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ELECTROFISHING SURVEY OF THE GREAT MIAMI RIVER

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ANNUAL REPORT

by

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EXECUTIVE SUMMARY

The electrofishing survey of fish from the Great Miami River at RM 19, 24 and 38 from late summer 1996 demonstrated the sensitivity of the fish community to microhabitat variation. The variation was particularly clear between the pooled, low flow sections of the river and the runs, where fast current habitats occurred. In 1996, like most recent years, the differences were obvious between RM 24 and RM 19 and RM 38. River Mile 24 was characterized by a fish community of current-loving fish, dominated by Catastomidae (suckers), and Ictaluridae (catfish). In contrast, samples from pooled stations at RM 19 and 38 were dominated by Centrarchidae, Clupeidae and Cyprinidae, particularly the carp. The microhabitats sampled around the abutments of bridges at RM 19 and 38 where fast current and physical structure occurred, both resembled the community at RM 24. Changes in the fish communities associated with the upstream/downstream changes in stream volume, channel size, morphology, etc., were evidenced by the community coefficients which showed least similarity between the most distant sites. The microhabitat differences at sampling sites correlate with the species found and seem to explain the variation in the fish communities. External DELT anomalies (skeletal deformities, fin erosion, lesions, and tumors which reflect the health of individual fish within these communities) showed an elevated level of occurrence at RM 24 compared to normal background levels. Nonetheless, the electrofishing data from 1996 indicate that none of the differences in abundances or diversity between these fish communities in the Great

Miami River are associated with the outfall, runoff from, or activities at the Fernald site.

INTRODUCTION

The Ohio EPA has carried out regular longitudinal sampling of the Great Miami River (1980, 1989, and 1995) to determine compliance with clean water standards. Their water chemistry and sediment sampling, as well as, invertebrate and fish sampling has shown the continued and planned improvement in biological and chemical water quality along the mainstem of the Great Miami River, especially in the last decade. Implementation of the "Best Available Technology" for removal of TSS, BOD_{5day} and NH_4 has significantly reduced the levels of gross sewage pollutants in the Great Miami River, while the volume of treated sewage has continued to increase. Since little modification in stream channel habitat quality has taken place over the past decade, the improvements in the biological water quality seem to be a result of the improvements in waste water treatment facilities and the resulting improvement in the water chemistry (OEPA, July 1996).

In contrast to the intensive survey every decade or so by the OEPA, an annual fish community analysis has been conducted by the Fernald site and University of Cincinnati since 1984 to evaluate the general health of the river at a set of 3-4 sites between Hamilton, OH and Paddys Run on the Great Miami River. This report will present the data from the 1996 annual sampling.

All of these sampling efforts have necessitated the development of a new set of indices and standardized methods for evaluating the status of fish and macroinvertebrates communities as well as general stream health (OEPA, 1988). The OEPA has established sites that are sampled about once a decade, using similar methods and sample sizes; and with the development of a number of indices is able to compare the condition of the river along its length as well as from year to year (US EPA 1989, Rankin et al., 1990). The OEPA has also established a series of high quality reference streams in the state that allow the evaluation of biological health of streams with regard to ecoregion. These ecoregions are based upon soil type, bedrock, morphometry and potential climax vegetation. The potential and actual biological health of any particular stream or river is calculated relative to the best extant reference streams or rivers in that ecoregion. Hence the index scores, IBI and ICI, are scaled differently in different parts of the state (ecoregions), but still separate the streams into attainment classes: exceptional, good, fair and poor. The GMR in our reach crosses two of the ecoregions, flowing from the Eastern Corn Belt Plains (ECBP) to the Interior Plains (IP) Ecoregion near its mouth.

The diverse large river habitats of the Ohio River and the many small stream and river tributaries of the Great Miami River itself support a wide variety of biota which contribute to the diversity of the fish community. This fish community biodiversity is also dependent on sample size; ie. number of fish collected, the number of habitat types and number of seasons and number of years sampled. The cumulative list of species in the community may be several times the number of species found in a single sample or single day. Sampling of the fish in the Ohio River by the Ohio EPA (Randall Sanders, personal communication) between 1989 and 1995 resulted in 82 species. This number represents the species pool, available in the Ohio River, from which some fish can migrate into the Great Miami River and possibly influence the diversity at our sampling sites. In their recent survey of the 93 miles of the GMR, the OEPA found 79 species plus 10 hybrids (N=29,000 fish).

Between 1974 and 1986, single day sampling efforts on the Great Miami River resulted in an average of 22 species (N=2100-3700 individuals). Hence the daily find rate is about 25% of the total fish biodiversity of the river system. The other 75% of the species are less likely to be found consistently in the sampled areas for a number of reasons; they may be resident in the river only part of the time, they may be generally rare, or they may prefer other habitats such as small backwaters or impoundments and are washed into the river and sampled only periodically. In comparing the OEPA sampling of 29,000 fish and the 1996 Fernald study of 310 fish, the rare species are clearly under represented in the smaller sample (see results section).

The diversity of the fish community in a given stream reach is also a function of the water quality (chemical variables) (OEPA, 1995), stream size and order, habitat structure (riparian zone), energy base (autochthonous or allochthonous), flow regime (riffle or pool), and the biotic interactions (competition and predation risk) (Karr, 1981; Karr, 1988; Karr et al., 1986). The OEPA has developed a system of assessing habitat quality. This system, the Quality Habitat Environmental Index (QHEI), includes the factors of current velocity, bank stability, canopy, riparian vegetation, in-stream cover, stream gradient, channel morphology, channel width, and channel depth (OEPA, 1988). The development of the QHEI as well as other multicomponent indices, such as the Index of Biotic Integrity (IBI) and the Index of Well-Being (Iwb) (Gammon, 1976b) and the standardization of electroshocking sampling methods, has allowed the OEPA to evaluate the water quality of the Great Miami River and its tributary streams over the last decade (OEPA, 1990).

The Great Miami River is a multi-stressed stream receiving significant industrial and domestic sewage pollution from sites near Dayton, Middletown, Fairfield, and Hamiton, Ohio (Yoder et al., 1976; Beckett, 1978, 1977; Moller, 1986; OEPA 1989, 1996). Rankin et al. (1990) summarized the factors that degrade Ohio's streams. These factors include municipal and industrial point sources and agricultural non-point sources. Municipal and industrial point sources affect most river miles. The two most serious contributors to non-point source habitat impairment are the agriculturally caused siltation and channelization and the associated resultant habitat modification (Gammon et al., 1983).

The headwaters of the Great Miami River have exceptionally good water quality as assessed by multicomponent indices for fish and macroinvertebrates called the Index of Biotic Integrity (IBI) and Index of Community Integrity (ICI), respectively. The headwater reference sites have 19-21 species of fish, while clean water sites supported 17-30 species of fish in samples from a single day. Mid-sized rivers, such as the Great Miami River have a high diversity of fishes such as suckers, buffalos, carpsuckers and redhorses (Catastomidae), and catfishes (Ictaluridae). Fish such as White Bass, Sauger, Mooneye, Gizzard Shad and Carp often migrate in from large rivers. Minnows, daces, chubs, Darters, Northern Hogsuckers and White Suckers often migrate to the midsized rivers from the smaller streams. Waters pooled behind natural or man-made barriers select for pond species, such as members of the Clupeidae and Centrarchidae families; thus, washout from these upstream reservoirs and ponds can contribute species, such as Largemouth Bass, Sunfish and young-of year (YOY) Gizzard Shad to the river.

Upstream from the Fernald site, major sources of pollutants exist that may affect the biological water quality downriver. These include the cities of Dayton (RM 75--53.7 MGD), Montgomery Co. Western Reg. WWTP (RM 70--13.6 MGD), West Carrollton (RM 69-1.53 MGD), Miamisburg(RM 65--2.85 MGD)), Franklin(RM 59--3.05 MGD), Middletown (RM 48--20.7 MGD), and the city of Hamilton (RM 38--21.6 MGD). Toxins, excess nutrients, sewage, bacteria, and thermal enrichments are contaminants generated by these urban and industrial centers. Industrial waste dischargers upriver include Appleton Paper (RM 72) AK Steel (RM 51), and Miller Brewing Co.(RM 43). The concentration of all pollutants appears to drop in the area of the river near the Fernald site . This could be the result of the enforcement of water pollution laws and the construction of sewage treatment plants along the Great Miami River. The elevation of the river temperature and the loading of pollutants during low flow periods have combined to cause large fish kills in the past. During the 1988 drought, approximately 261,000 fish were killed due to the high temperature of the river (Rankin et al., 1990).

Between 1985 and 1989 sites below Dayton have shown IBI, Iwb, and ICI values in the poor to very poor range (USEPA, 1989; Rankin et al., 1990). During the last decade, the IBI index used by the Ohio Department of Natural Resources (ODNR) ranged from 20 (poor or degraded) to 33 (fair to moderate) for various sample sites from Middletown to the Paddys Run. From 1980 to 1989 no site between RM 19 and RM 38 had an IBI value of greater than 33; indicating that this section of the river was fair to moderately impacted (Rankin et al., 1990). In 1995, the IBI values had improved to 30-48 through this middle reach. Marked improvement in the past decade has been 5-6 IBI units at most stations, possibly reflecting the improvement in sewage treatment along the river.

The Index of Well Being (Iwb) and the Modified Index of Well-Being (MIwb) use the diversity of length and weight and the total number and weight of fish in its computation and is a composite index of numbers and weights calculated as Shannon Indices. This index ranges from poor values near 1 to good values of 9.6 and higher. The MIwb values have generally improved since 1980 for the entire river. They ranged from about 5.5 to about 7.5 for our sampling reach in 1980. The Iwb values ranged from 7.5 to 8.5 at our sampling sites in 1989 (OEPA, 1990) and continued to improve. In 1995, the MIwb had improved in this midsection of river and reached 8-10 at our sample sites. These achieved the WWH (Warm Water Habitat) Criterion at boat electrofishing sites (MIwb > 8.5 in the ECBP above Fernald and MIwb > 8.7 for the IP Ecoregion below Fernald).

In 1989, the health of the invertebrate community at our sampling sites: RM 38, RM 24 and RM 19, measured as ICI values, met the criteria for classification as 'Exceptional Warm Water Habitat' (EWH = ICI > 46). These values had all increased substantially from the those found in 1980, when only RM 19 met that criteria. In 1995, all sites had degraded slightly from those of 1989. This was the case for most of the river. All locations exceeded the WWH Criterion $=ICI_{ECBP} > 36$ in 1995, and ranged from 36 to 46. These values classify the sites as 'good'. Only in 1980 near Hamilton, Middletown and the Dayton WWTP outfall did the ICI values show degradation of invertebrate community to the 'Fair' or 'Impacted' levels.

The habitat quality of the Great Miami River is quite variable between RM 19 and RM 38 with QHEI (Quantitative Habitat Evaluation Index) values ranging from 45-84 (OEPA, 1988, 1989; Rankin, 1989). The lowest QHEI value in our sampling reach was found at Hamilton. When one compares these indices with a calculated potential value for each site, a 'Full', 'Partial' or 'Non' 'Aquatic Life Use Attainment' status is determined (Rankin, 1989). The surveys by the OEPA and the ODNR show that in 1995 the section of stream from RM 31 to RM 15 achieved 'Partial Aquatic Life Use Attainment' status. Based on the IBI for fish, 66% of fish sampling locations between Middletown and the Ohio River did not meet 'Full Use Attainment' in 1988; however, only two sites remained in the 'Non' Attainment category in 1995.

This year, again, the areas targeted were those that potentially might be affected by the effluents coming from the Fernald outfall or its watershed. This involved sampling the Great Miami River at a 'control site' (RM 38) and at the Fernald outfall pipe (RM 24). The potential effects of overland flow and hyporheic flow from the old industrial complex were tested by sampling downstream (RM 19) where the watershed, containing the Fernald site, drains into the Great Miami River via Paddys Run Creek. This is a wide portion of the GMR enlarged by periodic gravel mining from the eastern bank. Fish fillets from these sites were prepared, frozen and shipped as per instructions, to Acculabs Research Inc., Boulder, Colorado for uranium content analysis.

METHODS

Electrofishing: In order to conduct the most efficient and unbiased sampling of the fish community of the shallow, turbid waters of the Great Miami River, pulsed DC electroshocking methods were used (Rankin et al., 1990; Gammon, 1976a and b). A boat mounted Smith Root Electroshocking unit, powered by a Vanguard 7.5 kilowatt generator, was connected through a 10 foot long boom to two anode arrays ending in front of the boat, and extended 6 to 12 inches into the water. The boat hull, as well as a flexible cable, acted as the cathode. The shocking unit is capable of delivering a 60 cycle pulse at 240 VDC and up to 20 amps (Reynolds, 1983; Sternin et al.,1976; Vibert, 1967). Typical operating amperage was 10 to 12.

During sampling, two persons with long handled nets (10') on the bow of the boat collect the stunned fish and put them into an aerated live well on the boat. The stunned fish usually recover fully within 5 minutes (Vibert, 1967; Fisher and Brown, 1993). The fish were taken to shore, bagged and put on ice. Any large game fish (Largemouth Bass, Smallmouth Bass, White Bass etc. greater than 6 inches) that were caught were examined, measured, weighed and released in accordance with the provisions of our Ohio Scientific Collecting Permit.

Subsamples were taken in order to include the microhabitat variation at each site. The subsamples consisted of electroshocking predetermined reaches of the river, each for 10 minutes. Three subsamples were taken at the RM 24 and RM 19 sites (Fig 3 and

4) . Due to the diverse habitat types in the pool above the Hamilton I dam, four replicates were taken at the RM 38 site (Fig. 2).

Sample Preparation: The fish collected for uranium analysis were bagged by station, labeled and placed on ice in one or more locked coolers immediately after the shocking run was completed. These were then returned to a radiation-free laboratory at the University of Cincinnati. The fish were identified to species, weighed and measured (Clay, 1975; Pflieger, 1975; Smith, 1979; Trautman, 1981; Boschung et al., 1983; Page and Burr, 1991). Any external abnormalities, such as, fin rot, tumors, skeletal deformities, or evidence of disease, external parasites, or fungus were noted. The fish were then decapitated, eviscerated and definned. For large fish the fillet often had the skin removed. For small fish this was not the case. The resultant 'modified fillet', including some bones, is approximately what would be used for human consumption. Fillets from several fish from the same site were combined, if necessary, to achieve a sample weight of at least 200 grams. Samples were labeled sequentially and by site and sealed in plastic bags. To eliminate any contamination of samples from one site with those of another; fish from each site were processed as group. The work areas and equipment were cleaned before the collection from another site was processed. New labels were typed and added to the bags to insure clarity of identification. Tags noted the species or grouped species, sample weight and the sample number and site of collection. Samples were shipped to Acculabs Research Inc., Boulder, Colorado, for uranium analysis following the chain of custody requirements and instructions from Fluor Daniel Fernald personnel.

Water Analyses: The physical and chemical measurements from each site included: 1) temperature (C), 2) dissolved oxygen (ppm O2), 3) percent oxygen saturation (Wetzel and Likens, 1991), 4) pH, 5) conductivity (S), 6) soluble reactive phosphate (mg PO_4/l), 7) nitrate nitrogen (as mg NH_4-N/l), 8) sulphate as $SO_4^{=}$--S mg/l) and 9) conductivity (mhos/cm^2).

Temperature and Oxygen were determined using a YSI Model 57 (Yellow Springs Instruments Co.). Conductivity was read on a YSI Model 33 (Yellow Springs Instruments Co.). The pH was read on a Corning Model 610a expanded-scale portable pH Meter and combination electrode, standardized (pH 7 & 10) before reading. Suspended chlorophyll was determined fluorometrically after filtering a known amount of water and extracting the chlorophyll on the filters in 90% acetone for 24-48 hours at 4C (Wetzel and Likens, 1991). Soluble reactive phosphate, sulphate and nitrate were determined colorimetrically using Hach methods and spectrophotometer (Hach Inc., Boulder, Colorado).

Statistics: The fish community at each site was analyzed using Shannon Diversity Index (Hbar) and Coefficient of Community (CC). Shannon (Hbar) is a useful index for determining the diversity at each site. The Hbar of one site is compared to the Hbar value of another and the site with the highest Hbar is said to have greater diversity. The coefficient of community (CC) measures the percent similarity of two communities. A low CC may reflect differences in habitat due to geographical separation or a pollution gradient. Diversity of the fish community at each site was calculated using the Shannon-Weiner (Hbar) index based on the information theory using log base 2 (Krebs, 1989). This index of diversity measures the difficulty of predicting the species of the next individual selected, providing that the individual is selected at random. The value of Hbar increases as the number of species in a sample increases, assuming equal distribution of individuals among all species. Samples with fewer species or one dominant species have low calculated diversity (Hbar). The maximum diversity (Hmax) is a measure of the maximum diversity a community can have given a defined number of species and equal numbers of individuals of all species.

