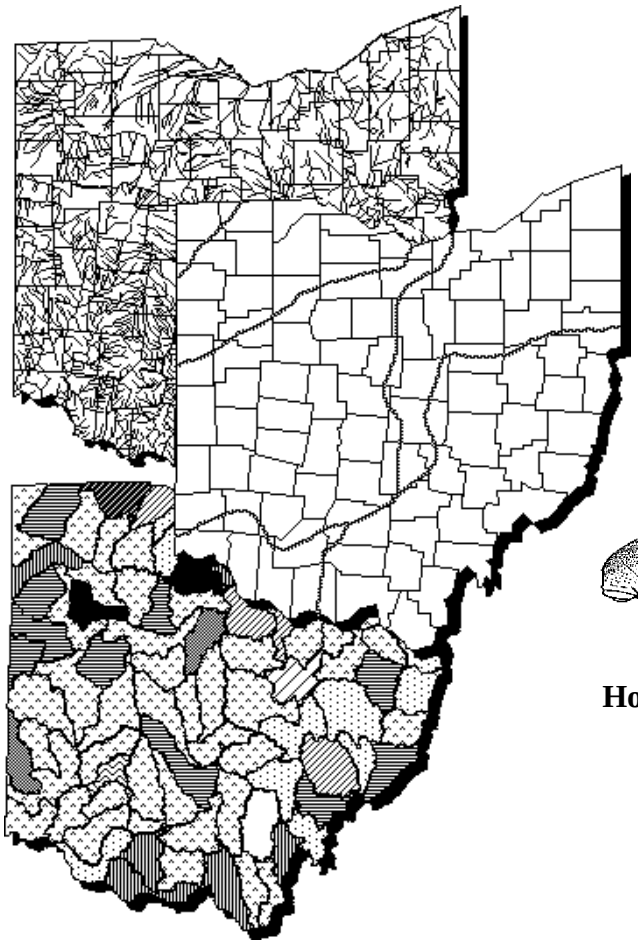
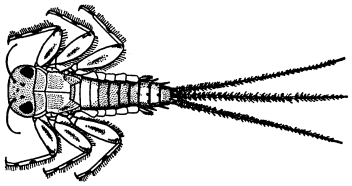
State of Ohio
Environmental Protection Agency

Ecological Assessment Section
Division of Surface Water

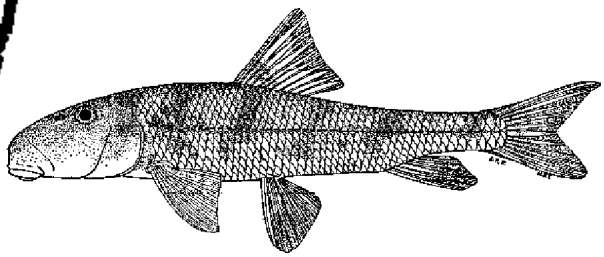
Biological, Sediment, and Water Quality Study of the Lower Mad River and Hebble Creek

Wright Patterson Air Force Base, Dayton, Ohio





Mayfly *(Stenonema)*



Hog Sucker (*Hypentelium nigricans*)

June 2, 1994

P.O. Box 163669 , 1800 WaterMark Dr., Columbus, Ohio 43216-3669

Biological, Sediment, and Water Quality Study of the Lower Mad River and Hebble Creek, Dayton, Ohio

Wright Patterson Air Force Base

Dayton, Ohio

June 2, 1994

OEPA Technical Report EAS/1994-6-9

prepared for

State of Ohio Environmental Protection Agency
Division of Emergency and Remedial Response

prepared by

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NOTICE TO USERS

Ohio EPA adopted biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (Effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish, and the Invertebrate Community Index (ICI), which is based on macroinvertebrates. Criteria for each index are specified for each of Ohio's five ecoregions, and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the chemical and whole effluent toxicity evaluation methods, figure prominently in the assessment of Ohio's surface water resources.

Several documents support the adoption of the biological criteria by outlining the rationale for using biological information, the specific methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results. These documents are:

Ohio Environmental Protection Agency. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Division of Water Quality Monitoring & Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Monitoring & Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989a. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989b. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1990a. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale,methods, and application. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

These documents and this document can be obtained by writing to:

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Acknowledgements

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Macroinvertebrate Data Analysis - Bernie Counts
Fish Data Analysis - Dave Altfater
Reviewer(s) - Chris Yoder, Jeff DeShon, and Marc Smith

This evaluation and report would not have been possible without the assistance of several full and part time staff in the field and the chemistry analyses provided by the Ohio EPA Division of Environmental Services and the Division of Emergency and Remedial Response contract laboratory.

Keith Orr of the Water Quality Modeling Section provided continuous dissolved oxygen data used in this report.

Biological, Sediment, and Water Quality Study of the Lower Mad River and Hebble Creek, Dayton, Ohio

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INTRODUCTION

The Mad River study area extended upstream from the Wright Patterson Air Force Base (River Mile [RM] 11.5) to Dayton (RM 1.6). The lower two miles of Hebble Creek were included in the study.

Specific objectives of this evaluation were to:

1) determine background conditions of the Mad River in the vicinity of the Wright Patterson Air Force Base prior to the commencement of treated groundwater discharges,

2) determine and measure adverse impacts on biological communities and water quality in the study area,

3) determine and measure the accumulation of contaminants in river sediments and fish tissue, and

4) determine the attainment status of current aquatic life use designations.

The findings of this evaluation may factor into regulatory actions taken by Ohio EPA (e.g. NPDES permits, Director's Orders), the Ohio Water Quality Standards (OAC 3745-1), and eventually be incorporated into the State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Ohio Water Resource Inventory (305[b] report).

SUMMARY/CONCLUSIONS

From June to November, 1992, Ohio EPA Division of Surface Water (DSW) staff, at the request of the Division of Emergency and Remedial Response (DERR), conducted biological community, fish tissue, sediment, and surface water sampling of the Mad River and Hebble Creek in the vicinity of the Wright Patterson Air Force Base (WPAFB), Dayton, Ohio. The results of these sampling events are summarized below.

- PARTIAL attainment of the Warmwater Habitat (WWH) use designation occurred in the upper 5.3 miles of the sampled segment of the Mad River (Table 1). FULL attainment was observed over the lower 5.2 miles of the study area. These statistics reflect an improvement from the results obtained from an Ohio EPA biological survey conducted in 1984.

- Wright Patterson Air Force Base appears to be having a negligible effect on the Mad River based on biological, sediment, water quality, and fish tissue sampling conducted by Ohio EPA during 1992. Impairment, in the form of organic enrichment, was evident downstream from the Fairborn WWTP as indicated by the response of fish communities and a slight depression in dissolved oxygen levels.

- In Hebble Creek, a tributary to the Mad River draining the WPAFB, contaminated sediments and impacts to the macroinvertebrate community were evident. Sediment samples had extremely elevated levels of total mercury and highly elevated levels of total lead. In addition, Hebble Creek had the only detected PAH levels and the highest level of 2378 - TCDD in the study area.

- Lists of spills to the Mad River and Hebble Creek indicate possible impacts due to pollutant loadings. A listing of spills with known amounts of material is detailed in Table 4. At least 10 spills have been associated with WPAFB between 1978 and 1992. Of the spills associated with WPAFB, most were composed of oil or jet fuel.

- Trends in loadings of three pollutants (ammonia-N, biochemical oxygen demand [BOD_5], and total nonfilterable residue) discharged to the Mad River from the Springfield Wastewater Treatment Plant (WWTP) 001 outfall (mean kg/day) from 1976 to 1992 indicated a substantial decrease in ammonia-N after 1988. An apparent, but less dramatic decline in BOD_5 loadings also occurred during the same time period. Both declines were associated with wastewater treatment plant improvements completed during 1988. Total suspended solids loadings showed a slight decline after 1988, with the lowest values occurring during 1991 and 1992. The Mad River was determined to be in NON attainment of the WWH use designation based on a 1984 survey of the mainstem downstream from Springfield (Ohio EPA 1986).

- Loading trends of three pollutants discharged to the Mad River from the Clark Co. South West Regional WWTP 001 outfall from 1981 to 1992 indicated no clear trends in the loadings of ammonia-N, BOD_5, or total nonfilterable residue over the last ten years. Ammonia-N values were generally low, with 50th percentile loadings less than 4 kg/day (9 of 12 years had values less than 1.0 kg/day). However, the differences between the 50th percentile and 95th percentile ammonia-N values were large between 1988 and 1990 and suggested higher variability in effluent quality.

- Loading trends of three pollutants discharged to the Mad River from the Fairborn WWTP 001 outfall from 1976 to 1992 indicated a substantial decrease in ammonia-N loadings (annual) starting in 1988, with 50th percentile values declining from 159 kg/day in 1987 to 1.3 kg/day in 1992. An apparent, but less dramatic decline in BOD_5 loadings also occurred during the same time period. Both of these parameter declines were associated with wastewater treatment plant improvements completed in 1988.

- Outfalls permitted under Wright Patterson Air Force Base permit number 1IO00001 discharge storm water draining the base. These discharges are intermittent and the result of rainfall events which generate surface runoff. The runoff is treated by oil and water separation prior to being discharged into the Mad River or Hebble Creek. All process, cooling tower, and sanitary wastes generated at the WPAFB are discharged to the Fairborn WWTP system. Discharge data reported from the 1IO00001 outfalls revealed relatively low loadings of total nonfilterable residue, oil & grease, total copper, and chromium between 1983 and 1992. Loadings data for 1991 and 1992 adjusted to a mean kg/day value revealed extremely low percentages of measured pollutants contributed to the Mad River in comparison to that discharged by the Fairborn and Springfield WWTPs.

- Wright Patterson Air Force Base received authorization in 1991 (OEPA permit number 1IN00156) to discharge effluent from groundwater treatment facilities located at two areas on the base. Outfall 001 discharges groundwater, which has been treated with an air stripper and oil/water separator system, to the Mad River at RM 6.83. Outfall 002 discharges groundwater, which has been treated with an air stripper and filtered through an activated carbon system, to a storm sewer which flows to a drainage ditch to the Mad River at RM 8.27. Both outfalls are regulated for a number of volatile organic compounds. A limited amount of data has been reported to the Ohio EPA about effluent discharged to the Mad River from outfall 001 since it began operation. Results show that from January to May, 1992, chloroform, benzene, 1,1-dichloroethylene, 1,1,1-trichloroethylene, 1,2-dichloroethane, trans-1,2-dichloroethane, naphthalene, vinyl chloride, and chlorobenzene values were all less than lab detection limits. Trichloroethylene was reported in the effluent at a 50th percentile concentration of 4.1 ug/l and a maximum of 18.4 ug/l; the 30-day average water quality standard is 75 ug/l.

- No apparent trend in Mad River water quality was noted upstream, adjacent to, or downstream from the WPAFB or the Fairborn WWTP. Chemical testing results revealed good water quality in the Mad River and Hebble Creek based on samples collected on October 14, 1992.

- Two pesticides (a-BHC and b-BHC) were detected in surface water samples from the Mad River at RM 11.44 and RM 8.67. Concentrations of both parameters were 0.02J ug/l (J = estimated value - below quantitation limit) and well below Ohio Water Quality Standards criteria.

- Continuous dissolved oxygen (D.O.) data was collected at seven locations in the Mad River from October 14 to 16, 1992. No violations of the Warmwater Habitat (WWH) or Exceptional Warmwater Habitat (EWH) Ohio Water Quality Standards for D.O. were detected. However, a distinct decline was observed downstream from the Fairborn WWTP. Upstream from the Fairborn WWTP at RM 11.44, the median D.O. value was more than 2 mg/l higher than the site 1.0 miles downstream from the 001 discharge. Overall, dissolved oxygen concentrations during the October sampling period were reflective of very good water quality.

- Using a relative ranking system for sediments developed by Kelly and Hite (1984), total arsenic, cadmium, chromium, copper, and lead concentrations were considered non-elevated at all Mad River sediment sampling locations and one site in the landfill 11 trib. draining WPAFB. Mercury was considered non-elevated in the landfill 11 trib. and at all but one Mad River sediment location; mercury was elevated (0.1 ppm) at RM 7.41 (located where the unnamed tributary draining the area of the number 11 landfill flows into the Mad River). Overall, the evaluation of Mad River and landfill 11 trib. metals concentrations in sediments revealed no appreciable contamination.

- Sediment from an impounded section of Hebble Creek documented extremely elevated mercury levels (0.37 ppm) and highly elevated total lead levels (63 ppm) landfill 11 trib.. Total cadmium was quantified at 1.4 ppm and indicated elevated levels. All other analyzed metal parameters in Hebble Creek were at non-elevated or slightly elevated levels, based on Kelly and Hite (1984).

- Elevated levels of seven polycyclic aromatic hydrocarbons (PAHs) were measured in Hebble Creek at RM 1.65. PAH values ranged between 0.95 ppm and 2.8 ppm (total PAHs = 11.1 ppm). Three of the seven PAH compounds in Hebble Creek sediment have been identified as possible human carcinogens: benzo(a)anthracene, benzo(b)fluoranthene, and chrysene. Hebble Creek was the only location within the Mad River study area where PAH compounds were detected.

- 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2378-TCDD), 2,3,7,8-tetrachlorodibenzofuran (2378-TCDF), and other dioxin and furan congeners were measured in the sediment of the Mad River, Hebble Creek, and the landfill 11 trib. 2378-TCDD total toxicity equivalents (TTE) for the Mad River and the landfill 11 trib. indicated relatively low levels of dioxin/furan contamination. TTE values in the Mad River and the landfill 11 trib. ranged between 2.91 parts per trillion (ppt) and 17.98 ppt; these TTE levels were substantially less than mine reclamation criterion (100 ppt 2378 TCDD TTEs) and the CDC action level (1 ppb 2378-TCDD/ or 1 ppb TTE as is commonly used by regulatory programs). The Hebble Creek 2378-TCDD TTE (75.93 ppt) was substantially higher than all other sampling locations and approached the 100 ppt TTE mine reclamation criterion.

- Macroinvertebrate community conditions in the Mad River during the 1992 study were reflective of good to exceptional community performance. The two sites which demonstrated the best macroinvertebrate community performance were RM 7.7 (exceptional) and RM 3.8 (very good); the sites which demonstrated the lowest performance were RM 8.7 (good), just downstream from the Fairborn WWTP, and RM 6.3 (good), adjacent to the Huffman Reserve Lake. Both sites were in the nonsignificant departure range of the applicable ICI biocriterion for the WWH. Although, these sites technically met the WWH ICI biocriterion, the results indicated minimal conditions and slightly impaired community performance. All other locations met or exceeded the WWH ICI biocriterion.

- The macroinvertebrate community in Hebble Creek reflected fair community performance and did not meet the Modified Warmwater Habitat (MWH) ICI biocriterion. The artificial substrate sampler had been washed over on its side with the Hester Dendy plates facing downstream. This may have excluded caddisflies from the sampler; however, this would not account for the overall performance of the macroinvertebrate community. A toxic effect is indicated by low species diversity and the absence of pollution sensitive taxa.

- Fish community performance in the Mad River ranged from fair to exceptional. At the upper three sample locations (RMs 11.3, 8.9, and 7.7) mean IBI scores significantly violated the applicable biocriterion. The downstream sample locations met the WWH IBI biocriterion with RM 6.3 in the nonsignificant departure range and RMs 3.8 and 1.6 meeting the Exceptional Warmwater Habitat (EWH) IBI criterion. Mean MIwb values were more varied with three sites meeting the WWH biocriterion (RMs 8.7, 3.8, and 1.6), one site in the nonsignificant departure range (RM 11.3), and two sites with significant violations (RMS 7.7 and 6.3). Impairment downstream from the Fairborn WWTP was suggestive of organic enrichment. The fish community in Hebble Creek was in the fair range (IBI = 30) and attained the MWH biocriterion.

- One PCB congener, Aroclor (1254), was identified and quantified in fish tissue samples from the Mad River during 1992. Six samples representing two fish species were analyzed. Three of the samples had detectable levels of Aroclor-1254, with values ranging from 160 ug/kg (ppb) to 420 ug/kg. Fish from the most upstream site did not have detectable concentrations of PCBs in their tissue. All PCB levels were below the FDA 2000 ug/kg (2.0 ppm) level of concern in edible portions as well as being below the Ohio Water Quality Standard criterion (any whole sample of any representative organism shall not exceed 640 ug/kg PCBs).

- Three metals (total barium, lead, and zinc) were detected in six whole body fish samples from the 1992 sampling sites. Six other metal parameters (total arsenic, cadmium, chromium, mercury, selenium, and silver) were not detected. Total zinc was detected in all fish samples analyzed, with values ranging from 12.0 mg/kg to 88.2 mg/kg. Total lead was reported above the lab detection limit of 0.30 mg/kg in one sample (0.45 mg/kg).

RECOMMENDATIONS

Status of Aquatic Life Uses

Prior to the present study, aquatic life use designations of the lower Mad River and Hebble Creek were Warmwater Habitat (WWH) and Modified Warmwater Habitat (MWH) (OAC Chapter 3745-1), respectively. The following recommendations are made based on the 1992 survey results.

- The current Warmwater Habitat aquatic life use designation is appropriate for the lower Mad River. The WWH biological criteria were fully met in the lower 5.2 miles of river, demonstrating the potential of the Mad River to support the designated WWH use.

- The existing Modified Warmwater Habitat designation for Hebble Creek should remain. Although the channel in the lower 0.3 miles of Hebble Creek has not been physically altered, the remainder of the stream has been extensively channelized. This factor limits the ability of the stream to support the WWH use designation.

Future Monitoring Concerns

- Additional sampling of Hebble Creek sediments should be conducted to determine the magnitude and extent of contaminants (dioxins, mercury, lead, pentachlorophenol [low detect level]. One sediment sample in Hebble Creek documented a 2378-TCDD TTE of 75 ppt which approached limits placed on sludge application at mine reclamation sites. Mercury was found at extremely elevated levels.

- A complete re-evaluation should be conducted following the installation at WPAFB of groundwater treatment facilities and their associated discharges to the Mad River.

Table 1. Aquatic life use attainment status for the Mad River and Hebble Creek based on sampling conducted from August to October, 1992. Attainment status is based on biocriteria for the Eastern Corn Belt Plains ecoregion of Ohio (OAC Chapter 3745-1-07, Table 7-17).

River Mile Fish/Invert.	IBI	Modified Iwb	ICI	QHEI	Attainment Status	Comments
Mad River (1992)						
	Eastern Corn Belt Plains (ECBP) Ecoregion / WWH Use Designation (existing)					
11.3/ 11.5	37*	8.2ns	38	84	PARTIAL	Upstream Fairborn WWTP, Dst. Springfield WWTP
8.9/ 8.7	31*	8.7	32ns	81	PARTIAL	Dst. Fairborn WWTP
7.7/ 7.7	30*	7.9*	48	77	PARTIAL	Adj. WPAFB
6.3/ 6.3	41ns	7.9*	34ns	79	PARTIAL	Adj. WPAFB
3.8/ 3.8	48	9.3	42	76	FULL	Attains EWH criteria
1.6/ 1.6	48	9.6	MG	79	FULL	Gravel mining in stream
Hebble Creek (1992)						
	Eastern Corn Belt Plains (ECBP) Ecoregion / MWH Use Designation (existing)					
0.1/ 0.1	30	NA	20*	80	PARTIAL	Dst. WPAFB

Ecoregion Biocriteria: Eastern Corn Belt Plains (ECBP)

INDEX - Site Type	WWH	EWH	MWH[a]
IBI - Headwaters (Hebble Cr.)	40	50	24
IBI - Boat (Mad R.)	42	48	24
Mod. Iwb - Boat (Mad R.)	8.5	9.6	5.8
ICI (Mad R./Hebble Cr.)	36	46	22

* - Significant departure from ecoregion biocriterion.

ns - Nonsignificant departure from ecoregion biocriterion (4 IBI or ICI units; 0.5 Iwb units).

