Biological and Water Quality Study of the Middle Scioto River and Select Tributaries, 2010

Delaware, Franklin, Pickaway, and Union Counties

Ohio EPA Technical Report EAS/2012-12-12

Division of Surface Water
Ecological Assessment Section
November 21, 2012

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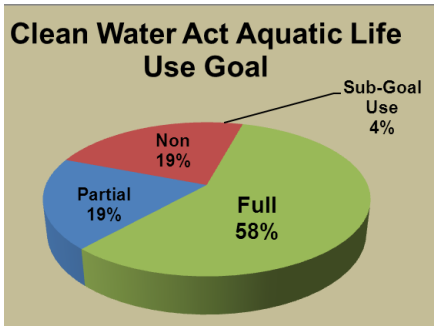
EXECUTIVE SUMMARY

All rivers and streams in Ohio are used for various purposes such as recreation or to support aquatic life. Ohio EPA evaluates each stream to determine the appropriate use designation and also to determine if the use is meeting the goals of the federal Clean Water Act. Nineteen streams in the study area were evaluated for aquatic life and recreational use potential between 2009 and 2010 (Figure 1 and Table 1). Sixteen streams are listed in the Ohio Water Quality Standards with the Warmwater Habitat (WWH) aquatic life use designation and two previously undesignated streams are being recommended for the WWH aquatic life use designation (Table 3). The Scioto River near Town Street (RM 131.4) is currently designated Modified Warmwater Habitat - Impounded (MWH-I) and Kian Run is recommended for Modified Warmwater Habitat – Channel Modification (MWH-C). The upper reach of Powderlick Run will retain the Limited Resource Water (LRW) aquatic life use designation. The existing Secondary Contact Recreation (SCR) use for Powderlick Run and Republican Run should be changed to Primary Contact Recreation (PCR). All remaining streams in this study should retain the PCR use or SCR use, along with the Agricultural and Industrial uses (Table 3).



Nearly half of the sites within the middle Scioto River basin did not meet the Clean Water Act biological integrity goal, as only 58% were in full attainment of the WWH aquatic life use designation. The remaining sites were in partial or non-attainment of WWH (both 19%) or were in full attainment of the sub-goal MWH and LRW aquatic life uses (4%) (Table 2). While 52.24 miles (84.6%) of the Scioto River main stem from the Little Scioto River to Big Darby Creek were in full attainment of the designated aquatic life use, organic enrichment from Columbus combined sewer overflows (CSOs) and Jackson Pike wastewater treatment plant (WWTP) contributed to 5.18 miles (8.1%) of partial attainment in the lower reach of the main stem. The only main stem site in non-attainment was the dam-impounded reach upstream from Columbus near prospect where 4.7 miles (7.3%) of biological community impairment was caused by physical habitat limitations.

Scioto River tributaries were negatively influenced by the surrounding agricultural landscape, poor sewage treatment, suburban sprawl and urbanization, with only 48% of sites in full attainment, 22% in partial attainment and 30% in non-attainment. Nutrient and organic enrichment combined to be the top causes of biological stream impairment. Sixty percent of stream impairments included nutrient or organic enrichment as a cause. Enrichment sources include CSOs, home sewage treatment systems, yard maintenance and agriculture.

Sediment chemistry was evaluated at nine sites in the study. Elevated concentrations of organics and heavy metals were common in the urbanized central Ohio area. Kian Run was markedly impacted by poor sediment chemistry conditions including high concentrations of polycyclic aromatic hydrocarbons (PAHs) and heavy metals (e.g. zinc, lead and chromium). Industrial NPDES dischargers and storm water runoff are sources for the impact to Kian Run.

Twenty-eight locations in the watershed were tested for *Escherichia coli (E. coli)* bacteria to determine recreation use attainment status. Evaluation of *E. coli* results revealed that 26 of the 28 locations sampled failed to attain the applicable geometric mean Water Quality Standards (WQS) criterion, indicating an impairment of the recreation use at these locations. Sources of elevated bacteria concentrations were ubiquitous and most likely due to a variety of inputs depending on the site location. In rural areas agricultural activities (including livestock

production and land application of manure) are more common and likely sources. In the central portion of the watershed (including the Columbus urban area), likely sources include WWTPs, CSOs, sanitary sewer overflows (SSOs) and unsewered areas. In mixed land use areas home sewage treatment systems (HSTS) and agricultural activities likely combine to contribute to bacteria contamination.

Table 1. Middle Scioto River and tributaries sampling locations, 2009-2010. Site number corresponds to sampling location in Figure 1.

Site	Stream Name and Location	RM	Station	Latitude	Longitude
1	Scioto River in Newman, dst. SR 4	174.22	201830	40.483300	-83.191100
2	Scioto River near Prospect at Hoskins Road	169.25	601280	40.419400	-83.197200
3	Scioto River dst Fulton Creek at Mink Street (CR 177)	163.80	V02P15	40.350000	-83.182500
4	Scioto River south of Klondike, adj. Klondike Road	157.10	201823	40.267200	-83.146900
5	Scioto River north of Dublin at I-270	145.57	V03P30	40.109200	-83.112200
6	Scioto River in Columbus at west 5th Avenue	136.50	V03W25	39.988900	-83.068100
7	Scioto River in Columbus at Town Street	131.40	V07P16	39.958300	-83.004400
8	Scioto River in Columbus at Greenlawn Avenue	129.48	600860	39.938900	-83.000000
9	Scioto River in Columbus at Frank Road	127.74	600870	39.916700	-83.009700
10	Scioto River 0.7 mile dst. Jackson Pike WWTP, dst. Kian Run	126.40	V07P28	39.901100	-83.000300
11	Scioto River at Shadeville at SR 665	119.90	600810	39.832500	-83.008300
12	Scioto River 0.45 mi. upst. Big Walnut Creek	117.60	V07W27	39.804700	-83.012800
13	Scioto River 0.4 mi dst. Picway power plant	116.40	V07W28	39.788800	-83.012100
14	Scioto River west of South Bloomfield at SR 316	109.37	600910	39.719400	-83.012500
15	Scioto River 0.8 mile dst. Walnut Creek	105.30	V07W45	39.671500	-82.990800
16	Scioto River upst. Circleville at Commercial Point Road	102.14	601340	39.632800	-82.962500
17	Scioto River in Circleville at US 22	99.82	600960	39.601400	-82.955300
18	Bokes Creek northwest of York Center at Phelps Road	27.22	V02S23	40.423100	-83.473300
19	Bokes Creek in Summersville at SR 47	22.23	301213	40.402022	-83.416042
20	Bokes Creek adjacent SR 31, upst Brush Run/dst Powder Lick Run	20.20	V02K05	40.380800	-83.407400
21	Bokes Creek at Taylor-Claiborne Road	14.73	V02S21	40.361400	-83.350600
22	Powderlick Run south of York Center at SR 739	3.40	V02K11	40.384700	-83.454700
23	Powderlick Run at Powder Lick Road (lower crossing)	1.20	V02K09	40.384200	-83.427200
24	Eversole Run at Concord Road	2.20	300965	40.181431	-83.159839
25	Eversole Run northwest of Shawnee Hills, dst. Cook Road	1.30	203160	40.176100	-83.147800
26	N. Fk. Indian Run at Highland Croy Road	5.20	300963	40.132644	-83.179145
27	N. Fk. Indian Run in Dublin at Coffman Road	1.80	300964	40.117828	-83.131925
28	S. Fk. Indian Run at Recreation Center Drive	1.30	300966	40.105778	-83.138517

Site	Stream Name and Location	RM	Station	Latitude	Longitude
29	Hayden Run at Hayden Run Road, adjacent Dexter Falls Road	0.83	300802	40.065480	-83.122050
30	Dry Run in Columbus at Holton Park	1.40	V03K04	39.961400	-83.068600
31	Trabue Run west of Marble Cliff at McKinley Avenue	0.28	V03P11	39.978100	-83.068600
32	Scioto Big Run adjacent Big Run Road	4.40	300968	39.916146	-83.064130
33	Scioto Big Run at Hardy Parkway	2.90	V07K11	39.911400	-83.041700
34	Kian Run in Columbus at Castle Road	0.45	300967	39.908236	-82.999214
35	Republican Run in Grove City at Buckeye Parkway	1.38	300969	39.867688	-83.045377
36	Grant Run at Buckeye Parkway	2.00	300803	39.835900	-83.024570
37	Grant Run adjacent Paul Talbot Circle	0.20	300970	39.843483	-83.021003
38	Plum Run southwest of Shadeville at SR 665	0.72	V07P23	39.824400	-83.024400
39	Peters Run east of Commercial Point at SR 762	1.75	300972	39.771110	-83.015530
40	Grove Run southeast of Commercial Point at Gibson Road	1.58	V07W05	39.748600	-83.035700
41	Van Meter Run at SR 104	1.00	300974	39.698170	-83.008750
42	Dry Run at Bell Station Road	3.70	300975	39.654199	-82.935461
43	Dry Run at Island Road	0.50	300976	39.650378	-82.969248
44	Griffy Run at Walnut Creek Pike	1.10	300977	39.641482	-82.932736

The color of the site number corresponds to the biological score (blue is exceptional to very good (meets EWH goals), green is good to marginally good (meets WWH goals), yellow is fair, orange is poor, and red is very poor (fair, poor, and very poor do not meet the goals of WWH).

