cepedianum*) were frequently decapitated, eviscerated and detailed only prior to placement in zip lock bags. All bags were frozen until 72 of the original 108 were shipped for uranium analysis according to the instructions of FERMCO personnel. The remaining 36 bags are being kept frozen (-20C) pending further instruction.

Water Chemistry: Water samples were all collected on 07 September 1995. Water samples were taken from each site in 1 Liter dark polypropylene bottles, placed on ice and brought back to the laboratory for analysis of pH, Chlorophyll, Phosphate, Nitrate and Sulfate. The pH was measured with a Beckman zeromatic ss-3 model pH meter after calibration with pH 4.0 and pH 10.0 buffer solution. For chlorophyll analysis, 250 ml of water was filtered through a 47 mm type A/E glass fiber filter. The filter was placed in 10 ml of 90% Acetone for pigment extraction in the dark at 4°C for 24 hours (Wetzel and Likens, 1991). Absorbance of the extract was measured at 665 nm and 750 nm. Two such filters were processed per site. Absorbance readings were converted to μg Chlorophyll/L using the formula: $11.3 * (\text{Abs}_{665} - \text{Abs}_{750}) * 10\text{ml}/250\text{ml}$ (Wetzel and Likens, 1991). Dissolved, soluble inorganic Phosphate, Nitrate and Sulfate were analyzed colorimetrically using duplicate 25 ml samples of the filtered water. Hach reagents were added to the sample and absorbance was measured at 890 nm, 500 nm, and 450 nm for Phosphate, Nitrate, and Sulfate, respectively. Absorbance readings for phosphate, nitrate and sulfate were compared to readings of known HACH standard concentrations for these nutrients and converted to concentration values based on the standard curve. Phosphate and nitrate were measured in concentrations of $\mu\text{g}/\text{L}$ while sulfate was

measured in concentrations of mg/L. Absorbance readings were all measured on a Hitachi Model 191 Digital Spectrophotometer.

Temperature, Conductivity and dissolved Oxygen were measured in the field. For RM 38 these were taken 07 September 1995 at roughly 10:00 A.M., for RM 24 on 08 September 1995 around 10:00 A.M. and at RM 19 around 2:00 P.M.. Temperature ($^{\circ}\text{C}$) and Oxygen (mg/L) were measured using a YSI Model 57 meter (Yellow Springs Instrument CO., Yellow Springs, Oh.). Conductivity was measured with a HACH portable Conductivity/TDS Meter.

Statistics: The fish community at each site was analyzed using Shannon Diversity Index (H') and coefficient of community. Shannon (H') is a useful index for determining the diversity at each site. The H' of one site is compared to the H' value of another and the site with the highest H' is said to have greater diversity. The coefficient of community (CC) measures the percent similarity of two communities. A low CC may reflect differences in habitat due to geographical separation or a pollution gradient.

Diversity of the fish community at each site was calculated using the Shannon-Weiner (H') index based on the information theory using log base 2 (Krebs, 1988, 1989; Smith, 1991). This index of diversity measures the difficulty of predicting the species of the next individual selected, providing that the individual is selected at random. The value of H' increases as the number of species in a sample increases, assuming equal distribution of individuals among all species. Samples with fewer species or one dominant species have low calculated diversity (H'). The maximum diversity (H_{max}) is a measure of the maximum diversity a community can have given a defined number of species and equal numbers of individuals of all species.

$$\text{Shannon Diversity Index: } H' = - \sum_{i=1}^s (P_i \log P_i)$$

$$\text{where } P_i = N_i / \Sigma N$$

N = total number of individuals

P_i is the proportion of individuals of species i .

Differences in community structure can be seen by comparing the similarity of species composition from the three sites. The community coefficient (CC) is a measure of the proportion of species shared by any two sites. It is based on species presence and does not consider the relative abundance of any species. It is calculated as two times the number of shared species (c) divided by the sum of all the species found at the two sites (a and b). A CC of 1.0 indicates that the two sites have identical species composition, while a CC of 0.0 means there are no shared species (Krebs, 1989). For example, a value of 0.5 indicates that two communities are 50 % similar.

$$\text{Coefficient of community: } cc = 2c / (a+b)$$

where c = # of species in common between sites a and b

$a + b$ = # of species at site a + # of species at site b

Statistical analysis was performed using one way Analysis of Variance (ANOVA) and Tukey Honestly Significant Difference (HSD) post F tests. One way ANOVAs were used to compare parameters of fish community (Hbar per individual, evenness, length, weight, number of species per site and number of fish per hour) between sites and years, assuming all sites and years are replicates. The hypotheses being tested were that there was no statistically significant

difference between the means of any groups or parameters being compared. Results of ANOVAs were evaluated using three parameters: F-statistic (F), degrees of freedom (df) and probability (p). The F-statistic was determined by dividing the between groups average square by the within groups average square. This value was then compared with a value in a table (Rosner, 1990; Siegel, 1988). If the calculated F was larger than the table value of F, for the appropriate degrees of freedom, then the results were considered significantly different. Degrees of freedom were calculated by taking the number of groups and subtracting one for both the between groups and the within groups comparisons. The p-value measured the probability of being wrong if we chose to reject the hypothesis that there was no difference between the groups being compared. The F-statistic (F), degrees of freedom (df) and probability (p) were reported as being highly significant (HS) or not significant (NS). Significance was determined at the 5% level: $p < .05$ was considered HS and $p > .05$ was NS. If no significant difference between sites or years was found using one way ANOVA no further statistical tests were performed. Kirby (1993) points out that unless significant differences are found using a one way ANOVA the data should not be explored further because increasing the number of statistical tests increases the likelihood of finding significant results due to chance. When significant results were found a Tukey HSD was used to determine which years or sites were different.

Finally, the fish communities at the three sites were compared using detrended correspondence analysis (DCA). DCA is a multivariate, eigenvector matrix manipulative technique to evaluate the differences in standard deviation units between communities at particular sites or between species at those sites using an algorithm which reduces the data to two

unrelated ordinales (ter Braak, 1986). Using only the species abundance data, the algorithm iterates to a solution that describes the differences in communities using only the species composition data. The ordination for communities using species data is underlain by the ordination of the species in community-defined space. Using the DCA, the relative position of the species on each ordination is proportional to the effect of each community on the ordinate. Two sites that are very dissimilar communities and share few species will be at extremes of the axis. The eigenvector method allows us to partition the variance to determine what proportion of the separation of communities or species is explained by species or communities, respectively.

SITE DESCRIPTION

In 1995, three sites on the GMR were chosen for fish community analysis (Fig. 1). Two of these sites have been sampled annually at the same time of year since 1984 (RM 24 and RM 19) (Figs. 3 and 4). An upstream site (RM 38) was added in 1991 as an additional control (Fig. 2). RM 38 has since taken the place of the previous upstream site RM 28 because RM 38 is isolated from the downstream sites by two dams that prevent migration of fish upstream from the RM 24 area except during high water flow. It is important to have an isolated upstream control site where the collected fish are not likely to have been influenced by downstream conditions.

RM 38 is located at the confluence of Talawanda Creek and the GMR, in Hamilton (Fig. 2). Riparian vegetation in this area is relatively undisturbed, and the habitat provided by fallen trees, rocky shoals and pools increases fish habitat heterogeneity. The site begins just upriver of the outlet of Seven Mile Creek and extends upstream to the bridge abutments of the US Route

127 bridge. A total of five subsamples were collected at this site each consisting of 7 minutes (approximately 420 seconds) total shocking time. Each subsample analyzed a different riverine habitat within the RM 38 reach. The first subsample sampled a 0.162 km distance along the eastern shore across from the boat dock. The second subsample was taken along the western shore. It began about 500 meters above the dam and sampled a total distance of 0.083 km. Subsample number three began downstream of Talawanda Creek on the western side of the GMR, continued up into Talawanda Creek, across the creek and down the opposite shore and then continued upstream along the western shore of GMR for a total distance of 0.208 km. Subsample number 4 sampled the eastern shoreline beginning downstream of the Route 127 bridge and continued upstream just past the bridge underpass (a total distance of 0.083 km). The fifth subsample was collected along the western shoreline of the GMR around the Route 127 bridge abutments. The subsampling approach encompassed the variety of habitats at this site.

RM 24 is near Stricker's Grove Park and the Fernald site's effluent line (Fig. 3). The mixing zone is a deep, fast section of river with strong eddy currents just below the effluent line. The riverbank tends to be steep and the current at this site is stronger and faster than the current at the other two sites. Riparian vegetation and fallen trees along the eastern shore provide habitat cover and concealment for a variety of fish species. The average pool depth at this site is 1.8 meters. Four subsamples were collected at this site each consisting of 7 minutes (approximately 420 seconds) total shocking time. The first subsample was taken along the western shore near the area of the effluent pipe; 0.167 km of shoreline were sampled. Subsample number 2 (0.125 km total shoreline distance) collected fish directly across the river from where subsample number

1 was taken. The third subsample encompassed the middle of the river (0.250 km shocking distance) between subsamples 1 and 2. The fourth subsample began on the western shore below the effluent pipe and continued downstream over some riffles, across the river and back up the other side for a total sampling distance of 0.250 km. Thus, both shores of the river were sampled. Also, both pools and riffles at this site were sampled for habitat diversity.

RM 19 is found at the outfall of Paddy's Run, which is the historic drainage route of stormwater runoff from the Fernald site (Fig. 4). Twenty-five years of dredging by a gravel company has created a deep pool at this site. The western shore contains many large boulders and submerged logs, and has good riparian vegetation which provides excellent cover for young fish and structure for adult fish. The eastern shore is steep gravel without vegetation and is unattractive to most fish. Vegetation provides habitat security. The average pool depth is about 2 meters. This site has the slowest current of the three sites and is pond-like in many respects. Four different subsamples were collected at RM 19. The first began about 100 meters downstream of Paddy's Run on the eastern shore and continued downstream for 0.167 km. The second subsample began at the outfall of Paddy's Run and continued downstream for 0.167 km along the western shore. Subsample number three analyzed the deep pools around the broken up concrete abutments located just upstream of Paddy's Run. The total distance sampled around these abutments was 0.250 km. The fourth subsample began about 300 meters downstream of Paddy's Run along the western shore and continued for 0.250 km. The four subsamples included all habitat types at this site: shoreline, slowly flowing water and deep pools.

RESULTS AND DISCUSSION

Physical, Chemical Parameters

Site Comparisons: Conductivity and pH varied slightly among the three sites.

Conductivity was highest at RM 24 (798 $\mu\text{S}/\text{cm}$), lowest at RM 38 (771 $\mu\text{S}/\text{cm}$) and measured 793 $\mu\text{S}/\text{cm}$ at the downstream site (Fig. 7). Conductivity changes as a result of changes in dissolved ion concentration and to some extent from temperature variation (Allan, 1995).

Temperature was highest at RM 19 but was measured in the afternoon while temperature at the two upstream sites was measured in the morning. Most likely, temperature increased with time of day. Unlike conductivity, pH varied slightly between sites but there was no overall downstream change in pH (Table 2, Fig. 8).

Oxygen concentration fluctuated down river. Oxygen concentration (mg/L) was supersaturated at RM 38, lowest at RM 24 and slightly less than saturated at RM 19 (Table 2, Fig. 8). The lower concentration found at RM 24 was partly because of morning sampling before photosynthesis by algae could increase the oxygen content of the water. Morning concentrations of oxygen are often low because of overnight respiration by algae and seston. Oxygen concentration may decrease overnight by as much as 4 to 6 mg/L in some eutrophic waters (Wetzel, 1975). The exceptional warm water habitat criteria for oxygen is 6 mg/L above which fish should not be stressed (OEPA, 1995).

Both Chlorophyll and Phosphate concentrations were highest at RM 24 but much lower at the upstream and downstream sites (Table 2). Phosphorus is commonly the limiting factor for primary productivity. The fact that chlorophyll concentration fluctuates with phosphorus

concentration indicates that the phosphorus is being incorporated into algal biomass. Nitrate continually increased downstream (Fig. 6) while Sulfate declined at RM 24 and increased again at RM 19 (Fig. 7). The nitrate to phosphate ratio (N:P) was lowest at RM 24 indicating that nitrogen was the limiting factor for primary productivity and phosphorus was in excess. At the downstream site the ratio changed (Fig. 9) and phosphorus became the limiting factor while nitrogen was in excess.

Down River Trends: Down river variations in water chemistry were indicative of both point and non-point sources of pollution. The high phosphorus concentration at RM 24 was most likely a result of point and non-point source input between RM 38 and RM 24. It could have been from sewage treatment facilities in Hamilton, Ohio. The change in phosphorus and chlorophyll concentrations from RM 24 to RM 19 indicated that phosphorus was either incorporated into algal biomass or precipitated out of the water. Because oxygen is the by-product of photosynthesis, high oxygen levels would be expected where algal photosynthesis is increased. However, the recorded low oxygen levels at RM 24 were because of respiration, a process that uses oxygen. Respiration occurs in the dark and overnight oxygen consumption also increases with increasing algal biomass. The fact that oxygen was measured at RM 24 in the morning explains the low oxygen levels. Nitrogen increases found down river were typical of non-point source nitrogen input from fertilized areas. The increasing sulfate concentration was expected because, unlike nitrogen and phosphorus, sulfur is not utilized in productivity and tends to accumulate in down stream reaches. The drop in sulfate concentration at RM 24 was

probably because of the current at this site. Sulfate accumulated at the two pooled sites where the current is much slower.

Fish Parameters

Species Richness: This year a total of 549 fish were captured as compared to 853 in 1994, 224 in 1993 and 491 in 1992. There were 29 species (vs. 27 in 1994, 26 in 1993 and 23 in 1992) belonging to 9 families (Table 3). However, two of the 29 species captured this year were unidentifiable species, one belonging to the family Centrarchidae and one belonging to the family Cyprinidae (Table 3). These unidentifiable specimens were of small size with immature characteristics that made it impossible to accurately identify them to species. None of the fish captured were threatened or endangered species. The most diverse families were Catostomidae with 7 species, Centrarchidae with 6 species and Cyprinidae with 6 species. The most diverse site was RM 38 with a total of 20 species. RM 24 had the lowest diversity with 15 species while 19 species were found at RM 19.

