

Division of Surface Water

**Biological and Water Quality
Study of the East Fork
Vermilion River**

Lorain and Erie Counties, Ohio



February 6, 2008

Ted Strickland, Governor
Chris Korleski, Director

Biological and Water Quality Study

East Fork Vermilion River

Green Circle Growers Project

2007

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SUMMARY

A total of 9.2 miles of the East Fork Vermilion River was assessed by the Ohio EPA in 2007. Based on the performance of the biological communities, 4.1 miles of the East Fork Vermilion River were in partial attainment of the Warmwater Habitat aquatic life use and 5.1 miles were in full attainment of the WWH use (Table 1). Although there is some ecological impairment in the river, it continued to show biological improvement from sampling completed in 2005 and 2002. Areas of impairment included sites at Green Circle Growers property and on the downstream end of Kipton. Fish communities were in full attainment of Water Quality Standards (WQS) biocriteria at all stations tested on the East Fork Vermilion River. The documented impairment was reflected in the macroinvertebrate results, and appeared to result from nutrient enrichment. Chemical constituents measured in the surface water of the East Fork Vermilion River during 2007 were below Ohio WQS criteria, and comparable to reference quality. Water quality samples were collected during lower stream flow periods, and not influenced by recent runoff events.

An unnamed tributary to the East Fork Vermilion River (confluence at RM 8.47) was evaluated at one site adjacent to the Green Circle Growers property east of State Route 511. Biological communities were in partial attainment of the Warmwater Habitat aquatic life use, with macroinvertebrate results indicative of fair water quality, and fish considered marginally good. A substantial improvement in biological quality occurred in this unnamed tributary since the last sampling in 2002 (fair- very poor quality). Chemical water quality testing documented elevated nutrient levels, along with copper concentrations nearly exceeding the Ohio WQS criterion.

RECOMMENDATIONS

The aquatic life use designation of Warmwater Habitat (WWH) for the East Fork Vermilion River and the unnamed tributary to the East Fork Vermilion River (@RM 8.47) has been confirmed in previous Ohio EPA biological and water quality studies. This study verified continued WWH performance or potential for both streams.

Physical habitat conditions and pool depths verified that the Primary Contact Recreation use is appropriate for both the East Fork Vermilion River and the unnamed tributary.

The observation of potting soil and vermiculite in the East Fork Vermilion River in the area of a discharge pipe on Green Circle Growers property needs to be further investigated. A more detailed nutrient study of the East Fork and unnamed tributary would shed light on the levels and potential sources of enrichment occurring in these two waterbodies, and help to explain the cause of impaired macroinvertebrate communities in the areas of Green Circle Growers and Kipton.

FOREWORD

What is a Biological and Water Quality Survey?

A biological and water quality survey, or “biosurvey,” is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year Ohio EPA conducts biosurveys in 4-5 watersheds study areas with an aggregate total of 250-300 sampling sites.

The Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives: 1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if use designations assigned to a given water body are appropriate and attainable; and 3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality report. Each biological and water quality study contains a summary of major findings and recommendations for revisions to WQS, future monitoring needs, or other actions which may be needed to resolve existing impairment of designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns, are also addressed.

The findings and conclusions of a biological and water quality study may factor into regulatory actions taken by Ohio EPA (e.g., NPDES permits, Director’s Orders, the Ohio Water Quality Standards [OAC 3745-1], Water Quality Permit Support Documents [WQPSDs]), and are eventually incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d]).

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators consisting of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach includes a hierarchical continuum from administrative to true environmental indicators (Figure 1). The six “levels” of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health, ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental “results” (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition. Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio’s biological criteria. Other response indicators could include target assemblages, i.e., rare, threatened, endangered, special status, and

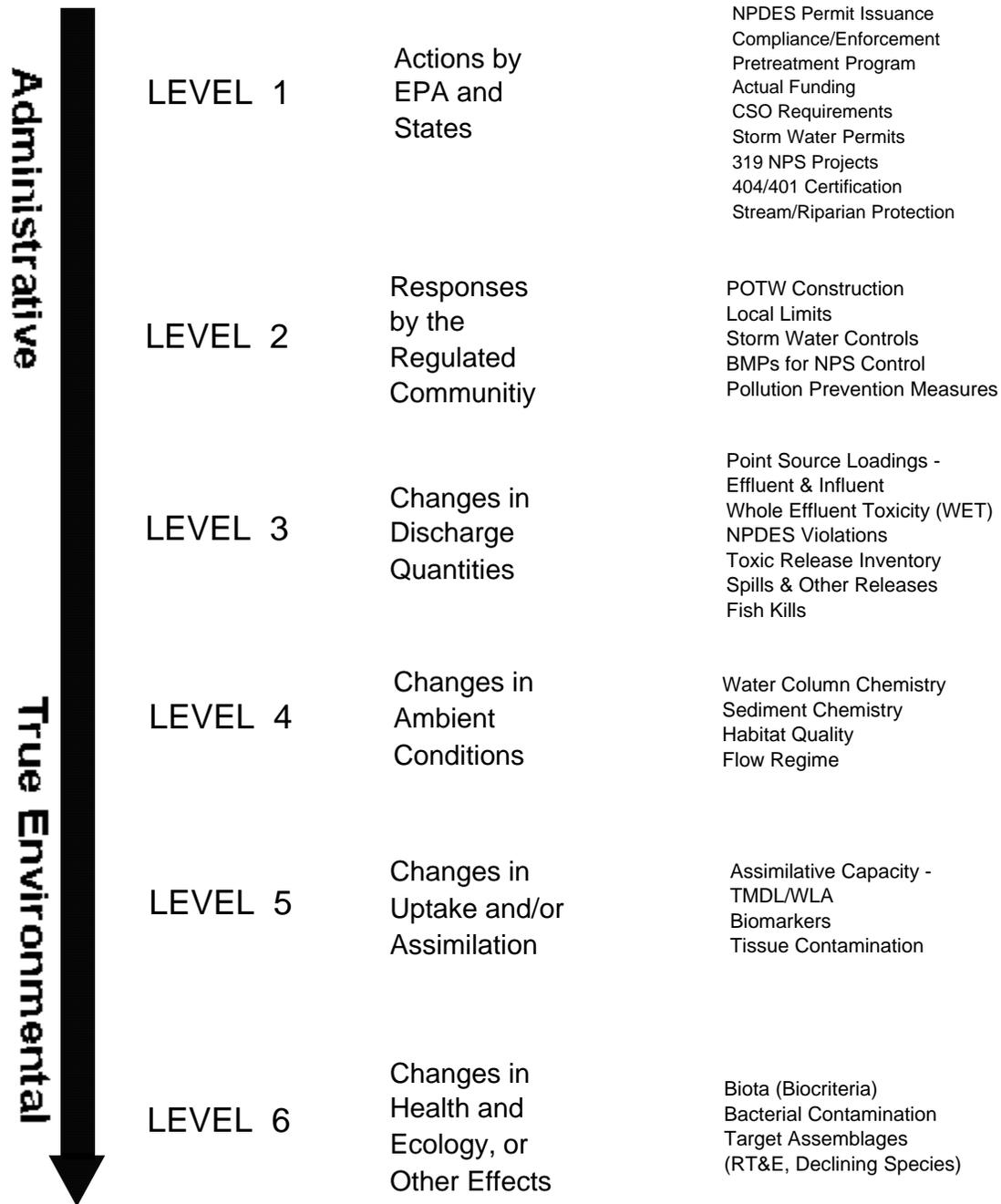


Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by the U.S. EPA.

declining species or bacterial levels which serve as surrogates for the recreation uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d]), the Ohio Nonpoint Source Assessment, and other technical bulletins.

Ohio Water Quality Standards: Designated Aquatic Life Use

The Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in Ohio's rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all uses. The five different aquatic life uses currently defined in the Ohio WQS are described as follows:

- 1) *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.*
- 2) *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.*, declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.*
- 3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall.
- 4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned by state or federal law*; the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.
- 5) *Limited Resource Water (LRW)* - this use applies to small streams (usually <3 mi² drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.*, true ephemeral streams), or other irretrievably altered waterways.

Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. As such the system of use designations employed in

the Ohio WQS constitutes a “tiered” approach in that varying and graduated levels of protection are provided by each. This hierarchy is especially apparent for parameters such as dissolved oxygen, ammonia-nitrogen, temperature, and the biological criteria. For other parameters such as heavy metals, the technology to construct an equally graduated set of criteria has been lacking, thus the same water quality criteria may apply to two or three different use designations.

