State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of the Paint Creek Watershed 2006

Hydrologic Units 05060003 010, 020, 030, 040, 050, 060, 070, 080, 090, 100.

Clinton, Fayette, Greene, Highland, Madison, and Ross Counties

OHIO EPA Technical Report EAS/2008-1-2

August 29, 2008

Ted Strickland, Governor, State of Ohio
Chris Korleski, Director

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= greater than the severe effect level). All metals parameters are compared with ecoregional (default) or statewide (noted by a subscript s) sediment reference values determined by Ohio EPA (Ohio EPA, 2003). Metals values in **boldface** and shaded are greater than the reference value. Boxes with no value were analyzed but not detected. 81

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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. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989b. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 1989c. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. Water Quality Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 1990. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

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, the following new publications by the Ohio EPA have become available. These publications should also be consulted as they represent the latest information and analyses used by the Ohio EPA to implement the biological criteria.

DeShon, J.D. 1995. Development and application of the invertebrate community index (ICI), pp. 217-243. in W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Rankin, E. T. 1995. The use of habitat assessments in water resource management programs, pp. 181-208. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological criteria program development and implementation in Ohio, pp. 109-144. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological response signatures and the area of degradation value: new tools for interpreting multimetric data, pp. 263-286. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. 1995. Policy issues and management applications for biological criteria, pp. 327-344. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. The role of biological criteria in water quality monitoring, assessment, and regulation. Environmental Regulation in Ohio: How to Cope With the Regulatory Jungle. Inst. of Business Law, Santa Monica, CA. 54 pp.

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

Ohio EPA, Division of Surface Water
Ecological Assessment Section
4675 Homer Ohio Lane
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(614) 836-8777

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Copies of this report are located on the Ohio EPA internet web page (www.epa.state.oh.us/dsw/document_index/psdindx.html) or may be available on CD 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 4-5 watersheds study areas with an aggregate total of 250-300 sampling sites.

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

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

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators consisting of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach includes a hierarchical continuum from administrative to true environmental indicators (Figure i). 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

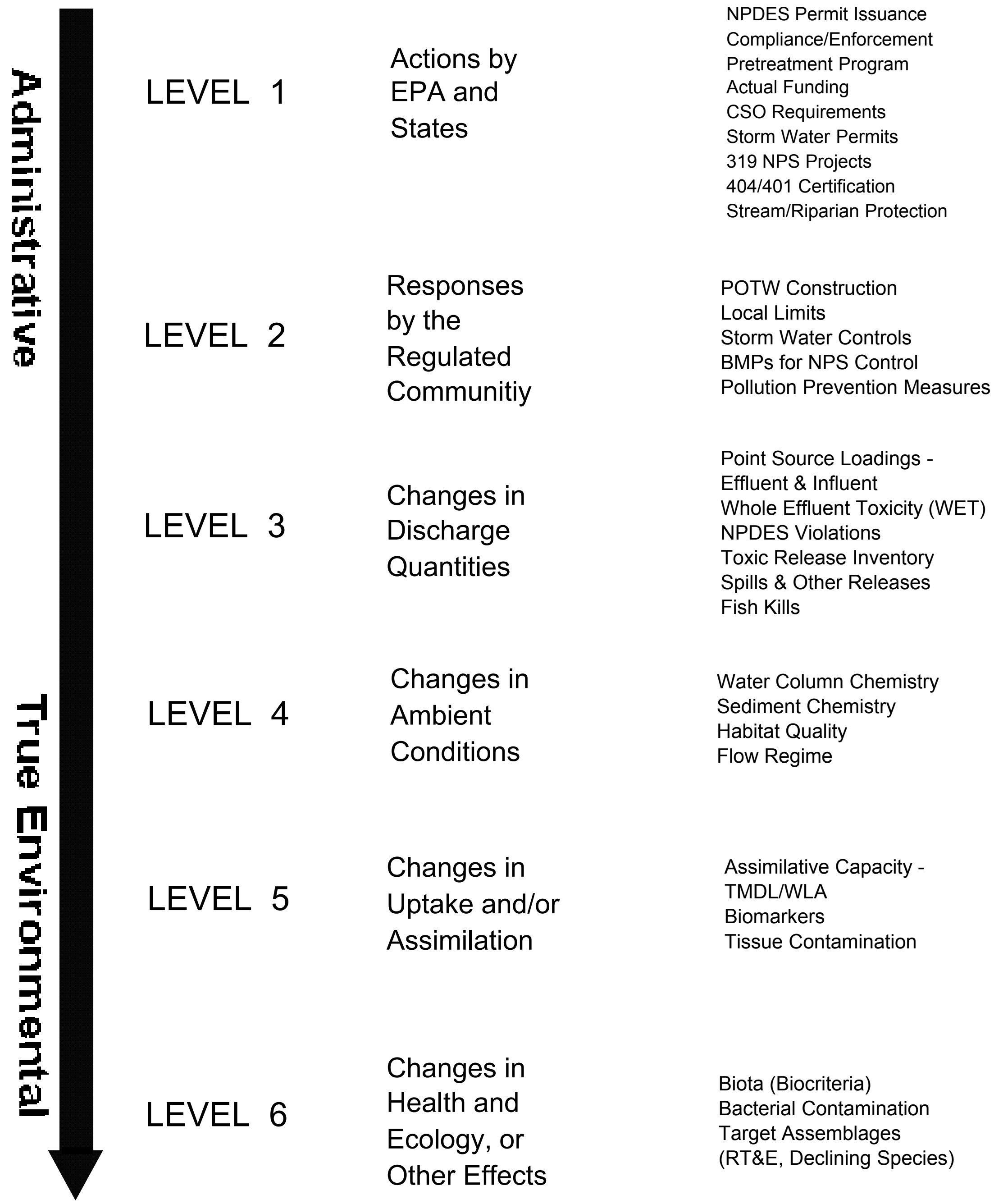

Figure i. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by the U.S. EPA.

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

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

Ohio Water Quality Standards: Designated Aquatic Life Use

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

1) *Warmwater Habitat (WWH)* - this use designation defines the “typical” warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.*

2) *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support “unusual and exceptional” assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.,* declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio’s best water resources.*

3) *Cold-water Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic “runs” of salmonids during the spring, summer, and/or fall.

4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned by state or federal law;* the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.

5) *Limited Resource Water (LRW)* - this use applies to small streams (usually <3 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 can be having a water depth of at least one meter over an area of at least 100 square feet or, lacking this, where frequent human contact is a reasonable expectation. If a water body does not meet either criterion, the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.,* fecal coliform, *E. coli)* and the criteria for each are specified in the Ohio WQS.

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

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

Introduction

A biological and water quality survey of the Paint Creek watershed was conducted in 2006. The geographic scope of the survey included the entire drainage basin, comprising ten hydrologic units (see **Study Area** for a description of the hydrologic units). Objectives of the survey were to determine the status of recreational and aquatic life uses, assign causes and sources of impairment where appropriate (Table 1), assess performance of National Pollution Discharge Elimination System (NPDES) permitted dischargers, and support development of Total Maximum Daily Loads for stream segments identified as impaired or threatened. Recommended changes and additions to aquatic life uses are summarized in Appendix Table 11.

The following publicly owned wastewater treatment plants were evaluated:

Facility	Receiving Stream
Bloomingburg WWTP	East Fork Paint Creek
Jeffersonville WWTP	Sugar Creek
New Holland WWTP	North Fork Paint Creek
South Solon WWTP	Rattlesnake Creek
Washington Court House WWTP	Paint Creek
Pleasant Valley Reg Sewer District	North Fork Paint Creek
Frankfort WWTP	North Fork Paint Creek
Greenfield WWTP	Paint Creek
Hillsboro WWTP	Clear Creek
Leesburg WWTP	Lees Creek
Rocky Fork Regional WWTP	Rocky Fork (Lake)

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]).

Executive Summary

CAUSES AND SOURCES - Water quality in Paint Creek is influenced by physical habitat quality, agricultural landuses, and treated wastewater effluent (Figure 1). Row crop and livestock agriculture in the northern half of the basin contributes nitrogen and phosphorus via synthetic fertilizer and manure. Together, physical habitat quality, nutrient concentrations, and dissolved oxygen account for about half the variation in both fish IBI scores and the number of EPT taxa (a key macroinvertebrate metric) in samples collected throughout the basin. Poor physical habitat quality from stream ditching in the northern and western portions of the basin, apart from being directly limiting to aquatic life, limits the capacity of the stream network to process and assimilate nutrients and other pollution. This effect is most evident in the upper

Paint Creek (including the East Fork), Sugar Creek and Rattlesnake Creek sub-basins, and is manifest in routinely low dissolved oxygen concentrations.

Localized impacts due to organic enrichment from livestock were rare, but scattered throughout the basin. Under-treated municipal wastewater was a source of organic enrichment to Clear Creek downstream from Hillsboro, and the North Fork downstream from Frankfort. In the latter case, dilution prevented impacts to aquatic life. Ammonia toxicity to Wilson Creek from a failing collection system serving the Village of Sabina was noted. A minor impact from nutrient enrichment due to municipal wastewater was evident in the mainstem of Paint Creek in the reach between Washington Court House and Paint Creek Reservoir.

Watershed Overview - The portion of the watershed north of Washington Court House is Wisconsin till plain, and has the low relief and rich soils conducive to intensive rowcrop agriculture. However, because some of the soils in this part of the basin, particularly those in the Rattlesnake Creek subwatershed, are poorly drained due to high clay content, most of the stream drainage network has been ditched to help lower the water table and expedite surface drainage. Other areas that are actively maintained for drainage include the mainstem of Sugar Creek and its tributaries upstream from Jeffersonville, and the headwaters of the East Fork. In the North Fork subwatershed, soils are generally coarser and better drained, and stream gradients are relatively high. So although the stream network was historically ditched, most streams in the North Fork have recovered many important features typical of natural streams.

South of the Wisconsin glacial boundary, the watershed is more dissected given the older age of the Illinoisan deposits, and highly dissected along the southern edge of the unglaciated Appalachian foothills. As such, the landscape is not as well suited to row crop agriculture, so landuse changes over to a greater percentage of pasture and forest cover.

The condition of biological communities varies across this east-west, and north-south gradient. No streams were impaired in the North Fork drainage, whereas over seventy-five percent of the sites sampled in the upper Paint Creek (including the East Fork) and Rattlesnake subbasins were impaired. Roughly one third of the sites in Sugar Creek were impaired. In the North Fork, where streams have largely recovered natural features, the improved habitat supports more species of fish, notably those dependent on pools (e.g., longear sunfish, striped shiners, golden redhorse, rockbass, smallmouth bass) and clean substrates (i.e., darters) than streams to the west.

In the southern half of the basin, where the stream network is mostly natural (or has recovered natural function), biological communities are generally in good shape. Improved water quality from better wastewater treatment, and decreased sediment from soil conservation measures have allowed bigeye chub, a species sensitive to sediment pollution, to expand its range in the watershed. Prior to 2006, bigeye chubs were only observed in Clear Creek, but now are found in the North Fork, Little Creek and Buckskin Creek. The mainstem of Paint Creek downstream from Bainbridge supports a diverse and exceptional aquatic fauna, and serves as a source population refuge for large river fish species in the Scioto basin.

Table 1. Attainment status (existing or recommended), and causes and sources of impairment to sites* sampled during the 2006 Paint Creek Biological and Water Quality Survey. Scoring criteria is for Eastern Cornbelt Plains unless otherwise noted. Mixing zones are noted in italic font.

RM	Drain	QHEI	IBI	MIWb	ICI	ATTAINMENT	SOURCES	CAUSES
05060003 010								
02-500	**Paint Creek**			***WWH-Existing***				
96.00	31.0	65.5	36 ns	8.5	V.Good	Full		
80.00	54.0	62.0	39 ns	6.6*	54	Partial	Ag - row crop and livestock	Sedimentation, D.O.
75.30	58.0	77.0	35*	7.4*	46	Partial	Ag - row crop and livestock	Sedimentation, D.O.
73.30	60.0	66.0	33*	6.6*	46	Partial	Ag - row crop and livestock	Nutrient Enrichment, D.O. & Sediment
70.90	63.0	64.5	49	9.4	42	Full		
69.70	67.0	38.0	41	7.8	28*	Partial	Channelization, Urban runoff	Hydromod (flow & habitat), Nutrients, D.O.
69.40	*67.0*	*0.0*	*48*	*7.2**	*Poor**			
69.40	*67.0*	*0.0*	*30**	*6.9**				
69.20	67.0	40.5	42	8.2	24*	Partial	Channelization, Urban runoff , WWTP	Habitat assessment, Nutrients
02-580	**E. Fk. Paint Creek**			***WWH-Existing***				
8.60	28.0	44.0	35*	7.1*	24*	Non	Channelization - Ag	Sedimentation, D.O.
5.10	33.0	56.0	36 ns	8.1	34	Full		
0.70	50.4	63.0	41	7.6*	40	Partial	Channelization - Ag	Sedimentation, D.O.
02-678	**Vallery Ditch**			***MWH-Recommended***				
2.30	5.5	56.0	42		Fair	Full		
05060003 020								
02-579	**Sugar Creek**			***MWH-Recommended, previously unsampled***				
36.90	5.3	38.0	32		Fair	Full		
				WWH-Existing				
29.20	23.0	60.0	42	7.6*	28*	Partial	Ag - row crop	Habitat, Nutrient Enrichment, D.O.
24.80	27.0	48.5	38 ns	6.9*	26*	Partial	Ag - livestock, Minor muni WWTP	Habitat, Nutrient Enrichment, D.O.

*Randomly selected headwater sites are listed in Appendix Table 9.

Table 1. Continued.

RM	Drain	QHEI	IBI	MIWb	ICI	ATTAINMENT	SOURCES	CAUSES
05060003 020								
02-579	**Sugar Creek**			***WWH-Existing***				
18.60	47.0	60.5	48	8.9	56	Full		
12.00	61.0	69.0	48	7.2*	56	Partial	Ag - row crop, livestock	Nutrient Enrichment
5.40	72.0	73.0	45	7.9	46	Full		
4.20	75.0	76.0	54	9.0	50	Full		
05060003 030								
02-550	**Rattlesnake Creek**			***WWH-Existing***				
40.40	16.5	51.5	44		Good	Full		
38.10	25.0	59.5	27*	6.3*	M. Good	NON	Channelization - Ag	Habitat, D.O.
35.20	34.0	58.0	27*	5.9*	38	NON	Channelization - Ag	Habitat
31.40	40.8	49.0	31*	6.0*	34	Partial	Channelization - Ag	Habitat
24.00	110.0	52.0	33*	6.4*	44	Partial	Channelization - Ag	Habitat
15.00	125.0	71.0	43	7.6*	44	Partial	Channelization - Ag	Sedimentation
13.30	128.0	77.5	45	8.3	Except	Full		
02-562	**W Br Rattlesnake Cr.**			***WWH-Existing/MWH Proposed***				
11.40	6.3	27.0	32		Fair	None/Full	Habitat alteration - Ag	Sedimentation, D.O.
				WWH-Existing				
4.30	15.8	53.0	32*		38	Partial	Channelization - Ag	Sedimentation
2.80	41.6	46.5	37 ns	7.5*	22*	Partial	Channelization - Ag	Sedimentation, D.O.
02-563	**Wilson Creek**			***MWH-Recommended***				
5.00	11.3	38.0	36 ns					
3.80	17.8	43.0	32		Low Fair*	Partial	Urban Runoff, Channelization - Ag	Unknown toxicity, Habitat
2.90	18.4	--	--		Poor*		Urban Runoff, Channelization - Ag	Unknown toxicity, Habitat

Table 1. Continued.

RM	Drain	QHEI	IBI	MIWb	ICI	ATTAINMENT	SOURCES	CAUSES
05060003 030								
02-563	**Wilson Creek**			***MWH-Recommended***				
2.80	18.4	44.0	26		16	Partial	Minor municipal WWTP	Toxicity (ammonia), organic enrichment
02-598	**Trib. to Rattlesnake**			***MWH-Recommended***				
1.10	4.6	37.0	24		M. Good	Full		
05060003 040								
02-550	**Rattlesnake Creek**			***WWH-Existing***				
7.90	209.0	71.3	50	9.0	52	Full		
02-552	**Fall Creek**			***WWH-Recommended***				
7.50	3.7	58.5	34*		M. Good	Partial	Ag - row crop and livestock	Nutrient & Organic Enrichment
1.60	13.3	67.0	38		Except	Full		
02-554	**Hardin Creek**			***WWH-Recommended***				
5.80	2.8	61.3	47		Good	Full		
0.90	20.5	74.0	50	8.8	54	Full		
02-557	**Walnut Creek**			***WWH-Existing***				
4.20	5.7	64.3	50		Except	Full		
0.60	13.4	75.8	44		V. Good	Full		
02-558	**Lees Creek**			***WWH-Existing***				
10.40	14.3	36.5	40		Good	Full		
4.50	25.6	76.0	53	9.2	48	Full		
1.20	73.0	76.8	51	9.1	42	Full		
02-559	**M. Fk. Lees Creek**			***WWH-Existing***				
5.10	12.4	70.0	56		M. Good	Full		

Table 1. Continued.

RM	Drain	QHEI	IBI	MIWb	ICI	ATTAINMENT	SOURCES	CAUSES
05060003 040								
02-559	**M. Fk. Lees Creek**		***WWH-Existing***					
1.10	36.1	53.8	51	9.3	38	Full		
02-560	**S. Fk. Lees Creek**		***WWH-Recommended***					
1.30	16.0	50.5	44		M. Good	Full		
05060003 050								
02-500	**Paint Creek**		***EWH-Existing***					
67.20	120.0	61.0	44*	9.5	44	Partial	Marginal Habitat for EWH	Natural
63.30	131.0	68.5	46	10.1	48	Full		
58.80	224.0	83.0	52	9.9	50	Full		
52.50	249.0	78.5	48	9.1	50	Full		
48.90	261.0	83.0	44*	8.5*	54	Partial	Municipal WWTP	Nutrient/Organic Enrichment
39.00	570.0	82.0	46	10.2	18*	Partial	Impoundment	Enrichment/Low D.O.
02-578	**Wabash Creek**		***WWH-Recommended***					
0.80	4.6	67.0	44		M. Good	Full		
05060003 060								
02-530	**Rocky Fork Paint Cr.**		***EWH-Existing***					
23.30	16.2	55.5	56		46	Full		
18.00	33.0	58.0	49	10.1	46	Full		
4.50	138.0	--	--	--	40		Impoundment	Nutrient Enrichment
3.10	140.0	88.5	44	9.5	Except	Full		

Table 1. Continued.

RM	Drain	QHEI	IBI	MIWb	ICI	ATTAINMENT	SOURCES	CAUSES
05060003 060								
02-532	**Pickett Run**			***Interior Plateau WWH/CWH-Recommended****				
0.10	1.8	50.5	44		Good	All		
02-540	**Clear Creek**			***EWH-Existing***				
11.30	7.4	68.0	58		V. Good	Full		
8.30	20.1	70.8	51	9.3	42	Full		
6.80	24.9	74.5	53	9.9	50	Full		
6.60	25.1	71.5	49	9.7	38	Partial	Municipal WWTP	Organic Enrichment/D.O.
5.40	28.0	59.0	52	9.7	Good	Partial	Municipal WWTP	Municipal WWTP
2.60	40.0	65.5	49	9.2	54	Full		
02-585	**Moberly Branch**			***WWH-Existing***				
0.90	2.5	66.0	58		Fair*	Partial	Urban runoff	Unknown Toxicity
05060003 070								
02-500	**Paint Creek**			***EWH-Existing***				
32.50	773.0	81.0	46	11.2	32[ns]	Partial	Impoundment	Enrichment/Low D.O
27.50	788.0	84.5	51	10.8	48	Full		
21.60	807.0	80.0	53	11.0	50	Full		
02-545	**Lower Twin Creek**			***Western Allegheny Plateau EWH-Recommended***				
2.20	15.0	78.0	58		Except	Full		
02-546	**Upper Twin Creek**			***Western Allegheny Plateau EWH-Recommended***				
5.80	5.5	75.0	60		V. Good	Full		
1.70	12.7	70.0	58		Except	Full		
02-564	**Buckskin Creek**			***EWH-Recommended***				
3.10	36.4	74.0	54	9.9		Full		
0.40	39.7	77.5	53	9.7	52	Full		

Table 1. Continued.

RM	Drain	QHEI	IBI	MIWb	ICI	ATTAINMENT	SOURCES	CAUSES
05060003 080								
02-510	**N. Fk. Paint Creek**			***EWH-Existing***				
42.00	11.0	72.5	50		V. Good	Full		
31.00	45.0	72.5	52	10.1	48	Full		
26.60	51.1				46			
02-522	**Compton Creek**			***WWH-Recommended (Previously Unsampled)***				
17.60	13.2	55.0	48		Good	Full		
				EWH-Existing				
11.20	19.9	74.0	54		36	Partial	Channelization - Ag	Habitat
3.40	48.7	71.5	55	9.9	Except	Full		
1.10	59.0				50			
02-524	**Mud Run**			***WWH-Recommended***				
0.40	7.3	67.5	50		Except	Full		
05060003 090								
02-510	**N. Fk. Paint Creek**			***EWH-Existing***				
22.30	122.0	84.0	55	10.4	50	Full		
17.00	153.0	84.0	56	10.8	V. Good	Full		
13.60	164.0	86.5	52	10.9	50	Full		
10.50	207.0	79.0	56	10.5	56	Full		
3.90	230.0	81.5	58	10.7	56	Full		
2.30	232.0	75.0	58	10.7	54	Full		
02-511	**Biers Run**			***WWH-Recommended***				
1.50	7.1	61.5	52		Good	Full		
02-516	**Little Creek**			***WWH-Recommended***				
5.60	9.3	63.0	52		Good	Full		
1.00	22.7	58.8	45	8.8		Full		

Table 1. Continued.

RM	Drain	QHEI	IBI	MIWb	ICI	ATTAINMENT	SOURCES	CAUSES
05060003 100								
02-500	**Paint Creek**			***EWH-Existing***				
8.90	895.0	82.0	56	11.4	56	Full		
3.80	1138.0	83.5	54	10.6	52	Full		
				WWH-Existing				
0.70	1144.0	79.0	45	10.0	42	Full		
02-527	**Cattail Run**			***CWH-Recommended***				
1.20	2.9	47.0	50		V. Good	Full		
02-528	**Owl Creek**			***CWH-Recommended***				
0.30	6.5	65.0	48		V. Good	Full		
02-529	**Plug Run**			***CWH-Recommended***				
0.40	5.4	68.5	48		Except	Full		
02-543	**Black Run**			***CWH-Recommended***				
3.90	5.0	61.0	52		V. Good	Full		
				WWH-Recommended				
1.00	8.6	40.5	54		M. Good	Full		

Biological Criteria – Eastern Corn Belt Plains (EWH criteria apply across ecoregions)									
	IBI			MIwb			ICI		
	EWH	WWH	MWH	EWH	WWH	MWH	EWH	WWH	MWH
Boat	48	42	24	9.6	8.5	5.8	46	36	22
Wading	50	40	24	9.4	8.3	6.2	46	36	22
Headwaters	50	40	24	NA	NA	NA	46	36	22

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	Use Designations													
		Aquatic Life Habitat						Water Supply			Recreation			
Water Body Segment	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	Comments
Paint creek - at RM 71.4		*/+						o	*/+	*/+		*/+		PWS intake - Washington Court House
- U.S. rte. 35 (RM 67.4) to Paint creek reservoir (RM 46.5)			+						*/+	*/+		*/+		
- Paint creek reservoir (RM 46.5) to st. rte. 772 (RM 3.8)			+						+	+		+		
- st. rte. 772 (RM 3.8) to the mouth		+							+	+		+		
- all other segments		*/+							*/+	*/+		*/+		
North fork			+						+	+		+		
Biers run		*/+							*/+	*/+		*/+		
Mad run		*							*	*		*		
Anderson run		*							*	*		*		
Sulphur lick		*							*	*		*		
Dry run		*							*	*		*		
Little creek		*/+							*/+	*/+		*/+		
Dewey creek		*							*	*		*		
Oldtown run		*							*	*		*		
McCortney run		*							*	*		*		
Herrod creek		*							*	*		*		
Whetstone run		*							*	*		*		
Compton creek			+						+	+		+		
- upstream Dews Run (RM 11.3)		Δ	+						+	+		+		

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	Use Designations													
		Aquatic Life Habitat						Water Supply			Recreation			
Water Body Segment	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	**Comments**
Crooked creek		*/+							*/+	*/+		*/+		
Mud run		*/+							*/+	*/+		*/+		
Thompson creek		*/+							*/+	*/+		*/+		
Ralston run		*							*	*		*		
Cattail run		*				Δ			*/+	*/+		*/+		
Owl creek		*				Δ			*/+	*/+		*/+		
Plug run		*				Δ			*/+	*/+		*/+		
Black run		*/+							*/+	*/+		*/+		
- ust Spruce Hill Road (RM 1.0)						Δ			*/+	*/+		*/+		
Mine run		*							*	*		*		
Lower Twin creek		*	Δ						*/+	*/+		*/+		
Upper Twin creek		*	Δ						*/+	*/+		*/+		
Proud run		*							*	*		*		
Sulphur lick		*							*	*		*		
Minnehan run		*							*	*		*		
Buckskin creek downstream from Cliff Run Road (RM 5.75)		*	Δ						*/+	*/+		*/+		
headwaters to Cliff Run Road		*/+							*/+	*/+		*/+		
Slate run		*							*	*		*		
North fork		*							*	*		*		

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Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Cove run		*							*	*		*		
Massie run		*							*	*		*		
Rocky fork			+						+	+		+		
Factory branch	*		*						*	*		*		
Pickett run	*		*			Δ			*/+	*/+		*/+		
Heads branch	*		*						*	*		*		
Puncheon run	*		*						*	*		*		
Franklin branch	*		*						*	*		*		
Plum run	*		*						*	*		*		
Blinco branch	*		*						*	*		*		
Churn creek	*		*						*	*		*		
Smith branch	*		*						*	*		*		
Clear creek - at RM 7.4			+					o	+	+		+		PWS intake - Hillsboro
- all other segments			+						+	+		+		
Moberly branch		+							+	+		+		
Hussey run	*		*						*	*		*		
Little Rock Creek		Δ							Δ	Δ		Δ		
Fenner Tributary to Clear Creek		Δ							Δ	Δ		Δ		

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Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
South fork	*		*						*	*		*		
Tributary to Rocky Fork at RM 17.55		Δ							Δ	Δ		Δ		
Cliff creek		*							*	*		*		
Plum run		*							*	*		*		
Rattlesnake creek		+							+	+		+		
Cedar run		*							*	*		*		
Fell creek		*							*	*		*		
Big branch		*/+							*/+	*/+		*/+		
Hardin creek		*/+							*/+	*/+		*/+		
Bull creek		*							*	*		*		
Bridgewater creek		*							*	*		*		
Walnut creek		+							+	+		+		
Lees creek		+							+	+		+		
Middle fork		+							+	+		+		
South fork		*/+							*/+	*/+		*/+		
West Branch Rattlesnake - Downstream Pearson Road (RM 9.8)		+							+	+		+		
Headwaters to Pearson Road (RM 9.8)				Δ					+	+		+		
Grassy branch		*							*	*		*		
Wilson creek		*		Δ					*/+	*/+		*/+		

Table 2. Use designations for water bodies in the Paint Creek basin updated based on the results of the 2006 survey. Asterisks denote existing uses unverified by intensive surveys. Unverified existing uses confirmed by the present survey are noted by */+. Use changes recommended based on the results of the 2006 survey are noted by a delta (Δ) symbol.

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Unnamed Tributary to Rattlesnake Creek at RM 40.21		*		Δ					*/+	*/+		*/+		
Opossum run		*							*	*		*		
Farmers run		*							*	*		*		
Duncan run		*							*	*		*		
Sugar run		*							*	*		*		
Holliday run		*							*	*		*		
Stone run		*							*	*		*		
Buck run		*							*	*		*		
Indian creek		*							*	*		*		
Wabash creek		*/+							*/+	*/+		*/+		
Sugar creek Headwaters to Carrs Mill-Jamestown Road (RM 32.2)				Δ					+	+		+		
Sugar Creek Carrs Mill-Jamestown Road to Mouth		+							+	+		+		
East fork		+							+	+		+		
Big run		*							*	*		*		
Brock ditch		*							*	*		*		
Vallery ditch		*		Δ					*/+	*/+		*/+		
County ditch		*							*	*		*		

SRW = state resource water; WWH = warmwater habitat; EWH = exceptional warmwater habitat; MWH = modified warmwater habitat; SSH = seasonal salmonid habitat; CWH = coldwater habitat; LRW = limited resource water; PWS = public water supply; AWS = agricultural water supply; IWS = industrial water supply; BW = bathing water; PCR = primary contact recreation; SCR = secondary contact recreation.

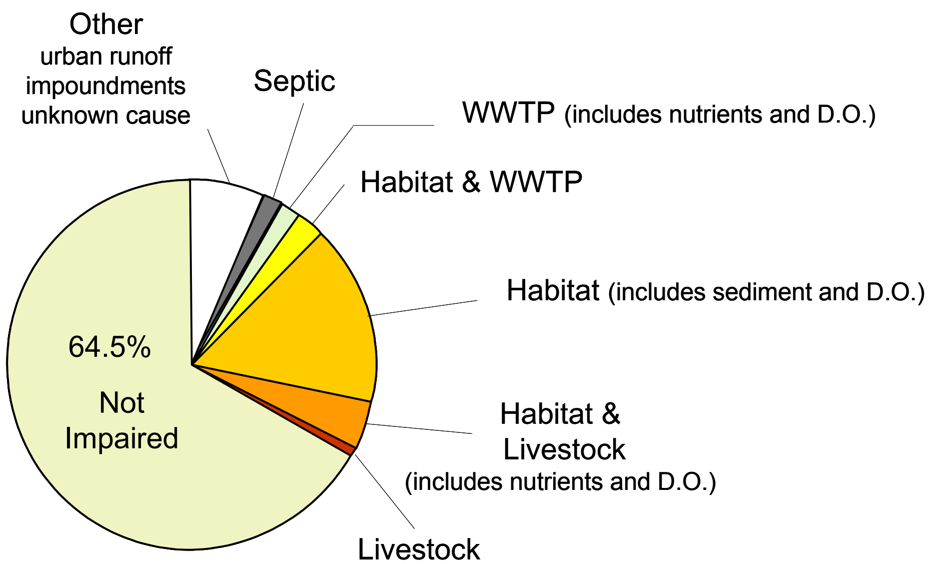


Figure 1. Impairment noted during the 2006 Paint Creek survey apportioned by source.

Recommendations - Hydrologic Unit 05060003 010 (Paint Creek mainstem and tributaries north of Washington C.H.)

Status of Non-aquatic Life Uses
All non-aquatic life uses should remain as presently designated in the Ohio Water Quality Standards for all of the waters surveyed within the hydrologic unit unless specifically noted. These standards presently include the public water supply uses at RM 71.4 of the Paint Creek mainstem, agricultural and industrial water supply, and primary contact recreation.

Paint Creek (02-500)
Status of Aquatic Life Uses
The warmwater habitat (WWH) aquatic life use assigned to the Paint Creek mainstem upstream from its confluence with the East Fork is appropriate. That use was partially met over most of its length, and the reasons for the impairment, in order of magnitude, are: poor habitat quality due to excessive sediment, enrichment from livestock and rowcrop agriculture, and poor habitat due to channelization in Washington Court House.

Other Recommendations and Future Monitoring Concerns
Reducing sediment and nutrient loads via agricultural best management practices, reforesting floodplains where practical, using modern channel designs for small drainage ditches and channelized tributary streams, and wetland restoration is recommended. Modern channel designs include natural channel design, especially for very small headwaters that lack the power to recover natural channel features, and over-wide or two-stage ditch designs for streams having the power and available substrate to self-form natural features. Wetland restoration includes reforesting of riparian areas, restoration of drained pocket wetlands, and creation of farm runoff

wetlands to intercept tile drainage (Mitsch and Day 2006). Additionally, wherever pastures are grazed at high densities, restricting access to streams by livestock is recommended to reduce organic enrichment and sedimentation. This list of prescriptive recommendations is broadly applicable, but most specifically to headwaters in the northern half of the basin.

The reach of Paint Creek flowing through Washington Court House is constrained by developed land. However, immediately downstream from town, undeveloped, former floodplain could be reconnected with the creek to help move the sediment load in a more organized fashion. Restoration of natural features in this reach, especially functional riffles, would augment the assimilative capacity of the stream.

East Fork Paint Creek (02-580)

Status of Aquatic Life Uses

The East Fork is designated WWH, and that use was not met at two of three sites surveyed because of poor habitat quality from historic channelization, and sedimentation from current sources. The sediment load to the East Fork appears to come primarily from channelized headwaters. Low stream gradient is likely to preclude passive recovery of natural features in the mainstem; therefore the sediment load will have to be reduced through active measures in the headwaters.

Vallery Ditch (02-678)

Status of Aquatic Life Uses

Vallery Ditch is presently undesignated, but actively maintained for agricultural drainage. The fish community met expectations for a small, warmwater habitat stream. The stream supported two prairie species, the least darter and the western creek chubsucker. Additionally, several other species characteristic of hydrologically stable (relatively speaking) settings were present, notably rainbow darters and striped shiners. The macroinvertebrate community was limited by sediment, and rated fair. Modern channel designs (either two-stage or naturalized channel) to facilitate sequestration of sediment, and best management practices (BMPs) to prevent soil loss in the surrounding uplands are encouraged to augment the potential of Vallery Ditch, and help alleviate sedimentation in the East Fork.

Status of Non-aquatic Life Uses

Vallery Ditch is recommended for a primary contact recreation, and agricultural and industrial water supply.

Recommendations - Hydrologic Unit 05060003 020 (Sugar Creek and its tributaries)

Sugar Creek (02-579)

Status of Non-aquatic Life Uses

Unless otherwise noted, industrial, agricultural and primary contact recreational uses apply as presently designated in the Ohio Water Quality Standards.

Status of Aquatic Life Uses

Sugar Creek is designated WWH. It is actively maintained, along with its tributaries, as a ditch upstream from Carrs Mill-Jamestown Road (RM 32.2), and, axiomatically, the biological communities in the modified reach do not meet WWH. That reach is therefore recommended for modified warmwater habiat. Apart from the obvious limitations posed by degraded habitat, nutrient enrichment, interacting with the poor habitat, is an added stress. The footprint caused by the degraded headwaters extends well downstream to at least US 22 (RM 12.0). The reach between McKillip Road (RM 29.2) and Creamer Road (RM 24.8), however, has a very high potential to support a desirable fish community given that the reach has baseflow sustained by groundwater and surficial deposits amenable to passive recovery.

Other Recommendations and Future Monitoring Concerns
Clearly, habitat restoration is needed to help process and sequester nutrient loads in an orderly manner. Creation of an active floodway, where the stream is allowed to meander and riparian vegetation allowed to undergo normal succession, is recommended.

Recommendations - 05060003 030 (Rattlesnake Creek and its tributaries upstream from the confluence with Lees Creek)

Status of Non-aquatic Life Uses
Unless otherwise noted, industrial, agricultural and primary contact recreational uses apply as presently designated in the Ohio Water Quality Standards.

Rattlesnake Creek (02-550)
Status of Aquatic Life Uses
Rattlesnake Creek is designated WWH. Most of its tributaries are actively maintained as ditches, and the mainstem was historically channelized for drainage. Unlike Sugar Creek, the potential for recovery in the mainstem of Rattlesnake Creek is limited by high clay-content soils, and low baseflow. Consequently, habitat is presently less than optimal, and the WWH use was not met at five of seven stations sampled. Downstream from Zimmerman Road (RM 15), Rattlesnake Creek has sufficient gradient and habitat to expect fish and macroinvertebrates to meet WWH; however, the site at Zimmerman Road only partially met the biocriteria. The site at Fishback Road (RM 13.3) fully met WWH.

Other Recommendations and Future Monitoring Concerns
Channelization projects to the mainstem of Rattlesnake Creek should be discourage to allow the habitat to recover.

West Branch Rattlesnake (02-562)
Status of Aquatic Life Uses
The West Branch is designated WWH, but that use was not met. For the same reasons stated for the Rattlesnake mainstem, the West Branch lacks the potential for recovery over the short-term.

Status of Non-aquatic Life Uses
Based on results of the present survey, sufficient channel depth and width exists in the West Branch of Rattlesnake Creek to warrant a Primary Contact Recreational use.

Wilson Creek (02-563)

Status of Aquatic Life Uses

Wilson Creek presently has an unconfirmed, default WWH aquatic life use. Though not a petitioned ditch, Wilson Creek is actively maintained for agricultural and residential drainage, and as such, presently has limited potential to fully support WWH aquatic life. Therefore, a MWH use is recommended. Apart from the limitations imposed by channelization, leaky sanitary sewers and organic enrichment from the Sabina WWTP were sources of impairment.

Other Recommendations and Future Monitoring Concerns

Restoration in Wilson Creek should be directed towards fixing the sewerage system in Sabina to alleviate unsanitary conditions.

U.T. to Rattlesnake Creek at RM 40.21 (02-598)

Status of Aquatic Life Uses

This small, headwater tributary to Rattlesnake Creek, though not a county maintained ditch, was historically ditched for drainage. It lacks the attributes necessary to support a WWH community. Given the limitations of small drainage area, high clay soils and low gradient, it is not likely to passively recover those attributes over the next several decades. A modified warmwater habitat use is therefore recommended. The biological communities present were consistent with modified habitat.

Recommendations – Hydrologic Unit 05060003 040 (Lees Creek, Walnut Creek, Hardin Creek, Fall Creek and the Rattlesnake mainstem downstream from Lees Creek)

Status of Non-aquatic Life Uses

Unless otherwise noted, industrial, agricultural and primary contact recreational uses apply as presently designated in the Ohio Water Quality Standards.

Rattlesnake Creek (02-550)

Status of Aquatic Life Uses

The one site sampled on the Rattlesnake mainstem in the 040 hydrologic unit (RM 7.9, Centerfield Road) fully met WWH, confirming the appropriateness of that existing use.

Fall Creek (02-552)

Status of Aquatic Life Uses

Fall Creek has an unconfirmed, default WWH aquatic life use. That use is appropriate based on samples collected in 2006. That use, however, was narrowly missed at one of the two sites sampled (SR 138, RM 7.5) due to sedimentation, and nutrient and organic enrichment from livestock.

Other Recommendations and Future Monitoring Concerns

The magnitude of impairment at this site is relatively small and could best be addressed through a comprehensive watershed plan that encourages agricultural BMPs.

Hardin Creek (02-554)

Status of Aquatic Life Uses

Hardin Creek has an unconfirmed WWH aquatic life use. Results from the 2006 survey fully support and confirm that use given the good habitat quality and regionally typical faunas found there.

Walnut Creek (02-557)

Status of Aquatic Life Uses

Walnut Creek has a confirmed WWH aquatic life use. That use was fully supported as indicated by samples collected during the 2006 survey.

Lees Creek (02-558)

Status of Aquatic Life Uses

Lees Creek has a field verified WWH aquatic life use. Samples collected from three sites in Lees Creek in 2006 fully support that designation. Lees Creek supports a good population of sport fish downstream from Leesburg.

Other Recommendations and Future Monitoring Concerns

A few instances of localized impairment in small tributaries to Lees Creek from unrestricted livestock access were noted. A comprehensive watershed plan should include strategies that encourage better livestock management wherever needed.

Middle Fork Lees Creek (02-559)

Status of Aquatic Life Uses

The Middle Fork of Lees Creek has a field verified WWH aquatic life use. That use was fully met at the two locations sampled in 2006.

South Fork Lees Creek (02-560)

Status of Aquatic Life Uses

The South Fork of Lees Creek has an unconfirmed WWH aquatic life use. The one site sampled adjacent to the Village of Highland confirms that use, at least for the reach downstream from SR 28 (RM 1.7) to the confluence with the Middle Fork.

Recommendations – Hydrologic Unit 05060003 050 Paint Creek mainstem downstream from the East Fork to the confluence with Rocky Fork

Status of Non-aquatic Life Uses

Unless otherwise noted, industrial, agricultural and primary contact recreational uses apply as presently designated in the Ohio Water Quality Standards.

Paint Creek (02-500)

Status of Aquatic Life Uses

Paint Creek is designated EWH downstream from US 35 (RM 67.4). The EWH aquatic life use was not met at three of six locations sampled. Immediately downstream from US 35, where the stream was historically channelized, and is contiguous with an actively channelized reach, the stream lacks the habitat attributes essential for EWH. Consequently, the fish community narrowly underperformed expectations. Habitat quality and stream gradient increases in the reach spanning Miami Trace, and the fish community improved to meet EWH. However, this reach experiences wide dissolved oxygen swings (≥ 5.0 mg/l) typical of nutrient enrichment. Stonerollers, a herbivore, were numerically the most abundant fish species sampled in this reach. Downstream from Greenfield, the high relative abundance of stonerollers resulted in partial attainment of the EWH aquatic life use.

Downstream from Paint Creek Reservoir, organic enrichment and low dissolved oxygen from hypolimnetic releases impaired the macroinvertebrate community.

Other Recommendations and Future Monitoring Concerns
Reduced phosphorus loads to this reach of Paint Creek would likely result in full attainment of the EWH aquatic life use.

Wabash Creek (02-578)
Status of Aquatic Life Uses
Wabash Creek has an unconfirmed WWH aquatic life use. Results from the 2006 survey fully support and confirm that use.

Recommendations – Hydrologic Unit 05060003 060 (Rocky Fork, Clear Creek and their tributaries)

Status of Non-aquatic Life Uses
Unless otherwise noted, industrial, agricultural, public water supply, and primary contact recreational uses apply as presently designated in the Ohio Water Quality Standards.

Rocky Fork of Paint Creek (02-530)
Status of Aquatic Life Uses
Rocky Fork has a confirmed EWH use. That use was met at the three sites sampled during the 2006 survey.

Other Recommendations and Future Monitoring Concerns
The site at US 62, though fully meeting EWH, had a nuisance bloom of algae when the fish were collected. Also a nuisance bloom of algae was noted in the dam pool upstream from Barrett Mill Road. Rocky Fork should be re-assessed in the near future to determine if these impacts were transient and due to the local incipient drought, or an indication of a persistent problem.

Clear Creek (02-540)
Status of Aquatic Life Uses
The verified EWH aquatic life use was fully met at four of six locations sampled in Clear Creek, and partially met at two locations downstream from the Hillsboro WWTP where organic enrichment and low dissolved oxygen stressed the macroinvertebrate community. The magnitude of impairment was relatively minor.

Other Recommendations and Future Monitoring Concerns
The Hillsboro WWTP is currently being expanded for greater treatment capacity, and that should address the impairment noted during the 2006 survey. Upgrades to the plant should be completed by 2010. A follow-up survey is recommended to confirm the expected full recovery.

Moberly Branch (02-585)
Status of Aquatic Life Uses
Moberly Branch has a field verified WWH aquatic life use. That use was not met because the macroinvertebrate community was impaired, presumably by urban stormwater from Hillsboro.

Other Recommendations and Future Monitoring Concerns
The amount of urban land upstream from the sampling location on Moberly Branch, estimated from satellite imagery, is roughly13 percent; an amount that represents a threshold beyond which biological impairment is increasingly likely. Maintaining the riparian buffers that presently exist between SR 73 and US 62, and downstream from US 62 to the confluence with Clear Creek is recommended to help attenuate any potential impact to Clear Creek. Retrofit opportunities for stormwater detention should be investigated.

Picket Run (02-532)
Status of Aquatic Life Uses
Picket Run is undesignated. The presence of 4 coldwater macroinvertebrate taxa in combination with mottled sculpin, blacknose dace and southern redbelly dace in samples collected at Ferneau Road indicate that a Coldwater Habitat aquatic life use is appropriate.

Recommendations – Hydrologic Unit 05060003 070 (Paint Creek from Rocky Fork to the Lower Twin Creek, Lower Twin Creek, Upper Twin Creek and Buckskin Creek)

Status of Non-aquatic Life Uses
All non-aquatic life uses should remain as presently designated in the Ohio Water Quality Standards for all of the waters surveyed within the hydrologic unit.

Paint Creek (02-500)
Status of Aquatic Life Uses
The EWH use for this reach of Paint Creek was fully met at two of the three locations sampled. Organic enrichment and low dissolved oxygen concentrations from hypolimnetic releases by the Paint Creek Reservoir impaired the macroinvertebrate community at the upstream-most sampling location (RM 31.7) near Bainbridge.

Lower Twin Creek (02-545)
Status of Aquatic Life Uses
Lower Twin Creek currently has an unverified, default WWH aquatic life use. The fish and macroinvertebrate communities sampled at RM 2.2 had very high biological integrity commensurate to the excellent habitat quality (QHEI = 78) found at the site and demonstrate that the lower 4.5 miles of Lower Twin Creek should be designated EWH.

Upper Twin Creek (02-546)
Status of Aquatic Life Uses
Upper Twin Creek has a default WWH aquatic life use. Sampling at two locations in 2006 show that the habitat quality was very good to excellent, and the fish and macroinvertebrates scored in the exceptional range. Collectively this demonstrates that the appropriate use is EWH.

Buckskin Creek (02-564)
Status of Aquatic Life Uses
Buckskin Creek currently has a default WWH use. Habitat quality in the excellent range as measured by the QHEI and fish and macroinvertebrate samples collected at two locations in the lower reach (from RM 5.0 downstream) indicated an appropriate designation should be EWH.

Other Recommendations and Future Monitoring Concerns
The upper third of the Buckskin Creek catchment is topographically flat and conducive to row crop agriculture. Consequently it suffers the general malaise typical of agricultural nonpoint pollution (i.e., sedimentation and nutrient enrichment). Conservation practices that keep soil on fields, creation of streamway buffers, and judicious use of fertilizers is recommended.

Recommendations – Hydrologic Unit 05060003 080 (North Fork of Paint Creek upstream from the confluence with Compton Creek, Compton Creek)

Status of Non-aquatic Life Uses
Unless otherwise noted, industrial, agricultural and primary contact recreational uses apply as presently designated in the Ohio Water Quality Standards.

North Fork Paint Creek (02-510)
Status of Aquatic Life Uses
The North Fork of Paint Creek is designated EWH, and the use was fully met as indicated by samples collected at three locations during the 2006 survey.

Compton Creek (02-522)
Status of Aquatic Life Uses
Compton Creek has a field verified EWH use. That use was fully met at three locations sampled downstream from the confluence with Dews Run at RM 11.23. Upstream from Dews Run, where Compton Creek had not been previously sampled, sampling during 2006 demonstrated that Compton Creek, lacks the habitat features to fully support EWH communities, and therefore should be designated WWH.

Other Recommendations and Future Monitoring Concerns
An ethanol plant being constructed near Bloomingburg will place a consumptive and waste-loading demand on the local water resource that will require close monitoring.

Mud Run (02-524)
Status of Aquatic Life Uses
Mud Run has a default WWH aquatic life use. A fish and macroinvertebrate sample collected downstream from the Pickaway-Fayette County line confirmed that use.

Other Recommendations and Future Monitoring Concerns
The macroinvertebrate community sampled from Mud Run scored in the Exceptional range, and the fish community scored in the Very Good range, suggesting the potential for an EWH use designation. Additional samples from two or more locations should be collected to fully assess the aquatic life potential of this stream.

Recommendations – Hydrologic Unit 05060003 090 (North Fork of Paint Creek downstream from Compton Creek, Biers Run, and Little Creek)

Status of Non-aquatic Life Uses
Unless otherwise noted, industrial, agricultural and primary contact recreational uses apply as presently designated in the Ohio Water Quality Standards.

North Fork of Paint Creek (02-510)
Status of Aquatic Life Uses
Six sites were sampled along this reach of the North Fork, and all fully met the existing EWH use.

Other Recommendations and Future Monitoring Concerns
Water quality sampling of the Frankfort WWTP effluent, and self monitoring by the Frankfort WWTP indicated that under-treated effluent was being discharged to the North Fork as evidenced by high ammonia-nitrogen concentrations and bacteria. New management and better maintance of the WWTP has greatly improved the operation of the Frankfort WWTP and should correct the problems. Follow-up effluent monitoring is recommended to demonstrate compliance and insure the aquatic life in the North Fork remains intact with respect to the EWH use.

Biers Run (02-511)
Status of Aquatic Life Uses
Biers Run has an unverified WWH use. Based on fish and macroinvertebrate samples collected at one location in 2006, that use is appropriate and fully met.

Little Creek (02-516)
Status of Aquatic Life Uses
Little Creek has an unverified WWH use. Results from fish and macroinvertebrate sampling at two locations in Little Creek (RMs 1.0 and 5.6) confirm that this use is appropriate and fully met.

Other Recommendations and Future Monitoring Concerns
Traffic from all-terrain vehicles has homogenized the stream bed in Little Creek. Alternative riding trails are encouraged.

Recommendations – Hydrologic Unit 05060003 100 (Paint Creek downstream from the confluence with Lower Twin Creek, Cattail Run, Owl Creek, Plug Run, and Black Run)

Status of Non-aquatic Life Uses
Unless otherwise noted, industrial, agricultural and primary contact recreational uses apply as presently designated in the Ohio Water Quality Standards.

Paint Creek (02-500)
Status of Aquatic Life Uses
Paint Creek has a verified EWH use from the confluence with Lower Twin Creek to SR 772 (RM 3.8). From SR 772 to the confluence with the Scioto River, a WWH use applies. Two samples collected in the EWH reach (RMs 8.9 and 3.8) and one collected in the WWH reach at RM 0.7 all met applicable uses.

Other Recommendations and Future Monitoring Concerns
The lower 20 miles of the Paint Creek mainstem has served as a refuge for large river fish fauna once excluded from the Scioto mainstem due to pollution. Maintaining the high biotic integrity of this reach will continue to be important as a buffer against the vicissitudes inherent in a system subject to the anthropogenic stresses associated with a large metropolitan area.

Sediments contaminated with polychlorinated biphenyls (PCBs) were found in Paint Creek near SR 23 below the P.F. Glatfelter outfall (formerly Mead Paper). PCBs were formerly used in the manufacture of carbonless paper. The PCBs are likely originating either from or near the Paint Street landfill, or near the P.H. Glatfelter facility, and are contaminating fish in the lower three miles of Paint Creek. The exact source locations need to be identified and remediated.

Cattail Run (02-527)
Status of Aquatic Life Uses
The unverified WWH use assigned to Cattail Run was verified and supported by fish and macroinvertebrate samples collected at Owl Creek Road (RM 1.2). The presence of 6 coldwater macroinvertebrates indicates that this stream should be recommended for a Coldwater Habitat aquatic life use.

Owl Creek (02-528)
Status of Aquatic Life Uses
Owl Creek has an unverified WWH use. That use was verified and supported by fish and macroinvertebrate samples collected upstream from US 50 (RM 0.3). The presence of 4 coldwater macroinvertebrates indicates that this stream should be recommended for a Coldwater Habitat aquatic life use.

Plug Run (02-529)
Status of Aquatic Life Uses
The unverified WWH use was verified and supported by fish and macroinvertebrate samples collected at Mingo Road (RM 0.4). The presence of 4 coldwater macroinvertebrates indicates that this stream should be recommended for a Coldwater Habitat aquatic life use.

Black Run (02-543)

Status of Aquatic Life Uses

The unverified WWH use was verified and supported by fish and macroinvertebrate samples collected at Spruce Hill Road (RM 1.0) and Baum Hill Road (RM 3.9). The presence of 4 coldwater macroinvertebrates indicates that this stream should be recommended for a Coldwater Habitat aquatic life use.

Study Area

The Paint Creek watershed north of Greenfield is situated in the Wisconsin till plain, and has the low relief and rich soils conducive to intensive rowcrop agriculture. Landuse in this part of the basin approaches 90 percent row crop agriculture (Figure 2). South of the Wisconsinan glacial boundary, the watershed is more dissected given the older age of the Illinoisan deposits, and highly dissected along the southern edge of the unglaciated Appalachian foothills. As such, the landscape is not as well suited to row crop agriculture, so landuse changes over to a greater percentage of pasture and forest cover. County-level farm statistics reflect the change in landuse. Roughly ninety percent of the farmed acreage in Fayette County is devoted to corn and soybeans compared to roughly half the farmed acreage for Highland and Ross Counties.

*2006 County Level Farm Statistics**
for Selected Counties in the Paint Creek Watershed

	Fayette	Highland	Ross
Percent of Land Area in Farms	80.2	72.8	54.8
Value of Farm Sales (in millions)	56.1	49.2	41.9
Percent of Farmed Land in:			
Soybeans	56.4	36.7	25.6
Corn	33.2	12.8	18.1
Hay	2.8	6.9	7.6
Livestock Head per Farmed Acre			
Cattle	2.6	8.2	6.8
Hogs	4.5	3.7	1.6

*http://www.nass.usda.gov/Statistics_by_State/Ohio

Bedrock and surficial geology, as influenced by glacial history, also determine groundwater potential in the basin. The northeast quarter of the basin, drained by the North Fork, has limestone bedrock interbedded with shale and overlain by relatively thick layers of coarse, unconsolidated, glacial till. Well yields in this part of the basin may range up to 500 gallons per minute (gpm). This fact has not escaped the notice of ethanol producers who have sited a plant near the town of Bloomingburg. The coarse till deposits and sustained baseflow in the North Fork subcatchment have allowed recovery of natural features to historically channelized streams as those streams have scavenged gravel sized substrate from stream banks. Sustained baseflow keeps the re-formed riffles functioning and relatively free of fine sediments. Similarly, pre-glacial river valleys filled by till, explicitly, the lower North Fork valley and the Paint Creek Valley downstream from the confluence with Rocky Fork, have groundwater yields in excess of 100 gpm, and sustained base flow to these segments augments habitat for aquatic life. In contrast, streams draining the northwestern flank of the watershed receive comparatively less groundwater, owing to a generally thinner layer of till, less permeable soils, and more uniformly consolidated carbonate bedrock.

Population growth between the 1990 and 2000 Census was 3.49 percent in Fayette County, 9.96 percent for Highland County, and 6.69 percent for Ross Counties. The highest rates of growth in Highland County were in census blocks in the northwest quarter of the county where population growth as high as 49 percent occurred. Despite the high rates of increase in Highland County, the county remains rural in character, with population densities outside Hillsboro and Leesburg falling below 100 people•mi^{-2} (Figure 2). Other areas with high growth rates were the census

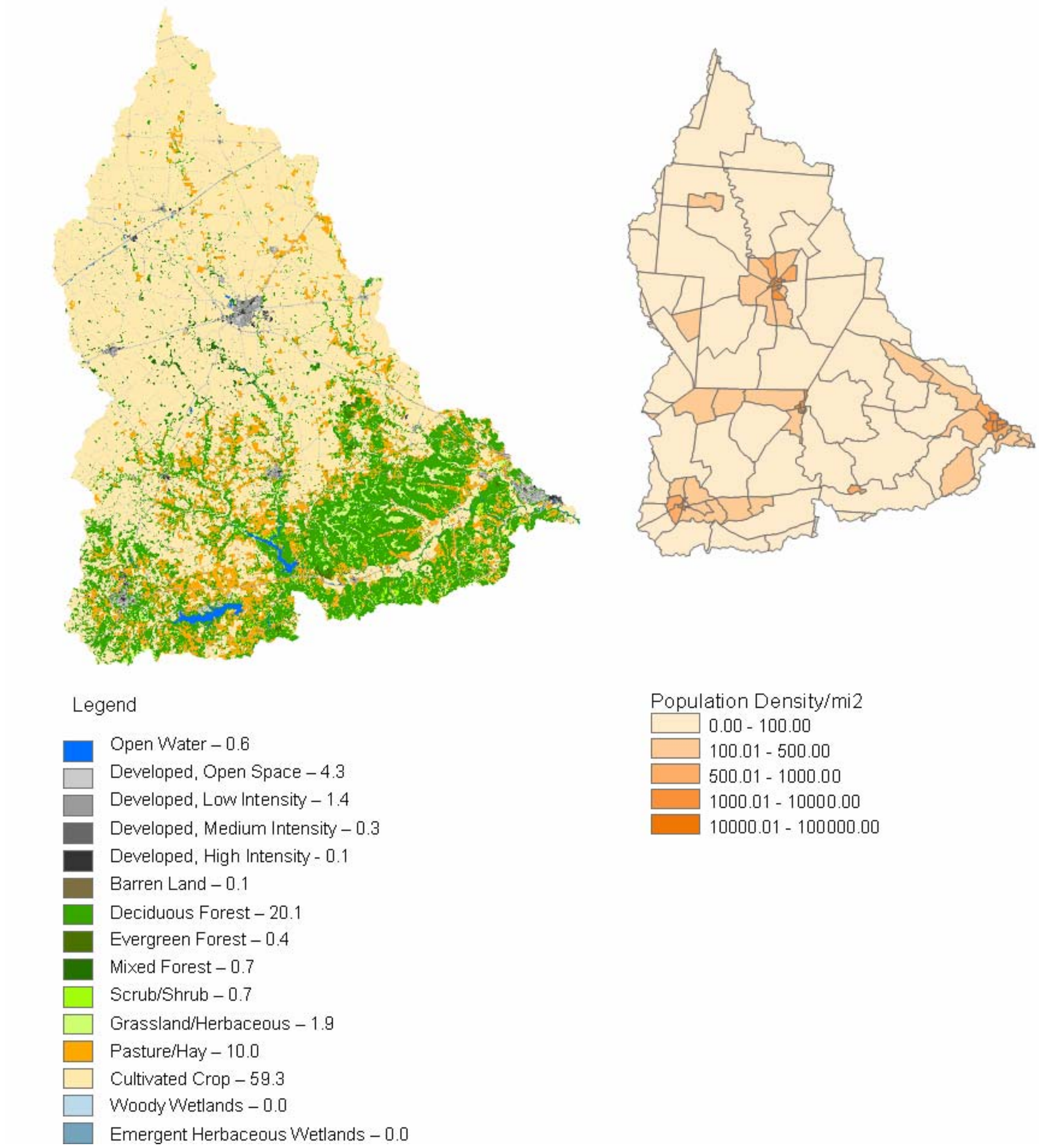


Figure 2. Left panel: Landuse and land cover in the Paint Creek watershed from 2001 Landsat imagery. The percent of the watershed each class comprises is shown to the right of each class. Right panel: Population density in the Paint Creek basin from the 2000 Census.

blocks west of Chillicothe, especially along US Routes 35 and 50, where growth rates ranged between 20 and 50 percent, and population densities approached 300 people•mi^{-2}, potentially threatening small streams draining to the North Fork such as Biers, Corey and Oldtown Run. Detrimental effects to aquatic resources associated with urban/suburban stormwater generally become detectable, in the context of the existing Ohio landscape, when population densities exceed 300 people•mi^{-2} (Miltner et al. 2004).

The Paint Creek watershed, or hydrologic unit 05060003, is subdivided into ten, 11 digit hydrologic units, the last three digits of which identify the specific unit within the basin. For example hydrologic unit 05060003 040, is the Lees Creek subwatershed. Figure 3 identifies the various units by their 3-digit names, and the principal streams draining those units. Table 3 lists specific streams and locations sampled with each unit.

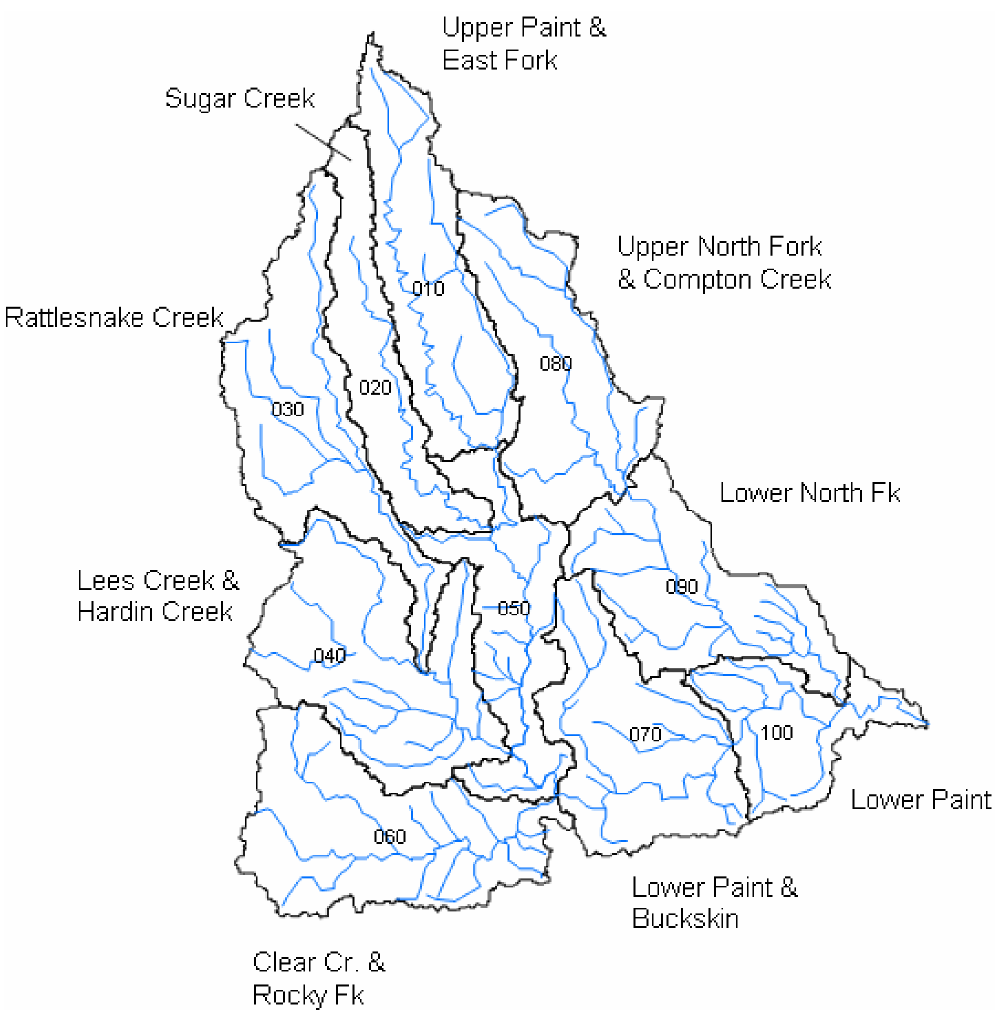


Figure 3. The Paint Creek watershed subdivided by 11-digit hydrologic units.