For statistical analysis, a one way ANOVA was used to test the hypothesis that there was no difference in number of species found per site, between sites (RM 38, RM 28, RM 24 and RM 19) and between years (1984-1995). The number of species per site was not significantly different between sites ($F = 1.250$; $df\ 3, 34$; $p = .307$ NS) but was significantly different between years ($F = 4.027$; $df\ 11, 26$; $p = .002$ HS). A Tukey HSD test showed that the number of species found per site in 1995 was different from 1987, 1990 and 1992. Low numbers of species were found in 1990 and 1992 (Table 5). In 1987 the sites sampled were RM 28, RM 24 and RM 19 and the number of species reported at each site was nearly equal: 10 species at RM 28, 11

species at RM 24 and 10 species at RM 19 (Table 5). The high diversity in 1995 is consistent with a river that has significantly recovered from the conditions that caused low diversity in 1990 and 1992. Additionally, efficient electroshocking with good, reliable equipment using subsampling techniques to survey the habitat diversity at each site allowed for a complete analysis of the diversity of the fish community.

Density: Total electroshocking time (in seconds) was 2106, 1682 and 1681 for RM 38, RM 24 and RM 19, respectively (Table 4). The number of fish shocked per hour was 426, 220 and 422 for RM 38, 24 and 19, respectively (Fig. 12, Tables 4 and 5), compared to 422, 300 and 426 fish per hour in 1994, 72.5, 35 and 90.2 fish per hour in 1993 and 175, 106 and 305 fish per hour in 1992 (Table 5) from the respective locations (RM 38, RM 24 and RM 19). RM 38 had the greatest number of fish caught per hour and the highest number of individuals collected. However, RM 19 had nearly as many fish per hour (422) as RM 38 (426) yet the total shocking time at RM 19 was only 1681 seconds while total shocking time at RM 38 was 2106 seconds. Also, one subsample (subsample 3) taken at RM 38 resulted in an exceedingly high number of fish (135) and this one subsample skewed the number of fish caught per hour at RM 38 (Table 3). RM 24 had the fewest number of individuals collected and lowest number of fish per hour (Table 4). This year more fish were captured per unit effort at RM 38 > RM 19 > RM 24. In previous years the trend has been more fish per unit effort at RM 19 > RM 38 > RM 24. However, the difference between fish caught per hour at RM 38 and RM 19 this year was low: a difference of 4 fish per hour (Table 4).

Statistical analysis by a one way ANOVA showed that there was no difference in the number of fish caught per hour between sites ($F = 2.371$, $df = 3, 31$, $p = .089$ NS). However, there was a significant difference in the number of fish caught per hour between the years 1985 to 1995 ($F = 5.810$, $df = 10, 24$, $p = .000$ HS). A post F comparison (Tukey HSD) showed that the number of fish caught per hour in 1995 was significantly different from 1987, 1989, 1990, 1991 and 1993 indicating that the density of the fish community in 1995 was higher than in these years. The fact that there was no significant difference in the number of fish caught per hour between sites demonstrated that, in any year, the density of fish at each site was similar and that electrofishing was not more efficient at one site than at the other.

Species Diversity Indices: This year RM 19 had the lowest diversity index because of a high abundance of Gizzard shad at RM 19 (Table 3). RM 38 had the highest diversity index and was dominated by two species: Golden redhorse and Bluntnose minnow. RM 24 was dominated by Freshwater Drum and had an intermediate diversity index. The twelve year mean for H' (Table 7) shows a trend of $RM\ 24 > RM\ 38 > RM\ 19$. Thus, the trend found in 1995 differed from the trend of the 12 year means. The change in diversity this year at RM 38 might at first appear to be a result of sampling procedure. A decision was made in the field to take a fifth subsample at RM 38 to ensure adequate weight for uranium analysis. Only four subsamples were conducted at each of the other two sites. However, this fifth subsample at RM 38 only increased the number of species found at this site by one (Fig. 23). It is more likely that the diversity of the fish community at RM 38 has improved over recent years as a result of improved habitat conditions.

Statistically, a one way ANOVA of the diversity index (H') showed that there was no significant difference between sites ($F = 2.362$, $df = 3, 34$, $p = .089$ NS) or years ($F = .749$, $df = 11, 26$, $p = .644$ NS). On average, the index followed a decreasing trend from RM 24 > RM 38 > RM 28 > RM 19. A one way ANOVA showed a significant difference in mean evenness of species diversity between sites ($F = 7.019$, $df = 3, 34$, $p = .001$ HS) but not between years ($F = .839$, $df = 11, 26$, $p = .605$ NS). A post F comparison showed that mean evenness for RM 19 was significantly different from RM 24 and RM 28 but not significantly different from RM 38. RM 19 and RM 38 had similar evenness in species distribution because they are both pooled sites and do not exclude small fish. The twelve year average of evenness is lowest at RM 19 (Table 7). During most years this site was dominated by Gizzard shad and dominance by one species may explain the difference between mean evenness at RM 19 and RM 24.

Community Coefficients: The CC showed that all three sites (RM 38, 24 and 19) are similar ($CC = ca. 0.50$) (Table 8). RM 24 and 19 were the most similar ($CC = .65$) but less so than in 1994 ($CC = .74$). RM 24 and 38 were the least similar ($CC = .57$). Another way to examine species data at several sites is to observe how many species are found at only one site, two sites, etc.. For 1995, 8 of the 29 species found were at all three sites, 8 of the 29 species were at two of the three sites and 12 species were found at only one site, compared with 10, 9 and 8, respectively, in 1994 (Table 3).

Weight/Length Distributions: The weight and length frequency distributions of fish collected were calculated as percent per size and cumulative percent per size (Tables 9 and 10). The modal weight was around 25 grams for RM 38, ranged between 25 and 100 grams for RM

19 while 75 grams was the modal weight for RM 24 (Table 9). Cumulative distribution of proportion of fish by weight shows effect of size classes in composition of the fishery. If the cumulative weight distribution rises quickly, then small fish dominate. This is the form of the distribution for RM 38 and 19, the two most ponded sites. At both of these sites, more than 80% of the fish accumulated were less than 225 grams (Fig. 15). RM 38 had a large number of YOY Golden redhorse and Gizzard shad. In addition, RM 38 contained a large number of Bluntnose minnows. RM 19 was dominated by YOY Gizzard shad as well as some YOY Bluegill. On the other hand, if the cumulative weight distribution curve increases slowly then the fishery is dominated by larger fish. This type of weight distribution was found at RM 24 (Fig. 15). Less than 50% of the fish found at RM 24 weighed less than 225 grams (Fig. 15). These large differences stemmed from the large number of YOY and small species found at the two pooled sites (RM 38 and 19). Small species and YOY cannot tolerate the rough current at RM 24.

Length frequency distributions for RM 38 show that the modal length of fish was 8 to 10 cm (Table 10). Modal length for RM 24 ranged from 18 to 28 cm and was bimodal at 22 and 28 cm (Table 10). RM 19 also showed a bimodal length distribution at 8 cm and 22 to 24 cm. The diagram of cumulative proportion of fish by length (Fig. 16) illustrates a gradual rise to the asymptote. In a uniform sized distribution, the curve rises linearly to the asymptote. The graph shows that there is a slightly even distribution of fish from different length classes. However, there is clearly a large number of small fish. RM 38 and RM 19 are dominated by smaller fish with 80% of fish found at these sites being less than 22 cm long (Fig. 16, Table 10). RM 24 had

the largest and most uniform size distribution with a more linear rise in the cumulative frequency curve.

The curve of the cumulative frequency plot can help to describe a site. When skewed to the young of one species, the curves imply enrichment in food or habitat. When uniform and linear, the curves suggest an older population, which could mean a uniformly fast current of a condition that has lead to a loss of the more sensitive young fish. The young-biased curves at RM 38 and RM 19 probably reflect enrichment and pooling that favor Gizzard shad and immature fish. On the other hand, the absence of young fishes at RM 24 probably reflects habitat conditions and current that excludes the small, weak swimmers.

The changes in growth rate and condition can be examined for common species using (length X wet weight) distributions. This curve reflects deviations in weight per unit length and shows changes in the condition of fish (amount of fat stored). Deviations from the allometric curve of length and weight may indicate poor growth conditions, such as food source quality, at particular sites or in the river as a whole.

Gizzard shad was a common species at all three sites, especially RM 19. Most of the Gizzard shad collected at RM 19 were YOY (6 to 14 cm) and one year-old fish (16 to 27 cm) (Fig. 17). However, there were some larger individuals taken from RM 19. For RM 38, all Gizzard shad collected were YOY and one year-old fish because they were all less than 25 cm in body length (Fig. 17). RM 24 had some of the heavier Gizzard shad and appeared to have mostly one year-old fish (Fig. 17).

Smallmouth, Largemouth and White bass had similar weight/length relationships between sites (Fig. 18). For smaller fish the weight/length curve increased nearly linearly for all three sites. For fish greater than 30 cm total body length, however, the weight increased exponentially with increasing length for RM 38 and RM 19 (Fig. 18). There were no Bass longer than 30 cm found at RM 24. However, there is no reason to assume that the weight/length curve for large bass at RM 24 would be any different than that for RM 38 and RM 19. The observed relationship between weight and length among older bass may be because bass species from two different families were combined to produce the weight/length curve for bass or it could also be a characteristic of these species.

The weight/length relationship for sunfish produced a smooth tight curve (Fig. 19). This year Sunfish were found almost exclusively at RM 38 and RM 19. Only one sunfish was found at RM 24 and this may explain why we found little variability in the weight/length relationship for sunfish. As was pointed out earlier, RM 24 has a swift current that may make it difficult for small fish to compete and survive. Small fish, like sunfish, that do persist at RM 24 are likely to have lower overall weight than their length counterpart located at another site along the river and may contribute to a loose correlation between weight and length at RM 24.

Freshwater drum was found only at RM 24 and RM 19. There were no Drum found that were less than 12 cm in length. The majority of Drum were found at RM 24 and most of them ranged between 17 and 32 cm total body length (Fig. 20) contributing to the fact that RM 24 had the highest biomass per hour this year.

RM 24 had the highest total weight and biomass per-hour (Fig. 13). In general, the fish collected at RM 24 were larger and more mature than those collected at RM 38 and RM 19. The swift current found at RM 24 probably excludes smaller fish. Statistically, a one way ANOVA showed a significant difference in average weight ($F = 6.233$, $df = 3, 31$, $p = .002$ HS) and average length ($F = 13.660$, $df = 3, 31$, $p = .000$ HS) between sites. However, there was no significant difference in average weight ($F = .998$, $df = 10, 24$, $p = .472$ NS) or average length ($F = 1.263$, $df = 10, 24$, $p = .305$ NS) between the years. A post F comparison of average weight and length by site showed that RM 28 and RM 24 were significantly different (for both length and weight) from RM 38 and RM 19. Comparison of RM 38 to RM 19 and RM 28 to RM 24 showed no statistically significant differences. Thus, RM 24 has consistently had larger fish throughout this twelve year survey.

Sampling Adequacy: Collection of fish by a subsampling technique was an adequate method of assessing the diversity of the fish community of the GMR. In 1992, the total sample was subdivided into subsamples to examine variance by habitat within sites and adequacy of sampling effort to capture most of the species. In 1993, 1994 and 1995, attempts were not made to take replicates, but to maximize the habitat sample differences; hence the term subsample. At all RM locations sampled, the number of species per subsample was relatively constant (Fig. 11) with the exception of subsample 3 at RM 38. The cumulative species captured increased significantly with the second and third subsamples but, in general, leveled off with the fourth subsample (Fig. 23). These findings indicate that four subsamples, each assessing a different

habitat, are sufficient to capture the majority of all species at a given site. Further subsamples would not significantly increase the number of species captured.

Ordination by Detrended Correspondence Analysis (DECORANA or DCA): The DCA for species and for sites were iterated to the same coordinates and were plotted on axes based on standard deviation units. Separation of RM 19 and RM 24 by two standard deviations on the second axis showed that the fish communities at these site were greater than 66 % different in composition and relative abundance. DCA by species abundances showed that RM 38 was only 1 standard deviation apart from RM 19 and RM 24 on the first axis (25.8% variance explained), while RM 24 and RM 19 were separated by 2 standard deviations on the second axis (15.0% variance explained) (Fig. 24). Only 8 species were found in all three sites; hence the sites were drawn apart by species not in common. The subsamples from RM 19 and RM 24 were tightly clustered together, indicating little variance in composition; however the subsamples for RM 38 was very wide on the first axis (2.5 standard deviations). Behind Hamilton Dam 1 some subsamples were taken from ponded sites and some from shallow gravel bottom near the junction with Talawanda Creek. Hence small stream fish like the log perch, bluntnose minnow, emerald shiner, and hog sucker separated subsample 1-3 from the others within that site.

The DCA of species by sites related the species associations with site separation. The catfishes, golden redhorse, minnows and shiners. and hog sucker were grouped together at RM 38 (Fig. 24). The larger fish (carp, smallmouth buffalo, and fresh water drum) separated from other species into RM 24 (Fig. 24). Pool fishes such as gizzard shad, sunfishes, white bass (from Ohio River) were grouped together at RM 19 (Fig. 24). The first ordinate (X axis) appears to

separate the sites based weakly on stream order from upstream to downstream, while the second ordinate (Y axis) appears to separate the sites based on current velocity from rapid at site 2 (RM 24) to slow at site 3 (RM 19). The influence of current was more important to the fish community in 1995 than in 1994, when stream order was sufficient to separate the three sites in a downriver gradient.