Ohio Water Quality Standards: Non-Aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use can be having a water depth of at least one meter over an area of at least 100 square feet or, lacking this, where frequent human contact is a reasonable expectation. If a water body does not meet either criterion, the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.*, fecal coliform, *E. coli*) and the criteria for each are specified in the Ohio WQS.

Attainment of recreation uses are evaluated based on monitored bacteria levels. The Ohio Water Quality Standards state that all waters should be free from any public health nuisance associated with raw or poorly treated sewage (Administrative Code 3745-1-04, Part F). Additional criteria (Administrative Code 3745-1-07) apply to waters that are designated as suitable for full body contact such as swimming (PCR- primary contact recreation) or for partial body contact such as wading (SCR- secondary contact recreation). These standards were developed to protect human health, because even though fecal coliform bacteria are relatively harmless in most cases, their presence indicates that the water has been contaminated with fecal matter.

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The AWS and IWS use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data, but any consumption advisories are issued by the Ohio Department of Health.

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INTRODUCTION

In July 2002, Ohio EPA, US EPA and Ohio Bureau of Identification and Investigation initiated a criminal investigation into the operations of Green Circle Growers. As a result of the investigation, Green Circle Growers pled guilty and as part of its sentence funded this study.

Green Circle Growers is an Oberlin, Ohio based commercial greenhouse that is among the 25 largest in the country. In July 2002, while conducting a routine biological assessment, Ohio EPA biologists noticed a substantial decline in aquatic life in the East Fork Vermillion River adjacent to Green Circle Growers. They observed that the fish and macroinvertebrate populations were negatively affected for several miles downstream. In addition, they observed several discharge pipes in the section of the river that bisected Green Circle Grower's property. An investigation later determined that these and other discharge pipes were unpermitted. After making these observations, the biologists contacted the Ohio EPA's Office of Special Investigations (OSI). OSI is responsible for conducting criminal investigations for the agency.

A multi-agency criminal investigation ensued. The results of the investigation showed that for years Green Circle Growers had negligently discharged wastewater from multiple discharge points from its greenhouse operations into the river. The wastewater contained various pollutants, including pesticides, herbicides, and fertilizers used in the greenhouse operations. These pollutants had an adverse impact on the water quality of the stream and were the cause of a several mile segment of the river not meeting Ohio Water Quality Standards.

On February 25, 2005 Green Circle Growers pled guilty and was sentenced for negligently discharging wastewater to the East Fork Vermillion River. Green Circle Growers' sentence was:

- \$50,000 fine and
- \$200,000 restitution, which included the following:
 - ▶ \$50,000 to the Lorain County Soil and Water Conservation District, a nonprofit organization which funds projects to protect and conserve waterways in the Lorain County watershed
 - ▶ \$120,000 to a water quality project selected by Division of Surface Water, and
 - ▶ \$30,000 to Ohio EPA to conduct this follow-up biological and chemical assessment of the impacted area.

During 2007, the Division of Surface Water evaluated surface water and biological conditions in the East Fork Vermillion River to assess river conditions since the elimination of point source discharges from the Green Circle Growers facility. An assessment of an unnamed tributary to the East Fork adjacent to Green Circle Growers was also evaluated.

Specific objectives of this evaluation were to:

- Establish biological conditions in the East Fork Vermillion River in the vicinity of the Green Circle Growers property by evaluating fish and macroinvertebrate communities,
- Evaluate surface water chemical quality at biological stations in the East Fork Vermillion River,
- Determine the aquatic life use attainment status of the East Fork Vermillion River with regard to the Warmwater Habitat (WWH) aquatic life use designation codified in the Ohio Water Quality Standards, and
- Compare 2007 results with biological and water quality samples collected in 2005 and 2002.

The study segment of the East Fork Vermillion River is located in the Eastern Corn Belt Plains (ECBP) ecoregion. The East Fork Vermillion River is currently assigned the Warmwater Habitat (WWH) aquatic life use designation in the Ohio Water Quality Standards.

Aquatic life use attainment conditions are presented in Table 1, and sampling locations are detailed in Table 2 and graphically presented in Figure 2.

Table 1. Aquatic life use attainment status for sampling locations in East Fork Vermilion River study area, 2007. The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and macroinvertebrate narrative values are based on the performance of the biological community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biological community. Stream sites are located in Eastern Corn Belt Plains (ECBP) ecoregion. The East Fork Vermilion River and unnamed tributary to the E. F. Vermilion River are designated Warmwater Habitat (WWH) in the Ohio Water Quality Standards.

Sample Site River Mile	Attainment Status	IBI	MIwb	ICI ^a	QHEI	Location
East Fork Vermilion River						
10.5	FULL	41	NA	Marginally Good	66.5	Schawn Campground
8.9	PARTIAL	42	NA	Fair*	68.0	Green Circle Grower property
7.4	PARTIAL	48	NA	Fair*	73.0	Downstream SR 10 @ Kipton
2.3	FULL	45	NA	Marginally Good	80.0	Upstream Green Road
Unnamed Trib. To East Fork Vermilion River (RM 8.47)						
0.7	PARTIAL	38 ^{ns}	NA	Fair*	54.0	Upstream US 20, east of SR 511

Ecoregion Biocriteria: Eastern Corn Belt Plains (ECBP)		
INDEX - Site Type	WWH	EWH
IBI: Headwater/Wading	40	50
ICI	36	46

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

^{ns}Nonsignificant departure from biocriterion (≤ 4 IBI or ICI units).

^a Evaluation based on best professional judgment utilizing qualitative sample attributes.

Table 2. Sampling locations in the East Fork Vermilion River study area, 2007. Type of sampling included fish community (F), macroinvertebrate community (M), and surface water (W).

Stream/River Mile	Type of Sampling	Latitude	Longitude	Landmark
East Fork Vermilion River				
10.5	F,M,W	41° 14' 28.0"	82° 18' 57.7"	Schawn Campground
8.9	F,M,W	41° 15' 21.0"	82° 18' 06.3"	Between SR 511& US 20 – Green Circle Grower property
7.4	F,M,W	41° 16' 14.8"	82° 18' 11.2"	Downstream SR 10 @ Kipton
2.3	F,M,W	41° 18' 11.5"	82° 20' 35.7"	Upstream Green Road
Unnamed Tributary (@RM 8.47) to East Fork Vermilion River				
0.7	F,M,W	41° 15' 28.2"	82° 17' 24.7"	Upstream US 20, just east of SR 511

