State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of Sevenmile Creek and Select Tributaries, 2002

Butler and Preble Counties

***Pycnopsyche* caddisfly larva**

Greenside darter

Sevenmile Cr. at Swain Rd.

Sevenmile Cr. at Hamilton-Eaton Rd.

December 28, 2005

Bob Taft, Governor
Joseph P. Koncelik, Director

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OEPA Technical Report EAS/2005-12-8

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 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. 1987. 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. 1987. 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. 1989. 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., Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989. 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.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale,methods, and application. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Since the publication of the preceding guidance documents new publications by Ohio EPA have become available. The following publications should also be consulted as they represent the latest information and analyses used by 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.

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

Ohio EPA, Division of Surface Water
Ecological Assessment Section
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Copies of this report are located on the Ohio EPA internet web page (http://www.epa.state.oh.us/dsw/document_index/psdindx.html) or may be available from:

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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 4-6 different study areas with an aggregate total of 350-400 sampling sites.

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]), and are eventually incorporated into Water Quality Permit Support Documents (WQPSDs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the Ohio Water Resource Inventory (305[b] report).

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised 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 is outlined in Figure 1 and includes a hierarchical continuum from administrative to true environmental indicators. 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 declining species or bacterial levels which serve as surrogates for the recreational 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 scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Ohio Water Resource Inventory (305[b] report), the Ohio Nonpoint Source Assessment, and other technical bulletins.

Ohio Water Quality Standards: Designated Aquatic Life Uses

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.

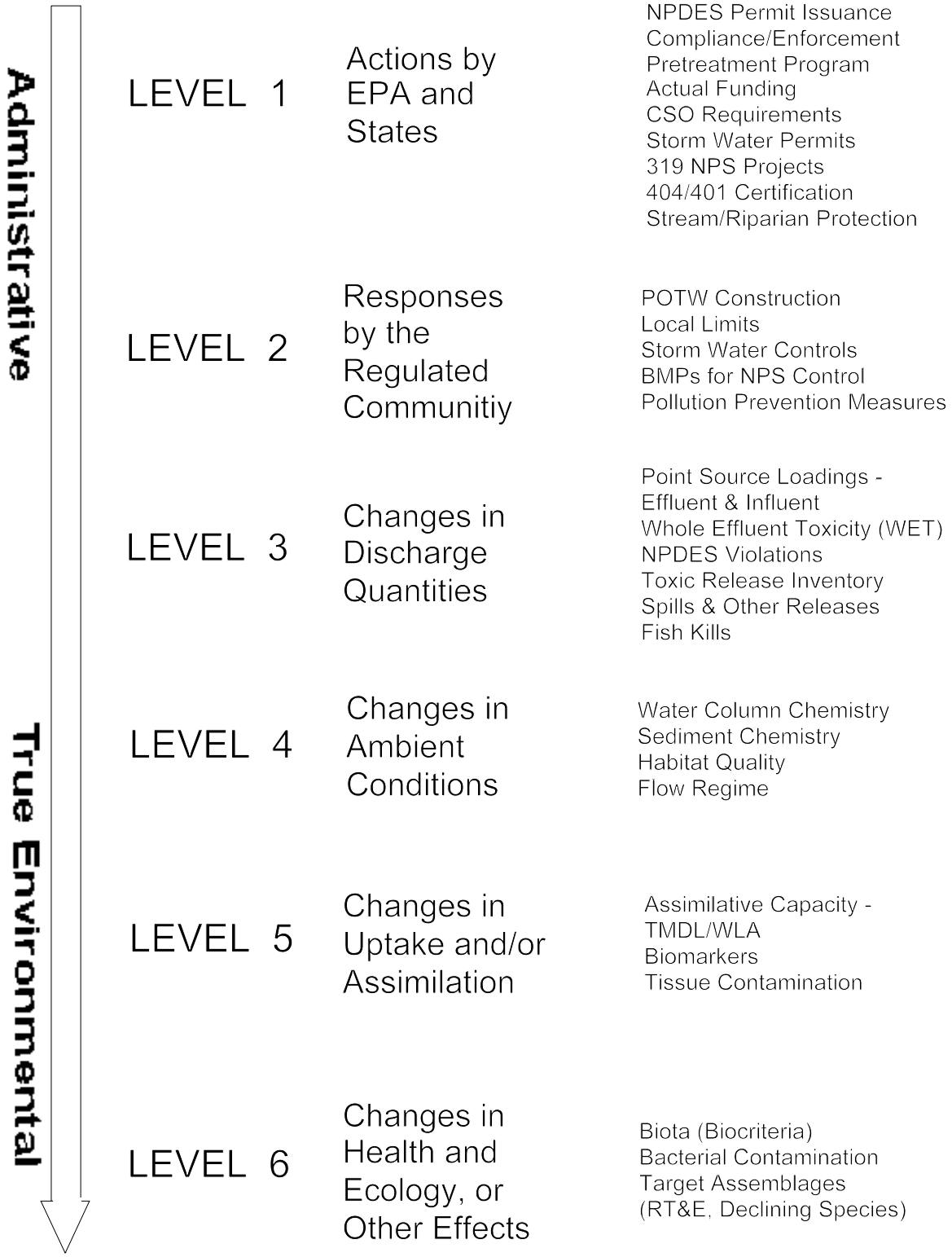

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by the U.S. EPA.

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 and permitted 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 mi.^{2} 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 is simply 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 coliforms, *E. coli)* and the criteria for each are specified in the Ohio WQS.

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 Agricultural Water Supply (AWS) and Industrial Water Supply (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 are detailed in other documents.

Causes of Resource Quality Impairment

The following paragraphs are provided to present the varied causes of impairment that are encountered during stream studies. While the various perturbations are presented under separate headings, it is important to remember that they are often interrelated and cumulative in terms of the detrimental impact that can result.

Habitat and Flow Alterations

Habitat alteration, such as channelization, impacts biological communities directly by limiting the complexity of living spaces available to aquatic organisms. Consequently, fish and macroinvertebrate communities are not as diverse. Indirect impacts include the removal of riparian trees and field tiling to facilitate drainage. Following a rain event, most of the water is quickly removed from tiled fields rather than filtering through the soil, recharging groundwater, and reaching the stream at a lower volume and more sustained rate. As a result, small streams more frequently go dry or become intermittent.

Tree shade is important because it limits the energy input from the sun, moderates water temperature, and limits evaporation. Removal of the tree canopy further degrades conditions because it eliminates an important source of coarse organic matter essential for a balanced ecosystem. Erosion impacts channelized streams more severely due to the lack of a riparian buffer zone to slow runoff, trap sediment and stabilize banks. Additionally, deep trapezoidal channels lack a functioning flood plain and therefore cannot expel sediment as would occur during flood events along natural watercourses.

The lack of water movement under low flow conditions can exacerbate impacts from organic loading and nutrient enrichment by limiting reaeration of the stream. The amount of oxygen soluble in water decreases as temperature increases. This is one reason why tree shade is so important. The two main sources of oxygen in water are diffusion from the atmosphere and plant photosynthesis. Turbulence at the water surface is critical because it increases surface area and promotes diffusion,

but channelization eliminates turbulence produced by riffles, meanders, and debris snags. Plant photosynthesis produces oxygen, but at night, respiration reverses the process and consumes oxygen. Oxygen is also used by bacteria that decay dead organic matter. Nutrient enrichment can promote the growth of nuisance algae that subsequently dies and serves as food for bacteria. Under these conditions, oxygen can be depleted unless it is replenished from the air.

Sedimentation

Whenever the natural flow regime is altered to facilitate drainage, increased amounts of sediment are likely to enter streams either by overland transport or increased bank erosion. The removal of wooded riparian areas furthers the erosional process. Channelization keeps all but the highest flow events confined within the artificially high banks. As a result, areas that were formerly flood plains and allowed for the removal of sediment from the primary stream channel no longer serve this function. As water levels fall following a rain event, interstitial spaces between larger rocks fill with sand and silt and the diversity of available habitat to support fish and macroinvertebrates is reduced. Silt also can clog the gills of both fish and macroinvertebrates, reduce visibility thereby excluding site feeding fish species, and smother the nests of lithophilic fishes. Lithophilic spawning fish require clean substrates with interstitial voids in which to deposit eggs. Conversely, pioneering species benefit. They are generalists and best suited for exploiting disturbed and less heterogeneous habitats. The net result is a lower diversity of aquatic species compared with a typical warmwater stream with natural habitats.

Sediment also impacts water quality, recreation, and drinking water. Nutrients absorbed to soil particles remain trapped in the watercourse. Likewise, bacteria, pathogens, and pesticides which also attach to suspended or bedload sediments become concentrated in waterways where the channel is functionally isolated from the landscape. Community drinking water systems address these issues with more costly advanced treatment technologies.

Nutrients

The element of greatest concern is phosphorus because it critical for plant growth and it is often the limiting nutrient. The form that can be readily used by plants and therefore can stimulate nuisance algae blooms is orthophosphate (PO_4^{-3}). The amount of phosphorus tied up in the nucleic acids of food and waste is actually quite low. This organic material is eventually converted to orthophosphate by bacteria. The amount of orthophosphate contained in synthetic detergents is a great concern however. It was for this reason that the General Assembly of the State of Ohio enacted a law in 1990 to limit phosphorus content in household laundry detergents sold in the Lake Erie drainage basin to 0.5 % by weight. Inputs of phosphorus originate from both point and nonpoint sources. Most of the phosphorus discharged by point sources is soluble. Another characteristic of point sources is they have a continuous impact and are human in origin, for instance, effluents from municipal sewage treatment plants. The contribution from failed home sewage treatment systems can also be significant, especially if they are concentrated in a small area. The phosphorus concentration in raw waste water is generally 8-10 mg/l and after secondary treatment is generally 4-6 mg/l. Further removal requires the added cost of chemical addition. The most common methods use the addition of lime or alum to form a precipitate, so most phosphorus (80%) ends up in the sludge. A characteristic of phosphorus discharged by nonpoint sources is that the impact is intermittent and associated with stormwater runoff. Most of this phosphorus is bound tightly to soil particles and enters streams from erosion, although some comes from tile drainage.

Urban stormwater is more of a concern if combined sewer overflows are involved. The impact from rural stormwater varies depending on land use and management practices and includes contributions from livestock feedlots and pastures and row crop agriculture. Crop fertilizer includes granular inorganic types and organic types such as manure or sewage sludge. Pasture land is especially a concern if the livestock have access to the stream. Large feedlots with manure storage lagoons create the potential for overflows and accidental spills. Land management is an issue because erosion is worse on streams without any riparian buffer zone to trap runoff. The impact is worse in streams that are channelized because they no longer have a functioning flood plain and cannot expel sediment during flooding. Oxygen levels must also be considered, because phosphorus is released from sediment at higher rates under anoxic conditions.

There is no numerical phosphorus criterion established in the Ohio Water Quality Standards, but there is a narrative criterion that states phosphorus should be limited to the extent necessary to prevent nuisance growths of algae and weeds (Administrative Code, 3745-1-04, Part E). Phosphorus loadings from large volume point source dischargers in the Lake Erie drainage basin are regulated by the National Pollutant Discharge Elimination System (NPDES). The permit limit is a concentration of 1.0 mg/l in final effluent. Research conducted by the Ohio EPA indicates that a significant correlation exists between phosphorus and the health of aquatic communities (Association Between Nutrients, Habitat, and Aquatic Biota in Ohio Rivers and Streams, MAS/1999-1-1). It was concluded that biological community performance in headwater and wadeable streams was highest where phosphorus concentrations were lowest. It was also determined that the lowest phosphorus concentrations were associated with the highest quality habitats, supporting the notion that habitat is a critical component of stream function. The report recommends WWH criteria of 0.08 mg/l in headwater streams (<20 mi^2 watershed size), 0.10 mg/l in wadeable streams (>20-200 mi^2) and 0.17 mg/l in small rivers (>200-1000 mi^2).

Organic Enrichment and Low Dissolved Oxygen

The amount of oxygen soluble in water is low and it decreases as temperature increases. This is one reason why tree shade is so important. The two main sources of oxygen in water are diffusion from the atmosphere and plant photosynthesis. Turbulence at the water surface is critical because it increases surface area and promotes diffusion. Drainage practices such as channelization eliminate turbulence produced by riffles, meanders, and debris snags. Although plant photosynthesis produces oxygen by day, it is consumed by the reverse process of respiration at night. Oxygen is also consumed by bacteria that decay organic matter, so it can be easily depleted unless it is replenished from the air. Sources of organic matter include poorly treated waste water, sewage bypasses, and dead plants and algae.

Dissolved oxygen criteria are established in the Ohio Water Quality Standards to protect aquatic life. The minimum and average limits are tiered values and linked to use designations (Administrative Code 3745-1-07, Table 7-1).

Ammonia

Ammonia gas (NH_3) readily dissolves in water to form the compound ammonium hydroxide (NH_4OH). In aquatic ecosystems an equilibrium is established as ammonia shifts from a gas to undissociated ammonium hydroxide to the dissociated ammonium ion (NH_4^{+1}). Under normal conditions (neutral pH 7 and 25°C) almost none of the total ammonia is present as gas, only 0.55%

is present as ammonium hydroxide, and the rest is ammonium ion. Alkaline pH shifts the equation toward gaseous ammonia production, so the amount of ammonium hydroxide increases. This is important because while the ammonium ion is almost harmless to aquatic life, ammonium hydroxide is very toxic and can reduce growth and reproduction or cause mortality.

The concentration of ammonia in raw sewage is high, sometimes as much as 20-30 mg/l. Treatment to remove ammonia involves gaseous stripping to the atmosphere, biological nitrification and de-nitrification, and assimilation into plant and animal biomass. The nitrification process requires a long detention time and aerobic conditions like that provided in extended aeration treatment plants. Under these conditions, bacteria first convert ammonia to nitrite (*Nitrosomonas*) and then to nitrate (*Nitrobacter*). Nitrate can then be reduced by the de-nitrification process (*Pseudomonas*) and nitrogen gas and carbon dioxide are produced as by-products.

Ammonia criteria are established in the Ohio Water Quality Standards to protect aquatic life. The maximum and average limits are tiered values based on sample pH and temperature and linked to use designations (Administrative Code 3745-1-07, Tables 7-2 through 7-8).

Metals

Metals can be toxic to aquatic life and hazardous to human health. Although they are naturally occurring elements many are extensively used in manufacturing and are by-products of human activity. Certain metals like copper and zinc are essential in the human diet, but excessive levels are usually detrimental. Lead and mercury are of particular concern because they often trigger fish consumption advisories. Mercury is used in the production of chlorine gas and caustic soda and in the manufacture of batteries and fluorescent light bulbs. In the environment it forms inorganic salts, but bacteria convert these to methyl-mercury and this organic form builds up in the tissues of fish. Extended exposure can damage the brain, kidneys, and developing fetus. The Ohio Department of Health (ODH) issued a statewide fish consumption advisory in 1997 advising women of child bearing age and children six and under not to eat more than one meal per week of any species of fish from waters of the state because of mercury. Lead is used in batteries, pipes, and paints and is emitted from burning fossil fuels. It affects the central nervous system and damages the kidneys and reproductive system. Copper is mined extensively and used to manufacture wire, sheet metal, and pipes. Ingesting large amounts can cause liver and kidney damage. Zinc is a by-product of mining, steel production, and coal burning and used in alloys such as brass and bronze. Ingesting large amounts can cause stomach cramps, nausea, and vomiting.

Metals criteria are established in the Ohio Water Quality Standards to protect human health, wildlife, and aquatic life. Three levels of aquatic life standards are established (Administrative Code 3745-1-07, Table 7-1) and limits for some elements are based on water hardness (Administrative Code 3745-1-07, Table 7-9). Human health and wildlife standards are linked to either the Lake Erie (Administrative Code 3745-1-33, Table 33-2) or Ohio River (Administrative Code 3745-1-34, Table 34-1) drainage basins. The drainage basins also have limits for additional elements not established elsewhere that are identified as Tier I and Tier II values.

Bacteria

Bacteria levels in streams are a concern because of human health. People can be exposed to contaminated water while wading, swimming, and fishing. Fecal coliform bacteria are relatively

harmless in most cases, but their presence indicates that the water has been contaminated with feces from a warm-blooded animal. Although intestinal organisms eventually die off outside the body, some will remain virulent for a period of time and may be dangerous sources of infection. This is especially a problem if the feces contained pathogens or disease producing bacteria and viruses. Reactions to exposure can range from an isolated illness such as skin rash, sore throat, or ear infection to a more serious wide spread epidemic. Some types of bacteria that are a concern include *Escherichia*, which cause diarrhea and urinary tract infections, *Salmonella*, which cause typhoid fever and gastroenteritis (food poisoning), and *Shigella*, which cause severe gastroenteritis or bacterial dysentery. Some types of viruses that are a concern include polio, hepatitis A, and encephalitis. Disease causing microorganisms such as cryptosporidium and giardia are also a concern.

Since fecal coliform bacteria are associated with warm-blooded animals, there are both human and animal sources. Human sources, including effluent from sewage treatment plants or discharges by home sewage treatment systems, are a more continuous problem. Bacterial contamination from combined sewer overflows are associated with wet weather events. Animal sources are usually more intermittent and are also associated with rainfall, except when domestic livestock have access to the water. Large livestock farms store manure in holding lagoons and this creates the potential for an accidental spill. Liquid manure applied as fertilizer is a runoff problem if not managed properly and it sometimes seeps into field tiles.

Bacteria criteria are established in the Ohio Water Quality Standards to protect human health. The maximum and average limits are tiered values and linked to use designation, but only apply during the May 1-October 15 recreation season (Administrative Code 3745-1-07, Table 7-13). The standards also state that streams must be free of any public health nuisance associated with raw or poorly treated sewage during dry weather conditions (Administrative Code 3745-1-04, Part F).

Sediment Contamination

Chemical quality of sediment is a concern because many pollutants bind strongly to soil particles and are persistent in the environment. Some of these compounds accumulate in the aquatic food chain and trigger fish consumption advisories, but others are simply a contact hazard because they cause skin cancer and tumors. The physical and chemical nature of sediment is determined by local geology, land use, and contribution from manmade sources. As some materials enter the water column they are attracted to the surface electrical charges associated with suspended silt and clay particles. Others simply sink to the bottom due to their high specific gravity. Sediment layers form as suspended particles settle, accumulate, and combine with other organic and inorganic materials. Sediment is the most physically, chemically, and biologically reactive at the water interface because this is where it is affected by sunlight, current, wave action, and benthic organisms. Assessment of the chemical nature of this layer can be used to predict ecological impact.

The Ohio EPA evaluation of sediment chemistry results are evaluated using a dual approach, first by evaluating sediment metals using Ohio Specific Sediment Reference Values (SRV) (OEPA 2003) and then by determining the potential for toxicity based on guidelines developed by MacDonald *et al.* (2000). The Ohio SRVs are site specific background metal concentrations based upon ecoregions and identify whether a site has been contaminated. The MacDonald guidelines are consensus based using previously developed values. The system predicts that sediments below the

threshold effect concentration (TEC) are absent of toxicity and those greater than the probable effect concentration (PEC) are toxic.

Sediment samples collected by the Ohio EPA are measured for a number of physical and chemical properties. Physical attributes included % particle size distribution (sand ≥60 µ, silt 5-59 µ, clay ≤4 µ), % solids, and % organic carbon. Due to the dynamics of flowing water, most streams do not contain a lot of sediment and samples often consist mostly of inert sand. This scenario changes if the stream is impounded by a dam or channelized. Chemical attributes included metals, volatile and semi-volatile organic compounds, pesticides, and poly-chlorinated biphenyls (PCBs).

Biological and Water Quality Study of the Sevenmile Creek Basin 2002

Butler and Preble Counties, Ohio

State of Ohio Environmental Protection Agency
Division of Surface Water
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INTRODUCTION

Ambient biological, water column chemical and sediment sampling was conducted in the Sevenmile Creek basin (Watershed Assessment Unit 05080002 060) from June to October 2002 as part of the five-year basin approach for monitoring, assessment, and the issuance of National Pollution Discharge Elimination System (NPDES) permits and to facilitate a Total Maximum Daily Load (TMDL) assessment. This study area included over 33 miles of Sevenmile Creek beginning in the headwaters upstream from Oxford-Gettysburg Road (RM 34.73) and extending to Taylor School Road (RM 1.32) near the confluence with Fourmile Creek. Eight tributary streams were sampled as part of this basin study.

Specific objectives of this evaluation were to:

1) Monitor and assess the chemical, physical and biological integrity of the streams within the Sevenmile Creek basin;

2) Evaluate the influence of the Eaton and Camden wastewater treatment plants (WWTPs);

3) Evaluate the potential impacts from the unsewered community of Gettysburg and from the Parker Hannifan metal plating facility; and

4) Determine the attainment status of the current designated Warmwater Habitat (WWH) and Exceptional Warmwater Habitat (EWH) aquatic life uses and other non-aquatic use designations and recommend changes where appropriate.

The findings of this evaluation factor into regulatory actions taken by the 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 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]).

SUMMARY

Biological, physical habitat, and surface water chemistry information was collected from 20 stations in eight streams within the Sevenmile Creek watershed during 2002. All of these stations were in FULL attainment of their designated or recommended aquatic life uses (Table 1). Biological community performance ranged from marginally good (fish community in Paint Creek RM 4.2) to exceptional. In general, fish and macroinvertebrate communities were diverse and contained significant proportions of environmentally sensitive taxa, indicating a high degree of biological integrity. Comparison of the 2002 sampling results to a similar survey conducted by the Ohio EPA (1992) in 1991 reveals a significant positive trend in biological community performance in the segment from Eaton to Camden (Figs. 19, 22-24). Other areas that are comparable between the surveys were similar.

Bacteriological sampling in 2002 found elevated levels in Beasley Run (RM 0.25) and Sugar Run (RM 0.07). The Beasley Run station was located within a highly urbanized part of Camden and recorded grossly elevated fecal coliform and *E. coli* bacteria levels throughout the survey (median fecal coliform and *E. coli* counts of 40,500 colonies/100 ml and 36,500 colonies/100 ml, respectively). This portion of Beasley Run was probably not representative of the rest of the stream. Stream flows at the chemistry station declined through the summer until by August 1 the stream was restricted to a 12 ft by 12 ft pool with no downstream flow and by September 11 the station consisted of a 2 ft by 2 ft pool with no inflow (no sample was taken on this date). The biological samples were taken farther upstream, outside of the city, with more normal flows observed on August 2 and 7.

The Sugar Run station was located downstream from the Lake Lakengren WWTP (RM 0.49). Besides high bacteria counts (median fecal coliform and *E. coli* counts of 2,300/100 ml and 1,700/100 ml, respectively) recorded from Sugar Run, one ammonia-N concentration (1.0 mg/l) exceeded the Ohio Water Quality Standards (WQS) criterion on August 14 and highly elevated concentrations of nitrate-nitrite-N (median 8.91 mg/l) and total phosphorus (median 3.61 mg/l) were also present. These water quality measures indicate an impairment from the Lake Lakengren WWTP. This WWTP has a history of overflows and basement back-ups relating to wet weather, power failures, or mechanical failures in the collection system. Other possible contributing sources were run-off from agricultural and livestock operations or poorly maintained on-site sewage systems. Nutrient enrichment continued downstream into Paint Creek (RM 4.22) where elevated total phosphorus concentrations (median 0.38 mg/l) and supersaturated D.O. concentrations (ranged from 105 to 217%) were recorded. Excessive algal growth was observed at this station throughout the summer.

In a followup investigation during the summer of 2004, sixteen (16) sites were sampled in the Sevenmile Creek watershed including five sites in Beasley Run (RMs 2.04, 1.85, 0.8, 0.6, 0.25), and five sites in the Sugar Run watershed (Sugar Run RMs 1.27, 0.64, 0.62, 0.07, and at RM 0.25 in a tributary entering Sugar Run at RM 0.76). Another six sites were sampled in the Paint Creek drainage (Paint Creek RMs 5.3, 4.85, 4.22, 3.44, 1.3, and in Opossum Run at RM 0.01). Results from 2004 indicate the Primary Contact Recreation use was attained in 2004 (Table 8).

Additional potential threats to the resource quality of this basin were primarily associated with

nutrient loading from the Eaton WWTP, and to a lesser degree from the Camden WWTP. The Eaton WWTP historically has had problems with bypasses at the plant and Sanitary Sewer Overflows from the collection system. The high cadmium sediment concentrations documented downstream from the Eaton WWTP are believed to be attributed to legacy inputs to the Eaton WWTP from the Parker Hannifin plating facility. The zinc (180 mg/kg) and cadmium (3.46 mg/kg) sediment concentrations recorded from Waterworks Park (RM 27.1), exceeded the Ohio SRV numbers. These contaminants may be attributable to legacy run-off from the Parker Hannifin facility via a drainage ditch.

RECOMMENDATIONS

Current and recommended aquatic life, water supply and recreation uses are presented in Table 2. The tributary streams evaluated in this study were originally assigned aquatic life use designations in the 1978 and 1985 Ohio WQS based largely on best professional judgement, while others were left undesignated. The current biological assessment methods and numerical criteria did not exist then. This study, as an objective and robust evaluation of beneficial uses, is precedent setting in comparison to the 1978 and 1985 designations.

This survey is the first time Big Cave Run and Paint Creek were sampled so that a use attainability analysis could be completed. The QHEI scores were in the range generally sufficient to support WWH communities and the biological communities were not demonstrating FULL attainment of the existing Exceptional Warmwater Habitat aquatic life use designation, so therefore, these two streams should be reclassified as Warmwater Habitat.

Efforts should be made to make sure on-site sewage treatment systems are inspected regularly and repaired as needed and that agricultural and livestock operations are taking every effort to prevent the run-off of animal wastes and fertilizers.

Every effort should be made to reduce the high nutrient concentrations coming from the Lake Lakengren WWTP.

Table 1. Aquatic life use attainment status of the Sevenmile Creek basin, June-October, 2002. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate communities (ICI). The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

River Mile Fish[a]/Invert.	IBI	MIwb	ICI[b]	QHEI	Attainment Status	Comment
Sevenmile Creek (14-410)						
			WWH Use Designation (Existing)			
31.2[E]	48	NA	G	67.5	FULL	Swain Rd.
28.2[E]	46	8.6	48	66.5	FULL	Dst. Periwinkle Run
27.0[E]	47	8.4	42	71.0	FULL	Dst. Waterworks Park
25.2[D]	53	8.8	46	80.0	FULL	Ust. Eaton WWTP
25.1[D]	53	9.1	50	75.5	FULL	Dst. Eaton WWTP
23.7[E]/24.2	50	8.3	48	72.0	FULL	Ust. Consolidated Rd. / US 127
20.2[D]	51	9.0	54	76.5	FULL	Seven Mile Rd.
16.1[D]/16.2	47	8.9	56	76.0	FULL	SR 725
15.3[D]/15.5	54	9.7	44	69.0	FULL	Dst. Camden WWTP
			EWH Use Designation (Existing)			
14.4[D]	53	10.0	48	84.0	FULL	Anthony Wayne Parkway
9.3[D]	53	10.7	46	82.0	FULL	Hamilton-Eaton Rd.
1.3[D]	51	9.5	E	78.0	FULL	Taylor School Rd.
Periwinkle Run (14-429) *WWH Use Designation (Existing)*						
0.1[E]	48	NA	G	72.5	FULL	Near mouth
Rocky Run (14-419) *WWH Use Designation (Existing)*						
0.3[E]	54	NA	G	76.5	FULL	Consolidated Rd.
Pottenger Run (14-418) *WWH Use Designation (Existing)*						
0.9[E]	40	NA	G	61.0	FULL	Upper Somers Rd.
Beasley Run (14-417) *WWH Use Designation (Existing)*						
0.6[E]/0.9	40	NA	G	66.0	FULL	Camden Rd.
Paint Creek (14-414) *EWH Use Designation (Existing)/WWH (Recommended)*						
4.2[E]	38[ns]	NA	G	63.0	FULL	Camden-Sugar Valley Rd.
1.3[E]/1.2	48	NA	G	59.0	FULL	SR 725
Rush Run (14-413) *WWH Use Designation (Existing)*						

River Mile Fish[a]/Invert.	IBI	MIwb	ICI[b]	QHEI	Attainment Status	Comment
0.1[E]	50	NA	-	56.0	(FULL)	Hoel Rd.
Big Cave Run (14-412) *EWH Use Designation (Existing)/WWH (Recommended)*						
1.2[E]	56	NA	G	67.5	FULL	Somerville Rd.