CONCLUSIONS

The water quality and health of the fish community of the GMR was good in 1995. The fish community differences between stations were explained by changes in physical habitat, rather than changes in water quality. The diversity of fish species at each site was significantly higher than it was during some previous years which indicated the river had recovered from conditions causing low diversity during those years. Though water chemistry showed evidence of nutrient enrichment there was no evidence to suggest that the health of the fish community was affected by this observed enrichment (Table 2). In addition, the river was free of exogenous stress on the fish community as evidenced by the absence of deformed or diseased fish, lack of dominance by a single species (Table 3), and fish condition measured by length x weight relations (Figures 17-22). The measurements of biomass, density and diversity of fish communities in September 1995 were similar to those of previous years when the river was in good condition (Tables 5, 6 and 7). Reproducing fish populations were evidenced by the presence of YOY gizzard shad and golden redhorse at the two pooled sites.

Down river trends in chemical parameters indicated that some pollution was occurring between RM 38 and the Fernald site. High phosphate concentration at RM 24 suggested an

upstream source of phosphorus loading, possibly sewage treatment facilities in Hamilton, Ohio. Phosphate and chlorophyll were both highest at RM 24 and decreased downstream (Fig. 6, Table 2). Thus, phosphate was likely incorporated into algal biomass or removed abiotically from the water. Accumulation of nitrate at downstream sites was indicative of other sources of pollution such as run-off from fertilized areas or input from ground water seepage (Figures 6 and 9). The lower oxygen at RM 24 was a result of morning sampling and not indicative of an unhealthy stream. The high chlorophyll levels at this site indicate that oxygen levels would have increased later in the day. Overnight oxygen consumption by algal respiration is a common occurrence in streams. The effect of algal respiration must be considered when analyzing early morning oxygen concentrations.

Changes seen in species richness and biomass were related more to physical parameters of the stream than to chemical factors. Larger fish and species that are tolerant of and require rapid current (freshwater drum and carp) were found at RM 24, while YOY and smaller species (gizzard shad, golden redhorse, sunfishes and minnows) were typical of the pooled sites (RM 38 and RM 19) (Table 3). Presence of YOY gizzard shad and golden redhorse indicated the fish communities were reproducing. Overall diversity in 1995 was higher than it was in some of the early years of this twelve year study but was similar to reported values in 1994 and 1993 (Table 7). Stable diversity in recent years indicates a recovered, stable river. High diversity of the fish communities at the three sites sampled was what would be expected in a clean mid-sized river. Lack of diseased or otherwise unhealthy fish indicated there was no evidence of a pollution gradient sufficient to affect the status of the fishery.

Analysis of both water chemistry and fish communities indicated that the GMR between RM 38 and RM 19 was a eutrophic river in September 1995, as it has been since 1992. The fish community has clearly recovered from the low diversity community found in 1992 despite the eutrophication and growth of planktonic algae in the river.

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Figure 1. Overview map of the sampling sites in the Great Miami River, 1995.

Figure 2. Map of River Mile 38.

Figure 3. Map of River Mile 24.

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Figure 5. Index of Biotic Integrity, Index of Well Being, and Index of Habitat Quality in the Great Miami River from the Ohio River (RM 0) to Dayton (RM 50) from OEPA data, 1980, 1987, 1989.

Figure 6. Phosphate and nitrate concentrations found at each site in the Great Miami River, 1995.

Figure 7. Sulfate concentrations and conductivity levels found at each site in the Great Miami River, 1995.

Figure 8. Levels of pH and Oxygen concentrations found in the Great Miami River, 1995.

Figure 9. Inorganic nitrogen to phosphorus ratio, by weight for each site in the Great Miami River, 1995.

Figure 10. The number of species and number of fish per site in the Great Miami River, 1995.

Figure 11. The number of fish species in four subsamples at three river sites in the Great Miami River, 1995.

Figure 12. The number of fish caught per hour and the number of fish caught per kilometer in the Great Miami River, 1995.

Figure 13. The total weight and the biomass per hour of fish captured at each site in the Great Miami River, 1995.

Figure 14. Shannon Diversity Index of fish captured in the Great Miami River, 1995.

Figure 15. The cumulative proportion of fish by weight captured in the Great Miami River, 1995.

Figure 16. The cumulative proportion of fish by length captured in the Great Miami River, 1995.

Figure 17. Length/weight relationship for gizzard shad in the Great Miami River, 1995.

Figure 18. Length/weight relationship for white bass, smallmouth bass and largemouth bass in the Great Miami River, 1995.

Figure 19. Length/weight relationship for sunfish in the Great Miami River, 1995.

Figure 20. Length/weight relationship for freshwater drum in the Great Miami River, 1995.

Figure 21. Length/weight relationship for carp in the Great Miami River, 1995.

38=RM 38, 24=RM 24, 19=RM19

Figure 22. Length/weight relationship for Catostomidae in the Great Miami River, 1995.

Figure 23. The cumulative number of fish species per number of fish at each site in the Great Miami River, 1995.

Figure 24. Detrended Corresponded Analysis of sites using fish species composition in the Great Miami River, 1995.

DCA OF FISH SPECIES, GMR 1995

Table 1. Biotic and drainage data from OEPA for the Great Miami River for reference sites for comparison of other sites in the drainage area (data 1980 to 1986).

GMR Tributaries	RM	Year	D	ECOREG	Drainage	Mean	lwb	IBI	SRP
Backpack Shocker					miles^2	Spp. #			
Twin Creek	0.2	1986	A	ECBP	316.0	21.7	9.1	49	
Fourmile Creek	0.3	1980	A	ECBP	315.0	18.7	8.8	49	
Mad River	1.2	1984	A	ECBP	655.0	17.0	8.7	33	
Indian Creek	4.1	1983	D	ECBP	77.0	26.3	8.9	43	Y
Whitewater River	9.4	1985	D	ECBP	45.0	25.5	10.3	46	
Stillwater River	51.2	1983	D	ECBP	106.0	30.7	8.9	45	Y
Boat Shocker									
Loramie Creek	0.1	1982	A	ECBP	201.0	17.0	8.6	47	
Green Creek	16.0	1982	A	ECBP	607.0	22.7	9.1	49	
GMR Mainstem	88.1	1980	A	ECBP	1150.0	20.7	8.3	37	
GMR Mainstem	91.0	1980	A	ECBP	1161.1	18.7	8.6	33	

Data from OEPA Ecological Assessment Section, 1988 Biological Criteria for the Protection of Aquatic Life: Vol. II: Users Manual for Biological Field Assessments of Ohio Surface Waters. Columbus, OH.

Table 2. Physical and chemical parameters for all sites sampled in the Great Miami River, 1995.

Parameters	Units	RM 38	RM 24	RM 19
Oxygen	mg/L	11.4	7.6	8.1
% O2 Saturation	%	120.42%	83.52%	95.41%
Temperature	degrees Celcius	18	19.5	23.5
Total Dissolved Solids	ug/L	385	377	397
Conductivity	micro Siemens	771	798	793
pH	units	8.3	8.2	8.3
Total Chlorophyll	ug/L	15.00	18.23	15.15
Phosphate	ug/L	3.14	13.38	1.86
Nitrate	ug/L	19.65	21.50	24.62
Sulfate	mg/L	101.74	100.05	106.97

Table 3. Common name, family, and numbers of fish collected by site in the Great Miami River, 07 and 08 September 1995.

#	Common Name	Family	River Mile 38 Subsample					River Mile 24 Subsample					River Mile 19 Subsample					Total		
			1	2	3	4	5 sum	1	2	3	4 sum	1	2	3	4 sum					
1	Longnose Gar	Lepisostidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1			
2	Gizzard Shad	Clupeidae	0	0	9	1	7	17	3	2	2	3	10	44	21	32	129			
3	Skipjack Herring	Clupeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1			
4	Golden Redhorse	Catostomidae	1	1	37	6	23	68	1	3	0	1	5	1	0	2	77			
5	Highfin Carpsucker	Catostomidae	2	0	0	0	0	2	0	0	0	0	0	0	0	0	2			
6	Northern Hog Sucker	Catostomidae	0	0	6	0	0	6	1	0	1	0	2	0	0	0	8			
7	Quillback Carpsucker	Catostomidae	0	1	1	2	1	5	0	1	0	1	2	1	0	2	12			
8	River Carpsucker	Catostomidae	2	0	0	0	0	2	2	1	0	1	4	0	0	0	6			
9	Smallmouth Buffalo	Catostomidae	0	0	0	0	0	0	2	1	0	5	8	1	1	0	2			
10	Black Crappie	Catostomidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1			
11	Bluegill	Centrarchidae	7	0	1	0	3	11	0	0	0	1	1	0	6	4	18			
12	Longear Sunfish	Centrarchidae	3	0	0	3	9	0	0	0	0	0	0	7	0	4	30			
13	Green Sunfish	Centrarchidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2			
14	Unknown Sunfish	Centrarchidae	0	0	0	0	0	0	0	0	0	0	0	0	3	2	9			
15	Smallmouth Bass	Centrarchidae	1	0	5	1	4	11	0	1	2	0	3	0	2	1	5			
16	Largemouth Bass	Centrarchidae	0	1	3	0	0	4	0	0	0	0	0	0	0	0	1			
17	Bluntnose Minnow	Cyprinidae	0	0	61	0	0	61	0	0	0	0	0	0	1	0	62			
18	Unknown Minnow	Cyprinidae	1	0	0	2	0	3	0	0	0	0	0	0	0	0	3			
19	Silverjaw Minnow	Cyprinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11			
20	Steelcolor shiner	Cyprinidae	0	0	8	6	2	16	0	0	0	0	0	0	0	0	16			
21	Emerald shiner	Cyprinidae	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1			
22	Carp	Cyprinidae	3	6	0	3	6	18	2	2	1	5	10	1	0	1	30			
23	Channel Catfish	Ictaluridae	2	3	1	0	3	9	6	2	1	2	11	0	0	2	21			
24	Flathead Catfish	Ictaluridae	0	0	0	2	0	2	0	0	1	1	2	0	1	0	3			
25	Yellow Bullhead	Ictaluridae	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1			
26	White Bass	Percichthyidae	0	0	0	0	0	0	0	1	0	2	1	0	3	1	7			
27	Ohio Logperch	Percidae	0	0	2	0	0	2	0	0	0	0	0	0	1	0	3			
28	Sauger	Percidae	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4			
29	FW Drum	Sciaenidae	0	0	0	0	0	0	0	5	19	7	10	41	4	1	51			
Total Fish			22	14	135	28	52	249	23	34	16	30	103	48	48	68	33			
Species Total			9	7	12	9	9	20	9	11	8	10	15	5	11	16	11			
Shannon Diversity Index			2.273556															2.074011	1.922721	2.623939
Diversity/Individual H'			2.995732															2.70805	2.944439	3.367296
Hmax																				
Evenness E			0.758932															0.765869	0.653001	0.779242

Table 4. Analysis of subsamples at each of the site locations in the Great Miami River, 1995.

Site	River mile 38						River mile 24						River mile 19						Total
Subsample	1	2	3	4	5	Sum	1	2	3	4	Sum	1	2	3	4	Sum			
Individuals	22	14	135	26	52	249	23	34	16	30	103	48	48	68	33	197	549		
Species	9	7	12	9	9	20	9	11	8	10	15	5	11	16	11	19	29		
Time shocked (sec)	421	424	422	419	420	2106	420	422	420	420	1682	420	421	420	420	1681	5469		
Fish shocked/hr	188	119	1152	223	446	426	197	290	137	257	220	411	410	583	283	422	361		
Individuals/species	2	2	11	3	6	12	3	3	2	3	7	10	4	4	3	10	19		
Distance shocked (km)	0.167	0.083	0.208	0.083	0.167	0.708	0.167	0.125	0.250	0.250	0.792	0.167	0.167	0.250	0.083	0.667	2.167		
Fish/km	132	168	648	312	312	351.5	138	272	64	120	130.1	288	288	272	396	295.5	253.4		

Table 5. The number of fish captured per hour and the number of species captured by river mile and by year from the Great Miami River, 1984 to 1995.

Yr/Site	Number of Fish per Hour				Number of Species per Site			
	RM 38	RM 28	RM 24	RM 19	RM 38	RM 28	RM 24	RM 19
1984						15	12	15
1985		104	84	314		11	19	16
1986		98	79	266		12	15	16
1987		73	75	102		10	11	10
1988		146	3	154		15	12	15
1989		120	69	136		13	12	16
1990		65	60	119		8	10	7
1991	67	225	174	100	18	14	15	15
1992	175	133	106	305	13	13	8	7
1993	73		35	90	13		11	19
1994	422		300	426	15		20	17
1995					20		15	19
Mean	184.2	120.5	98.5	201.2	15.8	12.3	13.3	14.3
Coef. Var.	90.2%	41.9%	85.0%	58.3%	19.7%	19.0%	26.8%	28.7%

Table 6. Mean weight and length of fish electroshocked by year and by river mile in the Great Miami River, 1984 to 1995.

Yr/Site	Weight of Fish (g)				Length of Fish (cm)			
	RM 38	RM 28	RM 24	RM 19	RM 38	RM 28	RM 24	RM 19
1984								
1985		623	376	115		23.8	26.3	18.5
1986		471	271	160		30.5	23.3	23.8
1987		180	260	130		26.0	28.0	23.0
1988		175	135	62		25.0	23.5	14.5
1989		195	186	110		21.8	21.0	17.4
1990		289	316	187		30.3	29.4	23.5
1991	140	166	157	56	16.9	21.8	17.6	14.8
1992	39	345	150	53	10.3	25.7	21.9	16.6
1993	244		494	118	18.6		31.2	16.6
1994	176		386	137	16.0		24.8	14.9
1995								
Mean	149.9	305.5	273.1	112.8	15.4	25.6	24.7	18.4
Coef. Var.	57.2%	54.6%	43.9%	39.7%	23.2%	13.1%	16.7%	20.2%

Table 7. Species diversity and evenness using the Shannon Information Index (H' (log base-2)) by year and by river mile in the Great Miami River, 1984 to 1995.

