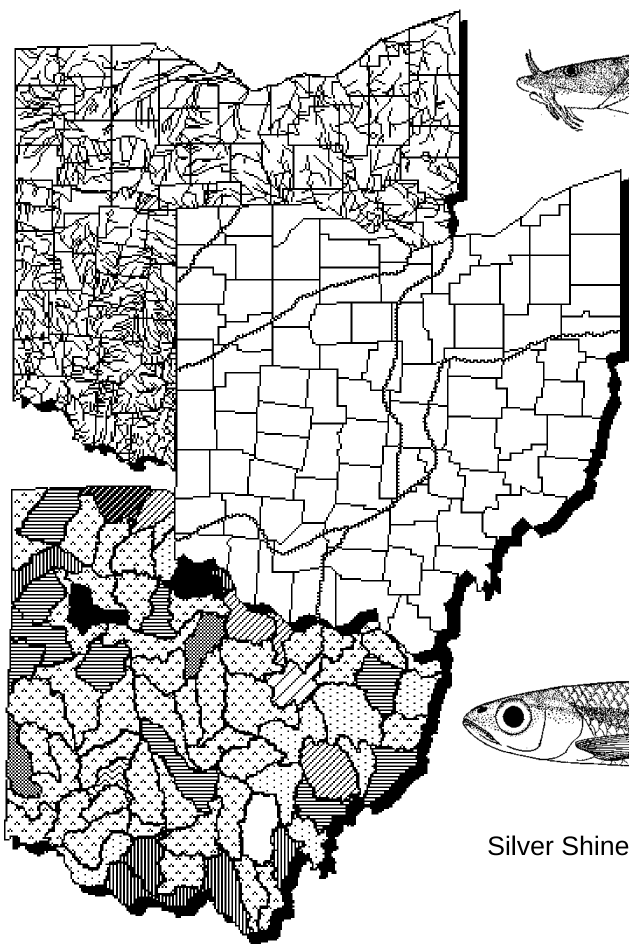
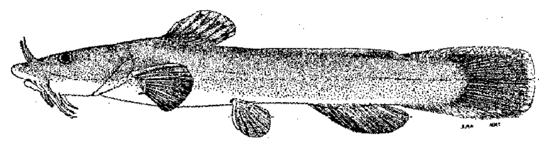
State of Ohio
Environmental Protection Agency

Ecological Assessment
Division of Surface Water

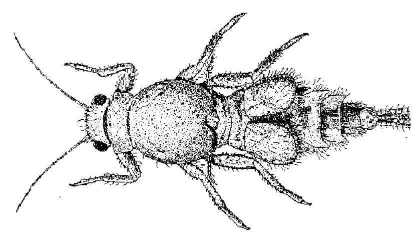
# Biological and Water Quality Study of Whetstone Creek and Selected Tributaries

## Morrow, Marion, and Delaware Counties, Ohio

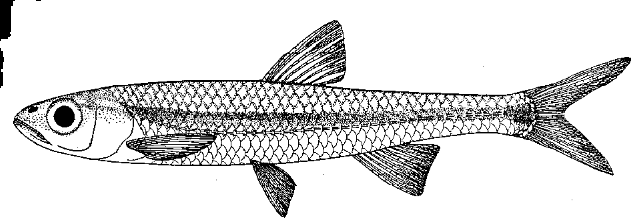




Stonecat
*(Noturus flavus)*



Mayfly *(Caenis)*



Silver Shiner *(Notropis photogenis)*

December 8, 1995

P.O. Box 1049, 1800 WaterMark Dr., Columbus, Ohio 43266-1049

**Whetstone Creek upstream of McKibben Road (above) and downstream of Marion Williamsport Road (left) north of Mt. Gilead, Morrow County, Ohio. Both photos typify the exceptional aquatic habitat offered by Whetstone Creek.**

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Morrow, Delaware and Marion Counties, Ohio

December 8, 1995

OEPA Technical Report MAS/1995-12-6

prepared by

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# NOTICE TO USERS

Ohio EPA incorporated 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 assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1987), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio's surface water resources.

The following Ohio EPA documents support the use of biological criteria by outlining the rationale for using biological information, the methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results:

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. 1989b. 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. 1989c. 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. 1990. 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 report can be obtained by writing to:

Ohio EPA, Division of Surface Water
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This evaluation and report would not have been possible without the additional assistance of the study team, many full and part-time staff in the field (Anthony (Tony) Minamyer, Julie Sullivan, Chris Skalski and Tim Schmitt) and office (particularly Jack Freda, Michael Bolton and Chuck McKnight), and the chemistry analyses provided by the Ohio EPA Division of Environmental Services. Acknowledgment is also given to the property owners that allowed Ohio EPA personnel access to Whetstone Creek and Shaw Creek.

# Biological and Water Quality Survey of Whetstone Creek and Selected Tributaries (Morrow and Delaware Counties, Ohio)

State of Ohio Environmental Protection Agency
Division of Surface Water
1800 WaterMark Drive
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## INTRODUCTION

The 1994 Whetstone Creek study area included the mainstem from beginning upstream of Mt.Gilead, Ohio at McKibben Road (RM 25.5 ) to downstream from Cardington, Ohio (RM 9.1) and Shaw Creek whose confluence with Whetstone Creek is at RM 8.5. Specific objectives of this evaluation were to:

1) monitor and assess chemical, physical and biological integrity of the Whetstone Creek study area.

2) evaluate impacts from combined sewer and stormwater overflows, habitat alterations and municipal and industrial wastewater treatment plants (WWTPs) on the receiving stream including a follow-up evaluation of the Mt. Gilead WWTP following a treatment upgrade in 1985-6.

3) make a nonpoint source evaluation of Shaw Creek, Whetstone Creek, and possible oil well runoff and spills in the basin.

4) resample one regional reference site (RM 21.8).

5) evaluate existing aquatic life stream use designations and recommend changes in use where appropriate Warmwater Habitat (WWH) designated.

6) determine the attainment status of the current aquatic life use and other non-aquatic use designations.

7) conduct a water resource trend assessment where historical data exists.

The findings of this evaluation may factor into regulatory actions taken by Ohio EPA (e.g., NPDES permits or 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 Water Resource Inventory (305[b] report).

SUMMARY

**Whetstone Creek**

A total of 16.4 miles of Whetstone Creek were assessed in 1994. Based on the performance of the biological communities and the ecoregional biocriteria, all 16.4 miles of Whetstone Creek were in full attainment of the designated Warmwater Habitat (WWH) aquatic life use (100% of the study area). Sampling in Shaw Creek demonstrated full attainment of the designated WWH aquatic life use. The peformance of the macroinvertebrate and fish communities was consistent with the Exceptional Warmwater Habitat (EWH) use criteria at 12 of 16 sites with the other four sites at least partially attaining EWH (Table 1). The mean QHEI for all of the Whetstone Creek sites was greater than 70 (80 if the two localized bedrock sites are excluded; Table 12). This suggests that near and instream habitats of Whetstone Creek are of a sufficient quality to support and maintain a community of aquatic organisms consistent with the EWH designation (Rankin 1989).

Dramatic improvements between 1984 and 1994 could be attributed to the 1985-86 upgrade of the Mt. Gilead WWTP. However, localized reaches of Whetstone Creek remain slightly impacted due mostly to periodic lower quality WWTP discharges, unsewered areas (Edison and individual on-site systems), and possibly unreported fertilizer spillage. At times inconsistent WWTP performance allows for increased loadings (*e.g.*, fecal coliform, ammonia-N, high COD, and high residual chlorine) (Tables 4,6) which is of greater concern during lower flows when WWTP effluent comprises more than 40% of total flow volume in Whetstone Creek (Figure 10).

Potential impacts from the unsewered town of Edison and the Mid-Ohio Chemical Corporation downstream of Mt. Gilead WWTP could be hindering complete recovery by the macroinvertebrates near RM 19.2. The IBI scores also decreased to very good (45) from an exceptional assessment (50) downstream of the Mt. Gilead WWTP. There were minimum D.O. violations outside the mixing area (23 June) in the reach near Edison at RM 20.1 and at RM 19.17 (2.2 and 2.4 mg/l, respectively).

The Cardington WWTP has been operating at or near capacity service since approximately 1986. Problems during high flow (fecal coliform, ammonia, high COD/BOD, low D.O.s, high residual chlorine, and high phosphorus concentrations) impact water quality and add to nutrient enrichment downstream. Nutrient enrichment was indicated downstream at RM 12.9 (increased proportion of herbivores and omnivores) (Figure 15) and RM 10.1 (highest macroinvertebrate densities) (Table 13).

Physical habitat quality also declined in the short reach below Cardington (RM 10.1 to 9.2) and was comprised of bedrock and slabs with little available spawning habitat. High stoneroller and bluntnose minnow populations skewed IBI results (Figures 15, 16). Nonpoint source (NPS) impacts contributed to the decreased fish community IBI score at RM 9.2 which was downstream from open pastures and the geotextile project. Elevated fecal coliform concentrations were still evident at RM 9.2.

The sediment load in Shaw Creek was still substantial, but biological community performance was very good. Higher stream flows, good dissolved oxygen, and habitat were apparently sufficient to ameliorate the effects of siltation. The substantial improvement since the 1984 survey could be attributed to: 1) a significant increase in conservation tillage (i.e., no-till); 2) fewer and better managed livestock operations; 3) better fertilization practices (decrease in nutrient runoff); and 4) a

decrease in oil and gas operations in the watershed (pers. comm, V. Mazeika, DSW OEPA, 6/19/95).

Overall the NPS abatement actions have enhanced the Whetstone Creek watershed. There is now between 30 and 35 percent no-till agriculture production occurring basin-wide (pers. comm. with V. Mazeika, DSW OEPA, 6/19/95). Unrestricted access by livestock has decreased but is still an issue in some areas. Future improvements are expected, as an increased number of cooperative bank restoraton and stabilization and riparian fencing projects are being initiated by some landowners.

In summary, Whetstone Creek supports a wide and diverse assemblage of aquatic life. Overall diversity was high for both fish and invertebrates: 23 to 33 fish species per site with six darter species/site and an average of 71 macroinvertebrate taxa (105 taxa at one site). Fifteen of the 40 fish species collected in Whetstone Creek are considered to be environmentally sensitive. These 15 comprised 32% of the fish fauna. The IBI and ICI scores indicate good to exceptional community performance. Efforts to improve WWTP performance (through better plant management or future upgrades), enhancement of the riparian corridor, continued progress with NPS abatement projects, and limiting sedimentation and nutrient enrichment should result in exceptional performance at all locations.

## CONCLUSIONS

- Whetstone Creek and Shaw Creek support good to exceptional macroinvertebrate and fish communities with some potential remaining for future improvement. Significant improvement has been noted since the 1984 survey.

- QHEI scores indicate that exceptional biological community performance can be achieved in Whetstone Creek.

- The Mt. Gilead WWTP, despite improvements made since the 1985-86 upgrade, has experienced inconsistent plant performance, particularly since 1991. Ammonia-N loadings have increased 800 percent compared to 1991 values (Figure 5). Nonfilterable residues (total suspended solids) increased 250 percent during the same period. During 1994 six violations of the monthly average ammonia-N concentration occurred, and seven of the average ammonia-N loadings totals were in violation. The total suspended solids (TSS) monthly average loadings were in violation 3 of 12 months, and the TSS average loadings violated limits 5 of 12 months in 1994 (Table 4). There were NPDES violations for daily maximum chlorine (0.67 mg/l) and 7-day ($\leq$ 3.0 mg/l) and 30-day ($\leq$ 4.5 mg/l) average ammonia concentrations (8.73 mg/l) on 23 June (Table 7).

- The proportion of stream flow comprised by the Mt.Gilead WWTP can exceed 40% during low flow periods. NPDES permit violations during these periods have the greatest impact on receiving stream quality and aquatic communities (Figures 8, 10, and 11).

- The Cardington WWTP has been operating at near capacity since approximately 1986. Infrequent perturbations in treatment processes with probable decreased retention times (likely unfinished treatment) have caused NPDES violations and criteria exceedances (fecal coliform, D.O., TSS and TRC concentrations) (Tables 4,6) with the severity of impacts downstream depending on the magnitude of upset and instream volume flow.

- Nutrient enrichment was apparent downstream from the Cardington WWTP at RM 10.0/10.1 (increased proportion of herbivores, omnivores). The magnitude of enrichment was insufficient to decrease the ICI. The slight decline in fish community performance may also have been related to a habitat change and sedimentation in this reach (Figure 15, 16). An upgrade and expansion of the Cardington WWTP would decrease nutrient impacts downstream through improved effluent quality. This should be followed by an improvement in biological community performance.

- Discharges from the unsewered area of Edison and possibly from Mid-Ohio Chemical Co. (fertilizer plant) may be causing a slight impact (increased algal production, increased fecal coliform, increased BOD, and lower D.O. at RM 20.8 and RM 19.2 (Table 6, Figure 8).

- Concentrations of metals in bottom sediments were not a significant factor in Whetstone Creek. Nickel (RM 9.2) had the highest potential (25 percent risk) for some type of adverse effect based in the Low and Severe Effect Levels (LEL and SEL) for that metal in the sediments. Arsenic and copper concentrations showed a very limited potential for any adverse chronic effects (Table 9).

## RECOMMENDATIONS

### Pollutant Loadings

- Water quality based limits for residual chlorine should be recalculated for both WWTPs.

- Efforts to reduce agricultural sediment and nutrient loadings should continue, particularly downstream from Cardington and in Shaw Creek. The success of past NPS abatement strategies (conservation tillage, closure of streams and streambanks to cattle, riparian enhancement, willow posting for bank stabilization and other best management practices) was especially evident in Shaw Creek with subsequent biological improvement.

### Future Monitoring Issues

- Resample following survey in next ten years with some localized sampling (i.e., Mt. Gilead/ Edison and near Cardington WWTP) within Five-Year Basin schedule to determine success in addressing WWTP variability, expansion requests and unsewered area problems after each is addressed.

- Reassess NPS geotextile project site within next couple of years to determine success of bank stabilization and riparian restoration and utility of this method.

### Status of Aquatic Life Uses

Several of the streams evaluated during this study were originally designated for aquatic life uses in the 1978 Ohio WQS. The techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. Therefore, because this study represents a first use of this type of biological data to evaluate and establish aquatic life use designations, several revisions are recommended. While some of the changes may appear to constitute "downgrades" (*i.e.* EWH to WWH, WWH to MWH, etc.) or "upgrades" (*i.e.* LWH to WWH, WWH to EWH, etc.), any changes should not be construed as such because this constitutes the first use of an objective and robust use evaluation system and database. Ohio EPA is under obligation by a 1981 public notice to review and evaluate all aquatic life use designations outside of the WWH use prior to basing any permitting actions on the existing, unverified use designations. Thus some of the following aquatic life use recommendations constitute a fulfillment of that obligation.

- The overall performance of the aquatic communities in Whetstone Creek was very good to exceptional. For this reason a redesignation to the EWH use from the headwaters to RM 2.55 (at SR 229 where the backwater influence from Delaware Reservoir is not usually evident) is recommended, as every reach was in full or partial attainment of the EWH biocriteria (Table 1). Those reaches with partial attainment have shown dramatic improvements since 1984, and further improvements are being implemented. A technical advisor is assisting the Mt. Gilead WWTP with improving overall treatment performance (personal comm. with Todd Brown, DSW). This was reflected in improvement in the aquatic community performance in the immediate downstream reach. The Cardington WWTP is also scheduled for an upgrade and the impacts observed just downstream from the WWTP discharge and the village (nutrients, elevated ammonia with high pH, and fecal coliform) should be significantly reduced or eliminated. Thus the change in the aquatic life use from WWH to EWH should be consistent with on-going or planned wastewater treatment and infrastructure improvements.

- Shaw Creek is recommended to retain the existing WWH aquatic use designation based on full attainment of that aquatic life use during the fish and macroinvertebrate biosurveys.

### Status of Non-Aquatic Life Uses

- All non-aquatic uses, Primary Contact Recreation (PCR), Agricultural and Industrial Water Supply use designations (AWS and IWS, respectively) should remain as currently designated despite some exceedences or violations at or below Mt. Gilead and Cardington WWTPs. Improvements in treatment and/or forthcoming expansions should largely mitigate these situations.

Table 1. Aquatic life use attainment status for the existing Warmwater Habitat (WWH) and recommended Exceptional Warmwater Habitat (EWH) use designations in the Whetstone Creek study area based on data collected during July - October, 1994.

| RIVER MILE Fish/ Invert. | IBI | Modified Iwb | ICI[a] | QHEI | Attainment Status[b] | Comments |
|---|---|---|---|---|---|---|
| ***Whetstone Creek (WWH/recommended EWH)*** | | | | | | |
| 25.4/25.5 | 51/51 | 8.9/8.9[ns] | E/E | 77.0 | FULL/FULL | Upst.Mt. Gilead |
| 22.2/21.8 | 46/46[ns] | 9.2/9.2[ns] | E/E | 71.0 | FULL/FULL | Upst. Mt. Gilead WWTP |
| 20.9/20.9 | 50/50 | 8.9/8.9[ns] | 36/36* | 90.0 | FULL/PARTIAL | Dst. Mt. Gilead WWTP |
| 19.2/19.2 | 45/45* | 8.9/8.9[ns] | VG/VG[ns] | 78.5 | FULL/PARTIAL | Dst. Mt. Gilead & Edison |
| 16.1/16.1 | 49/49[ns] | 9.4/9.4 | 54/54 | 78.0 | FULL/FULL | Upst. Cardington |
| 12.9/13.0 | 50/50 | 10.2/10.2 | E/E | 90.0 | FULL/FULL | Dst. Cardington WWTP |
| 10.0/10.1 | 37[ns]/37* | 8.3/8.3* | 46/46 | 45.5 | FULL/PARTIAL | Dst. Cardington |
| 9.1/9.2 | 42/42* | 9.1/9.1[ns] | 44/44[ns] | 38.5 | FULL/PARTIAL | Dst. NPS project |
| ***Shaw Creek (WWH)*** | | | | | | |
| 0.4/0.4 | 44 | 8.9 | E | 60.0 | FULL | At Waldo-Fulton-Chesterfield Rd. |

* - significant departure from biocriteria; poor and very poor results underlined.
ns- nonsignificant departure from ecoregion biocriteria for WWH or EWH ($\leq$4 IBI or ICI units; 0.5 MIwb units ).
a - narrative evaluation used in lieu of ICI (E = Exceptional; VG = Very Good) when ICI scores not available.
b - attainment status simultaneously based on the existing WWH use and recommended EWH use (WWH/EWH).

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

| INDEX - Site Type | WWH | EWH | MWH[d] |
|---|---|---|---|
| IBI - Headwaters/Wading | 40 | 50 | 24 |
| Mod. Iwb - Wading | 8.3 | 9.4 | 5.8 |
| ICI | 36 | 46 | 22 |

[d] - Modified Warmwater Habitat for channel modified areas.

## STUDY AREA

Whetstone Creek (35.0 miles in length) originates in north central Ohio, flowing southwesterly across Morrow County and discharging to the Olentangy River within the Delaware Reservoir. The elevation at the source is 1295 feet; the elevation at the mouth is 893 feet yielding an average gradient of 11.5 feet/mile. The drainage area is 113.7 square miles. The major tributary, Shaw Creek (18.2 miles long), drains 30.44 square miles and enters Whetstone Creek at RM 8.47.

The Whetstone Creek watershed lies within the Eastern Corn Belt Plains ecoregion and is part of the Scioto River basin. This study area is characterized by flat to gently rolling relief, a result of the Wisconsin age glacial deposition. The present topography includes glacial features such as kames, eskers, moraines and other depositional features formed over time by erosional processes and land use. Glacial erratics and prairie potholes are features of this landscape.

Soils in the watershed are also a product of its glacial history. Parent materials in the western portion of Morrow County consists of high lime glacial drift with the resultant soils lightly colored, poorly drained, and generally fertile. The predominant soil groups are the Blount on uplands and the poorly drained Pewamos in depressions and low areas. These soils are susceptible to high rates of erosion.

Groundwater yields in eastern Morrow County average 5 - 25 gallons per minute (gpm). Western Morrow County is underlain by shales with much lower yields. Dug wells may yield less than one gpm. Both Mt. Gilead and Cardington rely on groundwater as the primary drinking water source.

The native plant community reflects the poorly-drained soils. Green and white ash, sycamore, cottonwood, hackberry, box elder, pin oak, swamp white oak, burr oak, and black ash are common overstory species. Other oaks (red), hickories, and black walnut are present on well-drained soils. The Chinkapin (sweet oak) and redbud are found in areas of limestone. Shrubs include paw-paws, black haw, and arrowwood in open settings with sumac, hawthorns, black cherry, and crabapple in areas which are reverting towards climax (pers. comm., Harold Bower, ODNR Division of Forestry).

Land use changes within the watershed since the 1984 survey partially reflect changes in population, economic activites, and agricultural practices. Between the census years of 1980 and 1990, the population of Morrow County has changed from an estimated 26,476 to 27,749, an increase of 5.1% or 0.5% per year. No major changes in land use are expected. Large concentrated animal production facilities (turkeys) are presently expanding in the county.

Cropping patterns vary annually depending on commodity prices, government programs (e.g., CRP) and other variables. Corn and soy beans are the predominant row crops within the watershed. Conservation practices have increased since the 1984 survey. Estimates of no-till in 1994 were 32% of corn acreage and 44% of soybean acres compared to 10% and 15%, respectively, in 1990 which demonstrates the rapid expansion of conservation tillage.

Seven permitted discharges occur within Whetstone Creek watershed. The two largest dischargers by volume are the village of Mt. Gilead Wastewater Treatment Plant (WWTP) with an average design average flow of 0.474 MGD and the village of Cardington WWTP (0.30 MGD). Combined flow from these WWTPs increased from 0.06 MGD to 0.774 MGD which greatly increased the influence of treated wastewater on the Whetstone Creek watershed.

## Nonpoint Source Issues

In 1994 a USEPA 319 grant funded implementation project was completed approximately 120 yards upstream from Waldo-Fulton-Chesterfield Rd. The goal of the project was to reduce siltation caused by unrestricted cattle access to Whetstone Creek. Prior to completion, repeated passage of cattle into the stream resulted in a gully cut into the west bank. The unrestricted access by cattle crossing the stream also embedded the substrates, increased turbidity, caused more nutrient enrichment, and increased the fecal coliform counts downstream.

Some of the NPS issues in the watershed are starting to be addressed through voluntary and cost share projects. Some landowners are beginning to restrict cattle from streams, restoring and stabilizing banks, and/or allowing some extension of riparian habitat. Unrestricted access by livestock is still an issue downstream of Cardington. A site visit (3/28/95) to the NPS project (RM 9.2) showed the exposed gully surfaces had been layered over with geotextile cloth and gravel. In the stream where cattle normally crossed or watered a layer of geotextile had been laid down and covered with gravel. New fencing had been installed between pasture and stream bank, limiting cattle access across the banks. Substrate immediately up and downstream of the bridge showed limestone boulders and a mix of limestone and shale cobbles and gravel. The embeddedness problem has decreased some as some small gravel in the substrate was exposed and visible in the clear water on this date. There was still some silty sedimentation in areas of slower current flow. The banks are fully tree lined downstream of the bridge and approximately 25% tree lined upstream. The remaining 75% of the upstream corridor visible from the bridge area is thickly grassed pasture with the exception of an eroded bank rising ten feet above the substrate across from the project site. This bank may be a suitable site for willow post stabilization efforts.

Table 2. Stream characteristics and significant identified pollution sources in the Whetstone Creek study area.

| Stream | Length | Average Fall | Drainage Area | Nonpoint Source | Point Sources |
|---|---|---|---|---|---|
| Whetstone Creek | 35.0 | 11.5 | 113.7 | -Agriculture runoff field<br>-Agr. runoff animal waste<br>-Stream bank erosion via cattle access<br>-Gas/oil brines from previous drilling activities | Mt. Gilead WTP<br>Mt. Gilead WWTP<br>Cardington WWTP<br>HPM Corp. #1 & #2<br>Candlewood Lake Util. |
| Shaw Creek | 18.2 | 11.1 | 30.44 | -Agriculture runoff field<br>-Agr. runoff animal waste<br>-Stream bank erosion via cattle access<br>-Gas/oil brines from present drilling activities | Present oil production on Shaw Creek |

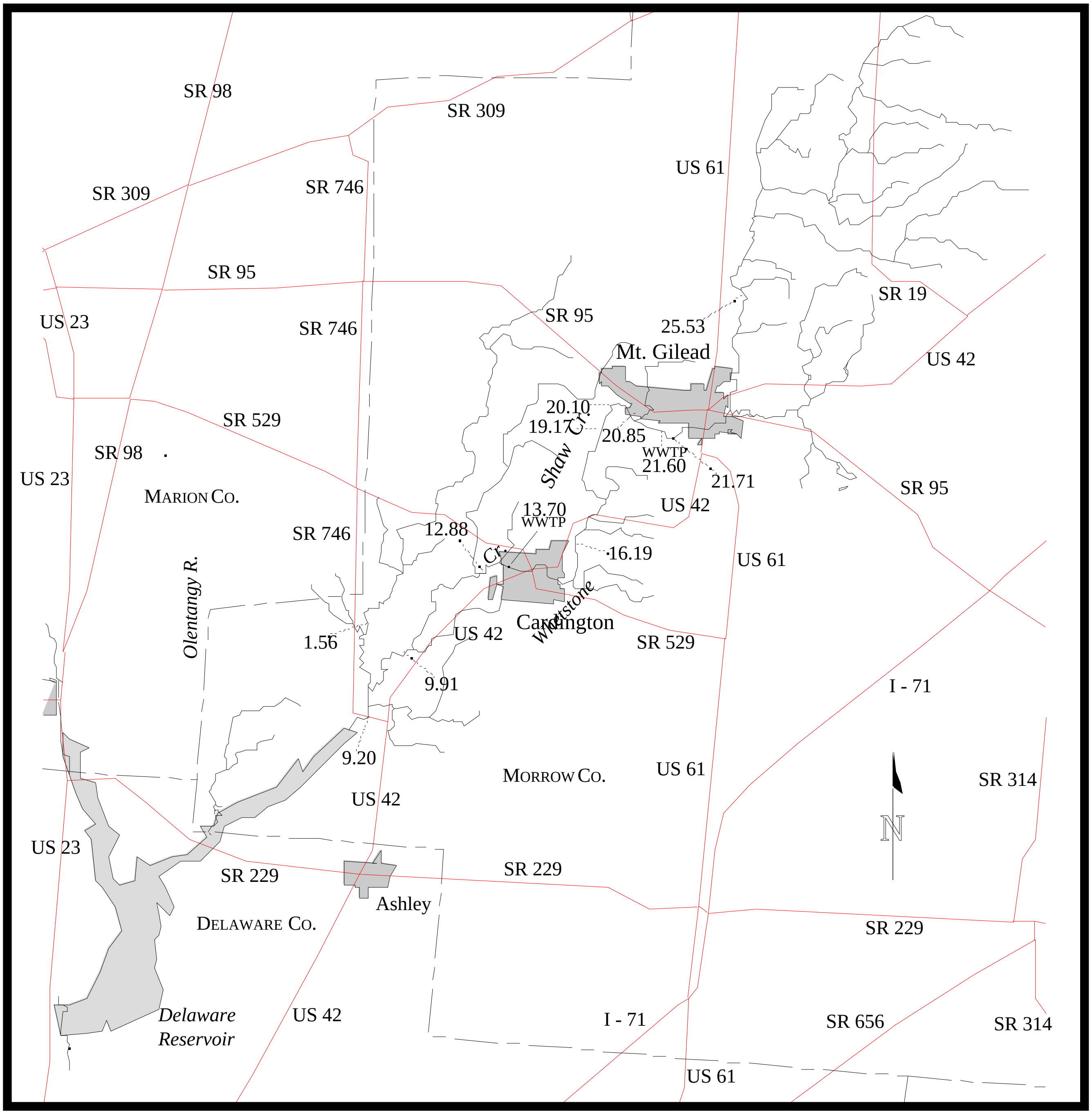



Figure 1. The Whetstone Creek study area for 1994 showing principal streams and tributaries, population centers, and pollution sources.

# METHODS

All chemical, physical, and biological field, laboratory, data processing, and data analysis methodologies and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989a) and 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 aquatic habitat assessment. Chemical, physical and biological sampling locations are listed in Table 4.

## Determining Use Attainment Status

The attainment status of aquatic life uses (*i.e.,* FULL, PARTIAL, and **NON**) is determined by using the biological criteria codified in the Ohio Water Quality Standards (WQS; Ohio Administrative Code [OAC] 3745-1-07, Table 7-17). The biological community performance measures which are used include the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. The IBI and ICI are multimetric indices patterned after an original IBI described by Karr (1981) and Fausch *et al.* (1984). The ICI was developed by Ohio EPA (1987b) and further described by DeShon (1994). The MIwb is a measure of fish community abundance and diversity using numbers and weight information and is a modification of the original Index of Well-Being originally applied to fish community information from the Wabash River (Gammon 1976; Gammon *et al.* 1981).

Performance expectations for the principal aquatic life uses in the Ohio WQS (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 the aquatic life use is FULL if all three indices (or those available) meet the applicable biocriteria, PARTIAL if at least one of the indices does not attain and performance at least fair, and **NON**-attainment if all indices fail to attain or any index indicates poor or very poor performance. Partial and non-attainment indicate that the receiving water is impaired and does not meet the designated use criteria specified by the Ohio WQS.

## Habitat Assessment

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1994). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the metrics used to determine the QHEI score which generally ranges from 20 to 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have 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 greater than 60 are *generally* conducive to the existence of warmwater faunas. Scores greater than 75 frequently typify habitat conditions which have the ability to support exceptional warmwater faunas.

## Macroinvertebrate Community Assessment

Macroinvertebrates were sampled quantitatively using multiple-plate, artificial substrate samplers (modified Hester/Dendy) in conjunction with a qualitative assessment of the available natural substrates. At a number of locations, only qualitative data was available due to the loss of the artificial substrates. During the present study, macroinvertebrates collected from the natural substrates were also evaluated using an assessment tool currently in the testing and refinement phase. This method relies on tolerance values derived for each taxon, based upon the abundance data for that taxon from artificial substrate (quantitative) samples collected throughout Ohio. To determine the tolerance value of a given taxon, ICI scores at all locations where the taxon has been collected are weighted by its abundance on the artificial substrates. The mean of the weighted ICI scores for the taxon results in a value which represents its relative level of tolerance on the ICI's 0 to 60 scale. For the qualitative collections in the Whetstone Creek study area, the median tolerance value of all organisms from a site resulted in a score termed the Qualitative Community Tolerance Value (QCTV). The QCTV shows potential as a method to supplement existing assessment methods using the natural substrate collections. QCTV scores for sampling locations in the Whetstone Creek study area were used in conjunction with other aspects of the community data to make evaluations and were not unilaterally used to interpret quality of the sites or aquatic life use attainment status.

## Fish Community Assessment

Fish were sampled twice at each site using pulsed DC electrofishing wading methods following protocols specified in Ohio EPA (1989a). All chemical/physical and biological sampling locations are listed in Table 3.

## Area of Degradation Value (ADV)

An Area Of Degradation Value (ADV; Rankin and Yoder 1991; Yoder and Rankin 1994) was calculated for the study area based on the longitudinal performance of the biological community indices. The ADV portrays the length or "extent" of degradation to aquatic communities and is simply the distance that the biological index (IBI, MIwb, or ICI) departs from the applicable biocriterion or the upstream level of performance (Fig. 4). The "magnitude" of impact refers to the vertical departure of each index below the biocriterion or the upstream level of performance. The total ADV is represented by the area beneath the biocriterion (or upstream level) when the results for each index are plotted against river mile. The results are also expressed as ADV/mile to normalize comparisons between segments and other streams and rivers.

## Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are the principal arbiter of aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria in the role of principal arbiter within a weight of evidence framework has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991a; Yoder 1994). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and the biological response signatures (Yoder and Rankin 1994) within the biological data itself. Thus the assignment of principal causes and sources of impairment in this report do not represent a true "cause and effect" analysis, but rather represent the association of impairments (based on response indicators) with stressor and exposure indicators whose links with the biosurvey data are based on previous research or experience with analogous situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified. The process is similar to making a medical diagnosis in which a doctor relies on multiple lines of evidence concerning patient health. Such diagnoses are based on previous research which experimentally or statistically linked symptoms and test results to specific diseases or pathologies. Thus a doctor relies on previous experience in interpreting symptoms (*i.e.*, multiple lines from test results) to establish a diagnosis, potential causes and/or sources of the malady, a prognosis, and a strategy for alleviating the symptoms of the disease or condition. As in medical science, where the ultimate arbiter of success is the eventual recovery and the well-being of the patient, the ultimate measure of success in water resource management is restoration of lost or damaged ecosystem attributes including aquatic community structure and function. While there have been criticisms of misapplying the metaphor of ecosystem "health" compared to human patient "health" (Suter 1993) here we are referring to the process for identifying biological integrity and causes/sources associated with observed impairment, not whether human health and ecosystem health are analogous concepts.