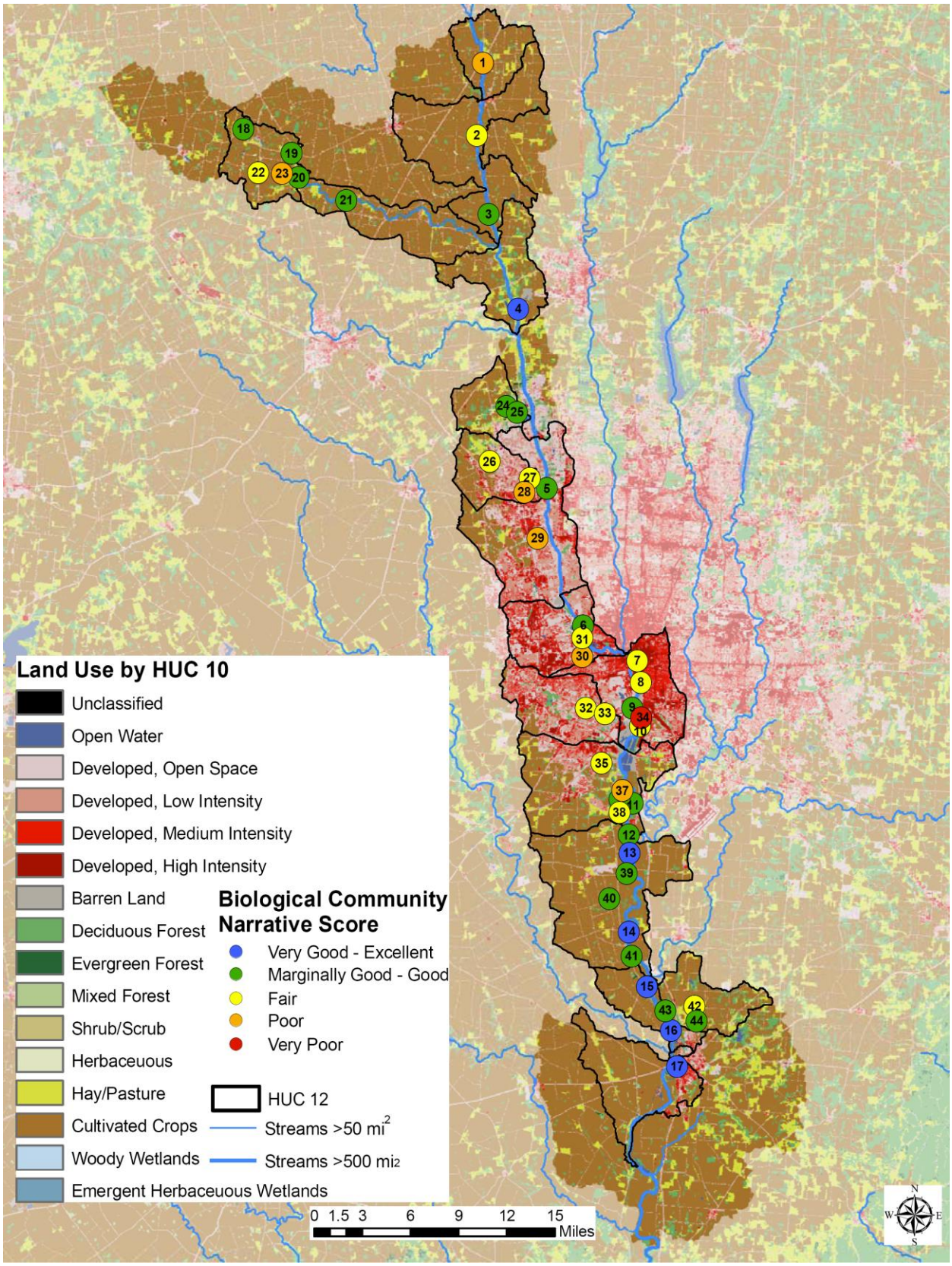


Figure 1. Middle Scioto River study area sampling locations and biological community performance, 2009-2010. Site numbers correspond to Table 1.

Table 2. Aquatic life use attainment status for stations sampled in the middle Scioto River and select tributaries based on data collected June-October 2009 and June–October 2010. The Index of Biotic Integrity (IBI), Modified Index of well-being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat of the stream to support a biotic community. The Scioto River is located in the Eastern Corn Belt Plains (ECBP) ecoregion. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted. NA = not applicable.

Location	STORET (RM)[a]	DRAIN. (MI²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
Scioto River (02-001)	**WWH Existing**								
Scioto River at Newman, downstream State Route 4 - 2009	201830 (174.22)	530[B]	24	7.1	14	49.0	**NON**	Direct habitat alterations (Impounded)	Dam
Scioto River near Prospect at Hoskins Road - 2009	601280 (169.25)	567[W]	36	9.0	38	75.5	FULL		
Scioto River downstream Fulton Creek at Mink Street (CR 177) - 2009	V02P15 (163.8)	660[B]	41	9.6	52	75.0	FULL		
Scioto River south of Klondike, adjacent Klondike Road - 2009	201823 (157.1)	764[B]	52	10.2	54	74.0	FULL		
Scioto River at I-270,north of Dublin -2009	V03P30 (145.57)	990[B]	52	10.6	38	82	FULL		
Scioto River at Fifth Avenue in Columbus -2009	V03W25 (136.5)	1049[B]	54	10.3	G	85.5	FULL		
Scioto River (02-001)	**MWH-I Existing**								
Scioto River at Town Street, downstream Olentangy River - 2009	V07P16 (131.4)	1,614[B]	34	8.4	N/A	45	FULL	Comments – Impounded by Town Street dam	
Scioto River (02-001)	**WWH Existing**								
Scioto River at Greenlawn Avenue - 2009	600860 (129.48)	1,617[B]	48	11.7	28*	83.0	**PARTIAL**	Organic enrichment (sewage) biological indicators	Columbus CSOs
Scioto River at Frank Road - 2010	600870 (127.74)	1,628[B]	47	10.8	36	74.5	FULL		
Scioto River, 0.7 mile dst. Jackson Pike WWTP, dst. Kian Run - 2010	V07P28 (126.4)	1,636[B]	47	10.5	28*	83.5	**PARTIAL**	Organic enrichment (sewage) biological indicators	Columbus CSOs and municipal point source discharge; Jackson Pike WWTP

Location	STORET (RM)[a]	DRAIN. (MI²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
Scioto River dst. Jackson Pike WWTP – 2009	V07P28 (126.4)	1,636[B]	52	11.5	16*	84.5	**PARTIAL**	Organic enrichment (sewage) biological indicators	Columbus CSOs and municipal point source discharge; Jackson Pike WWTP
Scioto River at State Route 665 in Shadeville - 2009	600810 (119.9)	1,697[B]	50	11.7	36	84.0	FULL		
Scioto River dst. Columbus Southerly WWTP - 2009	V07W27 (117.6)	1,709[B]	52	11.1	32[NS]	73.0	FULL		
Scioto River dst. Picway power station - 2009	V07W28 (116.4)	2,266[B]	52	11.6	44[NS]	79.5	FULL		
Scioto River West of South Bloomfield at State Route 316, upstream Walnut Creek - 2009	600910 (109.37)	2,311[B]	54	11.6	54	79.0	FULL		
Scioto River West of South Bloomfield at State Route 316, upstream Walnut Creek - 2010	600910 (109.37)	2,311[B]	50	11.1	48	88.3	FULL		
Scioto River one mile downstream Walnut Creek - 2009	V07W45 (105.3)	2,615[B]	48	11.4	52	79.5	FULL		
Scioto River ust.Circleville at Commercial Point Road - 2010	601340 (102.1)	2,638[B]	55	10.3	48	76.8	FULL		
Scioto River at Circleville at US 22 - 2010	600960 (99.82)	3,217[B]	52	10.8	N/A	N/A	FULL		
Scioto River at Circleville at US 22 - 2009	600960 (99.82)	3,217[B]	54	11.4	54	83.5	FULL		
Bokes Creek (02-138)	**WWH Existing**								
Bokes Creek at Phelps Road	V02S23 (27.22)	35.0[W]	46	8.6	38	60.3	FULL		
Bokes Creek at Summerville, State Route 47	301213 (22.23)	46.0[W]	48	8.7	46	56.8	FULL		
Bokes Creek at State Route 31	V02K05 (20.2)	51.0 [W]	50	8.1[NS]	38	74.3	FULL		
Bokes Creek at Taylor-Claiborne Road	V02S1 (14.73)	60.0[W]	46	9.2	38	63.0	FULL		