Table 3. Locations and media sampled in the Paint Creek basin, 2006. Sample codes are as follows: B – benthic macroinvertebrates via artificial substrates, Bq – benthic macroinvertebrates from in situ substrates, F – fish, C – water chemistry, Co – water chemistry with organic scan, S - sediment chemistry, D – hourly oxygen monitoring, E – effluent chemistry. Randomly selected terminal-node headwaters are denoted with an asterisk.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 010					
02-581-000 Big Run					
V10K83*	1.8	Bq, F, C	Lewis Road	39.5611	-83.4366
02-580-000 East Fork Paint Creek					
V10W23	8.6	B, F, C	Lewis Rd.	39.6250	-83.4211
V10K84	6.3	E	Bloomburg WWTP	39.6023	-83.4012
V10W24	5.1	B, F, C	Matthews Rd.	39.5872	-83.3964
V10W25	0.7	B, F, Co, D	U.S. Rt. 22	39.5406	-83.4147
02-500-000 Paint Creek					
V10W18	96.0	Bq, F, C	Charleston-Chillicothe Road	39.7319	-83.5428
V10W20	80.0	B, F, Co, S	Adj. Wildwood Rd.	39.6081	-83.4864
V10S36	75.3	B, F, Co, S	Bloomingburg Road	39.5753	-83.4758
V10S35	73.3	B, F, Co, D, S	Ust./Adj. SR 41, Ust. Washington CH PWS	39.5586	-83.4594
V10K87	71.4	Co	Washington Court House PWS	39.5442	-83.4477
V10W21	70.9	B, F, C	At park in Washington Court House	39.5378	-83.4447
V10S34	69.7	B, F, Co, D	Ust. Washington Court House	39.5350	-83.4267
V10S26	69.5	E	Washington Court House WWTP	39.5339	-83.4239
V10W02	69.4	B, F, C	Washington Court House	39.5336	-83.4228
V10W03	69.2	B, F, C	Dst Washington C. H. WWTP	39.5331	-83.4205
02-580-002 Vallery Ditch					
V10K86	2.3	Bq, F,C	Prairie Road - AFO	39.7230	-83.4875
02-580-001 William Cathcart Ditch					
V10K85*	0.2	Bq, F, C	SR 38 - AFO	39.7094	-83.4643

Table 3. Continued.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 020					
02-579-001 Missouri Ditch					
V10K80*	1.6	Bq, F, C	Harmony	39.5902	-83.5478
02-579-000 Sugar Creek					
V10K82	36.9	Bq, F, C	Selsor Moon Road	39.7665	-83.5628
V10W26	29.2	B, F, C	McKillip Road	39.6717	-83.5625
V10K81	25.9	E	Jeffersonville WWTP	39.6364	-83.5336
V10W27	24.8	B, F, Co, S	Creamer Road	39.6292	-83.5350
V10W28	18.6	B, F, C	Ford Road	39.5697	-83.5247
V10W29	12.0	B, F, C	US 22	39.5153	-83.5206
V10W30	5.4	B, F, C	Mark Road	39.4869	-83.4728
300050	4.2	B, F, Co, D	Armbrust Rd	39.4802	-83.4593

Table 3. Continued.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 030					
02-561-000 Grassy Branch					
V10K68*	8.7	Bq, F, C, S	Marchant-Luttrell Road	39.5970	-83.6639
02-550-002 Maple Grove Creek					
V10K73*	1.6	Bq, F, C	Pleasant View Road	39.6349	-83.6356
02-550-000 Rattlesnake Creek					
V10W32	40.4	Bq, F, C	SR 734	39.6514	-83.6164
V10W33	38.1	B, F, C	Ust. US 35	39.6236	-83.6167
V10S37	35.2	B, F, C	Milledgville-Octa Rd	39.5986	-83.6067
V10W37	31.4	B, F,C	SR 729	39.5569	-83.5906
V10W38	24.0	B, F, C	Snow Hill Road	39.4817	-83.5442
200429	15.0	B, F, Co, D, S	Zimmerman Road (near jct. w/ Penn Rd)	39.4006	-83.4897
V10S05	13.3	B, F, Co, D, S	Fishback Rd.	39.3819	-83.4931
02-550-003 Trib to Rattlesnake Creek					
V10K75	0.2	E	South Solon WWTP	39.7335	-83.6139
02-550-003 U.T. to Rattlesnake Creek					
V10K74	1.1	Bq, F,C	Pleasantview Road & SR 734	39.6521	-83.6341
02-563-001 UT to Wilson Creek					
V10K71*	0.4	Bq, F, C	US 22	39.4867	-83.6482
02-562-000 West Branch Rattlesnake Creek					
V10K72*	11.4	Bq, F, C, S	Hargrave Road	39.5840	-83.6941
V10S03	4.3	B, F, Co, S	Ust. SR 729	39.5317	-83.6192
V10K69	2.8	B, F, C	Dst. confluence w/ Wilson Creek	39.5186	-83.6022
02-563-000 Wilson Creek					
V10K70	2.8	Bq, F, C	Dst. Sabina WWTP (access at WWTP)	39.4972	-83.6308

Table 3. Continued.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 040					
02-553-000 Big Branch					
V10K49*	1.6	Bq, F, C	Hardins Creek Road	39.2789	-83.4719
02-556-000 Bridgewater Creek					
V10K56	0.2	C	Monroe Rd	39.3064	-83.5230
02-552-000 Fall Creek					
V10K48	7.5	Bq, F, C	Dst. SR 138	39.2605	-83.5449
V10K47	1.6	Bq, F, C	Bectal Road	39.2689	-83.4585
02-554-000 Hardin Creek					
V10K57*	5.8	Bq, F, C	Black Rabbit Road	39.2891	-83.5444
V10K50	0.9	B, F, C	Ust. Big Oak Road	39.3011	-83.4735
02-558-000 Lees Creek					
V10K67	10.4	Bq, F, C	Redbud Road	39.4288	-83.5459
V10W44	4.5	B, F, C	US 62	39.3593	-83.5552
V10S27	3.6	E	Leesburg WWTP	39.3506	-83.5431
V10W45	1.2	B, F, Co, D	Monroe Road	39.3444	-83.5103
02-559-000 Middle Fork Lees Creek					
V10K65	5.1	Bq, F, C	Stowe Road	39.3765	-83.5966
V10W46	1.1	B, F, C	US 62	39.3467	-83.5603
02-550-000 Rattlesnake Creek					
300049	7.9	B, F, Co, D	Centerfield Road	39.3289	-83.4739
02-560-000 South Fork Lees Creek					
V10K63	1.3	Bq, F, C	Hixon Road	39.3408	-83.6000
02-558-001 Trib to Lees Creek					
V10K61*	1.3	Bq, F, C	Thomas Road	39.3671	-83.5279
02-550-001 Trib to Paint Creek Lake					
V10K46	1.0	C	New Petersberg area unsewered	39.2681	-83.4359
02-560-001 Trib to South Fork					
V10K64*	0.5	Bq, F, C	Careytown Road (South of SR 28)	39.3354	-83.6311

Table 3. Continued.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 040					
02-558-002 U.T. to Lees Creek					
V10K66*	0.3	Bq, F, C	Sabina Road	39.3609	-83.5636
02-557-000 Walnut Creek					
V10K59*	4.2	Bq, F, C	Walnut Creek Road	39.3844	-83.4560
V10K58	0.6	Bq, F, C	Centerfield Road	39.3358	-83.4675

Table 3. Continued.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 050					
02-576-000 Buck Run					
V10K77	0.8	C	SR 41	39.3966	-83.3907
02-577-000 Indian Creek					
V10K78*	1.6	Bq, F, C	Miami Trace	39.4353	-83.3669
02-500-000 Paint Creek					
V10S32	67.2	B, F, C	Dst. U.S. Rt. 35	39.5114	-83.4178
V10W22	63.3	B, F, C	Adj. Flakes Ford Road	39.4706	-83.3986
V10S31	58.8	B, F, C, D	Miami Trace Rd.	39.4427	-83.4104
V10S30	52.5	B, F, Co, D	SR 753	39.3797	-83.3758
V10S06	49.6	E	Greenfield WWTP	39.3420	-83.3788
V10S29	48.9	B, F, C	0.4 miles Dst. Greenfield	39.3336	-83.3839
300053	39.0	B, F, Co, D	below Paint Ck Dam USGS	39.2528	-83.3476
02-500-003 Plum Run					
V10K45	2.0	C	Beaver Road	39.2391	-83.4069
02-578-000 Wabash Creek					
V10K79	0.8	Bq, F, C	New Martinsburg	39.4535	-83.4352

Table 3. Continued.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 060					
02-540-000 Clear Creek					
V10K41*	11.3	Bq, F, C, S	Roundhead Road	39.2741	-83.6382
V10W47	8.3	B, F, Co, D, S	adj. Evans Rd.	39.2425	-83.6164
V10K38	7.4	Co	Ust. Hillboro PWS intake, Dst. culvert RR	39.2342	-83.6086
V10S13	6.8	B, F, Co, S	ust Hillsboro WWTP Dst. Moberly Br	39.2283	-83.6028
V10S07	6.7	E	Hillsboro WWTP	39.2273	-83.6015
V10S12	6.6	B, F, C	Dst. Hillsboro WWTP	39.2280	-83.5997
V10S11	5.4	B, F, C, D, S	Dst. Selph Rd.	39.2303	-83.5783
V10P15	2.7	B, F, C	Dst. U.S. Rt. 50	39.2128	-83.5508
02-540-001 Coon Creek					
V10P14*	0.1	Bq, F, C	Off Clear Creek Road	39.2120	-83.5453
02-535-000 Franklin Branch					
V10K35	1.9	C	SR 506	39.1600	-83.4320
02-540-007 Hussey Run					
V10K40*	0.8	Bq, F, C	Off Careytown Rd, Fallsville WA south unit	39.2555	-83.6243
02-540-002 Little Rock Creek					
V10K37*	1.4	Bq, F, C	Lewis Road (off Selph Road)	39.2488	-83.5832
02-540-004 Moberly Branch Clear					
V10Q06	0.9	B, F, Co, S	U.S. Rt. 62	39.2196	-83.6086
02-532-000 Pickett Run					
V10K32*	0.1	Bq, F, C	Ferneau	39.1957	-83.3900
02-530-000 Rocky Fork					
V10S16	23.3	B, F, Co, D, S	U.S. Rt. 62	39.1750	-83.6225
V10P16	18.1	B, F, Co, D, S	Fettro Rd.	39.1799	-83.5515
300091	17.8	E	Rocky Fork Regional WWTP	39.1806	-83.5478
V10P02	17.5	C	SR 124 Dst. Rocky Fork Regional WWTP	39.1782	-83.5437
610800	3.1	B, F, Co, D	Browning Rd.	39.2182	-83.3859

Table 3. Continued.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 060					
02-542-000 South Fork Rocky Fork					
V10K43*	3.3	Bq, F, C	Dst. SR 247	39.1496	-83.6039
02-540-005 Trib to Clear Creek (Fenner Trib)					
V10K39	0.4	Bq, F, C	Careytown Road (South of Evans Road)	39.2392	-83.6289
02-530-002 Trib to Rocky Fork @ RM 17.55					
V10K44	0.8	C	SR 138	39.1926	-83.6402
02-530-001 Trib to Rocky Fork @ RM 24.27					
V10K42*	1.0	Bq, F, C	Pigeon Roost Road	39.1668	-83.5516

Table 3. Continued.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 070					
02-564-000 Buckskin Creek					
V10K04*	3.1	Bq, F, C	Black Lane	39.3756	-83.2983
V10K05	0.4	B, F, C	Ust. Falls Road	39.2369	-83.2767
02-545-000 Lower Twin Creek					
V10K07	2.2	Bq, F, C	farm off Lower Twin Rd.	39.3006	-83.1722
02-568-000 Massie Run					
V10K08*	0.1	Bq, F, C	US 50	39.2193	-83.2902
02-500-000 Paint Creek					
V10S28	31.5	B, F, C	SR 41	39.2348	-83.2722
V10W14	27.5	B, F, C	Dills Road	39.2311	-83.2164
601320	21.6	B, F, Co, D	Bourneville @ Jones Levee Road	39.2636	-83.1673
02-548-000 Sulpher Lick					
V10K10*	1.5	Bq, F, C, S	Spargersville Road	39.2336	-83.1754
02-500-001 Taylor Run					
V10K11	1.3	Bq, F, C	Potts Hill Road	39.2239	-83.2472
Trib to Buckskin Creek					
V10K54*	0.2	Bq, F, C	McCann	39.3570	-83.2895
02-546-000 Upper Twin Creek					
V10K20	5.8	Bq, F, C	Tong Hollow Road	39.2753	-83.2448
V10K12	2.0	Bq, F, C	Upper Twin Cr Rd (1.4 m W of Bourneville)	39.2850	-83.1822

Table 3. Continued.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 080					
02-522-000 Compton Creek					
V10K27*	17.6	Bq, F, C	Meyers Road	39.6521	-83.3915
V10K26	11.2	Bq, F, C	Washington Waterloo Road	39.5898	-83.3370
300048	3.4	B, F, Co, D	Good Hope - New Holland	39.5149	-83.2963
V10S02	1.1	B, F, Co, S	Dogtown Road	39.4950	-83.2825
02-523-000 Crooked Creek					
V10K31*	3.0	Bq, F, C	Camp Grove	39.5112	-83.3460
02-524-000 Mud Run					
V10K24	0.4	Bq, F, C	Lane off Good Hope - New Holland Road	39.5143	-83.2700
02-510-000 North Fork Paint Creek					
V10K52*	42.0	Bq, F, C, Q, S	Yankeetown Chenoweth	39.7003	-83.3556
V10W16	31.0	B, F, C	Glaze Road	39.5781	-83.2908
V10E01	26.7	E	New Holland WWTP	39.5517	-83.2597
300046	26.7	B, F, Co, D	Good Hope - New Holland	39.5235	-83.2811
02-525-000 Thompson Creek					
V10K51*	3.3	Bq, F, C, Q	Wissler Road - AFO	39.6832	-83.3871
02-510-002 Wolf Run					
V10K25*	0.3	Bq, F, C, Q	Rockwell Road	39.6548	-83.3389

Table 3. Continued.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 090					
02-511-000 Biers Run					
V10K06	1.5	Bq, F, C	Co. Rd 550	39.3778	-83.0676
02-516-000 Little Creek					
V10K02*	6.0	Bq, F, C	Clipps Bridge Road	39.3678	-83.2320
V10K13	1.0	B, F, C	Little Creek Road (Near Jct w/ Rodgers Rd)	39.3799	-83.1738
02-510-000 North Fork Paint Creek					
V10S01	22.3	B, F, Co, S	Dexter Rd.	39.4242	-83.2145
V10K14	17.6	B, F, C	Asbury Road	39.4840	-83.2412
V10S19	14.2	E	Frankfort WWTP 001 outfall	39.3990	-83.1813
V10K23	14.1	B, F, C	Dst. Frankfort WWTP (access at WWTP)	39.3980	-83.1794
V10S18	10.5	B, F, C	Musselman Hill Rd.	39.3669	-83.1419
V10K01	3.9	B, F, C	U.S. Rt. 50	39.3508	-83.0536
300047	2.3	B, F, Co, D	Polk Hollow Road	39.3367	-83.0367
V10K30	0.1	E	Pleasant Valley Reg Sewer 001 Outfall	39.3556	-83.0522
02-518-000 Oldtown Run					
V10K15*	1.3	Bq, F, C	Ust. Frankfort Clarksburg Pike	39.4065	-83.1771
02-510-001 Trib to North Fork Paint @ RM 6.56					
V10K29	0.3	Bq, F, C	Maple Grove Road	39.3624	-83.0843

Table 3. Continued.

STORET	RM	SAMPLE	LOCATION	Lat DD	Long DD
Hydrologic Unit 100					
02-543-000 Black Run					
V10K21	4.0	Bq, F, C	Baum Hill Road	39.2562	-83.1196
V10K16	1.0	Bq, F, C	Spruce Hill Road	39.2893	-83.1283
02-527-000 Cattail Run					
V10K53	1.2	Bq, F, C	Owl Creek Road	39.3380	-83.1025
02-528-000 Owl Creek					
V10K22	0.1	Bq, F, C	Ust. US 50	39.3145	-83.1147
02-500-000 Paint Creek					
V10K17	8.9	B, F, C	0.8 miles upst. North Fork	39.3053	-83.0356
V10P06	3.8	B, F, Co, D, S	adjacent to St. Rt. 772	39.3097	-82.9911
V10S17	3.4	E	Mead Paper Co. 001 outfall to Paint Creek	39.3179	-82.9729
V10S43	0.7	B, F, C	U.S. Rt. 23	39.3022	-82.9464
02-529-000 Plug Run					
V10K03	0.4	Bq, F, C	Mingo Road	39.3098	-83.1324
02-526-000 Ralston Run					
V10K19*	2.8	Bq, F, C	Turner Road	39.2588	-83.0513

Surface Water Quality – Watershed Overview

Water quality in Paint Creek is influenced by physical habitat quality, agricultural landuses, and treated wastewater effluent. Row crop agriculture in the northern half of the basin contributes nitrate-nitrogen and phosphorus via fertilizer. Localized impacts due to organic enrichment from livestock were rare, but scattered throughout the basin. Organic enrichment from failing septic systems was noted in Oldtown Run, Cattail Run and Ralston Run. Under-treated municipal wastewater was a source of organic enrichment to Clear Creek downstream from Hillsboro, Wilson Creek downstream from Sabina, and the North Fork downstream from Frankfort. In the latter case, dilution prevented impacts to aquatic life. Some of these impacts can be visualized in Figure 4 as elevated levels of ammonia nitrogen. Livestock and municipal treated wastewater also contributed nutrients (phosphorus and nitrogen) to the streams. A minor impact from nutrient enrichment due to municipal wastewater was evident in the mainstem of Paint Creek in the reach between Washington Court House and the Paint Creek Reservoir.

Together, physical habitat quality, nutrient concentrations, and dissolved oxygen account for about half the variation in both fish IBI scores and the number of EPT taxa (Table 4) in samples collected throughout the basin. Poor physical habitat quality from stream ditching in the northern and western portions of the basin, apart from being directly limiting to aquatic life, limits the capacity of the stream network to process and assimilate nutrients and other pollution. This effect was most evident in the upper Paint Creek (including the East Fork), Sugar Creek and Rattlesnake Creek sub-basins, and was manifest in routinely low dissolved oxygen concentrations (Figure 5).

Table 4. Results of stepwise (backward elimination) multiple regression of IBI scores and the number of EPT taxa on water quality variables and habitat scores (QHEI). Data were collected during the 2006 survey of the Paint Creek watershed.

Dependent Variable: IBI N: 114 Adjusted squared multiple R: 0.5175

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	61.1109	8.4110	0.0000	.	7.2656	0.0000
QHEI	0.3234	0.0462	0.4894	0.8737	7.0011	0.0000
LOGNOX	-4.2429	1.6830	-0.1785	0.8515	-2.5210	0.0131
LOGTKN	-11.0457	2.7301	-0.2883	0.8409	-4.0459	0.0001
MIN_DO	0.9808	0.3139	0.2225	0.8417	3.1243	0.0023

Dependent Variable: EPT N: 108 Adjusted squared multiple R: 0.6301

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	11.5962	4.1200	0.0000	.	2.8146	0.0059
LOGTP	-4.6263	1.1457	-0.2623	0.8189	-4.0378	0.0001
LOGNOX	-3.5001	1.4375	-0.1881	0.5791	-2.4349	0.0166
MIN_DO	0.6552	0.2153	0.1958	0.8349	3.0426	0.0030
LOGDRAIN	5.1357	0.8520	0.5081	0.4865	6.0278	0.0000
QHEI	0.1749	0.0383	0.3443	0.6088	4.5690	0.0000

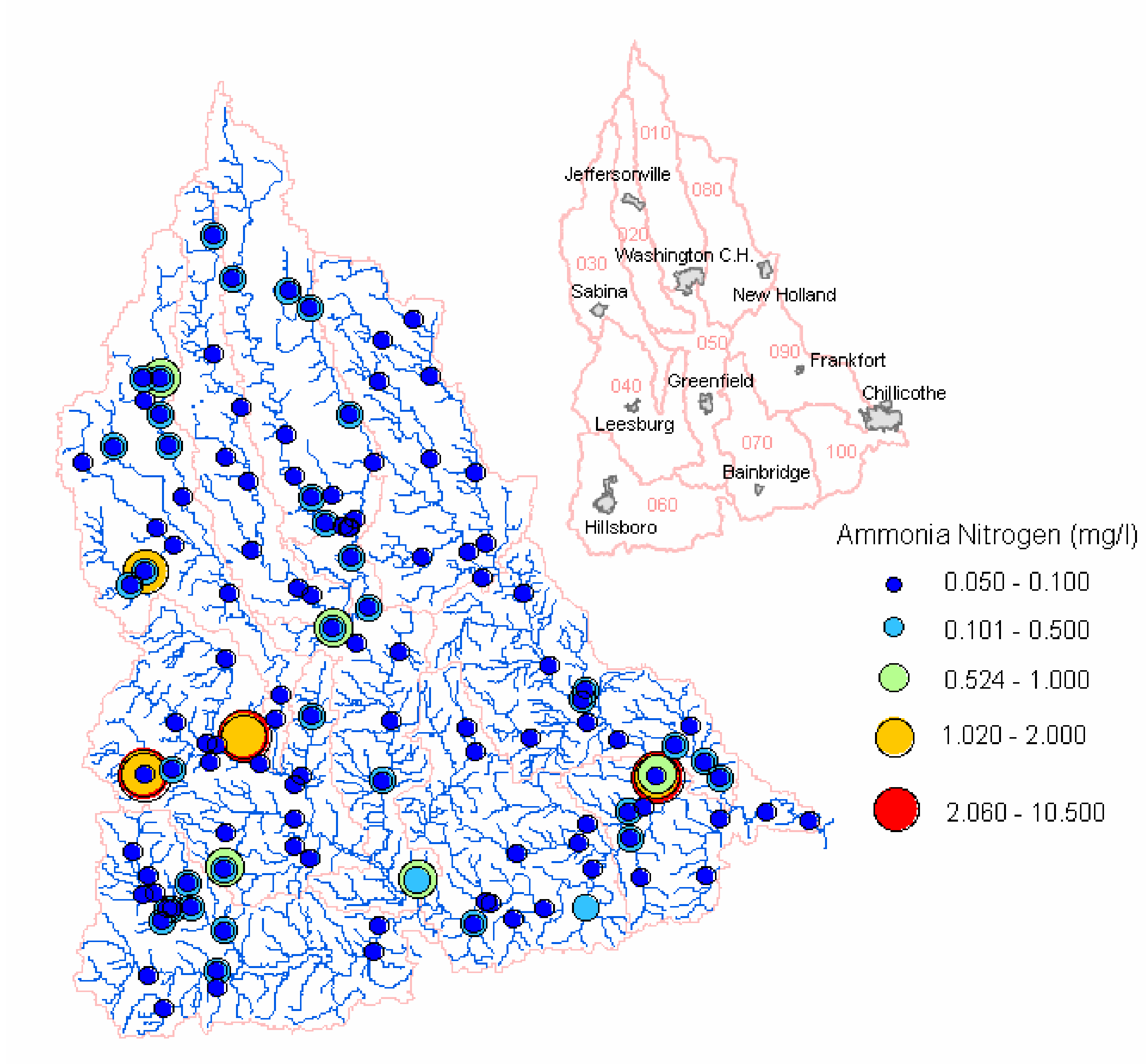


Figure 4. Ammonia nitrogen concentrations measured in water quality samples collected from the Paint Creek basin during 2006. Yellow and red circles indicate ammonia concentrations that are toxic to aquatic life. Green circles show concentrations that are elevated well-above background concentrations and likely to be toxic to sensitive species. Light blue circles show concentrations elevated above background levels and that may be toxic only to highly intolerant species. Dark blue circles show concentrations typical of background levels.

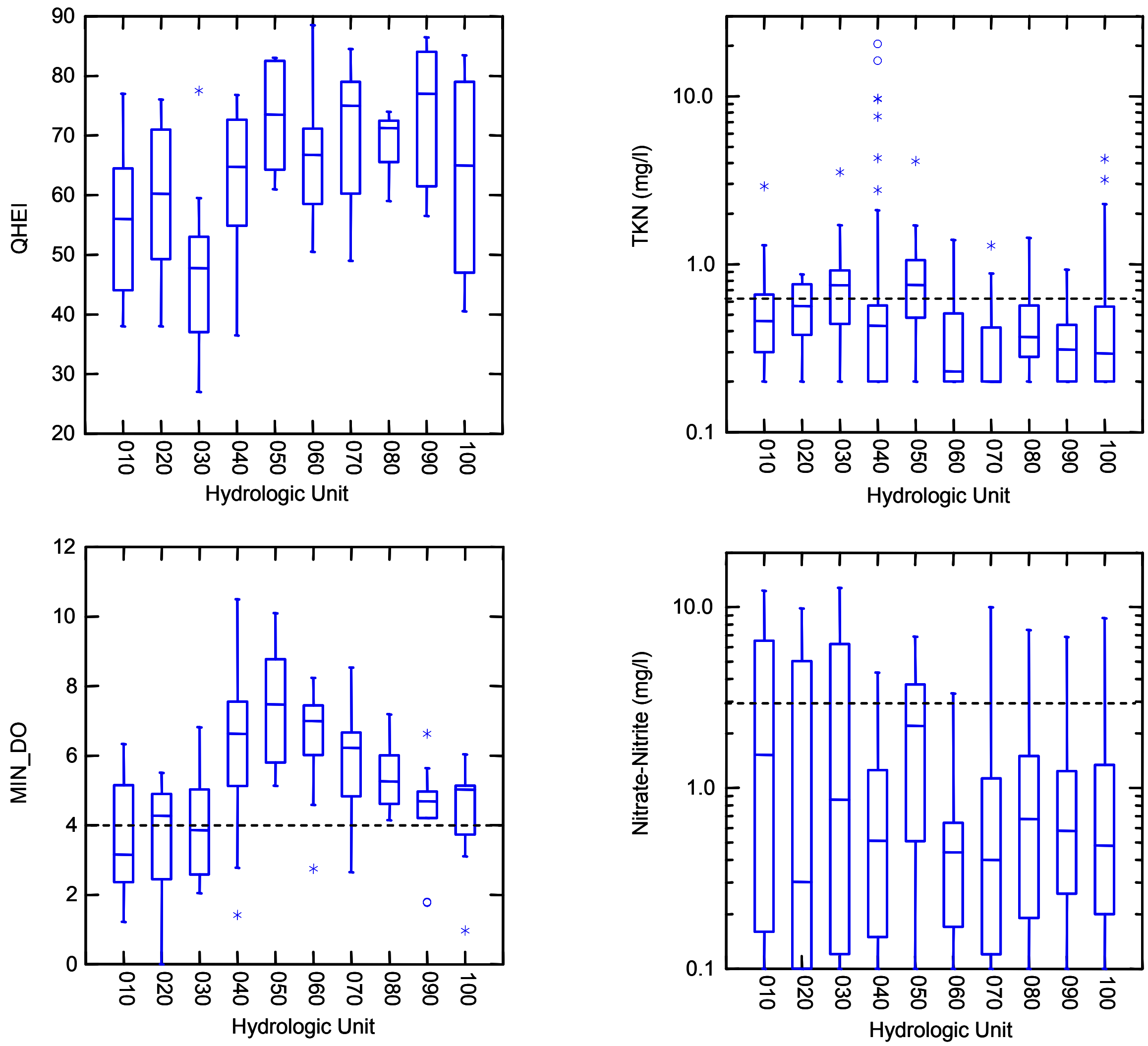


Figure 5. Distributions of QHEI scores, total Kjeldahl nitrogen (TKN) concentrations, minimum dissolved oxygen concentrations, and nitrate-nitrite nitrogen concentrations recorded during the Paint Creek survey and plotted by hydrologic unit. Stippled lines in the nitrogen plots correspond to the respective 75th percentile concentrations from a reference population of least impacted wadeable streams. The stippled line in the dissolved oxygen plot shows the WWH water quality standard for the protection of aquatic life.

Surface Water Quality – Hydrologic Unit Assessments

Paint Creek (headwaters to below East Fork) Assessment Unit (05060003-010)

The Paint Creek assessment unit (Hydrologic Unit Code 05060003-010) encompasses the drainage area of upper Paint Creek from the headwaters to just downstream of the confluence with East Fork Paint Creek at RM 69.04. The headwaters are located in southwestern Madison County. Paint Creek flows through northern Fayette County and the town of Washington Court House prior to its confluence with East Fork on the southeast side of town. Tributaries to East Fork Paint Creek in this assessment unit include Vallery Ditch, William Cathart Ditch, and Big Run. This area falls within the Eastern Corn Belt Plains (ECBP) ecoregion.

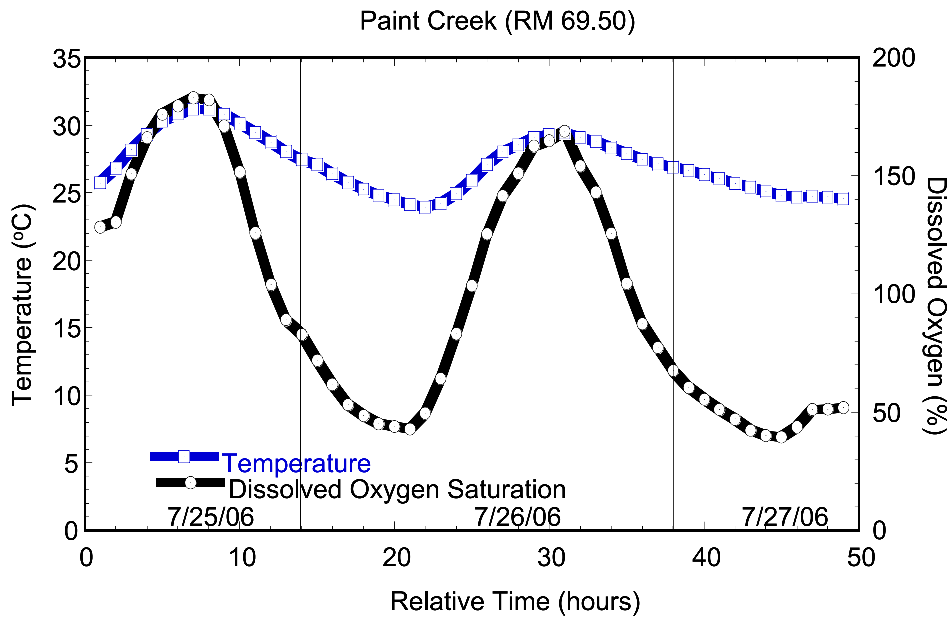
There were 16 stream monitoring sites in this unit that were evaluated for chemical water quality, 7 sites on the Paint Creek mainstem, and 7 sites on tributaries. Two sites evaluated wastewater treatment plant effluent from the Washington Court House WWTP, which discharges to Paint Creek at RM 69.45, and from the Bloomingburg WWTP, which discharges to the East Fork at RM 6.30 (See Table 3).

Paint Creek (WWH, AWS, IWS, PCR)

The upstream reaches of the Paint Creek mainstem included 7 stream sites, 1 mixing zone, and 1 WWTP outfall (Washington Court House) for a total of 9 chemistry sampling sites. Sampling revealed a variety of problems with water chemistry. Violations of the dissolved oxygen criteria were noted numerous times at 3 sites, specifically RM 96.0, RM 71.40, and RM 69.70 as noted in Table 5.

Temperatures in these stream locations were also well above the background median, especially at RM 70.90 and RM 69.70 where over 56% of the values exceeded the 90th percentile (Appendix 1). Continuous monitoring of temperature and dissolved oxygen with sensory sondes revealed wide variation in diurnal dissolved oxygen concentrations (Figure 6) with several violations of the WWH minimum for dissolved oxygen. Diurnal dissolved oxygen saturation also exhibited corresponding variability (Figure 6). The combinations of higher temperatures, sunlight, and nutrients, lead to the overabundance of filamentous algae instream, ultimately causing the violations of the water quality standards for dissolved oxygen due to intense algal respiration at night. Obviously supersaturated conditions such as those found during the day (150% as shown in Figure Figure 6 are also problematic for fish and invertebrates although there is no standardized upper limit to dissolved oxygen in water).

Nutrient enrichment was also noted in the upper mainstem. Ammonia-N, total phosphorus, and organic nitrogen were present in concentrations above the 75th percentile in most samples obtained at RM 96.00 (Appendix 1). Moving downstream, these nutrients were converted to vegetation (primarily filamentous algae) in areas where the channel was devoid of riparian cover and exposed to sunlight, primarily within the city limits of Washington Court House. Nutrient enrichment was especially prevalent downstream of the Washington Court House WWTP at RM 69.20 due to the high concentrations of total phosphorus, organic nitrogen, and nitrates discharged in the WWTP effluent (Figure 7).



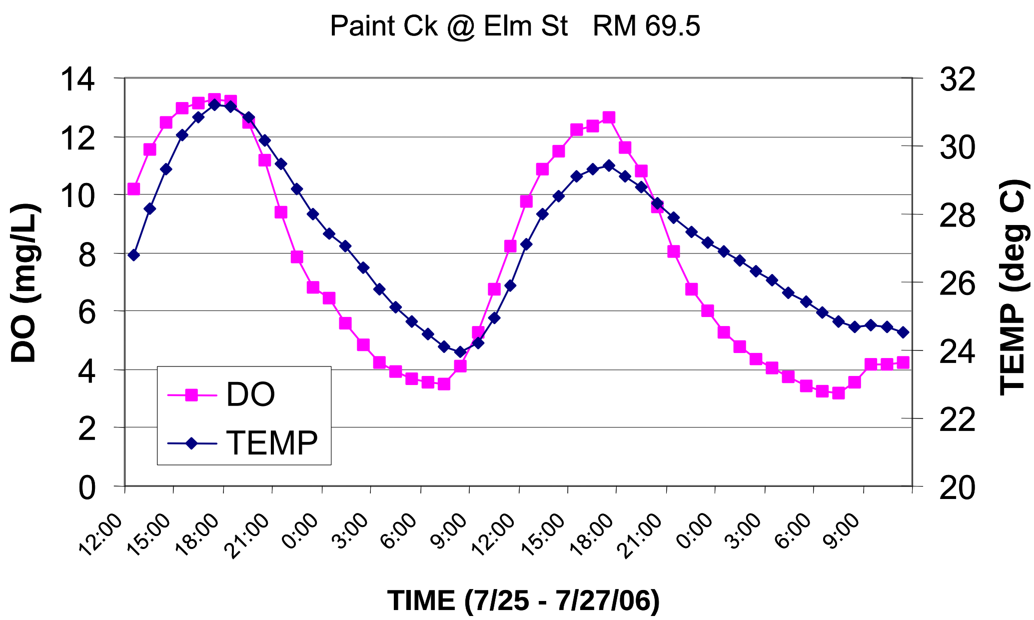


Figure 6. Dissolved oxygen percent saturation (top) and dissolved oxygen concentrations (bottom) in relation to temperature recorded with hourly automated data loggers in Paint Creek near Elm Street, July 25-27, 2006.

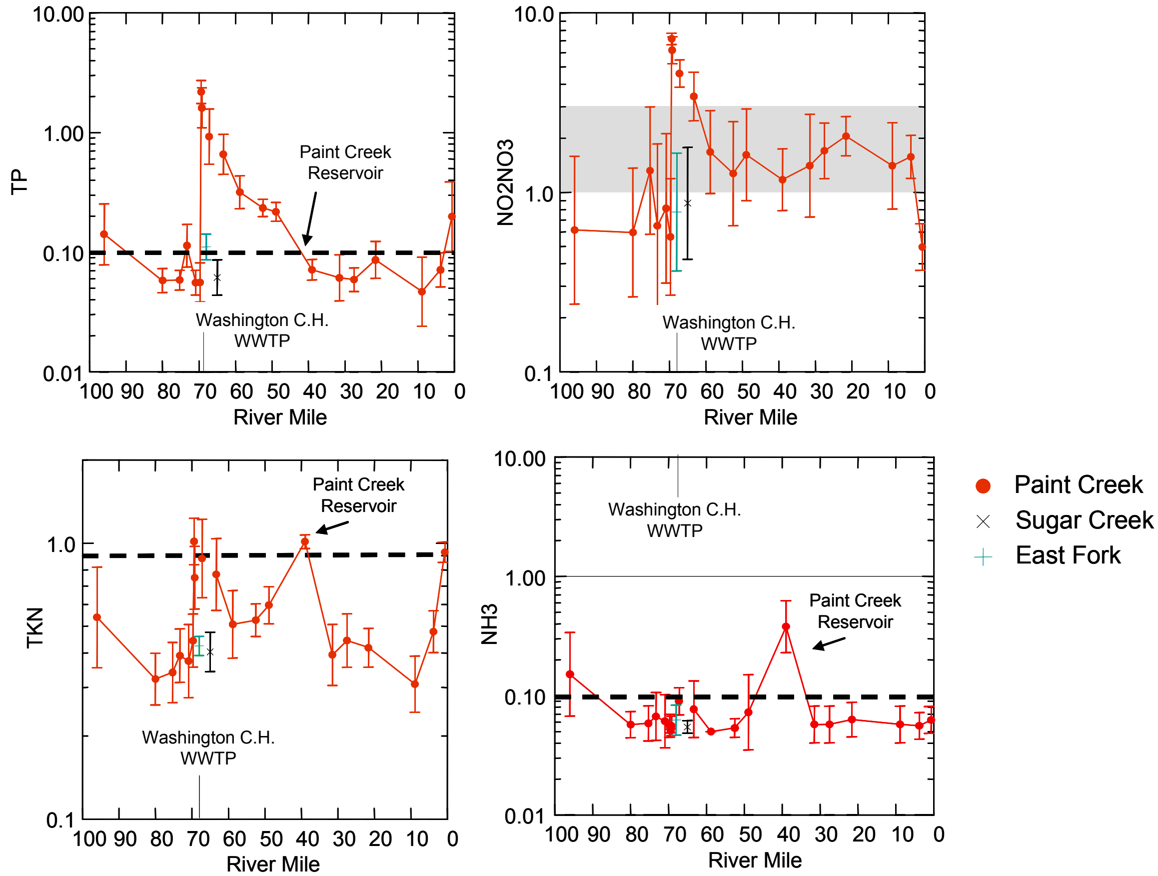


Figure 7. Longitudinal profiles of selected nutrient water quality parameters for the Paint Creek mainstem. Dashed lines in the TP and TKN plots show the upper range of background concentrations typical for the ecoregion. The shaded area in the NO3-NO2 plot spans the range of concentrations defining elevated to grossly elevated. The solid line at 1.0 mg/l in the NH3-N plot is the concentration beyond which acute toxicity is likely, and the dashed line at 0.1 mg/l shows the concentration where chronic toxicity becomes increasingly likely.

The combination of abundant sunlight and nutrients caused blooms of large masses of filamentous algae and other aquatic vegetation, dominating the stream channel.

Primary contact recreation standards for bacteria were also violated at most mainstem sites (Table 5, Appendix 3) either exceeding the 30-day geometric mean and/or the maximum. Only the site at Eyman Park Drive (RM 70.90) revealed no violations of recreational water quality standards.

There was an illicit discharge of white-colored, opaque, filter backwash water discovered at RM 70.90 emanating from the Washington Court House community swimming pool. This opaque water was observed flowing regularly from a pipe on the west side of the creek, upstream of the bridge during the summer of 2006. The city was informed of this illegal discharge and promised to redirect the discharge to the sanitary sewer system instead of Paint Creek.

MIAMI TRACE HIGH SCHOOL WWTP

The package plant design capacity is 0.030 MGD and consists of a trash trap, aeration basin with clarifier, and sand filter. The WWTP discharges to Paint Creek around RM 73.00 from the high school located at 3722 State Route 41 NW, Washington Court House, Ohio, in Fayette County. The WWTP is owned and operated by Miami Trace High School and historically has been in compliance with its permitted effluent limits. Due to enlargement of the high school, the WWTP will be abandoned and the high school complex will connect to the City of Washington Court House sanitary sewer system. The permit to install for this connection is currently under review.

PRAIRIE KNOLLS MOBILE HOME PARK WWTP

The Prairie Knolls MHP WWTP is a package-type facility owned and operated by Ms. Clarice Grace. Currently, the WWTP services 8 units (about 0.0025 MGD). The plant began operation in the 1990's and was permitted in 2002 for a design capacity of 0.010 MGD.

The WWTP has never serviced more than eight units because of non-compliance with the Fayette County Health Department regulations for mobile home parks. Additional units could be added (up to 33) if the owner would come into compliance with the health department rules. For now, this plant discharges intermittently and when sampled does not meet the effluent limits for TSS, ammonia and cBOD. At this time the health department is working with the owner to devise some other method to treat sewage since the WWTP is incapable of properly treating such a small volume and prospects for adding additional units is small due to non-compliance with county rules.

FAYETTE COUNTY FLAKES FORD ESTATES WWTP

The Fayette County Board of Commissioners owns and operates this package plant regulated by NPDES permit 4PG00000. The plant discharges to Paint Creek at RM 63.35 and began operation in 1975. The design capacity of the WWTP is 0.01375 MGD. The treatment train consists of a trash trap, aeration tank and clarifier, (2) slow sand filters, chlorine contact tank and an aerated sludge holding tank

This plant usually meets the permitted effluent limits for TSS, Ammonia and cBOD about seven months out of the year. Violations of permit limits for ammonia and dissolved oxygen typically occur here in July and August and TSS violations typically occur in March and April.

CITY OF WASHINGTON COURT HOUSE WTP

The City of Washington Court House owns and operates a water treatment plant located at 220 Park Avenue in Washington Court House, Fayette County, Ohio. Water from Paint Creek is pumped to a settling basin and then treated with lime to soften and condition the water followed by chlorination for disinfection prior to distribution. The city holds NPDES permit number 4IW00017 for backwash discharges from the WTP to Paint Creek. Currently, the plant is designed to treat up to 3 MGD gallons per day of potable water.

BP AMOCO OIL BULK PLANT WWTP

The plant storm retention basin is lined and discharges and average of 1,870 gpd. The system consists of a (one) cell lined retention basin. The water is retained to allow the solids to settle. This facility is in compliance with its NPDES permit.

CITY OF WASHINGTON COURT HOUSE WWTP

The City of Washington Court House owns and operates a wastewater treatment plant located at 1110 South Elm Street in Washington Court House, Fayette County, Ohio. The city holds NPDES permit number 4PD00002 for discharges from the WWTP outfall 001 to Paint Creek at RM 69.45. Currently, the WWTP is designed to treat up to 6 million gallons per day (MGD) of municipal wastewater. Treatment consists of screening and grit removal, primary clarification, extended aeration with flow equalization, secondary clarification, and chlorine disinfection.

In 1978-79, Washington Court House completed a sewer separation project. Originally designed and constructed in the 1930's as a combined storm and sanitary sewer system, the sewer system allegedly consists of 100% separate sanitary sewers. However, city officials have indicated that some of the sewer separation was not performed properly. The city has known, since at least 1985, that hydraulic overloading of the WWTP is a result of inflow and infiltration (I/I) problems with city sewers. Because the plant cannot handle the excessive flow it receives during rainfall events, the city was forced to divert flow from the plant through a bypass line at the headworks of the plant. The bypass, when in use, discharged untreated sewage through outfall 002 to Paint Creek.

Ohio EPA has addressed the City’s I/I and bypass problems in its NPDES permit, through Director’s Findings and Orders, and through referral to the Ohio Attorney General’s Office (AGO) in numerous actions taken over the last 21 years. These have resulted in construction of a flow equalization basin and further sewer work. However, these efforts failed to eliminate sewage overflows from manholes and flooding of basements resulting in illegal discharges of untreated sewage to Paint Creek. In May 2006 the Ohio EPA and the city agreed to a consent order which requires a sanitary sewer capacity analysis and work to develop a plan to eliminate the SSO events. In addition, the city is limited to 200 new sewer taps per year until these problems cease. The plan is currently under development.

Additionally, work was conducted during 2006 to test for effluent toxicity at the Washington Court House WWTP. Chronic toxicity was not indicated for either fathead minnows (*Pimephales promelas*) or water fleas (*Ceriodaphnia dubia*). Acute toxicity testing performed between 1997 and 2002 revealed 3 of 4 instances of acute whole effluent toxicity to *Ceriodaphnia*. Neither acute nor chronic toxicity were apparent in the 2006 testing.

PETRO ENVIRONMENTAL TECHNOLOGIES WWTP

The plant began operation in 1992 and was designed to treat up to 0.0425 MGD. The system consists of cell lined bioreactors, stormwater retention, oil/water separation, and canister-type carbon absorption prior to discharge to a roadside ditch which confluences with Paint Creek around RM 68.0

Petro recycles and treats petroleum contaminated soil through the addition of water and fertilizer to supply the nutrients required to optimize the biodegradation of petroleum products in the soil. The water is collected and half is recycled through a sprinkler system back onto the cell. The other half is pumped to the carbon absorption system prior to discharge. This facility is in compliance with its NPDES permit. Currently approximately 0.01 MGD is treated and discharged. To ensure the ground water is not contaminated, Petro samples a series of monitoring wells semi-annually and submits the results to Ohio EPA. No contamination of the ground water has been reported.

East Fork Paint Creek (WWH, AWS, IWS, PCR)

Water chemistry sampling in East Fork was performed at 3 stream sites and at one WWTP outfall (Bloomingburg WWTP). Two of these stream monitoring sites (RM 8.60 and 5.10) revealed violations of minimum standards for dissolved oxygen in WWH streams (Table 5, Appendix 1). The recreational maximum standard for bacteria was violated at both RM 5.10 and RM 0.70.

Generally speaking, East Fork exhibited habitat comparable to the Paint Creek mainstem. A modified, open channel with a lack of riparian canopy resulted in higher water temperatures than those typically associated with a shaded stream (Figure 8, Table 5). Modified habitat accompanied by nutrient enrichment promoted extensive growth of a variety of filamentous algae and macrophytes in the channel accompanied by early morning dissolved oxygen depletion with violations of WWH minimum standards (Table 5 Figure 8).

Table 5. Violations of chemical water quality standards in Hydrologic Unit 05060003-010, June through August, 2006. Primary tributary streams are listed where they intersect the Paint Creek mainstem and the listing is shaded blue. Secondary tributary streams are listed where they intersect a primary tributary and the listing is shaded pink. Streams labeled U.T. are unnamed tributaries. Wastewater treatment facilities are listed where their discharge points occur and are shaded green. Sites with no entries do not have any violations.

River/Stream (RM sample point or discharge if WWTP, , Uses)	NPDES Discharge	River Mile or Confluence	Parameter	Code
Paint Creek headwaters (HUC 05060003-010,)				
Paint Creek (WWH, AWS, IWS, PCR)		96.00	Dissolved Oxygen Bacteria	c g, h
Paint Creek (WWH, AWS, IWS, PCR)		80.00	Bacteria	h
Paint Creek (WWH, AWS, IWS, PCR)		75.30	Bacteria	h
→Paint Creek	Prairie Knolls MHP WWTP	73.10		
→Paint Creek	Miami Trace High School WWTP	73.00		
→Paint Creek	Washington C.H. WTP Discharge	71.55		
Paint Creek (WWH, PWS, AWS, IWS, PCR)		71.40	Dissolved Oxygen Bacteria	c h
Paint Creek (WWH, AWS, IWS, PCR)		70.90		
Paint Creek (WWH, AWS, IWS, PCR)		69.70	Dissolved Oxygen Bacteria	c h
→Paint Creek	Washington C.H. WWTP	69.45	Bacteria	a
Paint Creek (WWH, AWS, IWS, PCR)	Mixing Zone	69.40		
Paint Creek (WWH, AWS, IWS, PCR)		69.20	Bacteria	g, h
→E. Fork Paint Creek (WWH, AWS, IWS, PCR)		69.04		
→→Vallery Ditch (2.30, U)		15.91	Dissolved Oxygen Bacteria	c h
→→William Cathcart Ditch (0.20, U)		15.91	Dissolved Oxygen Bacteria	c h
→E. Fk. Paint Creek (8.60, WWH, AWS, IWS, PCR)		69.04	Dissolved Oxygen	c
→→E. Fk. Paint Creek (6.30)	Bloomingburg WWTP	69.04	Ammonia	a

River/Stream (RM sample point or discharge if WWTP, , Uses)	NPDES Discharge	River Mile or Confluence	Parameter	Code
→E. Fk. Paint Creek (5.10, WWH, AWS, IWS, PCR)		69.04	Bacteria	h
→→Big Run (1.80, WWH, AWS, IWS, PCR))		2.87		
→E. Fk. Paint Creek (0.70, WWH, AWS, IWS, PCR)		69.04	Dissolved Oxygen Bacteria	c h

WWH—Warm Water Habitat
AWS—Agricultural Water Supply
IWS—Industrial Water Supply
PCR—Primary Contact Recreation
SCR—Secondary Contact Recreation
U—Undesignated (treat as WWH, AWS, IWS, PCR or SCR)
a—violates an NPDES permit limit
b—violates the aquatic life protection criterion outside the mixing zone (24 hour average)
b_{TDS}—violates the aquatic life protection criterion outside the mixing zone for total dissolved solids
c—violates the aquatic life protection criterion outside the mixing zone (minimum or maximum)
d—violates the aquatic life protection criterion inside the mixing zone (maximum)
e—violates the bathing water 30 day geometric mean
f—violates the bathing water 30 day maximum
g—violates the primary contact recreation 30 day geometric mean
h—violates the primary contact recreation 30 day maximum
i—violates the secondary contact recreation 30 day maximum
j—violates the agricultural water supply protection criterion outside the mixing zone (24 hour average)
k—violates the human health protection criterion outside the mixing zone (24 hour average) for drinking water
l—violates the human health protection criterion outside the mixing zone (24 hour average) for non-drinking water

VILLAGE OF BLOOMINGBURG WWTP

The Village of Bloomingburg operates a WWTP that discharges to East Fork Paint Creek at RM 6.30. The plant was constructed in 1976 to treat 0.160 MGD of municipal sewage. Treatment consists of a comminutor, extended aeration and clarification along with ultraviolet disinfection, and slow sand filters. A sludge drying bed is also present to manage excess sludge. Maintenance at the plant has been severely neglected. The Village has repeatedly violated the effluent limits for $cBOD_5$, ammonia, total suspended solids, fecal coliform bacteria and dissolved oxygen as listed in their NPDES discharge permit. In 2003, Ohio EPA initiated escalated enforcement action. The Village responded by securing a grant from the Army Corps of Engineers in 2004, for maintenance and improvement of the wastewater treatment plant and collection system. The detailed plans were revised and the upgrade was delayed due to construction of a new ethanol plant in the service area, so Ohio EPA anticipates receiving the engineering report detailing the upgrade in 2007.

Vallery Ditch (undesignated)

Vallery Ditch is an undesignated direct tributary to East Fork Paint Creek. It discharges into East Fork at RM 15.91. One location was evaluated for water chemistry at RM 2.30. Chemistry results were initially compared with warm water habitat water quality standards as is appropriate for a previously unsurveyed and undesignated stream.

Daytime dissolved oxygen values in Vallery Ditch dropped below the WWH minimum standard of 4 mg/l in three of seven measurements during the summer (Table 5). Bacteria concentrations were also found in excess of either the primary or secondary contact recreational maximums on August 28, 2006 (a primary or secondary contact recreation designation will be assigned to Vallery Ditch at a future date).

Nutrient enrichment was moderate as chemical results revealed significant concentrations of ammonia, TKN, and total phosphorus in the water column along with significant amounts of filamentous algae. Both total phosphorus and nitrate+nitrite concentrations were comparable to other undesignated headwater streams (Figure 9). Nutrient cycling was obviously disrupted via riparian removal and channel modification for drainage. The largely open channel also facilitated higher than normal background water temperatures and light conditions which promoted excessive algal growth in the stream and low dissolved oxygen concentrations. These issues, combined with sedimentation served to inhibit attainment in the invertebrate community.

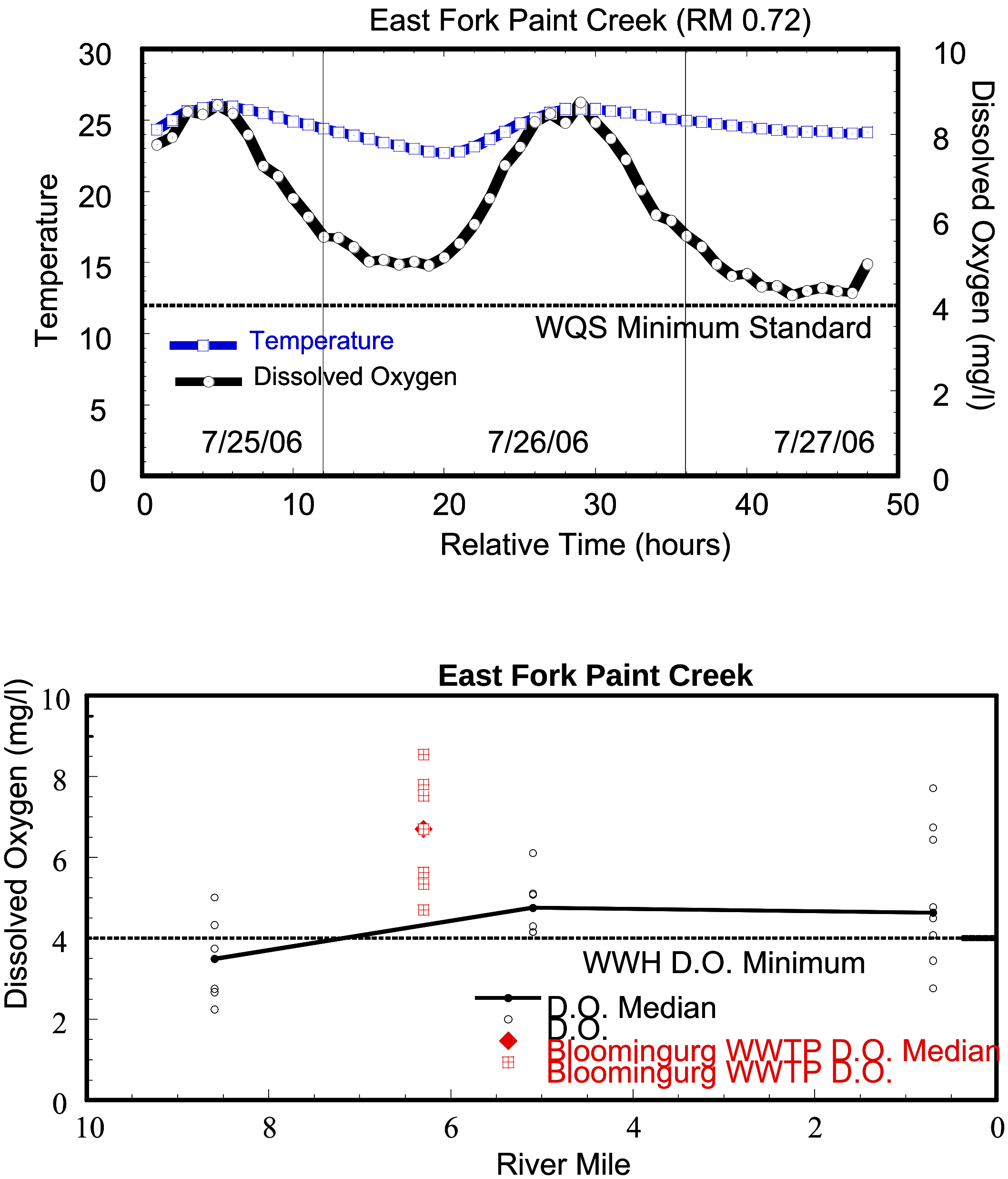


Figure 8. Top panel - temperature and dissolved oxygen concentrations in the East Fork recorded hourly by a continuous data logger at US 22 (RM 0.72), July 25 – 27, 2006. Lower panel – longitudinal profile of dissolved concentrations in daytime water quality spot samples collected from the East Fork in 2006.

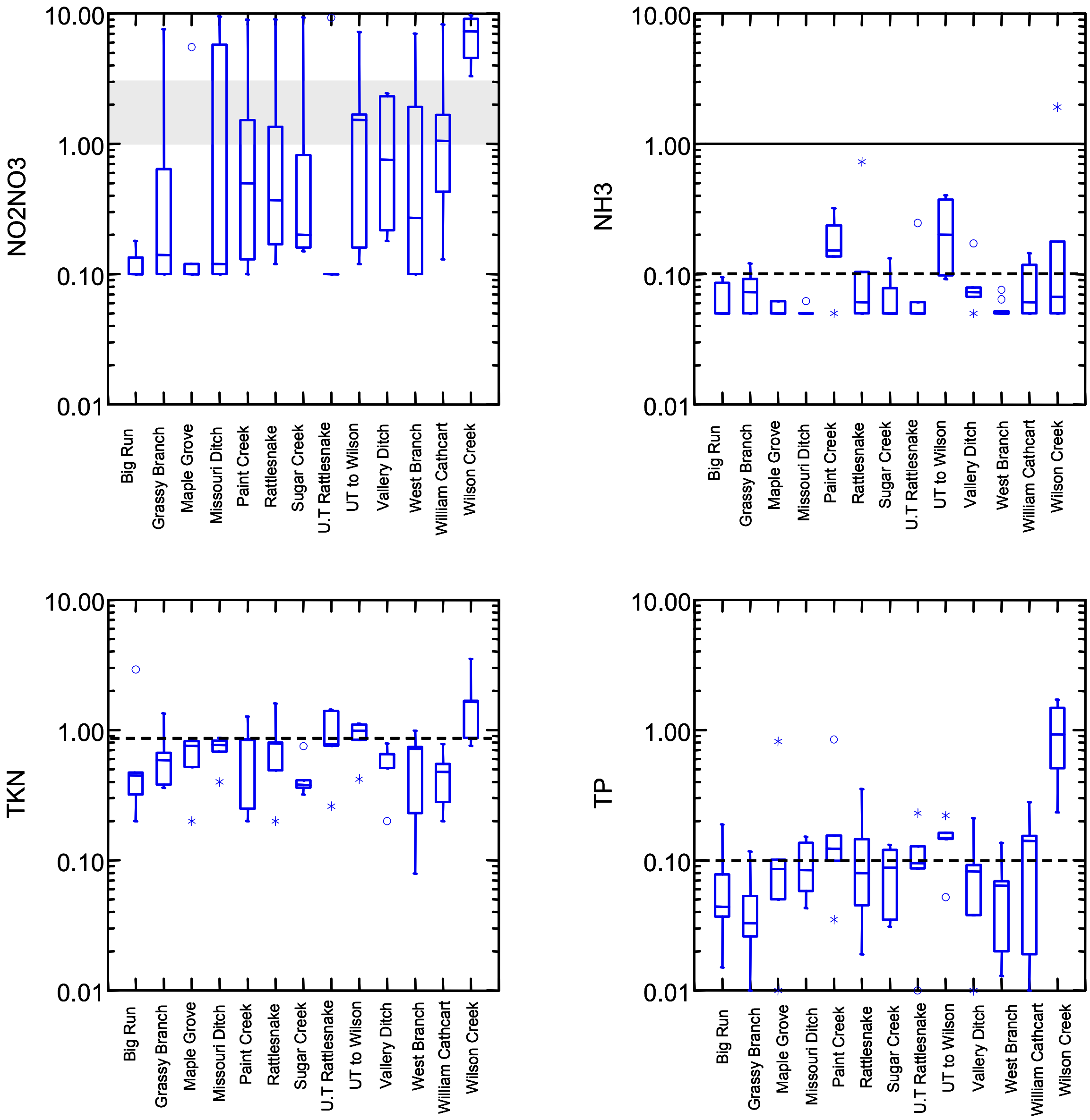


Figure 9. Distributions of selected nutrient concentrations measured in water quality spot samples collected from various small headwater tributaries in the Paint Creek watershed, 2006. Dashed lines in the TP and TKN plots show the upper range of background concentrations typical for the ecoregion. The shaded area in the NO3-NO2 plot spans the range of concentrations defining elevated to grossly elevated. The solid line at 1.0 mg/l in the NH3-N plot is the concentration beyond which acute toxicity is likely, and the dashed line at 0.1 mg/l shows the concentration where chronic toxicity becomes increasingly likely.

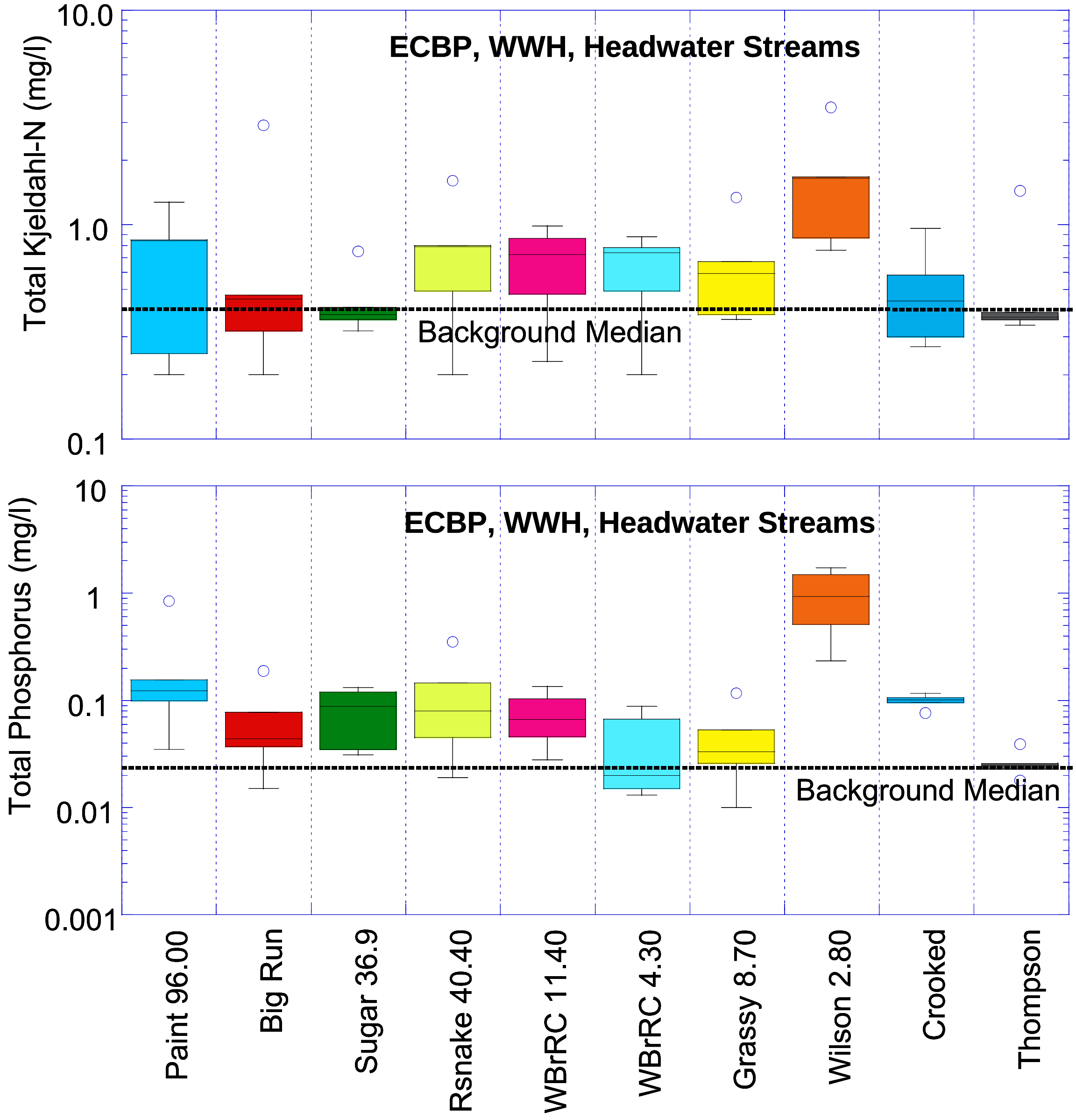


Figure 10. Distributions of TKN and TP concentrations in water quality spot samples collected at headwater locations referenced in the text.