Yr/Site	H bar/Individual				Evenness			
	RM 38	RM 28	RM 24	RM 19	RM 38	RM 28	RM 24	RM 19
1984		2.24	1.70	2.06		0.58	0.48	0.53
1985		2.93	3.82	1.28		0.85	0.90	0.32
1986		2.62	3.40	2.20		0.73	0.87	0.55
1987		1.68	2.33	2.78		0.51	0.89	0.40
1988		2.23	2.33	2.78		0.57	0.75	0.71
1989		2.18	2.43	1.96		0.59	0.68	0.49
1990		2.33	2.03	1.04		0.78	0.61	0.37
1991	3.11	2.10	2.82	1.75	0.45	0.47	0.58	0.32
1992	2.55	2.49	1.68	0.49	0.69	0.67	0.56	0.18
1993	1.80		2.07	2.10	0.70		0.86	0.71
1994	1.94		2.32	4.69	0.72		0.77	0.60
1995	2.27		2.07	1.90	0.76		0.77	0.65
Mean	2.33	2.31	2.42	2.09	0.66	0.64	0.73	0.49
Coef. Var.	22.5%	15.2%	26.7%	50.5%	18.4%	19.9%	19.7%	35.1%

Table 8. Community coefficients of species similiarity between sites in the Great Miami River, 1995.

	RM 38	RM 24	RM 19
RM 38	1.000	0.571	0.615
RM 24	0.571	1.000	0.647
RM 19	0.615	0.647	1.000

Table 9. Weight frequency distribution of fish electroshocked in the Great Miami River, 07 and 08 September 1995.

Wieght Frequency Distribution				
gm	RM 38	RM 24	RM 19	Total
0	0	0	0	0
25	154	1	52	207
50	19	5	15	39
75	8	14	26	48
100	6	8	44	58
125	4	6	22	32
150	7	2	8	17
175	4	6	4	14
200	5	3	1	9
225	4	4	0	8
250	6	3	1	10
275	1	5	4	10
300	2	0	1	3
325	0	3	1	4
350	2	4	2	8
375	1	0	4	5
400	3	1	0	4
425	1	3	2	6
450	0	1	0	1
475	1	0	0	1
500	0	0	0	0
525	1	2	0	3
550	0	0	2	2
575	0	1	1	2
600	1	0	0	1
625	1	0	0	1
650	0	2	1	3
675	0	1	0	1
700	1	1	0	2
725	1	0	1	2
750	1	1	0	2
775	0	2	0	2
800	1	0	1	2
825	1	2	0	3
850	1	0	0	1
875	0	0	0	0
900	0	0	1	1
925	0	1	0	1
950	0	0	0	0
975	0	1	0	1
1000	0	1	0	1
1500	6	7	0	13
2000	3	2	2	7
>2000	1	8	1	10
SUM	247	101	197	545

Table 10. Length frequency distribution of fish electroshocked in the Great Miami River, 07 and 08 September 1995.

Length Frequency Distribution				
cm	RM 38	RM 24	RM 19	Total
0	0	0	0	0.00
2	0	0	0	0.00
4	0	0	1	1.00
6	13	0	6	19.00
8	76	0	23	99.00
10	31	1	14	46.00
12	28	1	9	38.00
14	16	1	11	28.00
16	11	1	6	18.00
18	5	8	4	17.00
20	7	7	14	28.00
22	6	10	39	55.00
24	4	9	30	43.00
26	6	5	8	19.00
28	5	11	7	23.00
30	6	4	5	15.00
32	5	3	4	12.00
34	5	4	5	14.00
36	4	4	2	10.00
38	2	2	2	6.00
40	5	4	2	11.00
42	1	6	1	8.00
50	11	7	3	21.00
55	1	6	0	7.00
60	1	0	0	1.00
70	0	5	0	5.00
75	0	0	0	0.00
>75	0	2	1	3.00
Sum	249	101	197	547

Appendix A. Listing of common names, species, and families of fish found in the Great Miami River, 1995.

#	Common Name	Species	Family
1	Longnose Gar	<i>Lepisosteus osseus</i>	Lepisosteidae
2	Gizzard Shad	<i>Dorosoma cepedianum</i>	Clupeidae
3	Skipjack Herring	<i>Alosa chrysochloris</i>	Clupeidae
4	Golden Redhorse	<i>Moxostoma erythrurum</i>	Catostomidae
5	Highfin Carpsucker	<i>Carpionodes velifer</i>	Catostomidae
6	Northern Hog Sucker	<i>Hypentelium nigricans</i>	Catostomidae
7	Quillback Carpsucker	<i>Carpionodes cyprinus</i>	Catostomidae
8	River Carpsucker	<i>Carpionodes carpio</i>	Catostomidae
9	Smallmouth Buffalo	<i>Ictiobus bubalus</i>	Catostomidae
10	Black Crappie	<i>Pomoxis nigromaculatus</i>	Catostomidae
11	Bluegill	<i>Lepomis macrochirus</i>	Centrarchidae
12	Longear Sunfish	<i>Lepomis megalotis</i>	Centrarchidae
13	Green Sunfish	<i>Lepomis cyanellus</i>	Centrarchidae
14	Unknown Sunfish	<i>Lepomis ?</i>	Centrarchidae
15	Smallmouth Bass	<i>Micropterus dolomieu</i>	Centrarchidae
16	Largemouth Bass	<i>Micropterus salmoides</i>	Centrarchidae
17	Bluntnose Minnow	<i>Pimephales notatus</i>	Cyprinidae
18	Unknown Minnow	<i>?</i>	Cyprinidae
19	Silverjaw Minnow	<i>Ericymba buccata</i>	Cyprinidae
20	Steelcolor shiner	<i>Notropis whipplei</i>	Cyprinidae
21	Emerald shiner	<i>Notropis atherinoides</i>	Cyprinidae
22	Carp	<i>Cyprinus carpio</i>	Cyprinidae
23	Channel Catfish	<i>Ictalurus punctatus</i>	Ictaluridae
24	Flathead Catfish	<i>Ictalurus olivaris</i>	Ictaluridae
25	Yellow Bullhead	<i>Ictalurus natalis</i>	Ictaluridae
26	White Bass	<i>Morone chrysops</i>	Percichthyidae
27	Logperch	<i>Percina caprodes</i>	Percidae
28	Sauger	<i>Stizostedion canadense</i>	Percidae
29	FW Drum	<i>Aplodinotus grunniens</i>	Scianidae

Appendix B. Listing of the lengths and weights of fish captures at River Mile 38, 1995.

#	Sub. #	Common Name	FAMILY	LENGTH (cm)	WEIGHT (g)	BAG #	BAG WT (g)	NOTES
1	1	GOLDEN REDHORSE	CATOSTOMIDAE	26.2	181.15	112	317	
2	1	HIGHFIN	CATOSTOMIDAE	35.70	468.83	104	269	
3	1	HIGHFIN	CATOSTOMIDAE	40.90	719.72	104	269	
4	1	RIVER CARPSUCKER	CATOSTOMIDAE	33.00	343.88	105	224	
5	1	RIVER CARPSUCKER	CATOSTOMIDAE	38.20	615.83	105	224	
6	1	BLUEGILL SUNFISH	CENTRARCHIDA	6.7	5.41	106	285	
7	1	BLUEGILL SUNFISH	CENTRARCHIDA	8	11.55	106	285	
8	1	BLUEGILL SUNFISH	CENTRARCHIDA	6.7	5.39	106	285	
9	1	BLUEGILL SUNFISH	CENTRARCHIDA	7.5	7.29	106	285	
10	1	BLUEGILL SUNFISH	CENTRARCHIDA	6.4	5.13	106	285	
11	1	BLUEGILL SUNFISH	CENTRARCHIDA	6.6	5.46	106	285	
12	1	BLUEGILL SUNFISH	CENTRARCHIDA	7.1	5.98	106	285	
13	1	LONGEAR SUNFISH	CENTRARCHIDA	11.1	33.31	106	285	
14	1	LONGEAR SUNFISH	CENTRARCHIDA	8.4	11.21	106	285	
15	1	LONGEAR SUNFISH	CENTRARCHIDA	9.1	18.53	106	285	
16	1	SMALL MOUTH BASS	CENTRARCHIDA	16	5.69	115	249	
17	1	UNKNOWN MINNOW	CYPRINIDAE	4.6	0.9	No Ba	N/A	
18	1	CARP	CYPRINIDAE	42.70	1254.35	102	237	Female with eggs
19	1	CARP	CYPRINIDAE	48.40	1520.00	101	334	
20	1	CARP	CYPRINIDAE	57.70	2639.98	100	547	Female with eggs
21	1	CHANNEL CATFISH	ICTALURIDAE	33.60	377.52	103	202	
22	1	CHANNEL CATFISH	ICTALURIDAE	26.40	241.29	103	202	
23	2	GOLDEN REDHORSE	CATOSTOMIDAE	31.60	350.42	112	317	
24	2	QUILLBACK	CATOSTOMIDAE	32.60	409.71	114	302	
25	2	BLACK CRAPPIE	CENTRARCHIDA	16.20	58.67	106	285	
26	2	LARGE MOUTH BASS	CENTRARCHIDA	34.70	599.00	No Ba	N/A	released on site
27	2	CARP	CYPRINIDAE	47.00	1333.38	111	746	
28	2	CARP	CYPRINIDAE	47.20	1314.81	111	746	
29	2	CARP	CYPRINIDAE	45.20	1098.57	109	335	
30	2	CARP	CYPRINIDAE	24.30	188.00	108	368	
31	2	CARP	CYPRINIDAE	35.20	119.77	108	368	no tail std. msr
32	2	CARP	CYPRINIDAE	45.70	1128.52	110	320	
33	2	CHANNEL CATFISH	ICTALURIDAE	43.50	811.38	107	357	
34	2	CHANNEL CATFISH	ICTALURIDAE	36.70	346.34	107	357	
35	2	CHANNEL CATFISH	ICTALURIDAE	35.50	382.79	107	357	
36	2	YELLOW BULLHEAD	ICTALURIDAE	10.20	10.97	116	326	
37	3	GIZZARD SHAD	CLUPEIDAE	24.70	171.26	113	346	
38	3	GIZZARD SHAD	CLUPEIDAE	19.40	78.33	113	346	
39	3	GIZZARD SHAD	CLUPEIDAE	17.60	59.63	113	346	
40	3	GIZZARD SHAD	CLUPEIDAE	14.80	32.19	113	346	
41	3	GIZZARD SHAD	CLUPEIDAE	22.20	129.08	113	346	
42	3	GIZZARD SHAD	CLUPEIDAE	13.30	26.61	113	346	
43	3	GIZZARD SHAD	CLUPEIDAE	12.50	19.55	113	346	
44	3	GIZZARD SHAD	CLUPEIDAE	20.30	87.61	113	346	
45	3	GIZZARD SHAD	CLUPEIDAE	13.20	25.43	113	346	
46	3	GOLDEN REDHORSE	CATOSTOMIDAE	11.10	15.27	117	298	
47	3	GOLDEN REDHORSE	CATOSTOMIDAE	8.80	17.86	117	298	
48	3	GOLDEN REDHORSE	CATOSTOMIDAE	12.40	20.02	117	298	

Appendix B. Listing of the lengths and weights of fish captures at River Mile 38, 1995.