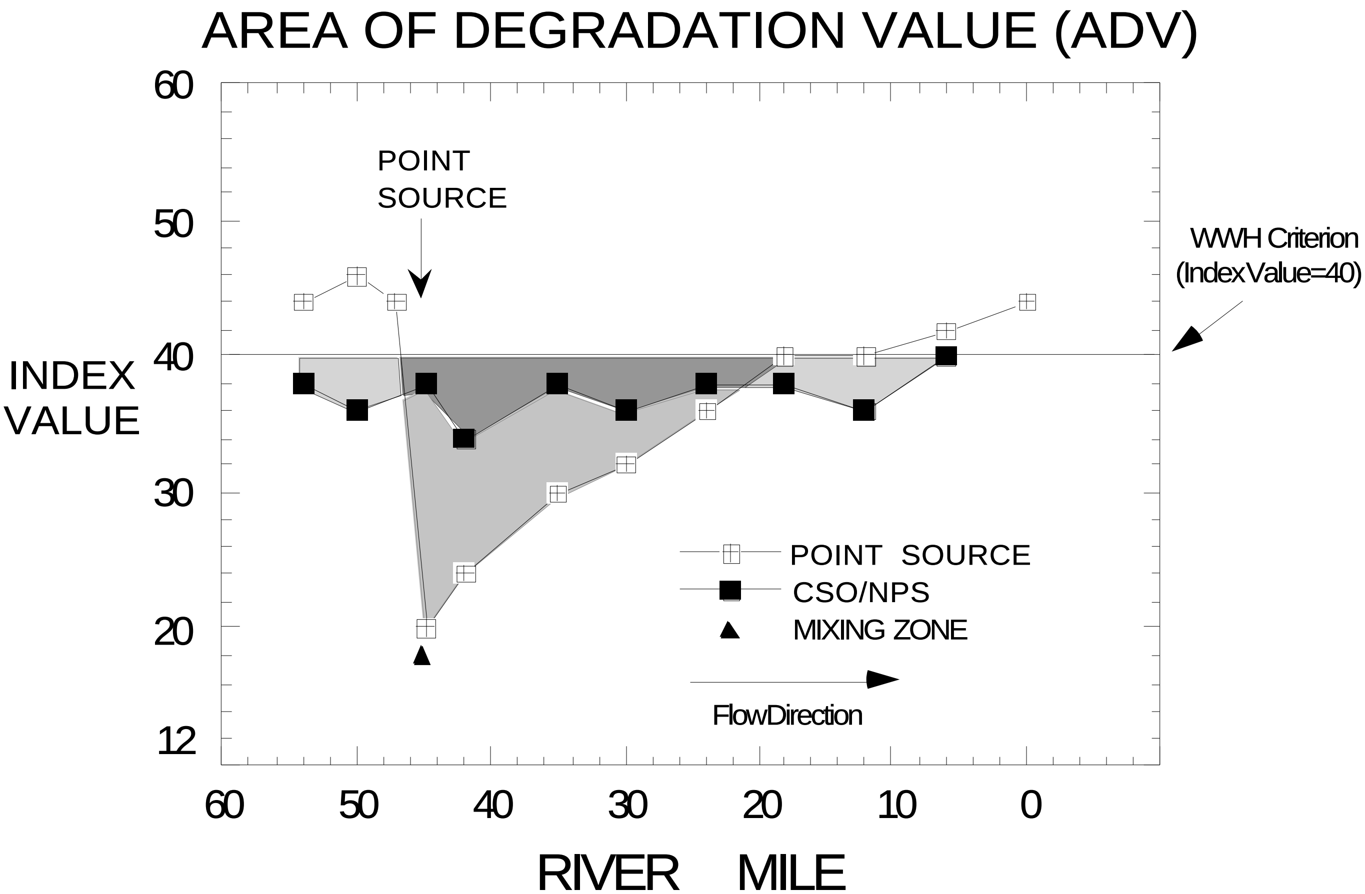



Figure 2. Graphic illustration of the Area of Degradation Value (ADV) based on the ecoregion biocriterion (WWH in this example). The index value trend line indicated by the unfilled boxes and solid shading (area of departure) represents a typical response to a point source impact (mixing zone appears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

Table 3. List of sampling locations (E - effluent, C-chemical, Q-flow, F-fish, S-sediment, M -macroinvertebrate) in the Whetstone Creek study area, 1994.

| Stream River Mile | Type of Sampling | Latitude/Longitude | Landmark | County | USGS 7.5 min.Quad. Map |
|---|---|---|---|---|---|
| Whetstone Creek | | | | | |
| 25.53 | C,S | 40°34’44”/82°48’56” | @ McKibben Rd. | Morrow | Mt. Gilead |
| 25.5 | M | 40°34’43”/82°48’56” | @ McKibben Rd. | Morrow | Mt. Gilead |
| 25.4 | F | 40°34’40”/82°49’00” | @ McKibben Rd. | Morrow | Mt. Gilead |
| 22.2 | F | 40°32’43”/82°50’03” | @ Loren Rd. | Morrow | Mt. Gilead |
| 21.8 | M | 40°33’30”/82°50’29” | @ Loren Rd. | Morrow | Mt. Gilead |
| 21.71 | C | 40°32’30”/82°50’29” | @ Loren Rd. | Morrow | Mt. Gilead |
| 21.60 | E,C | 40°32’29”/82°50’39” | @ Mt. Gilead WWTP | Morrow | Mt. Gilead |
| 20.9 | F | 40°32’43”/82°51’09” | @ Cardington Rd. | Morrow | Mt. Gilead |
| 20.9 | M | 40°32’43”/82°50’29” | @ Cardington Rd. | Morrow | Mt. Gilead |
| 20.85 | C,S,Q | 40°32’43”/82°51’16” | @ Cardington Rd. | Morrow | Mt. Gilead |
| 20.10 | C,Q | 40°33’05”/82°51’46” | @ Boundry Rd. | Morrow | Mt. Gilead |
| 19.2 | F | 40°32’35”/82°52’08” | @ Newcomer Rd. | Morrow | Mt. Gilead |
| 19.2 | M | 40°32’32”/82°52’10” | @ Newcomer Rd. | Morrow | Mt. Gilead |
| 19.17 | C | 40°32’32”/82°52’10” | @ Newcomer Rd. | Morrow | Mt. Gilead |
| 16.19 | C | 40°30’34”/82°52’39” | @ Morris Rd. | Morrow | Denmark |
| 16.1 | F | 40°30’30”/82°52’38” | @ Morris Rd. | Morrow | Denmark |
| 16.1 | M | 40°30’34”/82°52’39” | @ Morris Rd. | Morrow | Denmark |
| 13.70 | E,C | 40°30’05”/82°54’12” | @ Cardington WWTP | Morrow | Denmark |
| 13.0 | M | 40°29’58”/82°54’48” | @ Cardington Western Rd. | Morrow | Ashley |
| 12.9 | F | 40°29’58”/82°54’47” | @ Cardington Western Rd. | Morrow | Ashley |
| 12.88 | C,Q | 40°29’56”/82°54’53” | @ Cardington Western Rd. | Morrow | Ashley |
| 10.1 | M | 40°28’32”/82°56’31” | @ Coleman Rd. | Morrow | Ashley |
| 10.0 | F | 40°28’30”/82°56’34” | @ Coleman Rd. | Morrow | Ashley |
| 09.91 | C | 40°28’30”/82°56’39” | @ Coleman Rd. | Morrow | Ashley |
| 09.2 | M | 40°28’09”/82°57’00” | @ Waldo-Fulton-Chesterville Rd. | Morrow | Ashley |
| 09.1 | F | 40°28’06”/82°57’00” | @ Waldo-Fulton-Chesterville Rd. | Morrow | Ashley |
| 09.1 | C,S | 40°28’10”/82°57’00” | @ Waldo-Fulton-Chesterville Rd. | Morrow | Ashley |
| Shaw Creek | | | | | |
| 01.56 | C,Q | 40°28’59”/82°57’25” | @ Beatty Rd. | Morrow | Ashley |
| 00.4 | M | 40°28’11”/82°57’24” | @ Beatty Rd. | Morrow | Ashley |
| 00.4 | F | 40°28’10”/82°57’20” | @ Beatty Rd. | Morrow | Ashley |

# RESULTS AND DISCUSSION

## Pollutant Loadings: 1976 - 1994

*HPM Corporation (#1 and #2)*
HPM Corporation is located at 394 Lincoln Avenue in Mount Gilead (Lat. 40º 33'01''N Long. 82º50'32''W) employs approximately 500 people in the manufacturing of injection and/or extrusion molding, thermoforming, and die casting machinery for plastic products. Discharges from these facilities are limited to non-contact cooling water and storm water runoff. HPM plants 1 and 2 have current indirect discharge permits which allow process water to be discharged to the Mt. Gilead WWTP. Chrome plating has ceased at both facilities since the waste chrome tank in plant #2 was removed. There has been a major reduction of water usage by HPM. Installation of two non-contact cooling towers has reduced the flow of discharges to the WWTP from 0.06 MGD to 0.001 MGD.

Both facilities have been in compliance with pretreatment permit limits and no significant violations have been evident during the past 5 years. pH violations reported in 1994 (Table 4) resulted from the improper calibration of a pH meter. In 1990-1991, discharges from a stormwater collection pond were in violation of oil and grease limits, and dissolved oxygen limits, but these problems have been corrected.

*Candlewood Lake Utilities*
Candlewood Lake Utilities, located at 7326 S.R. 19 in Mount Gilead discharges only 0.030 MGD of treated wastewater to Whetstone Creek at RM 30.15. The WWTP design capacity is 0.150 MGD. Waste stabilization ponds serving the Candlewood Lake Subdivision came on-line in July 1989. Since that time, NPDES permit violations have increased in both frequency and magnitude. The majority of permit violations involved loadings limitations. At present, the sewer system is hydraulically overloaded. The facility is attempting to raise the water level in the lagoons and adding additional surface aerators to increase retention time and improve treatment.

*Cardington WWTP*
The Cardington WWTP is located approximately 0.25 miles west of S.R. 529 in the village of Cardington and was designed to discharge 0.30 MGD (1973). The average annual flow has been approximately 0.285 MGD (95% of capacity). The existing plant utilizes dual contact stabilization units with chlorination and dechlorination. The treated wastewater is discharged to Whetstone Creek at RM 13.70 (Lat. 40º 30'10''N Long. 82º47'30'' W). The Cardington WWTP has significant infiltration and inflow (I/ I) problems which have led to numerous NPDES permit violations and bypasses (Table 4). Cardington has been working to eliminate the I/I sources that were identified in a general facilities report completed in May 1992. In October 1994 an application for an Issue II Grant was submitted in order to finance an upgrade to the WWTP. The village of Cardington recently landed Cardington Yutaska Technologies, Inc. which will employ 280 people. Domestic wastewater will likely be discharged to the WWTP. This facility may recycle its process wastewaters (pers. comm. R. Wilson, CDO). Pending issuance of grant funds, Cardington should complete the upgrade by June 1996. WWTP flows will increase to approximately 0.5-0.6 MGD, and the treatment process will be modified from contact-stabilization to a process which can meet Best Available Demonstrated Control Technology (BADCT) limits.

An assessment of annual loadings at the Cardington WWTP shows a dramatic increase in $CBOD_5$ and TSS since 1989 (Figure 4). These results reflect the recent I/I problems which interrupt plant flow regimes by washing away flocculent microbial bacteria. The wasting of this floc causes multiple problems. First, it places the municipality in violation of the total suspended solids (TSS) limits. Secondly, it interrupts the stability of population dynamics of Microbacters which are integral in the breakdown of sewage. Lastly, its solids and nutrients are added to the receiving stream which may lead to nutrient enrichment and adverse effects on ambient water quality.

*Mount Gilead WWTP*
The village of Mount Gilead WWTP located at 3636 Loren Rd. in Mount Gilead, discharges treated wastewater to an unnamed tributary of Whetstone Creek 0.1-0.2 miles upstream from the confluence with Whetstone Creek at RM 21.60 (Lat. 40º 32'25''N Long. 82º50'36'' W). The WWTP was designed to treat an average influent flow of 0.474 MGD. A significant number of NPDES violations have been reported at the facility since 1992 (Tables 4 and 6). Reasons for the violations include an increasing I/I problem, poor plant maintenance, and inadequate record keeping. A technical advisor was hired in November 1994 to assist with improving WWTP performance.

Annual loadings reveal significant increases in $NH_{3-N}$ and TSS during the past 4 years relative to other WWTPs which discharge to Whetstone Creek (Figure 4). Median *$NH_3$ -N in 1994 was over 10 mg/l*, similar to the results exhibited prior to 1986. These results run counter to that demonstrated by most WWTPs which have improved the quality of effluents in response to compliance with the standards set forth by the Clean Water Act of 1987 (July 1, 1988 was National Municipal Policy deadline).

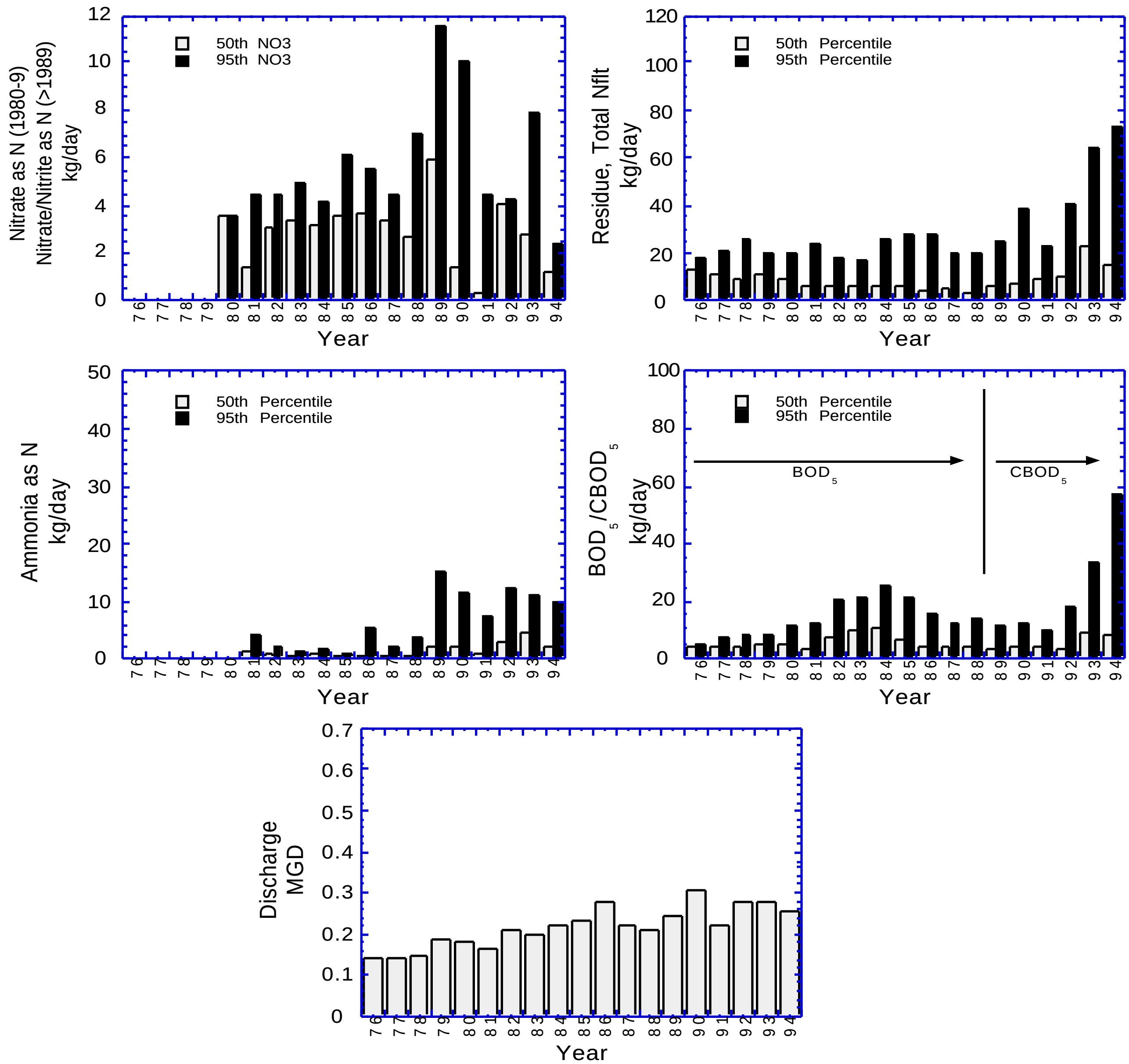



Figure 3. Annual loadings (kg/day) of Nitrates - Nitrate/Nitrites, Ammonia, Total Nonfilterable Residue, $BOD_5$/$CBOD_5$, and Discharge at the Cardington WWTP in the Whetstone Creek study area, 1994.

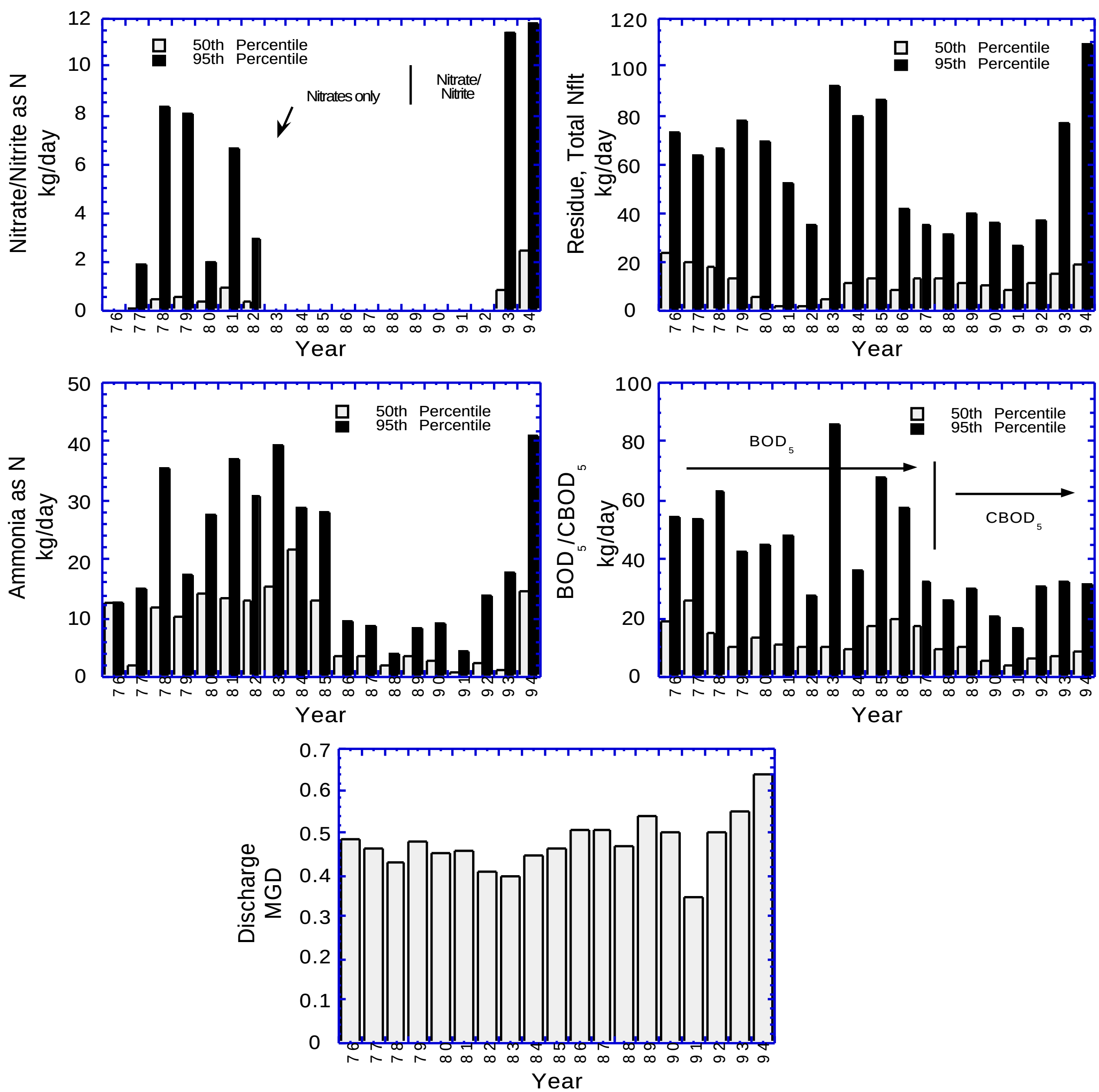



Figure 4. Annual loadings (kg/day) of Nitrates - Nitrate/Nitrites, Ammonia, Total Nonfilterable Residue, $BOD_5$/$CBOD_5$, and Discharge at Mt.Gilead WWTP in the Whetstone Creek study area, 1994.

Table 4. Number of NPDES permit violations documented at HPM Corp., Candlewood Lake Utilities, Cardington WWTP, and Mt. Gilead WWTP from January-December, 1994. Data evaluated was contained in monthly operating reports submitted to the Ohio EPA by those entities.

| | | Type of Violation | | | |
|---|---|---|---|---|---|
| Outfall | Parameter | Daily Maximum Concentration | Daily Maximum Loading | Monthly Average Concentration | Monthly Average Loading |
| **Candlewood Utilities** | | | | | |
| 001 | | | | | |
| | $CBOD_5$ | | | 3 | 6 |
| | TSS | | | | 2 |
| Sum of Violations | | | | 3 | 8 |
| **HPM Corp.** | | | | | |
| 001 | | | | | |
| | pH | 2 | | | |
| | Temperature | 6 | | 2 | |
| Sum of Violations | | 8 | | 2 | |
| **Cardington WWTP** | | | | | |
| 001 | | | | | |
| | D.O. | 5 | | | |
| | TSS | 1 | 3 | 1 | 2 |
| | $CBOD_5$ | | 2 | 1 | 1 |
| | Fecal Coliform | 11 | | 2 | |
| | Chlorine | 2 | | | |
| Sum of Violations | | 19 | 5 | 4 | 3 |
| **Mt. Gilead WWTP** | | | | | |
| 001 | | | | | |
| | D.O. | 14 | | | |
| | $NH_3$ | 18 | 17 | 6 | 7 |
| | TSS | 5 | 11 | 3 | 5 |
| | $CBOD_5$ | 21 | 5 | 1 | 3 |
| | Fecal Coliform | 5 | | 1 | |
| | pH | 1 | | | |
| Sum of Violations | | 64 | 33 | 11 | 15 |
| **Total Violations** | | 91 | 38 | 20 | 26 |

*Summary of Pollutant Spills*

- In addition to NPDES permit violations and water quality criteria exceedences, a review of Ohio EPA Division of Emergency and Remedial Response spill records documented unpermitted releases of toxic and/or oxygen-demanding substances into the Whetstone Creek watershed (Table 5). Accidental spills and unauthorized discharges of pollutants are quite common in the state of Ohio due to a fairly dense population and widespread industrial base. Accidental or unauthorized discharges represent a potential impact on aquatic life which may or may not be traceable to a specific source. Spills are episodic and may significantly impact aquatic and terrestrial organisms without leaving obvious signs other than the changes seen in these communities. It is likely that the reported spills represent a fraction of the actual spill occurrences within the Whetstone Creek watershed.

Table 5. Summary of Pollutants spilled into Whetstone Creek and its tributaries reported to the Ohio EPA Div. of Emergency and Remedial Response from Jan. 1989 - Dec. 1994.

| Date | Entity | Material | Amount | Waterway |
|---|---|---|---|---|
| 03-30-89 | Mount Gilead WWTP | sewage | unk | trib. to Whetstone Cr. |
| 05-18-89 | Mr. Floyd Faust | crude oil | 1110 gal | unnamed stream |
| 07-21-89 | Oden Sausage Co | diesel fuel | 75 gal | unnamed ditch |
| 09-04-89 | Ashland Oil | crude oil | 7 barrels | Shaw Creek |
| 10-03-89 | unknown | gasoline | unk | storm sewer |
| 12-08-89 | Landmark Town & Country | fuel oil | unk | Whetstone Creek |
| 12-09-89 | Marion Landmark | # 2 heating oil | 500 gal | Whetstone Creek |
| 01-04-90 | Jerry Moore Inc | crude oil | 630 gal | Whetstone Creek |
| 02-22-90 | Englefield Oil Co | heating oil | 50 gal | storm sewer |
| 12-07-90 | unknown | diesel fuel | unk | storm sewer |
| 04-02-91 | Mid Ohio Chemical | fertilizer | 1000gal | unnamed ditch |
| 08-13-91 | Jack Fishburn Trucking | oil | unk | Shaw Creek |
| 03-07-92 | Fishburn Services Inc. | crude oil | 125 gal | Shaw Creek |
| 03-11-92 | Mr. Jack Fishburn | crude oil | 3 barrels | Shaw Creek |
| 04-21-92 | unknown | diesel fuel | 50 gal | Whetstone Creek |
| 06-30-92 | Graham Well Services | oil | unk | field tile -Whetstone Cr. |
| 07-31-92 | Morrow County Commissioners Office | asphalt emulsion | unk | Whetstone Creek |
| 10-16-92 | Fishburn Services | crude oil | unk | unnamed tributary |
| 12-02-92 | Morrow County Board | diesel fuel | 35 gal | Whetstone Creek |
| 04-02-93 | unknown | oil | unk | unnamed tributary |
| 04-13-93 | unknown | septic water | unk | Shaw Creek |
| 09-25-93 | Mr. Jack Fishburn | oil | unk | Big Run |

- Spill episodes in Morrow County were relatively uncommon and low in volume. Since January 1989, 19 of the 22 recorded spills involved petroleum constituents of which 2 events amounts exceeded 1000 gallons. Since August 1991, 5 of the 12 reported spills involved operations owned by a single individual. All of the spills related to this individual were petroleum in nature and are associated with oil and gas wells and transportation.

- Mid Ohio Chemical, located on St. Rt. 95 in Edison, Ohio, stores and distributes bulk fertilizer and was responsible for a spill of approximately 1000 gallons of fertilizer into an unnamed tributary discharging of Whetstone Creek. This particular incident raises concerns about the facility since potentially toxic and harmful materials are routinely loaded and off-loaded at this facility.

*Fish Kills*

- In 1991 a bulk carrier with ammonia overturned and spilled resulting in a kill of approximately 80 fish. This was the only reported fish kill in the Whetstone Creek watershed. Fish kills are either not a problem or are underreported.

## Chemical Water Quality

- Between June and August 1994, five surface water grab samples were collected from each site in the Whetstone Creek study area. Using sampling protocols specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA 1982a), samples were collected, preserved, and analyzed for a variety of pollutants including metals, nutrients and demand parameters. Tabular results of the analytical results are presented in Appendix Table 2. Graphical representations of this data appear in Figures 7-9 and 11. Most graphical depictions were generated using median values to represent the chemical regime at a given site.

- Sampling stations were selected to provide information concerning ambient and effluent water quality, and to assess impacts, if any, from major industrial and municipal discharges on Whetstone Creek (Table 3). Ambient results were evaluated to determine instantaneous exceedences of Ohio Water Quality Standards (OAC Chapter 3745-1) based on Warmwater Habitat aquatic life (WWH), Primary Contact Recreation (PCR), and Agricultural Water Supply and Industrial Water Supply use designations (AWS and IWS, respectively). Effluent results were compared to NPDES permit limitations and permit violations totals are noted in Table 4.

- The upstream sampling station located at McKibben Road (RM 25.53) is a headwater site with few known sources of pollutants. Data from this site was collected to provide ambient background water chemistry information from a relatively unimpacted part of Whetstone Creek. There were no exceedences of water quality criteria at this site, and all analytical results were at or near detection limits.

- The station at Loren Road (RM 21.71) reflects water quality immediately upstream of the Mt. Gilead WWTP outfall. The stream flows past several miles of farm/pasture land use and on-site systems before reaching this point. There was an exceedence of the minimum D.O. criterion (4 mg/l) on June 23 (Table 6). This was most likely attributed to a greater oxygen demand under low flow conditions (Figures 5,8). Fecal strept, fecal coliform, and phosphorus increased noticeably at this site compared to upstream (RM 25.53; Figure 6). This was likely the result of agricultural land use practices and impacts from on-site septic systems. All other samples exhibited little or no variance from the upstream site, remaining at or near the detection limits.

- The Mt. Gilead WWTP (RM 21.60) outfall was sampled to monitor effluent quality and to explain shifts in water chemistry outside the mixing zone. Two NPDES permit violations were detected with both occurring on the same day (Table 6). On June 23 chlorine and ammonia-N concentrations exceeded NPDES permit limits (Table 7). Elevated concentrations of suspended filterable solids, chloride and associated conductivity were also detected in the treated effluent water (Figures 6,7). Concentrations of nutrients and zinc were slightly elevated but did not exceed permit limitations (Figure 8). With daily low stream flows on June 20-23 the Mt. Gilead WWTP discharge was estimated to comprise approximately 41 percent of the total stream flow (Figure 9). The residual chlorine concentration during that time was 0.670 mg/l (an NPDES permit exceedence) yielding an estimated instream residual $Cl_2$ concentration of 0.275 mg/l (Table 7; Figure 9). At 0.102 mg/l residual chlorine there was 50 percent mortality (LC50) and/or adverse acute effects (EC50) observed to *Stenonema* mayflies (U.S.EPA 1984). Residual chlorine has been shown to be persistent in other streams and acutely toxic instream for at least 0.8 miles downstream (U.S.EPA 1976), roughly the distance to the next downstream site (RM 20.9). The ammonia-N concentration (NPDES permit

Table 6. Exceedences of chemical/physical water quality criteria (OAC 3745-1) for the WWH aquatic life use designation in the Whetstone Creek study area, 1994. Units are #/100ml for fecal coliform and mg/l for D.O..

| Stream Name<br>River Mile | Date | Violation: Parameter (Value) |
|---|---|---|
| 21.71 | 6/23/94 | D.O. (2.7†) |
| 20.85 | 8/10/94 | Fecal Coliform (1270◊) |
| 20.10 | 6/23/94 | D.O. (2.2†) |
| 19.17 | 6/23/94 | D.O. (2.4†) |
| 16.19 | 6/23/94 | D.O. (4.0††) |

◊ Exceeds 30-day average bacteriological criteria for primary contact waters .
† Below minimum outside mixing zone D.O. criteria for warmwater habitat.
†† Below minimum 30-day average D.O. criterion

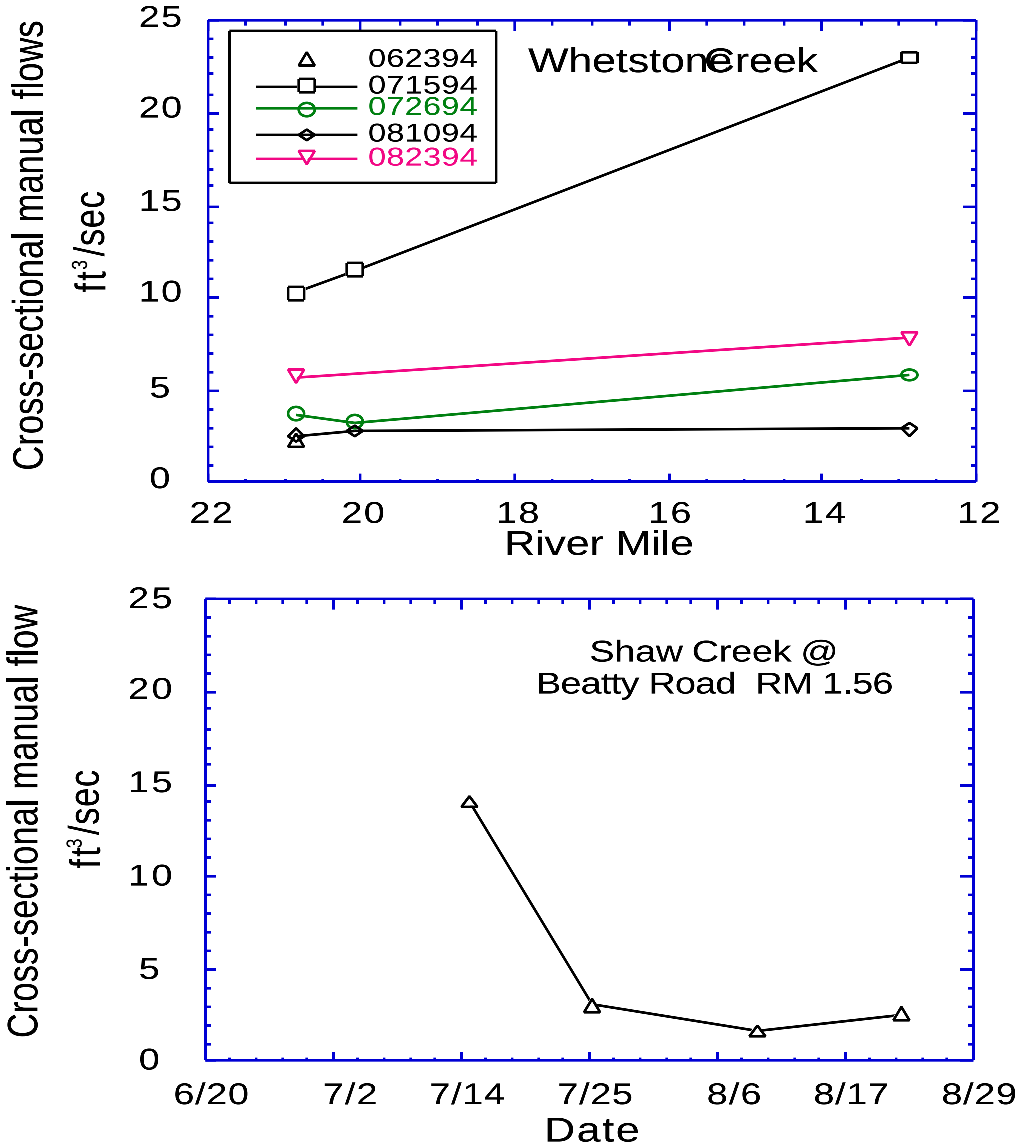



Figure 5. Periodic cross-sectional manual flow rates for Whetstone Creek dst. Mt. Gilead WWTP (RM 20.85) and dst. of Cardington WWTP (RM 12.88), and in Shaw Creek near Beatty Rd. (RM 1.56) during 1994 survey.

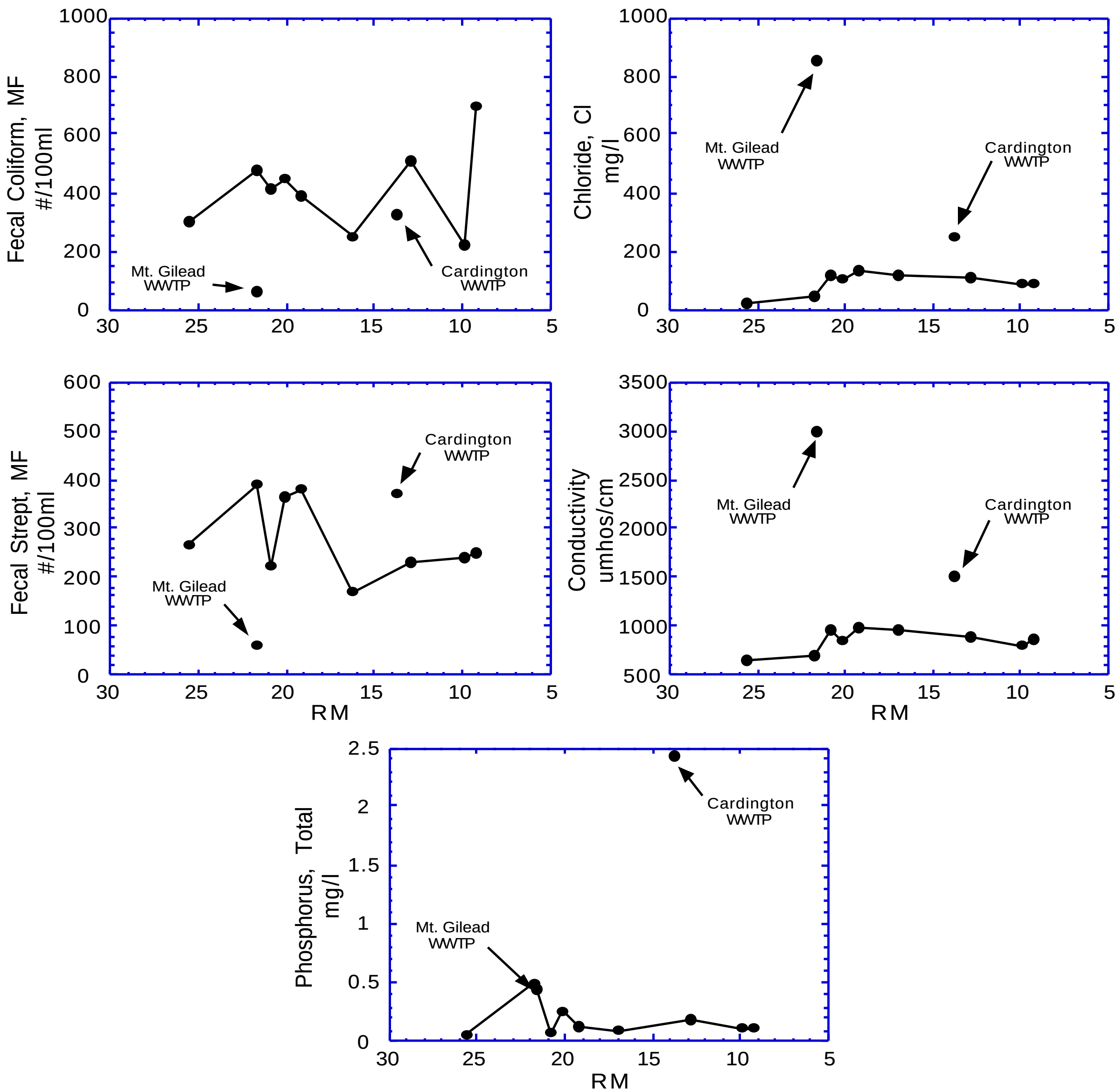



Figure 6. Longitudinal plots of fecal coliform, fecal streptococcus, chloride, conductivity and phosphorus in the Whetstone Creek study area, 1994.

Table 7. Exceedences of NPDES permits detected by OEPA in major discharger effluent grab samples during Whetstone Creek survey, for chemical/physical parameters measured in the Whetstone Creek study area, January-December 1994. Units are #/100ml for fecal coliform and mg/l for all other parameters. NPDES permit violations are based on most current permit.

| River Mile | Stream Name<br>Date | Violation: Parameter (Value) |
|---|---|---|
| ***Mt Gilead WWTP Effluent (OEPA #4PB00102*ED)*** | | |
| 21.60 | 6/23/94 | Chlorine (.67∆) |
| | | Ammonia (8.73 ∆∆) |
| ***Cardington WWTP Effluent (OEPA #4PA00100*DD)*** | | |
| 13.70 | 8/22/94 | Chlorine (.66¤) |
| | | D.O. (4.7¤¤) |
| | | Fecal Coliform (1700¤¤¤) |
| | 8/10/94 | Chlorine (.55¤) |
| | 7/26/94 | Chlorine (1.61¤) |
| | 6/23/94 | Fecal Coliform (1099¤¤¤) |

∆ Violates Mt Gilead WWTP permit limitation of .5 mg/l.

