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ELECTROFISHING SURVEY OF THE GREAT MIAMI RIVER
SEPTEMBER, 1992
ANNUAL REPORT

by

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March 1993

Prepared for the
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FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION
P.O. BOX 398704
CINCINNATI, OH 45239-8704

Under Contract DE-AC05-92OR21972
U.S. Department of Energy
Fernald Field Office

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EXECUTIVE SUMMARY

At the end of summer in 1992 the fishery of the Great Miami River took an unexpected deviation from the stasis of past years as an intense suspended algal bloom decreased the compositional diversity found at the lower GMR stations.

Daytime supersaturation of oxygen and elevated pHs, reaching 9 by midday during the month of August, undoubtedly caused severe deficits of oxygen at night. Despite the aeration at every riffle, the intensities of the biological processes in the water were sufficient to cause very high positive and negative excursions of oxygen over the day and night cycle. The number of species dropped from 13 at upriver sites to only 7-8 at sites III and IV. Since the soluble reactive phosphorus was highest at site I (Hamilton) and decreased downriver, the source of the nutrients was probably domestic or industrial sources above Hamilton. Since the river is rapid riffles and long pools in the upstream reaches, the effect of a large algal biomass and strong diurnal variation in oxygen and pH did not affect fish species composition (sites I and II); however, in the extended pools above and below sites III and IV, the huge hypereutrophic suspended algal biomass and its microbial assemblage were likely able to cause severe stress to the fish populations. Since 1992 was not a low-flow year, this eutrophication of the river stems from some new source of nutrients.

The FEMP effluent pipe does not appear to be the major source of this event. Since the gradient was from upstream to downstream, there is no way to identify the contribution from the Fernald operation. The groundwater removal to halt the spread of uranium from the property had not yet begun. If the phosphate enrichment found this summer continues

next year, then the addition of ammonia or nitrite in groundwater may exacerbate this condition. The all-time low fish species richness at site IV could have been caused by a toxin, not related to the eutrophy, since so many community parameters were uniformly low. The number of species, the Shannon diversity per individual, evenness, and number of fish per kilometer were at an all-time low at site IV and lower than any other samples in the recent years.

INTRODUCTION

Each August or September from 1984 to the present, we have examined the status of the fishery of the Great Miami River (abbreviated as GMR) as part of a survey of uranium content of fish fillets (1984-1990) and whole fish (1991,1992, Fig. 1). The fish community in the river has been studied only sporadically before 1980 (Miller et al., 1987). Only when the Ohio Environmental Protection Agency (EPA) began surveying the streams, rivers and lakes in Ohio to determine compliance with clean water standards have biological sampling of water quality become more systematic. This necessitated developing a new set of indices and standardized sampling methods for fish and macroinvertebrates (Ohio EPA 1988). Our continued monitoring of three (now four) sites over nine years at the same time of year using very similar methods and samples sizes allows us to compare our new results with the findings of the Ohio EPA taken in 1980, 1987, and 1990 over the length of the river mainstem (Rankin et al., 1990). Moreover the Ohio EPA established reference streams in the state by ecoregion, a province of similar soils, bedrock, morphometry, and drainage that might cause some degree of equivalence between equal-sized water bodies or water courses. Our interpretation is strengthened by their effort.

The fish communities of the Great Miami River near Fernald, River Mile (RM) 22-38, are affected by the Ohio River as a source and as a refugium for species that live in the river and by the diversity and number of tributary rivers (Mad River, Stillwater River, GMR mainstem and Whitewater River). Between 1957-1959 fish sampling in the middle Ohio River identified 83 species of fish in lock and dam rotenone studies each autumn (Pearson and Pearson 1989). Studies on tributaries have found more species (108 spp. ORSANCO 1962). By 1970 the cumulative species list of fish for the Ohio River was 120 (Pearson and Krumholz 1979; Krumholz 1981). An average of 22 species of fish were taken in a single day sample between 1974-1986 from samples of 2100-3700 fish. 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.

The fish diversity in middle sized rivers is determined by migration from big rivers of fish such as the white bass, gizzard shad and carp. The small tributary streams are sources for minnows, darter relatives, white sucker and other fish. Rivers of intermediate order have a high diversity

of lithophils belonging to the suckers, buffalo, carpsuckers, and redhorses (Catostomidae) and catfish (Ictaluridae), the true large river fish species.

The diversity of fish in a given reach of stream is a function of the water quality (chemical variables), the structure of the habitat (habitat structure), energy base (allochthonous or autochthonous), flow regime and biotic interactions (competition and predation risk) (Karr 1981; Karr et al., 1986). The Ohio EPA has codified a system of assessing habitat quality, their QHEI (Quality of Habitat Evaluation Index) that includes current, bank stability, canopy, riparian vegetation, instream cover, gradient, channel morphology, channel width and depth (Ohio EPA 1987). The codification of wader and boat electroshocking and use of multicomponent indices like the Modified Index of Well Being (Iwb) (Gammon et al., 1981) and the Index of Biotic Integrity (IBI, Ohio EPA 1987), have allowed an aggressive EPA to characterize the water quality of the Great Miami River and its tributary streams (Ohio EPA 1990).

The GMR has been an industrial river receiving significant industrial and domestic sewage pollution from sites near Dayton, OH (Yoder and Gammon 1976). The Ohio EPA (Dayton Office, personal communication) did not know of but one new plant located above Hamilton and had no other reports of new nutrient-rich effluents in 1992. Rankin et al.(1990) summarize the factors that degrade Ohio's running waters; in which municipal and industrial point sources are number 1 affecting the most river miles; agricultural and non-point sources are number 2; channelization and habitat modification are number 3. Siltation and habitat modification are the two most serious sources of non-point habitat impairment. The GMR headwaters have exceptional water quality for the multicomponent indices for fish (called IBI and Iwb) and for macroinvertebrates (called the ICI or Index of Community Integrity). From headwater reference sites the Ohio EPA finds 19-21 species in single day samples and from clean tributaries of GMR from 17 to 30 species/ day (Table 8).

For one pollutant, Dayton is the source of PCB's that are diluted downriver in sediments and fish. There were > 2ppm PCB's in fish tissue of all species, especially carp, catfish, and suckers (in 1987) (Rankin et al. 1990). The toxicants and sewage (fecal coliforms) combine to create a suite of stations that have IBI, ICI or Iwb values in the poor-very poor range in mid-river.

In a two station comparison (RM 52.6, RM 60.6) of chemical parameters in the GMR in 1980 and 1989, all heavy metals and nutrient and

toxic anions, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were improved over the decade. In fact the total capital expenditures for water pollution control for 2 years, 1987 & 1988, in GMR were \$110 million, second only to the Maumee River in Ohio, equivalent to 1/6 of the total dollars spent. Enforcement of water pollution laws and federal aid for sewage plants are slowly changing our perception of the lower GMR. Still, low flow, pollution loading and elevated summer temperature lead to a massive fish kill at 261,000 fish near Hamilton in the drought of 1988. In the reach of GMR from Fourmile Creek to RM 26.6, no river mile reached an EPA designation as 'Full Aquatic Life Use Attainment' of water quality goals; one mile reached partial attainment and 11.8 miles did not reach attainment.

In the reach of river from Dayton to the Ohio River the IBI was 20 (poor-degraded) at three sites in the reach surveyed in this report. No site in the lower GMR reached an IBI of greater than 33 (fair-moderate impact) in electroshocking surveys between 1980 and 1989 (Fig. 2). The Index of Well-Being is a composite index using numbers and weights of fish computed into Shannon-type Indices. The modified Iwb ranges from 7.7 to 8.1 in the reach of the FEMP in 1989 (Karr et al., 1986). On a scale of 1-10 this is 'good'. (Ohio EPA 1990). The invertebrate community index, ICI, ranged from 40-50 in the area of FEMP, classed as 'good' or 'enriched' to 'exceptional' (Ohio EPA 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, in the reach below FEMP. The lowest quality of habitat was found in Hamilton (Fig. 2). Thus the extensive surveys of the Ohio EPA over the past decade show an enriched or degraded river in the area of FEMP, improving from point source degradation upriver.

This report will emphasize the comparison among the years, sites and replicates on the status of the fishery in terms of numbers, health, species richness, and diversity. The collection has been performed in late summer for the last nine years. With our extensive comparative, nine year database, we should be able to follow trends in changes or stasis of the river biota. If abnormal changes did occur 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, or as changes in condition as observed in length-weight distributions among sites.

The samples were collected and analyzed for uranium content of fish

fillets and whole fish. They were shipped as per instructions by Fernald Environmental Restoration Management Corporation (FERMCO) to Oak Ridge Analytical Services Laboratory in Oak Ridge, Tennessee. The fisheries analysis contained in this report focuses on the areas that are upstream of the Fernald Environmental Management Project (FEMP), the outfall pipe from FEMP, and those sites downstream of the outfall potentially impacted by FEMP effluents.

METHODS

Electrofishing: Electrofishing with pulsed DC is among the most efficient methods of collecting 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 aboard a 3 meter long, flat-bottom boat. The anode is located at the end of a 3 meter boom and consists of two to six vertical cables, extending 10-15 cm beneath the surface of the water. The cathode is composed of five 1 meter-long cables extending well under the bow of the boat. The electroshocking transformer is powered by a gasoline-driven ONAN^R generator, delivering 3500-watts of 120-volt AC at 29 amperes. The shocker delivers about 3.6-4.2 amperes (at 240 volts), depending on the conductivity of the water. The system is similar to the type 'A' rig specified by the Ohio EPA in routine boat electrofishing (Ohio EPA 1988). Two people standing behind a railing on the bow catch fish with long-handled (3 m) dip nets. The netters control the application of electricity to the anode (boom) with a foot-operated "dead-man" switch. The fish lose their equilibrium momentarily in a 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 in an aerated, central well within five minutes (Vibert, 1967). Some of the larger game fish (large mouth bass, small mouth bass and striped bass) were identified, measured and released immediately after gill motion and equilibrium appeared normal, as specified in our State of Ohio Scientific Collecting Permit.

In the smaller Paddys Run, a 1500 watt AC shocker was used for convenience and portability. Since the harvested fish were all used for uranium analysis, the low rate of recovery of the fish from AC shocking was not a prerequisite for this sampling site.

The fish collected for uranium analysis and biological survey were placed in plastic bags by replicate number, then combined by site in a larger bag, placed in a cooler on ice immediately and brought back to a radionuclide-free laboratory at the University of Cincinnati for identification and processing. In each replicate 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. Most of the fish used for uranium analysis were whole fish. Some fish, for comparison with methods used in previous years, were decapitated, eviscerated and definned to make modified fillets with scales, skin and some bones. These modified fillets are approximately what fishermen would consume if they ate fish from the river. In order to determine the full body burden for the fish filleted, the heads, fins and internal organs were bagged for uranium analysis as well. The sum of parts and modified fillets equals the body burden of the fish. Whole fish, modified fillets and visceral parts from each species or trophic status were adjusted to greater than or equal to 400 grams wet weight, labeled sequentially within each site by species group and sealed into resealable plastic bags. Fish from each collection site were processed as a group. The area was then cleaned and fish from the next site were processed completely so that contamination between stocks could not occur. Upstream or control stations were processed first as well in order to minimize cross contamination, were there any to be found.

Water Analysis: Physical-chemical measurements from each site included: 1) temperature ($^{\circ}\text{C}$) dissolved oxygen (ppm O_2 at 0.25 m) both with a YSI Model 57 meter (Yellow Springs Instruments Co., Yellow Springs, OH), 3) percent oxygen saturation (assumes 1 atmosphere. of pressure at the ambient river temperature taken from Table 6-1 in Wetzel and Likens (1991)) and 4) conductivity (μ Siemens or micromhos per centimeter square) determined with a YSI Model 33 conductivity meter. Suspended chlorophyll was analyzed on filters fluorometrically after extracting in 10 ml of 90% acetone for 24-48 hours at 4°C in darkness (Wetzel and Likens 1991). 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 DR 2000 HACH spectrophotometer, (HACH, Inc., Loveland, Colorado). FTU's, an absorbance-based measure

of turbidity measured at 450 nm (called Formazin Turbidity Units after a standard used in its quantification), was measured by spectrophotometer using a 2 cm light path. The pH was measured electrometrically, using a HACH 450 digital portable pH meter standardized by a pH 7 and pH 10 standard buffer. 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 STATISTIX 4.0 for DOS. Multiple pairwise comparisons were performed using a Tukey HSD post F test. All statistically significant results are *p* values less than or equal to 0.05 (two tailed). Two way ANOVA was used to examine the effect of site and year on parameters of fish community structure. We felt that the sites were far enough apart and the same fish were not likely to be in the same river location in the next year, that we could do this and not use ANOVA with years as repeated measures.