Shannon Diversity Index: $Hbar = -\underset{i=1}{S} (P_i \log P_i)$

where $P_i = N_i / SN$

N=total number of individuals

P_i is the proportion of individuals of species I.

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

Coefficient of community: $CC = 2c / (a+b)$

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

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

Statistical analysis was performed using one way Analysis of Variance (ANOVA). These ANOVAs were used to compare parameters of fish community, number of species per site and subsample, number of fish per site and subsample). The hypotheses being tested were that there was no statistically significant difference between the means of any groups or parameters being compared. Results of ANOVAs were evaluated using three parameters: F-statistic (F), degrees of freedom (df) and probability (p). The F-statistic was determined by dividing the between groups mean sums of deviation squares by the within groups mean sums of deviation squares. This value was then compared with a value in a table (Rosner, 1990; Siegel, 1988). If the calculated F was larger than the table value of F, for the appropriate degrees of freedom, then the results were considered significantly different. Degrees of freedom were calculated by taking the number of groups and subtracting one for both the between groups and the within groups comparisons. The p-value measured the probability of being wrong if we chose to reject the hypothesis that there was no difference between the groups being compared. The F-statistic (F), degrees of freedom (df) and probability (p) were reported as being significant ($p<.05$), highly significant (HS, $p<.01$)or not significant (NS, $p>.05$). If no significant difference between sites was found using one way ANOVA no further statistical tests were performed. Kirby (1993) points out that unless significant differences are found using a one way ANOVA the data should not be explored further because increasing the number of statistical tests increases the likelihood of finding significant results due to chance.

Site Description: Three sites on the Great Miami River were chosen for sampling in 1996 (Fig. 1). Two of these sites have been sampled annually at the same time of year since 1984 (RM 24 and RM 19) (Figs. 3 and 4). The third site at RM 38 (Fig. 2) was added in 1991 as an additional control site.

RM 38: River Mile 38 is near the confluence of Talawanda Creek, just upstream from Hamilton, Ohio (Fig. 2). This upstream 'control site' is isolated from the other sites by two dams which prevent upstream migration of fish from the area of the Fernald facility during the majority of the year. Four areas were sampled at this site. Subsamples 1) and 2) focused on the shoreline just upstream of the Hamilton Dam. These areas consisted of relatively undisturbed riparian vegetation as well as rocky shoals, pools, and partially submerged trees. Subsample 1 was approximately 300 meters of the east shore and was shocked for 10 minutes. Subsample 2 was also approximately 100 meters on the west side of the river about 300 meters upstream from the boat launch and also was shocked for 10 minutes. Subsample 3) was taken upriver from the boat launch around the Route 127 bridge. The sample covered approximately 175 meters along each shore and around the abutments for a total time of 10 minutes The habitat includes deep fast flowing water between the bridge abutments, slow backwater eddies above and below the abutments as well as mud shallows. The shoreline consists of concrete and stone rip-rap and some steep mud banks. The riparian vegetation was somewhat smaller and less continuous and more disturbed than downstream where subsamples 1 and 2 were taken. Subsample 4) was taken at the mouth of Seven Mile Creek. The slow backwater of the creek converged with the faster water of the main river creating a well defined shear zone. Many submerged trees were present at the downstream side of the creek mouth. A large, deep backwater eddy with a steep, eroded mud bank was just upstream from the creek mouth, on the main river . The riparian zone consisted of mostly larger trees on high, steep eroded banks. The eastern shoreline of the creek was a shallow, sloping, deposited mud bank. Approximately 50 meters of shoreline downstream from the confluence, about 60 meters across the mouth of the creek along the shear zone and about 60 meters along the shore upstream from the confluence were shocked for a total of 10 minutes.

RM 24: River Mile 24 (Fig. 3) is located near Strickers Grove Park where the outfall pipe from the Fernald site empties in the Great Miami River. The first subsample was taken near the mixing zone at the outfall pipe. This is on the outside of a long curve on the western side of the river with fast current and strong eddy currents. It is steep sided with a fairly rapid current. Some riparian trees, both standing and fallen, provide good cover for fish. The average depth of water here is 1.8 meters. Approximately 280 meters of shoreline was sampled for 10 minutes. The second subsample was taken near the shore on the inside of the same curve. The water is shallow and the bottom of the river consists of gravel and rock. Several muddy shallow areas are also present. Riparian vegetation is very sparse or absent on the wide, flat, rocky shore. Again, the second sample, including about 350m of this habitat, was sampled for 10 minutes. The third subsample was taken below the riffle, approximately 300 meters downstream of the outfall pipe. The western side bank with large trees overhanging the river and a large, deep backwater eddy. The eastern side is shallow and rocky with a flat rocky shore. The riparian vegetation consists of some small willows and grasses. Approximately 125 meters on each side of the river was sampled for a total of 10 minutes.

RM 19: The confluence of Paddys Run Creek is at River Mile 19.6. The watershed of Paddys Run includes the Fernald facility. Approximately 500 meters of the river was sampled from the old railroad bridge, downstream. The first subsample was taken from the eastern side of the river. This portion of the river is slow and wide. The banks on this side are high and steep consisting of gravel and mud with only grasses on the top. The bottom is mud and gravel. Only several small tree stumps contributed complexity to the habitat. Approximately 250 meters was sampled for 10 minutes. The second subsample was taken around the concrete bridge abutments. Fast chutes and their resultant eddies, as well as, large logjams around and just downstream of the abutments provide good habitat for fish. The gravel and rock banks, often steep and high, were free of vegetation. Approximately 75 meters of the rivers length was sampled but consisted of 2 shorelines and areas around the abutments and large logjams. An approximate total of 350 meters of habitat was sampled for 10 minutes. The third subsample was taken on the western side of the river. There were several deep holes along with shallow mud and gravel areas. The banks were sloping and had large trees overhanging the river. No fallen or submerged trees were seen in this sampling area. A large portion of this section was residential with mowed lawns and little brush growth along the river, but this section of river had never been mined and was underlain by flattened limestone boulders. The water, again, was very slow moving. A section of shoreline, approximately 300 meters long, was sampled for 10 minutes.

Samples were collected on September 17, 1996 at RM 38. River Mile 24 and RM 19 were sampled on September 18, 1996. River Mile 38 was sampled for a total of 40 minutes. River Mile 24 and RM 19 were sampled for 30 minutes each. The total distance electrofished was .820 km, .880 km and .860 km at RM 38, RM 24 and RM 19 respectively. This distance represents the approximate amount of shoreline habitat sampled rather than river "mileage" (Table 3).

Since the active stun zone of the electroshocker was small (0.5-1.0 m deep x 2 x 1.5 meters) it is most effective near shore in shallow water. The size of the river and the diversity of the habitat cover dictated the amount of shoreline that was sampled. Poor habitats require less time to electrofish than good habitats, thus larger areas of poor habitat are covered for the same amount of time. Also the fish yield is higher in the good habitats. The use of fish/kilometer for reporting electrofishing data is commonly used and eliminates some of the biases associated with fish/time.

RESULTS AND DISCUSSION

Physical and Chemical Parameters: Physical and chemical differences were detected between the three sites, consistent with upstream downstream metabolism of a river receiving nutrient enrichment above the samples sites (Table 1). The temperature of the river ranged from 15.0 C to 15.6 C, probably as a function of time of day (Table 1).

The conductivity ranged from 780 to 800 which is consistent with an area of limestone bedrock. The levels changed little along the experimental reach of river and were similar to last year (Table 1, Fig 6). Phosphorus, nitrogen and sulfate all decrease downstream in 1996 (Table 1, Fig. 5). Phosphorus concentration dropped from 1.083 mg/l at RM 38 to .688 mg/l at RM 19 (Fig. 5). These levels were lower than in 1995 (Table 1). Nitrate levels decreased more than an order of magnitude from the previous year and ranged from .46 to .43 mg/l (Table 1). Sulfate ranged from 133 mg/l to 121.25 mg/l which were slightly elevated from 1995 levels (Table 1). The secchi disk readings are a measure of color and turbidity. The secchi was low, varying only from 30 to 32 cm. However the turbidity increased downstream (Fig. 7) consistent with an increasing algal biomass. The sestonic algal biomass (measured as chlorophyll a) increased downstream; ranging from 12.6 ug/l at RM 38 to 15.6 ug/l at RM 19 (Fig. 7). These levels were slightly lower than in 1995. During this study the pH ranged from 8.2 to 8.4 (Fig. 8) similar to 1995 (Table 1). The oxygen concentration of the water may change as a result of algal activity: increasing with photosynthesis and decreasing with respiration (Wetzel, 1975). The oxygen produced by photosynthesis accumulates in the water over the daylight hours; thus the amount of oxygen dissolved in the water can be a function of the time of day. Oxygen concentration at our sampling sites seem to reflect the time of day that each was sampled (Table 1, Fig. 8). Oxygen levels are reasonable and similar to those seen in 1995 (Table 1).

Some variation in these parameters could be due to physical or diurnal differences. Water temperature can change the solubility of dissolved material such as nutrients or components that change turbidity and conductivity; however, the water temperature varied only 0.6 C between the sampling sites (Table 1). Diel variation may effect changes in the physical and chemical parameters. If the time of day were a factor, data should show variation relative to the sampling time (Table 1). The only parameters that might be associated with the time of day are pH and oxygen (Table 1). The pH is buffered in its rate of change with photosynthesis and reflected the profile of algal biomass; ie. increasing downriver. The oxygen concentration and % saturation are functions of temperature and photosynthetic activity in the water and the hours since sunrise.

The energy level of streams, such as current velocity and presence of riffles can affect the physical and chemical characteristics of the water in several ways (Allen, 1995). Riffles can help equilibrate dissolved gasses in the water with those in the air and result in readings of 100% saturation in the absence of biological activity. Only algal activity or air bubbles entrained at great depths, such as occurs below a dam, can cause of oxygen supersaturation. Oxygen saturation was above 100% at RM 19, sampled in the afternoon. The lowest saturation was seen in the sample taken earliest in the day.

Soluble reactive PO4 (SRP), Nitrate (NO3) and Sulfate (SO4) (Fig. 5), and algal derived turbidity and algal biomass (Fig. 7) seem to be consistent with moderate upstream nutrient enrichment, probably above Hamilton (RM 38). The concentrations of the biologically limiting nutrients, phosphorus and nitrate declined with algal utilization. The sestonic algal biomass did show an increase of almost 50% from RM 38 to RM 19. Turbidity, pH and sestonic algal chlorophyll increase downstream while nutrient levels decrease. Nutrient loading in the study section appears less than in 1995, possibly reflecting improved sewage treatment along the river.

Fish Population Parameters:

Sampling Adequacy: In order to insure that the various sites were sampled sufficiently to accurately evaluate the biodiversity of fish, we divided the sampling into 3 or 4 subsamples to sample all the perceived habitats at a site. The areas of the subsample collections were chosen to select for habitat variation within a particular site. As the number of fish collected increases, the rate of addition of new species will decrease. When the asymptote of the curve of the cumulative species (Y) x number of fish sampled (X) is reached, an adequate sample has been taken to represent the community. If this asymptote has not been reached (ie. a continuing upward curve) then new species are being easily encountered and the sample may not be large enough to represent the community. In 1996 all stations appeared to have nearly reached saturation, meaning that despite the small total number of fish taken, the rate of addition of new species with additional replicates or additional individuals was small (Fig. 9a and b). Our sampling appeared to adequate to represent the stations, despite the low number of fish collected per km of river shoreline sampled.

Species richness and density: A total of 310 individuals and 31 species of fish were collected during the two days of electroshocking on the Great Miami River in 1996 (Table 2, Fig 10) as compared to 549 individuals and 29 species in 1995. The number of species of fish caught declined downstream. At RM 38, 165 individuals were collected representing 23 species. Sampling efforts at RM 24 yielded 71 individuals and 17 species. The sample from RM 19 had 74 individuals and 14 species. Four subsamples of 10 minutes each were taken at RM 38, while only 3 subsamples were taken at the sample sites. Thus the sampling effort was greatest at RM 38. The number of individuals at RM 38 was twice that at the other stations. RM 38 yielded a calculated 247.5 fish/hour while collections at RM 24 and RM 19 had 142 and 148 fish/hour, respectively. This was lower than that found in 1995 when the fish/hour was 426, 220 and 422 at RM 38, RM 24 and RM 19, respectively.

The number of individuals, however, was not proportional to the number of species caught. Collections at RM 38, RM 24, and RM 19 had 23, 17 and 14 species in 1996, whereas 20, 15 and 19 species, respectively, were collected in 1995. As in 1995 the most diverse species were the Catastomidae, Centrarchidae and the Cyprinidae.

There were from 4.2 to 7.2 individuals/species (Table 2, Fig. 10) in the GMR sites. This is a measure of comparative abundance per species. Values would be highest with many individuals and few species. A comparative examination of which species are at each site shows that all sites were marginally similar, having a Community Coefficient of approximately 0.5. Sites 1 and 2 were the most similar at CC= 0.55. Sites 1 and 3 were slightly less at CC=0.486. Sites 2 and 3 were at CC= 0.581 (Table 2). The greatest similarity is seen between the two closest (geographically) sites. The lowest level is between the two most distant sites. These data suggest that there is an upstream/downstream component to the fish community.

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 1996, only 6 species were found at all sites, 11 species were found at two sites and 14 were found at only one site. In 1995, 8 of the 29 species were found at all three sites, 8 at two sites and 12 at only one site (Table 3).

For statistical analysis, a one way ANOVA was used to test the hypothesis that there was no difference between the number of species found per site and the number found in the subsamples, and between the sites. There was no statistical difference between the number of species found at the sites (df=2, F=.37 and p=0.7106), nor between the number of species found in the subsamples for each site (df=3, F=.8 and p=.5534). There was, also, no statistical difference between the number of fish caught at the sites (df=2, F=0.32 and p=0.7426), or between the number of fish caught in the subsamples for each site (df=3, F=4.26 and p=0.0976).

Species Diversity: Hbar is a measure of diversity and is a combined parameter sensitive to both the number of species and the number of individuals in each species (Krebs, 1989). Despite having the lowest number of individuals the diversity was highest at Site 2 (Table 3, Fig. 11). Evenness was also highest at Site 2 indicating that each species was represented by a more equal number of individuals than at the other stations.

Fish Size: The weights of the fish sampled ranged from 1 gm to 4562 gms for the river. The range for RM 38 was 1.1 to 4562 gms, while those ranges for RM 24 and RM 19 were 1.65 - 4436 gms and 8 - 1554 gms, respectively (appendix 1, 2, and 3). The modal weight was 40 gms, 140 gms and 20 gms for RM 38, RM 24 and RM 19.

The fish lengths ranged from 52 to 780 cm for the river and ranged from 52 - 730 cm, 58 - 780 cm and 76 - 539 cm for RM 38, RM 24 and RM 19 respectively. All sampling sites showed a bimodal distribution for length. The modal length for the fish were: 150 mm and 200 mm at RM 38, 220 mm and 420 mm for RM 24, and 120 mm and 240 mm for RM 19.

The cumulative distribution of proportion of fish by length and weight shows the effect of size classes in composition of the fishery. If the cumulative length or weight distribution rises quickly, then small fish dominate. The graphs of cumulative % of fish by length and weight (Figs. 12 & 13) give a visual representation of the size distribution for the fish collected by river mile. Fish at RM 24 had the largest size distribution in both length (Fig. 12) and weight (Fig. 13), and thus the slowest rise of the curve to the asymptote. Fish at RM 19 and RM 38, on the other hand, had the smallest distributions, the curves of cumulative length and weight rising most quickly to the asymptote. This is the historic pattern for these stations. In the more rapid current of the run at RM 24, smaller individuals are just not able to swim strongly enough to handle the fast current and turbulent water. Larger individuals can position themselves just out of the current and wait for prey to pass in the flow. At the two pooled stations, small fish are able to swim after abundant prey and not be washed out.

Fish Length/Weight Relationship: The relationship between length and weight is a condition factor of fish. However, since the weight increases nearly as the cube of length (volume or mass = f $(\text{length})^3$), a log(length) x log(weight) is linear. For 1996 there appear to be several outliers on the graph in Fig. 14 plotted by RM site and that in Fig. 15 plotted by fish family. The fish off the line on the upper left are heavier per unit length, while those to the lower right are lighter or longer. When plotted by RM site, there is no relationship to the outliers (Fig. 14). However, when plotted by family, the long nose gar (family Lepisosteidae) are longer and thinner, thus, off to the lower right as expected by their morphometry (Fig. 15). The fish that are heavier per unit length appear to be the sunfish and basses (family Centrarchidae). Are they in excellent condition this year or does this variant reflect their deep, short body plan (except in black basses). As the rivers become more eutrophic during summer low flow, perhaps pond fish are doing better.