Ecoregion Biocriteria: Eastern Cornbelt Plains Ecoregion

INDEX - Site Type	WWH	EWH
IBI - Headwater/Wading	40	50
MIwb - Wading	8.3	9.4
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, ≤0.5 MIwb units).
a Fish sampling methods: A=Boat, D=Sportyak, E=Longline.
b Narrative evaluation based on qualitative macroinvertebrate sample (E=Exceptional, VG=Very Good, G=Good, F=Fair, Low F=Low Fair, P=Poor, and VP=Very Poor).

Table 2. Waterbody use designations for the Sevenmile Creek basin. Designations based on the 1978 and 1985 water quality standards appear as asterisks (*). Designations based on Ohio EPA biological field assessments appear as a plus sign (+). Designations based on the 1978 and 1985 standards for which results of a biological field assessment are now available are displayed to the right of existing markers. Designated uses based on results other than Ohio EPA biological data are marked with an circle (o). A delta (Δ) indicates a new recommendation based on the findings of this report.

Water Body Segment	Use Designations												
		Aquatic Life Habitat						Water Supply			Recreationn		
	SRW	WWH	EWH	MWW	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Sevenmile Creek - Paint Creek (RM 15.2) to the mouth			+						+	+		+	
- all other segments		+							+	+		+	
Ninemile Creek		*							*	*		*	
Big Cave Run		Δ	*						*/+	*/+		*/+	
Rush Run		*							*/+	*/+		*/+	
Paint Creek	*	Δ	*						*/+	*/+		*/+	
Opossum Run		*							*	*		*	
Sugar Run		*							*	*		*	
Beasley Run		*/+							*/+	*/+		*/+	
Pottenger Run		*/+							*/+	*/+		*/+	
Rocky Run		*/+							*/+	*/+		*/+	
Periwinkle Run (not Crumbaker Run)		*/+							*/+	*/+		*/+	

STUDY AREA DESCRIPTION

The Sevenmile Creek watershed lies in the central portion of Preble County and northern Butler County. It covers a total area of 137 mi^2 with 109 mi^2 in Preble County and 20 mi^2 in Butler county. Sevenmile Creek flows for approximately 35 miles in a southerly direction to a confluence with Fourmile Creek at the community of Sevenmile. According to the "Gazetteer of Ohio Streams" (ODNR 2001) all of the designated streams in the watershed, including Sevenmile Creek, total 68.3 miles. Tributaries assessed in this survey include: Periwinkle Run, Rocky Run, Pottenger Run, Beasley Run, Paint Creek, Sugar Run, Rush Run, and Big Cave Run. All streams are designated Warmwater Habitat (WWH) except for the lower 15.2 miles of Sevenmile Creek, Paint Creek, and Big Cave Run which are Exceptional Warmwater Habitat (EWH). Impoundments include Rush Run Lake in the Rush Run State Wildlife Area, and Lake Lakengren, part of a private residential development. A summary of the stream characteristics of the larger streams in this basin are presented in Table 3.

Topography of the watershed changes from the northern to southern reaches. The headwaters are typical of the Eastern Cornbelt Plains ecoregion with a generally flat appearance as a result of glaciation. The southern portion becomes more hilly as it approaches the edge of the Interior Plateau ecoregion. As a result the tributary streams are generally short with limited drainage areas but high rates of fall (up to 76.9 feet per mile in Rush Run). The mainstem of Sevenmile Creek runs over glacial outwash that is made up of sand, gravel, and cobbles which are exposed in the stream bottom. In a few areas the the mainstem and some of the tributaries flow across exposed bedrock which is thinly interbedded limestone and shale. Soils in the watershed tend to vary with their location and slope. Along the stream over sands and gravel is the Fox-Ockley-Thackery association while slightly higher floodplains are typically made up of the Ross-Medway-Landes association. Both of these soil types are well drained and do not exhibit wetland characteristics. The uplands of the watershed are either the Miami-Celina association or the Russell-Xenia association which also are characteristically well drained.

Population centers in the watershed include Eaton (pop. 8133), Camden (pop. 2302), and Somerville (pop. 294). A large private housing development in the Paint Creek watershed is known as Lake Lakengren. The development surrounds a 207 acre man-made reservoir which is used for recreation during the summer months. Due to development at Lake Lakengren the population of Gasper Township increased from 1638 in 1990 to 3229 in 2000. Eaton, Camden, and Lake Lakengren all have WWTPs that discharge within the watershed. Smaller communities are served by individual on-lot septic systems that operate to various levels of treatment.

Table 3. Stream characteristics and significant identified pollution sources in the Sevenmile Creek study area.

Stream Name	Length (Miles)	Average Fall (Ft/mile)	Drainage Area (Mi^2)	Nonpoint Source Pollution Categories	Point Sources Evaluated
Sevenmile Creek	35	16.5	137	Urban, Agriculture	Eaton Camden
Ninemile Creek	3.6	35	7.94		
Big Cave Run	2.9	45.5	5.7		
Rush Run	3.3	76.9	4.6		
Paint Creek	10	28	22.8		
Opossum Run	.5	72	1.34		
Sugar Run	1.7	54	2.96		Lake Lakengren
Beasley Run	3.6	42.2	5.86		
Pottenger Run	3.2	29.3	6.3		
Rocky Run	5	20.2	8.94		
Periwinkle Run	2	25.5	5.92		

Source: Gazetteer of Ohio Streams, Ohio Department of Natural Resources, 2nd edition, 2001
Ohio EPA, 305b Report, 2000

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, 1995) for aquatic habitat assessment. Chemical, physical and biological sampling locations are listed in Table 4.

Table 4. Sampling locations in the Sevenmile Creek study area, 2002 (C - conventional water chemistry, E - effluent water chemistry, S - sediment, D - Datasonde® continuous monitors, O - organics, M - macroinvertebrates, F - fish).

Stream River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 minute Quadrangle M
Sevenmile Creek (14-410)				
34.73	C	39.8334775/84.7245275	Ust. Oxford-Gettysburg Rd.	Eaton North
31.2	C,O,M,F	39.7974442/84.6861442	Swain Rd.	Eaton North
28.2	C,D,O,M,F	39.7657942/84.6535275	Dst. Periwinkle Run	Eaton North
27.1	C,S,O	39.7526775/84.6456942	At Waterworks Park	Eaton North
27.0	M,F	39.7492222/84.6449166	Dst. Waterworks Park	Eaton North
26.00	D	39.7399409/84.6387304	St. Clair Ave.	Eaton South
25.2	C,S,O,M,F	39.7299275/84.6355275	Ust. Eaton WWTP	Eaton South
25.1	M,F	39.7299444/84.6335000	Dst. Eaton WWTP	Eaton South
24.45	C,S,O	39.7228966/84.6268605	Adj. US 127, dst. Eaton WWTP	Eaton South
24.2	M	39.7200000/84.6277777	US 127	Eaton South
23.7	F	39.7142/84.6256	Ust. Consolidated Rd.	Eaton South
20.2	C,S,D,O,M,F	39.6740775/84.6222775	Seven Mile Rd.	West Alexandria
16.2	M	39.6305000/84.6440277	SR 725, ust. Camden WWTP	Eaton South
16.1	C,S,D,F	39.6291458/84.6445383	SR 725, ust. Camden WWTP	Eaton South
15.5	M	39.6221388/84.6488611	Dst. Camden WWTP	Oxford
15.3	F	39.6197/84.6489	Dst. Camden WWTP	Oxford
14.4	C,S,D,O,M,F	39.6086313/84.6532358	Anthony Wayne Parkway	Oxford
10.8	C	39.5687608/84.6431108	Anthony Wayne Parkway, ust Somerville	Oxford
9.3	C,S,D,O,M,F	39.5528709/84.6372263	Hamilton-Eaton Rd., dst. Somerville	Oxford
4.36	C,O	39.5044862/84.5953358	US 127, dst. Collinsville	West Elkton
1.3	C,S,D,M,F	39.4793264/84.5637594	Taylor School Rd.	Hamilton
Periwinkle Run (14-429)				
0.1	C,O,M,F	39.7699306/84.6557554	Adj. Eaton-New Hope Rd.	Eaton North
Rocky Run (14-419)				
0.3	C,M,F	39.7153595/84.6183756	Consolidated Rd.	West Alexandria
Pottenger Run (14-418)				
0.9	M,F	39.6423611/84.6200833	Ust. Upper Somers Rd.	West Alexandria
0.85	C	39.6428136/84.6214452	Dst. Upper Somers Rd., dst northern trib.	West Alexandria
Beasley Run (14-417)				
0.9	M	39.6448055/84.6459722	Adj. Camden Rd.	Eaton South
0.6	F	39.6372/84.6439	US 127	Eaton South
0.25	C,O	39.6371442/84.6435108	Main St.	Eaton South
Paint Creek (14-414)				
4.2	C,S,M,F	39.6583282/84.6862967	Camden-Sugar Valley Rd.	Eaton South
1.3	F	39.6258/84.6661	SR 725	Eaton South
1.2	M	39.6251111/84.6654722	SR 725	Eaton South
Sugar Run				

Table 4. Sampling locations in the Sevenmile Creek study area, 2002 (C - conventional water chemistry, E - effluent water chemistry, S - sediment, D - Datasonde® continuous monitors, O - organics, M - macroinvertebrates, F - fish).

Stream River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 minute Quadrangle M
0.07	C,O	39.6683556/84.6870961	Paint Creek Rd., dst. L. Lakengren WWTP	Eaton South
Rush Run (14-413)				
0.1	C,O,M,F	39.5742764/84.6431458	Hoel Rd.	Oxford
Big Cave Run (14-412)				
1.2	M,F	39.5526666/84.6478055	Somerville Rd.	Oxford

Determining Aquatic Life Use Attainment Status

The attainment status of aquatic life uses (*i.e.*, full, partial, and non-attainment) is determined by using the biological criteria codified in the Ohio Water Quality Standards (WQS; Ohio Administrative Code [OAC] 3745-1-07, Table 7-15). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. The biological community performance measures 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 (1995). 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 1987). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Aquatic life use status is full attainment if all three indices (or those available) meet the applicable biocriteria, partial attainment if at least one of the indices does not attain and performance is 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. Index scores and corresponding narrative evaluations for the are based on expectations in the Eastern Corn Belt Plains ecoregion (Table 5).

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, 1995). 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 habitat characteristics used to determine the QHEI score which generally ranges from 20 to less than 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 whereas scores less than 45 generally cannot support a warmwater assemblage consistent with the WWH biological criteria. The segments with scores greater than 75 frequently support exceptional warmwater faunas.

Table 5. Biological metric scores and corresponding narrative evaluations for the Eastern Corn Belt Plains ecoregion. Minimum scores for attainment of the WWH criteria (bold), MWH (underlined) and EWH (italics) are also provided. The marginally good range represents nonsignificant departure of the WWH aquatic life use. The very good range corresponds with nonsignificant departure of the EWH aquatic life use.

Eastern Corn Belt Plains						
IBI			**MIwb**		**ICI**	**Narrative Evaluation**
Headwater	Wading	Boat	Wading	Boat	All	
50-60	*50*-60	*48*-60	≥*9.4*	≥*9.6*	*46*-60	Exceptional
46-49	46-49	44-47	8.9-9.3	9.1-9.5	42-44	Very Good
40-45	**40**-45	**42**-43	**8.3**-8.8	**8.5**-9.0	**36**-40	Good
36-39	36-39	38-41	7.8-8.2	8.0-8.4	32-34	Marginally Good
28-35	28-35	26-37	5.9-(6.2) 7.7	6.4-7.9	14-(22) 30	Fair
18-(24) 27	18-(24) 27	16-(24) 25	4.5-5.8	5.0-(5.8) 6.3	8-12	Poor
12-17	12-17	12-15	0-4.4	0-4.9	<8	Very Poor

Macroinvertebrate Community Assessment

Macroinvertebrates were sampled quantitatively, from the larger stream sites, using multiple-plate, artificial substrate samplers (modified Hester/Dendy) in conjunction with a qualitative assessment of taxa inhabiting the available natural substrates. The smaller stream sites were sampled using the qualitative method only. Qualitative macroinvertebrate sampling consisted of an inventory of the taxa at a sampling station with an attempt to field estimate predominant populations. An assessment of the status of the macroinvertebrate community was made based on the Invertebrate Community Index (ICI) for quantitative sites and best professional judgement utilizing sample attributes such as EPT (Ephemeroptera - mayfly, Plecoptera - stonefly, and Trichoptera - caddisfly) diversity, sensitive taxa diversity and predominance, and tolerant taxa predominance for qualitative sites.

Fish Community Assessment

Fish were sampled once or twice at each site using pulsed DC electrofishing methods. 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 1989b).

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 AND DISCUSSION

Pollutant Loadings

C.R Coblentz Local School District (National Trails High School)

Sevenmile Creek-RM 34.69 39^0 50' 00"; 84^0 43' 23"

National Trails High School WWTP is located at 6940 Oxford-Gettysburg Road, New Paris, Ohio, 45347 in Preble County. The original facility was a 12,000 gpd (gallons per day) package plant, built in 1968 and permitted in 1997, serving a population of 1500. Original treatment consisted of a septic tank, activated sludge tank, clarification tanks and chlorination for disinfection. Current treatment consists of a septic tank, equalization tanks, activated sludge tank, clarification tank, upflow filters, sand filters, tablet chlorination and tablet dechlorination. The discharge is very near where I-70 crosses Sevenmile Creek.

Upstream from the WWTP discharge is a storm sewer outfall which receives flow from the unsewered Village of Gettysburg. The village is located near where US 40 intersects Sevenmile Creek. It is suspect that sewage discharges from Gettysburg enter into the storm sewer system.

Discussions for an expansion to consolidate the elementary and middle schools into one campus with the high school began in 1995. Approval for expansion occurred in 1997 which increased the facility design to 30,000 gpd average flow. There are no bypassing capabilities associated with this facility.

Violations of the National Pollutant Discharge Elimination System (NPDES) were evaluated for part of 1999 through all of 2003. For the nearly 5 years of data evaluated through SWIMS (Surface Water Information Management System), approximately 39 violations were documented for chlorine. Two violations were reported for ammonia-N and occurred in the winter months of 2001 and 2002.

Annual median and peak flows were typically below the design capacity for the three years evaluated exhibiting a slight increase due possibly to greater volumes from population growth. Variability seen in annual loads could be attributed to the fluctuation in student population from season to season. Overall reductions in loads observed in the conventional parameters is most likely due to improved operational controls.

Eaton WWTP-Sevenmile Creek (001)-RM 25.17
Overflows to Rocky Run
39^0 43' 52"; 83^0 38' 49"

The Eaton WWTP is located at 901 S. Barron Street, Eaton, Ohio in Preble County. The original facility was built in 1930, with subsequent upgrades in 1966 and 1983 with no expansion anticipated. Current treatment consists of a bar screen, grit removal, scum removal, primary sedimentation, activated bio-filter (ABF) activated sludge-conventional, secondary clarification, mixed media filter, chlorination, dechlorination and post aeration utilizing a cascade effect. The Eaton WWTP has a design capacity of 1.9 MGD (million gallons per day) and a hydraulic capacity of 1.4 MGD serving a population of 8,630. The annual, average daily flow rate from 2001 to 2003 was 1.53, 1.40, and 1.69 MGD, respectively. Eaton's actual inflow is higher than what is reported on Monthly Operating Reports (MOR's). During storm event high inflows, Eaton bypasses the final treatment filters downstream of the final effluent meters.

The collection system contains an approximate 36 miles of separate sanitary sewers with five minor lift stations and one major lift station. The oldest part of the wastewater collection system is 90 years old. Sludge generated at the facility is currently sent to the Preble Co. landfill, however, approval does exist for land application. Significant industrial users to the system are Bullen Ultrasonics (semi-conductor wafers), Parker Hannifin (fluid connectors; pipe and tube fitters), and Weyerhaeuser (corrugated containers). In the period November 2003 through December 2004 Bullen Ultrasonic was in significant non-compliance for copper violations. In addition, enforcement actions had been taken against Bullen Ultrasonic and Parker Hannifin for zinc violations. The zinc violations appear to have been resolved.

Discussions began in October of 1998 over the existing Sanitary Sewer Overflows (SSO's) and their slated removal. The construction of off-line storage basins to contain the added effluent volume during storm events was designed at an estimated cost of $5,200,000. Due to the cost and the under use of the basins this proposed action was suspended and new alternatives were introduced. An infiltration/inflow (I/I) investigation was conducted in 1999 by ADS Environmental Services. Activities included flow monitoring, TV video investigation, manhole inspection, dye and smoke testing and improved preventative maintenance procedures. Repair of 25 manholes and the replacement of 1000 ft of 8" sanitary sewer line were immediately scheduled. Of the 25 manholes, 10 demonstrated leakage, 10 were below gradient, one had sustained damage and four had lids

removed.

Currently SSO structures still exist in the collections system. A problematic SSO at the east side pump station frequently overflows at the first upstream manhole from the pump station. These overflows are located in the Rocky Run watershed. The east side pump station is located in the southeast quadrant of the city near the fairgrounds. No fish kills were reported at or near the Eaton WWTP based on available data from the Ohio Division of Natural Resource Reports from 1997-2002.

Eaton WWTP currently has a manhole located between the primary clarifiers that overflows to a storm basin in the facility parking lot during storm events that exceeds one inch. Overflows at this manhole were reported nearly monthly through late summer 2002 until 2003. This problem dates back to 1995. Volumes for these overflows are largely unreported, attributable to flow volume variation and intermittent occurrences.

The City of Eaton has approximately 700 sanitary sewer manholes. Eaton's plans are to inspect 30-70 manholes per year, covering all 700 manholes over the next several years. The current average inflow and infiltration (I/I) to the collection system is estimated at a minimum of 250,000 gpd.

The City of Eaton was required by their NPDES permit to perform quarterly chronic toxicity tests for one year using effluent from outfall 001 to determine the need for further toxicity testing as part of the NPDES program. This requirement was for the NPDES permit period 1989 to 1994. Eight chronic bioassay tests were conducted up until 1994. Two of these tests demonstrated toxicity to *Ceriodaphnia dubia*. The two chronic toxicity tests in 1990 and 1992 showed reduced reproductive success for this organism. Ohio EPA conducted acute toxicity tests on five occasions at the Eaton WWTP. Test conducted in February and April of 1996, July of 2001 and March and May of 1988 were not acutely toxic to either test species.

For the nearly five years of data evaluated through SWIMS (Surface Water Information Management System) and Ohio EPA records for violations of the National Pollutant Discharge Elimination System (NPDES), 18 violations were reported. Permit violations included chlorine, TSS, ammonia-N, lindane, bacteria, and dissolved oxygen in order of decreasing frequency. From May of 2000 through August of 2000, 11 violations of the chlorine limit were reported, however, the violations of chlorine were isolated to that time period. Seventy-seven percent of the documented violations occurred between 2001 and 2002.

Peak flows, as represented by the 95th percentile, consistently exceeded design flow for the majority of the period between 1983 and 2002 displaying no discernable trend except for a reduction in variance from 1997 to 2002. During the unusually elevated precipitation year of 1996 $cBOD_5$, TSS, and flow were unusually high due to the inflow/infiltration problems plaguing the aging collection system. This problem is being addressed by replacement of deteriorating trunk sewers and manholes reconstruction.

Camden WWTP-Sevenmile Creek-RM 15.52
39^0 37' 24"; 84^0 38' 55"

The original wastewater facility built in 1936 utilizing an Imhoff Tank Treatment System and served a population of 1200. A new facility was constructed and completed in 1971 with a design of 0.25 MGD. A subsequent upgrade occurred approximately in 1995. Average daily flows in the early 1990's were ~ 0.158 MGD. As of 1995 the design flow increased to 0.35 MGD serving a population of approximately 2,200. This increased design flow was derived partially on a consultant's survey conducted in the 1990's, demonstrating that 75% of Camden consumer water use was returned to the sanitary sewers. Sewers were extended north of the village and the Rose Mobile Home Park (currently Quail Creek MHP), which discharged to Sevenmile Creek. Construction was completed by 1999, which eliminated a direct discharge of approximately 274,000 gallons per day of flow to the mainstem.

The entire treatment area is on a sanitary sewer system consisting of approximately 100 miles of separate sanitary sewers with one lift station. The WWTP is an extended aeration facility with aerobic digestion consisting of a bar screen, activated sludge-extended aeration, secondary clarification, oxygen ditch and ultraviolet disinfection. There are no industrial users contributing to the waste collection system.

Collection system inflow and infiltration (I/I) studies, conducted in 1999, indicated that there were no significant hydraulic overloading problems. Toxicity testing is not required for this facility as it is classified a "Minor" (*i.e*. less than 1 MGD) permitted facility.

Directors Findings and Orders were issued in 1995 for failure to comply with final NPDES effluent limitations that were to be met by 1987. Director's Finding and Orders (F&O's) were also issued for permit violations of ammonia-N, fecal coliform bacteria and chlorine from 1990-1993 in addition to failure to submit an approvable Sludge Management Plan (SMP) by the given time line.

Evidence of facility bypassing untreated inffluent was detected upon a scheduled inspection by Ohio EPA personnel in March of 2001. A reported facility bypass of effluent occurred in April of 2001 (36,000 gal). A month later a reported overflow from the Wagers Drive Lift Station (located in the southwest corner of the village) occurred where quantities of the overflow went unreported. In March of 2001, inspection notes describe a pretreatment issue involving presence of "floatables" in the various treatment basins. Suggested causes were described as a failure of the mechanical barscreen and the clarifier skimmers discharging back to the aeration basin allowing and retaining "floatables" in the treatment system. No further file documentation of current conditions was available. Current operation of the plant is conducted by Streamborn Environmental Services.

Two violations for fecal coliform were reported in SWIMS between 1999 and 2003. Ohio EPA derived biological community response indicators, downstream of the Camden WWTP, help support the absence or infrequent occurrence of permit violations of wastewater constituents. Monitoring results from fixed stations 801 and 901, which bracket outfall 001, revealed upstream concentrations of ammonia-N consistently more elevated than downstream for 56% of the years evaluated. The upstream monitoring location is situated at the SR 725 bridge. It is thought that perhaps unsewered campgrounds upstream or livestock operations could be contributing to the ammonia-N load.

Annual median and 95th percentile flow exhibited a general increasing trend following the upgrade in 1995. Flow percentiles remained mostly below plant design capacity of 0.35 gpd. The benefits

of the upgrade of 1995 were evident for all conventional parameters showing steady declines, with minimal numbers of reported NPDES violations.

Lake Lakengren WWTP-Sugar Run-RM 0.49
spillway at RM 5.41
39^0 40'18";84^0 41' 34"

The Lake Lakengren WWTP is located at 3800 Longman Road, Eaton, Ohio in Preble County. The original facility was built in 1976 with a subsequent upgrade completed in 1995. No expansion is currently anticipated. A Comprehensive Performance Evaluation (CPE) was conducted in 1998 by an engineering firm for the purpose of an overall evaluation of the treatment works. It was noted that facility design limitations impair the reserve treatment capacity of the system. That could affect effluent quality as flows and loadings increase. The engineering firm recommended immediate improvements in the stabilization tank in order to achieve NPDES requirements on a consistent basis. Original treatment consisted of two pretreatment basins, primary clarifiers, RBC units, secondary clarifiers, sludge drying beds, microscreens and chlorine contact. Lake Lakengren WWTP originally had a design capacity of 0.60 MGD with four lift stations but only processes on average about 0.10 MGD. The annual operating cost for this facility, including collection system, is approximately $250,000.

Current treatment consists of bar screen, grit removal, primary sedimentation, preaeration, stabilization pond, RBC, activated sludge-contact stabilization, secondary clarification, and ultraviolet disinfection. Switching to surface downdraft aerators a few years back has aided in a more predictable treatment process. Sewer operation duties were turned over in October of 1998 to the Lake Lakengren Water Authority. Facility bypassing was reported in 2000, which sent untreated sewage to Sugar Run.

The Lake Lakengren Water Authority initiated a program to eliminate or substantially reduce both intentional and unintentional inflow and infiltration. Inflow and infiltration is currently estimated at 200,000 gpd. Sewage bypasses and backups into homes have been documented for this facility since 1998 and perhaps prior as a result of storm events, power outages and mechanical failures in the collection system. Shortly after 1998, the Lake Lakengren Water Authority implemented a program called Preventative Monitoring of Lift Station Capability and Use to ensure lift stations were being kept up to an acceptable operating level and monitor for conditions of overload so that sewer backups could be reduced or prevented.

Lift station bypass events have historically occurred at the Paint Creek Road Lift Station (lift station #4) where unknown amounts of untreated sewage were discharged into the Paint Creek Watershed. Bypasses also occurred at lift station #3 (Lakengren Cove) which migrated into the lake and at the north end of the lake through a manhole at Stiver Cove (September-2000). Most overflows were unreported and spill volumes were undocumented.

For the nearly 12 years of data evaluated through SWIMS (Surface Water Information Management System) and Ohio EPA records (part of 1991 through all of 2003), ammonia-N has been a reoccurring parameter in violation of NPDES limits over the entire period. A common reason offered related to temperature variances inhibiting bacteria growth on the RBC's. From 1999 to

2003 a total of 59 violations were reported, limited to ammonia-N, TSS, and dissolved oxygen. Fifty-four percent of the documented violations were violations of ammonia-N. Most of the ammonia-N violations occurred from October of 1999 through 2000. Although influent flow percentiles remained below plant design capacity for the majority of years, many plant bypasses and backups in the collection system were reported through the period of record. Annual median flow was typically below the design capacity for all years. Conduit flow and the 95th percentile loadings of $cBOD_5$, suspended solids and ammonia-N have increased since the 1995 plant upgrade.

Ammonia-N concentrations were consistently higher downstream from the 001 discharge than upstream for the years sampled. Upstream values remained fairly consistent throughout the record as opposed to the downstream values. Fecal coliform in contrast had 62% of the upstream values more elevated than the downstream values. Concentrations at both locations did not reveal any predictable trend.

Crouse MHP-unnamed tributary to Ninemile Creek at RM-2.30
Confluence with Ninemile Creek at RM 0.2
39^0 29' 31";84^0 34' 10"

The Crouse MHP (mobile home park) WWTP is located at 4141 Hamilton-Eaton Rd, Hamilton, Ohio in Butler County. The original facility was built in 1972 with a subsequent upgrade in 1989 and 2000. No current expansion is anticipated. Wastewater treatment consists of two extended aeration units, flow equalization, two aeration tanks, two clarification tanks, fixed media filters, a dosing tank, four surface sand filters, chlorine contact tank and dechlorination tank (2000). Waste sludge from the WWTP is treated in the activated sludge holding tank prior to being dewatered in the sludge drying beds. Wastewater sludge produced onsite was land applied until 2000. Currently wastewater sludge is being hauled to the Rumpke Landfill in Hamilton County.