William Cathcart Ditch (Undesignated)

William Cathcart Ditch is another undesignated direct tributary to East Fork Paint Creek discharging into East Fork at RM 15.91. Water chemistry was evaluated at RM 0.20, near the confluence with East Fork Paint Creek. Chemistry results were again compared with warm water habitat standards as appropriate for a previously unsurveyed and undesignated stream.

Several potential violations of water quality standards were evident (Table 5). Half of the daytime dissolved oxygen measurements fell far below the WWH minimum standard of 4 mg/l (Table 5). Bacterial concentrations also exceeded both primary and secondary contact recreational standards at least twice during the survey (Appendix 3). The number of violations will ultimately depend on the recreational use designation assigned to William Cathcart Ditch.

Nutrient samples revealed high nitrate+nitrite concentrations in the early summer with moderate concentrations of ammonia, TKN, and total phosphorus over the entire sampling period (Appendix 1). Both total phosphorus and nitrate+nitrite concentrations were comparable to other undesignated headwater streams in HUCs 010, 020, and 030 (Figure 9). Shaded conditions at the sampling site kept filamentous algae blooms to a minimum although proper nutrient cycling in this stream has certainly been disrupted by channel modification and agricultural drainage improvement activities.

Big Run (WWH, AWS, IWS, PCR)

Big Run discharges directly to East Fork Paint Creek at RM 2.87. Water samples were collected at RM 1.80 just northwest of Washington Court House. Significant bacterial contamination was noted, revealing violations of primary contact recreational standards in 5 of 6 samples, both for the maximum and also for the 30-day geometric mean standard (Appendix 3, Table 5). No obvious sources of bacteria were identified during the survey work.

Nutrient enrichment was low to moderate in this stream with large amounts of nitrate+nitrite present in early summer and the noticeable presence of total phosphorus and TKN during the rest of the sampling season. Nutrient enrichment certainly arises in part from the artificial drainage associated with row crop agriculture. An incised straightened channel disconnected from the floodplain, few riparian trees, and the encroachment of row crop fields also serve to disrupt normal nutrient cycling in Big Run. Nutrient enrichment in Big Run was comparable with other WWH-designated headwater streams in HUCs 010, 020, and 030 (Figure 9).

Trends

Paint Creek

Upper Paint Creek has shown little change in mean nutrient composition compared with past survey results. Mean nutrient concentrations are similar among the survey points and the years surveyed with some small variation (Figure 10). However, between RM 96 and RM 71.40 mean TKN and mean total phosphorus concentrations were somewhat diminished compared with 1997 results, possibly due to the use of agricultural best management practices. Nutrient enrichment has revealed little change in the lower portion of this stream reach downstream from RM 71.40 (Figure 10).

Mean total suspended solids showed a significant decrease in 2006 compared with 1997 upstream of RM 69.7 (Figure 10). Differences in stream flow, precipitation events, and erosion are likely the major causes of the decrease since the summer of 2006 was relatively dry.

Mean dissolved oxygen concentrations upstream of the Washington Court House WWTP were noticeably lower than those found in 1997 and 1989 while downstream values were very similar (Figure 10). Sustained periods of dry, hot weather in 2006 likely contributed to this difference.

East Fork Paint Creek

Comparison of water quality data collected in the East Fork in 1997 and 2006 show no difference beyond normal variation with the exception of dissolved oxygen. Mean dissolved oxygen concentrations were systematically lower in 2006 (4.4 mg/l) than in 1997 (7.1 mg/l), likely due to low stream flows in 2006.

Sediment

Sediment samples were obtained from 3 locations in the Upper Paint Creek watershed. All 3 locations were on the Paint Creek mainstem. Sediment samples revealed little in the way of contamination from organic chemicals or metals. Pesticides, PCBs, BNAs and VOCs were not detected at any of the 3 sample locations. Metals (including arsenic) were not detected at concentrations above sediment reference values (Table 6). Only total organic carbon and sediment phosphorus were detected at concentrations that might be slight cause for concern for the benthic community (Table 6) but impairment of the invertebrate community was not noted at any of these sites.

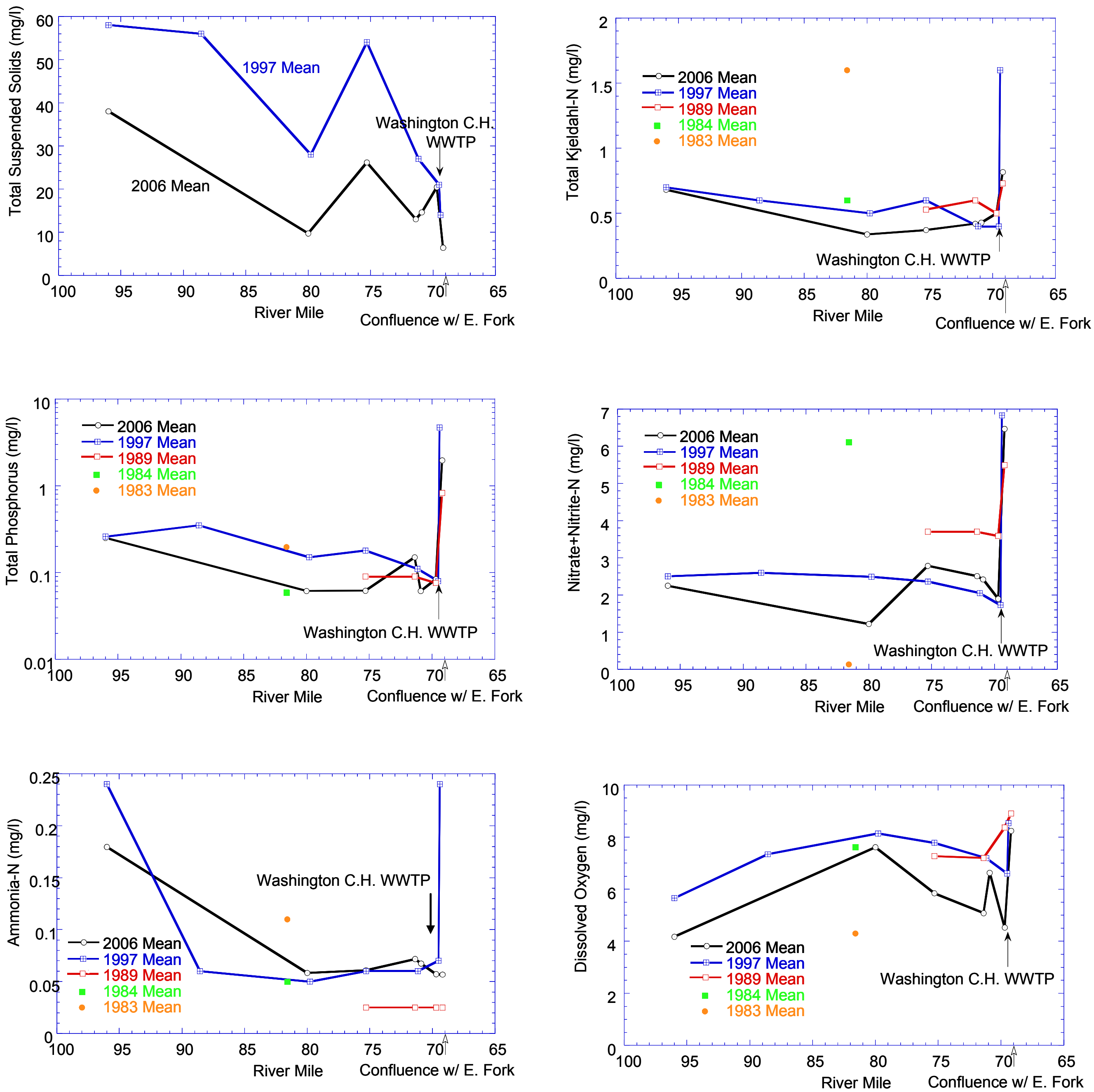


Figure 11. Longitudinal profiles of mean concentrations of selected water quality parameters in spot samples collected from the mainstem of Paint Creek upstream from the confluence with the East Fork, 1983 - 2006.

Table 6. Results of chemical/physical sediment quality sampling conducted in the Paint Creek study area (HUC 05060003-010) during July-September, 2006. Parameters in *italics* have no established guideline for comparison. Underlined values indicate concentrations below the method-reporting limit. NA means not analyzed. Parameters noted with a ◙ are compared with the Ontario guidelines published by Persaud and Jaagumagi, 1993 (LEL = greater than the Lowest Effect Level but less than the Severe Effect Level, SEL = greater than the severe effect level). All metals parameters are compared with ecoregional (default) or statewide (noted by a subscript s) sediment reference values determined by Ohio EPA (Ohio EPA, 2003). Metals values in **boldface** and shaded are greater than the reference value. Boxes with no value were analyzed but not detected.

Analyte	Units	Paint Creek		
	RM	**80.0**	**75.30**	**71.40**
Solids	%	49.5	51.7	42.7
NUTRIENTS				
Tot. Organic Carbon◙	%	4.4_{LEL}	4.1_{LEL}	4.2_{LEL}
Ammonia	mg/kg	NA	NA	78
Phosphorus◙	mg/kg	NA	NA	932_{LEL}
METALS				
Aluminum	mg/kg	8210_j	8560_j	11000_j
Arsenic	mg/kg	7.89	6.41	7.06
Barium	mg/kg	91.2	101	131
Cadmium	mg/kg	0.333	0.333	0.477
Calcium	mg/kg	64900	28300	36700
Chromium	mg/kg	22	21	25
Copper	mg/kg	11.2	12.6	18.0
Iron	mg/kg	17900	18100	22800
Lead$_s$	mg/kg	29	28	33
Magnesium	mg/kg	31200	13300	15900
Manganese	mg/kg	572	489	384
Nickel	mg/kg	29	28	33
Mercury$_s$	mg/kg	0.044	0.037	0.048
Potassium	mg/kg	1440	1380	1640
Selenium	mg/kg	1.44	1.38	1.64
Sodium	mg/kg	3610	3450	4110
Strontium	mg/kg	209	172	237
Zinc	mg/kg	59.5	63.5	85.4
ORGANICS (none detected)				
j = estimated due to matrix interference.				

Sugar Creek Assessment Unit (05060003-020)

The Sugar Creek assessment unit (Hydrologic Unit Code 05060003-020) encompasses the entire drainage area of Sugar Creek from the headwaters to the confluence with Paint Creek at RM 60.63. Sugar Creek flows in a southerly direction through Jeffersonville on the western side of Fayette County before turning southeast toward the confluence with Paint Creek. The only tributary to Sugar Creek that was assessed in this survey was Missouri Ditch (confluence with

Sugar Creek at RM 19.66). This assessment unit is located within the Eastern Corn Belt Plains (ECBP) ecoregion.

There were 8 stream monitoring sites in this unit that were evaluated for chemical water quality, 7 sites on the Sugar Creek mainstem, and 1 site on Missouri Ditch. One effluent site was evaluated at the Jeffersonville WWTP (Table 3).

Sugar Creek (WWH, AWS, IWS, PCR)

The uppermost sampling site on Sugar Creek was located on Selsor-Moon Road (RM 36.9) in the southwest corner of Madison County. Five additional sites were included on Sugar Creek extending downstream to the final site at Armbrust Road in southern Fayette County. The drainage area for Sugar Creek is 75 square miles.

The upper reaches of Sugar Creek at RM 36.9, 29.20 and 24.80 showed problems with low dissolved oxygen concentrations (Appendix 1). Numerous water quality violations for dissolved oxygen were recorded for these upper sites (Table 7). Extending downstream dissolved oxygen concentrations improved with median concentrations above 6.0 mg/l (Figure 12).

Nutrient enrichment was evident in the upper reaches of Sugar Creek. Heavy to moderate algae growth was noted at several sites including RM 29.2 and RM 24.80. Several samples here exceeded the 75th percentile for nitrate+nitrite, total phosphorus and TKN (Appendix 1). Elevated concentrations of nutrients were also noted downstream of the Jeffersonville WWTP discharge and confirmed in effluent samples. At RM 24.80, a 135.3% dissolved oxygen saturation level was recorded during mid-morning sampling on July 29, 2006. Supersaturated dissolved oxygen concentrations were due to nuisance levels of algae. Nuisance growths of algae were not apparent at Mark Road (RM 5.4) and Armbrust Road (RM 4.2), due in part to better habitat conditions leading to more normal nutrient cycling.

Diel dissolved oxygen patterns were evaluated at RM 4.24 (Armbrust Rd.). The WWH 24 hour average dissolved oxygen criterion (5.0 mg/l) was met here during sampling from July 25 to July 27 (Figure 12).

Systemic bacteria issues were not observed throughout the basin. Single excursions of one of the two components of the bacteria standards occurred at RM 36.9 and 4.2. At RM 18.6, both of the components of the bacteria standards were exceeded resulting in violation of the recreational use designation. (Table 7).

a)

b)

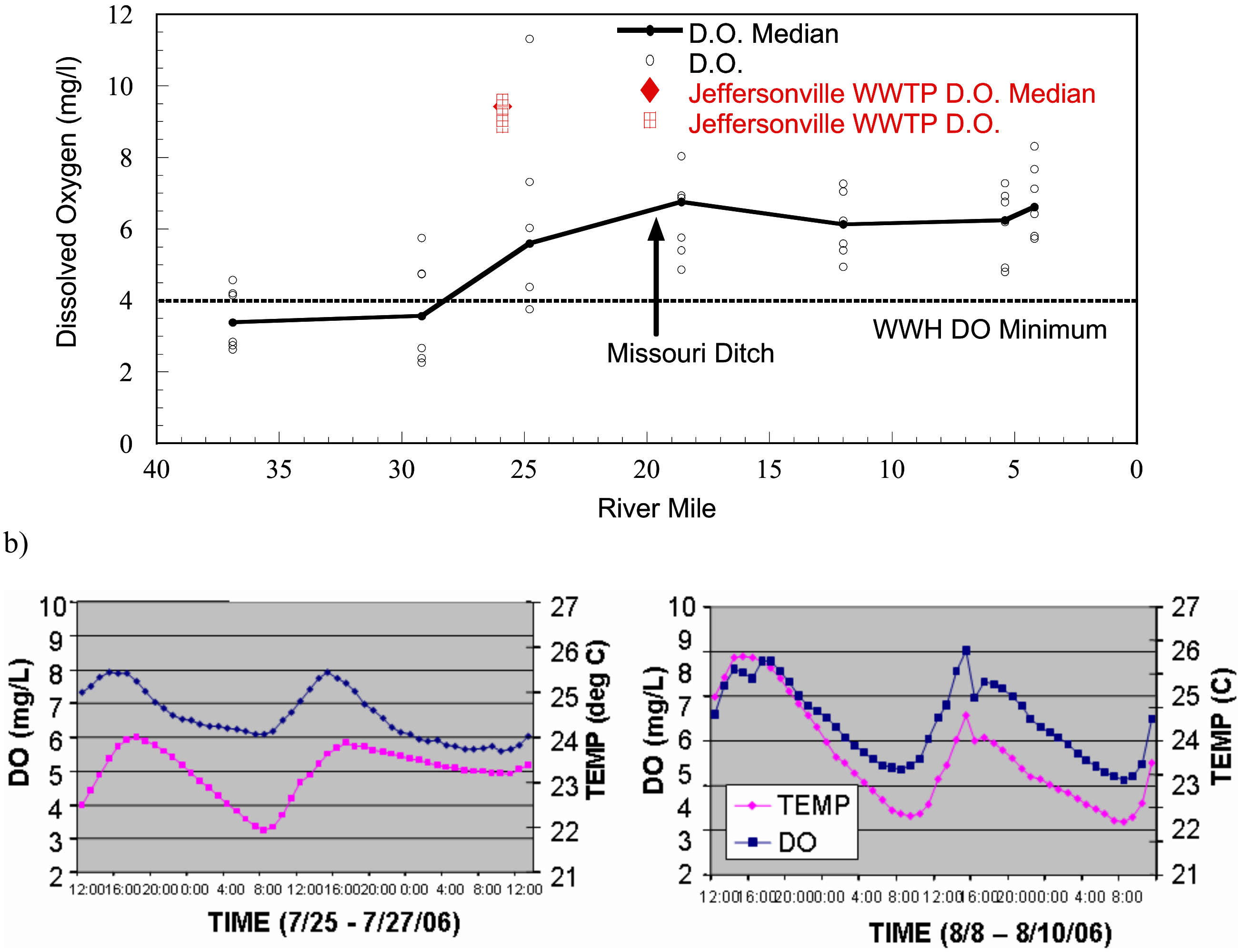


Figure 12. a) Longitudinal profile of dissolved oxygen concentrations in daytime spot samples collected from Sugar Creek, 2006. The stippled line shows the water quality standard for minimum dissolved oxygen concentrations needed to sustain aquatic life. b) Hourly dissolved oxygen concentrations and temperature recorded by automated data loggers in Sugar Creek at Armbrust Road (RM 4.24) for the dates shown.

Table 7. Violations of chemical water quality standards in the Sugar Creek assessment unit, June through August, 2006. Primary tributary streams are listed where they intersect the Sugar Creek mainstem and the listing is shaded blue. Secondary tributary streams are listed where they intersect a primary tributary and the listing is shaded pink. Streams labeled U.T. are unnamed tributaries. Wastewater treatment facilities are listed where their discharge points occur and are shaded green. Sites with no entries do not have any violations.

River/Stream (RM, Uses)	NPDES Discharge	QHEI	River Mile or Confluence	Parameter	Code
Sugar Creek (HUC 05060003-020,)					
Paint Creek					
→Sugar Creek (36.90, WWH, AWS, IWS, PCR)			60.63	D.O., Bacteria	b, c, h
→Sugar Creek (29.20, WWH, AWS, IWS, PCR)			60.63	D.O.	c
→→Sugar Creek (25.90)	Jeffersonville WWTP		60.63		
→Sugar Creek (24.80, WWH, AWS, IWS, PCR)			60.63	D.O.	c
→→Missouri Ditch (1.60, U)			19.66		
→Sugar Creek (18.60, WWH, AWS, IWS, PCR)			60.63	Bacteria	g, h
→Sugar Creek (12.00, WWH, AWS, IWS, PCR)			60.63		
→Sugar Creek (5.40, WWH, AWS, IWS, PCR)			60.63		
→Sugar Creek (4.20, WWH, AWS, IWS, PCR)			60.63	Bacteria	h

WWH—Warm Water Habitat
AWS—Agricultural Water Supply
IWS—Industrial Water Supply
PCR—Primary Contact Recreation
SCR—Secondary Contact Recreation
U—Undesignated (treat as WWH, AWS, IWS, PCR or SCR)
a—violates an NPDES permit limit
b—violates the aquatic life protection criterion outside the mixing zone (24 hour average)
b_{TDS}—violates the aquatic life protection criterion outside the mixing zone for total dissolved solids
c—violates the aquatic life protection criterion outside the mixing zone (minimum or maximum)
d—violates the aquatic life protection criterion inside the mixing zone (maximum)
e—violates the bathing water 30 day geometric mean
f—violates the bathing water 30 day maximum
g—violates the primary contact recreation 30 day geometric mean
h—violates the primary contact recreation 30 day maximum
i—violates the secondary contact recreation 30 day maximum
j—violates the agricultural water supply protection criterion outside the mixing zone (24 hour average)
k—violates the human health protection criterion outside the mixing zone (24 hour average) for drinking water
l—violates the human health protection criterion outside the mixing zone (24 hour average) for non-drinking water

VILLAGE OF JEFFERSONVILLE WWTP NO. 2

The Village of Jeffersonville WWTP No. 2 discharges to Sugar Creek at RM 25.9. The Village of Jeffersonville WWTP #2 is a new WWTP that just went on-line in June 2006. The 0.5 MGD mechanical oxidation ditch (activated sludge) system replaces a former controlled discharge lagoon system. The new WWTP was built as a result of a third consent order between Ohio EPA and the Village to address chronic effluent violations from the old lagoon system. The existing lagoon system now serves as flow equalization before the two-oxidation ditches, two-clarifiers, UV disinfection, post aeration, two-aerated digesters, and three-sludge drying beds. At this time the Village is under the year-long certification program with Ohio EPA/DEFA, before the plant is certified.

Water chemistry results were obtained from seven samples collected at the WWTP effluent. Dissolved oxygen, total suspended solids, oil & grease and ammonia levels were within permit limits. Median levels for total phosphorus and ammonia were 2.510 mg/l and 0.131 mg/l respectively (Appendix 1) contributing to nutrient enrichment noted instream.

Missouri Ditch (Undesignated)

Missouri Ditch enters Sugar Creek at RM 19.66 and has a drainage area of 6.4 miles. One site on Missouri Ditch was evaluated at RM 1.6 (Harmony Road).

The dissolved oxygen concentrations here were above average with a median concentration of 6.65 mg/l. Specific conductivity levels were slightly elevated with a median of 729 μS. Nutrient conditions were slightly elevated with total phosphorus and TKN concentrations exceeding the 50th percentile when compared to background conditions (Appendix 1).

Trends

Trends in water quality chemistry were evaluated for Sugar Creek by examining chemical sampling results from this survey with results recorded during a1997 sampling effort. There were five (5) common sampling sites on Sugar Creek during 2006 and 1997 sampling. 2006 sampling was conducted during periods of above average temperatures and below average precipitation. Dissolved oxygen concentrations in 2006 were slightly lower than those observed in 1997 at common sites sampled with the exception of RM 29.2 where the mean DO concentrations recorded in 2006 (3.73 mg/l) was significantly lower than in 1997 (9.82 mg/l). The difference was due to oxygen depletion caused by decaying organic matter (i.e., dead or dying algae) in 2006. Concentrations of ammonia-N were very similar on a site-by-site basis between 1997 and 2006. Nitrate-nitrite and TKN mean concentrations for 2006 were slightly higher than those observed in 1997, which may reflect lower dilution due to incipient drought conditions in 2006. For total phosphorus, some sites showed higher total phosphorus concentrations in 1997 compared to 2006. For example, mean sampling results in 1997 for RM 29.2 and RM 18.6 were 0.07 mg/l and 0.12 mg/l respectively compared to 0.017 mg/l and 0.042 mg/l respectively in 2007. Phosphorus uptake by the thick algae mats noted at McKillip Road (RM 29.2) and Creamer Road (24.8) in 2006 may have been responsible for the difference.

Sediment

Fine grained, unconsolidated sediments were sampled at one location in the Sugar Creek assessment unit. This site was located in the middle portion of the watershed at RM 24.8 (Creamer Road). Total organic carbon and total phosphorus concentrations exceeded the Lowest Effect Level (LEL) in a sample collected at this site on September 21, 2006. All sediment metals, with the exception of strontium, were below Ohio sediment reference values (SRV). Sediment organic analysis detected only one organic, Toluene, at 7.56 mg/kg (Table 8).

Table 8. Results of sediment quality sampling conducted in Sugar Creek, 2006. Parameters in *italics* have no established guideline for comparison. Underlined values indicate concentrations below the method-reporting limit. NA means not analyzed. Parameters noted with a ◙ are compared with the Ontario guidelines published by Persaud and Jaagumagi (1993; LEL = greater than the Lowest Effect Level but less than the Severe Effect Level, SEL = greater than the severe effect level). All metals parameters are compared with ecoregional (default) or statewide (noted by a subscript s) sediment reference values determined by Ohio EPA (Ohio EPA, 2003). Metals values in **boldface** and shaded are greater than the reference value. Italicized values are greater than the Probable Effect Concentration (PEC) for organics established by MacDonald *et. al.* (2000). Boxes with no value were analyzed but not detected.

Analyte	**Units**	**@ Creamer Rd.**
	RM	**24.8**
Solids	%	38.9
NUTRIENTS		
Tot. Organic Carbon◙	%	4.3
Ammonia	mg/kg	73
Phosphorus◙	mg/kg	1080
METALS		
Aluminum	mg/kg	4430
Arsenic	mg/kg	5.40
Barium	mg/kg	79.9
Cadmium	mg/kg	0.280
Calcium	mg/kg	85300
Chromium	mg/kg	22
Copper	mg/kg	9.3
Iron	mg/kg	11800
$Lead_s$	mg/kg	29
Magnesium	mg/kg	20700
Manganese	mg/kg	292
Nickel	mg/kg	29
$Mercury_s$	mg/kg	0.039
Potassium	mg/kg	1460
Selenium	mg/kg	1.46
Sodium	mg/kg	3560
Strontium	mg/kg	**595**
Zinc	mg/kg	67.2
ORGANICS		
Toluene	mg/kg	7.56
All other organics below detection		

Rattlesnake Creek (headwaters to above Lees Creek) Assessment Unit (05060003-030)

The upper Rattlesnake Creek assessment unit (Hydrologic Unit Code 05060003-030) is the catchment upstream from the confluence with Lees Creek at RM 9.46. Rattlesnake Creek flows in a southerly direction beginning in far southwestern Madison County near South Solon and moving through rural western and south central Fayette County and into Highland County near East Monroe. Tributaries assessed in this unit included an unnamed tributary to Rattlesnake Creek (confluence with Rattlesnake Creek at RM 40.21), Maple Grove Creek (confluence with Rattlesnake Creek at RM 37.61), West Branch Rattlesnake Creek (confluence with Rattlesnake Creek at RM 26.87), Wilson Creek (confluence with West Branch at RM 2.90), and an unnamed tributary to Wilson Creek (confluence with Wilson Creek at RM 4.25). This assessment unit is located within the Eastern Corn Belt Plains (ECBP) ecoregion.

There were 15 stream monitoring sites in this unit evaluated for chemical water quality, 7 sites on the Rattlesnake Creek mainstem, and 8 sites on tributaries. One effluent site was evaluated at the South Solon WWTP (Appendix 1).

Rattlesnake Creek (WWH, AWS, IWS, PCR)

The uppermost water chemistry sampling site on this reach of Rattlesnake Creek mainstem was located at RM 40.4 in the northwest corner of Fayette County. This segment of Rattlesnake Creek included six additional sampling sites extending downstream to the final mainstem site at Fishback Road (RM 13.3) located above the village of East Monroe and just above Paint Creek Lake. This portion of Rattlesnake Creek encompasses a drainage area over 137 square miles. Water chemistry sampling revealed a number of concerns with low dissolved oxygen levels and elevated nutrient concentrations.

Dissolved oxygen concentrations were variable with most site medians around 5.5 mg/l in the upper and middle portion of Rattlesnake Creek (Figure 13). At RM 40.4 and RM 38.1 in the upper portion, several dissolved oxygen water quality violations below the 4.0 mg/l minimum standard were recorded. Dissolved oxygen concentrations improved at the two sites on the lower portion of Rattlesnake Creek (RM 15.0 and RM 13.3) where much improved stream habitat conditions existed (Appendix 1, Figure 13). In addition, diel dissolved oxygen patterns were also evaluated at RM 15.0 and RM 13.3. Typical diurnal dissolved oxygen patterns were observed at both sites where the 24 hour average dissolved oxygen criteria was met (Figure 13).

Elevated nutrient conditions were pervasive throughout Rattlesnake Creek. Nitrate+nitrite concentrations above the 75th percentile compared to reference background concentrations were common at all sampled sites. (Figure 14; Appendix 1). Downstream from the Rattlesnake Sewer District #1 WWTP discharge, total phosphorus concentrations were well above the 0.10 mg/l statewide target for warmwater wadeable streams (Figure 14; Ohio EPA 1999).

Moderate stream algae growth was present at several sites in the upper and middle portions of Rattlesnake Creek. Stream channelization with minimal riparian buffer in many areas failed to

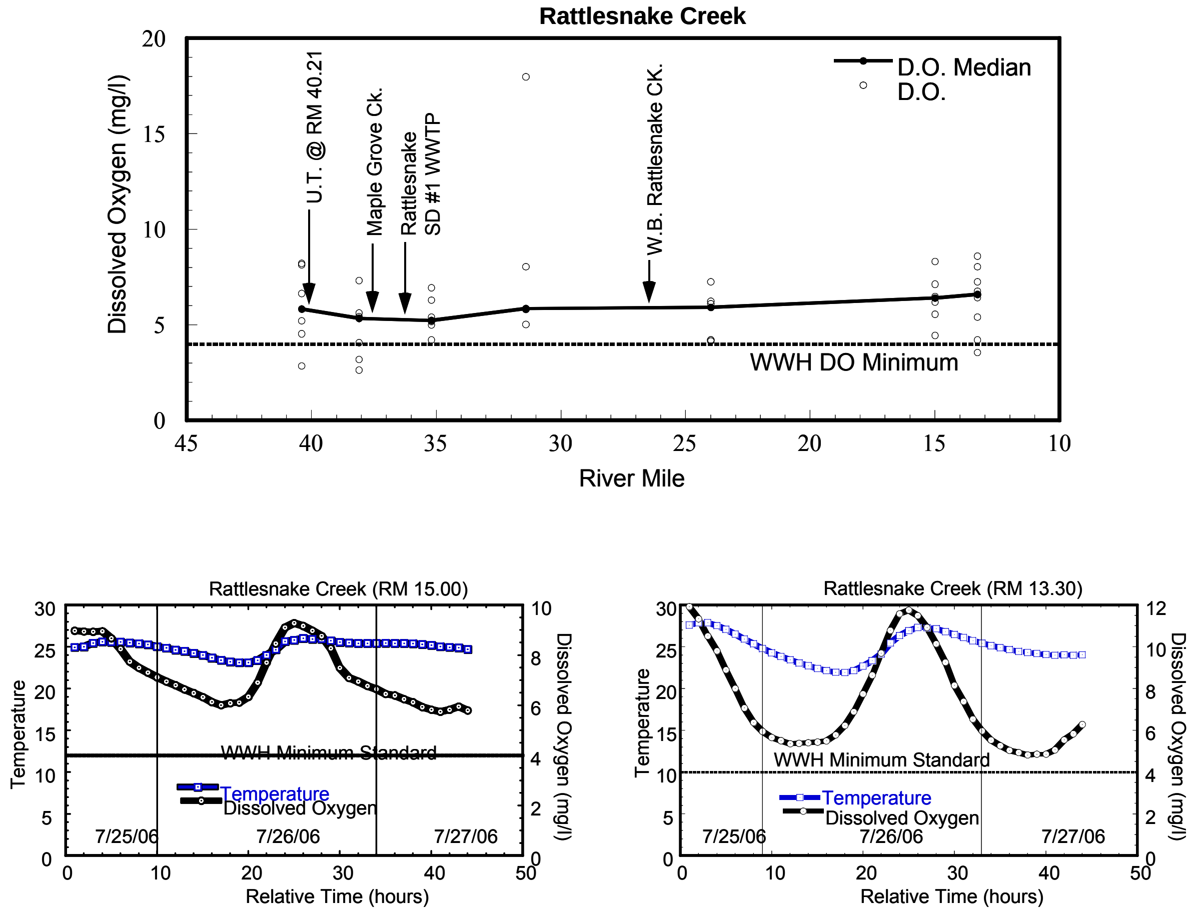


Figure 13. Upper panel – longitudinal profile of dissolved oxygen concentrations measured in water quality spot samples collected from Rattlesnake Creek. Lower panel – hourly temperature and dissolved oxygen concentrations recorded by automated data loggers placed near Zimmerman Road (RM 15.0) and Fishback Road (RM 13.3).

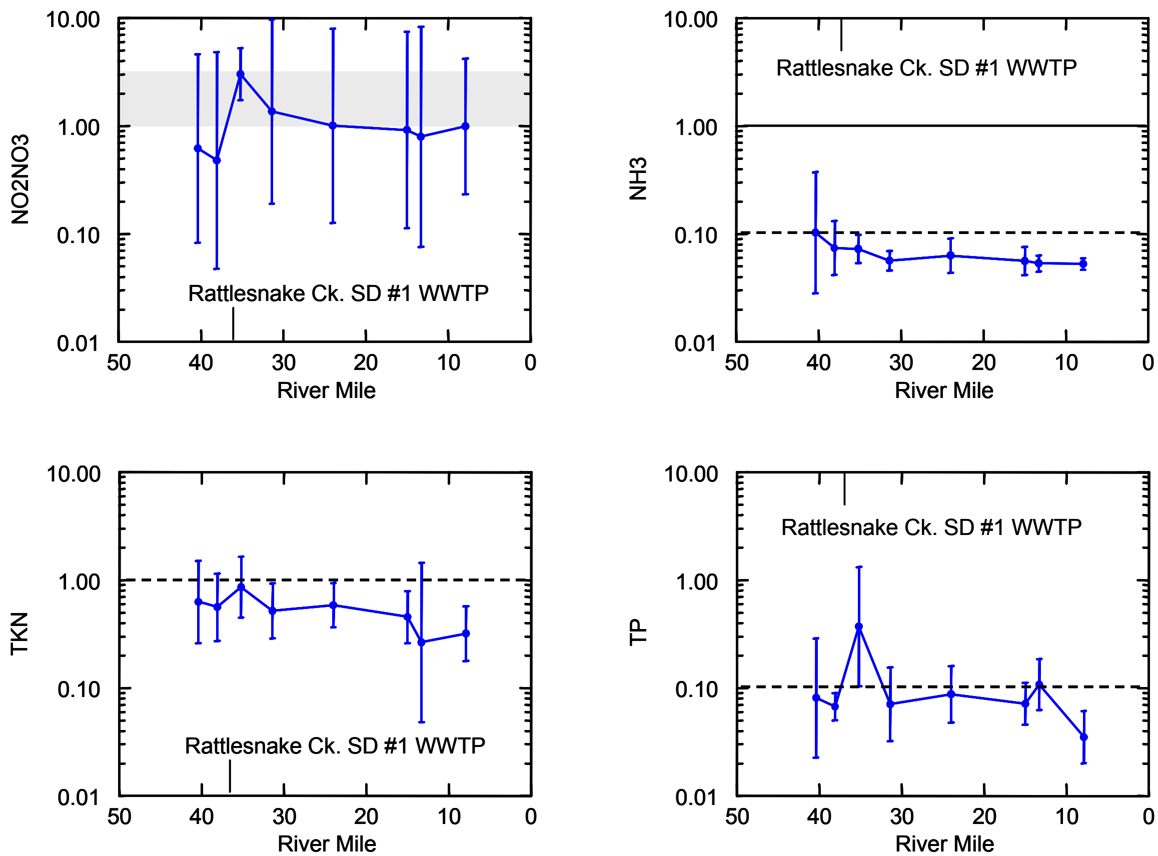


Figure 14. Longitudinal profiles of mean (+/- 1 SD) nutrient concentrations in water quality spot samples collected from Rattlesnake Creek, 2006. Dashed lines in the TP and TKN plots show the upper range of background concentrations typical for the ecoregion. The shaded area in the NO3-NO2 plot spans the range of concentrations defining elevated to grossly elevated. The solid line at 1.0 mg/l in the NH3-N plot is the concentration beyond which acute toxicity is likely, and the dashed line at 0.1 mg/l shows the concentration where chronic toxicity becomes increasingly likely.

provide much capacity for nutrient assimilation. These conditions also contributed to higher stream temperatures with the median exceeding reference background conditions.

Single excursions of one of the two components of bacteria standards were noted at RM 38.1, RM 24.1, RM 15.0 and RM 13.3 (Table 9). Overall, however, bacteria concentrations observed in mainstem Rattlesnake Creek during this survey did not appear to be problematic and the recreational use was attained.

VILLAGE OF SOUTH SOLON WWTP

The Village of South Solon WWTP discharges to Rattlesnake Creek at RM 47.33. South Solon constructed a new WWTP that began operations in April 2006. Previously, the village was unsewered. The WWTP utilizes a Biolac® aerated basin activated sludge system with post aeration and UV disinfection. The average design capacity for the WWTP is 0.098 MGD.

Water chemistry results were obtained from six samples collected from the WWTP effluent (Appendix 1). On three occasions, dissolved oxygen concentrations were below the 6.0 mg/l minimum permit limit. Median levels for BOD_5, total suspended solids, and total ammonia were 16.0 mg/l, 5.0 mg/l and 2.774 mg/l respectively. An extremely elevated total ammonia concentration of 17.7 mg/l was recorded from a grab sample taken July 18, 2006. The median total phosphorus concentration was 2.710 mg/l. Fecal coliform (bacteria) concentrations were not a concern. Effluent results of this nature usually result in organic and nutrient enrichment instream.

RATTLESNAKE CREEK SEWER DISTRICT #1 WWTP

The Rattlesnake Sewer District #1 WWTP discharges to Rattlesnake Creek at RM 36.3. The Fayette County Board of Commissioners owns and operates this wastewater treatment plant. The plant began operation in the 1980's and has been expanded to a design capacity of 0.5 MGD. The plant equipment consists of mechanical screen, "Orbal" oxidation ditch, two (2) clarifiers, ultra-violet disinfection, post aeration and aerobic sludge digestion.

No WWTP effluent sampling was conducted as part of this study. This facility is currently in compliance with its NPDES permit based on monthly operating reports and inspections.

Unnamed Tributary to Rattlesnake Creek (undesignated)

This unnamed headwater stream enters Rattlesnake Creek at RM 40.21 and has a drainage area of 4.6 miles. Poor stream habitat conditions and intensive agricultural land use, including crop production, were present here and a likely cause of nutrient enrichment. One site was sampled at RM 1.10 (near State Route 734 and Pleasantview Road). A single instance of dissolved oxygen concentration (2.58 mg/l) falling below the minimum warmwater habitat criteria of 4.0 mg/l was recorded (Table 9). Here nutrient enrichment was problematic with four of five samples exceeding the 75th percentile for total phosphorus and TKN when compared to reference background concentrations (Appendix 1). TKN concentrations here were among the highest observed compared to other sites of similar drainage area (Figure 8).

Table 9. Violations of chemical water quality standards in the Rattlesnake Creek assessment unit, June through August, 2006. Primary tributary streams are listed where they intersect the Paint Creek mainstem and the listing is shaded blue. Secondary tributary streams are listed where they intersect a primary tributary and the listing is shaded pink, with tertiary streams yellow and quaternary streams grey. Streams labeled U.T. are unnamed tributaries. Wastewater treatment facilities are listed where their discharge points occur and are shaded green. Sites with no entries do not have any violations.

River/Stream (RM, Uses)	NPDES Discharge	River Mile or Confluence	Parameter	Code
Rattlesnake Creek headwaters to Lees Creek (HUC 05060003-030,)				
Paint Creek				
→→Rattlesnake Creek (47.33)	S. Solon WWTP	43.27	Dissolved Oxygen	c
→Rattlesnake Creek (40.40, WWH, AWS, IWS, PCR)		43.27	Dissolved Oxygen	c
→→U.T. to Rattlesnake Ck. (1.10, U)		40.21	Dissolved Oxygen	c
→Rattlesnake Creek (38.10, WWH, AWS, IWS, PCR)		43.27	Dissolved Oxygen Bacteria	c, h
→→Maple Grove Creek (1.60, U)		37.61	Dissolved Oxygen	c
→→Rattlesnake Creek (36.27)	Rattlesnake SD #1 WWTP	43.27		
→Rattlesnake Creek (35.20, WWH, AWS, IWS, PCR)		43.27	Dissolved Oxygen	c
→Rattlesnake Creek (31.40, WWH, AWS, IWS, PCR)		43.27		
→→W. Br. Rattlesnake Creek (11.40, WWH, AWS, IWS, SCR)		26.87	Dissolved Oxygen	b, c
→→W. Br. Rattlesnake Creek (4.30, WWH, AWS, IWS, SCR)		26.87		
→→→Wilson Creek (WWH, AWS, IWS, PCR)		2.90		
→→→→U.T. to Wilson Ck (0.40, U)		4.25	Bacteria	g, h
→→→→Wilson Creek (2.85)	Sabina WWTP	2.90		
→→→Wilson Creek (2.80, WWH, AWS, IWS, PCR)		2.90	Bacteria	g, h
→→W. Br. Rattlesnake Creek (2.80, (WWH, AWS, IWS, SCR)		26.87	Dissolved Oxygen	c
→Rattlesnake Creek (24.00, WWH, AWS, IWS, PCR)		43.27	Bacteria	h
→→Grassy Branch (8.70, WWH, AWS, IWS, PCR		1.38		
→Rattlesnake Creek (15.00, WWH, AWS, IWS, PCR)		43.27	Bacteria	h
→Rattlesnake Creek (13.30, WWH, AWS, IWS, PCR)		43.27	Dissolved Oxygen Bacteria	c, h

Table 9. Continued.

WWH—Warm Water Habitat
AWS—Agricultural Water Supply
IWS—Industrial Water Supply
PCR—Primary Contact Recreation
SCR—Secondary Contact Recreation
U—Undesignated (treat as WWH, AWS, IWS, PCR or SCR)
a—violates an NPDES permit limit
b—violates the aquatic life protection criterion outside the mixing zone (24 hour average)
b_{TDS}—violates the aquatic life protection criterion outside the mixing zone for total dissolved solids
c—violates the aquatic life protection criterion outside the mixing zone (minimum or maximum)
d—violates the aquatic life protection criterion inside the mixing zone (maximum)
e—violates the bathing water 30 day geometric mean
f—violates the bathing water 30 day maximum
g—violates the primary contact recreation 30 day geometric mean
h—violates the primary contact recreation 30 day maximum
i—violates the secondary contact recreation 30 day maximum
j—violates the agricultural water supply protection criterion outside the mixing zone (24 hour average)
k—violates the human health protection criterion outside the mixing zone (24 hour average) for drinking water
l—violates the human health protection criterion outside the mixing zone (24 hour average) for non-drinking water

Elevated bacteria levels for both fecal coliform and *E. coli* were observed here on several sampling events. Livestock activities in this area are a probable source. Recreational use would not have been met here if this stream was designated as primary contact.

Maple Grove Creek (undesignated)

One site on Maple Grove Creek was sampled for water chemistry at Pleasantview Road (RM 1.6). The sampling location on this channelized, headwater stream encompasses a drainage area of 2.3 miles and is dominated by row crop agricultural land use. Four of seven samples here fell below the minimum warmwater habitat criterion of 4.0 mg/l for dissolved oxygen (Table 9) and were among the lowest observed for other headwater streams. This site was also adversely affected by moderately elevated concentrations of total phosphorus and TKN (Appendix 1).

Poor nutrient cycling here resulted from channel modifications and riparian tree removal. The lack of adequate shading promoted algal growth in the stream which in turn negatively impacted dissolved oxygen concentrations through plant respiration.

West Branch Rattlesnake Creek (WWH, AWS, IWS, SCR)

West Branch Rattlesnake Creek encompasses a drainage area of 59.9 square miles. Water chemistry sampling was conducted at three sites on West Branch Rattlesnake Creek (RM 11.4, RM 4.3 and 2.8). The upper sampling site on West Branch at Hargrave Road experienced low dissolved oxygen concentrations with four of the seven samples taken here failing to meet the 4.0 mg/l minimum dissolved oxygen standard (Table 9). In addition, diel dissolved oxygen sampling at this site recorded a violation of the 24 hour average criteria during sampling from July 25 to July 27, 2007 (mean = 4.68, min = 1.85). Nutrient concentrations were elevated here during early summer sampling and moderate algae growth was present most of the summer

(Appendix 1). Lack of water movement due to low flow conditions and an instream woody debris obstruction caused water stagnation limiting stream reaeration and nutrient cycling.

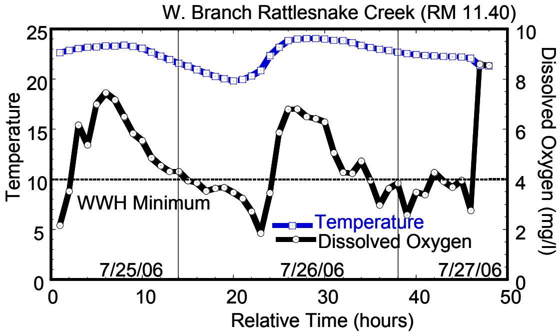


Figure 15. Hourly dissolved oxygen concentrations and temperature measured in the West Branch Rattlesnake Creek by an automated data logger placed near Hargrave Road (RM 11.4) July 25-27, 2006.

The sample site at RM 4.3 (immediately upstream S.R. 729) was modified during the survey (Figure 16). The West Branch of Rattlesnake Creek is a petitioned ditch under active county maintenance. Ditching, however, results in poor water quality and habitat conditions. Most stream temperatures exceeded the 95th percentile compared to reference background including the highest temperature reading of 29.1 ^{o}C recorded during mid-morning sampling on June 22. 2006. In addition, supersaturated dissolved oxygen concentrations were common and were the highest observed compared to other sites of similar drainage area. Nutrient concentrations were slightly elevated during early summer sampling (Appendix 1).

Figure 16. Channelization of the West Branch Rattlesnake Creek upstream from SR 729 observed in 2006. The West Branch Rattlesnake is petitioned for county drainage maintenance.

At the lower site at RM 2.8 just downstream of Wilson Creek, specific conductivity levels were elevated (most likely due to Sabina WWTP effluent). In addition, this site showed the highest nutrient concentrations on West Branch (Appendix 1). Median concentrations for total phosphorus and nitrate+nitrite exceeded recommended statewide target levels for these pollutants (Ohio EPA, 1999).

Problematic bacteria levels were evident at RM 11.40 (Hargrave Road) where both fecal coliform levels and *E. coli* levels were elevated on three of six sample events. However, secondary contact recreational use was attained.

Wilson Creek (WWH, AWS, IWS, PCR)

One site on Wilson Creek was sampled downstream of the Sabina WWTP at RM 2.80 encompassing a drainage area of 19.5 miles. Wilson Creek showed serious problems with nutrient enrichment. Total phosphorus and nitrate+nitrite sample concentrations all exceeded the 90^{th} percentile when compared to reference background, likely due to the influence of the Sabina WWTP discharge, just upstream from the sample point. The median concentrations for total phosphorus and nitrate+nitrite were 0.928 mg/l and 8.58 mg/l respectively (Appendix 1). By comparison, statewide target levels for total phosphorus and nitrate-nitrite are 0.08 mg/l and 1.0 mg/l respectively (Ohio EPA, 1999). Nutrient concentrations in this reach were well above other sites of similar drainage (Figure 9).

Similar to some other Rattlesnake Creek tributaries, nutrient cycling was disrupted by riparian removal and channel modification for drainage. The largely open channel also facilitated higher than normal background water temperatures and light conditions which promoted algal growth. On June 22, 2006 a dissolved oxygen saturation level of 178.8 percent was recorded during mid-morning sampling indicating extraordinary amounts of photosynthetic activity occurring (Appendix 1). Sampling for bacteria indicated that recreational use was not met here due to high *E.coli* and fecal coliform concentrations possibly emanating from the Sabina WWTP or other sources in the Village.

SABINA WWTP

The Village of Sabina WWTP is located at 700 Mill St, Sabina in Clinton County . The facility serves an approximate population of 2000 with a slow growth pattern predicted. The facility has 6 lift stations with one bypass.

The facility was built in 1960 and consists of; comminution (currently not in service), manual bar screening, grit removal, off-line storage (207,210 gallon capacity), 2 oxidation ditches (21 hour detention), 2 clarifiers, 2 chlorine contact tanks, one dechlorination tank, and 2 post aeration tanks. Sludge handling is accomplished in 2 sludge holding/digestion tanks (104 days detention total).

Power outages and high flows are handled by a generator backup and an Auto dialer notifies staff of high influent wet well alarms. The Village currently utilizes an ultrasonic flow meter with a weir to measure treated effluent to Wilson Creek; until recently (April 2007) the flow meter was unable to measure extremely high discharge flow rates.

The average daily designed treatment capacity is 0.38 MGD and hydraulic capacity is 1.84 MGD. As of 2003, dry weather flows were about 0.20 MGD and wet weather was an average 0.440 MGD. At times wet weather flows exceed 3.0 MGD. The equalization basin has the ability to bypass secondary treatment before disinfection (2 bypassing events total in all of 2005 and 2006). The monthly operating reports from 2005 up to 2006 show an average daily flow of 0.413 MGD indicating that the plant is hydraulically overloaded.

Ohio EPA has been working with the Village on their extraneous water issues since 1996. Topography around Sabina is very flat with frequent flooding problems. In a 2001 Phase II Strategic Flow Monitoring Study (Plan), URS Engineering identified the Village's storm sewer system as the main problem for the wet weather issues within the sanitary sewage collection system. As an outgrowth of this study, the Village has implemented gutter downspout removal from the sanitary sewer system, mapped the storm sewer system, cleaned a large section of storm sewers, isolated dye and smoke testing projects, channelized and removed riparian vegetation from approximately 2 miles of Wilson Creek all in an effort to reduce the amount of stormwater that infiltrates into the sanitary sewer system.

In 2007, the Village of Sabina will be working on three sewer relining projects, particularly East Elm Street, West Elm Street and Vine Street. These projects were recommended in the Phase II, Strategic Flow Monitoring Study prepared by URS in 2001.

The Village of Sabina has four known Sanitary Sewer Overflow locations moving from the west to east; Florence Ave, Grand Ave, West Washington and Krebs Dr. The 2007 Ohio EPA inspection revealed a significant amount of algae in Wilson Creek downstream of the final outfall (001). The Hunt Drive SSO was eliminated with the Rose Avenue Pump Station improvement project (2006). West Washington and Krebs Dr. had similar overflows patterns and overflowed with greatest frequency.

Table 10. Village of Sabina Sanitary Sewer Overflows

Florence Ave	Grand Ave	Krebs Dr	Hunt Dr	West Washington
		1/15/2007		
12/5/2006	12/5/2006			
10/5/2006	10/5/2006	10/5/2006		10/5/2006
10/17/2006		10/17/2006		10/17/2006
9/12/2006	9/12/2006	9/12/2006		9/12/2006
3/13/2006		3/13/2006		3/13/2006
3/28/2005		3/28/2005		3/28/2005
			3/16/2005	
			1/12/2005	1/12/2005
1/6/2005	1/6/2005	1/6/2005	1/6/2005	1/6/2005
1/5/2005	1/5/2005	1/5/2005	1/5/2005	1/5/2005
7/31/2004	7/31/2004	7/31/2004	7/31/2004	
6/20/2004	6/20/2004			
6/19/2004	6/19/2004			
6/17/2004				
		6/11/2004		6/11/2004

Unnnamed Tributary to Wilson Creek (undesignated)

One site on this undesignated headwater stream site was sampled at RM 0.4 on U.S. 22 in Sabina, Clinton County. Dissolved oxygen concentrations here were satisfactory with all sample results above the 4.0 mg/l minimum standard for warmwater habitat streams. Nutrient sampling revealed moderately elevated concentrations of ammonia, TKN and total phosphorus throughout the summer. These values were among the highest observed compared to other sites of similar drainage area (Figure 9).

Elevated concentrations of zinc, chlorides and TSS were recorded on August 22, 2006. It is likely these concentrations were the result of a minor illicit storm water discharge within the village. No rainfall occurred within 24 hours of this sampling event (Appendix 1). In addition, bacteria levels were also elevated here for *E.coli* (25,000/100 ml) and fecal coliform (27,000/100 ml) on August 8, 2007. Village sanitary sewer overflows are a likely contributing source.

Trends

Trends in water quality chemistry were evaluated for Rattlesnake Creek. All chemical parameters have data from at least as far back as 1997 with some limited data from sampling of a single site (RM 13.3) taken in 1983 and 1984. The 2006 sampling was conducted during periods of above average temperatures and below average precipitation.

Reflecting the lower stream flows, dissolved oxygen concentrations in 2006 were generally lower than those observed in 1997 (Figure 17). The lower dilution was evident in higher nitrate-nitrite concentrations. Ironically though, phosphorus concentrations were lower (Figure 17). The lower phosphorus concentrations may reflect greater uptake by the periphyton due to longer residence times. Ammonia-nitrogen and TKN concentrations were similar between periods.

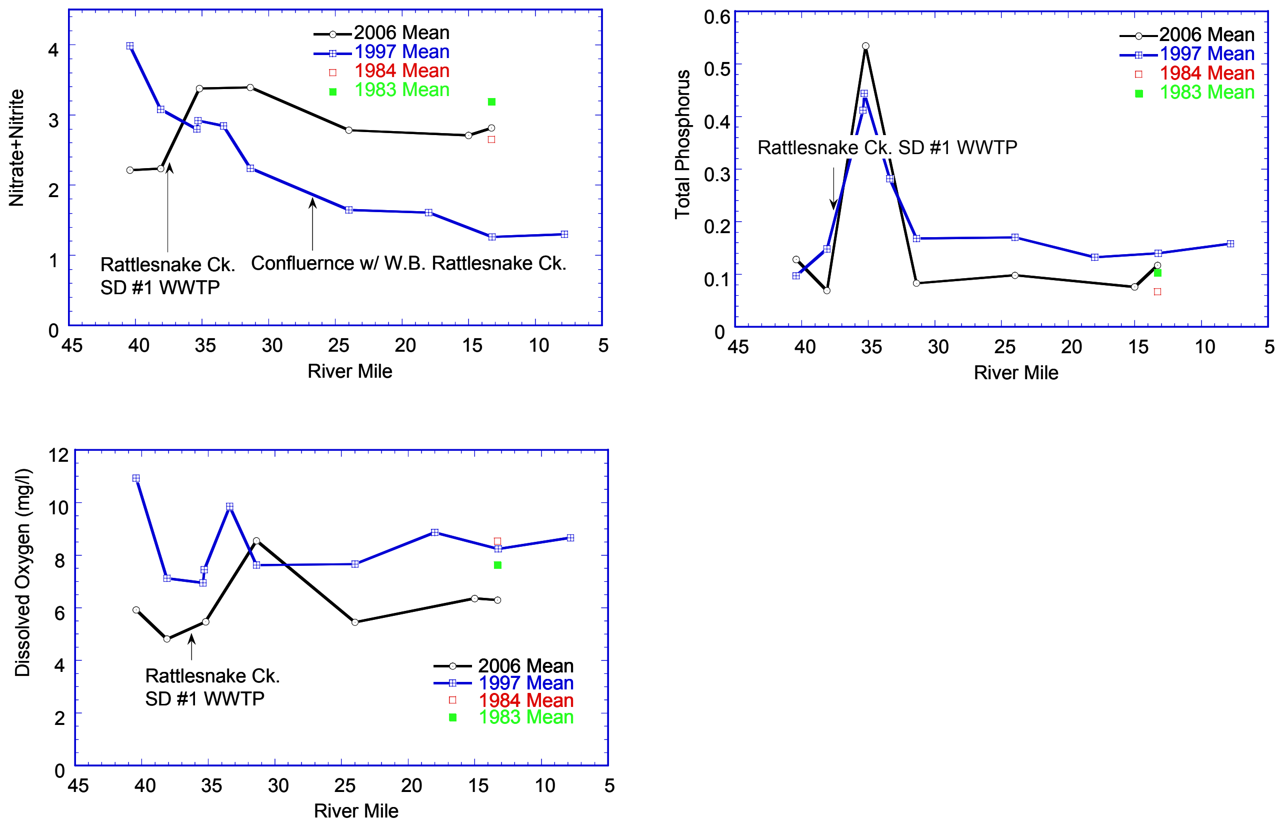


Figure 17. Longitudinal profiles of mean nitrate-nitrite, total phosphorus and dissolved oxygen concentrations in spot samples collected from Rattlesnake Creek, 1983 – 2006.

Sediment

Fine grained, unconsolidated sediments were sampled at five locations in the Rattlesnake Creek assessment unit. Two sites were located on the mainstem of Rattlesnake Creek at RM 15.0 and RM 13.3. Two sites were located on West Branch at RM 11.4 and RM 4.3. The remaining site was located on Grassy Branch at RM 8.7. Concentrations of total organic carbon (all sites) and total phosphorus (RM 11.4 only) exceeded the Lowest Effect Level (LEL). Sediment metals concentrations were below Ohio sediment reference values (SRV). Sediment organic analysis detected only one organic, Isopropylbenzene, at 0.104 mg/kg (Table 11).

Table 11. Results of chemical/physical sediment quality sampling conducted in the Rattlesnake Creek (HUC 05060003-030) study area during July-September, 2006. Parameters in *italics* have no established guideline for comparison. Underlined values indicate concentrations below the method-reporting limit. NA means not analyzed. Parameters noted with a ◙ are compared with the Ontario guidelines published by Persaud and Jaagumagi, 1993 (LEL = greater than the Lowest Effect Level but less than the Severe Effect Level, SEL = greater than the severe effect level). All metals parameters are compared with ecoregional (default) or statewide (noted by a subscript s) sediment reference values determined by Ohio EPA (Ohio EPA, 2003). Italicized values are greater than the Probable Effect Concentration (PEC) for organics established by MacDonald *et. al.* (2000). Metals values in **boldface** and shaded are greater than the reference value. Boxes with no value were analyzed but not detected.

Rattlesnake Creek (HUC 05060003-030)						
Analyte	Units	**Rattlesnake Creek**		**West Branch Rattlesnake Creek**		**Grassy Branch**
	RM	**15.0**	**13.3**	**11.4**	**4.3**	**8.7**
Solids	%	59.0	56.5	54.5	71.7	48.5
NUTRIENTS						
Tot. Organic Carbon◙	%	5.0_{LEL}	5.2_{LEL}	3.7_{LEL}	1.4_{LEL}	2.4_{LEL}
Ammonia	mg/kg	NA	130	60	27	97
Phosphorus◙	mg/kg	NA	519	786_{LEL}	461	474
METALS						
Aluminum	mg/kg	4630	5270	NA	5600	NA
Arsenic	mg/kg	3.68	5.20	NA	12.5	NA
Barium	mg/kg	53.5	50.8	NA	77.7	NA
Cadmium	mg/kg	0.237	0.207	NA	0.291	NA
Calcium	mg/kg	30500	35700	NA	60700	NA
Chromium	mg/kg	19	20	NA	14	NA
Copper	mg/kg	9.9	9.2	NA	11.5	NA
Iron	mg/kg	10800	11800	NA	18600	NA
Lead$_s$	mg/kg	25	27	NA	18	NA
Magnesium	mg/kg	11800	12000	NA	28100	NA
Manganese	mg/kg	198	210	NA	623	NA
Nickel	mg/kg	25	27	NA	22	NA
Mercury$_s$	mg/kg	0.025	0.024	NA	0.027	NA
Potassium	mg/kg	1230	1340	NA	914	NA
Selenium	mg/kg	1.23	1.34	NA	0.91	NA
Sodium	mg/kg	3080	3340	NA	2290	NA
Strontium	mg/kg	92	127	NA	111	NA
Zinc	mg/kg	43.1	44.9	NA	45.6	NA
ORGANICS						
Isopropylbenzene	mg/kg		0.104			
All other organics below detection						

North Fork Paint Creek (headwaters to below Compton Creek) Assessment Unit (05060003-080)

The upper North Fork Paint Creek assessment unit (Hydrologic Unit Code 05060003-080) encompasses the drainage area of North Fork Paint Creek from the headwaters to downstream of the confluence with Compton Creek at RM 24.57. North Fork Paint Creek flows in a southerly direction through eastern Fayette County and on into Ross County. Tributary streams to North Fork assessed in this area included Compton Creek, Thompson Creek (confluence with North Fork at RM 38.91), Wolf Run (confluence with North Fork at RM 37.80), Mud Run (confluence with North Fork at RM 25.32), and Crooked Creek (confluence with Compton Creek at RM 4.77). This assessment unit is located within the Eastern Corn Belt Plains (ECBP) ecoregion.

There were 12 stream monitoring sites in this unit that were evaluated for chemical water quality, 3 sites on North Fork, and 8 sites on tributaries, particularly Compton Creek. One effluent site was evaluated at the New Holland WWTP outfall (Table 3).

North Fork Paint Creek (EWH, AWS, IWS, PCR)

The upper reach of North Fork of Paint Creek was evaluated for water chemistry at 3 sites along with the WWTP outfall for the Village of New Holland. These 3 sites yielded one violation each of the 90th percentile standard for primary contact recreation (Table 12 and Appendix 1). The EWH minimum criterion for dissolved oxygen was violated once at RM 26.70.

Nutrient enrichment did not appear to be problematic in Upper North Fork although median concentrations of total phosphorus and TKN increased with movement downstream (Figure 18). In fact, the range of TKN values as well as the median far exceeded the values found in similar ECBP EWH streams (Figure 17). This could be related to nearby agri-businesses. Nutrient enrichment does not seem to be an artifact of the New Holland WWTP discharge as a comparison of nitrate+nitrite shows very similar values across the same ECBP EWH streams (Figure17). Instream nitrate+nitrite concentrations were highest during the late spring and likely due to the typical springtime agricultural applications of nitrogenous fertilizers (Appendix 1).

VILLAGE OF NEW HOLLAND WWTP

The Village of New Holland operates a WWTP which discharges to the North Fork of Paint Creek at RM 26.71. Design capacity is 0.160 MGD and the treatment train consists of a comminutor/bar screen, two race track oxidation ditches, a pair of clarifiers, slow sand filters, ultraviolet disinfection, and a pump station which pumps the final effluent nearly a mile down to the discharge point on North Fork

For the last six years the Village administration has been in litigation with their former operator. Since the plant has not complied with its NPDES permitted discharge limits during that timespan, Ohio EPA initiated an escalated enforcement action in 2004 to force the Village to

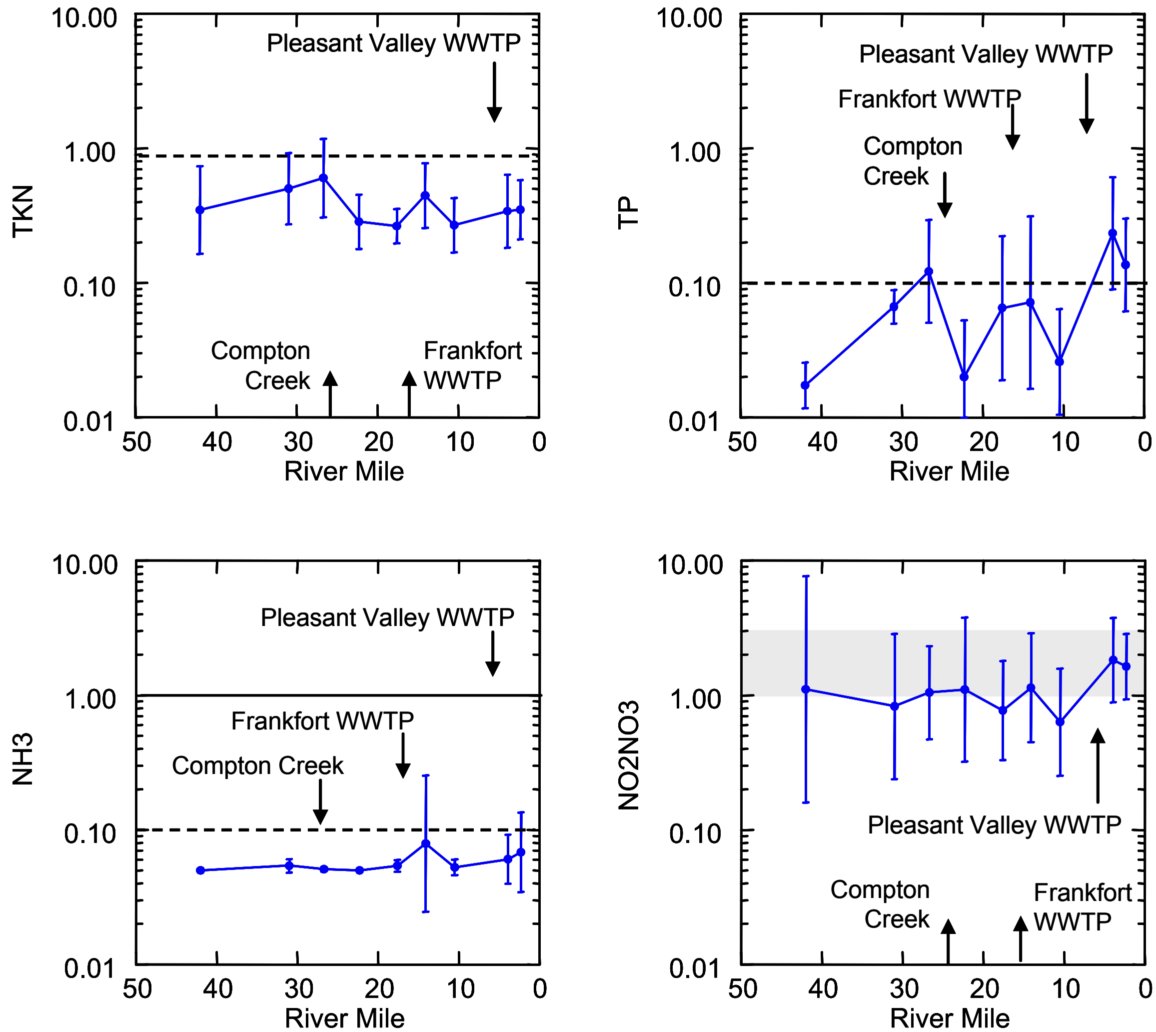


Figure 18. Longitudinal profiles of mean (+/- 1 SD) nutrient concentrations in the North Fork Paint Creek, 2006, in relation to the confluence with Compton Creek, and the Frankfort and Pleasant Valley WWTPs. Dashed lines in the TP and TKN plots show the upper range of background concentrations typical for the ecoregion. The shaded area in the NO3-NO2 plot spans the range of concentrations defining elevated to grossly elevated. The solid line at 1.0 mg/l in the NH3-N plot is the concentration beyond which acute toxicity is likely, and the dashed line at 0.1 mg/l shows the concentration where chronic toxicity becomes increasingly likely.