DELT Anomalies: Skeletal deformations, fin erosion, open lesions, and external tumors (DELT Anomalies) are sensitive indicators of fish health that are being used comprehensively in Ohio streams by the Ohio EPA (Randy Sanders, OEPA, personal communication). "High percentages of these type of gross external anomalies (anomalies visible to the eye) are typically related (either directly of indirectly) to chemical sediment and/or water quality problems" (OEPA, 1996). A number of studies have shown a correlation between the occurrence of DELT anomalies and the presence of a variety of pollutants such as treated domestic sewage (Bucher and Hofer, 1993), pulp mill effluents (Lindesjoo et al., 1994), heavy metals (Hg, Cd, Pb, Cu and Zn) (Backiel et al., 1984; Lemly, 1993; Reash and Berra, 1989; Baumann, 1984) and some chlorinated hydrocarbons (such as: HCB, PCBs, OCS, DDT and d-HCH) (Kohler, 1990; Smith et al., 1994; Baumann et al, 1987; Myers et al., 1992). Only 25 of the 310 fish captured in our study showed evidence of physical problems, however, some DELT anomalies were found at all sites. At RM 38 only one case of a deformity and fin erosion was noted. At RM 24, seven deformities, one fin erosion and 2 lesions were observed; at RM 19 two cases each of deformities and fin erosion and one case of a lesion were noted (Table 4). This amounts to 1.6%, 14% and 5.4% DELT anomalies at RM 38, RM 24, and RM 19, respectively.

Normally, only 1% DELT's are observed, however the OEPA uses 3% as a baseline level. DELT anomalies were inventoried by Moller (1986) in a survey of stress in carp above and below Datyon, Ohio. The lower stations included the Hamilton site (RM 38) at which 7-9% of the carp had what are now called DELT anomalies. In the study area below Dayton, 3 of the 7 sites had fish communities with >20% of the carp showing DELTs. In 1995, the Ohio EPA found 5% occurrence of DELTs at RM 23. In 1996, RM 24 was our best site for most parameters (IBI, Iwb, species diversity, etc.), however, it had the highest level of DELT anomalies of the three stations sampled.

The OEPA (1996) reports exceedences for chemical/physical water parameters at a number of sites near our study reach in 1995. None was listed for 4-5 miles above the RM 38 site. Between RM 38 and RM 24, 4 locations showed 15 exceedences. Between RM 24 and RM 19, two sites had 4 exceedences. These exceedences were for a number of materials that are possible causative agents. Concentration of metals in sediment samples at RM 24.55 (OEPA, 1996) showed 'elevated' levels of Cadmium and Chromium; Cadmium being the only one that was appreciably higher there than at the other stations upstream or down. Mercury for RM 24.55 was appreciably lower than at other sampling sites in our study reach even though they (OEPA, 1996) report 3 exceedences for Mercury at that site. These data are for 1995. Conditions in the river can change substantially from year to year; especially with regard to the sediment composition. Abnormally high runoff, such as occurred in the spring of 1996 as a result of the record rainfall, can wash out old sediments and/or deposit new sediments. Since RM 24 was the only site surveyed in the local area, we do not know if other sites might have higher levels of anomalies. In light of the variety of chemicals implicated in causation of DELT anomalies, the source(s) and extent of DELTs in this reach remains unknown.

Community Differences by Detrended Correspondence Analysis: The Detrended Correspondence Analysis (DCA) is an eigenvector algorithm method that places communities, based only on numerical abundance of species, in a multidimensional space on unrelated axes (ter Braak, 1986). The units are standard deviations. In a comparison of the species at two sites, the species that are not common to both cause those two sites to separate on the axes. The first axes explains most of the information. The presumption is that some set of physical and/or chemical parameters vary systematically among sites and explain the differences in species abundance patterns along this gradient. Thus there is an inferred environmental gradient associated in some way with the axes. The DCA method iterates the data so that the communities and the causal species are distributed along the axes causally. That is, the species associated with the extremes of the axis are the critical species whose difference in abundance or presence caused the separation of community types that underlie those species.

The DCA shows that microhabitat within sites is important. Without using deletions or transformations, and default options, the first axis of the DCA explains 28.6% of the variance among subsamples and RM sites; while the second axis explains only 11.2% of the variance (Fig. 16). The closer the proximity of sites or species placement on the plot, the greater the similarity between them. The sites tend to separate on the first axis according to the flow attributes at the sites; ie pool or run. The community from RM 19 is most distant from the other two sites overall, apparently being pulled that way by the pond species of bluegill, white crappie, and gizzard shad. The community from RM 24 is on the other extreme of axis 1; pulled that direction by sauger, smallmouth buffalo, quillback carpsucker, channel catfish, river redhorse, and black buffalo, all mid-river, current-loving fish. The implied gradient along the first axis is current velocity from a river run to a pooled habitat. The community from RM 38 is intermediate between the others, as is its flow regime. Most importantly in 1996, is the observation that the second subsample taken around the bridge abutments at RM 19, collected the current-loving fish species. This microhabitat was anomalous for the site, and demonstrates the power of microhabitat in selecting for the fish species. Clearly, habitat characteristics and not river size, as inferred by the river continuum hypothesis, relate to distribution of fish species and community composition in the mid Great Miami River.

Habitat Quality: The QHEI for the Great Miami River in 1995 was computed systematically by the Ohio EPA (OEPA 1996) for this reach of the river (Fig. 17). The arrows indicate the sites sampled in this study. RM 24 has the best quality habitat based upon characteristics such as; riparian growth, in-river structure (logs and rocks), embeddedness of large boulders, and depth. These characteristics correlate with conditions preferred by fish. RM 19 and 38 are both pooled areas and appear to show substantial simplification of the habitat for fish as indicated by their QHEI values

Index of Biotic Integrity and Iwb: The Index of Biotic Integrity (IBI) is a multimetric score from 12 parameters derived from a fishing sample, that emphasizes high biodiversity and presence of predators, and the absence of 'rough' and pollution tolerant species (like the white sucker). The index scores range from near 0 to over 50. The scoring for the metric components in the OEPA version is referenced against the best streams in the ecoregion that could be found today. The IBI score has improved greatly over the past 20 years in the Great Miami River below Dayton. The results of the 1995 survey by OEPA (OEPA 1996) shows problems upriver, with some improvement above Hamilton at our RM 38 site. The improvement continues below Hamilton overall. However, in the 1995 data all of the RM sites we used are compromised in some way relative to sites upstream and downstream.

Hydrographic data shows higher than average flow for the first part of the summer in 1996 which might have been reflected in increased index values. IBI values were computed for 1996 using data collected during the electroshocking and following the methods in the US EPA's Rapid Bioassessment Protocol for Streams and Rivers (US EPA 1989). These IBI values are more than 5 points higher than those reported in the 1995 OEPA survey (Fig. 18, Table 3). In 1996, the relative ranking of the sampling sites by IBI values was RM 24 > RM 38 > RM 19.

The Index of well being (Iwb) and the Modified Index of well being (MIwb) are based on the distribution of sizes and total number of fish and biomass caught per kilometer of electrofishing. The MIwb eliminates the effect of several superabundant rough fish. In 1996, we used a simpler Iwb and found the same relative ranking of sites that we saw in the IBIs; RM 24 was the highest > RM 38 > RM 19. The Iwb value at RM 24 was much higher than the MIwb for 1995 while the Iwb for 1996 at RM 38 was slightly lower than the OEPA value for 1995. The Iwb value for RM 19 was much lower than the MIwb of OEPA in 1995, however, deposition of sand and gravel has changed the physical landscape of the river at this site following the very high flows during the winter/spring of 1995-1996 and may have also altered the microhabitat and subsequently the fish community.

CONCLUSIONS

1. The middle and lower sections of the Great Miami River, including the area near Fernald have improved demonstrably according to OEPA's 5 year surveys of the entire river, and its tributaries. Fish and macroinvertebrate communities, water chemistry, and habitat quality have clearly substantiated significant improvements in the general health of the river since waste water treatment facilities were upgraded during the late 1980's. Sewage treatment is better although the volume is continually increasing. Secondary treated sewage converts all organic nutrients to inorganic nutrients such as ammonia, nitrate and orthophosphate. This nutrient loading has been causing the river to show signs of eutrophication over the past 5 years, evidenced by blooms of suspended algal blooms, even in a free-flowing shallow mid-sized river. These effects change the nature of the food supply from a food base that is attached to rocks to one that is free floating. In years that have very low flow, altered pH and availability of metals and problems associated with day/ night variation in oxygen tension, may become problems for the fish. In the high flow conditions of 1996, no problems in oxygen tension or pH were indicated.

2. When the water quality is good the fish communities form as a result of the available microhabitat. The sites located behind a dam or in a pooled section of the river

were similar in community structure according to the DCA analysis. The Community Coefficient, based only on presence and absence showed that species differences were greatest between RM 38 and RM 19, however, the DCA found that one microhabitat at RM 19 attracted fish similar to those in the fastest current at RM 24. This microhabitat contained fast, turbulent and mixing water around the bridge abutments.

3. In 1996, the Delt anomalies observed in fish were above OEPA baseline levels at RM 24 and RM 19. DELT anomalies are typically related to a variety of pollutants in the water and/or the sediments. However, detailed data on the occurrence of the DELTs, as well as chemistry of the water and sediments in adjacent sections of the river were not collected, and thus this study cannot point to any site as the origin of the DELTs nor can it identify any particular causative agent.

Since past studies (Moller 1986, OEPA 1995) show varying levels of DELT anomalies at a number of sites along the length of the Great Miami River, one or more causative agents could be involved that may vary by location. Future study is needed to identify where and why these elevated levels of DELT anomalies occur.

4. Improvements in the general water quality will allow researchers to identify and resolve minor problems associated with microhabitat and even the effects of small effluents and pipe discharges. Components of microhabitats that support diverse fish and macroinvertebrate communities might include: riparian zone vegetation, imbeddedness of large boulders, mean depth, current velocity, gravel bars and islands. Microhabitat has

been the single strongest variable to differentiate fish communities between stations and among replicates.

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Figure 1. Overview map of sampling sites in the Great Miami River, 1996

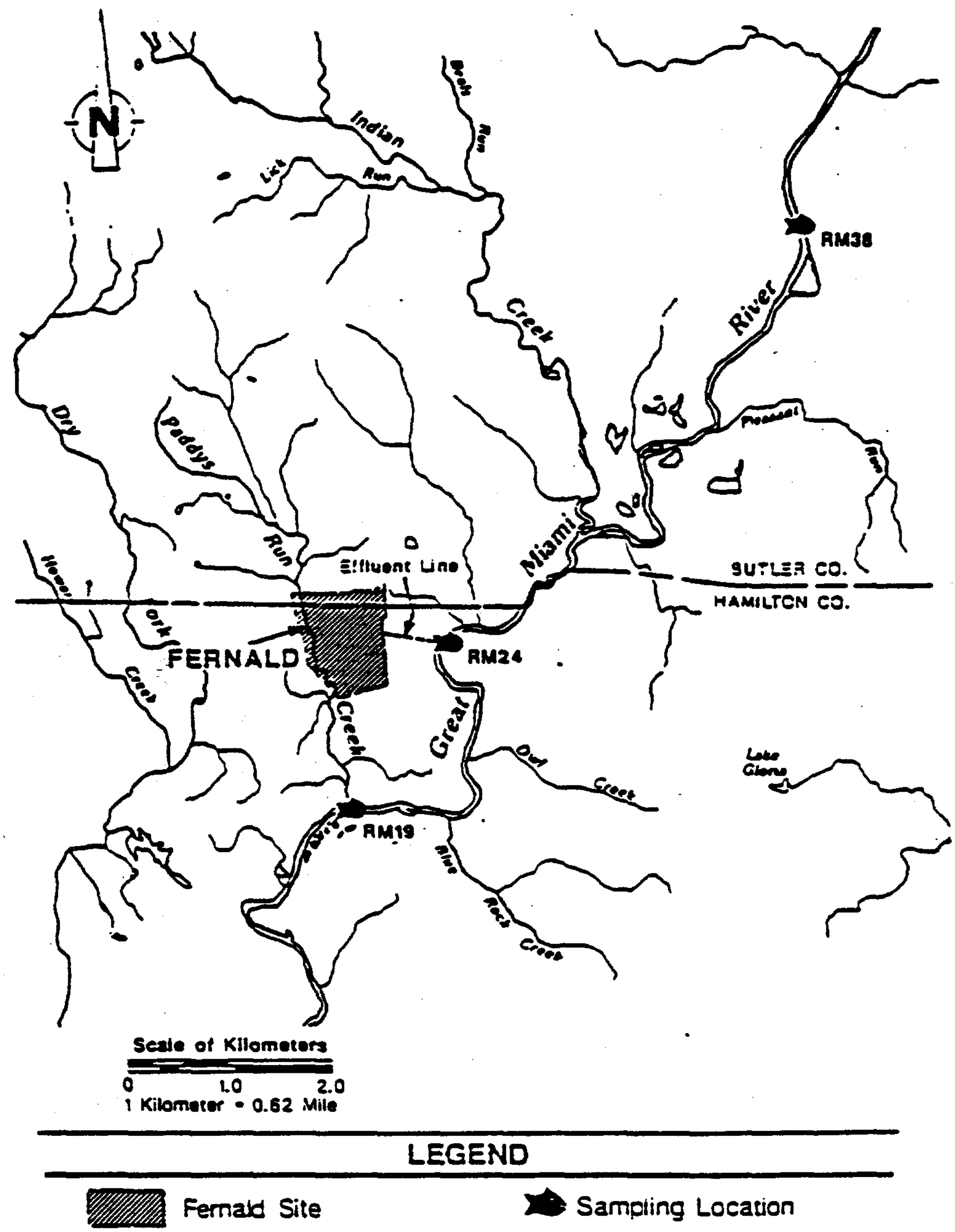


Figure 2. Map of site and electrofishing subsamples at river mile 38

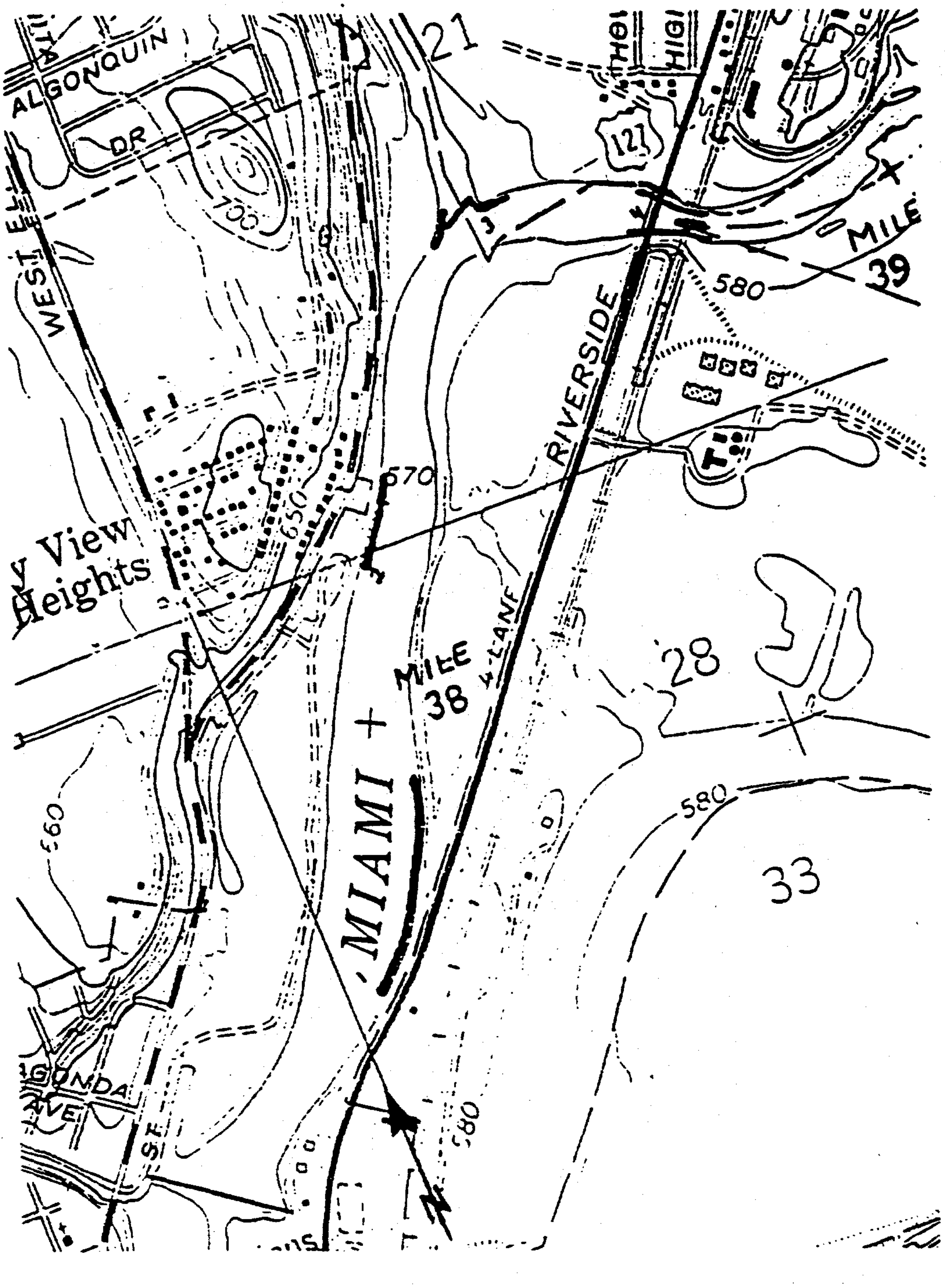


Figure 3. Map of site and electrofishing subsamples at river mile 24 .