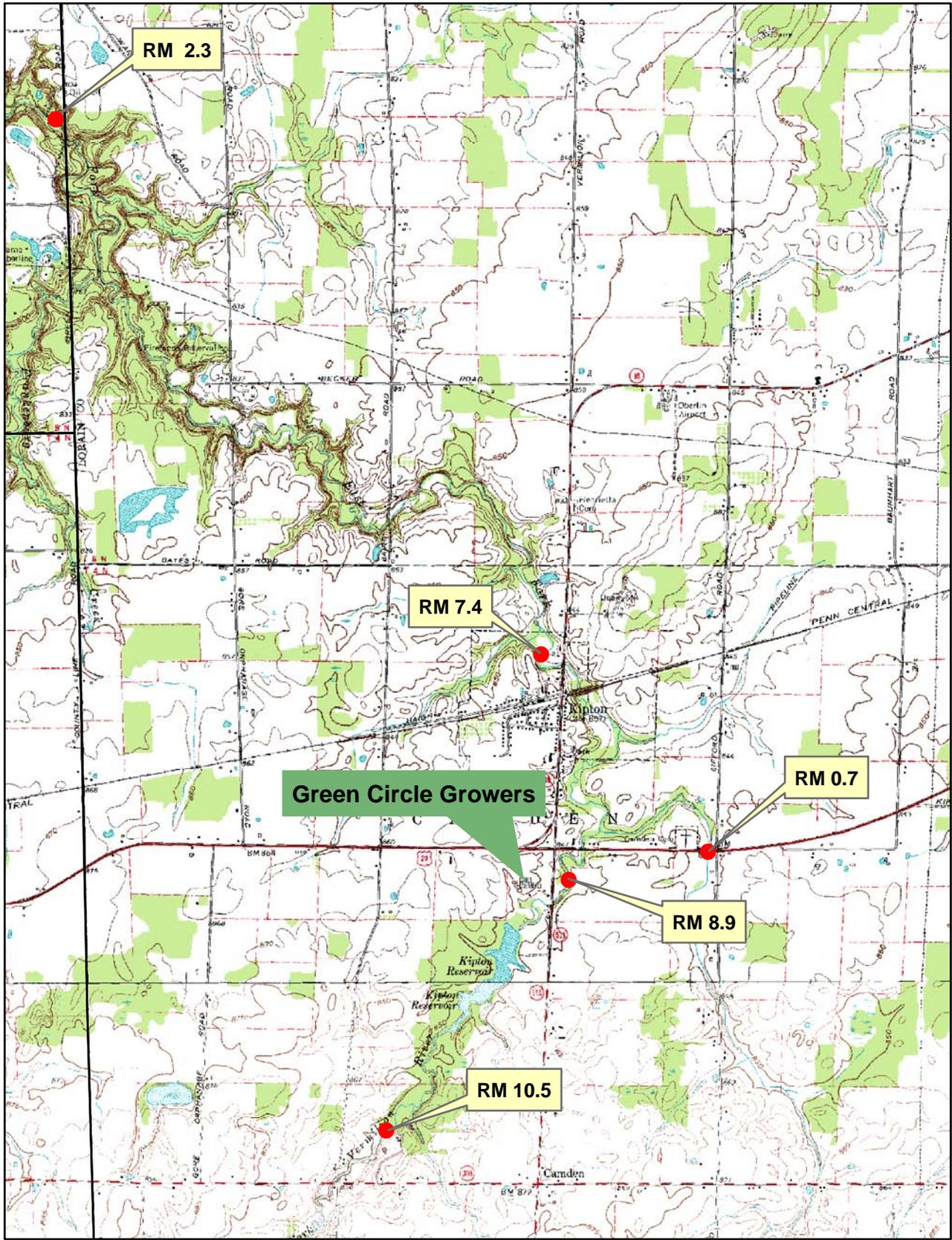


Figure 2. Map of East Fork Vermillon study area, 2007 showing sampling locations.

METHODS

All chemical, physical, and biological field, EPA laboratory, data processing, and data analysis methods and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 2006d), Biological Criteria for the Protection of Aquatic Life, Volumes II - III (Ohio Environmental Protection Agency 1987b, 1989a, 1989b, 2006a, 2006b), The Qualitative Habitat Evaluation Index (QHEI); Rationale, Methods, and Application (Rankin 1989), and Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (Ohio EPA 2006c).

Determining Use Attainment

Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1). Assessing aquatic use attainment status involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-15). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), indices measuring the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Three attainment status results are possible at each sampling location - full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. An aquatic life use attainment table (Table 1) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile, the applicable biological indices, the use attainment status (*i.e.*, full, partial, or non-attainment), the Qualitative Habitat Evaluation Index (QHEI), and a sampling location description. All biological results were compared to WWH biocriteria. The East Fork Vermilion River and the unnamed tributary to the East Fork Vermilion River (@ RM 8.47) are currently listed as Warmwater Habitat (WWH) streams in the Ohio Water Quality Standards.

Stream Habitat Evaluation

Physical habitat is evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995; Ohio EPA 2006c). Various attributes of the available habitat are scored based on their overall importance to the establishment of viable, diverse aquatic faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among the metrics used to evaluate the characteristics of a stream segment, not just the characteristics of a single sampling site. As such, individual sites may have much poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values higher than 60 were generally conducive to the establishment of warmwater faunas while those which scored in excess of 75 often typify habitat conditions which have the ability to support exceptional faunas.

Surface Water Assessment

Surface water samples were collected directly into appropriate containers, preserved and delivered to Ohio EPA DES lab. Surface water samples were collected twice from each location from the upper 12 inches of water. Collected water was preserved using appropriate methods, as outlined in Parts II and III of the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA 2006d). Surface water samples were evaluated using comparisons to Ohio Water Quality Standards criteria, reference conditions, or published literature.

Macroinvertebrate Community Assessment

A qualitative multihabitat composite sample was collected from the natural habitats at all stream sites. Stream flows were too low to conduct quantitative sampling using multi-plate macroinvertebrate samplers (modified Hester-Dendy samplers). This sampling effort consisted of an inventory of all observed macroinvertebrate taxa from the natural habitats at each site with no attempt to quantify populations other

than notations on the predominance of specific taxa or taxa groups within major macrohabitat types (e.g., riffle, run, pool, and margin). Detailed discussion of macroinvertebrate field and laboratory procedures is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989a, 2006b).

Fish Community Assessment

Fish were sampled twice at each fish site using pulsed DC wading electrofishing methods. Fish were processed in the field, and included identifying each individual to species, counting, and recording any external abnormalities. Discussion of the fish community assessment methodology used in this report is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989a, 2006b).

Field Instrument Calibration

Field instruments are calibrated using manufacturer recommended procedures along with procedures noted in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (2006d) and Biological Criteria for the Protection of Aquatic Life, Volume III (1989b). Laser rangefinders, used to measure sampling distance, were calibrated once at the Groveport Field Facility prior to summer field sampling activities.

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 used to judge aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria, 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 1991; Yoder 1995). 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, land use data, and biological results (Yoder and Rankin 1995). Thus the assignment of principal causes and sources of impairment in this report represent the association of impairments (based on response indicators) with stressor and exposure indicators. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified, or have been experimentally or statistically linked together. The ultimate measure of success in water resource management is the 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), in this document we are referring to the process for evaluating biological integrity and causes or sources associated with observed impairments, not whether human health and ecosystem health are analogous concepts.

RESULTS

Surface Water Quality

Chemical analyses were conducted on surface water samples collected on July 2 and September 13, 2007 from five locations in the study area (Table 3). Surface water samples were analyzed for total copper, ammonia-N, nitrate/nitrite-N, total Kjeldahl nitrogen, and total phosphorus. Parameters measured in the stream included conductivity, dissolved oxygen, pH, percent D.O. saturation, and water temperature. Parameters which were in exceedence of Ohio WQS criteria are reported in Table 4.

Table 3. Chemical analyses of surface water samples collected from the East Fork Vermilion River and an unnamed tributary to the East Fork Vermilion River, 2007. Sampling stations are identified by river mile location.

Parameters	East Fork Vermilion River				Unnamed Tributary
	RM 10.5	RM 8.9	RM 7.4	RM 2.3	RM 0.7
Copper-T (ug/l)	<10/<10	<10/<10	<10/<10	<10/<10	27/21
Ammonia-N (mg/l)	<0.050/<0.050	<0.050/0.056	0.083/0.081	<0.050/<0.050	0.090/0.067
Nitrate/Nitrite-N (mg/l)	0.24/0.17	0.96/0.24	0.84/1.39	0.27/0.99	14.8/3.32
TKN (mg/l)	1.66/0.62	4.39/0.55	1.19/0.81	0.61/0.87	7.18/1.14
Phosphorus-T (mg/l)	0.051/0.108	0.149/0.062	0.230/0.200	0.055/0.078	1.57/<0.010
Conductivity (umhos/cm)	963/693	943/690	933/692	805/599	808/679
Dissolved oxygen (mg/l)	8.15/7.46	7.05/7.66	9.60/8.85	11.15/11.23	5.8/5.23
pH (SU)	7.67/7.28	7.6/7.22	7.27/7.22	8.13/7.59	7.02/6.99
Temperature (°C)	16.51/14.92	16.48/15.03	17.95/16.81	19.84/15.97	16.6/15.02
% D.O. Saturation	85/74	71/76	102/91	125/114	64/ -

Aside from one nitrate-N measurement from the unnamed tributary, none of the chemicals measured in this study exceeded water quality criteria developed for the protection of aquatic life and human health. Ammonia-N values were all below water quality criteria and 90th percentile reference levels (Ohio EPA 1999). Nitrate+nitrite nitrogen measurements for the East Fork Vermilion River sites were below reference conditions.

Table 4. Exceedences of Ohio Water Quality Standards criteria (OAC3745-1) for chemical/physical parameters measured in the East Fork Vermilion River study area, 2007.