Table 12. Violations of chemical water quality standards in the Paint Creek (Scioto River basin) study area, June through August, 2006. Primary tributary streams are listed where they intersect the Paint Creek mainstem and the listing is shaded blue. Secondary tributary streams are listed where they intersect a primary tributary and the listing is shaded pink, with tertiary streams yellow. Streams labeled U.T. are unnamed tributaries. Wastewater treatment facilities are listed where their discharge points occur and are shaded green. Sites with no entries do not have any violations.

River/Stream (RM sample point or discharge if WWTP, Uses)	NPDES Discharge	River Mile or Confluence	Parameter	Code
North Fork Paint Creek headwaters to Compton Creek (HUC 05060003-080,)				
Paint Creek				
→North Fork Paint Ck (42.00, EWH, AWS, IWS, PCR)		2.06	Dissolved oxygen Bacteria	b, c h
→→Thompson Creek (3.30, WWH, AWS, IWS, PCR)		38.91	Bacteria	h
→→Wolf Run (0.30, U)		37.80	Bacteria	h
→North Fork Paint Ck (31.00, EWH, AWS, IWS, PCR)		2.06	Bacteria	h
→→North Fork Paint Ck (26.71)	New Holland WWTP	2.06	Bacteria	a
→North Fork Paint Ck (26.70, EWH, AWS, IWS, PCR)		2.06	Dissolved Oxygen Bacteria	b, c h
→→Mud Run (0.40, WWH, AWS, IWS, PCR)		25.32		
→→Compton Creek (17.60, EWH, AWS, IWS, PCR)		24.57	Dissolved Oxygen Bacteria	c h
→→Compton Creek (11.20, EWH, AWS, IWS, PCR)		24.57		
→→→Turkey Run (U)		5.60		
→→→→Turkey Run (~2.50)	Pine Tree Ct. Apts. WWTP	5.60		
→→→Crooked Creek (3.00, WWH, AWS, IWS, PCR)		4.77	Bacteria	g, h
→→Compton Creek (3.40, EWH, AWS, IWS, PCR)		24.57	Bacteria	h
→→Compton Creek (1.10, EWH, AWS, IWS, PCR)		24.57		
→North Fork Paint Ck (EWH, AWS, IWS, PCR)		2.06		

Table 12. Continued.

WWH—Warm Water Habitat
AWS—Agricultural Water Supply
IWS—Industrial Water Supply
PCR—Primary Contact Recreation
SCR—Secondary Contact Recreation
U—Undesignated (treat as WWH, AWS, IWS, PCR or SCR)
a—violates an NPDES permit limit
b—violates the aquatic life protection criterion outside the mixing zone (24 hour average)
b_{TDS}—violates the aquatic life protection criterion outside the mixing zone for total dissolved solids
c—violates the aquatic life protection criterion outside the mixing zone (minimum or maximum)
d—violates the aquatic life protection criterion inside the mixing zone (maximum)
e—violates the bathing water 30 day geometric mean
f—violates the bathing water 30 day maximum
g—violates the primary contact recreation 30 day geometric mean
h—violates the primary contact recreation 30 day maximum
i—violates the secondary contact recreation 30 day maximum
j—violates the agricultural water supply protection criterion outside the mixing zone (24 hour average)
k—violates the human health protection criterion outside the mixing zone (24 hour average) for drinking water
l—violates the human health protection criterion outside the mixing zone (24 hour average) for non-drinking water

repair and upgrade their WWTP. The Village responded by requesting that the agency help them handle the repairs and upgrade through a compliance schedule in their NPDES permit. Their permit was revised to include a construction schedule. Currently, the Village is in violation of this compliance schedule. This may result in the issuance of Ohio EPA Director's Final Findings and Orders.

Thompson Creek (WWH, AWS, IWS, PCR)

Thompson Creek was evaluated at one site (RM 3.30) with few problems noted. A single violation of the primary contact recreational standard for bacteria was noted here (Table 12). Daytime dissolved oxygen concentrations were appropriate and nutrient concentrations akin to normal background values (Appendix 1). Electrofishing confirmed an exceptional fish community present in Thompson Creek.

Wolf Run (undesignated)

Water chemistry sampling and analysis was performed on Wolf Run at RM 0.30. Chemistry results for Wolf Run were similar to those found in Thompson Creek. If primary contact recreational uses are assigned to Wolf Run, then there are 2 potential violations of those criteria (Appendix 1). Daytime dissolved oxygen concentrations were within norms for a stream of this nature and nutrient concentrations showed normal variation as well.

Compton Creek (EWH, AWS, IWS, PCR)

Compton Creek was evaluated for water chemistry at 4 sites beginning at Meyers Road (RM 17.60) and extending down to Dogtown Road at RM 1.10. Violations of water quality criteria were noted at RM 17.60 for minimum concentrations of dissolved oxygen and 90^{th} percentile concentrations of bacteria for both RM 17.60 and RM 3.40 at Good Hope-New Holland Road (Table 12). Light to moderate nutrient enrichment was evident at the upstream locations (RM 17.60 and 11.20) becoming more diffuse moving downstream. The New Holland WWTP seemed to contribute to occasional high concentrations of instream total phosphorus at RM 3.40 (Appendix 1). The site at Dogtown Road showed little, if any excess nutrients.

Crooked Creek (WWH, AWS, IWS, PCR)

Water chemistry was evaluated at one site on Crooked Creek at RM 3.00. Consistent violations of the primary contact recreational bacterial standards for both geometric mean and 90^{th} percentile values were identified (Table 12). Both total dissolved solids and total phosphorus concentrations were significantly elevated at this site leading to the supposition that all three pollutants are resulting from poorly operating home sewage treatment systems discharging to the stream. The very good fish community showed no perturbation from these pollutants.

Trends

No trends heralded worsening conditions in water chemistry results for the North Fork when comparing 2006 data with that taken in 1997. Lower than normal stream flows resulted in lower dissolved oxygen concentration and higher TKN concentrations in 2006 compared to 1997. Mean values for ammonia and nitrate+nitrite were nearly identical between years.

Sediment

Sediment samples were obtained from 2 locations in the Upper North Fork watershed, one on North Fork proper at RM 42.00 and one on Compton Creek at RM 1.10. Both sites revealed phosphorus and total organic carbon concentrations above the lowest effect level (Table 13). North Fork exhibited a sediment magnesium concentration in excess of the background reference value while Compton Creek showed a sediment strontium concentration greater than background. While sediment phosphorus may be a “source” of the nutrient in this watershed, it does not appear that sediment contamination from nutrients or metals caused a problem in these areas.

Table 13. Results of chemical/physical sediment quality sampling conducted in the North Fork Paint Creek study area (HUC 05060003-080) during July-September, 2006. Parameters in *italics* have no established guideline for comparison. Underlined values indicate concentrations below the method-reporting limit. NA means not analyzed. Parameters noted with a ◙ are compared with the Ontario guidelines published by Persaud and Jaagumagi, 1993 (LEL = greater than the Lowest Effect Level but less than the Severe Effect Level, SEL = greater than the severe effect level). All metals parameters are compared with ecoregional (default) or statewide (noted by a subscript s) sediment reference values determined by Ohio EPA (Ohio EPA, 2003). Metals values in **boldface** and shaded are greater than the reference value. Boxes with no value were analyzed but not detected.

Analyte	Units	**North Fork Paint Creek**	**Compton Creek**
	RM	**42.00**	**1.10**
Solids	%	53.7	43.5
NUTRIENTS			
Tot. Organic Carbon◙	%	2.8_{LEL}	3.6_{LEL}
Ammonia	mg/kg	54	68
Phosphorus◙	mg/kg	735_{LEL}	1250_{LEL}
METALS			
Aluminum	mg/kg	6990_j	10000_j
Arsenic	mg/kg	10.7	1.67
Barium	mg/kg	76.3	144
Cadmium	mg/kg	0.356	0.334
Calcium	mg/kg	84000	72100
Chromium	mg/kg	18	25
Copper	mg/kg	13.4	15.7
Iron	mg/kg	17500	20300
Lead$_s$	mg/kg	24	33
Magnesium	mg/kg	**35500**	18700
Manganese	mg/kg	416	563
Nickel	mg/kg	24	33
Mercury$_s$	mg/kg	0.034	0.030
Potassium	mg/kg	1180	1670
Selenium	mg/kg	1.18	1.67
Sodium	mg/kg	2960	4180
Strontium	mg/kg	331	**694**
Zinc	mg/kg	54.8	73.4
ORGANICS (None detected)			
j = estimated due to matrix interference.			

Ross, Highland, and Clinton counties - 11 digit HUC 05060003-040, 050, 060, 070, -090, and -100

Surface water grab samples were collected from the Paint Creek Watershed at 84 stream locations and six point source dischargers in Ross, Clinton and Highland counties between June 21 and October 30, 2006. Stream samples were primarily collected from bridge crossings. Treated waste water was collected from the outfalls of the Greenfield waste water treatment plant (WWTP), Rocky Fork Lake WWTP, Hillsboro WWTP, Frankfort WWTP, Bainbridge WWTP, and P. H. Glatfelter paper plant in Chillicothe.

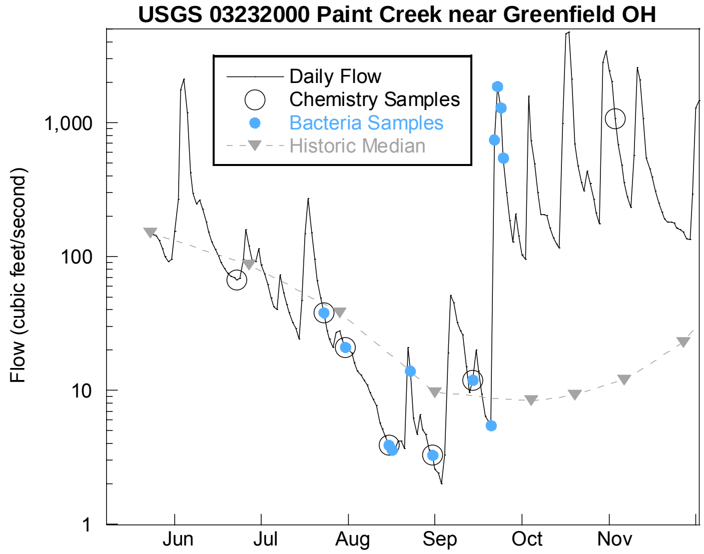


Figure 19. Flow conditions in Paint Creek near Greenfield OH during the 2006 Ohio EPA survey.

River flows measured at a United States Geological Survey (USGS) gage on Paint Creek at Greenfield are presented in Figure 19. Dates when water samples and bacteria samples were collected in the Paint Creek watershed are noted on the graph. Flow conditions during the 2006 sampling season were at or below the historical monthly median flows from June to August but flows were elevated during September and October. Chemistry samples were typically collected during low flow conditions with the exception of one chemistry run collected during October during significantly high flow conditions. Bacteria samples were collected in Ross County during low flow conditions from July through September but were collected in Clinton and Highland counties in September during high flows (September 11 – September 15).

Surface water samples were analyzed for metals, nutrients, suspended and dissolved solids, PCBs, semivolatile organic compounds, and organochlorinated pesticides (Appendix 1). Summary statistics for select nutrient parameters are detailed in Table 14. Bacteriological samples were collected from 84 locations and the results are reported in the Recreational Use section. DataSonde© water quality recorders were placed throughout the watershed to monitor hourly levels of dissolved oxygen, pH, temperature, and conductivity. Measurements were conducted from July 25- 27, 2006 and August 8 – 10, 2006.

Table 14. Summary statistics for select nutrient water quality parameters sampled in the Paint Creek watershed for HUC 05060003- 040, 050, 060, 070, 090 and 100, (Ross, Highland and Clinton counties), 2006. Values above reference conditions are shaded green (Reference conditions for total phosphorus and nitrate+nitrite-N are suggested statewide criteria and are based on drainage area (OEPA, 1999a). Reference conditions for ammonia-N are derived from the 90th percentile statewide reference data and are also based on drainage area (OEPA, 1999a)

		Ammonia—N		Nitrate+Nitrite-N		Phosphorus-T	
Stream	**River Mile**	Mean	Median	Mean	Median	Mean	Median
HUC 040		0.46	0.025	0.02	0.01	0.272	0.0535
Lees Creek	10.4	0.055	0.054	0.0398	0.01	0.0698	0.061
Lees Creek	4.5	0.0374	0.025	0.01	0.01	0.0324	0.032
Lees Creek	1.16	0.032	0.025	0.0131	0.01	0.0728	0.051
U.T. to Lees Creek	1.3	5.544	5	0.0186	0.01	3.3632	3.51
U.T. to Lees Creek	0.3	0.025	0.025	0.01	0.01	0.0346	0.033
U.T. to S. Fk. Lees Cr.	0.23	1.6184	1.18	0.1222	0.032	0.2588	0.209
M. Fk. Lees Creek	5.1	0.0756	0.079	0.0136	0.01	0.1058	0.1
M. Fk. Lees Creek	1.15	0.0402	0.025	0.01	0.01	0.0656	0.059
S. Fk. Lees Cr.	1.6	0.157	0.142	0.0296	0.031	0.1412	0.115
Big Branch	1.6	0.039	0.025	0.0146	0.01	0.1208	0.039
Rattlesnake Creek	7.55	0.0339	0.025	0.0134	0.01	0.0778	0.049
Walnut Creek	4.2	0.1866	0.155	0.0218	0.01	0.1678	0.174
Walnut Creek	0.6	0.025	0.025	0.0138	0.01	0.02	0.012
Bridgewater Cr.	0.21	0.0342	0.025	0.01	0.01	0.0424	0.04
Hardin Creek	5.8	0.04	0.025	0.0132	0.01	0.0634	0.056
Hardin Creek	1.1	0.025	0.025	0.01	0.01	0.0326	0.018
Fall Creek	7.2	0.2368	0.14	0.0386	0.025	0.1512	0.153
Fall Creek	1.6	0.0314	0.025	0.01	0.01	0.0754	0.048
Leesburg WWTP outfall to Lees Creek at RM 3.55		0.0795	0.076	0.023	0.01	2.065	2.14
HUC 050		0.0929	0.051	0.0336	0.023	0.3816	0.194
Pain Creek	67.1	0.092	0.086	0.0366	0.034	1.3224	0.917
Pain Creek	63.3	0.0806	0.065	0.0266	0.023	0.8334	0.597
Paint Creek	58.8	0.025	0.025	0.01	0.01	0.3704	0.232
Paint Creek	52.5	0.0292	0.025	0.0112	0.01	0.1871	0.167
Paint Creek	48.7	0.0734	0.025	0.0176	0.01	0.2296	0.197
Paint Creek	39.1	0.2479	0.209	0.0715	0.046	0.1055	0.067
Wabash Creek	0.8	0.1744	0.051	0.0768	0.049	0.2134	0.194
Buck Run	0.82	0.0586	0.05	0.01	0.01	0.0414	0.046
Indian Creek	1.6	0.0552	0.064	0.042	0.037	0.1314	0.072
Greenfield WWTP Outfall to Paint Creek At RM 49.6		2.8456	0.08	0.0311	0.01	0.4742	0.474
HUC 060		0.1322	0.0575	0.034	0.01	0.103	0.0405
Rocky Fork	23.3	0.0542	0.053	0.0124	0.01	0.0232	0.017
Rocky Fork	18.1	0.0674	0.069	0.0136	0.01	0.1952	0.024
Rocky Fork	17.5	0.2473	0.2215	0.0323	0.0265	0.173	0.1755
Rocky Fork	17.0	0.282	0.282	0.01	0.01	0.178	0.178
U.T. to Rocky Fork (24.27)	0.76	0.05	0.064	0.01	0.01	0.0338	0.03
S. Fk. Rocky Fork	3.3	0.0426	0.025	0.01	0.01	0.0466	0.037
U.T. to Rocky Fork (17.55)	1.0	0.0424	0.051	0.01	0.01	0.0144	0.018

Table 14. Summary statistics for select nutrient water quality parameters sampled in the Paint Creek watershed for HUC 05060003- 040, 050, 060, 070, 090 and 100, (Ross, Highland and Clinton counties), 2006. Values above reference conditions are shaded green (Reference conditions for total phosphorus and nitrate+nitrite-N are suggested statewide criteria and are based on drainage area (OEPA, 1999a). Reference conditions for ammonia-N are derived from the 90th percentile statewide reference data and are also based on drainage area (OEPA, 1999a)

		Ammonia—N		Nitrate+Nitrite-N		Phosphorus-T	
Stream	**River Mile**	Mean	Median	Mean	Median	Mean	Median
Coon Creek	0.01	0.1743	0.219	0.055	0.049	0.019	0.018
Fenner Trib to Clear Cr.	0.4	0.0334	0.025	0.01	0.01	0.1324	0.011
Hussey Run	0.8	0.0534	0.051	0.014	0.01	0.06	0.05
Moberly Br.	0.9	0.0755	0.06	0.0198	0.01	0.1173	0.1175
Moberly Br.	0.01	0.612	0.612	0.064	0.064	0.415	0.415
Little Rock Cr.	1.4	0.0888	0.095	0.012	0.01	0.1012	0.044
Clear Creek	11.3	0.0368	0.025	0.0144	0.01	0.1114	0.079
Clear Creek	8.45	0.0454	0.025	0.0154	0.01	0.04	0.011
Clear Creek	7.4	0.0706	0.025	0.0148	0.01	0.0448	0.019
Clear Creek	6.8	0.088	0.055	0.0162	0.01	0.0862	0.044
Clear Creek	6.6	0.2538	0.208	0.2474	0.22	0.1626	0.074
Clear Creek	5.2	0.1908	0.143	0.1027	0.133	0.118	0.05
Clear Creek	1.65	0.1244	0.08	0.0316	0.035	0.0564	0.034
Franklin Branch	1.9	0.4136	0.296	0.0574	0.027	0.1386	0.13
Pickett Run	0.1	0.025	0.025	0.01	0.01	0.0148	0.005
Rocky Fork	3.03	0.0451	0.025	0.0123	0.01	0.0317	0.027
Plum Run	3.07	0.0568	0.053	0.0198	0.01	0.1586	0.094
Rocky Fork WWTP Outfall to Rocky Fr. At RM 17.8		3.4908	1.22	0.4732	0.306	5.5068	2.56
Hillsboro WWTP outfall to Clear Creek @ RM 6.73		1.0864	0.473	0.6968	0.677	0.5448	0.097
HUC 070		0.046	0.025	1.37	0.74	0.077	0.039
Paint Cr.	31.5	0.031	0.025	2.73	1.68	0.171	0.104
Paint Cr.	27.5	0.031	0.025	2.10	1.81	0.100	0.072
Paint Cr.	21.6	0.038	0.025	3.28	2.72	0.135	0.052
Buckskin Cr.	3.1	0.050	0.050	0.82	0.16	0.076	0.047
Buckskin Cr.	0.4	0.025	0.025	0.38	0.16	0.029	0.017
Lower Twin Cr.	2.2	0.025	0.025	0.96	0.93	0.063	0.125
Upper Twin Cr.	5.8	0.025	0.025	0.21	0.13	0.035	0.017
Upper Twin Cr.	2.0	0.039	0.025	0.31	0.23	0.020	0.011
Massie Run	0.1	0.060	0.038	0.92	0.88	0.029	0.025
Sulpher Lick	1.5	0.187	0.210	0.21	0.10	0.038	0.022
Taylor Run	1.3	0.025	0.025	0.41	0.16	0.031	0.017
Trib. To Buckskin Cr.	0.2	0.037	0.025	0.32	0.10	0.072	0.037
HUC 090		0.047	0.025	1.41	0.80	0.120	0.077
North Fork Paint Cr.	22.3	0.025	0.025	1.32	0.63	0.106	0.064
North Fork Paint Cr.	17.6	0.041	0.039	2.12	0.98	0.037	0.020
North Fork Paint Cr.	14.1	0.103	0.025	1.72	1.65	0.118	0.105
North Fork Paint Cr.	10.5	0.032	0.025	1.19	0.53	0.046	0.026
North Fork Paint Cr.	3.9	0.034	0.025	2.54	2.14	0.326	0.223
North Fork Paint Cr.	2.3	0.048	0.025	2.29	2.26	0.121	0.086
Oldtown Run	1.3	0.120	0.084	0.90	0.15	0.159	0.156

Table 14. Summary statistics for select nutrient water quality parameters sampled in the Paint Creek watershed for HUC 05060003- 040, 050, 060, 070, 090 and 100, (Ross, Highland and Clinton counties), 2006. Values above reference conditions are shaded green (Reference conditions for total phosphorus and nitrate+nitrite-N are suggested statewide criteria and are based on drainage area (OEPA, 1999a). Reference conditions for ammonia-N are derived from the 90th percentile statewide reference data and are also based on drainage area (OEPA, 1999a)

		Ammonia—N		Nitrate+Nitrite-N		Phosphorus-T	
Stream	**River Mile**	Mean	Median	Mean	Median	Mean	Median
Little Creek	6.0	0.025	0.025	0.43	0.28	0.040	0.032
Little Creek	1.0	0.025	0.025	0.57	0.40	0.069	0.040
Biers Run	1.5	0.034	0.025	0.42	0.12	0.192	0.055
Trib. to NF Paint Cr.	0.3	0.049	0.025	0.35	0.31	0.116	0.019
Frankfort WWTP Outfall to N.Fk. Paint Creek at RM 14.26		8.17	0.5375	10.85	12.61	3.21	3.17
Pleasant Valley WWTP Outfall to N. Fk. Paint Creek at RM 4.0		0.04	0.025	16.02	17.8	5.37	4.97
HUC 100		0.093	0.025	1.47	0.67	0.083	0.042
Paint Creek	8.9	0.030	0.025	2.45	1.27	0.120	0.100
Paint Creek	3.8	0.032	0.025	3.06	2.47	0.098	0.059
Paint Creek	0.7	0.058	0.058	0.90	0.54	0.282	0.259
Black Run	3.96	0.025	0.025	1.39	1.25	0.030	0.012
Black Run	1.0	0.068	0.067	0.25	0.10	0.047	0.041
Cattail Run	1.2	0.576	0.344	0.34	0.29	0.065	0.042
Owl Creek	0.1	0.025	0.025	0.26	0.18	0.025	0.010
Plug Run	0.4	0.048	0.025	0.20	0.10	0.035	0.030
Ralston Run	2.8	0.025	0.025	0.45	0.40	0.026	0.014
P. H. Glatfelter (formerly Mead Paper) Outfall to Paint Creek at RM 3.3		0.0545	0.025	0.155	0.085	0.4405	0.231

Ross County 11 digit HUC Code 05060003-070, 090, and 100

A total of 32 locations and three NPDES treatment facilities were evaluated in Ross County for the Paint Creek watershed. All of the locations within Ross county met their appropriate biological use designations and in general demonstrated good water quality. Cattail Run on Owl Creek road was the only location in Ross county that had several exceedances of the Ohio Water Quality Standard outside mixing zone average criteria (OMZA) for metals and nutrients. The residences adjacent to Cattail Run may have failing home septic systems are most likely causing these exceedances.

Organic chemical analyses were conducted on water samples collected from three locations which include Paint Creek at Bourneville (RM 21.6), Paint Creek at SR 772 (RM 3.8), and the North Fork of Paint Creek at Poke Hollow Road (RM 2.1). All semivolatile organic compounds, PCB and pesticide measurements were reported as not detected. Atrazine and bis(2-Ethylyexyl)phthalate were detected at all three sites and metolachlor was detected at both of the Paint Creek sites. Both Atrazine and Metolachlor are common herbicides that are typically applied on corn and soybean farm fields. None of the detected compounds exceeded the Ohio Water Quality Standard OMZA.

Metals were measured at 32 stream locations, with 18 parameters tested (Appendix 1). One copper value exceeded the Ohio Water Quality Standard OMZA at Cattail Run on Owl Creek road and elelvated levels of aluminum, lead, and nickel were also found at Cattail Run. No other metals violations were found at the remaining 31 locations.

Nutrients were measured at each water sampling location, and included ammonia-N, nitrate+nitrite-N, total phosphorus, and total Kjeldahl nitrogen (TKN). Summary statistics for nutrients measured are detailed in Table 14. One value exceeded the Ohio Water Quality Standard OMZA for ammonia at Cattail Run on Owl Creek Road. The summer ammonia limit for the Frankfort WWTP is 1.8 mg/l but grab samples collected from their 001 outfall to the North Fork of Paint Creek on June 21 and July 26, 2006 were 22.7mg/l and 24.8 mg/l, respectively. See the effluent discharge section for more information about the Frankfort WWTP.

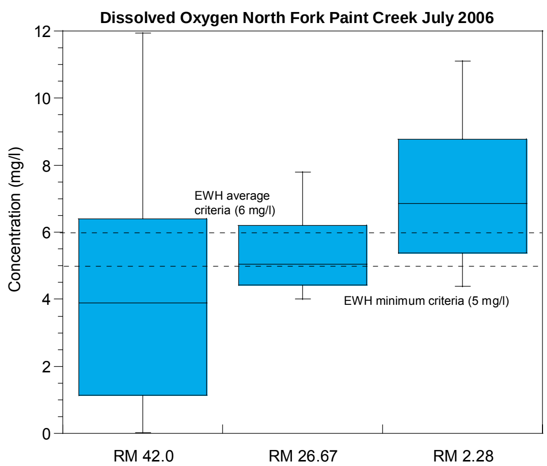


Figure 20. Box plot of hourly dissolved oxygen measurements from three locations on the North Fork Paint Creek collected July 25-27, 2006. Aquatic life Exceptional Warmwater Habitat water quality criteria are noted.

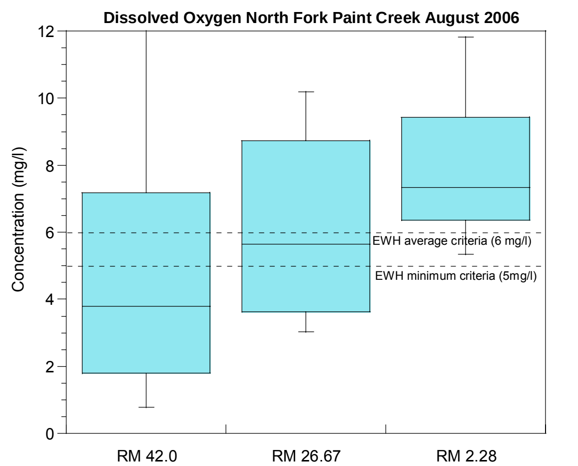


Figure 21. Box plot of hourly dissolved oxygen measurements from three locations on the North Fork Paint Creek collected August 8-10, 2006. Aquatic life Exceptional Warmwater Habitat water quality criteria are noted.

DataSonde© water quality recorders were placed at three locations in Ross County (Paint Creek @ RM 3.8 & RM 21.6 and North Fork Paint Creek @ RM 2.28) to monitor hourly levels of dissolved oxygen, pH, temperature, and conductivity. Measurements were conducted from July 25- 27, 2006 and August 8 – 10, 2006. Conductivity and pH levels were well within acceptable environmental levels for all sites monitored.

The average temperature for the three sites on North Fork of Paint Creek were well within acceptable environmental levels with no exceedances of the daily maximum water quality standard criteria of 29.4^{o}C. Dissolved oxygen on the North Fork of Paint Creek (Poke Hollow Road) at RM 2.28 did fall below the average EWH water quality criteria in both July and August, 2006 and also went below the minimum EWH criteria of 5 mg/l in July (Figures 20 and 21). However, the median values were above the average criteria of 6 mg/l and were greatly improved compared to the upstream locations at Yankeetown-Chenowith Road (RM 42.0) and New Holland Road (RM 26.67). More information about these upper sites on the North Fork of Paint Creek can be found in the results section for the 11 digit HUC 05060003-080 in Fayette County.

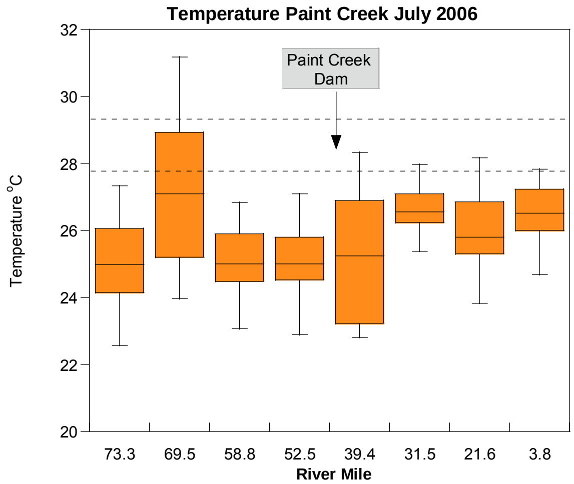


Figure 22. Box Plots of hourly temperature measurements from seven locations on Paint Creek collected July 25-27, 2006. Temperature water quality criteria are noted (daily maximum and average).

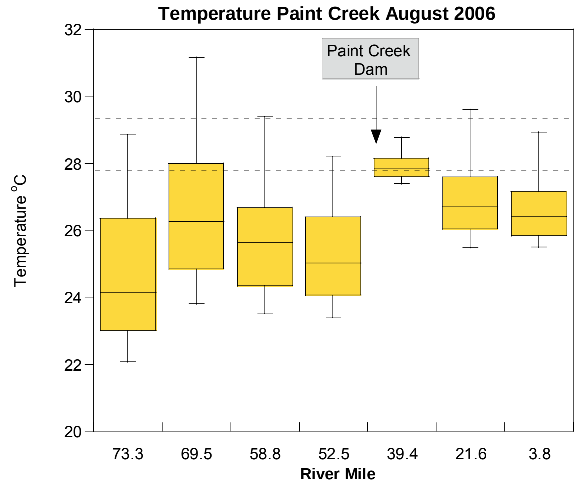


Figure 23. Box Plots of hourly temperature measurements from seven locations on Paint Creek collected August 8-10, 2006. Temperature water quality criteria are noted (daily maximum and average).

The average temperature for the eight sites monitored on the mainstem of Paint Creek were also well within acceptable environmental levels with the exception of the site located just downstream of Paint Creek Dam in August. The two lower sites in Ross County at RM 21.6 (Jones-Levee Road), and RM 3.8 (SR 772) was below the maximum criteria of 29.4°C in July but did exceed the daily maximum criteria in August (Figures 22 and 23). The areas of Paint Creek that have consistent temperatures above the average criteria are at RM 69.5 in Washington Court House and at RM 39.4 downstream from the Paint Creek Dam spillway. More information about these locations can be found in the results section for the 11 digit HUC 05060003-010 in Fayette County.

The average dissolved oxygen at most of the stations on Paint Creek were well above the EWH criteria of 5.0 mg/l with the exception of RM 69.5 (Elm Street in Washington Courthouse) and at RM 39.4 (downstream from the Paint Creek Dam. The sites in Ross County (RM 21.6 and 3.6) were all meeting the EWH criteria (Figures 24 and 25).

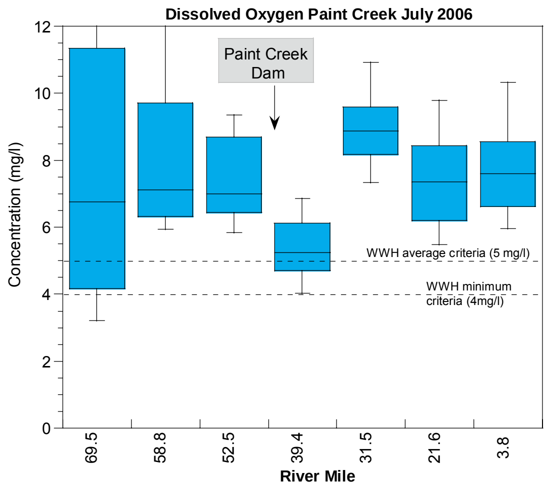


Figure 24. Box plot of hourly dissolved oxygen measurements from seven locations on Paint Creek collected July 25-27, 2006. Aquatic life Warmwater Habitat water quality criteria are noted.

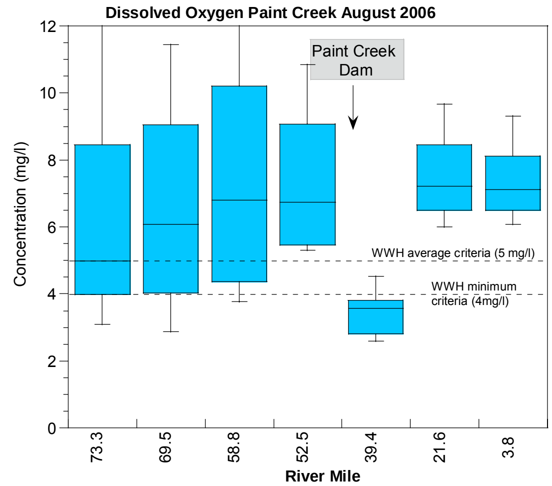


Figure 25. Box plot of hourly dissolved oxygen measurements from seven locations on the North Fork Paint Creek collected August 8-10, 2006. Aquatic life Warmwater Habitat water quality criteria are noted.

Highland and Clinton County 11 digit Hydrologic Unit Code 05060003-040, 050, and 060
A total of 52 locations and three NPDES facilities were sampled in Highland and Clinton Counties for the Paint Creek Watershed. Most locations were fully or partially meeting the appropriate biological use designation. Only one location on Fall Creek (HUC 05060003-040) was in NON attainment of the existing biological use designation due to nutrient and organic enrichment from agricultural activities. Partial attainment of the appropriate biological use designation was attributed to impacts from municipal WWTP (these include both Washington Court House and Hillsboro WWTPs), urban runoff (Moberly Branch in Hillsboro), and poor habitat.

Lees Creek, Hardin Creek, Fall Creek and Lower Rattlesnake Creek Assessment Unit (05060003-040)

The downstream terminus of this assessment unit is the confluence of Rattlesnake Creek with the Paint Creek mainstem, and includes all tributaries draining to Rattlesnake Creek up to and including the confluence with Lees Creek. Principal tributaries draining this catchment include Lees Creek, Hardin Creek, Fall Creek, and Walnut Creek. The Village of Leesburg is centrally located within the catchment at the confluence of the Middle Fork Lees Creek and Lees Creek.

Spot sampling revealed poor water quality in several streams within the assessment unit. Low dissolved oxygen concentrations were routinely noted in Fall Creek, an unnamed tributary to the South Fork, and an unnamed tributary to Lees Creek (Table 15), along with high ammonia-nitrogen concentrations and elevated 5-day biochemical oxygen demand (Figure 26). The co-occurrence of these water quality conditions strongly implies organic enrichment, and coincided with field observations of impaired biological communities and relatively high densities of livestock enjoying unrestricted access to the streams.

Low dissolved oxygen concentrations were also recorded in Walnut Creek and the Middle Fork of Lees Creek, but evidence of organic enrichment in other water quality parameters was lacking, and no biological impairment was detected. Relative to other hydrologic units in the basin and absent extreme values, routine water quality parameters followed similar distributions to those from other units (Figure 27). This suggests that the organic enrichment noted in the preceding paragraph was highly localized.

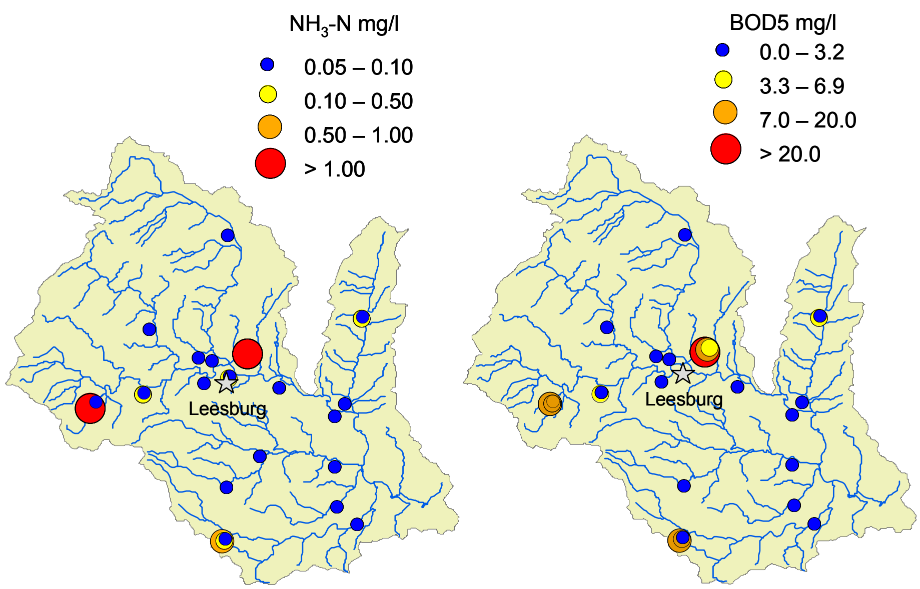


Figure 26. Concentrations of NH3-N and BOD5 in water quality spot samples collected in the Lees Creek assessment unit, 2006. Blue symbols represent concentrations typical of normal background conditions, yellow symbols show concentrations elevated above background conditions, orange symbols represent highly elevated concentrations, and red symbols indicated concentrations detrimental to aquatic life.

Paint Creek Assessment Unit (05060003-050)

This assessment unit is essentially the Paint Creek mainstem and a handful of small direct tributaries. The unit is defined by the confluence with the East Fork to the confluence with Rocky Fork. This reach includes Paint Creek Reservoir.

The Washington Court House WWTP plant discharges immediately upstream from the confluence with the East Fork, strongly influencing the water quality in this reach, especially with respect to nutrients. Relative to the other assessment units, phosphorus concentrations were an order of magnitude higher, and ammonia concentrations were frequently elevated above background conditions (Table 14, Figure 27). Nutrient enrichment in the mainstem of Paint Creek was evident in high diel swings in dissolved oxygen concentrations at RM 58.8 near Miami Trace Road (Figure 28). Excellent habitat, especially high gradient riffle habitat, in this reach apparently offered sufficient refugia to prevent localized impacts to the aquatic biota. Downstream from Greenfield, however, stonerollers, an herbivorous fish, had an unusually high relative abundance apparently stimulated by enrichment. Release of oxygen depleted, hypolimnetic water from the Paint Creek reservoir was recorded by automatic data loggers in the reach downstream from the reservoir, and resulted in impaired macroinvertebrate communities. Remineralization of inorganic nitrogen was also evident in relatively high ammonia concentrations recorded at RM 39.4 below the Paint Creek Reservoir dam (Table 14); however, the reservoir appears to be a sink for phosphorus (Figure 27).

Water quality samples from Wabash Creek were collected downstream from a livestock pasture and consequently showed elevated concentrations of TKN, NH3-N, and BOD5. Biological communities were, however, not impaired.

Rocky Fork and Clear Creek Assessment Unit (05060003-060)

This assessment unit is comprised of Rocky Fork and its adjoining tributaries, and includes Clear Creek and Rocky Fork Reservoir. The city of Hillsboro is located in the northwestern part of the assessment unit.

Water quality at sites sampled in the Rocky Fork assessment unit was generally as good, or better than the other assessment units in the Paint Creek basin (Figure 27). Bypasses of minimally treated wastewater from the Hillsboro WWTP, however, resulted in organic enrichment downstream from the plant, and negatively affected biological communities monitored at Selph Road (RM 5.4). The magnitude of impairment related to the bypasses was relatively minor, and upgrades to the plant planned to start in 2008 should fully rectify the problem. Also, nutrient concentrations increased downstream from the plant relative to concentrations measured upstream (Figure 29). The nutrient load exacerbated the already-high level of background enrichment, as evidenced by comparatively wide dissolved oxygen swings downstream from the plant (Figure 30).

Water quality and sediment samples collected from Moberly Branch, a tributary to Clear Creek that drains downtown Hillsboro, showed evidence of urban stormwater in elevated levels of TDS and nutrients, and detectable concentrations of polycyclic aromatic hydrocarbons (PAHs; Appendix 2). PAHs were also detected in Clear Creek downstream from the Moberly Branch at RM 6.8. PAHs are by-products of incomplete petroleum combustion, and build up on road surfaces in urban areas.

Figure 31. Algae bloom in Rocky Fork upstream Barrett Mill Road.

Effluent sampling at the Rocky Fork Regional WWTP revealed high concentrations of ammonia-nitrogen on two occasions. Spot samples collected at the far-field location at SR 124 (RM 17.53) showed ammonia concentrations elevated above background levels, but less than water quality criteria for the protection of aquatic life. Downstream from Rocky Fork Reservoir, a nuisance bloom of algae was noted in the dam pool upstream from Barrett Mill Road (Figure 31).

Table 15. Chemical concentrations exceeding water quality standards for the protection of aquatic life detected in the Lees Creek and Rocky Fork Hydrologic Units during the 2006 Biological and Water Quality Survey of Paint Creek.

Date	D.O.	NH3
Lees Creek Hydrologic Unit (05060003 040)		
Fall Creek Dst. SR 138 (V10K48)		
7/20/2006	3.99*	
8/24/2006	4.13[†]	
Walnut Creek Walnut Creek Road (V10K59)		
7/20/2006	3.65*	
8/09/2006	4.96[†]	
8/24/2006	2.78*	
Tributary to Lees Creek; Thomas Road (V10K61)		
7/20/2006		5.0*
8/09/2006	1.80*	
8/24/2006	3.37*	10.5*
9/06/2006		8.8*
Geometric Mean		4.8**
Middle Fork Lees Creek Stowe Road (V10K65)		
8/24/2006	4.98[†]	
Tributary to South Fork; Careytown Road South of SR 28 (V10K64)		
8/9/2006	2.56*	
8/24/2006	1.69*	
9/6/2006	1.42*	
Rocky Fork Hydrologic Unit (05060003 060)		
Tributary to Rocky Fork @ RM 24.27; Pigeon Roost Road (V10K42)		
8/10/2006	4.59[†]	
8/23/2006	4.92[†]	
Hussey Run; Careytown Rd, Fallsville Wildlife Area (V10K40)		
8/23/2006	2.75*	

* Exceeds the water quality standard for a measurement taken at anytime Outside of a Mixing Zone (OMZ).
** Exceeds the water quality standard for a 30-day average of measurements taken OMZ.
[†] Point value exceeding the water quality standard for a 30-day average of measurements taken OMZ.

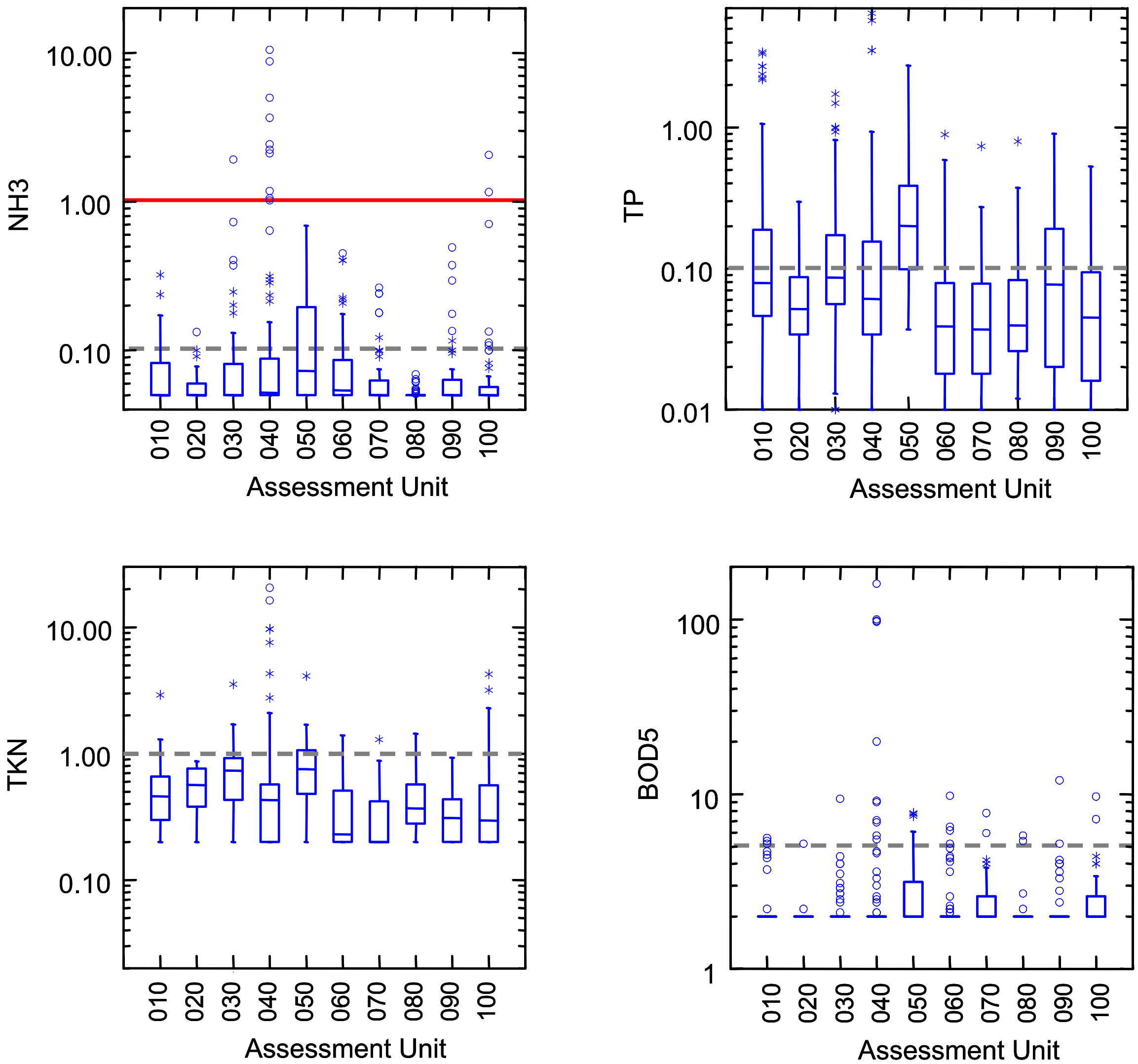


Figure 27. Distributions of NH3-N, TP, TKN and BOD5 concentrations in water quality spot samples plotted by assessment unit. Dashed lines in the TP, TKN, and BOD5 plots show the upper range of background concentrations typical for the ecoregion. The solid red line at 1.0 mg/l in the NH3-N plot is the concentration beyond which acute toxicity is likely, and the dashed line at 0.1 mg/l shows the concentration where chronic toxicity becomes increasingly likely.

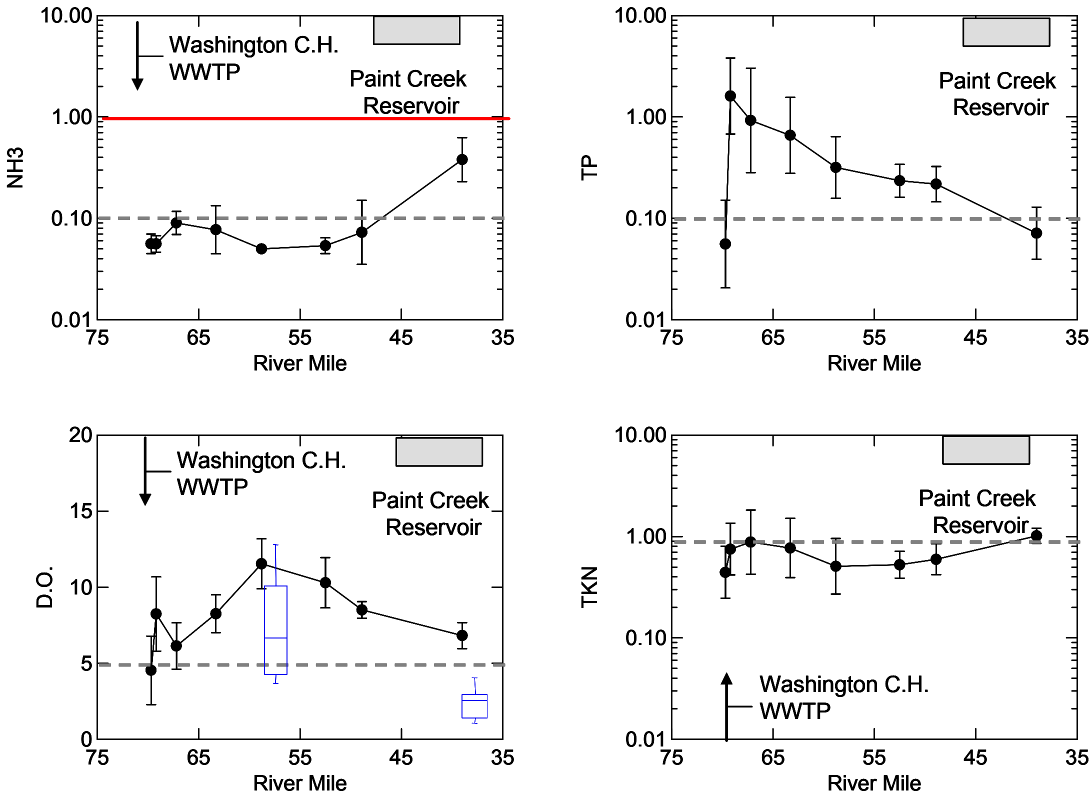


Figure 28. Longitudinal profiles of mean (+/- 1 SD) nutrient concentrations and dissolved oxygen concentrations in water quality samples collected from the Paint Creek mainstem in relation to the Washington Court House WWTP and Paint Creek Reservoir. The box plots shown in the dissolved oxygen panel show distributions of concentrations measured in automated data loggers placed at Miami Trace Road (RM 58.8) and downstream from the reservoir (RM 39.4). Dashed lines in the TP and TKN plots show the upper range of background concentrations typical for the ecoregion. The solid line at 1.0 mg/l in the NH3-N plot is the concentration beyond which acute toxicity is likely, and the dashed line at 0.1 mg/l shows the concentration where chronic toxicity becomes increasingly likely. The dashed line in the dissolved oxygen plot is the water quality standard (24 hour average for WWH, instantaneous for EWH. Paint Creek is designated EWH downstream from RM 67.0).

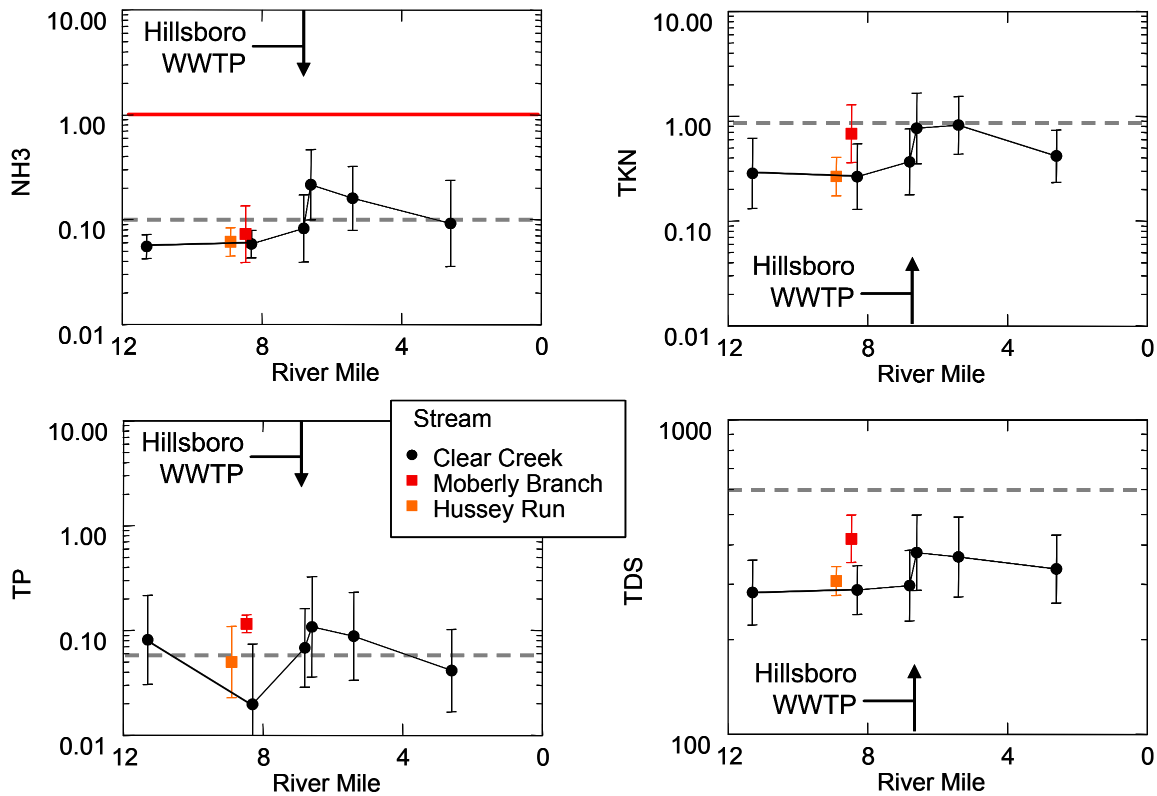


Figure 29. Longitudinal profiles of mean (+/- 1 SD) nutrient and total dissolved solids concentrations in water quality samples collected from Clear Creek in relation to the Hillsboro WWTP. Dashed lines in the TP, TKN and TDS plots show the upper range of background concentrations typical for the ecoregion. The solid line at 1.0 mg/l in the NH3-N plot is the concentration beyond which acute toxicity is likely, and the dashed line at 0.1 mg/l shows the concentration where chronic toxicity becomes increasingly likely.

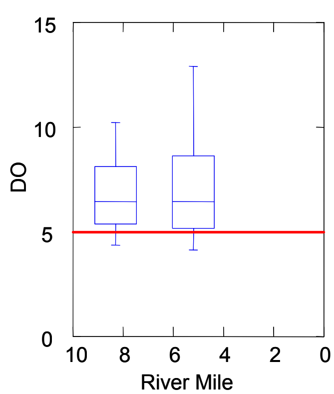


Figure 30. Distributions of dissolved oxygen concentrations measured hourly by automated data loggers deployed in Clear Creek, July 25-27, 2006. The Hillsboro WWTP discharges to Clear Creek at RM 6.7

Recreational Use

Water quality criteria for determining whether rivers and streams are suitable for recreational uses are established in the Ohio Water Quality Standards (Table 8-13 in OAC 3745-1-07) based upon the presence or absence of bacteria indicators in the water column. Indicator organisms used for these determinations are fecal coliform bacteria and *Escherichia coli*.

Fecal coliform bacteria are microscopic organisms that are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals. *E. coli* typically comprises approximately 97 percent of the organisms found in the fecal coliform bacteria of human feces (Dufour, 1977), but there is currently no simple way to differentiate between human and animal sources of coliform bacteria in surface waters, although methodologies for this type of analysis are becoming more practical. These microorganisms can enter water bodies where there is a direct discharge of human and animal wastes, or may enter water bodies along with runoff from soils where these wastes have been deposited.

Pathogenic (disease causing) organisms are typically present in the environment in such small amounts that it is impractical to monitor them directly. Fecal coliform bacteria, including *E. coli*, by themselves are usually not pathogenic. However, some strains of *E. coli* can be toxic, causing serious illness. Although not necessarily agents of disease, fecal coliform bacteria and *E. coli* may indicate the potential presence of pathogenic organisms that enter the environment through the same pathways. When fecal coliform bacteria or *E. coli* are present in high numbers in a water sample, it invariably means that the water has received fecal matter from one source or another. Swimming or other recreational-based contact with water having a high fecal coliform or *E. coli* count may result in ear, nose, and throat infections, as well as stomach upsets, skin rashes, and diarrhea. Young children, the elderly, and those with depressed immune systems are most susceptible to infection.

Most of the streams in the Paint Creek watershed are designated as a Primary Contact Recreation (PCR) use in OAC Rule 3745-1-24. Water bodies with a designated recreational use of Primary Contact Recreation (PCR) "...are waters that, during the recreation season, are suitable for fullbody contact recreation such as ... swimming, canoeing, and SCUBA diving with minimal threat to public health as a result of water quality" [OAC 3745-1-07 (B)(4)(b)]. The recreational use water quality criteria applicable to the Paint Creek watershed are reported in Table 8-13 of OAC 3745-1-07. At least one of the two bacteriological standards (fecal coliform or *E. coli*) must be met. These criteria apply outside of the mixing zone. For the Primary Contact use, the following applies: fecal coliform - geometric mean fecal coliform content (either MPN or MF), based upon not less than five samples within a thirty-day period, shall not exceed 1,000 per 100 ml and fecal coliform content (either MPN or MF) shall not exceed 2,000 per 100 ml in more than ten percent of the samples taken during any thirty-day period. *E. coli* - geometric mean *E. coli* content (either MPN or MF), based upon not less than five samples within a thirty-day period, shall not exceed 126 per 100 ml and *E. coli* content (either MPN or M F) shall not exceed 298 per 100 ml in more than ten percent of the samples taken during any thirty-day period. Bacteriological results from environmental samples are typically reported as colony forming units (cfu) per 100 ml of water.

Summarized bacteria results are listed in Table 16, and the complete dataset is reported in Appendix 3. Ninety-seven locations within the Paint Creek watershed were tested for bacteria levels during the summer recreational season in 2006. Evaluation of fecal coliform and *E. coli* results revealed that less than half of the sites are fully attaining the recreational use with 51 sites in NON attainment and 46 in Full attainment.

Ross County (HUC 070, 090, and 100)
A total of 31 bacteria samples were collected in Ross County (HUC 070, 090 and 100) during low flow conditions from July through September 2006. Of the 31 sites sampled, fifteen were fully meeting the PCR use designation and sixteen sites were not meeting the PCR use designation (Table 4). The source of elevated bacteria levels is failing home septic treatment systems, poorly maintained waste water treatment plants (village of Frankfort) and farming activity (such as livestock with free access to waterways and land applied manure runoff).

Four locations in HUC 070 were not meeting the PCR use designation: Buckskin Creek upstream from Falls Road, Lower Twin Creek, Massie Run, and Upper Twin Creek west of Bourneville. This area may be affected by farming activity and is also unsewered and may be receiving untreated or poorly treated wastewater from failing home septic treatment systems.

Three locations on the North Fork of Paint Creek and several tributaries (Little Creek, Oldtown Run, Biers Run) in the HUC 090 subwatershed were not meeting the PCR use designation. Most of the smaller tributaries such as Oldtown Run Little Creek and Biers Run are located in unsewered areas that may have failing home septic treatment systems.

The North Fork of Paint Creek is in HUC 090 and was found to be not meeting the PCR use designation downstream from the Frankfort WWTP. Samples collected during the summer of 2006 from the WWTP had extremely elevated bacteria colonies. The WWTP was found to be poorly maintained with improper sludge disposal and insufficient amounts of chlorine in the chlorine contact tank. New management and better maintance of the WWTP has greatly improved the operation of the Frankfort WWTP and should address this impairment.

Little Creek is a tributary to the North Fork of Paint Creek in the HUC 090 subwatershed that flows through the village of Roxabel. Roxabel is completely unsewered and most likely has numerous failing home septic treatment systems. Some older homes might have no treatment at all and discharge directly to Little Creek. The North Fork of Paint Creek at Musselman Hill Road (downstream from the confluence of Little Creek) was also not meeting the PCR use designation most likely due to the unsewered community of Roxabel.

One site on Paint Creek (at Jones Levee Road) and four tributaries to Paint Creek (Cattail Run, Owl Creek, Ralston Run, and Plug Run) in the HUC 100 subwatershed were found to be not meeting the PCR use designation. The source of bacteria is most likely from farm activity and failing home septic treatment systems. Cattail Run located on Owl Creek road had elevated bacteria and poor water quality including elevated metals (copper, aluminum, lead and nickel), and ammonia values exceeding reference conditions.

Highland and Clinton Counties (HUC 040, 050, and 060)
Nineteen bacteria samples were collected in Clinton and Highland counties in September during high flows (September 11 – September 15; Table 4, Appendix 3). Only one sample collected below the Paint Creek dam was meeting the PCR use designation. It is typical to see elevated bacteria in streams throughout the state of Ohio during extremely high flows because sediments in aquatic systems are a reservoir for pathogenic organisms and indicator bacteria. As the flow of streams increase, sediment resuspension can significantly increase bacteria counts in overlying waters (Ohio EPA 2006). Because these samples were collected during high flows, it would be difficult to attribute the source of the elevated bacteria.

Sediment Quality
Sediment samples were collected at 11 locations in the Paint Creek watershed by the Ohio EPA from August through November, 2006 (Table 17; Appendix 2). Samples were analyzed for semivolatile organic compounds, PCBs, total analyte list inorganics, and nutrients. Specific chemical parameters tested and complete results are listed in Appendix 2. Sediment data were evaluated using guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald *et.al*. 2000), and *Ohio Specific Sediment Reference Values (SRVs)* for metals (Ohio EPA 2003b). The consensus-based sediment guidelines define two levels of ecotoxic effects. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed.

Sediment samples were conservatively sampled by focusing on depositional areas of fine grain material. These areas typically are represented by higher contaminant levels, compared to sands and gravels. Detectable levels of metals, semivolatile organic compounds, and PCBs are presented in Table 17. Five metal parameters (arsenic, cadmium, chromium, nickel, and zinc) were noted at levels above either Ohio SRV or TEC values. Only one metal (nickel) was found above the PEC value on Sulphur Lick.

Polychlorinated biphenyl (PCB) values well above the PEC threshold were documented in sediment samples collected from Paint Creek at RM 1.9 downstream from the P.H. Glatfelter outfall and the Paint Street landfill. Historically, PCBs were used in the production of carbonless paper at the P.H. Glatfelter facility (formerly Mead Westvaco). Even though usage of PCBs was banned in the 1970’s, they are persistent in the environment and may not break down for decades. PCBs were not detected at any other sites in the Paint Creek watershed.