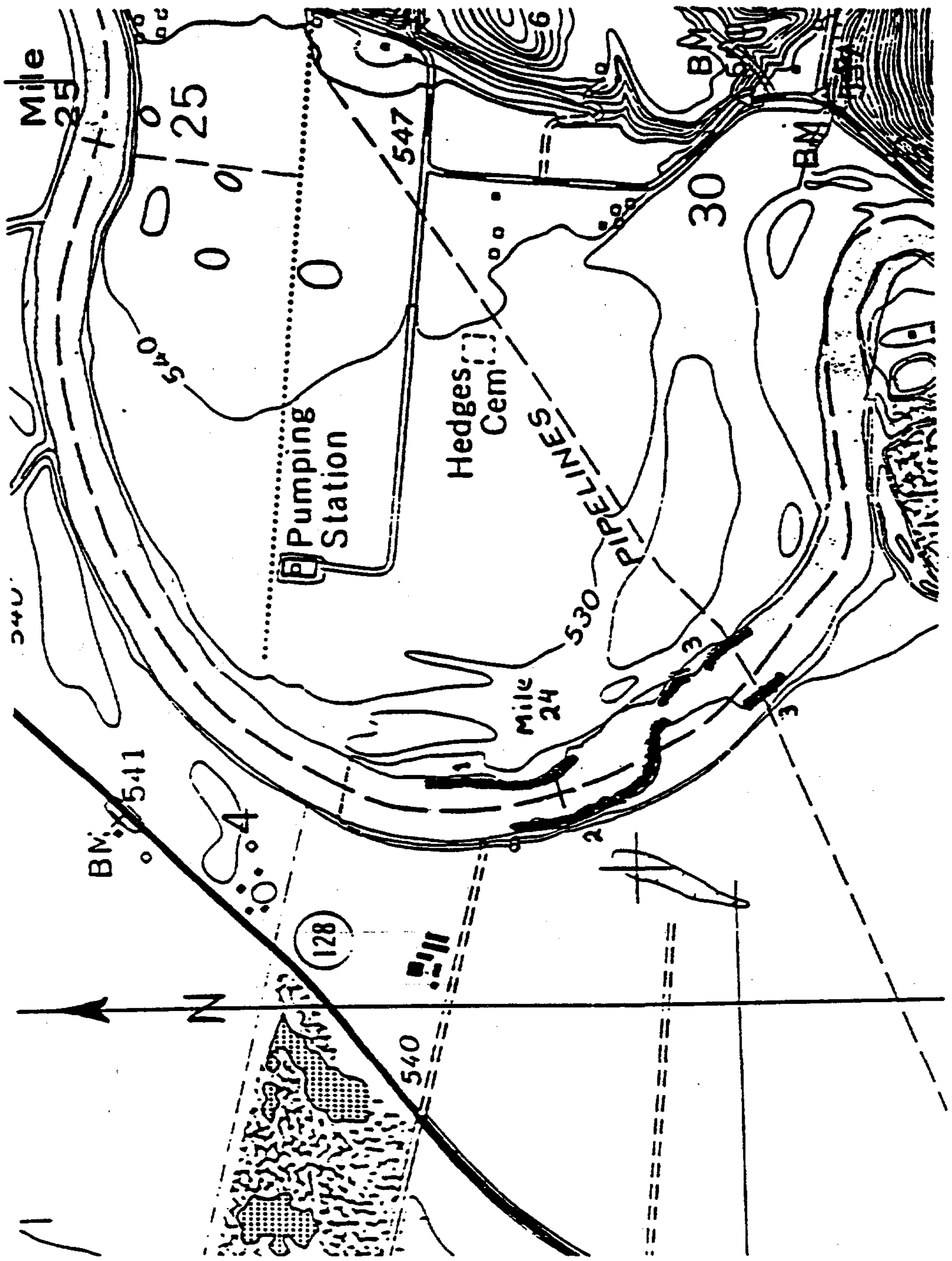


Figure 4. Map of site and electrofishing subsamples at river mile 19

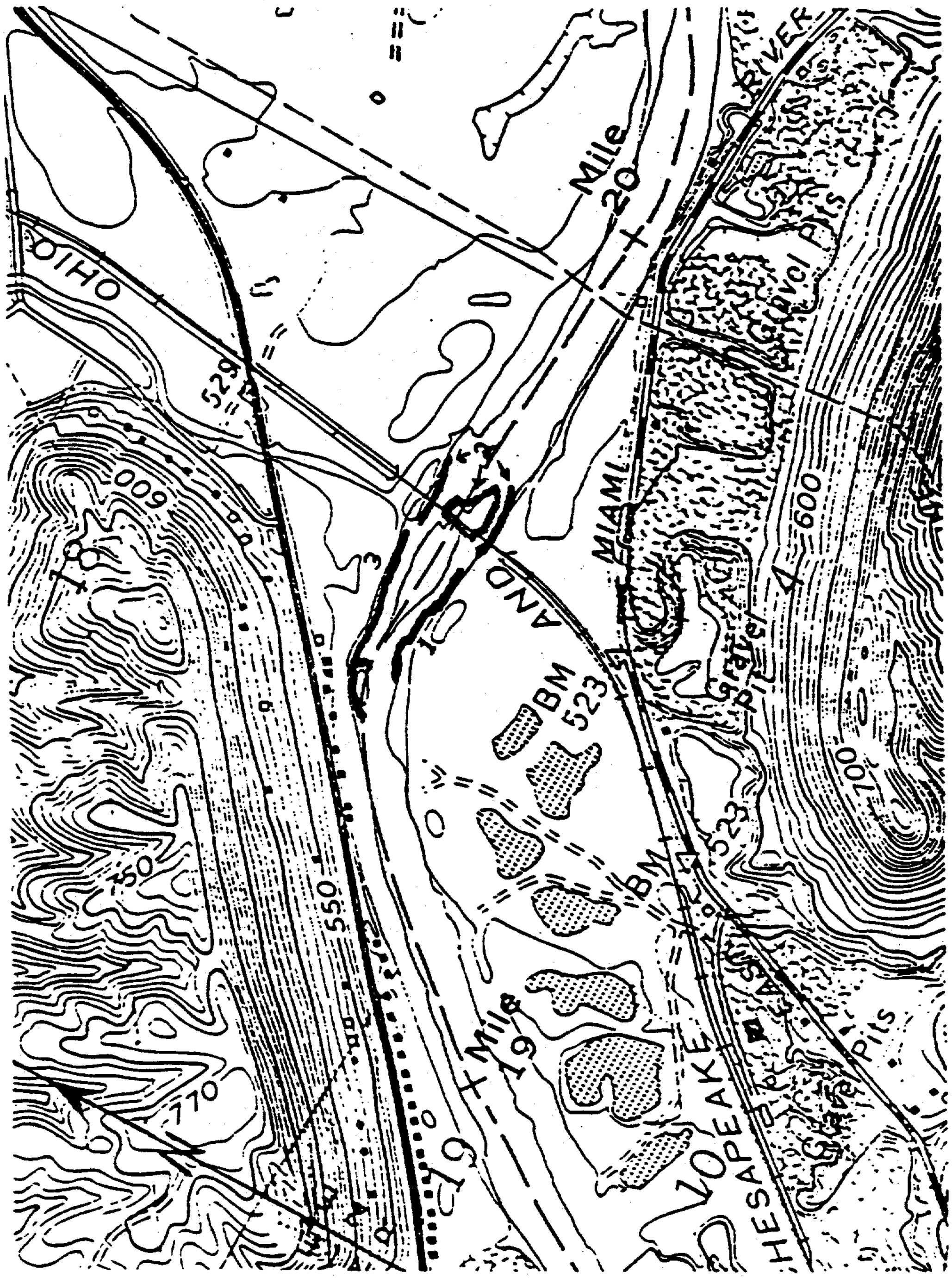


Figure 5. Phosphorus(mg PO_4^{-3}/l, nitrate(mg NO_3^{-1}-N/l and sulfate (ug SO_4 S/l) concentrations found at each site in the Great Miami, River Septembe 17-18,1996

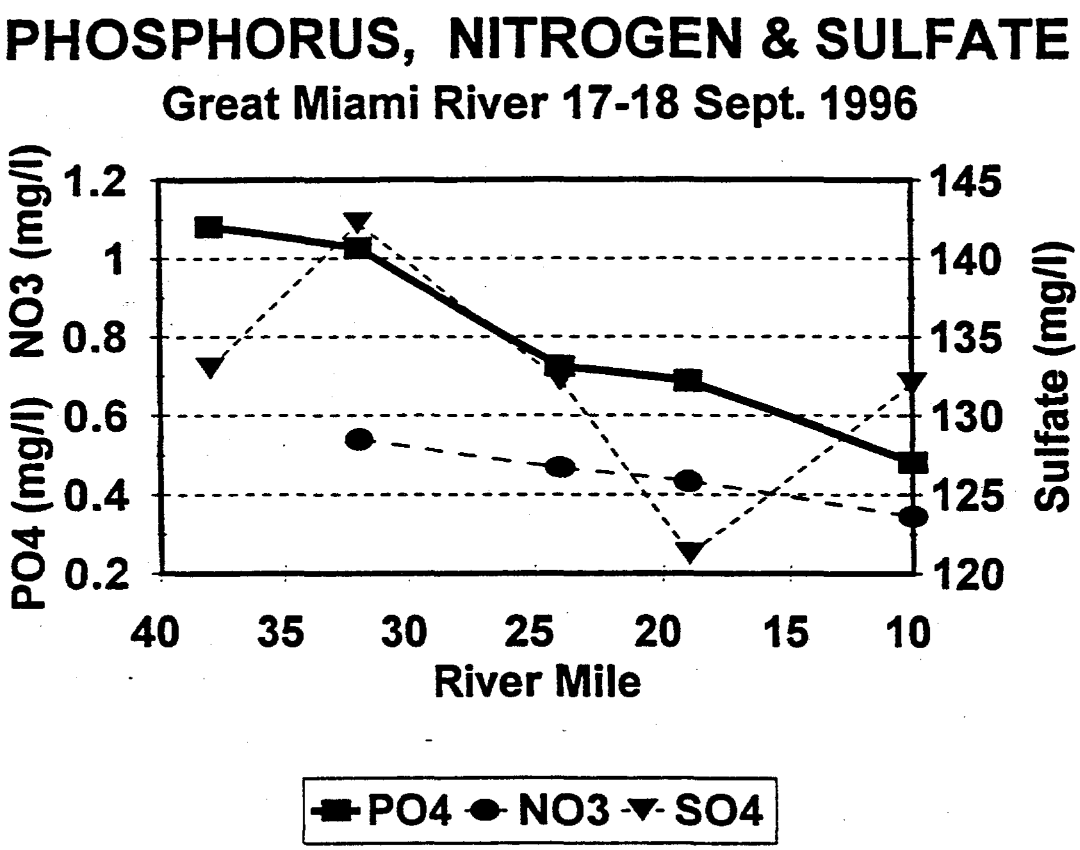


Figure 6 . Conductivity (uS) and turbidity (FTU's) found at each site in the Great Miami River, September 17-18, 1996

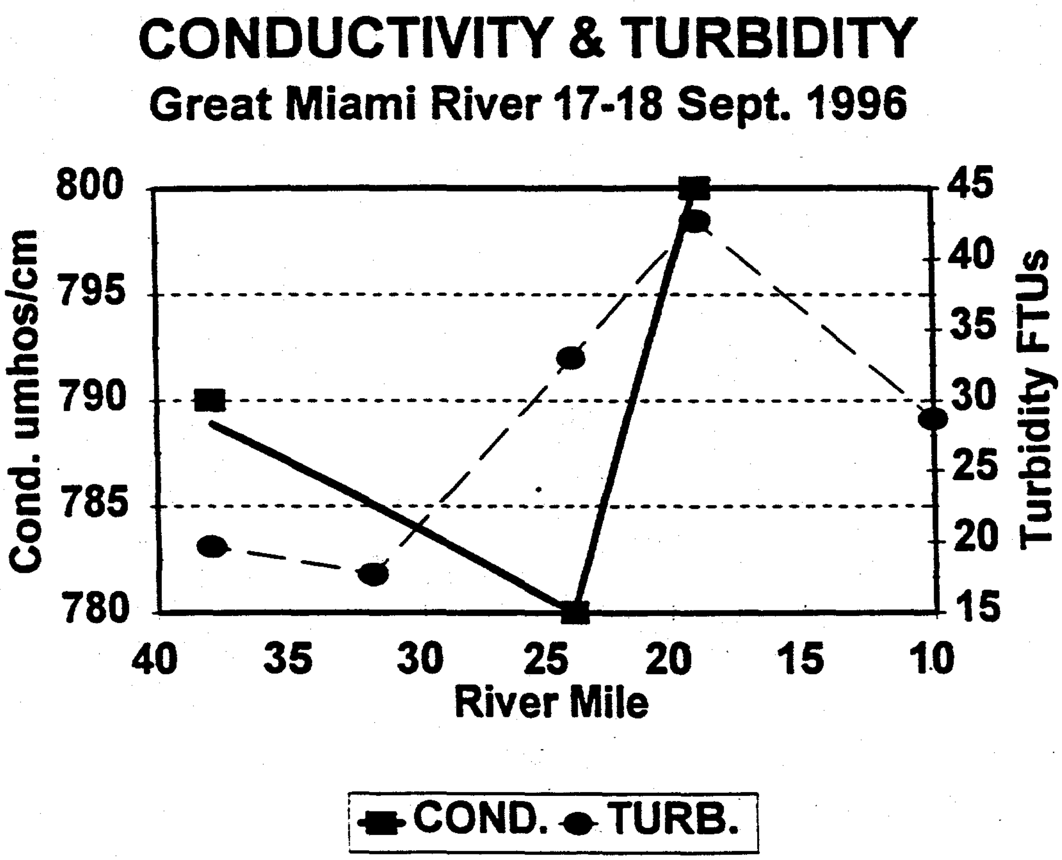


Figure 7. Sestonic algal biomass as chlorophyll a (ug/l) and turbidity (FTU's) found at each site in the Great Miami River, September 17-18,1996

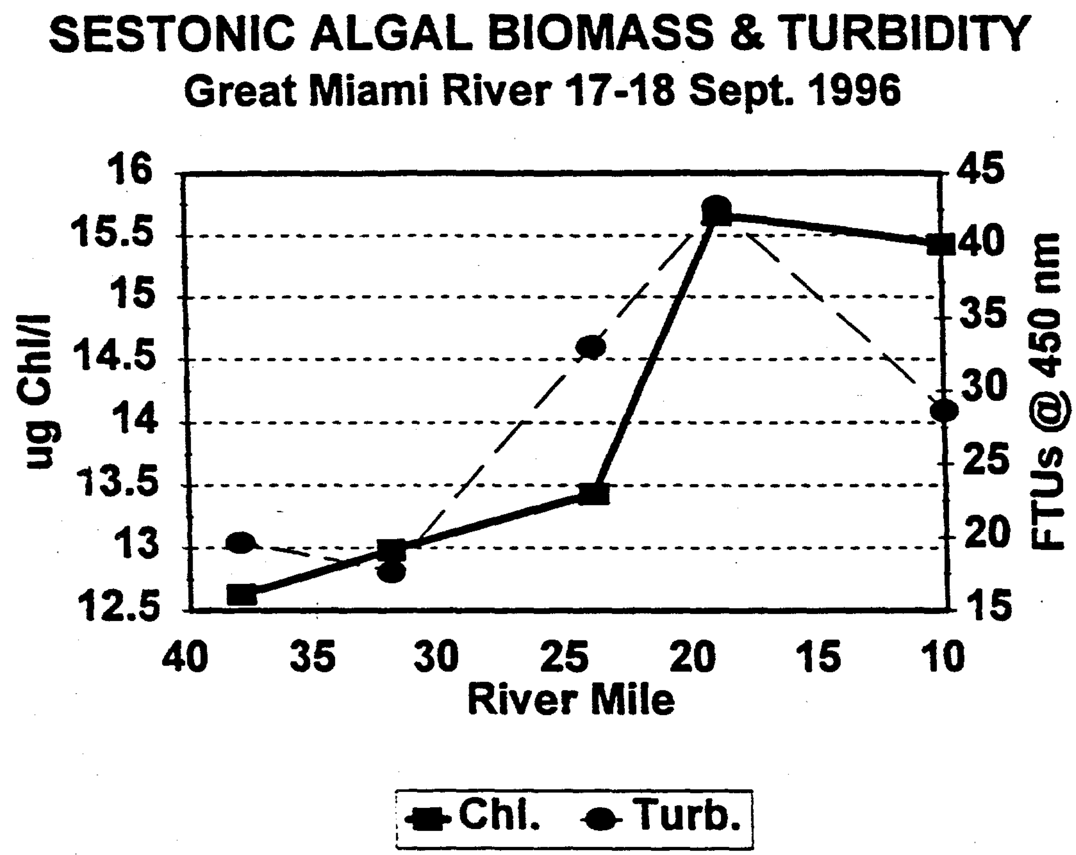


Figure 8. Dissolved Oxygen (mg O_2/l) and pH found at each site in the Great Miami River, September 17-18, 1996

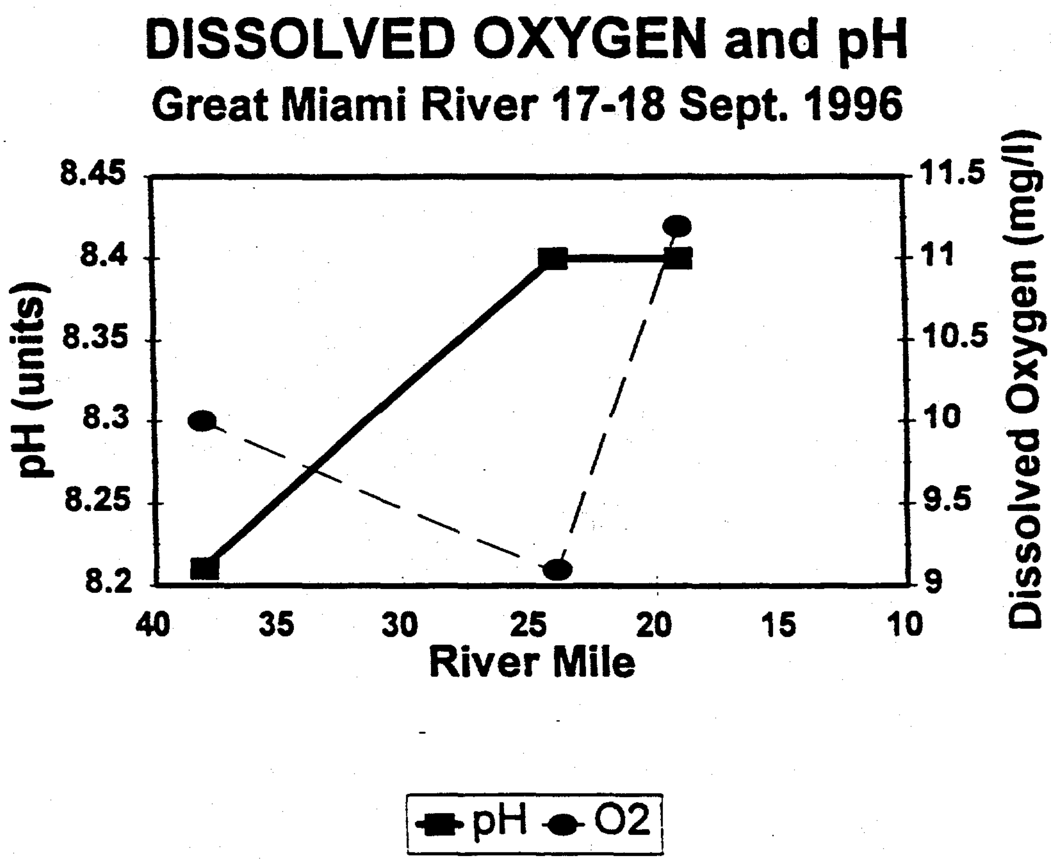
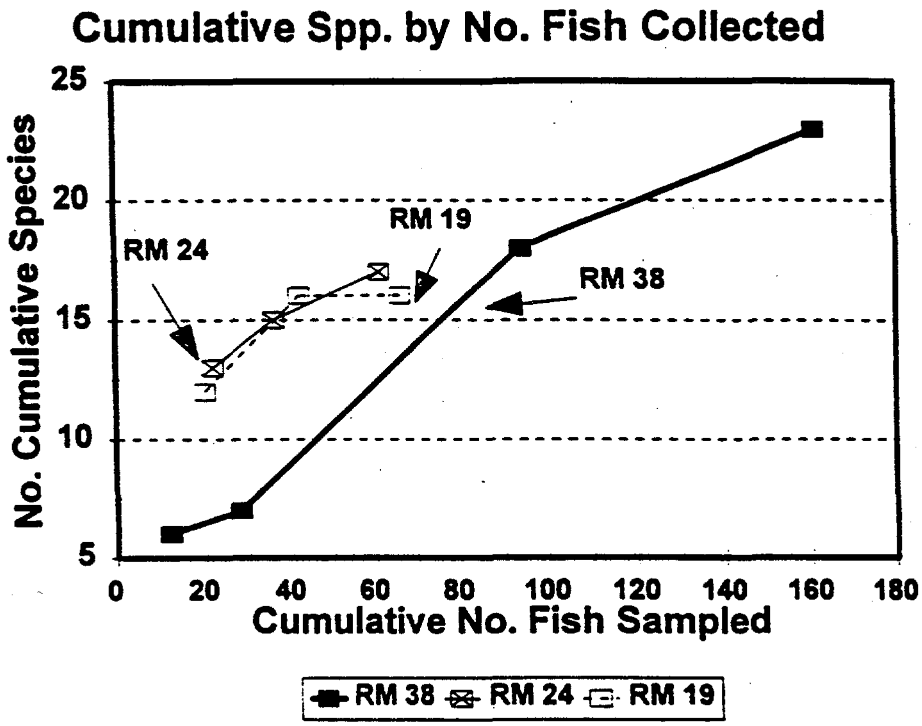


Figure 9a. Cumulative species as function of subsamples at three sampling sites in the Great Miami River, 17-18 Sept. 1996



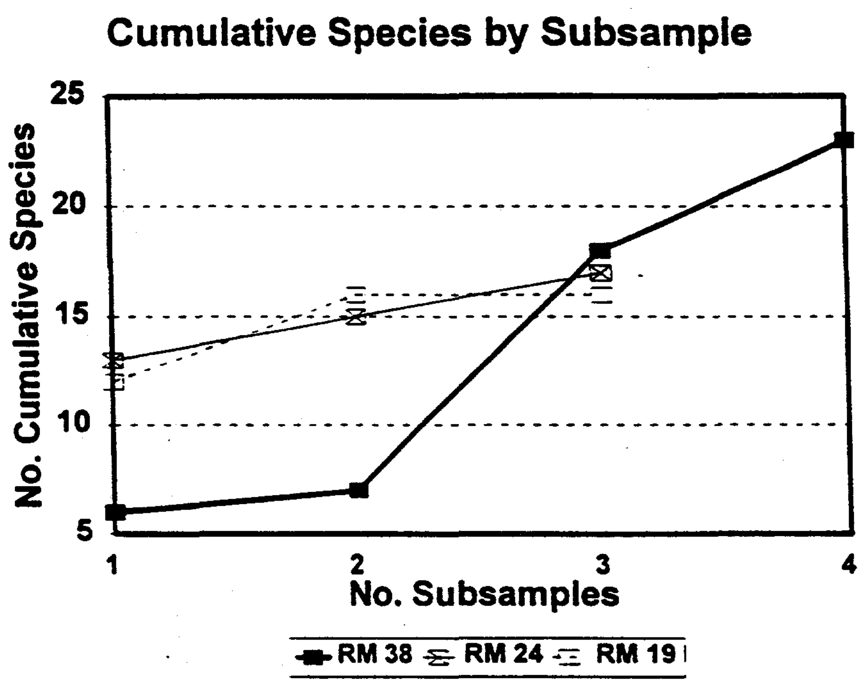


Figure 9b. Cumulative species collected as a function of the number of fish captured at three sites in the Great Miami River, 17-18 Sept. 1996

Figure 10. Number of species, number of individuals and number of individuals/species found at each site and total for all sites in the Great Miami River, September 17-18, 1996

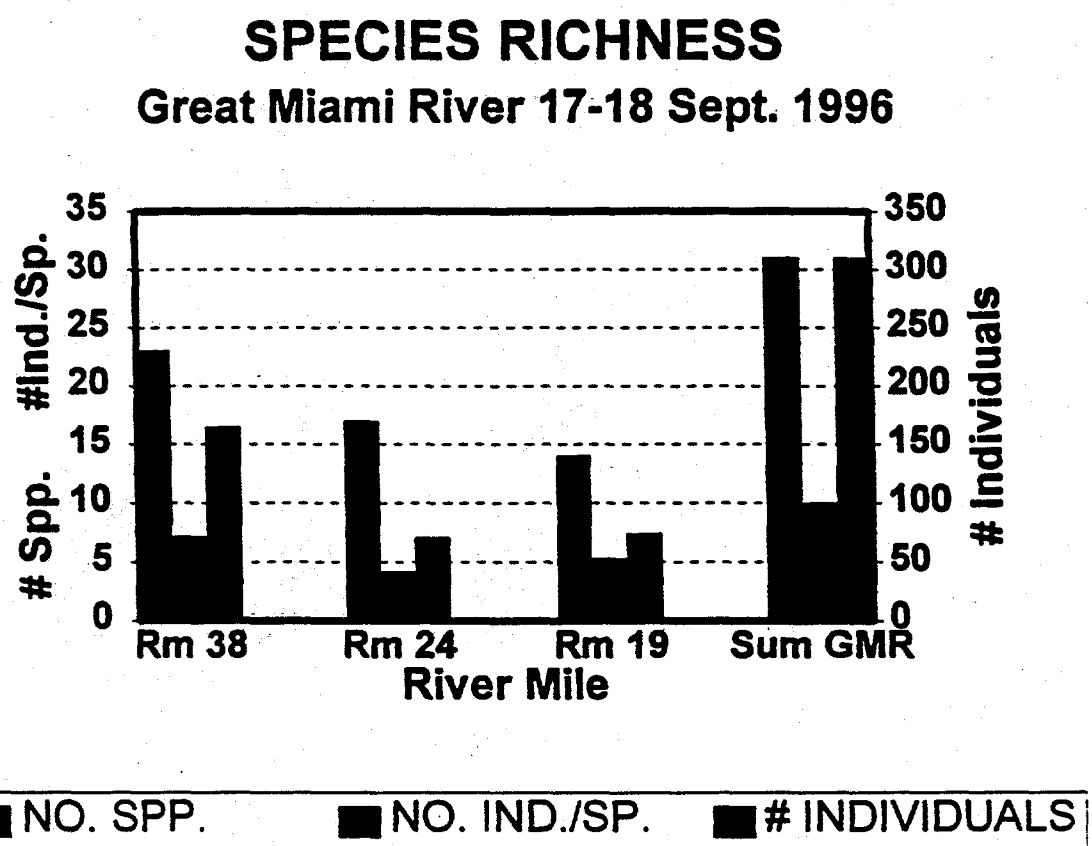


Figure 11. Species Diversity (HBar, HMax and Eveness) as $\log_2$ at sites in the Great Miami River, September 17-18, 1996

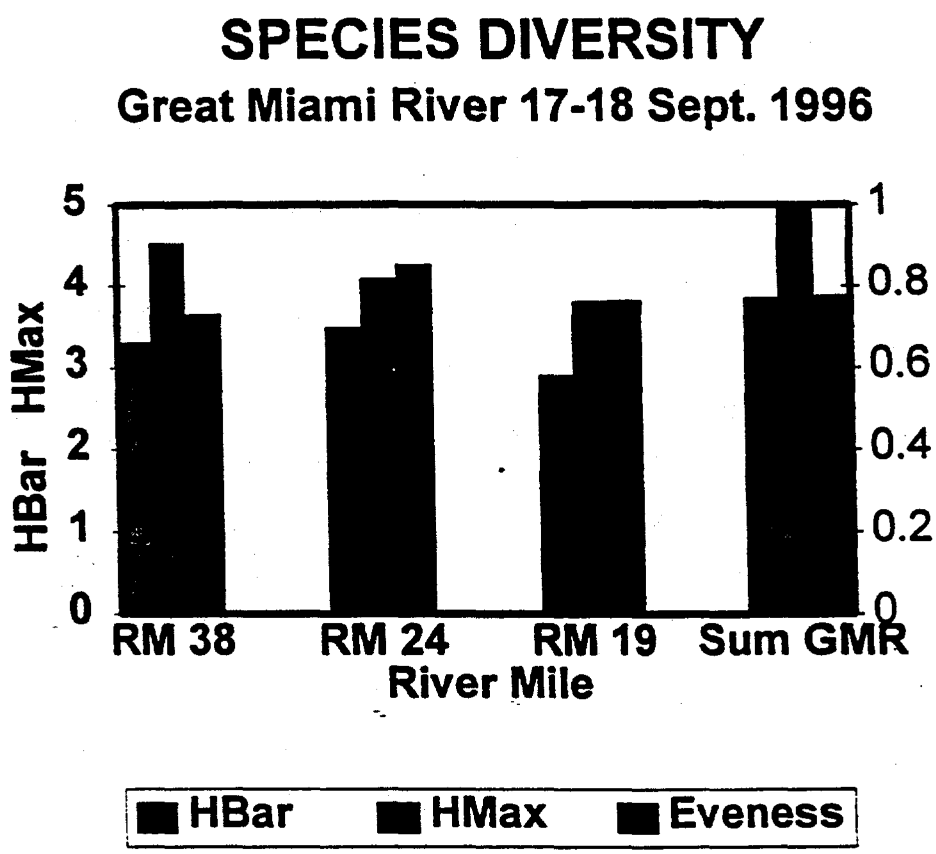


Figure 12. Cumulative proportion of fish by length at sites in the Great Miami River, 17-18 Sept. 1996

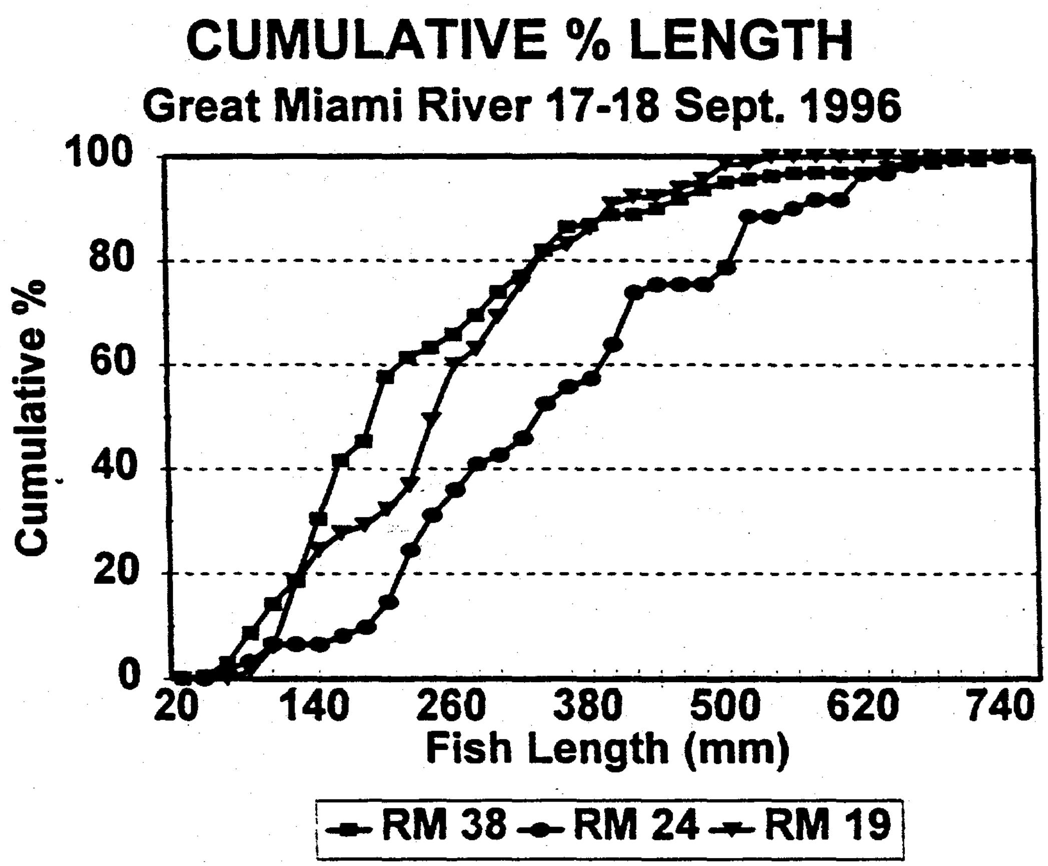


Figure 13. Cumulative proportion of fish by weight at sites in the Great Miami River, 17-18 Sept. 1996