Stream River Mile	Parameter (value – ug/l)
East Fork Vermilion River	
RM 10.5	None
RM 8.9	None
RM 7.4	None
RM 2.3	None
Unnamed Tributary	
RM 0.7	Nitrate-N (14.8)*

* - Exceeds Human Health Drinking criterion

Total phosphorus levels were at or below reference levels in the East Fork Vermilion River, and one measurement in the unnamed tributary was substantially above reference levels. Nutrient levels in the East Fork Vermilion River were not substantially different between the upstream site, and sites located adjacent and downstream from Green Circle Growers. Nutrient enrichment is occurring in the unnamed tributary, as evidenced by elevated nitrate+nitrite-N and total phosphorus. East Fork Vermilion River copper results were all reported as *not detected*. However, copper was measured in the unnamed tributary above background levels, but both values (21 and 27 ug/l) were slightly below the WQS criterion.

Field measurements at each site were within acceptable ecological levels.

Water sampling during this study occurred during lower stream flows. During the sampling events, pipes along the East Fork Vermilion River located on Green Circle Growers property were not actively discharging. However, Ohio EPA personnel collected a sediment sample which consisted largely of vermiculite and potting soil from a depositional area of the stream at RM 8.87, which was 10-20 meters downstream from a discharge pipe. The vermiculite and potting soil in the stream suggest intermittent discharges to the East Fork Vermilion River.

Stream Physical Habitat

Physical habitat was evaluated in the East Fork Vermilion River study area at each fish sampling location. Physical habitat was assessed using the Qualitative Habitat Evaluation Index (QHEI); scores are detailed in Table 5.

QHEI scores for the East Fork Vermilion River sites ranged between 66.5 and 80.0. These scores reflect good river habitat and are adequate for supporting Warmwater Habitat biological communities. The four sampling locations were represented by various types of bottom substrates, and the predominant types included gravel, sand, and cobble. Bedrock was a predominant substrate only at RM 2.3. Good quality substrates were moderately to extensively embedded with silts, both in riffle and pool areas. Each site was composed of a natural stream channel.

Stream habitat in the unnamed tributary to the East Fork Vermilion River was of fair-marginally good quality, with a QHEI score of 54.0. Although the channel appeared to have been previously modified, it has shown good recovery to natural conditions. Riffles were composed of gravel, cobble, and boulders, but flow conditions were interstitial during both fish sampling events.

Table 5. Qualitative Habitat Evaluation Index (QHEI) scores and physical attributes for fish sampling sites in the East Fork Vermilion River study area, 2007.

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes													MWH Attributes													Total Moderate Influence Attributes	(MWH H.I.+1) / (WWH+1) Ratio	(MWH M.I.+1) / (WWH+1) Ratio				
			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-Normal Riffle Embeddedness	Total WWH Attributes	High Influence						Moderate Influence																
													Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/ No Cover	Max. Depth <40 cm (WD, HW sites)	Total High Influence Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness				High/Mod. Riffle Embeddedness	No Riffle		
East Fork Vermilion River Year: 2007																																			
10.5	66.5	5.26	■	■	■	■	■	■	■	■	■	■	6	■	■	■	◆	■	1	●	■	■	■	■	■	■	■	■	■	■	■	■	5	0.29	1.00
8.9	68.0	9.62	■	■	■	■	■	■	■	■	■	■	6	■	■	■	◆	■	1	●	■	■	■	■	■	■	■	■	■	■	■	■	5	0.29	1.00
7.4	73.0	10.87	■	■	■	■	■	■	■	■	■	■	6	■	■	■	◆	■	1	●	■	■	■	■	■	■	■	■	■	■	■	■	5	0.29	1.00
2.3	80.0	14.29	■	■	■	■	■	■	■	■	■	■	9	■	■	■	■	■	0	●	■	■	■	■	■	■	■	■	■	■	■	■	2	0.10	0.30
Unnamed Tributary to East Fork Vermilion River (RM 8.47) Year: 2007																																			
0.7	54.0	15.00	■	■	■	■	■	■	■	■	■	3	■	■	◆	◆	■	2	●	■	■	■	■	■	■	■	■	■	■	■	■	5	0.75	2.00	

Fish Community

A total of 5,215 fish representing 27 species were collected from the East Fork Vermilion River between July and September, 2007. Relative numbers and species collected per location are presented in Appendix Table 1 and IBI metrics are presented in Appendix Table 2. Sampling locations were evaluated using the Warmwater Habitat biocriterion. Sampling areas in the East Fork Vermilion River replicated locations sampled during 2002 and 2005, and were designed to assess stream conditions since the elimination of point source discharges from the Green Circle Growers nursery facilities. Sampling in an unnamed tributary to the East Fork Vermilion River (@ RM 8.47) occurred downstream from an area receiving drainage from the eastern facilities of Green Circle Growers.

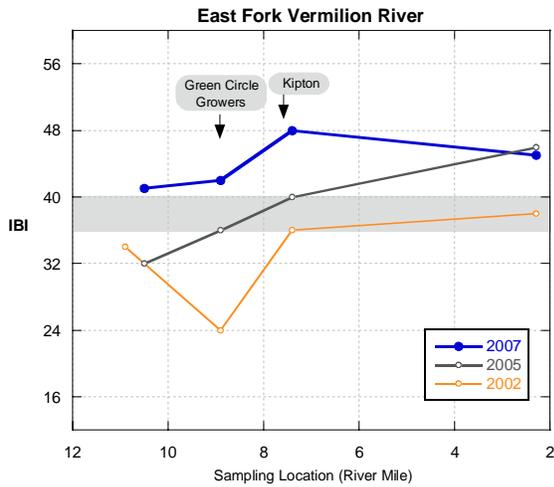


Figure 3. Index of Biotic Integrity (IBI) scores by location in the East Fork Vermilion River, 2007 - 2002. Shading represents the non-significant departure range for the IBI biocriterion.

East Fork Vermilion River fish communities at all four sampling locations achieved the WWH biocriterion. IBI scores ranged from 41 to 48, all within the good to very good range (Table 6). Results from all four fish sampling locations showed incremental improvement from upstream to downstream, with no obvious impairment associated with the Green Circle Growers nursery property. Comparison of 2007 results with 2005 and 2002 data revealed improved biological integrity at the sites upstream from and adjacent to Green Circle Growers, along with improvement at the two downstream locations (Figure 3). Sampling during 2007 suggested that operations at the Green Circle Growers facilities did not negatively impact the fish community of the East Fork Vermilion River.

The fish community in the unnamed tributary to the East Fork Vermilion River attained the WWH biocriterion, with an IBI score of 38. This occurred in light of only fair stream habitat quality - which included past channel modification work and shallow riffle areas. Sampling of this unnamed tributary during 2002 documented non-attainment of the WWH biocriterion, with an IBI score of 32. Improvement of the fish community in the unnamed tributary occurred between 2002 and 2007.

Table 6. Fish community summaries based on pulsed D.C. electrofishing sampling conducted by Ohio EPA in the East Fork Vermilion River study area from July and September, 2007. Relative numbers are per 0.3 km. The applicable aquatic life use designation is WWH.

Stream River Mile	Sampling Method	Species (Mean)	Species (Total)	Relative Number	Relative Weight (kg)	QHEI	Modified Index of Well-Being	Index of Biotic Integrity	Narrative Evaluation
East Fork Vermilion River									
10.5	Wading	14.0	16	1190	NA	66.5	NA	41	Good
8.9	Wading	13.0	15	894	NA	68.0	NA	42	Good
7.4	Wading	16.5	20	1420	NA	73.0	NA	48	Very Good
2.3	Wading	20.0	24	1283	NA	80.0	NA	45	Good
Unnamed Tributary to East Fork Vermilion River @ RM 8.47									
0.7	Wading	10.5	13	938	NA	54.0	NA	38 ^{ns}	Marginally Good

Ecoregion Biocriteria: Eastern Corn Belt Plains (ECBP) (Ohio Administrative Code 3745-1-07, Table 7-15)		
INDEX - Site Type	WWH	EWH
IBI: Headwater/Wading	40	50

*Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
^{ns}Non-significant departure from biocriterion (≤ 4 IBI units).

Macroinvertebrate Community

The macroinvertebrate communities at four East Fork Vermilion River sites and an unnamed tributary to East Fork Vermilion River at RM 8.47 were sampled in 2007 using qualitative (multi-habitat composite) sampling protocols. Qualitative sampling results for 2007 and previous surveys in 2005 and 2002 are summarized in Table 7. In 2005 artificial substrate samplers for quantitative sampling in addition to the qualitative sampling was done. Low flow conditions in 2005 resulted in inadequate current velocities at several of the sampling locations for the quantitative samples. For this reason and to be consistent with the qualitative sampling methods used in 2002 and 2007, only qualitative sample results from 2005 are included in this report. The qualitative narrative evaluation is based on best professional judgment utilizing sample attributes such as taxa richness, EPT taxa richness, tolerant and intolerant taxa richness, and predominant organisms at the site. The raw data are attached as Appendix Table 3.