SITE DESCRIPTION

Four sites on the Great Miami River and one on Paddys Run were used for electrofishing in 1992. Three of the sites have been sampled annually at the same time of year since 1984 (RM 28, 24, & 19.3) (Fig. 1). A fourth site was added upstream as an additional control in 1991 at RM 38 (Fig. 1). Currently, the original three sites are connected by free flowing river with no effective barriers to fish movement between sites. The new upstream site is isolated from the downstream sites by two dams, preventing any migration of fish upstream from the FEMP area during a majority of the year. The river levels this year were normal allowing boat travel between sites below the Hamilton Dams and over the natural gas pipeline above Paddys Run.

Site I is north of Hamilton at River Mile 38, the confluence of Talawanda Creek and the Great Miami River. The site was channelized, moderately deep (>2m), clearly backed up by the dam since there was little detectable downstream water movement. The riparian community is relatively undisturbed, and the habitat provided by fallen trees, rocky shoals, and pools increases habitat heterogeneity. The site is just upriver of the outlet of Seven Mile Creek up to and around bridge bases of the US Route 127 bridge. A reach of 700 meters of the river was sampled in two 15 minute replicates, one on the north side and one on the south side of

the river with nearly equivalent margins and riparian vegetation. All sites were similarly sampled in 2-3 subsamples for replicability and the total time standardized to maintain continuity with the sampling methods of previous years. A third sample was collected within a kilometer upriver of the first Hamilton dam on the way to sample site for replicate 1 and 2. The third sample was grouped with site I samples as a replicate to maximize species pool including more habitats. The site of the third replicate was pooled, with younger riparian vegetation and obvious channel modification at some time in the past, probably upon dam construction. A similar third replicate was taken at all sites in order to determine the effect of different habitat types on the diversity of the sample.

Site II is at River Mile 28 near the City of Cincinnati's Bolton Water Works, upstream of any FEMP effluent. The site is a straight section of shallow pool below a sharp curve and above small rapids. A backwater thumb projects from the section of pool behind a bar above the rapids. The shores of the thumb and river on both sides are covered with overhanging riparian vegetation, with many treefalls in the river. The average pool depth was 1.1 meters. Several snags on the bottom make this the best habitat for fish, based on the criteria established by Gammon (1973) from work on the Wabash and the Ohio Rivers. The pool is cobble-covered and the sides are moderately steep and rocky on the eastern shore. The current here is faster than that found at site IV and slower than site III. A reach of 400 meters of the river was sampled as two replicates of 15 minutes each from the east shore and then the west shore. A third sample was taken in the backwater thumb, which is a deadwater that can deviate chemically from flowing river water in the main channel.

Site III is located at River Mile 24 near Stricker's Grove Park and the outfall pipe from FEMP. The mixing zone is a deep, fast section of river with strong eddy currents just below the outfall pipe. This site is on the outside of a long curve on the western shore of the river. It is steep-sided with a fairly rapid current, the fastest of the survey sites. Some riparian trees, either standing or fallen, provide good cover and high fish species diversity on the east side. The average pool depth here is 1.8 meters. This site has had the fastest current every year sampled. A reach of 500 meters of the river was sampled downstream of the outfall and divided into two subsamples: one on the eastern shore along a gravel bar and island and one on the western shore along the steep, wooded shoreline. Replicates were duplicate samples taken from navigating the circumference of the river

margins between the outfall and the rapids below. A third sample included riffle sections below the lower rapid.

Site IV is found at River Mile 19.3, the outfall of Paddys Run, which is the historic drainage route of surface runoff from the FEMP facility. A pool has been created here by 25 years of dredging by Welch's Sand and Gravel Co. The western shore is unaffected by the dragline operations and contains many large boulders and submerged logs, and has a good riparian vegetation which provide 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. The current is the slowest at this site and the river is pond-like in many respects. Three subsamples included the west shore, the east shore and around the old railroad bridge abutments up to the CG&E pipeline-crossing barrier at the north end of the Dravo Park.

Paddys Run Site is located at the pool located under and north of the bridge of New Haven Road. This is approximately 1.4 km upstream from the confluence of Paddys Run and the Great Miami River. The site is on flat limestone bedrock. Water depth is slight, less 20-30 cm in the pools and 2-10 cm in the riffle below. The site was worked with backpack electroshocker and nets and more effectively by a small 110VAC generator. The fish were very small requiring substantially more work to obtain a sample for nuclide analysis. This pool was isolated by hyporheic flow above and below this point through sand and unconsolidated material. These fish were thus restricted to this small section of stream during most of the low flow period. Judging from driftwood piles, during rainstorms very strong currents had swept through this section of stream.

Samples were collected at sites I and II on 20 August, 1992, and at sites III and IV on 21 August (Table 1, Figure 1). In Paddys Run, because of the small size of fish, many individuals were required in each sample, which required two sampling efforts. Paddys Run was sampled in a part on 20 Aug. and finished on 23 Aug. 1992. Each GMR site was sampled for about 40 minutes (site I= 45 min, site II= 36 min, site III = 46.9 min, and site IV = 39.3 min). At each site three equally timed samples were taken, each about 15 minutes in duration. This was a test of replicability of presumably equivalent habitats for at least two of the subsamples. The third sample was usually on a different, less ubiquitous habitat, either ponded (sites I and II) or more structure (site IV).

The total distance electrofished was 0.4 km, 0.5 km, 1.01 km, and

1.66 km at sites I, II, III and IV, respectively. This distance is the number of kilometers of shore traversed, at least once. Thus if both sides of the river were fished equally, then 1 km of river would be 2 km of electrofishing. In some cases (site III) some sections were fished twice, but the second pass did not add to the distance in this measure but did add to the time. The river was too large to consider a pass down either side to represent sampling all the fish in the whole river. The active stun zone was so small (4'x4'x 2-3' deep) that samples are a volume of water sampled with a nearly constant efficiency. Thus reporting as time is equivalent to a volume measure is biased by speed of movement. In complex shore zone, speed is slow as the boat and boom work in and out of the structure. However, reporting by shore kilometers compares rich and poor habitat in a km equally. Sampling a 1 km of barren shore zone may take only a few minutes, whereas working 200 meters of complex shoreline around logs and trees falling into the river may take many minutes and net even more fish. Both time and distance have biases in interpretation. Use of fish/kilometer is more common. Sites I and IV were pooled; sites II and III were flowing waters primarily in open runs. Sites II and III had the best development of riparian zone structure that fish prefer. These inequities are mandated by the requirements for sampling the fish for uranium and not by ecological criteria.

RESULTS AND DISCUSSION

A. Physical, Chemical:

The physical-chemical data support a picture of a severely eutrophicated section of river below Hamilton with wide day to night changes in chemistry (Figs 3, 4, 5, and 6). For the four river sites, there was no downstream pattern of increase in conductivity from Hamilton to Paddys Run (Table 1). However the samples taken in the morning at Hamilton and Strickers had higher conductivity than the samples collected in the afternoon at Bolton and Welch's. Perhaps the output from Dayton Sewage Plant is morning pulsed. More likely, the difference was due to strong diurnal variation in production and dissolution of calcium carbonate caused by wide diurnal swings in primary production (oxygen increase), pH and temperature (Table 1). The bedrock of the GMR is limestone. Water moving over limestone slowly will become saturated with CaHCO_3 . The very high conductivity of this water is a surrogate measure of the dominant minerals in surface waters in S.W. Ohio. From experience with chemistry

of surface waters of the region, those salts, we contend (without having done the analyses) are largely Ca^{++} and HCO_3^- . Some soluble salts from sewage may contribute to the total conductivity measured, but if all the salts in the river were all CaCO_3 , then the conductivity of 730 uS found would be about 320 mg CaCO_3 /liter (Hach, Inc. 1989). This is near the saturation point of CaCO_3 in freshwater where CO_2 is in equilibrium with the air. Photosynthetic decrease in free CO_2 , increases in pH and increases in temperature towards mid-afternoon could cause the precipitation of calcium carbonate. As photosynthesis uses free CO_2 from the water and some HCO_3^- is hydrolyzed to give OH^- , the pH rises (Wetzel 1983). Elevated afternoon temperature reduces the solubility of CaHCO_3 in water. The low concentrations of free CO_2 found in mid-afternoon can reduce the solubility of carbonate/bicarbonate even more, causing precipitation of calcite (marl) from bicarbonate-saturated solutions (Hanson et al., 1990).

The oxygen concentrations and the percent oxygen saturation were lower at morning sampling sites, due to reduced time for photosynthetic oxygen to build up in the water. Oxygen concentrations were supersaturated from 110% to 170% in all samples taken during the day (Table 1). The oxygen concentration did not relate to river mile in the river, but to time of day of sampling. Oxygen tension increased as a linear function of daylight hours proceeding the time of sample (Fig. 6). The river was apparently severely eutrophicated in 1992 and maintained a dense green bloom during all of late August, even after a major rainfall event.

Soluble reactive phosphate (SRP), turbidity and suspended algal chlorophyll support this hypothesis of increasing trophy of the river (Figs. 3, 4, & 5). The SRP, normally the limiting nutrient controlling algal biomass in midwestern lakes and rivers, was high with 85-180 ug P/liter (Bothwell 1985; Dillon and Rigler 1974; Peterson et al., 1985; Soballe and Kimmel 1987). The concentration of SRP dropped from upriver to downriver as the PO_4 was utilized by algal growth (Fig. 3) and sequestered by the suspended clays. The algal chlorophyll as a measure of algal biomass, showed the same pattern with a slight decrease downriver, presumably as phosphorus spiralled through the algae into the sediments (Fig. 4). However, the algal chlorophyll concentration was high at all sites, about 25 ug/liter, equivalent to what might be found in a eutrophic lake or hypereutrophic lake (Wetzel 1983). Normally, sestonic chlorophyll is a minor portion of river algal biomass, because most is attached to rocks as periphyton or epilithon. A rich suspended algal turbidity would tend to

light-limiting growth on rocks. Finding a 'green-looking' river water in 1992, caused by high biomass of suspended algae, was different than any previous year.

The **turbidity** is a measure of silt from erosion or gravel mining and from the algal biomass itself. The turbidity in general increased downriver from Hamilton. Since this measure of turbidity does not follow the pattern of chlorophyll biomass, the bulk of this turbidity must be suspended silt (Fig. 5). The silt load appears to be related to the apparent current velocity at each site with concentrations at site II > site III > site IV > site I. Perhaps the light flocculent silts and dying algae are resuspended by the increased sheer stress at the higher velocities. There was an active drag line working above Stricker's on the day the sample was taken. At Welch's Sand and Gravel (site IV) across from the mouth of Paddys Run, there was no dredging in the river during summer of 1992. However, the upstream operations left a thick scum of silt, mud and organic matter on all the rocks in the pool at site IV. Mining and resuspension probably explain the pattern of turbidity by site found in 1992.

For the first time in our late summer samples since 1984, biological processes seem to dominate the chemistry of the river causing supersaturation of oxygen from sestonic algal growth by day and, presumably oxygen depletion from respiration at night (Fig. 6, Table 1). The daylight demand for carbon dioxide by the huge algal biomass raised the pH of the river. At pHs of almost 9, carbonate was likely precipitated, which decreased the conductivity of the river water in the afternoon. At night the oxygen may have dropped to very low values by morning, caused by respiration of the large algal biomass and microbial flora suspended in the water. The release of large amounts of respiratory CO₂ will decrease the pH, allowing redissolution of carbonates by the aggressive CO₂ (Wetzel, 1983). This probable large day-to-night variation in oxygen and pH could be major physiological stresses on fish and macroinvertebrates.

B. Fish:

1. Species Richness and Abundance: This year in this survey, 491 fish (vs. 526 fish 1991) from 23 species (vs. 33 species 1991) in eight families, were sampled from the four sites in the Great Miami River (Figs. 7 & 8, Table 2). An additional 1635 small-stream fish in 13 species and four families were taken from one pool in Paddys Run at the New Haven Road bridge. The most diverse families from the river were the

Catostomidae and the Centrarchidae with six species each (Table 2). In the GMR, the number of different species per site ranged from 13 at sites I and II to only seven species at site IV (Fig. 8). The most numerous species was the gizzard shad (Clupeidae) with 319 individuals, followed by freshwater drum (Sciaenidae) with 60 individuals, green sunfish with 23 and smallmouth bass (Centrarchidae) with 18 individuals (Table 2). There were many fewer species at the downriver sites. Only in 1990, was comparably low species richness found (Table 4). However, this diversion from the norm was not basin-wide, as it was in 1990, because normal species richness was found at sites I and II.