Location	STORET (RM)[a]	DRAIN. (MI²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
Powderlick Run (02-144)	**LRW Existing**								
Powderlick Run at State Route 739	V02K11 (3.4)	1.8[H]	32	N/A	LF	54.0	FULL	Comment – Water quality is negatively influenced by organic enrichment, nutrient enrichment, embedded substrates, salinity/TDS/chlorides and unionized ammonia from a combination of on-site treatment systems and agriculture (land application of manure, row crops, and pasture land).	
Powderlick Run (02-144)	**WWH Existing**								
Powderlick Run at Powderlick Road	V02K09 (1.2)	3.5[H]	38	N/A	P*	55.0	**NON**	Sedimentation/Siltation Nutrient enrichment Organic enrichment Salinity/TDS/chlorides Embedded substrates	Agriculture (land application of manure, row crop agriculture) Loss of riparian vegetation
Eversole Run (02-108)	**WWH Existing**								
Eversole Run at Concord Road	300965 (2.20)	4.3[H]	36 [NS]	N/A	MG[NS]	49.3	FULL		
Eversole Run dst. Cook Road	203160 (1.30)	10.5[H]	42	N/A	G	59.8	FULL		
North Fork Indian Run (02-098)	**WWH Existing**								
North Fork Indian Run at Hyland Croy Road	300963 (5.20)	5.6[H]	32*	N/A	LF*	54.3	**NON**	Nutrient/eutrophication biological indicators Siltation Direct habitat alteration	Agriculture Streambank modifications Yard maintenance Channelization
North Fork Indian Run at Coffman Road	300964 (1.80)	10.2[H]	36[NS]	N/A	LF*	63.8	**PARTIAL**	Siltation Nutrient/eutrophication biological indicators	Upstream agriculture On-site treatment systems Yard maintenance
South Fork Indian Run (02-099)	**WWH Existing**								

Location	STORET (RM)[a]	DRAIN. (MI²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
South Fork Indian Run at Dublin Rec Center entrance	300966 (1.3)	5.1[H]	26*	N/A	LF*	68.5	**NON**	Nutrient/eutrophication biological indicators Organic enrichment (sewage) biological indicators Natural Conditions (waterfalls affect fish community recovery)	Yard maintenance On-site treatment systems Natural sources (waterfalls as fish passage barriers)
Hayden Run (02-097)	**WWH Existing**								
Hayden Run at Hayden Run Road	300802 (0.83)	7.0[H]	24*	N/A	F*	68.8	**NON**	Natural Conditions (waterfalls affect fish community recovery) Nutrient/eutrophication biological indicators	On-site treatment systems Yard maintenance Site clearance (land development) Natural sources (waterfalls as fish passage barriers)
Dry Run (02-095)	**WWH Existing**								
Dry Run at Holton Park Sewer Crossing	V03K04 (1.40)	7.0[H]	26*	N/A	F*	73.0	**NON**	Organic enrichment (sewage) biological indicators Particle distribution (embedded substrates) Other flow regime alteration	Sanitary sewer overflows (collection system failures) On-site treatment systems Residential districts (flashy hydrology)
Trabue Run (02-266)	**WWH Recommended**								
Trabue Run at McKinley Road	V03P11 (0.28)	6.6[H]	30*	N/A	LF*	64.0	**NON**	Organic enrichment (sewage) biological indicators Other flow regime alteration	Sanitary sewer overflows (collection system failures) On-site treatment systems Residential districts (flashy hydrology)
Scioto Big Run (02-092)	**WWH Existing**								

Location	STORET (RM)[a]	DRAIN. (MI²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
Scioto Big Run at Big Run Road	300968 (4.40)	11.8[H]	48	N/A	LF*	55.8	**PARTIAL**	Organic enrichment (sewage) biological indicators	On-site treatment systems
Scioto Big Run at Hardy Parkway	V07K11 (2.90)	17.6[H]	52	N/A	F*	67.8	**PARTIAL**	Other flow regime alteration Particle distribution (embeddedness)	Municipal (urban high density area) Urban runoff/storm sewers
Kian Run (02-197)	**WWH Existing / MWH-C Recommended**								
Kian Run at Castle Road	300967 (0.45)	9.1[H]	24*	N/A	VP*	34.3	**NON**	Sediment screening value (exceedence) Sedimentation/siltation Direct habitat alterations	Industrial point source discharge Streambank modifications Channelization
Republican Run (02-243)	**WWH Existing**								
Republican Run at Buckeye Parkway	300969 (1.38)	5.7[H]	32*	N/A	LF*	79.5	**NON**	Other flow regime alterations Organic enrichment (biological indicators)	Site clearance (land development) Municipal (urban high density area) On-site treatment systems
Grant Run (02-091)	**WWH Existing**								
Grant Run at Buckeye Parkway	300803 (2.0)	7.8[H]	48	N/A	MG[NS]	77.0	FULL		
Grant Run at Paul Talbot Drive	300970 (0.2)	14.1[H]	24*	N/A	MG[NS]	72.0	**PARTIAL**	Other flow regime alterations Fish-passage barrier	Site clearance (land development) Hydrostructure impacts on fish passage (dam)
Plum Run (02-090)	**WWH Existing**								
Plum Run at State Route 665, southwest of Shadeville	V07P23 (0.72)	7.0[H]	44	N/A	F*	66.5	**PARTIAL**	Natural	Natural low flow conditions
Peter's Run (02-368)	**WWH Recommended**								
Peter's Run at State Route 762	300972 (1.75)	7.2[H]	40	N/A	G	35.8	FULL		
Grove Run (02-089)	**WWH Existing**								

Location	STORET (RM)[a]	DRAIN. (MI²)	IBI	MIwb[b]	ICI[c]	QHEI	Status[d]	Causes	Sources
Grove Run at Gibson Road	300973 (1.58)	5.6[H]	42	N/A	MG[NS]	60.5	FULL		
Van Meter Run (02-088)	**WWH Existing**								
State Route 104	300974 (1.0)	5.8[H]	46	N/A	G	66.5	FULL		
Dry Run (02-077)	**WWH Existing**								
Dry Run at Belles Station Road	300975 (3.7)	4.7[H]	28*	N/A	MG[NS]	54.0	**PARTIAL**	Intermittent Other flow regime alterations	Agriculture
Dry Run at Island Road	300976 (0.5)	18.4[H]	52	N/A	G	57.5	FULL		
Griffy Run (02-076)	**WWH Existing**								
Griffy Run at Walnut Creek Pike	300977 (1.1)	4.9[H]	44	N/A	G	58.0	FULL		

a - River Mile (RM) represents the Point of Record (POR) for the station, not the actual sampling RM.

b - MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.

c - A narrative evaluation of the qualitative sample based on attributes such as EPT taxa richness, number of sensitive taxa, and community composition was used when quantitative data was not available or considered unreliable. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional

d - Attainment is given for the proposed status when a change is recommended.

e -Two scores for each metric are provided. The first score presented in *italics* is from sampling conducted in 2009. The second score presented in normal script is from sampling conducted in 2010.

ns - Nonsignificant departure from biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

B - Boat site.

H - Headwater site.

W - Wading site.