The macroinvertebrate communities from the upstream (RM 10.5) and downstream (RM 2.3) sites were evaluated as marginally good in 2007 which is a nonsignificant departure from attainment of the designated WWH use. These results are consistent with the previous 2002 and 2005 samples (Ohio EPA 2004 and Ohio EPA 2006).

Macroinvertebrate samples collected in 2007 from sites adjacent to the Green Circle Growers facility (RM 8.9) and the first site downstream from the facility (RM 7.4) were evaluated as fair and not in attainment of the WWH use. Large quantities of filamentous algae were observed in the stream at the RM 7.4 sampling location which indicate a nutrient enrichment problem. On September 13, 2007, Ohio EPA personnel collected a sediment sample which consisted largely of vermiculite and potting soil from a depositional area of the stream at RM 8.87 which was 10-20 meters downstream from a discharge pipe. The presence of vermiculite was confirmed by Haz Mat ID using infrared spectroscopy. While the frequency of the discharge and the constituents in the discharge were not determined due to the potential intermittent nature of the discharge, it appears to be exerting an impact on the macroinvertebrate community.

In 2002, the macroinvertebrate communities from the RMs 9.1 and 7.4 sites were evaluated as very poor due to impacts from Green Circle Grower discharges. In 2005, these sites had improved to the low end of fair range. The 2007 macroinvertebrate sample results, while still not attaining the WWH use, have continued to improve from 2005.

The macroinvertebrate community from the unnamed tributary to the East Fork Vermilion River at RM 8.47, while still not attaining the WWH use, has improved from very poor in 2002 to the low end of the fair range in 2007.

Table 7. Summary of macroinvertebrate data collected from natural substrates (qualitative sampling) in East Fork Vermilion River.

Stream/ River Mile	Total Taxa	Tolerant Taxa	Intolerant Taxa	EPT ^a Taxa	Predominant Organisms	Evaluation ^b
East Fork Vermilion River, 2007						
10.5	29	2	10	7	Mayflies and caddisflies	Marginal Good
8.9	40	10	7	3	Midges	Fair
7.4	28	6	6	2	Blackflies, <u>Physella</u> snails, midges	Fair
2.3	39	7	12	7	Midges, mayflies, caddisflies	Marginal Good
East Fork Vermilion River, 2005						
10.5	22	1	9	4	Riffle beetles, mayflies	Marginal Good
8.9	22	4	5	3	Flatworms, sponge	Fair
7.4	13	3	2	2	<u>Physella</u> snails, flatworms	Fair
2.3	24	1	7	8	Mayflies, blackflies, caddisflies	Marginal Good
East Fork Vermilion River, 2002						
10.8	50	8	8	8	Midges, caddisflies	Marginal Good
9.1	12	6	0	0	<u>Physella</u> snails	Very Poor
7.4	14	5	1	0	Midges, sponge, flatworms	Very Poor
2.3	39	9	5	7	Midges, blackflies	Marginal Good
Unnamed tributary to East Fork Vermilion River @ RM 8.47, 2007						
0.7	29	9	4	1	Caddisflies, midges, and <u>Physella</u> snails	Fair
Unnamed tributary to East Fork Vermilion River @ RM 8.47, 2002						
0.7	17	6	1	0	Midges	Very Poor

^a EPT=total Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa richness, a measure of pollution sensitive organisms.

^b Evaluation based on best professional judgment utilizing sample attributes.

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 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. Div. Water Qual. Monit. & Assess., 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. Div. Water Qual. Monit. & Assess., 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. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., 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. Div. Water Quality Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.
- Ohio Environmental Protection Agency. 1990. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.
- Ohio Environmental Protection Agency. 2006a. 2006 updates to Biological Criteria for the Protection of Aquatic Life: Volume II and Volume II Addendum. Users manual for biological field assessment of Ohio surface waters. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.
- Ohio Environmental Protection Agency. 2006b. 2006 updates to Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.
- Ohio Environmental Protection Agency. 2006c. Methods for assessing habitat in flowing waters: Using the Qualitative Habitat Evaluation Index (QHEI). Ohio EPA Tech. Bull. EAS/2006-06-1. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.
- Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale, methods, and application. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

In addition to the preceding guidance documents, the following publications by the Ohio EPA should also be consulted as they present supplemental information and analyses used by the Ohio EPA to implement the biological criteria.

- DeShon, J.D. 1995. Development and application of the invertebrate community index (ICI), pp. 217-243. in W.S. Davis and T. Simon (eds.). *Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making*. Lewis Publishers, Boca Raton, FL.
- Rankin, E. T. 1995. The use of habitat assessments in water resource management programs, pp. 181-208. in W. Davis and T. Simon (eds.). *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. Lewis Publishers, Boca Raton, FL.
- Yoder, C.O. and E.T. Rankin. 1995. Biological criteria program development and implementation in Ohio, pp. 109-144. in W. Davis and T. Simon (eds.). *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. Lewis Publishers, Boca Raton, FL.
- Yoder, C.O. and E.T. Rankin. 1995. Biological response signatures and the area of degradation value: new tools for interpreting multimetric data, pp. 263-286. in W. Davis and T. Simon (eds.). *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. Lewis Publishers, Boca Raton, FL.
- Yoder, C.O. 1995. Policy issues and management applications for biological criteria, pp. 327-344. in W. Davis and T. Simon (eds.). *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. Lewis Publishers, Boca Raton, FL.
- Yoder, C.O. and E.T. Rankin. 1995. The role of biological criteria in water quality monitoring, assessment, and regulation. *Environmental Regulation in Ohio: How to Cope With the Regulatory Jungle*. Inst. of Business Law, Santa Monica, CA. 54 pp.
- Yoder, C.O. and M.A. Smith. 1999. Using fish assemblages in a State biological assessment and criteria program: essential concepts and considerations, pp. 17-63. in T. Simon (ed.). *Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities*. CRC Press, Boca Raton, FL.

These documents and this report may be obtained by writing to:

Ohio EPA, Division of Surface Water
Ecological Assessment Section
4675 Homer Ohio Lane
Groveport, Ohio 43125
(614) 836-8786

or

www.epa.state.oh.us/dsw/formspubs.html

REFERENCES

- Karr, J. R. 1991. Biological integrity: A long-neglected aspect of water resource management. *Ecological Applications* 1(1): 66-84.
- Karr, J.R., K.D. Fausch, P.L. Angermier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. *Ill. Nat. Hist. Surv. Spec. Publ.* 5. 28 pp.
- Miner R. and D. Borton. 1991. Considerations in the development and implementation of biocriteria, *Water Quality Standards for the 21st Century*, U.S. EPA, Offc. Science and Technology, Washington, D.C., 115 pp.
- Ohio Environmental Protection Agency. 2006a. 2006 updates to Biological Criteria for the Protection of Aquatic Life: Volume II and Volume II Addendum. Users manual for biological field assessment of Ohio surface waters. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.
- Ohio Environmental Protection Agency. 2006b. 2006 updates to Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.
- Ohio Environmental Protection Agency. 2006c. Methods for assessing habitat in flowing waters: Using the Qualitative Habitat Evaluation Index (QHEI). Ohio EPA Tech. Bull. EAS/2006-06-1. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.
- Ohio Environmental Protection Agency. 2006d. Ohio EPA manual of surveillance methods and quality assurance practices, updated edition. Division of Environmental Services, Columbus, Ohio.
- Ohio Environmental Protection Agency. 2006e. Biological and water quality study of the East Fork Vermilion River. Technical report EAS/2006-3-2. Division of Surface Water, Columbus, Ohio.
- Ohio Environmental Protection Agency. 2004. Biological and water quality study of the Vermilion River, Old Woman Creek, Chappel Creek, Sugar Creek, and select Lake Erie, 2002. Technical report EAS/2004-10-22. Division of Surface Water, Columbus, Ohio.
- Ohio Environmental Protection Agency. 2003. Ecological risk assessment guidance manual. Feb. 2003. Division of Emergency and Remedial Response, Columbus, Ohio.
- Ohio Environmental Protection Agency. 1999. Association between nutrients, habitat, and the aquatic biota in Ohio rivers and streams. Ohio EPA Technical Bulletin MAS/1999-1-1. Div. of Surface Water, Columbus, Ohio.
- Ohio Environmental Protection Agency. 1989a. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.
- Ohio Environmental Protection Agency. 1989b. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. Water Quality Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.
- Ohio Environmental Protection Agency. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Div. Water Qual. Monit. & Assess., 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. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