NA -Headwater site - Modified Iwb criterion does not apply.

MG Macroinvertebrate community performance was marginally good. The artificial substrate samplers were lost therefore, only a qualitative assessment was performed.

a Modified Warmwater Habitat for channel modified areas.

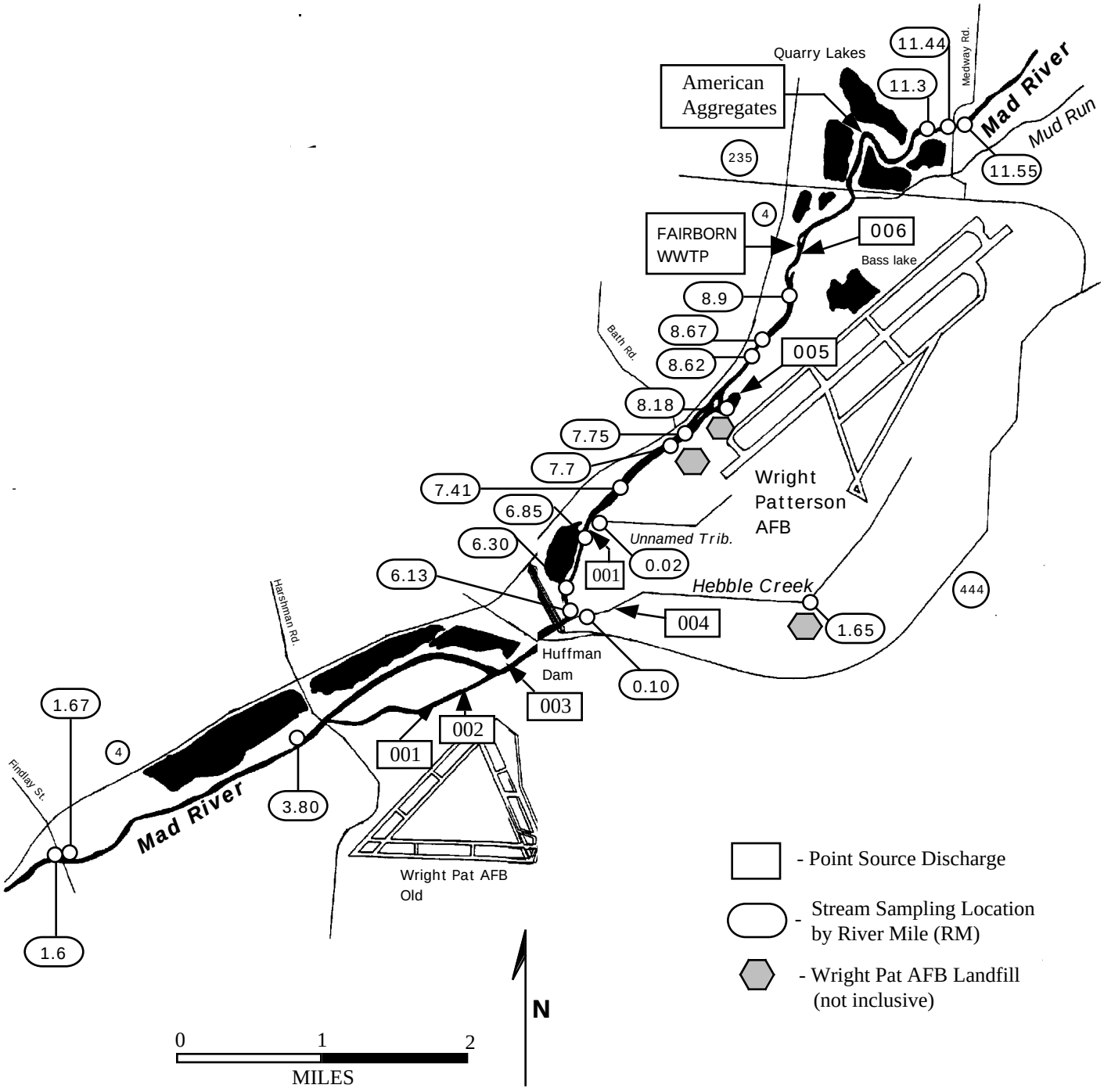

Figure 1. The lower Mad River study area showing principal streams, landmarks, and sampling locations.

METHODS

All physical and biological field, laboratory, data processing, and data analysis methods and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989a), Biological Criteria for the Protection of Aquatic Life, Volumes I - III (Ohio Environmental Protection Agency 1987a, 1987b, 1989b, 1989c), and The Qualitative Habitat Evaluation Index (QHEI); Rationale, Methods, and Application (Rankin 1989) for habitat assessment.

Attainment/non-attainment of aquatic life uses was determined by using biological criteria codified in Ohio Administrative Code (OAC) 3745-1-07, Table 7-17. The biological community performance measures that were used included the Index of Biotic Integrity (IBI) and the Modified Index of Well-being (MIwb), both of which are based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. The IBI and ICI are multi-metric indices patterned after an original IBI described by Karr (1981) and Fausch et al. (1984). The MIwb is a measure of fish community abundance and diversity using numbers and weight information; it is a modification of the original Index of Well-Being applied to fish community information from the Wabash River (Gammon 1976, Gammon et al. 1981).

Performance expectations for the basic aquatic life uses (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH] were developed using the regional reference site approach (Hughes et al. 1986; Omernik 1988). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of an aquatic life use was FULL if all three indices (or those available) meet the applicable criteria, PARTIAL if at least one of the indexes did not attain and performance did not fall below the fair category, and **NON** if all indices either failed to attain or any index indicated poor or very poor performance.

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989). Various attributes of the available habitat were scored based on their overall importance to the establishment of viable, diverse aquatic faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among the metrics used to evaluate the characteristics of a stream segment, not just the characteristics of a single sampling site. As such, individual sites may have much poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values higher than 60 were generally conducive to the establishment of warmwater faunas while those which scored in excess of 75-80 often typify habitat conditions which have the ability to support exceptional faunas.

During this survey, macroinvertebrates were sampled using modified Hester/Dendy multiple-plate artificial substrate samplers supplemented with a qualitative assessment of the available natural substrates. Qualitative macroinvertebrate sampling consists of an inventory of species with no attempt to quantify the populations and a measure of EPT (Ephemeroptera -mayfly, Plecoptera - stonefly, and Trichoptera - caddisfly) taxa richness - an indication of the prevalence of pollution sensitive organisms. Fish were sampled 2 or 3 times using pulsed DC electrofishing gear using either the wading or boat methods. Fine grained sediment samples were collected in the upper 6 inches of bottom material at each location using decontaminated stainless steel scoops (decontamination followed the procedures outlined in FSOP 10.01, DERR Sampling Guidance, Vol III, 1992). Collected sediment was placed into clear glass jars with teflon lined lids, placed on ice (to maintain 4^{o}C) and shipped to an Ohio EPA contract lab. Surface water samples were collected directly into appropriate containers, preserved, and shipped to either the Ohio EPA lab (nutrients) or a contract lab (organics and metals). Whole body fish composites were collected in October, 1992 for tissue analysis. Fish tissue sampling procedures are detailed in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989a). Dissolved oxygen was monitored continuously over a three-day period during October in the Mad River using Datasonde monitors. All surface water, sediment, fish tissue, and biological sampling locations are listed in Table 2.

An Area of Degradation Value (ADV; Rankin and Yoder 1991) was calculated for the study area based on the longitudinal performance of the biological communities. The ADV portrays the length or “extent” of degradation to aquatic communities and is simply the distance that the biological index (IBI, MIwb, and ICI) departs from the stream criterion or the upstream level of performance (Figure 2). The magnitude of impact refers to the vertical departure of each index below the criterion. The total ADV is the area beneath the ecoregional criterion when the results for each index are plotted against river mile. This is also expressed as ADV/mile to normalize comparisons between segments and other areas.

Table 2. Sampling locations (sediment - S, macroinvertebrate - M, fish - F, surface water - W, fish tissue - T, continuous dissolved oxygen - D) in the Mad River study area, 1992.

Stream/ River Mile	Type of Sampling	Latitude/ Longitude	Landmark	USGS 7.5 min. Quad. Map
Mad River				
11.50	M	39° 50’ 58”/ 84° 02’ 08”	Upst. Medway/Osborn Rds.	Fairborn
11.44	S, W, D	39° 50’ 58”/ 84° 02’ 12”	Medway/Osborn Rds.	Fairborn
11.3	F, T	39° 50’ 56”/ 84° 02’ 24”	Dst. Medway/ Osborn Rds.	Fairborn
8.9	F	39° 49’ 50”/ 84° 03’ 32”	Dst. Fairborn WWTP	Fairborn
8.67	M,W	39° 49’ 35”/ 84° 03’ 50”	Adj. Fairborn Pump Station	Fairborn
8.62	S, D	39° 49’ 32”/ 84° 03’ 49”	Dst. Fairborn Pump Station	Fairborn
8.18	S,T	39° 49’ 11”/ 84° 04’ 12”	Adj. WPAFB landfill 14	Fairborn
7.75	M, S, W	39° 49’ 02”/ 84° 04’ 22”	Adj. WPAFB landfill 11	Fairborn
7.7	F	39° 48’ 58”/ 84° 04’ 34”	Adj. WPAFB landfill 11	Fairborn
7.41	S	39° 48’ 51”/ 84° 04’ 42”	At tributary mouth from landfill 11	Fairborn
6.85	D	39° 48’ 30”/ 84° 05’ 09”	Adj. Huffman Dam Park	Fairborn
6.30	F, M, W, T	39° 48’ 03”/ 84° 05’ 23”	Adj. Huffman Park	Fairborn
6.13	S	39° 47’ 55”/ 84° 05’ 21”	Upst. Hebble Creek	Fairborn
3.80	F, M, W	39° 47’ 10”/ 84° 07’ 38”	Dst. Harshman Rd.	Dayton North
3.6	D	39° 47’ 06”/ 84° 07’ 48”	Dst. Harshman Rd.	Dayton North
1.67	S, W, D	39° 46’ 30”/ 84° 09’ 34”	Findlay St.	Dayton North
1.6	F, M	39° 46’ 29”/ 84° 09’ 29”	Findlay St.	Dayton North
0.4	D	39° 46’ 06”/ 84° 10’ 57”	Deeds Park	Dayton North
Hebble Creek				
1.65	S	39° 48’ 00”/ 84° 03’ 32”	Hebble Creek Rd.	Fairborn
0.10	F, M, W	39° 47’ 55”/ 84° 05’ 14”	Old R.R. bridge	Fairborn
Landfill 11 trib. (Confluence at RM 6.88 of Mad River)				
0.02	S	39° 48’ 30”/ 84° 05’ 06”	At mouth	Fairborn

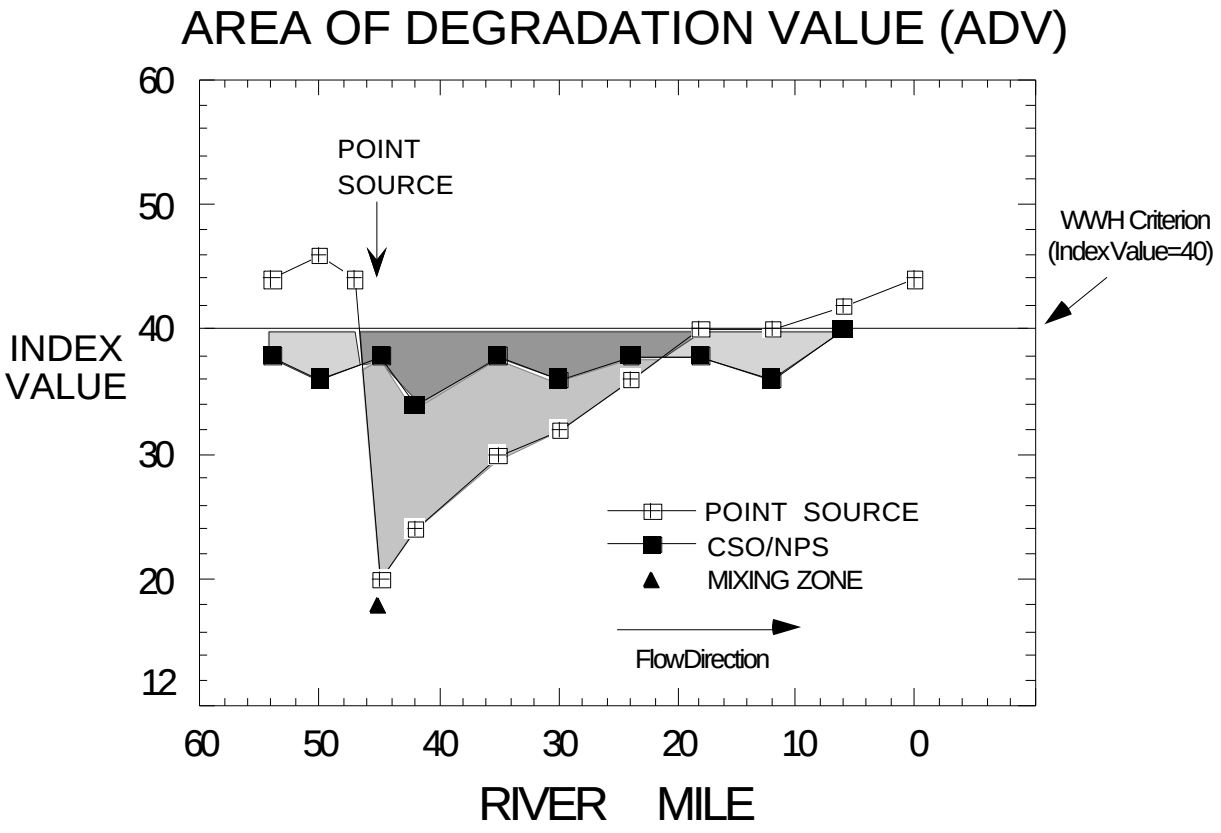

Figure 2. Graphic illustration of the Area of Degradation Values (ADV) based on the ecoregion biocriterion (WWH in this example). The index value trend line indicated by the unfilled boxes and solid shading (area of departure) represents a typical response to a point source impact (mixing zone appears as a solid triangle); the filled boxes and dashed shading (area of departure) represents a typical response to a nonpoint source impact or combined sewer overflow impact. The blended shading represents the overlapping impact of the point and nonpoint sources.

RESULTS AND DISCUSSION

Pollutant Loadings: 1976-1992

- Wright Patterson Air Force Base has eight permitted outfalls discharging to the Mad River or tributaries to the Mad River. Six outfalls are included in Ohio EPA permit number 1IO00001 and two outfalls are included in permit number 1IN00156.

- Outfalls permitted under WPAFB permit number 1IO00001 discharge storm water draining from and through the WPAFB. The outfall numbers and river mile discharge points are as follows: 001 - Mad River RM 4.90, 002 - Mad River RM 5.05, 003 - Mad River RM 5.50, 004 - Hebble Creek RM 0.30, 005 - Mad River RM 8.27, 006 - Mad River RM 9.60. The discharges from the 1IO00001 outfalls are intermittent and controlled by rainfall events which generate surface runoff. The runoff receives oil and water separation prior to being discharged into the Mad River or Hebble Creek. All process, cooling tower, and sanitary wastes generated at the WPAFB are discharged to the sanitary sewer system. Outfalls 001, 002, 005 and 006 report total nonfilterable residue, pH, and flow as a permit requirement. Outfalls 003 and 004 report total nonfilterable residue, pH, flow, oil & grease, and iron. Additionally, 004 reports chromium and copper. Results of discharge data reported from the 1IO00001 outfalls revealed relatively low loadings of total nonfilterable residue, oil & grease, copper, and chromium between 1983 and 1992. Loadings data for 1991 and 1992 adjusted to a mean kg/day value revealed extremely low percentages of pollutants contributed to the Mad River in comparison to the Fairborn and Springfield WWTPs (Table 3).

- Wright Patterson Air Force Base received authorization in 1991 (Ohio EPA permit number 1IN00156) to discharge effluent from groundwater treatment facilities located at two areas on the base. Outfall 001 discharges treated groundwater (air stripping, oil/water separator system) to the Mad River at RM 6.83. Outfall 002 discharges treated groundwater (air stripper, activated carbon system) to a storm sewer which flows to a drainage ditch to the Mad River at RM 8.27. Both outfalls are regulated for a number of volatile organic compounds. A limited amount of data has been reported to the Ohio EPA on effluent discharged to the Mad River from outfall 001 since it began operation. Results show that from January to May, 1992, chloroform, benzene, tetrachloroethylene, 1,1-dichloroethylene, 1,1,1-trichloroethylene, 1,2-dichloroethane, trans-1,2-dichloroethane, naphthalene, vinyl chloride and chlorobenzene values were all less than lab detection limits. Trichloroethylene was reported in the effluent at a 50th percentile concentration of 4.1 ug/l and a maximum of 18.4 ug/l ; the 30 - day average Ohio WQS criterion is 75 ug/l..

- Fairborn operates a wastewater plant which achieves tertiary treatment (Ohio EPA permit number 1PD00002) and during 1992 treated an average of 3.9 million gallons per day (MGD). The wastewater treatment plant was undergoing renovation during the 1992 survey period. Final effluent from the plant enters the Mad River at RM 9.60. The Fairborn collection system is serviced by separate sewers; therefore, no CSOs or bypasses exist. There are no significant industrial users which discharge into the sewer system. Current summer 30-day average permit limits for ammonia-N and $CBOD_5$ are 10 mg/l (208 kg/day) and 15 mg/l (313 kg/day), respectively.

- Loading trends of three pollutants discharged to the Mad River from the Fairborn WWTP 001 effluent from 1976 through 1992 are shown in Figure 5. The ammonia-N annual loadings graph shows a substantial decrease in loadings during and after 1988, with 50th percentile values declining from 159 kg/day in 1987 to 1.3 kg/day in 1992. A clear but less dramatic decline in BOD_5 loadings also occurred during the same time period. Both of these parameter declines were associated with treatment plant improvements completed during 1988.

- Springfield operates a wastewater plant which achieves tertiary treatment (Ohio EPA permit number 1PE00007) and during 1992 treated an average of 15.7 MGD. The wastewater treatment plant was most recently renovated in 1988. Final effluent from the plant enters the Mad River at RM 25.58. The city has an Ohio EPA approved industrial pretreatment program, with 3-5% of the influent flow to the plant comprised of significant categorical industrial users (categories of industries which fall under regulatory control). The collection system contains approximately 60% combined sewers, with 49 associated combined sewer overflows (CSOs). These overflows are permitted to discharge during wet weather periods and have discharge monitoring requirements. The plant also has influent and secondary treatment bypasses. Current summer 30-day average permit limits for ammonia-N and $CBOD_5$ are 3.0 mg/l (284 kg/day) and 15 mg/l (1419 kg/day), respectively.

- Loadings trends of three pollutants discharged to the Mad River from the Springfield WWTP 001 effluent (mean kg/day) from 1976 to 1992 are shown in Figure 3. The ammonia-N annual loadings graph shows a substantial decrease in loadings after 1988. A clear but less dramatic decline in BOD_5 loadings also occurred during the same time period. Both of these parameter declines were associated with treatment plant improvements completed in 1988. Total suspended solids loadings showed a slight decline after 1988, with the lowest values occurring in 1991 and 1992.

- The Clark County SW Regional WWTP (Ohio EPA permit number 1PK00013) is an advanced tertiary treatment plant which during 1992 treated an average of 0.7 MGD. This plant was constructed in 1981. The final effluent from the plant enters the Mad River at RM 13.26. The collection system is serviced by separate sewers with no CSOs or bypasses. There are no significant industrial users which discharge to the sewer system. Current summer 30-day average permit limits for ammonia-N and $CBOD_5$ are 2.5 mg/l (19 kg/day) and 8.0 mg/l (62 kg/day), respectively.

- Loading trends of three pollutants discharged to the Mad River from the Clark Co. SW Regional WWTP 001 effluent from 1981 to 1992 are shown in Figure 4. No clear trends are evident in the loadings of ammonia-N, BOD_5, or total nonfilterable residue from the Clark Co. SW Regional WWTP during this time frame. Ammonia-N values were generally low, with 50th percentile loadings values less than 4 kg/day, 9 of 12 years had values less than 1.0 kg/day. However, the differences between the 50th percentile and 95th percentile ammonia-N values were large from 1988 to 1990 and suggested high variability in effluent quality.

- American Aggregates Co. (Fairborn Plant #413, Ohio EPA permit number 1IJ00026) operates a sand and gravel operation adjacent to the Mad River. During 1992, an average of 1.1 MGD of effluent was discharged from a lake overflow into an unnamed drainage ditch tributary to the Mad River at RM 10.62. Little variability in total nonfilterable residue loadings was apparent from 1976 to 1992, with 50th percentile values ranging between 12.5 kg/day and 37 kg/day.

- Comparison of ammonia-N, $CBOD_5$, and total nonfilterable residue loadings among facilities in the lower Mad River during 1992 revealed that the Springfield WWTP (including combined sewer overflows) contributed greater than 90 percent of the load for each parameter.

- A significant decline in ammonia-N loadings to the Mad River has occurred between 1976 and 1992 in direct response to improvements made at the Springfield and Fairborn WWTPs. Outfall ammonia-N loadings (sum of the 50th percentile loadings) from these two plants between 1976 and 1988 were 546 kg/day; loadings between 1989 and 1992 declined to 12.1 kg/day.

- Lists of spills to the Mad River and Hebble Creek indicate possible impacts due to pollutant loadings. A listing of spills with known amounts of material is detailed in Table 4. At least 10 spills have been associated with the WPAFB between 1978 and 1992. Of the spills associated with the base, most were composed of oil or jet fuel.

Table 3. Comparison of loadings of selected pollutants from the Wright Patterson Air Force Base, Springfield WWTP, Fairborn WWTP, Clark Co. SW Regional WWTP, and American Aggregates to the Mad River from January to December, 1991 and January to November, 1992. Results are reported in mean kg/day. (Asterisks indicate all values reported as below lab detection limits.)

Facility	Ammonia-N (kg/day)	Total Non-Filterable Residue (kg/day)	$CBOD_5$ (kg/day)	Oil & Grease (kg/day)	Total Copper (kg/day)	Total Chromium (kg/day)
1991						
Springfield WWTP	66.07	1055.2	313.2	0.97	0.55107	*
Clark Co. WWTP	1.14	10.3	5.2	1.87	0.07143	NA
American Aggregates	NA	16.4	NA	NA	NA	NA
Fairborn WWTP	21.61	262.5	90.0	77.31	0.15276	*
WPAFB	NA	35.3	NA	0.51	0.00037	0.0031
1992						
Springfield WWTP	12.4	765.3	268.6	NA	0.32561	0.11569
Springfield CSOs	24.2	669.6	265.4	NA	NA	NA
Clark Co. WWTP	1.19	8.4	5.5	2.39	*	0.01529
American Aggregates	NA	17.4	NA	NA	NA	NA
Fairborn WWTP	1.42	111.2	49.0	46.96	0.09283	*
WPAFB	NA	4.4	NA	0.08	0.00025	0.0021

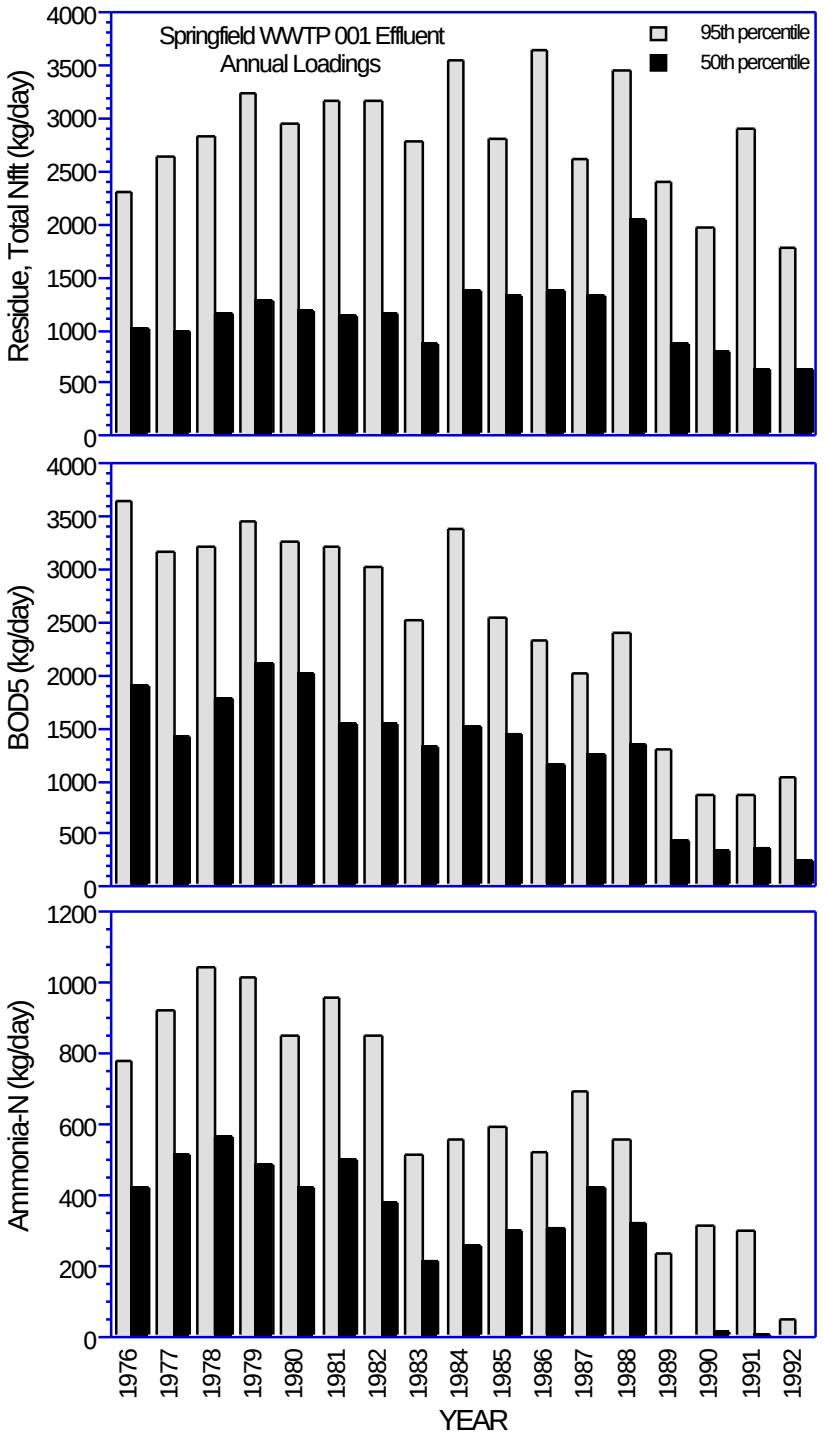

Figure 3. Loadings (kg/day) of total nonfilterable residue, biochemical oxygen demand (BOD_5), and ammonia-nitrogen from the Springfield WWTP 001 effluent to the Mad River from 1976 to 1992. Since 1988, $CBOD_5$ (carbonaceous biochemical oxygen demand) has been measured in lieu of BOD_5; all measurements are normalized to BOD_5.

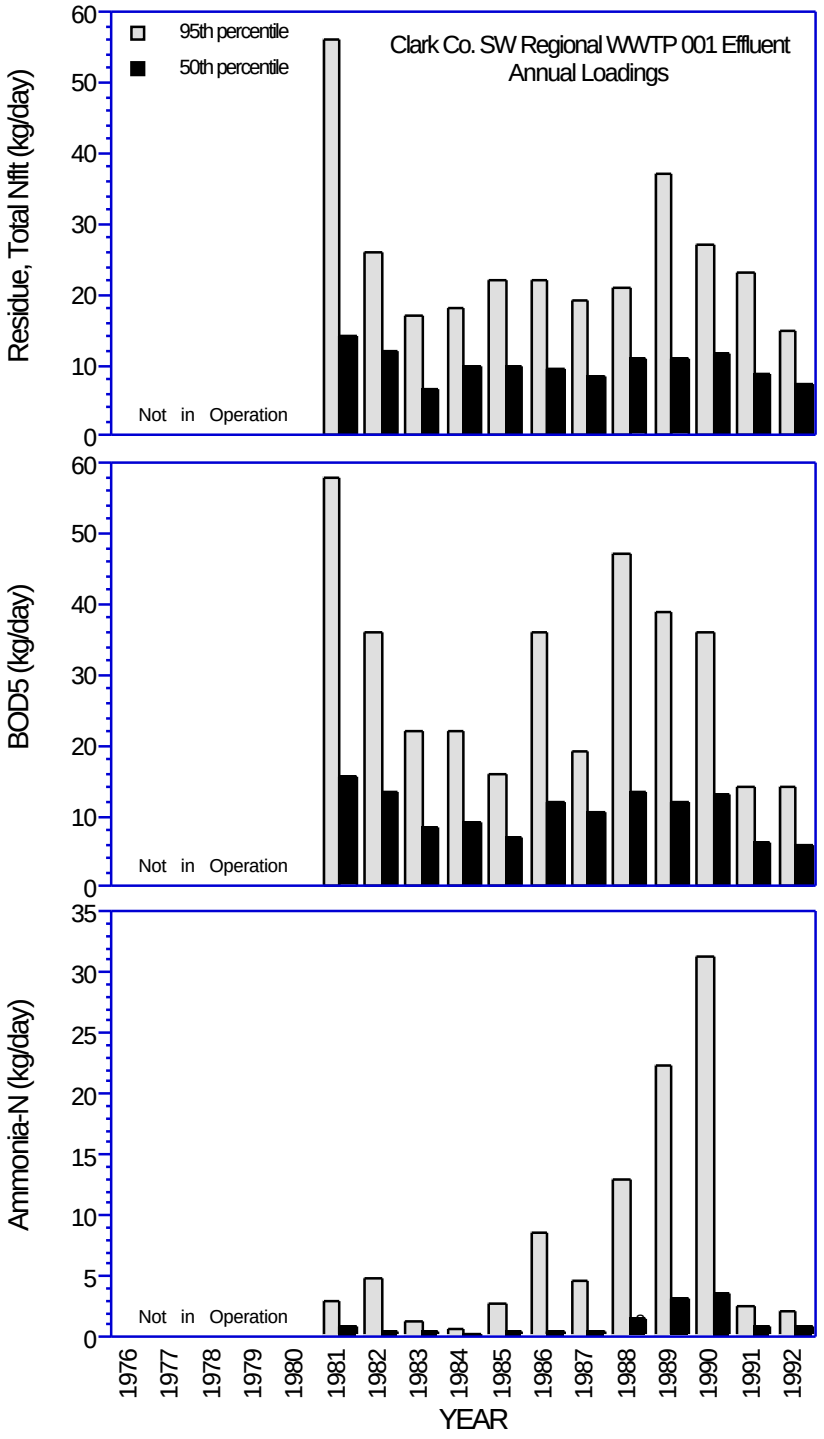

Figure 4. Loadings (kg/day) of total nonfilterable residue, biochemical oxygen demand (BOD_5) and ammonia-nitrogen from the Clark County Southwest Regional WWTP 001 effluent to the Mad River from 1981 to 1992. Since 1988, $CBOD_5$ (carbonaceous biochemical oxygen demand) has been measured in lieu of BOD_5; all measurements are normalized to BOD_5.

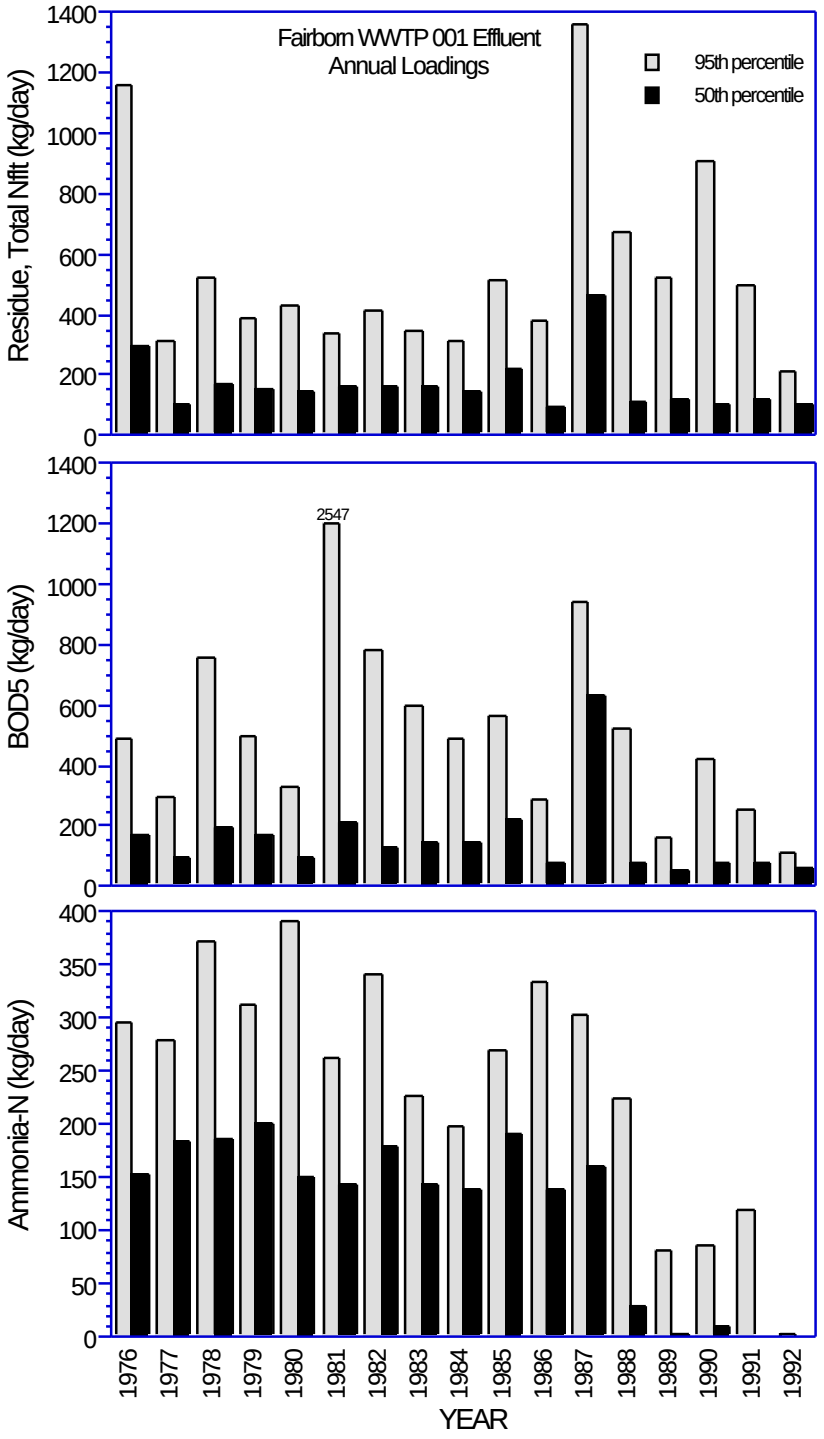

Figure 5. Loadings (kg/day) of total nonfilterable residue, biochemical oxygen demand (BOD_5) and ammonia-nitrogen from the Fairborn WWTP 001 effluent to the Mad River from 1976 to 1992. Since 1988, $CBOD_5$ (carbonaceous biochemical oxygen demand) has been measured in lieu of BOD_5; all measurements are normalized to BOD_5.

Table 4. Summary of pollutant discharges (spills) to the Mad River in the lower 15 miles and to Hebble Creek reported to the Ohio EPA Division of Emergency and Remedial Response from 1978 to 1992.

Date	Entity	Material	Amount	Units	Recovered
Hebble Creek					
011780	WRIGHT PATTERSON AFB	EDTA	2000	GAL	0
091382	WRIGHT PATTERSON AFB	SULFURIC ACID	75	GAL	0
111185	SW PORTLAND CEMENT	KEROSENE	200	GAL	0
032686	BAKER ELEMENTARY	GASOLINE	2000	GAL	1000
010589	UNKNOWN	YELLOW-ORANGE STUFF	35	GAL	0
Mad River					
021078	FAIRBORN STP	SETTLED SEWAGE	1000	GAL	0
033078	TERMINEX	HEPTACHLOR	26	GAL	15
		CHLORDANE	15	GAL	0
090178	LYONS TRUCKING	FUEL OIL	100	GAL	0
060479	DAYTON FORGING & HEAT	OIL	55	GAL	0
070979	TEXACO OIL CO	FUEL OIL	2500	GAL	700
121079	WRIGHT PATTERSON AFB	JET FUEL	180	GAL	180
042280	WRIGHT PATTERSON AFB	OIL	100	GAL	90
090680	D & H MANUFACTURING (ZINC AND CYANIDE)	PLATING SOLUTION	3400	GAL	0
041681	RISS TRUCKING	FUEL OIL	50	GAL	0
030182	WRIGHT PATTERSON AFB	FUEL OIL	100	GAL	50
052982	WRIGHT PATTERSON AFB	OIL	20	GAL	0
051683	LEOHNER & ROSALES	EMULSIFIED ASPHALT	300	GAL	0
052283	WRIGHT PATTERSON AFB	JET FUEL	10	GAL	10
033184	DAYTON FORGING & HEAT	WASTE OIL	100	GAL	0
021385	DAYTON WATER PLANT	CALCIUM CARBONATE	4000000	GAL	0
092085	SW PORTLAND CEMENT	WASTE CHEMICAL	60000	GAL	0
050288	MID-OHIO CHEMICALS	LASSO-ATRAZINE	50	GAL	0
110188	DAYTON ELECTROPLATING	BICO-STRIP	55	GAL	0
082790	FRALEY & SHILLING	DIESEL FUEL	100	GAL	0
102590	JOHN DAVIS CONSTRUCTION	RS-1 ASPHALT EMULSION	900	GAL	0
103190	U S AIR FORCE	PCB OIL	1	GAL	0
060491	WRIGHT PATTERSON AFB	JET FUEL	500	GAL	0

Surface Water Chemical Quality

Surface water samples were collected in the Mad River and Hebble Creek during the 1992 study on October 14. Results are presented in Table 5.

- The daily flows for May through early October 1992 in the Mad River at RM 6.03 are shown in Figure 6. The mean monthly discharge during these months was greatest during July (1156 cfs) and lowest during September (360 cfs). The minimum daily flows during June, July, August, and September were substantially above the 80% duration value (220 cfs) and $Q_{7,10}$ (133 cfs) during the 1992 survey.

- No apparent chemical trends in Mad water quality were noted upstream, adjacent to, or downstream from the Wright Patterson Air Force Base or the Fairborn WWTP. Overall, chemical testing results revealed good water quality in the Mad River and Hebble Creek based upon the one grab sample collected on October 14, 1992.

- Results for total arsenic, cadmium, chromium, copper, lead, mercury, selenium, and silver were all reported as below lab detection limits.

- Ammonia-N concentrations were documented at or below the lab detection limit of 0.05 mg/l.

- PCBs, semivolatile organic compounds, and volatile organic compounds were not detected, in surface water grab samples.

- Two pesticides (a-BHC and b-BHC) were detected in surface water samples from the Mad River at RM 11.44 and RM 8.67. Concentrations of both parameters were 0.02J ug/l (J = estimated value - below quantitation limit) and well below Ohio Water Quality Standards criteria.

- Continuous dissolved oxygen data were collected at seven locations in the Mad River between October 14 and 16, 1992 (Figure 7). No violations of the WWH or EWH Ohio WQS were detected; however, a distinct decline was observed downstream from the Fairborn WWTP. Upstream from the Fairborn WWTP at RM 11.44, the median D.O. value was over 2 mg/l higher than the site 1.0 miles downstream from the 001 discharge. Overall, however, dissolved oxygen concentrations during the October sampling period were reflective of very good water quality.

Table 5. Surface water chemical sampling results from the Mad River and Hebble Creek based on one grab sample collected on October 14, 1992.

	Mad River						Hebble Cr.
Parameter	RM 11.44	RM 8.67	RM 7.75	RM 6.30	RM 3.80	RM 1.67	RM 0.10
pH (SU)	7.40	7.71	7.85	7.87	8.39	7.03	7.65
Temp.(^{O}C)	13.0	13.0	14.0	13.0	15.0	14.5	11.0
BOD5 (mg/l)	<1.0	<1.0	1.0	3.7	<1.0	<1.0	1.1
Nitrate-Nitrite,N (mg/l)	3.14	3.17	3.17	2.90	2.77	2.85	1.18
Nitrite, N (mg/l)	0.02	0.02	0.02	0.02	0.02	0.02	<0.02
Ammonia-N (mg/l)	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05
Phosphorus-T (mg/l)	0.22	0.26	0.28	0.20	0.18	0.18	0.05
Arsenic-T (ug/l)	<5	<5	<5	<5	<5	<5	<5
Barium-T (ug/l)	112	115	112	115	114	114	86
Cadmium-T (ug/l)	<5	<5	<5	<5	<5	<5	<5
Chromium-T (ug/l)	<10	<10	<10	<10	<10	<10	10
Copper-T (ug/l)	<10	<10	<10	<10	<10	<10	<10
Lead-T (ug/l)	<3	<3	<3	<3	<3	<3	<3
Mercury-T (ug/l)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Selenium-T (ug/l)	<5	<5	<5	<5	<5	<5	<5
Silver-T (ug/l)	<10	<10	<10	<10	<10	<10	<10
Pesticides							
a-BHC (ug/l)	ND	0.02J	ND	ND	ND	ND	ND
b-BHC (ug/l)	0.02J	0.02J	ND	ND	ND	ND	ND
All others	ND	ND	ND	ND	ND	ND	ND
PCBs	ND	ND	ND	ND	ND	ND	ND
Semivolatile Organics	ND	ND	ND	ND	ND	ND	ND
Volatile Organics	ND	ND	ND	ND	ND	ND	ND

J- Estimated value (below quantitation limit).

ND- Not Detected

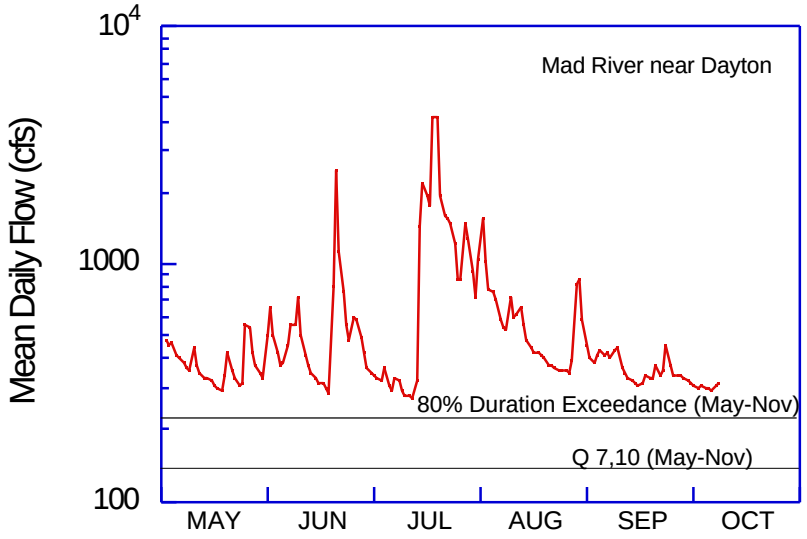

Figure 6. Flow hydrograph for the Mad River near Dayton, Ohio (RM 6.03), May through October, 1992.

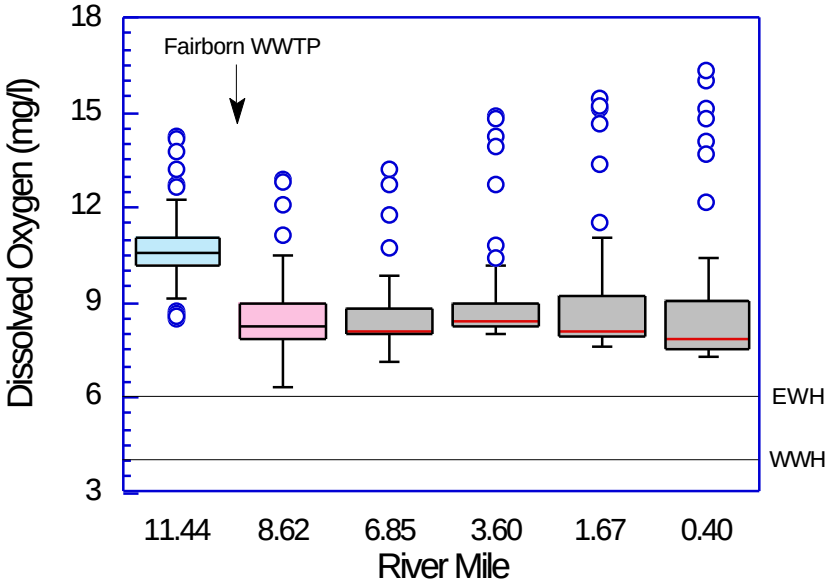

Figure 7. Boxplots of dissolved oxygen data (mg/l) recorded with Datasonde continuous monitors at six locations in the Mad River between October 14 to 16, 1992. The minimum D.O. criteria for the WWH (4 mg/l) and EWH (6 mg/l) use designations are indicated by horizontal lines.

Sediment Chemistry

Sediment samples were collected at seven locations in the Mad River, one location in Hebble Creek, and one location in the landfill 11 trib. to the Mad River, at RM 6.88, which drains WPAFB property in the area of landfill 11. All sampling locations are indicated by river mile in Figure 1. Each sample was analyzed for volatile organic compounds, semivolatile organic compounds, pesticides, PCBs, herbicides, RCRA metals, and polychlorinated dibenzo-p-dioxins and dibenzofurans; specific chemical parameters are listed in Appendix Table A-1.

- Landfill 11 trib.using a relative ranking system for sediments developed by Kelly and Hite (1984), total arsenic, cadmium, chromium, copper, and lead were considered non-elevated at all Mad River sediment sampling locations and the site on the landfill 11 trib (Table 6). Mercury was considered non-elevated in the landfill 11 trib. and at all but one Mad River sedimentlocation; mercury was elevated (0.1 ppm) at RM 7.41 (located where landfill 11 tributary flows into the Mad River). Selenium and silver were below lab detection limits (<10 ppm and <2 ppm, respectively) at all sampling locations. Evaluation of Mad River and landfill 11 trib. metals concentrations in sediments revealed low concentrations.

- Sediment from an impounded section of Hebble Creek documented extremely elevated mercury (0.37 ppm) and highly elevated lead (63.0 ppm) based on Kelly and Hite (1984). Cadmium was quantified at 1.4 ppm and indicated elevated levels (Kelly and Hite 1984). All other analyzed metal parameters were present in low concentrations.

- All pesticides, PCBs, and semi-volatile organic compounds measured in the Mad River were reported as not detected above lab quantitation limits (Table 7). Three volatile organic compounds (acetone, methylene chloride, and chloromethane) were detected in the Mad River in low concentrations at several locations. Values of these three compounds ranged between 2 ppb and 35 ppb; all concentrations were reported as 'J' (less than limit of practical quantitation but greater than zero).

- All pesticide and PCB parameters measured in Hebble Creek were reported as not detected above lab quantitation limits.

- Elevated levels of seven polycyclic aromatic hydrocarbons (PAHs) were measured in Hebble Creek at RM 1.65. PAH values ranged between 0.95 ppm and 2.8 ppm (total PAH = 11.1 ppm). Three of the seven PAH compounds in Hebble Creek sediment have been identified as possible human carcinogens: benzo(a)anthracene, benzo(b)fluoranthene, and chrysene. Hebble Creek at RM 1.65 was the only location within the Mad River study area where PAH compounds were detected.

- 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2378-TCDD), 2,3,7,8-tetrachlorodibenzofuran (2378-TCDF), and other dioxin and furan congeners were measured in the sediment of the Mad River, Hebble Creek, and the landfill 11 trib.. (Table 8). 2378-TCDD total toxicity equivalents (TTE) for the Mad River and the landfill 11 trib. indicated relatively low levels of dioxin/furan. TTE values in the Mad River and landfill 11 trib. ranged between 2.91 ppt and 17.98 ppt; these TTE levels were substantially less than the mine reclamation criterion (100 ppt 2378 TCDD TTEs) and the CDC action level (1 ppb 2378-TCDD/ or 1 ppb TTE as is commonly used by regulatory programs). The Hebble Creek 2378-TCDD TTE (75.93 ppt) was substantially higher than all other sampling locations and approached the 100 ppt TTE mine reclamation criterion.

Table 6. Total metal concentrations (mg/kg dry weight) in sediment samples collected from the Mad River study area, 1992. Sediment evaluations were based upon criteria in Kelly and Hite (1984). (Bold face type indicates highly or extremely elevated values.)

Stream River Mile (Location)	**TOTAL METALS - mg/kg (ppm) dry weight**								
	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver
Mad River									
11.44 (Medway/Osborn Rds.)	<10.0 a,b	91.2	<1.0 a,b	12.4 a	12.4 a	10.0 a	<0.1 a,b	<10	<2
8.62 (Fairborn Pump Station)	<10.0 a,b	75.0	<1.0 a,b	11.0 a	14.6 a	17.2 a	<0.1 a,b	<10	<2
8.18 (Adj. WPAFB landfill 14)	<10.0 a,b	86.2	<1.0 a,b	15.4 a	19.6 a	18.6 a	<0.1 a,b	<10	<2
8.18 (Duplicate)	<10.0 a,b	86.8	<1.0 a,b	14.4 a	19.6 a	13.6 a	<0.1 a,b	<10	<2
7.75 (Adj. WPAFB landfill 11)	<10.0 a,b	84.2	<1.0 a,b	14.0 a	16.0 a	12.6 a	<0.1 a,b	<10	<2
7.41 (Tributary mouth, landfill 11)	<10.0 a,b	65.4	<1.0 a,b	12.4 a	16.0 a	15.0 a	0.1 c	<10	<2
6.13 (Upst. Hebble Creek)	<10.0 a,b	63.4	<1.0 a,b	8.4 a	10.8 a	10.6 a	<0.1 a,b	<10	<2
1.67 (Findlay St.)	<10.0 a,b	59.8	<1.0 a,b	10.2 a	12.6 a	16.6 a	<0.1 a,b	<10	<2
Hebble Creek									
1.65 (Hebble Creek Rd.)	<10.0 a,b	60.0	1.4 c	10.8 a	29.8 a	**63.0** d	**0.37** e	<10	<2
Landfill 11 trib. (Confluence with Mad River at RM 6.88)									
0.02 (Tributary mouth))	<10.0 a,b	52.6	<1.0 a,b	5.8 a	9.0 a	13.8 a	<0.1 a,b	<10	<2

a - non elevated; b - slightly elevated; c - elevated; d - highly elevated; e - extremely.
Arsenic: a <8.0, b ≥8.0, c ≥ 11; Cadmium: a <0.5, b ≥0.5, c ≥1.0; Mercury: a <0.07, b ≥0.07, c ≥0.10.

Table 7. Pesticide, PCB, and volatile and semivolatile organic compound levels in sediment samples collected from the Mad River study area, 1992.

SEDIMENT		
Stream River Mile (Location)	Parameter	Concentration ug/kg (ppb)
Mad River		
11.44 (Medway/Osborn Rds.)	Acetone	24J
	Methylene chloride	2J
8.62 (Fairborn Pump Station)	All Compounds	Not Detected
8.18 (Adj. WPAFB landfill 14)	Acetone	35J
8.18 (Adj. WPAFB landfill 14)	Bis(2-ethylhexyl) phthalate	460*
(Duplicate)	Acetone	24J
7.75 (Adj. WPAFB landfill 11)	Acetone	20J
7.41 (Trib. mouth, landfill 11)	All Compounds	Not Detected
6.13 (Upst. Hebble Creek)	Chloromethane	5J
1.67 (Findlay St.)	Bis(2-ethylhexyl) phthalate	5660*
Hebble Creek		
1.65 (Hebble Creek Rd.)	Benzo(a)anthracene	1000J
	Benzo(b)fluoranthene	950J
	Benzo(k)fluoranthene	1150J
	Chrysene	1300J
	Fluoranthene	2600
	Phenanthrene	1300J
	Pyrene	2800
	Methylene chloride	2J
Landfill 11 trib. (Confluence with Mad River at RM 6.88)		
0.02 (At mouth)	Bis(2-ethylhexyl) phthalate	360*
	Di-n-butyl phthalate	230J

J = less than limit of practical quantitation but greater than zero.

* - found in method blank.

Table 8. Dioxin and furan levels in sediment collected from the Mad River study area, 1992.

DIOXINS AND FURANS

Mad River

Parameter	RM 11.44 Conc. (ppt)	RM 11.44 Toxicity Equivalent[1] (ppt)	RM 8.62 Conc. (ppt)	RM 8.62 Toxicity Equivalent[1] (ppt)	RM 8.18 Conc. (ppt)	RM 8.18 Toxicity Equivalent[1] (ppt)	RM 8.18 Conc. (ppt)	RM 8.18 Toxicity Equivalent[1] (ppt)
2378- TCDD	3.2	3.20	3.8	3.80	1.9	1.90	1.3	1.30
12378- PeCDD	2.2	1.10	ND	0.65	6.1	3.05	ND	0.55
123478 - HxCDD	2.3	0.23	3.1	0.31	8.8	0.88	3.3	0.33
123678 - HxCDD	4.9	0.49	6.4	0.64	10.1	1.01	7.5	0.75
123789 - HxCDD	6.3	0.63	10.7	1.07	13.5	1.35	9.1	0.91
1234678 - HpCDD	96.0	0.96	134	1.34	180	1.80	161	1.61
OCDD	850	0.85	1070	1.07	1240	1.24	1210	1.21
2378 - TCDF	2.1	0.21	2.7	0.27	9.0	0.90	3.4	0.34
12378 - PeCDF	ND	0.02	ND	0.04	3.7	0.18	ND	0.03
23478 - PeCDF	ND	0.25	2.2	1.10	4.7	2.35	1.6	0.80
123478 - HxCDF	1.6	0.16	3.8	0.38	14.6	1.46	5.0	0.50
123678 - HxCDF	1.2	0.12	2.8	0.28	4.8	0.48	2.6	0.26
234678 - HxCDF	1.9	0.19	3.9	0.39	5.1	0.51	3.7	0.37
123789 - HxCDF	ND	0.04	ND	0.06	ND	0.04	ND	0.05
1234678 - HpCDF	21.7	0.22	31.4	0.31	35.8	0.36	32.8	0.33
1234789 - HpCDF	ND	0.00	ND	0.01	2.7	0.03	ND	0.01
OCDF	61.7	0.06	92.2	0.09	95.2	0.09	91.6	0.09
Total TCDD	18.9	-	20.4	-	22.3	-	7.1	-
Total PeCDD	17.1	-	87.4	-	10.4	-	26.5	-
Total HxCDD	45.2	-	66.6	-	111	-	67.6	-
Total HpCDD	189	-	264	-	348	-	318	-
Total TCDF	14.6	-	14.8	-	70.9	-	26.3	-
Total PeCDF	44.2	-	38.6	-	91.8	-	25.2	-
Total HxCDF	35.4	-	56.8	-	74.4	-	72.8	-
Total HpCDF	27.0	-	92.5	-	58.3	-	99.2	-
2378 TCDD Total Toxicity Equivalent (TTE)		**8.73**		**11.81**		**17.63**		**9.44**

Table 8. Continued.

DIOXINS AND FURANS

Mad River

Parameter	RM 7.75 Conc. (ppt)	RM 7.75 Toxicity Equivalent[1] (ppt)	RM 7.41 Conc. (ppt)	RM 7.41 Toxicity Equivalent[1] (ppt)	RM 6.13 Conc. (ppt)	RM 6.13 Toxicity Equivalent[1] (ppt)	RM 1.67 Conc. (ppt)	RM 1.67 Toxicity Equivalent[1] (ppt)
2378- TCDD	1.7	1.70	0.99	0.99	1.3	1.30	2.5	2.50
12378- PeCDD	2.4	1.20	ND	0.25	ND	0.40	5.2	2.60
123478 - HxCDD	2.4	0.24	0.88	0.09	ND	0.06	8.8	0.88
123678 - HxCDD	6.2	0.62	1.6	0.16	4.3	0.43	9.8	0.98
123789 - HxCDD	7.9	0.79	2.0	0.20	4.9	0.49	19.1	1.91
1234678 - HpCDD	150	1.50	32.2	0.32	85.8	0.86	193	1.93
OCDD	1150	1.15	248	0.25	681	0.68	1510	1.51
2378 - TCDF	2.7	0.27	1.2	0.12	1.9	0.19	5.4	0.54
12378 - PeCDF	ND	0.02	ND	0.02	1.1	0.05	2.5	0.12
23478 - PeCDF	1.7	0.85	ND	0.15	0.82	0.41	4.6	2.30
123478 - HxCDF	3.2	0.32	0.94	0.09	1.5	0.15	9.2	0.92
123678 - HxCDF	2.1	0.21	0.49	0.05	1.3	0.13	5.2	0.52
234678 - HxCDF	2.3	0.23	1.2	0.12	2.0	0.20	7.3	0.73
123789 - HxCDF	ND	0.04	ND	0.03	ND	0.03	ND	0.03
1234678 - HpCDF	28.8	0.29	6.1	0.06	17.7	0.18	39.5	0.39
1234789 - HpCDF	ND	0.01	ND	0.00	ND	0.00	2.3	0.02
OCDF	86.0	0.09	15.0	0.01	42.6	0.04	96.0	0.10
Total TCDD	17.5	-	16.3	-	16.8	-	38.6	-
Total PeCDD	7.7	-	5.2	-	13.1	-	9.7	-
Total HxCDD	60.7	-	8.2	-	42.2	-	112	-
Total HpCDD	294	-	59.3	-	165	-	367	-
Total TCDF	20.9	-	6.4	-	17.7	-	42.2	-
Total PeCDF	48.0	-	3.8	-	56.8	-	68.7	-
Total HxCDF	56.5	-	14.2	-	35.7	-	84.5	-
Total HpCDF	87.6	-	12.2	-	51.5	-	106	-
2378 TCDD Total Toxicity Equivalent (TTE)	**9.53**		**2.91**		**5.60**		**17.98**	

Table 8. Continued.