Biological Criteria Eastern Corn Belt Plains			
Index – Site Type	**EWH**	**WWH**	**MWH**
IBI – Headwaters	50	40	24
IBI – Wading	50	40	24
IBI – Boat	48	42	24
MIwb – Wading	9.4	8.3	6.2
MIwb – Boat	9.6	8.5	5.8
ICI	46	36	22

INTRODUCTION

The middle Scioto River watershed, delineated by United States Geological Survey as 8-digit hydrological unit code (HUC) 05060001, is located in portions of Delaware, Franklin, Pickaway, and Union Counties in central Ohio (Figure 1 and Figure 2). Between 2009 and 2010, Ohio EPA conducted a water resource assessment of the middle Scioto River main stem and tributaries using standard Ohio EPA protocols as described in Appendix Table A. Included in this study are assessments of the biological, habitat, surface water, sediment, and recreational (bacterial) condition. The Scioto River main stem and nineteen tributaries were evaluated with a total of 44 biological, 44 habitat, 38 water chemistry, and 9 sediment stations sampled within the study area.

Figure 2. Middle Scioto River watershed location.

Specific objectives of the evaluation were to:

- establish the present biological conditions in the study area by evaluating fish and macroinvertebrate communities,
- assess physical habitat influences on stream biotic integrity,
- identify the relative levels of organic, inorganic, and nutrient parameters in the sediments and surface water,
- determine recreational water quality,
- compare present results with historical conditions,
- assign uses to undesignated streams, and
- determine the attainment status of the existing beneficial use designations, and recommend changes if appropriate.

The study area is located in the Eastern Corn Belt Plains (ECBP) ecoregion and most streams are currently assigned the WWH aquatic life use designation in the Ohio Water Quality Standards (WQS), as well as Primary Contact Recreation (PCR), Agricultural Water Supply (AWS) and Industrial Water Supply (IWS). The middle Scioto River main stem is designated WWH throughout the study area, except for the 2.5 miles impounded by the Greenlawn Avenue dam (river miles 132.3-129.8) which is designated MWH-I. In addition, two stretches of the middle Scioto River are impounded by reservoirs: O'Shaugnessy Reservoir from River Miles (RMs) 155.4-148.83 and Griggs Reservoir from RMs 144.68-138.82.

Most of the tributaries to the middle Scioto River were sampled by Ohio EPA for the first time during 2010. Nearly all of these tributaries have either unverified beneficial uses, or are undesignated. A few sites within the Bokes Creek (HUC 0506000107) portion of the study area were sampled to assess the effect of agricultural operations in Powderlick Run.

The findings of this evaluation may factor into regulatory actions taken by the Ohio EPA (e.g. National Pollution Discharge Elimination System (NPDES) permits, Director's Orders, or the Ohio Water Quality Standards [OAC 3745-1]), and may eventually be incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, Total Maximum

Daily Loads (TMDLs) and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d] report).

STUDY AREA DESCRIPTION

The middle Scioto River study area extended from near Newman and Prospect in Marion County south through Delaware and Franklin, to Circleville in Pickaway County. The natural course of the main stem is interrupted by two major impoundments (Griggs and O'Shaughnessy reservoirs) and three low head dams (Dublin Road Waterworks, Town Street, and Greenlawn Avenue). In Columbus the river flows through a channel which has a modified geometry and is reinforced with concrete. Flood flows have been contained here by levee construction.

Flowing over a buried valley filled with glacial outwash materials of sand and course gravels, the Scioto River substrates vary from limestone bedrock and silt-muck above Columbus to coarse sand and gravel south of the city. Downstream from the Jackson Pike WWTP the Scioto River appears as a large free flowing river with good sinuosity and riffle-pool development. The river valley, broad and poorly defined south of Columbus, has been subject to extensive flooding in the floodplain area. South of Columbus and north of Circleville, the watershed shows a mix of agricultural and urban land uses.

Although erosion from agricultural croplands was the main source of sediment in the river throughout the last century, rapid land use development has increased in importance since the early 1990's. Development in Delaware and Franklin counties was among the most rapid in Ohio between the mid-1990's to the late 2000's. Yard maintenance activities through the highly suburbanized areas likely contribute to nutrient enrichment in tributary streams, while surface runoff from residential, commercial and transportation construction sites contributes to sediment load finding its way to the Scioto River. The increase in impervious surface in both the suburban and metropolitan areas alters the hydrology of the system creating flashy hydrology and increasing the rate of pollutants entering tributaries and the main stem. Post construction increase in impervious surfaces upstream (parking lots, highways, driveways, rooftops, etc.) can affect the river's peak flows as rainwater and snowmelt quickly move to the river with less chance of infiltration into the soil strata or uptake by plant roots. An increased frequency of high flows provides opportunity for erosion of banks (particularly those denuded of tree cover) and thus contributes additional sediments to the river.

Animal feedlot operations can contribute sediment, nutrients and bacterial contaminants to streams as wastes enter the water column through surface runoff, leaks in holding ponds, animal access to the stream or poorly designed holding and waste control systems. Row crop agriculture may contribute sediment, nutrients and pesticides through runoff. These, combined with the aforementioned suburban and urban influences, were the primary drivers of non-attainment in the middle Scioto River study area.

RECOMMENDATIONS

The majority of the streams listed in the Ohio Water Quality Standards for the study area are assigned the WWH aquatic life use designation (Table 3). These streams were originally designated for aquatic life uses in the 1978 Ohio WQS. The techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. This study used biological data to evaluate and establish aquatic life uses for a number of streams in the study area.

Nineteen streams were evaluated for aquatic life and recreation use potential between 2009-2010 (Table 2, Table 12). Significant findings include the following.

- Two undesignated streams were evaluated for the first time and are recommended the WWH aquatic life use designation. Peter's Run had fish and macroinvertebrate communities in full attainment of the WWH aquatic life use designation. The fish and macroinvertebrate community of Trabue Run did not meet WWH expectations due to nutrient and organic enrichment from sewer infrastructure issues. Addressing the sewage issues should result in improvement of the aquatic communities. Therefore, Trabue Run has the potential to meet WWH expectations.

- Kian Run was previously designated as WWH without any biological data. Sampling results from 2010 indicate that Kian Run should be designated MWH-C. Kian Run exhibited poor habitat conditions with extensive siltation/sedimentation from upstream sources and poor channel development. The fish community was dominated by pioneering species. The 13 macroinvertebrate taxa that were collected from Kian Run were the lowest of any stream in the middle Scioto River survey. These taxa were collected almost exclusively from margin habitat near the water line, demonstrating a clear avoidance of contaminated bottom sediments. The highly modified conditions and aquatic communities present in Kian Run deem MWH-C as the most appropriate aquatic life use designation.

- The upper reach of Powderlick Run is designated LRW. Sampling results indicate that this use designation is still appropriate, although the reach may be in recovery. Periodic monitoring of this site should be undertaken to determine if either the MWH or WWH use designation may be recommended in the future.

- The existing Secondary Contact Recreation use for Powderlick Run and Republican Run should be changed to Primary Contact Recreation. When these streams received the SCR designation, it was based on the understanding that PCR only applied to streams of sufficient depth and breadth to allow for full body immersion and swimming by adults. Today, PCR is looked upon from a more general perspective, in that if access is available and people live within the vicinity, children are likely to play and come into contact with the waters of the stream. Field observations, combined with a review of aerial photos for each stream, indicate potential for easy access to the streams through residential yards.

- Biological sampling confirmed the appropriateness of the WWH aquatic life use designation for eleven streams in the study area. These streams included Eversole Run, North Fork Indian Run, South Fork Indian Run, Grant Run, Plum Run, Grove Run, Van Meter Run, Griffy Run, Hayden Run, Dry Run, and Scioto Big Run. The remaining

streams sampled within the study area should retain the associated designated aquatic life use.

The remaining streams in this study should retain the Primary Contact Recreation use, or Secondary Contact Recreation use, along with the Agricultural Water Supply and Industrial Water Supply uses.

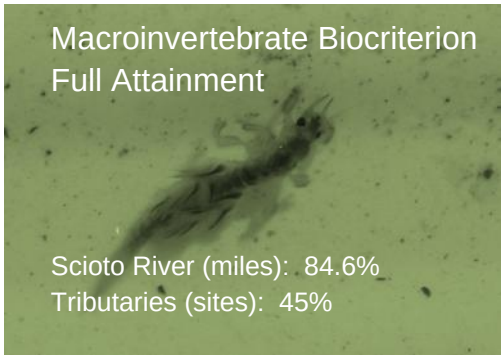
Table 3. Water body use designation recommendations for the middle Scioto River and select tributaries study area. Designations based on the 1978 and 1985 water quality standards appear as asterisks (*). A plus sign (+) indicates a new recommendation or confirmation of an existing use based on the findings of this report. A delta(∆) indicates a change in a previously verified use, while a 'o' indicates a public water supply intake.