Statistically, a two-way ANOVA showed that among the years 1985 to 1992, there was a difference in the number of species captured by year ($F = 3.90$, $df = 7,23$, $p = 0.0145$ HS), but not by site ($F = 0.26$, $df = 2,23$, $p = 0.077$ NS). The collection years 1985, 1991 and 1986 netted the most species, while 1990 and 1992 had the fewest respectively (Table 3).

The sites were electroshocked for 45, 36, 46.9 and 39.3 minutes at sites I, II, III, and IV, respectively (Table 2). 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; Ohio EPA, 1989; Yoder and Gammon, 1976). We collected 175, 133, 106, and 305 fish/hour in 1992 (Fig. 7), compared to 67, 225, 172, and 101 fish/hour in 1991 from the respective sites (Table 3). Thus the reduced species richness in the downstream sites was not caused by reduced number of fish sampled (since 121, 80, 83, and 200 individuals were actually captured at sites I, II, III, and IV, respectively)(Table 2). However, the distance traveled to collect that number of individuals was much farther at the downstream sites (0.4, 0.5, 1.0, 1.7 km, respectively) as we searched for more species (Table 2). As a result, the number of fish collected per kilometer of shoreline was greater at the upstream sites (328, 160, 82, 120 fish/km at sites I, II, III, and IV, respectively)(Table 2, Fig. 7). In fact, the density of fish may have been lower at the downstream sites where habitat structure was simpler.

A two-way analysis of variance using four sites from 1985-1992, found no differences in the number of fish electrofished per hour between years ($F = 1.12$, $df = 7,23$, $p = 0.402$) or among sites (II, III, IV) ($F = 3.46$, $df = 2,23$, $p = .06$). No years or sites were different than any other year or site in a post F comparison by Tukey's Honestly Significant

Difference (HSD). However, in 1992 the catch was high, primarily because of the returns from the pool at site IV. As usual more fish were returned per unit effort at sites $IV > II > III$.

Electrofishing presumably has some selectivity in sensitivity of certain species to the anode and in sensitivity of large fish compared to small fish to the voltage field. The efficiency of the electroshocker varies in volume of the stun zone as an inverse function of water conductivity and in netting efficiency as functions of water clarity and skill of boat operator and skill of the two netters. However, this late summer survey used the same equipment with broad overlap in personnel between years. Clearly, some of the differences observed between years may be mechanical, but many of those constraints are minimized in this operation. The analysis of replicate subsamples in this 1992 survey addresses one component of inter-year variance, namely the suitability of sample size and selection of macrohabitat.

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 that have been very dominant have low calculated diversity (H'). The maximal 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 site IV and their numbers had the greatest effect on reducing the diversity at that site (Table 2, 4). At site IV, gizzard shad accounted for 93% of all fish collected. Sites I and II had the highest diversity ($H' \geq 2.5$, $E \geq 0.67$) (Table 4, Fig. 9) and were dominated by gizzard shad, green sunfish and smallmouth bass. The highest evenness was found at site I ($E = 0.69$) (Table 4). The diversity at sites III and IV were the lowest for 1992 compared to the previous 9 years. The 8 year mean for H' and evenness shows a trend by site with $III > II > IV$ (Table 4). That was not true in 1992. For the diversity index H_{bar} , a two way ANOVA disclosed no significant differences between years ($F = 1.21$, $df = 7, 23$, $p = 0.359$ NS) or sites ($F = 3.40$, $df = 2, 23$, $p = 0.0627$ NS) in the Great Miami River. On average the index was highest at sites III, II, and IV, decreasing in that order. Amongst the years H_{bar} was highest in

1986 and 1985 and lowest in 1992.

The two-way ANOVA revealed a significant difference in mean evenness between sites ($F = 9.22$, $df = 2,26$, $p = 0.002$ HS, Table 4). Site IV had significantly lower evenness than sites II and III in a post F comparison of means. The eight-year mean evenness at site IV is statistically lower than other sites because of the high proportion of gizzard shad present in the large dredged pool at site IV. 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. However, the years 1985-1988 are higher than the years 1989-1992 in both indices ranked by year (but not significantly different).

3. Community Coefficients: Differences in community structure can be seen by comparing the similarity of species composition from the four 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. This is the simplest index of community change and has not statistical significance used alone, but shows the species overlap between all stations.

The community coefficient shows that sites I and II are similar (CC = 0.61) and sites II, III and IV are similar (CC = ca 0.40) (Table 5). The degree of similarity between site I and the downstream sites is low (site III, 29%; site IV, 30%) (Table 5). Another way to compare species data at several sites is to ask how many species are found at only one site, two sites, etc. For 1992 11 species were found at only one site (if Paddys Run is not included), 10 are found at two sites, 8 at three and only 3 at all four sites. Thus most species are specialists, restricted to a single site, or are so rare that the probability of recovering a specimen is completely random. However, since only three species were found at all four sites along only a

few river kilometers, suggests that stream order is changing the community composition continuously from upstream to downstream. Thus the occurrence of species at only one or two stations suggests that the stream order and/or habitat for fish changes along this small reach of river.

4. Weight/Length Distributions: The weight and length frequency distributions of fish collected (Tables 7a and 7b) were calculated as percent per size and cumulative percent per size. The modal weight is observed to be between 1- 25 grams for fish caught at site I, 25-60 grams for fish from site II, 75-100 grams for fish from sites III and 25-50 grams from site IV (Fig. 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 at site I and site IV (Table 7b, Fig. 11), the two most ponded sites. In both of these sites, more than 90% of the fish accumulated were in less than 100 gm size (Figs. 10, 11). 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 sites II and III, with less than 65% of these fish weighing less than 100 gms (Fig. 11). The big differences were differences in strength of 1-2 year old gizzard shad in the ponded sites.

The length frequency distributions (Fig. 12) show the modal length of fishes at site I (6-8 cm) was the smallest. Site II had the longest modal length (24-26 cm), almost the same as in 1991, and a very uniform number of fish at all sizes from 10-50 cm (Table 7a, Fig. 12). Site III appears to have a broad modal spread or a bimodal distribution (16-24 cm). Site IV modal length of the distribution is 14-18 cm. The diagram of cumulative percent frequency by length (Fig. 13) illustrates the dominance of small fish with a quick rise initially to the asymptote, compared to a uniform size distribution where the curve rises linearly to the asymptote. Clearly sites I and IV are dominated by more small fish than the other sites, with 90% of the fish being less than 20 cm (Fig. 13). Site II had the largest and most uniform size frequency with a linear rise in the cumulative frequency curve from 8 to 50 cm total length. When skewed to the young of one species, the curves demonstrate enrichment in food or habitat. When uniform and linear, the curves demonstrate an older population, which could mean a uniform current or a condition that has lead to a loss of the more sensitive young fish. We interpret the young-biased curves at site I and site IV to

reflect enrichment and pooling that favor gizzard shad. We interpret the loss of young to reflect habitat conditions and current, not a toxic stress at site II. The cumulative length or weight diagrams tell us much about the ability of a reach to support fish by size classes (regardless of species) as functions of hydrology, size of substrata, habitat complexity, and food availability. This is a useful index even though the composite species may vary widely.

The changes in growth rate and somatic condition can be compared for common species using (length x wet weight) distributions. This is curve reflecting allometry of length and weight, but deviations in weight per unit length show changes in 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) (6-8 cm) at site I and one-year-old fish (12-18 cm) at sites I and IV (Fig. 14). The larger fish only were found at sites II and III. Some of the larger shad at site II appeared to be light for their length (Fig. 14). Since most of the shad at that site live in the shallow-water 'thumb' of backwater lagoon, low oxygen on a diurnal basis may be limiting their growth compared to previous years.

Data for the smallmouth and largemouth bass were pooled to show a consistent length x weight relationship at sites I, II and III (Fig. 15). The lack of black basses at site IV is unusual, but might reflect changes in the channel at that site by gravel dredging, which is eliminating fast-water habitats. Normally smallmouth and largemouth basses have been found in the turbulence around the bridge abutments at the confluence of Paddys Run. The related sunfishes were widely distributed in all sizes at sites I, II, and III but were missing at site IV (Fig. 16) where one or more species have been common in the large pool at site IV. The freshwater drum was found in several size classes distributed in the downriver sites II, III, and IV (Fig. 17).

In conclusion, the diversity and evenness of the sites are highly influenced by the numbers of gizzard shad at each station. Sites I and III had the highest diversity and lowest gizzard shad populations. Pooling at sites I and IV 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, many species, normally found at site IV, were not found or found in such low numbers that they could not be included.

5. Ordination by Detrended Correspondence Analysis

(DECORANA): In order to evaluate the differences in the fish community by site, an eigenvector detrended correspondence analysis (DCA) was used (ter Braak 1986). This indirect gradient analysis is a type of principal component analysis which uses weighted sums. Its algorithm computes 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. Two sites that are very dissimilar in species composition will be located more than 2 standard deviations apart.

The DCA of sites using $\log(\text{species abundance})$ showed that site I was 2 standard deviations distant from fish community at sites III and IV (Fig. 18). This reinforces the community coefficient data which uses only presence/absence data. The eigenvalues of the two ordinales are 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 which species are responsible for the separation seen in Fig. 18 (Fig. 19). Sites I and IV were ponded and shared the species between them, bluegill, small-mouth bass, and gizzard shad (Fig. 19). The upstream site (I) was pulled in one direction by presence of small stream fish, minnows, shiner, white sucker, immature sunfish, and green sunfish, large-mouth bass and carp. The downstream site (IV) was pulled in the opposite direction by some big river fish from the Ohio River (gar, skipjack herring, drum and white bass). Sites II and III are clean boulder-covered stations dominated by river species from the sucker and catfish families: river carpsucker, small mouth buffalo, golden redhorse, and channel catfish and flathead catfish, respectively)(Fig. 19).

6. Analysis of Replicate Samples: In 1992 for the first time 3 replicates were taken at each of the 4 sites. Two were similar habitats and one was a different habitat in some structural way, designed to maximize

the number of fish species captured. In this way we could determine the efficiency of a single large sample, used in past years, to characterize the fish community and examine the variance between smaller samples from the same site. The fish species per replicate were similar and low at site IV, and quite variable at all other sites (Fig. 20, Table 9). However, a two-way ANOVA of sites x replicates found no significant difference in sites or in replicates for H_{max} , H_{bar} , species number, or density. There was a significant difference between sites for Evenness ($F=10.18$, $df(3,6)$, $p < .009$) with site IV being different and lower than the other sites (Tukey HSD, $p < .05$). The difference in density between stations was not significantly different at the 5% level, but close ($F= 4.43$, $df(3,6)$, $p = 0.058$). In an ideal world, larger sample sizes and more replicates would allow better resolution of patterns, but the results become only incrementally better and sacrifice potentially many more fish.

To evaluate the sufficiency of our normal sample sizes (1984-1992), a cumulative curve fish species against number of replicates was plotted. The curve should rise and reach an asymptote if all the fish have been sampled. In practice this is impossible to find the asymptote for riverine fish; however, the curves should begin to reach a plateau. In our 1992 samples, we could argue that those conditions of sufficiency were reached at sites I, II, and III, but not at site IV or in Paddys Run (Fig. 21). Our sample size was similar to that used by Ohio EPA in the GMR(100-600 fish/site), but represented a smaller distance of river and did not have 3 passes over the same area (Ohio EPA, 1990).

Fishes at site I are in populations isolated for most of the year from upstream migration by the two high dams. Sites II, III and IV can be influenced by effluents from the city of Hamilton and fish migration from the Ohio River. No indicators examined show any sign of differential pollution stress in the lower three sites that would be monitored as ulcers, epidermal fungal growth, growth anomalies or fin rot. However, the number of fish per kilometer, the number of species, the diversity per individual and the evenness were all lower in 1992 at the downstream sites, III and IV (Fig. 22). These declines in fish community structure could have been caused by the discharges from FEMP; however, circumstantial evidence is consistent with the primary cause being the biological response to a point source of nutrients upriver. The phosphate concentrations were very high for surface waters and the chlorophyll levels reached unparalleled

concentrations for so shallow a river. The metabolism of that seston could cause wide swings in oxygen concentration from day to night. Chemical changes in pH from respiration and photosynthesis and even in conductivity from CaCO_3 dissolution and precipitation, could follow on the same diel cycle. Oxygen depletion at night might be the cause of the decrease of the downriver diversity, since the build up of seston is time and distance related. That is, for a large biomass of algae to create a night time oxygen demand that will fall below the tolerance for a stationary fish in the river, the biomass would have had to develop to sufficiently high levels at least as far upstream as the water will move at night.