∆∆ Exceeds Mt Gilead WWTP permit limitation for the summer 30-day average concentration (3.0mg/l) and 7-day average concentration (4.5mg/l).

¤ Violates Cardington WWTP permit limitation of .5 mg/l.

¤¤ Violates Cardington WWTP permit minimum of 5.0 mg/l.

¤¤¤ Exceeds Cardington WWTP permit limitation for the summer 30-day average count (1000 /100ml).

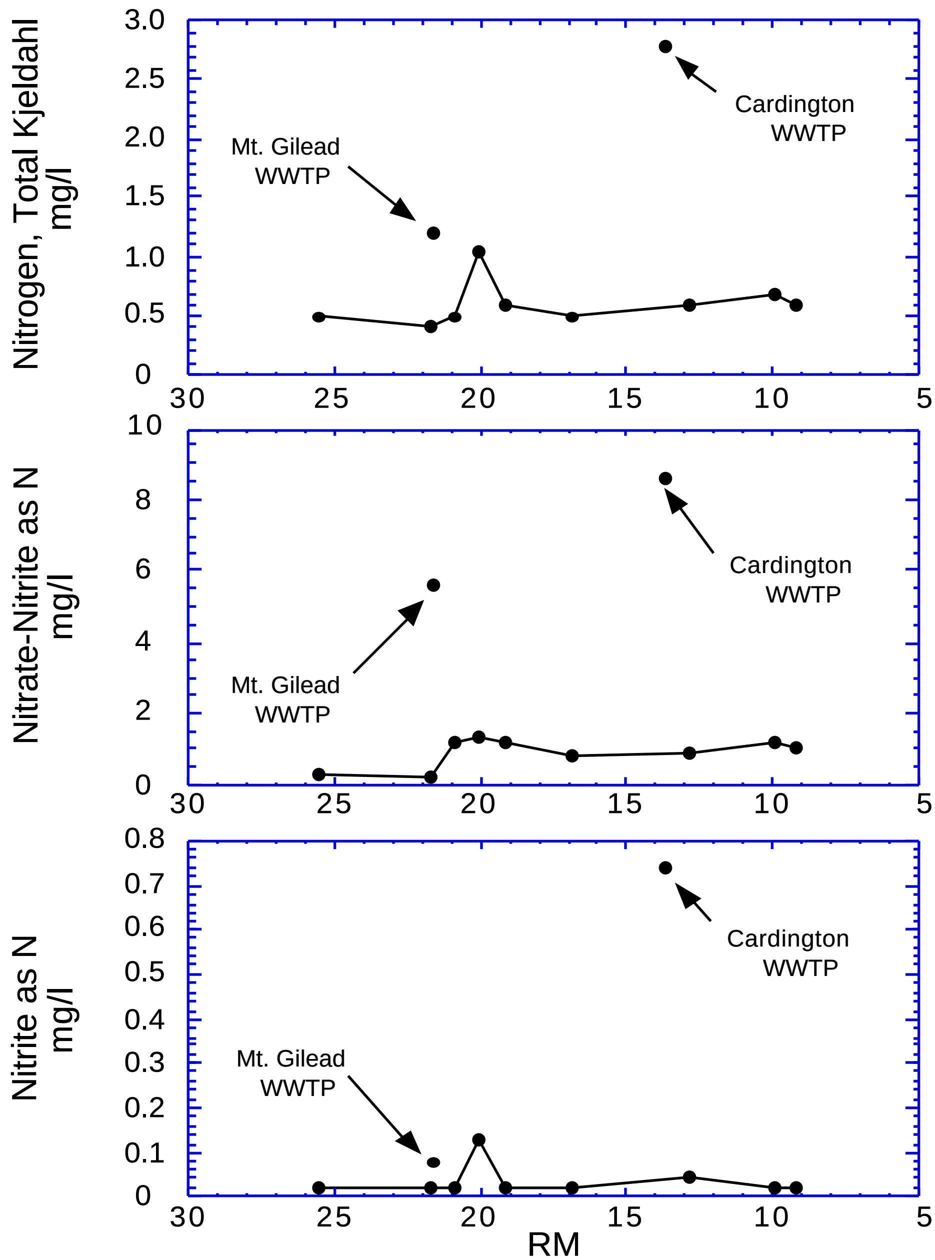



Figure 7. Longitudinal plots of total Kjeldahl nitrogen, nitrate-nitrite and nitrite in the Whetstone Creek study area, 1994.

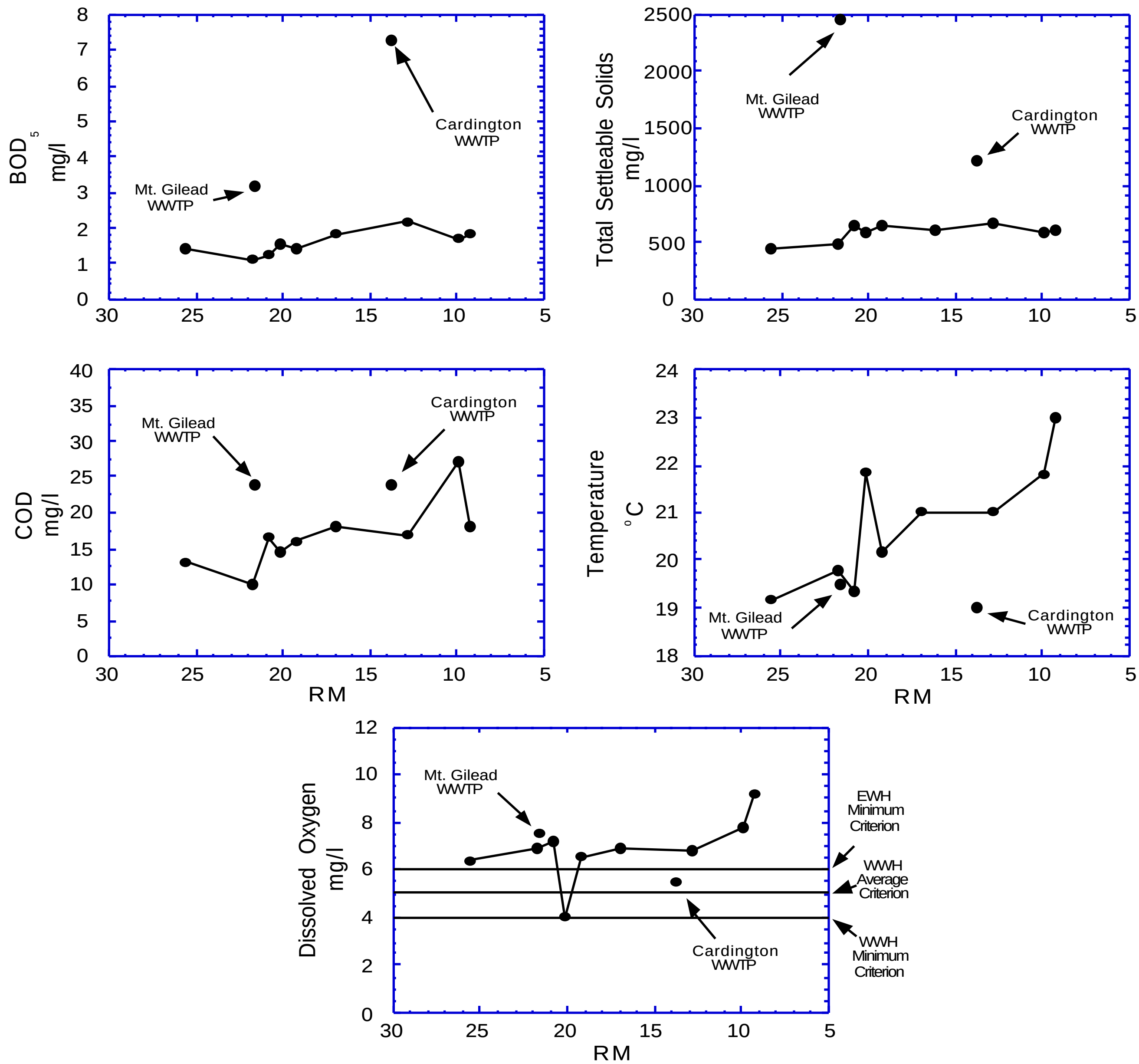
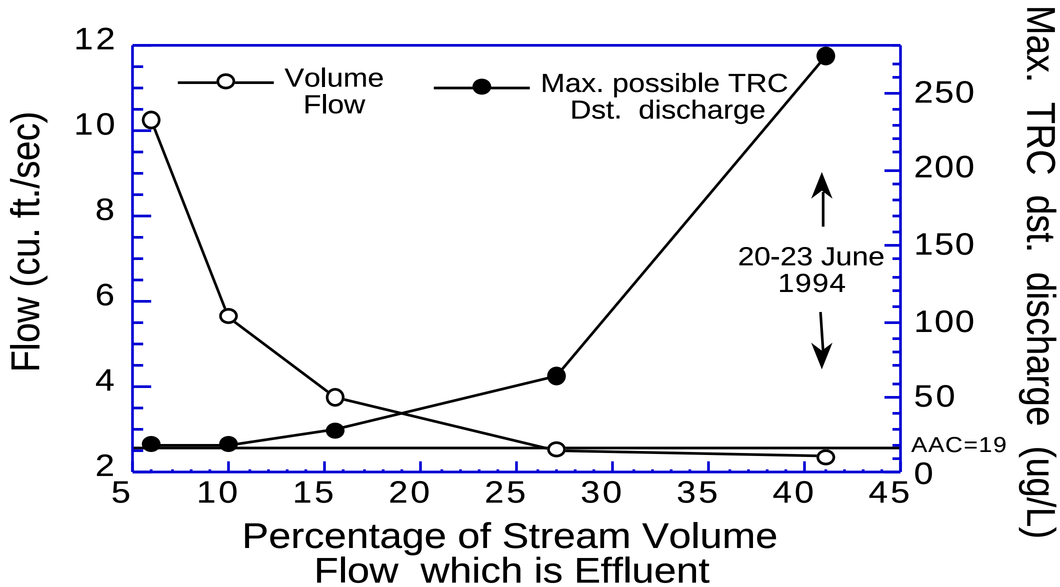



Figure 8. Longitudinal plots of biological oxygen demand (BOD), chemical oxygen demand (COD), total filterable residue or total settleable solids, temperature and dissolved oxygen (D.O.) in the Whetstone Creek study area, 1994.



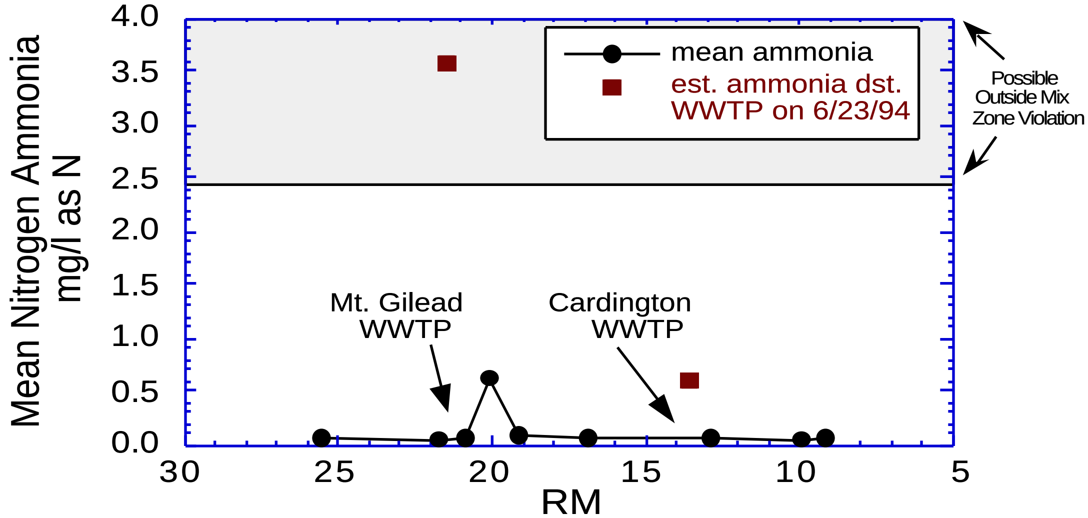




Figure 9. Measurements of Mt. Gilead WWTP 001 effluent discharge as percent of instream volume flow and associated maximum possible TRC concentrations in Whetstone Creek downstream of the WWTP at RM 20.85 and longitudinal mean ammonia concentrations with estimated ammonia concentrations corresponding to lowest measured instream flow during survey, 1994.

violation) on June 23 of 8.73 mg/l yielded an estimated instream total ammonia-N of 3.6 mg/l (Table 7; Figure 9). Using the approximate temperature and pH, the maximum un-ionized ammonia-N downstream of the Mt. Gilead WWTP was approximately 0.110 mg/l (Thurston et al 1979). This concentration is sufficient to result in acute impacts instream to some fish and molluscs (*e.g., Amblema plicata plicata* and *Corbicula*), and any adverse effects are exacerbated by low dissolved oxygen (U.S. EPA 1985). Since Mt. Gilead is permitted to discharge approximately 0.5 MGD, improperly treated sewage has the realistic potential to impact instream water chemistry, *especially at low flows*.

- The Cardington Road site (RM 20.85) was assessed to detect far-field impacts from the Mt. Gilead WWTP. One exceedence of the 30-day average for fecal coliform was noted on 8/10/94, but may not be attributable to the WWTP since the fecal count in the effluent was much lower (Table 6). The instream water chemistry at this point was reflective of the WWTP effluent, with a direct correlation existing between effluent and instream chemical concentrations and any impacts.

- Two samples were collected at Boundry Road (RM 20.10) to determine the potential effects from on-site septic systems in Edison. The slight nutrient enrichment associated with sewage as well as elevated fecal counts suggest that the unsewered area of Edison is adversely impacting water quality (Figure 7 and 8). A D.O. sag was also detected at this location implying increased oxygen demand from the Mt. Gilead WWTP effluent and discharges from the unsewered community of Edison (Figure 8). One exceedence of the minimum D.O. criteria appeared on June 23 which was attributed to low flow conditions (Table 6). Water temperature increased significantly at RM 20.10 relative to upstream locations (Figure 8). This phenomenon may be due to a local decline in the riparian corridor and a more open canopy.

- Newcomer Road (RM 19.17) was assessed to determine the presence of urban influences from Mt. Gilead and Edison. A violation of the D.O. criteria occurred on June 23, possibly in response to low flow conditions (Table 6). At this point the stream has assimilated much of the load from Mt. Gilead WWTP and the community of Edison. A decline in nutrient concentrations at this location supports the assertion (Figure 8). Water temperature also decreased slightly and seemed correlated with increased riparian vegetation (Figure 8).

- The station located at Morris Road (RM 16.19) was sampled to examine water chemistry upstream of the Cardington WWTP. A violation of the average D.O. criterion occurred on 23 June (Figure 6). Like several upstream sites, this condition is most likely a result of low flow conditions (Figure 8). Some recovery, exemplified by decreased nutrient load, is apparent at RM 16.19 (Figures 7 and 8).

- The Cardington WWTP (RM 13.70) outfall was sampled to explain any shifts in water quality in this area of Whetstone Creek. Six NPDES permit violations were detected during the study period. Three of these violations involved elevated chlorine levels, occurring on July 26, August 10, and August 22 (Table 7). A fecal coliform violation occurred on June 23 and on August 22, and one violation of the minimum D.O. criteria occurred also on August 22 (Table 7). Similar to Mt. Gilead WWTP results, elevated concentrations of suspended solids and nutrients (e.g., phosphorus and nitrites) were detected (Figures 6-8). These instantaneous concentrations were significantly higher than the Mt. Gilead results, although permit limits were not exceeded (except as noted above). Also, the effluent D.O. was considerably lower than instream conditions. These are all symptoms of periodic incomplete treatment due to the continuous capacity conditions (Figure 8).

- The sampling station located at Cardington Western Road (RM 12.88) was intended to assess the effects of the Cardington WWTP discharge. While no exceedences were observed impacts from Cardington may occur at lower flows. For example on June 23 during the lowest measured stream flow, the lowest D.O. (4.8 mg/l) was measured in addition to increased fecal coliform counts (Table 7), the highest measured ammonia-N (6.53 mg/l), and high COD (48 mg/l in effluent - still 24 mg/l here - Figures 8 and 9).

- Coleman Road (RM 9.91) was also sampled to determine impacts resulting from the Cardington WWTP discharge. The only apparent difference in water chemistry between this site and RM 12.88 was increased COD and D.O. (Figure 8). The increased D. O. concentrations are likely from reaeration and increased algal photosynthesis (Figure 8).

- The Waldo-Fulton-Chesterville Road sampling station (RM 9.20) was intended to evaluate a Section 319 nonpoint source implementation project located immediately upstream of the site. Agricultural land use activities included livestock grazing near the stream. These activities can potentially affect water quality. Livestock can alter stream dynamics by removing vegetation, by damaging stream banks which accelerates silt loads, and through increased nutrient enrichment. The 319 project (not initiated until after chemical sampling was completed) was designed to prevent substrate disturbances by cattle crossing the creek. Chemical sampling indicated water temperature had increased, most likely due to the lack of a shading tree canopy (Figure 8). Increases in D.O. and fecal coliform counts indicate both nutrient enrichment and presence of animal waste products (Figures 6-8). This site assessment essentially represented the conditions prior to the bank stabilization project. Future chemical assessments will be needed to determine water quality improvements from this geotextile bank stabilization project.

## Sediment Chemistry

Sediments were collected from the top two inches of the stream bottom at 3 locations in the Whetstone Creek study area (Table 7). Sediment from the stream margins or pooled areas downstream of riffles was then composited into a sample jar. The composite sample was then placed on ice before being transported to the Ohio EPA lab for analysis. Sediment samples were analyzed for heavy metals at 3 sample locations, while volatile organic compounds (VOCs), Base Neutral Acid organic compounds (BNAs), and PCB/Pesticides were analyzed at 1 location (RM 20.85).

Table 7. Concentrations of heavy metals in sediments of Whetstone Creek, 1994. All parameter concentrations, excluding aluminum and nickel, were ranked based on a stream sediment classification system described by Kelly and Hite (1984).

| | Sediment Concentration (mg/kg. dry weight) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| River Mile | As | Cu | Cd | Cr | Fe | Pb | Ni | Zn |
| 25.53 | 8.86[b] | 13.2[a] | 0.328[a] | 9.14[a] | 13500[a] | 21.0[a] | 17.3 | 55.9[a] |
| 20.85 | 10.8[b] | 22.9[a] | 0.392[a] | 13.8[a] | 18100[a] | 29.2[b] | 22.5 | 78.0[a] |
| 09.20 | 11.4[c] | 18.1[a] | 0.540[b] | 12.0[a] | 16700[a] | 22.9[a] | 30.5 | 75.0[a] |

[a]Non-elevated; [b] Slightly elevated; [c] Elevated; [d] **Highly elevated**; [e] **Extremely elevated**

Note: The Kelly and Hite classification system addresses relative concentrations but does not directly assess toxicity and does not evaluate nickel concentrations (both tables).

Table 8. Concentration (ug/kg) of Pesticides/PCBs in the sediments of Whetstone Creek, 1994.[1]

| | | Sediment Concentration (mg/kg. dry weight) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Location | River Mile | Chlor-dane | Hepta-chlor | Aldrin | Dieldrin | pp-DDE | PCBs Total | DDT Total |
| Dst. Mt. Gilead WWTP | 20.85 | NA | 0.80[a] | 2.71[f] | 1.47[a] | 0.56[a] | ND | ND |

[1] All pesticide concentrations were ranked on a stream sediment classification system described by Kelly and Hite (1984).

[a] Non-elevated
[b] Slightly elevated
[c] Elevated
[d] **Highly elevated**
[e] **Extremely elevated**
[f] Not evaluated by Kelly and Hite (1984)
NA Data not available
ND Concentrations under detection limits or not detected

- Further evaluation of the sediment quality was conducted utilizing Guidelines For the Protection and Management of Aquatic Sediment Quality in Ontario (Persaud and Jaagumagi 1994). The No Effect Level (NEL) and Lowest Effect Level (LEL) guidelines are comparable to those values determined by Long and Morgan's (1990) review of sediment toxicity bioassays performed by the National Atmospheric Administration (NOAA)(Long, E.R. and L.G. Morgan. 1990).

- Sediments were analyzed for heavy metals at three sampling locations (Table 9). The arsenic and nickel concentrations indicated that potential may exist for the sediment to have an adverse effect on some aquatic life forms since those compounds were slightly above the LEL at all sampling locations. The source of arsenic is unknown, though arsenic was a component of certain pesticides and is a constituent in wood treating processes. Arsenic, a naturally occurring element, is prevalent in the soil in this area of the state. Copper concentrations exceeded LEL at RMs 20.85 and 9.20. Nickel origins are unknown. Possible copper sources are copper piping, residue from copper sulfate (algicide), or road run off (tire fragments).

- Aldrin was the only pesticide analyzed that exceeded the LEL (Table 10) . Given the predominant agricultural land use in this area, one might expect more of a pesticide presence in the sediment. Based on these findings, adverse effects on aquatic communities due to pesticide contamination is not suspected.

- The VOC, BNA and PAH scans produced no evidence that these compounds would cause significant adverse effects to organisms inhabiting the benthos at RM 20.85 (Table 10). None of the VOC parameters were above detection while three of the BNA parameters analyzed were slightly above detection which placed them above LEL. Of PAHs analyzed, only fluoranthene and benzo[k]fluoranthene were slightly above LEL (Table 11).

- There is a general lack of guidelines developed for the protection of benthic organisms which assist in the evaluation of sediment chemistry results. A conclusion can be drawn that, based solely on the guidelines set by Persaud et. al., a slight potential for adverse effects on some benthic organisms in Whetstone Creek may exist. Several parameters exceeded LEL values in Whetstone Creek. Since the range of values between LEL and SEL is in most cases quite large, it is important to emphasize that these exceedences were only slightly above LEL . The potential adverse effects on benthic biological resources due to sediment toxicity are: a 10-20 percent probability of chronic effects from arsenic and/or copper sediment concentrations; a ≤ 10 percent risk of chronic toxicity due to nickel in sediments at RM 25.53 and 20.85; a ≤ 10 percent risk of chronic toxicity due to the three BNA and two PAH compounds that were slightly elevated above LEL in sediments at RM 20.85; and a 25 percent risk of chronic toxicity from sediments containing nickel at RM 9.20.

Table 9. Dry weight concentrations of heavy metals (mg/kg or ppm) in the sediments of Whetstone Creek from three sampling locations in study area during 1994. All parameter concentrations were ranked according to the *ecotoxic effects* guideline described by Persaud et. al. (1994).

| River Mile | As | Cd | Cr | Cu | Fe | Pb | Ni | Zn |
|---|---|---|---|---|---|---|---|---|
| 25.53 | 8.86[b] | 0.328[a] | 9.14[a] | 13.2[a] | 13500 | 21.0[a] | 17.3[b] | 55.9[a] |
| 20.85 | 10.8[b] | 0.392[a] | 13.8[a] | 22.9[b] | 18100 | 29.2[a] | 22.5[b] | 78.0[a] |
| 09.20 | 11.4[b] | 0.540[a] | 12.0[a] | 18.1[b] | 16700 | 22.9[a] | 30.5[b] | 75.0[a] |

a > No Effect Level and < Lowest Effect Level (NEL)
b > or = Lowest Effect Level (LEL)
**c > or = Severe Effect Level (SEL)**

Table 10. Dry weight concentrations of PCBs and Organochlorine Pesticides (µg/kg or ppb) in the sediments at River Mile 20.85 of the Whetstone Creek study area during 1994. All parameter concentrations were ranked according to the *ecotoxic effects* guideline described by Persaud et. al. 1994.

| Aldrin | BHC | a-BHC | b-BHC | d-BHC | y-BHC | Chlordane | DDT (Total) |
|---|---|---|---|---|---|---|---|
| 2.71[b] | ND | ND | ND | ND | ND | NA | ND |

| op+pp-DDT | pp-DDD | pp-DDE | Dieldrin | Endrin | HCB | Heptachlor |
|---|---|---|---|---|---|---|
| NA | ND | 0.56[a] | 1.47[a] | ND | ND | ND |

| H Epoxide | Mirex | PCB (Total) | PCB 1254 | PCB 1248 | PCB 1016 | PCB 1260 |
|---|---|---|---|---|---|---|
| 0.80[a] | ND | ND | ND | ND | ND | ND |

a > No Effect Level and < Lowest Effect Level (NEL)
b > or = Lowest Effect Level (LEL)
**c > or = Severe Effect Level (SEL)**

Table 11. Dry weight concentrations of Polycyclic Aromatic Hydrocarbons (mg/kg or ppm) in the sediments at River Mile 20.85 of the Whetstone Creek study area during 1994. All parameter concentrations were ranked according to the *ecotoxic effects* guideline described by Persaud et. al. 1994.

| Anthracene | Benz[a]anthracene | Benzo[k]fluoranthene | | Benzo[a]pyrene |
|---|---|---|---|---|
| ND | ND | 0.7[b] | | ND |
| **Chrysene** | **Benzo[g,h,i]perylene** | **Dibenzo[a,h]anthracene** | | **Fluoranthene** |
| ND | ND | ND | | 0.9[b] |
| **Fluorene** | **Indenol[1,2,3-cd]pyrene** | **Phenanthrene** | **Pyrene** | **PAH (total)** |
| ND | ND | ND | 0.7[b] | 2.3[a] |

a > No Effect Level and < Lowest Effect Level (NEL)
b > or = Lowest Effect Level (LEL)
**c > or = Severe Effect Level (SEL)**

*Fish Tissue Contaminants*

- Fish tissue samples were collected and analyzed to support the biological and chemical surveys on Whetstone Creek watershed. Two samples each were collected at three locations on 12-13 September 1994 within the Whetstone Creek study area: 1) downstream of McKibben Rd at RM 25.5 (#F489-94, F490-94); 2) upstream of Cardington-Western Rd at RM 12.9 (#F493-94, F494-94); and downstream of Waldo-Fulton-Chesterville Rd at RM 9.2 (#F491-94, F492-94).

- The analyses of these fish tissue samples indicated favorable conditions with few pesticides and generally low PCB concentrations were found (Table 12). There was a total concentration of 146 ppb PCBs at RM 12.9 (downstream from the Cardington WWTP) which was slightly elevated (Vandermeer, 1994). The other sample (rock bass) at RM 12.9 contained PCBs at levels below the detection limits. Mercury contamination was generally low at 5 to 15 percent of the U.S.FDA recommended action level of 1000 ppb. Only the rock bass collected at RM 25.5 contained slightly elevated Hg concentrations (271 ppb) which indicates some trophic accumulation.

Table 12. Summary of compounds detected in fish tissue analysis of samples collected on September 27, 1994 in Whetstone Creek. All results are reported as µg/kg (parts per billion).

| *Whetstone Creek* Parameter | RM 25.5 3 carp[a] | RM 25.5 3 rock bass[c] | RM 12.9 4 rock bass[c] | RM 12.9 2 w.sucker [a] | RM 9.2 3 w.sucker [a] | RM 9.2 4 SM bass[c] |
|---|---|---|---|---|---|---|
| Aldrin | ND | ND | ND | ND | ND | ND |
| a-BHC | ND | ND | ND | ND | ND | ND |
| b-BHC | ND | ND | ND | ND | ND | ND |
| d-BHC | ND | ND | ND | ND | ND | ND |
| y-BHC | ND | ND | ND | ND | ND | ND |
| 4,4-DDD | ND | ND | ND | ND | ND | ND |
| 4,4-DDE | ND | ND | ND | 6.3 | ND | ND |
| 4,4-DDT | ND | ND | ND | ND | ND | ND |
| Dieldrin | ND | ND | ND | ND | 4.8 | ND |
| Endosulfan I | ND | ND | ND | ND | ND | ND |
| Endosulfan II | ND | ND | ND | ND | ND | ND |
| Endsulfan sulfate | ND | ND | ND | ND | ND | ND |
| Endrin | ND | ND | ND | ND | ND | ND |
| Heptachlor | ND | ND | ND | ND | ND | ND |
| Heptachlor epoxide | ND | ND | ND | ND | ND | ND |
| Methoxychlor | ND | ND | ND | ND | ND | ND |
| Mercury | 73.8 | 271 | 155 | 78.7 | 50.4 | 107 |
| Mirex | ND | ND | ND | ND | ND | ND |
| Hexachlorobenzene | ND | ND | ND | ND | ND | ND |
| Alpha-Chlordane | ND | ND | ND | ND | ND | ND |
| Gamma-Chlordane | ND | ND | ND | ND | ND | ND |
| Oxychlordane | ND | ND | ND | ND | ND | ND |
| Cis-Nonachlor | ND | ND | ND | ND | ND | ND |
| Trans-Nonachlor | ND | ND | ND | 5.8 | ND | ND |
| Toxaphene | NA | NA | NA | NA | NA | NA |
| PCB-1016 | ND | ND | ND | ND | ND | ND |
| PCB-1221 | ND | ND | ND | ND | ND | ND |
| PCB-1232 | ND | ND | ND | ND | ND | ND |
| PCB-1242 | ND | ND | ND | ND | ND | ND |
| PCB-1248 | ND | ND | ND | ND | ND | ND |
| PCB-1254 | ND | ND | ND | 90 | 20 | ND |
| PCB-1260 | ND | ND | ND | 56 | ND | ND |

ND = not detected.
NA = not analyzed.
a WBC (Whole Body Composite)
b SFFC (Skin Off Fillet Composite)
c SOFC (Skin On Fillet Composite)

## Physical Habitat for Aquatic Life

*Whetstone Creek*

- The studied reach of Whetstone Creek is a nearly natural boulder and cobble bottom stream with an average gradient of 7.5 feet per mile. Two low head dams are located within the study area at RM 14.6 (Cardington) and RM 16.2; each impounds only a short section of the mainstem. Moderate amounts of silt throughout the reach have resulted in moderate substrate embeddedness.

- Macrohabitats of Whetstone Creek were evaluated at eight fish sampling sites in 1994. QHEI scores ranged from 90 (RM 20.9, 12.9) to 38.5 (RM 9.1). Including all sites, the mean QHEI is 71 (Table 12). Generally, QHEI scores above 60 reflect habitat conditions which are able to support and maintain an aquatic community consistent with the WWH aquatic life use designation. An EWH designation is typically associated with mean QHEI scores above 75 (Rankin 1989). Excluding the two most downstream sites which are locally modified, the mean QHEI for Whetstone Creek is 81.

- The six upper reach sites (RM 25.4 to 12.9) contained a predominance of warmwater habitat attributes with silt and embeddedness as the only consistently appearing modified habitat attributes. In general, this reach had good variation in substrates, good to excellent development and instream cover, good flow characteristics, and relatively deep pools (see Appendix Table 1). The riparian corridor was fairly intact along this reach with localized interruptions in Mt. Gilead and Cardington.

- Lower reach sites (RM 10.0 and 9.1) exhibited several negative habitat traits. Shale bedrock covered with silt provided a poor quality substrate. Limited instream cover and shallow, poorly defined riffle/run sequences further limited habitat quality. Cattle have unrestricted access to the stream in the vicinity of this site. All-terrain vehicles frequently cross the creek at RM 9.1 as part of a recreational off road race course.

*Shaw Creek*

- Macrohabitats of Shaw Creek were evaluated at one fish sampling site (RM 0.4) where a QHEI value of 60 was determined. A QHEI value of 60 suggests that near and instream habitats of Shaw Creek are adequate to support a biological community capable of attaining the WWH aquatic life use designation (Rankin 1989). This site has a good riffle, run and pool series, moderate instream cover, and good sinuosity. Silt and associated substrate embeddedness are factors which presently limit habitat quality.

Table 12. Average QHEI scores for four relatively homogenous segments of Whetstone Creek based on sampling conducted during July - October, 1994.

| **Sample Location: Segment Description** Upstream River Mile | Downstream River Mile | River Mile | Sample Location QHEI | Segment Average QHEI |
|---|---|---|---|---|
| **Segment 1: Above Mt. Gilead to just downstream of Cardington** | | | | |
| 25.4 | 12.9 | 25.4 | 77.0 | 80.8 |
| | | 22.2 | 71.0 | |
| | | 20.9 | 90.0 | |
| | | 19.2 | 78.5 | |
| | | 16.1 | 78.0 | |
| | | 12.9 | 90.0 | |
| **Segment 2: Downstream from Cardington** | | | | |
| 10.0 | 9.1 | 10.0 | 45.5 | 42.0 |
| | | 9.1 | 38.5 | |
| **Shaw Creek** | | | | |
| 0.4 | 0.4 | 0.4 | 60.0 | |

### *Biological Assessment: Macroinvertebrate Community*

- Quantitative and qualitative data were collected from eight Whetstone Creek stations between RM 25.5 and RM 9.2 (Table 7). Flow over the quantitative artificial substrate samplers ranged from 0.5 0 ft/sec to 1.0 ft/sec (2.0 ft/sec at Shaw Creek site) when set on August 8, 1994, and from 0.40 ft/sec to 0.70 ft/sec on September 19-20, 1994, when they were collected. On Whetstone Creek, four out of eight artificial substrate samplers were vandalized and removed from the water; the Shaw Creek set was also removed. As such, only qualitative data was collected from the natural substrates and habitats at RMs 25.5, 21.8, 19.2, and 13.0 on Whetstone Creek and at RM 0.4 on Shaw Creek. Evaluations ranged from exceptional at most sites to an evaluation of good downstream from the Mt. Gilead WWTP at RM 20.9 (Table 13). Three of the four sites with available ICI scores achieved or exceeded the EWH biocriterion (RMs 16.1, 10.1, and 9.2).

Table 13. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in Whetstone Creek study area, July - October, 1994. Aquatic life uses indicated are those currently designated in the Ohio Water Quality Standards or proposed for use designation change.

| ***Stream*** River Mile | Relative Density | Quant. Taxa | Qual. Taxa | Qual. EPT[a] | Predominant Organisms | QCTV[c] | ICI | Evaluation[b] |
|---|---|---|---|---|---|---|---|---|
| ***Whetstone Creek (proposed EWH)*** | | | | | | | | |
| 25.5 | Moderate | - | 60 | 20 | 3,6,11,2 | 39.3 | - | Exceptional |
| 21.8 | Mod.-Low | - | 54 | 16 | 3,6,9,12,1 | 38.9 | - | Exceptional |
| 20.9 | 493 | 48 | 51 | 16 | 3,6,9,12,10 | 39.2 | 36* | Good |
| 19.2 | Mod.-Low | - | 46 | 13 | 3,9,12,7,5 | 39.2 | - | Very Good |
| 16.1 | 482 | 43 | 54 | 15 | 9,3,6,11,4 | 38.9 | 54 | Exceptional |
| 13.0 | Moderate | - | 65 | 16 | 3,6,9,7 | 38.5 | - | Exceptional |
| 10.1 | 910 | 58 | 85 | 20 | 3,11,6 | 39.2 | 46 | Exceptional |
| 9.2 | 560 | 46 | 73 | 17 | 3,6,8,7,11 | 38.9 | 44[ns] | Very Good |
| ***Shaw Creek (WWH)*** | | | | | | | | |
| 0.4 | Moderate | - | 67 | 16 | 3,6,4,10,12,9 | 39.2 | - | Exceptional |

**Ecoregion Biocriteria:** E. Corn Belt Plains (ECBP)

| INDEX | WWH | EWH |
|---|---|---|
| ICI | 36 | 46 |

a- EPT=total Ephemeroptera (mayflies), Plecoptera (stoneflies), & Trichoptera (caddisflies) taxa richness.
b- The qualitative narrative evaluation is based on best professional judgment utilizing sample attributes such as taxa richness, EPT richness, and QCTV score and is used when quantitative data are not available to calculate an Invertebrate Community Index (ICI) score.
c- Qualitative Community Tolerance Value (QCTV) is derived as the median of the tolerance values calculated for each qualitative taxon present (see discussion in Methods Section).
*- Significant departure from ecoregion biocriterion (>4 ICI units); poor and very poor results are underlined.
ns- Nonsignificant departure from ecoregion biocriterion (≤4 ICI units).