- Rankin, E. T. 1995. The use of habitat assessments in water resource management programs, pp. 181-208. in W. Davis and T. Simon (eds.). *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. Lewis Publishers, Boca Raton, FL.
- Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale, methods, and application. *Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio*.
- Suter, G.W., II. 1993. A critique of ecosystem health concepts and indexes. *Environmental Toxicology and Chemistry*, 12: 1533-1539.
- Yoder, C.O. 1995. Policy issues and management applications for biological criteria, pp. 327-344. in W. Davis and T. Simon (eds.). *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. Lewis Publishers, Boca Raton, FL.
- Yoder, C. O. 1991. Answering some concerns about biological criteria based on experiences in Ohio, *in* G. H. Flock (ed.) *Water quality standards for the 21st century*. Proceedings of a National Conference, U. S. EPA, Office of Water, Washington, D.C.
- Yoder, C.O. 1989. The development and use of biological criteria for Ohio surface waters. U.S. EPA, Criteria and Standards Div., *Water Quality Stds. 21st Century*, 1989: 139-146.
- Yoder, C.O. and E.T. Rankin. 1995. The role of biological criteria in water quality monitoring, assessment, and regulation. *Environmental Regulation in Ohio: How to Cope With the Regulatory Jungle*. Inst. of Business Law, Santa Monica, CA. 54 pp.

Appendix Table 1. Ohio EPA fish results from the East Fork Vermilion River study area, 2007.

Species List

River Code: 21-002	Stream: East Fork Vermilion River	Sample Date: 2007
River Mile: 10.50	Location: adj. Schawn Campground	Date Range: 07/02/2007
Time Fished: 4420 sec	Drainage: 8.6 sq mi	Thru: 09/13/2007
Dist Fished: 0.30 km	Basin: Vermilion River	Sampler Type: E
	No of Passes: 2	

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	10	10.00	0.84			
Northern Hog Sucker	R	I	S	M	1	1.00	0.08			
White Sucker	W	O	S	T	34	34.00	2.86			
Western Blacknose Dace	N	G	S	T	101	101.00	8.49			
Creek Chub	N	G	N	T	423	423.00	35.55			
Striped Shiner	N	I	S		7	7.00	0.59			
Spotfin Shiner	N	I	M		1	1.00	0.08			
Silverjaw Minnow	N	I	M		35	35.00	2.94			
Bluntnose Minnow	N	O	C	T	11	11.00	0.92			
Central Stoneroller	N	H	N		8	8.00	0.67			
Smallmouth Bass	F	C	C	M	2	2.00	0.17			
Green Sunfish	S	I	C	T	8	8.00	0.67			
Bluegill Sunfish	S	I	C	P	2	2.00	0.17			
Blackside Darter	D	I	S		8	8.00	0.67			
Johnny Darter	D	I	C		124	124.00	10.42			
Mottled Sculpin		I	C		415	415.00	34.87			
<i>Mile Total</i>					1,190	1,190.00				
<i>Number of Species</i>					16					
<i>Number of Hybrids</i>					0					

Species List

River Code: 21-002	Stream: East Fork Vermilion River	Sample Date: 2007
River Mile: 8.90	Location: dst. St. Rt. 511, upst. U.S. Rt. 20	Date Range: 07/02/2007
Time Fished: 4501 sec	Drainage: 10.9 sq mi	Thru: 09/13/2007
Dist Fished: 0.30 km	Basin: Vermilion River	Sampler Type: E
	No of Passes: 2	

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	13	13.00	1.45			
White Sucker	W	O	S	T	18	18.00	2.01			
Western Blacknose Dace	N	G	S	T	24	24.00	2.68			
Creek Chub	N	G	N	T	149	149.00	16.67			
Striped Shiner	N	I	S		37	37.00	4.14			
Bluntnose Minnow	N	O	C	T	38	38.00	4.25			
Central Stoneroller	N	H	N		67	67.00	7.49			
Smallmouth Bass	F	C	C	M	10	10.00	1.12			
Largemouth Bass	F	C	C		2	2.00	0.22			
Green Sunfish	S	I	C	T	47	47.00	5.26			
Bluegill Sunfish	S	I	C	P	3	3.00	0.34			
Blackside Darter	D	I	S		9	9.00	1.01			
Johnny Darter	D	I	C		235	235.00	26.29			
Rainbow Darter	D	I	S	M	5	5.00	0.56			
Mottled Sculpin		I	C		237	237.00	26.51			
<i>Mile Total</i>					894	894.00				
<i>Number of Species</i>					15					
<i>Number of Hybrids</i>					0					

Species List

River Code: 21-002	Stream: East Fork Vermilion River	Sample Date: 2007
River Mile: 7.40	Location: St. Rt. 10, just N of Kipton	Date Range: 07/02/2007
Time Fished: 4742 sec	Drainage: 16.4 sq mi	Thru: 09/13/2007
Dist Fished: 0.30 km	Basin: Vermilion River	Sampler Type: E
	No of Passes: 2	

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	19	19.00	1.34			
White Sucker	W	O	S	T	9	9.00	0.63			
Common Carp	G	O	M	T	1	1.00	0.07			
Bigeye Chub	N	I	S	I	2	2.00	0.14			
Western Blacknose Dace	N	G	S	T	153	153.00	10.77			
Creek Chub	N	G	N	T	309	309.00	21.76			
Striped Shiner	N	I	S		132	132.00	9.30			
Spotfin Shiner	N	I	M		4	4.00	0.28			
Silverjaw Minnow	N	I	M		1	1.00	0.07			
Bluntnose Minnow	N	O	C	T	2	2.00	0.14			
Central Stoneroller	N	H	N		146	146.00	10.28			
Rock Bass	S	C	C		10	10.00	0.70			
Smallmouth Bass	F	C	C	M	9	9.00	0.63			
Green Sunfish	S	I	C	T	14	14.00	0.99			
Bluegill Sunfish	S	I	C	P	1	1.00	0.07			
Blackside Darter	D	I	S		7	7.00	0.49			
Johnny Darter	D	I	C		151	151.00	10.63			
Greenside Darter	D	I	S	M	11	11.00	0.77			
Rainbow Darter	D	I	S	M	109	109.00	7.68			
Mottled Sculpin		I	C		330	330.00	23.24			
<i>Mile Total</i>					1,420	1,420.00				
<i>Number of Species</i>					20					
<i>Number of Hybrids</i>					0					

Species List

River Code: 21-002	Stream: East Fork Vermilion River	Sample Date: 2007
River Mile: 2.30	Location: Green Rd.	Date Range: 07/02/2007
Time Fished: 5434 sec	Drainage: 33.0 sq mi	Thru: 09/13/2007
Dist Fished: 0.40 km	Basin: Vermilion River	No of Passes: 2
		Sampler Type: E

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	0.06			
Rainbow Trout	E		N	2	1.50	0.12			
Quillback	C	O	M	1	0.75	0.06			
Northern Hog Sucker	R	I	S M	6	4.50	0.35			
White Sucker	W	O	S T	28	21.00	1.64			
Bigeye Chub	N	I	S I	40	30.00	2.34			
Western Blacknose Dace	N	G	S T	32	24.00	1.87			
Creek Chub	N	G	N T	32	24.00	1.87			
Striped Shiner	N	I	S	155	116.25	9.06			
Spotfin Shiner	N	I	M	15	11.25	0.88			
Sand Shiner	N	I	M M	66	49.50	3.86			
Silverjaw Minnow	N	I	M	35	26.25	2.05			
Bluntnose Minnow	N	O	C T	26	19.50	1.52			
Central Stoneroller	N	H	N	510	382.50	29.81			
Black Bullhead		I	C P	1	0.75	0.06			
Smallmouth Bass	F	C	C M	11	8.25	0.64			
Largemouth Bass	F	C	C	1	0.75	0.06			
Green Sunfish	S	I	C T	5	3.75	0.29			
Bluegill Sunfish	S	I	C P	3	2.25	0.18			
Blackside Darter	D	I	S	2	1.50	0.12			
Johnny Darter	D	I	C	85	63.75	4.97			
Greenside Darter	D	I	S M	75	56.25	4.38			
Rainbow Darter	D	I	S M	365	273.75	21.33			
Mottled Sculpin		I	C	214	160.50	12.51			
<i>Mile Total</i>				1,711	1,283.25				
<i>Number of Species</i>				24					
<i>Number of Hybrids</i>				0					