The Crouse MHP WWTP has a design capacity of 0.04 MGD based on 113 mobile home pads. Observations by Ohio EPA personnel have noted that the effluent stream has not typically reached Sevenmile Creek. Discharge is near the rear railroad tracks and the effluent channel loses flow as it seeps into the sand and gravel streambed.

For the nearly seven years of data evaluated from SWIMS and Ohio EPA records (part of 1997 through all of 2003), chlorine, dissolved oxygen, and suspended solids (TSS) have repeatedly been in violation. During this time period a total of 62 violations were reported for these three parameters. Ninety-one percent of the documented violations were for chlorine. Most of the chlorine violations occurred between October, 1999 and August, 2001. A common reason offered for the chlorine violations was due to summer chlorinating adjustment periods.

Percentile flows remained fairly constant over time, not changing much after the upgrade of 2000. Other typical constituents of the wastewater mimicked peak-flows from 1992 through 1994. However, these remained relatively constant in ensuing years, suggesting a limited period of inadequate treatment. Suspended solid (TSS), ammonia-N, and cBOD5 loads demonstrated variability between median and 95th percentiles, with peak loads doubling and more after the upgrade. Operational controls can be affected when new equipment is brought online and this could account for abrupt variances seen in conventional loads.

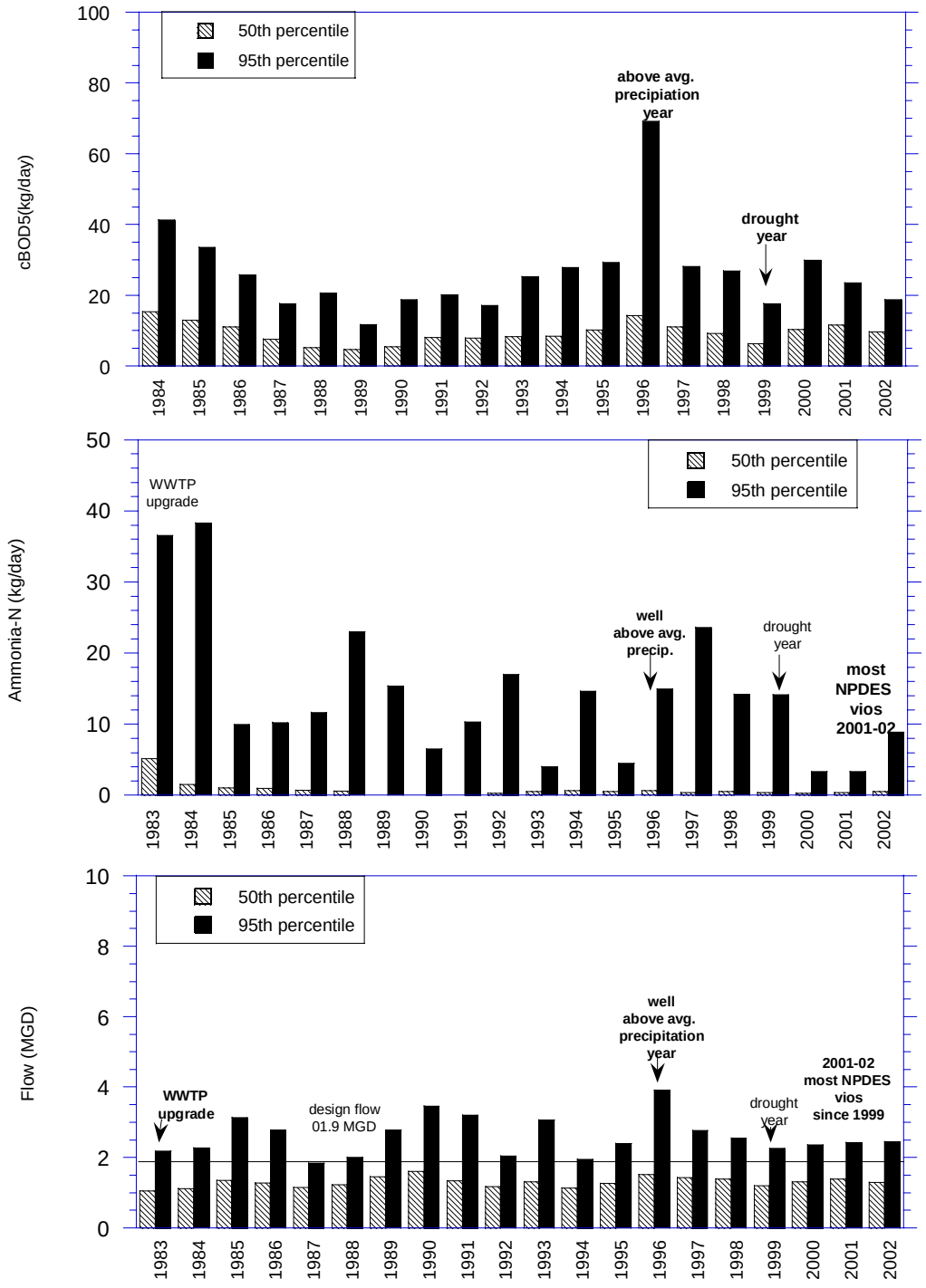


Figure 2. Annual loadings (kg/day) of $cBOD_5$ and Ammonia-N and conduit flow at the Eaton WWTP in the Sevenmile Creek study area, 1983-2002.

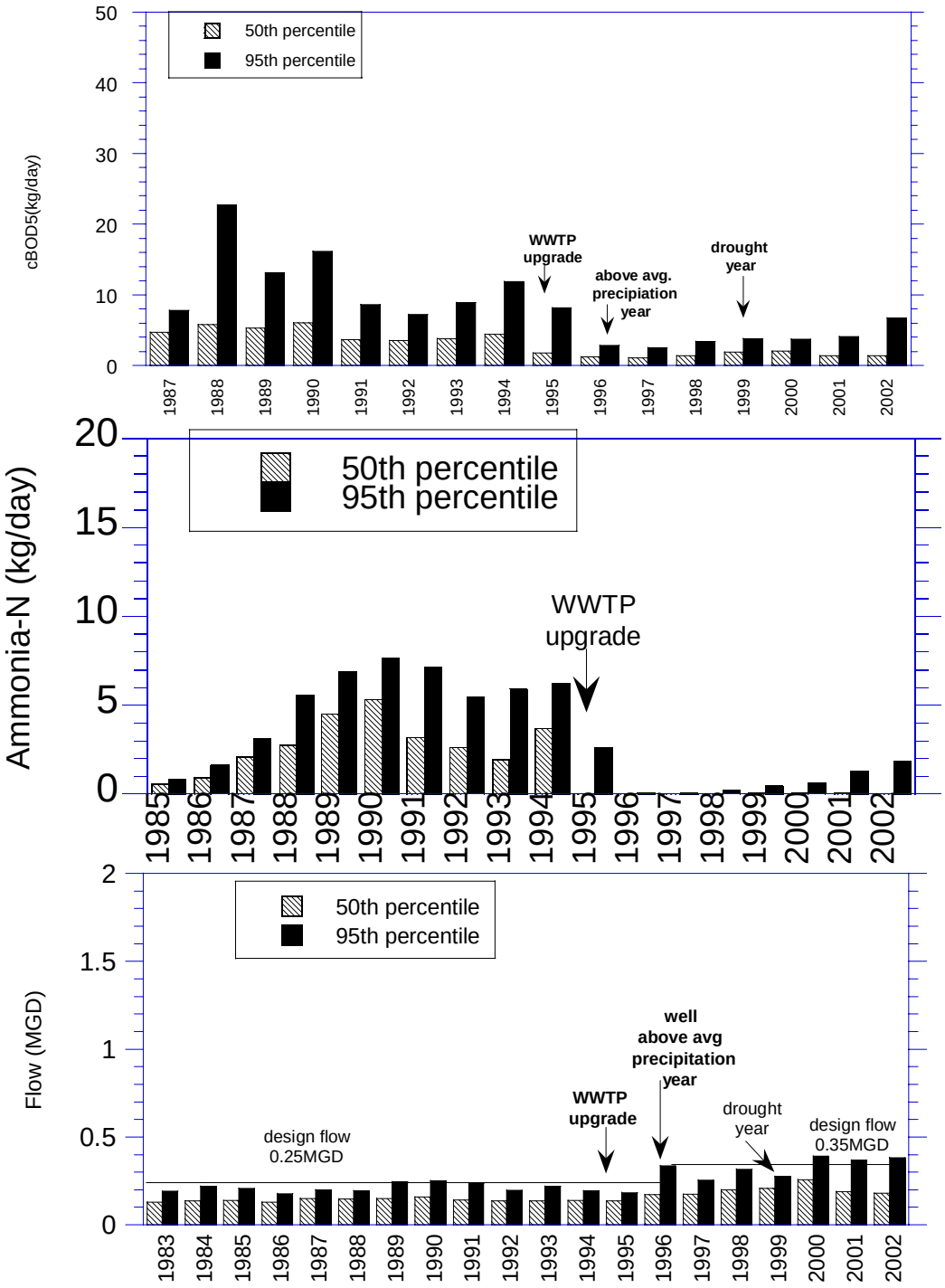


Figure 3. Annual loadings (kg/day) of $cBOD_5$ and Ammonia-N and conduit flow at the Camden WWTP in the Sevenmile Creek study area, 1983-2002.

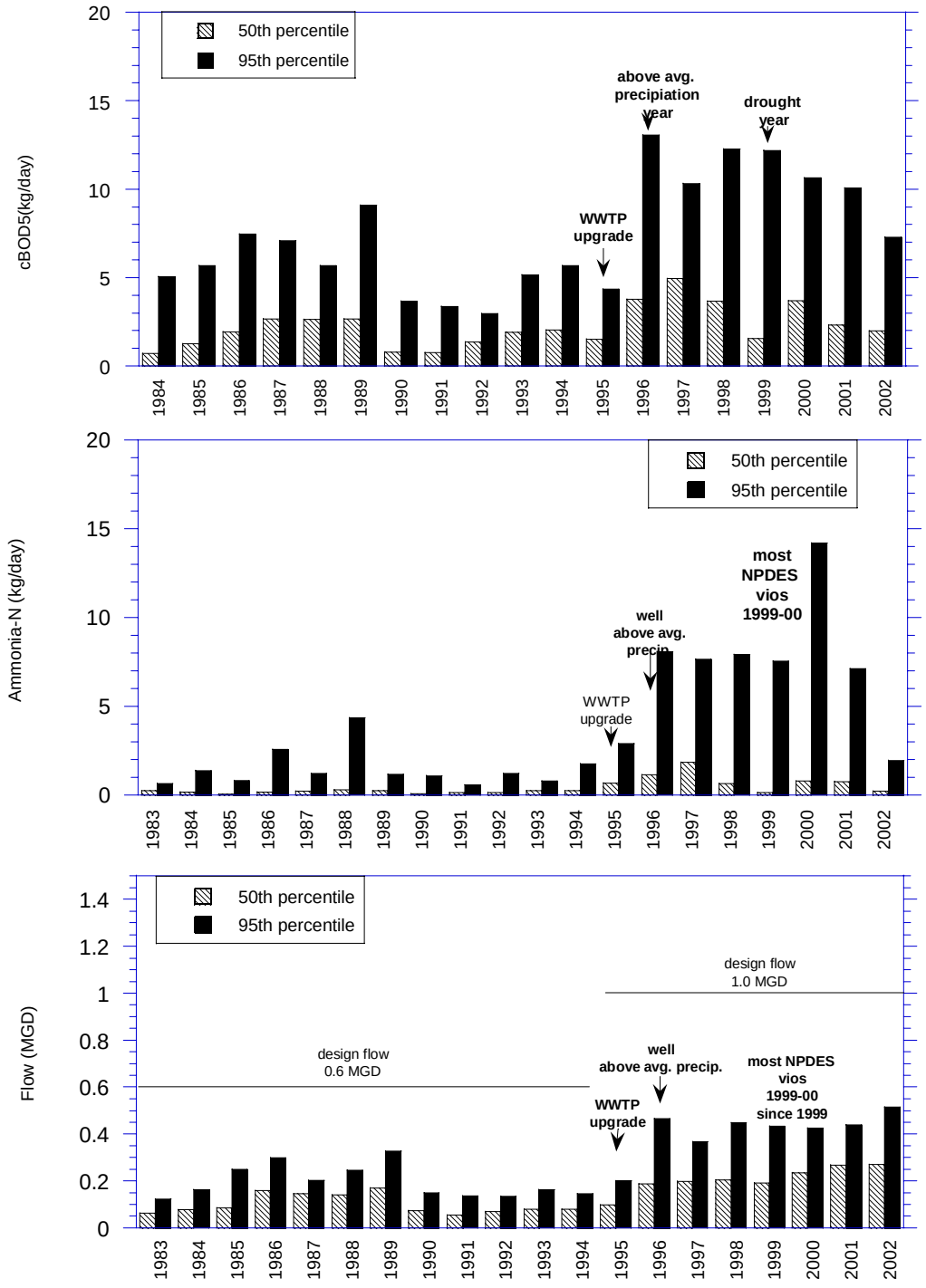


Figure 4. Annual loadings (kg/day) of $cBOD_5$ and Ammonia-N and conduit flow at the Lake Lakengren WWTP in the Sevenmile Creek study area, 1983-2002.

Pollutant Spills, Overflows, and Unauthorized Releases

Pollutant discharges from spills, overflows, permit violations and other unauthorized releases can be significant sources of lethal and sublethal stresses to the aquatic communities in the Sevenmile watershed. Forty-two spills were recorded by the Ohio EPA Emergency Response Section from 1999 to 2003. Sewage and wastewater discharges accounted for 21% of the spills (9 events) in the watershed. Lake Lakengrin reported 7 of the 9 sewage and wastewater discharged events (17 % of the total spills).

Petroleum related materials accounted for 62% (26 events) of the total spills. The majority of petroleum spills were diesel fuel that leaked from saddle tanks in trucks after traffic accidents.

The most significant spill in the watershed was a fuel oil release from the Preble County Engineers office in Eaton on March 24, 2003. Four hundred-fifty gallons of fuel oil were leaked into Sevenmile Creek in Eaton Ohio.

The sanitary sewer system of the city of Eaton has infiltration and inflow (I&I) problems. During heavy rain events, a partial plant bypass occurs after the primary settling tanks. This partially treated sewage flows out of a manhole at the facility and into Sevenmile Creek near RM 24.45. It is estimated that this bypassing occurs from 12 to 18 times a year.

Chemical Water Quality

[Many of the graphs included with the following summaries include dotted lines representing the 90th, 75th, or 50th percentile concentrations from least impacted regional reference sites of similar size (Ohio EPA 1999). Statistical data were segregated by ecoregion and further stratified by ranges of stream size for these analyses as follows: headwater streams (0-20 sq. mi.) and wadeable streams (> 20-200 sq. mi.) .]

Sevenmile Creek

Daily precipitation for the period May through October 2002 for the City of Eaton is presented in Figure 5 (MCD 2002). There was no active stream flow gauging station in the basin during the 2002 survey. Total precipitation was 25.54 inches for the period, approximately 4.7 inches above normal with the majority of precipitation falling in May, June and late September. However, with the exception of a storm event in late July, the months of July and August were much drier with below normal precipitation. By August the Palmer Drought Severity Index (PDSI) indicated the Southwest region of Ohio was in a moderate drought (ODNR 2002). No precipitation was recorded on the five specific water chemistry sampling days during the 2002 survey (July 17, August 1, 14, 28, and September 11).

The aquatic life use designation for Sevenmile Creek is Warmwater Habitat (WWH) from its headwaters to Paint Creek (RM 15.2) and Exceptional Warmwater Habitat (EWH) from RM 15.2 to the mouth. Datasonde™ continuous monitors recorded hourly dissolved oxygen (D.O.) concentration, D.O. percent saturation, temperature, pH and conductivity from September 10-12 and again from October 1-3 at eight sites in the mainstem in 2002 (Figs. 6 and 7). All Datasonde D.O.

concentrations remained above applicable minimum at any time water quality criteria (4.0 mg/l WWH and 5.0 mg/l EWH). However, values dropped below applicable minimum 24-hour average criteria (5.0 mg/l WWH and 6.0 mg/l EWH) on occasion at four sites (RMs 28.15, 16.10, 9.28, and 1.32) during the September sampling and at one site (RM 28.15) during October. Typically, lower values were recorded at night when algal respiration utilizes dissolved oxygen. Lower levels were more frequently recorded at RM 16.10 upstream of Camden where eleven of 58 (19%) hourly measurements fell below average criterion. Median Datasonde D.O. concentrations and saturations remained relatively stable longitudinally (upstream to downstream) with the greatest diurnal variation measured upstream of Camden (RM 16.10) and at Taylor School Road (RM 1.32) during September sampling. The lowest D.O. saturations (median 58 %) occurred in September at St. Clair Avenue (RM 26.00) downstream of the Eaton Country Club dam. Median temperatures during September sampling ranged from 20.2˚C at RM 28.15 (Washington Jackson Road) to 25.4˚C at RM 9.28 (Hamilton Eaton Road downstream Dingledine Basic Materials). October medians ranged from 19.4˚C at RM 28.15 to 22.1˚C at RM 26.00 (St. Clair Avenue). While water temperatures measured in October were frequently elevated above the applicable WWH average criterion (21.7 ˚C), values measured downstream of the Eaton Country Club dam at St Clair Avenue (RM 26.00) exceeded criterion in 61% of the samples. Datasonde pH values, relatively stable longitudinally with medians ranging from 7.75 SU (RM 28.15) to 8.24 SU (RMs 20.20 and 14.44), occasionally fell outside of the acceptable water quality criteria range of 6.5-9.0 SU. Conductivity, low at upstream sites, peaked downstream of the Eaton WWTP at RM 24.10 (September and October respective medians of 1605 µmhos/cm and 1121 µmhos/cm). Concentrations gradually decreased longitudinally to medians of less than 600 µmhos/cm at RM 1.32.

Water chemistry grab samples were collected every other week (five times) at 13 sites in the mainstem of Sevenmile Creek and analyzed for a variety of parameters (Figures 6-10, Table 6). Reflecting lower flows, daytime grab dissolved oxygen concentrations fell below water quality criteria in the headwaters (RM 34.73), downstream of the Camden WWTP (RM 14.44), and at Taylor School Road (RM 1.32) once during the survey. Lower D.O. levels and occasionally elevated phosphorus concentrations at RM 34.73 may also be partially attributable to impacts from the unsewered community of Gettysburg less than a mile upstream. Median dissolved oxygen percent saturations ranged from 66% at RM 34.73 to 133% at RM 10.8. Nutrients (primarily phosphorus), from the Eaton WWTP (RM 25.17) and to a lesser degree from the Camden WWTP (RM 15.52), were conserved and assimilated downstream (Figure 9), resulting in excessive algal production and supersaturated daytime dissolved oxygen concentrations at this site (RM 10.8) throughout the summer. Impacts were exacerbated by low flow conditions and the open canopy in this reach.

Virtually all (98%) five-day biochemical oxygen demand (BOD_5) concentrations recorded in Sevenmile Creek were less than the minimum detection limit (MDL) of 2 mg/l (Figure 8). Ammonia-N levels were also low with the majority (95%) of values less than the MDL of 0.05 mg/l. The highest concentrations occurred at RM 24.45 downstream of the Eaton WWTP (median 0.142 mg/l) (Figure 9).

Nitrate-nitrite-N levels remained low in the mainstem with an overall median of 1.86 mg/l and 97% of values well below 90th percentile Eastern Corn Belt Plains (ECBP) ecoregion background levels (4.6 to 4.8 mg/l) (Figure 9). However, median concentrations increased dramatically from 0.1 mg/l

at RM 34.73 to 3.32 mg/l at RM 31.25. In addition to residential on-site sewage systems, this area may be impacted by the National Trails High School WWTP discharge (RM 34.69). (Excluding weekends, monthly operating reports (MORs) for this facility from July through September 2002 indicate a median discharge rate of 0.011 MGD.). While these higher levels may also be partially attributable to agricultural runoff, non-point source impacts are typically more apparent during higher flows than occurred during the 2002 survey. Concentrations peaked at RM 24.45 (median 4.72 mg/l) downstream of the Eaton WWTP discharge, gradually decreasing longitudinally to a median of 0.77 mg/l at Taylor School Road (RM 1.32).

Phosphorus levels, low in the upper reaches (overall median of 0.06 mg/l), spiked downstream of the Eaton WWTP at RM 24.45 (median 0.85 mg/l) (Figure 9). Concentrations remained elevated well above the ECBP 90th percentile reference background concentration of 0.22 mg/l downstream at RM 20.2 (median 0.47 mg/l) before dropping at RM 16.1 (median of 0.15 mg/l). Levels increased again at RM 14.44 (median 0.25 mg/l) downstream of the Camden WWTP and the confluence of Paint Creek before becoming assimilated in the lower reaches (RMs 10.8 -1.32) where an overall median of 0.05 mg/l was recorded.

Total suspended solids (TSS) remained low throughout the mainstem with the majority of values (65 %) less than or equal to the MDL of 5 mg/l and all values less than applicable 75th percentile ECBP reference background concentrations (Figure 10). While still relatively low, peaks were recorded upstream of the Eaton WWTP at RM 25.18 (median 12 mg/l), downstream of the Camden WWTP and Paint Creek at RM 14.44 (median 12 mg/l), and downstream of the Dingledine Basic Materials sand and gravel facility at RM 9.28 (median 14 mg/l).

The majority of bacteriological samples collected in the mainstem (97% of fecal coliform samples and 67% of *E. coli* samples) were less than the applicable maximum Primary Contact Recreation (PCR) criterion (Figure 10). Excluding the most headwater site (RM 34.73), somewhat higher median values were documented in the upper section of the mainstem (RM 31.25 through RM 20.2) compared to sites sampled downstream. In addition to agricultural non-point sources, this area may be impacted by discharges from inadequately maintained on-site sewage systems, the National Trails High School WWTP (RM 34.69), the Eaton WWTP (RM 25.17), and waterfowl on the 4.3 acre Eaton Country Club lake, dammed at RM 26.10. The highest fecal coliform values occurred downstream of the Eaton WWTP at RM 24.45 (median 970 colonies/100 ml) while the highest *E. coli* concentrations were recorded at RM 27.1 (median 360 colonies/100 ml).

Cadmium, while well below the WQS criterion, was consistently elevated above the 90th percentile ECBP reference background concentration of 0.25 µg/l from RM 24.45 through RM 14.44. Medians ranged from 0.27 µg/l downstream of the Eaton WWTP at RM 24.45 to 0.48 µg/l at Seven Mile Road (RM 20.2). Concentrations at all other sites in the basin (mainstem and tributaries) were less than the MDL of 0.2 µg/l. Cadmium was also elevated in the sediments at RM 24.45 and RM 20.2.

Additionally, while well below the WQS criterion, the highest arsenic concentrations of the survey were recorded at RM 34.73 with four of five values (median 6 µg/l) elevated above the 90th percentile ECBP reference concentration of 4 µg/l.

Nine of the 13 water chemistry sites in the mainstem were sampled for organic compounds twice

during the 2002 survey (Table 7). Samples were scanned for 59 volatile organic compounds (VOCs), 53 semivolatile compounds, 34 pesticide compounds, and seven polychlorinated biphenyl (PCB) congeners. Nine of the eleven organic compounds (and 46 of the 59 detections) found in the mainstem were pesticides. Dieldrin, an insecticide no longer manufactured or used in the United States, was the most frequently detected compound, exceeding the non-drinking water human health WQS criterion of 0.0014 µg/l in 15 of 18 samples. Atrazine and bis(2-Ethylhexyl)phthalate (a plasticizer) each accounted for an additional 15% of the detections (9 of 59) with bis(2-Ethylhexyl)phthalate exceeding WQS criterion on one occasion at RM 9.28. Concentrations of aldrin and heptachlor epoxide also exceeded applicable non-drinking water human health WQS criteria at numerous sites in the mainstem. PCBs were not detected in the water column at any site (mainstem or tributary) during the 2002 survey.

Table 6. Exceedences of Ohio Water Quality Standards criteria (OAC 3745-1) (and other chemicals not codified for which toxicity data is available) for chemical/physical water parameters measured in grab samples taken from the Sevenmile Creek study area during 2002 (units are µg/l for metals and organics, #colonies/100 ml for fecal coliform and *E. coli*, SU for pH, and mg/l for all other parameters).

Stream (use designation [a])	River Mile	Parameter [b] (value)
Sevenmile Creek -Paint Creek (RM 15.2) to the mouth (EWH, PCR, AWS, IWS)	34.73	Dissolved oxygen (3.1‡‡) *E. coli* (390◊◊, 270◊P)
	31.25	*E. coli* (360◊◊, 560◊◊P, 190◊, 330◊◊) Dieldrin (0.0028#, 0.0024#)
-all other segments (WWH, PCR, AWS, IWS)	28.15	Fecal coliform (1100◊) *E. coli* (560◊◊, 190◊P, 340◊◊, 790◊◊, 270◊) Dieldrin (0.0040#)
	27.10	Fecal coliform (2100◊◊) *E. coli* (310◊◊P, 210◊P, 370◊◊, 2500◊◊, 360◊◊) Dieldrin (0.0053#, 0.0050#)
	25.18	*E. coli* (350◊◊, 230◊, 490◊◊, 150◊, 270◊) Dieldrin (0.0076#, 0.0041#) Aldrin (0.0041#) Heptachlor Epoxide (0.0025#)
	24.45	Fecal coliform (3500◊◊, 1100◊) *E. coli* (160◊, 170◊, 250◊, 1100◊◊, 270◊) Dieldrin (0.0094#)
	20.20	*E. coli* (340◊◊, 350◊◊, 300◊◊, 310◊◊, 330◊◊) Dieldrin (0.0089#, 0.0064#) Heptachlor Epoxide (0.0034#)
	16.10	*E. coli* (130◊, 390◊◊)
	14.44	Dissolved oxygen (5.0‡) *E. coli* (280◊, 550◊◊) Dieldrin (0.0064#, 0.0032#) Heptachlor Epoxide (0.0033#)
	10.80	*E. coli* (140◊)
	9.28	*E. coli* (210◊, 150◊, 130◊,180◊) Dieldrin (0.0029#, 0.0020#) Aldrin (0.0028#) Heptachlor Epoxide (0.0034#) bis(2-Ethylhexyl)phthalate (35.3*)
	4.36	*E. coli* (130◊) Dieldrin (0.0038#) Heptachlor Epoxide (0.0027#)

Table 6. Continued.