Predominant organism code list

| | | | |
|---|---|---|---|
| 1 - alderflies | 4 - clams | 7 - midges | 10 - river snails |
| 2 - bryozoans | 5 - isopods | 8 - moth larvae | 11 - Tanytarsini midges |
| 3 - caddisflies | 6 - mayflies | 9 - riffle beetles | 12 - water pennies |

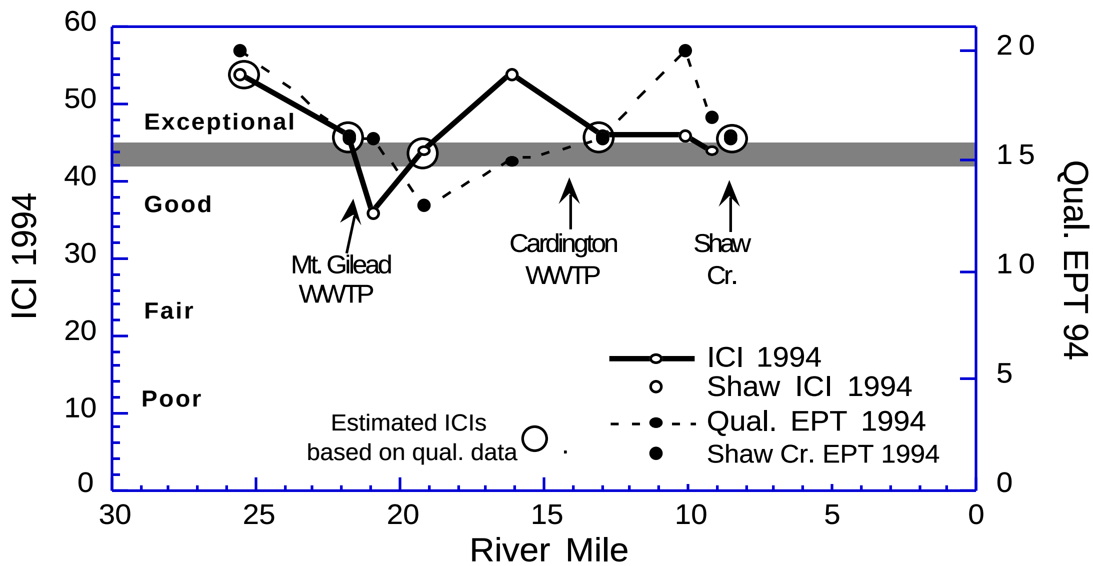



Figure 10. Comparison of ICI and the number of qualitative Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) EPT taxa collected from the Whetstone Creek survey, 1994.

- The upstream site at McKibben Road (RM 25.5) upstream from Mt. Gilead was evaluated as exceptional. There were eight caddisfly and eight mayfly taxa included with the 60 total taxa collected from the natural substrates. Hydropsychid caddisflies, several mayflies, and tanytarsini midges were predominant in the riffle. The caddisfly *Chimarra* and the lepidopteran *Petrophila* were common. Mayflies (Heptageniidae), bryozoans, and tanytarsini midges were predominant in the run. It's noteworthy that water pennies were predominant in the pools along with heptageneid mayflies and red midges; lack of dissolved oxygen was apparently not a problem. Based on the moderate organism density and balanced community structure, nutrient enrichment from upstream agriculture and/or subdivision inputs was not readily apparent as a problem at this site. However, there were slightly embedded conditions in the riffle substrates which indicated some likely NPS silt runoff input from upstream sources.

- The site above the Mt. Gilead WWTP and below most of town at RM 21.8 remained exceptional. Sixteen EPT taxa were again collected, including the stonefly *Acroneuria* and burrowing mayflies of the genus *Ephemera*. Baetid mayflies were not as common but hydropsychid caddisflies, heptageneid mayflies, the caddisfly genus *Neophylax*, riffle beetles, water pennies, and the mayfly genus *Caenis* were predominant in the riffle/run habitats. The mayfly *Isonychia* and river snails (*Elimia* ) were common in the riffle. A large group, a few of which were red midges, crayfish, and the caddisfly species *Helicopsyche borealis* were common in the run. Good riffle quality with cool clear water were positive habitat attributes, though the riffle depth was somewhat shallow. An upstream pool had about 4 to 6 inches of mucky silt and sand in the bottom indicating some siltation (probably from tilled cornfields adjacent and upstream). Nutrient or herbicide applications from agriculture and/or unsewered discharges from residences along the stream could be causing a few more tolerant midge taxa (in low numbers) to appear and a decrease of sensitive midges (e.g., Tanytarsini midges and *Corynoneura*). Fatmucket and squawfoot bivalve molluscs were collected here.

- Downstream from the Mt. Gilead WWTP (RM 20.9), the macroinvertebrate community collected from natural substrates was still diverse and of high quality and was narratively evaluated as very good. Riffle densities of hydropsychid caddisflies and mayflies were moderate to high. Water pennies were still common in the riffle and were predominate along with hydropsychid caddisflies and river snails (*Elimia* ) in the run. The densities of caddisflies and mayflies (and possibly tanytarsini) collected from the artificial substrates seemed to be underrepresented when compared to total numbers in the qualitative sampling; the ICI score of 36 (good) reflected these differences. A high number of *Corynoneura lobata*, a midge usually associated with good water quality, probably skewed results negatively, as the % Dipteran/NI (non-insect) metric was highly increased (lower score) and % Mayfly, % Caddisfly, and % Tanytarsini midge metrics were decreased with much lower percentages (lower score). The QCTV score of 39.2, however, was almost identical to the upstream site (39.3). The apparent underrepresentation of mayflies, caddsiflies, and tanytarsini midges could be due to possible episodic toxic pulses of high total residual chlorine (TRC) at lower flows in combination with other chemical parameters (e.g., elevated COD/BOD, lower D.O.s, and possibly ammonia). As noted in a previous section of this report (p.22) residual chlorine has been shown to persist and can cause acute toxicity instream at least 0.8 miles downstream (Quality Criteria for Water 1976) which is roughly the distance this downstream site was from the Mt. Gilead WWTP.

- The stream site at RM 19.2 was selected to assess potential impacts from Edison, an unsewered community, and possible effects from NPS inputs (agricultural runoff/erosion and/or fertilizer plant located 0.5 miles upstream). The stream gradient was lower in this reach and a long pool preceded the riffle/run area. Predominate land use was rowcrop agriculture with a few houses interspersed behind a 20-40 foot riparian corridor. Thirteen EPT taxa were collected from the natural substrates compared to sixteen at RM 20.9; this was the lowest number of EPT taxa collected from sites in the Whetstone creek study area. Hydropsychid caddisflies and riffle beetles predominated in the riffle while in mayflies, the caddisfly genus *Neophylax*, and midges were common. Water pennies, midges, and isopods predominated in the run. Partially embedded substrates indicated some NPS effects. The more pollution tolerant midges, evident at the site downstream from the WWTP, were not collected at this location during qualitative sampling. The QCTV score was again 39.2 for this site. The community structure, with isopods being one of the predominant organisms, and lower EPT totals indicated the unsewered community of Edison was probably exerting a slight influence. Nutrients and poorly treated sewage are likely causing some higher BODs and periodic low D.O. concentrations. In the past a large fertilizer spill (1000 gallons) just upstream from Newcomer Road likely impacted this reach. Possible smaller unreported spills (direct or from surface runoff) may still be impacting this stream segment. Despite the possible impacts to this reach, the macroinvertebrate community continued to be assessed as very good.

- Whetstone Creek, upstream from Cardington at Morris Rd. (RM 16.0), was composed of large slabs of shale bedrock in riffle/run reach with a lowhead dam located just upstream. Quantitative sampling results were available at this location and an ICI value of 54 (exceptional) as scored. Numerous mayfly and caddisfly taxa were collected from the artificial substrates as well as from natural substrates and habitats. In the riffle during qualitative sampling, caddisflies, mayflies, and riffle beetles were predominate with water pennies, lepidopterans, midges, and river snails common. Density and diversity were moderate to high. The run was predominated by mayflies, tanytarsini midges, and fingernail clams with caddisflies common. Diversity and density in the run were also moderate to high. Tanytarsini midges comprised approximately 37 percent of the total number of organisms collected while the combined caddisfly/mayfly totals equalled 30 percent. No indications of nonpoint influences were noted.

- The macroinvertebrate community remained exceptional downstream from the Cardington WWTP near Cardington-Western Rd. (RM 13.0) . Sixteen EPT taxa were collected from natural substrates and habitats. Caddisflies, mayflies, riffle beetles, and midges were predominate in the riffle/run habitats with lepidopterans, caddisflies, alderflies, and fingernail clams common. There was high quality riffle development and good margin habitat present which supported a moderate diversity and density of organisms. Damselflies and mayflies were predominate in the pool habitats. The midge community collected here indicated good water quality, as the more pollution tolerant midge species were not collected. However a couple of the more sensitive midge species (e.g., *Corynoneura*, *Thienemanniella, and Nilotanypus)* were not collected here in contrast to the upstream site at RM 16.1. The number of total EPT taxa decreased to 16 from 18 and the density decreased compared to RM 16.1. The Cardington WWTP effluent discharge probably affected this downstream reach slightly. There was not a lot of macroinvertebrate diversity on rocks in the riffle, and the rocks were moderately bare and clean of allochthonous growth. This would not be expected considering the high phosphorus input in the effluent discharged. Higher TRC concentrations with increased COD/BOD, occasional ammonia, and other D.O. depleting parameters downstream could be "disinfecting" and causing more sterile conditions downstream from the WWTP.

- The most diverse site sampled during the survey was collected downstream from Cardington at RM 10.1 (upstream from Coleman Rd.); there were 105 distinct taxa (84 qualitative taxa and 58 quantitative taxa). The ICI score was 46 (exceptional). There were 20 qualitative EPT taxa and 22 total EPT taxa including 14 taxa of mayflies, 7 taxa of caddisflies, and one stonefly taxon. Five mussel species were collected at this site: the Wabash Pigtoe, Fatmucket, Creek Heelsplitter, Squawfoot, and Threeridge. Habitat requirements of the Creek Heelsplitter, *Lasmigonacompressa*, includes clean streams or creeks with sandy mud areas adjacent to good current (Watters 1993). Macroinvertebrate density reached its highest level at this site which suggested some nutrient enrichment upstream (higher phosphorus and other nutrients from the Cardington WWTP effluent and NPS runoff) and through this stream reach. Based on limited data, it appeared that some nutrient/primary production cyclical diurnal D.O. pattern existed downstream in this reach. There are closed pastures (some are likely open) and rowcrop agriculture upstream with potential NPS nutrient/siltation input. Bank erosion was also a problem at this locale. There was a slight to moderate amount of silt on the artificial substrates at retrieval, but the water was still considered clear. Some riparian zone was still intact upstream, but patchworked riparian (forested and rowcrop) probably best described the upstream reach. There was open pasture immediately downstream at a location where a NPS improvement project was being conducted.

- The site at Waldo-Fulton-Chesterville Rd. (Township Rd. 25) at RM 9.2 was initially selected to assess a geotextile bank stabilization project to improve grazing operations with respect to the riparian zone. However, the project was not initiated until after biosurvey sampling was completed. As such, survey results will establish baseline water quality and biological condition prior to the project improvements. Instream conditions were silty and sandy through all habitat types. If the sediment was stirred, the water color changed from clear to turbid brown. The stream substrates (cobble/rubble/gravel/sand)were slightly to moderately embedded, and the artificial substrates, when retrieved, were covered with a slight to moderate amount of silt. The upstream banks in two location were slumped, eroded, and denuded of vegetation; cattle were observed in the stream. Despite these conditions, there was still a diverse macroinvertebrate community present which included caddisflies, mayflies, and lepidopterans predominant in the riffle/run habitats. Red midges were predominant in the runs and pools along with mayflies, bryozoans, caddisflies, and Asiatic clams (*Corbiculafluminea*). The ICI score was 44 (very good). A total of 92 taxa were collected at this site. The macroinvertebrate community should improve once the silt and nutrient loadings decrease as a result of the bank stabilization project.

- Habitat at the Shaw Creek site (RM 0.4) was silty from nonpoint inputs, but there was still enough flow and dissolved oxygen to support a good diverse macroinvertebrate community. Included among the 67 taxa collected from natural substrates were 16 EPT taxa. The riffle/run habitats were predominated by hydropsychid caddisflies, mayflies, and Asiatic clams with riffle beetles, water pennies, river snails, and midges common. There were five mussel species collected here. The Kidneyshell (*Ptychobranchusfasciolaris*) is collected in "good quality streams or rivers in muddy sand or gravel in moving water" (Watters 1993). The Threeridge (*Amblema plicata plicata*), whose range is "widespread" but " is being reduced, particularly in agricultural areas" (Watters 1993), was collected here in addition to RM 10.1 in Whetstone Creek. Based on the number of EPT taxa, total taxa, and the QCTV, this site was narratively assessed as exceptional. However, macroinvertebrates should improve dramatically, if the silt inputs were decreased; the percentage of caddisflies and mayflies should increase and the tolerant organisms, like the Asiatic clam, should be reduced in numbers.

## ***Biological Assessment: Fish Community***

*Whetstone Creek*

- Forty species and two hybrids (17,647 individuals) were collected in Whetstone Creek in 1994. Sampling occurred twice at eight sites between RM 25.4 (McKibben Rd., upstream from Mt. Gilead) and RM 9.1 (Waldo-Fulton-Chesterville Rd., downstream from Cardington). These sites comprise 1.6 km of this 26.2 km (16.3 mile) stream reach.

- Overall, the Whetstone Creek fish assemblage was very good (Table 14). This narrative evaluation was based on fish community indices which ranged from exceptional (IBI=50; MIwb=10.2 at RM 12.9) to good and marginally good (IBI=37; MIwb=8.3 at RM 10.0). Including all sites, the mean IBI was 46 and the mean MIwb was 9.1 (Figure 11). Ecoregional expectations were met or exceeded at all sites.

- In the aggregate, the most abundant fish collected were: central stoneroller (29%), bluntnose minnow (14%), greenside darter (11%), rainbow darter (9%), northern hogsucker (5%), and creek chub (4%). In terms of biomass, the predominant species were: northern hog sucker (22%), white sucker (13%), central stoneroller (12%), common carp (8%), golden redhorse (7%), rock bass (6%), and creek chub (6%).

- Whetstone Creek supports a rich fish community. The cumulative number of species ranged from 23 to 33 per site including at least six darter species present at all locations.

Table 14. Fish community indices based on wading method pulsed D.C. electrofishing samples collected by Ohio EPA in the Whetstone Creek study area, 1984 and 1994.

| ***Stream*** River Mile | Mean Number of Species | Cumulative Species | Mean Rel. No. (No./Km) | Mean Rel. Wt. (Kg/Km) | QHEI | Mean MIwb | Mean IBI | Narrative Evaluation[a] |
|---|---|---|---|---|---|---|---|---|
| ***Whetstone Creek (1994)*** | | | | | | | | |
| *Eastern Corn Belt Plain - WWH Use designation (Existing)* | | | | | | | | |
| 25.4 | 22.0 | 25 | 867 | 6.8 | 77.0 | 8.9 | 51 | Exc.-Very Good |
| 22.2 | 22.5 | 24 | 3132 | 25.3 | 71.0 | 9.2 | 46 | Very Good |
| 20.9 | 23.5 | 26 | 1178 | 28.3 | 90.0 | 8.9 | 50 | Exc.-Very Good |
| 19.2 | 24.0 | 29 | 920 | 23.5 | 78.5 | 8.9 | 45 | Very Good-Good |
| 16.1 | 21.0 | 23 | 1692 | 14.7 | 78.0 | 9.4 | 49 | Exc.-Very Good |
| 12.9 | 30.0 | 33 | 2212 | 41.1 | 90.0 | 10.2 | 50 | Exceptional |
| 10.0 | 21.0 | 28 | 1649 | 6.1 | 45.5 | 8.3 | 37ns | Good-Mrg.Good |
| 9.1 | 28.0 | 30 | 1542 | 24.1 | 38.5 | 9.1 | 42 | Very Good-Good |
| ***Whetstone Creek (1984)*** | | | | | | | | |
| 25.5 | 19.0 | 23 | 539 | 3.2 | — | 8.1ns | 46 | V.Good-Mrg.Good |
| 22.3 | 17.0 | 20 | 899 | 5.6 | — | 8.6 | 44 | Good |
| 20.6 | 18.0 | 22 | 540 | 53.3 | — | 7.2* | 40 | Good-Fair |
| 18.1 | 19.0 | 21 | 608 | 14.3 | — | 8.0ns | 45 | Good-Mrg.Good |
| 16.3 | 14.0 | 18 | 420 | 9.0 | — | 7.0* | 34* | Fair |
| 12.9 | 26.0 | 31 | 563 | 35.3 | — | 8.5 | 46 | Good |
| 9.6 | 27.0 | 30 | 584 | 45.2 | — | 8.1* | 42 | Good-Mrg.Good |
| ***Shaw Creek (1994)*** | | | | | | | | |
| 0.4 | 26.5 | 28 | 1193 | 19.9 | 60.0 | 8.9 | 44 | Very Good-Good |
| ***Shaw Creek (1984)*** | | | | | | | | |
| 0.4 | 16.0 | 19 | 615 | 1.2 | — | 6.9* | <u>25</u> | Fair-Poor |

| ***Ecoregion Biocriteria:*** E. Corn Belt Plain (ECBP) | | |
|---|---|---|
| **INDEX - Site Type** | **WWH** | **EWH** |
| IBI - Headwaters/Wading | 40 | 50 |
| MIwb - Wading | 8.3 | 9.4 |

* - Significant departure from biocriteria (>4 IBI or >0.5 MIwb units); poor and very poor values are underlined.

ns - Nonsignificant departure from biocriteria (≤4 IBI or ≤ 0.5 MIwb units).

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

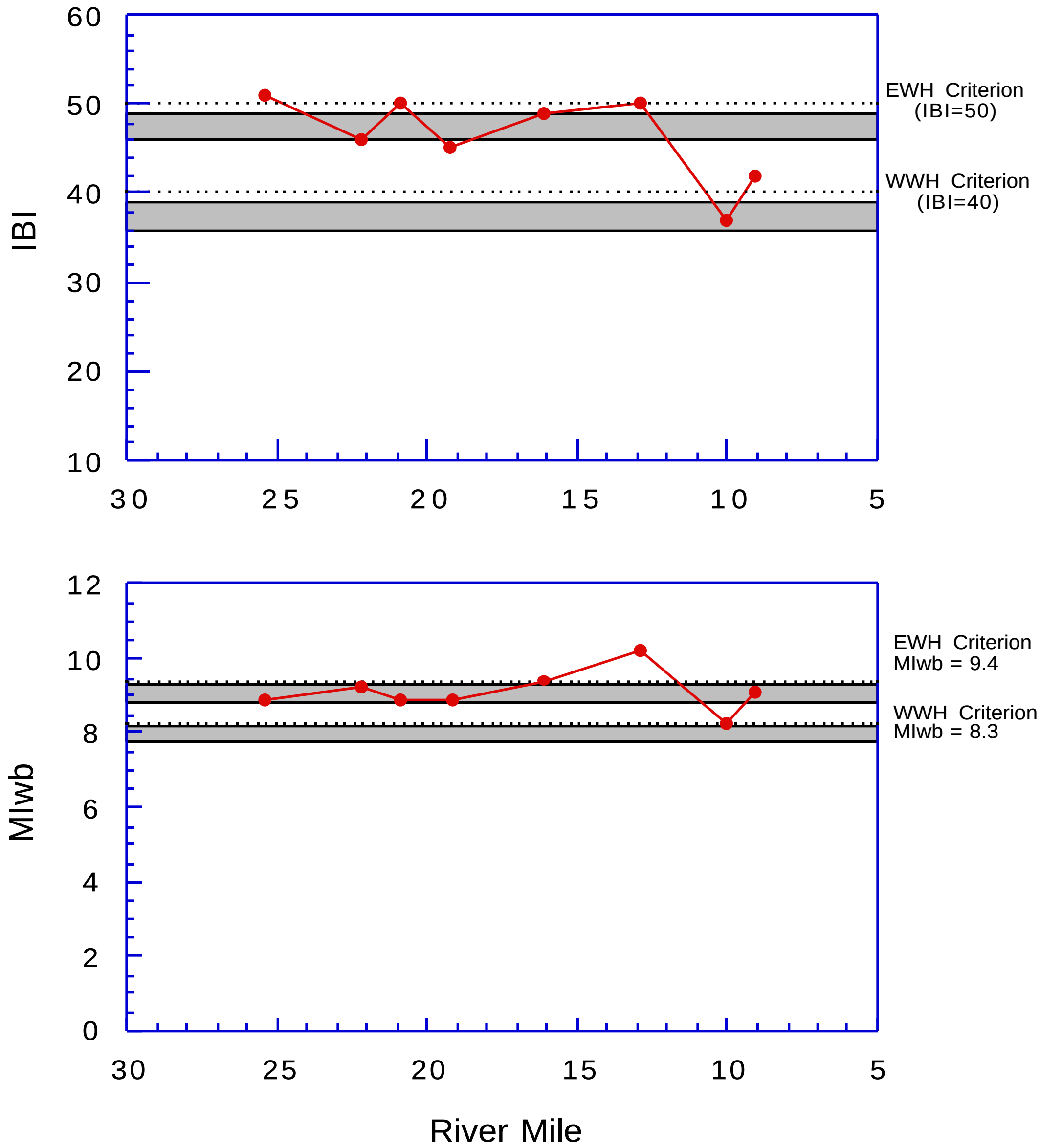



Figure 11. IBI and MIWB results longitudinally for Whetstone Creek survey, July-October 1994.

- The IBI metrics for total number of species and darter species consistently scored the highest possible value for each sample. However, metric scores for number of intolerant species were noticeably lower. In total, only four intolerant species were found in Whetstone including silver shiners which were present at all locations. Banded darters and stonecat madtoms were also well represented. Intolerant fish conspicuous by their absence in this survey include rosyface shiner, black redhorse and bigeye chub (Trautman 1981).

- All Whetstone Creek sites fell short of the highest value for the metric for percent of top carnivores.

- Stream habitat seems to directly influence populations of two minnow species in Whetstone Creek. At RM 22.2 and 12.9 the stream channel generally lacked mature forest canopy. With limited shade and the resultant algal growth, the herbivorous central stoneroller maintained populations of 56% and 36% of the fish fauna at the respective sites (Figure 12). The proportional high percent of bluntnose minnow in this reach also exerts a negative influence across several IBI metric scores for these sites. Large numbers of central stonerollers or bluntnose minnow in one place are often associated with moderate nutrient enrichment. Bluntnose minnow populations were inversely related to QHEI values (Figure 13). As QHEI levels diminished, especially at RM 10.0 and 9.1, bluntnose minnows composed 32% and 41% of the fish community, respectively. Substrate at these sites was mostly bedrock, complete with small ledges, joints and crevices offering limited spawning area for most species. The tolerant bluntnose finds ample spawning opportunity here due to its ability to secure eggs to the underside of surfaces, keep its nest free of silt, and defended against predators (Trautman 1981).

- In summary, Whetstone Creek provides habitat to a diverse, healthy fish community. In the aggregate, 15 of the 40 species noted in Whetstone Creek are considered sensitive to water pollution. These 15 comprised 32% of the entire fish population in the studied reach. Additionally, IBI metric tabulations indicate good community structural and functional balance is present. With further efforts to enhance the riparian buffer and limit siltation and nutrient enrichment, it is more than likely that Whetstone Creek will sustain further improvements to the fish fauna.

*Shaw Creek*

- Twenty-eight fish species (1,590 individuals) were collected in Shaw Creek in 1994. Sampling occurred twice at RM 0.4 downstream of Waldo-Fulton-Chesterville Rd. Fish community results were rated as very good to good (IBI=44; MIwb=8.9). Ecoregional expectations for the WWH use designation were met at this site.

- Numerically, creek chub (25%), johnny darter (13%), and white sucker (13%) were most abundant. In terms of biomass, the predominant species were: creek chub (32%), white sucker (19%), and northern hogsucker (15%). Ten water pollution sensitive species comprised 17% of the fish population. Overall, the fish community with seven darter species and five sunfish species (by IBI group), exhibited good structural and functional balance.

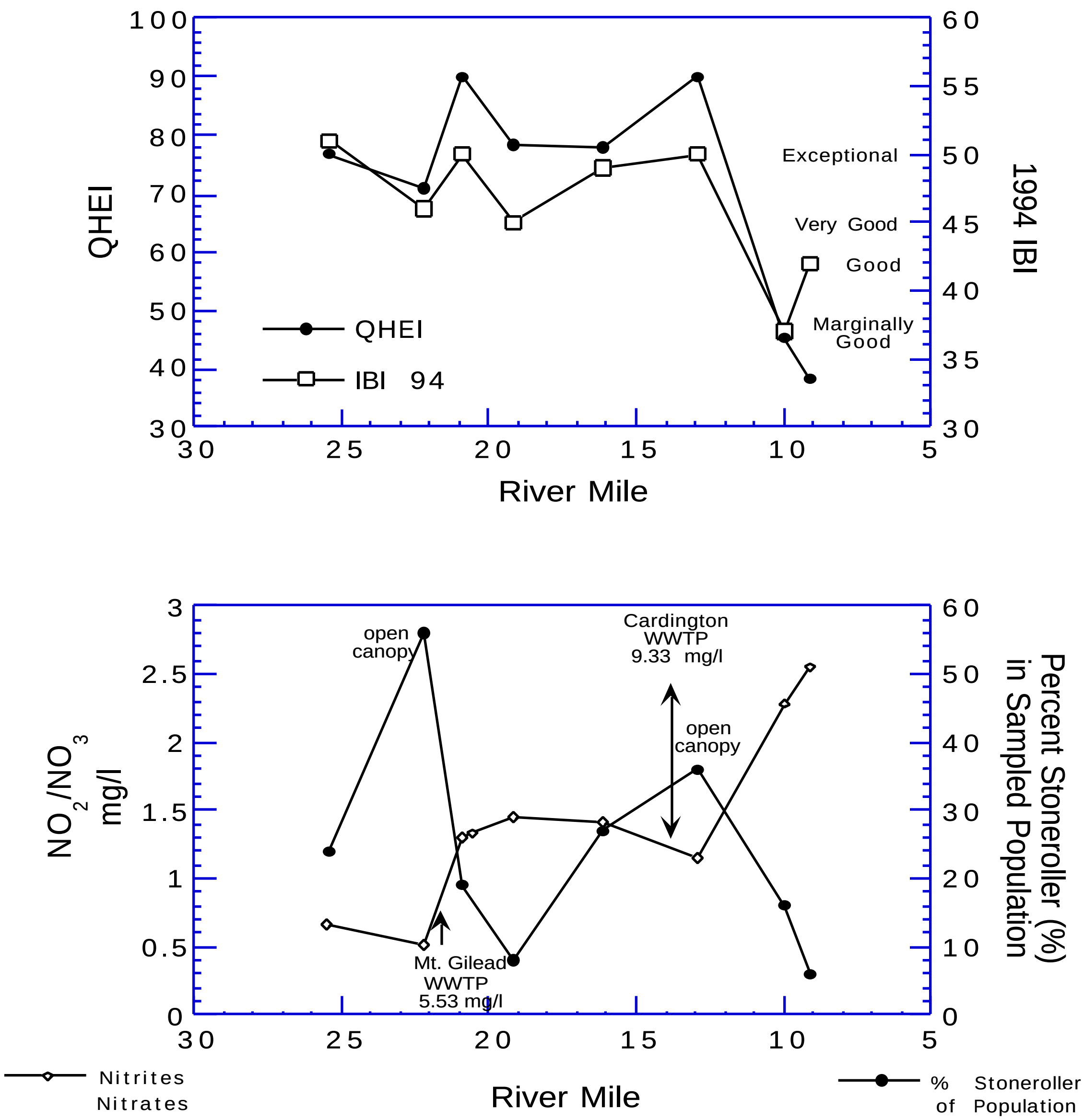
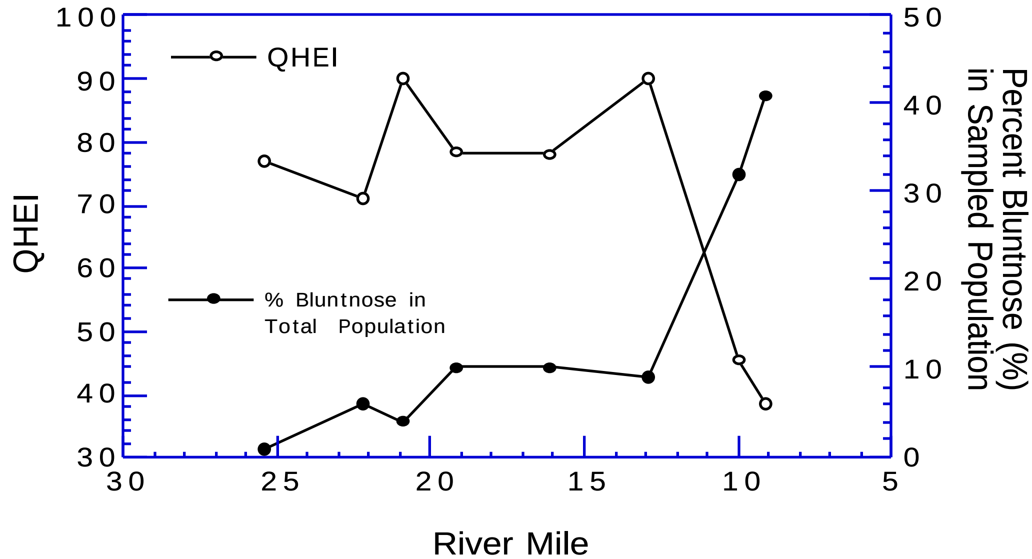



Figure 12. QHEI / IBI comparison and comparison of Stoneroller abundance vs.nitrite/nitrate concentrations longitudinally for Whetstone Creek survey, July-October 1994.



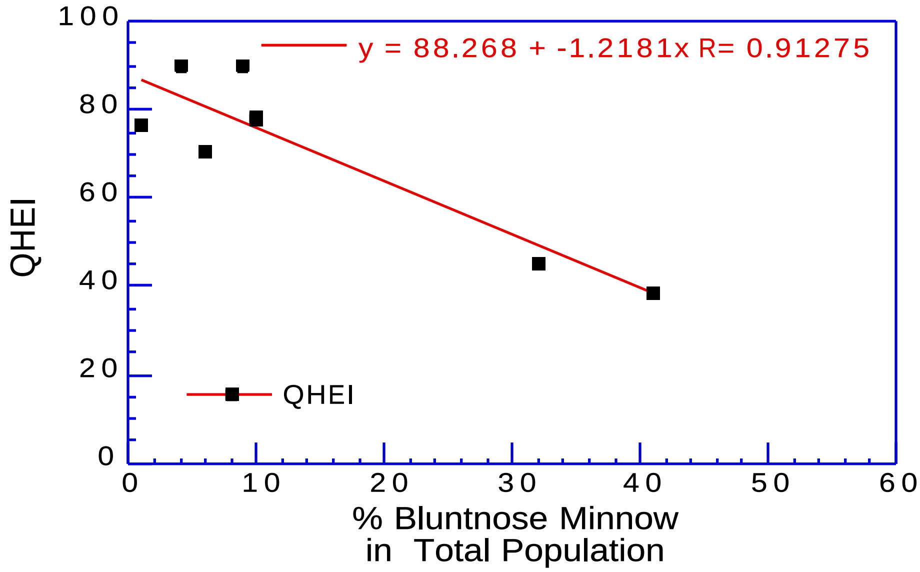




Figure 13. QHEI and Bluntnose minnow abundance comparisons longitudinally with correlation results for Whetstone Creek survey, July-October 1994.

## Trend Assessment

*Chemical Water Quality Changes: 1984- 1994*

- Where available, historic data from 1984 is shown in the graphical representation along with the 1994 data. This side by side comparison of data gives us important information concerning chemical changes that have occurred instream between 1984 and 1994.

- Heavy metal concentrations were elevated just downstream of the Mt. Gilead WWTP in 1984 (Figure 14). This trend has changed significantly since OEPA assigned a Pretreatment Program to monitor indirect discharges from industries into sewer systems. The lower 1994 concentrations of zinc, lead, copper and cadmium can be attributed to growing environmental awareness coupled with technological advances that allow less water to be used for a given process. Magnesium concentrations decreased throughout the study area in 1994, and calcium increased only slightly near RM 19.2 and below the Cardington WWTP discharge (Figure 14). Concentrations of naturally occurring elements may shift through time as the stream changes course or is fed by different sources of water.

- Fecal coliform levels from RM 25.53 to RM 21.71 have increased slightly between 1984 and 1994 (Figure 15). Additional homes in the unsewered headwaters and/or nonpoint runoff are likely the causes of this increasing trend in bacterial counts. From RM 20.85 to RM 9.91, the trend is the opposite with a decrease in fecal coliform levels. Total nonfilterable residues (or total dissolved solids) decreased significantly downstream from Mt. Gilead WWTP (Figure 15). Improved sewage treatment at the WWTPs as well as service area expansion of the WWTPs helps explain these trends. However future fecal coliform violations are a distinct possibility with the Cardington WWTP approaching and potentially exceeding design capacity (Table 7; Figure 15).

- The median instream pH levels throughout the study area were above 8.0 indicating an increased buffering capacity in the stream (Figure 15). Possibilities for the overall increase are a decrease of oil spills or salt brine introductions into the stream, an overall increase in instream algal production, and/or more dissolved buffering elements, like calcium, in the water column from local sediments through NPS inputs or from WWTP effluents (Figure 14). *However* insufficient nitrification in treated wasewater discharged at higher pHs can potentially increase ammonia toxicity instream causing lower N-ammonia concentrations to be more acutely toxic.

- When comparing the two data sets, nutrients associated with sewage have generally declined over time (Figure 16). This is especially noticeable immediately downstream of the Mt. Gilead WWTP and the unsewered community of Edison. Some concentrations have dropped by more than 50 percent. There is still some impact at approximately RM 20 initiated by effluent nutrients from the WWTP and unsewered septic inputs from Edison. Nutrient-induced low D.O. episodes interacting with related factors (high BOD/COD, possible diurnal D.O. fluctuations by algal production increased by more open canopy and higher water temperatures) are still a concern (Table 6; Figure 16). The overall improvement though may be directly attributed to upgrades in the system and strict requirements defined by the Clean Water Act (CWA) of 1984. The deadline for compliance with standards set by the amended CWA was July 1, 1988. The higher relative concentrations at Cardington WWTP of nitrites, nitrogen-ammonia, phosphorus and lower effluent D.O. (Figure 16; Table 7) again illustrated periodic incomplete waste treatment associated with flows at or near capacity.