Species List

River Code: 21-020	Stream: Trib. to E. Fk. Vermilion R. (RM 8.47)	Sample Date: 2007
River Mile: 0.70	Location: upst. U.S. Rt. 20	Date Range: 07/02/2007
Time Fished: 3192 sec	Drainage: 3.5 sq mi	Thru: 09/13/2007
Dist Fished: 0.24 km	Basin: Vermilion River	Sampler Type: E
	No of Passes: 2	

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	251	313.75	33.47			
White Sucker	W	O	S	T	17	21.25	2.27			
Western Blacknose Dace	N	G	S	T	122	152.50	16.27			
Creek Chub	N	G	N	T	165	206.25	22.00			
Striped Shiner	N	I	S		2	2.50	0.27			
Spotfin Shiner	N	I	M		6	7.50	0.80			
Silverjaw Minnow	N	I	M		1	1.25	0.13			
Bluntnose Minnow	N	O	C	T	3	3.75	0.40			
Central Stoneroller	N	H	N		7	8.75	0.93			
Largemouth Bass	F	C	C		1	1.25	0.13			
Green Sunfish	S	I	C	T	106	132.50	14.13			
Johnny Darter	D	I	C		66	82.50	8.80			
Mottled Sculpin		I	C		3	3.75	0.40			
<i>Mile Total</i>					750	937.50				
<i>Number of Species</i>					13					
<i>Number of Hybrids</i>					0					

River Mile	Type	Date	Drainage area (sq mi)	Number of						Percent of Individuals					Rel.No. minus tolerants /(0.3km)	IBI	
				Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Tolerant fishes	Omni- vores	Pioneering fishes	Insect- ivores	DELT anomalies			
<i>E. Fk. Vermilion R. - (21-002)</i>																	
Year: 2007																	
10.50	E	07/02/2007	8.6	13(3)	6(3)	2(3)	0(1)	3(3)	4(3)	46(3)	5(5)	44(3)	55(5)	0.0(5)	626(3)	40	
10.50	E	09/13/2007	8.6	15(5)	7(5)	2(3)	2(1)	3(3)	5(3)	53(3)	3(5)	57(1)	48(5)	0.0(5)	580(3)	42	
8.90	E	07/02/2007	10.9	11(3)	5(3)	2(3)	0(1)	3(3)	4(3)	38(3)	7(5)	50(3)	62(5)	0.0(5)	464(3)	40	
8.90	E	09/13/2007	10.9	15(5)	5(3)	2(3)	2(1)	4(3)	5(3)	29(5)	6(5)	54(3)	68(5)	0.0(5)	746(3)	44	
7.40	E	07/02/2007	16.4	13(3)	4(3)	2(3)	2(1)	5(5)	6(3)	33(3)	0(5)	28(5)	60(5)	0.0(5)	742(3)	44	
7.40	E	09/13/2007	16.4	19(5)	8(5)	2(3)	4(3)	5(5)	7(5)	37(3)	1(5)	37(3)	52(5)	0.0(5)	1084(5)	52	
<i>E Fk Vermilion t 8.4 - (21-020)</i>																	
Year: 2007																	
0.70	E	07/02/2007	3.5	8(3)	3(3)	2(3)	0(1)	2(3)	2(1)	94(1)	3(5)	44(3)	68(5)	0.0(5)	53(1)	34	
0.70	E	09/13/2007	3.5	13(5)	7(5)	2(3)	0(1)	2(3)	3(3)	84(1)	2(5)	47(3)	50(5)	0.0(5)	163(3)	42	

◆ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

River Mile	Type	Date	Drainage area (sq mi)	Number of					Percent of Individuals					Rel.No. minus tolerants /(0.3km)	IBI	Modified Iwb	
				Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Simple Lithophils	Tolerant fishes	Omni- vores	Top carnivores	Insect- ivores				DELT anomalies
E. Fk. Vermilion R. - (21002)																	
Year: 2007																	
2.30	E	07/02/2007	33	19(5)	1(1)	3(3)	1(1)	4(3)	49(5)	8(5)	3(5)	0.1(1)	68(5)	0.0(5)	1176(5)	44	na
2.30	E	09/13/2007	33	20(5)	2(3)	2(3)	1(1)	3(3)	33(3)	6(5)	3(5)	1.3(3)	57(5)	0.0(5)	1206(5)	46	na

na - Qualitative data, Modified Iwb not applicable.

◆ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

Appendix Table 3. Ohio EPA macroinvertebrate results from the East Fork Vermilion River study area, 2007.

**Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection**

Site: East Fork Vermilion River

Collection Date: 07/02/2007 River Code: 21-002 RM: 10.40

Taxa Code	Taxa	Quant/Qual	Taxa Code	Taxa	Quant/Qual
03600	<i>Oligochaeta</i>	+			
04666	<i>Helobdella triserialis</i>	+			
06201	<i>Hyalella azteca</i>	+			
07860	<i>Cambarus (Puncticambarus) robustus</i>	+			
08260	<i>Orconectes (Crockerinus) sanbornii sanbornii</i>	+			
11120	<i>Baetis flavistriga</i>	+			
11130	<i>Baetis intercalaris</i>	+			
13000	<i>Leucrocuta sp</i>	+			
13400	<i>Stenacron sp</i>	+			
13521	<i>Stenonema femoratum</i>	+			
23909	<i>Boyeria vinosa</i>	+			
47600	<i>Sialis sp</i>	+			
51400	<i>Nyctiophylax sp</i>	+			
52200	<i>Cheumatopsyche sp</i>	+			
69400	<i>Stenelmis sp</i>	+			
71100	<i>Hexatoma sp</i>	+			
72340	<i>Dixella sp</i>	+			
72700	<i>Anopheles sp</i>	+			
77500	<i>Conchapelopia sp</i>	+			
81650	<i>Parametriocnemus sp</i>	+			
82820	<i>Cryptochironomus sp</i>	+			
83820	<i>Microtendipes "caelum" (sensu Simpson & Bode, 1980)</i>	+			
83840	<i>Microtendipes pedellus group</i>	+			
84315	<i>Phaenopsectra flavipes</i>	+			
84480	<i>Polypedilum (P.) laetum group</i>	+			
85625	<i>Rheotanytarsus sp</i>	+			
85800	<i>Tanytarsus sp</i>	+			
93900	<i>Elimia sp</i>	+			
98600	<i>Sphaerium sp</i>	+			

No. Quantitative Taxa: 0	Total Taxa: 29
No. Qualitative Taxa: 29	ICI:
Number of Organisms: 0	Qual EPT: 7

**Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection**

Site: East Fork Vermilion River
dst. St. Rt. 511, upst. U.S. Rt. 20

Collection Date: 07/02/2007 River Code: 21-002 RM: 8.90

Taxa Code	Taxa	Quant/Qual	Taxa Code	Taxa	Quant/Qual
00401	<i>Spongillidae</i>	+			
01320	<i>Hydra sp</i>	+			
01801	<i>Turbellaria</i>	+			
03360	<i>Plumatella sp</i>	+			
03600	<i>Oligochaeta</i>	+			
08260	<i>Orconectes (Crockerinus) sanbornii sanbornii</i>	+			
13400	<i>Stenacron sp</i>	+			
21200	<i>Calopteryx sp</i>	+			
23600	<i>Aeshna sp</i>	+			
29000	<i>Sympetrum sp</i>	+			
49101	<i>Sisyridae</i>	+			
52200	<i>Cheumatopsyche sp</i>	+			
52430	<i>Ceratopsyche morosa group</i>	+			
68708	<i>Dubiraphia vittata group</i>	+			
69400	<i>Stenelmis sp</i>	+			
71900	<i>Tipula sp</i>	+			
74100	<i>Simulium sp</i>	+			
77120	<i>Ablabesmyia mallochi</i>	+			
77800	<i>Helopelopia sp</i>	+			
78401	<i>Natarsia species A (sensu Roback, 1978)</i>	+			
78655	<i>Procladius (Holotanypus) sp</i>	+			
80510	<i>Cricotopus (Isocladius) sylvestris group</i>	+			
81650	<i>Parametriocnemus sp</i>	+			
82730	<i>Chironomus (C.) decorus group</i>	+			
82820	<i>Cryptochironomus sp</i>	+			
83002	<i>Dicrotendipes modestus</i>	+			
83040	<i>Dicrotendipes neomodestus</i>	+			
84210	<i>Paratendipes albimanus or P. duplicatus</i>	+			
84450	<i>Polypedilum (Uresipedilum) flavum</i>	+			
84470	<i>Polypedilum (P.) illinoense</i>	+			
84540	<i>Polypedilum (Tripodura) scalaenum group</i>	+			
84800	<i>Tribelos jucundum</i>	+			
85500	<i>Paratanytarsus sp</i>	+			
85625	<i>Rheotanytarsus sp</i>	+			
85821	<i>Tanytarsus glabrescens group sp 7</i>	+			
93900	<i>Elimia sp</i>	+			
95100	<i>Physella sp</i>	+			
96002	<i>Helisoma anceps anceps</i>	+			
96120	<i>Menetus (Micromenetus) dilatatus</i>	+			
98001	<i>Sphaeriidae</i>	+			

No. Quantitative Taxa: 0 Total Taxa: 40

No. Qualitative Taxa: 40 ICI:

Number of Organisms: 0 Qual EPT: 3

**Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection**

Site: East Fork Vermilion River
St. Rt. 10, just N of Kipton

Collection Date: 07/02/2007 River Code: 21-002 RM: 7.40

Taxa Code	Taxa	Quant/Qual	Taxa Code	Taxa	Quant/Qual
00401	<i>Spongillidae</i>	+			
01320	<i>Hydra sp</i>	+			
01801	<i>Turbellaria</i>	+			
03360	<i>Plumatella sp</i>	+			
03600	<i>Oligochaeta</i>	+			
13521	<i>Stenonema femoratum</i>	+			
49400	<i>Sisyra sp</i>	+			
52200	<i>Cheumatopsyche sp</i>	+			
71900	<i>Tipula sp</i>	+			
74100	<i>Simulium sp</i>	+			
77120	<i>Ablabesmyia mallochi</i>	+			
77500	<i>Conchapelopia sp</i>	+			
80510	<i>Cricotopus (Isocladius) sylvestris group</i>	+			
81650	<i>Parametriocnemus sp</i>	+			
83002	<i>Dicrotendipes modestus</i>	+			
83040	<i>Dicrotendipes neomodestus</i>	+			
83051	<i>Dicrotendipes simpsoni</i>	+			
84210	<i>Paratendipes albimanus or P. duplicatus</i>	+			
84450	<i>Polypedilum (Uresipedilum) flavum</i>	+			
84470	<i>Polypedilum (P.) illinoense</i>	+			
84800	<i>Tribelos jucundum</i>	+			
85500	<i>Paratanytarsus sp</i>	+			
85625	<i>Rheotanytarsus sp</i>	+			
85800	<i>Tanytarsus sp</i>	+			
93900	<i>Elimia sp</i>	+			
94400	<i>Fossaria sp</i>	+			
95100	<i>Physella sp</i>	+			
96900	<i>Ferrissia sp</i>	+			

No. Quantitative Taxa: 0	Total Taxa: 28
No. Qualitative Taxa: 28	ICI:
Number of Organisms: 0	Qual EPT: 2

**Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection**

Site: East Fork Vermilion River
Green Rd.

Collection Date: 07/02/2007 River Code: 21-002 RM: 2.30

Taxa Code	Taxa	Quant/Qual	Taxa Code	Taxa	Quant/Qual
01801	<i>Turbellaria</i>	+			
04901	<i>Erpobdellidae</i>	+			
06201	<i>Hyalella azteca</i>	+			
07860	<i>Cambarus (Puncticambarus) robustus</i>	+			
08260	<i>Orconectes (Crockerinus) sanbornii sanbornii</i>	+			
11120	<i>Baetis flavistriga</i>	+			
11130	<i>Baetis intercalaris</i>	+			
13000	<i>Leucrocuta sp</i>	+			
13521	<i>Stenonema femoratum</i>	+			
13590	<i>Maccaffertium vicarium</i>	+			
25510	<i>Stylogomphus albistylus</i>	+			
29000	<i>Sympetrum sp</i>	+			
45300	<i>Sigara sp</i>	+			
52200	<i>Cheumatopsyche sp</i>	+			
52430	<i>Ceratopsyche morosa group</i>	+			
61400	<i>Agabus sp</i>	+			
71900	<i>Tipula sp</i>	+			
74100	<i>Simulium sp</i>	+			
74501	<i>Ceratopogonidae</i>	+			
77500	<i>Conchapelopia sp</i>	+			
78401	<i>Natarsia species A (sensu Roback, 1978)</i>	+			
78450	<i>Nilotanytus fimbriatus</i>	+			
80420	<i>Cricotopus (C.) bicinctus</i>	+			
80430	<i>Cricotopus (C.) tremulus group</i>	+			
80440	<i>Cricotopus (C.) trifascia</i>	+			
82100	<i>Thienemanniella sp</i>	+			
82730	<i>Chironomus (C.) decorus group</i>	+			
83820	<i>Microtendipes "caelum" (sensu Simpson & Bode, 1980)</i>	+			
84440	<i>Polypedilum (Uresipedilum) aviceps</i>	+			
84450	<i>Polypedilum (Uresipedilum) flavum</i>	+			
84480	<i>Polypedilum (P.) laetum group</i>	+			
84540	<i>Polypedilum (Tripodura) scalaenum group</i>	+			
84750	<i>Stictochironomus sp</i>	+			
85625	<i>Rheotanytarsus sp</i>	+			
85800	<i>Tanytarsus sp</i>	+			
85821	<i>Tanytarsus glabrescens group sp 7</i>	+			
86401	<i>Atherix lantha</i>	+			
94400	<i>Fossaria sp</i>	+			
95100	<i>Physella sp</i>	+			

No. Quantitative Taxa: 0 Total Taxa: 39
 No. Qualitative Taxa: 39 ICI:
 Number of Organisms: 0 Qual EPT: 7

**Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection**

Site: Trib. to E. Fk. Vermilion R. (RM 8.47)
upst. U.S. Rt. 20

Collection Date: 07/02/2007 River Code: 21-020 RM: 0.70

Taxa Code	Taxa	Quant/Qual	Taxa Code	Taxa	Quant/Qual
03600	<i>Oligochaeta</i>	+			
04664	<i>Helobdella stagnalis</i>	+			
08200	<i>Orconectes sp</i>	+			
23600	<i>Aeshna sp</i>	+			
23909	<i>Boyeria vinosa</i>	+			
52200	<i>Cheumatopsyche sp</i>	+			
68707	<i>Dubiraphia quadrinotata</i>	+			
71900	<i>Tipula sp</i>	+			
72900	<i>Culex sp</i>	+			
74100	<i>Simulium sp</i>	+			
77500	<i>Conchapelopia sp</i>	+			
78401	<i>Natarsia species A (sensu Roback, 1978)</i>	+			
81040	<i>Limnophyes sp</i>	+			
81620	<i>Paracricotopus sp</i>	+			
82730	<i>Chironomus (C.) decorus group</i>	+			
83002	<i>Dicrotendipes modestus</i>	+			
83040	<i>Dicrotendipes neomodestus</i>	+			
83051	<i>Dicrotendipes simpsoni</i>	+			
84210	<i>Paratendipes albimanus or P. duplicatus</i>	+			
84450	<i>Polypedilum (Uresipedilum) flavum</i>	+			
84470	<i>Polypedilum (P.) illinoense</i>	+			
84750	<i>Stictochironomus sp</i>	+			
84800	<i>Tribelos jucundum</i>	+			
85500	<i>Paratanytarsus sp</i>	+			
85625	<i>Rheotanytarsus sp</i>	+			
85800	<i>Tanytarsus sp</i>	+			
94400	<i>Fossaria sp</i>	+			
95100	<i>Physella sp</i>	+			
98600	<i>Sphaerium sp</i>	+			

No. Quantitative Taxa: 0	Total Taxa: 29
No. Qualitative Taxa: 29	ICI:
Number of Organisms: 0	Qual EPT: 1