Sediment samples collected from Moberly Branch, a tributary to Clear Creek that drains downtown Hillsboro, showed evidence of impacts from urban stormwater with polycyclic aromatic hydrocarbons (PAHs) and phenanthrene exceeding the TEC values and other numerous organic compounds above the PEC values (Table 17). PAHs and other organic compounds above the TEC value were also detected in Clear Creek downstream from the Moberly Branch at RM 6.8. PAHs are by-products of incomplete petroleum combustion, and build up on road surfaces in urban areas.

Paint Creek downstream from Washington Court House at RM 67.2 also showed evidence of impacts from stormwater runoff with PAHs, chrysene, fluoranthene, and pyrene found in the sediment at levels above the TEC value (Table 17).

Table 16. Summary fecal coliform and E. coli bacteria data for 97 locations in the Paint Creek watershed, May 11 – October 12, 2006. Attainment status is based on comparing the geometric mean and 90th percentile values to the Primary Contact Recreation (PCR) or Secondary Contact Recreation (SCR) criteria (Ohio Administrative Code 3745-1-07, Table 8-13). All values are expressed as colony forming units (cfu) per 100 ml of water. Gray shaded values exceed applicable PCR or SCR criteria. Attainment status in parentheses is based on fewer than 5 samples.

			Geometric Mean		90th Percentile		
Location	HUC 05060003	River Mile	Fecal Coliform	E. Coli	Fecal Coliform	E. Coli	Recreational Attainment Status
***Paint Creek** - PCR*							
SR 323 N. of Jeffersonville	010	96.03	2574	1650	18,320	11,760	**NON**
Adjacent Wildwood Rd.	010	79.86	808	473	4900	2500	**NON**
Bloomingburg-New Holland Road	010	75.33	676	359	4720	2460	**NON**
Private Rd. upst Washington CH	010	73.28	410	271	1980	898	Full
Perry Park (Eyeman Park Dr.)	010	71.16	146	87	708	351	Full
Elm St, upst Washington CH WWTP	010	69.52	338	169	13,000	11,000	**NON**
WASHINGTON C.H. WWTP 001	010	69.44	1557	343	4480	764	NA
Dst. Washington CH WWTP outfall	010	69.35	1015	254	12,920	2446	**NON**
Dst. U.S. 35, adj Rock Bridge Rd.	050	67.1	8503	5680	28,500	16,700	**(NON)**
Miami Trace Rd. @ Rock Mills	050	58.75	7464	3151	23,200	6600	**(NON)**
SR 753, Upst. Greenfield	050	52.54	2849	2235	17,400	14,400	**NON**
Adj. Washington St.	050	48.7	2963	1249	17,000	5760	**NON**
Dst. Paint Creek Dam	050	39.14	91	79	1170	925	Full
SR 41 North of Bainbridge	070	31.5	137	77	440	344	Full
Dills Road	070	27.43	159	80	961	792	Full
Bourneville @ Jones Levee Road	070	21.6	167	82	600	308	Full
0.8 miles upst. North Fork Paint Cr.	100	8.9	107	72	2644	1426	**NON**
SR 772 @ Chillicothe	100	3.8	184	106	1090	516	Full
P.H. Gledfelter 001	100	3.3	12	<10	73	<10	NA
US 23	100	0.68	98	51	235	180	Full
***North Fork Paint Creek**- PCR*							
Yankeetown-Chenoweth Rd.	080	42.0	233	67	1214	264	Full
Glaze Rd. NW of New Holland	080	31.02	495	325	1610	1032	Full
Good Hope-New Holland Rd	080	26.67	302	166	740	410	Full
Asbury Rd.	090	22.3	126	52	364	150	Full
Dexter Rd.	090	17.5	494	119	2115	260	Full
FRANKFORT WWTP 001	090	14.26	3341	772	51600	39200	NA
Dst. Frankfort WWTP	090	14.1	731	250	4480	1340	**NON**
Musselman Hill Rd.	090	10.5	416	206	2160	1256	**NON**
Pleasant Valley WWTP 001	090	4.0	14	9	412	175	NA
US 50	090	3.9	181	79	536	146	Full
Poke Hollow Rd.	090	2.28	279	147	2200	2028	**NON**
***Compton Creek** - PCR*							
Meyers Rd	080	17.6	1187	593	2720	1330	**NON**

Table 16. Continued.

Location	HUC 05060003	River Mile	Geometric Mean: Fecal Coliform	Geometric Mean: E. Coli	90th Percentile: Fecal Coliform	90th Percentile: E. Coli	Recreational Attainment Status
Washington Waterloo Rd	080	11.2	575	372	760	616	Full
Good Hope-New Holland Rd	080	3.37	393	285	440	320	Full
Dogtown Rd	080	1.1	576	268	1502	458	Full
***East Fork Paint Creek**- PCR*							
Lewis Rd NW of Bloomingburg	010	8.55	352	202	1038	528	Full
Dst. Bloomingburg WWTP	010	6.32	31	19	160	62	Full
Matthews Rd S. of Bloomingburg	010	5.06	497	338	1780	1456	Full
US 22	010	0.72	762	328	15,000	7000	**NON**
Dst. Hillsboro WWTP	060	6.6	6907	3642	60,000	44,800	**NON**
Rattlesnake Creek							
SR 734 West of Jeffersonville	030	40.44	652	414	1347	794	Full
US 35 SW of Jeffersonville	030	38.12	576	417	1220	856	Full
Milledgeville-Octa Rd.	030	35.36	236	164	408	294	Full
SR 729 South of Milledgeville	030	31.48	198	96	499	301	Full
Snow Hill Rd.	030	23.97	315	174	1936	1644	Full
Upst. Zimmerman Rd.	030	15.0	451	256	1492	1028	Full
Fishback Rd.	030	13.23	677	361	1900	634	Full
Centerfield Rd.	040	7.55	1572	553	13,500	6000	**NON**
***W. Branch Rattlesnake Creek**- SCR*							
@ Hargrave	030	11.4	331	174	2950	2052	Full
SR 729	030	4.3	160	66	505	262	Full
Dst. Wilson Creek	030	2.8	311	168	1028	590	Full
***Sugar Creek**- PCR*							
Selsor Moon Rd.	020	36.9	228	90	1164	718	Full
McKillip Rd N. of Jeffersonville	020	29.21	153	86	270	250	Full
Creamer Rd. SE of Jeffersonville	020	24.21	218	59	1138	212	Full
Ford Rd. SE of Milledgeville	020	18.48	981	564	2400	1444	**NON**
US 22 @ Jasper Mills	020	11.99	404	223	742	336	Full
Mark Rd. NE of Staunton	020	5.4	524	244	840	366	Full
Armbrust Rd.	020	4.24	643	330	770	600	Full
***Little Creek**- PCR*							
Higgenbotham Rd	090	5.62	278	125	1741	721	Full
Little Creek Rd near Rogers Rd	090	1.0	576	322	2640	1380	**NON**
***Buckskin Creek**- PCR*							
Black Lane	070	3.1	389	152	1920	612	Full
Upst. Falls Rd.	070	0.4	347	108	3528	1656	**NON**
***Upper Twin Creek**- PCR*							
Strauss Lane/Tong Hollow Rd.	070	5.8	302	162	730	532	Full
Upper Twin Cr. Rd. W of Bourneville	070	2.0	964	806	2360	1694	**NON**
***Black Run**- PCR*							
Baum Hill Rd.	100	3.96	223	68	444	110	Full
Shoemaker Lane (Spruce Hill)	100	1.0	151	57	218	86	(Full)

Table 16. Continued.

Location	HUC 05060003	River Mile	Geometric Mean Fecal Coliform	Geometric Mean E. Coli	90th Percentile Fecal Coliform	90th Percentile E. Coli	Recreational Attainment Status
Other Streams							
Big Run – Lewis Rd. (PCR)	010	1.8	3839	2449	58,600	37,300	**NON**
William Cathcart Ditch - SR 38	010	0.2	2427	1541	16,460	7080	**NON**
Vallery Ditch – Prairie Rd.	010	2.3	1199	799	17,700	7764	**NON**
Missouri Ditch – Harmony Rd.	020	1.6	326	163	2060	1700	**NON**
Maple Grove Cr.- Pleasant View Rd.	030	1.6	299	170	1120	692	Full
Trib. To Rattlesnake Cr. - Pleasant View Rd.	030	1.1	1327	762	5260	3460	**NON**
Wilson Cr. - Dst. Sabina WWTP (PCR)	030	2.8	1387	473	4360	1980	**NON**
Trib. To Wilson Cr. - US 22	030	0.4	4525	2068	16,560	13,000	**NON**
Grassy Br.-Merchant Luttrell Rd.(PCR)	030	8.7	156	82	874	676	Full
Lees Creek – Monroe Rd. (PCR)	040	1.16	2766	1490	19,000	11,000	**NON**
SF Lees Creek - Hixon Rd. (PCR)	040	1.6	8145	3466	43,400	21,160	**NON**
Trib. to Lees Creek - Thomas Rd.	040	1.3	45,672	33,715	384,000	490,400	**NON**
Walnut Creek - Walnut Cr. Rd. (PCR)	040	4.2	28,364	21,434	600,000	684,000	**NON**
Franklin Branch - SR 506 (PCR)	060	1.9	4307	1864	25,600	16,200	**NON**
Pickett Run – Ferneau (PCR)	060	0.1	2814	1609	28,200	15,000	**NON**
Massie Run - US 50 W of Bainbridge (PCR)	070	0.1	1895	689	2740	1480	**NON**
Sulphur Lick -Spargersville Rd. (PCR)	070	1.5	168	74	362	304	Full
L. Twin Cr. - Farm off Lower Twin Rd. (PCR)	070	2.2	339	239	2454	1422	**NON**
Trib. To Buckskin Cr. - McCann Rd.	070	0.18	473	309	1940	1080	Full
Wolf Run - Rockwell Rd.	080	0.3	924	461	3040	1196	**NON**
Thompson Creek - Wissler Rd. (PCR)	080	3.3	635	344	2000	730	Full
Crooked Cr. -Camp Grove Rd. (PCR)	080	3.0	1638	1025	3620	2300	**NON**
Oldtown Run - Ust. Clarksburg Pike (PCR)	090	1.3	517	260	6044	2854	**NON**
Trib. To NF Paint Cr. - Adj. Maple Grove Rd.	090	0.3	382	140	6400	1546	**NON**
Biers Run - CR 550 (PCR)	090	1.5	406	242	4800	3000	**NON**
Plug Run - Mingo Rd. (PCR)	100	0.4	209	167	3360	2560	**NON**
Ralston Run - Turner Rd. (PCR)	100	2.8	571	192	4814	1442	**NON**
Owl Creek - Upst. US 50 (PCR)	100	0.35	308	205	2300	1300	**NON**
Cattail Run - Owl Creek Rd. (PCR)	100	1.2	8323	2697	34,100	10,420	**NON**

Sediment Quality

Table 17. Select chemical compounds detected in sediment samples collected by Ohio EPA from the Paint Creek watershed, August - November, 2006. Shaded numbers indicate values above the following ecological screening guidelines: Ohio Sediment Reference Values for metals (green), Threshold Effect Concentration - TEC (blue), and Probable Effect Concentration - PEC (red). Sampling locations are indicated by river mile (RM). NA – not analyzed.

	Sediment Sampling Locations										
Parameter	**Paint Creek RM 67.2**	**Paint Creek RM 21.6**	**Paint Creek RM 3.8**	**Paint Creek RM 1.9**	**N.F. Paint Cr. RM 42.0**	**N.F. Paint Cr. RM 2.3**	**Compton Creek RM 1.1**	**W.B. Rattlesnake Creek RM 4.3**	**Sulpher Lick RM 1.5**	**Clear Creek RM 6.8**	**Moberly Branch RM 0.9**
Arsenic (mg/kg)	9.77	11.9*	11.6*	12.2*	10.7*	10.5*	13.4*	12.5*	17.9*	7.28	6.25
Cadmium (mg/kg)	0.409	0.467	1.04	0.738	0.356	0.513	0.334	0.291	2.60	0.196	0.164
Chromium (mg/kg)	<15	<25	<34	48*	<18	<18	<25	<14	<20	<15	<13
Nickel (mg/kg)	<20	<34	<45	32*	<24	<23	<33	22	67	<20	<17
Zinc (mg/kg)	86.9	66.0	106	273	54.8	71.0	73.4	45.6	198	52.9	50.4
Benz[a]anthracene (mg/kg)	<0.65	<0.91	<1.14	<0.71	NA	<0.72	<0.92	<0.55	<0.75	0.89	1.65
Benzo[a]pyrene (mg/kg)	0.86	<0.91	<1.14	<0.71	NA	<0.72	<0.92	<0.55	<0.75	1.20	1.66
Chrysene (mg/kg)	0.77	<0.91	<1.14	<0.71	NA	<0.72	<0.92	<0.55	<0.75	0.83	1.69
Fluoranthene (mg/kg)	1.11	<0.91	<1.14	<0.71	NA	<0.72	<0.92	<0.55	<0.75	1.66	3.62
Phenanthrene (mg/kg)	<0.65	<0.91	<1.14	<0.71	NA	<0.72	<0.92	<0.55	<0.75	1.00	0.99
Pyrene (mg/kg)	0.89	<0.91	<1.14	<0.71	NA	<0.72	<0.92	<0.55	<0.75	1.40	3.05
Total PAHs (mg/kg) - calculated	6.31	<0.91	<1.14	<0.71	NA	<0.72	<0.92	<0.55	<0.75	9.96	17.82
PCB-1242 (ug/kg)	<32.2	<45.7	<57.1	13,800	NA	<36.1	<45.5	<27.6	<37.7	<27.4	<26.6

* Value is below the Sediment Reference Value

Effluent Discharges

Ross County - 11 digit Hydrologic Unit Code 05060003-070, -090, and -100

A total of nine National Pollutant Discharge Elimination System (NPDES) permitted facilities discharge sanitary wastewater, industrial process water, and/or industrial storm water into the Paint Creek Watershed within Ross County. Included in this list are six publicly owned sanitary wastewater plants, one privately owned sanitary wastewater plant, and two industrial facilities. One industrial facility is the Melvin Stone Company which discharges storm water from a retention pond located at the limestone quarry. The other industrial facility is the P.H. Glatfelter Company, a privately owned paper mill in Chillicothe, which discharges an average daily flow of 25 MGD of industrial process wastewater into Paint Creek. The P.H. Glatfelter Company also has eight storm water outfalls throughout the facility which discharge industrial storm water runoff. Each facility is required to monitor their discharges according to sampling and monitoring conditions specified in their NPDES permit and report results to the Ohio EPA on a Monthly Operating Report (MOR). Summarized effluent results are listed in Appendix 4.

The Melvin Stone Company, LLC. (Ohio EPA Permit # 0IN00217*BD)

The Melvin Stone Company is located on Plano Rd approximately one mile north of State Route 35 in Concord Township, Ross County, Ohio. This facility is a limestone quarry where different grades of limestone aggregates and sand are mined and sold. The limestone quarry consists of a sediment pond which collects storm water runoff from the mining site and discharges to the North Fork of Paint Creek following storm events. The impact of the storm water discharge to the North Fork of Paint Creek is very minimal as discharge is infrequent and solids are contained within the retention pond.

Village of Frankfort WWTP (Ohio EPA Permit # 0PB00014*FD)

The Village of Frankfort WWTP is located at 91 South Main Street, Frankfort, Ohio in Ross County and is a publicly owned treatment works providing sanitary wastewater treatment for the village. The population served by the treatment plant is 1,000 people within the small village located in Concord Township in the northwestern area of Ross County. The original plant was constructed in 1969 with an upgrade completed in 1996 which increased the design flow from .150 MGD to .190 MGD. The treatment plant had an average daily flow in 2006 of .108 MGD and consists of primary treatment through a bar screen and secondary treatment with the two contact stabilization extended aeration tanks. The treated effluent is disinfected through chlorination and de-chlorinated with liquid sodium bisulfite from May through October according to their NPDES permit.

The Frankfort WWTP is required to submit monthly operating reports (MORs) to the Ohio EPA as part of their permit requirements. Third quarter median and 95th percentile data collected by Frankfort WWTP show median plant performance improving for ammonia and $cBOD_5$ following the upgrade in 1996. Prior to the upgrade the plant capacity was exceeded during peak flow events primarily contributed to Inflow and Infiltration (I&I) flows entering the collection system. The inadequate plant capacity to handle peak flows lead to several permit violations and prompted the issuance of a consent order in 1995 which required the village to upgrade to come into compliance. The upgrade consisted of a new head works component complete with a mechanical bar screen and splitter box to divert flow to either the old or new contact stabilization tanks for secondary treatment. The second contact stabilization extended aeration tank was added as well as a sludge holding tank complete with new blowers for the entire facility which were housed in a portion of the new laboratory building. The facility upgrades combined with the village's continued efforts to minimize and reduce I&I flows have enabled the plant to handle peak flows when using both contact stabilization tanks.

Recent Ohio EPA compliance inspections have found the plant to be in substantial compliance with the terms and conditions of their NPDES permit. Review of MOR data for 2006 revealed permit violations for TSS, ammonia, and CBOD in the summer quarter of 2006 which would explain the spike in the 95th percentile concentrations for these parameters. Inspections conducted throughout 2005 and 2006 showed the village to be operating only one contact stabilization tank due to needed repairs to the old tank. In April 2007 the village placed the old tank back on-line which will provide the needed capacity for peak flows and provide operational flexibility at the treatment plant. Overall if both contact stabilization tanks are on line the facility will have capacity to handle peak flows and is expected to provide effective wastewater treatment and contribute minimal impact to the water quality of the North Fork of Paint Creek.

Pleasant Valley Regional Sewer District WWTP (Ohio EPA Permit # 0PQ00002*FD)
The Pleasant Valley Regional Sewer District (PVRSD) WWTP is located at 1822 Anderson Station Road, Chillicothe, Ohio and is a publicly owned wastewater treatment plant serving the Pleasant Valley Regional Sewer District. The sewer district includes portions of Union, Twin, and Scioto townships west of Chillicothe and currently serves approximately 4,700 people. The original wastewater plant was built in 1976 with a design flow of .600 MGD and consisted of two oxidation ditches, two secondary clarifiers, tertiary sand filters and disinfection with chlorination. A recent modification was completed in 2001 to increase the hydraulic capacity of the plant through the replacement of the two secondary clarifiers with new larger units. The design flow of the current plant is .900 MGD with an average daily flow of .615 MGD in 2006.

The PVRSD WWTP is required to submit monthly operating reports (MORs) to the Ohio EPA as part of their discharge permit requirements. Annual median and 95th percentile data collected by the PVRSD WWTP show that plant performance improved after 1995 as ammonia and suspended solids loadings decreased and have remained stable despite increasing flows. Secondary treatment was improved in the oxidation ditches with the replacement of submerged blowers with stainless steel brush rotors that occurred in the mid 1990s. The biological treatment within the oxidation ditches has become so efficient that only one oxidation ditch is currently in use treating an average daily flow rate of over .600 MGD. The improvement to the oxidation ditches combined with the two new secondary clarifiers, sludge holding tank, and UV disinfection system installed in 2001 have enabled the facility to consistently meet permit effluent limits and cause little impairment to the water quality of the North Fork of Paint Creek.

The PVRSD was awarded a Region 5 USEPA Operation and Maintenance (O&M) Award for having the best-operated wastewater treatment facility in the Most Improved Plant Category in 1997. The award was presented to Jeff Raines, Plant Superintendent recognizing him and his staff for their operational and maintenance efforts to improve the efficiency of the treatment plant. Data collected by PVRSD showed that plant efficiency improved greatly after 1995, such that the facility consistently removed more than 96% of the biochemical oxygen demand, and 93% of the suspended solids and ammonia from the incoming wastewater. These high efficiency numbers were being met prior to the plant upgrade in 2001 which improved the plant's performance even more. The treatment plant's efficiency is evidenced by the ability to treat peak flows greater than 1.0 MGD with only one oxidation ditch even though the entire plant design capacity is only 0.90 MGD. Recent inspections at the facility have found the treatment plant to be in compliance with the terms and conditions of their permit and review of 2006 MORs revealed no effluent limit violations. The efficient treatment of sanitary wastewater at PVRSD has caused little impairment to the water quality of the North Fork of Paint Creek and is of minimal concern for future impairment.

ODNR – Paint Creek Lake Campground WWTP (Ohio EPA Permit # 0PP00076*DD)
The Paint Creek State Park has a full utility hookup campground located near Rapid Forge Road and Taylor Road in the southwestern corner of Ross County which serves several campsites, the convenience store and a couple full service restrooms for the campers. The treatment plant consists of a trash trap followed by an extended aeration package plant with surface sand filters and disinfection with chlorine. The wastewater plant has a design capacity of .022 MGD with an average daily flow of .004 MGD for 2006. The campground is a seasonal operation primarily from May through October with only very minimal discharges during the off season. Recent inspections conducted in 2006 found the facility to be in substantial compliance with their discharge permit and review of MORs for 2006 only revealed a few effluent violations. The relatively small seasonal discharge to Paint Creek Lake has shown no documented impact to the water quality of the lake or downstream segments of Paint Creek.

Village of South Salem WWTP (Ohio EPA Permit # 0PA00018*BD)
The Village of South Salem is a small village located in Buckskin Township in west central Ross County. The Village WWTP consists of one facultative lagoon which serves a population of 300 people who reside within the village. The one facultative lagoon provides for settling of the solids and biological decomposition due to the relatively long detention time. The discharge from the lagoon gravity flows to a large drip irrigation field for on-site treatment. The lagoon does have an occasional controlled discharge to Buckskin Creek when weather conditions don't allow for a discharge to the drip irrigation field. The lagoon has a design capacity of .031 MGD and an average daily flow rate of .002 MGD was discharged to Buckskin Creek for approximately three months in 2006. The controlled discharge from the South Salem Lagoon to Buckskin Creek has minimal organic loading to Buckskin Creek and is a minimal threat to water quality impairment of Buckskin Creek.

Bainbridge Manor Apartments (Ohio EPA Permit # 0PW00016*CD)
The Bainbridge Manor Apartments are located on Shawnee Street within the unsewered village of Bainbridge in southwestern Ross County, Ohio. The apartment complex is provided sanitary sewer service through an on-site wastewater treatment plant with a design capacity of .0144 MGD and an average daily flow rate of .0046 in 2006. The treatment plant consists of an extended aeration package plant with surface sand filters and chlorination with dechlorination for disinfection. The treated wastewater discharges to an unnamed tributary to Paint Creek which becomes dry during a large portion of the year due to the coarse well drained soils in the Paint Creek valley near Bainbridge. The tendency of the treated wastewater to leach into the ground upon discharging into the unnamed tributary has caused the sanitary discharge to be a minimal threat to the water quality of Paint Creek.

The presence of well drained soils in the Paint Creek valley near Bainbridge have allowed a majority of the on-site residential septic systems to function well enough to not present a public health threat at this time. There are a few small village lots where the sanitary wastewater likely discharges into adjacent storm sewers where it is conveyed into various ditches and unnamed tributaries to Paint Creek. Further investigation would be recommended within the village to determine if direct sanitary wastewater discharges are present within the village. The Village of Bainbridge has made some efforts to obtain funding to conduct a feasibility study to determine the most appropriate type of centralized sanitary wastewater treatment which will be needed in the near future. At the present time no funding has been secured and no extensive investigation of current on-site septic systems has been conducted.

Paint Valley Jr. and Sr. High School (Ohio EPA Permit # 0PT00054*BD)
Paint Valley Jr. and Sr. High Schools located at 7454 State Route 50, Bainbridge, Ohio in Ross County is a publicly owned wastewater treatment plant with a design flow of .0096 MGD and an average daily flow rate of .0054 MGD in 2006. The treatment plant is an extended aeration plant with a trash trap, up flow fixed media clarifiers, sand filters and disinfection with chlorine. Due to the plant's proximity to Paint Creek the treated effluent is pumped directly to Paint Creek.

Huntington Jr. and Sr. High School (Ohio EPA Permit # 0PT00007*FD)
The Huntington Jr. and Sr. High Schools located at 188 Huntsman Road, Huntington township in Ross County is a publicly owned wastewater treatment plant with a design flow of .030 MGD and an average daily flow rate of .013 MGD in 2006. The treatment plant is an extended aeration plant with preliminary screening, extended aeration with return activated sludge for secondary treatment and tertiary treatment with surface sand filters. The treated effluent is disinfected with chlorine and de-chlorinated prior to discharging to Ralston Run.

P.H. Glatfelter - formerly MeadWestvaco
(Ohio EPA Permit # 0IA00002)
P.H. Glatfelter is located at 401 S Paint Street, Chillicothe, Ohio in Ross County and is a privately owned paper mill. The facility includes a wood yard where chips are produced to be processed at the pulp mill. The facility manufactures carbonless paper and fine high-quality papers, both coated and uncoated. Other operations include paper rolling, coating and finishing. P.H. Glatfelter has nine permitted outfalls including outfall 001 which discharges treated process water directly to Paint Creek and outfalls 002, 003, 004, 005, 006, 007, 008, and 009 which are storm water outfalls. The average flow of outfall 001 is 25 MGD.

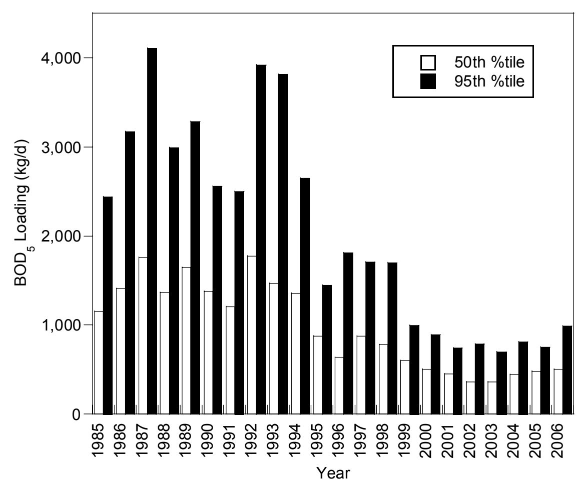


Figure 32. Annual median and 95th percentile loadings of BOD5 from P.H. Gladtelter, 1985-2006.

P.H. Glatfelter is required to submit monthly operating reports (MORs) to Ohio EPA as part of their permit requirements. Annual median and 90th percentile data collected by PH Glatfelter show that

BOD5 TSS and TDS loads have steadily declined from 1985 to 2006 (Figures 32, 33, and 34). TDS loads are still relatively high with median values consistently near or greater than 150,000 kg/d from 1985 to 2006.

The discharge from outfall 001 has a distinctive brown color which causes Paint Creek to be discolored and can extend into the Scioto River during low flow conditions. The biological community was sampled below the P.H. Glatfelter outfall during the 2006 survey and was found to be meeting Warmwater Habitat (WWH) however biological samples upstream from the outfall were fully meeting Exceptional Warmwater Habitat (EWH) criteria. Habitat scores below the outfall show that an EWH community could be supported which indicates that the more sensitive species typically associated with an EWH community are avoiding this area due to the P.H. Glatfelter 001 outfall. PCB contamination was also found in the sediment downstream from the P.H. Glatfelter 001 outfall. PCBs were routinely used by Mead Westvaco to produce carbonless paper before they were in banned in the 1970s.

Ohio EPA conducted a compliance sample and bioassay of the 001 outfall from P.H. Glatfelter on December 4-5, 2006. None of the parameters exceeded the permit limits and the effluent was not found to be acutely toxic to P*imephales promelas* (fathead minnows) or *Ceriodaphnia dubia*. Previous samples collected in May 1997 were also not found to be acutely toxic to either test organism.

Because paper mills typically have high concentrations of total suspended solids, total dissolved solids, and BOD_5, it is very probable that while the effluent does not have an immediate effect just below the outfall, the breakdown of these constituents can cause a dissolved oxygen sag further downstream. Although no biological impairment was found in Paint Creek below the 001 outfall, further studies should be conducted on the Scioto River to determine if the discharge from P.H. Glatfelter has far reaching effects.

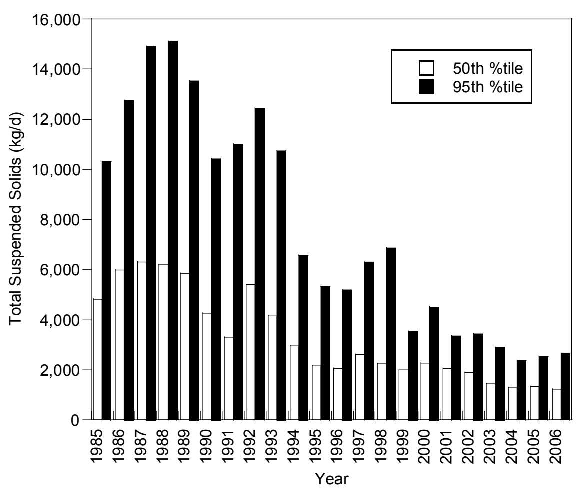


Figure 33. Annual median and 95th percentile loadings of Total Suspended Solids from P.H. Gladfelter, 1985-2006.

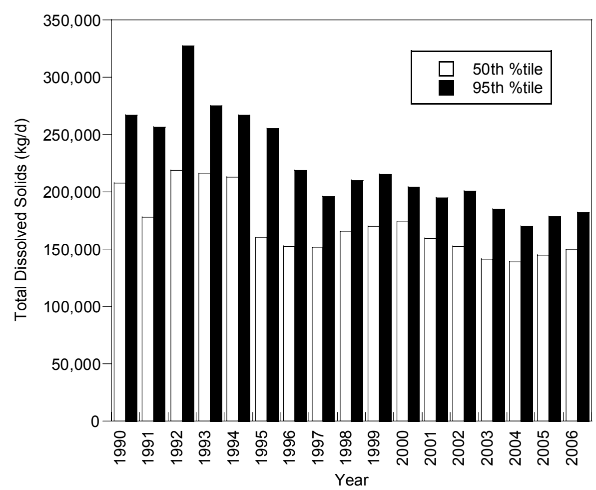


Figure 34. Annual median and 95th percentile loadings of TDS from P.H. Gladfelter, 1985-2006.

Effluent Discharges

Highland & Clinton County - 11 digit Hydrologic Unit Code 05060003-030, -060, and -070

A total of 16 National Pollutant Discharge Elimination System (NPDES) permitted facilities discharge sanitary wastewater, industrial process water, and/or industrial storm water into the Paint Creek watershed within Highland County. In addition, one sanitary wastewater facility is located in Clinton County in the Paint Creek watershed. Included in this list are nine publicly owned sanitary wastewater plants, seven privately owned sanitary wastewater plants, and one industrial facility. Each facility is required to monitor their discharges according to sampling and monitoring conditions specified in their NPDES permit and report results to the Ohio EPA on a Monthly Operating Report (MOR). Numeric violations of the NPDES permit were evaluated from 2000 to 2007 and are summarized in the following paragraphs. Additionally the summarized effluent permit limits and MOR data are listed in Appendix 4.

Babington Camp and Mobile Home Park WWTP (Ohio EPA #-1PV00087)

The Babington Camp and Mobile Home Park WWTP is located at 11993 Spruance Rd, Hillsboro, Ohio in Highland County and discharges to an unnamed tributary to Plum Run at river mile 2.3. The original facility was built in 1967 and no current expansion is anticipated. Wastewater treatment consists of two extended aero flow treatment system with extended aeration and chlorination. The design flow is 20,000 gallons per day based on 108 mobile homes. Sludge produced onsite is trucked to a local public wastewater treatment plant and then land applied.

As of 2005 the Babington WWTP was conveying treated wastewater to an excavated pit located next to the stream. Ohio EPA had notified the facility in 1999 to eliminate this type of discharge and install a slow surface sand filter system. During a 2005 inspection, Ohio EPA found that the treatment plant operator was not certified and he was also not sampling in accordance to the NPDES permit. The owner of the facility, Mr. Babington, has since hired a certified operator who is currently following the NPDES monitoring schedule.

Approximately 53 permit violations were reported by the facility from 2000 to 2007. Ohio EPA permit violations included fecal coliform, dissolved oxygen, ammonia-N, and TSS with the greatest frequency of violations listed respectively. During the 2006 recreational season (May – October), the median value of fecal coliform was reported as 4700 cfu/100ml and the 95 percentile value was 6670 cfu/100ml which greatly exceeds the permit limit of 1000 cfu/100ml. Most violations occurred in 2006 and 2007; however, violations may have been under-reported from 2000 to 2005 (see previous paragraph). Ohio EPA will continue to monitor and work with the Babington WWTP to ensure that the facility is in compliance with the NPDES permit.

BP Amoco Oil Bulk Corp-Hillsboro (Ohio EPA #-1IN00255)

The BP Amoco Oil Bulk Corp WWTP is located at 161 Fair St, Hillsboro, Ohio in Highland County and discharges storm water to an unnamed tributary to Clear Creek. This bulk plant receives refined petroleum products by transport truck from a BP owned terminal. The products are stored in above-ground or underground tanks and distributed to consumers via smaller tanker trucks. Wastewater treatment consisted of oil/water separator and holding pond. Discharge from the facility is insignificant and consists of storm water runoff from the load-rack.

Butler Springs Christian Camp and Retreat Center (Ohio EPA #-1PX00061)
The Butler Springs Christian Camp and Retreat Center WWTP is located at 3701 SR 41 in Hillsboro, Ohio in Highland County and discharges to an unnamed tributary to Sunfish Creek at RM 27.8. The Butler Springs WWTP was built in 1978 and an expansion is not anticipated at this time. Wastewater treatment consists of a trash trap, two aeration tanks, two clarifiers, one sand filter dosing chamber, two slow surface sand filters, chlorination, dechlorination and one aerated sludge holding tank. The current daily design flow is set at 10,000 GPD based on 210 camp sites. The facility was inspected by Ohio EPA in 2006 and was found to be in fairly good working order with a clear discharge and the receiving stream free from wastewater solids. Approximately 16 permit violations were reported from 2006-2007 mostly for dissolved oxygen and chlorine.

Country Home MHP and Campgrounds (Ohio EPA #-1PV00093)
The Country Home MHP and Campground's WWTP is located at 7305 SR 753 in Hillsboro, Ohio in Highland County and discharges to an unnamed tributary of Rocky Fork Lake. The design flow of Country Home MHP is 7,550 gallons per day (GPD) based on 25 mobile homes and 65 campsites. Wastewater treatment consists of a trash trap, dual extended aeration systems, fixed media clarifier, slow surface sand filters and ultraviolet disinfection. Sludge produced onsite is hauled to another Ohio EPA permit holder. The facility was upgraded in 2007.

Approximately 16 permit violations were reported from 2000 to 2007 with ammonia-N accounting for fifty percent of the violations. From 2000 to 2006, the median summer value for ammonia-N was 1.15mg/l and the 95th percentile was a value of 1.77mg/l which exceeds the permit limit of 1.0 mg/l.

Greenfield WWTP (Ohio EPA #-1PD00022)
The Greenfield WWTP is in Highland County at 187 Lost Bridge Rd, Greenfield, Ohio and discharges directly to Paint Creek at RM 49.6. The Greenfield WWTP is a publicly owned treatment works providing wastewater treatment for the City of Greenfield and an unincorporated area of Madison TWP. The total population served is approximately 5,450 people.

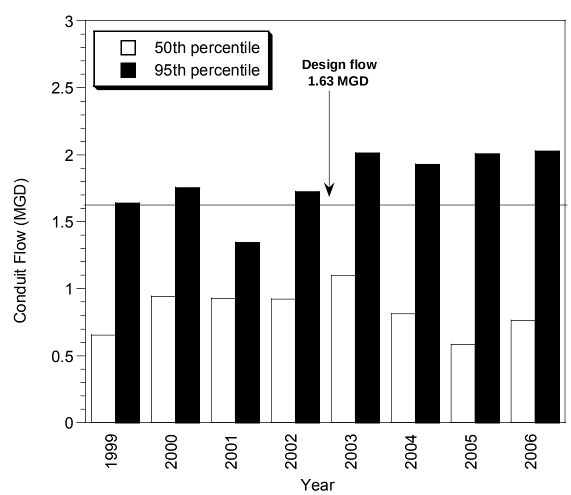


Figure 35. Annual median and 95th percentile conduit flow from the Greenfield WWTP, 1999-2006.

The design flow for the facility is 1.643 MGD which includes approximately 0.03 MGD of industrial waste water and an average daily flow rate of 0.70 MGD in 2006. The WWTP was constructed in 1938, modified in 1985, and is scheduled for an upgrade to be completed by 2009. Existing treatment consists of grit removal, primary sedimentation, activated sludge, secondary clarification, chlorination, dechlorination and post aeration. Sludge from the Greenfield WWTP is applied to local agricultural fields.

In July of 2005, Ohio EPA issued the City of Greenfield Directors Findings and Orders prompted by continued hydraulic overloading of the collection system due to regular sanitary sewer overflows at three different locations. The head works and activated sludge system, secondary clarifiers, disinfection system, blower improvements and various other projects have been identified to be included in the facility upgrade. In addition to these upgrades, a grant has been awarded for repairs of the collection system. Debris gets through to the aerobic digesters affecting oxygen transfer to the aerobic organisms leading to permit violations.

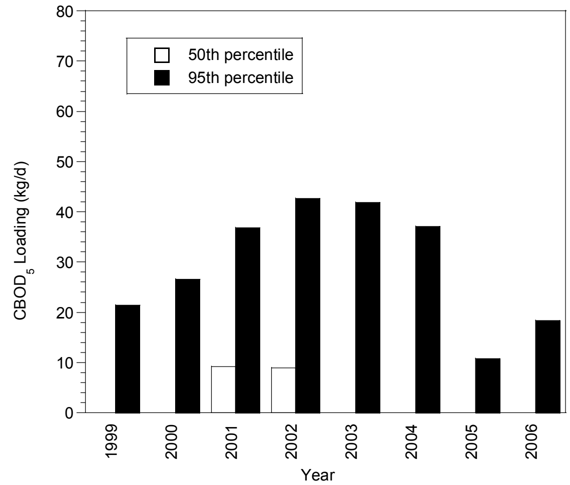


Figure 36. Annual median and 95th percentile loadings of cBOD5 from the Greenfield WWTP, 1999-2006.

Approximately 180 permit violations were reported from 2000 to 2007 with more than half of the violations occurring in 2004 and 2006. The majority of the reported violations were for ammonia-N, phosphorus and chlorine. From 2000 to 2006, the median summer value for ammonia-N was at the 1.0 mg/l permit limit however the 95th percentile was a value of 14.2mg/l which greatly exceeds the permit limit of 1.0 mg/l (Appendix 4). Upgrades at the Greenfield WWTP should resolve these exceedances but operational challenges will likely continue until the upgrade is completed.

The Greenfield WWTP is required to submit monthly operating reports (MORs) to Ohio EPA as part of their permit requirements. Annual median flows have been fairly consistent from 1999 to 2006 and below the design flow but the 95th percentile flows have continuously exceeded the design flow of 1.63 MGD with the exception of 2001 (Figure 34). The annual median loadings data for cBOD5 were relatively low from 1999 to 2006. The 90th percentile CBOD5 loads were highest in 2002 and 2003 but have been declining. The 3rd quarter (summer) ammonia-N loads have remained elevated most years between 2002 through 2006 (Figures 36 & 37) but both median and 95th percentile values were highest from 2002 to 2004.

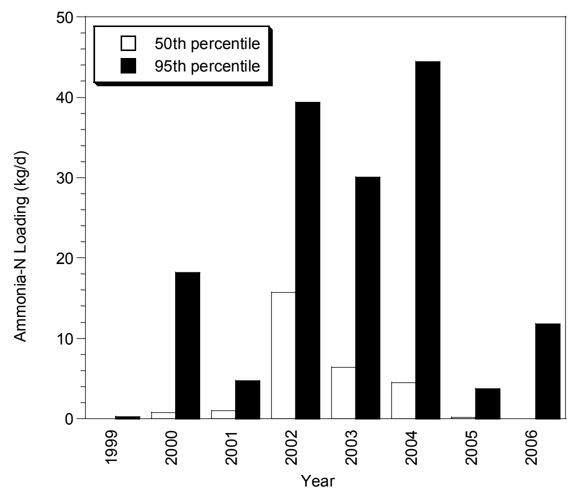


Figure 37. 3rd quarter (July, August, and September) median and 95th loadings of ammonia-nitrigen from the Greenfield WWTP, 1999-2006.

Ohio EPA conducted five compliance sampling inspections and bioassays from 1996 to 2006 at the Greenfield WWTP. Of the five samples, toxicity was found during the 1996 and 2006 inspection. The bioassay collected in 1996 resulted in acute toxicity to both *Ceriodaphnia dubia* and *Pimphales* *promelas* (fathead minnows). The bioassay collected in 2006 also resulted in acute toxicity to *P. promelas.*

Hickory Hills Lake Company WWTP (Ohio EPA #-1PX00063)
The Hickory Hills Lake Company WWTP is in Highland County at 5900 Hickory Hills Drive, and discharges to Heads Branch at RM 1.60 just east of Rocky Fork Lake. This facility currently serves 20-25 permanent residences and 100 seasonal trailers. The facility was constructed in 1972 and is designed to treat and discharge 21,000 GPD. The WWTP consists of a comminutor, aeration tank, clarifier and chlorination. Sludge from this facility is hauled to another Ohio EPA permit holder.

In 2007, Ohio EPA issued the initial NPDES permit for this facility. Hickory Hills Lake Company has been given 24 months from the effective date of the NPDES permit (July 1, 2007) to upgrade the WWTP in order to meet current technology standards.

Highland County Water Company, Incorporated (Ohio EPA #-1IW01001)
The Highland County Water Company Incorporated is located at 14080 US RT 50 West in Bainbridge, Ohio in Highland County and discharges to an unnamed ditch to Rocky Fork Creek at RM 0.1 (outfall 001) and RM 2.34 (outfall 002). This facility is a municipal water treatment plant which includes iron and manganese removal as well as chlorination and fluoridation. The current design flow is four MGD. The red filter backwash discharges to a series of three lagoons before discharging at outfall 001. No permit violations were reported from 2000 to 2007.

Hillsboro WWTP (Ohio EPA#:1PC00100)
The Hillsboro WWTP is in Highland County at 1520 N. High St in Hillsboro, Ohio and discharges to Clear Creek at RM 6.73. The Hillsboro WWTP is a publicly owned treatment works providing wastewater treatment for the city of Hillsboro and serves a population of approximately 7,200. The design flow of the WWTP is 1.2 MGD with an average daily flow rate of 1.075 MGD in 2006 (Figure 38). The treatment plant was constructed in 1971 and modified in 1989. Treatment consists of grit removal, communition, flow equalization, secondary clarification, post-aeration and ultraviolet disinfection.

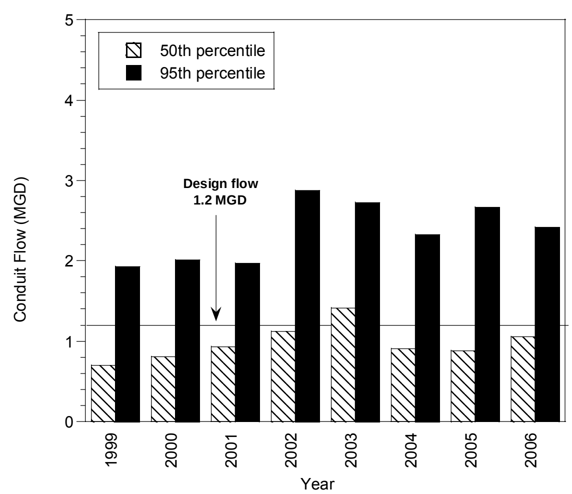


Figure 38. Annual median and 95th percentile conduit flow from the Hillsboro WWTP, 1999-2006.

The sewage collection system has a total of seven lift stations with a bypass location at the South Lift Station. During high flows the South Lift Station discharges to a tributary of Rocky Fork Creek. An upgrade to the South Lift Station and replacements of trunk sewers at Muntz, Belfast Pike and Northview Dr areas occurred in 2006. The City of Hillsboro is planning to replace a significant amount of collection sewers in order to reduce the amount of wet weather influent flows. The NPDES permit also requires the elimination of the facilities' equalization basin bypass, which activates during certain peak wet weather flow periods. The city is scheduled to begin construction in 2008 for facility improvements that are designed to eliminate this overflow and are scheduled to be completed with this upgrade by 2010.

Approximately 88 permit violations were reported from 2000-2007. The majority of the reported violations were for ammonia-N, phosphorus, TSS and mercury. During the 2006 survey of the Paint Creek watershed, Ohio EPA field staff observed solids downstream from the WWTP in Clear Creek. Hillsboro reported that bypasses occurred in August 2006 because a secondary clarifier was down for repairs. Both the macroinvertebrates and the fish community in Clear Creek were affected by this bypass.

The Hillsboro WWTP is required to submit MORs to Ohio EPA as part of their permit requirements. Loadings data collected by Hillsboro WWTP show that during 2003, both the median and 95th percentile ammonia data indicated major plant upsets with 95th percentile loads of ammonia over 60 kg/d, CBOD5 over 90 kg/d, and total suspended solids over 14 kg/d (Figure 39, 40, and 41). From 1999 to 2006, annual median flows from the Hillsboro WWTP were below the design flow with the exception of 2003 when flows to the plant exceeded the design flow of 1.2 MGD (Figure 38). The 90th percentile data was consistently well above the design flow from 1999 to 2006.

Two acute bioassay events, conducted by Ohio EPA in 2001 and 2002 revealed no acute toxicity to either *C. dubia* or *P. promelas* test organisms in effluent samples or ambient waters. Survival in the laboratory controls was 100% for both test organisms. An acute bioassay event, conducted by Ohio EPA in 2004, indicated acute toxicity in the effluent grab sample to both *C. dubia* and *P. promelas* test organisms. Minor toxicity occurred in the mixing zone, upstream samples and test controls. Composite samples were not acutely toxic.

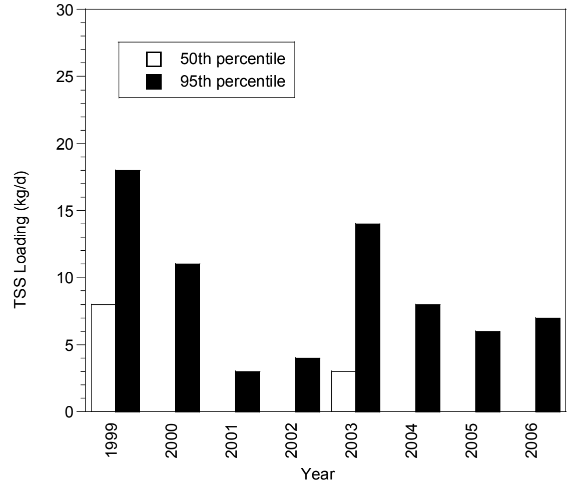


Figure 39. Annual median and 95th percentile loadings of total suspended solids from the Hillsboro WWTP, 1999-2006.

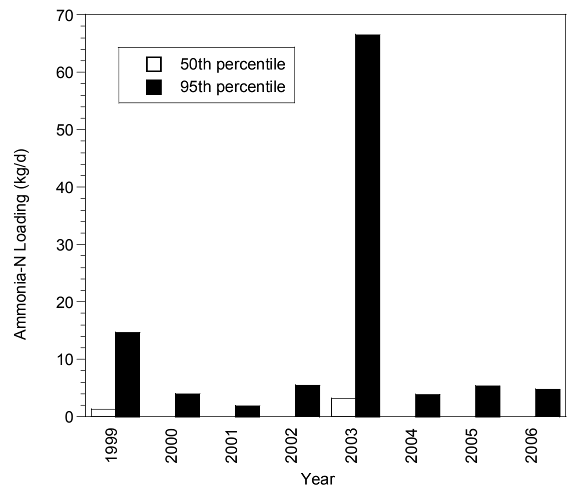


Figure 40. Annual median and 95th loadings of ammonia-nitrigen from the Hillsboro WWTP, 1999-2006.

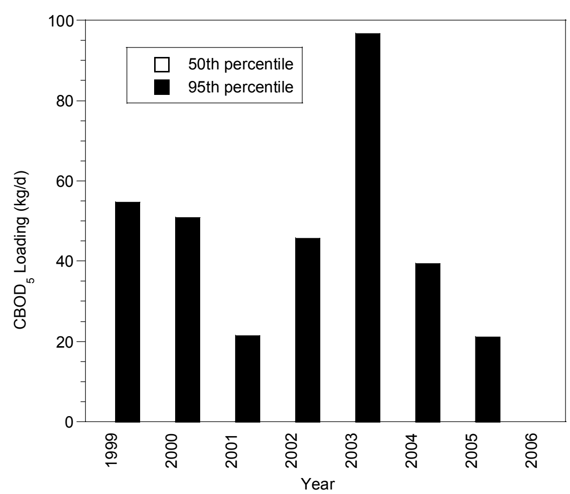


Figure 41. Annual median and 95th percentile loadings of cBOD5 from the Hillsboro WWTP, 1999-2006.

Highland County Commissioners Lakeside Estates WWTP (Ohio EPA #-1PV00121)
The Lakeside Estates WWTP is located in Highland County at 9875 SR 753, Greenfield, Ohio and discharges to a tributary to the Paint Creek Reservoir. This facility was constructed in 1976 and currently serves 22 subdivision homes and two apartments. The WWTP is designed to treat and discharge 9,350 GPD. Treatment for the facility consists of a grease trap, trash trap, equalization tank, aeration tanks, clarifiers, fixed media clarifiers, slow surface sand filters, chlorination, sludge holding tank and sludge drying beds. Sludge from this facility is hauled to another Ohio EPA permit holder. The Highland County Commissioners have been given 18 months from the effective date of the discharge permit (July 1, 2007) to upgrade the Lakeside Estates WWTP in order to meet current technology standards.

Leesburg WWTP (Ohio EPA #-1PB00106)
The Leesburg WWTP is located in Highland County on US 62 North in Leesburg, Ohio and discharges to Lees Creek at RM 3.55. The Leesburg WWTP is a publicly owned treatment works providing wastewater treatment for the Village of Leesburg surrounding areas. The total population served by the Leesburg WWTP is 1510 (1,253 in Leesburg and 275 in the village of Highland).

The treatment works were constructed in 1978 with a design capacity of 0.16 MGD and had a minor modification in 2005. In April of 2007, a new sequencing batch reactor (SBR) plant came into operation in response to hydraulic overloading causing the facility to operate above its rated capacity. The current design capacity of the WWTP is now 0.40 MGD and treatment consists of an influent screen, flow equalization, sequencing batch reactors, effluent filtration, ultraviolet disinfection, aerobic digesters and sludge drying beds. The average daily flow from all industrial users is 0.035 MGD with an average daily flow rate at 0.160 MGD.

Bypassing at the facility has been documented since at least 2004 and at lift stations in the collection system locations on High Street near Swift Street. Generally lift station overflows were related to blockages in the collection system**.** The bypassing at the facility was eliminated with the upgrade completed in 2007. Aproximately 89 permit violations were reported from 2000 to 2007. Most annual violations were reported in 2005 prior to the new facility in 2007 and during a modification to the wastewater works. The most frequent permit violations included TSS, CBOD, fecal coliform and ammonia-N respectively.

Paint Creek State Park Beach (Ohio EPA #1PP00009)
The Paint Creek State Park Beach is located in Highland County at 14265 US Route 50 in Bainbridge, Ohio and discharges to a tributary on the south side of Paint Creek Lake. The Paint Creek State Park Beach operates one rest room/shower facility for a public bathing beach. The wastewater treatment plant serving the Paint Creek State Park Beach area consists of an equalization basin, extended aeration basin, clarifier, chlorination, post aeration and sand filters. The system is permitted to treat an average daily design flow of 10,000 GPD. According to monthly operating reports (MORs), the facility discharges only a few hundred gallons per month during the summer recreational season and is closed the rest of the year.

Pleasant Acres MHP (Ohio EPA#-1PV00127)
The Pleasant Acres MHP is located in Highland County at 7146 Eldoranda Circle in Hillsboro Ohio in Highland County and discharges to an unnamed tributary to Rocky Fork Creek near the northeast corner of Rocky Fork Lake. The original facility was built in 1971 and recently brought under an Ohio EPA NPDES permit. The site is located on approximately 8.75 acres of southerly sloping land. The current daily design flow is set at 11,100 GPD based on 37 homes at 300 gallons per day. Wastewater treatment consists of a collection vault, extended aeration, chlorine contact box, tertiary lagoon, aeration line and a lagoon discharge.

An inspection from 1999 indicated wastewater solids as well as seventy-five yards of sewage fungus were found in the receiving stream just downstream from the Pleasant Acres MHP outfall. In addition, odor complaints, lack of equipment to clean the clarifiers and the absence of a certified operator were noted during the inspection.

In 2007, detailed plans were approved by Ohio EPA for improvements to the existing facility which included the following: new trash trap, an equalization tank (with associated blower and pumps), extended aeration system (with associated blowers and air piping), slow surface sand filters (with associated dosing pumps), post aeration, ultraviolet disinfection, and sludge holding tank. The contents of the existing tertiary lagoon will be pumped and hauled to a publicly owned treatment works for disposal. It will then be brought to grade with fill material.

Approximately 21 permit violations were reported with of cBOD5, fecal coliform and TSS occurring with greatest frequency respectively. Seventy-six percent (76%) of the violations were for $cBOD_5$ and occurred nearly every month.

Rocky Fork Lake WWTP (Ohio EPA#-1PS00015)
The Rocky Fork Lake WWTP is in Highland County at 9353 SR 124 in Hillsboro, Ohio and discharges into Rocky Fork Creek at RM 17.8. The facility was constructed in 1999 with a design capacity of 0.30 MGD and serves the North Shore area of Rocky Fork Lake. Treatment consists of a fine screen, oxidation ditch (activated sludge), clarification, alum dosing/clarifier, rapid sand filtration, ultra violet disinfection and cascade post-aeration. The average daily flow rate in 2006 was 0.145 MGD based on a population of approximately 3,200.

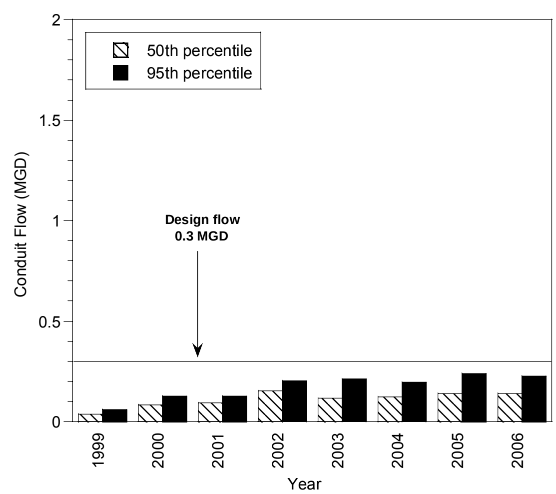


Figure 42. Annual median and 95th percentile conduit flow from the Rocky Fork Lake WWTP, 1999-2006.

The treatment system has one main lift station (North Shore pump station) and approximately 1,100 grinder pump systems to serve all of the users. Between 2001 and 2003 the North Shore pump station overflowed four times as a result of power failure. In 2004, Ohio EPA took enforcement on the Highland County Commissioners and a back-up power diesel generator was installed at the North Shore pump station. From January of 2006 until May 2007 Rocky Fork Lake personnel reported 170 service runs. Some service runs reported no issues with the grinder pump. During this same period of review, only two grinder pump overflows were reported.

From 1999 through 2006, median and 95^{th} percentile conduit flows at the plant remain below the 0.3 MGD design flow but have been steadily increasing since the plant was constructed in 1999 (Figure 42). Median and 95^{th} percentile MOR data from 2000 through 2006 indicates that nitrate+nitrite-n has been elevated with a median value of 10.45mg/l and 95^{th} percentile value of 27.66 mg/l (Appendix 4). Samples collected during the 2006 summer field season below the WWTP shows both total phosphorus and ammonia-n values elevated above reference values (Appendix 1).

Approximately 17 permit violations were reported from 2000 to 2007 with mostly ammonia-N and phosphorus comprising the violations. Seventy-one percent (71%) of the violations occurred in the spring and summer which could relate to heavier lake home use in the recreational season. One acute bioassay event, conducted by Ohio EPA in May of 2004 revealed no acute toxicity to either *C. dubia* or *P. promelas* test organisms in effluent samples or ambient waters.

Rocky Fork Truck Stop WWTP (Ohio EPA #-1PZ00038)
The Rocky Fork Truck Stop WWTP is a restaurant and convenience store located in Highland County at 12410 U S RT 50 in Hillsboro, Ohio which discharges to Puncheon Run at RM 2.33. Wastewater treatment consists of extended aeration system, fixed media clarifier, tertiary sand filter and chlorination. The current daily design flow is set at 4,000 GPD based on historical flow records and the design of the existing treatment plant which was upgraded in 1991. Average daily flows for this facility are typically between 2000–3000 GPD. Approximately 59 permit violations were reported from 2000 to 2007.

Highland County Commissioners Rolling Acres Subdivision WWTP (Ohio EPA #-1PG00100)
The Rolling Acres Subdivision WWTP is in Highland County at Mad River and Grande Roads in Hillsboro, Ohio and discharges to an unnamed tributary to Dodson Creek 0.2. The subdivision consists of thirteen single family homes, two mobile homes and eighteen apartment units. Treatment works were constructed in 1971. An upgrade with a twenty year design was completed in 2003 at a design flow of 10,000 GPD. The current WWTP consists of a trash trap, equalization tank, aeration tanks, final clarifiers, slow surface sand filters, chlorination, dechlorination, post aeration and sludge holding. Discharge flows measured in 2006 indicate an average daily flow of 7,800 GPD. Sludge produced onsite is trucked to Rocky Fork Regional WWTP.

A total of 142 permit violations were reported from 2000-2007 for the Rolling Acres Subdivision WWTP. Most violations were reported in 2000 and 2001 prior to the facility upgrade and averaged 4-5 violations for subsequent years. From 2002 until 2007 most of the violations were for $cBOD_5$, ammonia-N and TSS.

Village of Sabina WWTP (Ohio EPA # 1PB00038)
The Village of Sabina WWTP is located at 700 Mill St, Sabina in Clinton County and discharges to Wilson Creek at RM 2.85. The facility serves a population of approximately 2000 with a slow growth pattern predicted. The facility has 6 lift stations with one bypass. The facility was built in

1960 and consists of; comminution (not in service), manual bar screen, grit removal, off-line storage tank, oxidation ditches, clarifiers, chlorination, dechlorination, post aeration and sludge holding. Power outages and high flows are handled by a generator backup and an auto dialer notifies staff of high influent wet well alarms.

The design flow is 0.38 MGD and hydraulic capacity is 1.84 MGD. Average flows were 0.418 MGD. At times, wet weather flows can exceed 3 MGD. The Village currently utilizes an ultrasonic flow meter with a weir to measure treated effluent to Wilson Creek however the flow meter is unable to measure extremely high discharge flows. At this time, there are no feasible alternatives to bypassing such as auxiliary treatment or retention.

Ohio EPA has been working with the Village of Sabina to identify and correct bypassing problems during wet weather events since 1996. In a 2001 a Phase II Strategic Flow Monitoring Study Plan identified wet weather events as the main problem within the sewage collection system. The Village of Sabina is very flat and has frequent flooding issues. As a result, The Village has taken steps to control storm water runoff that infiltrates the sanitary sewer system. However, since this project was completed, the Village has not followed through with the recommended CCTV work or with any collection system flow monitoring as recommended in the Phase II plan.

The Village of Sabina has four known sanitary sewer overflow locations at Florence Ave, Grand Ave, N Washington and Krebs Dr. The 2007 Ohio EPA inspection revealed a significant amount of algae in Wilson Creek downstream of the final outfall (001). The Hunt Drive SSO was eliminated with the Rose Avenue Pump Station improvement project (2006). West Washington and Krebs Dr had similar overflow patterns and overflowed with the greatest frequency.

A total of 120 permit violations were reported for the Sabina WWTP from 2000 to 2006 with the most frequently reported parameters being TSS, cBOD5, ammonia-N and chlorine respectively. Most of the violations that occurred in 2005 occurred because a secondary clarifier that went off line was not replaced for over two months. In the spring of 2006, operations staff began utilizing a woven geotextile bag to dewater the digested sludge. Since this time, operators have been able to remove solids from the wastewater system more readily.

Rocky Fork Golf and Tennis Center (No Permit)
The Rocky Fork Golf Course is located at 9965 E SR 124 in Highland County. It was constructed to serve a development of 50 two-bedroom townhouses at 15,000 gallons per day GPD. Currently only seven condominiums have been constructed and are being serviced by the waste treatment facility. Treatment consists of a trash trap, equalization tank, aeration tank, two clarifiers, two fixed upflow filters, two slow surface sand filters, chlorine contact tank, and three storage ponds.

There is no associated Ohio EPA discharge permit associated with this facility as the facility does not directly discharge to waters of the state. However, during high flows effluent waters could overflow to nearby swales/streams to Rocky Fork Lake. Water discharged is sent to the first of the three ponds which is sent to the golf course way of greens and t-boxes. There is an emergency overflow impoundment in another area of the golf course that provides additional storage should the lowest pond become full. Off-season levels are checked as well. At the time of the inspection there was no evidence of pond overflow or sewage in the nearby drainage swales.

Physical Habitat Quality for Aquatic Life

Headwaters

Stream habitat quality in the Paint Creek basin is related to the glacial history of the watershed. The northwestern quarter of the basin is a low-relief glacial plain with high-clay content soils. Consequently, most of the headwater drainage network and mainstems (i.e., East Fork, Paint Creek, Sugar Creek and Rattlesnake Creek) in this portion of the basin have either been recently or historically channelized for agricultural drainage. The net effect is that QHEI scores for headwater streams in HUCs 010, 020 and 030 average 13 to 21 points lower (95% C.I. of the linear contrast) than those in the remainder of the basin (Figure 43). The potential for some of the headwaters within these three HUCs to support fish communities with sufficient integrity to meet biological criteria established for the Eastern Corn-Belt Plains (ECBP) ecoregion is limited. Evidence for this assertion is apparent in the relatively high ratio of modified habitat attributes to warmwater habitat (WWH) attributes, and the frequency of high-influence modified attributes noted at many of the sampling locations in these headwaters (Figure 44; Table 18). A ratio of modified to warmwater habitat attributes exceeding 1, or more than 1 high-influence modified attribute at a given site strongly predicts that the physical habitat is too simplified to support a typical WWH fauna (Rankin 1989, Ohio EPA 1999). This is especially true where contiguous stream reaches have a relatively high proportion of modified attributes. Conversely, exceptions to this rule are seen where habitat modifications are localized within an otherwise natural reach, or where groundwater augments stream flow.