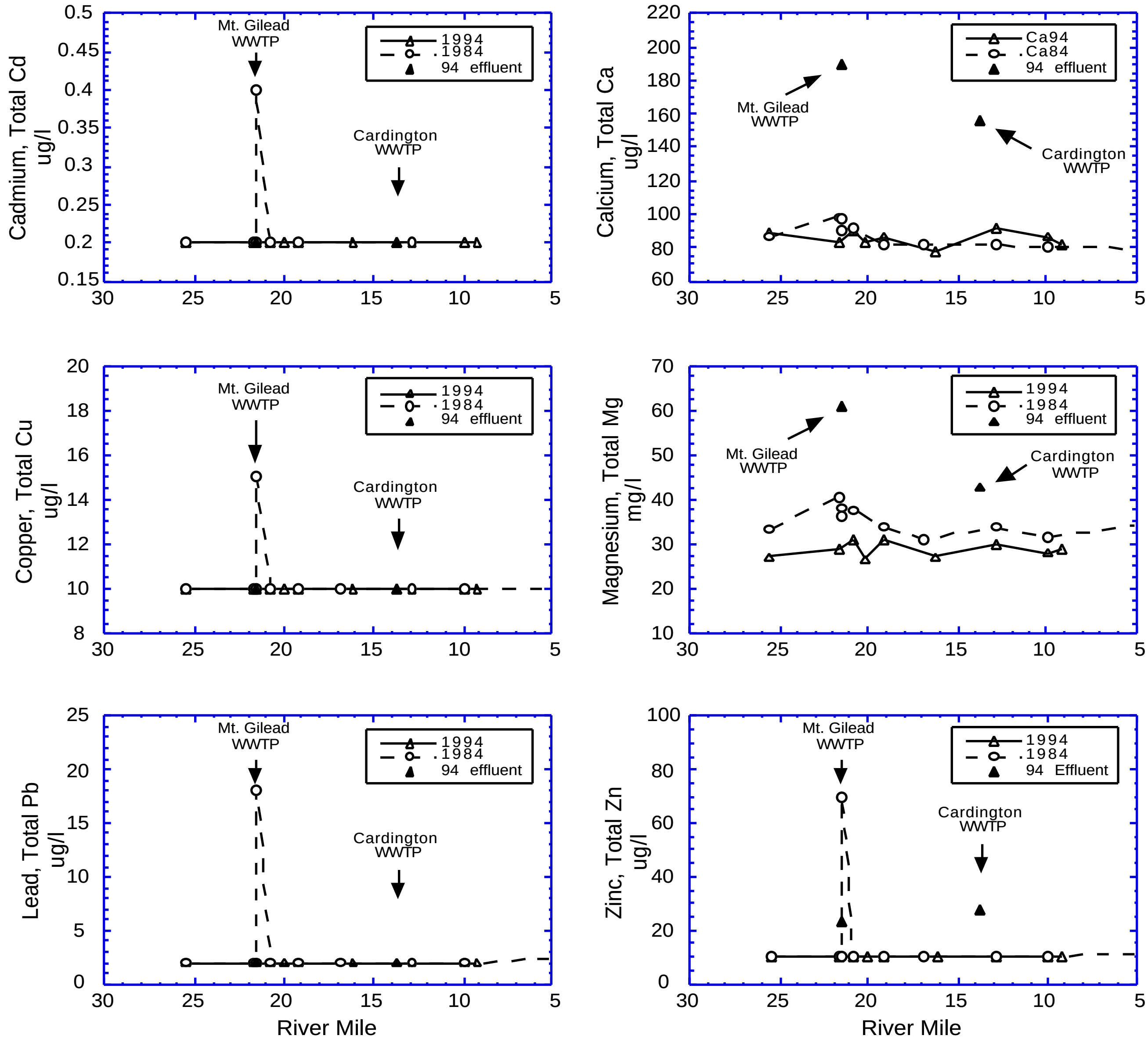



Figure 14. Chemical trends using median concentrations for cadmium, calcium, copper, lead, magnesium and zinc in Whetstone Creek, 1984 and 1994.

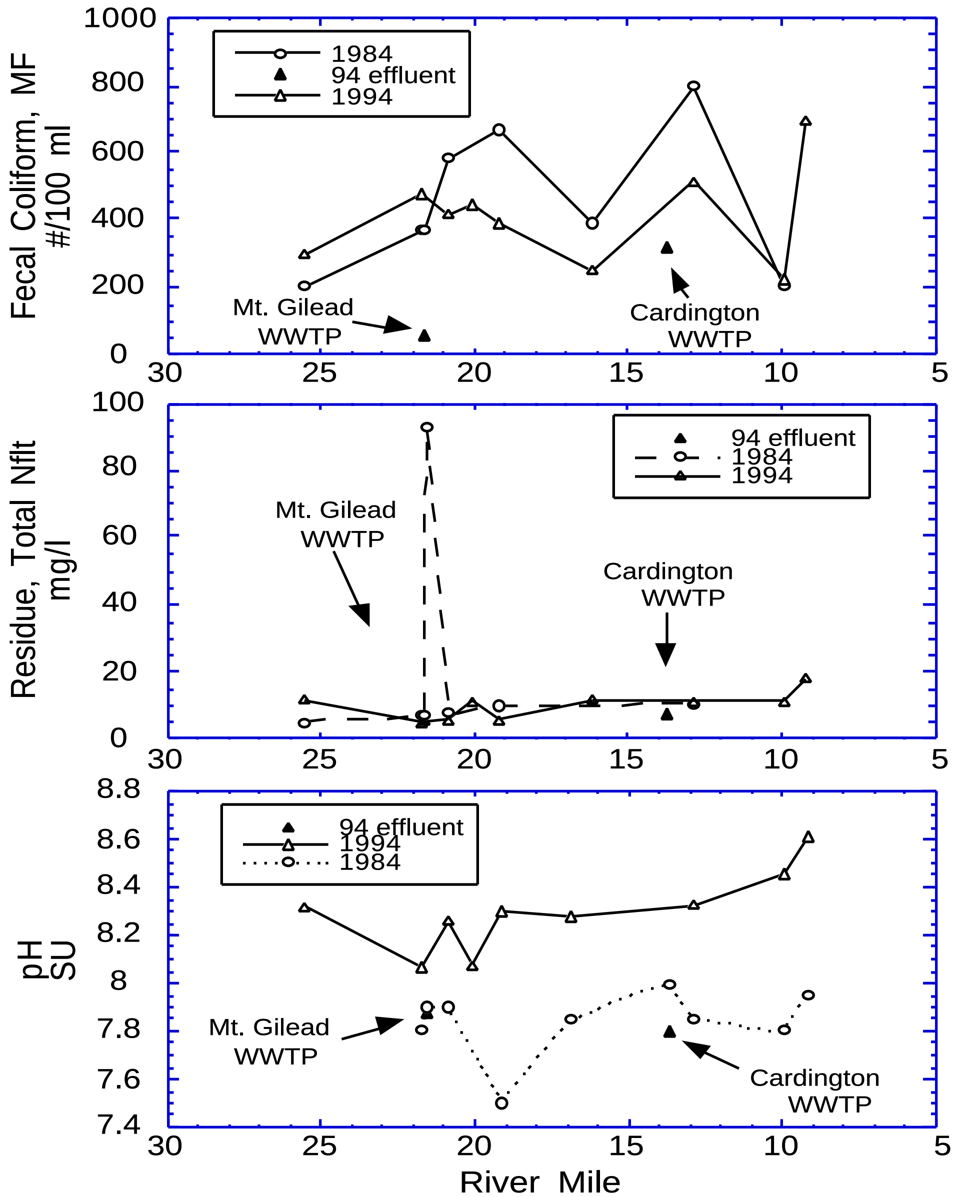



Figure 15. Chemical trends using median concentrations for fecal coliforms, nonfilterable residues and pH in Whetstone Creek, 1984 and 1994.

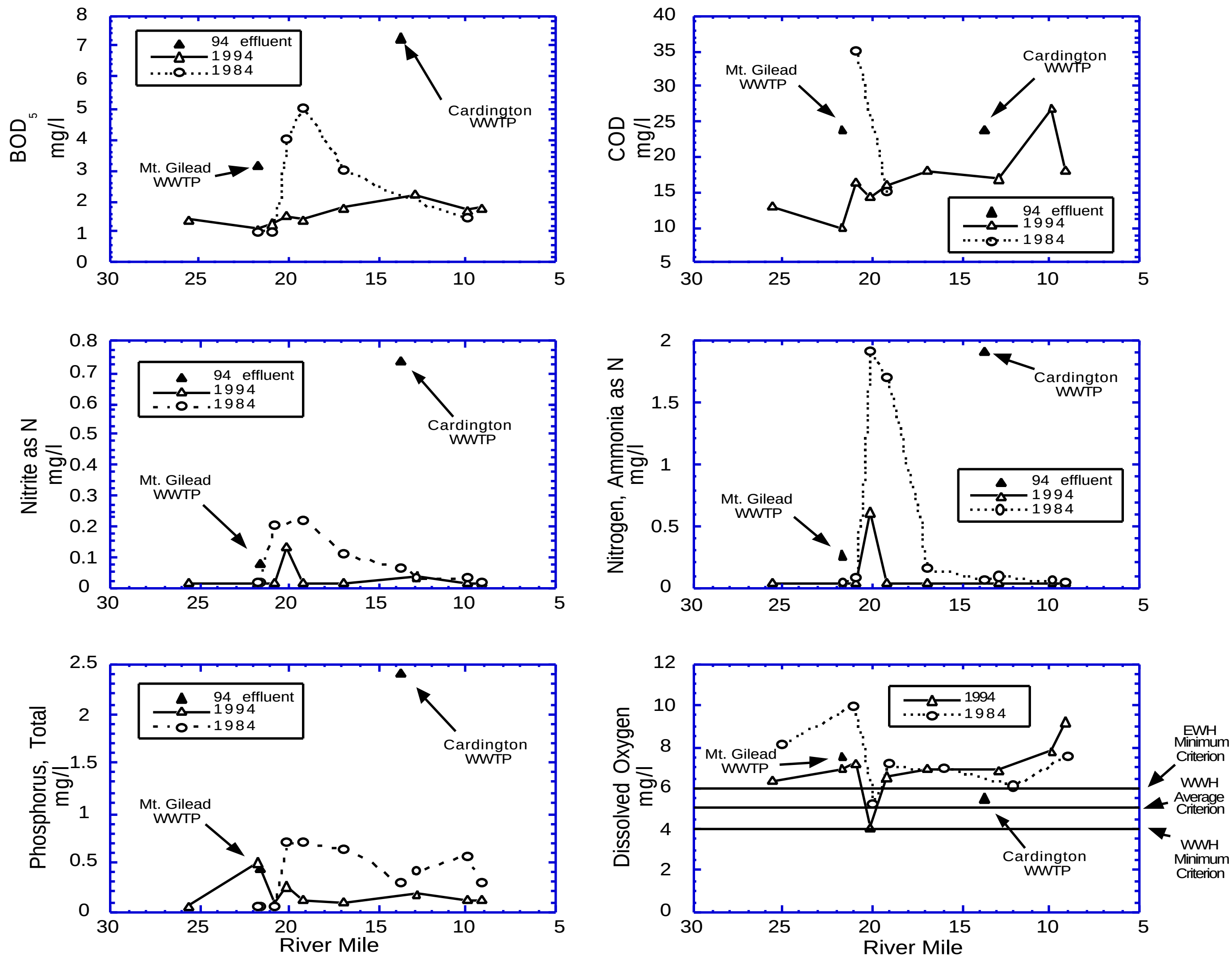



Figure 16. Chemical trends using median concentrations for BOD, COD, D.O., nitrogen-ammonia, nitrites and phosphorus in Whetstone Creek, 1984 and 1994.

*Changes in Biological Community Performance:*

***Macroinvertebrate Community 1984-1994***

- Macroinvertebrates were collected from Whetstone Creek in 1984 and 1994 from RM 25.5 to RM 10.1/9.9 (downstream from Cardington near Coleman Rd.). Generally, there was an increase of EPT taxa longitudinally over the whole stream except for downstream from Mt. Gilead and Edison at RM 19.2. Dramatic improvement since 1984 occurred downstream from the Mt. Gilead WWTP (RM 20.8) where there were 18 EPT taxa compared to 10 previously (Figure 17). Downstream from the Cardington WWTP at RM 10.1, EPT taxa totals increased from 15 in 1984 to 20 in 1994 (Figure 17). The Mt. Gilead WWTP did improve its treatment performance after the upgrade in 1984, but over the last few years the $NH_3$ and TSS concentrations have increased and poor maintenance has occurred (Tables 4,6 and Figures 5,16). The ICI score downstream from the WWTP (RM 20.9) achieved the WWH criterion with a score of 36 compared to 18 in 1984 (Figure 18). The QCTV trends plot also illustrates the improvement after the upgrade at Mt. Gilead WWTP (Figure 18). The 1994 QCTV scores

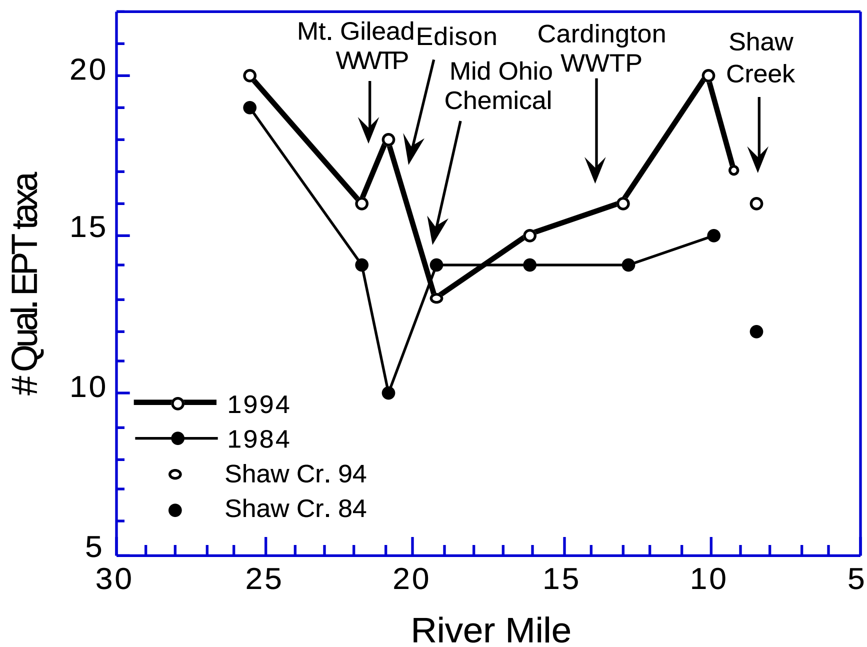



Figure 17. Qualitative EPT trends for Whetstone Creek, 1984 and 1994.

ranged from 38.5 to 39.3; all were above the ECBP ecoregion threshold QCTV (38.2) which denotes the minimum acceptable value as determined by QCTVs calculated for other sites in the ecoregion where ICI scores met or exceeded the WWH criterion. The 1984 QCTV score downstream of the Mt. Gilead WWTP (33.0) fell below the interquartile range (34.7-38.2) into the range of values from sites which failed to achieve the criterion (Figure 18). Now during times of efficient wastewater treatment plant performance and lower stream flows, the flow augmentation from the WWTP appears to improve instream conditions *if* the WWTP is functioning correctly. This was observed in the biological community by an increase in EPT taxa downstream from the WWTP discharge compared to RM 21.8 (upstream from the discharge) in 1994, while the 1984 sampling indicated worse conditions below the WWTP discharge (EPT decreased from 14 to 10 taxa; Figure 17). Also, the 25th percentile Tolerance Value scores downstream from the Mt. Gilead WWTP improved dramatically indicating some of the more tolerant macroinvertebrates previously present were absent (Figure 18). There was still a slight urban (septic) and/or NPS (likely fertilization/nutrients) threat from Mt. Gilead city limits to the WWTP, though the effect has substantially decreased (a fair assessment in 1984 versus an exceptional in 1994). This situation was still observed during qualitative sampling and also illustrated in Figures 17 and 18. The large, sustained decline in community quality (low ICIs) observed in 1984 between Mt. Gilead and Cardington was not detected in 1994 (Figure 18). Another substantial improvement in quality (downstream of Cardington) was attributed to a decrease in nutrient loadings (ammonia and phosphorus) from the Cardington WWTP and/or better NPS abatement strategies resulting in lower nutrient loadings. Though some D.O. fluctuations were measured, the quality of the macroinvertebrate community has improved overall. The number of qualitative taxa (84), total taxa (105), EPT taxa and organism density at RM 10.1 were the highest from Whetstone Creek (Figures 17,18). The site assessing NPS issues on Shaw Creek indicated good improvement in all comparative categories between 1984 and 1994 (Figures 17,18). However there still is a threat upstream from NPS agriculture inputs, riparian encroachment and possible spills from some oil operations.

- Area of Degradation Values (ADV) for the 1984 and 1994 surveys (Table 15) provide a relative measure of performance of the ICI from quantitative assessments and qualitative assessments estimating the ICI in the Whetstone Creek system. In 1984, about 45% of the stream miles surveyed fully achieved and about 55% did not achieve the WWH biocriterion for macroinvertebrates (ICI ADV/MILE=46.9). All sites in 1994 achieved the WWH biocriterion over a similar stretch of Whetstone Creek (ICI ADV/MILE=0). The decreased ICI ADV/MILE illustrates the improvements in the macroinvertebrate community since the 1984 biosurvey. The WWTP upgrade in Mt. Gilead late in 1984 was likely a major contributor to the improvement in water quality.

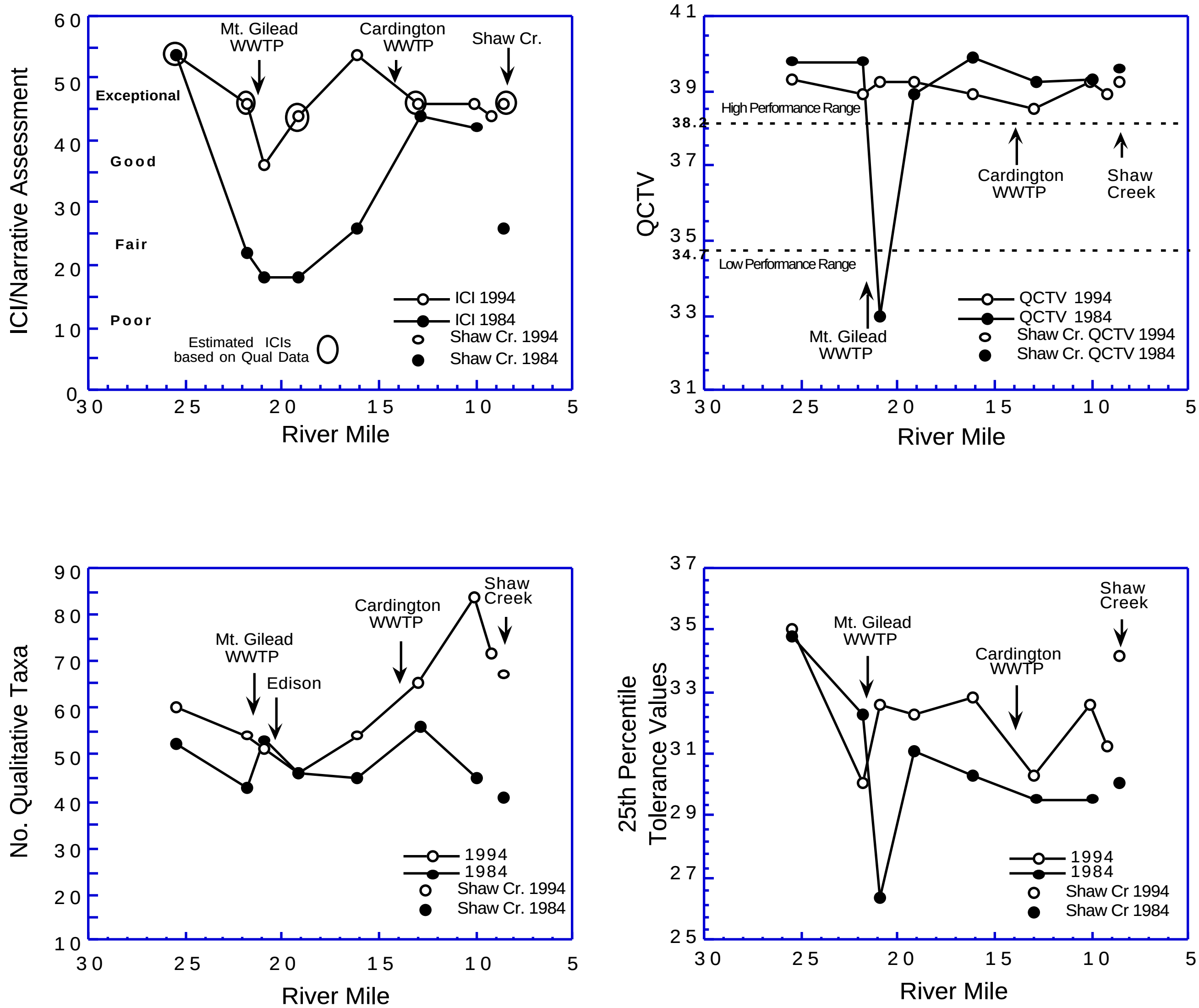



Figure 18. Trend plots for ICI/Narrative Assessment scores, QCTV scores, 25th percentile Tolerance Value Scores and number of total qualitative taxa for Whetstone Creek surveys, 1984 and 1994.

Table 15. Area of Degradation (ADV) statistics for the Whetstone Creek study area, 1984 and 1994 (calculated using ecoregion criteria as the background community performance) based on WWH criteria.

| 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 | PARTIAL | **NON** | Poor/VP |
| ***Whetstone Creek (1984)*** | | | | | | | | | | | |
| IBI | 25.5 | 9.6 | 34 | 46 | **9** | 0.57 | 0 | 8.1 | 7.6 | **0.7** | 0 |
| MIwb | | | 7.0 | 8.6 | **105** | 6.61 | 0 | | | | |
| ICI | | | 18 | 54 | **746** | 46.9 | 0 | | | | |
| ***Whetstone Creek (1994)*** | | | | | | | | | | | |
| IBI | 25.5 | 9.2 | 37 | 51 | **0** | 9.4 | 0 | 16.4 | 0.0 | **0.0** | 0 |
| MIwb | | | 8.2 | 10.2 | **0** | 3.7 | 0 | | | | |
| ICI | | | 36 | 54 | **0** | 2.3 | 0 | | | | |
| ***Shaw Creek (1984)*** | | | | | | | | | | | |
| IBI | 0.4 | 0.4 | 25 | 25 | **110** | NA | 20 | 0.0 | 0.0 | **1.0** | 1.0 |
| MIwb | | | 6.8 | 6.8 | **50** | NA | 0 | | | | |
| ICI | | | 26 | 26 | **60** | NA | 0 | | | | |
| ***Shaw Creek (1994)*** | | | | | | | | | | | |
| IBI | 0.4 | 0.4 | 44 | 44 | **0** | 0 | 0 | 1.0 | 0.0 | **0.0** | 0 |
| MIwb | | | 8.9 | 8.9 | **0** | 0 | 0 | | | | |
| ICI | | | 46 | 46 | **0** | 0 | 0 | | | | |

*Changes in Biological Community Performance:*

### ***Fish Community 1984-1994***

- Fish community data were collected from seven sites in Whetstone Creek in 1984. This survey was essentially duplicated in 1994. Longitudinal comparison of recent and past fish community data indicates an average improvement of four IBI points and 1.2 MIwb points has occurred in Whetstone Creek over this 10 year period (Figure 19).

- In 1984, the fish community performance was generally characterized as good (mean IBI=42). However, some moderate toxicity appeared to be limiting the community as indicated by typically marginally good MIwb scores (mean MIwb=7.9). In the 1984 study, high levels of Ammonia-N, low dissolved oxygen levels, and organic enrichment were attributed to effluent from the Mt. Gilead and Cardington WWTP's .

- The improvement in the 1994 fish assemblage was most closely associated with reductions in toxic point source loadings. Although both Mt. Gilead and Cardington WWTP's continued to have episodic exceedences of permit limitations, general improvements in WWTP operating conditions have occurred and the fish community response reflected this.

- In 1984, the mean number of species at each site was 20 compared to 24 in 1994. The mean relative number of fish at each site increased from 593 in 1984 to 1649 in 1994. The number of darter species and the percentage of simple lithophils also significantly increased at each site over the ten year period.

- Field notes from the 1984 study did not indicate any excessive silt load in the Creek. In 1994, silt was present in heavy and moderate amounts at each sample location. Pools are depositional areas with excess silt collecting there. Additionally many toxic pollutants adhere to the surface of sediment particles increasing the potential for stress in these areas. The influence of these factors may be responsible for the disproportionate representation by top carnivores and the pool habitat sensitive sunfish species.

- Pool conditions in the Creek appeared to be more stressed than previously detected. The percentage of top carnivores fell below 5 percent in all 1994 samples (mean=2.1%). The number of sunfish species also declined from 1984 in several 1994 samples. This, coupled with the presence of only two or three intolerant species at each site in 1994, provided support for concern over the amount of silt in the stream.

- Despite this observation the fish community in Whetstone Creek performed at an exceptional to near exceptional level in 1994. In 1994, ADV statistics indicated 16.4 miles of the Creek were in full attainment of the WWH criteria compared to 8.1 miles in 1984 (Table 15).

- In order for the fish community in Whetstone Creek to achieve additional increases in its performance, efforts to enhance the riparian corridor and limit siltation and nutrient enrichment will be necessary.

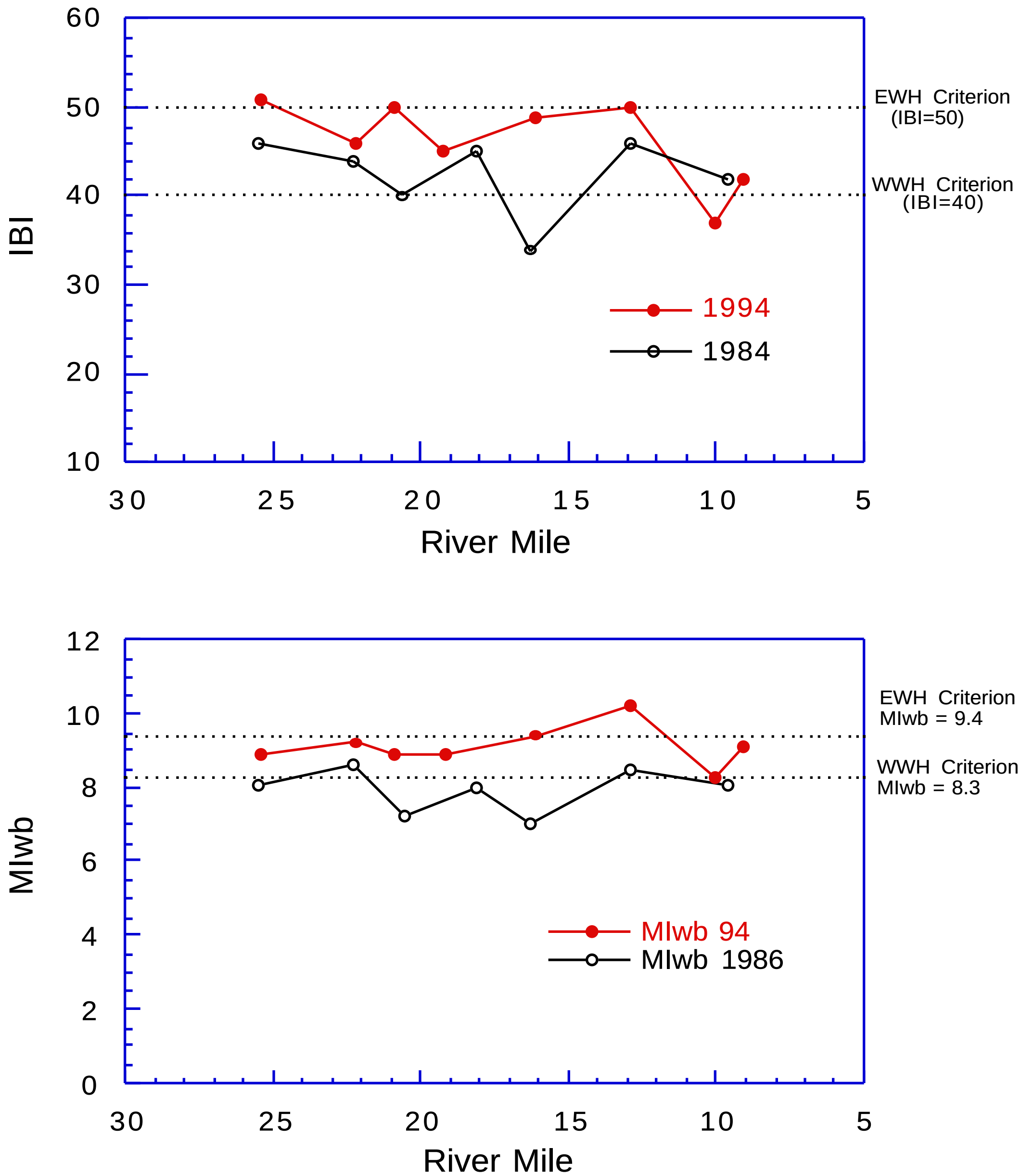



Figure 19. Fish community IBI and MIwb trends for Whetstone Creek, 1984 and 1994.

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Appendix Table 1 QHEI Scores for Whetstone Creek Survey,1994

**Key QHEI Components**

| River Mile | QHEI | Gradient (ft/mile) | WWH Attributes | | | | | | | | | | | MWH Attributes: High Influence | | | | | | MWH Attributes: Moderate Influence | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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** | Channelized or No Recovery | Silt/Muck Substrates | Low Sinuosity | Sparse/No Cover | Max. Depth < 40 cm (WD/HW) | **Total H.I. MWH Attributes** | 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 H.I./WWH Ratio** | **MWH M.I./WWH Ratio** |
| (02-450) Whetstone Creek | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 94 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25.4 | 77.0BA | 5.85 | ■ | ■ | | ■ | ■ | ■ | | | ■ | | 6 | | | | | | 0 | ▲ | | | | | | | ▲ | ▲ | ▲ | | | 4 | 0.14 | 0.71 |
| 22.2 | 71.0BA | 15.63 | ■ | ■ | | ■ | | ■ | ■ | | ■ | | 6 | ● | | | | | 1 | ▲ | | | | ▲ | | | | ▲ | ▲ | | | 4 | 0.29 | 0.86 |
| 20.9 | 90.0BA | 9.80 | ■ | ■ | | ■ | ■ | ■ | ■ | | ■ | | 7 | | | | | | 0 | ▲ | | | | | | | | ▲ | ▲ | | | 3 | 0.13 | 0.50 |
| 19.2 | 78.5BA | 6.33 | ■ | ■ | | ■ | | ■ | ■ | | ■ | | 6 | | | | | | 0 | ▲ | | | | ▲ | | | | ▲ | ▲ | | | 4 | 0.14 | 0.71 |
| 16.1 | 78.0BA | 6.17 | ■ | ■ | | ■ | | ■ | ■ | | ■ | | 6 | | | | | | 0 | ▲ | | | | ▲ | | | | ▲ | ▲ | | | 4 | 0.14 | 0.71 |
| 12.9 | 90.0BA | 5.43 | ■ | ■ | | ■ | ■ | ■ | ■ | | ■ | | 7 | | | | | | 0 | ▲ | | | | | | | | ▲ | ▲ | | | 3 | 0.13 | 0.50 |
| 10.0 | 45.5BA | 5.10 | ■ | | | ■ | | | ■ | | ■ | | 4 | ● | | ● | | | 2 | ▲ | | | | ▲ | | | | ▲ | ▲ | | | 4 | 0.60 | 1.40 |
| 9.1 | 38.5BA | 5.81 | ■ | | | | | | | | ■ | | 2 | ● | | ● | | | 2 | ▲ | | | ▲ | ▲ | ▲ | | ▲ | ▲ | ▲ | ▲ | | 8 | 1.00 | 3.67 |
| (02-453) Shaw Creek | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 94 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.4 | 60.0BA | 6.49 | ■ | | | ■ | ■ | ■ | | | ■ | | 5 | ● | | | | | 1 | ▲ | | | | | | | ▲ | ▲ | ▲ | | | 4 | 0.33 | 1.00 |

Appendix Table 2 Chemical data for Whetstone Creek Survey, 1994

| River Mile | Date | Lead | Magnesium | Calcium | Zinc | Hardness |
|---|---|---|---|---|---|---|
| ***Whetstone Creek*** | | | | | | |
| 25.53 | 082394 | 2* | 24 | 74 | 10* | 284 |
| 25.53 | 081094 | 2* | 30 | 90 | 25 | 348 |
| 25.53 | 072694 | 2* | 27 | 89 | 10* | 333 |
| 25.53 | 071494 | 2* | 19 | 64 | 10* | 238 |
| 25.53 | 062394 | 2* | 29 | 90 | 27 | 344 |
| 21.71 | 082394 | 2* | 29 | 86 | 10* | 334 |
| 21.71 | 081094 | 2* | 32 | 85 | 10 | 344 |
| 21.71 | 072694 | 2* | 28 | 83 | 10* | 323 |
| 21.71 | 071494 | 2* | 20 | 67 | 10* | 250 |
| 21.71 | 062394 | 2* | 30 | 82 | 10* | 328 |
| 21.60 | 082294 | 2* | 60 | 180 | 18 | 697 |
| 21.60 | 081094 | 2* | 70 | 201 | 22 | 790 |
| 21.60 | 072694 | 2* | 64 | 194 | 25 | 748 |
| 21.60 | 071494 | 2* | 61 | 190 | 26 | 726 |
| 21.60 | 062394 | 2 | 60 | 188 | 23 | 717 |
| 20.85 | 082394 | 2* | 30 | 85 | 15 | 336 |
| 20.85 | 081094 | 2* | 34 | 97 | 10* | 382 |
| 20.85 | 072694 | 2* | 32 | 98 | 10* | 376 |
| 20.85 | 071594 | 2* | 22 | 71 | 10* | 268 |
| 20.10 | 071494 | 2* | 20 | 70 | 10* | 257 |
| 20.10 | 062394 | 2* | 33 | 96 | 10* | 376 |
| 19.17 | 082394 | 2* | 31 | 87 | 10* | 345 |
| 19.17 | 081094 | 2* | 38 | 107 | 10* | 424 |
| 19.17 | 072694 | 2* | 31 | 96 | 10* | 367 |
| 19.17 | 071494 | 2* | 20 | 72 | 39 | 262 |
| 19.17 | 062394 | 2* | 29 | 87 | 10* | 337 |
| 16.19 | 082394 | 2* | 27 | 73 | 11 | 293 |
| 16.19 | 081094 | 2* | 34 | 92 | 10* | 370 |
| 16.19 | 072694 | 2* | 31 | 98 | 16 | 372 |
| 16.19 | 071494 | 2* | 21 | 74 | 10* | 271 |
| 16.19 | 062394 | 2* | 25 | 78 | 10* | 298 |
| 13.70 | 082294 | 2* | 41 | 156 | 30 | 558 |
| 13.70 | 081094 | 2* | 45 | 158 | 26 | 580 |
| 13.70 | 072694 | 2* | 48 | 159 | 28 | 595 |
| 13.70 | 071494 | 2* | 38 | 131 | 19 | 484 |
| 13.70 | 062394 | 2* | 43 | 151 | 31 | 554 |
| 12.88 | 082394 | 2* | 23 | 67 | 15 | 262 |
| 12.88 | 081094 | 2* | 33 | 92 | 10* | 365 |
| 12.88 | 072694 | 2* | 30 | 97 | 10* | 366 |

| River Mile | Date | Lead | Magnesium | Calcium | Zinc | Hardness |
|---|---|---|---|---|---|---|
| ***Whetstone Creek*** | | | | | | |
| 12.88 | 071494 | 2* | 21 | 72 | 10 | 266 |
| 12.88 | 062394 | 8 | 31 | 92 | 23 | 357 |
| 09.91 | 082394 | 2* | 30 | 86 | 12 | 338 |
| 09.91 | 081094 | 2* | 33 | 92 | 10* | 366 |
| 09.91 | 072694 | 2* | 27 | 89 | 10* | 333 |
| 09.91 | 071494 | 2* | 21 | 72 | 10* | 266 |
| 09.91 | 062394 | 2* | 28 | 84 | 23 | 325 |
| 09.20 | 082394 | 2* | 29 | 81 | 11 | 322 |
| 09.20 | 081094 | 2* | 33 | 90 | 10* | 361 |
| 09.20 | 072694 | 2* | 29 | 91 | 10* | 347 |
| 09.20 | 071494 | 2* | 22 | 74 | 10* | 275 |
| 09.20 | 062394 | 2* | 25 | 81 | 11 | 305 |
| ***Shaw Creek*** | | | | | | |
| 01.56 | 082394 | 2* | 31 | 87 | 13 | 345 |
| 01.56 | 081094 | 2* | 33 | 87 | 10* | 353 |
| 01.56 | 072694 | 2* | 32 | 98 | 10* | 376 |
| 01.56 | 071494 | 2* | 24 | 83 | 11 | 306 |
| 01.56 | 062394 | 3 | 25 | 81 | 24 | 305 |