DIOXINS AND FURANS

Parameter	Hebble Creek RM 1.65 Conc. (ppt)	Hebble Creek RM 1.65 Toxicity Equivalent[1] (ppt)	Landfill 11 Trib. RM 0.02 Conc. (ppt)	Landfill 11 Trib. RM 0.02 Toxicity Equivalent[1] (ppt)
2378- TCDD	1.2	1.20	0.82	0.82
12378- PeCDD	ND	0.92	ND	0.47
123478 - HxCDD	5.0	0.50	4.7	0.47
123678 - HxCDD	10.9	1.09	6.2	0.62
123789 - HxCDD	15.5	1.55	12.0	1.20
1234678 - HpCDD	217	2.17	111	1.11
OCDD	1590	1.59	829	0.83
2378 - TCDF	14.3	1.43	8.1	0.81
12378 - PeCDF	7.1	0.35	3.0	0.15
23478 - PeCDF	33.5	16.75	4.8	2.40
123478 - HxCDF	320	32.00	13.3	1.33
123678 - HxCDF	34.7	3.47	4.3	0.43
234678 - HxCDF	25.2	2.52	6.0	0.60
123789 - HxCDF	ND	0.09	ND	0.04
1234678 - HpCDF	802	8.02	29.7	0.30
1234789 - HpCDF	25.3	0.25	2.5	0.02
OCDF	2030	2.03	62.0	0.06
Total TCDD	6.8	-	10.7	-
Total PeCDD	264	-	36.3	-
Total HxCDD	96.5	-	85.7	-
Total HpCDD	448	-	261	-
Total TCDF	141	-	53.2	-
Total PeCDF	578	-	102	-
Total HxCDF	722	-	65.0	-
Total HpCDF	1660	-	68.3	-
2378 TCDD Total Toxicity Equivalent (TTE)		**75.93**		**11.66**

[1] - 2,3,7,8 TCDD toxicity equivalents.

Physical Habitat for Aquatic Life

- Physical habitats in the Mad River within the lower 11 miles are predominantly free-flowing and consist of fairly equal distributions of run, riffle, and pool areas. Bottom substrates are predominated by cobble and gravel. Qualitative Habitat Evaluation Index (QHEI) scores for the Mad River (76 - 83.5) were reflective of good to excellent stream habitat (Table 9). The total number of WWH attributes were considerably higher than the total of MWH attributes at all Mad River locations sampled. Substantial base flows in the Mad River, along with a moderately high to high gradient, are reflected in the high percentage of riffle and run areas for such a large size river.

- Hebble Creek physical habitat was evaluated at RM 0.1. Substrates are predominated by slab boulders and hardpan. Stream morphology consists of deep pools (>1.5m) and shallow riffles and runs (5-10cm); both are characteristic of good channel development. The sampling site riparian zone is predominated by woodland (95% closed canopy). The lower 0.3 miles of Hebble Creek are natural and the physical habitat is considered very good (QHEI = 80). Hebble Creek upstream from RM 0.3 (within Wright Patterson AFB property) has been extensively modified, resulting in its current Modified Warmwater Habitat use designation. Habitat results from 1989 for RMs 0.4 - 4.5 revealed QHEIs between 28 and 51. This section of Hebble Creek is predominated by sand and gravel substrates, large sections are devoid of trees, instream cover is sparse to nearly absent, and pools/riffles/runs are largely replaced by glide habitat. A habitat evaluation conducted in 1992 as part of a site evaluation revealed extensively modified habitats upstream from this area.

Table 9. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Mad River study area, August - October, 1992.

Table 9. Qualitative Habitat Evaluation Index

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Overall Embeddedness	Max. Depth > 40 cm	Low/No Riffle Embeddedness	Total WWH Attributes	MWH *High Influence*: Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD/HW)	Total H.I. MWH Attributes	MWH *Moderate Influence*: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	MWH HL/WWH Ratio	MWH ML/WWH Ratio
(14-100) Mad River																																	
Year: 92																																	
11.3	**83.5**	6.80	■	■	■	■	■	■	■	■	■	■	9						0													0	0.10	0.10
8.9	**80.5**	6.37	■	■	■	■	■	■	■	■	■	■	9			●			1													0	0.20	0.20
7.7	**77.0**	6.37	■	■	■		■	■	■	■	■	■	8						0				▲									1	0.11	0.22
6.3	**79.0**	8.62	■	■	■	■	■	■	■	■	■	■	9						0													0	0.10	0.10
3.8	**76.0**	13.89	■	■	■	■	■	■	■	■	■	■	9			●			1													0	0.20	0.20
1.6	**79.0**	9.26	■	■	■	■	■	■	■	■	■	■	9						0				▲									1	0.10	0.20
(14-147) Hebble Creek																																	
Year: 92																																	
0.1	**79.5**	6.76	■	■	■	■	■	■	■	■	■		8			●			1	▲												1	0.22	0.33

Macroinvertebrate Community

Macroinvertebrate communities were sampled at seven locations in the Mad River and Hebble Creek between August and September, 1992. The sampling effort included the placement of Hester-Dendy (HDs) artificial substrate samplers and qualitative sampling of all available natural substrate types (Table 2, Figure 1). Lists of taxa collected at each sample location is included as Appendix Table A-2.

- The upstream sampling site in the Mad River (RM 11.5) had a macroinvertebrate community in the good range with an ICI of 38. The total number of taxa collected was 65 and included 13 mayfly taxa and seven caddisfly taxa. However, the caddisflies made up only a small percentage of the collected organisms while dipterans, non-insects, and pollution tolerant taxa composed a disproportionately large part of the sample. The site was located upstream from the Fairborn WWTP and Wright Patterson Air Force Base and downstream from the Springfield WWTP and associated CSOs (Table 10, Figure 8).

- The macroinvertebrate community downstream from the Fairborn WWTP (RM 8.7) exhibited marginally good conditions with an ICI of 32 (nonsignificant departure from the applicable biocriterion). The total number of taxa collected was 63 and included eight mayfly taxa and four caddisfly taxa. Mayflies comprised nearly 40% of the sampled organisms. However, as at RM 11.5 the caddisflies made up a negligible percentage of the sample while dipterans, non-insects, and pollution tolerant taxa composed a large part of the sample. The low numbers of caddisflies may have been partially due to slow current velocity at this location which physically consisted of a long deep pool.

- The macroinvertebrate community downstream from the Fairborn WWTP and adjacent to the Wright Patterson Air Force Base (RM 7.7) exhibited exceptional conditions and scored an ICI of 48. The total number of taxa collected was 66 and included 13 mayfly taxa, four caddisfly taxa, and one stonefly taxon. Mayflies and caddisflies comprised nearly 64% of the sample organisms. Dipterans, non-insects, and pollution tolerant taxa composed only a small part of the sample. This site did have a high incidence of what appeared to be oil or tar globules on the antennas and setae of many of the organisms especially the caddisflies and midges; however, this did not seem to negatively influence the macroinvertebrate community performance.

- The macroinvertebrate community adjacent to the Huffman Reserve (RM 6.3) exhibited marginally good conditions with an ICI of 34 (nonsignificant departure of the applicable biocriterion). The total number of taxa collected was 54 and included nine mayfly taxa and four caddisfly taxa. However, mayflies made up only a small percentage of the sample while dipterans and non-insects composed a disproportionately large part (70%) of the collected organisms. The Coelenterate genus Hydra comprised 63% (4,832 individuals) of the sample; this was probably associated with the spillway connecting the Mad River with the lake at Huffman Reserve. A riffle area upstream from where the artificial substrate samplers were placed was formed almost completely of Corbicula fluminea (Asiatic clam) shells which was an indication of high suspended solids and an abundant food source.

- Themacroinvertebrate community downstream from the Huffman Dam at Harshman Road (RM 3.8) exhibited very good conditions with an ICI of 42; this score was in the nonsignificant departure range of the Exceptional Warmwater Habitat criterion. The total number of taxa collected was 53 and included nine mayfly taxa and six caddisfly taxa. Mayflies and caddisflies comprised 72% of the sample with caddisflies alone making up 54.2% of the sample organisms. This site had large amounts of the aquatic plant Elodea trapped on the artificial substrates.

- The macroinvertebrate community at Findlay Street (RM 1.6) was qualitatively sampled due to the loss of the artificial substrate samplers either from washing out by high water or gravel mining by the City of Dayton. The community exhibited marginally good conditions. The total number of taxa collected was 40 and included nine mayfly taxa and two caddisfly taxa. While there were only two caddisfly taxa collected, the genus Cheumatopsyche and the Hydropsyche (Ceratopsyche) morosa species group, they were numerically predominate. The midge taxa were predominantly pollution tolerant individuals of the genera Cricotopus and Polypedilum. The lack of caddisfly diversity and other taxa requiring good current velocity may have been due to the gravel mining by the city below the Finlay Street bridge. Habitat upstream from the bridge consisted of a long deep pool which may have limited current dependant taxa; below the bridge, habitat was a high gradient, shallow reach which, if undisturbed by the gravel operation, could have provided good habitat for greater diversity of macroinvertebrates.

- Hebble Creek was sampled at one location near the mouth (RM 0.1) during the 1992 survey. The macroinvertebrate community was in the fair range (ICI = 20) and did not meet the Modified Warmwater Habitat (MWH) biocriterion (22). The total number of taxa collected was 50 and included only two mayfly taxa and three caddisfly taxa. Mayflies made up only a small percentage of the sample organisms while dipterans and non-insects composed nearly 74% of the sample. The pollution tolerant component of the community was also very high at 28.3% of the collected organisms. The artificial substrate sampler had been washed over with the Hester Dendy plates on the downstream side. This may have had some impact on the number of organisms collected, in particular caddisflies; however, this certainly would not account for the overall performance of the macroinvertebrate community. The lower reach of the stream (lower 0.3 miles), where macroinvertebrates were collected, has not been modified and exhibited good habitat heterogeneity (QHEI = 79.5) and adequate current velocities; both inferred that the impact to the macroinvertebrate community was water quality related.

Table 10. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Mad River study area, 1984 and 1992.

Stream River Mile	Density (Orgs./ ft^2)	Total Taxa	Quant. Taxa	Qual. Taxa	Qual. EPT[a]	ICI	Evaluation
Mad River (1992)							
Eastern Corn Belt Plains (ECBP) Ecoregion / WWH Use Designation (existing)							
11.5	243	65	49	38	13	38	Good
8.7	280	63	47	41	10	32[ns]	Marginally Good
7.7	575	66	46	45	13	48	Exceptional
6.3	1534	54	39	33	9	34[ns]	Marginally Good
3.8	2286	53	33	35	12	42	Very Good
1.6	-	-	-	40	11	-	Marginally Good[b]
Mad River (1984)							
11.5	534	52	35	40	13	44	Very Good
8.7	350	53	36	34	10	28*	Fair
6.3	279	54	41	36	9	42	Very Good
3.9	561	54	49	30	13	36	Good
1.6	1096	46	36	27	10	46	Exceptional
0.2	802	53	41	38	12	44	Very Good
Hebble Creek (1992)							
Eastern Corn Belt Plains (ECBP) Ecoregion / MWH Use Designation (existing)							
0.1	81	50	35	27	4	20*	Fair

Ecoregion Biocriteria: Eastern Corn Belt Plains (ECBP)

INDEX	WWH	EWH	MWH
ICI	36	46	22

a Qual EPT = total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa in the qualitative sample.

b A qualitative narrative evaluation is based on best professional judgement and is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) score.

ns Nonsignificant departure from ecoregion biocriterion (≤4 ICI units).

* Significant departure from ecoregional biocriterion; poor and very poor results are underlined.

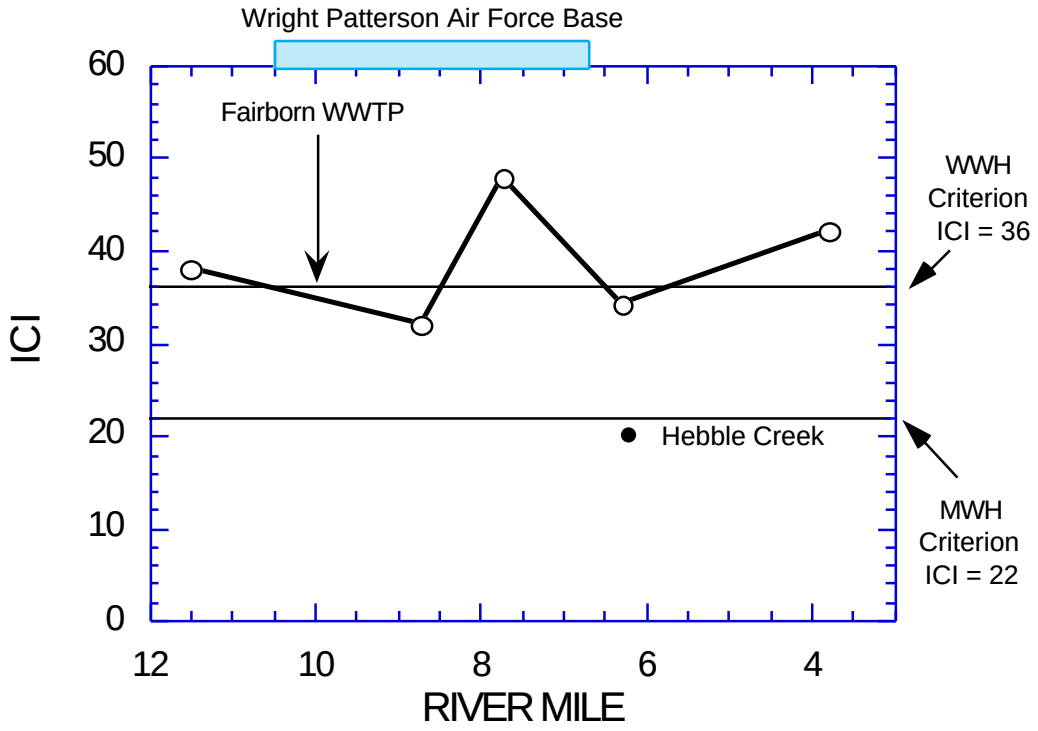

Figure 8. Longitudinal trend of the Invertebrate Community Index (ICI) in the Mad River study area, 1992. The aquatic life use designation for the Mad River is Warmwater Habitat (WWH); Hebble Creek is designated Modified Warmwater Habitat (MWH).

Fish Community

A total of 5,142 fish representing 37 species and five hybrids were collected from the Mad River and Hebble Creek between August and October, 1992. The sampling effort included a cumulative distanced electrofished of 9.20 km at seven locations (Table 2, Figure 1). Relative numbers and species collected per location is presented in Appendix Table A-3.

- The upstream sampling site in the Mad River (RM 11.3) had a fish community in the fair to marginally good range with an IBI of 37 (significant departure from the WWH ecoregional biocriterion) and a MIwb of 8.2 (nonsignificant departure of biocriterion). The site was located upstream from the Fairborn WWTP and the Wright Patterson Air Force Base and downstream from the Springfield WWTP and associated CSOs (Table 11, Figure 9).

- The fish communities in three sites downstream from the Fairborn WWTP and adjacent to the Wright Patterson AFB (RM 8.9 - 6.3) exhibited fair to good performance. Sampling at RM 8.9, 0.7 miles downstream from the Fairborn WWTP, revealed an IBI of 31(fair range) and a MIwb of 8.7 (good range). Both fish indices were in the significant departure range of the criterion at RM 7.7, with IBI (30) and MIwb (7.9) scores reflective of fair community performance and not meeting WWH criteria. Some improvement occurred at RM 6.3, as evidenced by an increase in the IBI score to 41(marginally good).

- Very good to exceptional fish communities were documented in the lower four miles of the Mad River. At RMs 3.8 and 1.6, IBI scores of 48 were recorded and MIwb values ranged between 9.3 and 9.6. Fish communities at both RMs 3.8 and 1.6 were predominated by pollution sensitive suckers, such as northern hog sucker, black redhorse, golden redhorse, and shorthead redhorse (Figure 10).

- The physical condition of fish in the Mad River was monitored at each fish sampling site by recording the incidence of gross DELT (deformities, fin erosion, lesions/ulcers and tumors) external anomalies. The two highest stations for DELT anomalies in the Mad River occurred at RM 8.9 (2.6 %) and RM 7.7 (2.4 %), both sites located immediately downstream from the Fairborn WWTP and adjacent to the WPAFB.

- Overall, fish community performance in the Mad River during the 1992 study were indicative of fair to good community performance. Some impairment was evident downstream from the Fairborn WWTP, suggestive of organic enrichment. Of particular note during the fish collection runs were extensive growths of Elodea in the area of RM 8.0 to RM 7.2. This area of the Mad River has a very wide, previously modified channel which is open to sunlight for extensive periods of the day.

- Hebble Creek was sampled at one location (RM 0.1) during the 1992 survey. The fish community was in the fair range (IBI = 30) and met the Modified Warmwater Habitat conditions. Although the lower 0.3 miles of Hebble Creek was unmodified, the entire upstream reach has been previously channelized with little indication of recovery; hence the MWH use designation.

Table 11. Fish community indices based on pulsed D.C. electrofishing samples at 7 locations sampled by Ohio EPA in the Mad River study area for 1992. Mad River sites were sampled using the boat method and Hebble Creek was sampled using the wading method. (Relative number and weight are per km for boat and 0.3 km for wading sites.)

Stream River Mile	Mean Number of Species	Cumulative Species	Mean Relative Number	Mean Relative Weight	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Mad River (1992)								
Eastern Corn Belt Plains (ECBP) Ecoregion / WWH Use Designation (existing)								
11.3	13.7	17	404	74.3	84	8.2ns	37*	Fair-Marg. Good
8.9	14.7	19	486	109.1	81	8.7	31*	Fair-Good
7.7	13.7	19	472	240.5	77	7.9*	30*	Fair
6.3	13.3	17	441	120.8	79	7.9*	41ns	Fair-Marg. Good
3.8	16.3	19	689	218.4	76	9.3	48	V. Good-Except.
1.6	19.7	26	571	168.2	79	9.6	48	Exceptional
Hebble Creek (1992)								
Eastern Corn Belt Plains (ECBP) Ecoregion / MWH Use Designation (existing								
0.1	11.0	13	712	b	80	b	30	Fair

Ecoregion Biocriteria: Eastern Corn Belt Plain (ECBP)

INDEX - Site Type	WWH	EWH	MWH
IBI - Headwaters/ Wading	44	50	24
IBI - Boat	42	48	24
Mod. Iwb - Boat	8.5	9.6	5.8
ICI	36	46	22

* Significant departure from ecoregion biocriteria; poor and very poor results are underlined.

ns Nonsignificant departure from ecoregion biocriteria (4 IBI units; 0.5 Iwb units).

NA Not available.

a Narrative evaluation is based on both MIwb and IBI scores.

b Headwater site; Modified Iwb is not applicable.

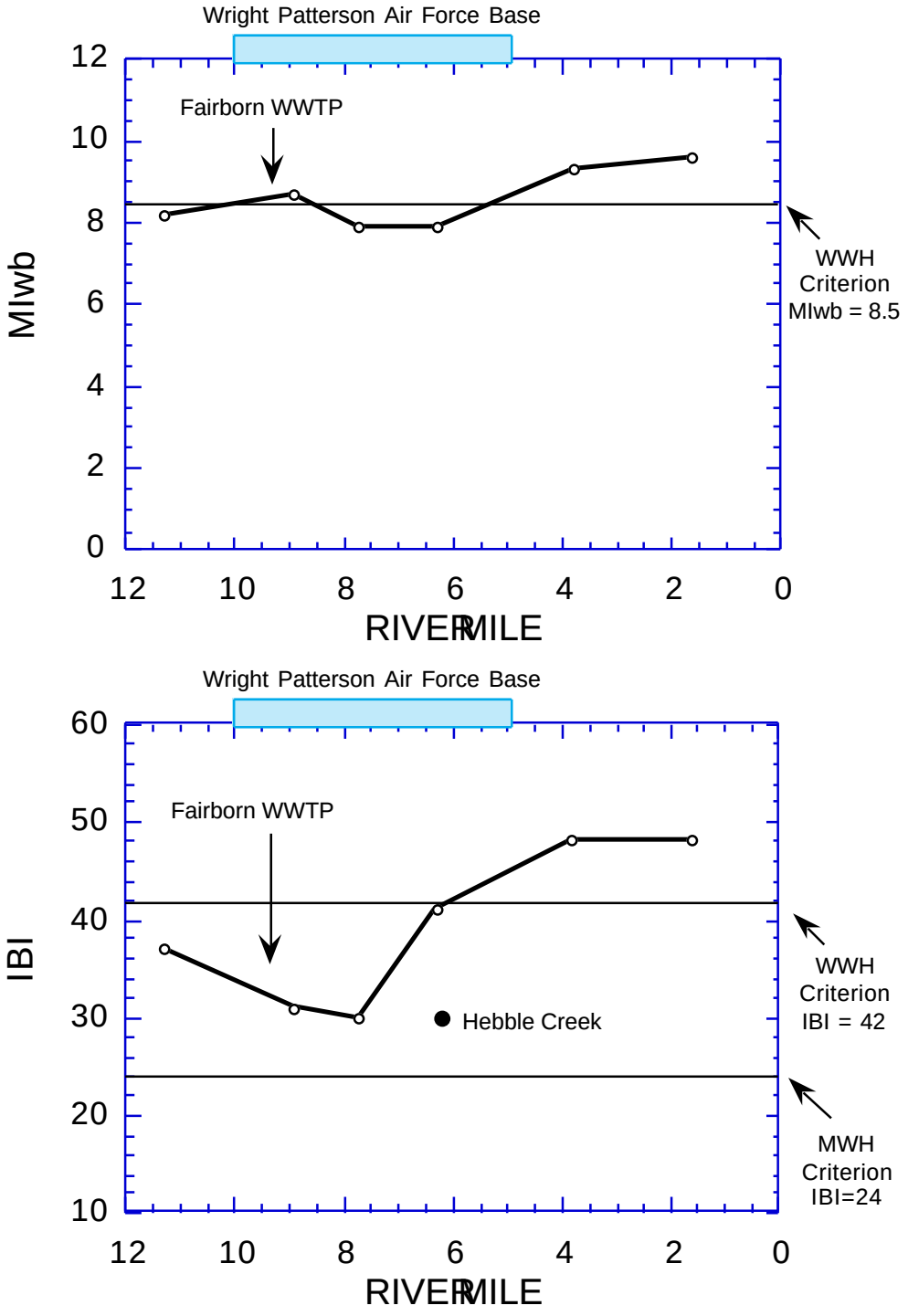

Figure 9. Longitudinal trend of the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb) in the Mad River study area, 1992.

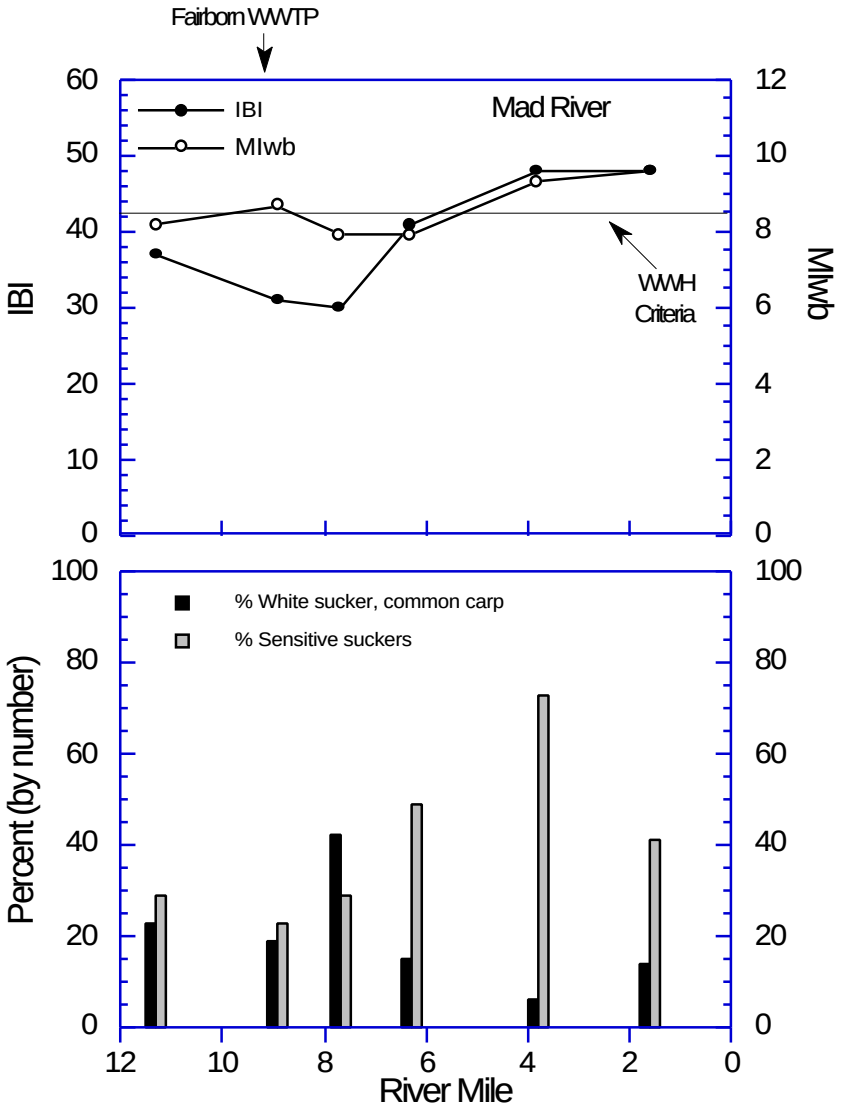

Figure 10. Comparison of IBI, MIwb, percent relative abundance of white sucker and common carp, and percent relative abundance of sensitive suckers in the Mad River study area, 1992.

Trend Assessment

Changes in Macroinvertebrate Community Performance: 1984 - 1992

- Six macroinvertebrate locations (RMs 11.5 - 0.2) were sampled during 1984 by the Ohio EPA in the Mad River. All sites achieved or exceeded the ecoregional biocriterion except the site downstream from the Fairborn WWTP (RM 8.7) which scored an ICI of 28. In 1992, six locations were sampled (RMs 11.5 - 1.6); all sites achieved, exceeded, or were in the non-significant departure range of the WWH biocriterion. ADV statistics (Table 12) indicated a slight overall improvement with an ADV score of zero in 1992 down from a 28 in 1984.

Changes in Fish Community Performance: 1984 - 1992

- Seven locations (RM 11.5 - 0.2) were electrofished during 1984 by Ohio EPA in the Mad River. Although the lower four sites (RM 3.9 - 0.2) varied widely in IBI and MIwb scores during 1984, the overall results in the lower 11.5 miles indicated a significant departure from the WWH criteria. IBI scores from 6 of 7 locations ranged between 22 and 33, and 4 of 7 MIwb scores were below 7.6. A comparison of the 1992 and 1984 (poor to fair) results revealed a significant improvement during 1992 (Figure 12). During this same time period, substantial reductions in ammonia-N and BOD_5 were measured at the Springfield and Fairborn WWTPs.

- Area of Degradation Values (ADV) from 1992 and 1984 (Table 12) provides a relative measure of community performance. The ADV/ mile for the IBI and MIwb demonstrates the improvements between 1984 and 1992. IBI ADV/ mile values improved substantially by declining from 92.7 in 1984 to 23.6 in 1992. MIwb ADV/ mile scores also showed improvement between 1984 and 1992 (36.3 and 1.0, respectively).

Table 12. Area of Degradation (ADV) statistics for the Mad River, 1984 and 1992 (calculated using the ecoregion biocriteria as the background community performance).

	Biological Index Scores				ADV Statistics			Attainment Status (miles)			
Stream Index	Upper RM	Lower RM	Mini-mum	Maxi-mum	ADV	**ADV/ Mile**	Poor/VP ADV	FULL	PAR-TIAL	**NON**	POOR/ VP
Mad River (1984)											
IBI	11.5	0.2	22	49	1048	**92.7**	17				
MIwb			5.9	9.5	410	**36.3**	0	1.4	8.1	**2.6**	**1.3**
ICI			28	46	28	**2.5**	0				
Mad River (1992)											
IBI	11.3	1.6	30	48	229	**23.6**	0				
MIwb			7.8	9.6	10	**1.0**	0	5.2	5.3	0	0
ICI	11.5	1.6	32	48	0	**0**	0				

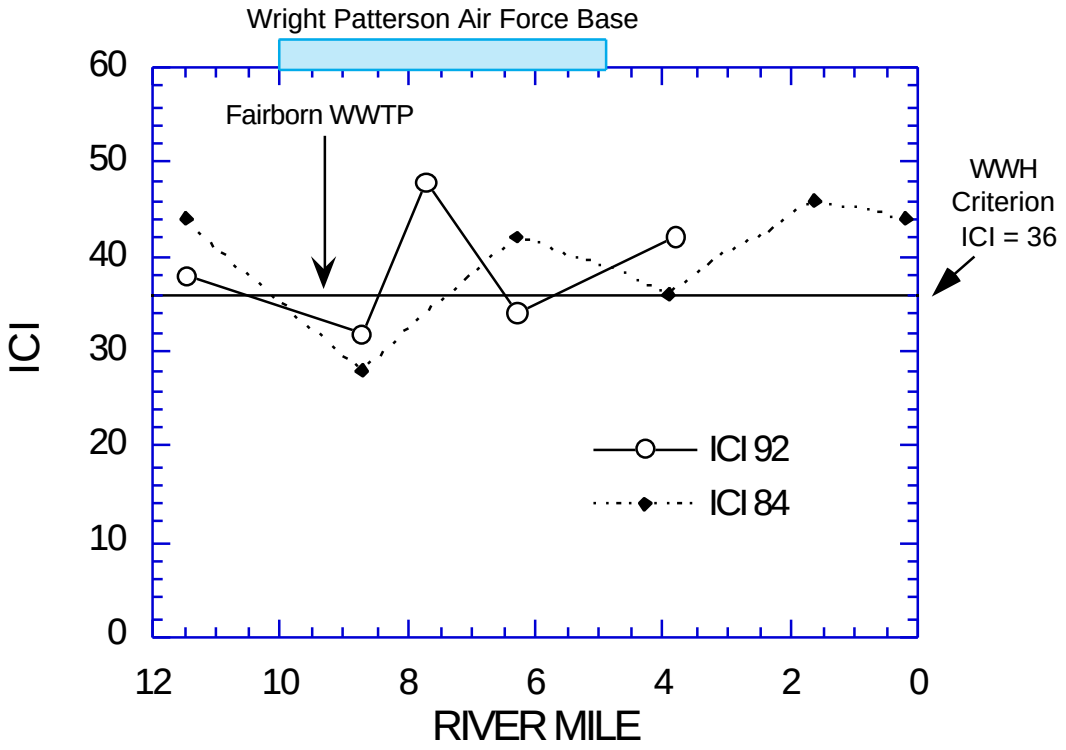

Figure 11. Longitudinal trend of the Invertebrate Community Index (ICI) in the Mad River during 1984 and 1992.

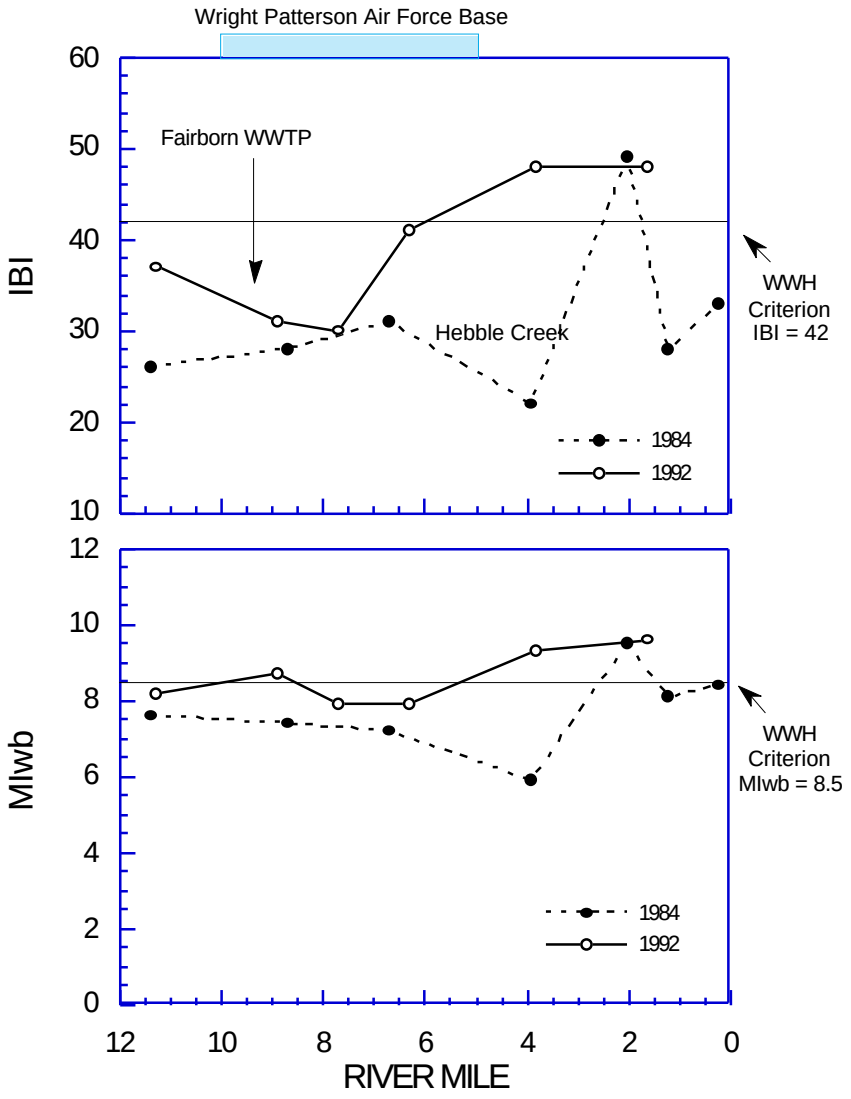

Figure 12. Longitudinal trend of the Modified Index of Well-Being (MIwb) and Index of Biotic Integrity (IBI) in the Mad River during 1984 and 1992.

Fish Tissue

Fish tissue samples were collected from the Mad River at three locations by the Ohio EPA during 1992. Whole body composites of fish representing two species were analyzed for pesticides, PCBs, metals, semivolatile organic compounds, dioxin (presence/absence), and percent lipid (Table 13).

- One PCB congener, Aroclor 1254, was identified and quantified. Six samples representing two species were analyzed for PCBs in the Mad River during 1992. Three of the samples had detectable levels of Aroclor-1254, with values ranging from 160 ug/kg (ppb) to 420 ug/kg. Fish from the upstream reference site did not have detectable concentrations of PCBs in their tissue. All PCB levels were below the FDA 2,000 ug/kg (2.0 ppm) total PCB level of concern in edible portions as well as being below the Ohio Water Standard for PCBs (any whole sample of any representative organism shall not exceed 640 ug/kg PCBs).

- Nineteen pesticide compounds were tested in six fish tissue samples. All values were below lab detection limits. Detection levels for pesticides generally varied from between 33 ug/kg and 67 ug/kg.

- Fifty-six semivolatile organic compounds were measured in six fish samples. All values were below lab detection limits. Detection levels for semivolatile parameters generally varied from between 2,700 ug/kg and 5,300 ug/kg.

- Three metals (total barium, lead and zinc) were detected in six fish whole body samples from the 1992 sampling sites. Six other metal parameters (total arsenic, cadmium, chromium, mercury, selenium and silver) tested in whole body fish samples were reported as ‘not detected’. Total zinc was detected in all fish samples analyzed, with values ranging from 12.0 mg/kg to 88.2 mg/kg. Total lead was reported above the lab detection limit of 0.30 mg/kg in one sample (0.45 mg/kg).

Table 13. Summary of contaminant levels in whole body fish samples collected in the Mad River, October, 1992. The Dioxin Screening Test was a positive/negative test not a quantitative test.

River Mile Species	Lead mg/kg	Zinc mg/kg	Aroclor 1254 ug/kg	Pesti-cides ug/kg	Semi Volatiles ug/kg	Total PCBs ug/kg	Dioxin Screen	Percent Lipid %
11.3								
Common carp (2 fish composite)	NA	NA	ND	ND	ND	ND	Negative	3.0
Common carp (2 fish composite)	ND	88.2	NA	NA	NA	NA	NA	9.3
Smallmouth bass (2 fish composite)	NA	NA	ND	ND	ND	ND	Negative	4.0
Smallmouth bass (3 fish composite)	ND	12.6	NA	NA	NA	NA	NA	2.6
8.2								
Common carp (2 fish composite)	NA	NA	180	ND	ND	180	Negative	4.0
Common carp (2 fish composite)	0.45	58.1	NA	NA	NA	NA	NA	4.3
Smallmouth bass (2 fish composite)	ND	12.0	160	ND	ND	160	Negative	2.3
6.3								
Common carp (2 fish composite)	NA	NA	420	ND	ND	420	Negative	3.6
Common carp (2 fish composite)	ND	79.6	NA	NA	NA	NA	NA	0.66
Smallmouth bass (2 fish composite)	NA	NA	ND	ND	ND	ND	Negative	2.6
Smallmouth bass (2 fish composite)	ND	12.1	NA	NA	NA	NA	NA	ND

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APPENDIX TABLES

Table A-1. Semivolatile, volatile, pesticides, PCBs, dioxin, and total metal compounds analyzed in Ohio EPA 1992 Mad River sediment and surface water samples. Nutrients were sampled in surface water only.

TOTAL METALS

Arsenic	Chromium	Mercury
Barium	Copper	Selenium
Cadmium	Lead	Silver

SEMIVOLATILE COMPOUNDS

Acenaphthene	Benzidine	Hexachlorocyclopentadiene
Acenaphthylene	N-nitrosodimethylamine	Indeno (1,2,3-CD) pyrene
Anthracene	Dibenzo(A,H) anthracene	Isophorone
Benzo (A) anthracene	Dibenzofuran	2-Methyl-4,6-Dinitrophenol
Benzo(A) pyrene	1,2-Dichlorobenzene	2-Methylnaphthalene
Benzo(B) fluoranthene	1,3-Dichlorobenzene	Naphthalene
Benzo(G,H,I) perylene	1,4-Dichlorobenzene	2-Nitroaniline
Benzo(K) fluoranthene	3,3'-Dichlorobenzidine	3-Nitroaniline
Benzoic acid	2,4-Dichlorophenol	4-Nitroaniline
Benzyl alcohol	Diethyl phthalate	Nitrobenzene
Butylbenzyl phthalate	2,4-Dimethylphenol	2-nitrophenol
Bis(2-chloroethoxy) methane	Dimethyl phthalate	4-Nitrophenol
Bis(2-chloroethyl) ether	Di-N-butyl phthalate	N-nitrosodiphenyl amine
Bis(2-chloroisopropyl)ether	2,4-Dinitrophenol	N-Nitroso-N-propylamine
Bis(2-ethylhexyl) phthalate	2,4-Dinitrotoluene	Pentachlorophenol
4-Bromophenyl phenyl ether	2,6-Dinitrotoluene	Phenanthrene
4-Chloroaniline	Di-N-octyl phthalate	Phenol
4-Chloro-3-methyl phenol	Fluoranthene	Pyrene
2-Chloronaphthalene	Fluorene	1,2,4-Trichlorobenzene
2-Chlorophenol	Hexachlorobenzene	2,4,5-Trichlorophenol
4-Chlorophenyl phenyl ether	Hexachlorobutadiene	2,4,6-Trichlorophenol
Chrysene	Hexachloroethane	2-Methylphenol
		4-Methylphenol

VOLATILE COMPOUNDS

Acetone	Chloroethane	1,2-Dichloropropane	Tetrachloroethene
Benzene	2-Chloroethylvinylether	cis-1,3-Dichloropropene	Toluene
Bromodichloromethane	Chloroform	Trans-1,3-dichloropropene	1,1,1-Trichloroethane
Bromoform	Chloromethane	Ethylbenzene	1,1,2-Trichloroethane
Bromomethane	Dibromochloromethane	2-Hexanone	Trichloroethene
2-Butanone	1,1-Dichloroethane	Methylene chloride	Vinyl acetate
Carbon disulfide	1,2-Dichloroethane	4-Methyl-2-pentanone	Vinyl chloride
Carbon tetrachloride	1,1-Dichloroethene	Styrene	Total Xylenes
Chlorobenzene	Trans-1,2-dichloroethene	1,2-Dichloroethene (total)	1,1,2,2-Tetrachloroethane
Trichlorofluoromethane			

Appendix A-1. (Continued).

PESTICIDES

a-BHC	Aldrin	Heptachlor
b-BHC	Dieldrin	Heptachlor epoxide
g-BHC (Lindane)	Endrin	Methoxychlor
d-BHC	Endrin Aldehyde	a-Chlordane
Endosulfan I	Endrin ketone	Toxaphene
Endosulfan II	4,4'-DDT	g-Chlordane
Endosulfan sulfate	4,4'-DDD	4,4'-DDE

PCBs

Aroclor-1016	Aroclor-1232	Aroclor-1248
Aroclor-1221	Aroclor-1242	Aroclor-1254
		Aroclor-1260

HERBICIDES

2,4-D	Dicamba	MCPP
2,4,5-TP (Silvex)	2,4-DB	MCPA
2,4,5-T	Dalapon	Dichloroprop
Dinoseb		

DIOXINS AND FURANS

2378- TCDD	2378 - TCDF
12378- PeCDD	12378 - PeCDF
123478 - HxCDD	23478 - PeCDF
123678 - HxCDD	123678 - HxCDF
123789 - HxCDD	234678 - HxCDF
1234678 - HpCDD	123478 - HxCDF
OCDD	1234678 - HpCDF
Total TCDD	1234789 - HpCDF
Total PeCDD	123789 - HxCDF
Total HxCDD	OCDF
Total HpCDD	Total TCDF
	Total PeCDF
	Total HxCDF
	Total HpCDF

OTHER (Water)

pH	Nitrate - Nitrite, N
BOD5	Nitrite,N
Ammonia-N	Phosphorus, Total

Table A-2. Macroinvertebrate collections at each location (by RM) sampled in the Mad River study area during 1992.

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/92 River Code: 14-100 River: Mad River RM: 11.50

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	16	+
03600	*Oligochaeta*	4	+
05900	*Lirceus sp*	14	+
06700	*Crangonyx sp*	13	+
08601	*Hydracarina*	4	
11120	*Baetis flavistriga*	11	+
11125	*Labiobaetis frondalis*	0	+
11130	*Baetis intercalaris*	14	+
11300	*Baetidae (formerly in Centroptilum)*	4	
11700	*Baetidae (formerly in Pseudocloeon)*	0	+
12200	*Isonychia sp*	4	+
13000	*Leucrocuta sp*	22	+
13400	*Stenacron sp*	100	
13521	*Stenonema femoratum*	78	
13561	*Stenonema pulchellum*	49	
13570	*Stenonema terminatum*	16	
15000	*Paraleptophlebia sp*	4	
16700	*Tricorythodes sp*	156	+
21300	*Hetaerina sp*	0	+
23909	*Boyeria vinosa*	0	+
50804	*Lype diversa*	8	+
51400	*Nyctiophylax sp*	0	+
52200	*Cheumatopsyche sp*	25	+
52430	*Ceratopsyche morosa group*	44	+
52530	*Hydropsyche depravata group*	12	+
52540	*Hydropsyche dicantha*	4	+
59410	*Nectopsyche diarina*	12	
68601	*Ancyronyx variegata*	0	+
68702	*Dubiraphia bivittata*	0	+
68708	*Dubiraphia vittata group*	0	+
68901	*Macronychus glabratus*	8	+
69200	*Optioservus sp*	0	+
69400	*Stenelmis sp*	1	
71900	*Tipula sp*	0	+
74100	*Simulium sp*	0	+
77500	*Conchapelopia sp*	28	+
77750	*Hayesomyia senata or Thienemannimyia norena*	0	+
77800	*Helopelopia sp*	21	
78450	*Nilotanypus fimbriatus*	14	
80204	*Brillia flavifrons group*	14	
80310	*Cardiocladius obscurus*	0	+
80370	*Corynoneura lobata*	40	
80410	*Cricotopus (C.) sp*	21	
80420	*Cricotopus (C.) bicinctus*	28	+
80430	*Cricotopus (C.) tremulus group*	56	
80440	*Cricotopus (C.) trifascia group*	42	+
81650	*Parametriocnemus sp*	7	
82730	*Chironomus (C.) decorus group*	7	
82820	*Cryptochironomus sp*	7	+
83040	*Dicrotendipes neomodestus*	14	
84210	*Paratendipes albimanus or P. duplicatus*	7	
84300	*Phaenopsectra obediens group*	7	
84315	*Phaenopsectra flavipes*	7	
84450	*Polypedilum (P.) convictum*	21	
84460	*Polypedilum (P.) fallax group*	98	+
84470	*Polypedilum (P.) illinoense*	7	+
84540	*Polypedilum (Tripodura) scalaenum group*	35	
85625	*Rheotanytarsus exiguus group*	28	
85802	*Tanytarsus curticornis group*	7	
85814	*Tanytarsus glabrescens group*	0	+
85840	*Tanytarsus guerlus group*	14	
86401	*Atherix lantha*	1	
86501	*Stratiomyidae*	0	+
93900	*Elimia sp*	59	+
97601	*Corbicula fluminea*	0	+

No. Quantitative Taxa:	49	Total Taxa:	65
No. Qualitative Taxa:	38	ICI:	**38**
Number of Organisms:	1213	Qual EPT:	**13**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/92 River Code: 14-100 River: Mad River RM: 8.70

Taxa Code	Taxa	Quan/Qual	
04686	*Placobdella papillifera*	0	+
05900	*Lirceus sp*	5	+
06700	*Crangonyx sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11130	*Baetis intercalaris*	13	+
12200	*Isonychia sp*	0	+
13000	*Leucrocuta sp*	1	+
13510	*Stenonema exiguum*	37	+
13521	*Stenonema femoratum*	12	
13561	*Stenonema pulchellum*	136	
13570	*Stenonema terminatum*	193	+
16700	*Tricorythodes sp*	168	+
21200	*Calopteryx sp*	0	+
21300	*Hetaerina sp*	0	+
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	2	
47600	*Sialis sp*	1	+
52200	*Cheumatopsyche sp*	30	+
52430	*Ceratopsyche morosa group*	19	+
52530	*Hydropsyche depravata group*	0	+
52540	*Hydropsyche dicantha*	0	+
68601	*Ancyronyx variegata*	1	+
68702	*Dubiraphia bivittata*	1	+
68708	*Dubiraphia vittata group*	0	+
68901	*Macronychus glabratus*	4	+
69400	*Stenelmis sp*	1	+
74100	*Simulium sp*	0	+
77120	*Ablabesmyia mallochi*	16	+
77500	*Conchapelopia sp*	8	+
77750	*Hayesomyia senata or Thienemannimyia norena*	32	
80204	*Brillia flavifrons group*	8	
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	16	
80370	*Corynoneura lobata*	12	
80410	*Cricotopus (C.) sp*	32	
80420	*Cricotopus (C.) bicinctus*	32	+
80430	*Cricotopus (C.) tremulus group*	80	+
80440	*Cricotopus (C.) trifascia group*	0	+
80510	*Cricotopus (Isocladius) sylvestris group*	0	+
81201	*Nanocladius (N.) sp*	8	
81632	*Parakiefferiella n.sp 2*	8	
81650	*Parametriocnemus sp*	0	+
81825	*Rheocricotopus (Psilocricotopus) robacki*	0	+
82141	*Thienemanniella xena*	8	
82730	*Chironomus (C.) decorus group*	8	+
82820	*Cryptochironomus sp*	16	+
83040	*Dicrotendipes neomodestus*	16	
84210	*Paratendipes albimanus or P. duplicatus*	40	
84300	*Phaenopsectra obediens group*	8	+
84460	*Polypedilum (P.) fallax group*	80	+
84470	*Polypedilum (P.) illinoense*	32	+
84475	*Polypedilum (P.) ophioides*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	48	+
85500	*Paratanytarsus sp*	8	
85501	*Paratanytarsus n.sp 1*	8	
85615	*Rheotanytarsus distinctissimus group*	32	
85625	*Rheotanytarsus exiguus group*	160	+
85800	*Tanytarsus sp*	16	
85802	*Tanytarsus curticornis group*	8	
85814	*Tanytarsus glabrescens group*	8	
85840	*Tanytarsus guerlus group*	24	
93900	*Elimia sp*	1	+
96900	*Ferrissia sp*	4	
98600	*Sphaerium sp*	1	

No. Quantitative Taxa:	47	Total Taxa:	63
No. Qualitative Taxa:	41	ICI:	**32**
Number of Organisms:	1402	Qual EPT:	**10**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/92 River Code: 14-100 River: Mad River RM: 7.70

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	1	
03600	*Oligochaeta*	8	+
04964	*Mooreobdella microstoma*	0	+
05900	*Lirceus sp*	0	+
06700	*Crangonyx sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11120	*Baetis flavistriga*	40	+
11125	*Labiobaetis frondalis*	0	+
11130	*Baetis intercalaris*	256	+
11700	*Baetidae (formerly in Pseudocloeon)*	24	+
12200	*Isonychia sp*	33	+
13000	*Leucrocuta sp*	16	+
13400	*Stenacron sp*	72	
13510	*Stenonema exiguum*	3	+
13550	*Stenonema mexicanum integrum*	32	
13561	*Stenonema pulchellum*	248	
13570	*Stenonema terminatum*	192	+
16700	*Tricorythodes sp*	112	+
17200	*Caenis sp*	16	
21200	*Calopteryx sp*	0	+
21300	*Hetaerina sp*	0	+
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	0	+
35001	*Perlodidae*	8	
52200	*Cheumatopsyche sp*	360	+
52430	*Ceratopsyche morosa group*	360	+
52530	*Hydropsyche depravata group*	88	+
52540	*Hydropsyche dicantha*	16	+
68601	*Ancyronyx variegata*	1	+
68702	*Dubiraphia bivittata*	0	+
68708	*Dubiraphia vittata group*	0	+
68901	*Macronychus glabratus*	8	+
69400	*Stenelmis sp*	1	+
71900	*Tipula sp*	0	+
74100	*Simulium sp*	8	+
77500	*Conchapelopia sp*	12	+
77800	*Helopelopia sp*	24	
78450	*Nilotanypus fimbriatus*	12	
79085	*Telopelopia okoboji*	12	
80204	*Brillia flavifrons group*	0	+
80310	*Cardiocladius obscurus*	0	+
80370	*Corynoneura lobata*	24	
80420	*Cricotopus (C.) bicinctus*	12	+
80430	*Cricotopus (C.) tremulus group*	0	+
80440	*Cricotopus (C.) trifascia group*	0	+
81250	*Nanocladius (N.) minimus*	0	+
81650	*Parametriocnemus sp*	12	
81825	*Rheocricotopus (Psilocricotopus) robacki*	12	
82101	*Thienemanniella n.sp 1*	36	
82121	*Thienemanniella n.sp 3*	12	
82220	*Tvetenia discoloripes group*	12	
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	0	+
84300	*Phaenopsectra obediens group*	12	
84450	*Polypedilum (P.) convictum*	12	+
84460	*Polypedilum (P.) fallax group*	84	+
84470	*Polypedilum (P.) illinoense*	24	+
84540	*Polypedilum (Tripodura) scalaenum group*	60	+
85615	*Rheotanytarsus distinctissimus group*	48	
85625	*Rheotanytarsus exiguus group*	516	+
85800	*Tanytarsus sp*	12	
85802	*Tanytarsus curticornis group*	12	
85814	*Tanytarsus glabrescens group*	12	
86401	*Atherix lantha*	1	+
93900	*Elimia sp*	0	+
96900	*Ferrissia sp*	1	
97601	*Corbicula fluminea*	0	+

No. Quantitative Taxa:	46	Total Taxa:	66
No. Qualitative Taxa:	45	ICI:	**48**
Number of Organisms:	2877	Qual EPT:	**13**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/92 River Code: 14-100 River: Mad River RM: 6.30

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	4832	
01801	*Turbellaria*	0	+
03042	*Fredericella australiensis*	1	+
03600	*Oligochaeta*	64	+
05900	*Lirceus sp*	0	+
06700	*Crangonyx sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11120	*Baetis flavistriga*	32	+
11130	*Baetis intercalaris*	80	+
11700	*Baetidae (formerly in Pseudocloeon)*	0	+
12200	*Isonychia sp*	74	
13000	*Leucrocuta sp*	0	+
13400	*Stenacron sp*	32	
13561	*Stenonema pulchellum*	232	+
13570	*Stenonema terminatum*	312	
16700	*Tricorythodes sp*	40	+
21200	*Calopteryx sp*	12	+
21300	*Hetaerina sp*	0	+
52200	*Cheumatopsyche sp*	608	+
52430	*Ceratopsyche morosa group*	464	+
52530	*Hydropsyche depravata group*	280	+
52540	*Hydropsyche dicantha*	8	
68601	*Ancyronyx variegata*	0	+
68702	*Dubiraphia bivittata*	0	+
68901	*Macronychus glabratus*	16	+
69400	*Stenelmis sp*	0	+
74100	*Simulium sp*	4	+
77500	*Conchapelopia sp*	12	
77750	*Hayesomyia senata or Thienemannimyia norena*	48	
78450	*Nilotanypus fimbriatus*	6	
80204	*Brillia flavifrons group*	6	
80310	*Cardiocladius obscurus*	6	
80410	*Cricotopus (C.) sp*	0	+
80430	*Cricotopus (C.) tremulus group*	0	+
80440	*Cricotopus (C.) trifascia group*	0	+
81240	*Nanocladius (N.) distinctus*	96	
81650	*Parametriocnemus sp*	12	
82220	*Tvetenia discoloripes group*	30	+
82820	*Cryptochironomus sp*	6	+
83040	*Dicrotendipes neomodestus*	0	+
83300	*Glyptotendipes (G.) sp*	24	
84210	*Paratendipes albimanus or P. duplicatus*	6	
84300	*Phaenopsectra obediens group*	6	
84450	*Polypedilum (P.) convictum*	30	
84460	*Polypedilum (P.) fallax group*	72	
84470	*Polypedilum (P.) illinoense*	54	+
84540	*Polypedilum (Tripodura) scalaenum group*	12	+
85500	*Paratanytarsus sp*	30	
85625	*Rheotanytarsus exiguus group*	60	+
85814	*Tanytarsus glabrescens group*	18	
87501	*Empididae*	4	
93900	*Elimia sp*	20	+
96900	*Ferrissia sp*	20	
97601	*Corbicula fluminea*	0	+

No. Quantitative Taxa: 39 Total Taxa: 54

No. Qualitative Taxa: 33 ICI: **34**

Number of Organisms: 7669 Qual EPT: **9**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/92 River Code: 14-100 River: Mad River RM: 3.80

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	0	+
03600	*Oligochaeta*	104	+
05900	*Lirceus sp*	0	+
06800	*Gammarus sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11130	*Baetis intercalaris*	1232	+
11155	*Baetis punctiventris*	136	+
11200	*Callibaetis sp*	0	+
12200	*Isonychia sp*	200	+
13000	*Leucrocuta sp*	0	+
13400	*Stenacron sp*	0	+
13561	*Stenonema pulchellum*	217	+
13570	*Stenonema terminatum*	178	
16700	*Tricorythodes sp*	96	+
21200	*Calopteryx sp*	0	+
22001	*Coenagrionidae*	0	+
52200	*Cheumatopsyche sp*	2320	+
52430	*Ceratopsyche morosa group*	2688	+
52510	*Hydropsyche aerata*	568	
52530	*Hydropsyche depravata group*	520	+
52570	*Hydropsyche simulans*	0	+
53800	*Hydroptila sp*	96	
65800	*Berosus sp*	0	+
67800	*Tropisternus sp*	0	+
68601	*Ancyronyx variegata*	0	+
68702	*Dubiraphia bivittata*	8	
68901	*Macronychus glabratus*	10	+
69400	*Stenelmis sp*	8	+
71900	*Tipula sp*	1	
74100	*Simulium sp*	65	
77500	*Conchapelopia sp*	110	
77750	*Hayesomyia senata or Thienemannimyia norena*	55	
80204	*Brillia flavifrons group*	55	
80310	*Cardiocladius obscurus*	110	+
80370	*Corynoneura lobata*	40	
80420	*Cricotopus (C.) bicinctus*	0	+
80430	*Cricotopus (C.) tremulus group*	165	+
80440	*Cricotopus (C.) trifascia group*	702	+
81240	*Nanocladius (N.) distinctus*	55	
82141	*Thienemanniella xena*	55	
82220	*Tvetenia discoloripes group*	330	
82730	*Chironomus (C.) decorus group*	0	+
83040	*Dicrotendipes neomodestus*	0	+
84450	*Polypedilum (P.) convictum*	165	
84460	*Polypedilum (P.) fallax group*	110	
84470	*Polypedilum (P.) illinoense*	165	+
85500	*Paratanytarsus sp*	110	
85615	*Rheotanytarsus distinctissimus group*	55	
85625	*Rheotanytarsus exiguus group*	702	
93900	*Elimia sp*	0	+
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	0	+
97601	*Corbicula fluminea*	0	+

No. Quantitative Taxa: 33 Total Taxa: 53
No. Qualitative Taxa: 35 ICI: **42**
Number of Organisms: 11431 Qual EPT: **12**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/92 River Code: 14-100 River: Mad River RM: 1.60

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	0	+
03600	*Oligochaeta*	0	+
05900	*Lirceus sp*	0	+
06201	*Hyalella azteca*	0	+
06700	*Crangonyx sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11130	*Baetis intercalaris*	0	+
11200	*Callibaetis sp*	0	+
11300	*Baetidae (formerly in Centroptilum)*	0	+
12200	*Isonychia sp*	0	+
13000	*Leucrocuta sp*	0	+
13400	*Stenacron sp*	0	+
13570	*Stenonema terminatum*	0	+
16700	*Tricorythodes sp*	0	+
17200	*Caenis sp*	0	+
21200	*Calopteryx sp*	0	+
22001	*Coenagrionidae*	0	+
24820	*Gomphurus externus*	0	+
52200	*Cheumatopsyche sp*	0	+
52430	*Ceratopsyche morosa group*	0	+
60910	*Peltodytes edentulus*	0	+
68601	*Ancyronyx variegata*	0	+
68708	*Dubiraphia vittata group*	0	+
68901	*Macronychus glabratus*	0	+
69410	*Stenelmis crenata*	0	+
72700	*Anopheles sp*	0	+
74100	*Simulium sp*	0	+
77120	*Ablabesmyia mallochi*	0	+
77500	*Conchapelopia sp*	0	+
77750	*Hayesomyia senata or Thienemannimyia norena*	0	+
80420	*Cricotopus (C.) bicinctus*	0	+
80430	*Cricotopus (C.) tremulus group*	0	+
80440	*Cricotopus (C.) trifascia group*	0	+
80510	*Cricotopus (Isocladius) sylvestris group*	0	+
82820	*Cryptochironomus sp*	0	+
84450	*Polypedilum (P.) convictum*	0	+
84460	*Polypedilum (P.) fallax group*	0	+
84470	*Polypedilum (P.) illinoense*	0	+
85625	*Rheotanytarsus exiguus group*	0	+
95100	*Physella sp*	0	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa:	0	Total Taxa:	40
No. Qualitative Taxa:	40	ICI:	
Number of Organisms:	0	Qual EPT:	

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/92 River Code: 14-147 River: Hebble Creek RM: 0.10

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	2	
03360	*Plumatella sp*	3	
03600	*Oligochaeta*	13	
05900	*Lirceus sp*	6	+
06700	*Crangonyx sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11130	*Baetis intercalaris*	1	+
16700	*Tricorythodes sp*	15	
21200	*Calopteryx sp*	0	+
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	1	+
23909	*Boyeria vinosa*	0	+
52200	*Cheumatopsyche sp*	0	+
52430	*Ceratopsyche morosa group*	0	+
52530	*Hydropsyche depravata group*	0	+
65800	*Berosus sp*	2	+
68601	*Ancyronyx variegata*	0	+
68708	*Dubiraphia vittata group*	2	+
69400	*Stenelmis sp*	1	+
71900	*Tipula sp*	0	+
74100	*Simulium sp*	0	+
77120	*Ablabesmyia mallochi*	45	
77500	*Conchapelopia sp*	3	+
77750	*Hayesomyia senata or Thienemannimyia norena*	6	
77800	*Helopelopia sp*	12	
78401	*Natarsia species A (sensu Roback, 1978)*	3	
79400	*Zavrelimyia sp*	6	
80204	*Brillia flavifrons group*	0	+
80370	*Corynoneura lobata*	24	
80430	*Cricotopus (C.) tremulus group*	0	+
81250	*Nanocladius (N.) minimus*	12	
81650	*Parametriocnemus sp*	0	+
82730	*Chironomus (C.) decorus group*	21	+
83003	*Dicrotendipes fumidus*	3	
83040	*Dicrotendipes neomodestus*	12	+
83051	*Dicrotendipes simpsoni*	6	
83300	*Glyptotendipes (G.) sp*	9	
84210	*Paratendipes albimanus or P. duplicatus*	6	
84300	*Phaenopsectra obediens group*	6	+
84315	*Phaenopsectra flavipes*	6	+
84460	*Polypedilum (P.) fallax group*	18	
84470	*Polypedilum (P.) illinoense*	54	+
84540	*Polypedilum (Tripodura) scalaenum group*	21	
85400	*Micropsectra sp*	3	
85500	*Paratanytarsus sp*	6	
85800	*Tanytarsus sp*	18	
85814	*Tanytarsus glabrescens group*	45	
85840	*Tanytarsus guerlus group*	12	
96900	*Ferrissia sp*	3	
97601	*Corbicula fluminea*	0	+

No. Quantitative Taxa: 35 Total Taxa: 50
No. Qualitative Taxa: 27 ICI: **20**
Number of Organisms: 406 Qual EPT: **4**

Table A-3. Summary of relative numbers of fish and species collected at each location (by RM) sampled in the Mad River study area during 1992. Stream codes are as follows: Mad River - 14100, Hebble Creek - 14147.

Species List

River Code: **14-100**	Stream: **Mad River**	Sample Date: **1992**
River Mile: **11.30**	Basin: Great Miami River	Date Range: 08/14/92
Data Source: 01	Time Fished: 3899 sec Drain Area: 556.0 sq mi	Thru: 10/06/92
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
AMER BROOK LAMPREY		F	N	R	1	0.67	0.17	0.02	0.02	24.00
GIZZARD SHAD		O	M		32	21.33	5.28	4.40	5.92	206.21
GOLDEN REDHORSE	R	I	S	M	5	3.33	0.83	1.06	1.42	317.20
NORTHERN HOG SUCKER	R	I	S	M	173	115.33	28.55	26.86	36.16	232.86
WHITE SUCKER	W	O	S	T	120	80.00	19.80	15.41	20.75	192.68
COMMON CARP	G	O	M	T	18	12.00	2.97	16.15	21.74	1,345.89
CREEK CHUB	N	G	N	T	11	7.33	1.82	0.28	0.38	38.82
SILVER SHINER	N	I	S	I	113	75.33	18.65	0.51	0.68	6.74
SPOTFIN SHINER	N	I	M		14	9.33	2.31	0.08	0.11	8.43
BLUNTNOSE MINNOW	N	O	C	T	8	5.33	1.32	0.03	0.04	5.25
CENTRAL STONEROLLER	N	H	N		46	30.67	7.59	0.92	1.24	30.07
COM. CARP X GOLDFISH	G	O		T	1	0.67	0.17	0.35	0.47	520.00
WHITE CRAPPIE	S	I	C		1	0.67	0.17	0.01	0.02	21.00
ROCK BASS	S	C	C		21	14.00	3.47	1.50	2.02	107.38
SMALLMOUTH BASS	F	C	C	M	32	21.33	5.28	6.59	8.87	308.75
BLUEGILL SUNFISH	S	I	C	P	7	4.67	1.16	0.08	0.11	17.43
PUMPKINSEED SUNFISH	S	I	C	P	1	0.67	0.17	0.02	0.03	33.00
GREENSIDE DARTER	D	I	S	M	2	1.33	0.33	0.01	0.02	9.00
Mile Total					606	404.00		74.28		
Number of Species					17					
Number of Hybrids					1					

River Code: **14-100**	Stream: **Mad River**	Sample Date: **1992**
River Mile: **8.90**	Basin: Great Miami River	Date Range: 08/14/92
Data Source: 01	Time Fished: 3693 sec Drain Area: 617.0 sq mi	Thru: 10/05/92
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		24	16.00	3.29	3.04	2.79	190.17
QUILLBACK CARPSUCKER	C	O	M		2	1.33	0.27	1.27	1.16	950.50
GOLDEN REDHORSE	R	I	S	M	8	5.33	1.10	3.82	3.50	715.63
NORTHERN HOG SUCKER	R	I	S	M	159	106.00	21.78	34.02	31.18	320.96
WHITE SUCKER	W	O	S	T	113	75.33	15.48	15.68	14.37	208.12
COMMON CARP	G	O	M	T	30	20.00	4.11	39.52	36.22	1,976.03
CREEK CHUB	N	G	N	T	30	20.00	4.11	0.54	0.49	27.00
SILVER SHINER	N	I	S	I	43	28.67	5.89	0.24	0.22	8.42
SPOTFIN SHINER	N	I	M		11	7.33	1.51	0.04	0.04	6.00
SAND SHINER	N	I	M	M	42	28.00	5.75	0.07	0.07	2.55
BLUNTNOSE MINNOW	N	O	C	T	69	46.00	9.45	0.17	0.16	3.71
CENTRAL STONEROLLER	N	H	N		116	77.33	15.89	1.17	1.07	15.12
CHANNEL CATFISH	F		C		1	0.67	0.14	1.77	1.62	2,650.00
YELLOW BULLHEAD		I	C	T	1	0.67	0.14	0.31	0.28	462.00
ROCK BASS	S	C	C		15	10.00	2.05	1.12	1.03	112.27
SMALLMOUTH BASS	F	C	C	M	56	37.33	7.67	6.07	5.57	162.64
LARGEMOUTH BASS	F	C	C		3	2.00	0.41	0.16	0.15	79.67
GREEN SUNFISH	S	I	C	T	3	2.00	0.41	0.05	0.05	25.33
BLUEGILL SUNFISH	S	I	C	P	4	2.67	0.55	0.04	0.04	16.00
Mile Total					730	486.67		109.11		
Number of Species					19					
Number of Hybrids					0					

River Code: **14-100**	Stream: **Mad River**	Sample Date: **1992**
River Mile: **7.70**	Basin: Great Miami River	Date Range: 08/17/92
Data Source: 01	Time Fished: 4826 sec Drain Area: 619.0 sq mi	Thru: 10/05/92
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		3	2.00	0.42	0.38	0.16	190.00
QUILLBACK CARPSUCKER	C	O	M		2	1.33	0.28	1.77	0.73	1,325.00
GOLDEN REDHORSE	R	I	S	M	32	21.33	4.52	15.36	6.39	720.13
NORTHERN HOG SUCKER	R	I	S	M	170	113.33	24.01	28.59	11.89	252.25
WHITE SUCKER	W	O	S	T	198	132.00	27.97	32.37	13.46	245.19
COMMON CARP	G	O	M	T	98	65.33	13.84	154.62	64.30	2,366.66
CREEK CHUB	N	G	N	T	14	9.33	1.98	0.18	0.07	19.21
SILVER SHINER	N	I	S	I	17	11.33	2.40	0.11	0.05	10.12
STRIPED SHINER	N	I	S		1	0.67	0.14	0.01	0.00	15.00
SPOTFIN SHINER	N	I	M		8	5.33	1.13	0.03	0.01	5.25
BLUNTNOSE MINNOW	N	O	C	T	4	2.67	0.56	0.02	0.01	7.50
CENTRAL STONEROLLER	N	H	N		98	65.33	13.84	1.59	0.66	24.35
YELLOW BULLHEAD		I	C	T	2	1.33	0.28	0.28	0.11	207.00
WHITE CRAPPIE	S	I	C		1	0.67	0.14	0.02	0.01	26.00
ROCK BASS	S	C	C		23	15.33	3.25	1.34	0.56	87.35
SMALLMOUTH BASS	F	C	C	M	31	20.67	4.38	3.47	1.44	167.74
LARGEMOUTH BASS	F	C	C		2	1.33	0.28	0.32	0.13	236.50
BLUEGILL SUNFISH	S	I	C	P	3	2.00	0.42	0.03	0.01	16.67
GREENSIDE DARTER	D	I	S	M	1	0.67	0.14	0.00	0.00	4.00
Mile Total					708	472.00		240.48		
Number of Species					19					
Number of Hybrids					0					

River Code: **14-100**	Stream: **Mad River**	Sample Date: **1992**
River Mile: **6.30**	Basin: Great Miami River	Date Range: 08/17/92
Data Source: 01	Time Fished: 4133 sec Drain Area: 622.0 sq mi	Thru: 10/05/92
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GRASS PICKEREL		P	M	P	1	0.67	0.15	0.06	0.05	88.00
GOLDEN REDHORSE	R	I	S	M	9	6.00	1.36	2.48	2.05	413.33
NORTHERN HOG SUCKER	R	I	S	M	314	209.33	47.43	71.87	59.51	343.33
WHITE SUCKER	W	O	S	T	82	54.67	12.39	13.98	11.57	255.70
COMMON CARP	G	O	M	T	19	12.67	2.87	28.72	23.78	2,267.58
CREEK CHUB	N	G	N	T	26	17.33	3.93	0.11	0.09	6.15
SILVER SHINER	N	I	S	I	56	37.33	8.46	0.39	0.33	10.52
STRIPED SHINER	N	I	S		5	3.33	0.76	0.06	0.05	18.60
SPOTFIN SHINER	N	I	M		23	15.33	3.47	0.09	0.08	6.09
BLUNTNOSE MINNOW	N	O	C	T	9	6.00	1.36	0.03	0.02	4.33
CENTRAL STONEROLLER	N	H	N		59	39.33	8.91	0.33	0.27	8.44
ROCK BASS	S	C	C		27	18.00	4.08	1.15	0.95	63.70
SMALLMOUTH BASS	F	C	C	M	21	14.00	3.17	1.14	0.94	81.29
LARGEMOUTH BASS	F	C	C		2	1.33	0.30	0.21	0.18	159.50
GREEN SUNFISH	S	I	C	T	3	2.00	0.45	0.04	0.03	21.00
BLUEGILL SUNFISH	S	I	C	P	2	1.33	0.30	0.03	0.02	21.50
PUMPKINSEED SUNFISH	S	I	C	P	2	1.33	0.30	0.06	0.05	41.50
GREEN SF X BLUEGILL					2	1.33	0.30	0.03	0.02	22.50
	Mile Total				662	441.33		120.78		
	Number of Species				17					
	Number of Hybrids				1					

River Code: **14-100**	Stream: **Mad River**	Sample Date: **1992**
River Mile: **3.80**	Basin: Great Miami River	Date Range: 08/17/92
Data Source: 01	Time Fished: 2253 sec Drain Area: 642.0 sq mi	Thru: 10/06/92
Purpose:	Dist Fished: 1.46 km No of Passes: 3	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		12	8.06	1.17	0.86	0.39	105.92
QUILLBACK CARPSUCKER	C	O	M		10	6.84	0.99	4.30	1.97	626.50
BLACK REDHORSE	R	I	S	I	34	23.48	3.40	12.25	5.61	526.18
GOLDEN REDHORSE	R	I	S	M	97	67.51	9.79	35.93	16.45	530.95
SHORTHEAD REDHORSE	R	I	S	M	141	97.83	14.18	58.23	26.66	594.19
NORTHERN HOG SUCKER	R	I	S	M	471	318.29	46.15	68.83	31.52	216.40
WHITE SUCKER	W	O	S	T	33	22.17	3.21	3.79	1.73	171.33
COMMON CARP	G	O	M	T	29	20.09	2.91	24.63	11.28	1,231.66
CREEK CHUB	N	G	N	T	1	0.72	0.11	0.01	0.01	18.00
SILVER SHINER	N	I	S	I	59	40.61	5.89	0.35	0.16	8.53
STRIPED SHINER	N	I	S		5	3.39	0.49	0.19	0.09	56.20
SPOTFIN SHINER	N	I	M		4	2.72	0.40	0.02	0.01	9.00
BLUNTNOSE MINNOW	N	O	C	T	12	8.46	1.23	0.04	0.02	4.33
CENTRAL STONEROLLER	N	H	N		41	27.62	4.00	0.69	0.32	25.15
CHANNEL CATFISH	F		C		1	0.67	0.10	0.46	0.21	690.00
ROCK BASS	S	C	C		6	4.12	0.60	0.55	0.25	133.50
SMALLMOUTH BASS	F	C	C	M	44	29.97	4.35	6.80	3.11	227.62
LARGEMOUTH BASS	F	C	C		1	0.67	0.10	0.01	0.01	21.00
GREEN SUNFISH	S	I	C	T	7	5.07	0.74	0.14	0.06	27.00
GREEN SF X BLUEGILL					1	0.72	0.11	0.02	0.01	23.00
SAUGER X WALLEYE	E	P			1	0.72	0.11	0.32	0.15	438.00
Mile Total					1,010	689.74		218.41		
Number of Species					19					
Number of Hybrids					2					

River Code: **14-100**	Stream: **Mad River**	Sample Date: **1992**
River Mile: **1.60**	Basin: Great Miami River	Date Range: 08/18/92
Data Source: 01	Time Fished: 4601 sec Drain Area: 654.0 sq mi	Thru: 10/06/92
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		80	53.33	9.35	12.16	7.23	228.05
RAINBOW TROUT	E		N		1	0.67	0.12	0.17	0.10	255.00
QUILLBACK CARPSUCKER	C	O	M		8	5.33	0.93	2.44	1.45	458.38
HIGHFIN CARPSUCKER	C	O	M		2	1.33	0.23	0.56	0.33	418.50
BLACK REDHORSE	R	I	S	I	10	6.67	1.17	2.38	1.42	357.70
GOLDEN REDHORSE	R	I	S	M	84	56.00	9.81	28.09	16.70	501.67
SHORTHEAD REDHORSE	R	I	S	M	51	34.00	5.96	9.99	5.94	293.88
NORTHERN HOG SUCKER	R	I	S	M	205	136.67	23.95	26.38	15.68	193.00
WHITE SUCKER	W	O	S	T	64	42.67	7.48	7.74	4.60	181.47
SPOTTED SUCKER	R	I	S		1	0.67	0.12	0.03	0.02	52.00
COMMON CARP	G	O	M	T	59	39.33	6.89	57.39	34.12	1,459.07
GOLDFISH	G	O	M	T	1	0.67	0.12	0.34	0.20	510.00
SILVER SHINER	N	I	S	I	62	41.33	7.24	0.32	0.19	7.69
SPOTFIN SHINER	N	I	M		9	6.00	1.05	0.04	0.02	6.44
BLUNTNOSE MINNOW	N	O	C	T	2	1.33	0.23	0.01	0.00	4.00
CENTRAL STONEROLLER	N	H	N		3	2.00	0.35	0.06	0.04	32.33
CHANNEL CATFISH	F		C		3	2.00	0.35	3.41	2.03	1,704.67
WHITE CRAPPIE	S	I	C		1	0.67	0.12	0.04	0.02	61.00
ROCK BASS	S	C	C		6	4.00	0.70	0.34	0.20	84.17
SMALLMOUTH BASS	F	C	C	M	104	69.33	12.15	13.34	7.93	192.46
LARGEMOUTH BASS	F	C	C		1	0.67	0.12	0.15	0.09	224.00
GREEN SUNFISH	S	I	C	T	55	36.67	6.43	0.99	0.59	27.03
BLUEGILL SUNFISH	S	I	C	P	18	12.00	2.10	0.18	0.11	14.93
OR'GESPOTTED SUNFISH	S	I	C		1	0.67	0.12	0.02	0.01	33.00
LONGEAR SUNFISH	S	I	C	M	17	11.33	1.99	0.42	0.25	37.38
PUMPKINSEED SUNFISH	S	I	C	P	1	0.67	0.12	0.02	0.01	28.00
B'GILL X PUMPKINSEED					1	0.67	0.12	0.01	0.01	20.00
GREEN SF X HYBRID					2	1.33	0.23	0.03	0.02	22.00
SAUGER X WALLEYE	E	P			4	2.67	0.47	1.14	0.68	427.25
	Mile Total				856	570.67		168.21		
	Number of Species				26					
	Number of Hybrids				3					

River Code: **14-147**	Stream: **Hebble Creek**	Sample Date: **1992**
River Mile: **0.10**	Basin: Great Miami River	Date Range: 08/18/92
Data Source: 01	Time Fished: 3833 sec Drain Area: 12.7 sq mi	Thru: 10/06/92
Purpose:	Dist Fished: 0.24 km No of Passes: 2	Sampler Type: D

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	44	55.00	7.72	0.19	7.41	3.52
WHITE SUCKER	W	O	S	T	33	41.25	5.79	0.79	30.25	19.18
BLACKNOSE DACE	N	G	S	T	24	30.00	4.21	0.03	1.15	1.00
CREEK CHUB	N	G	N	T	317	396.25	55.61	1.36	51.84	3.42
STRIPED SHINER	N	I	S		4	5.00	0.70	0.00	0.06	0.25
SPOTFIN SHINER	N	I	M		4	5.00	0.70			
BLUNTNOSE MINNOW	N	O	C	T	14	17.50	2.46	0.00	0.06	0.07
CENTRAL STONEROLLER	N	H	N		110	137.50	19.30	0.02	0.82	0.15
GREEN SUNFISH	S	I	C	T	14	17.50	2.46	0.20	7.64	11.43
LONGEAR SUNFISH	S	I	C	M	1	1.25	0.18	0.02	0.57	12.00
RAINBOW DARTER	D	I	S	M	2	2.50	0.35			
FANTAIL DARTER	D	I	C		1	1.25	0.18			
MOTTLED SCULPIN		I	C		2	2.50	0.35	0.01	0.25	2.50
Mile Total					570	712.50		2.62		
Number of Species					13					
Number of Hybrids					0					

Table A-4. Raw chemical data for sediment and surface water sampling locations in the Mad River study area, 1992.

(Data is available upon request)