Stream (use designation [a])	River Mile	Parameter [b] (value)
	1.32	Dissolved oxygen (5.8‡) *E. coli* (140◊)
Periwinkle Run (UNDESIGNATED)	0.01	*E. coli* (630◊◊P, 130◊, 430◊◊) Dieldrin (0.0074#) Heptachlor Epoxide (0.0042#)
Rocky Run (WWH, PCR, AWS, IWS)	0.35	Dissolved oxygen (3.1‡‡) *E. coli* (210◊, 400◊◊, 170◊, 950◊◊)
Pottenger Run (WWH, PCR, AWS, IWS)	0.85	pH (10.22Δ) *E. coli* (300◊◊, 400◊◊, 180◊)
Beasley Run (WWH, PCR, AWS, IWS)	0.25	Dissolved oxygen (4.0‡, 4.2‡, 3.5‡‡) Fecal coliform (26000◊◊, 28000◊◊, 53000◊◊, 83000◊◊) *E. coli* (16000◊◊, 23000◊◊, 50000◊◊, 80000◊◊)
Paint Creek (SRW,EWH, PCR, AWS, IWS)	4.22	pH (9.01Δ) *E. coli* (170◊, 490◊◊)
Sugar Run (WWH, PCR, AWS, IWS)	0.07	Ammonia-N (1.00*) Fecal coliform (1320◊, 2400◊◊, 2300◊◊, 3500◊◊) *E. coli* (980◊◊, 2000◊◊, 1900◊◊, 1700◊◊, 620◊◊)
Rush Run (WWH, PCR, AWS, IWS)	0.10	Dissolved oxygen (2.0‡‡) Heptachlor Epoxide (0.0029#)

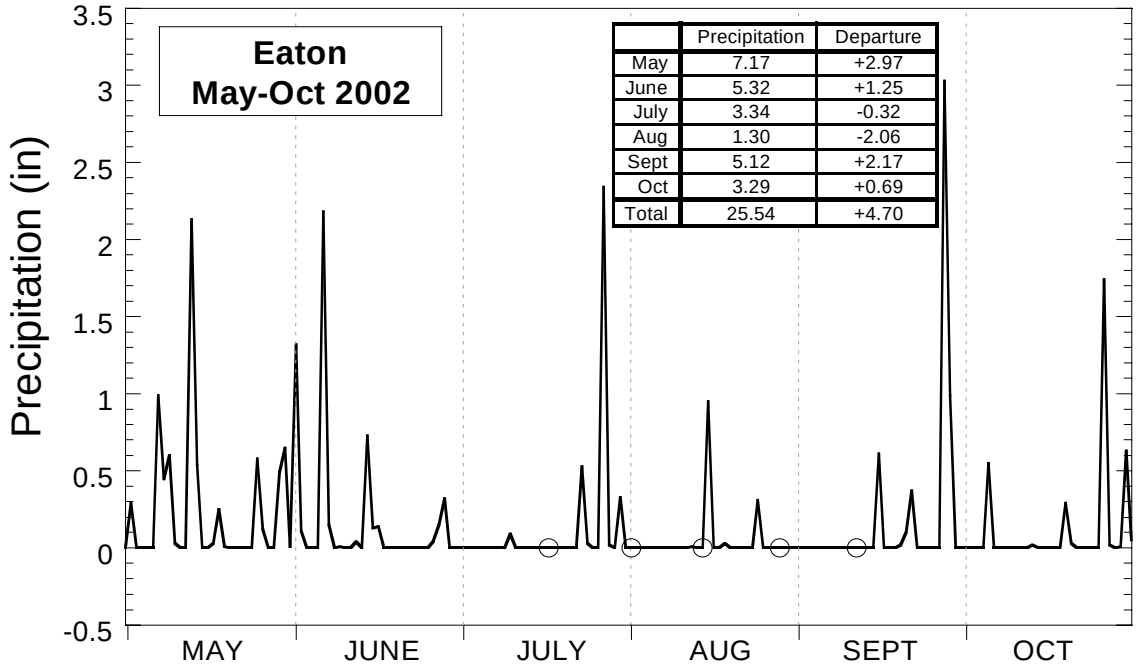
a Use designations:

Aquatic Life Habitat	Water Supply	Recreation
WWH - warmwater habitat	IWS - industrial water supply	PCR - primary contact
EWH - exceptional warmwater habitat	AWS - agricultural water supply	
Undesignated		

└[WWH criteria apply to 'undesignated' surface waters.]

b Bacteriological data (fecal coliform, *E. coli*) are shown to gauge the potential for impacts to receiving waters and do not represent actual violations of criteria. Actual violations of the average primary contact recreation (PCR) criteria are based on a geometric mean of not less than five samples within a thirty-day period whereas PCR maximum criteria represent the values which are not to be exceeded in more than ten percent of the samples in a thirty-day period.

* exceedence of numerical criteria for prevention of chronic toxicity (CAC).
** exceedence of numerical criteria for prevention of acute toxicity (AAC).
Δ exceedence of the pH criteria (6.5-9.0).
exceedence of numerical criteria for the protection of human health (non-drinking).
‡ value is below the EWH minimum 24-hour average D.O criterion (6.0 mg/l) or value is below the WWH minimum 24-hour average D.O criterion (5.0 mg/l) as applicable.
‡‡ value is below the EWH minimum at any time D.O. criterion (5.0 mg/l) or value is below the WWH minimum at any time D.O. criterion (4.0 mg/l) as applicable.
◊ value is above the average PCR criteria (fecal coliform 1000/100ml; *E. coli* 126/100ml)
◊◊ value is above the maximum PCR criteria (fecal coliform 2000/100ml; *E. coli* 298/100ml)
P The reported result is estimated because the sample was not analyzed within the required holding time.



	Precipitation	Departure
May	7.17	+2.97
June	5.32	+1.25
July	3.34	-0.32
Aug	1.30	-2.06
Sept	5.12	+2.17
Oct	3.29	+0.69
Total	25.54	+4.70

Figure 5. Daily precipitation recorded for the City of Eaton from May through October, 2002 (data per Miami Conservancy District). Open circles represent water chemistry sampling days in the Sevenmile Creek basin.

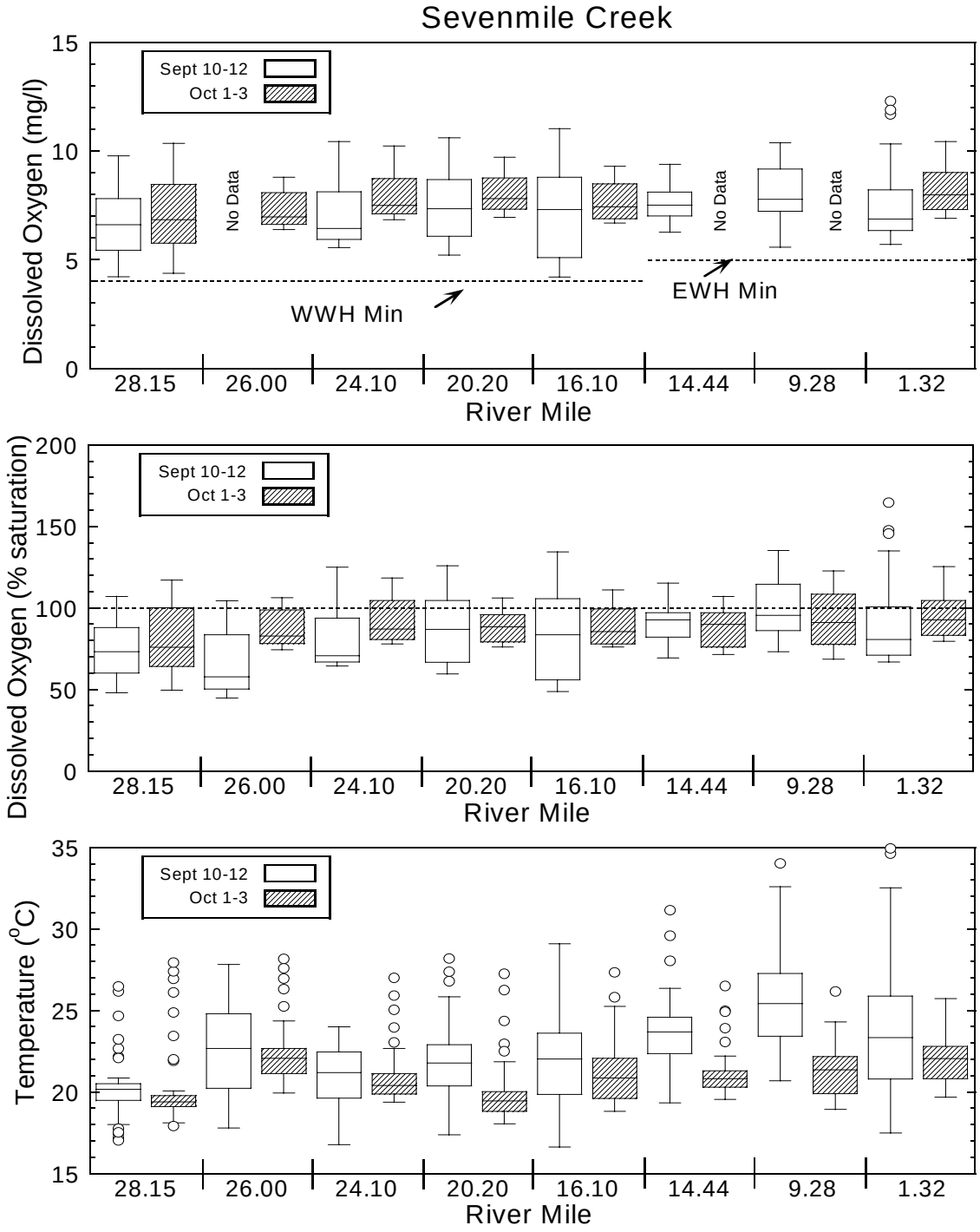


Figure 6. Distributions of dissolved oxygen concentration (top figure), dissolved oxygen percent saturation (middle figure), and temperature (bottom figure) recorded hourly with Datasonde™ continuous monitors from September 10-12 and from October 1-3 in Sevenmile Creek, 2002.

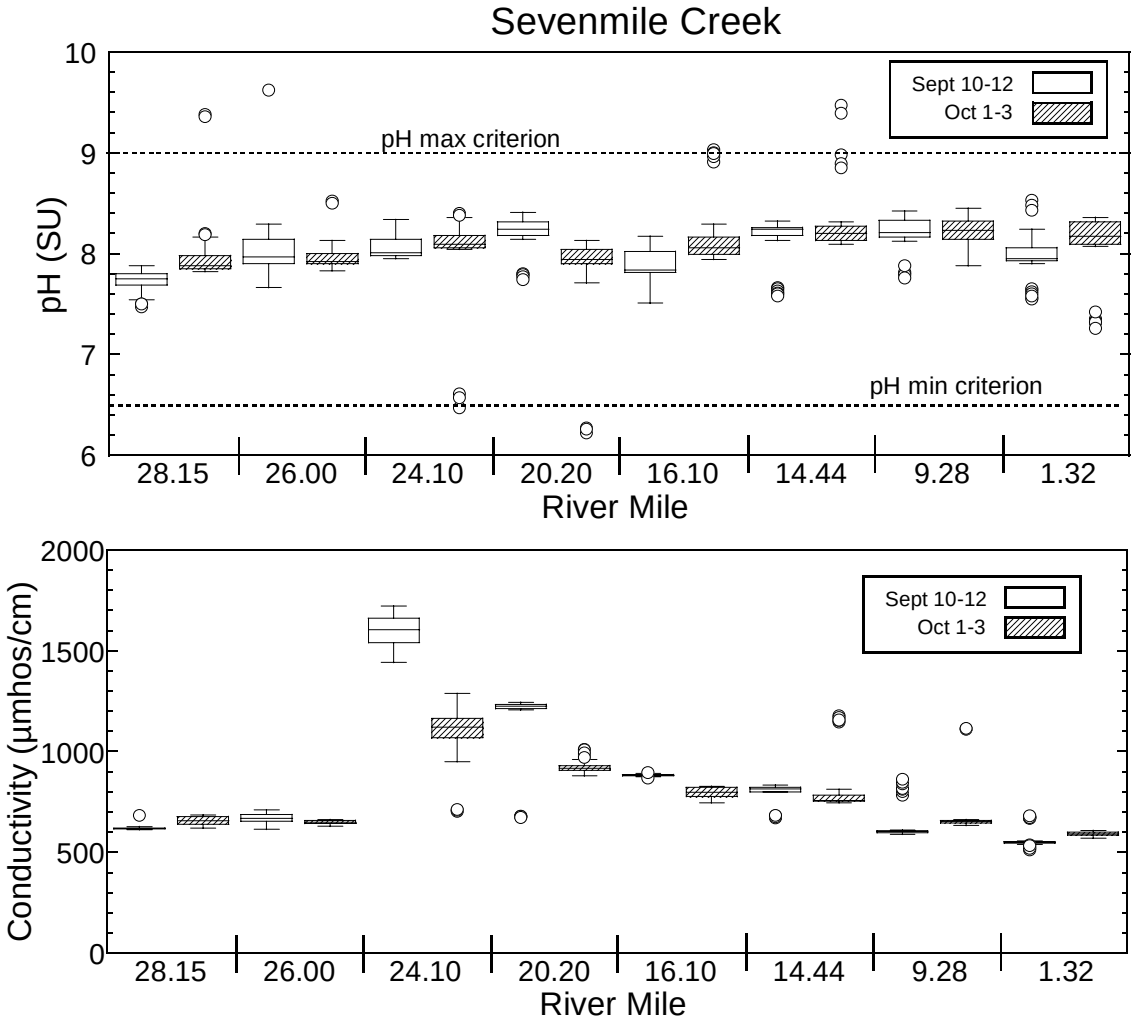


Figure 7. Distributions of pH (top figure) and conductivity (bottom figure) recorded hourly with Datasonde™ continuous monitors from September 10-12, and from October 1-3 in Sevenmile Creek, 2002.

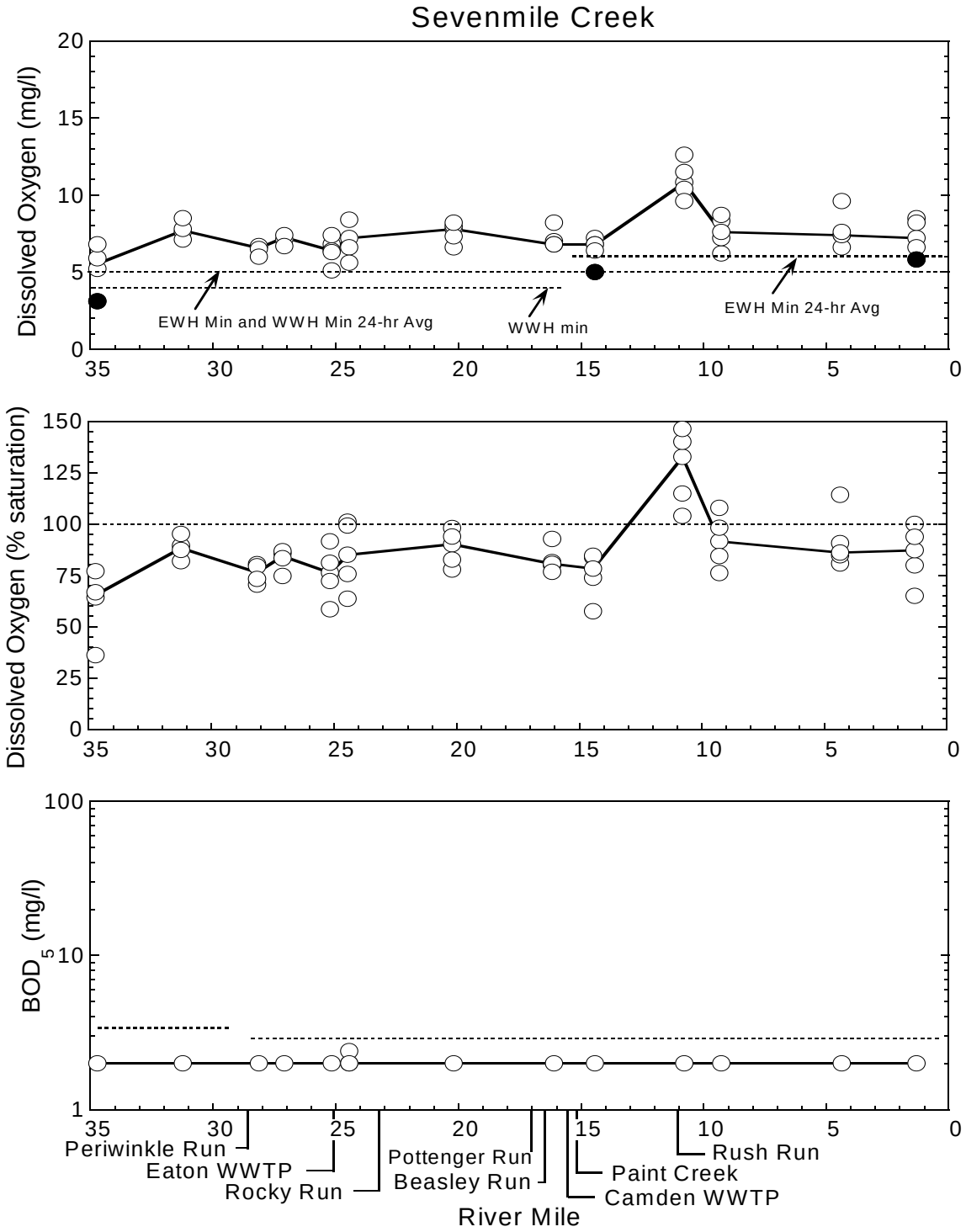


Figure 8. Longitudinal scatter plots of water chemistry results (daytime grabs) in Sevenmile Creek during the 2002 survey. Top to bottom: dissolved oxygen concentrations, dissolved oxygen percent saturations, and biochemical oxygen demand (BOD_5). The solid line depicts the median value at each river mile sampled. WQS criteria are shown in the dissolved oxygen plot. Values below criteria are shown as solid circles. The dotted lines in the BOD_5 plot represent the 90th percentile concentration from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

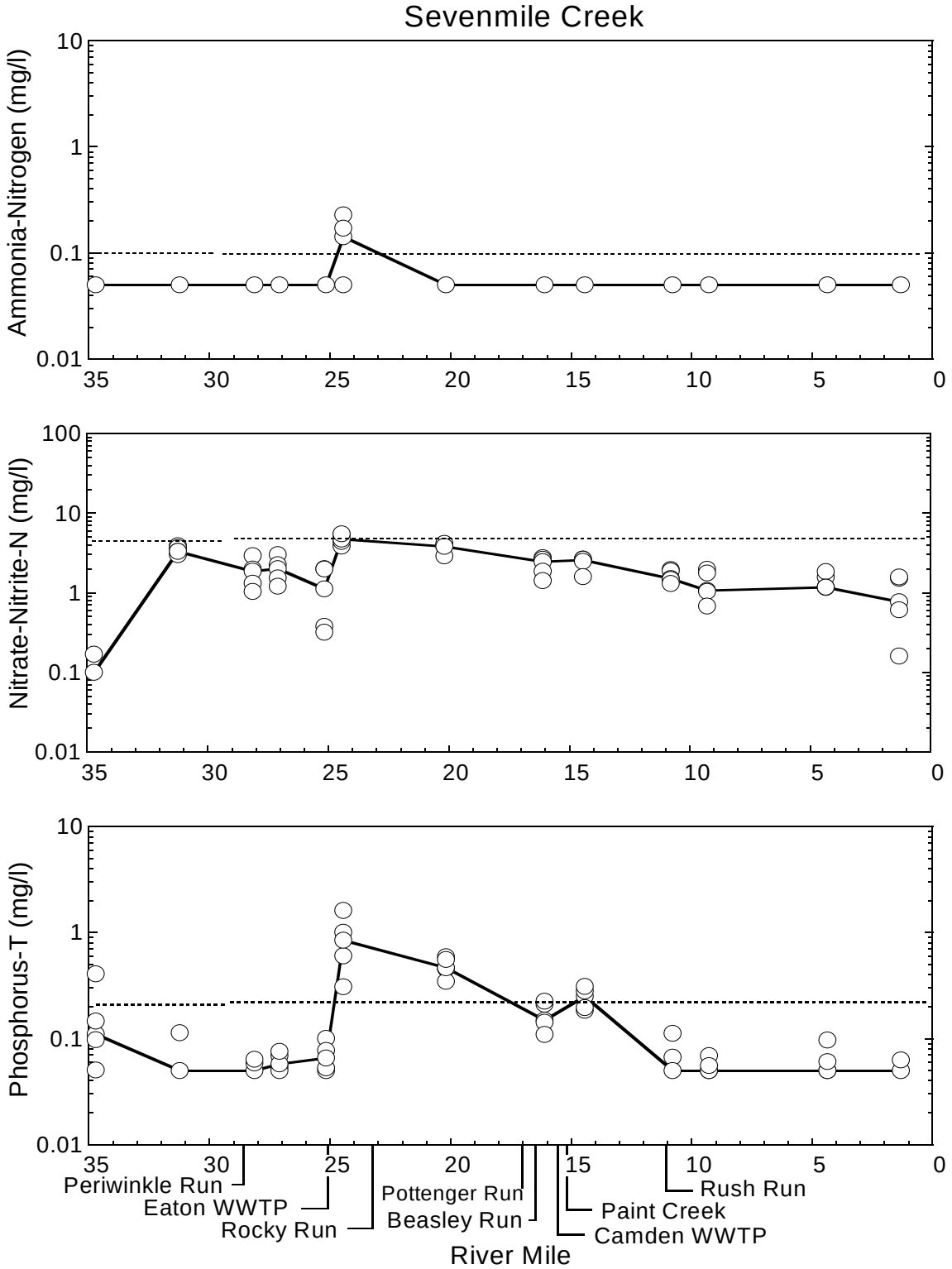


Figure 9. Longitudinal scatter plots of water chemistry results (daytime grabs) in Sevenmile Creek during the 2002 survey. Top to bottom: ammonia-nitrogen, nitrate-nitrite-nitrogen, and total phosphorus (MDL is 0.05 mg/l for NH_3-N and TP and 0.1 mg/l for NO_3-NO_2-N). The solid line depicts the median value at each river mile sampled. The dotted lines represent the 90th percentile concentration from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

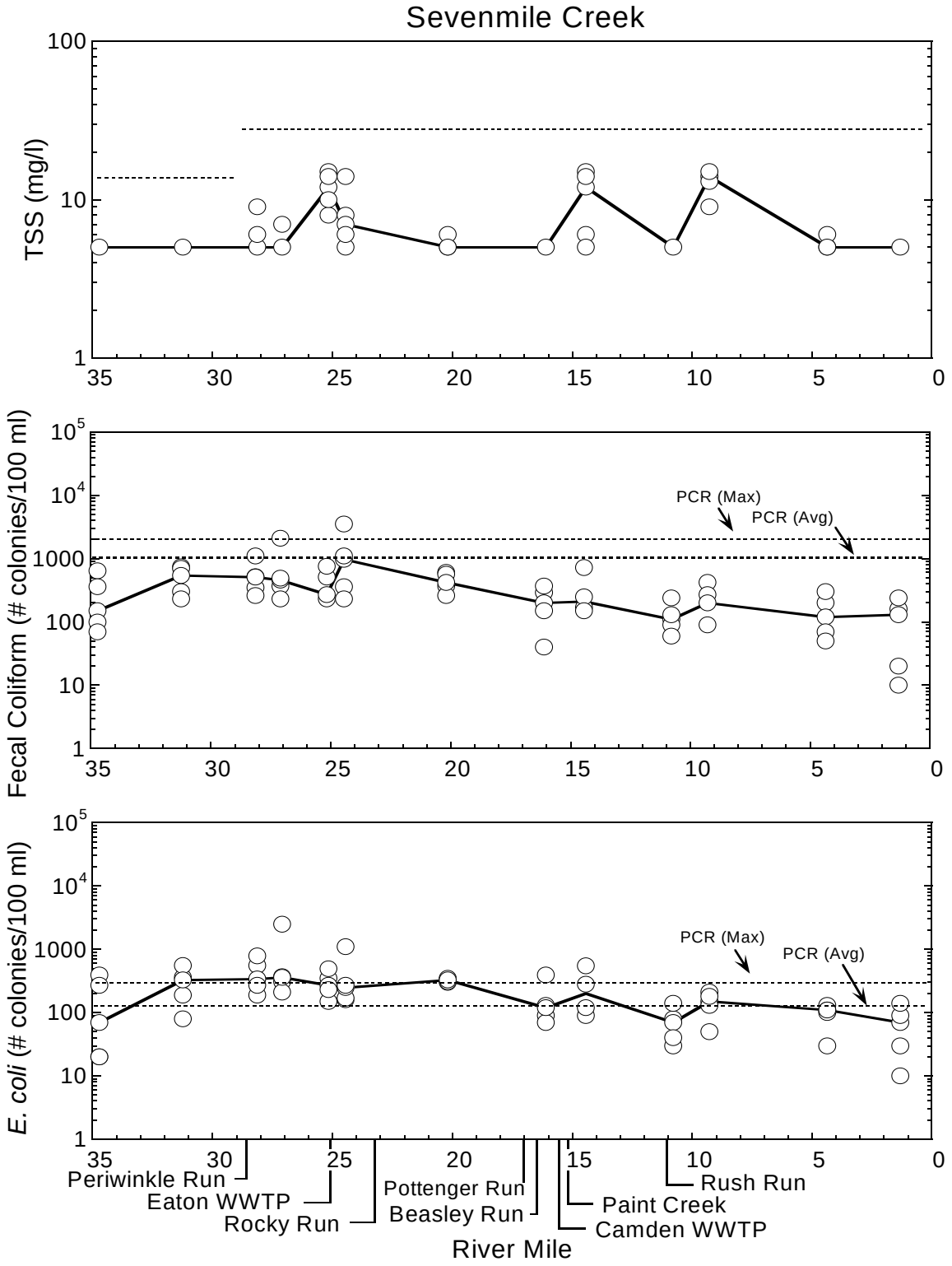


Figure 10. Longitudinal scatter plots of water chemistry results (daytime grabs) in Sevenmile Creek during the 2002 survey. Top to bottom: total suspended solids (TSS), fecal coliform, and *E. coli*. The solid line depicts the median value at each river mile sampled. The dotted line in the TSS plot represents the 75th percentile concentration from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

Table 7. Frequency of organic compounds detected in water samples collected in the Sevenmile Creek study area during 2002 (number of WQS criteria exceedences/number of detections).

Parameter	Sevenmile Creek	Periwinkle Run	Beasley Run	Sugar Run	Rush Run	Total
Pesticides						
Aldrin	2/2	-/-	-/-	-/-	-/-	2/2
Acetochlor*	*/1	-/-	-/-	-/-	-/-	*/1
Atrazine*	*/9	*/1	-/-	-/-	*/2	*/12
alpha-Hexachlorocyclohexane	-/3	-/-	-/-	-/-	-/1	-/4
delta-Hexachlorocyclohexane*	*/4	*/1	*/1	-/-	*/1	*/7
gamma-Hexachlorocyclohexane (Lindane)	-/6	-/-	-/-	-/2	-/1	-/9
Dieldrin	15/15	1/1	-/-	-/-	-/-	16/16
Endosulfan I	-/1	-/-	-/-	-/-	-/-	-/1
Endosulfan II	-/-	-/-	-/-	-/1	-/-	-/1
Heptachlor epoxide	5/5	1/1	-/-	-/-	1/1	7/7
Semivolatile compounds (SVOCs)						
bis(2-Ethyhexyl)phthalate	1/9	-/1	-/1	-/1	-/-	1/12
Volatile compounds (VOCs)						
Chloroform	-/4	-/-	-/1	-/-	-/-	-/5
TOTAL	23/59	2/5	-/3	-/6	1/6	26/79

* No applicable water quality criteria available for parameter.

Sevenmile Creek Tributaries
(Periwinkle Run, Rocky Run, Pottenger Run, Beasley Run, Paint Creek, Sugar Run, Rush Run)
Daytime grab water chemistry samples were collected from Periwinkle Run (RM 0.01), Rocky Run (RM 0.35), Pottenger Run (RM 0.85), Beasley Run (RM 0.25), Paint Creek (RM 4.22), and Rush Run (RM 0.10) during the 2002 survey (Figures 11-13, Table 6). Periwinkle Run, Rocky Run, Pottenger Run, Beasley Run, Paint Creek, and Rush Run enter Sevenmile Creek at RMs 28.52, 23.23, 17.03, 16.44, 15.18, and 11.10, respectively. Sugar Run, a tributary entering Paint Creek at RM 4.92, was sampled at RM 0.07 downstream of the Lake Lakengren WWTP discharge at RM 0.49.