* Denotes value was below this detection limit.

| River Mile | Date | Arsenic | Cadmium | Nickel | Chromium | Copper |
|---|---|---|---|---|---|---|
| ***Whetstone Creek*** | | | | | | |
| 25.53 | 082394 | 2 | .2* | 40* | 30* | 10* |
| 25.53 | 081094 | 3 | .2* | 40* | 30* | 10* |
| 25.53 | 072694 | 2* | .2* | 40* | 30* | 10* |
| 25.53 | 071494 | 2* | .2* | 40* | 30* | 10* |
| 25.53 | 062394 | 2* | .2* | 40* | 30* | 10* |
| 21.71 | 082394 | 2* | .2* | 40* | 30* | 10* |
| 21.71 | 081094 | 2* | .2* | 40* | 30* | 10* |
| 21.71 | 072694 | 2* | .2* | 40* | 30* | 10* |
| 21.71 | 071494 | 2* | .2* | 40* | 30* | 10* |
| 21.71 | 062394 | 2* | .2* | 40* | 30* | 10* |
| 21.60 | 082294 | 8 | .2* | 40* | 30* | 10* |
| 21.60 | 081094 | 11 | .2* | 40* | 30* | 10* |
| 21.60 | 072694 | 11 | .2* | 40* | 30* | 10* |
| 21.60 | 071494 | 3 | .2* | 40* | 30* | 10* |
| 21.60 | 062394 | 4 | .2* | 40* | 30* | 10* |

| River Mile | Date | Arsenic | Cadmium | Nickel | Chromium | Copper |
|---|---|---|---|---|---|---|
| ***Whetstone Creek*** | | | | | | |
| 20.85 | 082394 | 3 | .2* | 40* | 30* | 10* |
| 20.85 | 081094 | 4 | .2* | 40* | 30* | 10* |
| 20.85 | 072694 | 2 | .2* | 40* | 30* | 10* |
| 20.85 | 071594 | 2* | .2* | 40* | 30* | 10* |
| 20.10 | 071494 | 2* | .2* | 40* | 30* | 10* |
| 20.10 | 062394 | 3 | .2* | 40* | 30* | 10* |
| 19.17 | 082394 | 3 | .2* | 40* | 30* | 10* |
| 19.17 | 081094 | 4 | .2* | 40* | 30* | 10* |
| 19.17 | 072694 | 3 | .2* | 40* | 30* | 10* |
| 19.17 | 071494 | 2* | .2* | 40* | 30* | 10* |
| 19.17 | 062394 | 4 | .2* | 40* | 30* | 10* |
| 16.19 | 082394 | 3 | .2* | 40* | 30* | 10* |
| 16.19 | 081094 | 4 | .2* | 40* | 30* | 10* |
| 16.19 | 072694 | 2 | .2* | 40* | 30* | 10* |
| 16.19 | 071494 | 2 | .2* | 40* | 30* | 10* |
| 16.19 | 062394 | 2* | .2* | 40* | 30* | 10* |
| 13.70 | 082294 | 2* | .2* | 40* | 30* | 10* |
| 13.70 | 081094 | 2* | .2* | 40* | 30* | 10* |
| 13.70 | 072694 | 2* | .2* | 40* | 30* | 10* |
| 13.70 | 071494 | 2* | .2* | 40* | 30* | 10* |
| 13.70 | 062394 | 2* | .2* | 40* | 30* | 10* |
| 12.88 | 082394 | 3 | .2* | 40* | 30* | 10* |
| 12.88 | 081094 | 3 | .2* | 40* | 30* | 10* |
| 12.88 | 072694 | 3 | .2* | 40* | 30* | 10* |
| 12.88 | 071494 | 2* | .2* | 40* | 30* | 10* |
| 12.88 | 062394 | 3 | .2* | 40* | 30* | 10* |
| 09.91 | 082394 | 3 | .2* | 40* | 30* | 10* |
| 09.91 | 081094 | 3 | .2* | 40* | 30* | 10* |
| 09.91 | 072694 | 2 | .2* | 40* | 30* | 10* |
| 09.91 | 071494 | 2* | .2* | 40* | 30* | 10* |
| 09.91 | 062394 | 2* | .2* | 40* | 30* | 10* |
| 09.20 | 082394 | 4 | .2* | 40* | 30* | 10* |
| 09.20 | 081094 | 3 | .2* | 40* | 30* | 10* |
| 09.20 | 072694 | 3 | .2* | 40* | 30* | 10* |
| 09.20 | 071494 | 2* | .2* | 40* | 30* | 10* |
| 09.20 | 062394 | 2* | .2* | 40* | 30* | 10* |
| ***Shaw Creek*** | | | | | | |
| 01.56 | 082394 | 2* | .2* | 40* | 30* | 10* |
| 01.56 | 081094 | 2* | .2* | 40* | 30* | 10* |
| 01.56 | 072694 | 2* | .2* | 40* | 30* | 10* |
| 01.56 | 071494 | 2* | .2* | 40* | 30* | 10* |
| 01.56 | 062394 | 2* | .2* | 40* | 30* | 10* |

* Denotes value was below this detection limit.

| River Mile | Date | Nitrite+ Nitrite-N | Nitrite-N | Ammonia | Total Kjeldahl-N | Phosphorus |
|---|---|---|---|---|---|---|
| ***Whetstone Creek*** | | | | | | |
| 25.53 | 082394 | 0.34 | 0.02 | 0.05* | 0.6 | 0.05* |
| 25.53 | 081094 | 0.19 | 0.02* | 0.06 | 0.4 | 0.05* |
| 25.53 | 072694 | 0.29 | 0.02* | 0.05* | 0.3 | 0.05* |
| 25.53 | 071494 | 1.90 | 0.02 | 0.05* | 0.5 | 0.05* |
| 25.53 | 062394 | 0.33 | 0.03 | 0.10 | 0.6 | 0.06 |
| 21.71 | 082394 | 0.12 | 0.02* | 0.05* | 0.4 | 0.05* |
| 21.71 | 081094 | 0.18 | 0.02* | 0.05* | 0.3 | 0.05 |
| 21.71 | 072694 | 0.30 | 0.02* | 0.05* | 0.4 | 0.05* |
| 21.71 | 071494 | 1.77 | 0.02 | 0.05* | 0.6 | 0.05* |
| 21.71 | 062394 | 0.22 | 0.02 | 0.05* | 0.4 | 0.05 |
| 21.60 | 082294 | 4.45 | 0.05 | 0.05 | 1.0 | 0.67 |
| 21.60 | 081094 | 10.20 | 0.07 | 0.27 | 1.2 | 1.19 |
| 21.60 | 072694 | 5.56 | 0.10 | 0.31 | 1.4 | 0.43 |
| 21.60 | 071494 | 6.02 | 0.08 | 0.23 | 1.1 | 0.21 |
| 21.60 | 062394 | 1.40 | 1.28 | 8.73 | 11.0 | 0.38 |
| 20.85 | 082394 | 0.41 | 0.02 | 0.05* | 0.5 | 0.09 |
| 20.85 | 081094 | 2.47 | 0.02 | 0.06 | 0.9 | 0.28 |
| 20.85 | 072694 | 0.89 | 0.02* | 0.05* | 0.5 | 0.05* |
| 20.85 | 071594 | 1.42 | 0.03 | 0.05* | 0.5 | 0.05* |
| 20.10 | 071494 | 1.84 | 0.02 | 0.06 | 0.8 | 0.06 |
| 20.10 | 062394 | 0.83 | 0.23 | 1.18 | 1.3 | 0.44 |
| 19.17 | 082394 | 0.54 | 0.02* | 0.05* | 0.4 | 0.12 |
| 19.17 | 081094 | 2.53 | 0.02 | 0.05 | 0.8 | 0.25 |
| 19.17 | 072694 | 1.08 | 0.02* | 0.05* | 0.5 | 0.06 |
| 19.17 | 071494 | 1.96 | 0.03 | 0.05 | 0.6 | 0.08 |
| 19.17 | 062394 | 1.15 | 0.18 | 0.23 | 0.8 | 0.41 |
| 16.19 | 082394 | 0.40 | 0.02 | 0.05* | 0.5 | 0.10 |
| 16.19 | 081094 | 0.84 | 0.02* | 0.07 | 0.7 | 0.08 |
| 16.19 | 072694 | 0.84 | 0.02* | 0.05* | 0.5 | 0.06 |
| 16.19 | 071494 | 1.78 | 0.02 | 0.05* | 0.5 | 0.10 |
| 16.19 | 062394 | 3.31 | 0.18 | 0.12 | 0.6 | 0.19 |
| 13.70 | 082294 | 7.19 | 0.75 | 4.45 | 6.3 | 1.44 |
| 13.70 | 081094 | 12.00 | 0.71 | 1.46 | 2.5 | 2.61 |
| 13.70 | 072694 | 8.62 | 0.38 | 1.29 | 2.5 | 2.42 |
| 13.70 | 071494 | 7.52 | 1.32 | 1.92 | 2.8 | 1.33 |
| 13.70 | 062394 | 11.30 | 0.74 | 6.53 | 9.0 | 2.88 |
| 12.88 | 082394 | 1.30 | 0.04 | 0.05* | 0.5 | 0.18 |
| 12.88 | 081094 | 0.92 | 0.04 | 0.11 | 0.8 | 0.25 |
| 12.88 | 072694 | 0.70 | 0.02 | 0.05* | 0.6 | 0.18 |
| 12.88 | 071494 | 2.04 | 0.03 | 0.05* | 0.6 | 0.13 |
| 12.88 | 062394 | 0.86 | 0.08 | 0.08 | 0.8 | 0.33 |
| 09.91 | 082394 | 1.16 | 0.02 | 0.05* | 0.7 | 0.14 |
| 09.91 | 081094 | 0.59 | 0.02* | 0.05 | 0.6 | 0.11 |
| 09.91 | 072694 | 0.60 | 0.02* | 0.05* | 0.7 | 0.11 |

| River Mile | Date | Nitrite+ Nitrite-N | Nitrite-N | Ammonia | Total Kjeldahl-N | Phosphorus |
|---|---|---|---|---|---|---|
| ***Whetstone Creek*** | | | | | | |
| 09.91 | 071494 | 2.01 | 0.02 | 0.05* | 0.6 | 0.09 |
| 09.91 | 062394 | 7.09 | 0.13 | 0.05* | 0.8 | 0.18 |
| 09.20 | 082394 | 1.04 | 0.02 | 0.05* | 0.6 | 0.14 |
| 09.20 | 081094 | 0.48 | 0.02* | 0.06 | 0.6 | 0.09 |
| 09.20 | 072694 | 0.49 | 0.02* | 0.05* | 0.6 | 0.10 |
| 09.20 | 071494 | 2.09 | 0.02 | 0.06 | 0.6 | 0.11 |
| 09.20 | 062394 | 8.71 | 0.15 | 0.05* | 0.9 | 0.16 |
| ***Shaw Creek*** | | | | | | |
| 01.56 | 082394 | 0.94 | 0.04 | 0.05* | 0.6 | 0.09 |
| 01.56 | 081094 | 0.28 | 0.02* | 0.05 | 0.4 | 0.08 |
| 01.56 | 072694 | 0.68 | 0.02* | 0.05* | 0.5 | 0.08 |
| 01.56 | 071494 | 1.94 | 0.04 | 0.07 | 0.6 | 0.09 |
| 01.56 | 062394 | 8.12 | 0.18 | 0.05* | 0.7 | 0.13 |

* Denotes value was below this detection limit.

| River Mile | Date | Chlorine | Conductivity | Dissolved Oxygen | pH | Temperature (C) |
|---|---|---|---|---|---|---|
| ***Whetstone Creek*** | | | | | | |
| 25.53 | 082394 | - | 442 | 7.0 | 8.72 | 17.1 |
| 25.53 | 081094 | - | 700 | 7.5 | 8.32 | 15.5 |
| 25.53 | 072694 | - | 650 | 5.5 | 8.20 | 19.2 |
| 25.53 | 071494 | - | 420 | 6.4 | 8.36 | 20.9 |
| 25.53 | 062394 | - | 670 | 4.1 | 8.11 | 20.6 |
| 21.71 | 082394 | - | 590 | 7.4 | 8.57 | 18.2 |
| 21.71 | 081094 | - | 750 | 6.9 | 8.05 | 16.0 |
| 21.71 | 072694 | - | 700 | 6.0 | 8.03 | 19.8 |
| 21.71 | 071494 | - | 520 | 7.4 | 8.32 | 21.7 |
| 21.71 | 062394 | - | 710 | 2.7 | 8.06 | 21.3 |
| 21.60 | 082294 | .20 | 2200 | 7.8 | 7.89 | 20.9 |
| 21.60 | 081094 | .24 | 3400 | 7.6 | 8.04 | 18.5 |
| 21.60 | 072694 | .19 | 3900 | 7.2 | 7.88 | 19.8 |
| 21.60 | 071594 | .32 | - | - | - | - |
| 21.60 | 071494 | - | 2800 | 6.5 | 7.85 | 19.2 |
| 21.60 | 062394 | .67 | 3000 | 7.5 | 7.8 | 19.5 |
| 20.85 | 082394 | - | 800 | 8.0 | 8.64 | 18.8 |
| 20.85 | 081094 | - | 1250 | 7.5 | 8.30 | 16.5 |
| 20.85 | 072694 | - | 1100 | 6.9 | 8.22 | 19.9 |
| 20.85 | 071594 | - | 610 | 6.9 | 8.19 | 22.2 |

| River Mile | Date | Chlorine | Conductivity | Dissolved Oxygen | pH | Temperature (C) |
|---|---|---|---|---|---|---|
| ***Whetstone Creek*** | | | | | | |
| 20.10 | 071494 | - | 600 | 5.9 | 8.20 | 21.2 |
| 20.10 | 062394 | - | 1120 | 2.2 | 7.94 | 22.5 |
| 19.17 | 082394 | - | 700 | 6.6 | 8.73 | 18.2 |
| 19.17 | 081094 | - | 1325 | 7.1 | 8.37 | 16.4 |
| 19.17 | 072694 | - | 1020 | 6.0 | 8.30 | 20.2 |
| 19.17 | 071494 | - | 690 | 7.1 | 8.12 | 22.0 |
| 19.17 | 062394 | - | 980 | 2.4 | 7.97 | 21.9 |
| 16.19 | 082394 | - | 600 | 7.1 | 8.60 | 19.1 |
| 16.19 | 081094 | - | 950 | 7.3 | 8.42 | 16.2 |
| 16.19 | 072694 | - | 1010 | 6.3 | 8.28 | 21.0 |
| 16.19 | 071494 | - | 700 | 6.9 | 8.17 | 22.0 |
| 16.19 | 062394 | - | 950 | 4.0 | 7.99 | 24.8 |
| 13.70 | 082294 | .66 | 1500 | 4.7 | 7.83 | 18.5 |
| 13.70 | 081094 | .55 | 1800 | 5.4 | 7.81 | 19.2 |
| 13.70 | 072694 | 1.61 | 1600 | 6.4 | 7.74 | 20.1 |
| 13.70 | 071594 | .10 | - | - | - | - |
| 13.70 | 071494 | - | 1300 | 5.3 | 7.71 | 19.0 |
| 13.70 | 062394 | .09 | 1500 | 5.9 | 7.8 | 18.5 |
| 12.88 | 082394 | - | 720 | 6.8 | 8.59 | 19.3 |
| 12.88 | 081094 | - | 1000 | 7.0 | 8.39 | 17.9 |
| 12.88 | 072694 | - | 900 | 5.7 | 8.33 | 21.0 |
| 12.88 | 071494 | - | 650 | 7.0 | 8.22 | 22.9 |
| 12.88 | 062394 | - | 1000 | 4.8 | 8.12 | 23.5 |
| 09.91 | 082394 | - | 850 | 8.3 | 8.49 | 20.5 |
| 09.91 | 081094 | - | 975 | 9.0 | 8.55 | 18.9 |
| 09.91 | 072694 | - | 800 | 7.8 | 8.45 | 21.8 |
| 09.91 | 071494 | - | 610 | 7.0 | 8.22 | 23.1 |
| 09.91 | 062394 | - | 810 | 6.75 | 8.17 | 23 |
| 09.20 | 082394 | - | 890 | 9.2 | 8.86 | 21.5 |
| 09.20 | 081094 | - | 1000 | 10.2 | 8.72 | 20.7 |
| 09.20 | 072694 | - | 870 | 10.0 | 8.61 | 23.0 |
| 09.20 | 071494 | - | 600 | 8.0 | 8.23 | 23.5 |
| 09.20 | 062394 | - | 810 | 7.5 | 8.24 | 24.3 |
| ***Shaw Creek*** | | | | | | |
| 01.56 | 082394 | - | 600 | 7.7 | 8.64 | 20.5 |
| 01.56 | 081094 | - | 700 | 9.3 | 8.54 | 18.9 |
| 01.56 | 072694 | - | 720 | 7.1 | 8.35 | 22.1 |
| 01.56 | 071494 | - | 650 | 6.5 | 8.05 | 22.9 |
| 01.56 | 062394 | - | 800 | 8.9 | 8.8 | 22.5 |

- Denotes data not available

| River Mile | Date | $BOD_5$ | COD | Chloride | Dissolved Solids | Sulfate |
|---|---|---|---|---|---|---|
| ***Whetstone Creek*** | | | | | | |
| 25.53 | 082394 | 2.1 | 12 | 21 | 19 | 53 |
| 25.53 | 081094 | 1.1 | 13 | 22 | 5 | 73 |
| 25.53 | 072694 | 1.4 | 17 | 21 | 6 | 72 |
| 25.53 | 071494 | 1.4 | 21 | 17 | 15 | 64 |
| 25.53 | 062394 | 1.7 | 10* | 25 | 12 | 75 |
| 21.71 | 082394 | 1.0 | 10* | 36 | 5* | 75 |
| 21.71 | 081094 | 1.0 | 20 | 44 | 5* | 86 |
| 21.71 | 072694 | 1.5 | 10* | 42 | 5* | 83 |
| 21.71 | 071494 | 1.8 | 18 | 37 | 5 | 64 |
| 21.71 | 062394 | 1.1 | 10* | 49 | 5* | 94 |
| 21.60 | 082294 | 1.1 | 13 | 630 | 5* | 162 |
| 21.60 | 081094 | 2.4 | 24 | 1020 | 5 | 158 |
| 21.60 | 072694 | 4.9 | 32 | 1120 | 6 | 169 |
| 21.60 | 071494 | 3.2 | 24 | 850 | 8 | 64 |
| 21.60 | 062394 | 4.4 | 24 | 850 | 8 | 179 |
| 20.85 | 082394 | 1.0 | 10 | 63 | 6 | 89 |
| 20.85 | 081094 | 1.0 | 17 | 204 | 5* | 114 |
| 20.85 | 072694 | 1.5 | 16 | 178 | 6 | 101 |
| 20.85 | 071594 | 1.7 | 21 | 61 | 13 | 68 |
| 20.10 | 071494 | 2.1 | 18 | 52 | 17 | 57 |
| 20.10 | 062394 | 1.0 | 11 | 159 | 5 | 100 |
| 19.17 | 082394 | 1.0 | 10* | 78 | 15 | 92 |
| 19.17 | 081094 | 1.2 | 14 | 239 | 5* | 109 |
| 19.17 | 072694 | 1.4 | 16 | 139 | 6 | 100 |
| 19.17 | 071494 | 1.6 | 19 | 57 | 13 | 73 |
| 19.17 | 062394 | 2.1 | 20 | 130 | 6 | 95 |
| 16.19 | 082394 | 1.8 | 10* | 48 | 16 | 81 |
| 16.19 | 081094 | 2.4 | 17 | 140 | 9 | 91 |
| 16.19 | 072694 | 1.8 | 19 | 139 | 12 | 94 |
| 16.19 | 071494 | 1.2 | 20 | 60 | 19 | 70 |
| 16.19 | 062394 | 1.1 | 18 | 119 | 10 | 84 |
| 13.70 | 082294 | 7.3 | 20 | 247 | 8 | 265 |
| 13.70 | 081094 | 5.9 | 20 | 276 | 6 | 281 |
| 13.70 | 072694 | 1.6 | 29 | 252 | 5* | 236 |
| 13.70 | 071494 | 11 | 24 | 184 | 14 | 5* |
| 13.70 | 062394 | 13 | 48 | 230 | 15 | 190 |
| 12.88 | 082394 | 1.8 | 12 | 101 | 11 | 85 |
| 12.88 | 081094 | 2.3 | 16 | 151 | 7 | 108 |
| 12.88 | 072694 | 2.5 | 17 | 111 | 16 | 102 |
| 12.88 | 071494 | 1.9 | 19 | 51 | 26 | 134 |
| 12.88 | 062394 | 2.2 | 24 | 140 | 10 | 94 |
| 09.91 | 082394 | 1.2 | 14 | 124 | 11 | 97 |
| 09.91 | 081094 | 1.2 | 20 | 129 | 5 | 98 |
| 09.91 | 072694 | 2.9 | 28 | 84 | 8 | 95 |

| River Mile | Date | $BOD_5$ | COD | Chloride | Dissolved Solids | Sulfate |
|---|---|---|---|---|---|---|
| ***Whetstone Creek*** | | | | | | |
| 09.91 | 071494 | 2.5 | 30 | 44 | 26 | 135 |
| 09.91 | 062394 | 1.4 | 27 | 91 | 24 | 82 |
| 09.20 | 082394 | 1.7 | 18 | 126 | 18 | 95 |
| 09.20 | 081094 | 1.7 | 16 | 128 | 13 | 100 |
| 09.20 | 072694 | 4.7 | 16 | 85 | 14 | 90 |
| 09.20 | 071494 | 1.8 | 25 | 44 | 27 | 58 |
| 09.20 | 062394 | 2.0 | 41 | 87 | 33 | 74 |
| ***Shaw Creek*** | | | | | | |
| 01.56 | 082394 | 1.0 | 11 | 22 | 14 | 108 |
| 01.56 | 081094 | 1.4 | 16 | 26 | 9 | 95 |
| 01.56 | 072694 | 1.6 | 12 | 25 | 17 | 95 |
| 01.56 | 071494 | 3.3 | 51 | 19 | 45 | 137 |
| 01.56 | 062394 | 1.9 | 78 | 21 | 103 | 78 |

* Denotes value was below this detection limit.

| River Mile | Date | Fecal Coliform | Fecal Strept |
|---|---|---|---|
| ***Whetstone Creek*** | | | |
| 25.53 | 082394 | 340 | 265 |
| 25.53 | 081094 | 300 | 230 |
| 25.53 | 072694 | 270 | 390 |
| 25.53 | 071494 | 320 | 260 |
| 25.53 | 062394 | 150 | 290 |
| 21.71 | 082394 | 600 | 500 |
| 21.71 | 081094 | 480 | 390 |
| 21.71 | 072694 | 140 | 160 |
| 21.71 | 071494 | 250 | 150 |
| 21.71 | 062394 | 928 | 410 |
| 21.60 | 082294 | 60 | - |
| 21.60 | 081094 | 60 | 60 |
| 21.60 | 072694 | 70 | - |
| 21.60 | 071494 | 191 | 90 |
| 21.60 | 062394 | 20 | 20 |
| 20.85 | 082394 | 580 | 430 |
| 20.85 | 081094 | 1270 | 240 |
| 20.85 | 072694 | 220 | 140 |
| 20.85 | 071594 | 250 | 210 |
| 20.10 | 071494 | 480 | 380 |
| 20.10 | 062394 | 410 | 350 |

| River Mile | Date | Fecal Coliform | Fecal Strept |
|---|---|---|---|
| ***Whetstone Creek*** | | | |
| 19.17 | 082394 | 260 | 220 |
| 19.17 | 081094 | 390 | 290 |
| 19.17 | 072694 | 520 | 380 |
| 19.17 | 071494 | 350 | 490 |
| 19.17 | 062394 | 580 | 430 |
| 16.19 | 082394 | 420 | 210 |
| 16.19 | 081094 | 240 | 60 |
| 16.19 | 072694 | 250 | 100 |
| 16.19 | 071494 | 530 | 460 |
| 16.19 | 062394 | 230 | 170 |
| 13.70 | 082294 | 1700 | - |
| 13.70 | 081094 | 100 | 70 |
| 13.70 | 072694 | 50 | - |
| 13.70 | 071494 | 320 | 670 |
| 13.70 | 062394 | 1099 | - |
| 12.88 | 082394 | 530 | 150 |
| 12.88 | 081094 | 230 | 130 |
| 12.88 | 072694 | 640 | 380 |
| 12.88 | 071494 | 490 | 230 |
| 12.88 | 062394 | 510 | 290 |
| 09.91 | 082394 | 250 | 220 |
| 09.91 | 081094 | 170 | 280 |
| 09.91 | 072694 | 220 | 240 |
| 09.91 | 071494 | 73 | 220 |
| 09.91 | 062394 | 530 | 345 |
| 09.20 | 082394 | 270 | 250 |
| 09.20 | 081094 | 865 | 300 |
| 09.20 | 072694 | 694 | 110 |
| 09.20 | 071494 | 230 | 90 |
| 09.20 | 062394 | 702 | 380 |
| ***Shaw Creek*** | | | |
| 01.56 | 082394 | 420 | 210 |
| 01.56 | 081094 | 590 | 330 |
| 01.56 | 072694 | 850 | 530 |
| 01.56 | 071494 | 430 | 3700 |
| 01.56 | 062394 | 919 | 420 |

- Denotes data not available.

**Ohio EPA Water Quality Monitoring and Assessment Section**
**Macroinvertebrate Collection**

Collection Date: 09/19/94 River Code: 02-450 River: Whetstone Creek RM: 25.50

| Taxa Code | Taxa | Quan/Qual | |
|---|---|---|---|
| 00401 | *Spongillidae* | 0 | + |
| 01801 | *Turbellaria* | 0 | + |
| 03362 | *Plumatella casmiana* | 0 | + |
| 03360 | *Plumatella sp* | 0 | + |
| 08250 | *Orconectes (Procericambarus) rusticus* | 0 | + |
| 08601 | *Hydracarina* | 0 | + |
| 12200 | *Isonychia sp* | 0 | + |
| 17200 | *Caenis sp* | 0 | + |
| 13521 | *Stenonema femoratum* | 0 | + |
| 13590 | *Stenonema vicarium* | 0 | + |
| 13400 | *Stenacron sp* | 0 | + |
| 11130 | *Baetis intercalaris* | 0 | + |
| 11120 | *Baetis flavistriga* | 0 | + |
| 11670 | *Procloeon irrubrum* | 0 | + |
| 21200 | *Calopteryx sp* | 0 | + |
| 22001 | *Coenagrionidae* | 0 | + |
| 45300 | *Sigara sp* | 0 | + |
| 45900 | *Notonecta sp* | 0 | + |
| 48620 | *Nigronia serricornis* | 0 | + |
| 58505 | *Helicopsyche borealis* | 0 | + |
| 59110 | *Ceraclea ancylus* | 0 | + |
| 57400 | *Neophylax sp* | 0 | + |
| 56001 | *Limnephilidae* | 0 | + |
| 51400 | *Nyctiophylax sp* | 0 | + |
| 51600 | *Polycentropus sp* | 0 | + |
| 50315 | *Chimarra obscura* | 0 | + |
| 50301 | *Chimarra aterrima* | 0 | + |
| 52530 | *Hydropsyche (H.) depravata group* | 0 | + |
| 52200 | *Cheumatopsyche sp* | 0 | + |
| 52430 | *Hydropsyche (Ceratopsyche) morosa group* | 0 | + |
| 53800 | *Hydroptila sp* | 0 | + |
| 49101 | *Sisyridae* | 0 | + |
| 59970 | *Petrophila sp* | 0 | + |
| 68075 | *Psephenus herricki* | 0 | + |
| 60900 | *Peltodytes sp* | 0 | + |
| 63300 | *Hydroporus sp* | 0 | + |
| 68901 | *Macronychus glabratus* | 0 | + |
| 68700 | *Dubiraphia sp* | 0 | + |
| 69400 | *Stenelmis sp* | 0 | + |
| 86100 | *Chrysops sp* | 0 | + |
| 86200 | *Tabanus sp* | 0 | + |
| 84750 | *Stictochironomus sp* | 0 | + |
| 83840 | *Microtendipes pedellus group* | 0 | + |
| 72340 | *Dixella sp* | 0 | + |
| 85800 | *Tanytarsus sp* | 0 | + |
| 77500 | *Conchapelopia sp* | 0 | + |
| 84470 | *Polypedilum (P.) illinoense* | 0 | + |
| 81650 | *Parametriocnemus sp* | 0 | + |
| 85625 | *Rheotanytarsus exiguus group* | 0 | + |
| 77800 | *Helopelopia sp* | 0 | + |
| 80420 | *Cricotopus (C.) bicinctus* | 0 | + |
| 85500 | *Paratanytarsus sp* | 0 | + |
| 79400 | *Zavrelimyia sp* | 0 | + |
| 85814 | *Tanytarsus glabrescens group* | 0 | + |
| 72700 | *Anopheles sp* | 0 | + |
| 93900 | *Elimia sp* | 0 | + |
| 95100 | *Physella sp* | 0 | + |
| 96900 | *Ferrissia sp* | 0 | + |
| 98600 | *Sphaerium sp* | 0 | + |
| 98200 | *Pisidium sp* | 0 | + |

No. Quantitative Taxa: 0 Total Taxa: 60

No. Qualitative Taxa: 60 ICI:

Number of Organisms: 0 Qual EPT:

**Ohio EPA Water Quality Monitoring and Assessment Section**
**Macroinvertebrate Collection**

Collection Date: 09/19/94 River Code: 02-450 River: Whetstone Creek RM: 21.80

| Taxa Code | Taxa | Quan/Qual | |
|---|---|---|---|
| 01801 | *Turbellaria* | 0 | + |
| 03362 | *Plumatella casmiana* | 0 | + |
| 03600 | *Oligochaeta* | 0 | + |
| 08250 | *Orconectes (Procericambarus) rusticus* | 0 | + |
| 06201 | *Hyalella azteca* | 0 | + |
| 08601 | *Hydracarina* | 0 | + |
| 13400 | *Stenacron sp* | 0 | + |
| 12200 | *Isonychia sp* | 0 | + |
| 17200 | *Caenis sp* | 0 | + |
| 13521 | *Stenonema femoratum* | 0 | + |
| 13590 | *Stenonema vicarium* | 0 | + |
| 13540 | *Stenonema mediopunctatum* | 0 | + |
| 18619 | *Ephemera simulans* | 0 | + |
| 21200 | *Calopteryx sp* | 0 | + |
| 22300 | *Argia sp* | 0 | + |
| 22001 | *Coenagrionidae* | 0 | + |
| 23804 | *Basiaeschna janata* | 0 | + |
| 34130 | *Acroneuria evoluta* | 0 | + |
| 47600 | *Sialis sp* | 0 | + |
| 48620 | *Nigronia serricornis* | 0 | + |
| 58505 | *Helicopsyche borealis* | 0 | + |
| 50315 | *Chimarra obscura* | 0 | + |
| 52200 | *Cheumatopsyche sp* | 0 | + |
| 52430 | *Hydropsyche (Ceratopsyche) morosa group* | 0 | + |
| 52540 | *Hydropsyche (H.) dicantha* | 0 | + |
| 59110 | *Ceraclea ancylus* | 0 | + |
| 57400 | *Neophylax sp* | 0 | + |
| 59970 | *Petrophila sp* | 0 | + |
| 68075 | *Psephenus herricki* | 0 | + |
| 69400 | *Stenelmis sp* | 0 | + |
| 68201 | *Scirtidae* | 0 | + |
| 74100 | *Simulium sp* | 0 | + |
| 86401 | *Atherix lantha* | 0 | + |
| 87540 | *Hemerodromia sp* | 0 | + |
| 71900 | *Tipula sp* | 0 | + |
| 77500 | *Conchapelopia sp* | 0 | + |
| 82101 | *Thienemanniella n.sp 1* | 0 | + |
| 82820 | *Cryptochironomus sp* | 0 | + |
| 84750 | *Stictochironomus sp* | 0 | + |
| 84470 | *Polypedilum (P.) illinoense* | 0 | + |
| 84460 | *Polypedilum (P.) fallax group* | 0 | + |
| 82770 | *Chironomus (C.) riparius group* | 0 | + |
| 82730 | *Chironomus (C.) decorus group* | 0 | + |
| 84450 | *Polypedilum (P.) convictum* | 0 | + |
| 84300 | *Phaenopsectra obediens group* | 0 | + |
| 84210 | *Paratendipes albimanus or P. duplicatus* | 0 | + |
| 84480 | *Polypedilum (P.) laetum group* | 0 | + |
| 99180 | *Strophitus undulatus undulatus* | 0 | + |
| 96900 | *Ferrissia sp* | 0 | + |
| 93900 | *Elimia sp* | 0 | + |
| 95100 | *Physella sp* | 0 | + |
| 98600 | *Sphaerium sp* | 0 | + |
| 99860 | *Lampsilis radiata luteola* | 0 | + |
| 15000 | *Paraleptophlebia sp* | 0 | + |

No. Quantitative Taxa: 0 Total Taxa: 54

No. Qualitative Taxa: 54 ICI:

Number of Organisms: 0 Qual EPT:

## Ohio EPA Water Quality Monitoring and Assessment Section
## Macroinvertebrate Collection

Collection Date: 09/19/94 River Code: 02-450 River: Whetstone Creek RM: 20.90

| Taxa Code | Taxa | Quan/Qual | |
|---|---|---|---|
| 00556 | *Ephydatia fluviatilis* | 0 | + |
| 01320 | *Hydra sp* | 36 | |
| 01801 | *Turbellaria* | 4 | + |
| 03040 | *Fredericella sp* | 0 | + |
| 03600 | *Oligochaeta* | 32 | + |
| 08250 | *Orconectes (Procericambarus) rusticus* | 0 | + |
| 12200 | *Isonychia sp* | 7 | + |
| 17200 | *Caenis sp* | 49 | + |
| 18600 | *Ephemera sp* | 0 | + |
| 13400 | *Stenacron sp* | 14 | + |
| 15000 | *Paraleptophlebia sp* | 8 | |
| 13521 | *Stenonema femoratum* | 5 | + |
| 13590 | *Stenonema vicarium* | 3 | + |
| 13540 | *Stenonema mediopunctatum* | 0 | + |
| 13000 | *Leucrocuta sp* | 0 | + |
| 11670 | *Procloeon irrubrum* | 0 | + |
| 11130 | *Baetis intercalaris* | 5 | + |
| 11120 | *Baetis flavistriga* | 0 | + |
| 21200 | *Calopteryx sp* | 3 | + |
| 22300 | *Argia sp* | 27 | + |
| 22001 | *Coenagrionidae* | 7 | |
| 45900 | *Notonecta sp* | 0 | + |
| 45300 | *Sigara sp* | 0 | + |
| 47600 | *Sialis sp* | 1 | + |
| 48620 | *Nigronia serricornis* | 0 | + |
| 58505 | *Helicopsyche borealis* | 0 | + |
| 52200 | *Cheumatopsyche sp* | 52 | + |
| 52530 | *Hydropsyche (H.) depravata group* | 0 | + |
| 52540 | *Hydropsyche (H.) dicantha* | 0 | + |
| 59110 | *Ceraclea ancylus* | 0 | + |
| 52430 | *Hydropsyche (Ceratopsyche) morosa group* | 2 | |
| 68075 | *Psephenus herricki* | 0 | + |
| 60900 | *Peltodytes sp* | 0 | + |
| 65800 | *Berosus sp* | 0 | + |
| 68601 | *Ancyronyx variegata* | 0 | + |
| 68901 | *Macronychus glabratus* | 0 | + |
| 69400 | *Stenelmis sp* | 36 | + |
| 68708 | *Dubiraphia vittata group* | 29 | + |
| 86401 | *Atherix lantha* | 1 | + |
| 74100 | *Simulium sp* | 0 | + |
| 71100 | *Hexatoma sp* | 0 | + |
| 74501 | *Ceratopogonidae* | 8 | |
| 87540 | *Hemerodromia sp* | 36 | |
| 78450 | *Nilotanypus fimbriatus* | 16 | |
| 77500 | *Conchapelopia sp* | 82 | |
| 77800 | *Helopelopia sp* | 82 | + |
| 80351 | *Corynoneura n.sp 1* | 21 | |
| 80410 | *Cricotopus (C.) sp* | 33 | |
| 80420 | *Cricotopus (C.) bicinctus* | 49 | |
| 80430 | *Cricotopus (C.) tremulus group* | 16 | |
| 81825 | *Rheocricotopus (Psilocricotopus) robacki* | 49 | + |
| 80370 | *Corynoneura lobata* | 811 | + |
| 81631 | *Parakiefferiella n.sp 1* | 49 | |
| 81270 | *Nanocladius (N.) spiniplenus* | 165 | |
| 82101 | *Thienemanniella n.sp 1* | 16 | |
| 82141 | *Thienemanniella xena* | 21 | |
| 82730 | *Chironomus (C.) decorus group* | 0 | + |
| 84750 | *Stictochironomus sp* | 0 | + |
| 84450 | *Polypedilum (P.) convictum* | 115 | + |
| 84540 | *Polypedilum (Tripodura) scalaenum group* | 33 | + |
| 84460 | *Polypedilum (P.) fallax group* | 181 | |
| 81231 | *Nanocladius (N.) crassicornus or N. (N.)* | 49 | |
| 83000 | *Dicrotendipes sp* | 16 | |
| 84700 | *Stenochironomus sp* | 16 | |
| 83300 | *Glyptotendipes (Phytotendipes) sp* | 16 | |
| 85500 | *Paratanytarsus sp* | 16 | |
| 85800 | *Tanytarsus sp* | 33 | + |
| 85814 | *Tanytarsus glabrescens group* | 115 | + |
| 85625 | *Rheotanytarsus exiguus group* | 66 | |
| 85615 | *Rheotanytarsus distinctissimus group* | 16 | |
| 96900 | *Ferrissia sp* | 11 | + |
| 95100 | *Physella sp* | 0 | + |
| 93900 | *Elimia sp* | 5 | + |
| 98600 | *Sphaerium sp* | 0 | + |
| 98200 | *Pisidium sp* | 0 | + |