If the river water were moving at 3 mph, then in 8 hours, the water would move 24 miles on average. In order to sustain a low oxygen all night, the river seston would have to be high for 24 miles upriver at the beginning of darkness. The probable source would be Dayton or West Carrollton sewage treatment plants at RM 50+. Since two fish kills have been noted on the GMR in this middle reach since 1988, we know they can happen in even this free-flowing river (Ohio EPA 1990).

C. Paddys Run:

Paddys Run was a clear-water, intermittent creek flowing very slowly through a series of isolated pools in August 1992, as it does in most summers. The water was neutral in pH, had a conductivity nearly the same as the river, 681 $\mu\text{mhos}/\text{cm}^2$, oxygen near, but below saturation (Table 1). The water had a very high soluble reactive phosphorus concentration, 1.58 mg P/l. This sustained a luxuriant attached algal growth on the rocks in the stream. The hyporheic waters (groundwater) that made up 100% of stream flow, were apparently enriched in soluble phosphorus from reduced conditions in the underground portions of the creek. The shallow depth, high light and high nutrients allowed the benthic algae to dominate in this brook. Hence sestonic chlorophyll was very low at 1.11 $\mu\text{g}/\text{l}$ (Fig. 4). With effectively no flow in the creek, with a high benthic biomass, the elevated phosphate concentrations could not be maintained unless they are renewed from source with a high concentration. Hence nutrient loading from the infrequent rainfalls, washing in fertilizer-derived phosphate is an unlikely source, since the water could be cleared of phosphorus in only minutes, without continual renewal. The more likely source of high concentrations of soluble phosphate is from hyporheic water, percolating slowly through the water-saturated subsoil where redox potentials are low

and iron and phosphate can be solubilized.

In 1992 the fishes of lower Paddys Run were sampled by dip nets and small AC electroshocker for 90 minutes. A total of 1635 small fish were removed (1089 fish/hour) in 13 species. However only white sucker and largemouth bass were both found in Paddys Run and the Great Miami River. Most of the species in this small, ephemeral second order stream were minnows (8 species) and darters (3 species). The stream was dominated by the stoneroller, blacknose dace and bluntnose minnow.

This stream community was remarkably diverse for so ephemeral a stream. The flow goes underground in the entire lower section above the GMR and upstream of New Haven Road. Hence during the summer these populations exist in isolation from other genetic stocks. They are isolated in this very rich little stream in few standing water pools. Its compositional diversity is comparable to many streams that have water flowing continuously. After rainfall events this stream gorge is purged by storm runoff. This too could act as stress. Our samplings were before and after a major flood but the fish remained.

CONCLUSIONS

The fishery of the Great Miami River has been relatively stable over the last nine years, 1984-1992, except for sites III and IV in 1992. Over the nine years of sampling, 49 species have been recorded. A comparison of the 1992 species data with our 1991 data and with that of the Ohio EPA from 1980, 1987, and 1989, finds severe degradation of the community at sites III and IV, below the FEMP effluent zones (Fig. 22). Those sites lie well below all other samples of the fish communities in those lower reaches of river. Analysis of species area curves for replicates shows that only site IV was undersampled for species. This degradation could have come from a local toxic release from industrial plants, severe river dredging activity upstream, or the cumulative effects of nutrient loading and algal blooms.

Site I is protected from the upstream migration of fish by the two dams at Hamilton. In 1991 the site above the dam had many redhorse and northern hogsuckers, typical for mid-sized streams prior to cultural development. The absence of striped bass at site I also suggests that the two dams are successful barriers to the upstream migration of this fish in the spring. Also the drum, channel catfish and flathead catfish, three big river species, did not migrate beyond the dam. However in 1992, even

with good flow conditions most of the summer, the fishery was dominated by warm-water species from ponded habitats with many sunfish, bass and white suckers.

The lower sites are influenced by the backwater species, which migrate up from the dam-regulated Ohio River. Fish from site I could have originated from upstream of Hamilton or migrated up river during a previous year or during the spring prior to the low flow conditions. But clearly there are several lines of evidence that suggest that these barriers prevent the summer interchange of individuals that live in the downriver reaches of the GMR.

The diversity and evenness of the sites are highly influenced by the numbers of gizzard shad. Sites I and II had the highest diversity. At the latter station, the large shad appeared to lack condition factor compared to the other stations. Site IV was a nursery for young gizzard shad and had the lowest diversity and evenness. Other fish species appear to be the same condition of health, independent from site, as seen in the length x weight plots.

From circumstantial evidence we conclude that site I has a fish community isolated from upstream migration by two high dams. Only a few very large, rapid burst-swimming fish would have any chance of migrating up river (eg. sauger). Sites II, III and IV can be influenced by effluents from the city of Hamilton and from fish migration from the Ohio River. No indicators examined show any sign of differential pollution stress among the lower three sites causing ulcers, skin fungi, growth anomalies, etc. In this regard, there are no discernible statistically significant effects of the FEMP on the numbers, condition or species richness of the fish communities in the Great Miami River in 1992; however, the data show a probable degradation at sites III and IV, below conditions found any recent year. There was good circumstantial evidence that nutrient enrichment of the river, especially by phosphorus, was creating a river rich in seston, that could cause wide swings from day to night in oxygen tension, pH, and even conductivity. Oxygen depletion at night by respiration of the large biomass of algae and associated microbiota might be the source of the stress responsible for the decrease of downriver fish diversity.

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Figure 1. Map of sampling sites on the Great Miami River, 1992.

Figure 2. Index of Biotic Integrity, IBI; Index of Well Being, Iwb (multimetric indices of fish community status) and QHEI (index of habitat quality) in GMR from Ohio River (RM 0) to Dayton(RM 50) from Ohio EPA data, 1980, 1987, 1989.

Figure 3. Soluble reactive phosphate (mg PO₄-P/liter) in Great Miami River, 20-23 Aug. 1992.

Figure 4. Active chlorophyll a (ug/liter) in seston from Great Miami River and Paddy's Run, Aug. 20-22, 1992.

Figure 5. Turbidity as FTU's in Great Miami River 20-23 Aug. 1992.

Figure 6. Dissolved oxygen concentration, percent of air saturation, pH, and Temperature as functions of time of day during period 20-23 Aug. 1992 at Great Miami River sites.

Figure 7. Number of fish collected per hour and per kilometer of shoreline electroshocked at 4 sites on GMR, 20-21 Aug. 1992.

Figure 8. Number of species of fish and number of individuals capture/site in the 1992 electroshocking survey.

Figure 9. Shannon Diversity Index of fish captured by site on Great Miami River and Paddy's Run, 1992, showing H_{bar} /individual, H_{max} as $f(\text{total species})$ and Evenness ($H_{\text{bar}}/H_{\text{max}}$)

Figure 10. Frequency of fish weight categories for all sites from the Great Miami River, 1992

Figure 11. Cumulative proportion of fish weight for all sites from the Great Miami River, 1992.

Figure 12. Frequency of fish length categories for all sites from the Great Miami River, 1992.

Figure 13. Cumulative proportion of fish length from all sites in the Great Miami River, 1992.

Figure 14 Gizzard shad length/weight relationship of four sites from the Great Miami River, 1992.

Figure 15. Largemouth and smallmouth bass length/weight relationship for all sites from the Great Miami River, 1992.

Figure 16. Sunfish (all) length/weight relationship for all sites from the Great Miami River, 1992.

Figure 17. Drum length/weight relationship for all sites from the Great Miami River, 1992.

Figure 18. Canoco Detrended Correspondence Analysis of GMR sites in species space (density is log transformed to reduce effect of dominance) as function of first and second DCA ordinate axes.

Figure 19. Canoco Detrended Correspondence Analysis of GMR fish species in sample site space overlaid on the DCA of sites in Fig. 22 (density of each species is log transformed; first and second DCA ordinate axes presented)

Figure 20. Number of fish species in three replicates (ca 15 min.) at the 4 river sites and the total cumulative number of species at each site.

Figure 21. Cumulative number of species captured in three 15 minute samples taken at each station. The first two approximate replicate habitats; the third is normally a different type of habitat.

Figure 22. Number of species of fish per sample by river mile location in Great Miami River collected by Ohio EPA (1980, 1989), and our data in 1991 and 1992 (stations marked by vertical lines).

Table 1. Physical and chemical parameters of four sites sampled in GMR and one in Paddy's Run 1992.

Station	Site	Turbidity		Phosphorus		Chlor a		Total Chl.		Time of Day(hrs)	Temp. C	pH units	[H+]	Cond. umhos/cm	dissolved		
		mg/l	FTU's	mg/l PO ₄	mg/l P	ug chl/l	ug chl/l	ug chl/l	ug chl/l						oxygen mg/l	Oxygen Sat.at C	% O ₂ sat % Sat.
Hamilton	I		27.00	0.180	0.059	26.78	26.61	28.61	28.61	11.30	22.2	8.72	1.9E-09	725	11.4	8.70	131.0
Baton lagoon	II		31.50	0.140	0.046	27.09	28.61	28.61	28.61	13.15	23.6	8.86	1.4E-09	655	14.4	8.45	170.4
											26.2	8.94	1.1E-09	600			
Stricker's	III		37.50	0.120	0.039	24.82	28.48	28.48	28.48	10.00	22.2	7.85	1.4E-08	735	9.6	8.72	110.1
Welch's	IV		33.00	0.065	0.028	24.92	28.21	28.21	28.21	13.00	25.1	8.98	1.1E-09	632	13.1	8.60	152.3
Paddy's Run	V		0.00	1.575	0.514	1.11	1.99	1.99	1.99	16.15	21.5	7.38	4.2E-08	661	8.2	9.01	91.0

Table 2. Fish species and number of fish captured from four sites in the Great Miami River and one site Paddy's Run, 20-23 Aug. 1992.

SPECIES	FAMILY	RM18 SITE 1 TOTAL	RM28 SITE 2 TOTAL	RM24 SITE 3 TOTAL	RM19.3 SITE 4 TOTAL	SUM GM SITES	Paddy's PADDY TOTAL
LONG NOSE GAR	LEPISOSTEIDAE				1	1	
GIZZARD SHAD	CLUPEIDAE	61	32	41	185	319	
SKIPIACK HERRING	CLUPEIDAE				1	1	
BLACKNOSE DACE	CYPRINIDAE						2
BLUNTNOSE MINNOW	CYPRINIDAE						2
CREEK CHUB	CYPRINIDAE						
CYPRINUS CARPIO	CYPRINIDAE	2	2			4	
EMERALD SHINER	CYPRINIDAE						
ROSEFIN SHINER	CYPRINIDAE						
SILVERBANDED SHINER	CYPRINIDAE	2				2	
SOUTHERN REDBELLED DACE	CYPRINIDAE						
SPOT-FIN SHINER	CYPRINIDAE	1				1	
STONEROLLER	CYPRINIDAE						
UNID. CYPRIN_A	CYPRINIDAE						
BIG_MOUTH BUFFALO	CATASTOMIDAE	1				1	
BLACK REDHORSE	CATOSTOMIDAE	1			1	2	
GOLDEN REDHORSE	CATASTOMIDAE				1	1	
RIVER CARPSUCKER	CATOSTOMIDAE		3			3	
SM.MOUTH BUFFALO	CATOSTOMIDAE		1	1		2	
WHITE SUCKER	CATOSTOMIDAE	13				13	
BLUEGILL SUNFISH	CENTRARCHIDAE	3	2		2	7	
GREEN SUNFISH	CENTRARCHIDAE	22	1			23	
LARGE MOUTH BASS	CENTRARCHIDAE	3	2			5	
LONGEAR SUNFISH	CENTRARCHIDAE	4	3			7	
SMALL MOUTH BASS	CENTRARCHIDAE	8	2	4	4	18	
SUNFISH, IMMATURE	CENTRARCHIDAE	10				10	
CHANNEL CATFISH	ICTALURIDAE		2	1		3	
FLATHEAD CATFISH	ICTALURIDAE		3	2		5	
STRIPED BASS	PERCYCITHIDAE				2	2	
FANTAIL DARTER	PERCIDAE						
JOHNNY DARTER	PERCIDAE						
ORANGETHROAT DARTER	PERCIDAE						
SAUGER	PERCIDAE		1			1	
DRUM	SCIAENIDAE		26	32	2	60	
TOTAL							
SPECIES # = 34	INDIVIDUALS/STATION	131	80	83	200	491	
	SPECIES/STATION	13	13	8	7	23	
	MIN. SHOCKED	45	36	46.9	39.3	167.2	
	FISH SHOCKED/HOUR	175	133	106	305	176	
	# INDIVIDUALS/SP.	10.1	6.2	10.4	28.6	21.3	
	km SHOCKED	0.40	0.50	1.01	1.66	3.57	
	FISH/KM	328	160	82	120	173	
Shannon-Wiener	Index						
	Hbar/ind	2.6	2.49	1.68	0.49		
	Hmax	3.7	3.70	3.00	2.81		
	Evenness	0.7	0.67	0.56	0.18		

Table 3. The number of fish captured per hour and number of species by site and year from Great Miami River, 1984-1992.

YEAR/SITE	Number of Fish per Hour				Number of Species per Sit			
	I	II	III	IV	I	II	III	IV
1984								
1985		104	84	314		15	12	15
1986		98	79	266		11	19	16
1987		73	75	102		10	15	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
AVG	120.8	120.5	105.3	187.0	15.50	12.00	12.75	12.75
Coef.Var.	63.0%	41.9%	48.4%	49.3%	22.8%	19.5%	25.4%	30.4%

Table 4. Species diversity and evenness using Shannon Information Index (log bas 2) of fish by site and year from the Great Miami River, 1984-1992.

YEAR/SITE	H bar/INDIVIDUAL				EVENNESS			
	I	II	III	IV	I	II	III	IV
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
AVG	2.83	2.31	2.50	1.82	0.57	0.64	0.70	0.43
Coef.Var.	13.9%	15.2%	29.1%	42.4%	29.8%	19.9%	22.4%	36.8%

Table 5. Community coefficients of species similarity between sites from Great Miami River, Aug. 1992.

SITE	I	II	III	IV	PR
I	1	0.61	0.29	0.30	0.16
II	0.61	1	0.29	0.40	0.00
III	0.29	0.29	1	0.40	0.00
IV	0.30	0.40	0.40	1	0.00
PR	0.16	0.00	0.00	0.00	1

Table 6. Mean weight and length of average fish electroshocked by sites and year, 1985-1992.

yr/site	Weight of Fish (gm)				Length of Fish (cm)			
	I	II	III	IV	I	II	III	IV
1984								
1985			623	376		23.8	26.3	18.5
1986			471	271		30.5	23.3	23.8
1987			180	260			28	23
1988			175	135			23.5	14.5
1989			195	186		21.8	21	17.4
1990			289	316		30.3	29.4	23.5
1991		140	166	157		16.9	17.6	14.8
1992		39	345	150		10.3	21.9	16.6
Average	89.5	305.5	231.4	109.1	13.6	25.6	23.9	19.0
Coef. Var.	79.8%	54.6%	37.9%	45.6%	34.3%	13.1%	16.3%	20.4%

Table 7a. Length frequency distributions of fish electroshocked, Great Miami River, Aug. 1992.

LENGTH FREQUENCY DISTRIBUTION 1992

cm	total	SITE I	SITE II	SITE II	SITE IV
0	0	0	0	0	0
2	0	0	0	0	0
4	0	0	0	0	0
6	19	19	0	0	0
8	45	43	1	0	1
10	24	19	4	0	1
12	16	14	2	0	0
14	23	15	3	0	5
16	71	8	2	7	54
18	74	3	4	16	51
20	30	4	4	14	8
22	16	1	0	9	6
24	22	2	4	15	1
26	19	1	9	7	2
28	4	0	4	0	0
30	6	0	1	5	0
32	1	0	1	0	0
34	4	1	1	1	1
36	4	0	3	0	1
38	2	0	1	1	0
40	4	0	3	1	0
42	3	0	2	1	0
50	4	1	3	0	0
60	2	0	1	1	0
70	1	0	1	0	0
	0	0	0	0	0
SUM	394	131	54	78	131

Table 7b. Weight frequency distributions of fish electroshocked, Great Miami River, Aug. 1992.

WEIGHT FREQUENCY DISTRIBUTION 1992					
grams	total	SITE I	SITE II	SITE III	SITE IV
1	0	0	0	0	0
25	103	94	6	0	3
50	135	22	8	13	92
75	55	7	5	16	27
100	28	2	6	18	2
125	21	0	5	14	2
150	10	1	5	3	1
175	6	1	0	4	1
200	4	1	1	1	1
225	1	0	1	0	0
250	4	0	1	2	1
275	0	0	0	0	0
300	1	0	0	1	0
325	1	0	0	0	1
350	1	0	0	1	0
375	3	0	2	1	0
400	0	0	0	0	0
425	2	2	0	0	0
450	1	0	0	0	1
475	1	0	1	0	0
500	2	0	1	1	0
525	0	0	0	0	0
550	0	0	0	0	0
575	2	0	2	0	0
600	0	0	0	0	0
625	0	0	0	0	0
650	0	0	0	0	0
675	1	0	1	0	0
700	0	0	0	0	0
725	0	0	0	0	0
750	1	0	1	0	0
775	0	0	0	0	0
800	0	0	0	0	0
825	1	0	0	1	0
850	1	0	1	0	0
875	1	0	1	0	0
900	1	0	1	0	0
925	0	0	0	0	0
950	0	0	0	0	0
975	1	0	1	0	0
1000	1	0	0	1	0
1500	2	0	2	0	0
2000	1	1	0	0	0
3000	0	0	0	0	0
SUM	392	131	52	77	132

Table 8. Biotic and drainage data from Ohio EPA for GMR for reference sites from comparison of other sites in the drainage (data 1980-1986).

	rivermile	year	D	ECOREG	Drainage mi ²	MeanSpp. #	Index Well-		Index Biotic	
							Being	mod lwb	Integrity	SRP
GMR Tributaries										
BACKPACK SHOCKER										
Whitewater River	9.4	86	D	ECBP	45	25.5	10.3		46	Y
Indian Creek	4.1	83	D	ECBP	77	26.3	8.9		43	
Fourmile Crk.	0.3	80	A	ECBP	315	18.7	8.8		49	
Sevenmile Cr	0.2	86	A		316	21.7	9.1		49	
TwinCr.	1.2	84	A	ECBP	655	17.0	8.7		33	
Mad R.										
Buck Crk.										
Stillwater R	51.2	83	D	ECBP	106	30.7	8.9		45	Y
BOAT SHOCKER										
Greenville Cr	16.0	82	A	ECBP	607	22.7	9.1		49	
Loramie Cr	0.1	82	A	ECBP	201	17.0	8.6		47	
GMR Mainstem										
GMR Mainstem	88.1	80	A	ECBP	1150	20.7	8.3		37	
GMR Mainstem	91.0	80	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 9. Analysis of replicate samples at each station in Great Miami River and Paddy's Run, Aug 20-23, 1992.

Site I				Site II				Site III				Site IV				Site V			
HAMILTON				BOLTON W.W.				STICKER				WILCHAY				PADDY'S RUN			
1	2	3	TOTAL	1	2	3	TOTAL	1	2	3	TOTAL	1	2	3	TOTAL	1	2	3	TOTAL
INDIVIDUAL STATION				INDIVIDUAL STATION				INDIVIDUAL STATION				INDIVIDUAL STATION				INDIVIDUAL STATION			
53	97	21	171	30	11	30	71	10	27	20	57	40	40	72	200	40	50	40	130
7	11	7	25	8	7	3	18	7	2	3	12	4	5	5	14	8	8	8	24
15	15	15	45	15	15	6	36	15	15	16.0	46.0	15	15	0.5	30.5	20	20	20	60
212	228	84	524	120	44	300	464	72	140	135	347	250	200	400	850	150	140	400	730
7.6	5.2	3.0	15.8	3.75	1.57	13.00	6.15	2.57	13.50	12.67	16.30	15.75	13.00	14.00	26.57	12.13	13.50	44.44	134.25
TOTAL				TOTAL				TOTAL				TOTAL				TOTAL			
2.555	2.467	2.467	7.489	2.315	2.464	1.204	2.464	2.419	0.691	1.236	1.460	0.501	0.431	0.431	0.400	2.117	2.404	1.717	2.180
2.897	3.459	2.897	9.253	3.000	2.897	1.505	3.700	2.897	1.400	1.505	3.800	2.890	2.503	2.503	2.897	3.000	3.170	3.170	3.500
0.432	0.791	0.286	0.499	0.720	0.540	0.318	0.573	0.683	0.691	0.773	0.540	0.500	0.500	0.401	0.173	0.704	0.432	0.543	0.610
TOTAL				TOTAL				TOTAL				TOTAL				TOTAL			
2.897	3.459	2.897	9.253	3.000	2.897	1.505	3.700	2.897	1.400	1.505	3.800	2.890	2.503	2.503	2.897	3.000	3.170	3.170	3.500
0.432	0.791	0.286	0.499	0.720	0.540	0.318	0.573	0.683	0.691	0.773	0.540	0.500	0.500	0.401	0.173	0.704	0.432	0.543	0.610

Appendix A. List of Common names, family and species of fish from the Great Miami River, 1992.

LONG NOSE GAR	<i>Lepisosteus osseus</i>	LEPISOSTEIDAE
SKIPJACK HERRING	<i>Alosa Chrysochloris</i>	CLUPEIDAE
GIZZARD SHAD	<i>Dorosoma cepedianum</i>	CLUPEIDAE
STONEROLLER	<i>Campostoma anomalum</i>	CYPRINIDAE
CARP	<i>Cyprinus carpio</i>	CYPRINIDAE
ROSEFIN SHINER	<i>Notropis ardens</i>	CYPRINIDAE
EMERALD SHINER	<i>Notropis atherinoides</i>	CYPRINIDAE
SILVERBANDED SHINER	<i>Notropis shumardi</i>	CYPRINIDAE
SPOT-FIN SHINER	<i>Notropis spilopterus</i>	CYPRINIDAE
SOUTHERN REDBELLIED DACE	<i>Phoxinus erythrogaster</i>	CYPRINIDAE
BLUNTNOSE MINNOW	<i>Pimephales notatus</i>	CYPRINIDAE
BLACKNOSE DACE	<i>Rhinichthys atratulus</i>	CYPRINIDAE
CREEK CHUB	<i>Semotilus atromaculatus</i>	CYPRINIDAE
UNID.CYPRIN A		CYPRINIDAE
RIVER CARPSUCKER	<i>Carpodes carpio</i>	CATOSTOMIDAE
WHITE SUCKER	<i>Catostomus commersoni</i>	CATOSTOMIDAE
SM.MOUTH BUFFALO	<i>Ictiobus bubalus</i>	CATOSTOMIDAE
BIG MOUTH BUFFALO	<i>Ictiobus cyprinellus</i>	CATOSTOMIDAE
BLACK REDHORSE	<i>Moxostoma duquesnei</i>	CATOSTOMIDAE
GOLDEN REDHORSE	<i>Moxostoma erythrurum</i>	CATOSTOMIDAE
CHANNEL CATFISH	<i>Ictalurus punctatus</i>	ICTALURIDAE
FLATHEAD CATFISH	<i>Pylodictis olivaris</i>	ICTALURIDAE
GREEN SUNFISH	<i>Lepomis cyanellus</i>	CENTRARCHIDAE
BLUEGILL SUNFISH	<i>Lepomis macrochirus</i>	CENTRARCHIDAE
LONGEAR SUNFISH	<i>Lepomis megalotis</i>	CENTRARCHIDAE
SUNFISH, IMMATURE	<i>Lepomis sp.</i>	CENTRARCHIDAE
SMALL MOUTH BASS	<i>Micropterus dolomieu</i>	CENTRARCHIDAE
LARGE MOUTH BASS	<i>Micropterus salmoides</i>	CENTRARCHIDAE
STRIPED BASS	<i>Marone saxatilis</i>	PERCYCITHIDAE
FANTAIL DARTER	<i>Etheostoma flabellare</i>	PERCIDAE
JOHNNY DARTER	<i>Etheostoma nigrum</i>	PERCIDAE
ORANGETHROAT DARTER	<i>Etheostoma spectabile</i>	PERCIDAE
SAUGER	<i>Stizostedion canadense</i>	PERCIDAE
DRUM	<i>Aplodinotus grunniens</i>	SCIAENIDAE

Appendix B: List of species, weight, length and sample bag number from Site I, GMR, Aug. 20-23, 1992

COMMON NAME	FAMILY	LENGTH	WEIGHT	REP	BAG	NOTES
		cm	gm	#	# bag# = gms	
GIZZARD SHAD	CLUPEIDAE	16.60	50.33	1	201	201 = 485G
GIZZARD SHAD	CLUPEIDAE	14.40	33.58	1	201	
GIZZARD SHAD	CLUPEIDAE	10.70	14.00	1	201	
GIZZARD SHAD	CLUPEIDAE	8.30	6.24	1	201	
GIZZARD SHAD	CLUPEIDAE	8.30	6.28	1	201	
GIZZARD SHAD	CLUPEIDAE	7.20	4.56	1	201	
GIZZARD SHAD	CLUPEIDAE	6.90	3.91	1	201	
GIZZARD SHAD	CLUPEIDAE	7.30	4.72	1	201	
GIZZARD SHAD	CLUPEIDAE	7.50	4.78	1	201	
GIZZARD SHAD	CLUPEIDAE	9.70	10.87	1	201	
GIZZARD SHAD	CLUPEIDAE	6.30	3.18	1	201	
GIZZARD SHAD	CLUPEIDAE	6.70	3.65	1	201	
GIZZARD SHAD	CLUPEIDAE	7.40	5.36	1	201	
GIZZARD SHAD	CLUPEIDAE	6.30	3.29	1	201	
GIZZARD SHAD	CLUPEIDAE	7.40	4.40	1	201	
GIZZARD SHAD	CLUPEIDAE	6.70	3.51	1	201	
GIZZARD SHAD	CLUPEIDAE	6.00	2.80	1	201	
GIZZARD SHAD	CLUPEIDAE	7.20	4.17	1	201	
GIZZARD SHAD	CLUPEIDAE	5.80	2.55	1	201	
GIZZARD SHAD	CLUPEIDAE	6.80	3.59	1	201	
GIZZARD SHAD	CLUPEIDAE	5.90	2.51	1	201	
GIZZARD SHAD	CLUPEIDAE	6.50	3.34	1	201	
GIZZARD SHAD	CLUPEIDAE	5.80	2.28	1	201	
GIZZARD SHAD	CLUPEIDAE	5.90	2.49	1	201	
GIZZARD SHAD	CLUPEIDAE	6.20	2.30	1	201	
GIZZARD SHAD	CLUPEIDAE	6.70	3.32	1	201	
GIZZARD SHAD	CLUPEIDAE	6.60	3.29	1	201	
GIZZARD SHAD	CLUPEIDAE	6.10	2.65	1	201	
GIZZARD SHAD	CLUPEIDAE	6.80	3.58	1	201	
GIZZARD SHAD	CLUPEIDAE	5.50	1.92	1	201	
GIZZARD SHAD	CLUPEIDAE	5.80	2.29	1	201	
GIZZARD SHAD	CLUPEIDAE	5.70	2.46	1	201	
GIZZARD SHAD	CLUPEIDAE	6.40	2.76	1	201	
GIZZARD SHAD	CLUPEIDAE	6.70	3.44	1	201	
GIZZARD SHAD	CLUPEIDAE	5.70	2.41	1	201	
GIZZARD SHAD	CLUPEIDAE	5.90	2.32	1	201	
GIZZARD SHAD	CLUPEIDAE	6.20	3.00	1	201	
GIZZARD SHAD	CLUPEIDAE	5.60	1.92	1	201	
GIZZARD SHAD	CLUPEIDAE	5.70	2.17	1	201	
GIZZARD SHAD	CLUPEIDAE	5.80	2.53	1	201	
GIZZARD SHAD	CLUPEIDAE	6.50	3.51	1	201	
LARGE MOUTH BASS	CENTRARCHIDAE	22.30	170.93	1	F202 P2	202 = 512G FILLET; 203
CARP	CYPRINIDAE	24.20	403.00	1	204	RIGHT EYES MISSING
SMALL MOUTH BASS	CENTRARCHIDAE	14.70	40.04	1	202.2	
LONGEAR SUNFISH	CENTRARCHIDAE	11.80	43.99	1	206	206 = 236G

IMMATURE SUNFISH H	CENTRARCHIDAE	6.70	6.51	1	205	205 = 390G
IMMATURE SUNFISH H	CENTRARCHIDAE	7.50	8.32	1	205	
IMMATURE SUNFISH H	CENTRARCHIDAE	8.60	12.85	1	205	
IMMATURE SUNFISH H	CENTRARCHIDAE	6.90	6.25	1	205	
IMMATURE SUNFISH H	CENTRARCHIDAE	5.90	4.02	1	205	
IMMATURE SUNFISH H	CENTRARCHIDAE	6.30	5.44	1	205	
IMMATURE SUNFISH H	CENTRARCHIDAE	6.00	4.45	1	205	
WHITE SUCKER	CATOSTOMIDAE	8.90	8.23	1	211	211 = 328G
BLACK REDHORSE	CATOSTOMIDAE	33.70	409.00	2	210	210 = 418G
CARP	CYPRINIDAE	49.50	1750.00	2	F207 F2	207 = 508G ANT. FILLE
SMALL MOUTH BASS	CENTRARCHIDAE	23.60	194.39	2	F202P203	
SMALL MOUTH BASS	CENTRARCHIDAE	13.80	31.67	2	F202P203	
SMALL MOUTH BASS	CENTRARCHIDAE	15.40	47.19	2	F202P203	
SMALL MOUTH BASS	CENTRARCHIDAE	12.00	21.90	2	F202P203	
SMALL MOUTH BASS	CENTRARCHIDAE	9.00	8.74	2	F202P203	
LARGE MOUTH BASS	CENTRARCHIDAE	21.80	148.67	2	F202P203	
LARGE MOUTH BASS	CENTRARCHIDAE	14.00	37.27	2	F202P203	
GIZZARD SHAD	CLUPEIDAE	14.30	32.75	2	201	
GIZZARD SHAD	CLUPEIDAE	13.70	29.93	2	201	
GIZZARD SHAD	CLUPEIDAE	13.40	25.19	2	201	
GIZZARD SHAD	CLUPEIDAE	12.80	22.69	2	201	
GIZZARD SHAD	CLUPEIDAE	12.70	22.67	2	201	
GIZZARD SHAD	CLUPEIDAE	12.20	20.70	2	201	
GIZZARD SHAD	CLUPEIDAE	11.70	19.50	2	201	
GIZZARD SHAD	CLUPEIDAE	14.40	37.22	2	201	
GIZZARD SHAD	CLUPEIDAE	11.80	18.38	2	201	
GIZZARD SHAD	CLUPEIDAE	6.80	4.05	2	201	
GIZZARD SHAD	CLUPEIDAE	5.90	2.64	2	201	
GIZZARD SHAD	CLUPEIDAE	6.20	2.71	2	201	
GIZZARD SHAD	CLUPEIDAE	6.10	2.81	2	201	
WHITE SUCKER	CATOSTOMIDAE	15.40	44.43	2	211	
WHITE SUCKER	CATOSTOMIDAE	13.50	26.57	2	211	
WHITE SUCKER	CATOSTOMIDAE	9.60	9.87	2	211	
WHITE SUCKER	CATOSTOMIDAE	13.00	25.41	2	211	
WHITE SUCKER	CATOSTOMIDAE	13.00	24.32	2	211	
WHITE SUCKER	CATOSTOMIDAE	11.00	16.86	2	211	
WHITE SUCKER	CATOSTOMIDAE	9.50	9.74	2	211	
BIG MOUTH BUFFALO	CATOSTOMIDAE	10.80	19.56	2	211	
GREEN SUNFISH	CENTRARCHIDAE	12.60	37.58	2	206	
GREEN SUNFISH	CENTRARCHIDAE	13.50	60.27	2	206	
GREEN SUNFISH	CENTRARCHIDAE	11.80	33.27	2	206	
GREEN SUNFISH	CENTRARCHIDAE	10.90	26.38	2	205	
GREEN SUNFISH	CENTRARCHIDAE	10.90	27.13	2	205	
GREEN SUNFISH	CENTRARCHIDAE	10.50	26.72	2	205	
GREEN SUNFISH	CENTRARCHIDAE	10.00	20.02	2	205	
GREEN SUNFISH	CENTRARCHIDAE	9.60	19.09	2	205	
GREEN SUNFISH	CENTRARCHIDAE	9.50	18.11	2	205	
GREEN SUNFISH	CENTRARCHIDAE	9.40	16.47	2	205	
GREEN SUNFISH	CENTRARCHIDAE	9.40	18.06	2	205	
GREEN SUNFISH	CENTRARCHIDAE	8.50	13.39	2	205	
GREEN SUNFISH	CENTRARCHIDAE	7.70	9.24	2	205	

GREEN SUNFISH	CENTRARCHIDAE	7.50	8.64	2	205	
GREEN SUNFISH	CENTRARCHIDAE	6.70	6.17	2	205	
GREEN SUNFISH	CENTRARCHIDAE	7.40	8.69	2	205	
GREEN SUNFISH	CENTRARCHIDAE	6.60	5.47	2	205	
GREEN SUNFISH	CENTRARCHIDAE	6.40	4.88	2	205	
GREEN SUNFISH	CENTRARCHIDAE	6.60	5.43	2	205	
GREEN SUNFISH	CENTRARCHIDAE	6.10	4.16	2	205	
LONGEAR SUNFISH	CENTRARCHIDAE	9.40	16.21	2	205	
LONGEAR SUNFISH	CENTRARCHIDAE	7.00	5.91	2	205	
SILVERBAND SHINER	CYPRINIDAE	10.50	11.01	2	DISPOSED	
SILVERBAND SHINER	CYPRINIDAE	8.40	5.81	2	DISPOSED	
IMMATURE SUNFISH	CENTRARCHIDAE	5.70	4.53	2	205	
IMMATURE SUNFISH	CENTRARCHIDAE	5.80	4.25	2	205	
IMMATURE SUNFISH	CENTRARCHIDAE	5.20	2.93	2	205	
GIZZARD SHAD	CLUPEIDAE	17.80	67.83	3	212	212=399G
GIZZARD SHAD	CLUPEIDAE	19.00	69.52	3	212	
GIZZARD SHAD	CLUPEIDAE	18.60	72.77	3	212	
GIZZARD SHAD	CLUPEIDAE	20.00	79.11	3	212	
GIZZARD SHAD	CLUPEIDAE	18.90	77.03	3	212	
GIZZARD SHAD	CLUPEIDAE	10.80	16.67	3	212	
GIZZARD SHAD	CLUPEIDAE	6.80	3.99	3	212	
SMALL MOUTH BASS	CENTRARCHIDAE	15.00	44.37	3	F202 P203	
SMALL MOUTH BASS	CENTRARCHIDAE	12.80	31.01	3	F202 P203	
WHITE SUCKER	CATOSTOMIDAE	17.80	55.31	3	211	
WHITE SUCKER	CATOSTOMIDAE	13.40	27.80	3	211	
WHITE SUCKER	CATOSTOMIDAE	14.60	34.87	3	211	
WHITE SUCKER	CATOSTOMIDAE	10.30	12.48	3	211	
WHITE SUCKER	CATOSTOMIDAE	10.00	12.11	3	211	
LONGEAR SUNFISH	CENTRARCHIDAE	14.00	61.58	3	206	
GREEN SUNFISH	CENTRARCHIDAE	9.90	20.73	3	205	
GREEN SUNFISH	CENTRARCHIDAE	9.00	14.76	3	205	
BLUEGILL HYBRID	CENTRARCHIDAE	7.00	6.66	3	205	
BLUEGILL HYBRID	CENTRARCHIDAE	6.30	5.35	3	205	
BLUEGILL HYBRID	CENTRARCHIDAE	6.50	5.59	3	205	
SPOT FIN SHINER	CYPRINIDAE	7.10	2.57	3	DISPOSED	

Appendix C. List of Species, weight, length, and sample bag number at Site II, GMR, Aug. 20-23, 1992.