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	
Scioto river - at RM 33.6		+						o	+	+		+		PWS intake - U.S. Enrichment (emergency intake)
- Greenlawn dam (RM 129.8) to mouth		+							+	+		+		
- Olentangy river (RM 132.3) to Greenlawn dam				+					+	+		+		ECBP ecoregion - impounded
- Dublin Road WTP dam (RM 133.4) to the Olentangy river (RM 132.3)		+							+	+		+		
- O'Shaughnessy dam (RM 148.8) to the Dublin Road WTP dam		+						+	+	+		+		PWS intake - Columbus
- at RM 180.04		*						o	*	*		*		PWS intake - Marion
- all other segments		*							*	*		*		
Dry run		*+							*+	*+		*+		
Griffy run		*+							*+	*+		*+		
Cherry run		+							+	+		+		
Van Meter run		*+							*+	*+		*+		
Grove run		*+							*+	*+		*+		
Peter's run		∆+							∆+	∆+		∆+		
Plum run		*+							*+	*+		*+		
Grant run		*+							*+	*+		*+		
Republican run (Scioto river RM 122.9)		+							+	+			+	
South branch							+		+	+			+	Small drainageway maintenance
Scioto Big run		*+							*+	*+		*+		

Table 3. Water body use designation recommendations for the middle Scioto River and select tributaries study area. Designations based on the 1978 and 1985 water quality standards appear as asterisks (*). A plus sign (+) indicates a new recommendation or confirmation of an existing use based on the findings of this report. A delta(∆) indicates a change in a previously verified use, while a 'o' indicates a public water supply intake.

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	
Marsh run		*							*	*		*		
Kian run		*		∆+					*+	*+		*+		ECBP ecoregion -channel modification
Dry run		+							+	+		+		
Trabue Run		+							+	+		+		
Slate run		*							*	*		*		
Hayden run		*+							*+	*+		*+		
North Fork Indian run		*+							*+	*+		*+		
South Fork Indian run		*+							*+	*+		*+		
Deer run		*							*	*		*		
Eversole run		*+							*+	*+		*+		
Bokes creek - RM 35.51 (0.66 river miles downstream of st. rte.292) to RM 37.30 (1.13 river miles upstream of st. rte. 292)				+					+	+		+		ECBP ecoregion - channel modification
- all other segments		+							+	+		+		
Smith run		+							+	+			+	
Brush run		+							+	+			+	
Powderlick run - headwaters to RM 3.0 (0.35 river miles downstream of st. rte. 739)							+		+	+		∆+	+	Small drainageway maintenance
- all other segments		+							+	+		∆+	+	
Unnamed tributary (Powderlick run RM 2.0)		+							+	+			+	

RESULTS



Macroinvertebrate Community

The macroinvertebrate communities from 18 locations in the middle Scioto River and 20 locations in tributaries to the middle Scioto River watershed were sampled in 2009 and 2010. One location in the Scioto River main stem was sampled in both 2009 and 2010, for a total of 19 sampling events. Six sites from the Bokes Creek watershed were also assessed as part of the 2010 sampling effort. Qualitative samples were collected from all sampling locations. Quantitative Hester-Dendy artificial substrate samples were collected from the Scioto River. A summary of the macroinvertebrate data are presented in Table 4. The macroinvertebrate raw data are presented in Appendices H-J. Sampling locations were evaluated using Warmwater Habitat (WWH), Modified Warmwater Habitat (MWH) biocriteria, or Limited Resource Water (LRW) benchmarks based on current or recommended aquatic life uses.

Middle Scioto River Main Stem

The middle Scioto River main stem sites sampled during 2009 and 2010 achieved the WWH macroinvertebrate biocriterion at 14 of 19 sampling events (78%). The site at RM 131.8 is designated MWH-I due to its impoundment by the Town Street dam in Columbus, and therefore the Invertebrate Community Index (ICI) is not applicable in this reach. The average ICI score of 38 for the Scioto River main stem was reflective of overall good biological quality. The four sites that were not meeting WWH criteria were impacted by either limited physical habitat conditions (dams) or by the influence of CSOs and WWTP effluent.

Pooled conditions created by a low head dam downstream from the town of Prospect resulted in a fair ICI of 14 at RM 174.2. This dam is slated to be removed in 2015 and replaced by an inflatable dam that will be used as needed to supplement drinking water supplies. The restoration of free-flowing conditions to this segment of the river should result in vast improvement to the benthic community. The ICI of 28 that was garnered downstream of Greenlawn Avenue in Columbus at RM 129.1 was attributed to the effects of organic enrichment from CSOs in Columbus. Midges, aquatic worms, and filter-feeding caddisflies comprised most of the fauna on the artificial substrates, a community composition that signifies over-enrichment. The impacts from the Columbus CSO discharges were further exacerbated by the addition of effluent from the Jackson Pike WWTP at RM 126.0, where the ICI declined to a score of 16. Aquatic worms alone accounted for over 60 percent of the organisms on the artificial substrates at this location. At RM 125.5 (sampled in 2010), the Scioto River showed signs of recovery, as aquatic worms declined to 20 percent of the organisms on the artificial substrates, and thus the ICI improved to a 28. Fewer bypass events from the Jackson Pike WWTP were recorded in 2010 as compared to 2009, which also factored into the recovery at this station. Full recovery was realized by RM 119.9, where the macroinvertebrate community was once again meeting the WWH biocriterion with an ICI of 36. The city of Columbus has recently developed a Long Term Control Plan that addresses wet weather overflows via capital improvements to both sewers and treatment plants. It is anticipated that these infrastructure improvements will eventually translate into improved biological performance by the benthos downstream from Columbus.

Eleven species of freshwater mussels were collected at 12 locations in 2009 and 2010 (Table 4, Appendix J). Most were collected downstream from the city of Columbus and included three state-listed species: the Species of Concern deer toe (*Truncilla truncata*), and the Threatened fawn's foot (*Truncilla donaciformis*) and three-horned wartyback (*Obliquaria reflexa*). The fawn's foot was found as far upstream as Frank Road (RM 127.74), which represented a ten mile range expansion in Ohio EPA records since the 1996 biosurvey (Ohio EPA 1999b). The three-horned wartyback was collected from the Scioto River in Franklin County for the first time by Ohio EPA in 2009. The three locations from which it was collected represent a re-introduction of this species to a reach of river that was once decimated from improperly treated effluent.

Middle Scioto River Tributaries

The macroinvertebrate communities of the tributaries to the middle Scioto River were evaluated using a narrative assessment of the qualitative sample. Overall, only 45 percent (9/20) of those samples achieved the WWH biocriterion. Biological integrity was influenced most by the amount of development in the surrounding landscape. Sampling stations that were located within urbanized areas supported benthic communities that were in the fair to very poor range, while marginally good to good communities were found in the less developed, rural areas (Figure 5). Both EPT[1] and sensitive taxa numbers were considerably lower in the urban samples than those collected from rural sites (Figure 3). Only one rural stream, Plum Run, had an underperforming benthic community. Seasonally low flows contributed to the fair macroinvertebrate community collected in that stream.

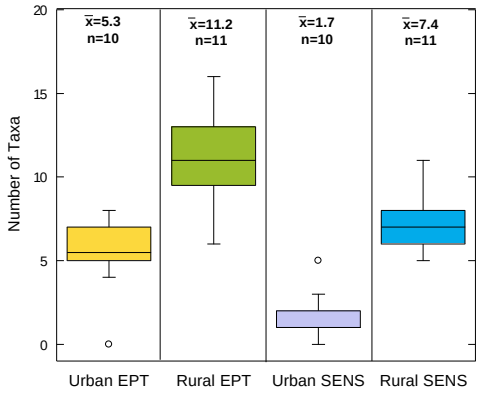


Figure 3. Aggregated EPT and sensitive taxa for the middle Scioto River tributaries, categorized by their location within urban or rural areas of the watershed.

The North and South Forks of Indian Run flow through the city of Dublin, Hayden Run flows through Hilliard, and Republican Run drains Grove City. All three of these Columbus suburbs have experienced a population boom in the past decade, with Dublin's population increasing by 33 percent, Hilliard's by 17 percent, and Grove City's by 31 percent (US Census Bureau 2011). This rapid growth and subsequent development has placed significant stress upon its watersheds, and the aforementioned streams are prime examples. Stream alterations (channelization, riparian removal), runoff laden with lawn chemicals, and failing septic systems have resulted in benthic communities with high densities of tolerant organisms, which indicate nutrient and/or organic over-enrichment. Correcting habitat deficiencies, repairing or replacing failing septic systems, and encouraging the use of natural, organic lawn treatments is recommended to aid in the recovery of these impacted streams.

Within Columbus proper, Dry Run, Trabue Run and Scioto Big Run were impacted by sanitary sewer overflows, failing septic systems and urban runoff. Both Dry Run and Trabue Run had

1 EPT stands for Ephemeroptera, Plecoptera, and Trichoptera – the orders of aquatic insects commonly known as mayflies, stoneflies, and caddisflies, respectively. The collective presence and abundance of these groups of insects is generally an indicator of high water resource quality.

relatively low total taxa numbers, and sensitive taxa were rare. An odor of sewage was emanating from the substrates in Dry Run, and sanitary debris was noted in the stream. In Trabue Run, gray silt, an indicator of potential sewage discharge, was observed on the substrates, and sanitary sewer structures were present upstream from the sampled reach. Blackflies were the predominant taxon in Scioto Big Run at Big Run Road (RM 4.4), which may indicate organic enrichment. The sampling station was located in an unsewered area, which lends credence to failing septic systems as a source of the degradation to the benthos. Downstream at RM 2.9 on Scioto Big Run, boulder and cobble substrates were present, but were largely immovable and therefore provided little interstitial space for colonization. Incised stream banks also indicated that flashy, scouring flows were frequent in this reach. As such, the macroinvertebrate community remained in the fair range, with only one sensitive taxon present.

The community at Kian Run RM 0.45 reflected very poor resource conditions. A thick layer of silt coated the entire stream bottom, and the reach was also channelized. The 13 total taxa collected were the lowest of any stream in the middle Scioto River survey. The headwaters of Kian Run are comprised of a network of storm sewers which receive numerous industrial discharges. Some of these entities have been discharging into Kian Run for decades. As a result, the bottom sediments of Kian Run are laden with toxic levels of metals. The macroinvertebrates that were collected from Kian Run demonstrated a clear avoidance of these sediments, as all taxa were collected from the margin habitat near the water line, rather than from the central channel. Removal of these accumulated contaminated sediments, habitat restoration, and monitoring of current discharges are recommended to remediate the lower reach of Kian Run.

Bokes Creek Watershed

Six sites in the Bokes Creek watershed (tributary to the Scioto River at RM 161.88) were selected to assess the effects of restoration efforts on Powderlick Run, a tributary to Bokes at RM 20.76 (Table 4). The assessment revealed that low fair to poor macroinvertebrate communities still persist in Powderlick Run in spite of the ongoing restoration. In Bokes Creek, taxa richness and qualitative EPT decline significantly downstream from Powderlick Run as compared to upstream. However, the ICI of 38 indicated good overall resource quality and therefore no detrimental impact from the tributary. An intensive biomonitoring survey of the entire Bokes Creek watershed is planned for 2013. Sediment sampling and Datasonde© monitoring are recommended to complement biological monitoring in Powderlick Run in order to characterize the current extent of nutrient over-enrichment and possible sediment contamination.

Trends

Historically, the macroinvertebrate communities in the middle Scioto River have not shown much change from the last comprehensive survey in 1996 (Figure 4). The only sampling location to exhibit significant change is at Frank Road, RM 127.74. This location scored an ICI of 18 in 1996, and improved to a WWH-attaining score of 36 in 2010. Extremely elevated metals (particularly cadmium, copper, chromium, lead, zinc and mercury) were detected in the sediment chemistry at Frank Road in 1996, which suggested a potential for adverse effects to the benthic community. As such, only seven total EPT taxa were collected from this location in 1996. Of these, three caddisfly individuals were noted as having mild gill “burns” and only one mayfly taxon was collected. In 2010, these same metals were detected below severe threshold levels and total EPT taxa increased to 18, with mayflies increasing to a total of seven taxa. The elimination of discharges from Techneglas Inc. may account for the improvement at this

location. This company, which manufactured cathode tubes for televisions and discharged effluent into the Scioto River at RM 128.95, ceased operations in 2004.

Most of the tributaries to the middle Scioto River were sampled for the first time in 2010. Scioto Big Run, however, was sampled extensively as part of special assessments that were conducted in 2007 and 2008. Seven total sites were evaluated from RM 11.00 to RM 1.80 over the two year period (Appendix H and Appendix J). Overall, total taxa ranged from 14 to 30, with a mean of 21, while EPT taxa ranged from 1 to 6, with a mean of 3.5. These numbers corresponded with a community assessment of *fair*. While the two sites from 2010 yielded total and EPT taxa numbers that were slightly higher than those of 2007 and 2008, the narrative assessments still remained in the fair range. The urbanized nature of the Scioto Big Run watershed (i.e. runoff, flashy flows, and unsewered areas) was responsible for the underperformance of the benthos in all three sampling years.

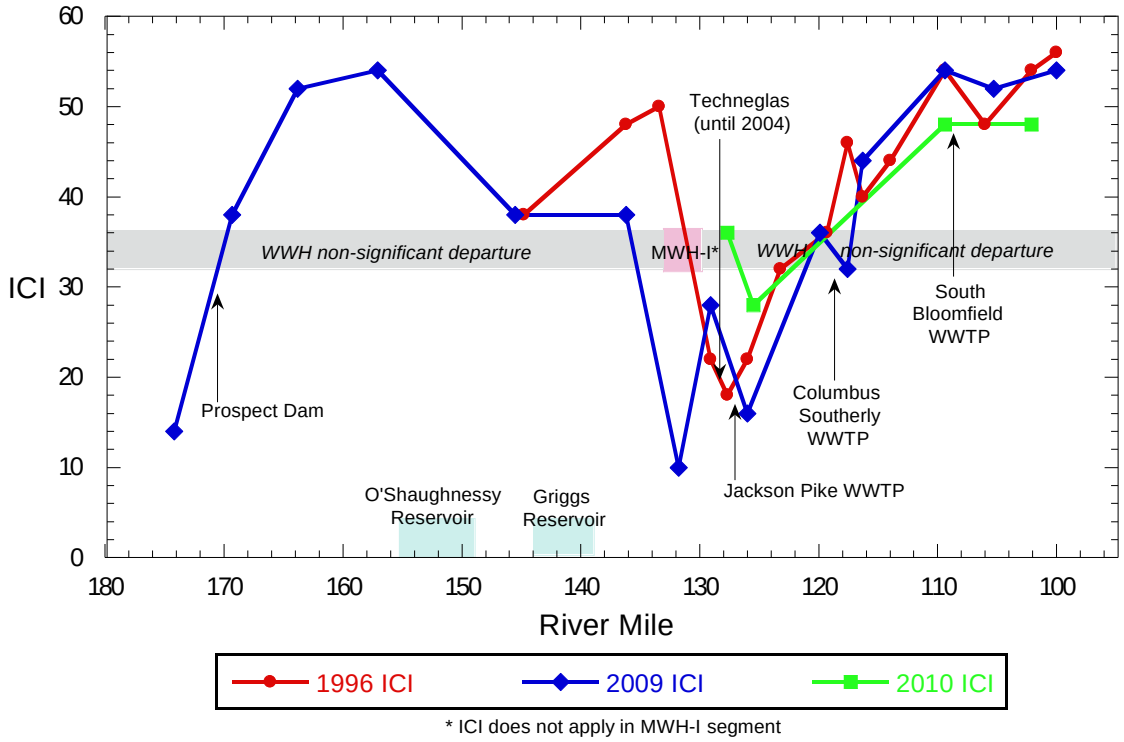


Figure 4. Longitudinal trend of the Invertebrate Community Index (ICI) in the middle Scioto River, 1996-2010. The ICI is estimated where quantitative data are not available.

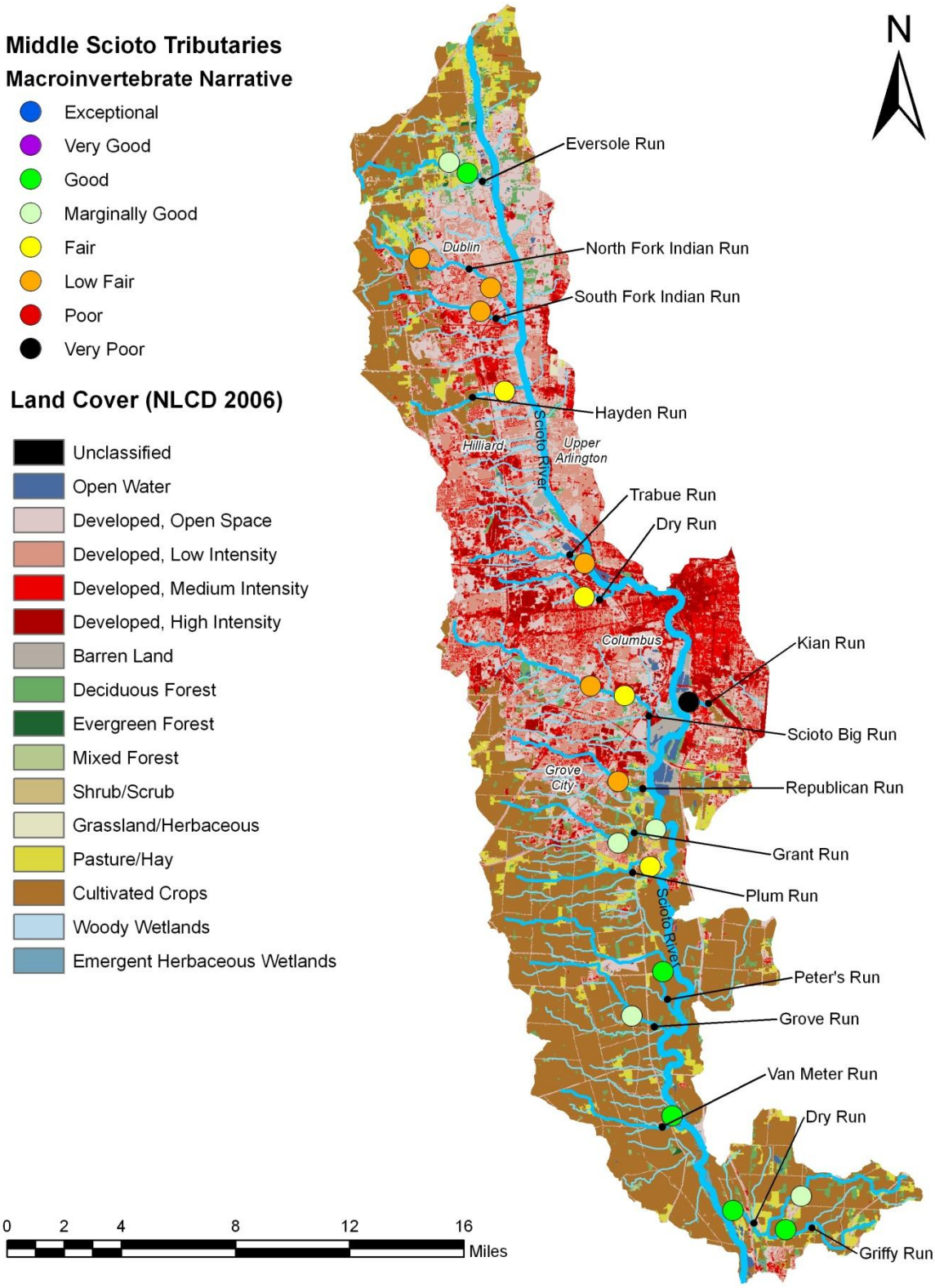


Figure 5. Macroinvertebrate narrative evaluations for the middle Scioto River tributaries, mapped against land cover.

Table 4. Summary of macroinvertebrate data collected from natural substrates (qualitative sampling) and quantitative samples in the middle Scioto River watershed study area, June-September 2009 and 2010.

Location	River Mile	Drain. (mi^2)	Total Taxa	Qual EPT	Total Sens	Total Tol.	CW Taxa	Substrate Density[a]	ICI[b]	Narrative Evaluation	Observations[c]
Large River Assessment Unit 05060001 – Scioto River											
Scioto River @ SR 4 Prospect dam pool (2009)	174.2	530.0	41	2	2	18	0	Low	14	Low Fair	Pooled habitat; corixids predominant in margin and a few midges and heptageniid mayflies common in silt-laden pool.
Scioto River @ Hoskins Rd (2009)	169.3	567.0	71	20	21	12	0	Moderate	38	Good	Heptageniid and baetid mayflies, *Petrophila* moths, and *Elimia* snails predominant. One mussel species.
Scioto River @ Mink St (2009)	163.8	660.0	65	22	25	8	0	Moderate	52	Exceptional	*Rheotanytarsus* midges and hydropsychid caddisflies predominant.
Scioto River adj Klondike Rd (2009)	157.1	764.0	62	20	25	8	0	Moderate	54	Exceptional	*Rheotanytarsus* midges and hydropsychid caddisflies predominant.
Scioto River @ I-270 (2009)	145.5	990.0	68	18	26	8	0	High	38	Good	Philopotamid caddisflies and baetid mayflies predominant. Two mussel species.
Scioto River @ W 5th Ave. (2009)	136.2	1049.0	69	16	15	16	0	Moderate	--	Good	Hydropsychid and philopotamid caddisflies, baetid mayflies and midges predominant.
Scioto River @ Town St. (2009)	131.8	1614.0	42	0	2	17	0	Moderate	10	Poor	Impounded; midges predominant.
Scioto River dst Greenlawn Dam (2009)	129.1	1623.0	57	12	15	13	0	High	28	Fair	Hydropsychid caddisflies predominant. Tailwaters Greenlawn Ave Dam. Two mussel species.
Scioto River @ Frank Rd (2010)	127.7	1628.0	66	16	17	18	0	High	36	Good	*Rheotanytarsus sp.* midges and hydropsychid caddisflies predominant. Enriched community. One mussel species (T).
Scioto River dst Jackson Pike WWTP, dst Kian Run (2009)	126.0	1636.0	49	7	9	15	0	Moderate	16	Low Fair	Midges and hydropsychid caddisflies predominant. No heptageniid mayflies collected. Two mussel species.
Scioto River dst sharp bend, dst trailer park(2010)	125.5	1636.0	56	11	13	19	0	High	28	Fair	Midges predominant. Only one heptagennid mayfly collected. One mussel species.
Scioto River @ Shadeville @ SR 665 (2009)	119.9	1697.0	66	13	22	14	0	Moderate	36	Good	Hydropsychids, baetids, and midges predominant. Six mussel species (S) and (T).
Scioto River 0.45 mi ust Big Walnut Creek (2009)	117.6	1709.0	72	13	18	19	0	High	32	Marg. Good	Baetid mayflies predominant. Three mussel species (S) and (T).
Scioto River 0.4 mi dst Picway Power Plant (2009)	116.3	2266.0	82	19	26	18	0	High	44	Very Good	Hydropsychids and baetids predominant. Seven mussel species (S) and (T).
Scioto River W of South Bloomfield @ SR 316 (2009)	109.4	2311.0	64	14	26	12	0	High	54	Exceptional	Midges predominant. Sand/gravel riffles. Five mussel species (S) and (T).