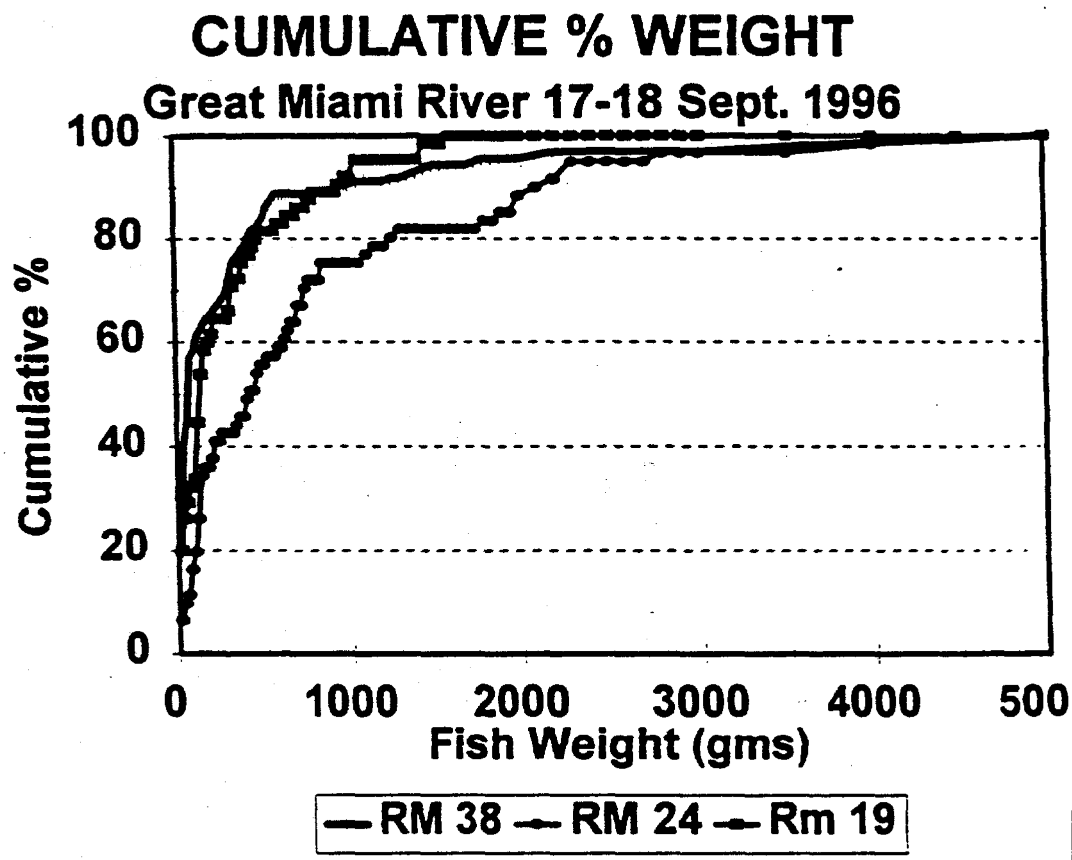


Figure 14. Length/weight (log vs log) relationship for all fish at all sites in Great Miami River, 17-18 Sept. 1996

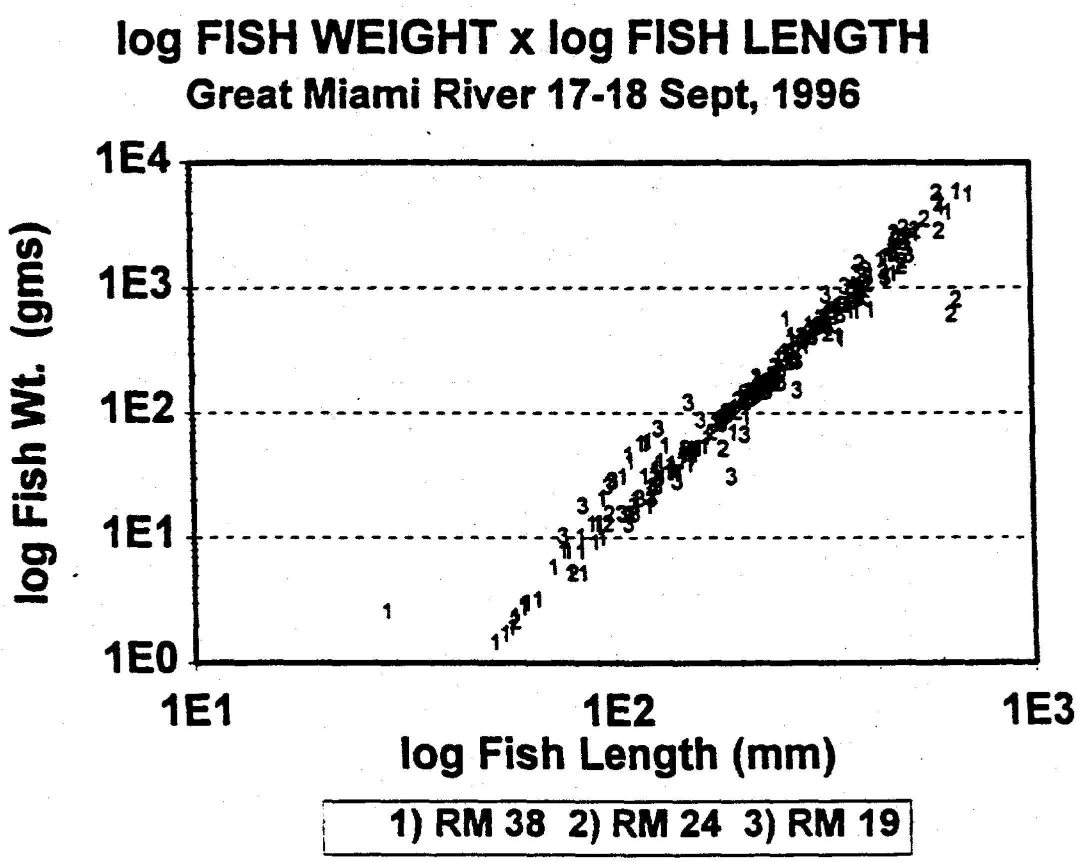


Figure 15. Length/weight (log vs log) relationship for all fish by family in Great Miami River, 17-18 Sept. 1996

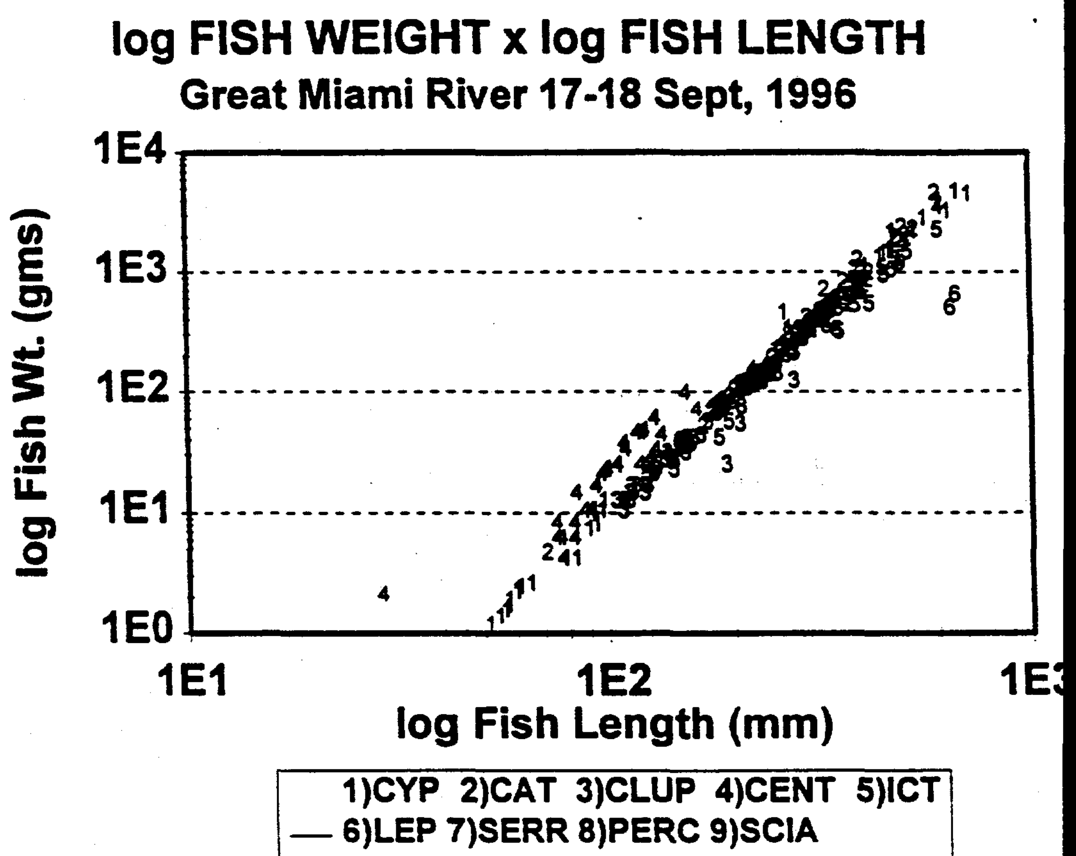


Figure 16. Detrended Correspondence Analysis of fish communities at 3 sites with overlain species responsible for the distribution of sites in GMR, 17-18 Sept. 1996

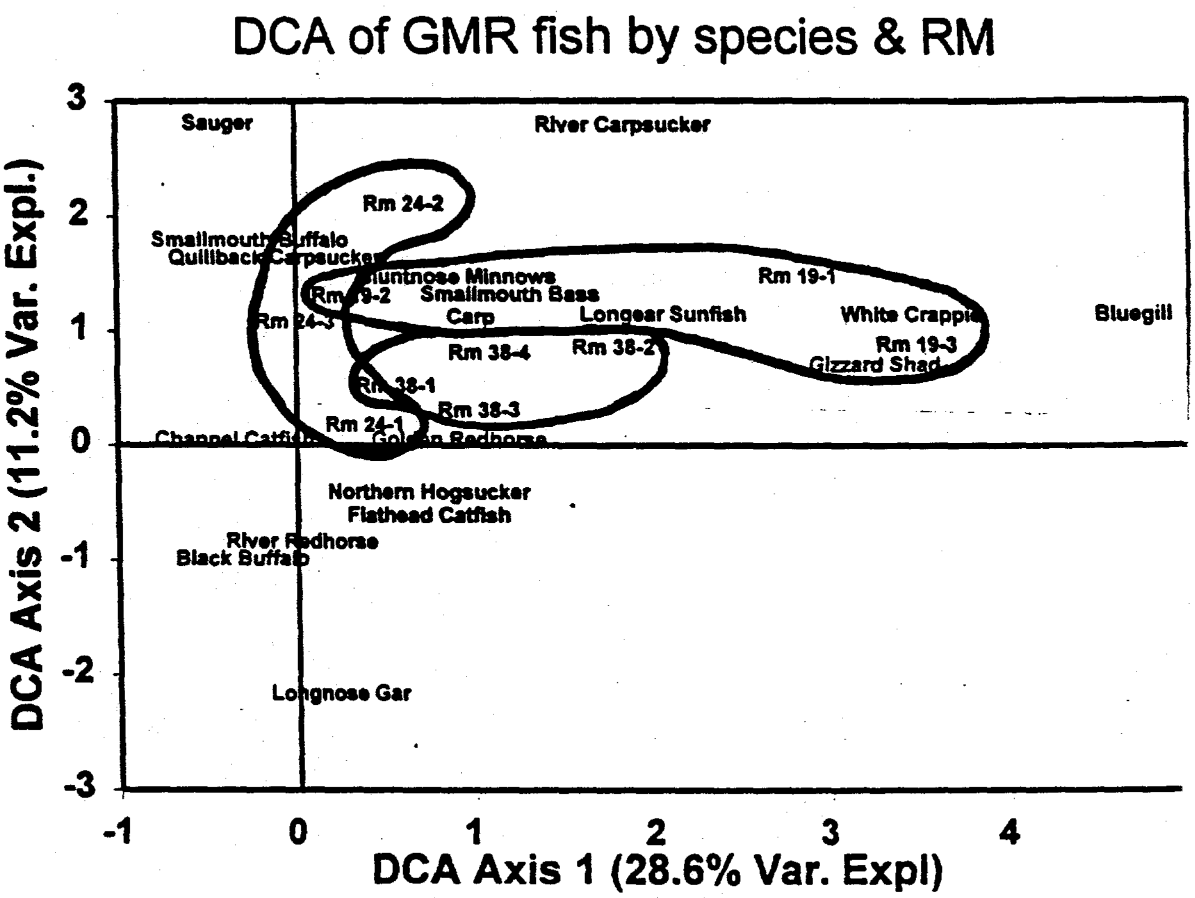


Figure 17. Ohio EPA calculated habitat quality index (QHEI) for the lower Great Miami River, summer 1995

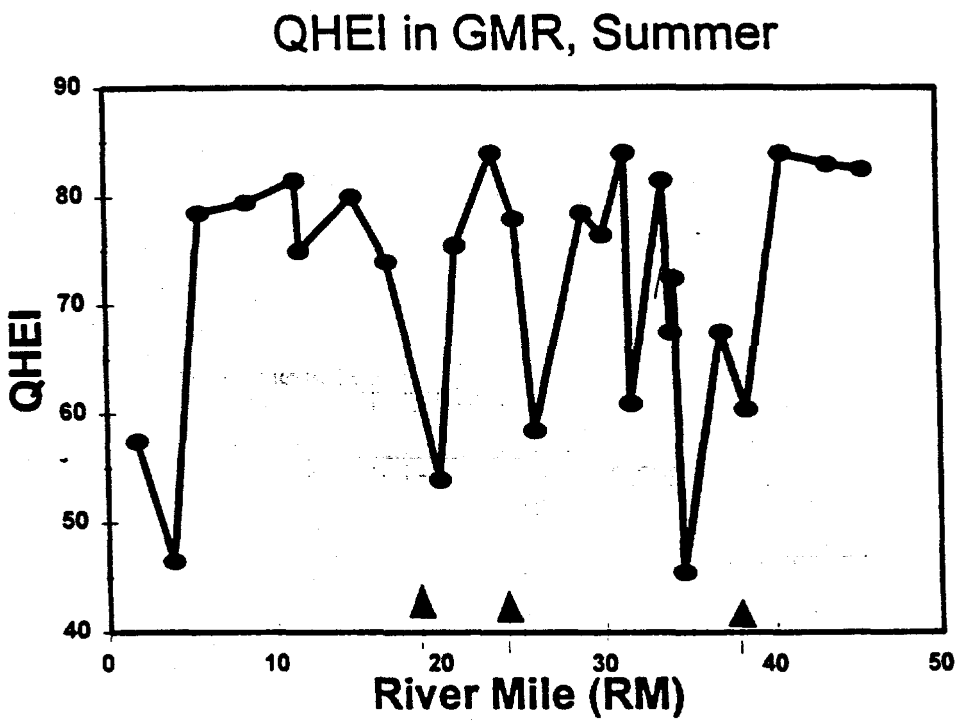


Figure 18. IBI and MIwb for fish in lower Great Miami River, summer 1995 compared to values for fishing sites 16-17 Sept. 1996

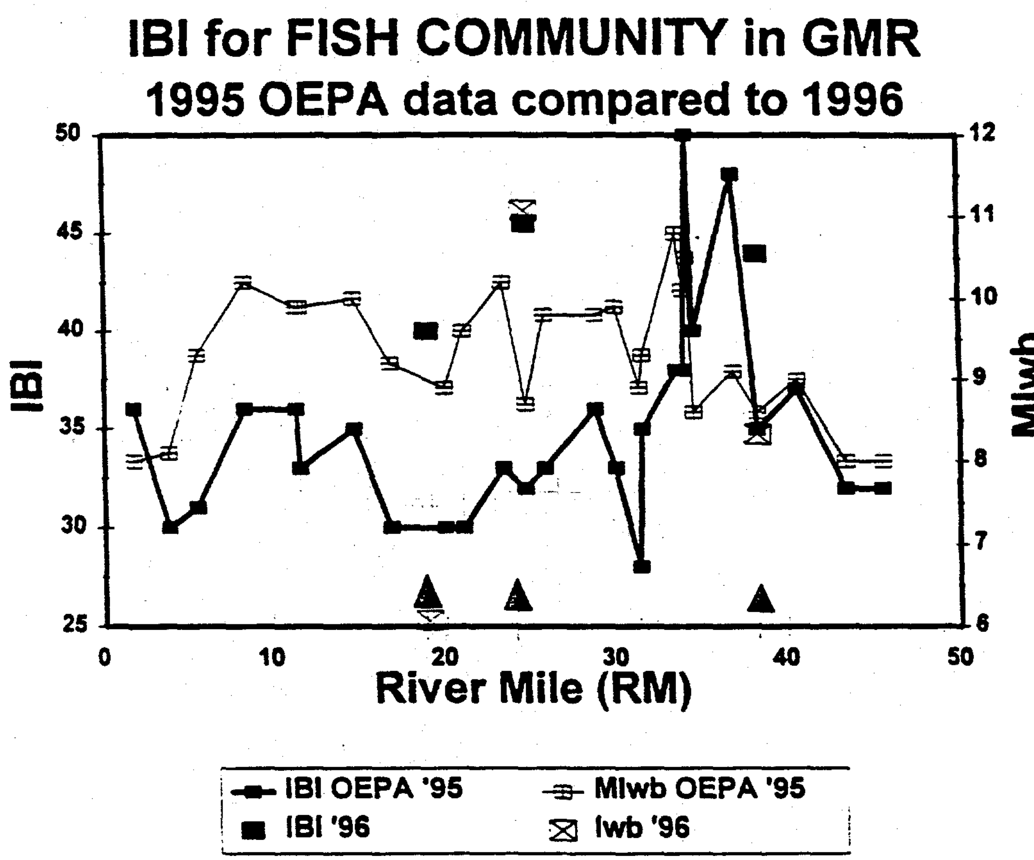


Table 1: Water Physics/Chemistry of the Great Miami River electroshocking stations during fish sampling, Sept. 1995 and 17-18 Sept. 1996

1996 Station	Hour Day	Temp C	Secchi cm	Oxygen mg/l	Oxygen % Sat.	Conduct umhos/cm	FTUs 450 nm	pH units	Chlor a ug act chl/l	Total Chlo ug /l	PO4 mg/l	NO3 mg/l	SO4 mg/l
RM 38	10:40	15.3	30	10	99.7	790	19.7	8.21	7.4565	12.6295	1.083		133
RM 32	13:30						17.7		8.4745	12.9825	1.027	0.54	142.25
RM 24	9:50	15	32	9.1	91.9	780	33	8.4	8.6345	13.431	0.724	0.468	132.25
RM 19	14:40	15.6	32	11.2	113.1	800	42.7	8.4	9.289	15.664	0.688	0.434	121.25
RM 10							28.7		9.362	15.4325	0.483	0.346	132
1995 RM 38		18		11.4	120.42	771		8.3		15	3.14	19.65	101.74
RM 24		19.5		7.6	83.52	798		8.2		18.23	13.38	21.5	100.05
RM 19		23.5		8.1	95.41	793		8.3		15.15	1.86	24.62	106.97

Table 2. *Number of each species caught at each site and subsample Great Miami River 17-18 Sept 1996*

		RM38 SITE	RM38 SITE	RM38 SITE	RM38 SITE 1		RM 24 SITE 2	RM 24 SITE 2	RM 24 SITE 2		RM 19 SITE 3	RM 19 SITE 3	RM 19 SITE 3	
COMMON NAME	FAMILY	rep 1	rep2	rep3	rep4	sum38	rep 1	rep2	rep3	sum 24	rep 1	rep2	rep3	sum 19
Longnose Gar	Lepisosteidae					0	2			2				0
Gizzard Shad	Clupeidae	1	8	12	12	33	5			5	13		18	31
Bluntnose Minnows	Cyprinidae				3	3				0				0
Blacktail Shiner	Cyprinidae			1		1	1			1				0
Creek Chub	Cyprinidae		1		2	3				0				0
Carp	Cyprinidae	3	3	3	8	17	1	3	2	6		2		2
Spotail Shiners	Cyprinidae				4	4				0				0
Suckermouth minnow	Cyprinidae					0	2			2				0
Carp/goldfish hybrid	Cyprinidae				1	1				0				0
Smallmouth Buffalo	Catastomidae					0	1	2	3	6		1		1
White Sucker	Catastomidae			1		1				0				0
Highfin Carpsucker	Catastomidae			1		1	1			1				0
Golden Redhorse	Catastomidae	1	2	34	16	53	2		1	3		1		1
Black Buffalo	Catastomidae					0	1			1				0
Northern Hogsucker	Catastomidae			1		1				0				0
River Redhorse	Catastomidae			3		3	3		1	4				0
River Carpsucker	Catastomidae					0		11	2	13	2	2		4
Quillback Carpsucker	Catastomidae	1			2	3	1	2	2	5		2		2
Spotted Bass	Centrarchidae			1		1				0		1		1
White Crappie	Centrarchidae					0				0	1			1
Bluegill	Centrarchidae			2	1	3				0	2		3	5
Largemouth Bass	Centrarchidae		1	1	5	7			1	1				0
Black Crappie	Centrarchidae			1		1				0				0
Smallmouth Bass	Centrarchidae		1		10	11	1			1		1	1	2
Longear Sunfish	Centrarchidae	1	2	1	2	6				0				0
Green Sunfish	Centrarchidae			1		1				0	1		1	2
Channel Catfish	Ictaluridae	5		2	1	8	1	1	4	6		7		7
Flathead Catfish	Ictaluridae			1	1	2			2	2				0
White Bass	Percicthyidae					0				0	3	3	1	7
Sauger	Percidae			1		1				0				0
Freshwater Drum	Scianidae					0		4	8	12		7	1	8
	Indiv.	12	18	67	68	165	22	23	26	71	22	27	25	74
	no. spp	6	7	17	14	23	13	6	10	17	6	10	6	14
	ind/spp	2	2.571	3.941	4.857	7.1739	1.692	3.833	2.6	4.1765	3.667	2.7	4.167	5.2857
	community coefficient site 1 and 2				0.55		site 1 and 3		0.486		site 2 and 3		0.581	

Table 3: Fish species and number captured by electroshocking from three sites in the Great Miami River . Hbar= ni/N*ln(ni/N)

Species	Family	RM 38 Rm 38	 Hbar38	RM 24 Rm 24	 Hbar24	RM 19 Rm 19	 hbar19	GM Sum	Sum Hbar
Longnose Gar	Lepisosteidae			2	-0.101			2	
Gizzard Shad	Clupeidae	33	-0.322	5	-0.187	31	-0.364	69	-0.334
Bluntnose Minnows	Cyprinidae	3	-0.073					3	-0.045
Blacktail Shiner	Cyprinidae	1	-0.031	1	-0.060			2	-0.033
Creek Chub	Cyprinidae	3	-0.073					3	-0.045
Carp	Cyprinidae	17	-0.234	6	-0.209	2	-0.098	25	-0.203
Spotail Shiners	Cyprinidae	4	-0.090					4	-0.056
Suckermouth minno	Cyprinidae			2	-0.101			2	-0.033
Carp/goldfish hybrid	Cyprinidae	1	-0.031					1	-0.019
Smallmouth Buffalo	Catastomidae			6	-0.209	1	-0.058	7	-0.086
White Sucker	Catastomida	1	-0.031					1	-0.019
Highfin Carpsucker	Catastomida	1	-0.031	1	-0.060			2	-0.033
Golden Redhorse	Catastomida	53	-0.365	2	-0.101	1	-0.058	56	-0.309
Black Buffalo	Catastomidae			2	-0.101			2	-0.033
Northern Hogsucker	Catastomida	1	-0.031					1	-0.019
River Redhorse	Catastomida	3	-0.073	4	-0.162			7	-0.086
River Carpsucker	Catastomidae			13	-0.311	4	-0.158	17	-0.159
Quillback Carpsucke	Catastomida	3	-0.073	5	-0.187	2	-0.098	10	-0.111
Spotted Bass	Centrarchida	1	-0.031			1	-0.058	2	-0.033
White Crappie	Centrarchidae					2	-0.098	2	-0.033
Bluegill	Centrarchida	3	-0.073			5	-0.182	8	-0.094
Largemouth Bass	Centrarchida	7	-0.134	1	-0.060			8	-0.094
Black Crappie	Centrarchida	1	-0.031					1	-0.019
Smallmouth Bass	Centrarchida	11	-0.181	1	-0.060	1	-0.058	13	-0.133
Longear Sunfish	Centrarchida	6	-0.121					6	-0.076
Green Sunfish	Centrarchida	1	-0.031			2	-0.098	3	-0.045
Channel Catfish	Ictaluridae	8	-0.147	6	-0.209	7	-0.223	21	-0.182
Flathead Catfish	Ictaluridae	2	-0.053	2	-0.101			4	-0.056
White Bass	Percicthyidae					7	-0.223	7	-0.086
Sauger	Percidae	1	-0.031					1	-0.019
Freshwater Drum	Scianidae			12	-0.300	8	-0.240	20	-0.177

	RM 38	RM24	RM 19	ALL SITES
Individuals/Station	165	71	74	310
Species/Station	23	17	14	31
Minutes Shocked	40	30	30	100
Fish/hour	247.5	142	148	186
Km Shocked	0.823	0.881	0.861	2.57
Fish/Km	195.7	81	86	121
Indiv./species	7.2	4.2	5.3	10

DIVERSITY ANALYSIS					
Hbarlne = Hbarln2*ln(2)	0.693	3.303	3.485	2.905	3.845
Hmax = ln(species no)		4.524	4.087	3.807	4.954
Eveness = Hbar/Hmax		0.730	0.853	0.763	0.776
IBI		44.000	46.000	40.000	
IWB		8.340	11.080	6.780	

Table 4. Number of physical anomalies present in the fish at each site in the Great Miami River 17-18 Sept. 1996

			DELT Anomalies			
	Injuries	Parasites	Deformities	Erosions	Lesions	Tumors
RM 38	1	1	1	1		
RM 24		3	7	1	2	
RM 19	1	1	2	2	1	

Appendix A: Lengths and weights of fish caught at RM 38

Date	Fish #	Site #	Sub #	Fam #	Species	Length (mm)	Weight (gm)	Comments
17 Sept 96	8	1	1	1	Carp	449	1310	
17 Sept 96	7	1	1	1	Carp	541	2098	
17 Sept 96	6	1	1	1	Carp	622	3796	Female with eggs
17 Sept 96	11	1	1	2	Golden Redhorse	304	398	
17 Sept 96	10	1	1	2	Quillback Carpsucker	424	954	
17 Sept 96	9	1	1	3	Gizzard Shad	140	26	
17 Sept 96	12	1	1	4	Longear Sunfish	122	44	
17 Sept 96	5	1	1	5	Channel Catfish	357	318	
17 Sept 96	4	1	1	5	Channel Catfish	361	302	heeled wound on lower jaw
17 Sept 96	3	1	1	5	Channel Catfish	394	504	immature female no leeches
17 Sept 96	2	1	1	5	Channel Catfish	459	902	no leeches
17 Sept 96	1	1	1	5	Channel Catfish	481	1002	Male with leeches
17 Sept 96	15	1	2	1	Carp	388	810	
17 Sept 96	14	1	2	1	Carp	472	1416	Female with eggs
17 Sept 96	13	1	2	1	Carp	730	4332	Signs of healing fin erosion on upper fork of tail fin
17 Sept 96	28	1	2	1	Creek Chub	55	1.32	
17 Sept 96	17	1	2	2	Golden Redhorse	330	414	
17 Sept 96	16	1	2	2	Golden Redhorse	350	544	
17 Sept 96	25	1	2	3	Gizzard shad	125	16	
17 Sept 96	24	1	2	3	Gizzard shad	142	28	
17 Sept 96	23	1	2	3	Gizzard shad	144	26	
17 Sept 96	20	1	2	3	Gizzard shad	149	32	
17 Sept 96	21	1	2	3	Gizzard shad	150	36	
17 Sept 96	22	1	2	3	Gizzard shad	163	40	
17 Sept 96	19	1	2	3	Gizzard shad	169	42	
17 Sept 96	18	1	2	3	Gizzard shad	332	462	
17 Sept 96	27	1	2	4	Longear Sunfish	112	32	
17 Sept 96	26	1	2	4	Longear Sunfish	119	44	
17 Sept 96		1	2	4	Largemouth Bass	418	840	
[illegible]		1	2	4	[illegible]	400	660	

17 Sept 96	54	1	3	1	Blacktail Shiner?	66	2.5	
17 Sept 96	31	1	3	1	Carp	339	512	
17 Sept 96	30	1	3	1	Carp	480	2110	
17 Sept 96	29	1	3	1	Carp	651	3112	
17 Sept 96	70	1	3	2	Golden Redhorse	150	38	
17 Sept 96	75	1	3	2	Golden Redhorse	157	40	
17 Sept 96	87	1	3	2	Golden Redhorse	171	50	
17 Sept 96	66	1	3	2	Golden Redhorse	175	54	
17 Sept 96	78	1	3	2	Golden Redhorse	179	66	
17 Sept 96	84	1	3	2	Golden Redhorse	181	70	
17 Sept 96	89	1	3	2	Golden Redhorse	181	64	
17 Sept 96	74	1	3	2	Golden Redhorse	184	66	
17 Sept 96	76	1	3	2	Golden Redhorse	184	66	
17 Sept 96	73	1	3	2	Golden Redhorse	184	68	
17 Sept 96	69	1	3	2	Golden Redhorse	184	72	
17 Sept 96	71	1	3	2	Golden Redhorse	185	66	
17 Sept 96	86	1	3	2	Golden Redhorse	185	74	
17 Sept 96	72	1	3	2	Golden Redhorse	186	72	
17 Sept 96	82	1	3	2	Golden Redhorse	187	76	
17 Sept 96	67	1	3	2	Golden Redhorse	188	70	
17 Sept 96	88	1	3	2	Golden Redhorse	192	80	
17 Sept 96	80	1	3	2	Golden Redhorse	192	74	
17 Sept 96	83	1	3	2	Golden Redhorse	197	86	
17 Sept 96	91	1	3	2	Golden Redhorse	199	88	
17 Sept 96	68	1	3	2	Golden Redhorse	204	102	
17 Sept 96	77	1	3	2	Golden Redhorse	206	102	
17 Sept 96	81	1	3	2	Golden Redhorse	212	104	
17 Sept 96	85	1	3	2	Golden Redhorse	213	102	
17 Sept 96	79	1	3	2	Golden Redhorse	219	108	
17 Sept 96	90	1	3	2	Golden Redhorse	234	138	
17 Sept 96	59	1	3	2	Golden Redhorse	296	300	
17 Sept 96	92	1	3	2	Golden Redhorse	297	306	
17 Sept 96	63	1	3	2	Golden Redhorse	312	340	
17 Sept 96	62	1	3	2	Golden Redhorse	313	342	
17 Sept 96	61	1	3	2	Golden Redhorse	326	416	

17 Sept 96	60	1	3	2	Golden Redhorse	333	376	
17 Sept 96	65	1	3	2	Golden Redhorse	334	438	
17 Sept 96	64	1	3	2	Golden Redhorse	340	370	
17 Sept 96	55	1	3	2	Highfin Carpsucker	277	254	
17 Sept 96	94	1	3	2	Northern Hogsucker	189	68	
17 Sept 96	56	1	3	2	River Redhorse	243	144	
17 Sept 96	57	1	3	2	River Redhorse	255	162	
17 Sept 96	58	1	3	2	River Redhorse	381	512	
17 Sept 96	93	1	3	2	White Sucker	161	40	
17 Sept 96	43	1	3	3	Gizzard Shad	140	26	
17 Sept 96	42	1	3	3	Gizzard Shad	144	26	
17 Sept 96	41	1	3	3	Gizzard Shad	146	26	
17 Sept 96	40	1	3	3	Gizzard Shad	149	34	
17 Sept 96	34	1	3	3	Gizzard Shad	151	36	
17 Sept 96	38	1	3	3	Gizzard Shad	155	30	
17 Sept 96	39	1	3	3	Gizzard Shad	155	34	
17 Sept 96	33	1	3	3	Gizzard Shad	155	38	
17 Sept 96	37	1	3	3	Gizzard Shad	157	36	
17 Sept 96	35	1	3	3	Gizzard Shad	157	34	
17 Sept 96	36	1	3	3	Gizzard Shad	159	36	
17 Sept 96	32	1	3	3	Gizzard Shad	253	186	
17 Sept 96	47	1	3	4	Black Crappie	225	150	
17 Sept 96	49	1	3	4	Bluegill	84	8	
17 Sept 96	50	1	3	4	Bluegill	95	16	
17 Sept 96	52	1	3	4	Green Sunfish	136	42	
17 Sept 96	51	1	3	4	Longear Sunfish	107	24	
17 Sept 96	48	1	3	4	Spotted Bass	129	28	
17 Sept 96	45	1	3	5	Channel Catfish	197	54	
17 Sept 96	44	1	3	5	Channel Catfish	425	520	
17 Sept 96	46	1	3	5	Flathead Catfish	493	1236	
17 Sept 96	53	1	3	8	Sauger	212	72	
17 Sept 96		1	3	4	Largemouth Bass			
17 Sept 96	160	1	4	1	Bluntnose Minnow	57	1.49	
17 Sept 96	158	1	4	1	Bluntnose Minnow	58	1.83	

17 Sept 96	102	1	4	1	Carp	256	218	
17 Sept 96	101	1	4	1	Carp	274	326	
17 Sept 96	100	1	4	1	Carp	459	1392	
17 Sept 96	98	1	4	1	Carp	475	1456	
17 Sept 96	97	1	4	1	Carp	517	1782	
17 Sept 96	99	1	4	1	Carp	521	1706	
17 Sept 96	96	1	4	1	Carp	624	3356	fish has scolioisis
17 Sept 96	95	1	4	1	Carp	682	4562	
17 Sept 96	103	1	4	1	Carp/goldfish hybrid	267	436	
17 Sept 96	152	1	4	1	Creek Chub	61	2.26	
17 Sept 96	153	1	4	1	Creek Chub	62	2.34	
17 Sept 96	157	1	4	1	Spotail	85	4	
17 Sept 96	156	1	4	1	Spotail Shiners	52	1.13	
17 Sept 96	154	1	4	1	Spotail Shiners	91	7.11	
17 Sept 96	155	1	4	1	Spotail Shiners	95	7.74	
17 Sept 96	122	1	4	2	Golden Redhorse	72	4.47	
17 Sept 96	121	1	4	2	Golden Redhorse	189	76	
17 Sept 96	119	1	4	2	Golden Redhorse	190	74	
17 Sept 96	120	1	4	2	Golden Redhorse	194	76	
17 Sept 96	113	1	4	2	Golden Redhorse	265	224	
17 Sept 96	112	1	4	2	Golden Redhorse	268	216	
17 Sept 96	116	1	4	2	Golden Redhorse	285	286	
17 Sept 96	117	1	4	2	Golden Redhorse	292	292	
17 Sept 96	111	1	4	2	Golden Redhorse	296	284	
17 Sept 96	114	1	4	2	Golden Redhorse	297	312	
17 Sept 96	118	1	4	2	Golden Redhorse	301	300	
17 Sept 96	115	1	4	2	Golden Redhorse	312	312	
17 Sept 96	109	1	4	2	Golden Redhorse	331	414	
17 Sept 96	107	1	4	2	Golden Redhorse	350	498	
17 Sept 96	110	1	4	2	Golden Redhorse	352	466	
17 Sept 96	108	1	4	2	Golden Redhorse	357	532	
17 Sept 96	105	1	4	2	Quillback Carpsucker	354	552	
17 Sept 96	106	1	4	2	Quillback Carpsucker	358	578	
17 Sept 96	131	1	4	3	Gizzard Shad	115	16	
17 Sept 96	130	1	4	3	Gizzard Shad	116	14	

17 Sept 96	133	1	4	3	Gizzard Shad	124	14	
17 Sept 96	128	1	4	3	Gizzard Shad	125	18	
17 Sept 96	134	1	4	3	Gizzard Shad	125	20	
17 Sept 96	132	1	4	3	Gizzard Shad	128	24	
17 Sept 96	126	1	4	3	Gizzard Shad	128	20	
17 Sept 96	129	1	4	3	Gizzard Shad	132	22	
17 Sept 96	125	1	4	3	Gizzard Shad	133	24	
17 Sept 96	127	1	4	3	Gizzard Shad	138	26	
17 Sept 96	124	1	4	3	Gizzard Shad	140	30	
17 Sept 96	123	1	4	3	Gizzard Shad	141	30	
17 Sept 96	151	1	4	4	Bluegill	29	2	
17 Sept 96	148	1	4	4	Largemouth Bass	79	4	
17 Sept 96	146	1	4	4	Largemouth Bass	92	10	
17 Sept 96	147	1	4	4	Largemouth Bass	93	10	
17 Sept 96	145	1	4	4	Largemouth Bass	111	12	
17 Sept 96	144	1	4	4	Largemouth Bass	121	24	
17 Sept 96	150	1	4	4	Longear Sunfish	111	36	
17 Sept 96	149	1	4	4	Longear Sunfish	124	46	
17 Sept 96	143	1	4	4	Smallmouth Bass	76	6	
17 Sept 96	139	1	4	4	Smallmouth Bass	78	6	
17 Sept 96	142	1	4	4	Smallmouth Bass	78	6	
17 Sept 96	141	1	4	4	Smallmouth Bass	84	6	
17 Sept 96	140	1	4	4	Smallmouth Bass	89	10	
17 Sept 96	137	1	4	4	Smallmouth Bass	128	26	
17 Sept 96	138	1	4	4	Smallmouth Bass	132	32	
17 Sept 96	136	1	4	4	Smallmouth Bass	225	148	
17 Sept 96	135	1	4	4	Smallmouth Bass	264	244	
17 Sept 96	161	1	4	5	Channel Catfish	160	36	
17 Sept 96	104	1	4	5	Flathead catfish	298	266	
17 Sept 96		1	4	4	Smallmouth Bass	320	452	

Appendix B: Lengths and weights of fish caught at RM 24

Date	Fish #	Site #	Sub #	Fam #	Species	Length (mm)	Weight (gm)	Comments
18 Sept 96	22	2	1	1	Blacktail Shiner	58	1.65	UC collection
18 Sept 96	3	2	1	1	Carp	483	2088	
18 Sept 96	21	2	1	1	Smallmouth Bass	99	12	UC collection
18 Sept 96	20	2	1	1	Suckermouth Minnow	80	4	UC collection
18 Sept 96	19	2	1	1	Suckermouth minnow	98	10	UC collection
18 Sept 96	1	2	1	2	Black Buffalo	612	4436	
18 Sept 96	6	2	1	2	Golden Redhorse	334	460	
18 Sept 96	7	2	1	2	Golden Redhorse	344	454	
18 Sept 96	5	2	1	2	Highfin Carpsucker	332	420	
18 Sept 96	4	2	1	2	Quillback Carp sucker	336	400	
18 Sept 96	9	2	1	2	River Redhorse	246	134	
18 Sept 96	10	2	1	2	River Redhorse	252	156	
18 Sept 96	8	2	1	2	River Redhorse	270	196	
18 Sept 96	2	2	1	2	Smallmouth Buffalo	401	1216	
18 Sept 96	15	2	1	3	Gizzard Shad	202	80	
18 Sept 96	14	2	1	3	Gizzard Shad	238	124	
18 Sept 96	12	2	1	3	Gizzard Shad	248	138	
18 Sept 96	13	2	1	3	Gizzard Shad	231	114	
18 Sept 96	11	2	1	3	Gizzard Shad	237	126	
18 Sept 96	18	2	1	5	Channel Catfish	502	1150	Lots of Leeches, Dermal Cysts
18 Sept 96	16	2	1	6	Longnose Gar	657	478	Female
18 Sept 96	17	2	1	6	Longnose Gar	677	624	
18 Sept 96	37	2	2	1	Carp	417	1076	
18 Sept 96	36	2	2	1	Carp	505	1958	Female
18 Sept 96	26	2	2	2	Quillback Carpsucker	400	740	
18 Sept 96	25	2	2	2	Quillback Carpsucker	385	611	
18 Sept 96	29	2	2	2	River Carpsucker	402	698	Lrg lesion on part of head over eye to parts of lft operculum
18 Sept 96	30	2	2	2	River Carpsucker	371	574	
18 Sept 96	28	2	2	2	River Carpsucker	413	748	

18 Sept 96	27	2	2	2	River Carpsucker	421	834	
18 Sept 96	23	2	2	2	Smallmouth Buffalo	541	2214	Left Pect. is nub, Anal fin is nub,Caudal fin top ray is deformed & not sym
18 Sept 96	24	2	2	2	Smallmouth Buffalo	516	1980	
18 Sept 96	35	2	2	5	Channel Catfish	187	40	
18 Sept 96	31	2	2	9	Freshwater Drum	342	504	Lft eye Protude out, Popeye
18 Sept 96	34	2	2	9	Freshwater Drum	191	78	
18 Sept 96	33	2	2	9	Freshwater Drum	228	132	Popeye on Rt side
18 Sept 96	32	2	2	9	Freshwater Drum	320	392	
18 Sept 96		2	2	1	Carp	570	1872	
18 Sept 96		2	2	2	River Carpsucker	398	816	
18 Sept 96		2	2	2	River Carpsucker	400	752	
18 Sept 96		2	2	2	River Carpsucker	405		
18 Sept 96		2	2	2	River Carpsucker	406	692	
18 Sept 96		2	2	2	River Carpsucker	410	852	
18 Sept 96		2	2	2	River Carpsucker	410	774	
18 Sept 96		2	2	2	River Carpsucker	410	822	
18 Sept 96	47	2	3	1	Carp	571	2748	Curved Dorsal spine rays, wavy Pect fin rays; first four rays caudal fin cu
18 Sept 96	42	2	3	2	Black Buffalao	504	1784	Male
18 Sept 96	44	2	3	2	Quillback Carpsucker	306	344	Dent in head, devlopmental?
18 Sept 96	43	2	3	2	Quillback Carpsucker	408	832	Female
18 Sept 96	46	2	3	2	River Carpsucker	383	686	Lesion, Lt Operculum, median Round& Deformed pupil lft eye
18 Sept 96	45	2	3	2	River Carpsucker	387	734	
18 Sept 96	52	2	3	2	River Redhorse	274	220	
18 Sept 96	41	2	3	2	Smallmouth Buffalo	490	1896	
18 Sept 96	40	2	3	2	Smallmouth Buffalo	509	2300	Female
18 Sept 96	39	2	3	2	Smallmouth Buffalo	620	3664	
18 Sept 96	61	2	3	4	Largemouth Bass	152	40	
18 Sept 96	50	2	3	5	Channel Catfish	339	338	3 inch Scar on belly, popeye rt eye,
18 Sept 96	49	2	3	5	Channel Catfish	408	658	Dermal cysts, One leech
18 Sept 96	48	2	3	5	Channel Catfish	505	1258	Lots of leeches, Dermal cysts, blind in lt eye, mod. fin erosion on caudal
18 Sept 96	51	2	3	5	Channel Catfish	618	2194	Blind in both eyes, leeches, fish louse,
18 Sept 96	38	2	3	5	Flathead Catfish	176	54	Intentended to be brought back alive
18 Sept 96	60	2	3	9	Freshwater Drum	19	80	
18 Sept 96	59	2	3	9	Freshwater Drum	203	98	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Freshwater Drum	210	112	

18 Sept 96	58	2	3	9	Freshwater Drum	211	102	
18 Sept 96	56	2	3	9	Freshwater Drum	212	96	
18 Sept 96	55	2	3	9	Freshwater Drum	216	116	
18 Sept 96	54	2	3	9	Freshwater Drum	261	208	
18 Sept 96	53	2	3	9	Freshwater Drum	285	246	Def in forehead, indent
18 Sept 96		2	3	5	Flathead Catfish	840		
18 Sept 96		2	3	1	Carp	780		

Appendix C: Lengths and weights of fish caught at RM 19

Date	Fish #	Site #	Sub #	Fam #	Species	Length (mm)	Weight (gm)	Comments
18 Sept 96	14	3	1	2	River Carpsucker	335	684	
18 Sept 96	15	3	1	2	River Carpsucker	371	798	
18 Sept 96	13	3	1	3	Gizzard Shad	111	12	
18 Sept 96	12	3	1	3	Gizzard Shad	114	14	
18 Sept 96	11	3	1	3	Gizzard Shad	127	20	
18 Sept 96	9	3	1	3	Gizzard Shad	185	64	
18 Sept 96	10	3	1	3	Gizzard Shad	195	24	
18 Sept 96	5	3	1	3	Gizzard Shad	210	52	
18 Sept 96	8	3	1	3	Gizzard Shad	220	102	
18 Sept 96	4	3	1	3	Gizzard Shad	222	116	
18 Sept 96	7	3	1	3	Gizzard Shad	225	108	
18 Sept 96	6	3	1	3	Gizzard Shad	234	128	
18 Sept 96	1	3	1	3	Gizzard Shad	238	138	
18 Sept 96	2	3	1	3	Gizzard Shad	239	116	
18 Sept 96	3	3	1	3	Gizzard Shad	283	118	
18 Sept 96	18	3	1	4	Bluegill	155	94	
18 Sept 96	19	3	1	4	Bluegill	98	20	
18 Sept 96	20	3	1	4	Green Sunfish	100	22	
18 Sept 96	17	3	1	7	White Bass	228	120	
18 Sept 96	16	3	1	4	White Crappie	225	150	
18 Sept 96		3	1	7	White Bass	260	218	
18 Sept 96		3	1	7	White Bass	286	306	
18 Sept 96	21	3	2	1	Carp	481	1554	
18 Sept 96	22	3	2	1	Carp	482	1442	
18 Sept 96	28	3	2	2	Golden Redhorse	365	574	Lesion on body at anal fin
18 Sept 96	27	3	2	2	Quillback Carpsucker	304	340	
18 Sept 96	26	3	2	2	Quillback Carpsucker	398	640	
18 Sept 96	24	3	2	2	River Carpsucker	400	748	
18 Sept 96	25	3	2	2	River Carpsucker	410	976	

18 Sept 96		3	2	4	Smallmouth Bass			
18 Sept 96	43	3	2	4	Spotted Bass	Small	Small	YOY
18 Sept 96	41	3	2	5	Channel Catfish	145	22	
18 Sept 96	40	3	2	5	Channel Catfish	311	314	Missing Four Barbles,Cut Off, with leeches, dermal cysts
18 Sept 96	39	3	2	5	Channel Catfish	360	472	Lf Pect. fin fst spine very deformed, dermal cysts on caudal fin
18 Sept 96	37	3	2	5	Channel Catfish	457	1044	
18 Sept 96	38	3	2	5	Channel Catfish	461	926	Two Leech
18 Sept 96	36	3	2	5	Channel Catfish	523	1414	Missing Barble
18 Sept 96		3	2	5	Channel Catfish	539	1300	
18 Sept 96		3	2	7	White Bass	261	236	
18 Sept 96		3	2	7	White Bass	279	260	
18 Sept 96		3	2	7	White Bass	294	314	
18 Sept 96	35	3	2	9	Freshwater Drum	250	184	
18 Sept 96	32	3	2	9	Freshwater Drum	275	292	
18 Sept 96	31	3	2	9	Freshwater Drum	291	320	
18 Sept 96	33	3	2	9	Freshwater Drum	296	308	Bulging Popeye
18 Sept 96	34	3	2	9	Freshwater Drum	308	366	
18 Sept 96	29	3	2	9	Freshwater Drum	325	448	
18 Sept 96	30	3	2	9	Freshwater Drum	325	434	
18 Sept 96	62	3	3	3	Gizzard Shad	106	12	
18 Sept 96	61	3	3	3	Gizzard Shad	107	12	
18 Sept 96	60	3	3	3	Gizzard Shad	110	10	
18 Sept 96	59	3	3	3	Gizzard Shad	114	12	
18 Sept 96	57	3	3	3	Gizzard Shad	118	16	
18 Sept 96	58	3	3	3	Gizzard Shad	126	16	
18 Sept 96	56	3	3	3	Gizzard Shad	130	20	
18 Sept 96	55	3	3	3	Gizzard Shad	236	126	
18 Sept 96	54	3	3	3	Gizzard Shad	245	132	
18 Sept 96	52	3	3	3	Gizzard Shad	246	148	
18 Sept 96	51	3	3	3	Gizzard Shad	246	158	
18 Sept 96	50	3	3	3	Gizzard Shad	250	136	
18 Sept 96	53	3	3	3	Gizzard Shad	259	136	
18 Sept 96	49	3	3	3	Gizzard Shad	259	168	
18 Sept 96	48	3	3	3	Gizzard Shad	279	208	
18 Sept 96	47	3	3	3	Gizzard Shad	284	202	

18 Sept 96	46	3	3	3	Gizzard Shad	318	372	
18 Sept 96	45	3	3	3	Gizzard Shad	330	394	
18 Sept 96	66	3	3	4	Bluegill	76	8	
18 Sept 96	65	3	3	4	Bluegill	85	14	
18 Sept 96	64	3	3	4	Bluegill	131	58	
18 Sept 96	67	3	3	4	Green Sunfish	101	22	
18 Sept 96	63	3	3	4	Smallmouth bass	165	68	
18 Sept 96		3	3	7	White Bass	279	226	
18 Sept 96	44	3	3	9	Freshwater Drum	216	114	