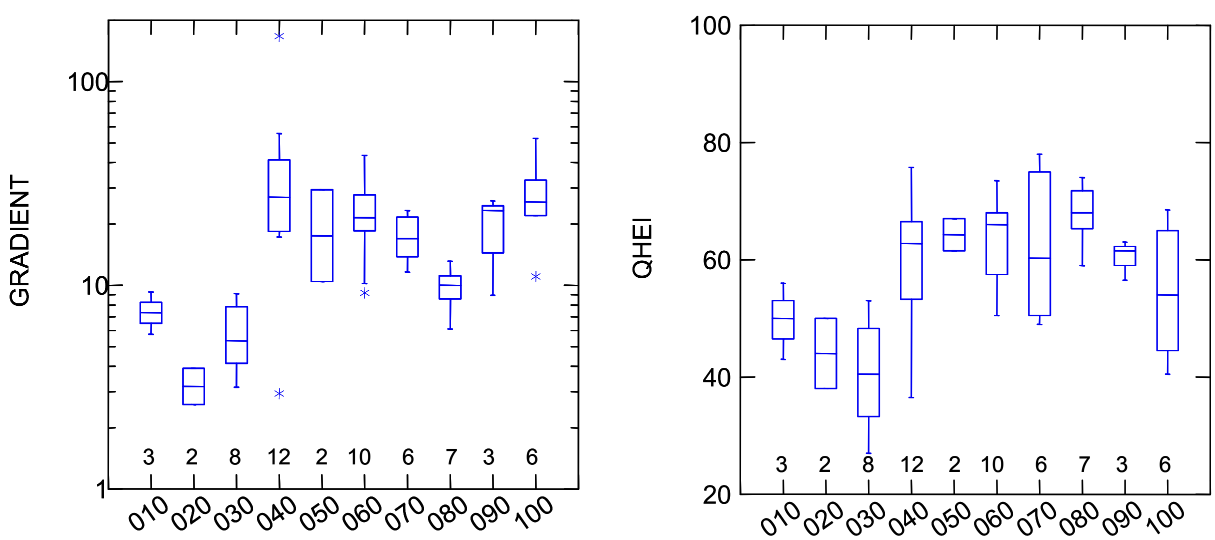


Figure 43. Box and whisker plots showing distributions of stream gradient in ft/mi (left panel) and QHEI scores (right panel) plotted by HUC code for headwaters sampled in the Paint Creek basin, 2006.

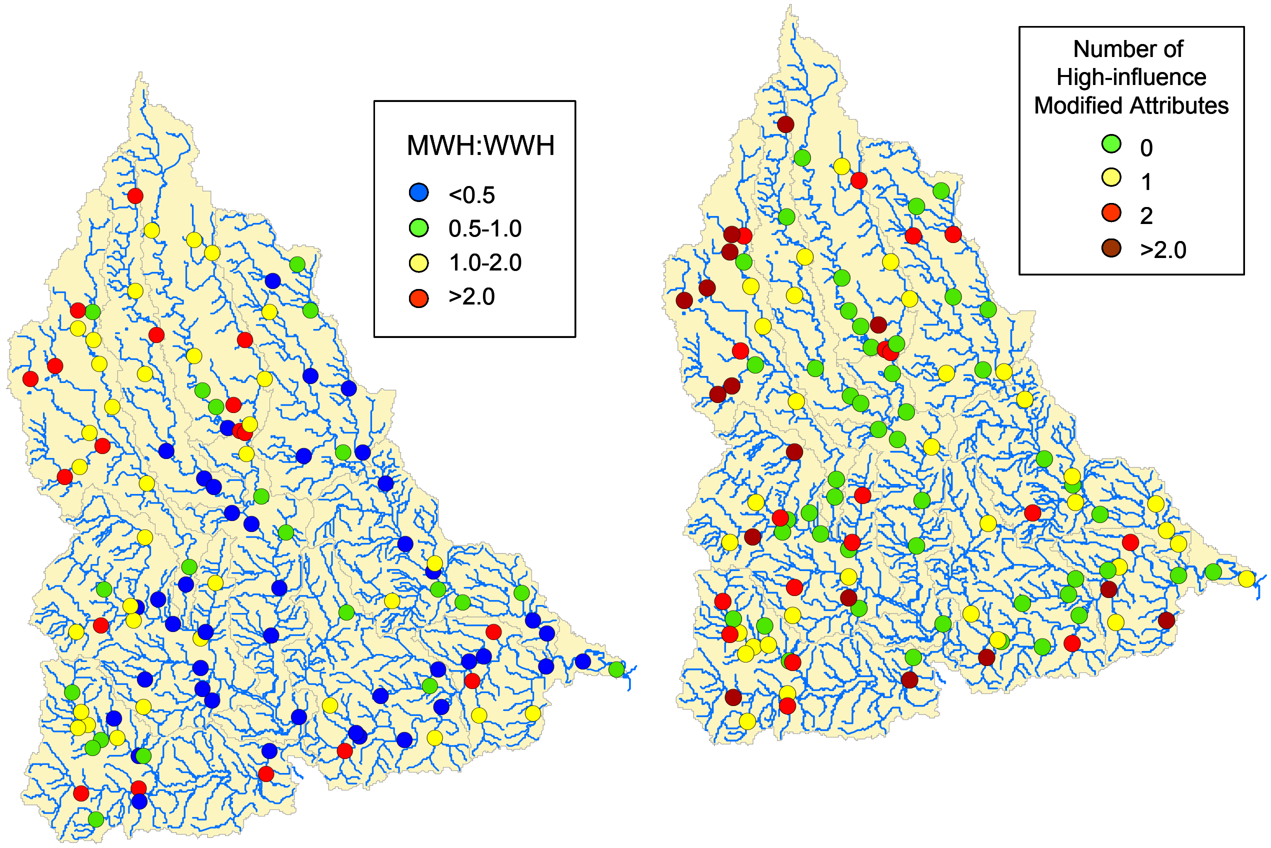


Figure 44. The ratio of modified to warmwater habitat attributes (left panel) and the number of high-influence modified habitat attributes plotted by site for the Paint Creek survey, 2006.

Headwater streams in hydrologic units 010, 020, and 030 that have been modified to the degree outlined above, are under county maintenance, and have gradients less than 10 ft•mi^{-1}, are not likely to recover the attributes needed to support integral fish assemblages. These streams are recommended for the Modified Warmwater Habitat (MWH) aquatic life use as noted in Table 1.

The pervasiveness of channelization in the basin was also evident in the frequency with which heavy to moderate siltation was noted at headwater sampling sites. The source of the sediment was mostly from sediment entrained in the stream channels from bank erosion. Unrestricted livestock access was also noted as a source of sedimentation affecting approximately 20% of the sampling locations.

Ironically, the glacial history that precipitated the need for agricultural drainage in the northern third of the basin has helped to ameliorate the negative effects of historic stream channelization when looking at the Paint Creek watershed as a whole. Most of the headwaters in the basin show signs of past modification, but many have recovered natural, functional attributes. This is because the end and ground moraine deposits comprising the till are thick, and contain coarse material; a combination that yields both groundwater and gravel-sized substrates to the streams. As channel features are reformed following channelization, sustained flow provides the energy to sort silt and sand-sized sediments from gravels in the riffles, thereby yielding enough function to sustain, at the very least, a nominally functional headwater fish assemblage. Therefore, headwaters in HUCs 040 – 100, as a rule, should be expected to support WWH fish assemblages.

Wadeable Creeks

The distributions of QHEI scores for wadeable streams by hydrologic unit follows the same pattern as that for headwaters (Figure 45). Habitat quality in HUCs 010, 020 and 030, where hydromodification is most extensive, have the worst habitat scores. Of these three units, habitat modifications extensive enough to obviate expectations of a WWH fish assemblage are apparent only for HUC 030. Specifically, Rattlesnake Creek and West Branch Rattlesnake Creek have long, contiguous reaches of historically modified habitat and monotonous hardpan substrates (Table 18), and therefore lack the ability to recover naturally, at least over the next several decades.

Distributions of QHEI scores in HUCs 040 - 100 show habitat quality is generally good to excellent and not limiting to aquatic life (Figure 45). Additionally, the ratio of modified to warmwater habitat attributes is consistently less than 1.0 (Table 18), with the exception of HUC 060, the Clear Creek and Rocky Fork drainage, where excessive sedimentation was noted for most of the mainstem sites. The channel of Clear Creek upstream from Hillsboro has been perturbed by road construction, and the stream is in the process of re-establishing equilibrium. The source of the sediment to Rocky Fork was not identified. Groundwater appears to have an ameliorative effect on both streams.

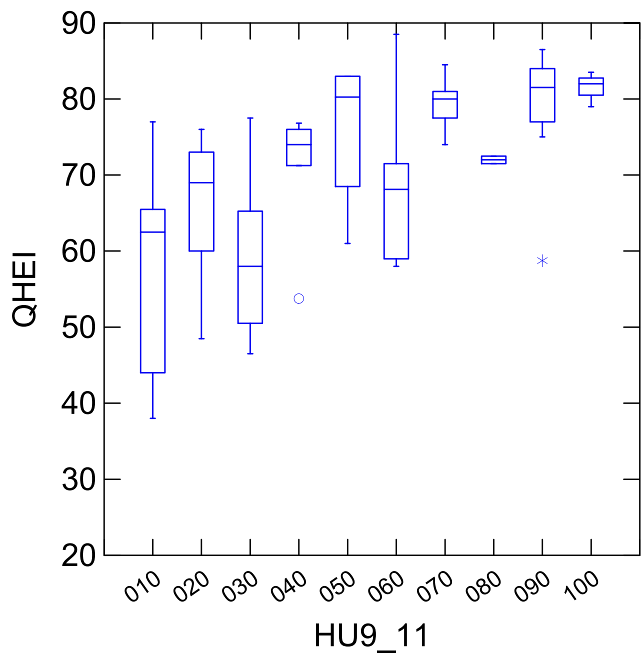


Figure 45. Distributions of QHEI scores by 11-digit hydrologic unit for wadeable streams sampled in the Paint Creek basin, 2006.

Habitat Narratives for Individual Streams
Paint Creek
Paint Creek upstream from US 35 is designated WWH, and the habitat quality throughout the reach is capable of supporting that use (Figure 46; Table 18). The reach of modified habitat through Washington Court House is short enough not to pose a limitation to the fish community as it is bracketed by significant reaches of good habitat, has sufficient depth to support sunfish and several sucker species, and the substrates, though monotonously composed of sand and gravel, are comparatively free from silt and stable enough to support rooted aquatic macrophytes.

Upstream from Washington Court House, sediment exported from the modified headwaters and from unrestricted cattle access is entrained in the channel, and degrades the habitat by covering natural substrates and smothering riffles.

Downstream from US 35, Paint Creek is designated EWH. The habitat in this reach (excluding the reservoir) is characterized by large, heterogeneous substrates, well developed, sinuous channels fringed with water willow, and point bars tapering up to forested flood plains. The habitat throughout this reach is capable of supporting EWH fish assemblages.

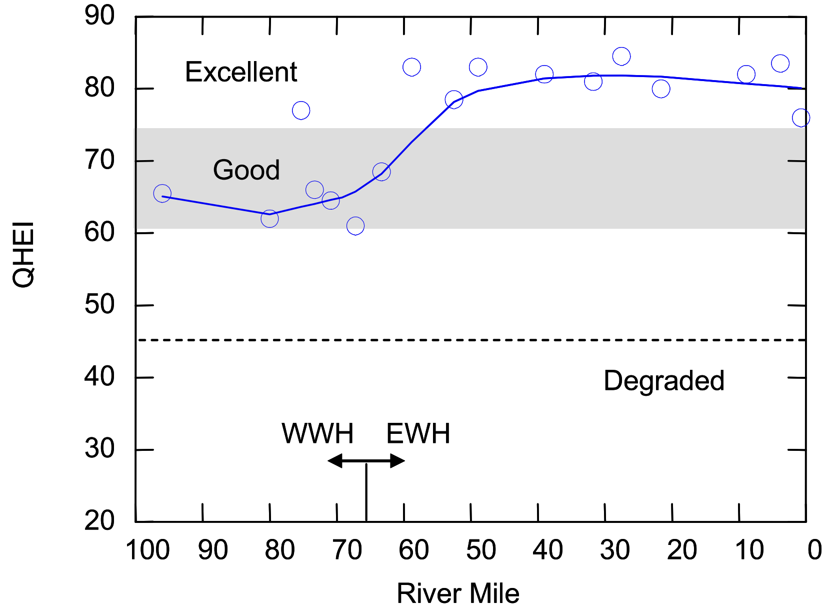


Figure 46. QHEI scores plotted by River Mile for sites sampled on the Paint Creek mainstem, 2006. Boundaries of narrative habitat quality ranges noted by shading and the stippled line demarcating poor quality. The mile point marking the transition between the existing WWH and EWH designations for the mainstem is shown along the x-axis.

East Fork Paint Creek

East Fork Paint Creek was historically channelized in its entirety. All three sites were entrenched and isolated from adjacent riparian floodplains. The entrenchment at the two upstream sites, Mathews Road (RM 5.1) and Lewis Road (RM 8.6), caused sediment to be entrained in the stream channel, thereby limiting the habitat quality. The short reach downstream from US 22 has the energy to convey the sediment load, but lacks channel area to sort and deposit sediment into point bars and riffles.

North Fork Paint Creek

Similar to the Paint Creek mainstem, the upper reaches of the North Fork have an excessive bedload of sediment, but not to the same degree (Table 18). The difference being the upper reaches of the North Fork have a slightly higher gradient and apparently receive more groundwater, and are therefore better able to sort sediment within the channel. The net result is that habitat quality throughout the North Fork is excellent.

Compton Creek
Compton Creek is designated EWH based on results from one sampling location at RM 1.4. The habitat through RM 11.2 (Washington - Waterloo Road) is very good, and does not possess any high-influence modified attributes. The site at RM 17.6 (Meyer Rd.), however, is influenced by row crop agriculture, and has been modified in the past. The habitat in this reach, though able to support a WWH fish community, is limited by a high number of modified attributes.

Little Creek
The habitat in Little Creek, HUC 090, is impacted by frequent off-road vehicle traffic. The disturbance appears to keep the substrate homogenized and reduces depth variation in the channel. Although the extent of the disturbance is significant, enough habitat features remain in place to support warmwater fish communities.

Rocky Fork Paint Creek
The reference sites at US 62 (RM 23.3) and Fetro Road (RM 18.1) had a notably higher bedload of sediment in 2006 than previous years, reducing the QHEI score by approximately 10 points in both cases. The source of the sediment was not identified.

Clear Creek
Historic channelization and recent road construction have combined to destabilize the channel of Clear Creek. Excessive sediment was noted at five of six sampling locations, corresponding to actively eroding banks. Unrestricted livestock access was noted in the headwaters. Overall, however, the habitat in Clear Creek is good to excellent.

Lees Creek and Tributaries
Habitat quality in Lees Creek and its adjoining tributaries mirrors that of the basin as a whole. Headwater channelization and unrestricted livestock access in the north and west sides of the subwatershed, where the topography is flat, combine to cause elevated levels of sedimentation. Habitat quality in streams and the mainstem segments draining the eastern half of the basin, where the till plain is more dissected, is generally good to excellent. Overall, the habitat quality is fully capable of supporting WWH fish communities.

Rattlesnake Creek
Most of the headwaters and the mainstems of Rattlesnake Creek, West Branch Rattlesnake Creek, and Wilson Creek have been channelized. Because the topography is flat, clay soils are common, and the depth of till over bedrock is comparatively shallow (i.e., compared to adjacent areas), little recovery has taken place, and the habitat is collectively the most degraded in the basin. The potential for fish communities to meet WWH is limited by the degraded habitat.

Sugar Creek

The habitat in Sugar Creek is degraded by extensive channelization and sedimentation from bank erosion and livestock access. Upstream from Creamer Road, Sugar Creek is actively maintained as a ditch by Fayette County. However, significant recovery of WWH attributes has occurred from McKillip Road downstream. The parent substrates from McKillip Road (RM 29.2) downstream are relatively coarse and erodible, and the stream possesses the energy to recover enough positive habitat attributes to support WWH fish communities. From Ford Road (RM 18.8) to the confluence with Paint Creek, Sugar Creek currently possesses the attributes of a WWH stream.

Table 18. Paint Creek QHEI Matrix

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-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 H.I. 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 M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(02-500) Paint Creek																																		
Year: 2006																																		
96.0	65.5	3.73	■	■		■	■	■			■		6						0		●		●	●				●	●	●		6	0.14	1.00
80.0	62.0	2.49	■	■			■	■			■		5						0		●		●	●	●			●	●	●		7	0.17	1.33
75.3	77.0	2.73	■	■		■	■	■	■		■		7						0		●		●						●	●		4	0.13	0.63
73.3	66.0	2.38	■	■		■	■	■	■		■		7						0		●		●	●					●	●		5	0.13	0.75
70.9	64.5	2.38	■	■		■	■	■	■	■	■	■	9						0					●								1	0.10	0.20
69.7	38.0	3.70						■			■		2	◆			◆		2	●				●	●			●	●		●	6	1.00	3.00
69.2	40.5	3.70		■							■		2	◆			◆		2	●	●			●	●			●	●		●	7	1.00	3.33
67.2	61.0	2.24		■				■		■	■		4						0	●	●		●	●	●			●	●	●		8	0.20	1.80
63.3	68.5	3.98	■	■		■	■	■		■	■		7						0				●	●				●			●	4	0.13	0.63
58.8	83.0	10.64	■	■		■	■	■	■	■	■	■	9						0										●	●		2	0.10	0.30
52.5	78.5	3.88	■	■		■	■	■		■	■	■	8						0									●	●	●		3	0.11	0.44
48.9	83.0	8.54	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
39.0	82.0	4.66	■	■		■	■	■	■		■		7						0		●								●	●		3	0.13	0.50
31.7	81.0	6.94	■	■		■	■	■	■	■	■	■	9						0					●								1	0.10	0.20
27.5	84.5	4.01	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
21.6	80.0	3.41	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
8.9	82.0	3.82	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
3.8	83.5	3.36	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
0.7	82.0	3.36	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
(02-510) North Fork Paint Creek																																		
Year: 2006																																		
42.0	72.5	11.63	■	■		■	■	■		■	■	■	8						0					●				●	●	●		4	0.11	0.56
31.0	72.5	8.93	■	■		■	■	■	■	■	■	■	9						0		●			●						●		3	0.10	0.40
22.3	84.0	7.69	■	■		■	■	■	■	■	■	■	9						0		●								●			2	0.10	0.30
17.0	84.0	6.25	■	■		■	■	■	■	■	■	■	9				◆		1		●								●			2	0.20	0.40
13.6	86.5	5.18	■	■		■	■	■	■		■	■	8						0		●								●			2	0.11	0.33
10.5	79.0	6.83	■	■		■	■	■	■		■	■	8						0		●				●				●	●		4	0.11	0.56
3.9	81.5	8.62	■	■		■	■	■	■	■	■	■	9				◆		1		●		●		●				●			4	0.20	0.60
2.3	75.0	9.09	■	■		■	■		■	■	■	■	8				◆		1						●							1	0.22	0.33
(02-511) Biers Run																																		
Year: 2006																																		

Key
QHEI
Components

Table 18. Paint Creek QHEI Matrix

Key QHEI Components

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-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 H.I. 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 M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(02-511) Biers Run																																		
Year: 2006																																		
1.5	61.5	25.97	■	■		■	■			■	■		6				♦		1					●				●			●	3	0.29	0.71
(02-516) Little Creek																																		
Year: 2006																																		
5.6	63.0	23.26	■	■						■	■	■	5			♦	♦		2	●	●		●	●				●	●			6	0.50	1.50
1.0	54.0	13.33	■	■			■				■		4				♦		1	●				●	●			●	●	●		6	0.40	1.60
(02-518) Oldtown Run																																		
Year: 2006																																		
1.3	56.5	8.93						■		■	■		3			♦			1	●	●			●				●	●		●	6	0.50	2.00
(02-522) Compton Creek																																		
Year: 2006																																		
17.6	59.0	6.10	■	■				■			■		4			♦	♦		2	●	●			●				●	●	●		6	0.60	1.80
11.2	74.0	7.81	■	■		■	■	■	■	■	■	■	9						0		●								●	●		3	0.10	0.40
3.4	71.5	10.00	■	■		■	■	■		■	■	■	8						0				●		●			●		●		4	0.11	0.56
(02-523) Crooked Creek																																		
Year: 2006																																		
3.0	71.0	13.16	■	■		■	■	■		■	■	■	8			♦			1									●				1	0.22	0.33
(02-524) Mud Run																																		
Year: 2006																																		
0.4	67.5	10.00	■	■		■		■		■	■	■	7			♦			1		●							●				2	0.25	0.50
(02-525) Thompson Creek																																		
Year: 2006																																		
3.3	68.0	9.43	■	■		■	■	■		■	■	■	8						0									●		●		2	0.11	0.33
(02-526) Ralston Run																																		
Year: 2006																																		
2.8	44.5	32.79	■									■	2		♦	♦	♦	♦	4		●			●				●	●			4	1.67	3.00
(02-527) Cattail Run																																		
Year: 2006																																		
1.2	47.0	52.63		■							■		2			♦	♦		2	●	●			●				●	●	●		6	1.00	3.00
(02-528) Owl Creek																																		
Year: 2006																																		
0.3	65.0	21.98	■	■		■	■			■	■	■	7				♦		1				●	●				●				3	0.25	0.63

Key QHEI Components

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-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 H.I. 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 M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(02-529) Plug Run																																		
Year: 2006																																		
0.4	68.5	25.97	■	■		■	■	■		■	■		7						0					●				●			●	3	0.13	0.50
(02-530) Rocky Fork Paint Creek																																		
Year: 2006																																		
23.3	55.5	22.99	■										1			♦	♦	♦	3		●			●				●	●	●		5	2.00	4.50
18.0	58.0	8.33					■	■			■		3		♦				1	●	●			●	●			●	●	●		7	0.50	2.25
3.1	88.5	10.00	■	■		■	■	■	■	■	■	■	9						0		●							●				2	0.10	0.30
(02-532) Pickett Run																																		
Year: 2006																																		
0.1	50.5	43.48								■		■	2			♦	♦	♦	3	●	●			●				●	●			5	1.33	3.00
(02-540) Clear Creek																																		
Year: 2006																																		
11.3	68.0	27.77	■	■				■		■	■	■	6			♦	♦		2		●			●				●	●			4	0.43	1.00
8.3	81.5	16.13	■	■		■	■	■		■	■	■	8						0									●				1	0.11	0.22
6.8	74.5	10.87	■	■		■	■	■			■	■	7						0	●	●			●	●			●	●	●		7	0.13	1.00
6.6	71.5	10.87	■	■		■	■	■			■		6				♦		1		●							●	●	●		4	0.29	0.86
5.4	59.0	11.17		■							■	■	3				♦		1	●	●			●	●			●	●			6	0.50	2.00
2.6	61.0	5.81				■	■	■	■		■		5				♦		1	●	●			●				●	●	●		6	0.33	1.33
(02-541) Hussey Run																																		
Year: 2006																																		
0.8	67.5	18.52	■	■			■	■			■		5						0		●			●				●	●	●		5	0.17	1.00
(02-542) South Fork Rocky Fork																																		
Year: 2006																																		
3.3	73.5	19.60	■	■		■	■	■		■	■		7			♦			1		●			●				●	●	●		5	0.25	0.88
(02-543) Black Run																																		
Year: 2006																																		
3.9	61.0	25.32	■	■		■	■				■		5				♦		1		●			●				●	●		●	5	0.33	1.17
1.0	40.5	11.05						■			■		2	♦	♦	♦	♦		4	●	●			●				●	●		●	6	1.67	3.67
(02-545) Lower Twin Creek																																		
Year: 2006																																		
2.2	78.0	17.54	■	■		■	■	■		■	■	■	8						0		●							●				2	0.11	0.33
(02-546) Upper Twin Creek																																		
Year: 2006																																		

Table 18. Paint Creek QHEI Matrix

Key QHEI Components

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-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 H.I. 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 M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(02-546) Upper Twin Creek																																		
Year: 2006																																		
5.8	75.0	23.26	■	■		■	■	■		■	■	■	8						0									●				1	0.11	0.22
1.7	70.0	16.39	■	■		■	■	■			■		6						0		●							●	●	●		4	0.14	0.71
(02-548) Sulphur Lick																																		
Year: 2006																																		
1.5	50.5	11.63	■				■	■			■		4		♦		♦		2		●		●	●				●	●		●	6	0.60	1.80
(02-550) Rattlesnake Creek																																		
Year: 2006																																		
40.4	51.5	5.05		■			■	■		■	■	■	6			♦	♦		2	●				●				●	●	●		5	0.43	1.14
38.1	59.5	4.55	■	■			■	■			■		5						0	●	●		●	●	●			●	●	●		8	0.17	1.50
35.2	58.0	2.82	■	■			■	■			■		5				♦		1	●	●		●	●				●	●	●		7	0.33	1.50
31.4	49.0	5.21		■						■	■		3				♦		1	●			●	●	●			●			●	6	0.50	2.00
24.0	52.0	1.72	■	■						■	■		4				♦		1					●	●			●			●	4	0.40	1.20
17.9	59.0	3.50	■	■				■			■		4						0		●			●	●			●	●		●	6	0.20	1.40
15.0	71.0	9.17	■	■		■	■	■	■		■		7						0					●	●				●	●		4	0.13	0.63
13.3	77.5	7.52	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
7.9	75.5	8.47	■	■		■	■	■			■		6						0									●	●	●		3	0.14	0.57
(02-552) Fall Creek																																		
Year: 2006																																		
7.5	58.5	17.24	■			■	■	■			■		5		♦				1		●			●				●	●	●		5	0.33	1.17
2.6	62.5	16.67	■		■			■		■		■	5			♦	♦	♦	3					●				●				2	0.67	1.00
1.6	67.0	55.56	■			■	■	■	■	■	■	■	8						0		●			●								2	0.11	0.33
(02-553) Big Branch																																		
Year: 2006																																		
1.6	63.0	17.54	■	■		■		■			■	■	6			♦			1				●	●				●	●			4	0.29	0.86
(02-554) Hardin Creek																																		
Year: 2006																																		
5.8	65.0	166.7	■			■	■	■	■	■	■	■	8						0		●											1	0.11	0.22
0.9	74.5	12.82	■	■		■	■	■	■		■	■	8						0				●	●					●			3	0.11	0.44
(02-557) Walnut Creek																																		
Year: 2006																																		
4.2	64.5	19.23	■	■		■	■	■			■		6			♦			1					●				●	●	●		4	0.29	0.86

Table 18. Paint Creek QHEI Matrix

Key QHEI Components

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence														
			No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-Normal Riffle Embeddedness	Total WWH Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW)	Total H.I. MWH Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(02-557) Walnut Creek																																		
Year: 2006																																		
0.6	75.5	27.78	■	■		■	■	■			■		6						0									●	●	●		3	0.14	0.57
(02-558) Lees Creek																																		
Year: 2006																																		
10.4	36.5	2.94								■	■	■	3	♦	♦	♦	♦		4	●	●			●				●	●			5	1.25	2.50
4.5	77.5	26.32	■	■		■	■	■		■	■	■	8						0				●					●				2	0.11	0.33
1.2	74.5	7.30	■	■		■	■	■		■	■	■	8						0									●				1	0.11	0.22
(02-559) Middle Fork Lees Creek																																		
Year: 2006																																		
5.1	71.0	19.23	■	■		■	■	■		■	■		7						0				●					●	●	●		4	0.13	0.63
1.1	48.5	43.48	■								■	■	3				♦		1		●			●	●			●	●			5	0.50	1.75
(02-560) South Fork Lees Creek																																		
Year: 2006																																		
1.3	50.5	26.32	■										1			♦	♦	♦	3		●			●				●	●	●		5	2.00	4.50
(02-561) Grassy Branch																																		
Year: 2006																																		
8.7	33.0	5.21											0	♦		♦	♦	♦	4		●			●				●	●		●	5	5.00	*.**
(02-562) West Branch Rattlesnake Creek																																		
Year: 2006																																		
11.4	27.0	3.38											0	♦	♦	♦	♦	♦	5	●	●		●	●				●	●		●	7	6.00	*.**
4.3	53.0	7.04	■	■				■		■	■		5			♦	♦		2	●			●	●				●			●	5	0.50	1.33
2.8	46.5	2.40		■				■			■		3						0	●	●		●	●	●			●	●		●	8	0.25	2.25
(02-563) Wilson Creek																																		
Year: 2006																																		
5.0	38.0	4.07		■									1	♦		♦	♦	♦	4	●	●			●				●	●		●	6	2.50	5.50
3.8	43.0	3.16									■		1	♦	♦	♦	♦		4	●	●			●				●	●	●		6	2.50	5.50
2.8	44.0	3.16		■						■	■		3	♦		♦	♦		3	●				●				●			●	4	1.00	2.00
(02-564) Buckskin Creek																																		
Year: 2006																																		
3.1	74.0	9.71	■	■		■	■	■			■		6				♦		1		●			●	●			●	●	●		6	0.29	1.14
0.4	77.5	22.22	■	■		■	■	■	■	■	■	■	9				♦		1						●							1	0.20	0.30
(02-568) Massie Run																																		
Year: 2006																																		

Table 18. Paint Creek QHEI Matrix

Key QHEI Components

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-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 H.I. 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 M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(02-568) Massie Run																																		
Year: 2006																																		
0.1	49.0	21.59					■						1			♦	♦	♦	3	●	●			●				●	●	●		6	2.00	5.00
(02-577) Indian Creek																																		
Year: 2006																																		
1.6	61.5	10.42	■	■				■		■	■	■	6			♦			1	●	●			●				●		●		5	0.29	1.00
(02-578) Wabash Creek																																		
Year: 2006																																		
0.8	67.0	29.41	■			■	■	■	■	■	■	■	8						0		●									●		2	0.11	0.33
(02-579) Sugar Creek																																		
Year: 2006																																		
36.9	38.0	3.91		■									1			♦	♦	♦	3	●	●			●		●		●	●		●	7	2.00	5.50
29.2	60.0	3.73		■			■	■		■	■		5						0	●	●			●	●			●		●		6	0.17	1.17
24.8	48.5	2.96		■				■			■		3				♦		1	●	●			●	●			●	●	●		7	0.50	2.25
18.8	60.5	3.01		■				■	■	■	■	■	6				♦		1	●			●	●	●					●		5	0.29	1.00
12.0	69.0	2.75	■	■		■	■	■		■	■	■	8						0									●				1	0.11	0.22
5.4	73.0	3.80	■	■		■	■	■		■	■	■	8						0									●		●		2	0.11	0.33
4.2	76.0	4.65	■	■		■	■	■		■	■	■	8						0									●		●		2	0.11	0.33
(02-580) East Fork Paint Creek																																		
Year: 2006																																		
8.6	44.0	3.73		■				■			■		3		♦				1	●	●			●	●			●	●		●	7	0.50	2.25
5.1	56.0	4.24	■	■			■	■			■		5		♦				1	●	●		●	●				●	●	●		7	0.33	1.50
0.7	63.0	6.76	■	■			■	■			■		5						0				●	●				●	●	●		5	0.17	1.00
(02-581) Big Run																																		
Year: 2006																																		
1.8	43.0	9.26		■				■					2			♦	♦	♦	3	●	●			●				●	●		●	6	1.33	3.33
(02-585) Moberly Branch Clear Creek																																		
Year: 2006																																		
0.9	66.0	27.40	■	■		■	■	■			■		6				♦		1		●			●				●	●	●		5	0.29	1.00
(02-587) Little Rock Creek																																		
Year: 2006																																		
1.4	69.5	9.17	■	■			■	■		■	■	■	7						0					●				●				2	0.13	0.38
(02-588) Coon Creek																																		
Year: 2006																																		

Table 18. Paint Creek QHEI Matrix

Key QHEI Components

River Mile	QHEI	Gradient (ft/mile)	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-Normal Riffle Embeddedness	Total WWH Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW)	Total H.I. MWH Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
			WWH Attributes											MWH Attributes: High Influence						Moderate Influence														
(02-588) Coon Creek																																		
Year: 2006																																		
0.1	55.0	10.20	■				■			■		■	4				♦	♦	2					●				●				2	0.60	1.00
(02-589) Trib. to Clear Creek (RM 8.47)																																		
Year: 2006																																		
0.4	66.0	20.00	■	■				■			■	■	5			♦	♦		2		●		●	●				●	●			5	0.50	1.33
(02-594) Pone Creek																																		
Year: 2006																																		
2.6	31.5	4.85									■		1	♦		♦	♦		3	●	●			●				●	●		●	6	2.00	5.00
(02-595) Wolf Run																																		
Year: 2006																																		
0.3	63.0	10.64		■				■		■	■	■	5			♦	♦		2	●				●				●				3	0.50	1.00
(02-596) Trib. to Rocky Fork (RM 17.55)																																		
Year: 2006																																		
1.0	66.0	31.75	■	■		■	■	■		■		■	7				♦	♦	2					●				●				2	0.38	0.63
(02-597) Maple Grove Creek																																		
Year: 2006																																		
1.6	45.0	5.49		■						■		■	3	♦		♦	♦	♦	4	●				●				●		●		4	1.25	2.25
(02-598) Trib. to Rattlesnake Creek (RM 40.21)																																		
Year: 2006																																		
1.1	37.0	9.09						■					1	♦		♦	♦	♦	4	●	●		●	●				●	●		●	7	2.50	6.00
(02-599) Trib. to Lees Creek (RM 2.57)																																		
Year: 2006																																		
1.3	66.0	32.26	■	■		■	■	■		■	■		7						0									●			●	2	0.13	0.38
(02-672) Trib. to Lees Creek (RM 4.83)																																		
Year: 2006																																		
0.3	56.0	29.41	■	■				■					3			♦		♦	2		●			●				●	●	●		5	0.75	2.00
(02-673) Trib to S Fk Lees Creek (RM 3.83/0.25)																																		
Year: 2006																																		
0.3	49.5	52.63	■	■			■	■					4					♦	1		●			●				●	●	●		5	0.40	1.40
(02-674) Trib. to Wilson Creek (RM 4.23)																																		
Year: 2006																																		
0.4	33.5	8.77											0			♦	♦	♦	3	●	●		●	●				●	●		●	7	4.00	*.**

Table 18. Paint Creek QHEI Matrix

Key
QHEI
Components

River Mile	QHEI	Gradient (ft/mile)	WWH: No Channelization or Recovered	WWH: Boulder/Cobble/Gravel Substrates	WWH: Silt Free Substrates	WWH: Good/Excellent Substrates	WWH: Moderate/High Sinuosity	WWH: Extensive/Moderate Cover	WWH: Fast Current/Eddies	WWH: Low-Normal Overall Embeddedness	WWH: Max Depth > 40 cm	WWH: Low-Normal Riffle Embeddedness	Total WWH Attributes	MWH High Influence: Channelized or No Recovery	MWH High Influence: Silt/Muck Substrates	MWH High Influence: No Sinuosity	MWH High Influence: Sparse/No Cover	MWH High Influence: Max Depth < 40 cm (WD, HW)	Total H.I. MWH Attributes	MWH Moderate Influence: Recovering Channel	MWH Moderate Influence: Heavy/Moderate Silt Cover	MWH Moderate Influence: Sand Substrates (Boat)	MWH Moderate Influence: Hardpan Substrate Origin	MWH Moderate Influence: Fair/Poor Development	MWH Moderate Influence: Low Sinuosity	MWH Moderate Influence: Only 1-2 Cover Types	MWH Moderate Influence: Intermittent and Poor Pools	MWH Moderate Influence: No Fast Current	MWH Moderate Influence: High/Mod. Overall Embeddedness	MWH Moderate Influence: High/Mod. Riffle Embeddedness	MWH Moderate Influence: No Riffle	Total M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(02-675) Missouri Ditch																																		
Year: 2006																																		
1.6	**50.0**	2.60		■			■	■			■	■	5			♦			1	●	●		●	●				●	●			6	0.33	1.33
(02-676) Trib. to Buckskin Creek (RM 12.25(																																		
Year: 2006																																		
0.2	**50.5**	13.79	■	■			■	■			■	■	6				♦		1	●	●			●				●	●			5	0.29	1.00
(02-677) William Cathcart Ditch																																		
Year: 2006																																		
0.2	**50.0**	7.35		■			■	■				■	4			♦		♦	2	●	●			●				●	●	●		6	0.60	1.80
(02-678) Vallery Ditch																																		
Year: 2006																																		
2.3	**56.0**	5.75	■	■				■		■	■		5			♦			1	●	●			●				●	●	●		6	0.33	1.33

Biological Quality - Fish Communities

Headwaters

The quality of fish communities in terminal-node headwaters was determined based on a stratified random sample of 36 sites out of 89 total possible sampling points. Terminal-node headwaters, as the name implies, and defined *ad hoc*, are the upstream most ends (i.e., outer-most tree branches, by way of analogy) of tributaries that abut watershed or subwatershed boundaries, and have drainage areas less than10 mi^2. The total population of sample points for the Paint Creek basin was defined, necessarily, by road crossings falling nearest the 4 mi^2 drainage demarcation. As a final note of clarification, terminal-node headwaters are larger than primary headwaters, and are presumed to support viable fish populations.

Each of the 89 sites were categorized by glacial moraine type and land use. Moraine type was stratified as Wisconsin ground moraine, Wisconsin end moraine, and Illinoisan. Land use within moraine strata was classified as either being primarily agricultural, or as having a significant amount of forested land cover within the catchment. Here, a significant amount was defined *ad hoc* as more than ten percent. Ten streams were then selected randomly within the moraine-land use strata. All sites classified as Illinoisan were also in the forested category. No Wisconsin ground moraine sites were forested. Of the Wisconsin end moraine sites, seven were forested, so all were included in the sample. The net result is that thirty-seven sites were randomly selected: 10 Wisconsin-end moraine agricultural, 7 Wisconsin-end moraine forested, 10 Wisconsin ground moraine agricultural, and 10 Illinoisan forested. All 7 Wisconsin-end moraine sites were sampled, and 9 sites in each of the other strata were sampled. Of the three sites not sampled, one was sampled at the wrong location, and two were not accessible.

The weighted, overall mean IBI score for the random sample was 43 ± 1. The effect of strata alone was tested with an ANOVA model, and was also tested with an Analysis of Covariance (ANCOVA) model where QHEI was used as the continuous covariate. Results from the ANOVA showed that mean IBI scores in the Illinoisan and Wisconsin-end moraine forested strata were between 4 and 17 points higher than those in the end moraine and ground moraine agriculture strata (Figure 47). Adjusted for habitat quality, IBI scores differed between the two forested strata and the two agricultural strata between 3 and 7 points. No difference was detected between mean IBI scores for the agricultural ground and end moraine classes. The coefficient of partial determination for strata in the ANCOVA model was 0.26, which represents a significant reduction in variance accounted for by QHEI scores.

Because habitat quality and percent forest cover both explained significant amounts of variation in IBI scores, and because stream channelization was most prevalent in the Wisconsin end and ground moraine strata, the scale-effect of habitat disturbance (Rankin 1991) and percent forest cover was tested by coding the random sites to whether their receiving streams were either channelized, or natural (including recovered channels), and then regressed against percent forest cover. Interpreted in this light, percent forest cover does not have significant explanatory power, and the scale-effect of habitat disturbance becomes readily apparent (Figure 47; Table 19).

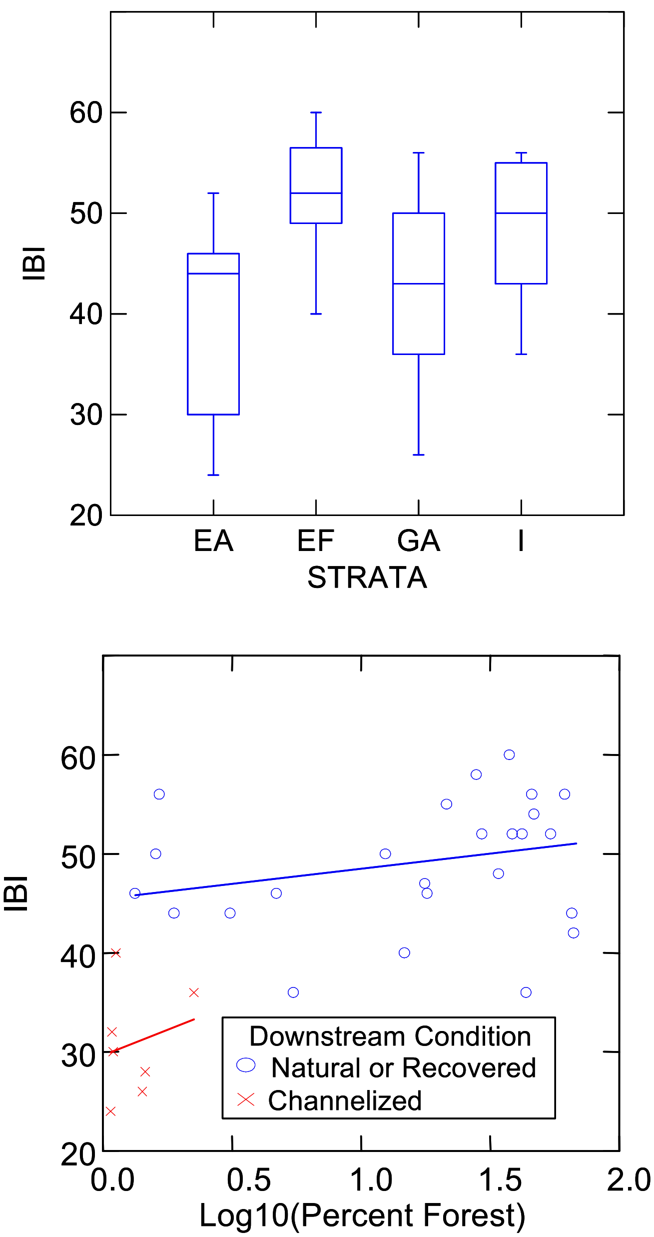


Figure 47. Distributions of IBI scores for random headwater sites grouped by strata (top panel), and IBI scores for random sites plotted by percent forest cover and coded to whether the downstream receiving stream was natural or channelized (lower panel). Strata codes are EA - end moraine, agriculture; EF - end moraine forested; GA - ground moraine, agriculture; I - Illinoisan.

Table 19. Linear regression results for the plot of IBI scores on percent forest cover for random headwater sites in Paint Creek. A binary coding variable was used to note whether or not the downstream receiving stream was channelized.

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
Constant	45.777	3.012	0.000	.	15.198	0.000
Percent Forest	2.571	2.264	0.178	0.546	1.135	0.266
DST Channelized	-15.222	3.662	-0.651	0.546	-4.157	0.000

Biological quality and QHEI scores in targeted samples collected from headwater streams followed the same pattern as that for the random sample with respect to hydrologic unit (Figure 48), further demonstrating the scale-effect of habitat disturbance. HUCs 010, 020 and 030 have the most extensively channelized stream network, and the lowest overall biological quality. Collectively, these results demonstrate that poor stream habitat quality is a major limiting factor to aquatic life in headwaters of the Paint Creek basin (Table 20).

Of the 33 sites sampled, fish communities fell below regional expectations for WWH at 8 sites. The limiting stressors at these sites were identified as either poor habitat, sedimentation or both due to channelization for agricultural drainage, and organic enrichment. from either livestock or on-site sewerage. Causes and sources of major stressors to headwaters in Paint Creek based on both fish and macroinvertebrate samples are listed in (Table 20).

Table 20. Causes and sources of stress to headwater biological communities in the Paint Creek basin identified from a random sample of headwaters.

Cause	Number of Sites	Source(s)
Poor habitat	7	Channelization for ag drainage
Organic Enrichment	4	On-site sewerage; livestock
Sediment	4	Channelization for ag drainage
Nutrients	2	Row crops w/ poor habitat
Toxicity	1	Urban stormwater
Ammonia	1	Livestock

Wadeable Streams

Distributions of IBI scores by hydrologic unit mirrored that for headwaters (Figure 49) and were correlated with QHEI scores (Figure 50). A plot of residuals by hydrologic unit from the regression of IBI on QHEI (Figure 50) shows that IBI scores in HUC 030 are under-predicted relative to the available habitat; a result that is at least partially related to the scale of habitat alteration in that hydrologic unit, but may also indicate water quality degradation. Distributions of MIWb scores by hydrologic unit (Figure 49) follow the same pattern as IBI scores, except in HUC 020, where MIWb scores are noticeably lower, relative to IBI scores, a pattern known to be caused by episodic stress, typically either toxicity or low dissolved oxygen.

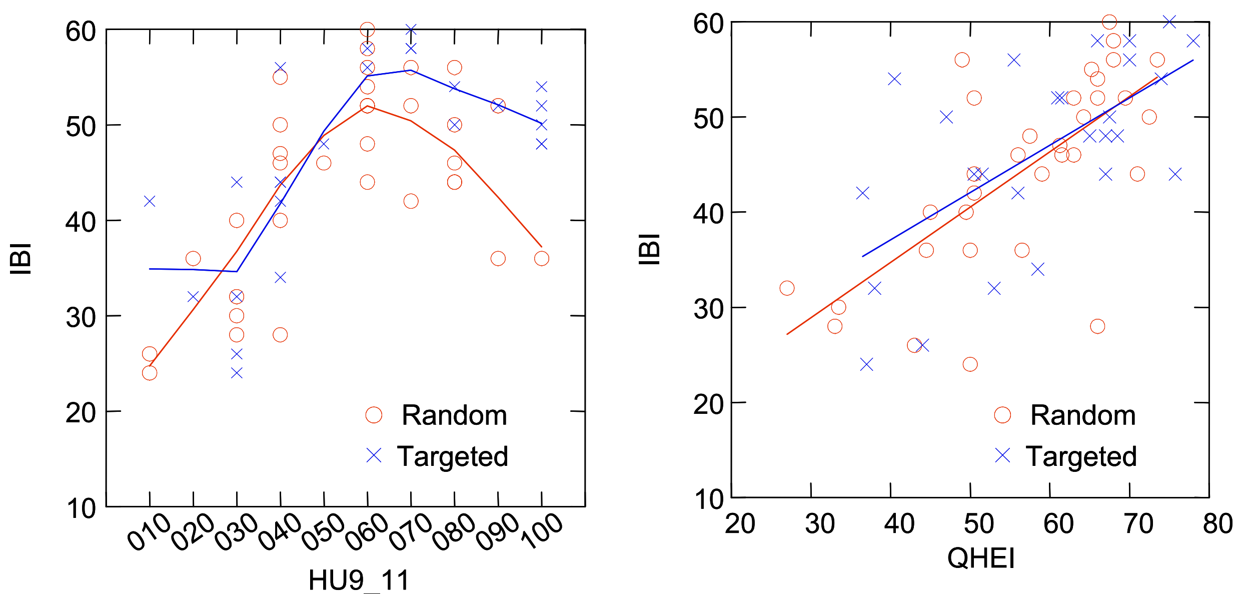


Figure 48. IBI scores sampled from random and targeted sites plotted by hydrologic unit (left panel) and QHEI scores (right panel). The trend lines in the left panel are locally weighted, the lines in the right panel are linear best fit.

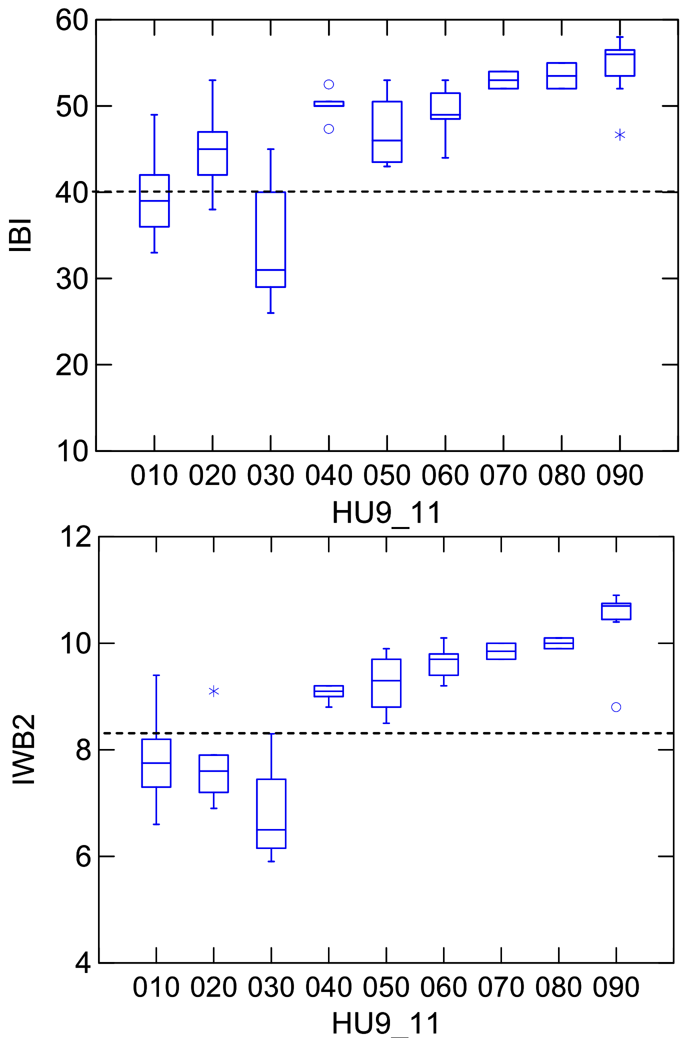


Figure 49. Distributions of IBI (top panel) and MIWb scores for wadeable streams sampled in the Paint Creek basin, 2006.

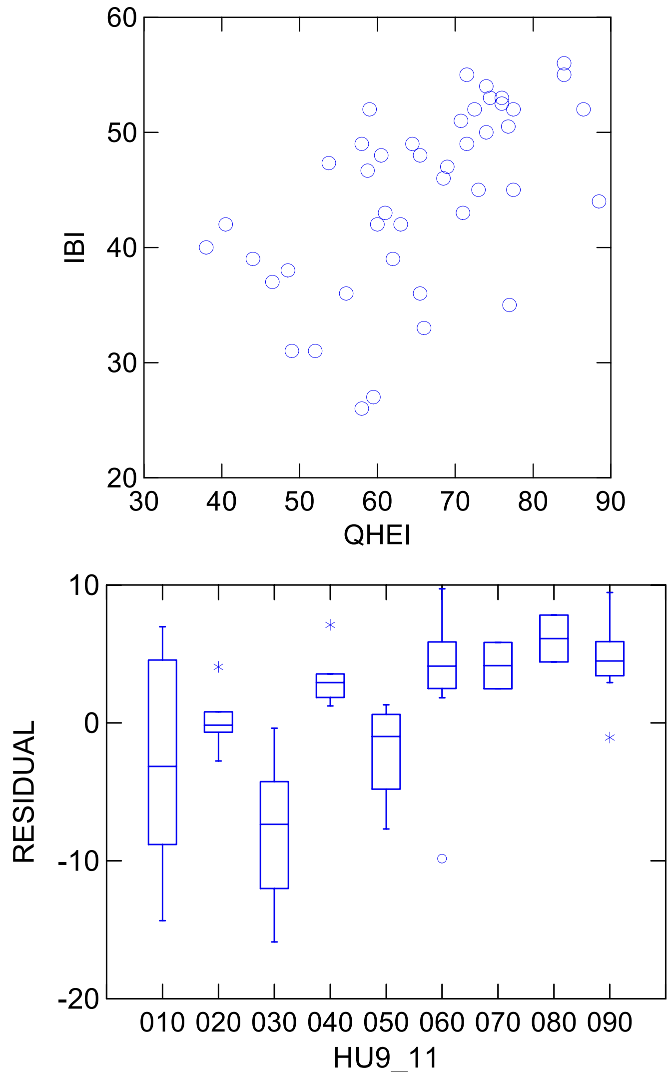


Figure 50. Scatter plot of IBI and QHEI scores (top panel) for wadeable streams sampled in Paint Creek, 2006, and distributions of residuals from the regression of IBI on QHEI plotted by 11-digit hydrologic unit.

Narrative Fish Community Assessments for Individual Streams

Paint Creek

Upstream from Washington Court House, the effect of habitat degradation, especially sedimentation, on the fish community in Paint Creek was pronounced. Three of seven sites in this reach did not meet the WWH criteria, and three other sites had at least one indicator that marginally departed from the WWH criteria. Ironically, the one site where the fish community rated very good in both indices was located in an historically modified reach running through downtown Washington Court House, and immediately downstream from a series of low head impoundments. Apparently the impoundments act to temporarily detain sediment, such that during normal flows, the reach immediately downstream is starved (relatively speaking) of sediment, and during high flows the sediment load is carried through this reach. No discernable near-field impact to the fish community was associated with the Washington Court House WWTP. However, the reach to which the plant dischargers is modified and hypertrophic.

Downstream from Washington Court House, Paint Creek flows through a natural channel, which allows the sediment load accumulated from the degraded headwaters to be purged, and the fish community to increase in quality (Figure 51). However, the fish community becomes limited by the effects of nutrient enrichment as evidenced by stonerollers dominating the fish community, wide D.O. swings, and lower than expected biological index scores.

Downstream from Paint Creek Reservoir biological index scores from electrofishing samples fully met the numeric WQS for EWH biotic integrity. The influence of the reservoir was apparent in the high relative abundance of sunfish collected downstream from the dam. The influence extended downstream to at least Dills Road, where longear sunfish and spotfin shiners were the most numerous fish species present. From Jones Levy Road downstream, redhorse and other sucker species dominated the community, as is expected for a large river. The sample collected downstream from the P. H. Glatfelter (former Mead Paper) fully met WQS for WWH.

North Fork Paint Creek

The North Fork Paint Creek is designated EWH. Biological index scores for fish communities sampled throughout its length fully met applicable WQS. The North Fork drains the portion of the catchment with the thickest layer of till, and so presumably receives abundant groundwater. Sustained flow and cool temperatures help to ameliorate impacts from the ubiquitous channelization of headwaters in the upper half of the basin. No impact to fish communities was detected downstream from the Frankfort WWTP.

Compton Creek

Similar to the North Fork, Compton Creek drains relatively thick till deposits. Consequently it has sustained flow over cobble, gravel, boulder substrates, and the fish community responds by meeting EWH at all sites except for the headwater sample where channelization prohibits any realistic expectation for EWH. The headwater site did meet WWH, however.

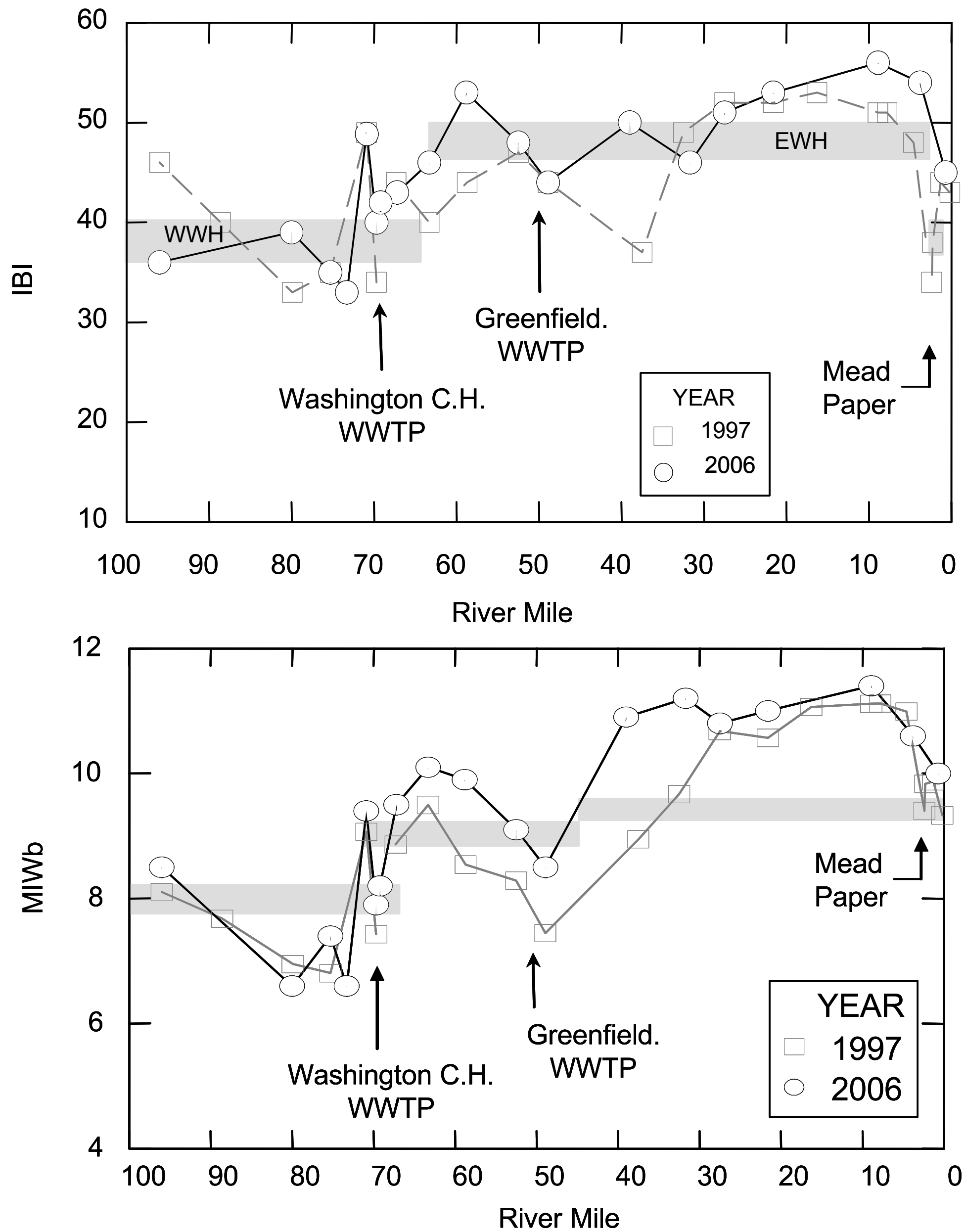


Figure 51. Line plots of IBI scores (top panel) and MIWb scores (bottom panel) by River Mile for sites sampled along the Paint Creek mainstem, 1997 and 2006 in relation to respective numeric biological criteria, and discharge locations of the Washington Court House WWTP, the Greenfield WWTP, and the Mead Paper Company.

Little Creek
Frequent use traffic by ATV through the steam bed destabilizes the channel bed and causes the substrate to be homogeneously composed of gravel. Despite the obvious habitat degradation, the fish community narrowly missed standards for EWH at one of two locations sampled, and fully met at the other. In the absence of the disturbance, the community would undoubtably achieve standards for EWH.

Biers Run
One site sampled on Biers Creek contained fish fully meeting WWH.

Black Run
Two sites sampled on Black Run both had fish communities meeting the ecoregional WWH biociterion.

Cattail Run, Owl Creek and Plug Run
These small direct tributaries to the Paint Creek mainstem in hydrologic unit 100 had fish communities meeting WWH.

Rocky Fork Paint Creek
All three sites sampled on Rocky Fork had fish communities meeting standards for the existing EWH designation.

Clear Creek
Formerly polluted with raw sewage, improvements to the Hillsboro WWTP effected a turn-around in Clear Creek that has resulted in fish communities meeting numeric standards for EWH downstream from the plant (Figure 52). The improved water quality has allowed the pollution sensitive bigeye chub to expand its range downstream from Hillsboro, where it is now one of the most abundant cyprinids. One note of caution; IBI scores recorded immediately downstream from the Hillsboro WWTP decreased 10 points between the first and second sampling pass due primarily to an unusually large number of bluntnose minnows in the second pass. Bluntnose minnows are coprophagous, and an unusual abundance may signify organic enrichment.

Lees Creek and Tributaries in Hydrologic Unit 040
The quality of fish communities sampled in Lees Creek, and the Middle and South Forks met expectations for WWH streams. Two sites were sampled on Fall Creek, one site (RM 7.5, Dst SR 138) was impaired by organic enrichment from nearby livestock, the other site fully met WWH.

Wabash Creek
Wabash Creek is a direct tributary to Paint Creek in hydrologic unit 050. The creek was sampled downstream from SR 41, and the fish met the standard for WWH.

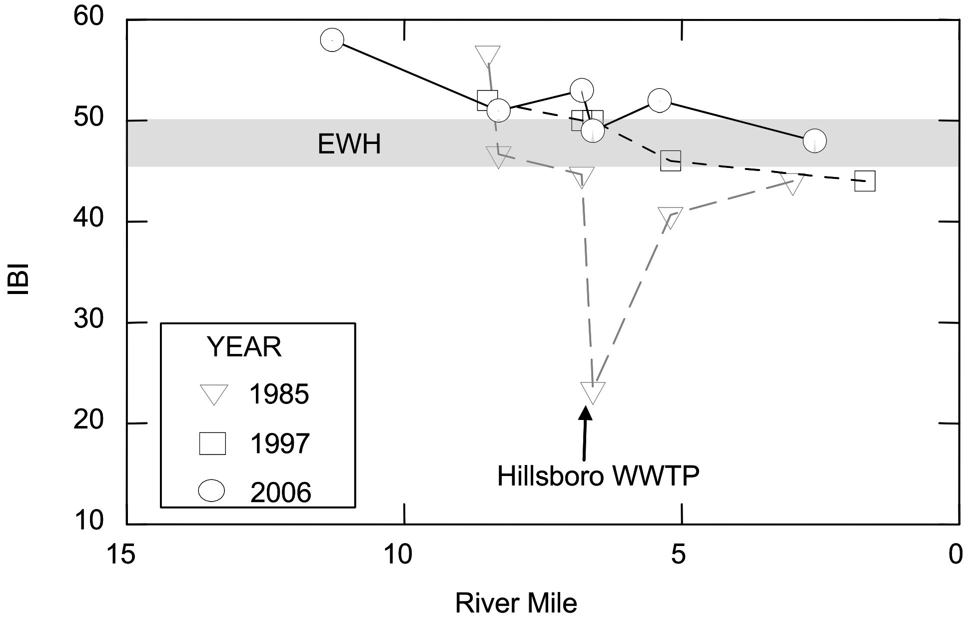


Figure 52. Line plot of IBI scores for fish communities sampled from Clear Creek, 1985, 1997 and 2006, in relation to the Hillsboro WWTP.

Rattlesnake Creek, West Branch Rattlesnake, and Wilson Creek

IBI scores failed to meet the WWH criterion at half of the locations sampled in Rattlesnake Creek (Figure 53). Low D.O. concentrations and poor habitat quality are the causes of impairment to Rattlesnake Creek. Low dissolved oxygen is apparently a chronic problem in the reach between US 35 and SR 720, as intolerant species were absent, overall relative abundance was low, and the proportion of tolerant fish in samples was unusually high. Low D.O. and poor habitat similarly plague the West Branch Rattlesnake Creek.

Fish communities in Wilson Creek were sampled upstream from Sabina, and upstream and downstream from the Sabina WWTP. Upstream from Sabina, the fish community was limited by the simplified stream habitat, but scored marginally good due to the influence of groundwater. The sites bracketing the Sabina WWTP failed to meet WWH, being rated fair and poor for the upstream and downstream samples, respectively. The upstream site was limited by habitat and urban runoff from an unnamed tributary that receives stormwater from Sabina. Downstream from the WWTP the electrofishing sample yielded low overall relative abundance, a high proportional composition of tolerant fish, but four sensitive fish species. This combination, along with relatively cool water temperatures, suggests a chronic stress partially ameliorated by groundwater.

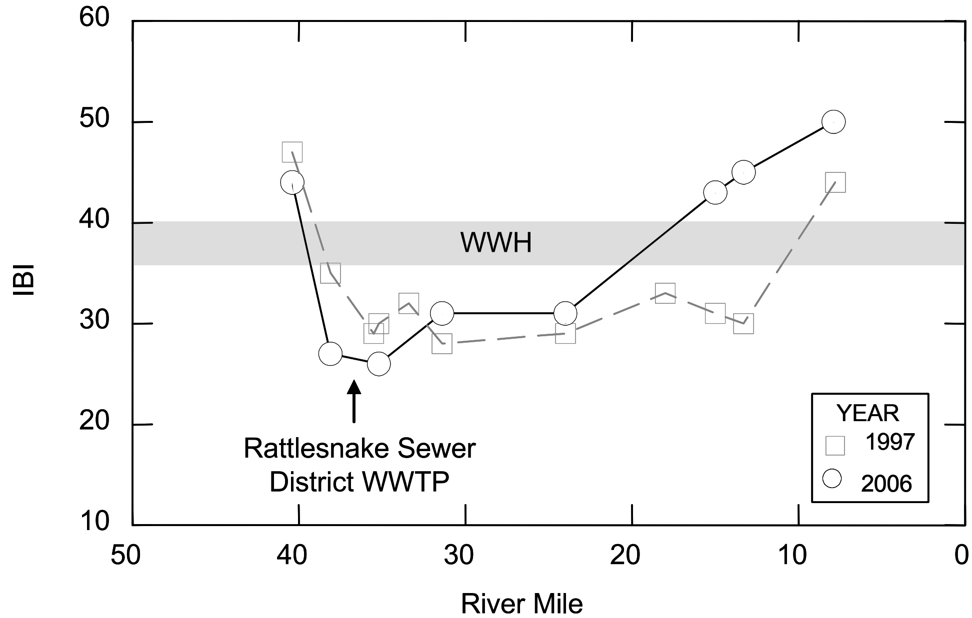


Figure 53. Line plot of IBI scores for Rattlesnake Creek in relation to the WWH biocriterion for wadeable streams, and the Octa WWTP, 1997 and 2006.

Sugar Creek

Seven locations were sampled on Sugar Creek for fish. IBI scores met WWH standards at six of the seven locations (Figure 54). The most upstream site is channelized and actively maintained, and therefore not likely to support a WWH assemblage under current management practices. The IBI score at this location was 32, consistent with the habitat limitation. Although IBI scores met WWH criterion for wadeable streams, MIWb scores were depressed because of severe nutrient enrichment (Table 21). Partial fish kills from low dissolved oxygen were noted during the second sampling pass at two of the locations sampled, one upstream from US 22 (RM 12.0), and at McKillip Road (RM 29.2). Both sites were choked with filamentous algae (Figure 54).

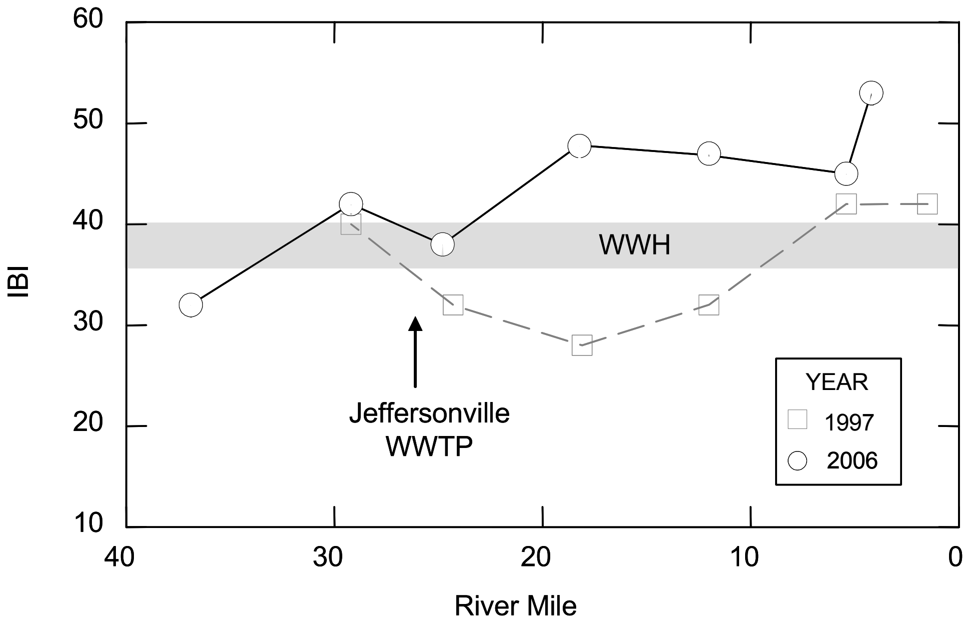


Figure 54. Top panel - line plot of IBI scores for Sugar Creek, 1997 and 2006, in relation to the Jeffersonville WWTP and the numeric biocriterion for wadeable WWH streams. Bottom panel - a nuisance bloom of filamentous algae in Sugar Creek.

Table 21. Fish community attributes from electrofishing samples collected during the Paint Creek basin survey, 2006.

RM	Cumulative Species	Relative Number	Relative Weight	QHEI	MIWb	IBI	Narrative Assessment	Drainage Area
Hydrologic Unit 010								
02-500	**Paint Creek**							
			Aquatic Life Use WWH					
96.0	24.0	1063.5	15.53	65.5	8.5	36	M. Good/Good	31.0
80.0	22.0	320.3	28.75	62.0	6.6	39	M. Good/Fair	54.0
75.3	25.0	1125.0	12.01	77.0	7.4	35	Fair /Fair	58.0
73.3	24.0	1511.3	7.86	66.0	6.6	33	Fair /Fair	60.0
70.9	29.0	734.3	29.15	64.5	9.4	49	V. Good/V.Good	63.0
69.7	23.0	440.3	37.39	38.0	7.9	40	Good / M. Good	67.0
69.4	*21.0*	*330.0*	*8.71*	*0.0*	*7.2*	*48*	*V. Good/Fair*	*67.0*
69.4	*21.0*	*444.0*	*15.46*	*0.0*	*5.7*	*24*	*Poor /Poor*	*67.0*
69.2	26.0	378.8	87.42	40.5	8.2	42	Good /M. Good	67.0
02-580	**E. Fk. Paint Creek**							
			Aquatic Life Use WWH					
8.6	22.0	374.3	43.10	44.0	7.3	39	M. Good/Fair	28.0
5.1	29.0	1013.5	22.79	56.0	8.1	36	M. Good/M. Good	33.0
0.7	24.0	383.3	4.07	63.0	7.6	42	Good /Fair	50.4
02-678	**Vallery Ditch**							
			Aquatic Life Use MWH					
2.3	13.0	1228.0	0.00	56.0	5.2	42	Good	5.5

Table 21. Fish community attributes from electrofishing samples collected during the Paint Creek basin survey, 2006.

RM	Cumulative Species	Relative Number	Relative Weight	QHEI	MIWb	IBI	Narrative Assessment	Drainage Area
Hydrologic Unit 020								
02-579	**Sugar Creek**							
			Aquatic Life Use MWH					
36.9	12.0	1365.0	0.00	38.0	5.0	32	Fair	5.3
			Aquatic Life Use WWH					
29.2	23.0	435.8	122.23	60.0	7.6	42	Good /Fair	23.0
24.8	20.0	224.3	31.92	48.5	6.9	38	M. Good/Fair	27.0
18.6	20.0	1266.0	11.91	60.5	8.9	48	Very Good	47.0
12.0	26.0	325.5	16.69	69.0	7.2	47	V. Good/Fair	61.0
5.4	26.0	441.8	5.33	73.0	7.9	45	Good /M. Good	72.0
4.2	33.0	563.3	19.16	76.0	9.1	53	Except /V.Good	75

Table 21. Fish community attributes from electrofishing samples collected during the Paint Creek basin survey, 2006.

RM	Cumulative Species	Relative Number	Relative Weight	QHEI	MIWb	IBI	Narrative Assessment	Drainage Area
Hydrologic Unit 030								
02-550	**Rattlesnake Creek**							
			Aquatic Life Use WWH					
40.4	15.0	856.0	0.00	51.5	5.5	44	Good	16.5
38.1	19.0	349.5	10.74	59.5	6.3	27	Poor /Fair	25.0
35.2	21.0	375.0	14.29	58.0	5.9	26	Poor /Fair	34.0
31.4	19.0	224.3	40.29	49.0	6.0	31	Fair /Fair	40.8
24.0	24.0	365.3	42.10	52.0	6.5	31	Fair /Fair	110.0
15.0	15.0	526.5	2.12	71.0	7.6	43	Good /Fair	125.0
13.3	16.0	691.5	9.23	77.5	8.3	45	Good /Good	128.0
02-562	**W Br Rattlesnake Cr.**							
			Aquatic Life Use WWH					
4.3	14.0	368.0	0.00	53.0	4.4	32	Fair	15.8
2.8	23.0	507.0	93.73	46.5	7.3	37	M. Good/Fair	41.6
02-563	**Wilson Creek**							
			Aquatic Life Use WWH					
5.0	16.0	764.0	0.00	38.0	5.2	38	M. Good	11.3
3.8	21.0	1164.0	70.31	44.0	6.8	32	Fair	17.8
2.9								
2.8	11.0	242.0	0.00	44.0	3.6	26	Poor	18.4
02-598	**Trib. to Rattlesnake**							
			Aquatic Life Use MWH					
1.1	8.0	245.0	0.00	37.0	3.9	24	Poor	4.6

Table 21. Fish community attributes from electrofishing samples collected during the Paint Creek basin survey, 2006.

RM	Cumulative Species	Relative Number	Relative Weight	QHEI	MIWb	IBI	Narrative Assessment	Drainage Area
Hydrologic Unit	*040*							
02-550	**Rattlesnake Creek**							
			Aquatic Life Use	*WWH*				
7.9	30.0	364.0	53.66	71.3	9.0	50	Except /V.Good	209.0
02-552	**Fall Creek**							
			Aquatic Life Use	*WWH*				
7.5	10.0	2000.0	0.00	58.5	5.3	34	Fair	3.7
1.6	15.0	1394.0	0.00	67.0	5.5	44	Good	13.3
02-554	**Hardin Creek**							
			Aquatic Life Use	*WWH*				
0.9	26.0	1166.9	10.50	74.0	8.8	50	Except /Good	20.5
02-557	**Walnut Creek**							
			Aquatic Life Use	*WWH*				
0.6	13.0	1191.3	4.63	75.8	5.8	44	Good	13.4
02-558	**Lees Creek**							
			Aquatic Life Use	*WWH*				
10.4	20.0	1672.0	0.00	36.5	5.2	42	Good	14.3
4.5	31.0	1365.2	22.40	76.0	9.2	53	Except /V.Good	25.6
1.2	35.0	1002.3	45.92	76.8	9.1	51	Except /V.Good	73.0
02-559	**M. Fk. Lees Creek**							
			Aquatic Life Use	*WWH*				
5.1	23.0	978.2	5.70	70.0	6.7	56	Except	12.4
1.1	26.0	1304.7	11.04	53.8	9.2	47	V. Good/V.Good	36.1
02-560	**S. Fk. Lees Creek**							
			Aquatic Life Use	*WWH*				
1.3	17.0	3354.0	0.00	50.5	5.4	44	Good	16.0

Table 21. Fish community attributes from electrofishing samples collected during the Paint Creek basin survey, 2006.

RM	Cumulative Species	Relative Number	Relative Weight	QHEI	MIWb	IBI	Narrative Assessment	Drainage Area
Hydrologic Unit 050								
02-500	**Paint Creek**							
			Aquatic Life Use EWH					
67.2	28.0	1478.3	16.26	61.0	9.5	43	Good /Except	120.0
63.3	26.0	631.1	242.28	68.5	10.1	46	Except /Except	131.0
58.8	30.0	936.0	36.40	83.0	9.9	53	Except /Except	224.0
52.5	21.0	675.0	16.42	78.5	9.1	48	V. Good/V.Good	249.0
48.9	21.0	1218.0	25.21	83.0	8.5	44	Good /Good	261.0
39.0	31.0	654.0	162.42	82.0	10.2	46	V. Good/Except	570.0
02-578	**Wabash Creek**							
			Aquatic Life Use WWH					
0.8	15.0	692.7	0.00	67.0	5.2	48	V. Good	4.6

Table 21. Fish community attributes from electrofishing samples collected during the Paint Creek basin survey, 2006.

RM	Cumulative Species	Relative Number	Relative Weight	QHEI	MIWb	IBI	Narrative Assessment	Drainage Area
Hydrologic Unit 060								
02-530	**Rocky Fork Paint Cr.**							
			Aquatic Life Use EWH					
23.3	17.0	1260.0	0.00	55.5	5.6	56	Except	16.2
18.0	36.0	1062.8	49.57	58.0	10.1	49	V. Good/Except	33.0
3.1	23.0	1154.3	34.90	88.5	9.5	44	Good /Except	140.0
02-540	**Clear Creek**							
			Aquatic Life Use EWH					
8.3	25.0	2547.0	32.25	70.8	9.3	51	Except /V.Good	20.1
6.8	28.0	2348.3	41.44	74.5	9.9	53	Except /Except	24.9
6.6	26.0	3030.8	28.25	71.5	9.7	49	V. Good/Except	25.1
5.4	28.0	2419.5	29.28	59.0	9.7	52	Except /Except	28.0
2.6	33.0	1107.5	23.96	65.5	9.2	48	V. Good/V.Good	40.0
02-585	**Moberly Branch**							
			Aquatic Life Use WWH					
0.9	18.0	1316.0	10.56	66.0	8.2	58	Except	2.5

Table 21. Fish community attributes from electrofishing samples collected during the Paint Creek basin survey, 2006.

RM	Cumulative Species	Relative Number	Relative Weight	QHEI	MIWb	IBI	Narrative Assessment	Drainage Area
Hydrologic Unit 070								
02-500	**Paint Creek**							
			Aquatic Life Use EWH					
31.7	42.0	632.0	190.48	81.0	11.2	46	V. Good/Except	773.0
27.5	44.0	813.9	166.01	84.5	10.8	51	Except /Except	788.0
21.6	46.0	748.0	153.89	80.0	11.0	53	Except /Except	807.0
02-545	**Lower Twin Creek**							
			Aquatic Life Use EWH					
2.2	24.0	1473.0	13.85	78.0	8.9	58	Except	15.0
02-546	**Upper Twin Creek**							
			Aquatic Life Use EWH					
5.8	20.0	702.5	4.99	75.0	8.3	60	Except	5.5
1.7	27.0	1230.0	15.22	70.0	9.5	58	Except	12.7
02-564	**Buckskin Creek**							
			Aquatic Life Use WWH					
0.4	36.0	2239.5	25.06	77.5	9.7	52	Except /Except	39.7

Table 21. Fish community attributes from electrofishing samples collected during the Paint Creek basin survey, 2006.

RM	Cumulative Species	Relative Number	Relative Weight	QHEI	MIWb	IBI	Narrative Assessment	Drainage Area
Hydrologic Unit 080								
02-510	**N. Fk. Paint Creek**							
			Aquatic Life Use EWH					
31.0	33.0	1470.8	38.53	72.5	10.1	52	Except /Except	45.0
26.6								51.1
02-522	**Compton Creek**							
			Aquatic Life Use EWH					
11.2	28.0	1551.0	38.00	74.0	9.4	54	Except	19.9
3.4	33.0	1796.3	39.79	71.5	9.9	55	Except /Except	48.7
1.1								59.0
02-524	**Mud Run**							
			Aquatic Life Use WWH					
0.4	20.0	1223.3	0.00	67.5	5.4	50	Except	7.3

Table 21. Fish community attributes from electrofishing samples collected during the Paint Creek basin survey, 2006.

RM	Cumulative Species	Relative Number	Relative Weight	QHEI	MIWb	IBI	Narrative Assessment	Drainage Area
Hydrologic Unit 090								
02-510 N. Fk. Paint Creek								
			Aquatic Life Use EWH					
22.3	38.0	2099.2	31.19	84.0	10.4	55	Except /Except	122.0
17.0	39.0	2811.0	63.87	84.0	10.8	56	Except /Except	153.0
13.6	38.0	2792.3	62.23	86.5	10.9	52	Except /Except	164.0
10.5	39.0	1495.5	38.18	79.0	10.5	56	Except /Except	207.0
3.9	44.0	1455.8	70.07	81.5	10.7	57	Except /Except	230.0
2.3	37.0	1474.5	93.62	75.0	10.7	58	Except /Except	232.0
02-511 Biers Run								
			Aquatic Life Use WWH					
1.5	18.0	3140.0	15.45	61.5	8.9	52	Except	7.1
02-516 Little Creek								
			Aquatic Life Use WWH					
1.0	29.0	3277.0	12.71	58.8	8.8	47	V. Good/Good	22.7

Table 21. Fish community attributes from electrofishing samples collected during the Paint Creek basin survey, 2006.

RM	Cumulative Species	Relative Number	Relative Weight	QHEI	MIWb	IBI	Narrative Assessment	Drainage Area
Hydrologic Unit 100								
02-500	**Paint Creek**							
			Aquatic Life Use EWH					
8.9	47.0	619.0	209.19	82.0	11.4	56	Except /Except	895.0
3.8	43.0	504.0	121.00	83.5	10.6	54	Except /Except	1138.0
			Aquatic Life Use WWH					
0.7	39.0	512.0	88.66	79.0	10.0	45	Good /Except	1144.0
02-527	**Cattail Run**							
			Aquatic Life Use WWH					
1.2	11.0	3794.0	9.91	47.0	8.0	50	Except	2.9
02-528	**Owl Creek**							
			Aquatic Life Use WWH					
0.3	16.0	340.0	1.93	65.0	6.0	48	V. Good	6.5
02-529	**Plug Run**							
			Aquatic Life Use WWH					
0.4	18.0	956.0	5.61	68.5	7.7	48	V. Good	5.4
02-543	**Black Run**							
			Aquatic Life Use WWH					
3.9	16.0	1396.0	4.74	61.0	7.9	52	Except	5.0
1.0	26.0	2902.0	16.80	40.5	9.7	54	Except	8.6

Fish Tissue
Fish samples in the lower reach of Paint Creek between Bainbridge and the Scioto River have been tested periodically since 1995 for contamination by polychlorinated biphenyls (PCBs; Figure 55) . Test results in 2006 show lower levels of contamination relative to previous years (Figure 56); however, caution is needed in interpreting the data. PCBs are lipophilic, and therefore readily soluble in fatty tissues. Lipid content in a sample of tissue varies by fish species, type of tissue sample collected, and the size of a given individual of a particular species. When these factors are controlled for in statistical analyses, there is no difference in PCB tissue concentrations between years (ANCOVA, p = 0.2525 for year effect), as one can readily infer by inspection in Figure 56. Higher PCB tissue concentrations were detected, however, in samples collected downstream from the P.H. Glatfelter facility compared to samples collected upstream from it (Figure 55).

Mean tissue concentrations (+/- 1 SD) detected in individual species are plotted in Figure 57 relative to advisory ranges for the protection of human health given in Anderson et al. (1993). The ranges given Anderson et al. (1993) assume a meal of 8 ounces, and that the fish were filleted and skinned. Filleting and skinning reduces fat soluble contaminants like PCBs because fat deposits on fish accumulate along the lateral line under the skin. The effect of removing the skin is evident in Figure 56, where fillet samples (type SFFC) generally had lower lipid content and PCBs concentrations than skin-on fillets (SFOC) or whole body composites (WBC) samples.

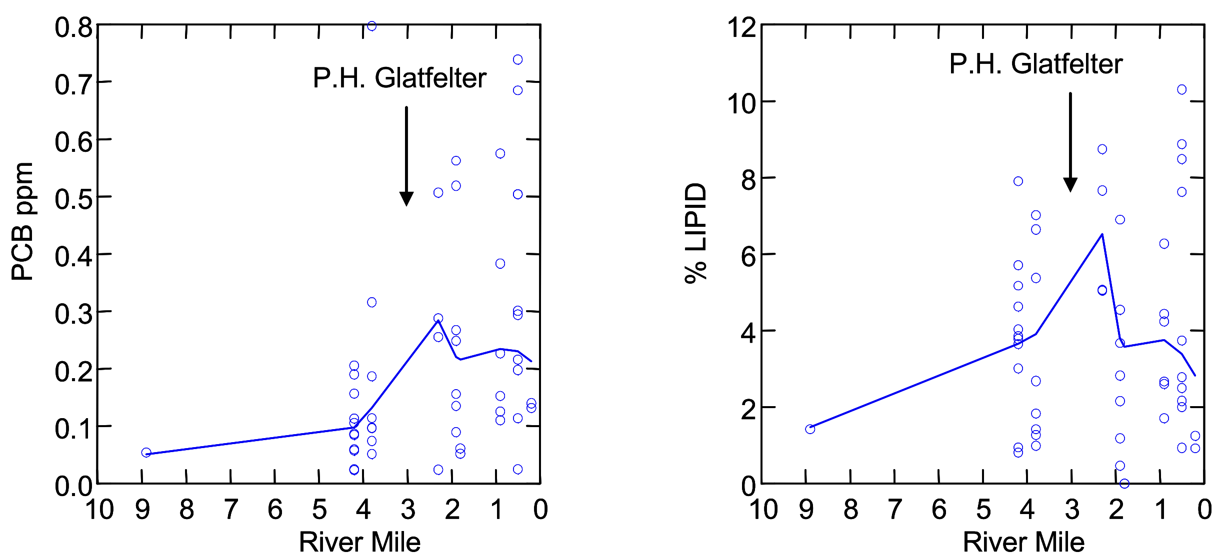


Figure 55. Left panel - concentrations of polychlorinated biphenyls (PCBs) detected in fish tissue samples collected from the lower 10 miles of Paint Creek, 1995 - 2006, in relation to the P. H. Glatfelter site (formerly Mead Westvaco). Right panel - percent lipid in respective tissue samples.

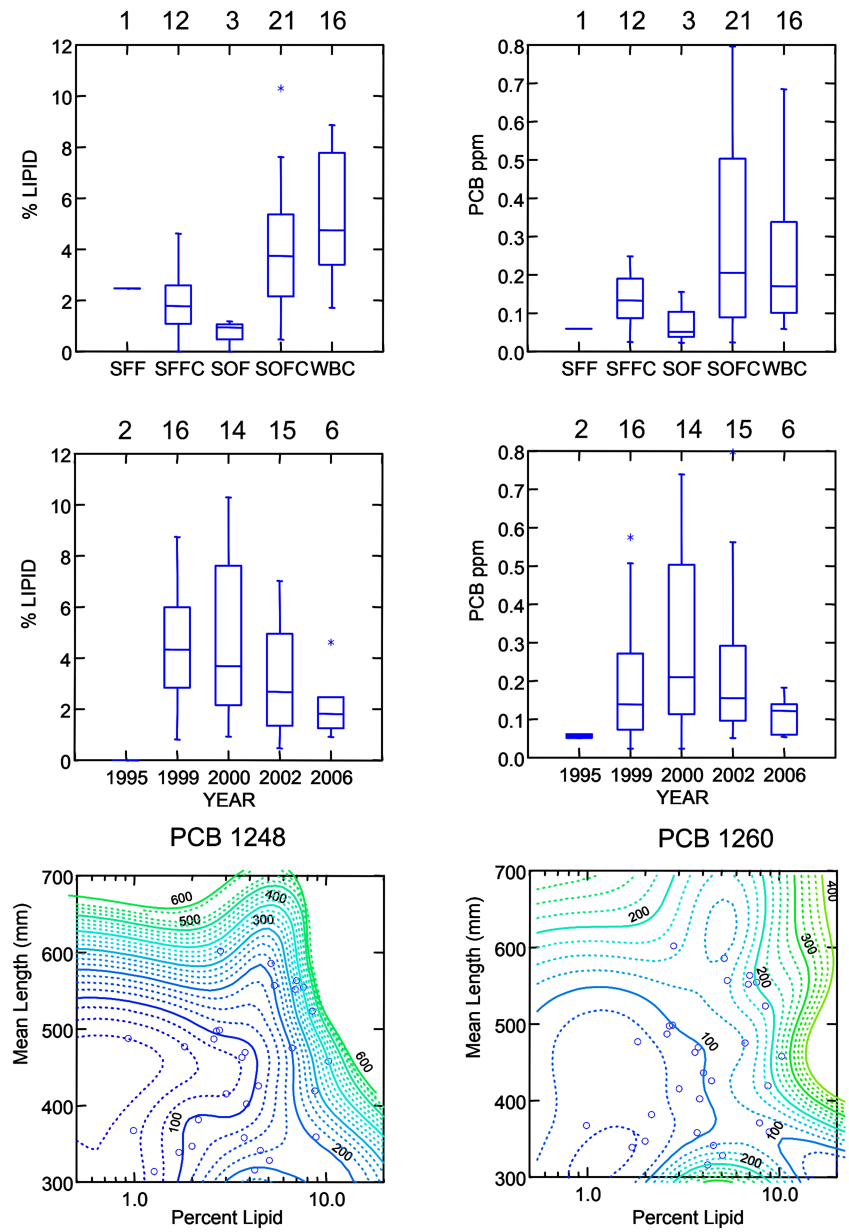


Figure 56. Top panel - distributions of percent lipid and PCB concentrations in tissues samples plotted by sample type. Acronyms for the sample type are as follows: SFF - skinless fillet from one fish; SFFC - skinless fillets from several fish; SOF - skin-on fillet from one fish; SOFC - skin-on fillet from several fish; WBC - Whole body composite from several fish. The number of analytical readings for each sample type is shown above the plot. Middle panel - distributions of percent lipid and PCB concentrations for all sample types combined plotted by year; sample sizes for each year are shown above the plots. Lower panel - concentrations, in parts per billion, of PCB 1248 and 1260 plotted as a function of mean length (y-axis) and percent lipid (x-axis) content of fish in a given sample.

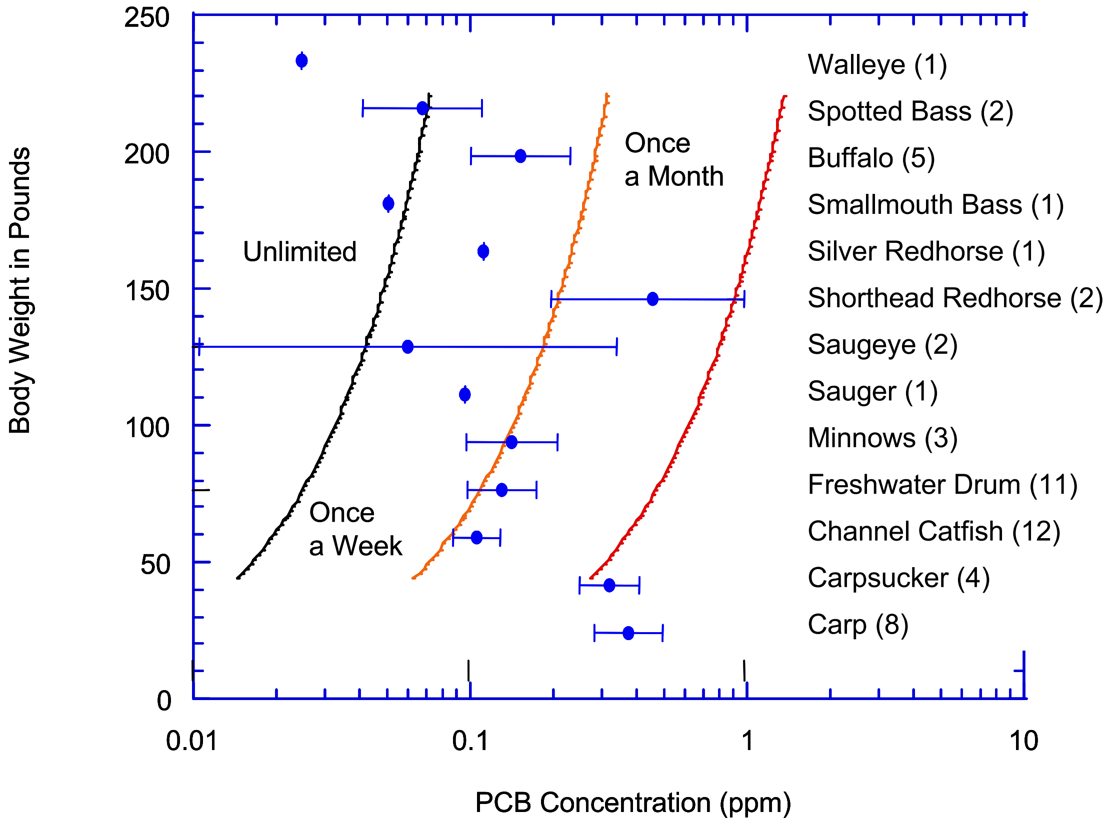


Figure 57. Mean (+/- 1 SD) concentrations of PCBs detected in fish tissues samples plotted by species. Respective species names are arrayed along the right hand edge; the number of samples for each species is shown to the right of the species name. Consumption advisory ranges for the protection of human health as suggested by Anderson et al. (1993) are plotted as a function of a consumer's body weight.(y-axis); the curvlinear lines demarcate the boundaries between consumption advisories.

Biological Quality - Macroinvertebrate Communities

PAINT CREEK BASIN (HUCs 010-100)
Headwaters (Random Site Sampling)
Macroinvertebrate community performance in terminal-node headwaters was evaluated at 34 of the 36 stratified random sample sites (Table 23) selected out of 89 possible sampling points (see discussion under Fish Headwater Communities page 137). Random sample points for the Paint Creek basin were selected by road crossings falling nearest the 4 mi^2 drainage demarcation; the macroinvertebrate sites ranged from 1.7 to 11 mi^2 and averaged 4.8 mi^2.

The pool of headwater sites was further categorized by glacial moraine type and land use resulting in four sub-categories; 1) Wisconsin end moraine-agricultural (EA), 2) Wisconsin end moraine-forested (EF), 3) Wisconsin ground moraine-agricultural (GA) and 4) Illinoisan (I). All sites in the Illinoisan category were forested. One random site was not sampled because the stream was dry where the channel crossed the lower Paint Creek flood plain (*i.e.*, a "losing" stream). Another site was not sampled due to lack of access.

For discussion purposes, the Paint Creek basin was divided into upper and lower halves divided at the Paint Creek Reservoir dam and the lower half of the North Fork Paint Creek. The upper Paint Creek basin included HUCs 010-030 (upper Paint Creek, Sugar Creek, Rattlesnake Creek) and HUC 080 (upper North Fork Paint Creek). The lower basin was made up of HUCs 040-070 and 090-100 and included the lower 39 miles of the Paint Creek mainstem, local tributaries, and the Rocky Fork Paint Creek, Lees Creek, and the lower North Fork Paint Creek basins.

Headwater sites associated with agricultural and forested landscapes were roughly divided between the upper Paint Creek and lower Paint Creek basins. Headwater sites in upper Paint Creek were entirely associated with the predominant agricultural land usage (12 EA and GA sites) while forested sites were entirely restricted to the lower Paint Creek basin (15 EF and I sites). Only 6 of 22 headwater sites (27%) in the lower basin were classified as agricultural and all were located in the northern portion of the subbasin, where land usage tends to transition from agriculture to forest.

To display macroinvertebrate performance, an average ICI score was assigned to the narrative evaluation associated with each headwater sample. Box and whisker plots of the evaluations in each land use category were then calculated and presented in Figure 58. For all sites, the median narrative ICI score was in the good range (ICI = 39) with only 8 sites (24%) falling below WWH criteria (*i.e.*, fair quality or worse). Impacts to the macroinvertebrates in the upper Paint Creek basin were primarily associated with enrichment and habitat modification (channelization) from agricultural activity (a more detailed evaluation of the upper basin macroinvertebrate sites follows on page 153). In the lower Paint Creek basin, impairment was rare but a few severely impacted sites (i.e., poor/very poor quality) were found scattered throughout the basin. These lower basin impairments were primarily associated with small scale or localized stressors including stream intermittence, unrestricted cattle access, septic tank runoff, and habitat disruption.

Based on the four land use categories, highest quality macroinvertebrate communities were associated with the forested end moraine and Illinoisan groups. Macroinvertebrates from these landscapes routinely reflected good to very good quality. Forested streams also tended to have natural, unaltered channels with well defined riffle/pool development, intact riparian borders, and coarse, unembedded substrates. Some small streams in the southern most, unglaciated portion of the basin (HUCs 070 and 100), also reflected coldwater potential.

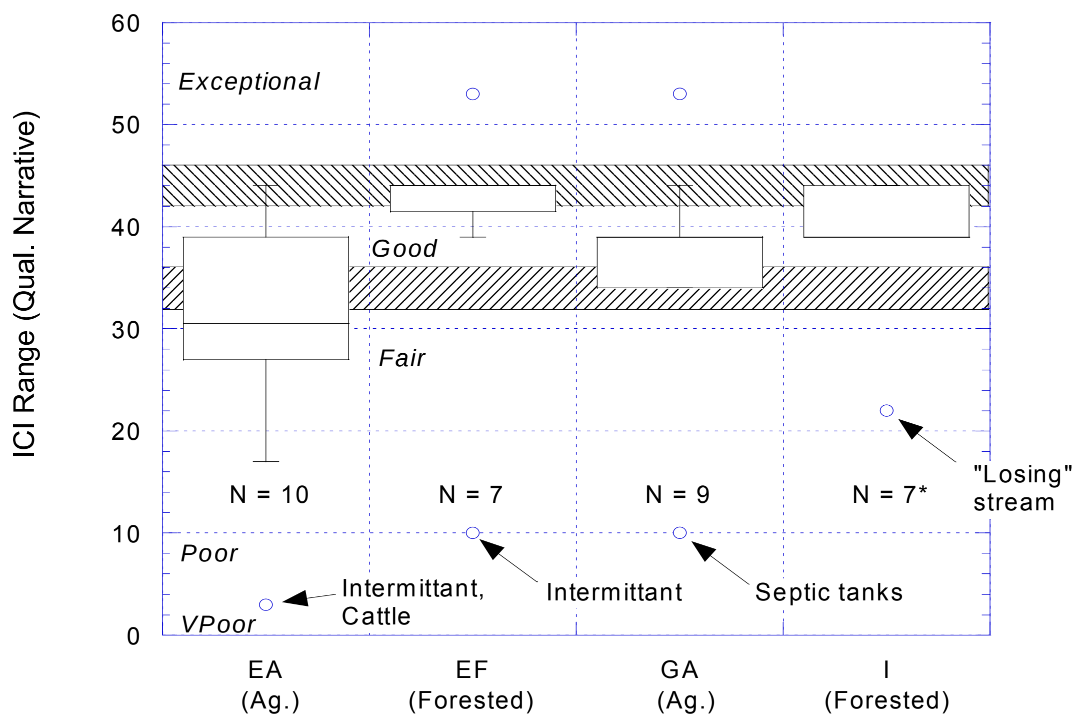


Figure 58. Box and whisker plots of macroinvertebrate performance based on qualitative sampling from randomly selected headwater sites in the Paint Creek basin, divided into four categories based on land use and geology.

In contrast to forested sites, end moraine-agriculture (EA) macroinvertebrate performance was lower and fell largely in the upper fair range. Stream channels at end moraine sites ranged from natural, to channelized recovered, to channelized and under active maintenance. With few exceptions, channelized stream performance was below WWH criteria while natural or recovered channels met at least minimum standards. In addition to habitat modification associated with row crop agriculture, other EA sites reflected localized impairment associated with low flow, unrestricted cattle access, and urban runoff.

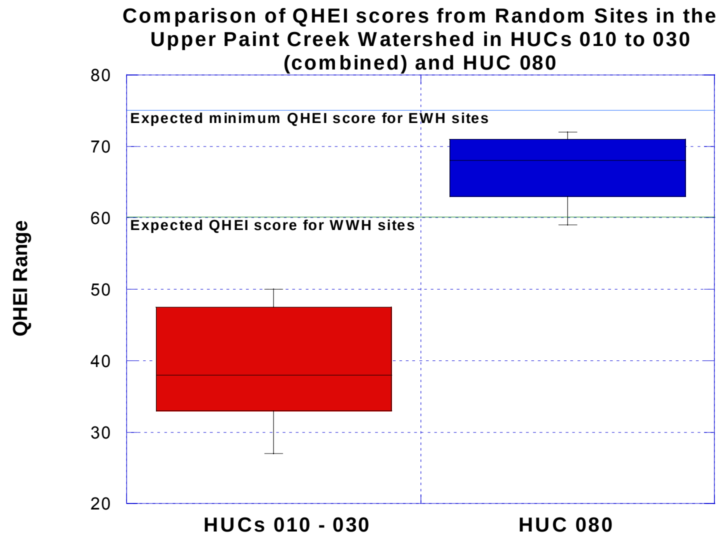
Macroinvertebrate performance at ground moraine-agricultural sites fell between the forested and EA groups with most sites in the good to marginally good range. Physical habitat quality at ground moraine sites tended to reflect the predominant agricultural land usage as most sites were moderately silty or enriched with thin or inconsistent riparian borders. Stream channels ranged from natural to historically modified but it appeared that most historically modified sections were quite old. These channels had recovered sufficiently from past disturbance to support at least marginally good communities.

UPPER PAINT CREEK BASIN (HUCs 010, 020, 030, and 080)

Upper Headwaters (Random Site Sampling)

There were twelve randomly selected headwater stream sites between HUCs 010 (upper Paint Creek and East Fork), 020 (Sugar Creek basin), 030 (Rattlesnake Creek basin), and 080 (North Fork Paint Cr.). The drainage areas ranged from 2.3 mi^2 to 11.0 mi^2. The mean drainage area for random headwater sites selected in the upper Paint Creek basin HUCs was 6.4 mi^2. The only selected sites in the upper Paint Creek basins were Wisconsin ground moraine agriculture and Wisconsin end moraine agriculture sites. No forest catchment stream sites were selected (Wisconsin- end moraine forested or Illinoisan forested), as they were rare or nonexistent in these upper HUCs. As noted earlier, stream channelization and minimal or removed riparian corridors (with the associated sedimentation and nutrient enrichment) were most prevalent in HUCs 010, 020, and 030 with row crop agriculture as its prevalent land use. These activities were commonplace in the Wisconsin end and ground moraine strata sites in the upper HUCs, and therefore the lowest QHEI scores (mean = 39.3) were in upper portions of the Paint Creek and the East Fork basins, the Sugar Creek basin, and the Rattlesnake Creek basin (see *Physical Habitat Quality for Aquatic Life*, p. 115). QHEI scores at the random headwater sites sampled were much higher in North Fork Paint Creek watershed with a mean of 66.7 - which is very capable of meeting WWH performance.

The biological community quality at the random headwater sites was higher overall in HUC 080 compared to the other three upper HUCs. The macroinvertebrate community quality



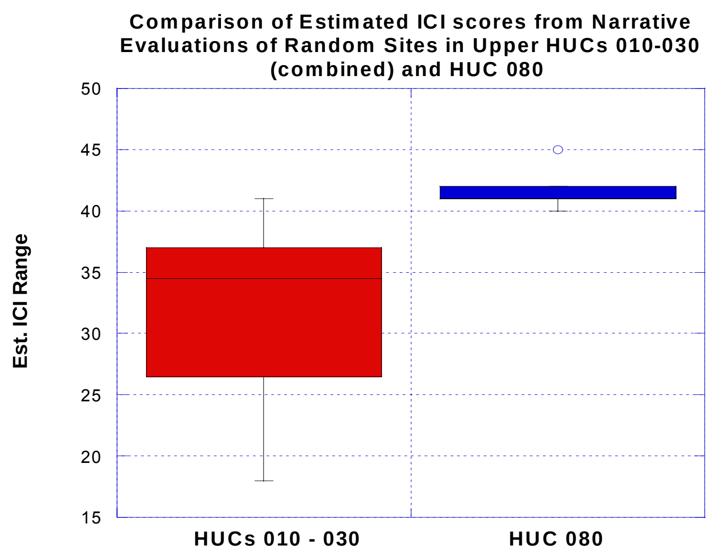


Figure 59. Comparison Graphs of QHEI and ICI scores for Random Sites in HUCs 010-030 and 080 of Upper Paint Creek Watershed, June-October 2006.

at all random sites was good to very good in the North Fork Paint Creek watershed (Figure 59). The interesting note in HUCs 010-030 is that despite the fair to poor habitat attributes at many sites (QHEIs of 27 to 45), most (60%) were still rated in marginally good to good condition with respect to macroinvertebrate quality (Figure 59). The primary reason for continued adequate biological performance at many habitat-impaired headwater sites is the amelioration of those conditions by the abundance of cool groundwater recharge in most of the Paint Creek watershed. Groundwater storage capacity in the Paint Creek watershed does generally increase from north to south and west to east (ODNR Geol. Survey Map BG-3, 8/2003). These headwater streams in the most eastern HUC in the upper watershed, North Fork Paint Creek, benefit highly from the larger groundwater volumes in their base flows during the drier months.

Overall, the random headwater sites sampled in the upper Paint Creek watershed indicated HUCs 010, 020 and 030 have the most extensively channelized stream network and the lowest overall biological quality. Collectively, these results demonstrate that poor stream habitat quality is a major limiting factor to aquatic life and that groundwater recharge is the ameliorating factor in the headwaters of the upper Paint Creek basin.

Wadeable Streams

Distributions of ICI scores, based on artificial substrate collections, were plotted by hydrologic unit (Figure 60). On a HUC basis, performance followed somewhat similar trends to those in the fish (IBI Figure 49) and to a lesser degree, QHEI (Figure 45). While the majority of macroinvertebrate sites exceeded minimum WWH criterion, lowest median ICI scores were found in the upper Paint Creek basin in the agricultural landscapes of HUCs 010 and 030. Habitat alteration, siltation and nutrient enrichment were common to streams in the upper HUCs, although these influences were more acute in smaller, headwater drainages. In contrast to the upper HUCs, performance tended to improve to the very good and exceptional ranges as sampling moved to the south, in the lower Paint Creek basin, and to the east, in the North Fork Paint Creek basin.

Higher quality communities observed in the narrow Sugar Creek basin (HUC 020) may be related to comparatively small sample size (N = 6) and the fact that sampling was limited to the Sugar Creek mainstem. Biological performance and habitat quality improved substantially in lower Sugar Creek and about half of the wadeable ICI sites were in the exceptional range.

In addition to larger stream size, one reason for the relatively higher quality communities at wading sites is that most stream assessments were based on artificial substrate sampling. By providing a consistent, high quality, colonizing surface at each site, quantitative collections tend to dampen the influence of habitat quality and, in the absence of significant water chemistry impacts, often reflect higher quality than more habitat dependent collections. Despite the difference in sampling methods, the general trend of improvement from west to east and north to south in the basin was apparent.

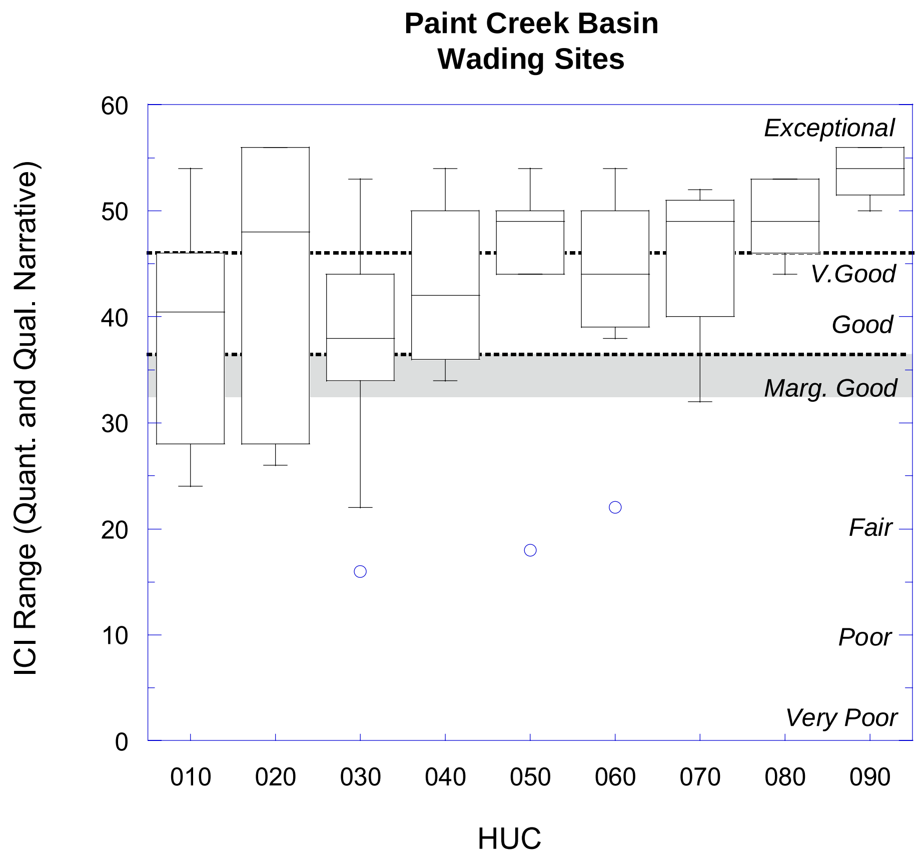


Figure 60. Box and whisker plots of ICI scores at wadeable sites (>20 sq. mi.) by HUC in the Paint Creek basin, 2006. HUC 100 was not included due to the limited number of sites.

Narrative Macroinvertebrate Community Assessments for Individual Streams

Upper Paint Creek

The Paint Creek mainstem in the upper watershed (HUC 010) flowed chiefly through row crop agricultural lands. There usually was some riparian corridor adjacent to the mainstem except in open pasture areas. As a result of this minimal canopy protection and sufficient cool groundwater recharge all sites harbored very good to exceptional macroinvertebrate communities and met the assigned WWH aquatic life use (Figure 61, Table 23). However in open canopy areas there were eroding, denuded banks which increased silty and nutrient enriched conditions, and the increased sunlight warmed local stream temperatures and increased algal production. Increased instream densities occurred at the upper sites with decreased community densities at RMs 75.4 and 73.2 due to higher quality riparian and instream habitat (reference site and more stable reach).

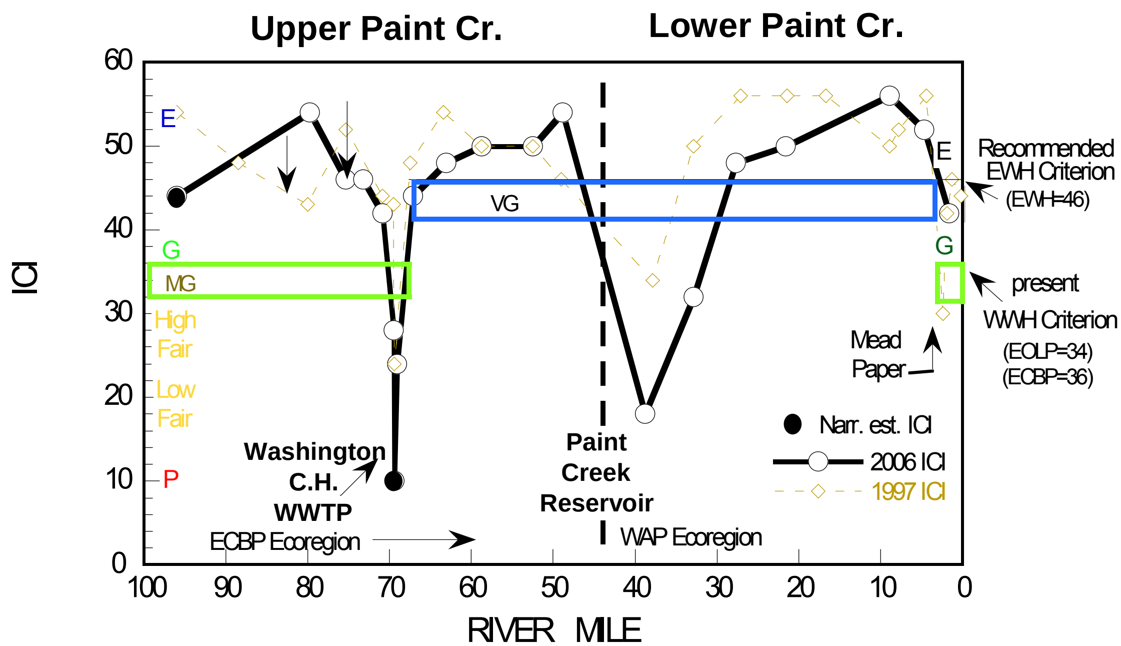


Figure 61.Line Plots of ICI scores by River Mile for sites sampled along the Paint Creek mainstem, 1997 and 2006 in relation to respective numeric biological criteria, and discharge locations of the Washington C.H.WWTP and the Mead Paper Company.

Very good conditions still prevailed in Washington C.H. through the upper park area, though the ICI score and overall community quality decreased at RM 70.9. Relative density and tolerant organisms increased in response to municipal inputs and lack of riparian canopy increasing temperatures and algal production. Community quality then decreased to fair conditions upstream from the Washington C.H. WWTP because of the cumulative poor habitat and accumulating municipal inputs increasing the density of facultative and tolerant organisms. The WWTP mixing zone was not acutely toxic with three EPT and 20 total taxa collected, but the wastewater effluent inputs did continue to cause fair quality conditions downstream at RM 69.1 with nutrient enriched conditions and facultative freshwater scuds and flatworms predominant.

Despite residual effects from Washington C.H. the macroinvertebrate community marginally met its EWH aquatic life use designation (HUC 050 and downstream) at RM 67.1, as the ICI was 44 (very good). There were 21 total EPT taxa and 27 sensitive taxa collected during sampling. Exceptional community quality continued in HUC 050 to Paint Creek Reservoir with ICI scores of 48 to 54 downstream to RM 48.9. High quality instream habitat and wider riparian corridors allowed nutrient assimilation with normal to low relative densities present.

Paint Creek stations at RMs 52.5 and 48.9 bracketed the Greenfield WWTP at RM 49.6. ICI scores from both sites were in the exceptional ranges (50 upstream; 54 downstream) and reflected no obvious impact below the discharge. EPT taxa richness, sensitive taxa richness, and population predominance was also very similar between sites indicating exceptional performance prior to entering Paint Creek Reservoir.

Lower Paint Creek

The Paint Creek Reservoir dam (RM 39.0) was used as the division between the upper and lower Paint Creek mainstem study areas. Seven mainstem stations located within all or portions of HUCs 050, 070, and 100 were sampled between RMs 38.8 and 0.7 (Table 23). The existing EWH designation extends downstream from the reservoir to Chillicothe (RM 3.8) while the remainder of the mainstem is WWH.

The remaining HUC 050 Paint Creek site was located at RM 38.8, immediately downstream from the Paint Creek Reservoir outlet. The outflow structure at Paint Creek Lake has two low-flow intakes and two sluice gates (USACOE, 2007, pers. comm.). Both sluice gates are located at the bottom of the lake (42' depth) while the two low flow intakes are located respectively at 9 ft deep (I9) and 28 ft deep (I28). All depths are referenced to the lake at summer pool elevation.

Typical operation of Paint Creek Lake is to use the sluice gates until dissolved oxygen in the hypolimnion drops below 2 mg/l (sometime in the spring). At that time the release is switched over to the low flow system. For storm events, all releases are made from the low flow system until capacity is reached and then the sluices are used for any additional flow. Water coming from the sluice gates during this time of year is usually anoxic, but it is diluted with water from the low flow intakes. In addition due to the design of the stilling basin and the high flow conditions, re-aeration of the release water is rapid. During the six-week Ohio EPA macroinvertebrate colonization period in July and August, all dam releases were from the low flow intakes. Median daily release volume was 62.5 cfs and ranged from 40.8 to 558.1 cfs during the same period (USGS 2007, pers. comm.).

Compared to stations upstream from the reservoir, community health declined sharply to the fair range (ICI = 18, Figure 61) and populations reflected extremely enriched conditions. Densities on the artificial substrates exceeded 10,000 per square foot compared to only 200 per square foot upstream. Artificial substrates were dominated by dense populations of filter-feeding midges (35% *Rheotanytarsus* and *Polypedilum flavum*), filter-feeding or “netspinner”caddisflies (22%), enrichment tolerant oligochaetes (17%), and midges (14% *Glyptotendipes* and *Nanocladius* *distinctus*). Total taxa richness, EPT and sensitive taxa richness also declined sharply compared to upstream collections. Increased productivity, particularly among filter feeders and reduced taxa richness is common below dam releases, and often related to the abundance of suspended zoo and phytoplankton in the outflows (Allen, 1995. Giller and Malmqvist, 1998).

Community response in Paint Creek below the reservoir outlet was nearly identical to 1997 collections from Rocky Fork Paint Creek RM 9.0, immediately downstream from Rocky Fork Lake dam (Table 22; OEPA file data). Rocky Fork was also highly enriched (>5,000 orgs./sq. ft.) and, like Paint Creek, the ICI of 24 was in the fair range. Predominant populations from both Paint Creek and Rocky Fork were very similar, accounting for 96% and 95% of total organisms at each site, respectively. The main difference was a greater proportion of oligochaetes at Paint Creek RM 38.8 but all the predominant populations were commonly associated with (either/or) enrichment (*e.g.*, oligochaetes, flatworms, *Glyptotendipes*), impoundment (*Nanocladius distinctus*, *Glyptotendipes*), strong current, and high levels of suspended solids (*e.g.,* filter-feeders). It is believed the Rocky Fork release is located at or near the lake surface but this has not been confirmed.

Table 22. A comparison of macroinvertebrate community attributes from Paint Creek (2006) and Rocky Fork Paint Creek (1997) samples collected immediately downstream from Paint Creek Reservoir and Rocky Fork Lake, respectively.

Macroinvertebrate Community Attributes (artificial substrate sample)	Paint Cr. RM 38.8 Dst. Paint Cr. Res. 2006	Rocky Fork RM 9.0 Dst. Rocky Fk Lake 1997
ICI	18 (Fair)	24 (Fair)
Density (# organisms/sq.ft)	10,101	5,208
Predominant Populations:	**Percent**	**Percent**
Polypedilum flavum (filter-feeding midge - F [a])	24	22
Oligochaeta (sludge worms - T)	17	1
Hydropsychidae (filter-feeding caddisflies- F, MI)	22	11
Rheotanytarsus sp (filter-feeding midge - MI)	11	34
Turbellaria (flatworms - F)	8	21
Glyptotendipes sp (red midge - T)	8	4
Nanocladius distinctus (midge - T)	6	2
Total	**96**	**95**

[a] Pollution Tolerance: F = Facultative, T = Tolerant, MI = Moderately Intolerant

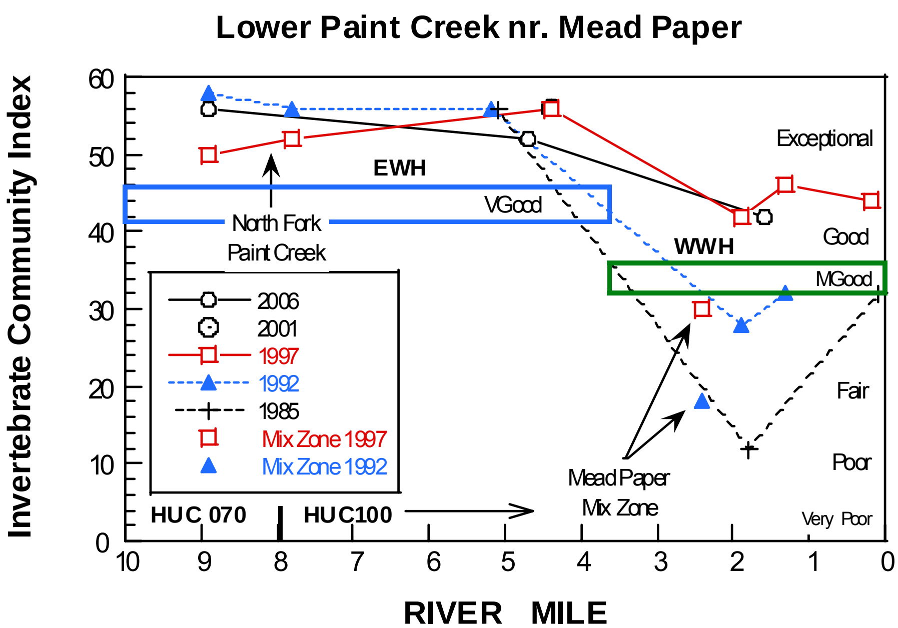
Downstream from the confluence with Rocky Fork, the ICI at RM 31.7 in Paint Creek was in the marginally good range and fell well below EWH standards. Macroinvertebrate performance appeared exceptional on a qualitative basis with 21 EPT and 29 sensitive taxa. However, the artificial substrate community indicated marginal quality with low ICI metric scores (*i.e.*, 0-2) for the percentages of tolerant taxa, other diptera/non insects, mayflies, and Tanytarsini midges. These relatively subtle impairments were sufficient to keep community performance below EWH standards and suggest a lingering negative influence from the Paint Creek Reservoir release, located approximately seven miles upstream.

Paint Creek ICI scores improved with increased distance downstream and fully met exceptional quality at remaining sites between Bourneville and Chillicothe (station RMs 27.7-4.7). Total EPT taxa richness averaged 30 and total sensitive taxa averaged 44, among the highest in the Paint Creek survey area. Based on macroinvertebrate performance, the approximate 25 mile stretch of Paint Creek upstream from Chillicothe, coupled with the lower 30 miles of North Fork Paint Creek (see HUC 090), account for the highest quality river reaches in the study area. The combined segments rank among the best quality stream reaches in the state.

Downstream from P. H. Glatfelter, macroinvertebrate community performance dropped from the exceptional to the very good range (ICI = 42 at RM 0.7) but remained well above the designated WWH criterion (ICI = 36). The river below Mead Paper was stained "tea-brown" and paper pulp solids coated substrates that were not observed upstream. An increase in density (from 453 to 1296 organisms per square foot), a 10 point decline in ICI score, and modest declines in Qual EPT and sensitive taxa richness (Table 22) reflected some negative influences associated with the discharge. However, overall community performance remained quite good prior to the confluence with the Scioto River.

Excluding the upper reach influenced by the Paint Creek Reservoir outlet and the lower miles influenced by Mead Paper, macroinvertebrates continue to strongly reflect exceptional quality in Paint Creek between Rocky Fork Paint Creek and Chillicothe (Figure 61). Exceptional habitat quality, low population densities, and the virtual absence of significant point or non-point stressors along the mainstem contribute to the stable trend. Enrichment associated with the Paint Creek reservoir outlet accounted for the most significant declines in the EWH designated reach in both 1997 and 2006 surveys.

Macroinvertebrate sampling surveys since 1985 indicate significant improvement in Paint Creek communities downstream from Mead Paper. Prior to 1997, mainstem ICI scores routinely dropped below WWH biocriterion downstream from Mead with commensurate increases in tolerant taxa percentages (Figure 62). Since 1997, mainstem ICI scores downstream from the discharge are all in the very good and low exceptional ranges (biocriteria are not applied to mixing zones) and the abundance of tolerant taxa has dropped precipitously.



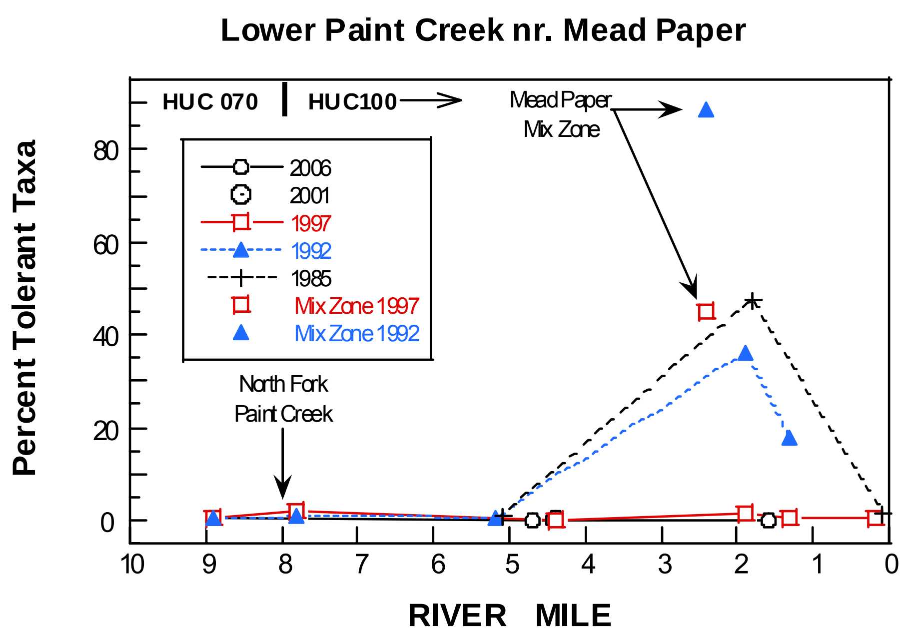


Figure 62. Trends in ICI scores and tolerant taxa percentage from the lower reaches of Paint Creek, 1985-2006.

HUC 010

East Fork Paint Creek

The upper East Fork was channelized, and because of low gradient, has little energy to recover channel development. The upper reach site was nutrient enriched, silty, and had periodic low D.O.s. Facultative flatworms and freshwater scuds predominated, resulting in a community narrative rating of fair, which did not attain the WWH biological criterion. The habitat in the middle and lower reach improved (QHEI of 56 and 63, respectively), but residual silt bedload limited the community to marginally good at the middle reach site. The site in the lower reach was evaluated as good. The ICI scores in 2006 were significantly lower than those from the 1997 survey, wherein scores were in the exceptional range of 48 - 52. Better habitat quality was documented in 1997 compared to 2006 (Figure 63).

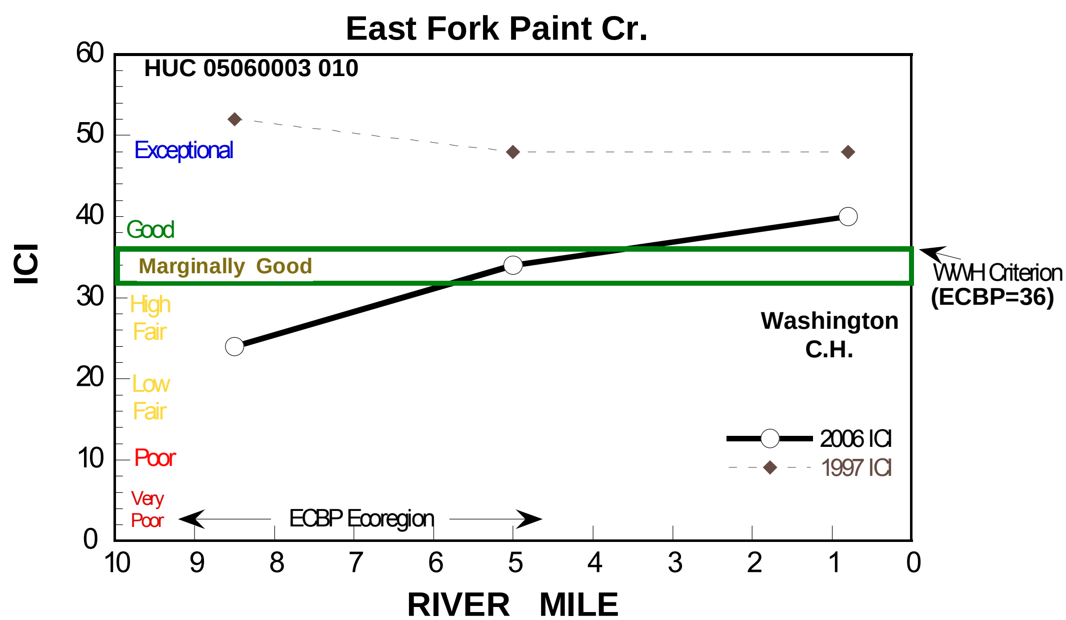


Figure 63. Line Plots of ICI scores by River Mile for sites sampled along the East Fork Paint Creek mainstem, 1997 and 2006 in relation to respective numeric biological criteria.

Vallery Ditch

A formerly channelized reach had recovered slightly where some riparian corridor and larger substrates were present, but a large sand bedload existed. The macroinvertebrate community was primarily comprised of caddisflies and riffle beetles but lacked mayflies and had little flow.

An increased number of tolerant organisms were present, and community quality was rated as fair due to channelization for agricultural drainage.

HUC 020

Sugar Creek

The upper reaches of Sugar Creek were modified for drainage and had high densities of blackflies and midges stimulated by abundant algae growing in the open ditch. Where unembedded rocky substrates were present, sensitive taxa (seven EPT taxa) were found, but the macroinvertebrate community was dominated by facultative and moderately tolerant (MT) taxa.

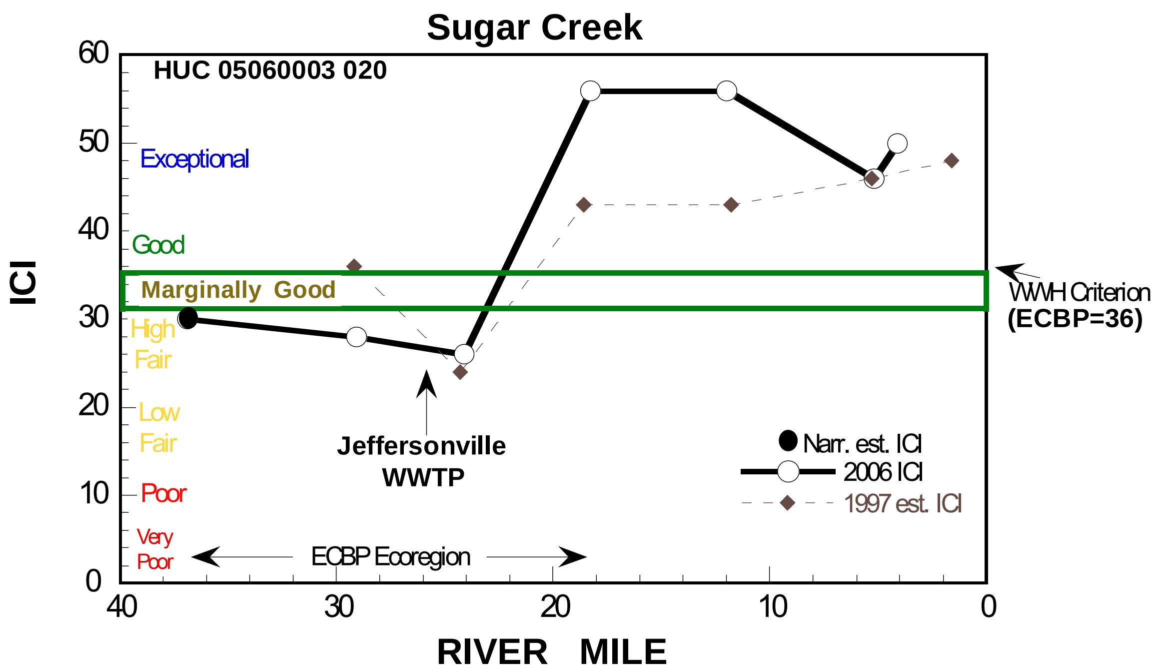


Figure 64. Line Plots of ICI scores by River Mile for sites sampled along Sugar Creek, 1997 and 2006 in relation to respective numeric biological criteria and the Jeffersonville WWTP.

Upstream and downstream from the Jeffersonville WWTP, sediment and nutrient loads from nonpoint and point sources caused fair conditions to prevail (Figure 64), and the macroinvertebrate community did not meet the WWH biocriterion. Upstream at McKillup Rd. (RM 29.2), channel development occurred within an over-widened ditched segment, but large populations of tolerant oligochaete worms in the quantitative sample (relative density of approximately 2550 organisms/ft.^{2}) confirmed nutrient enrichment. Habitat downstream from

Jeffersonville at Creamer Road was monotonous and sandy, and enriched by WWTP loads resulting in a fair community assessment (ICI=26).

Exceptional community quality was confirmed from near Ford Rd. (RM 18.3) to near the mouth. There was an 83-91% increase in EPT taxa and a 65-134 percent increase in sensitive taxa collected during qualitative sampling at RMs 18.3 and 12.0 compared to 1997 survey results. Exceptional community quality in the lower reaches was similar to 1997 results, but increased recreational ATV traffic instream does increase some sedimentation instream. A wider riparian corridor is more contiguous in the lower reaches of Sugar Creek.

HUC 030

Rattlesnake Creek

The macroinvertebrate community at the upper-most site of Rattlesnake Creek (SR 734, RM 40.4) met the WWH biocriterion despite showing evidence of effects from nutrient enrichment and sedimentation. However, poor habitat quality, sediment, and low dissolved oxygen resulted in the community departing non-significantly from the WWH biocriterion at RM 38.1 (US 35). Due to upgrades to the Octa WWTP the community quality downstream from the discharge at RM 35.3 was meeting the WWH biocriterion and performed distinctly better than in the 1997 survey (Figure 65). ICI scores were similar between 2006 and 1997 at RM 24.2.

Downstream from SR 62 the habitat quality improves, as gradient increases. Consistent, and very good to exceptional macroinvertebrate communities were present and represented mostly by moderately intolerant taxa (Figure 65). There were between 31-38 sensitive taxa and 19-27 EPT taxa collected at the three most downstream sites in the 2006 survey.

West Branch Rattlesnake Creek

Riparian removal and channelization occurred during May, 2006 at SR 729. Despite the habitat destruction, the site scored an ICI of 38, which was comparable to the 36 scored in 1997. The site at RM 2.8, however, did not meet the WWH biocriterion, owing to the cumulative effects of channelization, sedimentation, and possibly far-field effects from Sabina via Wilson Creek (fair quality with an ICI of 22).

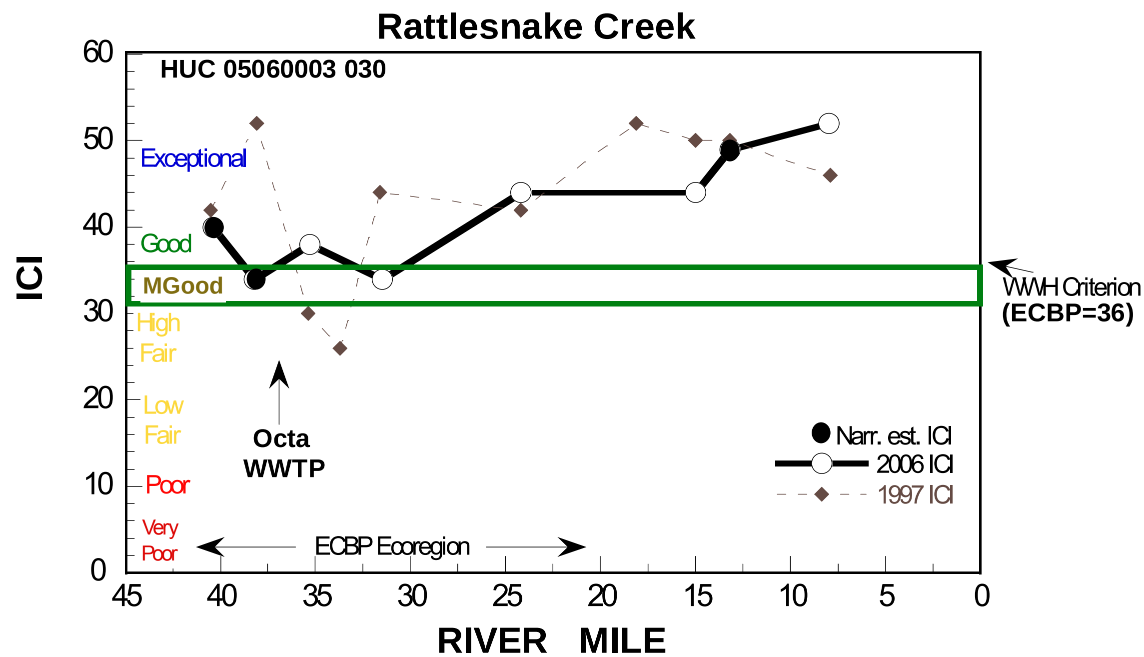


Figure 65. Line Plots of ICI scores by River Mile for sites sampled along Rattlesnake Creek, 1997 and 2006 in relation to respective numeric biological criteria and the Octa WWTP.

Wilson Creek

Macroinvertebrate communities in Wilson Creek were sampled upstream from Sabina at RM 5.0, downstream from an unnamed tributary that receives stormwater from Sabin and enters Wilson Creek near RM 4.2, and bracketing the Sabina WWTP at RMs 2.9 and 2.8 (Figure 66). Upstream from Sabina (at RM 5.0), the macroinvertebrate community was limited by poor habitat, and rated at the lower end of the fair range. Downstream from the unnamed tributary, the macroinvertebrate community was also rated at the low-end of the fair range, and appeared limited by sediment and stormwater. Also, an organic odor was noted, and was especially pronounced in the unnamed tributary where macroinvertebrates similarly scored in the low-fair range. The sites bracketing the Sabina WWTP failed to meet WWH, as the macroinvertebrate communities were rated at the lower end of fair for the site downstream from the municipal WWTP, and poor immediately upstream from the WWTP. The sample collected upstream from the WWTP (RM 2.9) contained mostly flatworms, and was limited by poor habitat and stormwater from Sabina. Downstream from the WWTP the macroinvertebrate community was affected by organic enrichment, low D.O.s, and elevated ammonia concentrations from the effluent.

Figure 66. Aerial photo of the Wilson Creek drainage in the vicinity of Sabina. Sampling locations referenced in the text are noted and color-coded by attainment status (red - not meeting WWH; yellow partially meeting WWH).

Trib. to Rattlesnake Creek (confl. @ RM 40.21)
A thin but intact riparian corridor apparently helped to keep the native gravel and cobble substrates free of sediment, resulting in marginally good community quality.

HUC 050
Wabash Creek
Upstream from St. Rt. 41, bedrock in the Wabash drainage is close to the surface. Consequently, Wabash Creek receives little groundwater, and had interstitial flow at the time of sampling. The bedrock and rocky substrate pools located between the dry riffles contained a marginally good community with *Helicopsyche* (snailcase) caddisflies and riffle beetles. The creek downstream from SR 41 cuts through the bedrock and is isolated from the surrounding uplands, thereby offering a measure of protection from nonpoint pollution.

Pone Creek
A channelized agricultural ditch with destabilized banks and mostly silt and clay bottoms, isopods, midges, and oligochaete worms were the most numerous organisms in the sample, thus leading to a low-fair rating.

HUC 080
North Fork Paint Creek
The macroinvertebrate community, though enriched by adjacent pastures (densities of ~1800/ft.^{2}), had very good diversity with 25 sensitive taxa present. The ICI of 48 indicated exceptional community quality (Figure 66).

Downstream from Good Hope-New Holland Road (RM 26.6), the riparian corridor was largely intact, which shaded the stream, and helped to stabilize the banks. Normal amounts of algae and stable substrates allowed for a diverse community with EPT and sensitive taxa present. The ICI of 46 rates as exceptional.

Compton Creek
The narrative assessment was used at RM 11.0 in lieu of the quantitative score as a beaver dam constructed during the colonization period reduced flow velocity over the artificial substrates. The woody riparian habitat at RM 11.0, though thin, had adjacent grass buffers and appeared to capture sediment. There was a diverse community present with 78 total taxa, and 21 sensitive taxa. Consequently the macroinvertebrate community was rated as very good. Exceptional community quality was also noted at RM 3.3 and at the regional reference site at RM 1.1 (ICI=50). Sensitive caddisflies, mayflies and midges were the predominant taxa in this lower reach, owning to moderate stream gradient, diverse, rocky substrates and good channel development.

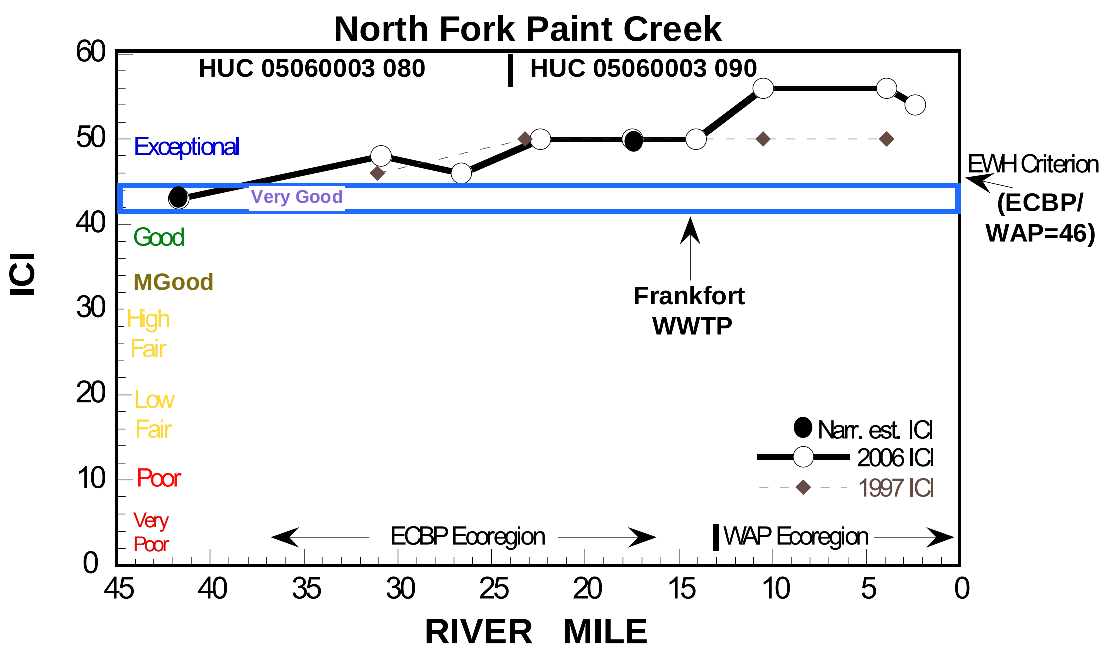


Figure 67. Line Plots of ICI scores by River Mile for sites sampled along North Fork Paint Creek, 1997 and 2006 in relation to respective numeric biological criteria and the Frankfort WWTP.

Mud Run

The sample reach was bordered by a consistent, narrow riparian corridor of trees and a 30-50 foot wide herbaceous filter strip. Channel substrates included gravels and cobbles that were relatively free from smothering fines, owing to the buffer effect of the riparian corridor that apparently filtered sediment from adjacent agricultural fields. Predominant taxa were net-spinning and cased caddisflies, with 18 EPT taxa and 21 sensitive taxa collected. Moderate to high densities of macroinvertebrates reflected the ubiquitous nutrient enrichment characteristic of the ECBP. Maintaining and enhancing the existing vegetative buffers is recommended to protect water quality.

HUC 040

Rattlesnake Creek

The site sample at RM 8.0 had an ICI score of 52, rating as exceptional (Figure 65), and similar to that found in 1997 (Figure 65).

Fall Creek
Fall Creek at RM 7.1 was small (3.9 sq. mi.) and nearly intermittent with bedrock substrates, but stream habitat was natural and intact. Pool habitats contained smothering silt, and the presence of numerous tolerant snails may have reflected enriched conditions, or low-flow stress. However, the presence of 11 EPT taxa and 12 sensitive taxa suggest impacts were not severe and overall community health was considered marginally good. Further downstream, at RM 1.7, community performance improved to the exceptional range with 20 EPT and 24 sensitive taxa (Table 23). Population densities appeared much lower at the downstream site compared to the upstream site, and numbers of tolerant snails were substantially less.

Hardin Creek and Walnut Creek
Unlike most other streams sampled in HUC 040, Hardin Creek (RM 0.9) and Walnut Creek (RM 0.7) were very clear with sustained base flow and low amounts of silt. Hardin Creek communities were exceptional (ICI = 54) and Walnut Creek communities were considered very good based on the numbers of EPT (17) and sensitive (19) taxa.

Lees Creek
Lees Creek was sampled at three locations, RMs 10.4, 4.5, and 1.1, that ranged in size from 14.3 to 73.0 sq. miles. The stream at RM 10.4 was ditched and enriched, but diversity was high, giving an ICI of 38. Cased caddisflies were found on rock and wood substrates. Further downstream, community performance improved to the exceptional and very good ranges at RMs 4.5 and 1.1, respectively (Table 23). Unlike the modified upper reach, stream channels at the downstream sites were natural and intact with excellent habitat and substrate quality.

Middle Fork Lees Creek
Community performance ranged from marginally good at RM 5.1 to good (ICI = 38) at RM 1.2. At RM 5.1, stream habitat was natural but flows were very low, and stream temperature was warm (26.5 degrees C). The community was dominated by high densities of flatworms, suggesting enrichment or low flow stress. Additionally, the substrate was mostly fine sand, and bank erosion appeared extensive. The number of EPT (9) and sensitive taxa (13) suggested overall impacts were not severe, and community performance was considered marginally good. Communities improved slightly with increased distance downstream but the large number of pollution tolerant oligochaetes from the artificial substrates (22%) and abundance of flatworms on natural substrates suggested continued enrichment. The stream drains Leesville, and a slight oil sheen was observed on the surface during one site visit.

South Fork Lees Creek
Similar to Middle Fork Lees Creek RM 5.1, the South Fork at RM 1.7 was natural but nearly intermittent, warm (25 degrees C) and appeared moderately enriched. Macroinvertebrates barely maintained WWH with only ten EPT and nine sensitive taxa found. The community was considered marginally good as low-flow stress appeared the most significant negative influence.

HUC 060

Rocky Fork Paint Creek

Rocky Fork Paint Creek was sampled at two locations upstream from Rocky Fork Lake (RMs 23.3 and 18.0) and two locations downstream from the lake (RMs 4.5 and 3.1). The RM 4.5 site was also located immediately downstream from the Barretts Mill low-head dam impoundment and was added to assess potential impacts associated with extensive mid-summer filamentous algae growth behind the dam. The entire length of Rocky Fork is designated EWH.

ICI scores upstream from Rocky Fork Lake were in the exceptional range and matched the trend of exceptional performance found at all upper Rocky Fork sampling sites since 1997 (Figure 68). Slightly lower scores in 2006 were likely related to slow current velocities over the artificial substrates and not declines in water quality. Positive community attributes such as the number of EPT taxa, sensitive taxa, and total taxa richness remained high in 2006 and in line with previous collections.

Community performance downstream from Rocky Fork Lake and the Barretts Mill dam pool dropped to the good range (ICI=40) and did not meet the designated EWH criterion (46 minimum). On a qualitative basis, macroinvertebrate performance was clearly exceptional with over 25 EPT taxa and over 30 sensitive taxa collected. However, ICI scoring was skewed by large numbers of *Hydra* (4,563) which accounted for 50% of total organisms. *Hydra* abundance was likely stimulated by enrichment and increased zooplankton growth from the low head dam pool immediately upstream. Artificial substrate samplers were lost at the next downstream site (RM 3.1) but qualitative sampling indicated exceptional quality.

Historic macroinvertebrate sampling from the lower reaches of Rocky Fork Paint Creek indicated exceptional quality except at RM 9.0, immediately downstream from the Rocky Fork Lake dam (ICI = 24/Fair in 1997). Like Paint Creek collections immediately downstream from the Paint Creek Reservoir outlet, the Rocky Fork communities reflected extremely enriched conditions associated with the seston-rich lake release water (Table 23). A somewhat similar phenomemon and enriched conditions were also observed immediately downstream from the Barretts Mill low head dam in 2006.

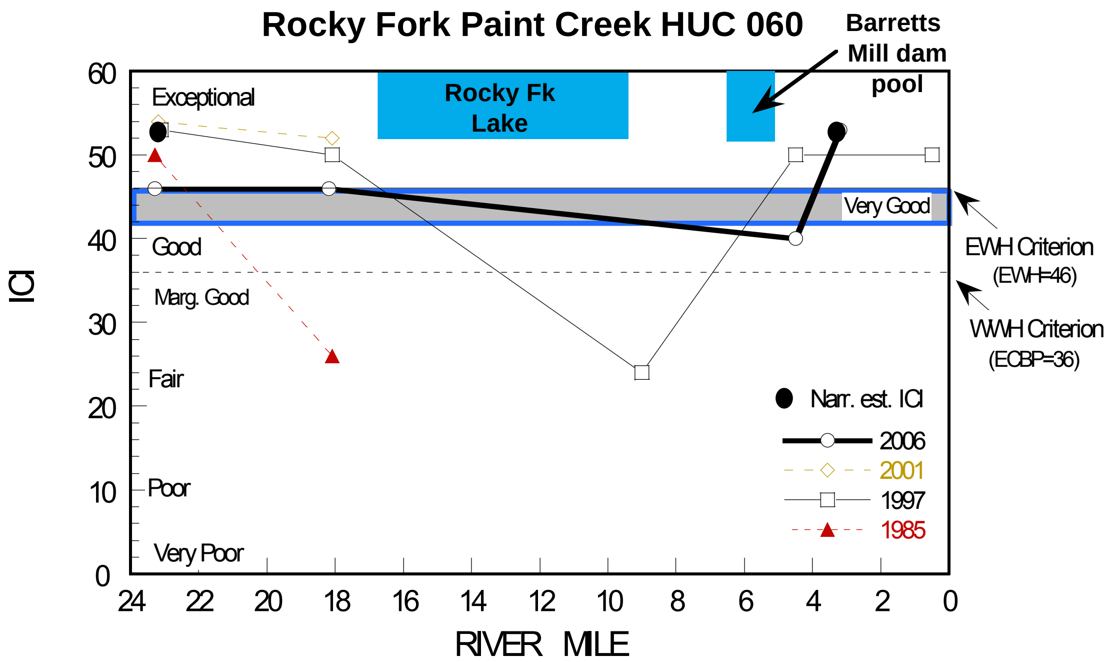


Figure 68. Line Plots of ICI scores by River Mile for sites sampled along Rocky Fork Paint Creek, 1997 and 2006 in relation to respective numeric biological criteria.

Clear Creek

Clear Creek collections upstream from Hillsboro and the Hillsboro WWTP reflected very good to exceptional quality communities that met the designated EWH aquatic life use (Figure 69). The somewhat marginal ICI score at RM 8.5 (42 = Very Good) was considered the result of slow current velocities over the artificial substrates as opposed to significant water quality stress.

At the Hillsboro WWTP, the ICI declined from the exceptional immediately upstream (50 at RM 6.9), to the good range immediately downstream (38 at RM 6.6). An effluent odor and thin, but pervasive layer of solids covered the substrates at RM 6.6. The decline in the ICI was manifest in an increased percentage of tolerant taxa and declines in mayfly and qualitative EPT taxa richness. It was later learned that a rain related bypass event occurred just two days prior to sampler retrieval and the WWTP experienced numerous permit violations in the preceding month due to a downed secondary clarifier.

Artificial substrates were lost at the next downstream site (RM 5.2) but qualitative sampling reflected good, but enriched conditions. Qual. EPT taxa increased from 12 at RM 6.6 to 17 at

RM 5.2 but the presence of dense populations of enrichment tolerant flatworms (turbellaria) suggested a continued influence from the WWTP. Prior to entering Rocky Fork Lake, the ICI score reached the exceptional range (ICI = 54 at RM 2.2). However, the presence of large blue-green algal mats in pools and along the margins suggest elevated nutrient levels persisted at the most downstream site.

Clear Creek community performance has improved drastically downstream from the Hilllsboro WWTP since the stream was first evaluated in 1985 (Figure 69). WWTP upgrades and improvements in effluent quality were largely credited with improved community health (from very poor to exceptional) between 1985 and 1997. 2006 collections represent a modest downturn in quality downstream from the plant, primarily attributed to plant disruptions and bypass events in the weeks preceding sample collection. As mentioned previously, lower 2006 ICI scores at RM 8.5, upstream from Hillsboro, were likely related to slow current velocities over the artificial substrates, not significant changes in water quality.

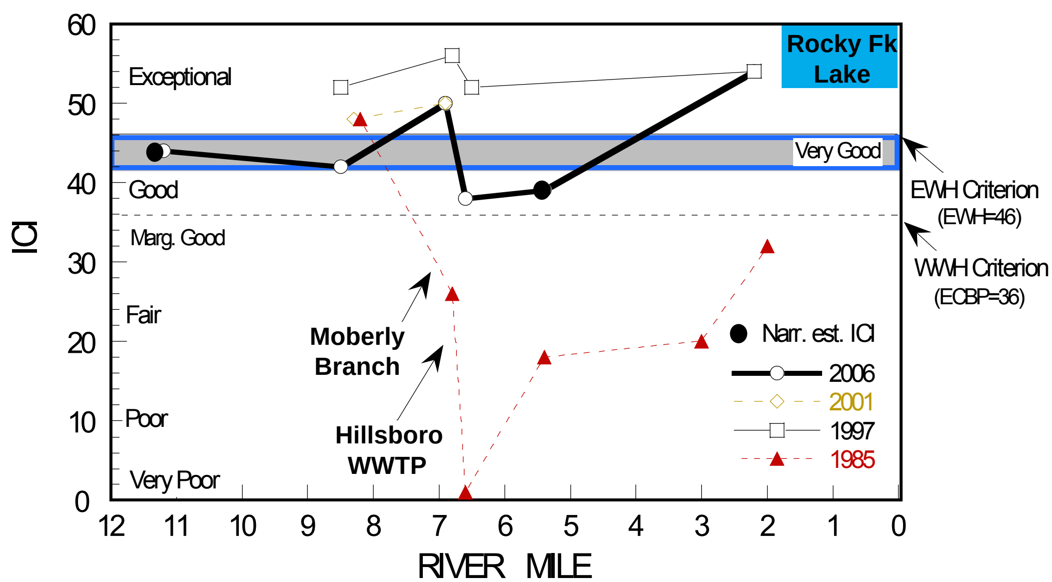


Figure 69. ICI scores by River Mile for sites sampled along Clear Creek, 1997 and 2006 in relation to respective numeric biological criteria and the Hillsboro.

Moberly Branch

Moberly Branch at RM 0.9 drains portions of the northern Hillsboro urban area. Qualitative sampling found a fair quality community with only four EPT taxa and three sensitive taxa in very low densities. The stream had a somewhat flashy appearance and most substrates were embedded. However, even substrates that were not embedded yielded very few organisms. Urban runoff appeared the most obvious source of impact.

Macroinvertebrate sampling has been conducted 4 times in Moberly Branch since 1985. ICI and narrative evaluations have shown variable quality during the period (*i.e.,* from marginally good in 1985 based on qualitative sampling, to poor in 1997 with an ICI of 12). Because of the very small stream size, there has been insufficient depth and flow to maintain current over the artificial substrates and this may account for some of the low ICI scores. Still, based on qualitative collections, community performance has rarely met ecoregional expectations and compares poorly to similar, small, rural streams in the area. Macroinvertebrates at eight randomly sampled HUC 060 tributaries with drainage areas less than 8 sq. mi., were in the good to exceptional ranges with no indications of significant impairment (Table 23).

HUC 070

Upper Twin Creek, Lower Twin Creek and Buckskin Creek

Macroinvertebrate collections from the three major Paint Creek tributaries in HUC 070 reflected exceptional quality at each of the four sampling site locations (Table 23). Qualitative sampling yielded over 20 EPT and sensitive taxa at each site, and the Buckskin Creek RM 0.6 ICI score of 52 was also in the exceptional range. Intact stream habitats, intact riparian buffers, high gradient, low nutrients and sustained flow in each tributary contributed to the exceptional performance. Upper Twin Creek sites also contained coldwater communities adequate for a CWH designation; four coldwater taxa were found at RM 2.1 and the three coldwater taxa at RM 5.8 were strong coldwater indicators.

HUC 090

Lower North Fork Paint Creek

Artificial substrate samplers were collected from five of six sampling locations in lower North Fork Paint Creek between RMs 22.4 and 2.4. Station RM 13.6 was located immediately downstream from the Frankfort WWTP, located at RM 14.2. The North Fork is designated EWH throughout it's length.

Macroinvertebrate performance was rated exceptional throughout the length of the lower North Fork (Table 23; Figure 67). Artificial substrates were lost at RM 17.5 but natural substrates populations were very similar to collections from the other sites. Despite plant disruptions and occasional operating violations, there was no indication of significant influence downstream from the Frankfort WWTP. The North Fork appears to have remarkable assimilative capacity and maintained very high quality despite potential stressors.

Sampling results at RM 17.5 in 1983 and 1997 were similar to 2006 collections. ICI scores were exceptional in previous sampling years (ICI = 46 vs. 48) and natural substrate sampling in 2006 also reflected exceptional quality.

Little Creek
Both quantitative and qualitative sampling results reflected exceptional quality at RM 3.7. The ICI of 54 was clearly in the exceptional range while the numbers of sensitive and EPT taxa were among the highest found in the Paint Creek survey area (Table 23). The stream was very clear, cool and natural with no indication of impairment. Further downstream near the mouth, the channel loses flow prior to entering the North Fork Paint Creek.

Biers Run
Biers Run was a small (7.1 sq. mi.), clear tributary to the North Fork Paint Creek with rubble, gravel and sand substrates. A thin layer of silt covered most substrates and bank erosion and slumpage appeared extensive. Macroinvertebrate performance was good (13 EPT; 19 sensitive taxa) but did not match the exceptional quality observed in the North Fork Paint Creek or Little Creek.

HUC 100
Cattail Run, *Owl Creek*, *Plug Run*, *Black Run RM 4.0*
Each stream site was small (3-6 sq. mi.), clear and cool with populations reflecting very good and exceptional quality (Table 23). In addition, each site included a minimum of 4 coldwater taxa indicating CWH potential in the macroinvertebrates.

Black Run RM 1.0
The lower reach of Black Run was a “losing stream” and flow ranged from very low to intermittent as the channel entered the Paint Creek flood plain. Despite the limiting flow regime, collections included 14 EPT and 18 sensitive taxa and reflected good quality. The coldwater characteristics observed upstream at RM 4.0 were lost in the lower reach with only one coldwater taxa collected.

Table 23. Summary of Macroinvertebrate Data Collected from Artificial Substrates (Quantitative Sampling) and Natural Substrates (Qualitative sampling) in the Paint Creek Study Area, June through October, 2006.

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Hydrologic Unit 05060003 010										
Paint Creek (02-500) (ECBP) - WWH (existing)										
96.0	31.0	59 / --	15 / --	22 / --	7	M / --	39.8	Riffle beetles (F), netspinner caddisflies (F), Tanytarsini and *Polypedilum* midges (MI,F)	VG	**Very Good**
79.8 R	54.0	42 / 59	14 /17	15 / 22	8	M-H/1,066	41.0	Riffle beetles (F,MI), Tanytarsini midges (MI), Asian clam (MI), netspinner caddisflies (F)	54	**Exceptional**
75.4 R	58.0	51 / 73	9 / 15	13 / 27	8	M-L / 481	35.7	Riffle beetles (F,MI), minnow mayflies & Asian clam (MI)	46	**Very Good**
73.2	60.0	42 / 65	14 / 19	15 / 23	3	M-L / 377	41.4	Minnow mayflies (MI,F), netspinner caddisfllies (F,MI)	46	**Very Good**
70.9	63.0	52 / 64	14 / 16	15 / 18	8	M-H/1,231	38.4	Netspinner caddisflies (F), riffle beetles (F), Tanytarsini (MI) and *Polypedilum flavum* midges (F)	42	**Very Good**
69.5	67.0	45 / 62	13 / 13	14 / 16	10	H-M/ 1,299	39.1	Tanytarsini (MI) and *Polypedilum flavum* midges (F)	28*	**Fair**
69.44	*67*	*21 / --*	*3 / --*	*2 / --*	*7*	*M-L /--*	*33.6*	*Flatworms (F), physid snails (T), aquatic worms (T)*	*P*	***Poor***
69.1	67	35 / 57	8 / 8	5 / 8	9	H-L / 463	33.7	Scuds (F), flatworms (F)	28*	**Fair**
East Fork Paint Creek (02-580) (ECBP) - WWH (existing)										
8.5	28.0	48 / 65	8 / 9	8 / 12	12	H / 927	34.8	Flatworms (F), riffle beetles (F), midges (F,MI,MT)	24*	**Fair**
5.0	33.0	44 / 64	7 / 9	11 / 17	7	L / 301	39.6	Riffle beetles (F), asian clam (MI), midges (F,MI,MT,T)	34^{ns}	**Marg. Good**
0.8 A / B	50.4	37 / 62 37 / 58	8 / 12 8 / 9	10 / 22 10 / 19	7 (both)	M-H / 500 / 330	37.6	Asian clam (MI), netspinner caddisflies (F), minnow mayflies (F), and riffle beetles (F)	40 / 38	**Good / Good**
Vallery Ditch (02-678) (ECBP) - MWH (recommended)										
2.3	2.3	35 / --	4 / --	2 / --	11	M / --	33.1	Micro caddisflies (F), riffle beetles (F)	HF*	**High Fair**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Hydrologic Unit 05060003 020										
Sugar Creek (02-579) (ECBP) - MWH (reccomended, previously unsampled this far upstream)										
36.9	5.3	43 / --	7 / --	7 / --	13	H-L / --	35.6	Blackflies (F), midges (F,MT,T,MI,VT)	HF	**High Fair**
Sugar Creek (02-579) (ECBP) - WWH (existing)										
29.1	23.0	42 / 52	8 / 9	8 / 9	12	M-H / 2,547	33.7	Snailcase caddiflies (MI), riffle beetles (F), micro caddisflies (F), midges (F,MI); HDs - flatworms (F), aquatic worms (T)	28*	**Fair**
24.1	28.0	42 / 65	9 / 10	10 / 15	13	M-H / 972	33.7	Scuds (F), Asian clam (MI), case builder caddisflies (*Oecetis*) (F,MI), flatworms (F)	26*	**Fair**
18.3	47.0	63 / 76	22 / 26	28 / 35	8	M-H / 717	42.5	Minnow mayflies (F,MI), netspinner caddisflies (F, MI), Asian clam (MI), Tanytarsini (MI) & other midges (F)	56	**Exceptional**
12.0	61.0	55 / 79	23 / 27	23 / 31	10	M / 679	40.0	Minnow mayflies (MI), flatheaded mayflies (F,MI), riffle beetles (F,MI), Tanytarsini midges (MI)	56	**Exceptional**
5.2	72.0	52 / 71	19 / 23	29 / 43	2	M / 308	43.2	Netspinner caddisflies (F), riffle beetles (F), water pennies (MI)	46	**Exceptional**
4.1	75.0	50 / 71	16 / 19	27 / 38	4	M / 236	42.1	Fingernet caddisfly, brush legged mayfly, water penny (MI), flatheaded mayflies (F,MI), snails (MI)	50	**Exceptional**
Hydrologic Unit 05060003 030										
Rattlesnake Creek (02-550) (ECBP) - WWH (existing)										
40.4	16.5	43 / --	15 / --	9 / --	7	M-L / --	39.9	Netspinner caddisflies, minnow mayflies and flatheaded mayflies (F,MI), blackflies (F)	G	**Good**
38.2	25.0	50 / 63	6 / 7	13 / 17	11	L-H/1,497	37.6	Snailcase (MI) and netspinner caddisflies (F), riffle beetles (F,MI), Tanytarsini (MI) & other midges (F)	MG^{ns}	**Marg. Good**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Rattlesnake Creek / HUC 030 (cont.)										
35.3	34.0	45 / 63	5 / 8	13 / 21	7	M-L / 617	38.9	Snailcase caddisflies (MI), riffle beetles (F,MI), fingernail clams (F,MI), damselflies (F) Tanytarsini midges (MI) and other midges (MI,F)	38	**Good**
31.5	40.8	45 / 62	9 / 13	9 / 17	10	M-L / 799	35.9	Netspinner, micro caddisflies (F), riffle beetles (F,MI)	34^{ns}	**Marg. Good**
24.2	110	41 / 68	17 / 20	13 / 25	7	M / 412	41.8	Micro caddisfly (F), moth larvae (MI), Asian clam (MI)	44	**Very Good**
15.0 R	125	42 / 64	16 / 19	21 / 33	2	M / 412	42.7	Riffle beetles (F,MI), case maker caddiflies (*Neophylax*), water pennies, and snails (MI)	44	**Very Good**
13.2	128	55 / 55	21 / --	31 / --	2	M-L / --	43.2	Caddisflies: fingernet, case maker (*Neophylax*), netspinner (F,MI); flatheaded and minnow mayflies (F,MI); water pennies (MI), snails (MI)	E	**Exceptional**
West Br. Rattlesnake Creek (02-562) (ECBP) - WWH (existing)										
4.2 R	19.0	44 / 62	9 / 12	9 / 13	9	M-L / 565	37.6	Riffle beetles (F), netspinner caddisflies (F), Tanytarsini midges and other midges (MI,F)	38	**Good**
2.8	41.6	39 / 56	7 / 7	7 / 10	8	M-L / 327	34.4	Tanytarsini midges (MI,F), micro caddisflies (F), scuds (F), damselflies (F)	22*	**Fair**
Wilson Creek (02-563) (ECBP) - WWH (reccomended)										
5.0	16.1	35 / --	4 / --	4 / v	16	H-L / --	30.0	Tanytarsini midges (MI), snails (MI), minnow mayflies (F), fingernet caddisflies (MI)	LF*	**Low Fair**
3.8	18.0	28 / --	3 / --	3 / --	11	L / --	31.9	Fingernail clams (F,MI), midges (F,MI,T)	LF*	**Low Fair**
2.9	18.4	20 / --	1 / --	3 / --	1	L / --	37.6	Flatworms (F)	P*	**Poor**
2.8	18.4	33 / 34	1 / 1	1 / 4	3	M-L / 580	33.1	Flatworms (F),fingernail clams (F,MI), micro caddisflies (F), aquatic worms (T)	16*	**Low Fair**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Trib. to Rattlesnake Creek (confl. @ RM 40.21) (02-598) (ECBP) - MWH (recommended)										
1.1	4.6	40 / --	10 / --	7 / --	11	M-H / --	35.6	Netspinner caddisflies (F), Tanytarsini midges (MI), other midges (F,MI), riffle beetles (F), snails (T,MT,F)	MG	**Marg. Good**
Hydrologic Unit 05060003 040										
Rattlesnake Creek (02-550) (ECBP) - WWH (existing)										
8.0	200	67 / 90	21 / 27	25 / 38	8	M / 393	40.0	Mayflies: minnow (F, I), brush legged (MI),flatheaded (MI, F); fingernet caddisflies (MI), water pennies (MI)	52	**Exceptional**
Fall Creek (02-552) (ECBP) - WWH (existing)										
7.1	3.9	40 / --	11 / --	12 / --	6	M-H / --	42.1	Netspinner caddisflies, riffle beetles, squaregill mayflies, and red midges (all F), physid snails (T)	MG^{ns}	**Marg Good**
1.7	13.3	60 / --	20 / --	24 / --	5	L / --	41.0	Fingernet (MI) and netspinner caddisflies (F), flat-headed mayflies (F, MI)	E	**Exceptional**
Hardin Creek (02-554) (ECBP) - WWH (existing)										
0.9	20.5	55 / 77	23 / 28	27 / 38	1	L-M / 224	42.1	Mayflies: brush legged (MI), flatheaded (F,MI), square-gill and minnow (F); long toed beetles (*Helichus*) (MI)	54	**Exceptional**
Walnut Creek (02-557) (ECBP) - WWH (existing)										
0.7	13.4	56 / --	17 / --	19 / --	7	M-H / --	39.9	Minnow mayflies (F,MI), netspinner caddisflies (MI,F), blackflies (F), red midges (F)	VG	**Very Good**
Lees Creek (02-558) (ECBP) - WWH (existing)										
10.4	14.3	57 / --	14 / --	10 / --	15	M-H / --	33.7	Caddisflies: snailcase (MI), case maker (*Neophylax)* (MI), micro (F); flatheaded mayflies (F)	G	**Good**
4.5	25.6	59 / 76	21 / 22	26 / 33	6	M-H / 142	39.9	Fingernet caddisflies (MI), netspinner caddisflies (F), flatheaded mayflies (MI, F), red midges (MI, F)	48	**Exceptional**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Lees Creek / HUC 040 (cont.)										
1.1	73.0	62 / 85	22 / 26	27 / 41	6	M-H / 357	42.1	Fingernet caddisflies (MI), squaregill mayflies (F), flatheaded mayflies (F, MI)	42	**Very Good**
Middle Fork Lees Creek (02-559) (ECBP) - WWH (existing)										
5.1	12.4	40 / --	9 / --	13 / --	6	H / --	39.1	Flatworms (F), squaregill mayflies (F)	MG[ns]	**Marg. Good**
1.2	36.1	52 / 68	13 / 14	16 / 20	5	L-M / 608	38.9	Flatheaded mayflies (MI), flatworms (F), fingernet caddisflies (MI), snails (MI)	38	**Good**
South Fork Lees Creek (02-560) (ECBP) - WWH (existing)										
1.7	15.9	40 / --	10 / --	9 / --	4	M-H / --	39.1	Mites (F), flatworms (F), netspinner caddisflies (F), snailcase caddisflies (MI), squaregill mayflies (F)	MG[ns]	**Marg. Good**
Hydrologic Unit 05060003 050										
Paint Creek (02-550) (ECBP) - EWH (existing)										
67.1	120	44 / 70	12 / 21	15 / 27	6	M /742	38.4	Minnow mayflies (F,MI), Asian clam (MI)	44	**Very Good**
63.1	131	49 / 76	21 / 26	27 / 41	3	M /363	43.2	Water pennies (MI), minnow mayflies (F,MI), case maker caddisflies (MI,I), Asian clam (MI)	48	**Exceptional**
58.8	224	49 / 67	22 / 24	27 / 38	2	M-L / 131	42.6	Netspinner (MI,F) and case maker (*Neophylax*) caddisflies (MI), minnow (F,MI,I) and flatheaded mayflies (F,MI), common stoneflies (I)	50	**Exceptional**
52.5	249	57 / 81	25 / 28	28 / 41	7	M / 340	43.2	Mayflies: minnow (F,MI,I), flatheaded (MI); Caddisflies: (*Neophylax*), fingernet (MI), moth larvae (MI)	50	**Exceptional**
48.9	261	55 / 76	24/ 28	26/ 39	5	M / 200	42.7	Minnow (F) and flatheaded mayflies (F,MI), fingernet and netspinner caddisflies (MI, F)	54	**Exceptional**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Paint Creek / HUC 050 (cont.)										
39.0	570	45 / 52	11/ 13	7/ 11	11	VHigh / 10,101	34.3	Netspinner caddisflies (MI, F), flatworms (F), red midges (T), oligochaetes (T)	18*	**Fair**
Wabash Creek (02-578) (ECBP) - WWH (existing)										
0.8	4.6	48 / --	7 / --	7 / --	17	M / --	33.1	Riffle beetles (F), snailcase caddisflies (MI), squaregill mayflies (F), snails (MI), midges (MT, F, T)	MG^{ns}	**Marg. Good**
Pone Creek (02-594) (ECBP) - WWH (existing) / MWH (recommended)										
2.6	2.7	26 / --	2 / --	2 / --	12	M -L / --	28.5	Isopods (F), midges (F,MI), oligochaete worms (T)	LF*	**Low Fair**
Hydrologic Unit 05060003 060										
Rocky Fork Paint Creek (02-530) - EWH (existing)										
23.3	16.2	51 / 68	17 / 19	20 / 29	6	L-M / 607	41.0	Mayflies (MI, F), fingernet caddisflies (MI)	46	**Exceptional**
18.2	33.0	49 / 69	13 / 18	17 / 28	7	M / 630	39.9	Mayflies (MI, F)	46	**Exceptional**
4.5	138	70 /102	26 / 32	31 / 46	10	L-M /1913	41.0	Stoneflies (I), mayflies (MI, F), riffle beetles (F)	40*	**Good**
3.2	140	63 / --	27 / --	32 / --	6	M / --	42.5	Mayflies (MI, F), blackflies, riffle beetles (F), tubemaker caddisflies (MI)	E	**Exceptional**
Clear Creek (02-540) (ECBP) - EWH (existing)										
8.5	16.9	47 / 68	19 / 20	18 / 27	6	L / 580	39.9	Minnow mayflies (F), fingernet (MI) and netspinner caddisflies (MI, F), flatheaded mayflies (MI, F)	42^{ns}	**Very Good**
6.9	24.9	61 / 85	19 / 20	17 / 28	10	M / 610	38.0	Fingernet (MI) and netspinner caddisflies (MI, F), flatheaded mayflies (F), water pennies (MI)	50	**Exceptional**
6.6	25.1	51 / 65	12 / 13	14 / 19	6	M / 622	39.2	Netspinner caddisflies (F, MI), flatworms (F), red midges, other midges (F, T)	38*	**Good**
5.2	32.0	58 / --	17 / --	19 / --	8	H / --	39.9	Flatworms (F), Tanytarsini midges (MI)	G*	**Good**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Clear Creek - EWH (existing)										
2.2	40.0	42 / 59	13 / 16	16 / 25	4	L-M / 428	41.0	Mayflies, flatworms, and riffle beetles (F)	54	**Exceptional**
Moberly Branch Clear Creek (02-585) - WWH (existing)										
0.9	2.5	28 / --	4 / --	3 / --	8	L / --	33.7	Riffle beetles, minnow mayflies (F), snails (MI)	F*	**Fair**
Hydrologic Unit 05060003 070										
Paint Creek (02-500) (WAP) - EWH (existing)										
32.9	730	69 / 79	21 / 23	29 / 33	12	M-H / 892	39.9	Netspinner caddisflies (F), moth larvae (MI)	32*	**Marg. Good**
27.7	788	79 / 83	32 / 33	47 / 50	5	M / 1,582	42.5	Fingernet (MI) and netspinner caddisflies (I, MI, F), Tanytarsini midges (MI), minnow mayflies (F, I, MI), moth larvae (MI)	48	**Exceptional**
21.6	807	65 / 71	29 / 30	33 / 37	6	M-H / 584	44.2	Mayflies (F, MI, I), netspinner caddisflies (I, MI, F), Tanytarsini midges (MI)	50	**Exceptional**
Lower Twin Creek (02-545) (WAP) - EWH (existing)										
2.3	15.0	72 / --	28 / --	34 / --	4	M-H / --	42.5	Caddisflies: fingernet, snailcase, netspinner (MI,F); minnow (F,MI) & squaregill mayflies (F), snails (MI)	E	**Exceptional**
Upper Twin Creek (02-546) (WAP) - EWH (existing)										
5.8	5.5	57 / --	23 / --	27 / --	4	H / --	42.5	Coldwater stoneflies (I), fingernet caddisflies (MI)	E	**Exceptional**
2.1	12.2	50 / --	23 / --	28 / --	2	M-H / --	43.2	Fingernet,caddisflies, water pennies, snails (MI)	E	**Exceptional**
Buckskin Creek (02-564) (ECBP) - WWH (existing)										
0.6	39.7	55 / 76	27 / 39	23 / 25	4	M-H / 551	42.6	Minnow mayflies (I, MI, F), other mayflies (F, MI)	52	**Exceptional**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Hydrologic Unit 05060003 080										
North Fork Paint Creek (02-510) (ECBP) - EWH (existing)										
North Fork Paint Creek (ECBP) / HUC 080 (cont.)										
30.9	45.0	58 / 72	11 / 17	17 / 25	11	M / 1,799	38.9	Netspinner (F,MI), fingernet and snailcase caddisflies (MI), Tanytarsini midges (MI), riffle beetles (F)	48	**Exceptional**
26.6	51.0	60 / 86	16 / 21	20 / 30	9	M-H /1,357	39.8	Caddisflies: netspinner (F), case builder (*Neophylax*), fingernet, snailcase (MI); riffle beetles (F), Tanytarsini midges and other midges (MI,F)	46	**Exceptional**
Compton Creek (02-522) (ECBP) - EWH (existing)										
11.0	19.9	49 / 78	11 / 13	14 / 21	7	M / 272	39.2	Fingernet(MI) and netspinner caddisflies (F,MI), riffle beetles (F)	VG[ns]	**Very Good**
3.3	49.7	62 / 62	19 / 19	23 / 23	8	M-L /--	41.0	Caddisflies: netspinner (F,MI), *Neophylax* (MI); Tanytarsini midges (MI), flatheaded mayflies (MI,F)	E	**Exceptional**
1.1 R	59.0	54 / 72	16 / 20	21 / 31	4	M-L / 413	41.0	Mayflies: brush legged (MI), flatheaded (MI,F); netspinner caddisflies, riffle beetles (F,MI), midges (MI)	50	**Exceptional**
Mud Run (02-524) (ECBP) - WWH (existing) / EWH (recommended)										
0.4	7.3	64 / --	18 / --	21 / --	9	M-H/ --	39.6	Caddisflies: netspinner (F,MI), snailcase (MI), and case builder (*Neophylax*) (MI)	E	**Exceptional**
Hydrologic Unit 05060003 090										
North Fork Paint Creek (02-510) (ECBP) - EWH (existing)										
22.4	122	58 / 89	18 / 28	26 / 40	7	M / 974	42.3	Mayflies: minnow (F),flatheaded (MI), other (F, MI); netspinner caddisflies (F, MI)	50	**Exceptional**
17.5	153	65 / --	22 / --	31 / --	8	M / --	42.5	Mayflies: minnow (F),flatheaded (MI), other (F, MI)	E	**Exceptional**

Stream RM	Drain. Area (mi. ²)	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
14.1	164	65/ 91	21 / 27	31 / 43	4	-- / 253	42.5	Netspinner caddisflies (F, MI), flatworms (F), Tanytarsini midges (MI), other mayflies (F, MI)	50	**Exceptional**
North Fork Paint Creek (WAP) - EWH (existing)										
10.5	207	67 / 93	24 / 31	31 / 48	5	- / 833	42.3	Mayflies: brush legged, flatheaded (MI), other (F, MI); Caddisflies: fingernet (MI), netspinner (F,MI)	56	**Exceptional**
3.9	230	55 / 78	19 / 24	22 / 37	7	- / 1,237	42.5	Mayflies: brush legged, flatheaded (MI), other (F, MI); Caddisflies: fingernet (MI), netspinner (F,MI)	56	**Exceptional**
2.4	232	58 / 92	22 / 34	30 / 49	8	- / 1,506	42.7	Mayflies: minnow (F ,MI, I), flatheaded (MI), other (F, MI); Caddisflies: fingernet (MI), netspinner (F,MI)	56	**Exceptional**
Biers Run (02-511) (WAP) - WWH (existing)										
1.6	7.1	45 / --	13 / --	19 / --	4	L-M / --	41.0	Netspinner caddisflies (F, MI), squaregill (F) and flatheaded (MI, F) mayflies, riffle beetles (F)	G	**Good**
Little Creek (02-516) (ECBP) - WWH (existing)										
3.7	14.7	61 / 82	27 / 29	32 / 41	3	M / 262	42.5	Mayflies: minnow (F), flatheaded (F, MI), squaregill (F); fingernet caddisflies (MI)	54	**Exceptional**
Hydrologic Unit 05060003 100 **Paint Creek** (02-500) (WAP) - EWH (existing)										
8.9	895	86 / 94	32 / 35	44 / 51	8	H / 771	43.2	Mayflies (I, MI, F), snails (MI), moth larvae (MI)	56	**Exceptional**
4.7	1137	70 / 83	27 / 29	37 / 49	6	M / 453	42.7	Mayflies (I, MI, F), *Macrostemum* caddisflies (I), snails (MI), moth larvae (MI)	52	**Exceptional**
Paint Creek (02-500) (WAP) - WWH (existing)										
1.6	1,143	70 / 76	26 / 30	30 / 35	10	H / 1,296	42.3	Caddisflies: fingernet (MI), netspinner (F,MI,I); Tanytarsini midges (MI), moth larvae (MI), blackflies (F)	42	**Very Good**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Cattail Run (02-527) (WAP) - WWH (existing) / CWH (recommended)										
1.2	2.9	54 / --	16 / --	22 / --	6	M / --	39.9	Coldwater stoneflies (I), netspinner caddisflies (F), water pennies (MI), snails (T), red midges (F, MI)	VG	**Very Good**
Owl Creek (02-528) (WAP) - WWH (existing) / CWH (recommended)										
0.3	6.5	52 / --	16 / --	23 / --	5	L / --	42.5	Coldwater stoneflies (I), diving beetles (T), snails (MI)	VG	**Very Good**
Plug Run (02-529) (WAP) - WWH (existing) / CWH (recommended)										
0.6	5.4	65 / --	19 / --	28 / --	5	H / --	39.6	Coldwater stoneflies (I), flatheaded mayflies (F, MI), red midges (F, MI)	E	**Exceptional**
Black Run (02-543) (WAP) - WWH (existing) / CWH Hdwters to Paint Cr. floodplain (recommended)										
4.0	5.0	48 / --	17 / --	20 / --	3	H / --	39.5	Coldwater stoneflies (I, MI), red midges (T,F,MI)	VG	**Very Good**
1.0	8.6	54 / --	14 / --	18 / --	9	L / --	40.5	Squaregill mayflies (F), midges (most F), physid snails (T)	G	**Good**
Randomly Selected Headwater Streams Sampled in Paint Creek Watershed										
Hydrologic Unit 05060003 010										
Big Run (02-581) (ECBP)										
1.8	3.7	51/ --	9 / --	9 / --	14	M-H / --	36.8	Midges: Tanytarsini (MI), otber (MI,F); netspinner caddisflies (F)	MG^{ns}	**Marg. Good**
William Cathcart Ditch (02-677) (ECBP)										
0.2	3.8	38 / --	10 / --	5 / --	6	M-L / --	37.6	Tanytarsini midges (MI), snailcase (MI) and net-spinner caddisflies (MI, F)	MG^{ns}	**Marg. Good**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Hydrologic Unit 05060003 020 (Randomly Selected Headwater Streams)										
Missouri Ditch (02-975) (ECBP)										
Grassy Branch Rattlesnake Creek (02-975) (ECBP)										
8.7	5.2	48 / --	13 / --	7 / --	14	M / --	35.9	Netspinner caddisflies (F), flatheaded mayflies (F)	G	**Good**
Hydrologic Unit 05060003 030 (cont.)										
Maple Grove Creek (02-597) (ECBP)										
1.6	2.3	42 / --	8 / --	7 / --	13	M-L / --	34.8	Water boatmen (F), netspinner caddisflies (F), midges (MI,F,MT), minnow mayflies (I)	MG[ns]	**Marg. Good**
Trib. to Wilson Creek (confl. @ RM 4.24) (02-674) (ECBP)										
0.3	5.5	16 / --	2 / --	3 / --	3	L / --	35.5	Tanytarsini midges (MI), riffle beetles (F), netspinner caddisflies (F)	LF*	**Low Fair**
West Branch Rattlesnake Creek (02-562) (ECBP) - WWH (existing)										
11.4	6.3	35 / --	4 / --	4 / --	13	H-M / --	31.8	Midges (F,MI,MT,T,VT), water beetles (MT), riffle beetles (F), flatworms (F)	HF*	**High Fair**
Hydrologic Unit 05060003 040 (Randomly Selected Headwater Streams)										
Big Branch (02-553) (ECBP)										
1.5	3.7	51 / --	18 / --	16 / --	8	M-H / --	39.6	Fingernet caddisflies (MI), squaregill mayflies (F), minnow mayflies (I, MI, F), midges (MI, F)	VG	**Very Good**
Hardin Creek (02-554) (ECBP)										
5.8	2.8	52 / --	16 / --	19 / --	5	L-M / --	39.6	Minnow mayflies (F), netspinner caddiflies (F), snail-case caddiflies (MI), physid snails (T)	G	**Good**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Walnut Creek (02-557) (ECBP) - WWH (existing)										
4.2	5.7	58 / --	18 / --	18 / --	7	M-H / --	39.6	Tanytarsini midges (MI), flatheaded mayflies (F, MI), snailcase caddiflies (MI), snails (MI)	E	**Exceptional**
Lees Creek Tributary (RM 2.57) (02-599) (ECBP)										
1.4	3.1	18 / --	1 / --	0 / --	11	H / --	23.4	Water boatmen (F), diving beetles (MT)	VP*	**Very Poor**
Lees Creek Tributary (RM 4.83) (02-672) (ECBP)										
0.3	2.2	37 / --	10 / --	16 / --	5	H / --	23.4	Fingernet caddisflies (MI), red midges (MI, F, T)	G	**Good**
South Fork Lees Creek Tributary (RM 3.83/0.25) (02-673) (ECBP)										
0.1	1.7	29 / --	2 / --	2 / --	10	M / --	34.9	Red midges (F), physid snails (T)	P*	**Poor**
Hydrologic Unit 05060003 050 (Randomly Selected Headwater Streams)										
Indian Creek (02-577) (ECBP) - WWH (existing)										
1.7	5.8	40 / --	5 / --	7 / --	12	M-H / --	34.3	Snailcase (MI) and micro caddisflies (F), snails (MI)	HF*	**High Fair**
Hydrologic Unit 05060003 060 (Randomly Selected Headwater Streams)										
Clear Creek (02-540) (ECBP)										
11.2	7.4	49 / --	12 / --	16 / --	8	M-H / --	39.9	Fingernet caddisflies (MI), squaregill mayflies, riffle beetles (F), flatworms (F)	VG	**Very Good**
Pickett Run (02-532) (IP) CWH (recommended)										
0.1	1.8	39 / --	11 / --	17 / --	2	L-M / --	43.2	Fingernet caddisflies (MI), coldwater stoneflies (I)	G	**Good**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Hussey Run (02-541) (ECBP)										
0.9	3.0	45 / --	15 / --	19 / --	3	L-M / --	41.0	Long toe beetles (*Helichus)* (MI), snailcase and tube-maker caddisflies (MI), squaregill mayflies (F), red midges (F, MI)	VG	**Very Good**
South Fork Rocky Fork (02-542) (?)										
3.3	7.2	45 / --	17 / --	18 / --	2	L / --	39.9	Snails (MI), fingernet (MI) and netspinner caddisflies (F, MI), squaregill mayflies	VG	**Very Good**
Little Rock Creek (02-587) (ECBP)										
1.4	2.2	59 / --	18 / --	24 / --	4	L-M / --	41.0	Mayflies (F, MI, I), netspinner caddisflies (F), craneflies (MI), mites (F), red midges (MI, F, T)	E	**Exceptional**
Coon Creek (02-588) (ECBP)										
0.2	4.1	44 / --	15 / --	15 / --	4	L-M / --	39.1	Netspinner caddisflies (F), squaregill mayflies (F)	G	**Good**
Fenner Tributary aka Trib. To Clear Creek (RM 8.57) (02-589) (ECBP) - WWH (existing)										
0.4	2.7	44 / --	12 / --	12 / --	5	L-M / --	39.1	Netspinner (F) and snailcase caddisflies (MI), flatworms (F), squaregill mayflies (F)	G	**Good**
Trib. To Rocky Fork (RM 17.55) (02-596) (IP)										
1.0	2.3	41 / --	15 / --	20 / --	5	L-M / --	42.6	Snails (MI), fingernet caddisflies (MI)	VG	**Very Good**
Hydrologic Unit 05060003 070 (Randomly Selected Headwater Streams)										
Sulphur Lick (02-548) (WAP)										
1.6	7.6	33 / --	6 / --	5 / --	10	L-M / --	33.1	Water boatmen (F), diving beetles (T), *Helichus* riffle beetles (MI), squaregill mayflies (F)	F	**Fair**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Buckskin Creek (02-564) (ECBP)										
13.9	4.8	49 / --	16 / --	18 / --	5	M / --	40.0	Minnow mayflies (I, F), flatworms, netspinner caddisflies, and squaregill mayflies (F)	G	**Good**
Massie Run (02-568) (ECBP)										
0.1	4.9	59 / --	18 / --	25 / --	5	L-M / --	40.0	Minnow and squaregill mayflies, netspinner caddisflies (F)	VG	**Very Good**
Trib. To Buckskin Creek (RM 12.25) (02-676) (WAP)										
0.1	2.7	45 / --	8 / --	9 / --	7	L-M / --	38.9	Snailcase (MI) and netspinner (F) caddisflies, snails (MI), fingernail clams and crayfish (F)	F	**Fair**
Hydrologic Unit 05060003 080 (Randomly Selected Headwater Streams)										
Compton Creek (02-522) (ECBP) - EWH (existing); WWH (recommended)										
17.6	6.1	53 / --	13 / --	12 / --	9	M / --	39.1	Midges (MI,F,T), minnow mayflies (F,MI), netspinner (F,MI) & micro caddisflies (F), squaregill mayflies (F)	G	**Good**
Crooked Creek (02-523) (ECBP)										
2.9	7.2	55 / --	14 / --	19 / --	7	M / --	38.9	Snailcase caddisflies (MI), flatheaded mayflies (F), red midges and Tanytarsini midges (MI,F)	VG	**Very Good**
North Fork Paint Creek (02-510) (ECBP) - EWH (existing)										
41.7	11.0	56 / --	14 / --	13 / --	12	M-H /--	39.1	Snailcase and fingernet caddisflies (MI), Tanytarsini midges (MI), riffle beetles (F)	VG[ns]	**Very Good**[ns]
Thompson Creek (02-525) (ECBP)										
3.3	8.0	47 / --	12 / --	10 / --	7	M / --	39.4	Snailcase (MI) and netspinner caddisflies (F,MI), riffle beetles (F)	G	**Good**

Stream RM	Drain. Area (mi. ^{2})	Qual./ Total Taxa	# EPT Ql. / Total	Sensitive Taxa Ql. / Total	Qual. Tol. Taxa	Rel. Density Ql. /Qt.	QCTV	Predominant Organisms on Natural Substrates With Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
Wolf Run (02-595) (ECBP)										
0.3	3.6	47 / 47	11 / 11	16 / 16	7	M-H /--	38.4	Snailcase caddiflies (MI), riffle beetles (F), flatheaded mayflies (F)	G	**Good**
Hydrologic Unit 05060003 090 (Randomly Selected Headwater Streams)										
Little Creek (02-516)										
5.8	8.4	45 / --	18 / --	18 / --	3	M / --	42.1	Netspinner (F, MI) and fingernet (MI) caddisflies, squaregill mayflies (F)	VG	**Very Good**
Oldtown Run (02-518) (ECBP)										
1.3	8.5	15 / --	3 / --	1 / --	2	H / --	31.8	Scuds (F)	P*	**Poor**
Hydrologic Unit 05060003 100 (Randomly Selected Headwater Streams)										
Ralston Run (02-526) (WAP)										
2.8	5.2	35 / --	8 / --	7 / --	6	M-H / --	35.6	Midges (most F and T), mnnow mayflies (F), physid snails (T)	F*	**Fair**

RM: River Mile.
Ql.: Qualitative sample collected from the natural substrates.
Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List as MI (moderately intolerant) or I (intolerant).
Qt.: Quantitative sample collected on Hester-Dendy artificial substrates, density is expressed in organisms per square foot.
Qualitative sample relative density: L=Low, M=Moderate, H=High.
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant
ns : nonsignificant departure from attainment criteria of designated aquatic life use (four units)
R ecoregional reference site
* significant departure from attainment criteria of designated aquatic life use (≥ four ICI units), *i.e.*, nonattainment of aquatic life use

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