COMMON NAME	FAMILY	LENGTH	WEIGHT	REP.	BAG #	WET WT./BAG
CHANNEL CATFISH	ICTALURIDAE	18.50	41.00	1	103	103=546G
CHANNEL CATFISH	ICTALURIDAE	40.00	496.00	1	103	
LARGE MOUTH BASS	CENTRARCHIDAE	24.30	190.00	1	F101 P1	ULCER ON TAIL-THU
LARGE MOUTH BASS	CENTRARCHIDAE	12.80	26.63	1	F101 P1	MALE
SAUGER	PERCIDAE	23.20	87.00	1	104	104=275G
LONGEAR SUNFISH	CENTRARCHIDAE	12.50	42.76	1	104	
LONGEAR SUNFISH	CENTRARCHIDAE	10.40	28.80	1	104	
LONGEAR SUNFISH	CENTRARCHIDAE	8.70	13.42	1	104	
GREEN SUNFISH	CENTRARCHIDAE	7.50	8.55	1	104	
BLUEGILL	CENTRARCHIDAE	10.00	18.82	1	104	
RIVER CARPSUCKER	CATOSTOMIDAE	17.10	76.48	1	125	125=552G
DRUM	SCIAENIDAE	13.30	23.18	1	124	124=220G
DRUM	SCIAENIDAE	16.00	34.11	1	124	
DRUM	SCIAENIDAE	16.40	50.23	1	124	
DRUM	SCIAENIDAE	16.00	45.90	1	124	
GIZZARD SHAD	CLUPEIDAE	24.60	132.00	1	105	105=529G
GIZZARD SHAD	CLUPEIDAE	24.40	106.00	1	105	
GIZZARD SHAD	CLUPEIDAE	22.60	100.00	1	105	
GIZZARD SHAD	CLUPEIDAE	25.00	142.00	1	105	
GIZZARD SHAD	CLUPEIDAE	17.50	47.00	1	105	
GIZZARD SHAD	CLUPEIDAE	22.80	90.00	1	106	106=450G
GIZZARD SHAD	CLUPEIDAE	26.60	95.00	1	106	
GIZZARD SHAD	CLUPEIDAE	26.30	138.00	1	106	
GIZZARD SHAD	CLUPEIDAE	27.30	126.00	1	106	
GIZZARD SHAD	CLUPEIDAE	25.00	110.00	1	107	107=544G
GIZZARD SHAD	CLUPEIDAE	19.40	71.00	1	107	
GIZZARD SHAD	CLUPEIDAE	25.80	137.00	1	107	
GIZZARD SHAD	CLUPEIDAE	24.70	118.00	1	107	
GIZZARD SHAD	CLUPEIDAE	24.60	110.00	1	107	
GIZZARD SHAD	CLUPEIDAE	24.50	114.00	1	108	108=632G
GIZZARD SHAD	CLUPEIDAE	22.10	76.00	1	108	
CARP	CYPRINIDAE	64.40	3295.45	2	F117F1	DORSAL FIN ROT;117
CARP	CYPRINIDAE	55.90	2159.09	2	F112F1	112=710G,113=761G;
GIZZARD SHAD	CLUPEIDAE	28.00	203.00	2	108	
SMALL MOUTH BASS	CENTRARCHIDAE	17.20	68.01	2	F101P102	
SMALL MOUTH BASS	CENTRARCHIDAE	18.50	69.71	2	F101P102	
DRUM	SCIAENIDAE	18.80	69.74	2	124	
SMALL MOUTH BUFFA	CATOSTOMIDAE	31.10	463.00	2	125	
RIVER CARP SUCKER	CATOSTOMIDAE	39.30	742.00	2	109	109=754G
RIVER CARP SUCKER	CATOSTOMIDAE	36.40	662.00	2	110	110=674G
RIVER CARP SUCKER	CATOSTOMIDAE	41.90	899.00	2	111	111=896G
BLUEGILL	CENTRARCHIDAE	11.40	34.22	2	104	
CHANNEL CATFISH	ICTALURIDAE	36.00	368.00	3	123	123=750
CHANNEL CATFISH	ICTALURIDAE	35.90	365.00	3	123	
GIZZARD SHAD	CLUPEIDAE	30.00	228.00	3	108	
RIVER CARPSUCKER	CATOSTOMIDAE	43.00	954.00	3	F115P1	115=696G;116=256G

RIVER CARPSUCKER	CATOSTOMIDAE	40.20	868.00	3	120	120=864G
RIVER CARPSUCKER	CATOSTOMIDAE	34.90	557.00	3	121	121=556G
RIVER CARPSUCKER	CATOSTOMIDAE	39.00	836.00	3	122	122=843G
SMALLMOUTH BUFFAL	CATOSTOMIDAE	43.10	1231.00	3	126	126=1227G
GOLDEN REDHORSE	CATOSTOMIDAE	42.60	1065.00	3	127	FIRST 5 DORSAL SPIN
LARGEMOUTH BASS	CENTRARCHIDAE	32.50	573.00	3	F101P1	F
SPOTTED SUNFISH	CENTRARCHIDAE	10.00	22.50	3	104	
SPOTTED SUNFISH	CENTRARCHIDAE	8.30	13.10	3	104	

Appendix D: List of Species, weight, length, and sample bag number at Site III, GMR, Aug. 20-23, 1992

COMMON NAME	FAMILY	LENGTH	WEIGHT	REP.	BAG #	WET WT./BAG
SMALLMOUTH BASS	CENTRARCHIDAE	22.2	159.64	1	301	301=476G
SMALLMOUTH BASS	CENTRARCHIDAE	19.00	86.42	1	301	
SMALLMOUTH BASS	CENTRARCHIDAE	20.90	123.61	1	301	
SMALLMOUTH BASS	CENTRARCHIDAE	19.10	93.28	1	301	
FW DRUM	SCIAENIDAE	15.50	40.09	1	302	302=338G
FW DRUM	SCIAENIDAE	17.30	58.83	1	302	
FW DRUM	SCIAENIDAE	17.80	64.11	1	302	
FW DRUM	SCIAENIDAE	19.20	84.03	1	302	
FW DRUM	SCIAENIDAE	15.20	37.86	1	302	
FW DRUM	SCIAENIDAE	17.30	48.89	1	302	
GIZZARD SHAD	CLUPEIDAE	18.30	60.63	1	303	303=388G
GIZZARD SHAD	CLUPEIDAE	23.10	91.12	1	303	
GIZZARD SHAD	CLUPEIDAE	23.40	102.86	1	303	
GIZZARD SHAD	CLUPEIDAE	25.20	129.65	1	303	
BLACK REDHORSE	CATOSTOMIDAE	39.20	806.00	1	F304P3	304=474G; 306=720G
GOLDEN REDHORSE	CATOSTOMIDAE	42.00	993.00	1	F305P3	305=625G;
SMALLMOUTH BUFFAL	CATOSTOMIDAE	53.40	2130.68	1	F307F3	307=910G; 308=672G;
CHANNEL CATSISH	ICTALURIDAE	17.70	41.84	1	DISPOSED	
GIZZARD SHAD	CLUPEIDAE	25.20	154.65	2	A	
GIZZARD SHAD	CLUPEIDAE	23.10	134.37	2	A	
GIZZARD SHAD	CLUPEIDAE	15.50	43.42	2	B	
GIZZARD SHAD	CLUPEIDAE	18.40	62.73	2	B	
GIZZARD SHAD	CLUPEIDAE	24.70	109.19	2	A	
GIZZARD SHAD	CLUPEIDAE	23.90	112.01	2	A	
GIZZARD SHAD	CLUPEIDAE	24.80	136.81	2	A	
GIZZARD SHAD	CLUPEIDAE	29.20	230.68	2	A	
GIZZARD SHAD	CLUPEIDAE	23.20	104.06	2	A	
GIZZARD SHAD	CLUPEIDAE	25.30	175.07	2	A	
GIZZARD SHAD	CLUPEIDAE	20.80	89.23	2	B	
GIZZARD SHAD	CLUPEIDAE	18.10	56.84	2	B	
GIZZARD SHAD	CLUPEIDAE	19.10	55.17	2	B	
GIZZARD SHAD	CLUPEIDAE	17.60	47.34	2	B	
GIZZARD SHAD	CLUPEIDAE	17.60	48.35	2	B	
GIZZARD SHAD	CLUPEIDAE	23.50	107.86	2	B	
GIZZARD SHAD	CLUPEIDAE	23.20	112.96	2	B	
GIZZARD SHAD	CLUPEIDAE	19.90	86.60	2	B	
GIZZARD SHAD	CLUPEIDAE	21.50	87.68	2	B	
GIZZARD SHAD	CLUPEIDAE	19.20	79.87	2	B	
GIZZARD SHAD	CLUPEIDAE	19.60	74.21	2	B	
GIZZARD SHAD	CLUPEIDAE	21.10	93.15	2	B	
FW DRUM	SCIAENIDAE	29.60	288.42	2	C	
FW DRUM	SCIAENIDAE	20.10	96.01	2	C	
FW DRUM	SCIAENIDAE	17.60	61.91	2	C	
FW DRUM	SCIAENIDAE	17.30	62.82	2	C	
FW DRUM	SCIAENIDAE	29.40	328.94	2	C	
FW DRUM	SCIAENIDAE	18.70	79.86	3	F310P311	

GIZZARD SHAD	CLUPEIDAE	16.10	40.41	2	411	
GIZZARD SHAD	CLUPEIDAE	16.50	42.31	2	411	
GIZZARD SHAD	CLUPEIDAE	16.40	45.21	2	411	
GIZZARD SHAD	CLUPEIDAE	16.50	45.75	2	411	
GIZZARD SHAD	CLUPEIDAE	15.50	37.97	2	412	412=415G
GIZZARD SHAD	CLUPEIDAE	14.30	28.32	2	412	
GIZZARD SHAD	CLUPEIDAE	15.50	38.64	2	412	
GIZZARD SHAD	CLUPEIDAE	16.60	45.94	2	412	
GIZZARD SHAD	CLUPEIDAE	16.40	44.08	2	412	
GIZZARD SHAD	CLUPEIDAE	14.40	32.98	2	412	
GIZZARD SHAD	CLUPEIDAE	20.20	68.53	2	412	
GIZZARD SHAD	CLUPEIDAE	15.90	43.76	2	412	
GIZZARD SHAD	CLUPEIDAE	14.70	34.45	2	412	
GIZZARD SHAD	CLUPEIDAE	15.50	37.11	2	412	
GIZZARD SHAD	CLUPEIDAE	18.60	68.95	2	413	413=620G
GIZZARD SHAD	CLUPEIDAE	14.20	31.76	2	413	
GIZZARD SHAD	CLUPEIDAE	17.00	56.25	2	413	
GIZZARD SHAD	CLUPEIDAE	18.00	57.61	2	413	
GIZZARD SHAD	CLUPEIDAE	15.00	32.55	2	413	
GIZZARD SHAD	CLUPEIDAE	16.20	44.93	2	413	
GIZZARD SHAD	CLUPEIDAE	15.90	40.22	2	413	
GIZZARD SHAD	CLUPEIDAE	16.60	39.92	2	413	
GIZZARD SHAD	CLUPEIDAE	15.80	42.02	2	413	
GIZZARD SHAD	CLUPEIDAE	18.70	59.43	2	413	
GIZZARD SHAD	CLUPEIDAE	13.30	22.41	2	413	
GIZZARD SHAD	CLUPEIDAE	15.10	35.42	2	413	
GIZZARD SHAD	CLUPEIDAE	14.60	35.27	2	413	
GIZZARD SHAD	CLUPEIDAE	16.50	47.49	2	413	
SMALLMOUTH BASS	CENTRARCHIDAE	23.80	164.56	3	401	
DRUM	SCIAENIDAE	16.80	58.88	3	405	
SKIPJACK HERRING	CLUPEIDAE	35.00	301.59	3	414	414=304
STRIPED BASS	CENTRARCHIDAE	14.50	40.61	3	401	
STRIPED BASS	CENTRARCHIDAE	14.70	41.12	3	401	
STRIPED BASS	CENTRARCHIDAE	13.10	30.26	3	401	

GIZZARD SHAD	CLUPEIDAE	16.80	46.26	1	407	
GIZZARD SHAD	CLUPEIDAE	15.90	39.46	1	407	
GIZZARD SHAD	CLUPEIDAE	15.00	36.46	1	407	
GIZZARD SHAD	CLUPEIDAE	16.90	48.25	1	407	
GIZZARD SHAD	CLUPEIDAE	16.70	48.16	1	407	
GIZZARD SHAD	CLUPEIDAE	16.70	41.92	1	407	
GIZZARD SHAD	CLUPEIDAE	17.30	51.43	1	407	
GIZZARD SHAD	CLUPEIDAE	14.50	37.13	1	407	
GIZZARD SHAD	CLUPEIDAE	16.20	41.05	1	407	
GIZZARD SHAD	CLUPEIDAE	17.50	48.25	1	407	
GIZZARD SHAD	CLUPEIDAE	16.50	45.96	1	407	
GIZZARD SHAD	CLUPEIDAE	13.80	32.11	1	407	
GIZZARD SHAD	CLUPEIDAE	15.30	36.02	1	407	
GIZZARD SHAD	CLUPEIDAE	15.10	41.89	1	407	
GIZZARD SHAD	CLUPEIDAE	16.50	45.25	1	407	
GIZZARD SHAD	CLUPEIDAE	16.00	42.96	1	407	
BLUEGILL	CENTRARCHIDAE	6.90	6.70	1	DISPOSED	
BLUEGILL	CENTRARCHIDAE	9.90	20.67	2	DISPOSED	
SMALLMOUTH BASS	CENTRARCHIDAE	15.30	43.48	2	401	
STRIPED BASS	PERCYCITHIDAE	24.60	182.66	2	401	
GIZZARD SHAD	CLUPEIDAE	16.10	35.21	2	408	408=508G
GIZZARD SHAD	CLUPEIDAE	17.50	52.50	2	408	
GIZZARD SHAD	CLUPEIDAE	25.20	136.98	2	408	
GIZZARD SHAD	CLUPEIDAE	18.50	62.47	2	408	
GIZZARD SHAD	CLUPEIDAE	16.60	47.64	2	408	
GIZZARD SHAD	CLUPEIDAE	17.00	47.78	2	408	
GIZZARD SHAD	CLUPEIDAE	19.30	74.49	2	408	
GIZZARD SHAD	CLUPEIDAE	16.20	46.66	2	408	
GIZZARD SHAD	CLUPEIDAE	14.50	33.12	2	409	409=406G
GIZZARD SHAD	CLUPEIDAE	17.60	58.35	2	409	
GIZZARD SHAD	CLUPEIDAE	16.70	44.35	2	409	
GIZZARD SHAD	CLUPEIDAE	17.10	50.63	2	409	
GIZZARD SHAD	CLUPEIDAE	16.80	46.76	2	409	
GIZZARD SHAD	CLUPEIDAE	15.10	39.82	2	409	
GIZZARD SHAD	CLUPEIDAE	15.50	37.87	2	409	
GIZZARD SHAD	CLUPEIDAE	15.60	37.44	2	409	
GIZZARD SHAD	CLUPEIDAE	16.60	49.34	2	409	
GIZZARD SHAD	CLUPEIDAE	17.80	55.24	2	410	410=424G
GIZZARD SHAD	CLUPEIDAE	18.30	67.49	2	410	
GIZZARD SHAD	CLUPEIDAE	14.40	33.00	2	410	
GIZZARD SHAD	CLUPEIDAE	17.30	57.16	2	410	
GIZZARD SHAD	CLUPEIDAE	15.80	40.74	2	410	
GIZZARD SHAD	CLUPEIDAE	15.70	33.30	2	410	
GIZZARD SHAD	CLUPEIDAE	16.00	43.64	2	410	
GIZZARD SHAD	CLUPEIDAE	16.60	47.45	2	410	
GIZZARD SHAD	CLUPEIDAE	15.90	40.59	2	410	
GIZZARD SHAD	CLUPEIDAE	17.90	65.53	2	411	411=410G
GIZZARD SHAD	CLUPEIDAE	14.50	36.22	2	411	
GIZZARD SHAD	CLUPEIDAE	15.20	37.52	2	411	
GIZZARD SHAD	CLUPEIDAE	16.40	45.55	2	411	
GIZZARD SHAD	CLUPEIDAE	16.40	46.62	2	411	

Appendix E. List of Species, weight, length and sample bag number at Site IV, GMR, Aug. 20-23, 1992.

COMMON NAME	FAMILY	LENGTH	WEIGHT	REP	BAG #	WET WT./BAG
SMALLMOUTH BASS	CENTRARCHIDAE	21.2	112.85	1	F401P4	401 = 490G
SMALLMOUTH BASS	CENTRARCHIDAE	20.70	124.97	1	F401P4	402 = 256G
FW DRUM	SCIAENIDAE	18.20	66.95	1	405	405 = 584G
FW DRUM	SCIAENIDAE	32.10	444.00	1	405	
GIZZARD SHAD	CLUPEIDAE	16.50	54.35	1	F403P4	403 = 736
GIZZARD SHAD	CLUPEIDAE	14.70	36.46	1	F403P4	404 = 634
GIZZARD SHAD	CLUPEIDAE	14.70	36.10	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	21.30	86.48	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	16.20	44.14	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	16.40	51.50	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	14.90	38.39	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	15.60	44.58	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	16.10	44.48	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	17.00	51.51	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	13.80	29.84	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	15.30	39.34	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	18.40	68.36	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	20.20	72.49	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	15.00	34.03	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	22.00	88.29	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	15.60	41.92	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	14.80	37.76	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	15.10	33.21	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	16.30	49.00	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	15.00	35.22	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	16.70	53.25	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	16.30	40.10	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	15.30	40.42	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	15.90	40.45	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	15.00	37.42	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	15.70	40.86	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	14.10	30.71	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	18.20	61.40	1	F403P404	
GIZZARD SHAD	CLUPEIDAE	16.70	47.88	1	406	406 = 400G
GIZZARD SHAD	CLUPEIDAE	15.90	42.16	1	406	
GIZZARD SHAD	CLUPEIDAE	13.80	26.45	1	406	
GIZZARD SHAD	CLUPEIDAE	15.60	42.89	1	406	
GIZZARD SHAD	CLUPEIDAE	15.40	39.12	1	406	
GIZZARD SHAD	CLUPEIDAE	16.20	40.45	1	406	
GIZZARD SHAD	CLUPEIDAE	15.70	39.03	1	406	
GIZZARD SHAD	CLUPEIDAE	17.60	52.83	1	406	
GIZZARD SHAD	CLUPEIDAE	18.00	60.55	1	406	
GIZZARD SHAD	CLUPEIDAE	14.80	33.85	1	407	407 = 856G
GIZZARD SHAD	CLUPEIDAE	15.60	40.42	1	407	
GIZZARD SHAD	CLUPEIDAE	17.40	52.46	1	407	
GIZZARD SHAD	CLUPEIDAE	16.30	44.31	1	407	

FW DRUM	SCIAENIDAE	17.40	58.00	3	F310P311	
FW DRUM	SCIAENIDAE	19.80	94.11	3	F310P311	
FW DRUM	SCIAENIDAE	32.10	361.94	3	F310P311	
FW DRUM	SCIAENIDAE	18.20	68.17	3	F310P311	
FW DRUM	SCIAENIDAE	15.50	38.97	3	F310P311	
FW DRUM	SCIAENIDAE	19.80	84.70	3	F310P311	
FW DRUM	SCIAENIDAE	17.20	64.00	3	F310P311	
FW DRUM	SCIAENIDAE	20.50	121.90	3	312	
FW DRUM	SCIAENIDAE	16.40	46.63	3	312	
FW DRUM	SCIAENIDAE	17.70	58.95	3	312	
FW DRUM	SCIAENIDAE	15.80	45.63	3	312	
FW DRUM		14.70	36.30	3	312	
FW DRUM	SCIAENIDAE	15.40	45.27	3	312	
FW DRUM	SCIAENIDAE	17.40	53.46	3	312	
FW DRUM	SCIAENIDAE	16.10	34.80	3	312	
GIZZARD SHAD	CLUPEIDAE	28.70	162.06	3	313	313=530G
GIZZARD SHAD	CLUPEIDAE	23.20	106.85	3	313	
GIZZARD SHAD	CLUPEIDAE	20.90	87.77	3	313	
GIZZARD SHAD	CLUPEIDAE	26.00	164.64	3	313	
GIZZARD SHAD	CLUPEIDAE	24.30	118.03	3	314	314=524G
GIZZARD SHAD	CLUPEIDAE	23.20	97.88	3	314	
GIZZARD SHAD	CLUPEIDAE	20.10	83.81	3	314	
GIZZARD SHAD	CLUPEIDAE	23.80	106.95	3	314	
GIZZARD SHAD	CLUPEIDAE	21.90	109.47	3	314	
GIZZARD SHAD	CLUPEIDAE	22.60	105.20	3	315	315=492G
GIZZARD SHAD	CLUPEIDAE	17.50	55.32	3	315	
GIZZARD SHAD	CLUPEIDAE	22.40	82.64	3	315	
GIZZARD SHAD	CLUPEIDAE	23.10	84.89	3	315	
GIZZARD SHAD	CLUPEIDAE	22.30	100.03	3	315	
GIZZARD SHAD	CLUPEIDAE	17.30	56.37	3	315	
FLATHEAD CATFISH	ICTALURIDAE	36.20	478.00	3	F316P3	316=415G
FLATHEAD CATFISH	ICTALURIDAE	28.70	227.00	3	F316P317	

Appendix F. List of Species, number of individuals in group, weight/individual and No. of Ind./Species in Paddy's Run, Aug. 20-23, 1992.

COMMON NAME	FAMILY	NO.IND.	Wt./IND. # gm/ind.	REP	No./sp.
White Sucker	CATOSTOMIDAE	3	2.59	1	3
Blacknose Dace	CYPRINIDAE	25	1.21	1	148
Blacknose Dace	CYPRINIDAE	36	0.96	1	
Blacknose Dace	CYPRINIDAE	30	1.16	1	
Blacknose Dace	CYPRINIDAE	57	1.02	1	
Bluntnose Minnows	CYPRINIDAE	9	0.48	1	209
Bluntnose Minnows	CYPRINIDAE	3	1.19	1	
Bluntnose Minnows	CYPRINIDAE	153	0.40	1	
Bluntnose Minnows	CYPRINIDAE	24	0.73	1	
Bluntnose Minnows	CYPRINIDAE	2	1.61	1	2
Bluntnose/Bullhead Minno	CYPRINIDAE	18	2.07	1	7
Rosefin Shinner	CYPRINIDAE	2	0.92	1	
Southern Redbelly Dace	CYPRINIDAE	6	1.24	1	197
Southern Redbelly Dace	CYPRINIDAE	1	0.96	1	
Stoneroller Minnow	CYPRINIDAE	25	2.18	1	
Stoneroller Minnow	CYPRINIDAE	25	1.85	1	
Stoneroller Minnow	CYPRINIDAE	27	1.81	1	
Stoneroller Minnow	CYPRINIDAE	25	1.63	1	
Stoneroller Minnow	CYPRINIDAE	30	1.93	1	
Stoneroller Minnow	CYPRINIDAE	25	1.67	1	
Stoneroller Minnow	CYPRINIDAE	16	2.31	1	
Stoneroller Minnow/Hybrid	CYPRINIDAE	24	2.00	1	
Blacknose Dace	PERCIDAE	5	1.34	1	5
Johnny Darter	PERCIDAE	11	1.17	1	12
Johnny Darter	PERCIDAE	1	0.91	1	
Large Mouth Bass	PERCIDAE	1	3.40	1	1
Orangethroat Darter	PERCIDAE	82	0.70	1	90
Orangethroat Darter	PERCIDAE	1	0.21	1	
Orangethroat Darters	PERCIDAE	7	0.79	1	
White Sucker	CATOSTOMIDAE	6	1.94	2	100
Blacknose Dace	CYPRINIDAE	94	0.57	2	
Blacknose Dace	CYPRINIDAE	6	2.02	2	
Bluntnose Minnow	CYPRINIDAE	51	0.89	2	52
Bluntnose Minnow	CYPRINIDAE	1	1.91	2	
Emerald Shiner	CYPRINIDAE	1	1.04	2	1
Southern Redbelly Dace	CYPRINIDAE	49	1.15	2	49
Stoneroller Minnow	CYPRINIDAE	50	1.18	2	308
Stoneroller Minnow	CYPRINIDAE	1	0.63	2	
Stoneroller Minnow	CYPRINIDAE	56	1.19	2	
Stoneroller Minnow	CYPRINIDAE	50	1.29	2	
Stoneroller Minnow	CYPRINIDAE	50	1.06	2	
Stoneroller Minnow	CYPRINIDAE	50	0.93	2	
Stoneroller Minnow	CYPRINIDAE	50	1.03	2	
Stoneroller Minnow	CYPRINIDAE	1	0.74	2	
Fantail Darter	PERCIDAE	2	0.91	2	2

Johnny Darter	PERCIDAE	4	0.68	2	4
Orangethroat Darter	PERCIDAE	48	0.50	2	48
White Sucker	CATOSTOMIDAE	37	1.13	3	38
White Sucker	CATOSTOMIDAE	1	1.51	3	
Blacknose Dace	CYPRINIDAE	1	1.57	3	38
Blacknose Dace	CYPRINIDAE	28	0.64	3	
Bluntnose Minnows	CYPRINIDAE	9	1.20	3	
Creek Chub	CYPRINIDAE	3	1.98	3	3
Stoneroller Minnow	CYPRINIDAE	50	0.88	3	264
Stoneroller Minnow	CYPRINIDAE	64	1.05	3	
Stoneroller Minnow	CYPRINIDAE	50	0.93	3	
Stoneroller Minnow	CYPRINIDAE	50	1.09	3	
Stoneroller Minnow	CYPRINIDAE	50	0.90	3	
Unidentified Cyprinidae	CYPRINIDAE	n.a.		3	
Fantail Darter	PERCIDAE	3	1.30	3	3
Johnny Darter	PERCIDAE	8	0.65	3	8
Orangethroat Darter	PERCIDAE	30	0.51	3	36
Orangethroat Darter	PERCIDAE	6	0.72	3	

**DATE
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9/20/93

END