Median D.O. percent saturations in the tributaries ranged from 45% in Beasley Run to 172% in Paint Creek. Concentrations fell below WWH water quality criteria in Rocky Run, Beasley Run, and Rush Run. Diminishing flows throughout the summer contributed to the lower dissolved oxygen levels observed in these tributaries. In contrast, supersaturated levels were consistently measured at the Paint Creek site downstream of Sugar Run with D.O. saturations ranging from 105% to 217%. Exacerbated by lower flows, excessive algal growth was observed at this site throughout the summer. Though only measured in daytime grab samples, these results suggest that D.O. concentrations at the Paint Creek site were likely falling to critical levels at night.

The majority (90 %) of BOD_5 concentrations measured in the seven tributaries were less than the ECBP 90th percentile reference value of 3.4 mg/l. The highest concentration of the survey (9.3 mg/l) occurred in Pottenger Run on August 14 when flows at the site were very low.

Ammonia-N exceeded the WQS criterion downstream of the Lakengren WWTP in Sugar Run at RM 0.07 on August 28 (1.0 mg/l). All other concentrations recorded in the tributaries were less than the 90th percentile reference site concentration of 0.1 mg/l. With the exception of Sugar Run, nitrate-nitrite-N concentrations generally remained below the 90th percentile reference concentration (4.60 mg/l) in the tributaries with medians ranging from 0.1 mg/l in Rush Run to 4.17 mg/l in Pottenger Run.

Exceptionally elevated concentrations of nitrate-nitrite-N (median 8.91 mg/l) and total phosphorus (median 3.61 mg/l) were recorded in Sugar Run at RM 0.07, downstream of the Lakengren WWTP. Apparently only partially assimilated, phosphorus remained elevated into Paint Creek (approximately 1.3 miles downstream of the Lakengren WWTP) at RM 4.22 (median 0.38 mg/l). As noted above, this site experienced excessive algal production and supersaturated D.O. levels throughout the summer. While primarily impacted by the Lakengren WWTP discharge, other potential contributors to the nutrient enrichment observed in Paint Creek at RM 4.22 include general agricultural runoff and Lake Lakengren, a 230 acre impoundment on Paint Creek surrounded by a private residential-resort development of over 1000 homes located approximately 1.2 miles upstream of the Paint Creek sampling site. Excluding Sugar Run and Paint Creek, phosphorus levels were generally low with medians ranging from 0.05 mg/l in Rush Run to 0.16 mg/l in Beasley Run. The Sugar Run site at RM 0.07 also experienced elevated levels of sodium, potassium, chloride, TKN, COD, total organic carbon (TOC), total dissolved solids, and conductivity.

Consistently elevated above the 75th percentile reference background concentration of 14 mg/l, the highest TSS levels of the survey were recorded in Sugar Run (respective median and maximum of

17 mg/l and 38 mg/l). With the exception of one elevated value recorded in Pottenger Run, TSS concentrations remained low in the other tributaries.

Beasley Run experienced grossly elevated fecal coliform and *E. coli* levels throughout the 2002 survey (respective median fecal coliform and *E. coli* counts of 40500 colonies/100 ml and 36500 colonies/100 ml). Continually diminishing flows may partially account for the high values. Bacteria concentrations in Sugar Run were also frequently elevated above applicable Primary Contact Recreation criteria downstream of the Lakengren WWTP (respective median fecal coliform and *E. coli* concentrations of 2300 colonies/100 ml and 1700 colonies/100 ml)

In a followup investigation during the summer of 2004, sixteen (16) sites were sampled in the Sevenmile Creek watershed including five sites in Beasley Run (RMs 2.04, 1.85, 0.8, 0.6, 0.25), and five sites in the Sugar Run watershed (Sugar Run RMs 1.27, 0.64, 0.62, 0.07, and at RM 0.25 in a tributary entering Sugar Run at RM 0.76). Another six sites were sampled in the Paint Creek drainage (Paint Creek RMs 5.3, 4.85, 4.22, 3.44, 1.3, and in Opossum Run at RM 0.01). Results from 2004 indicate the Primary Contact Recreation use was attained (Table 8).

Water samples analyzed for organic compounds in Periwinkle Run, Beasley Run, Sugar Run, and Rush Run revealed concentrations of heptachlor epoxide above the WQS criterion in Periwinkle Run and Rush Run and dieldrin concentrations above the criterion in Periwinkle Run (Tables 6 and 7).

Table 8. Results of Ohio EPA bacteriological sampling collected from July 19 to August 9 in the Sevenmile Creek study area during 2004. At least one of the two bacteriological WQS criteria (fecal coliform or *E. coli*) must be met. (Values above criteria are highlighted in **red**.)

	Entire Watershed (16 sites)	Beasley Run (5 sites)	Sugar Run* (5 sites)	Paint Creek** (6 sites)
Recreational Use Attained?	YES	YES	YES	YES
Primary Contact Recreation (Fecal coliform): Geometric mean fecal coliform content based on not less than five samples within a thirty-day period shall not exceed 1000 per 100 ml, *and* fecal coliform content shall not exceed 2000 per ml in more than ten percent of the samples taken during any thirty-day period.				
Geometric mean (#colonies/100ml)	132	206	184	66
% > max	1.5%	5%	0%	0%
n =	67	20	23	24
Primary Contact Recreation (*E. coli*): Geometric mean *E. coli* content based on not less than five samples within a thirty-day period shall not exceed 126 per 100 ml, *and E. coli* content shall not exceed 298 per 100 ml in more than ten percent of the samples taken during any thirty-day period.				
Geometric mean (#colonies/100ml)	78	112	82	55
% > max	**18%**	**25%**	**22%**	8.3%
n =	67	20	23	24

* includes the tributary to Sugar Run entering at rivermile 0.76
** includes Opossum Run

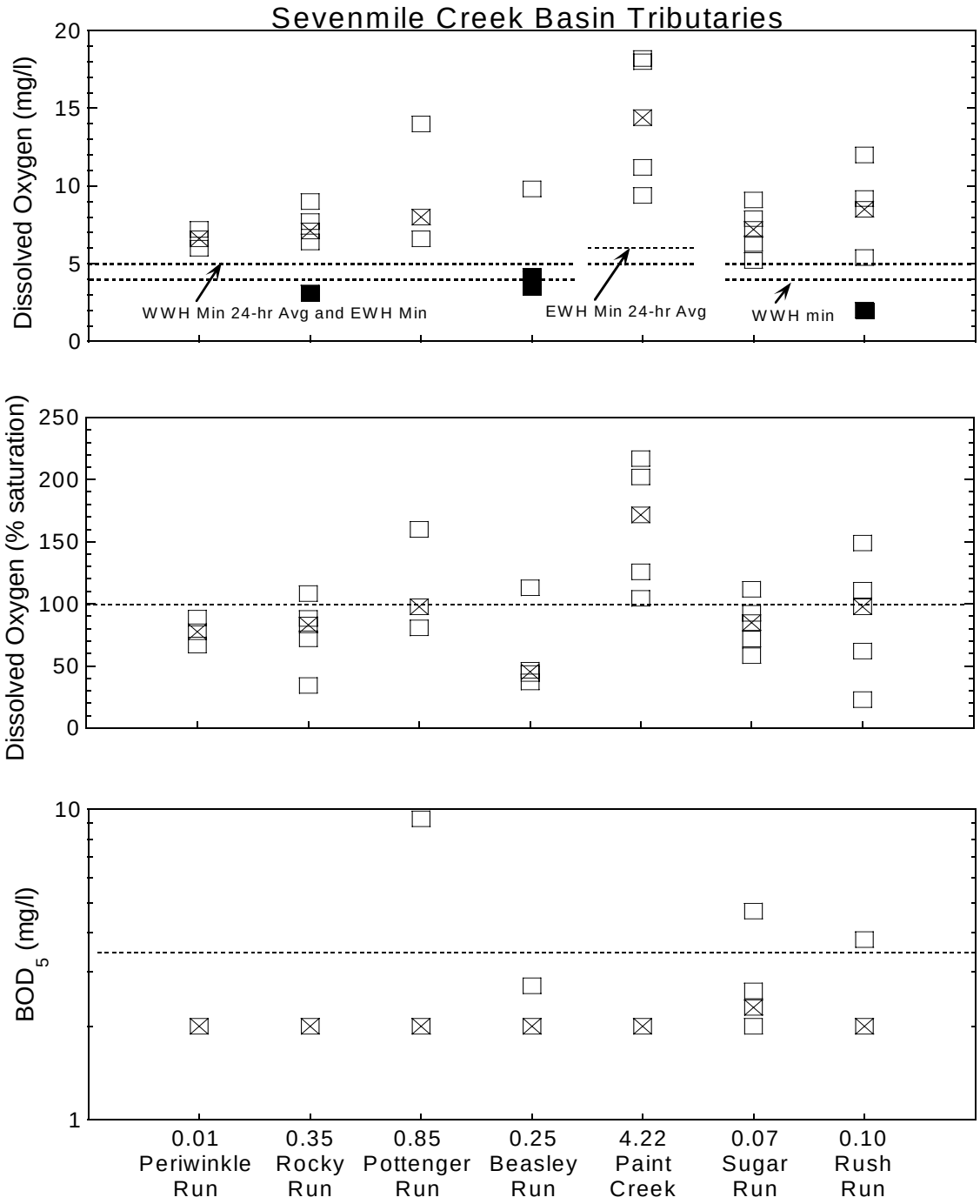


Figure 11. Scatter plots of water chemistry results (daytime grabs) in tributaries in the Sevenmile Creek basin during the 2002 survey. Top to bottom: dissolved oxygen concentrations, dissolved oxygen percent saturations, and biochemical oxygen demand (BOD_5). The median at each site is depicted by an 'X'. WQS criteria are shown in the dissolved oxygen plot. Values below criteria are shown as solid squares. The dotted line in the BOD_5 plot represents the 90th percentile concentration from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

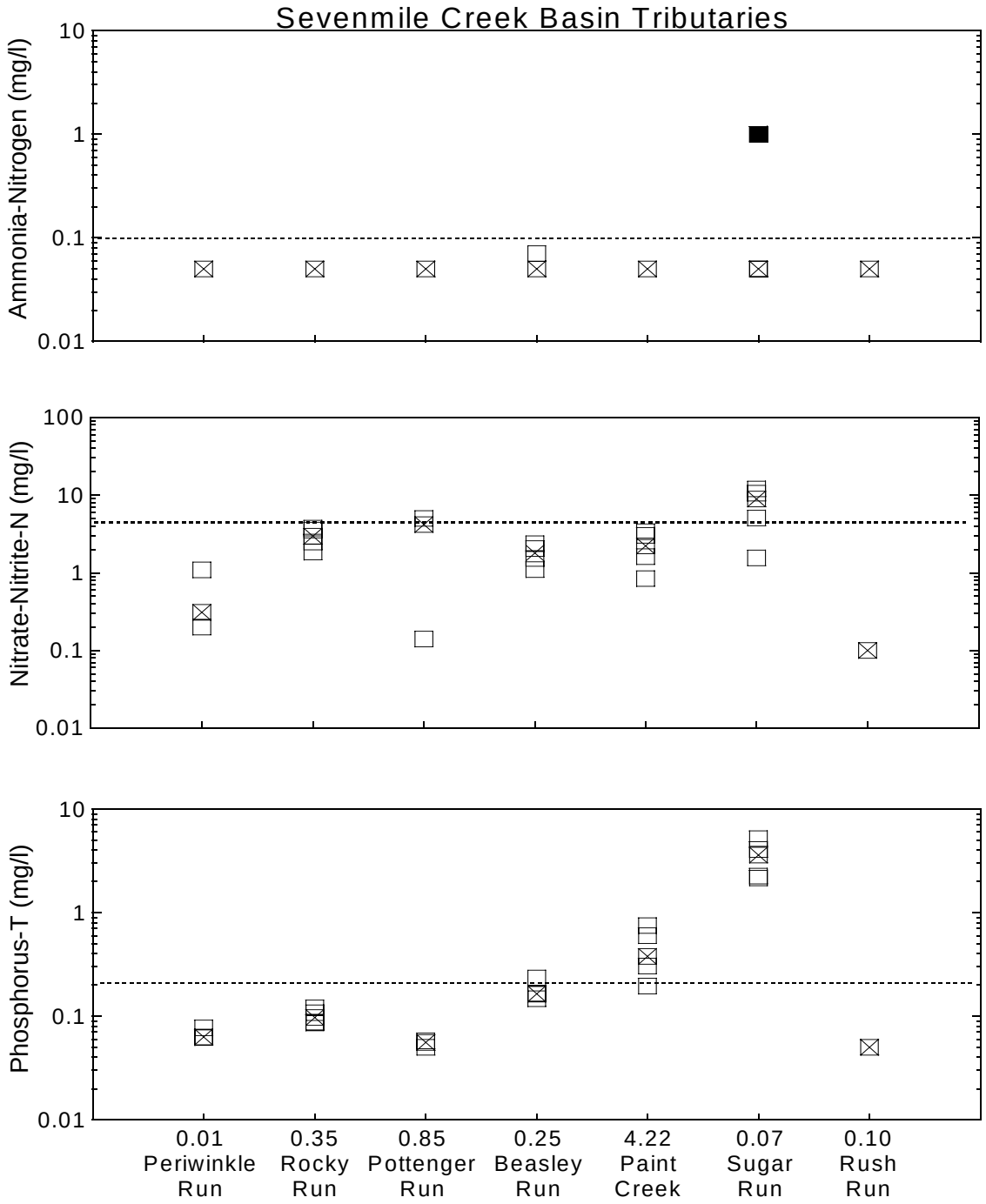


Figure 12. Scatter plots of water chemistry results (daytime grabs) in tributaries in the Sevenmile Creek basin during the 2002 survey. Top to bottom: ammonia-nitrogen, nitrate-nitrite-nitrogen, and total phosphorus (MDL is 0.05 mg/l for NH_3-N and TP and 0.1 mg/l for NO_3-NO_2-N). The median at each site is depicted by an 'X'. Values above the WQS criterion are shown as solid squares in the ammonia-N plot. The dotted lines represent the 90th percentile concentrations from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

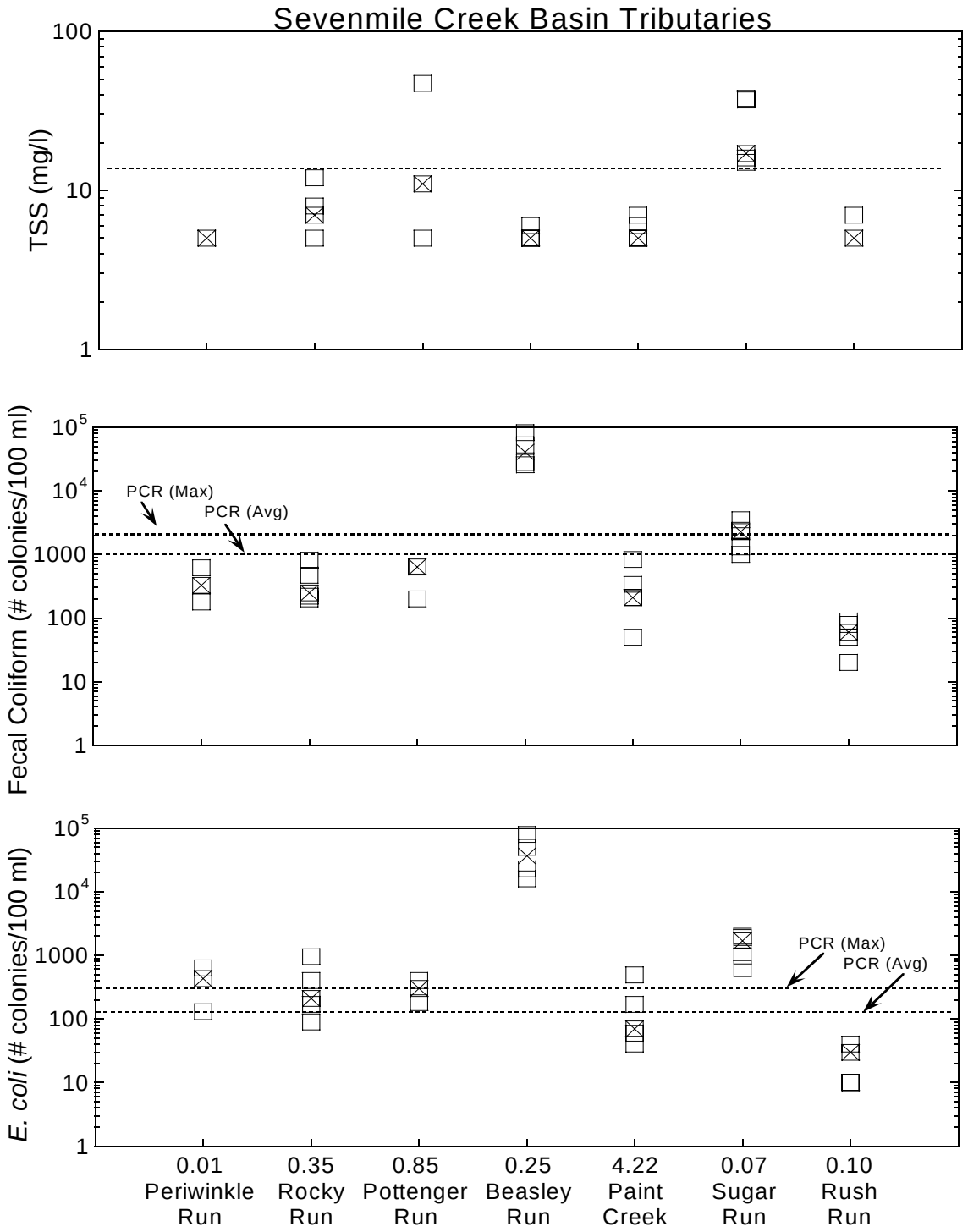


Figure 13. Scatter plots of water chemistry results (daytime grabs) in tributaries in the Sevenmile Creek basin during the 2002 survey. Top to bottom: total suspended solids (TSS), fecal coliform, and *E. coli*. The median at each site is depicted by an 'X'. The dotted line in the TSS plot represents the 75th percentile concentration from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

Chemical Sediment Quality

Fine grain sediment samples were collected in the upper 4 inches of bottom material at all nine Sevenmile Creek basin locations using decontaminated stainless steel scoops. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2001). Sediment grab samples were homogenized in stainless steel buckets, transferred into glass jars with teflon lined lids, placed on ice (to maintain 4°C) in a cooler, and shipped to the Ohio EPA DES laboratory. Sediment data is reported on a dry weight basis. Sediment evaluations were conducted using guidelines established in MacDonald *et al.* (2000), Ohio EPA Sediment Reference Values (SRV) (2003), and Ontario Sediment Quality Guidelines (Persuad *et al.* 1993).

Concensus-Based sediment quality guidelines for freshwater ecosystems were developed by MacDonald, Ingersoll and Berger (2000) to be used as an effective tool for assessing sediment quality. Sediment Quality Goals (SQGs) were developed using 12 previously published freshwater ecosystem studies derived from a variety of approaches. A concensus-based SQG developed 28 chemicals of concern matching sediment chemistry and toxicity data to provide a unifying synthesis of existing SQGs. The concensus-based SQGs are predictive of toxicity in sediments containing mixtures of contaminants, but do not consider the potential for bioaccumulation. Each of the 28 chemicals is evaluated in the following categories:

Threshold effect concentration (TEC) - Below which adverse effects are unlikely to occur.
Probable Effect Concentration (PEC) - Above which adverse effects usually or always occur.
Between the TEC and PEC - Between which adverse effects frequently occur.

Ohio Specific Sediment Reference Values (SRV) were developed by Ohio EPA to identify representative background sediment metal concentrations for lotic (flowing) water bodies. Sediment samples were taken from reference sites throughout the state that have been used historically to develop the biological criteria as part of the State of Ohio's water quality standards. These reference sites were selected as being representative of the least impacted conditions in the watershed. SRVs are site specific background metal concentrations based upon ecoregions and identify whether a site has been contaminated. SRVs are not Ohio EPA standards or criteria.

A limited suite of nutrient parameters were evaluated in this report. Ontario Severe Effect Level (SEL) guidelines (Persuad *et al.* 1993) were used to evaluate Total Organic Carbon and Total Phosphorus. Ohio and MacDonald SQGs do not have nutrient sediment parameter guidelines. No sediment guidelines were used to evaluate sediment ammonia.

Whenever possible, composite samples from a cross-section of the stream channel were collected with silts and clays comprising at least 30% of the sample. Sediments composed of sand and larger sized particles (>60 microns) are often stable inorganic silicate minerals and not usually associated with contaminants. Given that the finer grained silts and clays (<60 microns) are much more chemically, physically and biologically interactive, collection efforts were biased toward collecting these types of sediments. The % FGM category in the table is percent fine grained material that is defined as a particle size < 60 microns with a settling time > 30 seconds. In this survey 56% (5/9) of the sediment sampling sites failed to meet the greater than 30% FGM criteria.

Sediment samples were taken from nine locations in the Sevenmile Creek study area. Eight sites were sampled on the main-stem (Tables 9 and 10). The most upstream site was at Waterworks Park (RM 27.0) and the most downstream site was at Taylor School Road (RM 1.32). One sediment sample was taken from Paint Creek (RM 4.2) at Camden-Sugar Valley Road.

Sediment Metals and Nutrients (Table 9**)**
Sediment metals within the watershed were generally at levels below the Ohio SRV values. The only problem metals were cadmium and zinc.

There were three locations within the study area that had noticeable sediment problems: Sevenmile Creek RM 27.1 at Waterworks Park, Sevenmile Creek RM 24.45 downstream from the Eaton WWTP, and Sevenmile Creek RM 20.2 at Seven Mile Road.

Sevenmile Creek at Waterworks Park (RM 27.0) had cadmium (3.46 mg/kg) and zinc (180 mg/kg) at levels over the Ohio SRV sediment guidelines. Sediment organic analysis detected 5 polynuclear aromatic hydrocarbons (PAHs) totaling 8.90 mg/kg. All five PAHs individually and combined were between the MacDonald TEC and PEC, which indicate adverse benthic effects frequently occur. Acetone and 3&4 methyl phenol were also found in sediments. Acetone (0.290 mg/kg) is most likely laboratory contamination. Cresol (3&4 methyl phenol) (3.82 mg/kg) is found in association with disinfectants and with wooden pole preservation. There is no standard associated with this compound. Sediment ammonia was 140 mg/kg, the highest value on the survey. This value is well above the average for the 15 reference sites taken in 2002 (21.07 mg/kg) in Southwestern Ohio. No sediment guidelines are available for ammonia.

Sevenmile Creek RM 24.45 downstream of the Eaton WWTP, had sediment cadmium (18.2 mg/kg) over the MacDonald PEC (adverse benthic effects usually always occur) and over the Ohio SRV sediment guidelines. Sediment organic analysis detected 7 polynuclear aromatic hydrocarbons (PAHs) totaling 7.37 mg/kg. All seven PAHs individually and combined were between the MacDonald TEC and PEC, indicating adverse benthic effects frequently occur. Five of the seven PAHs were the same group found upstream at RM 27.0.

Sevenmile Creek RM 20.2 at Seven Mile Road had sediment cadmium (9.17 mg/kg) over the MacDonald PEC and Ohio SRV. This remote location appears to be contaminated by sediments carried from the upstream site. Sediment organic analysis detected 3&4 methylphenol at 1.89 mg/kg.

Legacy cadmium wastewater discharges to the sanitary sewer from the Parker-Hanifin plating operations were believed to have concentrated in the sludge from the Eaton WWTP. Sludge from the Eaton WWTP has been historically landfilled due to high cadmium content. The Eaton WWTP bypasses from the primary clarifier to the secondary clarifier during rain events. Bypasses discharged into Sevenmile Creek from the Eaton WWTP outfall are believed to be responsible for the high cadmium sediment levels at RM 24.45 and 20.2. Sediment cadmium levels of 18.2 mg/kg at RMs 24.45 and 9.17 mg/kg at RM 20.2, are elevated enough that adverse effects to the benthic community usually always occur.

Stormwater runoff draining into Sevenmile Creek at RM 27.0 is believed to have placed cadmium

and zinc into the sediments at Waterworks Park in Eaton. The cadmium levels are above the Ohio SRV sediment guidelines and between the MacDonald TEC and PEC, indicating that adverse effects in benthic organisms frequently occur. Zinc levels at Waterworks park are above the Ohio SRV sediment guidelines and between the MacDonald TEC and PEC. The Parker-Hanifin plating operations was the only manufacturing operation in the stormwater drainage area to use cadmium or zinc, and it is believed that historical operational practices at the plant may be responsible for the elevated concentrations. Parker Hannifin has made significant strides with attaining compliance with their pretreatment permit and are no longer believed to release elevated metals into the environment.

Sevenmile Creek is an agricultural watershed and nutrient loading from agricultural operations has not adversely impacted sediments. The sediment phosphorus levels in Sevenmile Creek averaged 745 mg/kg for eight sites. The highest sediment phosphorus was found at RM 27.0, Waterworks Park in Eaton (1240 mg/kg). This level of sediment phosphorus is well below the Ontario severe effect level of 2000 mg/kg. In comparison, sediment phosphorus in the Stillwater River, another agricultural watershed, averaged 697 mg/kg for 12 sites. The Little Miami River, a WWTP effluent dominated watershed, averaged 2056.5 mg/kg phosphorus for 15 sites.

Sediment Organics (Table 10)
Organic compounds detected in sediment samples are divided into two groups. One of these groups of compounds has quantifiable values (compounds detected are compared to a known standard at five different concentrations) and the second group are compounds whose peaks match the computer's spectral database, but are not compared to a known standard. The latter group of reported compounds is called tentatively identified compounds (TIC). Tentatively identified compound information is not as reliable as quantifiable compound information and is only used for screening in this report. The computer is approximately 80% accurate on TIC identification and concentrations can be off as much as 100%.

Seven different polynuclear aromatic hydrocarbons (PAHs) were found at two sites in the survey. All were part of the 16 priority pollutants PAHs identified by USEPA. All but benzo(b)fluoranthene were evaluated by the MacDonald Sediment Quality Guidelines.

PAHs are classified as " pyrogenic" or "petrogenic". Pyrogenic PAH compounds are generated from combustion or pyrolysis of organic matter (wood, coal, petroleum or wastes). Petrogenic PAHs are generated from organic matter subjected to temperature and pressure over geologic time (Van Metre and Mahler 2003).

The fingerprint of PAH compounds found in the Sevenmile Creek sediments would be classified as pyrogenic. Phenanthrene can be found in both pyrogenic and petrogenic samples. The major suspected source of PAH compounds would be runoff from asphalt roads and driveways with coal tar sealants (Mahler,et al. 2003). Other possible sources of PAHs are from urban runoff/fallout from diverse organic mixtures of soot, atmospheric dust, internal combustion exhaust, and storm water containing residual lubricating oils (Stout 2001).

Used motor oil is a mixture of pyrogenic and petrogenic PAHs. The fingerprint of "fresh" used motor oil has a wide range of PAHs, from the lighter naphthalene to heavier benz(b)fluoranthene

in addition to alkyl PAHs. As the motor oil ages it will tend to concentrate the less degradeable heavier pyrogenic PAH compounds.

Twenty-five tentatively identified compounds (TIC) were present in the semi volatile analysis and found in all eight mainstream and the one tributary sites. Most of the 25 TICs fall into four classes of chemicals: alkane hydrocarbons ($C_{16}H_{34}$) to ($C_{44}H_{90}$), aliphatic aldehydes, fatty acids, and sterols, with some outliers. Most are believed to be derived by the breakdown of plant material. Ubiquitous to most sediment sites was octameric sulfur (S_8), a product of the aquatic redox cycle of sulfur (Anders and Remberger 1998).

Table 9. Concentrations (mg/kg) of metals in sediment samples collected in Sevenmile Creek study area during 2002. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald *et al.* (2000) Sediment Quality Guidelines (SQG), and Persuad *et al.* (1993).

	Sediment Concentration (mg/kg dry weight)						
Sevenmile Creek	**Al-T [O]**	**As-T [PO]**	**Ba-T [O]**	**Ca-T ***	**Cd-T [OM]**	**Cr-T [OM]**	**Cu-T [OM]**
#4) RM 27.0 Waterworks Park	25800	10.3	225	55400	3.46+	<43	26.2
#5) RM 25.1 Ust. Eaton WWTP	21700	8.32	185	54800	0.671	<33	16.3
#6) RM 24.45 Dst. Eaton WWTP	11200	5.47	77.6	46300	**18.2+♣**	27	11.4
#7) RM 20.2 Seven Mile Road	7960	4.58	67.7	47800	**9.17+♣**	23	6.3
#8) RM 16.1 SR 725	6060	3.43	52.8	60200	0.875	<14	8.1
#9) RM 14.4 Dst. Camden WWTP	12000	5.00	82.3	61800	0.603	15	12.1
#11) RM 9.28 Anthony Wayne	7840	4.00	52.0	74600	0.275	<15	<5.0
#13) RM 1.32 Taylor School Road	7540	5.04	68.4	58200	0.500	<15	5.5
Paint Creek							
#18) RM 4.2 Camden-Sugar Valley Rd.	14100	6.25	107	58500	0.213	<20	10.6

Table 9. Continued.

	Sediment Concentration (mg/kg dry weight)							
Sevenmile Creek	**Fe-T [O]**	**Hg-T [OM]**	**K-T [O]**	**Mg-T [O]**	**Mn-T [O]**	**Na-T ***	**Ni-T [O]**	**NH_3-N**
#4) RM 27.0 Waterworks Park	21500	<0.065	6010	17700	612	<7200	<58	140
#5) RM 25.18 Ust. Eaton WWTP	18400	<0.051	5110	17900	530	<5500	<44	74
#6) RM 24.45 Dst. Eaton WWTP	10400	0.037	2490	17400	234	<2490	<20	19
#7) RM 20.2 Seven Mile Road	8780	<0.022	2060	18300	214	<2700	<22	19
#8) RM 16 SR 725	7460	<0.032	1490	22200	173	<2340	<19	17
#9) RM 14.4 Dst. Camden WWTP	11100	<0.03	3170	23000	248	<2580	<21	39
#11) RM 9.28 Anthony Wayne	8930	<0.019	2690	21800	275	<2500	<20	12
#13) RM 1.32 Taylor School Road	8540	<0.020	2280	14400	220	<2520	<20	17
Paint Creek								
#18) RM 4.2 Camden-Sugar Valley Rd.	13100	<0.025	4650	21900	364	<3320	<27	40

Table 9. Continued.

	Sediment Concentration (mg/kg dry weight)							
Sevenmile Creek	**Pb-T** [O]	**Se-T** [O]	**Sr-T** [O]	**Zn-T**[OM]	**TOC** [P]	**pH** *	**P-T** [P]	**%FGM**
#4) RM 27.0 Waterworks Park	<58	<2.88	282	180+	6.9%	7.7	1240	45.6 %
#5) RM 25.18 Ust. Eaton WWTP	<44	<2.20	210	136	5.0 %	7.7	1090	37.4 %
#6) RM 24.45 Dst. Eaton WWTP	<20	1.19	107	65.7	4.5 %	7.6	711	25.2 % 25.9 %
#7) RM 20.2 Seven Mile Road	<22	<1.08	131	48.6	4.3 %	7.9	469	23.4 %
#8) RM 16.1 SR 725	<19	<0.94	96	28.6	3.7 %	7.9	549	14.7 %
#9) RM 14.4 Dst. Camden WWTP	<21	<1.03	135	42.8	4.4 %	7.9	538	37.6 %
#11) RM 9.28 Anthony Wayne	<20	<1.00	125	33.8	4.7 %	8.0	757	18.1 %
#13) RM 1.32 Taylor School Road	<20	<1.01	171	41.8	5.0 %	8.0	606	18.8 %
#18) **Paint Creek** RM 4.2 Camden-Sugar Valley Rd.	<27	<1.33	162	55.2	5.3 %	7.5	589	45.1 %

%FGM Percent Fine Grain Material in sediment sample(<60 micron or >30 seconds settling time)
NA Compound not analyzed.
* Not evaluated
[O] evaluated by Ohio EPA (2003)
[M] evaluated by MacDonald *et al.* (2000)
[P] evaluated by Persuad *et al.* (1993)

Ohio SRV Guidelines 2003
+ above background for this area in Ohio

MacDonald *et al.* (2000) Sediment Quality Guidelines (SQG)
Three toxicity ranges:
<TEC Threshold effect concentration (TEC) - Below which adverse effects are unlikely to occur.
TEC-PEC ✢ above which adverse effects frequently occur
>PEC ✤ **Probable effect concentration** (PEC) - above which adverse effects usually or always occur

Ontario Sediment Guidelines (Persuad *et al.* 1993)
▲ > severe effect level (disturbance in benthic community can be expected)

Table 10. Sediment concentrations of semi-volatile, volatile, pesticide, and PCB compounds (priority pollutant scan) detected in the Sevenmile Creek study area during 2002. Individual compounds were evaluated by the MacDonald *et al.* Sediment Quality Guidelines (2000).

	Analysis Performed	**Compound Detected**	**Result**
#4) Sevenmile Creek RM 27.0, Waterworks Park TOC = 6.9 % Fine grain material 45.6 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone Benzo(b)fluoranthene Chrysene Fluoranthene Phenanthrene Pyrene **Total PAH's** 3&4 Methylphenol	0.290 mg/kg* 1.23 mg/kg * 1.47 mg/kg ✣ 2.80 mg/kg ✣ 1.25 mg/kg ✣ 2.18 mg/kg ✣ **8.90** mg/kg ✣ 3.82 mg/kg * BDL BDL
#5) Sevenmile Creek RM 25.18, Ust. Eaton WWTP TOC = 5.0 % Fine grain material 37.4 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	3&4 Methylphenol	BDL 1.89 mg/kg* BDL BDL
#6) Sevenmile Creek RM 24.45, Dst. Eaton WWTP TOC = 4.5 % Fine grain material 25.2 % 25.9%	1) VOC 2) BNA 3)Pesticides 4) PCBs	 Benz(a)anthracene Benzo(a) pyrene Benzo(b)fluoranthene Chrysene Fluoranthene Phenanthrene Pyrene **Total PAH's**	BDL 0.66 mg/kg ✣ 0.63 mg/kg ✣ 0.63 mg/kg * 0.80 mg/kg ✣ 1.94 mg/kg ✣ 1.14 mg/kg ✣ 1.57 mg/kg ✣ **7.37** mg/kg ✣ BDL BDL
#7) Sevenmile Creek RM 20.2, Seven Mile Road TOC = 4.3 % Fine grain material 23.4 %	) VOC 2) BNA 3) Pesticides 4) PCBs	bis(2-ethylhexyl)phthalate	BDL 0.63 mg/kg * BDL BDL
#8) Sevenmile Creek RM 16., SR 725 TOC = 3.7 % Fine grain material 14.7 %	) VOC 2) BNA 3) Pesticides 4) PCBs		BDL BDL BDL BDL

Table 10. Continued.

	Analysis Performed	Compound Detected	Result
#9) Sevenmile Creek RM 14.4, Dst. Camden WWTP TOC = 4.4 % Fine grain material 37.6 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	 Methoxychlor	BDL BDL 9.5 µg/kg* BDL
#11) Sevenmile Creek RM 9.28, Anthony Wayne Parkway TOC = 4.7 % Fine grain material 18.1 %	1) VOC 2) BNA 3) Pesticides 4) PCBs		BDL BDL BDL BDL
#13) Sevenmile Creek RM 1.32, Taylor School Road TOC = 5.0 % Fine grain material 18.8 %	1) VOC 2) BNA 3) Pesticides 4) PCBs		BDL BDL BDL BDL
#18) Paint Creek RM 4.2, Camden-Sugar Valley Rd. TOC = 5.3 % Fine grain material 45.1 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone 3&4 Methylphenol	0.089 mg/kg * 2.07 mg/kg * BDL BDL

1) Base Neutral & Acid Extractibles (BNA) - U.S. EPA Method 8270
2) Pesticides - U.S. EPA Method 8082A
3) Polychlorinated biphenyls (PCBs) - U.S. EPA Method 8082A
BDL Below Detection Limit
TOC Total Organic Carbon
Percent Fine Grain Material in sediment sample(<60 micron or >30 seconds settling time)
* Not evaluated

MacDonald *et al.* (2000) Sediment Quality Guidelines (SQG)
Three toxicity ranges:
<TEC Threashold effect concentration (TEC) - Below which adverse effects are unlikely to occur.
TEC-PEC ✢ above which adverse effects frequently occur.
>PEC ✤ **Probable effect concentration** (PEC) - Above which adverse effects usually or always occur.

Chemical Water Quality Changes

Sevenmile Creek

Ohio EPA previously conducted an intensive biological and water quality study of Sevenmile Creek in 1991 (Ohio EPA 1992). Comparisons of 2002 and 1991 median water chemistry results for select parameters are presented in Figures 15-17. Water samples were collected from thirteen (13) sites in the mainstem in 2002 and eleven (11) sites in 1991 with five (5) sites common to both surveys (RMs 28.15, 27.10, 14.44, 9.28, and 1.32). Tributaries were not sampled during the 1991 survey.

While diminishing flows were visually observed in Sevenmile Creek during the 2002 survey, critically low flows were also documented during the 1991 survey (Figure 14). Stream flows measured from July through September 1991 by the USGS gage station in Sevenmile Creek at Camden (USGS 1992 and 2000) dropped below the 80% duration exceedence flow of 4.8 cfs in 83% of daily measurements and below the 7 Q_{10} flow of 1.5 cfs in 23% of measurements. The 80% duration exceedence flow represents the discharge which was equaled or exceeded 80% of the time over the period of record while the 7 Q_{10} represents the lowest mean discharge for seven consecutive days over ten years during the period of record.

Median daytime grab dissolved oxygen concentrations and saturations were similar at common sites with values generally increasing longitudinally during both surveys. Notably, levels increased between RM 14.44 and RM 9.28 in both years. While RM 10.8 was not sampled in 1991, upstream nutrient loading likely caused the excessive algal production and resulting supersaturated concentrations observed at this site in 2002 and may also have contributed to the higher values observed in 1991 at RM 9.28.

Concentrations of ammonia-N remained low during both surveys with medians of 0.05 mg/l recorded at most sites. Values above WQS criteria were measured in 1991 in two of three samples collected at RM 35.43 (US 40) downstream of the unsewered community of Gettysburg. This site was not sampled in 2002, however, all ammonia-N concentrations at RM 34.73 were less than the MDL of 0.05 mg/l in 2002.

Longitudinal patterns were similar for nitrate-nitrite-N and total phosphorus concentrations during both survey years. Nitrate-nitrate-N remained low with an overall median of 1.86 mg/l recorded for all 2002 mainstem concentrations compared to a median concentration of 1.58 mg/l for 1991 sites. The highest median nitrate-nitrite-N in both surveys occurred downstream of the Eaton WWTP. Phosphorus levels also spiked downstream of the Eaton WWTP in both years with medians remaining elevated well above the ECBP 90th percentile reference background concentration (0.22 mg/l) for several miles downstream before again falling in the lower reaches (RMs 10.8 -1.32).

Total suspended solids were generally less than the 75th percentile ECBP background concentration during both surveys with overall medians of 5 mg/l (2002) and 8 mg/l (1991) recorded for the five sites common to both surveys. Fecal coliform concentrations were relatively comparable between surveys. The majority of 2002 samples (97%) were less than the applicable maximum primary contact recreation (PCR) criterion of 2000 colonies/100ml and, with the exception of elevated values at RM 35.43 (downstream Gettysburg), all 1991 concentrations were less than the PCR maximum criterion.

While below the WQS criterion, cadmium levels were consistently elevated above the 90th percentile ECBP reference background concentration of 0.25 µg/l downstream of the Eaton WWTP outfall (RM 25.17) through RM 14.44 in both surveys. The overall median and maximum concentrations for this reach of the river in 2002 were 0.31 µg/l and 0.64 µg/l, respectively, compared to 0.55 µg/l

and 2.1 µg/l in 1991.

On September 3, 1991, after recent precipitation, zinc exceeded the WQS criterion at RM 27.10, downstream of a storm drain which receives runoff from the metal finisher Parker Hannifan. Zinc also exceeded the criterion downstream of the Eaton WWTP at RM 24.10 on the same day. No elevated zinc concentrations were observed in the mainstem during the 2002 survey.

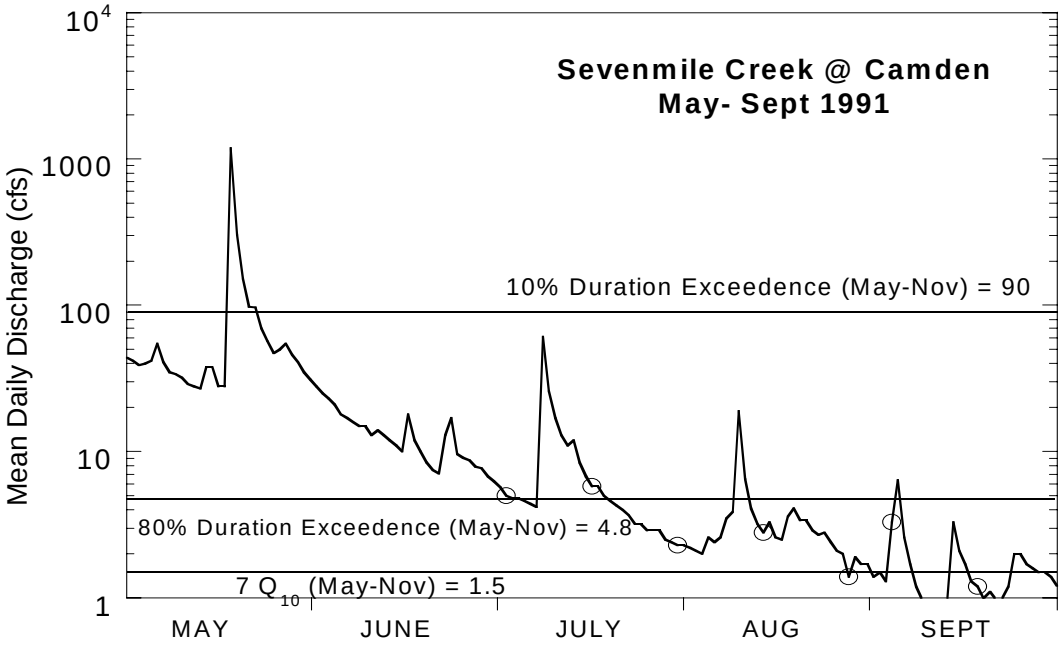


Figure 14. May through September, 1991 flow hydrograph for Sevenmile Creek at Camden (RM 16.1). Low flow conditions ($7Q_{10}$), 10%, and 80% duration exceedence flows are based on USGS station #03272700 (period of record 1970-1997). Open circles indicate river discharge on water chemistry sampling days in Sevenmile Creek during the 1991 survey. There was no active gauging station in the basin during the 2002 survey.

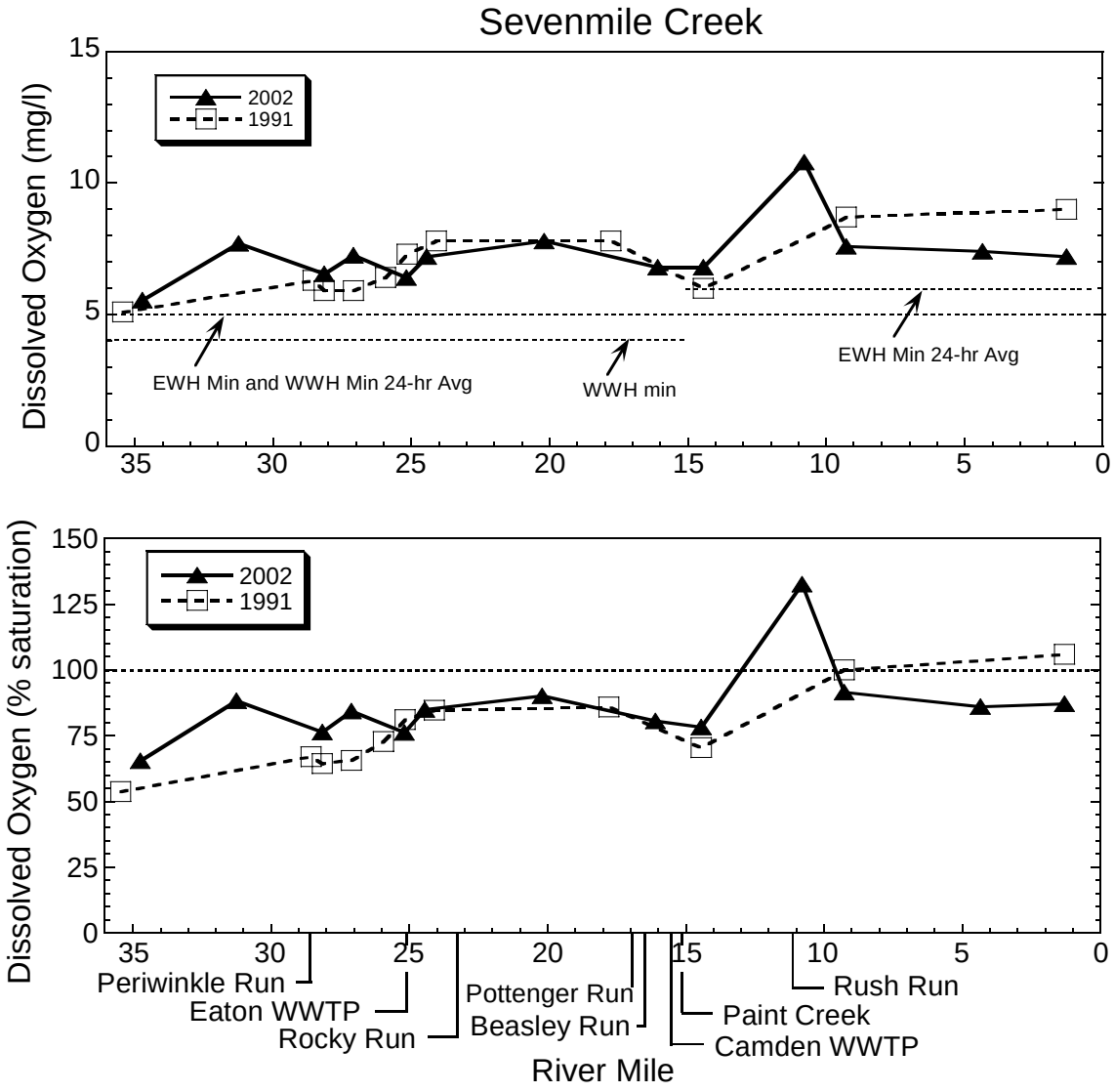


Figure 15. Median dissolved oxygen concentrations and dissolved oxygen percent saturations in Sevenmile Creek in 2002 and 1991.

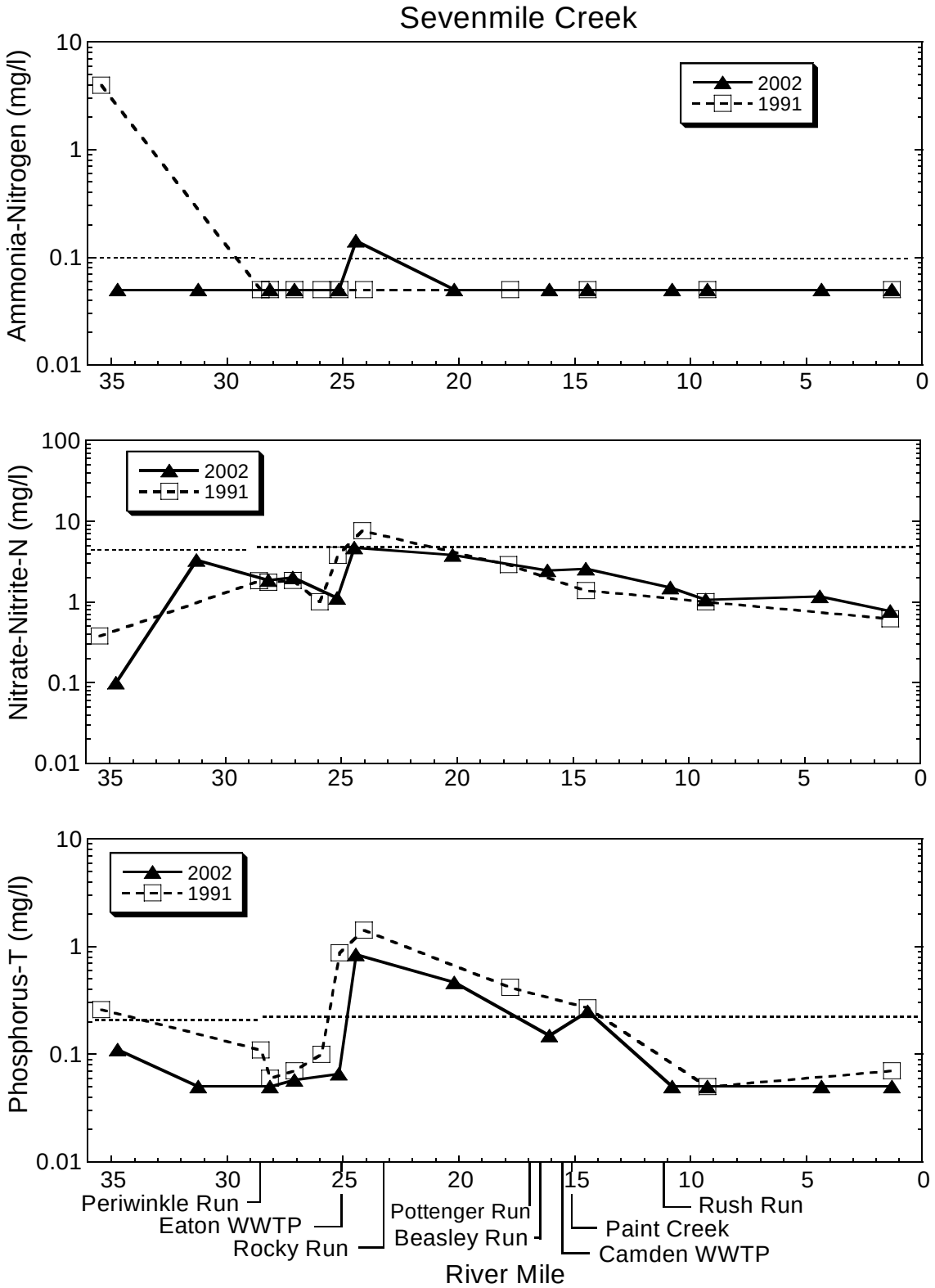


Figure 16. Median concentrations of ammonia-nitrogen, nitrate-nitrite-N, and total phosphorus in Sevenmile Creek in 2002 and 1991. The dotted horizontal lines represent the 90th percentile concentrations from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

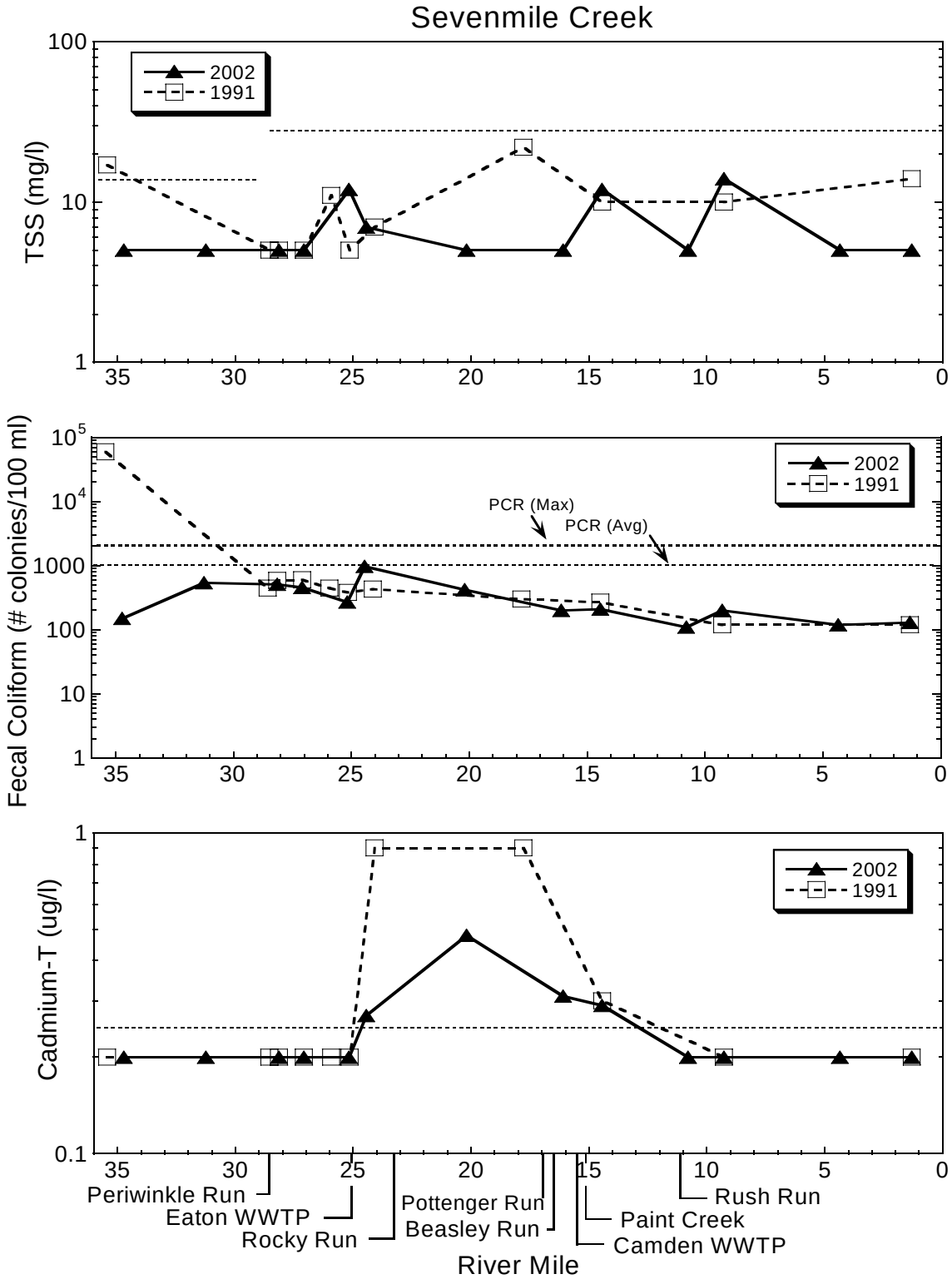


Figure 17. Median concentrations of total suspended solids (TSS), fecal coliform, and total cadmium in Sevenmile Creek in 2002 and 1991. The dotted horizontal lines in the TSS and cadmium plots, respectively, represent the 75th and 90th percentile concentrations from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

Physical Habitat for Aquatic Life

The assessment of the influence of physical stream features and riparian conditions on ambient biological performance for the Sevenmile Creek basin will proceed in a longitudinal manner (upstream to downstream). The discussion of tributaries will be treated in the aggregate. For the purposes of continuity, this longitudinal reporting structure will also be applied to the direct assessment of ambient biological performance (fish and benthic macroinvertebrate communities).

Sevenmile Creek *(mainstem)*
As part of the 2002 fish sampling effort, the quality of near and in-stream macrohabitats of Sevemile Creek were evaluated at 12 fish sampling locations, assessing 31.2 miles of the mainstem, between RM 31.2 (Oxford Rd.) and RM 1.3 (Taylor School Rd.). QHEI values ranged between 66.5 and 84.0, with a mean score of 74.8 ($\pm$5.69 SD). Longitudinal performance of the QHEI and a matrix of macrohabitat features, by stations, are presented in Table 11 and Figure 20. Mean QHEI values from rivers or river segments greater or equal to 60.0, generally indicate a level of macrohabitat quality sufficient to support an assemblage of aquatic organisms fully consistent with the WWH aquatic life use designation. Average reach values greater than 75.0 are generally considered adequate to fully support exceptional (EWH) communities (Rankin 1989 and Rankin 1995). Values between 55 and 45 suggest limiting components of physical habitat are present and will likely exert a negative influence upon ambient biological performance. However, due to compensatory stream features (e.g., strong ground water influence) or other watershed variables, QHEI scores within this range do not necessarily preclude WWH assemblages. Values below 45 indicate a high probability of habitat derived aquatic life use impairment.

As measured by the QHEI, the quality of near and in-stream macrohabitat throughout the entire length of Sevenmile Creek appeared fully capable of supporting diverse, functionally organized, and well-structured assemblages of aquatic organisms. Most sites contained a full compliment of positive channel, substrate, and riparian features. Riffle and run complexes were commonly observed throughout, with associated trench and lateral scour pools. Substrates consisted largely of coarse glacial material (e.g., gravel, cobble, and boulder) and were typically unencumbered with extensive deposits of clayey silts. Riparian areas at most sites were vegetated, more often wooded, and thus attenuated sunlight and provided in-stream structure in the form of woody debris and rootwad formations. The channel configuration of the mainstem was in a natural or recovered state, displaying a moderate to high degree of sinuosity. Evidence of previous channel modifications was found at six of the 12 sampling stations, all limited to the upper 15 miles. Despite this, the process of natural restoration or recovery of more complex channel features appeared well underway at all previously modified sites.

Ultimately, departures from applicable biocriteria derived solely from or associated with deficient, degraded or otherwise simplified macrohabitat were not anticipated. In the absence of significant water quality problems, Sevenmile Creek appeared capable of supporting aquatic communities consistent with the existing WWH and EWH aquatic life use designations.

Table 11. A matrix of QHEI scores and principal habitat features for Sevenmile Creek and tributaries, 2002.

Key QHEI Components

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Bculder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeccedness	Max Depth > 40 cm	Low-Normal Riffle Embeddedness	Total WWH Attributes	MWH Attributes — High Influence: Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW)	Total HL MWH Attributes	MWH Attributes — Moderate Influence: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total ML MWH Attributes	(MWH HL+1)/(MWH+1) Ratio	(MWH ML+1)/(MWH+1) Ratio
(14-410) Sevenmile Creek																																		
Year: 2002																																		
31.2	**67.5**	20.00	■	■		■	■	■		■	■	■	8			♦	♦		2	•		•		•								3	0.33	0.67
28.2	**66.5**	8.13		■			■			■	■		4				♦		1	•	•		•	•		•		•	•		7	0.40	1.80
27.0	**71.0**	18.18	■	■		■	■	■		■	■		7				♦		1	•			•			•			•		4	0.25	0.75
25.2	**80.0**	15.15	■	■		■	■	■			■		6						0		•	•				•		•	•		5	0.14	0.86
25.1	**75.5**	15.15	■	■		■	■	■	■		■		7						0	•	•		•						•	•	5	0.13	0.75
23.7	**72.0**	8.77	■	■		■	■	■			■		6				♦		1		•		•	•	•			•	•	•	7	0.29	1.29
20.2	**76.5**	9.90	■	■		■	■	■	■		■		7						0										•	•	2	0.13	0.38
16.1	**76.0**	10.75	■	■		■	■	■	■		■		7						0	•									•	•	3	0.13	0.50
15.3	**69.0**	9.09		■			■				■		3				♦		1	•	•		•	•		•		•	•	•	7	0.50	2.25
14.4	**84.0**	11.76	■	■		■	■	■	■		■	■	8						0		•			•					•	•	4	0.11	0.56
9.3	**82.0**	14.29	■	■		■	■	■			■		6						0		•							•	•	•	4	0.14	0.71
1.3	**78.0**	4.83	■	■		■	■	■	■		■		7				♦		1				•						•	•	3	0.25	0.63
(14-412) Big Cave Run																																		
Year: 2002																																		
1.2	**67.5**	25.64	■	■		■	■	■		■	■	■	8				♦		1	•		•						•	•		4	0.22	0.67
(14-413) Rush Run																																		
Year: 2002																																		
0.1	**56.0**	111.1	■	■			■				■		4				♦	♦	2			•	•			•				•	4	0.60	1.40
(14-414) Paint Creek																																		
Year: 2002																																		
4.2	**63.0**	22.22	■	■			■			■	■	■	6				♦		1	•		•				•		•	•	•	5	0.29	1.00
1.3	**59.0**	38.46	■							■	■	■	4			♦	♦		2			•				•					2	0.60	1.00
(14-417) Beasley Run																																		
Year: 2002																																		
0.6	**66.0**	35.71	■	■			■			■	■	■	6				♦	♦	2	•		•				•		•			4	0.43	1.00
(14-418) Pottenger Run																																		
Year: 2002																																		
0.9	**61.0**	29.41	■	■		■	■	■		■			6				♦	♦	2							•				•	2	0.43	0.71
(14-419) Rocky Run																																		
Year: 2002																																		
0.3	**76.5**	83.33	■	■		■	■	■		■	■	■	8						0							•			•	•		2	0.11	0.33

Table 11. A matrix of QHEI scores and principal habitat features for Sevenmile Creek and tributaries, 2002.

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Bculder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeccecness	MaxDepth > 40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**	MWH Attributes: *High Influence*: Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW)	**Total HL MWH Attributes**	*Moderate Influence*: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total ML MWH Attributes**	**(MWH HL+1)/(MWH+1) Ratio**	**(MWH ML+1)/(MWH+1) Ratio**
(14-429) Periwinkle Run																																	
Year: 2002																																	
0.1	**72.5**	14.93	■	■		■	■	■		■	■	■	8						0							•	•	•			3	0.11	0.44

Sevenmile Creek Tributaries

Eight direct tributaries comprise the principal drainage network of Sevenmile Creek: Periwinkle Run, Rocky Run, Pottenger Run, Beasley Run, Paint Creek, Rush Run, Big Cave Run, and Ninemile Creek. Of the nine sampling stations deployed to evaluate these tributaries, one to two were placed within each sub-basin, the effort typically limited to the lower 1.5 miles. QHEI values and a matrix of habitat features from these tributaries are presented in Table 11.

Nearly all of these tributaries displayed a level of macrohabitat quality commensurate with WWH aquatic communities. Big Cave Run, Paint Creek, Beasley Run, Pottenger Run, Rocky Run, and Periwinkle Run yielded QHEI values at or greater than the WWH threshold, and clearly displayed potential to support an assemblage of aquatic organisms comparable to Ecoregional Reference conditions. Positive features common to these streams included, wooded riparian corridors, unembedded coarse substrates, modest to good channel development, and generally a high degree of functional sinuosity. Departures from applicable biocriteria derived solely from or associated with deficient, degraded or otherwise simplified macrohabitat were not anticipated. In the absence of significant water quality problems Sevenmile Creek tributaries appeared fully capable of supporting aquatic communities consistent with the WWH aquatic life use designation.

Limiting aspects of habitat were indicated only for Rush Run and Ninemile Creek. As measured by the QHEI, macrohabitat in Rush Run was considered moderately impacted, yielding a score just below the WWH threshold (QHEI=56.0). Although by no means optimal, conditions should not have resulted in significant deleterious effect upon ambient biological performance. In contrast, Ninemile Creek appeared incapable of supporting an assemblage of WWH aquatic organisms due to intermittent flow. The 2002 survey found Ninemile Creek dry, the active channel containing only a few small, isolated, and stagnant pools. As such, no evaluation of macrohabitat quality or community assessment was attempted, due to the lack of aqueous habitat.

It is important here to bring into sharp relief the significant differences between interstitial flow and true intermittence. The first constitutes a category of streams (or segments) that during the dry summer months regularly lack visible surface flow, the wetted channel consisting of a series of pools separated by dry substrates. The pools are kept from becoming stagnant or developing septic conditions through near constant input of cool subsurface or hyporheic flow. Interstitial streams possess continuous flow, not readily apparent, as water is conveyed below the surface and through the streambed. Healthy and intact headwater faunas are adapted to interstitial conditions, finding the residual pools more than adequate refugia during periods of drought. This phenomenon was directly observed within the Sevenmile Creek study area, with Big Cave Run, Rush Run, and Pottenger Run having interstitial flow. The lack of perennial surface flow documented for these tributaries did not preclude or otherwise significantly limit ambient biological performance.

In contrast, truly intermittent or ephemeral streams, as a class, may be completely desiccated during dry periods or are reduced to a few discontinuous pools. These residual wetted areas, where present, may stagnate, depending on conditions like pool volume and canopy, and be rendered inhospitable to all but the most tolerant and facultative organisms. True intermittence significantly affects the biological potential of a water body, often precluding the permanent establishment of a diverse and healthy assemblage of aquatic organisms. Even during periods of abundant surface flow (spring or fall), intermittent streams typically support only transient populations of pioneering species. Ninemile Creek represented the only intermittent waterbody identified in the 2002 Sevenmile Creek study area.

Biological Assessment: Macroinvertebrate Communities

Sevenmile Creek

Macroinvertebrate communities were evaluated at 12 stations on Sevenmile Creek from near the headwaters at Swain Rd. (RM 31.2, 10.3 sq. mi drainage area) to near the mouth upstream from Taylor School Rd. (RM 1.4, 137 sq. mi drainage area) (Table 12). The community performance ranged from exceptional (ICI=56) at SR 725 (RM 16.2) to good (EPT=15) at Swain Rd. (RM 31.2) (Fig. 18). The stations with the highest total mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa richness (EPT) was downstream from the Camden WWTP (RM 15.5) with 22 taxa. The station with the highest number of total sensitive taxa was upstream from the Eaton WWTP (RM 25.2) with 33. Sensitive taxa found in Sevenmile Creek, which are noteworthy because they are not commonly collected, were the mayflies *Stenonema mediopunctatum* (RMs 25.2, 25.1, 24.2, 15.5, and 1.4) and *Acentrella turbida* (RM 16.2).

Macroinvertebrate community performance remained fairly consistent throughout the length of Sevenmile Creek. There were no clear cut cases of impairment attributable to a known source of pollution. The station located at Swain Rd. (RM 31.2) was located 3.5 miles downstream from the National Trails High School WWTP and about four miles downstream from the unsewered community of Gettysburg. The macroinvertebrate community at this station was diverse and well balanced with no obvious impairment (Fig. 18). However, it must be noted that the stated entities discharge a considerable distance upstream from the RM 31.2 sampling location.

The station at Waterworks Park (RM 27.0) was located downstream from the runoff ditch that has historically been contaminated by spills from the Parker Hannifan metal plating facility. There were minor declines in the ICI score and total number of sensitive taxa, but, overall, the station retained a diverse, well balanced community (Fig. 18).

Macroinvertebrate communities sampled downstream from the Eaton WWTP (RM 25.17) were not noticeably impacted by the discharge. The communities remained relatively diverse and balanced (Fig. 18). An increase in organism density downstream from the discharge (1873 orgs./sq. ft. at RM 25.1 compared to 916 at RM 28.2) may be an indication of mild enrichment from the WWTP. Organism density gradually declined at the next two downstream stations (Table 12).

The Camden WWTP (RM 15.52) was not distinctly impacting the macroinvertebrate community. The ICI declined from 56 (RM 16.2) upstream to 44 (RM 15.5) just downstream from the WWTP discharge due to minor shifts in relative abundances of various macroinvertebrate taxa groups. However, there was no decline in the diversity of the total sensitive taxa or total EPT (Fig. 18) and there was no increase in facultative or tolerant taxa. Even though there did not appear to be a short range impact, the downstream trend in ICI and total sensitive taxa was declining slightly compared to upstream from the Camden WWTP. Additional indications of enrichment in the Camden area were increases in organism density downstream from Beasley Run (1640 orgs./sq. ft. at RM 16.2) and farther downstream from Camden (RMs 14.4, 9.3) along with increased algae growth at RMs 16.2, 15.5, and 14.4. This may indicate a mild impact within and downstream from Camden.

Macroinvertebrate communities have generally improved since the 1991 study. The ICI and total EPT were generally moderately higher and the total sensitive taxa were substantially higher in the upper two thirds of the study area in 2002 (Fig. 19). The decline in ICI downstream from the Camden WWTP in 1991 was not repeated in 2002.

Sevenmile Creek Tributaries

Macroinvertebrate communities sampled from the tributaries of Sevenmile Creek were all performing in the good range (Table 12). These streams were supporting moderately diverse and well balanced communities. All these stations were flowing when sampled. Rush Run and Ninemile Creek were not sampled since they were dry when visited. The Beasley Run station was sampled about 0.6 mile upstream from the chemistry site where intermittent stream flows were observed and very high bacterial counts were recorded. There was no obvious impact from the Lake Lakengren WWTP, which discharges to Sugar Run, in Paint Creek at RMs 4.2 and 1.2.

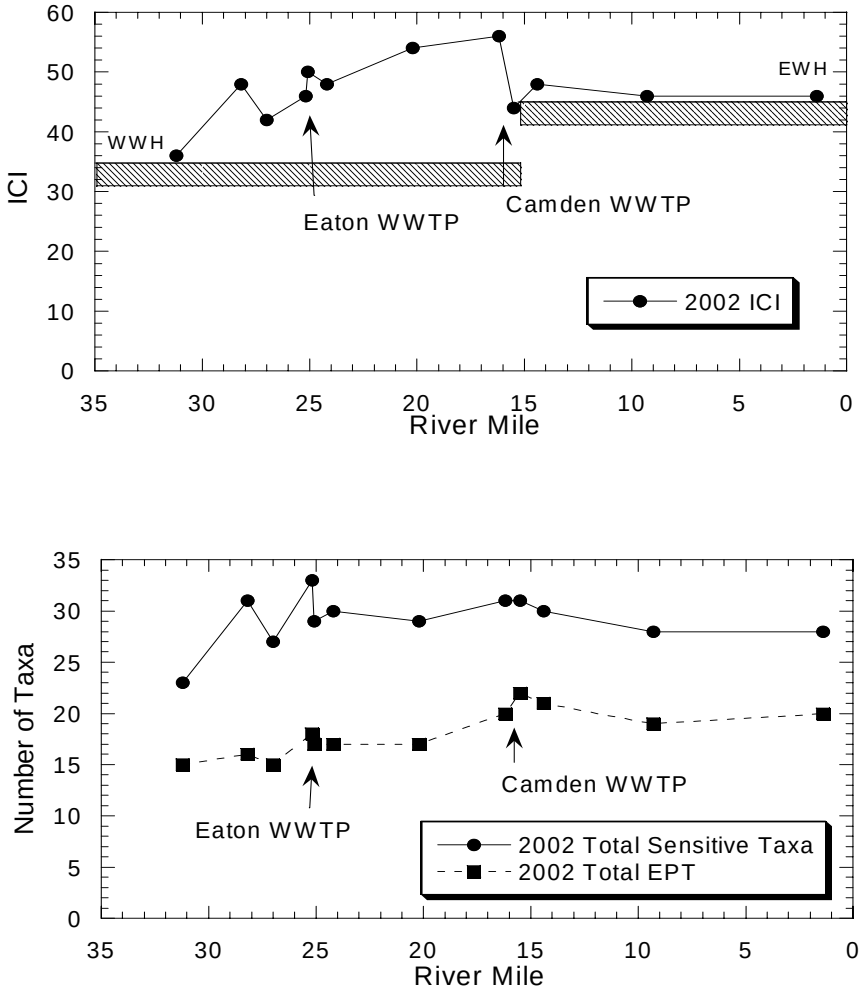


Figure 18. Longitudinal trend of the Invertebrate Community Index (ICI), total sensitive taxa, and EPT in Sevenmile Creek, 2002.

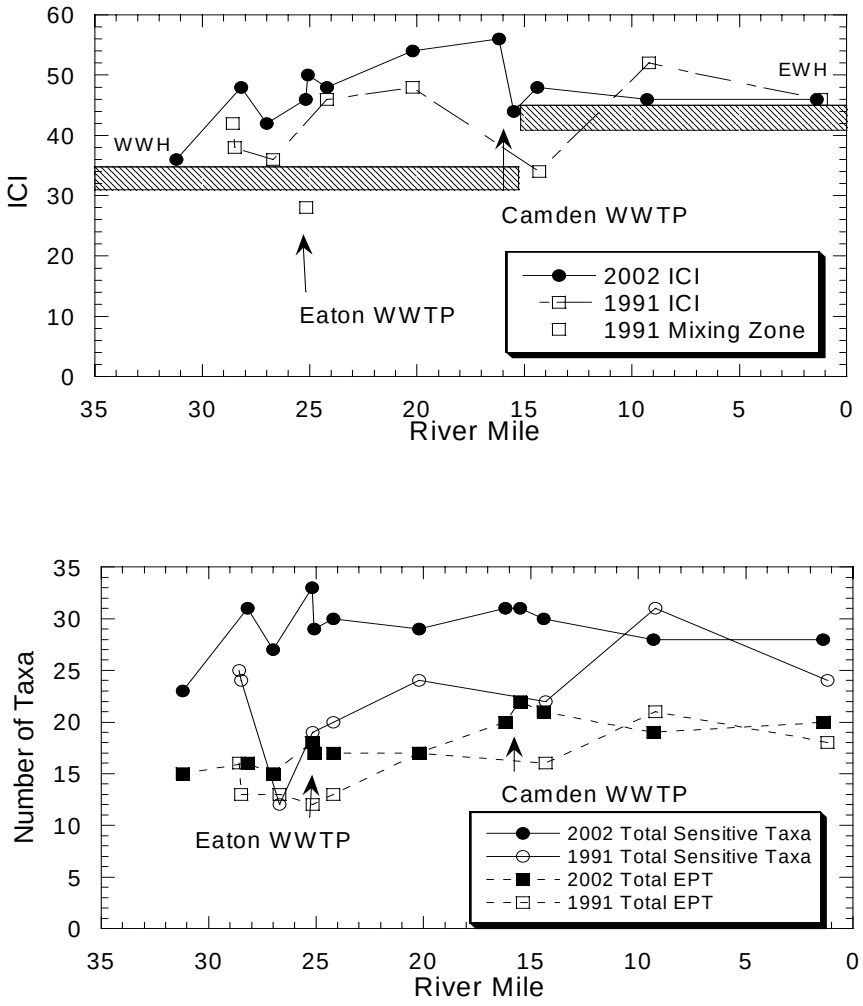


Figure 19. Longitudinal trend of the Invertebrate Community Index (ICI), total sensitive taxa, and total EPT in Sevenmile Creek, 1991-2002.

Table 12. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Sevenmile Creek study area, July to September, 2002.

Stream RM	Dr. Area (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / total	SensitiveTaxa Ql. / total	Density Ql. / Qt.	Predominant Organisms on the Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Sevenmile Creek (14-410)									
31.2	10.3	-	45	15 / -	23 / -	M / -	Caddisflies (F,MI,I), riffle beetles (F,MI), water penny beetles (MI)	-	Good
28.2	23.6	6	62	16 / 16	27 / 31	M / 617	Hydropsychid caddisflies (F), midges (F,MI)	48	Exceptional
27.0	25.7	-	53	14 / 15	22 / 27	M / 184	Caddisflies (F,MI,I), midges (MI,F) mayflies (F,MI,I)	42	Very Good
25.2	32	15	54	15 / 18	23 / 33	M / 916	Caddisflies (F,MI), midges (F,MI), baetid mayflies (F)	46	Exceptional
25.1	32	-	60	15 / 17	27 / 29	H / 1873	Hydropsychid caddisflies (F), midges (F,MI)	50	Exceptional
24.2	33	-	55	16 / 17	24 / 30	M / 1438	Hydropsychid caddisflies (F,MI), midges (F,MI), baetid mayflies (F)	48	Exceptional
20.2	50	-	57	16 / 17	24 / 29	M / 724	Hydropsychid caddisflies (F,MI), midges (F,MI), baetid mayflies (F)	54	Exceptional
16.2	69	-	58	20 / 20	27 / 31	M / 1640	Hydropsychid caddisflies (F,MI), midges (F,MI), baetid mayflies (F)	56	Exceptional
15.5	69.7	-	54	20 / 22	25 / 31	M / 840	Caddisflies (F,MI), midges (F,MI), baetid mayflies (F)	44	Very Good
14.4	91.5	-	51	18 / 21	24 / 30	M-H / 1138	Hydropsychid caddisflies (F,MI), midges (F,MI), baetid mayflies (F)	48	Exceptional
9.3	106	-	47	17 / 19	20 / 28	M / 1374	Hydropsychid caddisflies (MI,F), midges (F), baetid mayflies (F)	46	Exceptional
1.4	~137	-	60	20 / -	28 / -	M / -	Hydropsychid caddisflies (F,MI), baetid mayflies (F), midges (F,MI)	-	Exceptional
Periwinkle Run (14-429)									
0.1	4.8	-	42	14	24	M	Hydropsychid caddisflies (F), baetid mayflies (F), midges (F,MI)	-	Good
Rocky Run (14-419)									

Stream RM	Dr. Area (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / total	SensitiveTaxa Ql. / total	Density Ql. / Qt.	Predominant Organisms on the Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
0.3	8.9	-	54	14	22	M	Hydropsychid caddisflies (F), baetid mayflies (F), midges (F)	-	Good
Pottenger Run (14-418)									
0.9	5.9	-	45	15	21	M	Hydropsychid caddisflies (F), midges (F,MI), baetid mayflies (F,I)	-	Good
Beasley Run (14-417)									
0.9	~5.8	-	47	16	18	M	Hydropsychid caddisflies (F,MI), baetid mayflies (F)	-	Good
Paint Creek (14-414)									
4.2	14.2	-	54	16	17	M	Caddisflies (F,MI), midges (F,MI), baetid mayflies (F)	-	Good
1.2	~19	-	37	15	13	L-M	*Helichopsyche* caddisflies (MI), midges (F,MI)	-	Good
Big Cave Run (14-412)									
1.2	5.1	-	44	16	19	M-H	Midges (F,MI), caddisflies (F,MI), flatworms (F)	-	Good

Data Codes: 6=4 HD Only, 15=Slow Current (<0.3 ft/sec).
Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List as MI (moderately intolerant) or I (intolerant).
Ql.: qualitative sample collected from the natural substrates.
Qt.: quantitative sample collected on Hester-Dendy artificial substrates.
Relative Density of the qualitative sample: L=Low, M=Moderate, H=High.
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant.

Biological Assessment: Fish Communities

Sevenmile Creek

A total of 28,037 fish comprising 42 species and nine hybrids was collected from Sevenmile Creek between August and September 2002. The fish sampling effort included 23 sampling events, at 12 stations, evaluating 31.2 miles of the mainstem, between RM 31.2 (Oxford Rd.) and RM 1.3 (Taylor School Rd.).

Based on aggregated catch statistics, numerically predominant species (No./0.3km) included central stoneroller (33.8%), rainbow darter (14.9%), striped shiner (6.9%), and northern hog sucker (5.5%). In terms of relative biomass (kg/0.3km), dominant species were common carp (22.3%), central stoneroller (20.3%), northern hog sucker (16.1%), black redhorse (9.9%), and smallmouth bass (7.3%). No fish species classified as rare, threatened, endangered, or otherwise recognized as a special conservation unit by the Ohio DNR (1997) were collected from the Sevenmile Creek mainstem. Numerically, more than 20% of the assemblage was composed of environmentally sensitive species (northern hog sucker and rainbow darter). Similarly, 33% of the biomass was composed of sensitive taxa (northern hog sucker, black redhorse, and smallmouth bass), including the highly intolerant black redhorse. Although not a dominant component of the assemblage, Sevenmile Creek was found to support good populations of additional intolerant and/or declining species (e.g., river chub, southern redbelly dace, silver shiner, rosyface shiner, stonecat madtom, and banded dater). Taken together, the abundance of sensitive, intolerant, and declining taxa clearly indicated a high degree of biological integrity for the entire length of Sevenmile Creek.

Community indices and accompanying narrative evaluations ranged between exceptional (IBI=54/MIwb=10.7) and very good/good (IBI=46/MIwb=8.3). Overall, the fish assemblage of the Sevenmile Creek was characterized as exceptional/very good. Longitudinal performance of the IBI, MIwb, and other relevant indicators are presented in Figure 20. Summarized index scores and community statistics by station are presented in Table 13.

Presently, two verified aquatic life use designations are imposed on the length of Sevenmile Creek. The reach extending downstream from the headwaters to RM 15.0 is designated WWH. The remaining downstream segment is designated EWH. As measured by the IBI and MIwb (where applicable), community performance was found fully consistent with the existing aquatic life use designations. Every station was found to support an assemblage of fish possessing expected structure, functional organization, and species richness. Environmentally sensitive taxa were well represented and the incidence of serious disease was typically at or below expected levels derived from regional reference sites. The prescribed WWH and EWH biocriteria were easily met at all stations. In every instance point and non-point source pollutant loads currently delivered to Sevenmile Creek appeared safely assimilated.

Table 13. Fish community indices and descriptive statistics based on samples collected by Ohio EPA from the Sevenmile Creek basin in 1991 and 2002.

Stream River Mile	Mean Number Species	Cumul-ative Species	Mean Rel. No. (No./1.0km)[a]	Mean Rel. Wt. (Wt./1.0km)[a]	QHEI	Mean IBI	Mean MIwb	Narrative Evaluation
Sevenmile Creek (2002)								
Eastern Corn Belt Plains-WWH Use Designation (Existing)								
31.2[H]	15.0	15	1695.0	15.44	67.5	48	NA	Very Good
28.2[W]	18.0	20	766.5	15.52	66.5	46	8.6	V.Good-Good
27.0[W]	17.0	18	921.8	15.12	71.0	47	8.5	V.Good-Good
25.2[W]	27.0	29	1629.8	73.95	80.0	53	8.8	Exc.-Good
25.1[W]	24.0	27	2721.0	33.93	75.5	53	9.1	Exc.-V.Good
23.7[W]	18.5	21	1088.3	14.21	72.0	50	8.3	Exc.-Good
20.2[W]	23.5	27	1142.7	23.29	76.5	51	9.1	Exc.-V.Good
16.1[W]	24.5	27	2500.0	61.66	76.0	47	8.9	Very Good
15.3[W]	25.5	27	966.4	38.8	69.0	54	9.7	Exceptional
Eastern Corn Belt Plains-EWH Use Designation (Existing)								
14.4[W]	27.5	32	2009.4	45.17	84.0	53	10.0	Exceptional
9.3[W]	29.5	33	3126.8	60.72	82.0	53	10.7	Exceptional
1.3[W]	27.0	32	1348.4	67.46	78.0	51	9.5	Exceptional
Sevenmile Creek (1991)								
Eastern Corn Belt Plains-WWH Use Designation (Existing)								
28.6[H]	15.0	17	1362.1	12.9	85.5	45	NA	Good
28.5[W]	17.0	18	492.8	16.4	57.0	45	8.2[ns]	Good-M.Good
28.2[W]	17.5	18	1501.5	28.0	80.5	46	9.2	Very Good
26.5[W]	16.0	17	629.3	6.7	68.0	39[ns]	7.5*	M.Good-Fair
25.5[W, mz]	20.0	21	4782.0	50.2	NA	45	9.7	Good-V.Good

Table 13. continued.

Stream River Mile	Mean Number Species	Cumul-ative Species	Mean Rel. No. (No./1.0km)[a]	Mean Rel. Wt. (Wt./1.0km)[a]	QHEI	Mean IBI	Mean MIwb	Narrative Evaluation
Sevenmile Creek (1991)								
Eastern Corn Belt Plains-WWH Use Designation (Existing)								
24.1[W]	22.0	24	868.0	20.6	80.0	44	8.6	Good
18.8[W]	16.0	18	1770.1	44.6	74.0	43	9.0	Good-V.Good
Eastern Corn Belt Plains-EWH Use Designation (Existing)								
14.4[W]	28.5	31	1832.3	58.0	81.0	50	9.2	Exc.-V.Good
9.2[W]	25.0	29	1628.3	93.0	85.0	55	10.1	Exceptional
1.2[W]	25.0	28	1032.0	91.7	80.0	52	9.9	Exceptional
Sevenmile Creek (1981)								
Eastern Corn Belt Plains-EWH Use Designation (Existing)								
1.3[W]	22.0	22	874.0	-	79.0	44*	-	Good
Big Cave Run (2002)								
Eastern Corn Belt Plains-EWH Use Designation (Existing)								
1.2[H]	21.0	21	6421.5	16.4	67.5	56	NA	Exceptional
Rush Run (2002)								
Eastern Corn Belt Plains-WWH Use Designation (Existing)								
0.1[H]	11.0	11	1531.5	4.28	56.0	52	NA	Exceptional
Paint Creek (2002)								
Eastern Corn Belt Plains-EWH Use Designation (Existing)								
4.2[H]	14.0	14	4735.5	13.37	60.0	38*	NA	M. Good
1.3[H]	20.0	20	4143.9	20.04	59.0	48[ns]	NA	Very Good

Table 13. continued.

***Stream* River Mile**	**Mean Number Species**	**Cumul-ative Species**	**Mean Rel. No. (No./1.0km)[a]**	**Mean Rel. Wt. (Wt./1.0km)[a]**	**QHEI**	**Mean IBI**	**Mean MIwb**	**Narrative Evaluation**
Beasley Run(2002)								
Eastern Corn Belt Plains-WWH Use Designation (Existing)								
0.6[H]	10.0	10	1767.0	13.36	66.0	40	NA	Good
Pottenger Run (2002)								
Eastern Corn Belt Plains-WWH Use Designation (Existing)								
0.9[H]	12.0	12	2721.0	6.37	61.0	40	NA	Good
Rocky Run (2002)								
Eastern Corn Belt Plains-WWH Use Designation (Existing)								
0.3[H]	19.0	19	2085.0	16.05	76.5	54	NA	Exceptional
Periwinkle Run (2002)								
Eastern Corn Belt Plains-WWH Use Designation (Undesignated)								
0.1[H]	15.0	15	1315.5	8.52	72.5	48	NA	Very Good

Ecoregion Biocriteria: Eastern Corn Belt Plain (ECBP)

INDEX - Site Type	WWH	EWH	MWH[b]
IBI -Headwater/Wading	40	50	24
MIwb - Wading	8.3	9.4	6.2

b-Modified Warmwater Habitat for channel modified areas.

* - Significant departure from applicable biocriterion (≥4 IBI units or ≥0.5 MIwb units); underlined values are in the poor and very poor range.
ns - Nonsignificant departure from biocriterion (<4 IBI units or <0.5 MIwb units).
H - Headwaters (<20 miles2).
W -Wading (≥20miles2).
mz - Mixing Zone: Reach of high effluent concentration, biocriteria not applicable.
a -Relative measures normalized to 0.3km.

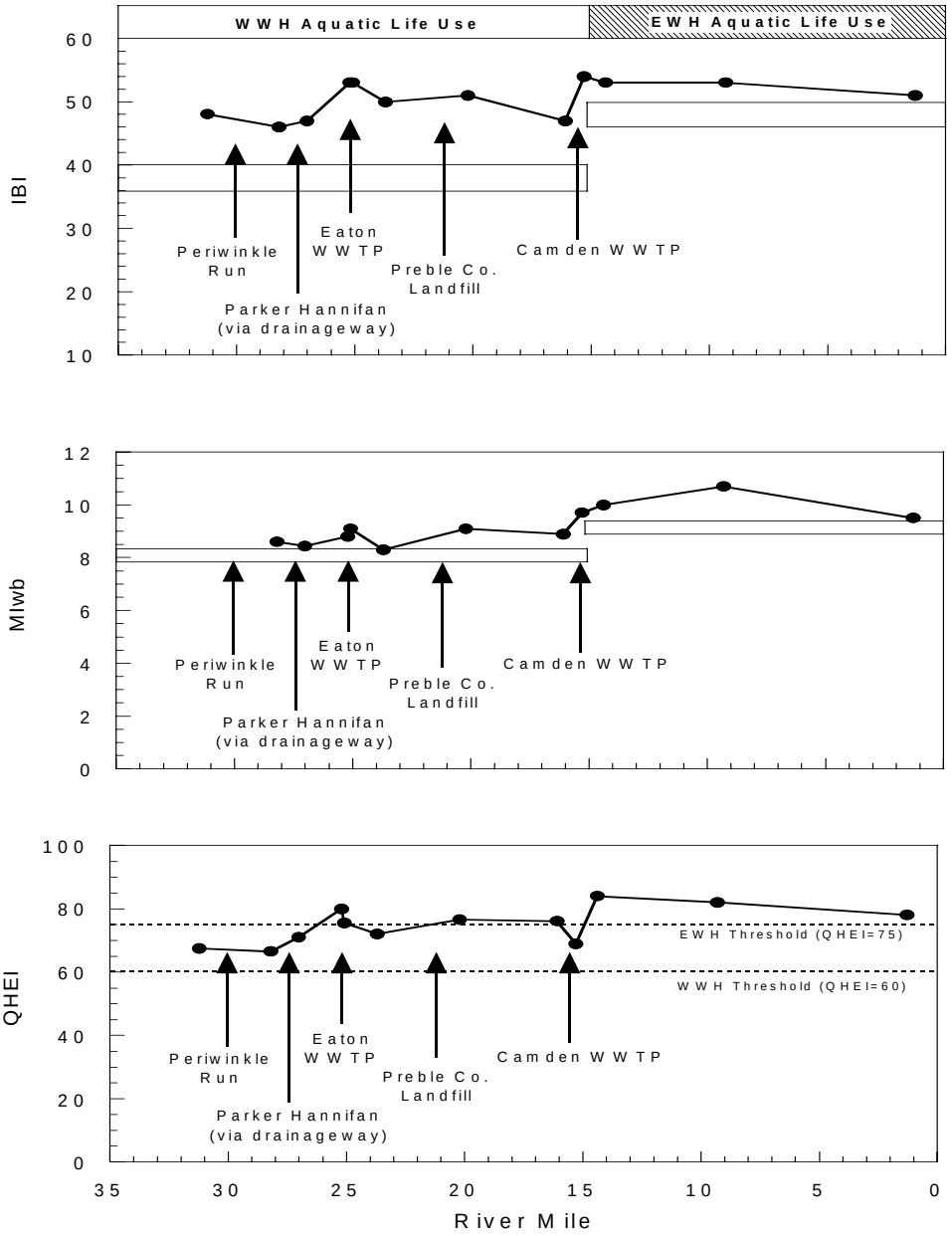


Figure 20. Longitudinal performance of the Index of Biological Integrity (IBI), Modified Index of well-being (MIwb), and the Qualitative Habitat Evaluation Index (QHEI) for Sevenmile Creek, 2002. Solid lines represent the prescribed biocriterion and area of nonsignificant departure, Eastern Corn Belt Plain (ECBP) ecoregion.

Sevenmile Creek Tributaries

Resident fish assemblages of seven of the eight direct tributaries that comprise the principal drainage network of Sevenmile Creek were surveyed and assessed in 2002. Ninemile Creek was excluded from the sampling effort, as this tributary was found dry between August and September. The remaining tributaries were each evaluated at a single location, no further than 1.5 miles from the mouth. As the largest tributary, a second station was placed on Paint Creek 4.2 miles from the mouth, to ensure an adequate assessment of the upper reaches. Performance of the IBI and QHEI for all evaluated tributaries are presented in Figure 21. Summarized index scores and community statistics, by station, are presented in Table 13.

Presently, nearly all Sevenmile Creek tributaries are listed and classified in the Ohio WQS as WWH. Paint Creek and Big Cave Run represented the only EWH designated tributaries. It is important to note that none of these Aquatic Life Uses are verified, and reflect designations made prior to the development of a robust and regionally calibrated bioassessment program by the Ohio EPA. As such, the 2002 survey results represent the first attempt to validate the veracity and appropriateness of these existing, yet unverified, aquatic life uses. In addition to the verification of existing aquatic life use and the classification of unlisted waters, sampling efforts were directed to many of the Sevenmile Creek tributaries to evaluate the potential deleterious effect of unsewered communities and small POTWs. Specifically these communities or facilities included, Somerville, Collinsville, Sevenmile, and the Lake Lakengren WWTP.

All tributary sampling locations were found to support an assemblage of aquatic organisms fully consistent with the WWH biocriterion. Five of the streams or stream segments, supported communities characterized as exceptional to very good. These included, Big Cave Run, Rush Run, lower Paint Creek, Rocky Run, and Periwinkle Run. Good to marginally good communities were indicated for the remaining three waterbodies: upper Paint Creek, Beasley Run, and Pottenger Run. Based upon existing aquatic life use designation, and supporting biocriteria, nearly all streams or stream segments performed at a level fully consistent with the prescribed biocriteria. Only upper three miles of Paint Creek (an EWH designate) failed to meet the ambient biological benchmark. Overall, performance of the biological indicators from Paint Creek were indicative of WWH, rather than EWH. Furthermore, macrohabitat quality at both stations never exceeded 60, further indicating WWH potential. Paint Creek simply lacked exceptional macrohabitats and associated high quality faunal components. Therefore, based upon both demonstrated performance and habitat potential, Paint Creek is recommended to be redesignated to, and verified as, WWH. Based upon the WWH biocriteria, the entire length of Paint Creek is brought into full attainment. Periwinkle Run easily met the WWH biocriterion. Based upon this finding, the commensurate aquatic life use is recommended. Waste loads delivered to selected tributaries from the minor sources (unsewered communities or minor POTWs) did not appear to have a demonstrative negative effect on the condition, structure, functional organization, or diversity of their respective resident fish assemblages. As stated previously, recommended and existing aquatic life use designation were fully attained at all sampling locations.

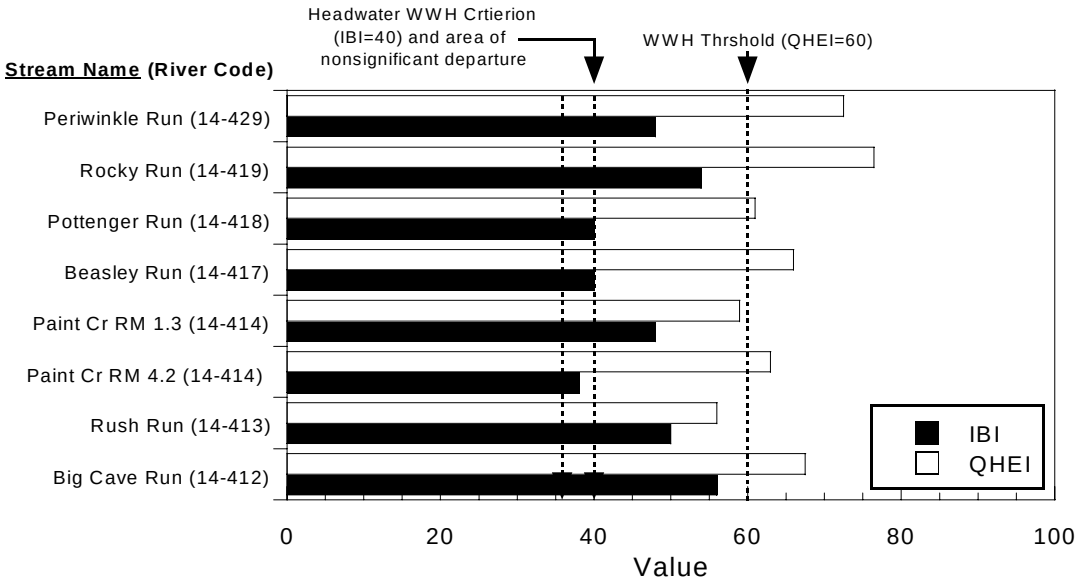


Figure 21. Performance of the Index of Biotic Integrity (IBI) and Qualitative Habitat Evaluation Index (QHEI) for all Sevenmile Creek tributaries, surveyed and assessed in 2002. Dashed lines represent the headwater WWH biocriterion, Eastern Corn Belt Plain (ECBP), and QHEI WWH threshold.

Trend Assessment

Sevenmile Creek

A previous evaluation of the fish fauna of Sevenmile Creek was performed by Ohio EPA during the summer of 1991 (Ohio EPA 1992). This survey included 10 mainstem stations, assessing the river reach between RM 28.6 (New Hope Rd.) and RM 1.2 (Taylor School Rd.). The effort corresponded well with the 2002 survey. The only significant differences between the two survey years were a slightly greater station density and the assessment of an additional 2.6 miles of the headwaters in 2002. These data provided an excellent opportunity to evaluate meaningful changes in the environmental conditions of the Sevenmile Creek over the last 11 years. In order to succinctly summarize and compare survey results, the analysis took two forms: 1) aggregated annual trends, examining cumulative performance from each field year through time, and 2) comparative longitudinal trends, relative to the principal associated stressors, through time.

Aggregate Community Performance: 1991-2002

Historic and contemporary data collected from Sevenmile Creek were considered ideal for cumulative or aggregate trends assessment, as there is ample correspondence between sampling stations and survey years. Annual cumulative community performance, summarized by box and whisker plots of the IBI, MIwb, and other community features portrayed a significant positive trend between 1991 and 2002 (Figure 22). Taken together, median, 75th percentile, 25th percentile, maximum, and minimum values for these various community measures were greater than that observed in 1991. Taken as a whole, Sevenmile Creek now supports greater species richness, higher numbers of fish, and a greater proportion of environmentally sensitive species than that observed in 1991. This phenomenon was manifested in improved community indices throughout.

Longitudinal Trends: 1991-2002

Similarly, longitudinal analysis clearly indicated that significant improvements in environmental conditions of Sevemile Creek have occurred over the intervening 11 years. The area of the greatest positive change was the 9.5 mile central or middle segment, defined by RM 26.5 (downstream from Parker Hannifan) and RM 16.1 (upstream from Camden WWTP). This segment receives treated waste water (and potentially affected by other pollutants) from Parker Hannifan, Eaton WWTP, Preble County Landfill, and other minor municipal sources via tributaries. The upper 6.7 miles (headwaters) and the lower EWH designated 15 miles portrayed little variation, as the prescribed biocriteria were met, or exceeded, in both 1991 and 2004. Longitudinal performance of the IBI and MIwb, through time, are presented in Figure 23.

The impacted area identified in 1991 began downstream from Parker Hannifan, at RM 26.5, where both the IBI and MIwb declined, the latter falling below the WWH area of nonsignificant departure. The area was relatively small, as full attainment of the WWH criteria was observed at the next downstream station, RM 24.1 (downstream from Eaton WWTP)(Ohio EPA 1992). In addition to the recovery of the WWH use of this 2.4 mile segment, the 2002 data also portrayed significant improvement in nearly every community metric for the 9.5 mile middle segment (Figure 24). The most notable of these positive changes included increased species richness, an increase in both the number and proportion of environmentally sensitive species, and an increase in the proportion of specialist insectivorous taxa. Since 1991, conditions have improved to the point that no impairment of the WWH and EWH aquatic life uses were observed. All station met, and more often exceeded, the prescribed biocriteria.

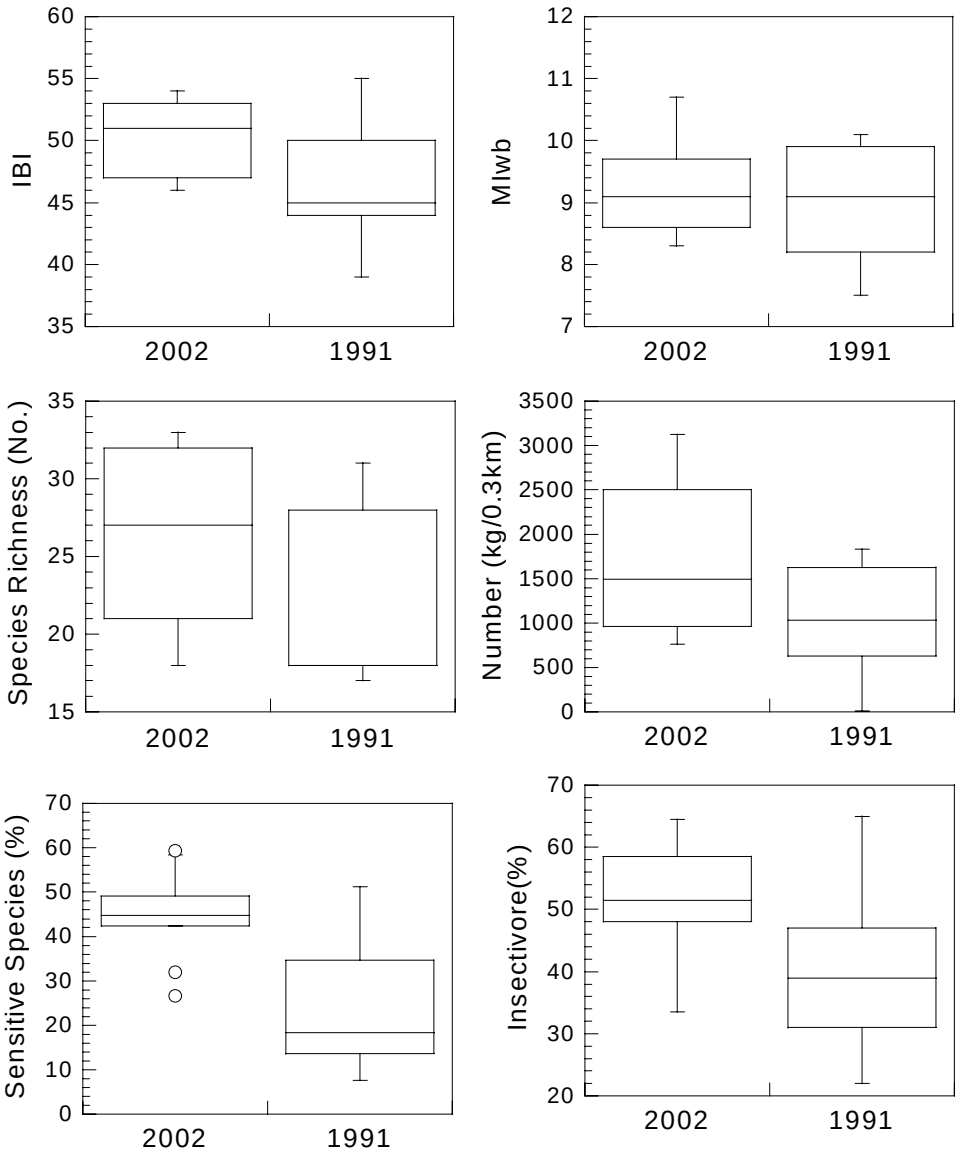


Figure 22. Box and whisker plots of the Index of Biotic Integrity (IBI), Modified Index of well-being (MIwb), and other fish community features of Sevenmile Creek, 1991 and 2002. To ensure comparability between survey years, only data exclusive to the stream reach between RM 28.5 and RM 1.2 were employed.

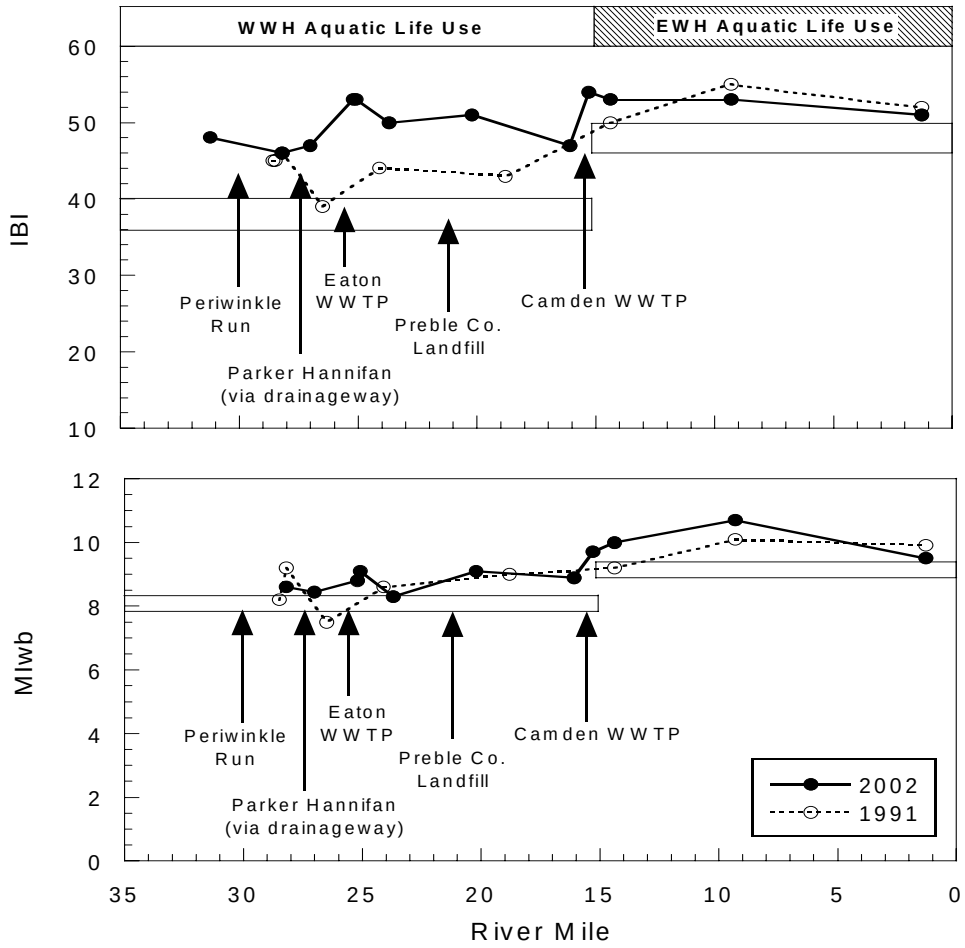


Figure 23. Longitudinal performance of the Index of Biological Integrity (IBI) and Modified Index of well-being (MIwb) for Sevenmile Creek, 1991-2002. Solid lines represent the prescribed biocriterion and area of nonsignificant departure, Eastern Corn Belt Plain(ECBP) ecoregion.

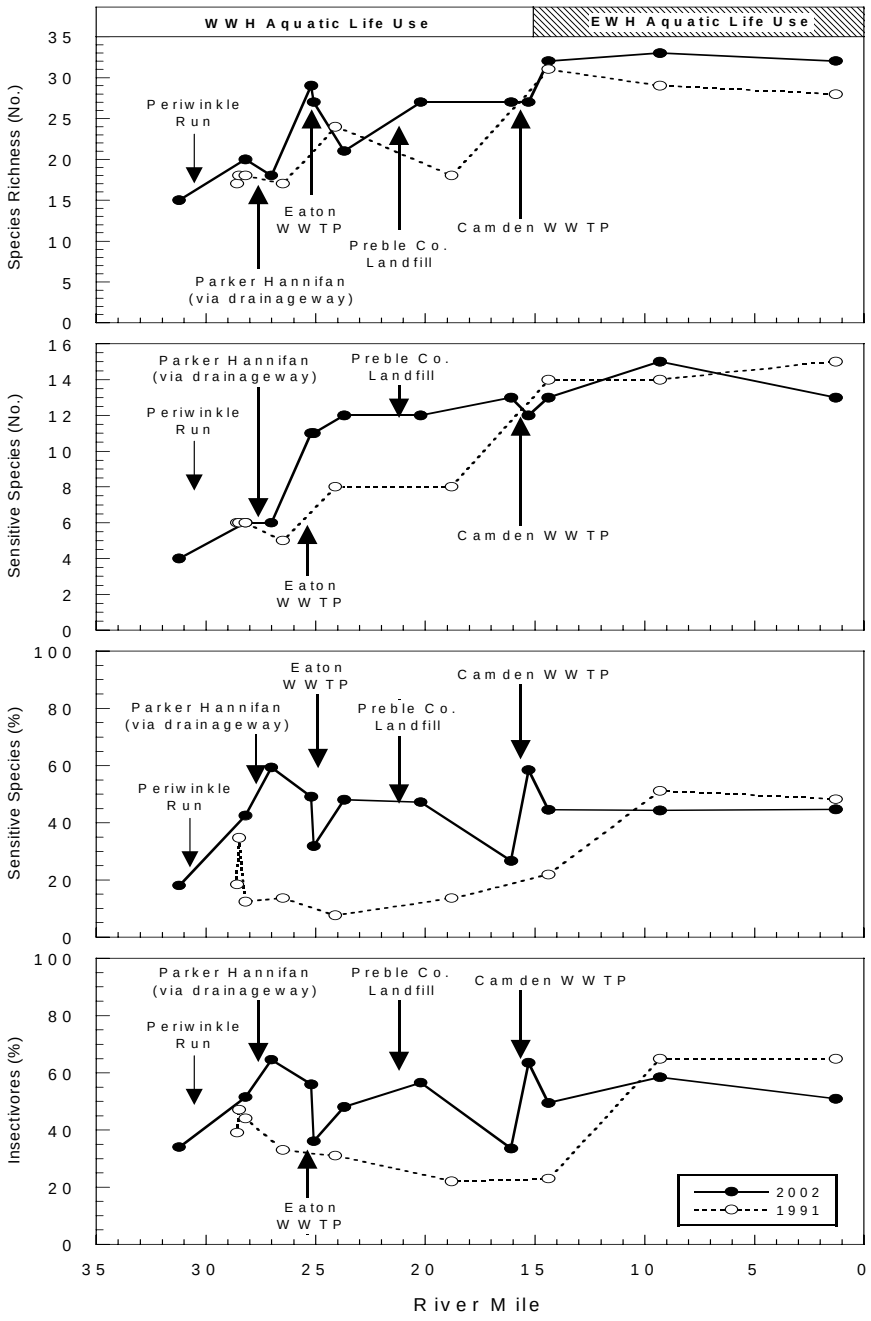


Figure 24. Longitudinal performance of selected fish community features for Sevenmile Creek, 1991-2002.

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