#	Sub. #	Common Name	FAMILY	LENGTH (cm)	WEIGHT (g)	BAG #	BAG WT (g)	NOTES
49	3	GOLDEN REDHORSE	CATOSTOMIDAE	12.30	21.32	117	298	
50	3	GOLDEN REDHORSE	CATOSTOMIDAE	11.40	16.45	117	298	
51	3	GOLDEN REDHORSE	CATOSTOMIDAE	10.50	12.67	117	298	
52	3	GOLDEN REDHORSE	CATOSTOMIDAE	11.70	15.49	117	298	
53	3	GOLDEN REDHORSE	CATOSTOMIDAE	9.80	9.43	117	298	
54	3	GOLDEN REDHORSE	CATOSTOMIDAE	9.20	8.70	117	298	
55	3	GOLDEN REDHORSE	CATOSTOMIDAE	9.30	7.92	117	298	
56	3	GOLDEN REDHORSE	CATOSTOMIDAE	9.40	8.82	117	298	
57	3	GOLDEN REDHORSE	CATOSTOMIDAE	12.00	18.41	117	298	
58	3	GOLDEN REDHORSE	CATOSTOMIDAE	11.10	14.78	117	298	
59	3	GOLDEN REDHORSE	CATOSTOMIDAE	11.10	13.12	117	298	
60	3	GOLDEN REDHORSE	CATOSTOMIDAE	12.20	20.22	117	298	
61	3	GOLDEN REDHORSE	CATOSTOMIDAE	11.10	15.85	117	298	
62	3	GOLDEN REDHORSE	CATOSTOMIDAE	12.30	19.65	117	298	
63	3	GOLDEN REDHORSE	CATOSTOMIDAE	28.50	210.95	112	317	
64	3	GOLDEN REDHORSE	CATOSTOMIDAE	28.10	200.00	112	317	
65	3	GOLDEN REDHORSE	CATOSTOMIDAE	10.40	12.86	117	298	
66	3	GOLDEN REDHORSE	CATOSTOMIDAE	9.70	11.01	117	298	
67	3	GOLDEN REDHORSE	CATOSTOMIDAE	9.70	10.92	117	298	
68	3	GOLDEN REDHORSE	CATOSTOMIDAE	10.80	13.79	117	298	
69	3	GOLDEN REDHORSE	CATOSTOMIDAE	11.70	16.90	117	298	
70	3	GOLDEN REDHORSE	CATOSTOMIDAE	11.80	17.43	117	298	
71	3	GOLDEN REDHORSE	CATOSTOMIDAE	9.60	10.62	117	298	
72	3	GOLDEN REDHORSE	CATOSTOMIDAE	10.40	12.50	117	298	
73	3	GOLDEN REDHORSE	CATOSTOMIDAE	7.80	4.79	117	298	
74	3	GOLDEN REDHORSE	CATOSTOMIDAE	8.80	7.29	117	298	
75	3	GOLDEN REDHORSE	CATOSTOMIDAE	10.00	10.61	117	298	
76	3	GOLDEN REDHORSE	CATOSTOMIDAE	8.70	6.61	117	298	
77	3	GOLDEN REDHORSE	CATOSTOMIDAE	9.30	7.50	117	298	
78	3	GOLDEN REDHORSE	CATOSTOMIDAE	9.10	8.58	117	298	
79	3	GOLDEN REDHORSE	CATOSTOMIDAE	8.30	6.12	117	298	
80	3	GOLDEN REDHORSE	CATOSTOMIDAE	10.00	10.62	117	298	
81	3	GOLDEN REDHORSE	CATOSTOMIDAE	9.00	7.29	117	298	
82	3	GOLDEN REDHORSE	CATOSTOMIDAE	9.00	7.67	117	298	
83	3	NORTHERN HOGSUC	CATOSTOMIDAE	9.60	8.87	no bag	N/A	discarded
84	3	NORTHERN HOGSUC	CATOSTOMIDAE	9.30	8.59	no bag	N/A	discarded
85	3	NORTHERN HOGSUC	CATOSTOMIDAE	9.80	9.75	no bag	N/A	discarded
86	3	NORTHERN HOGSUC	CATOSTOMIDAE	10.00	11.06	no bag	N/A	discarded
87	3	NORTHERN HOGSUC	CATOSTOMIDAE	10.30	11.74	no bag	N/A	discarded
88	3	NORTHERN HOGSUC	CATOSTOMIDAE	9.10	8.30	no bag	N/A	discarded
89	3	QUILLBACK	CATOSTOMIDAE	38.00	783.78	114	302	
90	3	BLUEGILL SUNFISH	CENTRARCHIDA	14.50	59.58	106	285	
91	3	SMALL MOUTH BASS	CENTRARCHIDA	18.60	77.82	115	349	
92	3	SMALL MOUTH BASS	CENTRARCHIDA	39.00	700.00	No Ba	N/A	released at site
93	3	SMALL MOUTH BASS	CENTRARCHIDA	43.70	>1000	No Ba	N/A	released at site
94	3	SMALL MOUTH BASS	CENTRARCHIDA	18.70	79.34	115	349	
95	3	SMALL MOUTH BASS	CENTRARCHIDA	9.80	10.16	115	349	
96	3	LARGE MOUTH BASS	CENTRARCHIDA	24.30	200.00	No Ba	N/A	released at site

Appendix B. Listing of the lengths and weights of fish captures at River Mile 38, 1995.

#	Sub. #	Common Name	FAMILY	LENGTH (cm)	WEIGHT (g)	BAG #	BAG WT (g)	NOTES
97	3	LARGE MOUTH BASS	CENTRARCHIDA	39.30	>1000	No Ba	N/A	released at site
98	3	LARGE MOUTH BASS	CENTRARCHIDA	22.60	133.61	115	349	
99	3	BLUNTNOSE MINNO	CYPRINIDAE	5.30	1.89	122	142	avg wt of 61 ind.
100	3	BLUNTNOSE MINNO	CYPRINIDAE	6.60	1.89	122	142	avg wt of 61 ind.
101	3	BLUNTNOSE MINNO	CYPRINIDAE	7.30	1.89	122	142	avg wt of 61 ind.
102	3	BLUNTNOSE MINNO	CYPRINIDAE	4.40	1.89	122	142	avg wt of 61 ind.
103	3	BLUNTNOSE MINNO	CYPRINIDAE	7.00	1.89	122	142	avg wt of 61 ind.
104	3	BLUNTNOSE MINNO	CYPRINIDAE	6.70	1.89	122	142	avg wt of 61 ind.
105	3	BLUNTNOSE MINNO	CYPRINIDAE	6.10	1.89	122	142	avg wt of 61 ind.
106	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
107	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
108	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
109	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
110	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
111	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
112	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
113	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
114	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
115	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
116	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
117	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
118	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
119	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
120	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
121	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
122	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
123	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
124	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
125	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
126	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
127	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
128	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
129	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
130	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
131	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
132	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
133	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
134	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
135	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
136	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
137	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
138	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
139	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
140	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
141	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
142	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
143	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
144	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length

Appendix B. Listing of the lengths and weights of fish captures at River Mile 38, 1995.

#	Sub. #	Common Name	FAMILY	LENGTH (cm)	WEIGHT (g)	BAG #	BAG WT (g)	NOTES
145	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
146	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
147	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
148	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
149	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
150	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
151	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
152	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
153	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
154	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
155	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
156	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
157	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
158	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
159	3	BLUNTNOSE MINNO	CYPRINIDAE	6.2	1.89	122	142	avg wt and length
160	3	STEELCOLOR SHINE	CYPRINIDAE	5.50	2.38	122	142	Avg of 5 ind.
161	3	STEELCOLOR SHINE	CYPRINIDAE	5.50	2.38	122	142	Avg of 5 ind.
162	3	STEELCOLOR SHINE	CYPRINIDAE	5.50	2.38	122	142	Avg of 5 ind.
163	3	STEELCOLOR SHINE	CYPRINIDAE	5.50	2.38	122	142	Avg of 5 ind.
164	3	STEELCOLOR SHINE	CYPRINIDAE	5.50	2.38	122	142	Avg of 5 ind.
165	3	STEELCOLOR SHINE	CYPRINIDAE	5.70	1.77	122	142	
166	3	STEELCOLOR SHINE	CYPRINIDAE	5.50	1.93	122	142	
167	3	STEELCOLOR SHINE	CYPRINIDAE	8.60	5.75	122	142	
168	3	EMERALD SHINER	CYPRINIDAE	9.10	5.28	122	142	
169	3	CHANNEL CATFISH	ICTALURIDAE	51.90	1255.93	116	326	
170	3	OHIO LOGPERCH	PERCIDAE	9.30	6.60	no bag	N/A	discarded
171	3	OHIO LOGPERCH	PERCIDAE	12.00	13.72	no bag	N/A	discarded
172	4	GIZZARD SHAD	CLUPEIDAE	18.00	63.74	123	146	
173	4	GOLDEN REDHORSE	CATOSTOMIDAE	12.00	19.42	117	298	
174	4	GOLDEN REDHORSE	CATOSTOMIDAE	29.40	238.75	118	313	
175	4	GOLDEN REDHORSE	CATOSTOMIDAE	24.20	152.25	118	313	
176	4	GOLDEN REDHORSE	CATOSTOMIDAE	33.60	271.90	118	313	
177	4	GOLDEN REDHORSE	CATOSTOMIDAE	30.30	236.46	118	313	
178	4	GOLDEN REDHORSE	CATOSTOMIDAE	13.10	26.42	117	298	
179	4	QUILLBACK	CATOSTOMIDAE	31.40	296.14	121	277	
180	4	QUILLBACK	CATOSTOMIDAE	38.30	512.22	121	277	
181	4	LONGEAR SUNFISH	CENTRARCHIDA	8.10	10.41	106	285	
182	4	LONGEAR SUNFISH	CENTRARCHIDA	11.90	39.36	106	285	
183	4	LONGEAR SUNFISH	CENTRARCHIDA	10.40	26.74	106	285	
184	4	SMALL MOUTH BASS	CENTRARCHIDA	13.7	30.95	115	349	
185	4	UNKNOWN MINNOW	CYPRINIDAE	6.50	4.18	no bag	N/A	discarded
186	4	UNKNOWN MINNOW	CYPRINIDAE	7.6	4.18	no bag	N/A	discarded
187	4	STEELCOLOR SHINE	CYPRINIDAE	7.10	2.65	122	142	Avg. wt of 6 ind.
188	4	STEELCOLOR SHINE	CYPRINIDAE	4.90	2.65	122	142	Avg. wt of 6 ind.
189	4	STEELCOLOR SHINE	CYPRINIDAE	7.60	2.65	122	142	Avg. wt of 6 ind.
190	4	STEELCOLOR SHINE	CYPRINIDAE	6.70	2.65	122	142	Avg. wt of 6 ind.
191	4	STEELCOLOR SHINE	CYPRINIDAE	5.2	2.65	122	142	Avg. wt of 6 ind.
192	4	STEELCOLOR SHINE	CYPRINIDAE	6.90	2.65	122	142	Avg. wt of 6 ind.

Appendix B. Listing of the lengths and weights of fish captures at River Mile 38, 1995.

#	Sub. #	Common Name	FAMILY	LENGTH (cm)	WEIGHT (g)	BAG #	BAG WT (g)	NOTES
193	4	CARP	CYPRINIDAE	47.50	1550.40	119	474	
194	4	CARP	CYPRINIDAE	21.90	137.82	119	474	
195	4	CARP	CYPRINIDAE	25.00	241.99	119	474	
196	4	FLATHEAD CATFISH	ICTALURIDAE	23.90	136.66	120	403	
197	4	FLATHEAD CATFISH	ICTALURIDAE	42.90	748.19	120	403	fish hook/lead sin
198	5	GIZZARD SHAD	CLUPEIDAE	14.50	32.02	123	146	
199	5	GIZZARD SHAD	CLUPEIDAE	14.10	31.76	123	146	
200	5	GIZZARD SHAD	CLUPEIDAE	11.10	14.86	123	146	
201	5	GIZZARD SHAD	CLUPEIDAE	15.00	34.79	123	146	
202	5	GIZZARD SHAD	CLUPEIDAE	13.00	23.50	123	146	
203	5	GIZZARD SHAD	CLUPEIDAE	15.00	36.97	123	146	
204	5	GIZZARD SHAD	CLUPEIDAE	13.70	28.31	123	146	
205	5	GOLDEN REDHORSE	CATOSTOMIDAE	15.40	36.49	127	430	
206	5	GOLDEN REDHORSE	CATOSTOMIDAE	13.50	26.46	127	430	
207	5	GOLDEN REDHORSE	CATOSTOMIDAE	12.10	18.10	127	430	
208	5	GOLDEN REDHORSE	CATOSTOMIDAE	14.30	30.00	127	430	
209	5	GOLDEN REDHORSE	CATOSTOMIDAE	26.30	164.61	126	550	
210	5	GOLDEN REDHORSE	CATOSTOMIDAE	27.10	202.74	126	550	
211	5	GOLDEN REDHORSE	CATOSTOMIDAE	26.00	176.35	126	550	
212	5	GOLDEN REDHORSE	CATOSTOMIDAE	28.50	216.25	126	550	
213	5	GOLDEN REDHORSE	CATOSTOMIDAE	28.30	235.68	126	550	
214	5	GOLDEN REDHORSE	CATOSTOMIDAE	11.80	18.42	127	430	
215	5	GOLDEN REDHORSE	CATOSTOMIDAE	11.00	14.60	127	430	
216	5	GOLDEN REDHORSE	CATOSTOMIDAE	22.80	128.79	127	430	
217	5	GOLDEN REDHORSE	CATOSTOMIDAE	12.20	19.39	127	430	
218	5	GOLDEN REDHORSE	CATOSTOMIDAE	12.50	19.76	127	430	
219	5	GOLDEN REDHORSE	CATOSTOMIDAE	15.70	43.08	127	430	
220	5	GOLDEN REDHORSE	CATOSTOMIDAE	19.20	66.04	127	430	
221	5	GOLDEN REDHORSE	CATOSTOMIDAE	20.00	76.51	127	430	
222	5	GOLDEN REDHORSE	CATOSTOMIDAE	15.80	36.13	127	430	
223	5	GOLDEN REDHORSE	CATOSTOMIDAE	19.70	85.32	127	430	
224	5	GOLDEN REDHORSE	CATOSTOMIDAE	11.70	17.09	127	430	
225	5	GOLDEN REDHORSE	CATOSTOMIDAE	10.90	13.61	127	430	
226	5	GOLDEN REDHORSE	CATOSTOMIDAE	10.20	13.97	127	430	
227	5	GOLDEN REDHORSE	CATOSTOMIDAE	10.00	11.62	127	430	
228	5	QUILLBACK	CATOSTOMIDAE	39.70	831.34	129	274	
229	5	BLUEGILL SUNFISH	CENTRARCHIDA	5.30	2.65	106	285	
230	5	BLUEGILL SUNFISH	CENTRARCHIDA	7.00	6.39	106	285	
231	5	BLUEGILL SUNFISH	CENTRARCHIDA	10.30	18.94	106	285	
232	5	LONGEAR SUNFISH	CENTRARCHIDA	13.80	57.05	106	285	
233	5	LONGEAR SUNFISH	CENTRARCHIDA	11.60	33.25	106	285	
234	5	LONGEAR SUNFISH	CENTRARCHIDA	8.20	11.95	106	285	
235	5	SMALL MOUTH BASS	CENTRARCHIDA	31.50	380.00	No Ba	N/A	released at site
236	5	SMALL MOUTH BASS	CENTRARCHIDA	27.20	230.00	No Ba	N/A	released at site
237	5	SMALL MOUTH BASS	CENTRARCHIDA	17.30	67.62	115	349	
238	5	SMALL MOUTH BASS	CENTRARCHIDA	17.40	68.01	115	349	
239	5	STEELCOLOR SHINE	CYPRINIDAE	7.40	3.92	122	142	
240	5	STEELCOLOR SHINE	CYPRINIDAE	7.10	3.03	122	142	

Appendix B. Listing of the lengths and weights of fish captures at River Mile 38, 1995.

#	Sub. #	Common Name	FAMILY	LENGTH (cm)	WEIGHT (g)	BAG #	BAG WT (g)	NOTES
241	5	CARP	CYPRINIDAE	20.60	123.98	125	374	
242	5	CARP	CYPRINIDAE	21.50	120.38	125	374	
243	5	CARP	CYPRINIDAE	20.00	104.94	125	374	
244	5	CARP	CYPRINIDAE	49.70	1529.50	124	431	Female with eg
245	5	CARP	CYPRINIDAE	21.50	140.29	125	374	
246	5	CARP	CYPRINIDAE	21.60	142.36	125	374	
247	5	CHANNEL CATFISH	ICTALURIDAE	33.50	292.89	128	420	
248	5	CHANNEL CATFISH	ICTALURIDAE	31.60	214.34	128	420	
249	5	CHANNEL CATFISH	ICTALURIDAE	29.50	171.62	128	420	
Total				3808.20	32823.15			

Appendix C. Listing of lengths and weights of fish captured at River Mile 24, 1995.

#	Sub. #	Common Name	Family	Length (cm)	Weight (g)	Bag #	BAG Wt (g)	Notes
1	1	GIZZARD SHAD	CLUPEIDAE	23.20	108.22	203	311	
2	1	GIZZARD SHAD	CLUPEIDAE	22.10	94.76	203	311	
3	1	GIZZARD SHAD	CLUPEIDAE	20.10	69.93	203	311	
4	1	SKIPJACK HERRING	CLUPEIDAE	36.00	318.57	no bag	N/A	UC Collection
5	1	GOLDEN REDHORSE	CATOSTOMIDAE	27.90	212.98	217	886	
6	1	NORTHERN HOGSUCKER	CATOSTOMIDAE	37.50	645.58	200	253	
7	1	RIVER CARPSUCKER	CATOSTOMIDAE	38.6	686.59	209, 210	229, 232	filets
8	1	RIVER CARPSUCKER	CATOSTOMIDAE	40.9	764.68	209, 210	229, 232	filets
9	1	SM.MOUTH BUFFALO	CATOSTOMIDAE	42.6	1214.93	207, 208	468, 461	filets
10	1	SM.MOUTH BUFFALO	CATOSTOMIDAE	52	2155.68	207, 208	468, 461	filets
11	1	CARP	CYPRINIDAE	488.00	1446.59	201, 202	543, 564	
12	1	CARP	CYPRINIDAE	590.00	2550.86	201, 202	543, 564	
13	1	CHANNEL CATFISH	ICTALURIDAE	16.5	35.18	206	326	
14	1	CHANNEL CATFISH	ICTALURIDAE	39.10	518.65	204, 205	361, 356	
15	1	CHANNEL CATFISH	ICTALURIDAE	46.40	1031.21	204, 205	361, 356	
16	1	CHANNEL CATFISH	ICTALURIDAE	34.1	343.43	206	326	
17	1	CHANNEL CATFISH	ICTALURIDAE	20.2	64.44	206	326	
18	1	CHANNEL CATFISH	ICTALURIDAE	31.9	250.19	206	326	
19	1	DRUM	SCIAENIDAE	23.8	140.84	211	567	
20	1	DRUM	SCIAENIDAE	26.9	52.59	211	567	
21	1	DRUM	SCIAENIDAE	40.1	904.5	211	567	
22	1	DRUM	SCIAENIDAE	26	214.19	211	567	
23	1	DRUM	SCIAENIDAE	24.3	157.04	211	567	
24	2	LONGNOSE GAR	LEPISOSTEIDAE	65.80	561.75	219, 220	213, 187	
25	2	GIZZARD SHAD	CLUPEIDAE	21.70	97.25	203	311	
26	2	GIZZARD SHAD	CLUPEIDAE	26.40	185.08	203	311	
27	2	GOLDEN REDHORSE	CATOSTOMIDAE	34.40	408.46	217	886	
28	2	GOLDEN REDHORSE	CATOSTOMIDAE	35.00	427.84	217	886	
29	2	GOLDEN REDHORSE	CATOSTOMIDAE	33.60	401.94	217	886	
30	2	QUILLBACK	CATOSTOMIDAE	33.40	302.59	221	1030	
31	2	RIVER CARPSUCKER	CATOSTOMIDAE	38.80	658.50	221	1030	
32	2	SM.MOUTH BUFFALO	CATOSTOMIDAE	50.20	1456.40	221	1030	
33	2	SMALL MOUTH BASS	CENTRARCHIDAE	25.40	214.24	215, 216	163, 186	
34	2	CARP	CYPRINIDAE	42.80	971.22	222	542	
35	2	CARP	CYPRINIDAE	52.50	1984.18	222	542	
36	2	CHANNEL CATFISH	ICTALURIDAE	44.10	811.33	218	412	
37	2	CHANNEL CATFISH	ICTALURIDAE	19.60	49.91	218	412	
38	2	WHITE BASS	SERRANIDAE	23.00	152.75	215, 216	163, 186	
39	2	DRUM	SCIAENIDAE	17.70	57.21	214	202	
40	2	DRUM	SCIAENIDAE	17.60	62.28	214	202	
41	2	DRUM	SCIAENIDAE	23.60	150.67	212	709	
42	2	DRUM	SCIAENIDAE	28.10	227.46	212	709	
43	2	DRUM	SCIAENIDAE	19.60	81.56	213	404	
44	2	DRUM	SCIAENIDAE	27.80	268.83	213	404	
45	2	DRUM	SCIAENIDAE	29.20	336.07	212	709	
46	2	DRUM	SCIAENIDAE	40.50	768.47	212	709	
47	2	DRUM	SCIAENIDAE	27.90	256.09	212	709	
48	2	DRUM	SCIAENIDAE	30.10	325.92	212	709	

Appendix C. Listing of lengths and weights of fish captured at River Mile 24, 1995.

#	Sub. #	Common Name	Family	Length (cm)	Weight (g)	Bag #	BAG Wt (g)	Notes
49	2	DRUM	SCIAENIDAE	18.40	67.42	213	404	
50	2	DRUM	SCIAENIDAE	18.60	64.72	214	202	
51	2	DRUM	SCIAENIDAE	17.60	56.58	214	202	
52	2	DRUM	SCIAENIDAE	18.10	63.27	214	202	
53	2	DRUM	SCIAENIDAE	22.30	111.92	214	202	
54	2	DRUM	SCIAENIDAE	17.80	60.85	213	404	
55	2	DRUM	SCIAENIDAE	18.00	65.80	213	404	
56	2	DRUM	SCIAENIDAE	14.60	69.41	213	404	
57	2	DRUM	SCIAENIDAE	19.80	112.52	213	404	
58	3	GIZZARD SHAD	CLUPEIDAE	21.00	68.85	231	244	
59	3	GIZZARD SHAD	CLUPEIDAE	21.10	77.58	231	244	
60	3	NORTHERN HOGSUCKER	CATOSTOMIDAE	24.40	154.22	no bag	N/A	discarded
61	3	SMALL MOUTH BASS	CENTRARCHIDAE	13.70	35.37	215, 216	163, 186	
62	3	SMALL MOUTH BASS	CENTRARCHIDAE	9.40	12.41	215, 216	163, 186	
63	3	CARP	CYPRINIDAE	41.10	999.89	236, 237	409, 437	
64	3	CHANNEL CATFISH	ICTALURIDAE	31.80	254.24	234	565	
65	3	FLATHEAD CATFISH	ICTALURIDAE	64.50	2761.28	223, 224	475, 563	
66	3	WHITE BASS	SERRANIDAE	26.70	237.43	215, 216	163, 186	
67	3	DRUM	SCIAENIDAE	23.90	165.33	226	403	
68	3	DRUM	SCIAENIDAE	25.10	185.65	226	403	
69	3	DRUM	SCIAENIDAE	47.40	1399.64	225	453	
70	3	DRUM	SCIAENIDAE	19.80	100.02	226	403	
71	3	DRUM	SCIAENIDAE	17.80	64.13	226	403	
72	3	DRUM	SCIAENIDAE	27.30	244.71	226	403	
73	3	DRUM	SCIAENIDAE	20.90	93.67	226	403	
74	4	GIZZARD SHAD	CLUPEIDAE	23.50	107.23	231	244	
75	4	GIZZARD SHAD	CLUPEIDAE	21.90	92.98	231	244	
76	4	GIZZARD SHAD	CLUPEIDAE	21.60	89.61	231	244	
77	4	GOLDEN REDHORSE	CATOSTOMIDAE	33.90	375.20	235	1098	
78	4	QUILLBACK	CATOSTOMIDAE	40.30	731.40	235	1098	
79	4	RIVER CARPSUCKER	CATOSTOMIDAE	39.10	648.30	235	1098	
80	4	SM.MOUTH BUFFALO	CATOSTOMIDAE	68.80	4927.20	227	410	female with egg
81	4	SM.MOUTH BUFFALO	CATOSTOMIDAE	69.40	5367.78	228	963	female with egg
82	4	SM.MOUTH BUFFALO	CATOSTOMIDAE	52.20	2136.05	229, 230	387, 379	
83	4	SM.MOUTH BUFFALO	CATOSTOMIDAE	45.20	1466.80	229, 230	387, 379	
84	4	SM.MOUTH BUFFALO	CATOSTOMIDAE	54.40	2014.51	229, 230	387, 379	
85	4	BLUEGILL SUNFISH	CENTRARCHIDAE	11.60	33.67	no bag	N/A	discarded
86	4	CARP	CYPRINIDAE	46.80	1364.48	236, 237	409, 437	
87	4	CARP	CYPRINIDAE	53.40	1676.78	236, 237	409, 437	
88	4	CARP	CYPRINIDAE	61.00	3238.00	232, 233	413, 350	female with egg
89	4	CHANNEL CATFISH	ICTALURIDAE	26.50	153.32	234	565	
90	4	CHANNEL CATFISH	ICTALURIDAE	36.40	421.41	234	565	
91	4	FLATHEAD CATFISH	ICTALURIDAE	27.40	184.80	234	565	
92	4	DRUM	SCIAENIDAE	21.10	93.78	239	537	
93	4	DRUM	SCIAENIDAE	17.20	49.38	239	537	
94	4	DRUM	SCIAENIDAE	29.30	327.90	238	893	
95	4	DRUM	SCIAENIDAE	26.90	253.29	239	537	
96	4	DRUM	SCIAENIDAE	40.80	813.99	238	893	

Appendix C. Listing of lengths and weights of fish captured at River Mile 24, 1995.

#	Sub. #	Common Name	Family	Length (cm)	Weight (g)	Bag #	BAG Wt (g)	Notes
97	4	DRUM	SCIAENIDAE	33.00	513.29	238	893	
98	4	DRUM	SCIAENIDAE	23.50	142.49	239	537	
99	4	DRUM	SCIAENIDAE	21.20	113.62	239	537	
100	4	DRUM	SCIAENIDAE	29.20	313.18	239	537	
101	4	DRUM	SCIAENIDAE	27.70	209.07	239	537	
Total				4161.4	60586.05			

Appendix D. Listing of the lengths and weights of fish captured at River Mile 19, 1995.

#	Sub. #	Common Name	Family	Length (cm)	Weight (g)	Bag #	Bag Wt (g)	Notes
1	1	GIZZARD SHAD	CLUPEIDAE	19.20	68.90	304	284	
2	1	GIZZARD SHAD	CLUPEIDAE	19.90	73.30	304	284	
3	1	GIZZARD SHAD	CLUPEIDAE	21.50	91.20	304	284	
4	1	GIZZARD SHAD	CLUPEIDAE	20.50	78.10	305	232	
5	1	GIZZARD SHAD	CLUPEIDAE	21.40	91.24	304	284	
6	1	GIZZARD SHAD	CLUPEIDAE	22.10	97.80	304	284	
7	1	GIZZARD SHAD	CLUPEIDAE	22.50	101.77	303	319	
8	1	GIZZARD SHAD	CLUPEIDAE	19.80	68.17	303	319	
9	1	GIZZARD SHAD	CLUPEIDAE	20.30	77.69	303	319	
10	1	GIZZARD SHAD	CLUPEIDAE	23.50	110.25	304	284	
11	1	GIZZARD SHAD	CLUPEIDAE	18.80	62.69	304	284	
12	1	GIZZARD SHAD	CLUPEIDAE	21.00	85.90	306	244	
13	1	GIZZARD SHAD	CLUPEIDAE	22.20	93.80	*306	244	
14	1	GIZZARD SHAD	CLUPEIDAE	24.10	122.30	306	244	
15	1	GIZZARD SHAD	CLUPEIDAE	15.30	33.17	306	244	
16	1	GIZZARD SHAD	CLUPEIDAE	16.60	47.00	306	244	
17	1	GIZZARD SHAD	CLUPEIDAE	19.80	67.60	306	244	
18	1	GIZZARD SHAD	CLUPEIDAE	20.00	58.90	305	232	
19	1	GIZZARD SHAD	CLUPEIDAE	21.00	86.10	305	232	
20	1	GIZZARD SHAD	CLUPEIDAE	21.30	84.20	305	232	
21	1	GIZZARD SHAD	CLUPEIDAE	20.10	67.60	305	232	
22	1	GIZZARD SHAD	CLUPEIDAE	21.50	89.90	305	232	
23	1	GIZZARD SHAD	CLUPEIDAE	26.10	150.75	301	324	
24	1	GIZZARD SHAD	CLUPEIDAE	22.40	97.85	301	324	
25	1	GIZZARD SHAD	CLUPEIDAE	21.70	90.62	301	324	
26	1	GIZZARD SHAD	CLUPEIDAE	20.9	88.3	301	324	
27	1	GIZZARD SHAD	CLUPEIDAE	22.4	106.2	301	324	
28	1	GIZZARD SHAD	CLUPEIDAE	22.00	101.45	300	283	
29	1	GIZZARD SHAD	CLUPEIDAE	23.40	93.92	300	283	
30	1	GIZZARD SHAD	CLUPEIDAE	23.10	110.02	300	283	
31	1	GIZZARD SHAD	CLUPEIDAE	22.10	95.04	300	283	
32	1	GIZZARD SHAD	CLUPEIDAE	22.30	96.58	300	283	
33	1	GIZZARD SHAD	CLUPEIDAE	21.40	89.95	300	283	
34	1	GIZZARD SHAD	CLUPEIDAE	20.6	68.34	303	319	
35	1	GIZZARD SHAD	CLUPEIDAE	15.4	33.91	302	289	
36	1	GIZZARD SHAD	CLUPEIDAE	21.4	96.05	303	319	
37	1	GIZZARD SHAD	CLUPEIDAE	21.9	99.5	303	319	
38	1	GIZZARD SHAD	CLUPEIDAE	22.3	96.79	303	319	
39	1	GIZZARD SHAD	CLUPEIDAE	24.5	129	302	289	
40	1	GIZZARD SHAD	CLUPEIDAE	25.1	138.49	302	289	
41	1	GIZZARD SHAD	CLUPEIDAE	20.6	76.61	301	324	
42	1	GIZZARD SHAD	CLUPEIDAE	21.2	91.58	302	289	
43	1	GIZZARD SHAD	CLUPEIDAE	20.4	79.48	302	289	
44	1	GIZZARD SHAD	CLUPEIDAE	22.8	104.7	302	289	
45	1	GOLDEN REDHORSE	CATOSTOMIDAE	32.10	359.40	321	437	
46	1	QUILLBACK	CATOSTOMIDAE	16.40	52.30	329	267	
47	1	CARP	CYPRINIDAE	77.10	5772.80	309, 310	664, 847	
48	1	WHITE BASS	SERRANIDAE	31.20	323.10	307, 308	168, 225	
49	2	GIZZARD SHAD	CLUPEIDAE	28.10	177.10	314	450	

Appendix D. Listing of the lengths and weights of fish captured at River Mile 19, 1995.

#	Sub. #	Common Name	Family	Length (cm)	Weight (g)	Bag #	Bag Wt (g)	Notes
50	2	GIZZARD SHAD	CLUPEIDAE	26.00	169.50	314	450	
51	2	GIZZARD SHAD	CLUPEIDAE	26.40	144.50	315	408	
52	2	GIZZARD SHAD	CLUPEIDAE	22.90	89.60	314	450	
53	2	GIZZARD SHAD	CLUPEIDAE	23.90	115.50	314	450	
54	2	GIZZARD SHAD	CLUPEIDAE	21.60	91.50	314	450	
55	2	GIZZARD SHAD	CLUPEIDAE	24.10	122.50	315	408	
56	2	GIZZARD SHAD	CLUPEIDAE	24.00	115.90	315	408	
57	2	GIZZARD SHAD	CLUPEIDAE	21.10	93.50	315	408	
58	2	GIZZARD SHAD	CLUPEIDAE	19.10	62.10	315	408	
59	2	GIZZARD SHAD	CLUPEIDAE	23.20	111.70	315	408	
60	2	GIZZARD SHAD	CLUPEIDAE	21.20	78.90	315	408	
61	2	GIZZARD SHAD	CLUPEIDAE	24.10	87.30	315	408	
62	2	GIZZARD SHAD	CLUPEIDAE	20.60	78.60	314	450	
63	2	GIZZARD SHAD	CLUPEIDAE	20.40	73.10	313	338	
64	2	GIZZARD SHAD	CLUPEIDAE	21.60	93.40	313	338	
65	2	GIZZARD SHAD	CLUPEIDAE	24.00	130.70	313	338	
66	2	GIZZARD SHAD	CLUPEIDAE	23.10	108.30	313	338	
67	2	GIZZARD SHAD	CLUPEIDAE	26.60	147.20	314	450	
68	2	GIZZARD SHAD	CLUPEIDAE	23.70	115.10	313	338	
69	2	GIZZARD SHAD	CLUPEIDAE	22.40	100.73	313	338	
70	2	SM.MOUTH BUFFALO	CATOSTOMIDAE	36.20	635.51	319	867	
71	2	BLUEGILL SUNFISH	CENTRARCHIDAE	14.50	66.60	317	127	
72	2	BLUEGILL SUNFISH	CENTRARCHIDAE	12.80	40.10	317	127	
73	2	BLUEGILL SUNFISH	CENTRARCHIDAE	12.40	37.50	317	127	
74	2	BLUEGILL SUNFISH	CENTRARCHIDAE	8.60	12.60	317	127	
75	2	BLUEGILL SUNFISH	CENTRARCHIDAE	8.4	11.4	317	127	
76	2	BLUEGILL SUNFISH	CENTRARCHIDAE	11.20	26.00	317	127	
77	2	LONGEAR SUNFISH	CENTRARCHIDAE	9.60	18.00	316	127	
78	2	LONGEAR SUNFISH	CENTRARCHIDAE	11.30	33.00	316	127	
79	2	LONGEAR SUNFISH	CENTRARCHIDAE	9.90	21.40	316	127	
80	2	LONGEAR SUNFISH	CENTRARCHIDAE	6.40	5.75	316	127	
81	2	LONGEAR SUNFISH	CENTRARCHIDAE	8.30	10.80	316	127	
82	2	LONGEAR SUNFISH	CENTRARCHIDAE	9.50	19.50	316	127	
83	2	LONGEAR SUNFISH	CENTRARCHIDAE	11.40	34.20	316	127	
84	2	GREEN SUNFISH	CENTRARCHIDAE	13.00	49.90	316	127	
85	2	UNKNOWN SUNFISH	CENTRARCHIDAE	7.70	8.50	316	127	
86	2	UNKNOWN SUNFISH	CENTRARCHIDAE	6.10	3.60	316	127	
87	2	UNKNOWN SUNFISH	CENTRARCHIDAE	5.50	2.80	no bag #	N/A	discarded
88	2	SMALL MOUTH BASS	CENTRARCHIDAE	15.30	44.50	307, 308	168, 225	
89	2	SMALL MOUTH BASS	CENTRARCHIDAE	9.10	9.10	307, 308	168, 225	
90	2	BLUNTNOST MINNOW	CYPRINIDAE	6.50	2.50	no bag #	N/A	discarded
91	2	FLATHEAD CATFISH	ICTALURIDAE	32.50	287.70	324, 325	364, 393	
92	2	SAUGER	PERCIDAE	27.00	136.80	318	308	
93	2	DRUM	SCIAENIDAE	31.40	352.15	311, 312	336, 332	
94	2	DRUM	SCIAENIDAE	38.10	573.80	311, 312	336, 332	
95	2	DRUM	SCIAENIDAE	29.00	343.90	311, 312	336, 332	
96	2	DRUM	SCIAENIDAE	35.00	539.35	311, 312	336, 332	

Appendix D. Listing of the lengths and weights of fish captured at River Mile 19, 1995.

#	Sub. #	Common Name	Family	Length (cm)	Weight (g)	Bag #	Bag Wt (g)	Notes
97	3	GIZZARD SHAD	CLUPEIDAE	21.70	88.70	326	360	
98	3	GIZZARD SHAD	CLUPEIDAE	18.60	61.10	326	360	
99	3	GIZZARD SHAD	CLUPEIDAE	19.90	65.10	326	360	
100	3	GIZZARD SHAD	CLUPEIDAE	22.8	93.8	328	260	
101	3	GIZZARD SHAD	CLUPEIDAE	21.60	68.00	328	260	
102	3	GIZZARD SHAD	CLUPEIDAE	20.00	70.00	326	360	
103	3	GIZZARD SHAD	CLUPEIDAE	23.80	111.20	326	360	
104	3	GIZZARD SHAD	CLUPEIDAE	21.30	84.40	327	463	
105	3	GIZZARD SHAD	CLUPEIDAE	22.90	95.60	326	360	
106	3	GIZZARD SHAD	CLUPEIDAE	23.40	114.30	326	360	
107	3	GIZZARD SHAD	CLUPEIDAE	26.00	153.70	326	360	
108	3	GIZZARD SHAD	CLUPEIDAE	20.70	68.80	328	260	
109	3	GIZZARD SHAD	CLUPEIDAE	8.40	6.23	no bag #	N/A	discarded
110	3	GIZZARD SHAD	CLUPEIDAE	9.70	8.63	no bag #	N/A	discarded
111	3	GIZZARD SHAD	CLUPEIDAE	8.10	5.80	no bag #	N/A	discarded
112	3	GIZZARD SHAD	CLUPEIDAE	7.50	4.10	no bag #	N/A	discarded
113	3	GIZZARD SHAD	CLUPEIDAE	7.10	3.76	no bag #	N/A	discarded
114	3	GIZZARD SHAD	CLUPEIDAE	9.60	8.76	no bag #	N/A	discarded
115	3	GIZZARD SHAD	CLUPEIDAE	21.6	92.04	328	260	
116	3	GIZZARD SHAD	CLUPEIDAE	20.7	85.6	328	260	
117	3	GIZZARD SHAD	CLUPEIDAE	13.40	21.00	328	260	
118	3	GIZZARD SHAD	CLUPEIDAE	13.10	20.80	no bag #	N/A	discarded
119	3	GIZZARD SHAD	CLUPEIDAE	12.40	16.60	no bag #	N/A	discarded
120	3	GIZZARD SHAD	CLUPEIDAE	21.00	75.91	327	463	
121	3	GIZZARD SHAD	CLUPEIDAE	22.40	100.70	327	463	
122	3	GIZZARD SHAD	CLUPEIDAE	21.90	84.10	327	463	
123	3	GIZZARD SHAD	CLUPEIDAE	26.90	150.40	327	463	
124	3	GIZZARD SHAD	CLUPEIDAE	19.70	67.20	327	463	
125	3	GIZZARD SHAD	CLUPEIDAE	21.80	93.90	327	463	
126	3	GIZZARD SHAD	CLUPEIDAE	20.30	61.60	327	463	
127	3	GIZZARD SHAD	CLUPEIDAE	20.40	70.80	327	463	
128	3	GIZZARD SHAD	CLUPEIDAE	21.80	84.50	327	463	
129	3	GOLDEN REDHORSE	CATOSTOMIDAE	32.70	351.10	321	437	
130	3	GOLDEN REDHORSE	CATOSTOMIDAE	44.90	1841.30	322, 323	526, 261	
131	3	QUILLBACK	CATOSTOMIDAE	33.70	419.80	329	267	
132	3	QUILLBACK	CATOSTOMIDAE	16.80	60.40	329	267	
133	3	SM.MOUTH BUFFALO	CATOSTOMIDAE	40.20	891.80	319	862	
134	3	BLUEGILL SUNFISH	CENTRARCHIDAE	12.40	36.80	336	347	
135	3	BLUEGILL SUNFISH	CENTRARCHIDAE	13.40	43.80	336	347	
136	3	BLUEGILL SUNFISH	CENTRARCHIDAE	11.80	36.30	336	347	
137	3	BLUEGILL SUNFISH	CENTRARCHIDAE	10.70	20.70	336	347	
138	3	GREEN SUNFISH	CENTRARCHIDAE	10.20	21.30	336	347	
139	3	UNKNOWN SUNFISH	CENTRARCHIDAE	5.90	3.80	336	347	
140	3	UNKNOWN SUNFISH	CENTRARCHIDAE	7.30	7.20	336	347	
141	3	SMALL MOUTH BASS	CENTRARCHIDAE	6.70	3.30	no bag #	N/A	discarded
142	3	SMALL MOUTH BASS	CENTRARCHIDAE	6.40	2.80	no bag #	N/A	discarded
143	3	SILVERJAW MINNOW	CYPRINIDAE	7.50	1.65	no bag #	N/A	Avg wt
144	3	SILVERJAW MINNOW	CYPRINIDAE	3.20	1.65	no bag #	N/A	Avg wt

Appendix D. Listing of the lengths and weights of fish captured at River Mile 19, 1995.