No. Quantitative Taxa: 48 Total Taxa: 75

No. Qualitative Taxa: 51 ICI: **36**

Number of Organisms: 2463 Qual EPT: **16**

**Ohio EPA Water Quality Monitoring and Assessment Section**
**Macroinvertebrate Collection**

Collection Date: 09/19/94 River Code: 02-450 River: Whetstone Creek RM: 19.20

| Taxa Code | Taxa | Quan/Qual | |
|---|---|---|---|
| 01801 | *Turbellaria* | 0 | + |
| 03039 | *Fredericellidae* | 0 | + |
| 03600 | *Oligochaeta* | 0 | + |
| 08250 | *Orconectes (Procericambarus) rusticus* | 0 | + |
| 05900 | *Lirceus sp* | 0 | + |
| 06201 | *Hyalella azteca* | 0 | + |
| 12200 | *Isonychia sp* | 0 | + |
| 17200 | *Caenis sp* | 0 | + |
| 13400 | *Stenacron sp* | 0 | + |
| 13590 | *Stenonema vicarium* | 0 | + |
| 13521 | *Stenonema femoratum* | 0 | + |
| 11651 | *Procloeon sp (w/o hindwing pads)* | 0 | + |
| 11670 | *Procloeon irrubrum* | 0 | + |
| 11130 | *Baetis intercalaris* | 0 | + |
| 22300 | *Argia sp* | 0 | + |
| 22600 | *Enallagma sp* | 0 | + |
| 42700 | *Belostoma sp* | 0 | + |
| 45300 | *Sigara sp* | 0 | + |
| 58505 | *Helicopsyche borealis* | 0 | + |
| 50315 | *Chimarra obscura* | 0 | + |
| 51400 | *Nyctiophylax sp* | 0 | + |
| 57400 | *Neophylax sp* | 0 | + |
| 52200 | *Cheumatopsyche sp* | 0 | + |
| 59970 | *Petrophila sp* | 0 | + |
| 68075 | *Psephenus herricki* | 0 | + |
| 69400 | *Stenelmis sp* | 0 | + |
| 65800 | *Berosus sp* | 0 | + |
| 60900 | *Peltodytes sp* | 0 | + |
| 68601 | *Ancyronyx variegata* | 0 | + |
| 68130 | *Helichus sp* | 0 | + |
| 68702 | *Dubiraphia bivittata* | 0 | + |
| 68708 | *Dubiraphia vittata group* | 0 | + |
| 86401 | *Atherix lantha* | 0 | + |
| 71200 | *Limnophila sp* | 0 | + |
| 84750 | *Stictochironomus sp* | 0 | + |
| 83003 | *Dicrotendipes fumidus* | 0 | + |
| 82880 | *Cryptotendipes sp* | 0 | + |
| 84450 | *Polypedilum (P.) convictum* | 0 | + |
| 84440 | *Polypedilum (P.) aviceps* | 0 | + |
| 85500 | *Paratanytarsus sp* | 0 | + |
| 85625 | *Rheotanytarsus exiguus group* | 0 | + |
| 99860 | *Lampsilis radiata luteola* | 0 | + |
| 93900 | *Elimia sp* | 0 | + |
| 96900 | *Ferrissia sp* | 0 | + |
| 98600 | *Sphaerium sp* | 0 | + |
| 98200 | *Pisidium sp* | 0 | + |

No. Quantitative Taxa: 0 Total Taxa: 46

No. Qualitative Taxa: 46 ICI:

Number of Organisms: 0 Qual EPT:

## Ohio EPA Water Quality Monitoring and Assessment Section
## Macroinvertebrate Collection

Collection Date: 09/19/94 River Code: 02-450 River: Whetstone Creek RM: 16.10

| Taxa Code | Taxa | Quan/Qual | | Taxa Code | Taxa | Quan/Qual | |
|---|---|---|---|---|---|---|---|
| 00556 | *Ephydatia fluviatilis* | 0 | + | 86200 | *Tabanus sp* | 0 | + |
| 00401 | *Spongillidae* | 1 | | 87501 | *Empididae* | 24 | |
| 01320 | *Hydra sp* | 8 | | 77120 | *Ablabesmyia mallochi* | 12 | |
| 01801 | *Turbellaria* | 0 | + | 77800 | *Helopelopia sp* | 24 | |
| 03360 | *Plumatella sp* | 0 | + | 78450 | *Nilotanypus fimbriatus* | 8 | |
| 03600 | *Oligochaeta* | 0 | + | 77500 | *Conchapelopia sp* | 71 | |
| 08250 | *Orconectes (Procericambarus) rusticus* | 0 | + | 80410 | *Cricotopus (C.) sp* | 24 | |
| 05900 | *Lirceus sp* | 1 | + | 82101 | *Thienemanniella n.sp 1* | 60 | |
| 12200 | *Isonychia sp* | 51 | + | 82141 | *Thienemanniella xena* | 16 | |
| 17200 | *Caenis sp* | 88 | + | 81825 | *Rheocricotopus (Psilocricotopus) robacki* | 12 | + |
| 15000 | *Paraleptophlebia sp* | 16 | + | 78650 | *Procladius sp* | 24 | |
| 13521 | *Stenonema femoratum* | 7 | + | 81229 | *Nanocladius (N.) crassicornus* | 0 | + |
| 13400 | *Stenacron sp* | 107 | + | 80360 | *Corynoneura "celeripes" (sensu Simpson &* | 0 | + |
| 13540 | *Stenonema mediopunctatum* | 0 | + | 80351 | *Corynoneura n.sp 1* | 12 | + |
| 18600 | *Ephemera sp* | 8 | + | 80370 | *Corynoneura lobata* | 232 | + |
| 11120 | *Baetis flavistriga* | 22 | + | 83840 | *Microtendipes pedellus group* | 59 | |
| 11130 | *Baetis intercalaris* | 143 | + | 82820 | *Cryptochironomus sp* | 0 | + |
| 13000 | *Leucrocuta sp* | 36 | | 84750 | *Stictochironomus sp* | 0 | + |
| 11020 | *Acerpenna pygmaeus* | 6 | | 84450 | *Polypedilum (P.) convictum* | 130 | + |
| 22300 | *Argia sp* | 12 | + | 84470 | *Polypedilum (P.) illinoense* | 0 | + |
| 45300 | *Sigara sp* | 0 | + | 84460 | *Polypedilum (P.) fallax group* | 35 | |
| 47600 | *Sialis sp* | 0 | + | 84040 | *Parachironomus frequens* | 0 | + |
| 48620 | *Nigronia serricornis* | 0 | + | 84888 | *Xenochironomus xenolabis* | 0 | + |
| 58505 | *Helicopsyche borealis* | 0 | + | 83040 | *Dicrotendipes neomodestus* | 0 | + |
| 50315 | *Chimarra obscura* | 75 | + | 85625 | *Rheotanytarsus exiguus group* | 520 | + |
| 57400 | *Neophylax sp* | 0 | + | 85814 | *Tanytarsus glabrescens group* | 260 | |
| 53400 | *Protoptila sp* | 0 | + | 85840 | *Tanytarsus guerlus group* | 12 | |
| 52200 | *Cheumatopsyche sp* | 121 | + | 85500 | *Paratanytarsus sp* | 94 | |
| 52430 | *Hydropsyche (Ceratopsyche) morosa group* | 21 | + | 93900 | *Elimia sp* | 17 | + |
| 52530 | *Hydropsyche (H.) depravata group* | 11 | | 96900 | *Ferrissia sp* | 4 | + |
| 49101 | *Sisyridae* | 0 | + | 95100 | *Physella sp* | 0 | + |
| 59970 | *Petrophila sp* | 0 | + | 99860 | *Lampsilis radiata luteola* | 0 | + |
| 68075 | *Psephenus herricki* | 0 | + | 98200 | *Pisidium sp* | 0 | + |
| 60900 | *Peltodytes sp* | 0 | + | 98600 | *Sphaerium sp* | 0 | + |
| 69400 | *Stenelmis sp* | 4 | + | | | | |
| 60400 | *Gyrinus sp* | 0 | + | | | | |
| 63300 | *Hydroporus sp* | 0 | + | | | | |
| 66500 | *Enochrus sp* | 0 | + | | | | |
| 68901 | *Macronychus glabratus* | 7 | | | | | |
| 68708 | *Dubiraphia vittata group* | 5 | | | | | |
| 74100 | *Simulium sp* | 9 | + | | | | |

No. Quantitative Taxa: 43 Total Taxa: 75

No. Qualitative Taxa: 54 ICI: **54**

Number of Organisms: 2409 Qual EPT: **15**

**Ohio EPA Water Quality Monitoring and Assessment Section**
**Macroinvertebrate Collection**

Collection Date: 09/20/94 River Code: 02-450 River: Whetstone Creek RM: 13.00

| Taxa Code | Taxa | Quan/Qual | |
|---|---|---|---|
| 00556 | *Ephydatia fluviatilis* | 0 | + |
| 00401 | *Spongillidae* | 0 | + |
| 01801 | *Turbellaria* | 0 | + |
| 03039 | *Fredericellidae* | 0 | + |
| 03600 | *Oligochaeta* | 0 | + |
| 08250 | *Orconectes (Procericambarus) rusticus* | 0 | + |
| 05900 | *Lirceus sp* | 0 | + |
| 05800 | *Caecidotea sp* | 0 | + |
| 06201 | *Hyalella azteca* | 0 | + |
| 12200 | *Isonychia sp* | 0 | + |
| 17200 | *Caenis sp* | 0 | + |
| 13400 | *Stenacron sp* | 0 | + |
| 13521 | *Stenonema femoratum* | 0 | + |
| 13590 | *Stenonema vicarium* | 0 | + |
| 13000 | *Leucrocuta sp* | 0 | + |
| 11120 | *Baetis flavistriga* | 0 | + |
| 11130 | *Baetis intercalaris* | 0 | + |
| 11670 | *Procloeon irrubrum* | 0 | + |
| 11650 | *Procloeon sp (w/ hindwing pads)* | 0 | + |
| 21200 | *Calopteryx sp* | 0 | + |
| 21300 | *Hetaerina sp* | 0 | + |
| 22300 | *Argia sp* | 0 | + |
| 22001 | *Coenagrionidae* | 0 | + |
| 23909 | *Boyeria vinosa* | 0 | + |
| 42700 | *Belostoma sp* | 0 | + |
| 45900 | *Notonecta sp* | 0 | + |
| 47600 | *Sialis sp* | 0 | + |
| 50315 | *Chimarra obscura* | 0 | + |
| 52200 | *Cheumatopsyche sp* | 0 | + |
| 52430 | *Hydropsyche (Ceratopsyche) morosa group* | 0 | + |
| 53501 | *Hydroptilidae* | 0 | + |
| 57400 | *Neophylax sp* | 0 | + |
| 59300 | *Mystacides sp* | 0 | + |
| 59970 | *Petrophila sp* | 0 | + |
| 68075 | *Psephenus herricki* | 0 | + |
| 60900 | *Peltodytes sp* | 0 | + |
| 69400 | *Stenelmis sp* | 0 | + |
| 68708 | *Dubiraphia vittata group* | 0 | + |
| 67000 | *Helophorus sp* | 0 | + |
| 66500 | *Enochrus sp* | 0 | + |
| 67800 | *Tropisternus sp* | 0 | + |
| 68702 | *Dubiraphia bivittata* | 0 | + |
| 74100 | *Simulium sp* | 0 | + |
| 71100 | *Hexatoma sp* | 0 | + |
| 78400 | *Natarsia sp* | 0 | + |
| 78402 | *Natarsia baltimoreus* | 0 | + |
| 77120 | *Ablabesmyia mallochi* | 0 | + |
| 77500 | *Conchapelopia sp* | 0 | + |
| 78650 | *Procladius sp* | 0 | + |
| 82141 | *Thienemanniella xena* | 0 | + |
| 83840 | *Microtendipes pedellus group* | 0 | + |
| 84450 | *Polypedilum (P.) convictum* | 0 | + |
| 82820 | *Cryptochironomus sp* | 0 | + |
| 83040 | *Dicrotendipes neomodestus* | 0 | + |
| 84750 | *Stictochironomus sp* | 0 | + |
| 85625 | *Rheotanytarsus exiguus group* | 0 | + |
| 85814 | *Tanytarsus glabrescens group* | 0 | + |
| 85800 | *Tanytarsus sp* | 0 | + |
| 99860 | *Lampsilis radiata luteola* | 0 | + |
| 99880 | *Lampsilis ventricosa* | 0 | + |
| 95100 | *Physella sp* | 0 | + |
| 93900 | *Elimia sp* | 0 | + |
| 96900 | *Ferrissia sp* | 0 | + |
| 98600 | *Sphaerium sp* | 0 | + |
| 04510 | *Hirudinea* | 0 | + |

No. Quantitative Taxa: 0 Total Taxa: 65

No. Qualitative Taxa: 65 ICI:

Number of Organisms: 0 Qual EPT:

**Ohio EPA Water Quality Monitoring and Assessment Section**
**Macroinvertebrate Collection**

Collection Date: 09/20/94 River Code: 02-450 River: Whetstone Creek RM: 10.10

| Taxa Code | Taxa | Quan/Qual | | Taxa Code | Taxa | Quan/Qual | |
|---|---|---|---|---|---|---|---|
| 00556 | *Ephydatia fluviatilis* | 0 | + | 57400 | *Neophylax sp* | 0 | + |
| 00805 | *Spongilla lacustris* | 0 | + | 51001 | *Polycentropodidae* | 0 | + |
| 01320 | *Hydra sp* | 80 | + | 49200 | *Climacia sp* | 0 | + |
| 01801 | *Turbellaria* | 26 | + | 59970 | *Petrophila sp* | 0 | + |
| 03369 | *Plumatella repens* | 0 | + | 68075 | *Psephenus herricki* | 0 | + |
| 03121 | *Paludicella articulata* | 1 | + | 60900 | *Peltodytes sp* | 0 | + |
| 03362 | *Plumatella casmiana* | 1 | + | 60400 | *Gyrinus sp* | 0 | + |
| 03600 | *Oligochaeta* | 0 | + | 69400 | *Stenelmis sp* | 27 | + |
| 08250 | *Orconectes (Procericambarus) rusticus* | 0 | + | 68901 | *Macronychus glabratus* | 3 | + |
| 06201 | *Hyalella azteca* | 0 | + | 68708 | *Dubiraphia vittata group* | 4 | + |
| 05900 | *Lirceus sp* | 1 | + | 68702 | *Dubiraphia bivittata* | 4 | + |
| 08601 | *Hydracarina* | 40 | + | 78450 | *Nilotanypus fimbriatus* | 8 | |
| 12200 | *Isonychia sp* | 34 | + | 80430 | *Cricotopus (C.) tremulus group* | 26 | |
| 18600 | *Ephemera sp* | 0 | + | 81250 | *Nanocladius (N.) minimus* | 26 | |
| 17200 | *Caenis sp* | 348 | + | 71100 | *Hexatoma sp* | 0 | + |
| 13400 | *Stenacron sp* | 102 | + | 86100 | *Chrysops sp* | 0 | + |
| 11130 | *Baetis intercalaris* | 136 | + | 74100 | *Simulium sp* | 0 | + |
| 13521 | *Stenonema femoratum* | 0 | + | 87540 | *Hemerodromia sp* | 184 | + |
| 11120 | *Baetis flavistriga* | 48 | + | 84540 | *Polypedilum (Tripodura) scalaenum group* | 77 | |
| 11670 | *Procloeon irrubrum* | 0 | + | 81231 | *Nanocladius (N.) crassicornus or N. (N.)* | 51 | |
| 11250 | *Centroptilum sp (w/o hindwing pads)* | 0 | + | 80410 | *Cricotopus (C.) sp* | 26 | |
| 11650 | *Procloeon sp (w/ hindwing pads)* | 2 | + | 77120 | *Ablabesmyia mallochi* | 0 | + |
| 13561 | *Stenonema pulchellum* | 61 | + | 77500 | *Conchapelopia sp* | 281 | + |
| 13540 | *Stenonema mediopunctatum* | 0 | + | 77800 | *Helopelopia sp* | 77 | + |
| 13000 | *Leucrocuta sp* | 34 | | 78402 | *Natarsia baltimoreus* | 0 | + |
| 11020 | *Acerpenna pygmaeus* | 4 | | 78650 | *Procladius sp* | 0 | + |
| 21200 | *Calopteryx sp* | 0 | + | 84300 | *Phaenopsectra obediens group* | 26 | + |
| 22300 | *Argia sp* | 38 | + | 82141 | *Thienemanniella xena* | 16 | + |
| 26715 | *Macromia taeniolata* | 0 | + | 83051 | *Dicrotendipes simpsoni* | 26 | |
| 23618 | *Aeshna umbrosa* | 0 | + | 80420 | *Cricotopus (C.) bicinctus* | 77 | |
| 22001 | *Coenagrionidae* | 0 | + | 80351 | *Corynoneura n.sp 1* | 24 | |
| 21300 | *Hetaerina sp* | 1 | | 80370 | *Corynoneura lobata* | 192 | + |
| 34700 | *Agnetina capitata complex* | 0 | + | 80360 | *Corynoneura "celeripes" (sensu Simpson &* | 0 | + |
| 43300 | *Ranatra sp* | 0 | + | 82101 | *Thienemanniella n.sp 1* | 40 | + |
| 45300 | *Sigara sp* | 0 | + | 84700 | *Stenochironomus sp* | 51 | |
| 47600 | *Sialis sp* | 0 | + | 83040 | *Dicrotendipes neomodestus* | 51 | |
| 50315 | *Chimarra obscura* | 9 | + | 84460 | *Polypedilum (P.) fallax group* | 281 | |
| 52430 | *Hydropsyche (Ceratopsyche) morosa group* | 37 | + | 84750 | *Stictochironomus sp* | 26 | + |
| 52550 | *Hydropsyche (H.) frisoni* | 0 | + | 84450 | *Polypedilum (P.) convictum* | 179 | + |
| 52200 | *Cheumatopsyche sp* | 190 | + | 84470 | *Polypedilum (P.) illinoense* | 0 | + |
| 52530 | *Hydropsyche (H.) depravata group* | 25 | + | 82820 | *Cryptochironomus sp* | 0 | + |

**Ohio EPA Water Quality Monitoring and Assessment Section**
**Macroinvertebrate Collection**

Collection Date: 09/20/94 River Code: 02-450 River: Whetstone Creek RM: 10.10

| Taxa Code | Taxa | Quan | Qual |
|---|---|---|---|
| 83840 | *Microtendipes pedellus group* | 306 | + |
| 83820 | *Microtendipes "caelum" (sensu Simpson &* | 0 | + |
| 84888 | *Xenochironomus xenolabis* | 0 | + |
| 84210 | *Paratendipes albimanus or P. duplicatus* | 26 | |
| 78140 | *Labrundinia pilosella* | 8 | |
| 85720 | *Stempellinella n.sp nr. flavidula* | 40 | + |
| 85814 | *Tanytarsus glabrescens group* | 485 | + |
| 85625 | *Rheotanytarsus exiguus group* | 409 | + |
| 85615 | *Rheotanytarsus distinctissimus group* | 179 | + |
| 85800 | *Tanytarsus sp* | 51 | + |
| 85500 | *Paratanytarsus sp* | 26 | |
| 97601 | *Corbicula fluminea* | 0 | + |
| 93900 | *Elimia sp* | 5 | + |
| 95100 | *Physella sp* | 0 | + |
| 96900 | *Ferrissia sp* | 4 | + |
| 99860 | *Lampsilis radiata luteola* | 0 | + |
| 99440 | *Fusconaia flava* | 0 | + |
| 99180 | *Strophitus undulatus undulatus* | 0 | + |
| 99420 | *Amblema plicata plicata* | 0 | + |
| 99260 | *Lasmigona compressa* | 0 | + |
| 98600 | *Sphaerium sp* | 9 | |

No. Quantitative Taxa: 58 Total Taxa: 103

No. Qualitative Taxa: 84 ICI: **46**

Number of Organisms: 4549 Qual EPT: **20**

**Ohio EPA Water Quality Monitoring and Assessment Section**
**Macroinvertebrate Collection**

Collection Date: 09/20/94 River Code: 02-450 River: Whetstone Creek RM: 9.20

| Taxa Code | Taxa | Quan/Qual | | Taxa Code | Taxa | Quan/Qual | |
|---|---|---|---|---|---|---|---|
| 00805 | *Spongilla lacustris* | 0 | + | 68601 | *Ancyronyx variegata* | 0 | + |
| 01320 | *Hydra sp* | 233 | | 68708 | *Dubiraphia vittata group* | 0 | + |
| 01801 | *Turbellaria* | 0 | + | 68901 | *Macronychus glabratus* | 4 | |
| 03362 | *Plumatella casmiana* | 0 | + | 71100 | *Hexatoma sp* | 0 | + |
| 03369 | *Plumatella repens* | 0 | + | 86200 | *Tabanus sp* | 0 | + |
| 08250 | *Orconectes (Procericambarus) rusticus* | 0 | + | 87540 | *Hemerodromia sp* | 113 | + |
| 06201 | *Hyalella azteca* | 0 | + | 74100 | *Simulium sp* | 8 | + |
| 08601 | *Hydracarina* | 0 | + | 80420 | *Cricotopus (C.) bicinctus* | 67 | |
| 13521 | *Stenonema femoratum* | 9 | + | 80430 | *Cricotopus (C.) tremulus group* | 90 | |
| 17200 | *Caenis sp* | 17 | + | 81630 | *Parakiefferiella sp* | 22 | + |
| 13400 | *Stenacron sp* | 141 | + | 81231 | *Nanocladius (N.) crassicornus or N. (N.)* | 45 | + |
| 12200 | *Isonychia sp* | 5 | + | 81650 | *Parametriocnemus sp* | 0 | + |
| 13561 | *Stenonema pulchellum* | 18 | + | 82101 | *Thienemanniella n.sp 1* | 48 | + |
| 11130 | *Baetis intercalaris* | 27 | + | 80410 | *Cricotopus (C.) sp* | 90 | + |
| 11120 | *Baetis flavistriga* | 28 | + | 81825 | *Rheocricotopus (Psilocricotopus) robacki* | 22 | |
| 11670 | *Procloeon irrubrum* | 0 | + | 77500 | *Conchapelopia sp* | 67 | + |
| 11249 | *Centroptilum sp (w/ hindwing pads)* | 0 | + | 78140 | *Labrundinia pilosella* | 24 | + |
| 11200 | *Callibaetis sp* | 0 | + | 77800 | *Helopelopia sp* | 90 | + |
| 11250 | *Centroptilum sp (w/o hindwing pads)* | 0 | + | 78650 | *Procladius sp* | 0 | + |
| 15000 | *Paraleptophlebia sp* | 65 | | 77750 | *Hayesomyia senata or Thienemannimyia* | 135 | |
| 21300 | *Hetaerina sp* | 1 | + | 77120 | *Ablabesmyia mallochi* | 45 | |
| 22300 | *Argia sp* | 8 | + | 78450 | *Nilotanypus fimbriatus* | 24 | |
| 22001 | *Coenagrionidae* | 0 | + | 80370 | *Corynoneura lobata* | 176 | |
| 23804 | *Basiaeschna janata* | 0 | + | 84750 | *Stictochironomus sp* | 0 | + |
| 23909 | *Boyeria vinosa* | 0 | + | 83840 | *Microtendipes pedellus group* | 0 | + |
| 21200 | *Calopteryx sp* | 1 | | 83820 | *Microtendipes "caelum" (sensu Simpson &* | 0 | + |
| 42700 | *Belostoma sp* | 0 | + | 84470 | *Polypedilum (P.) illinoense* | 0 | + |
| 43300 | *Ranatra sp* | 0 | + | 82730 | *Chironomus (C.) decorus group* | 0 | + |
| 45100 | *Palmacorixa sp* | 0 | + | 84450 | *Polypedilum (P.) convictum* | 112 | + |
| 48410 | *Corydalus cornutus* | 0 | + | 84300 | *Phaenopsectra obediens group* | 0 | + |
| 58505 | *Helicopsyche borealis* | 0 | + | 84790 | *Tribelos fuscicorne* | 0 | + |
| 50315 | *Chimarra obscura* | 7 | + | 82820 | *Cryptochironomus sp* | 0 | + |
| 52200 | *Cheumatopsyche sp* | 76 | + | 83040 | *Dicrotendipes neomodestus* | 45 | |
| 52430 | *Hydropsyche (Ceratopsyche) morosa group* | 81 | + | 83051 | *Dicrotendipes simpsoni* | 22 | |
| 52530 | *Hydropsyche (H.) depravata group* | 3 | + | 82121 | *Thienemanniella n.sp 3* | 8 | |
| 57400 | *Neophylax sp* | 0 | + | 82141 | *Thienemanniella xena* | 16 | |
| 59970 | *Petrophila sp* | 0 | + | 80360 | *Corynoneura "celeripes" (sensu Simpson &* | 24 | |
| 68075 | *Psephenus herricki* | 0 | + | 85720 | *Stempellinella n.sp nr. flavidula* | 8 | |
| 60900 | *Peltodytes sp* | 0 | + | 85800 | *Tanytarsus sp* | 45 | + |
| 65800 | *Berosus sp* | 0 | + | 85814 | *Tanytarsus glabrescens group* | 427 | + |
| 69400 | *Stenelmis sp* | 1 | + | 85840 | *Tanytarsus guerlus group* | 0 | + |

**Ohio EPA Water Quality Monitoring and Assessment Section**
**Macroinvertebrate Collection**

Collection Date: 09/20/94 River Code: 02-450 River: Whetstone Creek RM: 9.20

| Taxa Code | Taxa | Quan/Qual | |
|---|---|---|---|
| 85625 | *Rheotanytarsus exiguus group* | 269 | |
| 85500 | *Paratanytarsus sp* | 22 | |
| 97601 | *Corbicula fluminea* | 0 | + |
| 95100 | *Physella sp* | 0 | + |
| 96900 | *Ferrissia sp* | 12 | + |
| 98600 | *Sphaerium sp* | 0 | + |
| 98200 | *Pisidium sp* | 0 | + |
| 99440 | *Fusconaia flava* | 0 | + |
| 99880 | *Lampsilis ventricosa* | 0 | + |

No. Quantitative Taxa: 46 Total Taxa: 91

No. Qualitative Taxa: 72 ICI: **44**

Number of Organisms: 2801 Qual EPT: **17**

**Ohio EPA Water Quality Monitoring and Assessment Section**
**Macroinvertebrate Collection**

Collection Date: 09/20/94 River Code: 02-453 River: Shaw Creek RM: 0.40

| Taxa Code | Taxa | Quan/Qual | |
|---|---|---|---|
| 00556 | *Ephydatia fluviatilis* | 0 | + |
| 01801 | *Turbellaria* | 0 | + |
| 04685 | *Placobdella ornata* | 0 | + |
| 08250 | *Orconectes (Procericambarus) rusticus* | 0 | + |
| 06201 | *Hyalella azteca* | 0 | + |
| 13521 | *Stenonema femoratum* | 0 | + |
| 12200 | *Isonychia sp* | 0 | + |
| 18700 | *Hexagenia sp* | 0 | + |
| 13400 | *Stenacron sp* | 0 | + |
| 17200 | *Caenis sp* | 0 | + |
| 11130 | *Baetis intercalaris* | 0 | + |
| 11120 | *Baetis flavistriga* | 0 | + |
| 11670 | *Procloeon irrubrum* | 0 | + |
| 11650 | *Procloeon sp (w/ hindwing pads)* | 0 | + |
| 15000 | *Paraleptophlebia sp* | 0 | + |
| 21200 | *Calopteryx sp* | 0 | + |
| 21300 | *Hetaerina sp* | 0 | + |
| 22300 | *Argia sp* | 0 | + |
| 22001 | *Coenagrionidae* | 0 | + |
| 45300 | *Sigara sp* | 0 | + |
| 48410 | *Corydalus cornutus* | 0 | + |
| 47600 | *Sialis sp* | 0 | + |
| 58505 | *Helicopsyche borealis* | 0 | + |
| 52200 | *Cheumatopsyche sp* | 0 | + |
| 50315 | *Chimarra obscura* | 0 | + |
| 52430 | *Hydropsyche (Ceratopsyche) morosa group* | 0 | + |
| 52530 | *Hydropsyche (H.) depravata group* | 0 | + |
| 57400 | *Neophylax sp* | 0 | + |
| 59970 | *Petrophila sp* | 0 | + |
| 68075 | *Psephenus herricki* | 0 | + |
| 69400 | *Stenelmis sp* | 0 | + |
| 68708 | *Dubiraphia vittata group* | 0 | + |
| 68901 | *Macronychus glabratus* | 0 | + |
| 68702 | *Dubiraphia bivittata* | 0 | + |
| 71100 | *Hexatoma sp* | 0 | + |
| 86100 | *Chrysops sp* | 0 | + |
| 71900 | *Tipula sp* | 0 | + |
| 74501 | *Ceratopogonidae* | 0 | + |
| 74100 | *Simulium sp* | 0 | + |
| 71200 | *Limnophila sp* | 0 | + |
| 71910 | *Tipula abdominalis* | 0 | + |
| 89501 | *Ephydridae* | 0 | + |
| 68201 | *Scirtidae* | 0 | + |
| 77500 | *Conchapelopia sp* | 0 | + |
| 77800 | *Helopelopia sp* | 0 | + |
| 78140 | *Labrundinia pilosella* | 0 | + |
| 80370 | *Corynoneura lobata* | 0 | + |
| 81825 | *Rheocricotopus (Psilocricotopus) robacki* | 0 | + |
| 84450 | *Polypedilum (P.) convictum* | 0 | + |
| 84210 | *Paratendipes albimanus or P. duplicatus* | 0 | + |
| 83840 | *Microtendipes pedellus group* | 0 | + |
| 84750 | *Stictochironomus sp* | 0 | + |
| 84470 | *Polypedilum (P.) illinoense* | 0 | + |
| 85500 | *Paratanytarsus sp* | 0 | + |
| 85814 | *Tanytarsus glabrescens group* | 0 | + |
| 85800 | *Tanytarsus sp* | 0 | + |
| 99440 | *Fusconaia flava* | 0 | + |
| 99560 | *Ptychobranchus fasciolaris* | 0 | + |
| 99860 | *Lampsilis radiata luteola* | 0 | + |
| 99880 | *Lampsilis ventricosa* | 0 | + |
| 99420 | *Amblema plicata plicata* | 0 | + |
| 97601 | *Corbicula fluminea* | 0 | + |
| 93900 | *Elimia sp* | 0 | + |
| 95100 | *Physella sp* | 0 | + |
| 96900 | *Ferrissia sp* | 0 | + |
| 98600 | *Sphaerium sp* | 0 | + |
| 98200 | *Pisidium sp* | 0 | + |

No. Quantitative Taxa: 0 Total Taxa: 67

No. Qualitative Taxa: 67 ICI:

Number of Organisms: 0 Qual EPT:

# Species List

| River Code: **02-450** | Stream: **Whetstone Creek** | Sample Date: **1994** |
|---|---|---|
| River Mile: **25.40** | Basin: Scioto River | Date Range: 08/03/94 |
| Data Source: 01 | Time Fished: 4766 sec  Drain Area: 26.0 sq mi | Thru: 09/12/94 |
| Purpose: | Dist Fished: 0.40 km  No of Passes: 2 | Sampler Type: D |

| Species Name / 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 | 3 | 2.25 | 0.26 | 0.12 | 1.85 | 55.33 |
| NORTHERN HOG SUCKER | R | I | S | M | 19 | 14.25 | 1.64 | 0.88 | 13.03 | 61.68 |
| WHITE SUCKER | W | O | S | T | 79 | 59.25 | 6.83 | 0.78 | 11.57 | 13.16 |
| COMMON CARP | G | O | M | T | 1 | 0.75 | 0.09 | 0.73 | 10.84 | 975.00 |
| BLACKNOSE DACE | N | G | S | T | 1 | 0.75 | 0.09 | 0.00 | 0.04 | 3.00 |
| CREEK CHUB | N | G | N | T | 19 | 14.25 | 1.64 | 0.44 | 6.45 | 30.53 |
| REDSIDE DACE | N | I | S | I | 1 | 0.75 | 0.09 | 0.00 | 0.01 | 1.00 |
| SILVER SHINER | N | I | S | I | 102 | 76.50 | 8.82 | 0.15 | 2.18 | 1.92 |
| ROSEFIN SHINER | N | I | S | M | 1 | 0.75 | 0.09 | 0.00 | 0.04 | 3.00 |
| STRIPED SHINER | N | I | S | | 12 | 9.00 | 1.04 | 0.12 | 1.73 | 12.92 |
| BLUNTNOSE MINNOW | N | O | C | T | 16 | 12.00 | 1.38 | 0.09 | 1.33 | 7.44 |
| CENTRAL STONEROLLER | N | H | N | | 280 | 210.00 | 24.22 | 0.85 | 12.66 | 4.07 |
| ROCK BASS | S | C | C | | 12 | 9.00 | 1.04 | 0.83 | 12.31 | 92.25 |
| SMALLMOUTH BASS | F | C | C | M | 1 | 0.75 | 0.09 | 0.44 | 6.45 | 580.00 |
| LARGEMOUTH BASS | F | C | C | | 7 | 5.25 | 0.61 | 0.03 | 0.39 | 5.00 |
| GREEN SUNFISH | S | I | C | T | 14 | 10.50 | 1.21 | 0.25 | 3.74 | 24.00 |
| BLUEGILL SUNFISH | S | I | C | P | 6 | 4.50 | 0.52 | 0.07 | 0.99 | 14.83 |
| PUMPKINSEED SUNFISH | S | I | C | P | 2 | 1.50 | 0.17 | 0.05 | 0.76 | 34.00 |
| BLACKSIDE DARTER | D | I | S | | 18 | 13.50 | 1.56 | 0.04 | 0.55 | 2.72 |
| LOGPERCH | D | I | S | M | 1 | 0.75 | 0.09 | 0.00 | 0.04 | 3.00 |
| JOHNNY DARTER | D | I | C | | 50 | 37.50 | 4.33 | 0.05 | 0.73 | 1.30 |
| GREENSIDE DARTER | D | I | S | M | 115 | 86.25 | 9.95 | 0.19 | 2.79 | 2.18 |
| RAINBOW DARTER | D | I | S | M | 228 | 171.00 | 19.72 | 0.22 | 3.33 | 1.31 |
| FANTAIL DARTER | D | I | C | | 61 | 45.75 | 5.28 | 0.08 | 1.11 | 1.64 |
| MOTTLED SCULPIN | | I | C | | 107 | 80.25 | 9.26 | 0.35 | 5.16 | 4.34 |
| *Mile Total* | | | | | 1,156 | 867.00 | | 6.75 | | |
| *Number of Species* | | | | | 25 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| River Code: **02-450** | Stream: **Whetstone Creek** | | Sample Date: **1994** |
|---|---|---|---|
| River Mile: **22.20** | Basin: Scioto River | | Date Range: 08/04/94 |
| Data Source: 01 | Time Fished: 4621 sec | Drain Area: 34.0 sq mi | Thru: 09/19/94 |
| Purpose: | Dist Fished: 0.40 km | No of Passes: 2 | Sampler Type: D |

| Species Name / ODNR Status | IBI Grp | Feed Guild | Breed Guild | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| GOLDEN REDHORSE | R | I | S | M | 1 | 0.75 | 0.02 | 0.07 | 0.26 | 88.00 |
| NORTHERN HOG SUCKER | R | I | S | M | 167 | 125.25 | 4.00 | 5.74 | 22.69 | 45.80 |
| WHITE SUCKER | W | O | S | T | 131 | 98.25 | 3.14 | 4.56 | 18.02 | 46.37 |
| CREEK CHUB | N | G | N | T | 188 | 141.00 | 4.50 | 1.69 | 6.69 | 11.99 |
| SILVER SHINER | N | I | S | I | 121 | 90.75 | 2.90 | 0.21 | 0.85 | 2.36 |
| ROSEFIN SHINER | N | I | S | M | 3 | 2.25 | 0.07 | 0.01 | 0.02 | 2.33 |
| STRIPED SHINER | N | I | S | | 61 | 45.75 | 1.46 | 0.36 | 1.42 | 7.84 |
| SILVERJAW MINNOW | N | I | M | | 26 | 19.50 | 0.62 | 0.05 | 0.21 | 2.73 |
| BLUNTNOSE MINNOW | N | O | C | T | 235 | 176.25 | 5.63 | 0.60 | 2.36 | 3.39 |
| CENTRAL STONEROLLER | N | H | N | | 2,330 | 1,747.50 | 55.80 | 7.51 | 29.70 | 4.30 |
| YELLOW BULLHEAD | | I | C | T | 5 | 3.75 | 0.12 | 0.58 | 2.28 | 153.40 |
| WHITE CRAPPIE | S | I | C | | 1 | 0.75 | 0.02 | 0.07 | 0.26 | 87.00 |
| ROCK BASS | S | C | C | | 7 | 5.25 | 0.17 | 0.43 | 1.70 | 81.71 |
| LARGEMOUTH BASS | F | C | C | | 45 | 33.75 | 1.08 | 0.36 | 1.43 | 10.71 |
| GREEN SUNFISH | S | I | C | T | 82 | 61.50 | 1.96 | 1.67 | 6.59 | 27.10 |
| LONGEAR SUNFISH | S | I | C | M | 13 | 9.75 | 0.31 | 0.20 | 0.79 | 20.62 |
| GREEN SF X BLUEGILL | | | | | 1 | 0.75 | 0.02 | 0.01 | 0.03 | 10.00 |
| BLACKSIDE DARTER | D | I | S | | 5 | 3.75 | 0.12 | 0.02 | 0.07 | 4.40 |
| LOGPERCH | D | I | S | M | 3 | 2.25 | 0.07 | 0.02 | 0.07 | 8.00 |
| JOHNNY DARTER | D | I | C | | 72 | 54.00 | 1.72 | 0.06 | 0.24 | 1.11 |
| GREENSIDE DARTER | D | I | S | M | 272 | 204.00 | 6.51 | 0.53 | 2.11 | 2.62 |
| BANDED DARTER | D | I | S | I | 13 | 9.75 | 0.31 | 0.02 | 0.07 | 1.85 |
| RAINBOW DARTER | D | I | S | M | 160 | 120.00 | 3.83 | 0.17 | 0.66 | 1.39 |
| FANTAIL DARTER | D | I | C | | 157 | 117.75 | 3.76 | 0.19 | 0.74 | 1.58 |
| MOTTLED SCULPIN | | I | C | | 77 | 57.75 | 1.84 | 0.19 | 0.76 | 3.34 |
| *Mile Total* | | | | | 4,176 | 3,132.00 | | 25.29 | | |
| *Number of Species* | | | | | 24 | | | | | |
| *Number of Hybrids* | | | | | 1 | | | | | |

| River Code: **02-450** | Stream: **Whetstone Creek** | | Sample Date: **1994** |
|---|---|---|---|
| River Mile: **20.90** | Basin: Scioto River | | Date Range: 08/04/94 |
| Data Source: 01 | Time Fished: 6759 sec | Drain Area: 36.0 sq mi | Thru: 09/19/94 |
| Purpose: | Dist Fished: 0.40 km | No of Passes: 2 | Sampler Type: D |

| Species Name / ODNR Status | IBI Grp | Feed Guild | Breed Guild | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| CENTRAL MUDMINNOW | | I | C | T | 1 | 0.75 | 0.06 | 0.01 | 0.03 | 12.00 |
| GOLDEN REDHORSE | R | I | S | M | 2 | 1.50 | 0.13 | 0.14 | 0.49 | 92.50 |
| NORTHERN HOG SUCKER | R | I | S | M | 181 | 135.75 | 11.53 | 6.68 | 23.63 | 49.20 |
| WHITE SUCKER | W | O | S | T | 176 | 132.00 | 11.21 | 9.91 | 35.04 | 75.05 |
| COMMON CARP | G | O | M | T | 2 | 1.50 | 0.13 | 0.39 | 1.37 | 258.00 |
| CREEK CHUB | N | G | N | T | 186 | 139.50 | 11.85 | 5.39 | 19.05 | 38.60 |
| SILVER SHINER | N | I | S | I | 15 | 11.25 | 0.96 | 0.04 | 0.13 | 3.27 |
| STRIPED SHINER | N | I | S | | 64 | 48.00 | 4.08 | 0.68 | 2.41 | 14.19 |
| SPOTFIN SHINER | N | I | M | | 1 | 0.75 | 0.06 | 0.00 | 0.01 | 4.00 |
| SILVERJAW MINNOW | N | I | M | | 5 | 3.75 | 0.32 | 0.02 | 0.06 | 4.20 |
| BLUNTNOSE MINNOW | N | O | C | T | 55 | 41.25 | 3.50 | 0.15 | 0.52 | 3.53 |
| CENTRAL STONEROLLER | N | H | N | | 298 | 223.50 | 18.98 | 1.43 | 5.07 | 6.42 |
| YELLOW BULLHEAD | | I | C | T | 16 | 12.00 | 1.02 | 0.52 | 1.83 | 43.13 |
| ROCK BASS | S | C | C | | 18 | 13.50 | 1.15 | 0.85 | 3.00 | 62.89 |
| SMALLMOUTH BASS | F | C | C | M | 1 | 0.75 | 0.06 | 0.27 | 0.97 | 365.00 |
| LARGEMOUTH BASS | F | C | C | | 6 | 4.50 | 0.38 | 0.04 | 0.16 | 9.83 |
| GREEN SUNFISH | S | I | C | T | 55 | 41.25 | 3.50 | 0.55 | 1.94 | 13.27 |
| BLUEGILL SUNFISH | S | I | C | P | 2 | 1.50 | 0.13 | 0.02 | 0.08 | 15.00 |
| LONGEAR SUNFISH | S | I | C | M | 17 | 12.75 | 1.08 | 0.27 | 0.95 | 21.06 |
| BLACKSIDE DARTER | D | I | S | | 6 | 4.50 | 0.38 | 0.01 | 0.02 | 1.50 |
| JOHNNY DARTER | D | I | C | | 31 | 23.25 | 1.97 | 0.02 | 0.08 | 0.97 |
| GREENSIDE DARTER | D | I | S | M | 216 | 162.00 | 13.76 | 0.59 | 2.07 | 3.61 |
| BANDED DARTER | D | I | S | I | 3 | 2.25 | 0.19 | 0.00 | 0.01 | 1.33 |
| RAINBOW DARTER | D | I | S | M | 139 | 104.25 | 8.85 | 0.15 | 0.51 | 1.40 |
| FANTAIL DARTER | D | I | C | | 36 | 27.00 | 2.29 | 0.04 | 0.13 | 1.36 |
| MOTTLED SCULPIN | | I | C | | 38 | 28.50 | 2.42 | 0.13 | 0.45 | 4.42 |
| | | *Mile Total* | | | 1,570 | 1,177.50 | | 28.27 | | |
| | | *Number of Species* | | | 26 | | | | | |
| | | *Number of Hybrids* | | | 0 | | | | | |

# Species List

| River Code: **02-450** | Stream: **Whetstone Creek** | | Sample Date: **1994** |
|---|---|---|---|
| River Mile: **19.20** | Basin: Scioto River | | Date Range: 08/04/94 |
| Data Source: 01 | Time Fished: 4381 sec | Drain Area: 38.0 sq mi | Thru: 09/19/94 |
| Purpose: | Dist Fished: 0.40 km | No of Passes: 2 | Sampler Type: D |

| Species Name / 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 | | 1 | 0.75 | 0.08 | 0.05 | 0.19 | 60.00 |
| CENTRAL MUDMINNOW | | I | C | T | 1 | 0.75 | 0.08 | 0.00 | 0.02 | 6.00 |
| GOLDEN REDHORSE | R | I | S | M | 14 | 10.50 | 1.14 | 0.88 | 3.74 | 83.64 |
| NORTHERN HOG SUCKER | R | I | S | M | 86 | 64.50 | 7.01 | 3.55 | 15.11 | 55.10 |
| WHITE SUCKER | W | O | S | T | 110 | 82.50 | 8.97 | 3.42 | 14.53 | 41.43 |
| COMMON CARP | G | O | M | T | 13 | 9.75 | 1.06 | 8.15 | 34.67 | 836.18 |
| BLACKNOSE DACE | N | G | S | T | 1 | 0.75 | 0.08 | 0.00 | 0.00 | 1.00 |
| CREEK CHUB | N | G | N | T | 90 | 67.50 | 7.34 | 0.76 | 3.23 | 11.24 |
| REDSIDE DACE | N | I | S | I | 2 | 1.50 | 0.16 | 0.00 | 0.00 | 0.50 |
| SILVER SHINER | N | I | S | I | 11 | 8.25 | 0.90 | 0.03 | 0.13 | 3.64 |
| ROSEFIN SHINER | N | I | S | M | 1 | 0.75 | 0.08 | 0.00 | 0.01 | 2.00 |
| STRIPED SHINER | N | I | S | | 56 | 42.00 | 4.57 | 0.70 | 2.96 | 16.57 |
| SPOTFIN SHINER | N | I | M | | 4 | 3.00 | 0.33 | 0.01 | 0.06 | 4.50 |
| BLUNTNOSE MINNOW | N | O | C | T | 128 | 96.00 | 10.44 | 0.11 | 0.45 | 1.12 |
| CENTRAL STONEROLLER | N | H | N | | 98 | 73.50 | 7.99 | 0.22 | 0.94 | 2.99 |
| YELLOW BULLHEAD | | I | C | T | 7 | 5.25 | 0.57 | 0.53 | 2.27 | 101.57 |
| ROCK BASS | S | C | C | | 26 | 19.50 | 2.12 | 1.14 | 4.85 | 58.54 |
| SMALLMOUTH BASS | F | C | C | M | 3 | 2.25 | 0.24 | 0.65 | 2.78 | 290.33 |
| LARGEMOUTH BASS | F | C | C | | 13 | 9.75 | 1.06 | 0.05 | 0.23 | 5.38 |
| GREEN SUNFISH | S | I | C | T | 67 | 50.25 | 5.46 | 0.96 | 4.07 | 19.03 |
| BLUEGILL SUNFISH | S | I | C | P | 3 | 2.25 | 0.24 | 0.03 | 0.12 | 12.67 |
| LONGEAR SUNFISH | S | I | C | M | 96 | 72.00 | 7.83 | 1.66 | 7.04 | 22.99 |
| PUMPKINSEED SUNFISH | S | I | C | P | 1 | 0.75 | 0.08 | 0.00 | 0.01 | 3.00 |
| GREEN SF X BLUEGILL | | | | | 1 | 0.75 | 0.08 | 0.02 | 0.08 | 25.00 |
| BLACKSIDE DARTER | D | I | S | | 7 | 5.25 | 0.57 | 0.02 | 0.07 | 3.00 |
| LOGPERCH | D | I | S | M | 1 | 0.75 | 0.08 | 0.00 | 0.01 | 4.00 |
| JOHNNY DARTER | D | I | C | | 65 | 48.75 | 5.30 | 0.05 | 0.20 | 0.97 |
| GREENSIDE DARTER | D | I | S | M | 206 | 154.50 | 16.80 | 0.41 | 1.74 | 2.65 |
| BANDED DARTER | D | I | S | I | 15 | 11.25 | 1.22 | 0.01 | 0.06 | 1.27 |
| RAINBOW DARTER | D | I | S | M | 99 | 74.25 | 8.08 | 0.11 | 0.45 | 1.43 |
| *Mile Total* | | | | | 1,226 | 919.50 | | 23.52 | | |
| *Number of Species* | | | | | 29 | | | | | |
| *Number of Hybrids* | | | | | 1 | | | | | |

# Species List

| River Code: **02-450** | Stream: **Whetstone Creek** | Sample Date: **1994** |
|---|---|---|
| River Mile: **16.10** | Basin: Scioto River | Date Range: 08/04/94 |
| Data Source: 01 | Time Fished: 4926 sec   Drain Area: 43.0 sq mi | Thru: 09/20/94 |
| Purpose: | Dist Fished: 0.40 km   No of Passes: 2 | Sampler Type: D |

| Species Name / 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 | 111 | 83.25 | 4.92 | 2.60 | 17.68 | 31.17 |
| WHITE SUCKER | W | O | S | T | 6 | 4.50 | 0.27 | 0.02 | 0.15 | 5.00 |
| BLACKNOSE DACE | N | G | S | T | 1 | 0.75 | 0.04 | 0.00 | 0.01 | 2.00 |
| CREEK CHUB | N | G | N | T | 78 | 58.50 | 3.46 | 0.92 | 6.29 | 15.78 |
| SILVER SHINER | N | I | S | I | 57 | 42.75 | 2.53 | 0.16 | 1.12 | 3.82 |
| ROSEFIN SHINER | N | I | S | M | 13 | 9.75 | 0.58 | 0.02 | 0.14 | 2.06 |
| STRIPED SHINER | N | I | S | | 65 | 48.75 | 2.88 | 0.80 | 5.48 | 16.49 |
| SPOTFIN SHINER | N | I | M | | 57 | 42.75 | 2.53 | 0.12 | 0.79 | 2.71 |
| BLUNTNOSE MINNOW | N | O | C | T | 235 | 176.25 | 10.42 | 0.34 | 2.32 | 1.93 |
| CENTRAL STONEROLLER | N | H | N | | 607 | 455.25 | 26.91 | 3.06 | 20.88 | 6.73 |
| YELLOW BULLHEAD | | I | C | T | 4 | 3.00 | 0.18 | 0.13 | 0.90 | 43.75 |
| STONECAT MADTOM | | I | C | I | 1 | 0.75 | 0.04 | 0.01 | 0.08 | 16.00 |
| ROCK BASS | S | C | C | | 44 | 33.00 | 1.95 | 2.74 | 18.70 | 83.14 |
| SMALLMOUTH BASS | F | C | C | M | 11 | 8.25 | 0.49 | 1.42 | 9.70 | 172.55 |
| LARGEMOUTH BASS | F | C | C | | 14 | 10.50 | 0.62 | 0.11 | 0.72 | 10.07 |
| GREEN SUNFISH | S | I | C | T | 7 | 5.25 | 0.31 | 0.07 | 0.46 | 12.71 |
| LONGEAR SUNFISH | S | I | C | M | 46 | 34.50 | 2.04 | 0.65 | 4.41 | 18.74 |
| GREEN SF X LONGEAR | | | | | 1 | 0.75 | 0.04 | 0.03 | 0.17 | 33.00 |
| LOGPERCH | D | I | S | M | 26 | 19.50 | 1.15 | 0.18 | 1.20 | 9.02 |
| JOHNNY DARTER | D | I | C | | 50 | 37.50 | 2.22 | 0.05 | 0.31 | 1.23 |
| GREENSIDE DARTER | D | I | S | M | 293 | 219.75 | 12.99 | 0.66 | 4.47 | 2.98 |
| BANDED DARTER | D | I | S | I | 30 | 22.50 | 1.33 | 0.04 | 0.24 | 1.53 |
| RAINBOW DARTER | D | I | S | M | 475 | 356.25 | 21.05 | 0.52 | 3.55 | 1.46 |
| FANTAIL DARTER | D | I | C | | 24 | 18.00 | 1.06 | 0.04 | 0.26 | 2.13 |
| *Mile Total* | | | | | 2,256 | 1,692.00 | | 14.68 | | |
| *Number of Species* | | | | | 23 | | | | | |
| *Number of Hybrids* | | | | | 1 | | | | | |

# Species List

| River Code: **02-450** | Stream: **Whetstone Creek** | | Sample Date: **1994** |
|---|---|---|---|
| River Mile: **12.90** | Basin: Scioto River | | Date Range: 08/05/94 |
| Data Source: 01 | Time Fished: 4298 sec | Drain Area: 51.0 sq mi | Thru: 09/13/94 |
| Purpose: | Dist Fished: 0.41 km | No of Passes: 2 | Sampler Type: D |

| Species Name / 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 | | 134 | 98.43 | 4.45 | 0.94 | 2.30 | 9.53 |
| GOLDEN REDHORSE | R | I | S | M | 29 | 20.86 | 0.94 | 5.74 | 13.97 | 275.74 |
| NORTHERN HOG SUCKER | R | I | S | M | 167 | 122.79 | 5.55 | 9.37 | 22.83 | 76.75 |
| WHITE SUCKER | W | O | S | T | 67 | 48.64 | 2.20 | 2.94 | 7.15 | 60.24 |
| COMMON CARP | G | O | M | T | 6 | 4.32 | 0.20 | 3.77 | 9.18 | 878.08 |
| BLACKNOSE DACE | N | G | S | T | 1 | 0.75 | 0.03 | 0.00 | 0.00 | 2.00 |
| CREEK CHUB | N | G | N | T | 94 | 69.50 | 3.14 | 0.68 | 1.65 | 9.73 |
| SILVER SHINER | N | I | S | I | 27 | 19.86 | 0.90 | 0.07 | 0.17 | 3.52 |
| ROSEFIN SHINER | N | I | S | M | 7 | 5.21 | 0.24 | 0.01 | 0.02 | 1.66 |
| STRIPED SHINER | N | I | S | | 98 | 71.29 | 3.22 | 1.37 | 3.34 | 19.31 |
| SPOTFIN SHINER | N | I | M | | 103 | 76.18 | 3.44 | 0.21 | 0.51 | 2.73 |
| SAND SHINER | N | I | M | M | 12 | 8.86 | 0.40 | 0.02 | 0.05 | 2.17 |
| FATHEAD MINNOW | N | O | C | T | 1 | 0.75 | 0.03 | 0.00 | 0.00 | 2.00 |
| BLUNTNOSE MINNOW | N | O | C | T | 281 | 207.36 | 9.37 | 0.48 | 1.18 | 2.33 |
| CENTRAL STONEROLLER | N | H | N | | 1,072 | 787.89 | 35.62 | 5.18 | 12.62 | 6.56 |
| YELLOW BULLHEAD | | I | C | T | 30 | 21.96 | 0.99 | 1.80 | 4.38 | 82.47 |
| STONECAT MADTOM | | I | C | I | 18 | 13.18 | 0.60 | 0.22 | 0.54 | 17.06 |
| BROOK SILVERSIDE | | I | M | M | 3 | 2.25 | 0.10 | 0.00 | 0.01 | 1.33 |
| WHITE CRAPPIE | S | I | C | | 5 | 3.71 | 0.17 | 0.31 | 0.76 | 84.00 |
| ROCK BASS | S | C | C | | 62 | 45.43 | 2.05 | 3.71 | 9.03 | 81.76 |
| SMALLMOUTH BASS | F | C | C | M | 12 | 8.71 | 0.39 | 1.76 | 4.27 | 202.33 |
| LARGEMOUTH BASS | F | C | C | | 11 | 8.07 | 0.36 | 0.09 | 0.21 | 10.68 |
| GREEN SUNFISH | S | I | C | T | 33 | 24.07 | 1.09 | 0.53 | 1.30 | 22.16 |
| BLUEGILL SUNFISH | S | I | C | P | 5 | 3.64 | 0.16 | 0.17 | 0.40 | 45.60 |
| LONGEAR SUNFISH | S | I | C | M | 10 | 7.29 | 0.33 | 0.21 | 0.51 | 28.60 |
| PUMPKINSEED SUNFISH | S | I | C | P | 1 | 0.75 | 0.03 | 0.00 | 0.01 | 3.00 |
| GREEN SF X LONGEAR | | | | | 8 | 5.71 | 0.26 | 0.14 | 0.35 | 25.13 |
| BLACKSIDE DARTER | D | I | S | | 2 | 1.50 | 0.07 | 0.00 | 0.01 | 2.00 |
| LOGPERCH | D | I | S | M | 65 | 47.64 | 2.15 | 0.43 | 1.05 | 9.05 |
| JOHNNY DARTER | D | I | C | | 24 | 17.64 | 0.80 | 0.02 | 0.05 | 1.13 |
| GREENSIDE DARTER | D | I | S | M | 314 | 231.29 | 10.46 | 0.57 | 1.38 | 2.46 |
| BANDED DARTER | D | I | S | I | 44 | 32.54 | 1.47 | 0.04 | 0.10 | 1.30 |
| RAINBOW DARTER | D | I | S | M | 262 | 193.07 | 8.73 | 0.28 | 0.68 | 1.45 |
| FANTAIL DARTER | D | I | C | | 1 | 0.71 | 0.03 | 0.00 | 0.00 | 2.00 |
| *Mile Total* | | | | | 3,009 | 2,211.86 | | 41.07 | | |
| *Number of Species* | | | | | 33 | | | | | |
| *Number of Hybrids* | | | | | 1 | | | | | |

# Species List

| River Code: **02-450** | Stream: **Whetstone Creek** | | Sample Date: **1994** |
|---|---|---|---|
| River Mile: **10.00** | Basin: Scioto River | | Date Range: 08/05/94 |
| Data Source: 01 | Time Fished: 3872 sec | Drain Area: 61.0 sq mi | Thru: 09/20/94 |
| Purpose: | Dist Fished: 0.40 km | No of Passes: 2 | Sampler Type: D |

| Species Name / 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 | | 88 | 66.00 | 4.00 | 0.58 | 9.52 | 8.83 |
| GOLDEN REDHORSE | R | I | S | M | 16 | 12.00 | 0.73 | 0.02 | 0.39 | 2.00 |
| NORTHERN HOG SUCKER | R | I | S | M | 30 | 22.50 | 1.36 | 0.24 | 3.89 | 10.57 |
| WHITE SUCKER | W | O | S | T | 2 | 1.50 | 0.09 | 0.07 | 1.13 | 46.00 |
| CREEK CHUB | N | G | N | T | 55 | 41.25 | 2.50 | 0.81 | 13.25 | 19.67 |
| SILVER SHINER | N | I | S | I | 1 | 0.75 | 0.05 | 0.00 | 0.07 | 5.00 |
| ROSEFIN SHINER | N | I | S | M | 1 | 0.75 | 0.05 | 0.00 | 0.02 | 2.00 |
| STRIPED SHINER | N | I | S | | 6 | 4.50 | 0.27 | 0.05 | 0.74 | 10.00 |
| SPOTFIN SHINER | N | I | M | | 152 | 114.00 | 6.92 | 0.32 | 5.30 | 2.85 |
| SAND SHINER | N | I | M | M | 130 | 97.50 | 5.91 | 0.15 | 2.41 | 1.51 |
| SILVERJAW MINNOW | N | I | M | | 41 | 30.75 | 1.87 | 0.07 | 1.17 | 2.33 |
| FATHEAD MINNOW | N | O | C | T | 2 | 1.50 | 0.09 | 0.00 | 0.07 | 2.50 |
| BLUNTNOSE MINNOW | N | O | C | T | 707 | 530.25 | 32.17 | 1.12 | 18.32 | 2.11 |
| CENTRAL STONEROLLER | N | H | N | | 355 | 266.25 | 16.15 | 1.49 | 24.26 | 5.58 |
| STONECAT MADTOM | | I | C | I | 5 | 3.75 | 0.23 | 0.09 | 1.50 | 24.50 |
| WHITE CRAPPIE | S | I | C | | 1 | 0.75 | 0.05 | 0.06 | 1.05 | 86.00 |
| ROCK BASS | S | C | C | | 3 | 2.25 | 0.14 | 0.08 | 1.25 | 34.00 |
| SMALLMOUTH BASS | F | C | C | M | 1 | 0.75 | 0.05 | 0.03 | 0.51 | 42.00 |
| LARGEMOUTH BASS | F | C | C | | 4 | 3.00 | 0.18 | 0.02 | 0.31 | 6.25 |
| GREEN SUNFISH | S | I | C | T | 1 | 0.75 | 0.05 | 0.00 | 0.02 | 2.00 |
| LONGEAR SUNFISH | S | I | C | M | 1 | 0.75 | 0.05 | 0.00 | 0.07 | 5.00 |
| BLACKSIDE DARTER | D | I | S | | 1 | 0.75 | 0.05 | 0.00 | 0.02 | 2.00 |
| LOGPERCH | D | I | S | M | 23 | 17.25 | 1.05 | 0.13 | 2.15 | 7.61 |
| JOHNNY DARTER | D | I | C | | 62 | 46.50 | 2.82 | 0.04 | 0.59 | 0.77 |
| GREENSIDE DARTER | D | I | S | M | 323 | 242.25 | 14.70 | 0.55 | 8.97 | 2.27 |
| BANDED DARTER | D | I | S | I | 41 | 30.75 | 1.87 | 0.04 | 0.65 | 1.30 |
| RAINBOW DARTER | D | I | S | M | 144 | 108.00 | 6.55 | 0.14 | 2.32 | 1.32 |
| FANTAIL DARTER | D | I | C | | 2 | 1.50 | 0.09 | 0.01 | 0.09 | 3.50 |
| *Mile Total* | | | | | 2,198 | 1,648.50 | | 6.12 | | |
| *Number of Species* | | | | | 28 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

# Species List

| River Code: **02-450** | Stream: **Whetstone Creek** | | Sample Date: **1994** |
|---|---|---|---|
| River Mile: **9.10** | Basin: Scioto River | | Date Range: 08/05/94 |
| Data Source: 01 | Time Fished: 3864 sec | Drain Area: 62.0 sq mi | Thru: 09/13/94 |
| Purpose: | Dist Fished: 0.40 km | No of Passes: 2 | Sampler Type: D |

| Species Name / 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 | | 227 | 170.25 | 11.04 | 1.75 | 7.27 | 10.30 |
| SILVER REDHORSE | R | I | S | M | 2 | 1.50 | 0.10 | 0.20 | 0.84 | 134.50 |
| GOLDEN REDHORSE | R | I | S | M | 25 | 18.75 | 1.22 | 5.50 | 22.80 | 293.30 |
| NORTHERN HOG SUCKER | R | I | S | M | 163 | 122.25 | 7.93 | 8.56 | 35.51 | 70.05 |
| WHITE SUCKER | W | O | S | T | 16 | 12.00 | 0.78 | 1.17 | 4.85 | 97.44 |
| CREEK CHUB | N | G | N | T | 15 | 11.25 | 0.73 | 0.14 | 0.57 | 12.27 |
| SILVER SHINER | N | I | S | I | 16 | 12.00 | 0.78 | 0.04 | 0.16 | 3.13 |
| ROSEFIN SHINER | N | I | S | M | 5 | 3.75 | 0.24 | 0.01 | 0.02 | 1.60 |
| SPOTFIN SHINER | N | I | M | | 74 | 55.50 | 3.60 | 0.13 | 0.53 | 2.32 |
| SAND SHINER | N | I | M | M | 58 | 43.50 | 2.82 | 0.08 | 0.33 | 1.83 |
| SILVERJAW MINNOW | N | I | M | | 21 | 15.75 | 1.02 | 0.06 | 0.24 | 3.62 |
| BLUNTNOSE MINNOW | N | O | C | T | 842 | 631.50 | 40.95 | 1.19 | 4.92 | 1.88 |
| CENTRAL STONEROLLER | N | H | N | | 118 | 88.50 | 5.74 | 0.32 | 1.34 | 3.64 |
| CHANNEL CATFISH | F | | C | | 1 | 0.75 | 0.05 | 0.41 | 1.71 | 550.00 |
| YELLOW BULLHEAD | | I | C | T | 3 | 2.25 | 0.15 | 0.01 | 0.05 | 5.33 |
| STONECAT MADTOM | | I | C | I | 6 | 4.50 | 0.29 | 0.11 | 0.44 | 23.50 |
| WHITE CRAPPIE | S | I | C | | 7 | 5.25 | 0.34 | 0.62 | 2.56 | 117.57 |
| ROCK BASS | S | C | C | | 13 | 9.75 | 0.63 | 1.05 | 4.35 | 107.69 |
| SMALLMOUTH BASS | F | C | C | M | 9 | 6.75 | 0.44 | 1.70 | 7.04 | 251.44 |
| LARGEMOUTH BASS | F | C | C | | 13 | 9.75 | 0.63 | 0.26 | 1.06 | 26.15 |
| GREEN SUNFISH | S | I | C | T | 3 | 2.25 | 0.15 | 0.10 | 0.42 | 45.00 |
| BLUEGILL SUNFISH | S | I | C | P | 1 | 0.75 | 0.05 | 0.00 | 0.02 | 6.00 |
| LONGEAR SUNFISH | S | I | C | M | 17 | 12.75 | 0.83 | 0.15 | 0.63 | 11.88 |
| BLACKSIDE DARTER | D | I | S | | 4 | 3.00 | 0.19 | 0.01 | 0.02 | 2.00 |
| LOGPERCH | D | I | S | M | 30 | 22.50 | 1.46 | 0.15 | 0.63 | 6.70 |
| JOHNNY DARTER | D | I | C | | 124 | 93.00 | 6.03 | 0.08 | 0.33 | 0.86 |
| GREENSIDE DARTER | D | I | S | M | 149 | 111.75 | 7.25 | 0.24 | 0.98 | 2.13 |
| BANDED DARTER | D | I | S | I | 9 | 6.75 | 0.44 | 0.01 | 0.04 | 1.33 |
| RAINBOW DARTER | D | I | S | M | 76 | 57.00 | 3.70 | 0.07 | 0.27 | 1.13 |
| FANTAIL DARTER | D | I | C | | 9 | 6.75 | 0.44 | 0.02 | 0.08 | 2.78 |
| *Mile Total* | | | | | 2,056 | 1,542.00 | | 24.12 | | |
| *Number of Species* | | | | | 30 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

# Species List

| River Code: **02-453** | Stream: **Shaw Creek** | Sample Date: **1994** |
|---|---|---|
| River Mile: **0.40** | Basin: Scioto River | Date Range: 08/08/94 |
| Data Source: 01 | Time Fished: 5808 sec Drain Area: 30.0 sq mi | Thru: 09/13/94 |
| Purpose: | Dist Fished: 0.40 km No of Passes: 2 | Sampler Type: D |

| Species Name / 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 | | 4 | 3.00 | 0.25 | 0.14 | 0.72 | 48.00 |
| GRASS PICKEREL | | P | M | P | 8 | 6.00 | 0.50 | 0.40 | 2.02 | 66.88 |
| GOLDEN REDHORSE | R | I | S | M | 5 | 3.75 | 0.31 | 0.62 | 3.10 | 164.00 |
| NORTHERN HOG SUCKER | R | I | S | M | 48 | 36.00 | 3.02 | 2.98 | 14.99 | 82.73 |
| WHITE SUCKER | W | O | S | T | 205 | 153.75 | 12.89 | 3.86 | 19.43 | 25.10 |
| CREEK CHUB | N | G | N | T | 391 | 293.25 | 24.59 | 6.27 | 31.54 | 21.37 |
| SILVER SHINER | N | I | S | I | 14 | 10.50 | 0.88 | 0.03 | 0.14 | 2.71 |
| STRIPED SHINER | N | I | S | | 28 | 21.00 | 1.76 | 0.42 | 2.13 | 20.18 |
| SPOTFIN SHINER | N | I | M | | 26 | 19.50 | 1.64 | 0.04 | 0.20 | 2.00 |
| BLUNTNOSE MINNOW | N | O | C | T | 152 | 114.00 | 9.56 | 0.21 | 1.04 | 1.81 |
| CENTRAL STONEROLLER | N | H | N | | 22 | 16.50 | 1.38 | 0.22 | 1.12 | 13.50 |
| YELLOW BULLHEAD | | I | C | T | 28 | 21.00 | 1.76 | 1.70 | 8.57 | 81.04 |
| STONECAT MADTOM | | I | C | I | 12 | 9.00 | 0.75 | 0.27 | 1.36 | 30.00 |
| WHITE CRAPPIE | S | I | C | | 1 | 0.75 | 0.06 | 0.10 | 0.51 | 135.00 |
| ROCK BASS | S | C | C | | 12 | 9.00 | 0.75 | 0.43 | 2.16 | 47.58 |
| SMALLMOUTH BASS | F | C | C | M | 1 | 0.75 | 0.06 | 0.01 | 0.04 | 10.00 |
| LARGEMOUTH BASS | F | C | C | | 13 | 9.75 | 0.82 | 0.36 | 1.81 | 36.77 |
| GREEN SUNFISH | S | I | C | T | 9 | 6.75 | 0.57 | 0.17 | 0.83 | 24.44 |
| BLUEGILL SUNFISH | S | I | C | P | 7 | 5.25 | 0.44 | 0.29 | 1.44 | 54.43 |
| LONGEAR SUNFISH | S | I | C | M | 17 | 12.75 | 1.07 | 0.23 | 1.15 | 17.94 |
| REDEAR SUNFISH | E | I | C | | 1 | 0.75 | 0.06 | 0.05 | 0.26 | 70.00 |
| BLACKSIDE DARTER | D | I | S | | 25 | 18.75 | 1.57 | 0.05 | 0.26 | 2.78 |
| LOGPERCH | D | I | S | M | 43 | 32.25 | 2.70 | 0.40 | 2.03 | 12.49 |
| JOHNNY DARTER | D | I | C | | 213 | 159.75 | 13.40 | 0.17 | 0.86 | 1.06 |
| GREENSIDE DARTER | D | I | S | M | 117 | 87.75 | 7.36 | 0.23 | 1.16 | 2.62 |
| BANDED DARTER | D | I | S | I | 9 | 6.75 | 0.57 | 0.01 | 0.06 | 1.67 |
| RAINBOW DARTER | D | I | S | M | 55 | 41.25 | 3.46 | 0.06 | 0.29 | 1.38 |
| FANTAIL DARTER | D | I | C | | 124 | 93.00 | 7.80 | 0.16 | 0.80 | 1.69 |
| *Mile Total* | | | | | 1,590 | 1,192.50 | | 19.86 | | |
| *Number of Species* | | | | | 28 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |