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**ELECTROFISHING SURVEY OF THE GREAT MIAMI RIVER
SEPTEMBER 1993
ANNUAL REPORT**

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January 1994

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PREPARED FOR THE
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
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CINCINNATI, OHIO 45239-8704

Under Contract DE-AC05-92OR21972
U.S. Department of Energy
FERNALD FIELD OFFICE

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EXECUTIVE SUMMARY

Fish sampling by electroshocking in the Great Miami River above and below the Fernald site (September 14 and 15) was designed to determine changes in the health of the fish community compared to the previous nine years and to collect samples for uranium analyses in fish filets. Three sites were sampled, river mile (RM) 38 (upstream of the Fernald site's effluent line at Hamilton), RM 24 (Near the Fernald site's effluent line at Stricker's Grove) and RM 19 (downstream of the Fernald site's effluent line at the confluence of Paddys Run and the Great Miami River). The fish species richness at each site was proportional to the number of fish caught. The biomass of fish caught per hour was greatest at RM 38 > RM 24 > RM 19. The diversity index was nearly the same at all sites. The heaviest fish community was at RM 24 > RM 38 > RM 19. The fish communities at the pool sites and at the riffle sites were similar in composition regardless of the River Mile. Separation of species in sampled communities was more determined by habitat type (e.g. pool, riffle) than river mile alone. The pooled site at RM 38 was diagnostically separated from the other sites by the gizzard shad, green sunfish, and largemouth bass. The pool at RM 19 was characterized by bluegill, longear sunfish, and skipjack herring. The river run site, RM 24, was characterized by carpsuckers, drum, redhorse, catfish, white bass and smallmouth bass, which might be expected in rapid current reaches of mid-sized rivers. Thus the fish community in 1993 was separated ecologically by the physical features of the habitat more than by water quality differences between sites. These data suggest there was no effect of effluents, bases on three sites on one date, from the Fernald site in September on the distribution of fishes.

Compared to previous years, the number of fish captured per unit effort was lower, but there was no difference in species richness by station between years. With the lower densities, the fish

captured tended to be heavier fish than in previous years. In fish populations, when densities are reduced, there should be a compensatory increase in growth rates in the residents. Shannon diversity was not different between stations or between years. The low diversity found at RM 19 in 1992 had returned to normal, with a record number of species in 1993. The nutrient enrichment and extreme suspended high algal biomass documented at this time of year in 1992 did not reoccur. Thus the diel respiratory demand for oxygen did not lead to deoxygenation.

Samples of 224 fish, from seven families of representative fish, from three sites at RM 19, 24, and 38 provided sixty-six samples for uranium analyses by an independent contract laboratory.

The fish community in 1993 was healthy at all stations, reflecting changes in the physical habitat and not changes in water quality. This type of distribution of fish by habitat quality and high diversity is what is expected in a clean river.

INTRODUCTION

Each August or September from 1984 to the present, the status of the fishery has been examined at three or four sites in the Great Miami River (GMR) as part of a survey of uranium content of fish fillets (1984-1990, 1993) and whole fish (1991 and 1992) (Figures 1-4). The fish community in the river had been studied only sporadically before 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 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). 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, RM 22-38, 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 autumnal rotenone studies (Pearson and Krumholz, 1979; Krumholz, 1981). Additional studies on Ohio River tributaries have found more species; 108 species in 1962 (ORSANCO, 1962) 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). The Wabash River, monitored by Gammon et al. (1981), is a river of similar size to the GMR with similar high pollution loads. The community of fish ranged from 13-22 species in single day samples. 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, such as 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, the suckers, buffalo, carpsuckers, and redhorses (Catostomidae) and catfish (Ictaluridae). Washout from upstream reservoirs and ponds may contribute species of fish such as largemouth bass, sunfishes, and young of the year 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, habitat structure (riparian zone), energy base (allochthonous or autochthonous), flow regime (riffle or pool), and biotic interactions (competition and predation risk) (Karr, 1981; Karr et al., 1986). The OEPA has coded a system of assessing habitat quality. Their Quality Habitat Environmental Index (QHEI) includes current velocity, bank stability, canopy, riparian vegetation, instream 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 OEPA to characterize the water quality of the Great Miami River and its tributary streams over the past decade (OEPA, 1990).

The GMR has been 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. 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 samples in a single day (Table 1).

Upstream of the Fernald site, major sources of pollutants exists that may affect the biological water quality downriver. This includes the cities of Dayton (RM 50) and Hamilton (RM 38). Toxins, 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 (Fig. 5-2, Rankin et al., 1990). One of those contaminants of interest to OEPA has been elevated concentrations of PCB's in fish below Dayton. Levels of PCB's in fish samples taken below Dayton between 1985 and 1989

exceed 2 parts per million (Fig. 5-2, 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 (Appendix E, Rankin et al., 1990).

IBI, used by the Ohio Department of Natural Resources for fish communities, ranges from 20 (poor-degraded) to 40 (good) 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-moderate impact) (Fig. 5, Rankin et al., 1990). The Iwb is a composite index of numbers and weights calculated as Shannon Indices. The modified Iwb ranges from 7.7 to 8.1 in the Fernald site reach in 1989 on a scale of 1 to 10 which is good (OEPA, 1990). The ICI ranged from 40 to 50 in the area of 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, 1987). The lowest quality of habitat was found in Hamilton (Fig. 2). Thus the extensive surveys of the OEPA and Ohio Department of Natural Resources over the past decade show an enriched or degraded river in the area of the Fernald site, improving from point source degradation upriver.

This report emphasizes the comparison among the years, sites and subsamples on the status of the fishery in terms of numbers, health, species richness, and diversity. With the ten 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 as changes in condition as observed in length-weight distributions among sites.

Fish samples were collected and fillets were analyzed for uranium content (versus whole and filleted fish in 1991 and 1992). They were shipped as per instructions by the Fernald Environmental Restoration Management Corporation to an independent contract laboratory. The fisheries analysis contained in this report focuses on the areas that are upstream of the Fernald site's effluent line, near the effluent line, and downstream of the effluent line potentially impacted by the Fernald site effluents.

Hence, the survey of fish community status and fish radionuclide concentrations around the Fernald site attempts to detect a continuum of improving water quality downriver from Dayton and Hamilton, where dams and channel modification by gravel dredging have severely changed the physical habitat and migration probabilities of fish.

METHODS

Electrofishing: Pulsed DC electrofishing is among the most efficient method of collecting relatively unbiased samples with respect to fish size and species, especially in shallow, turbid waters (Gammon, 1976). Fish were electroshocked with a 240 volt, pulsed direct current transformer at 60 cycles per second from a five meter flat-bottom boat. The anode is located at the end of a three meter boom and consists of two to six vertical cables, extending 10 to 15 centimeters beneath the surface of the water. The cathode is composed of five one-meter-long cables extending well under the bow of the boat. The electroshocking transformer is powered by

a gasoline-driven Coleman generator, delivering 4,000-watts of 120-volt AC at 30 amperes. The shocker delivers about 3.6 to 4.2 amperes (at 240 volts), depending on the conductivity of the water. The system is similar to the type 'A' rig specified by the OEPA in routine boat electrofishing (OEPA, 1988; WQPA-SWS-3, 30 Sept. 1989). Two people, standing behind a railing on the bow of the boat, catch fish with long-handled (3 m) dip nets. The netters control the electroshocker with a foot-operated "dead-man" switch. The fish lose their equilibrium momentarily in the small area of electrical field near the anode, allowing them to be netted. Thus, the effective area and depth for stunning fish may depend on the species and their size. Large fish are reported to be the most sensitive to the electric field. Almost all fish recover within five minutes in an aerated central well (Vibert, 1967). Some of the larger game fish (largemouth bass, smallmouth bass, and striped bass) greater than fifteen centimeters were identified, measured, and released immediately after gill motion and equilibrium appeared normal, as specified in our State of Ohio Scientific Collecting Permit. No endangered species were captured.

At each site, three or four subsamples were taken (approximately 20 minutes each) to compare fish numbers, biomass, and species composition in the subsamples within each site's reach. The subsamples were not intended to be replicates of habitat, but to examine variability in spatial sections of each site reach and to develop a cumulative species list by site. The cumulative number of species for each site was intended to determine if the total sample was large enough to contain most of the species at that particular site.

Sample Preparation: The fish collected for uranium analysis and biological survey were placed in plastic bags identified by subsample number, combined by site in a larger bag.

immediately placed in a cooler on ice, and the coolers were locked and sealed in the field. The sealed coolers containing the fish were then brought back to a radionuclide-free laboratory at the University of Cincinnati for identification and processing. For each subsample, the fish were identified to species, weighed, and measured (Clay, 1975; Pflieger 1975; Smith, 1979; Trautman, 1981). Any external abnormalities, such as fin rot, diseases, or fungus were noted. The fish were decapitated, eviscerated, and fins removed to make modified fillets (some scales, skin, and some bones as had been done in previous years). These modified fillets are approximately what people would consume if they ate fish from the GMR. The modified fillets from each species or trophic grouping (planktivore, insectivore, piscivore, and benthivore) were adjusted to a wet weight of approximately 400 grams, labeled sequentially within each site by species and/or trophic group and sealed into resealable plastic bags. Fish from each collection site were processed as a group. After processing one group, the area was cleaned so that contamination between groups would not occur. The upstream or control site was processed first in order to minimize any possible cross contamination of uranium from the Fernald site. Any fish that was deemed too small for the uranium analysis was discarded and incinerated at the University of Cincinnati.

Water Analysis: Water analysis was performed both in the field and at the University of Cincinnati laboratory. Temperature (°C), conductivity (microSiemens/cm²), and total dissolved solids (mg/L) were measured in the field using a HACH conductivity/TDS meter (HACH, Inc., Loveland, Colorado). Dissolved oxygen (ppm O₂ at 0.25 m) was measured in the field using a YSI Model 57 meter (Yellow Springs Instruments Co., Yellow Springs, OH). The turbidity was measured in the field using a secchi disk (cm) and standard measuring techniques. The pH was

measured electrometrically using a HACH 450 digital portable pH meter (HACH, Inc., Loveland, Colorado) standardized by a pH 7 and pH 10 standard buffer. The remaining water analysis was performed in the laboratory on fresh water samples collected on 14 September, 1993. Suspended chlorophyll was separated by filtration on glass-fiber filters, extracted in 10 ml of 90% acetone for 24 to 48 hours at 4°C in darkness (Wetzel and Likens 1991), and analyzed fluorometrically. Active chlorophyll was calculated by the proportionate drop in fluorescence after adding 2 drops of 10% HCl to each tube (10 ml). Soluble reactive phosphate was determined colorimetrically by absorbance of phosphomolybdate at 890 nm in filtrate using the HACH methods and the HACH DR/2000 spectrophotometer (HACH, Inc., Loveland, Colorado). Ammonia concentrations were determined colorimetrically by absorbance of salicylate/cyanurate (method 385) and nitrate concentrations were measured by cadmium reduction to nitrite. The ammonia and nitrate measurements used the HACH DR/2000 spectrophotometer. These measurements were designed to discern effects of eutrophication and algal growth, sewage enrichment, and gravel mining activities on the water quality at our sites.

Statistics: Statistical analysis was performed using the statistical package SYSTAT 5.03 for DOS. Multiple pairwise comparisons were performed using Tukey Honestly Significant Difference post F test. All statistically significant results have $p \leq 0.05$ (two tailed). One way ANOVAs were used to examine the effect of location and year on parameters of fish community structure. Since the sites were far enough apart and the same fish were not likely to be in the same river location in the next year, ANOVA with years as repeated measures was not needed.

SITE DESCRIPTION

Three sites on the Great Miami River were used for electrofishing in 1993 (Fig. 1). Two of these sites have been sampled annually at the same time of year since 1984 (RM 24, & 19) (Figs. 3 and 4). A third site was added upstream in 1991 as an additional control at RM 38 (Fig. 2). This added site at RM 38 is isolated from the downstream sites by two dams. The site was purposefully chosen in an effort to prevent migration of fish upstream from the RM 24 area. The dams serve as an effective barrier to fish migration except during periods of high water flow.

RM 38 is located at the confluence of Talawanda Creek and the Great Miami River, in Hamilton (Fig. 2). The riparian community is relatively undisturbed, and the habitat provided by fallen trees, rocky shoals, and pools increases habitat heterogeneity. The site is located just upriver of the outlet of Seven Mile Creek up to and around bridge bases of the US Route 127 bridge. A 1,720 meter reach of the river was sampled in three 20 minute subsamples. The first subsample began on the south side of the river, starting approximately 1,000 meters above the dam, continuing around the bridge, and finishing 200 meters along the north shore. The second subsample was taken along the north side of the river, starting about 1,100 meters above the dam, and extending 200 meters along both sides of the Talawanda Creek. The third subsample was taken 600 meters above the dam along the southeastern shore for approximately 500 meters.

RM 24 is near Stricker's Grove Park and the Fernald site effluent line (Fig. 3). In previous years, this site was referred to as site 3, site III, or Stricker's Grove. The location of this site has not changed for this year; however the reference name has changed. The mixing zone is a deep, fast section of river with strong eddy currents just below a new effluent line. This site is on the

outside of a long curve on the western shore. It is steep-sided with a fairly rapid current, the fastest of the survey sites. Some riparian trees, both standing and fallen, provide good cover and high fish species diversity on the east side. The average pool depth here is 1.8 meters. Downstream of the effluent line, 2,200 meters of the river was sampled. It was divided into three subsamples each lasting approximately 20 minutes: two above the rapids, sampling both shores of the river including a gravel bar and island; and one below the rapids, sampling both shores. The west sample side had a steeply banked and wooded shoreline.

RM 19 was previously referred to as site 4, site IV, Paddys Run, or Welch's (Fig. 4). This location has not been changed from previous years, just the reference name. RM 19 is found at the outfall of Paddys Run, which is the historic drainage route of stormwater runoff from the Fernald site. A pool has been created here by 25 years of dredging by a gravel company. The western shore is unaffected by the dragline operations, 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. The average pool depth is about 2 meters. This site has the slowest current and is pond-like in many respects. Four subsamples were taken, each approximately 20 minutes in duration with a combined distance of 2,590 meters. The first subsample (500 meters) was taken just below the CG&E pipeline-crossing barrier at the north end of Dravo Park and included the west shore to the old railroad bridge abutments. The second subsample consisted of 700 meters along the west shore below the bridge abutments. The third subsample was taken along the east shore approximately 600 meters below and around the bridge abutments. There was

no mining activity along the eastern shore this year as there had been in the past. The fourth subsample was similar to the first subsample but the fourth included the east shore.

Samples were collected at RM 38 on 14 September, 1993 and at RM 24 and 19 on 15 September, 1993 (Table 1, Figures 1-4). Each site was sampled for about 60 minutes (RM 38 = 61.5 min., RM 24 = 60.0 min., and RM 19 = 76.5 min.). At each site, three or four equally timed subsamples were taken, each about 20 minutes in duration.

The total distance electrofished was 1.72 km, 2.20 km, and 2.59 km at RM 38, 24, and 19, respectively. This distance is the number of km of shore traversed not the km of river electrofished. The river was too wide to consider a pass down either side a representative sample for all the fish in the whole river. The habitat was different on each side of the river and these differences dictated the necessary distance of shore to be electrofished. Poor habitat required less time to electrofish than good habitat, but the fish yield was higher in the good habitat. This is one explanation for the difference in distance electrofished at each site. RM 38 and 19 were pooled sections of river; RM 24 was flowing water primarily in open runs. RM 24 had the best development of riparian zone structure that fish prefer.

Both time and distance have biases in interpretation. Time and volume of water sampled were not biased by the speed of movement. The active stun zone was so small (1.3 x 1.3 x 0.6-1 m deep) that the volume of water sampled was nearly constant. The use of fish/kilometer for reporting is more common and it eliminates some of the biases.

RESULTS AND DISCUSSION

A. Physical, Chemical Parameters:

Physical and chemical data for the three sites show a slight increase in conductivity from RM 38 to RM 19 (Table 2). Both RM 38 and 24 were sampled in the morning, but RM 19 was sampled in the afternoon. The slight difference in conductivity and total dissolved solids could be due to diel variation in production and dissolution carbonates caused by wide diurnal swings in oxygen (Table 2). High pH, temperature, and low concentrations of free CO_2 found in mid-afternoon can reduce the solubility of carbonate/bicarbonate causing precipitation of marl from saturated solutions (Fig. 6).

The oxygen concentration was lower at morning sampling sites due to diurnal variation in photosynthesis and respiration of the seston and benthos. Oxygen concentration at RM 24 was only 85% saturated, but the RM 19 sample was supersaturated, 137% (Table 2). The river was enriched since photosynthesis is the primary means of causing supersaturation.

Soluble reactive PO_4 (SRP) concentrations, suspended algal chlorophyll concentrations, ammonia and nitrate concentrations, and secchi depth support the hypothesis of increasing trophic of the river (Figs. 7, 8, and 9). The SRP, normally the limiting nutrient controlling algal biomass, was high with 440-590 $\mu\text{g P/liter}$. The concentration of SRP dropped from upriver to downriver as the PO_4 was utilized by algal growth (Fig.7). The algal chlorophyll, as a measure of algal biomass, showed the same pattern with a slight increase downriver (Fig. 8). However, the algal chlorophyll concentration was between 14.73 and 17.73 $\mu\text{g/liter}$, equivalent to what might be found in a eutrophic lake (Wetzel, 1983). Normally, sestonic chlorophyll is a minor portion of

river algal biomass, because most is attached to rocks as periphyton or epilithon. Concentrations of NH_4^+ appear to increase slightly below RM 38 (0.08 to 0.10 mg/L) while NO_3 decreased slightly down river (Fig. 9). Secchi depth decreased very slightly downriver.

B. Fish Parameters:

1. Species Richness: This year 224 fish (vs. 491 fish in 1992 and 526 fish in 1991), from 26 species (vs. 23 spp. in 1992 and 33 spp. 1991), in nine families, were collected from the three sites in the GMR (Figs. 10 and 11, Table 3). The most diverse families from the river were the Centrarchidae (8 species) and the Catostomidae (5 species) (Table 3). The number of different species per site ranged from 11 at RM 24 to 19 species at RM 19. The most numerous species was the gizzard shad (Clupeidae) with 92 individuals, followed by freshwater drum (Sciaenidae) with 22 individuals, and channel catfish (Ictaluridae) and the golden redhorse (Catostomidae) both with 17 individuals (Table 3). Species diversity seemed to have returned to a more normal level at RM 24 from last year and 1990. In addition, RM 19 had the highest number of species caught in the past decade.

Statistically, a one way ANOVA showed that among the years 1984 to 1993, there was a difference in the number of species captured by year ($F = 2.59$, $df = 9, 22$, $p = 0.02$ HS) (Table 4), but not by location ($F = 0.78$, $df = 3, 28$, $p = 0.51$ NS) (Table 4). The collection years 1985 and 1991 netted the most species, while 1990 and 1992 had the fewest. 1993 was equal to 1986 for the third most species collected.

The sites were electroshocked for 61.2, 60, and 76.5 minutes at RM 38, 24, and 19 respectively (Table 6). The fish diversity and density varies with habitat complexity, including

topography of the shore, the depth of the pool, the nature of the current, and the amount of vegetation in and over the water (Gammon et al, 1983; Yoder and Gammon, 1976, OEPA, 1988). In 1993, 72.5, 35, and 90.2 fish were collected per hour at RM 38, 24 and 19, respectively (Fig. 12, Tables 4 and 6), compared to 175, 106, and 305 fish per hour in 1992 and 67, 174, and 100 fish per hour in 1991 (Table 4) from the respective locations (38, 24, and 19). RM 19 had the greatest number of fish collected and the most meters of shore electroshocked; however, the total weight and biomass captured per hour is 3,000 to 4,000 grams less than RM 38 and 24 (Fig. 13). RM 24 had the fewest fish collected, half as many as RM 38, and the second most kilometers traveled (Table 6). However, RM 24 had the heaviest average fish, two times RM 38 and four times that of RM 19, and the longest average length of the three study sites (Table 5). Larger and more mature fish were found at RM 24. It has a swifter current that usually excluded the smaller fish. In 1993 and on average, the fish were the largest collected at RM 28 in the past decade (Table 5). The distance shocked increase with each location sampled. The habitat was not equal at all locations.

A one way analysis of variance using four sites from 1984-1993, found no differences in the number electrofished per hour between years ($F = 1.48$, $df = 8, 20$, $p = 0.23$) (Table 4) or among RMs (38, 24, and 19) ($F = 2.81$, $df = 2, 25$, $p = 0.07$). No years or locations were different than any other year or locations in a post F comparison by Tukey's HSD. However, in 1992 the catch was high, primarily because of the returns from the pool at RM 19. As usual, more fish were returned per unit effort at $RM\ 19 > 38 > 24$.

2. Species Diversity Indices: The diversity of fish at each site was measured by the Shannon-Wiener (H' or H_{bar}) index based on the information theory using log base 2 (Krebs, 1989). This index of diversity is increased by the number of species in a sample and the relative uniformity of the numbers of individuals of each species. Samples with fewer species or one species being very dominant have low calculated diversity (H'). The maximum diversity (H'_{max}) that can be attained in any sample is fixed by the number of species, assuming equal numbers of individuals in all species collected at the site. Gizzard shad dominated the fish community at RM 19. Their numbers had the greatest effect on reducing the diversity at that site (Tables 3 and 7, Fig. 14). At RM 38 and 19, gizzard shad accounted for 50% and 44% of all fish collected; however, at RM 24 freshwater drum accounted for 31% of all fish collected. RM 19 had the highest diversity ($H' = 2.098$, $E = 0.713$) (Table 7, Fig. 14) and was dominated by gizzard shad and freshwater drum. The highest evenness was found at RM 24 ($E = 0.86$) (Table 7). The diversity at RM 24 and 19 was raised from last year's levels which were the lowest found in the previous nine years. The ten year mean for H' and evenness shows a trend of $RM\ 24 > 28 > 19$ (Table 7). In 1993 RM 28 was not sampled. Thus, the trend for 1993 ($RM\ 19 > 24 > 38$) differed from the trend of the means. It is possible that the mean trend is affected by the very low diversity found in 1992 and 1990 at RM 19.

For the diversity index H_{bar} , a one way ANOVA disclosed no significant differences between years ($F = 0.96$, $df = 9, 22$, $p = 0.50$ NS) or RMs ($F = 2.31$, $df = 3, 28$, $p = 0.10$ NS) in the GMR. On average the index was highest at RM 38, 24, 28, and 19, decreasing in that order. Amongst the years, H_{bar} was highest in 1986 and 1985 and lowest in 1992.

The one-way ANOVA revealed a significant difference in mean evenness between RMs ($F = 6.44$, $df = 3, 28$, $p = 0.002$ HS, Table 7). RM 19 had significantly lower evenness than RM 24 and 28 in a post F comparison of means, but RM 19 was not significantly different than RM 38. The ten-year mean evenness at RM 19 is statistically lower than other locations because of the high proportion of gizzard shad present in the large dredged pool at RM 19. The years of highest average evenness were 1986 and 1985, contrasting to the years of lowest evenness in 1991 and 1992. There appears to be no trend towards lower diversity or evenness in recent years.

3. Community Coefficients: 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 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).

$$\text{Community Coefficient} = 2c / a+b$$

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). A low CC may reflect differences of habitat due to geographical separation or a pollution gradient.

The CC shows that all three sites (RM 38, 24, and 19) are similar (CC = ca. 0.50). RM 24 and 19 are slightly more similar (CC = 0.53) than are RM 38 and 24 and RM 38 and 19 (CC for both = 0.50) (Table 8). 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 1993, 15 species were found at only one site, 5 are found at two sites, and 6 at all three sites (Table 3).

4. 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 is observed to be between 1 to 25 grams (g) for fish caught at RM 38, 125 to 150 g for fishes from RM 24, and 1 to 25 g for fishes from RM 19 (Table 10). Cumulative distribution of proportion of fish by weight shows the 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 found in at RM 38 and RM 19 (Table 10, Fig. 15), the two most ponded sites. In both of these sites, more than 70% of the fish accumulated were less than 100 g in size (Fig. 15). On the other hand if the cumulative weight distribution curve increases slowly, then the fishery is dominated by larger fish. This is the distribution found at RM 24, with less than 6% of these fish weighing less than 100 g (Fig.15). The big differences were differences in density of 1 and 2 year old gizzard shad in the ponded sites.

The length frequency distributions (Table 9) show the modal length of fishes at RM 38 (8 to 10 and 10 to 12 cm) was the smallest. RM 24 had the longest modal length (22 to 24 and 24 to 26 cm), and a fairly uniform number of fish at all sizes from 20 to 60 cm (Table 9). RM 19's modal length of the distribution is 10 to 12 cm. The diagram of cumulative proportion of fish by length (Fig. 16) illustrates a more gradual rise to the asymptote than was observed in 1992. In a uniform sized distribution, the curve rises linearly to the asymptote. This graphically shows that there is a more even distribution of fish from different length classes than last year; however,

there is still a large number of small fish. Clearly RMs 38 and 19 are dominated by more small fish than any others, with 69% of the fish being less than 20 cm (Table 9, Fig. 16). RM 24 had the largest and most uniform size frequency with a more linear rise in the cumulative frequency curve. RM 24 had a dramatic rise in the cumulative frequency from 22 to 30 cm, 51% of the fish from RM 24 are within this range. When skewed to the young of one species, the curves imply enrichment in food or habitat. When uniform and linear, the curves suggest demonstrate an older population, which could mean a uniformly fast current or a condition that has lead to a loss of the more sensitive young fish. The young-biased curves at RM 38 and 19 to probably reflect enrichment and pooling that favor gizzard shad and immature fish. The loss of young to probably reflect habitat conditions and current, not a toxic stress, at RM 24.

The changes in growth rate and condition can be examined for common species using (length x wet weight) distributions. This curve, reflecting allometry of length and weight, but deviations in weight per unit length, shows changes in the condition of the fish (amount of fat stored). Deviations from the allometric curve of length and weight may indicate poor growth conditions at particular sites or in the river as a whole. Gizzard shad is the most common species at most sites. There were many Young-of-the-Year (YOY) (6 to 12 cm) and one year-old fish (16 to 24 cm) at RM 38 and 19 (Fig. 17). The larger fish (2 + years) mostly were found at RM 24; one large gizzard shad was found at RM 19.

The smallmouth and largemouth bass were summed to show a consistent length/weight relationship at RM 38, 24, and 19 (Fig. 18). The basses are semi-evenly distributed over the three sites with the exception of RM 24. No basses with a length less than 25 cm were found at RM

24. The related sunfishes are widely distributed in RM 38 and 19 but were completely absent at RM 24 (Fig. 19). The freshwater drums are found in a couple of size classes distributed in RM 24 and 19 (Fig. 20). There were no small (0 to 12 cm) freshwater drum at RM 24 and there were only three larger drum found at RM 38 and 19 combined. Carp at all three sites appeared to be growing equally well (Fig 21). River specialists, the catfish, were most common at RM 38 and 19 with the largest and smallest individuals found at RM 24 (Fig. 22).

In conclusion, pooling at RM 38 and 19 by damming or dredging, made them good nurseries for young gizzard shad that contributed to their abundance. All fish species appear to be in same condition of health independent of site, based on their weight/length ratios.

5. Sampling Adequacy: 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, attempts were not made to take replicates, but to maximize the habitat sample differences; hence the term subsample. At RM 38 and 24, the number of species per subsample was relatively constant (Fig. 11), with more variation at RM 19 where pool quality, habitat structure, and current varied markedly between subsamples. Subsample 3 at RM 19 was the dredged side of pool. Subsamples 1 and 4 were around a complex of rapid flows and behind sediment bars below a rock dam at the CG&E natural gas line. Subsample 2 was taken from constant cobble habitat with riparian cover. The cumulative number of fish per subsample found RM 19 near an asymptote, but not for RM 38 and 24 (Fig. 23). RM 38 and 24 were under-sampled for number of fish; however, fish were relatively rare this year (Table 4) despite a good and routine sampling effort.

6. Ordination by Detrended Correspondence Analysis (DECORANA or DCA): In order to evaluate the differences in the fish community by site, a eigen vector detrended correspondence analysis uses an algorithm to compute the separation of sites or species scaled in standard deviation units on two statistically unrelated ordinales (ter Braak 1986). The power of this ordination method is that, using only species abundance data, the algorithm iterates a single solution where the sample site, differentiated by species, comes to lie graphically on the same axes as the fish species differentiated by sample sites. Using DCA, the relative position of the species on an ordinate axis is proportional to its effect on the position of sample sites scaled on the same axis. Axes are in standard deviation units; hence, two sites that are very dissimilar in species composition will be located more than 2 standard deviations apart.

The DCA of sites using log (species abundance) showed that the fish community of RM 38 and 19 were two standard deviations from RM 24 (Fig. 24). RM 38 in this graph is disjunct: 1C (at RM 38-C) is approximately two standard deviations away from the other subsamples for RM 38. This subsample shows that 1C is more similar to RM 24, a swifter current site, than the other RM 38 subsamples. This is also true for subsample 3A. Subsample 3A was taken directly below the CG&E gas pipeline; the current was quite swift. Subsample 3D also was taken below the pipeline; however, the subsample also contained eddied, slow current, portions of the river. The eigen value of the two ordinales is proportional to the importance of that axis in explaining the separation observed. The first ordinate is selected to be the largest in every case.

The DCA of fish species in space defined by sites shows a separation of big river and pool communities. RM 24 is a boulder-covered site with little accumulated sediments and swift

currents. Current-loving lithophils ('cobble'-loving) are found at this site; they include river carpsuckers, brown bullheads and flathead catfish (Fig. 25), all of which were only captured at this location in 1993 (Table 3). RM 38 and 19 are more pooled in character and species that are better adapted for this condition (largemouth bass, longear sunfish, and green sunfish) are found here (Fig. 25). RM 38 subsample 3 (1C) and RM 19 subsample 1 (3A) were more related to a large river community than to the other subsamples in the same site (Fig. 24 and 25). The DCA indicates the importance of microhabitats in determining fish community composition taken by electrofishing.

CONCLUSIONS

The fishery of the Great Miami River has been relatively stable over the last ten years, 1984-1993. There has been variation between the sites and the various replicates and subsamples, but these differences are not significant. Over the ten years of sampling, forty-nine species have been recorded. During the 1993 survey, twenty-six species were captured (Tables 3 and Appendix A). The possible severe degradation of the fish community below the Fernald site, apparent in 1992, was no longer present. RM 19 had the highest species diversity this year (1993) (Table 7) compared to any of the ten years of surveys.

RM 38 is protected from the upstream migration of fish by the two dams at Hamilton. In 1991, RM 38 had many redhorse and northern hogsuckers, typical for mid-sized streams prior to cultural development. However, in 1992, RM 38 was dominated by warm water species from ponded habitats, sunfish, bass, and white suckers. Last year there was an absence of white and striped bass; however, there were two white bass at RM 38 this year. This suggests that the dams

may not have been such a successful barrier to the spring-upstream migration of fish as it was last year. Increased water flow this year may have allowed more fish to navigate the dams earlier in the spring. Channel catfish, a big river species, which was not captured last year, was caught this year.

RM 19 and 24 are influenced by the backwater species, which migrate up from the dam-regulated Ohio River. Fish from RM 38 could have originated from upstream of Hamilton or migrated up river during a previous year or during the spring high flow conditions prior to the low flow conditions. However, there are several distinct lines of evidence that suggest these dams prevent the summer interchange of individuals that live in the down-river reaches of the Great Miami River with those living above Hamilton.

The diversity and evenness of the sites are highly influenced by the numbers of gizzard shad and freshwater drum. RM 24 and 19 had the highest diversity and the lowest percent gizzard shad populations. RM 38 is a nursery for young gizzard shad and had the lowest diversity and evenness. RM 19 could also be considered a gizzard shad nursery, but it also had relatively high populations of other fish; freshwater drum and channel catfish (Table 3). In addition, nineteen species were found at this site. Other fish species appear to be in the same condition of health, independent from site, as seen in the length/weight plots (Figs. 17 through 22).

From circumstantial evidence the fish community at RM 38 has been isolated from migration during the summer of 1993. RM 24 and 19 can be influenced by effluents from the city of Hamilton and migration from the Ohio River. No indicators examined show any sign of differential pollution stress among the lower three sites causing ulcers, skin fungi, and/or growth

anomalies; etc.. In this regard, there are no discernible significant effects of the Fernald site on the population, size, numbers, condition, or species richness of the fish communities in the Great Miami River in 1993. The probable degradation in 1992 at RM 19 and 24 seems to have been negated.

One point that was very evident in the report is the importance of microhabitats. The number of fish captured varied dramatically depending on the area that was electroshocked. The subsamples did differ significantly in regards to fish captured per subsample. In future sampling, microhabitats within a sampling site and total numbers of fish should be considered.

Fish communities are good indices of water quality and habitat quality. In the absence of pollutant stressors, fish species utilize river sections by their unique habitat requirements. In 1993, habitat differences appeared to be connected with fish community structure. In 1992, the survey appeared to show that fish were separated by an upstream source of nutrient enrichment. This enrichment set up a gradient of decreasing water quality and fish community species richness down river. This condition was not repeated in the late summer of 1993. The 1993 survey tended to have fewer fish collected, but with larger average size. Either reproduction was lower in 1993 or current velocity had been high several times during the summer, washing out the young-of-the-year fish. This phenomenon existed at all surveyed sites and throughout the river; hence, the phenomenon was not associated with the Fernald site.

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Figure 1. Overview map of the sampling sites in the Great Miami River, 1993

Figure 2. Map of river mile 38.

Figure 3. Map of river mile 24.

Figure 4. Map of river mile 19.

Figure 5. Index of Biotic Integrity, IBI; Index of Well Being, Iwb (multimetric indices of fish community status) and QHEI (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.

Note: RM 19, 24 and 38 were sampled for comparison.

Figure 6. pH, temperature, and dissolved oxygen found at each site in the Great Miami River, 1993.

Figure 7. Soluble reactive phosphate found at each site in the Great Miami River, 1993.

Figure 8. Active chlorophyll a and total chlorophyll found at each site in the Great Miami River, 1993.

Figure 9. Soluble nitrite and ammonia found at each site in the Great Miami River, 1993

Figure 10. The number of species and the number of fish per site in the Great Miami River, 1993

Figure 11. The number of fish species in four subsamples at three sites in the Great Miami River, 1993.

Note: The duration of each subsample was approximately 20 minutes.

Figure 12. The number of fish caught per hour and the number of fish caught per kilometer in the Great Miami River, 1993.

Figure 13. The total weight and the biomass per hour of fish captured at each site in the Great Miami River, 1993.

Figure 14. Shannon Diversity Index of fish captured in the Great Miami River, 1993.

Figure 15. The cumulative proportion of fish by weight captured in the Great Miami River, 1993

Figure 16. The cumulative proportion of fish by length captured in the Great Miami River, 1993.

Figure 17. Length/weight relationship for gizzard shad in the Great Miami River, 1993

Figure 1 is a scatter plot showing the relationship between Length (cm) on the x-axis and Wet Weight (g) on the y-axis. The x-axis ranges from 5 to 40 cm, and the y-axis ranges from 0 to 800 g. The data points are labeled with their respective lengths, indicating a positive correlation between length and wet weight. The following table summarizes the data points shown in the plot:

Length (cm)	Wet Weight (g)
9	~10
11	~10
19	~130
24	~230
25	~110
26	~230
28	~310
29	~300
32	~510
38	~790

43

Figure 19. Length/weight relationship for sunfish in the Great Miami River, 1993

Figure 21. Length/weight relationship for carp in the Great Miami River, 1993.

Figure 20. Length/weight relationship for freshwater drum in the Great Miami River, 1993.

Figure 22. Length/weight relationship for Catostomidae in the Great Miami River, 1993.

Figure 23. The cumulative number of fish species per number of fish at each river site in the Great Miami River, 1993.

Figure 24. Detrended Correspondence Analysis of sites using fish species composition in the Great Miami River, 1993.

Note: The site mean and subsamples are grouped. A, B, C, and D are subsample designations.

Figure 25. Detrended Correspondence Analysis of species and sites using fish species composition in the Great Miami River, 1993.

Note: The fish species have been iterated by the same ordination as the sites in order to show the relative relationship between species and sites.

Table 1. Biotic and drainage data from Ohio EPA 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. #			
Whitewater River	9.4	1985	D	ECBP	45.0	25.5	10.3	46	
Indian Creek	4.1	1983	D	ECBP	77.0	26.3	8.9	43	Y
Fourmile Creek	0.3	1980	A	ECBP	315.0	18.7	8.8	49	
Twin Creek	0.2	1986	A	ECBP	316.0	21.7	9.1	49	
Mad River	1.2	1984	A	ECBP	655.0	17.0	8.7	33	
Stillwater River	51.2	1983	D	ECBP	106.0	30.7	8.9	45	Y
Boat Shocker									
Green Creek	16.0	1982	A	ECBP	607.0	22.7	9.1	49	
Loramie Creek	0.1	1982	A	ECBP	201.0	17.0	8.6	47	
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 Ohio EPA 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 three sites sampled in the Great Miami River, 1993

Parameters	Dat	pH	YSI31	HACH in field	Secchi	O2	PO4-P	NO3	NH4	Chl a	Total Chl
Units	Sep		Cond.	TDS	TP. (C)	Cond.	(mg PO4/l)	(mg NO3-N/l)	(mg NH4/l)	ug Chlorophyll/l	
RM 38	14	8.80	821	453	20.8	906	0.59	2.40	0.08	13.59	14.73
RM 24	15	8.73	833	456	22.6	913	0.44	2.25	0.10	16.18	17.73
RM 19	15	8.68	852	469	19.4	937	0.44	2.05	0.09	14.61	16.08

Table 4. 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 1993.

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	195	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	72.5		35	90.2	13		11	19
Mean	104.8	120.5	97.4	176.3	14.67	12.33	12.50	13.60
Coef.Var.	58.0%	41.9%	54.5%	52.2%	19.7%	19.0%	24.8%	30.3%

Table 3. Common name, family, and numbers of fish collected by site in the Great Miami River, 14 and 15 September 1993.

#	Common Name	Family	River Mile 38				River Mile 24				River Mile 19				Total		
			Subsample			Sum	Subsample			Sum	Subsample			Sum			
			1	2	3		1	2	3		1	2	3			4	
1	Gizzard Shad	Clupeidae	23	14		37	2	2		4	3	2	2	44	51	92	
2	Skipjack Herring	Clupeidae				0				0				1	1	1	
3	Mooneye	Hiodontidae				0				0	1				1	1	
4	Carp	Cyprinidae	1	1	5	7	2	2	1	5	1	1			2	14	
5	Mirror Carp	Cyprinidae			1	1				0					0	1	
6	Spotfin Shiner	Cyprinidae				0				0		3	1	1	5	5	
7	Golden Redhorse	Catostomidae	6	2	1	9		1		1		3		4	7	17	
8	Highfin Carpsucker	Catostomidae			1	1				0			1	1	1	2	
9	Quillback Carpsucker	Catostomidae				0		1		1	1	1		1	2	3	
10	River Carpsucker	Catostomidae				0		1		1					0	1	
11	Shorthead Redhorse	Catostomidae			1	1				0					0	1	
12	Brown Bullhead	Ictaluridae				0	1			1					0	1	
13	Channel Catfish	Ictaluridae	2		2	4		4		4	6		3		9	17	
14	Flathead Catfish	Ictaluridae				0		1		1					0	1	
15	Striped Bass	Percichthyidae				0				0	2				2	2	
16	White Bass	Percichthyidae			2	2	1	1	1	3	1				1	6	
17	Bluegill	Centrarchidae				0				0	1	4	1	1	7	7	
18	Green Sunfish	Centrarchidae	2			2				0					0	2	
19	Hybrd Bluegill and	Centrarchidae				0				0		1			1	1	
20	Longear Immature	Centrarchidae		1		1				0					0	1	
21	Bass Immature	Centrarchidae				0				0		3			3	3	
22	Sunfish Largemouth	Centrarchidae	2	2		4				0			1	1	1	5	
23	Bass Longear Sunfish	Centrarchidae	1	2		3				0		4		1	5	8	
24	Smallmouth Bass	Centrarchidae			2	2	1	2		3	1	2	1		4	9	
25	Sauger Freshwater	Percidae				0				0					1	1	
26	Drum Total Fish	Sciaenidae				0	3	3	5	11	6	1		4	11	22	
Total Fish			37	22	15	74	10	10	15	35	22	25	5	63	115	224	
Species Total			7	6	8	13	6	6	7	11	9	11	4	12	19	26	
Shannon Diversity Index																	
Diversity/Individual						1.797				2.067							2.098
Hmax						2.565				2.398							2.944
Evenness						0.700				0.862							0.713

Table 5. Mean weight and length of fish electroshocked by year and by river mile in the Great Miami River, 1984 to 1993.

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	28	23
1988		175	135	62		25	23.5	14.5
1989		195	186	110		21.8	21	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
Mean	141.0	305.5	260.6	110.1	15.3	25.6	24.7	18.7
Coef. Var	72.7%	54.6%	46.1%	42.3%	28.7%	13.1%	17.7%	19.9%

Table 6. Analysis of subsamples at each of the site locations in the Great Miami River, 1993.

	River Mile 38				River Mile 24				River Mile 19				Total	
	Subsample				Subsample				Subsample					
	1	2	3	Sum	1	2	3	Sum	1	2	3	4		Sum
Individuals	37	22	15	74	10	10	15	35	22	25	5	63	115	224
Species	7	6	8	13	6	6	7	11	9	11	4	12	19	26
Time shocked (min.)	20.0	20.0	21.2	61.2	20.0	20.0	20.0	60.0	20.0	16.5	20.0	20.0	76.5	197.7
Fish shocked/hour	111.0	66.0	42.5	73.2	30.0	30.0	45.0	35.0	66.0	90.9	15.0	189.0	90.2	68.0
Individuals/species	5.3	3.7	1.9	5.7	1.7	1.7	2.1	3.2	2.4	2.3	1.3	5.3	6.1	8.6
Distance shocked (km)	0.60	0.43	0.69	1.72	0.80	0.80	0.60	2.20	0.50	1.10	0.65	0.84	3.09	7.01
Fish/km	61.7	51.2	21.7	44.9	12.5	12.5	25.0	16.7	44.0	22.7	7.7	75.0	37.4	32.0

Table 7. Species diversity and evenness using the Shannon Information Index (Hbar (log base 2)) by year and by river mile in the Great Miami River, 1984 to 1993.

H bar/Individual					Evenness			
Yr/Site	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
Mean	2.49	2.31	2.46	1.84	0.61	0.64	0.72	0.46
Coef.Var.	26.4%	15.2%	28.5%	39.7%	23.1%	19.9%	21.8%	37.7%

Table 8. Community coefficients of species similarity between sites in the Great Miami River, 1993.

River Mile	38	24	19
38	1	0.50	0.50
24	0.50	1	0.53
19	0.50	0.53	1

Table 9. Length frequency distribution of fish electroshocked in the Great Miami River, 14 and 15 September 1993.

Length Frequency Distribution				
cm	Total	RM 38	RM 2	RM 19
0	0	0	0	0
2	0	0	0	0
4	1	0	0	1
6	7	0	0	7
8	22	13	1	8
10	31	16	0	15
12	42	16	0	26
14	8	2	0	6
16	2	1	0	1
18	7	2	0	5
20	14	1	1	12
22	13	3	1	9
24	13	1	7	5
26	13	1	7	5
28	7	1	4	2
30	4	1	1	2
32	1	1	0	0
34	2	0	0	2
36	3	0	2	1
38	4	2	0	2
40	4	3	0	1
42	4	1	2	1
44	6	0	4	2
46	4	2	1	1
48	6	4	1	1
50	4	3	1	0
60	2	0	2	0
SUM	224	74	35	115

Table 10. Weight frequency distribution of fish electroshocked in the Great Miami River, 14 and 15 September 1993.

Weight Frequency Distribution				
Grams	Total	RM 38	RM 24	RM 19
0	0	0	0	0
25	99	42	1	56
50	12	6	0	6
75	14	1	0	13
100	13	3	1	9
125	11	3	0	8
150	11	1	6	4
175	6	0	4	2
200	4	0	3	1
225	2	0	1	1
250	5	0	4	1
275	1	0	1	0
300	2	1	0	1
325	2	1	1	0
350	1	0	0	1
375	1	0	0	1
400	0	0	0	0
425	0	0	0	0
450	1	0	1	0
475	2	0	0	2
500	2	1	1	0
525	3	1	1	1
550	1	1	0	0
575	2	0	0	2
600	0	0	0	0
625	1	0	0	1
650	3	1	2	0
675	0	0	0	0
700	0	0	0	0
725	0	0	0	0
750	2	1	0	1
775	0	0	0	0
800	2	1	1	0
825	0	0	0	0
850	1	0	0	1
875	1	1	0	0
900	0	0	0	0
925	0	0	0	0
950	1	0	1	0
975	4	3	1	0
1000	2	0	1	1
1500	6	3	1	2
2000	5	3	2	0
2500	1	0	1	0
SUM	224	74	35	115

Appendix A. Listing of common names, species, and families in the Great Miami River, 1993.

#	Common Name	Species	Family
1	Skipjack Herring	<i>Alosa chrysochloris</i>	Clupeidae
2	Gizzard Shad	<i>Dorosoma cepedianum</i>	Clupeidae
3	Mooneye	<i>Hiodon tergisus</i>	Hiodontidae
4	Mirror Carp	<i>Cyprinus carpio</i>	Cyprinidae
5	Carp	<i>Cyprinus carpio</i> sp.	Cyprinidae
6	Spotfin Shiner	<i>Notropis spilopterus</i>	Cyprinidae
7	River Carpsucker	<i>Carpodes carpio</i>	Catostomidae
8	Quillback	<i>Carpodes cyprinus</i>	Catostomidae
9	Highfin Carpsucker	<i>Carpodes velifer</i>	Catostomidae
10	Golden Redhorse	<i>Moxostoma erythrurum</i>	Catostomidae
11	Shorthead Redhorse	<i>Moxostoma macrolepidotum</i>	Catostomidae
12	Brown Bullhead	<i>Ictalurus nebulosus</i>	Ictaluridae
13	Channel Catfish	<i>Ictalurus punctatus</i>	Ictaluridae
14	Flathead Catfish	<i>Ictalurus olivaris</i>	Ictaluridae
15	White Bass	<i>Morone chrysops</i>	Percichthyidae
16	Striped Bass	<i>Morone saxatilis</i>	Percichthyidae
17	Green Sunfish	<i>Lepomis cyanellus</i>	Centrarchidae
18	Bluegill	<i>Lepomis macrochirus</i>	Centrarchidae
19	Longear Sunfish	<i>Lepomis megalotis</i>	Centrarchidae
20	Hybrid Bluegill and Longear	<i>Lepomis</i> sp.	Centrarchidae
21	Immature Sunfish	<i>Lepomis</i> sp.	Centrarchidae
22	Smallmouth Bass	<i>Micropterus olomieu</i>	Centrarchidae
23	Largemouth Bass	<i>Micropterus salmoides</i>	Centrarchidae
24	Immature Bass	<i>Micropterus</i> sp.	Centrarchidae
25	Sauger	<i>Stizostedion canadense</i>	Percidae
26	Freshwater Drum	<i>Aploinotus grunniens</i>	Sciaenidae

Appendix B. Listing of the lengths and weights of fish captured at river mile 38, 1993.

#	Sub #	No.	Common Name	Family	Length (cm)	Weight (g)	Bag Number	Bag Wt (g)	Notes
1	1	1	Channel Catfish	Ictaluridae	44.7	731.00	104	388	
2	1	2	Channel Catfish	Ictaluridae	47.0	974.00	105	279	
	1	2	Channel Catfish	Ictaluridae			106	242	sample obtained from fish # 2
3	3	1	Channel Catfish	Ictaluridae	46.5	968.00	118,119	432,432	
4	3	2	Channel Catfish	Ictaluridae	38.4	494.00	118,119	432,432	
5	1	1	Carp	Cyprinidae	47.9	1477.00	107	431	
	1	1	Carp	Cyprinidae			108	550	sample obtained from fish # 5
6	2	1	Carp	Cyprinidae	39.5	859.00	110	552	
7	3	1	Carp	Cyprinidae	48.2	1545.00	120	945	
8	3	1	Mirror Carp	Cyprinidae	47.4	1053.00	121	713	Hairlip. Anus red. open jaw
9	3	2	Carp	Cyprinidae	49.1	1652.00	117	751	
10	3	3	Carp	Cyprinidae	41.5	967.00	115	598	
11	3	4	Carp	Cyprinidae	45.2	1318.00	113	474	
	3	4	Carp	Cyprinidae			114	392	sample obtained from fish # 11
12	3	5	Carp	Cyprinidae	49.2	1601.00	111	371	
	3	5	Carp	Cyprinidae			112	580	sample obtained from fish # 12
13	1	1	Gizzard Shad	Clupeidae	8.5	6.97	109	264	
14	1	2	Gizzard Shad	Clupeidae	10.8	12.05	109	264	
15	1	3	Gizzard Shad	Clupeidae	10.5	11.36	109	264	
16	1	4	Gizzard Shad	Clupeidae	8.0	5.31	109	264	
17	1	5	Gizzard Shad	Clupeidae	9.3	7.52	109	264	
18	1	6	Gizzard Shad	Clupeidae	8.7	7.21	109	264	
19	1	7	Gizzard Shad	Clupeidae	7.9	5.04	109	264	
20	1	8	Gizzard Shad	Clupeidae	10.0	10.18	109	264	
21	1	9	Gizzard Shad	Clupeidae	8.9	7.57	109	264	
22	1	10	Gizzard Shad	Clupeidae	7.4	4.36	109	264	
23	1	11	Gizzard Shad	Clupeidae	6.9	3.53	109	264	
24	1	12	Gizzard Shad	Clupeidae	10.1	10.64	109	264	
25	1	13	Gizzard Shad	Clupeidae	6.7	3.18	109	264	
26	1	14	Gizzard Shad	Clupeidae	8.1	5.35	109	264	
27	1	15	Gizzard Shad	Clupeidae	7.0	3.51	109	264	
28	1	16	Gizzard Shad	Clupeidae	9.9	9.59	109	264	
29	1	17	Gizzard Shad	Clupeidae	6.8	3.46	109	264	
30	1	18	Gizzard Shad	Clupeidae	7.1	3.70	109	264	
31	1	19	Gizzard Shad	Clupeidae	9.7	8.43	109	264	Laceration behind dorsal fin, possi
32	1	20	Gizzard Shad	Clupeidae	8.0	5.28	109	264	
33	1	21	Gizzard Shad	Clupeidae	7.1	3.61	109	264	
34	1	22	Gizzard Shad	Clupeidae	6.8	3.37	109	264	
35	1	23	Gizzard Shad	Clupeidae	7.4	4.24	109	264	
36	2	1	Gizzard Shad	Clupeidae	21.3	103.81	109	264	
37	2	2	Gizzard Shad	Clupeidae	20.3	96.52	109	264	
38	2	3	Gizzard Shad	Clupeidae	11.2	15.77	109	264	
39	2	4	Gizzard Shad	Clupeidae	11.8	13.28	109	264	
40	2	5	Gizzard Shad	Clupeidae	10.8	13.87	109	264	
41	2	6	Gizzard Shad	Clupeidae	11.1	14.33	109	264	
42	2	7	Gizzard Shad	Clupeidae	10.8	13.63	109	264	
43	2	8	Gizzard Shad	Clupeidae	11.1	14.22	109	264	
44	2	9	Gizzard Shad	Clupeidae	10.2	11.76	109	264	
45	2	10	Gizzard Shad	Clupeidae	9.6	10.91	109	264	
46	2	11	Gizzard Shad	Clupeidae	10.7	13.12	109	264	
47	2	12	Gizzard Shad	Clupeidae	10.8	12.51	109	264	
48	2	13	Gizzard Shad	Clupeidae	9.6	9.78	109	264	
49	2	14	Gizzard Shad	Clupeidae	10.0	10.76	109	264	
50	1	1	Golden Redhorse	Catostomidae	16.5	51.45	101	404	

51	1	2	Golden Redhorse	Catostomidae	12.8	25.53	101	404	
52	1	3	Golden Redhorse	Catostomidae	19.3	88.01	101	404	
53	1	4	Golden Redhorse	Catostomidae	16.0	49.93	101	404	
54	1	5	Golden Redhorse	Catostomidae	21.4	122.63	101	404	
55	1	6	Golden Redhorse	Catostomidae	6.8	3.21	101	404	
56	2	1	Golden Redhorse	Catostomidae	17.8	78.09	101	404	
57	2	2	Golden Redhorse	Catostomidae	22.7	139.54	101	404	
58	3	1	Golden Redhorse	Catostomidae	38.0	532.00	102	356	Scales missing, left side
59	3	1	Shorthead Redhorse	Catostomidae	29.9	287.60	103	388	
60	3	1	Highfin Carpsucker	Catostomidae	37.9	634.00	116	436	
61	3	1	White Bass	Percichthyidae	13.1	27.90	123	128	
62	3	2	White Bass	Percichthyidae	12.0	20.04	123	128	
63	1	1	Largemouth Bass	Centrarchidae	24.5	120.00	Returned		
64	1	1	Green Sunfish	Centrarchidae	12.0	34.58	123	128	
65	1	1	Large Mouth Bass	Centrarchidae	9.4	10.61	123	128	
66	1	1	Longear Sunfish	Centrarchidae	9.1	16.27	123	128	
67	1	2	Green Sunfish	Centrarchidae	8.5	11.74	123	128	
68	2	1	Largemouth Bass	Centrarchidae	38.5	792.00	Returned		
69	2	1	Immature Bass	Centrarchidae	9.5	10.90	122	342	
70	2	1	Longear Sunfish	Centrarchidae	9.9	25.94	123	128	
71	2	2	Largemouth Bass	Centrarchidae	28.0	318.00	Returned		
72	2	2	Longear Sunfish	Centrarchidae	11.4	30.61	123	128	
73	3	1	Smallmouth Bass	Centrarchidae	11.0	16.25	122	342	
74	3	2	Smallmouth Bass	Centrarchidae	31.8	506.00	122	342	

Appendix C. Listing of the lengths and weights of fish captured at river mile 24, 1993.

#	Sub #	No.	Common Name	Family	Length (cm)	Weight (g)	Bag Number	Bag Wt (g)	Notes
1	1	1	Brown Bullhead	Ictaluridae	42.5	791.00	201	480	
2	3	1	Flathead Catfish	Ictaluridae	35.5	439.00	216		
3	3	1	Channel Catfish	Ictaluridae	42.7	480.00	217, 221	297, 552	
4	3	2	Channel Catfish	Ictaluridae	48.5	965.00	217, 221	297, 552	
5	3	3	Channel Catfish	Ictaluridae	40.4	513.00	218, 222	358, 219	
6	3	4	Channel Catfish	Ictaluridae	43.7	629.00	218, 222	358, 219	Lacerated caudal fin
7	1	1	Carp	Cyprinidae	42.1	943.00	202, 203	520, 653	
8	1	2	Carp	Cyprinidae	41.2	977.00	202, 203	520, 653	Abrasion on lower lip
9	2	1	Carp	Cyprinidae	50.9	1893.00	204	448	
	2	1	Carp	Cyprinidae			205	628	sample obtained from fish # 9
10	2	2	Carp	Cyprinidae	45.2	1251.00	206	386	Abrasion on upper lip
	2	2	Carp	Cyprinidae			207	398	sample obtained from fish # 10
11	3	1	Carp	Cyprinidae	53.6	2270.00	219	840	
	3	1	Carp	Cyprinidae			220	740	sample obtained from fish # 11
12	1	1	Gizzard Shad	Clupeidae	24.5	136.50	212	312	
13	1	2	Gizzard Shad	Clupeidae	24.3	143.58	212	312	
14	3	1	Gizzard Shad	Clupeidae	23.4	188.46	212	344	Laceration on dorsal region
15	3	2	Gizzard Shad	Clupeidae	25.1	150.35	212	344	
16	2	1	Golden Redhorse	Catostomidae	7.0	3.90	Discarded		Juvenile
17	2	1	River Carpsucker	Catostomidae	46.4	1658.00	208	592	
	2	1	River Carpsucker	Catostomidae			209	544	sample obtained from fish # 17
18	3	1	Quillback	Catostomidae	35.7	646.00	215	418	
19	1	1	White Bass	Percichthyida	26.6	236.00	Returned		
20	2	1	White Bass	Percichthyida	26.5	222.00	Returned		
21	3	1	White Bass	Percichthyida	27.5	252.00	Returned		
22	1	1	Smallmouth Bass	Centrarchidae	26.5	227.00	Returned		
23	2	1	Smallmouth Bass	Centrarchidae	26.5	233.00	Returned		
24	2	2	Smallmouth Bass	Centrarchidae	25.5	230.00	Returned		
25	1	1	Freshwater Drum	Sciaenidae	23.0	165.77	210	312	
26	1	2	Freshwater Drum	Sciaenidae	22.1	125.79	210	312	
27	1	3	Freshwater Drum	Sciaenidae	22.0	133.88	210	312	
28	2	1	Freshwater Drum	Sciaenidae	25.6	175.78	211	324	
29	2	2	Freshwater Drum	Sciaenidae	23.5	171.76	211	324	
30	2	3	Freshwater Drum	Sciaenidae	23.0	148.80	211	324	
31	3	1	Freshwater Drum	Sciaenidae	29.3	301.59	213	278	
32	3	2	Freshwater Drum	Sciaenidae	19.9	99.94	213	278	
33	3	3	Freshwater Drum	Sciaenidae	24.5	180.82	214	353	
34	3	4	Freshwater Drum	Sciaenidae	23.0	134.95	214	353	
35	3	5	Freshwater Drum	Sciaenidae	24.6	164.51	214	353	

Appendix D. Listing of the lengths and weights of fish captured at river mile 19, 1993.

#	Sub #	No.	Common Name	Family	Length (cm)	Weight (g)	Bag Number	Bag W (g)	Notes
1	1	1	Channel Catfish	Ictalundae	24.6	127.33	304	472	
2	1	2	Channel Catfish	Ictalundae	24.8	123.11	304	472	
3	1	3	Channel Catfish	Ictalundae	23.2	100.30	304	472	
4	1	4	Channel Catfish	Ictalundae	37.8	555.00	307	351	
5	1	5	Channel Catfish	Ictalundae	45.3	843.00	311	300	
	1	5	Channel Catfish	Ictalundae			312	264	sample from # 5
6	1	6	Channel Catfish	Ictalundae	47.1	1083.00	319	374	
	1	6	Channel Catfish	Ictalundae			320	329	sample from # 6
7	4	1	Channel Catfish	Ictalundae	6.5	1.50	Discarded		
8	4	1	Channel Catfish	Ictalundae	38.8	451.00	304	472	
9	4	2	Channel Catfish	Ictalundae	5.3	1.21	Discarded		
10	1	1	Carp	Cyprinidae	40.4	976.00	303	517	
11	2	1	Spotfin Shiner	Cyprinidae	4.6	0.89	Discarded		
12	2	2	Spotfin Shiner	Cyprinidae	4.7	0.96	Discarded		
13	2	3	Spotfin Shiner	Cyprinidae	3.1	0.26	Discarded		
14	3	1	Spotfin Shiner	Cyprinidae	5.2	1.32	Discarded		
15	3	1	Carp	Cyprinidae	33.7	462.00	306	310	
16	4	1	Spotfin Shiner	Cyprinidae	6.6	2.72	Discarded		
17	1	1	Mooneye	Hiodontidae	26.8	219.91	UC collection		
18	1	1	Gizzard Shad	Clupeidae	22.0	99.12	301	310	
19	1	2	Gizzard Shad	Clupeidae	19.6	72.06	301	310	
20	1	3	Gizzard Shad	Clupeidae	10.8	13.26	310	235	
21	2	1	Gizzard Shad	Clupeidae	23.7	141.81	301	310	
22	2	2	Gizzard Shad	Clupeidae	22.2	109.79	301	310	
23	3	1	Gizzard Shad	Clupeidae	21.7	105.49	305	316	
24	3	2	Gizzard Shad	Clupeidae	17.6	54.79	305	316	
25	4	1	Skipjack Herring	Clupeidae	16.6	40.08	UC collection		
26	4	1	Gizzard Shad	Clupeidae	20.0	83.67	305	316	
27	4	2	Gizzard Shad	Clupeidae	9.9	10.25	305	316	
28	4	3	Gizzard Shad	Clupeidae	21.2	99.15	305	316	
29	4	4	Gizzard Shad	Clupeidae	19.2	72.51	308	290	
30	4	5	Gizzard Shad	Clupeidae	17.3	53.32	308	290	
31	4	6	Gizzard Shad	Clupeidae	20.0	79.88	308	290	
32	4	7	Gizzard Shad	Clupeidae	17.8	60.21	308	290	
33	4	8	Gizzard Shad	Clupeidae	20.9	84.17	308	290	
34	4	9	Gizzard Shad	Clupeidae	19.9	78.15	308	290	
35	4	10	Gizzard Shad	Clupeidae	18.9	74.96	310	235	
36	4	11	Gizzard Shad	Clupeidae	20.0	79.95	310	235	
37	4	12	Gizzard Shad	Clupeidae	10.3	11.71	310	235	
38	4	13	Gizzard Shad	Clupeidae	10.7	13.38	310	235	
39	4	14	Gizzard Shad	Clupeidae	10.9	12.46	310	235	
40	4	15	Gizzard Shad	Clupeidae	11.0	13.80	310	235	
41	4	16	Gizzard Shad	Clupeidae	10.3	13.40	310	235	Top half of caudal fi
42	4	17	Gizzard Shad	Clupeidae	10.7	12.30	310	235	
43	4	18	Gizzard Shad	Clupeidae	10.3	11.95	310	235	
44	4	19	Gizzard Shad	Clupeidae	10.1	10.67	310	235	
45	4	20	Gizzard Shad	Clupeidae	9.8	10.23	310	235	
46	4	21	Gizzard Shad	Clupeidae	10.5	11.46	310	235	
47	4	22	Gizzard Shad	Clupeidae	9.8	8.61	310	235	
48	4	23	Gizzard Shad	Clupeidae	8.0	5.73	310	235	
49	4	24	Gizzard Shad	Clupeidae	9.6	9.11	310	235	
50	4	25	Gizzard Shad	Clupeidae	6.7	3.33	310	235	
51	4	26	Gizzard Shad	Clupeidae	8.9	7.32	310	235	
52	4	27	Gizzard Shad	Clupeidae	10.5	11.90	310	235	

53	4	28	Gizzard Shad	Clupeidae	11.4	14.17	310	235	
54	4	29	Gizzard Shad	Clupeidae	9.2	7.74	310	235	
55	4	30	Gizzard Shad	Clupeidae	10.1	11.74	310	235	
56	4	31	Gizzard Shad	Clupeidae	10.8	14.24	310	235	
57	4	32	Gizzard Shad	Clupeidae	8.6	7.80	310	235	
58	4	33	Gizzard Shad	Clupeidae	9.6	9.04	310	235	
59	4	34	Gizzard Shad	Clupeidae	8.4	7.65	310	235	
60	4	35	Gizzard Shad	Clupeidae	6.4	2.73	310	235	
61	4	36	Gizzard Shad	Clupeidae	10.3	11.87	310	235	
62	4	37	Gizzard Shad	Clupeidae	10.9	12.72	310	235	
63	4	38	Gizzard Shad	Clupeidae	19.4	66.41	314	359	Part of caudal fin m
64	4	39	Gizzard Shad	Clupeidae	19.7	74.86	314	359	
65	4	40	Gizzard Shad	Clupeidae	21.7	107.50	314	359	
66	4	41	Gizzard Shad	Clupeidae	20.0	86.94	314	359	
67	4	42	Gizzard Shad	Clupeidae	21.1	89.53	314	359	
68	4	43	Gizzard Shad	Clupeidae	18.8	64.23	314	359	
69	4	44	Gizzard Shad	Clupeidae	17.7	57.34	314	359	
70	2	1	Golden Redhorse	Catostomidae	23.3	137.16	313	310	
71	2	1	Quillback Carpsucker	Catostomidae	28.6	363.22	318	460	
72	2	2	Golden Redhorse	Catostomidae	21.9	116.99	313	310	
73	2	3	Golden Redhorse	Catostomidae	24.2	167.73	313	310	
74	4	1	Highfin Carpsucker	Catostomidae	33.3	510.00	UC collection		
75	4	1	Golden Redhorse	Catostomidae	43.4	1006.00	317	400	
	4	1	Golden Redhorse	Catostomidae			321	338	sample from # 75
76	4	1	Quillback Carpsucker	Catostomidae	19.8	329.61	318	460	
77	4	2	Golden Redhorse	Catostomidae	6.7	3.77	UC collection		Juvenile
78	4	3	Golden Redhorse	Catostomidae	7.9	5.29	UC collection		Juvenile
79	4	4	Golden Redhorse	Catostomidae	8.0	5.35	UC collection		Juvenile
80	1	1	Striped Bass	Percichthyidae	27.0	226.00	Returned		
81	1	1	White Bass	Percichthyidae	24.3	160.00	Returned		Irregular lower stripe
82	1	2	Striped Bass	Percichthyidae	38.0	744.00	Returned		
83	1	1	Smallmouth Bass	Centrarchidae	25.0	182.00	Returned		
84	1	1	Bluegill	Centrarchidae	14.7	71.33	315	185	
85	2	1	Bluegill	Centrarchidae	11.5	33.02	315	185	
86	2	1	Hybrid Longear and Bluegill	Centrarchidae	11.5	36.72	315	185	
87	2	1	Immature Sunfish	Centrarchidae	5.7	4.12	316	179	
88	2	1	Longear Sunfish	Centrarchidae	12.7	42.50	316	179	
89	2	1	Smallmouth Bass	Centrarchidae	11.3	20.89	316	179	
90	2	2	Smallmouth Bass	Centrarchidae	22.7	134.00	Returned		
91	2	2	Bluegill	Centrarchidae	11.5	34.28	315	185	
92	2	2	Immature Sunfish	Centrarchidae	5.8	4.11	316	179	
93	2	2	Longear Sunfish	Centrarchidae	13.3	56.73	316	179	
94	2	3	Bluegill	Centrarchidae	9.8	21.41	316	179	
95	2	3	Immature Sunfish	Centrarchidae	5.7	3.04	316	179	
96	2	3	Longear Sunfish	Centrarchidae	12.5	57.64	316	179	
97	2	4	Bluegill	Centrarchidae	9.6	18.46	316	179	
98	2	4	Longear Sunfish	Centrarchidae	9.9	22.99	316	179	
99	3	1	Bluegill	Centrarchidae	9.5	17.48	316	179	
100	4	1	Largemouth Bass	Centrarchidae	28.7	300.00	Returned		
101	4	1	Longear Sunfish	Centrarchidae	12.6	46.28	315	185	
102	4	1	Bluegill	Centrarchidae	10.1	22.51	316	179	
103	4	1	Smallmouth Bass	Centrarchidae	9.2	11.16	316		
104	2	1	Sauger	Percidae	42.5	608.00	Returned		
105	1	1	Freshwater Drum	Sciaenidae	12.1	20.25	302	242	
106	1	2	Freshwater Drum	Sciaenidae	11.3	16.36	302	242	
107	1	3	Freshwater Drum	Sciaenidae	11.6	18.03	302	242	
108	1	4	Freshwater Drum	Sciaenidae	12.1	20.33	302	242	
109	1	5	Freshwater Drum	Sciaenidae	10.3	11.68	302	242	
110	1	6	Freshwater Drum	Sciaenidae	10.7	13.71	302	242	
111	2	1	Freshwater Drum	Sciaenidae	20.8	114.21	302	242	
112	4	1	Freshwater Drum	Sciaenidae	35.9	553.00	309	380	
113	4	2	Freshwater Drum	Sciaenidae	21.3	116.86	302	242	
114	4	3	Freshwater Drum	Sciaenidae	11.1	16.96	302	242	
115	4	4	Freshwater Drum	Sciaenidae	10.0	11.07	302	242	

Appendix E. Average length and weight with standard deviations for all species of fish from each site in the Great Miami River, 1993.

River Mile	n	Common Name Family Name	Average Length	STD Deviation	Average Weight	STD Deviation
		CLUPEIDAE				
38	37	Gizzard Shad	9.75	3.09	13.51	21.38
24	4	Gizzard Shad	24.33	0.70	154.72	23.19
19	51	Gizzard Shad	14.41	5.32	42.87	38.87
19	1	Skipjack Herring	16.60	n=1	40.08	n=1
		HIODONTIDAE				
19	1	Mooneye	26.80	n=1	219.91	n=1
		CYPRINIDAE				
38	7	Carp	45.80	3.90	1345.57	315.44
24	5	Carp	46.60	5.45	1466.80	588.99
19	2	Carp	37.05	4.74	719.00	363.45
38	1	Mirror Carp	47.40	n=1	1053.00	n=1
19	5	Spotfin Shiner	4.84	1.26	1.23	0.92
		CATOSTOMIDAE				
38	9	Golden Redhorse	19.03	8.55	121.15	160.11
24		Golden Redhorse	7.00	n=1	3.90	n=1
19	7	Golden Redhorse	19.34	13.19	206.04	359.53
38	1	Highfin Carpsucker	37.90	n=1	634.00	n=1
19	1	Highfin Carpsucker	33.30	n=1	510.00	n=1
24	1	Quillback Carpsucker	35.70	n=1	648.00	n=1
19	2	Quillback Carpsucker	24.20	6.22	346.42	23.77
24	1	River Carpsucker	46.40	n=1	1658.00	n=1
38	1	Shorthead Redhorse	29.90	n=1	287.60	n=1
		ICTALURIDAE				
24	1	Brown Bullhead	42.50	n=1	791.00	n=1
38	4	Channel Catfish	44.15	3.96	791.75	228.49
24	4	Channel Catfish	43.83	3.41	646.75	221.58
19	9	Channel catfish	28.16	15.41	365.05	393.23
24	1	Flathead Catfish	35.50	n=1	439.00	n=1
		PERCICHTHYIDAE				
19	2	Striped Bass	32.50	7.78	485.00	366.28
38	2	White Bass	12.55	0.78	23.97	5.56
24	3	White Bass	26.87	0.55	236.67	15.01
19	1	White Bass	24.30	n=1	160.00	n=1
		CENTRARCHIDAE				
19	7	Bluegill	10.96	1.85	31.21	18.91
38	2	Green Sunfish	10.25	2.47	23.16	16.15
19	1	Hybrid Longear and Bluegill	11.50	n=1	36.72	n=1
38	1	Imm. Largemouth Bass	9.50	n=1	10.90	n=1
19	3	Immature Sunfish	5.73	0.06	3.76	0.62
38	4	Largemouth Bass	25.10	12.04	310.15	345.51
19	1	Largemouth Bass	28.70	n=1	300.00	n=1
38	3	Longear Sunfish	10.13	1.17	24.27	7.31
19	5	Longear Sunfish	12.20	1.32	45.23	14.05
38	2	Smallmouth Bass	21.40	14.71	261.13	346.31
24	3	Smallmouth Bass	26.17	0.58	230.00	3.00
19	4	Smallmouth Bass	17.05	7.95	87.01	84.37
		PERCIDAE				
19	1	Sauger	42.50	n=1	608.00	n=1
		SCIAENIDAE				
24	11	Freshwater Drum	23.68	2.40	163.96	51.93
19	11	Freshwater Drum	15.20	7.95	82.95	160.93

DATE

FILMED

8/4/94

END