#	Sub. #	Common Name	Family	Length (cm)	Weight (g)	Bag #	Bag Wt (g)	Notes
145	3	SILVERJAW MINNOW	CYPRINIDAE	6.20	1.65	no bag #	N/A	Avg wt
146	3	SILVERJAW MINNOW	CYPRINIDAE	4.50	1.65	no bag #	N/A	Avg wt
147	3	SILVERJAW MINNOW	CYPRINIDAE	5.90	1.65	no bag #	N/A	Avg wt
148	3	SILVERJAW MINNOW	CYPRINIDAE	5.90	1.65	no bag #	N/A	Avg wt
149	3	SILVERJAW MINNOW	CYPRINIDAE	6.60	1.65	no bag #	N/A	Avg wt
150	3	SILVERJAW MINNOW	CYPRINIDAE	7.40	1.65	no bag #	N/A	Avg wt
151	3	SILVERJAW MINNOW	CYPRINIDAE	6.50	1.65	no bag #	N/A	Avg wt
152	3	SILVERJAW MINNOW	CYPRINIDAE	6.70	1.65	no bag #	N/A	Avg wt
153	3	SILVERJAW MINNOW	CYPRINIDAE	6.60	1.65	no bag #	N/A	Avg wt
154	3	CARP	CYPRINIDAE	47.90	1666.90	320	370	
155	3	CHANNEL CATFISH	ICTALURIDAE	44.50	779.30	324, 325	364, 393	
156	3	FLATHEAD CATFISH	ICTALURIDAE	23.30	114.20	324, 325	364, 393	
157	3	FLATHEAD CATFISH	ICTALURIDAE	14.50	54.60	324, 325	364, 393	
158	3	WHITE BASS	SERRANIDAE	20.20	100.50	307, 308	168, 225	
159	3	WHITE BASS	SERRANIDAE	32.40	127.10	307, 308	168, 225	
160	3	WHITE BASS	SERRANIDAE	18.90	69.80	307, 308	168, 225	
161	3	OHIO LOGPERCH	PERCIDAE	6.80	2.70	no bag #	N/A	discarded
162	3	SAUGER	PERCIDAE	36.00	347.30	318	308	
163	3	DRUM	SCIAENIDAE	31.20	355.50	330	359	
164	3	DRUM	SCIAENIDAE	29.10	268.00	330	359	
165	4	GIZZARD SHAD	CLUPEIDAE	23.30	110.00	331	219	
166	4	GIZZARD SHAD	CLUPEIDAE	15.90	36.10	331	219	
167	4	GIZZARD SHAD	CLUPEIDAE	22.60	96.80	331	219	
168	4	GIZZARD SHAD	CLUPEIDAE	19.30	67.60	331	219	
169	4	GIZZARD SHAD	CLUPEIDAE	22.40	88.30	331	219	
170	4	GOLDEN REDHORSE	CATOSTOMIDAE	28.40	241.20	332	499	
171	4	QUILLBACK	CATOSTOMIDAE	36.20	546.90	332	499	
172	4	QUILLBACK	CATOSTOMIDAE	19.20	84.30	332	499	
173	4	BLUEGILL SUNFISH	CENTRARCHIDAE	9.50	14.90	336	347	
174	4	BLUEGILL SUNFISH	CENTRARCHIDAE	10.40	21.90	336	347	
175	4	BLUEGILL SUNFISH	CENTRARCHIDAE	12.10	34.10	336	347	
176	4	BLUEGILL SUNFISH	CENTRARCHIDAE	13.30	52.60	336	347	
177	4	BLUEGILL SUNFISH	CENTRARCHIDAE	17.90	136.10	336	347	
178	4	BLUEGILL SUNFISH	CENTRARCHIDAE	13.30	50.80	336	347	
179	4	BLUEGILL SUNFISH	CENTRARCHIDAE	9.30	16.50	336	347	
180	4	BLUEGILL SUNFISH	CENTRARCHIDAE	8.30	10.90	336	347	
181	4	LONGEAR SUNFISH	CENTRARCHIDAE	10.20	21.70	336	347	
182	4	LONGEAR SUNFISH	CENTRARCHIDAE	10.10	22.10	336	347	
183	4	LONGEAR SUNFISH	CENTRARCHIDAE	7.60	10.80	336	347	
184	4	LONGEAR SUNFISH	CENTRARCHIDAE	7.80	8.60	336	347	
185	4	UNKNOWN SUNFISH	CENTRARCHIDAE	6.40	4.50	336	347	
186	4	UNKNOWN SUNFISH	CENTRARCHIDAE	6.20	4.44	336	347	
187	4	UNKNOWN SUNFISH	CENTRARCHIDAE	5.60	2.54	336	347	
188	4	UNKNOWN SUNFISH	CENTRARCHIDAE	7.40	8.70	336	347	
189	4	SMALL MOUTH BASS	CENTRARCHIDAE	6.60	3.50	no bag #	N/A	discarded
190	4	LARGE MOUTH BASS	CENTRARCHIDAE	30.80	416.10	334, 335	180, 143	335 duplic
191	4	WHITE BASS	SERRANIDAE	21.20	101.40	334, 335	180, 143	
192	4	SAUGER	PERCIDAE	25.90	117.00	337	147	

Appendix D. Listing of the lengths and weights of fish captured at River Mile 19, 1995.

#	Sub. #	Common Name	Family	Length (cm)	Weight (g)	Bag #	Bag Wt (g)	Notes
193	4	SAUGER	PERCIDAE	23.30	90.00	337	147	
194	4	DRUM	SCIAENIDAE	28.70	273.30	333	390	
195	4	DRUM	SCIAENIDAE	38.80	716.50	333	390	
196	4	DRUM	SCIAENIDAE	27.60	266.30	333	390	
197	4	DRUM	SCIAENIDAE	27.50	262.60	333	390	
Total				3796.5	29754.66			

Appendix E. Species occurrences in electroshocking samples taken from the Great Miami River, 1984 to 1995.

YEAR	19 84	19 85	19 86	19 87	19 88	19 89	19 90	19 91	19 92	19 93	19 94	19 95	19 96	19 97	19 98	19 99	20 00	20 01	20 02	20 03	20 04	20 05	20 06	20 07	20 08	20 09	20 10	20 11	20 12	20 13	20 14	20 15	20 16	20 17	20 18	20 19	20 20	20 21	20 22	20 23	20 24	20 25	20 26	20 27	20 28	20 29	20 30	20 31	20 32	20 33	20 34	20 35	20 36	20 37	20 38	20 39	20 40	20 41	20 42	20 43	20 44	20 45	20 46	20 47	20 48	20 49	20 50	20 51	20 52	20 53	20 54	20 55	20 56	20 57	20 58	20 59	20 60	20 61	20 62	20 63	20 64	20 65	20 66	20 67	20 68	20 69	20 70	20 71	20 72	20 73	20 74	20 75	20 76	20 77	20 78	20 79	20 80	20 81	20 82	20 83	20 84	20 85	20 86	20 87	20 88	20 89	20 90	20 91	20 92	20 93	20 94	20 95	20 96	20 97	20 98	20 99	20 100	20 101	20 102	20 103	20 104	20 105	20 106	20 107	20 108	20 109	20 110	20 111	20 112	20 113	20 114	20 115	20 116	20 117	20 118	20 119	20 120	20 121	20 122	20 123	20 124	20 125	20 126	20 127	20 128	20 129	20 130	20 131	20 132	20 133	20 134	20 135	20 136	20 137	20 138	20 139	20 140	20 141	20 142	20 143	20 144	20 145	20 146	20 147	20 148	20 149	20 150	20 151	20 152	20 153	20 154	20 155	20 156	20 157	20 158	20 159	20 160	20 161	20 162	20 163	20 164	20 165	20 166	20 167	20 168	20 169	20 170	20 171	20 172	20 173	20 174	20 175	20 176	20 177	20 178	20 179	20 180	20 181	20 182	20 183	20 184	20 185	20 186	20 187	20 188	20 189	20 190	20 191	20 192	20 193	20 194	20 195	20 196	20 197	20 198	20 199	20 200	20 201	20 202	20 203	20 204	20 205	20 206	20 207	20 208	20 209	20 210	20 211	20 212	20 213	20 214	20 215	20 216	20 217	20 218	20 219	20 220	20 221	20 222	20 223	20 224	20 225	20 226	20 227	20 228	20 229	20 230	20 231	20 232	20 233	20 234	20 235	20 236	20 237	20 238	20 239	20 240	20 241	20 242	20 243	20 244	20 245	20 246	20 247	20 248	20 249	20 250	20 251	20 252	20 253	20 254	20 255	20 256	20 257	20 258	20 259	20 260	20 261	20 262	20 263	20 264	20 265	20 266	20 267	20 268	20 269	20 270	20 271	20 272	20 273	20 274	20 275	20 276	20 277	20 278	20 279	20 280	20 281	20 282	20 283	20 284	20 285	20 286	20 287	20 288	20 289	20 290	20 291	20 292	20 293	20 294	20 295	20 296	20 297	20 298	20 299	20 300	20 301	20 302	20 303	20 304	20 305	20 306	20 307	20 308	20 309	20 310	20 311	20 312	20 313	20 314	20 315	20 316	20 317	20 318	20 319	20 320	20 321	20 322	20 323	20 324	20 325	20 326	20 327	20 328	20 329	20 330	20 331	20 332	20 333	20 334	20 335	20 336	20 337	20 338	20 339	20 340	20 341	20 342	20 343	20 344	20 345	20 346	20 347	20 348	20 349	20 350	20 351	20 352	20 353	20 354	20 355	20 356	20 357	20 358	20 359	20 360	20 361	20 362	20 363	20 364	20 365	20 366	20 367	20 368	20 369	20 370	20 371	20 372	20 373	20 374	20 375	20 376	20 377	20 378	20 379	20 380	20 381	20 382	20 383	20 384	20 385	20 386	20 387	20 388	20 389	20 390	20 391	20 392	20 393	20 394	20 395	20 396	20 397	20 398	20 399	20 400	20 401	20 402	20 403	20 404	20 405	20 406	20 407	20 408	20 409	20 410	20 411	20 412	20 413	20 414	20 415	20 416	20 417	20 418	20 419	20 420	20 421	20 422	20 423	20 424	20 425	20 426	20 427	20 428	20 429	20 430	20 431	20 432	20 433	20 434	20 435	20 436	20 437	20 438	20 439	20 440	20 441	20 442	20 443	20 444	20 445	20 446	20 447	20 448	20 449	20 450	20 451	20 452	20 453	20 454	20 455	20 456	20 457	20 458	20 459	20 460	20 461	20 462	20 463	20 464	20 465	20 466	20 467	20 468	20 469	20 470	20 471	20 472	20 473	20 474	20 475	20 476	20 477	20 478	20 479	20 480	20 481	20 482	20 483	20 484	20 485	20 486	20 487	20 488	20 489	20 490	20 491	20 492	20 493	20 494	20 495	20 496	20 497	20 498	20 499	20 500	20 501	20 502	20 503	20 504	20 505	20 506	20 507	20 508	20 509	20 510	20 511	20 512	20 513	20 514	20 515	20 516	20 517	20 518	20 519	20 520	20 521	20 522	20 523	20 524	20 525	20 526	20 527	20 528	20 529	20 530	20 531	20 532	20 533	20 534	20 535	20 536	20 537	20 538	20 539	20 540	20 541	20 542	20 543	20 544	20 545	20 546	20 547	20 548	20 549	20 550	20 551	20 552	20 553	20 554	20 555	20 556	20 557	20 558	20 559	20 560	20 561	20 562	20 563	20 564	20 565	20 566	20 567	20 568	20 569	20 570	20 571	20 572	20 573	20 574	20 575	20 576	20 577	20 578	20 579	20 580	20 581	20 582	20 583	20 584	20 585	20 586	20 587	20 588	20 589	20 590	20 591	20 592	20 593	20 594	20 595	20 596	20 597	20 598	20 599	20 600	20 601	20 602	20 603	20 604	20 605	20 606	20 607	20 608	20 609	20 610	20 611	20 612	20 613	20 614	20 615	20 616	20 617	20 618	20 619	20 620	20 621	20 622	20 623	20 624	20 625	20 626	20 627	20 628	20 629	20 630	20 631	20 632	20 633	20 634	20 635	20 636	20 637	20 638	20 639	20 640	20 641	20 642	20 643	20 644	20 645	20 646	20 647	20 648	20 649	20 650	20 651	20 652	20 653	20 654	20 655	20 656	20 657	20 658	20 659	20 660	20 661	20 662	20 663	20 664	20 665	20 666	20 667	20 668	20 669	20 670	20 671	20 672	20 673	20 674	20 675	20 676	20 677	20 678	20 679	20 680	20 681	20 682	20 683	20 684	20 685	20 686	20 687	20 688	20 689	20 690	20 691	20 692	20 693	20 694	20 695	20 696	20 697	20 698	20 699	20 700	20 701	20 702	20 703	20 704	20 705	20 706	20 707	20 708	20 709	20 710	20 711	20 712	20 713	20 714	20 715	20 716	20 717	20 718	20 719	20 720	20 721	20 722	20 723	20 724	20 725	20 726	20 727	20 728	20 729	20 730	20 731	20 732	20 733	20 734	20 735	20 736	20 737	20 738	20 739	20 740	20 741	20 742	20 743	20 744	20 745	20 746	20 747	20 748	20 749	20 750	20 751	20 752	20 753	20 754	20 755	20 756	20 757	20 758	20 759	20 760	20 761	20 762	20 763	20 764	20 765	20 766	20 767	20 768	20 769	20 770	20 771	20 772	20 773	20 774	20 775	20 776	20 777	20 778	20 779	20 780	20 781	20 782	20 783	20 784	20 785	20 786	20 787	20 788	20 789	20 790	20 791	20 792	20 793	20 794	20 795	20 796	20 797	20 798	20 799	20 800	20 801	20 802	20 803	20 804	20 805	20 806	20 807	20 808	20 809	20 810	20 811	20 812	20 813	20 814	20 815	20 816	20 817	20 818	20 819	20 820	20 821	20 822	20 823	20 824	20 825	20 826	20 827	20 828	20 829	20 830	20 831	20 832	20 833	20 834	20 835	20 836	20 837	20 838	20 839	20 840	20 841	20 842	20 843	20 844	20 845	20 846	20 847	20 848	20 849	20 850	20 851	20 852	20 853	20 854	20 855	20 856	20 857	20 858	20 859	20 860	20 861	20 862	20 863	20 864	20 865	20 866	20 867	20 868	20 869	20 870	20 871	20 872	20 873	20 874	20 875	20 876	20 877	20 878	20 879	20 880	20 881	20 882	20 883	20 884	20 885	20 886	20 887	20 888	20 889	20 890	20 891	20 892	20 893	20 894	20 895	20 896	20 897	20 898	20 899	20 900	20 901	20 902	20 903	20 904	20 905	20 906	20 907	20 908	20 909	20 910	20 911	20 912	20 913	20 914	20 915	20 916	20 917	20 918	20 919	20 920	20 921	20 922	20 923	20 924	20 925	20 926	20 927	20 928	20 929	20 930	20 931	20 932	20 933	20 934	20 935	20 936	20 937	20 938	20 939	20 940	20 941	20 942	20 943	20 944	20 945	20 946	20 947	20 948	20 949	20 950	20 951	20 952	20 953	20 954	20 955	20 956	20 957	20 958	20 959	20 960	20 961	20 962	20 963	20 964	20 965	20 966	20 967	20 968	20 969	20 970	20 971	20 972	20 973	20 974	20 975	20 976	20 977	20 978	20 979	20 980	20 981	20 982	20 983	20 984	20 985	20 986	20 987	20 988	20 989	20 990	20 991	20 992	20 993	20 994	20 995	20 996	20 997	20 998	20 999	20 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