Location	River Mile	Drain. (mi^2)	Total Taxa	Qual EPT	Total Sens	Total Tol.	CW Taxa	Substrate Density[a]	ICI[b]	Narrative Evaluation	Observations[c]
Scioto River W of South Bloomfield @ SR 316 (2010)	109.4	2311.0	62	18	26	15	0	High	48	Exceptional	Midges, hydropsychid caddisflies, baetid and leptohyphid mayflies predominant. Four mussel species (T).
Scioto River 0.8 mi dst Walnut Creek (2009)	105.3	2615.0	54	12	20	8	0	Moderate	52	Exceptional	Midges and hydropsychid caddisflies predominant. Four mussel species (S).
Scioto River ust Circleville @ Commercial Point Rd (2010)	102.1	2638.0	63	24	28	13	0	High	48	Exceptional	Hydropsychid and glossosomatid caddisflies, midges predominant. Two mussel species (S) and (T).
Scioto River at Circleville @ US 22 (2009)	99.82	3218.0	74	24	35	12	0	High	54	Exceptional	Baetid mayflies and midges predominant. Five mussel species (T).
HUC 050600011201 – Eversole Run											
Eversole Run @ Concord Rd	2.2	4.3	44	8	8	13	1	Moderate	n/a	Marg. Good	Hydropsychid caddisflies, midges, riffle beetles, water pennies, and heptageniid mayflies predominant. Low flows.
Eversole Run NW Shawnee Hills, dst Cook Rd	1.3	10.5	47	13	11	13	0	Moderate	n/a	Good	*Elimia sp* snails, crayfish, philopotamid caddisflies, water pennies, riffle beetles, and midges predominant.
HUC 050600011203 – Indian Run											
North Fork Indian Run @ Hyland-Croy Rd, adj Dublin Jerome High School	5.20	5.6	48	5	1	24	0	High	n/a	Low Fair	Beetles, snails, and flatworms predominant. Muck-bottom ditch.
North Fork Indian Run @ Coffman Road	1.80	10.2	43	6	1	16	0	Moderate	n/a	Low Fair	Midges, *Elimia sp* snails, and bryozoan predominant. Reach silty and enriched.
South Fork Indian Run @ Dublin Rec Center Entrance Road	1.30	6.0	39	7	2	13	0	Moderate	n/a	Low Fair	Blackflies, leptocerid caddisflies, flatworms, and sowbugs predominant.
HUC 050600011204 – Hayden Run-Scioto River											
Hayden Run @ Hayden Run Rd, adj Dexter Falls	0.83	7.0	39	8	5	11	0	Moderate	n/a	Fair	Heptageniid mayflies and hydropsychid caddisflies predominant.
HUC 050600011205 – Dry Run-Scioto River											
Dry Run @ Holton Park sewer crossing	1.40	7.2	24	6	2	5	1	Low	n/a	Fair	Baetid mayflies, flatworms, midges, *Antocha sp* crane flies, and oligochaetes predominant.
Trabue Run @ McKinley Road	0.28	5.9	25	5	1	4	0	Low	n/a	Low Fair	Baetid mayflies, hydropsychid caddisflies, Antocha sp crane flies, riffle beetles, and heptageniid mayflies predominant.
HUC 050600012301 – Scioto Big Run											

Location	River Mile	Drain. (mi^2)	Total Taxa	Qual EPT	Total Sens	Total Tol.	CW Taxa	Substrate Density[a]	ICI[b]	Narrative Evaluation	Observations[c]
Scioto Big Run @ Big Run Road	4.40	11.8	30	5	3	7	0	Low	n/a	Low Fair	Blackflies, hydropsychid caddisflies, baetid mayflies, and midges predominant.
Scioto Big Run @ Hardy Parkway	2.90	17.6	33	7	1	7	0	Moderate	n/a	Fair	Hydropsychid caddisflies, baetid mayflies, and riffle beetles predominant.
HUC 050600012302 – Kian Run-Scioto River											
Kian Run @ Castle Road	0.45	9.1	13	0	0	8	1	Low	n/a	Very Poor	Midges, flat worms, and sowbugs predominant. Heavy industrial pollution affecting community.
HUC 050600012303 – Grant Run-Scioto River											
Republican Run @ Buckeye Parkway	1.38	5.7	27	4	1	10	0	Moderate	n/a	Low Fair	*Rheotanytarsus sp* midges, bryozoan, and flat worms predominant. Embedded substrates.
Grant Run @ Buckeye Parkway	2.00	7.8	43	10	6	10	0	Moderate	n/a	Marg. Good	*Helicopsyche borealis* and hydropsychid caddisflies predominant.
Grant Run @ Paul Talbot Drive	0.20	14.1	51	11	5	12	0	Low	n/a	Marg. Good	*Helicopsyche borealis,* riffle beetles and heptageniid mayflies predominant. Heavy silt deposits.
Plum Run SW of Shadeville @ SR 665	0.72	7.0	46	6	6	12	2	Low	n/a	Fair	Midges predominant. Low flow and iron precipitate on substrates.
HUC 050600012304 – Grove Run-Scioto River											
Peter's Run @ SR 762	1.75	7.2	46	13	8	6	0	Moderate	n/a	Good	Hydropsychid caddisflies, riffle beetles, *Helicopsyche borealis*, and *Caenis sp* mayflies predominant.
Grove Run @ Gibson Road	1.58	5.6	38	10	6	7	1	Moderate	n/a	Marg. Good	Hydropsychid caddisflies, riffle beetles, *Helicopsyche borealis*, and heptageniid mayflies predominant.
Van Meter Run @ SR 104	1.00	5.8	71	16	10	16	0	Moderate	n/a	Good	Hydropsychid caddisflies, riffle beetles, and *Helicopsyche borealis* predominant.
HUC 050600012305 – Dry Run											
Dry Run @ Walnut Creek Pike	4.35	4.1	44	9	6	10	0	Low	n/a	Marg. Good	Hydropsychid caddisflies, riffle beetles, and *Caenis sp* mayflies predominant. Near interstitial flows.
Dry Run @ Island Road	0.50	18.4	56	14	7	10	1	Moderate	n/a	Good	*Rheotanytarsus sp* midges, hydropsychid caddisflies, heptageniid mayflies predominant.
Bokes Creek Watershed											
Bokes Creek @ Phelps Road	27.22	35.0	68	12	6	19	0	Moderate	38	Good	Midges predominant.
Bokes Creek @ SR 47	22.30	45.0	64	14	14	9	0	Low	46	Exceptional	*Petrophila sp.* moths, midges, and *Helicopsyche borealis* predominant. Low flows and fine substrates.
Bokes Creek adj SR 31, dst Powderlick Run	20.2	51.0	42	7	7	6	0	Moderate	38	Good	Riffle beetles, baetid mayflies, *Elimia sp*. snails, and fingernail clams predominant.

Location	River Mile	Drain. (mi^2)	Total Taxa	Qual EPT	Total Sens	Total Tol.	CW Taxa	Substrate Density[a]	ICI[b]	Narrative Evaluation	Observations[c]
Bokes Creek @ Taylor-Claiborne Road	14.73	60.0	56	13	12	10	0	Moderate	38	Good	Midges, hydropsychid caddisflies, riffle beetles, fingernail clams, and *Elimia sp.* snails predominant.
Powderlick Run @ SR 739	3.4	1.8	30	3	0	21	0	Moderate	n/a	Low Fair	Leeches and snails predominant.
Powderlick Run @ Powderlick Road	1.2	3.5	18	0	0	10	0	High	n/a	Poor	Flatworms and planorbid snails predominant.

a – Observed relative density of benthos on natural substrates. Please refer to Appendix J for relative densities on artificial substrates (where available).

b – Invertebrate Community Index. ICI not available for sampling locations with drainage area <20mi^2 (excluding reference sites), and are indicated by n/a. Dashed lines (--) indicate sites where quantitative data were not available due to vandalism, dessication, or some other disturbance of Hester Dendy artificial substrates (HDs).

c – Predominant taxa are those observed on natural substrates. Please refer to Appendix J for predominant taxa on artificial substrates.

Physical Habitat

Stream habitat was evaluated at 44 fish sampling locations (Table 5 and Appendix E). Excellent stream habitat was noted at 17 sites (39%), good stream habitat was recorded at 17 sites (39%), fair habitat was noted at 8 locations (18%), and poor habitat was documented at 2 locations (4%) (Table 5). The average QHEI score for the watershed was 66.5, reflecting the generally good habitat quality throughout the study area.

The Scioto River main stem had excellent to good habitat quality at 15 of 17 sampling locations. Two sites, downstream SR 4 (RM 174.22) and downstream of the Olentangy River at Town Street (RM 131.8), scored within the fair range (QHEI scores of 49 and 45, respectively) as a result of impounded conditions caused by dams. Tributaries of the Scioto River exhibited excellent to good habitat quality at 70% (19 of 27) of the sampling locations. These sites were characterized by diverse substrates and abundant instream cover with little, if any, evidence of channelization.

Six of the seven remaining tributary sites exhibited fair habitat quality. Eversole Run RM 2.2 was intermittent and had only a few isolated pools for fish. The fair habitat of Bokes Creek RM 22.2 and Powderlick Run RMs 3.4 and 1.2 reflected the surrounding agricultural landscape with siltation and poor to fair channel development. The habitat quality of North Fork Indian Run RM 5.2 and Dry Run RM 3.7 were negatively influenced by stormwater from the surrounding urbanized landscapes.

The two remaining sites, Kian Run RM 0.45 and Peter's Run RM 1.75 both received QHEI scores within the poor range. The straight ditch habitat of Kian Run RM 0.45 was characterized by a monotonous shallow pool with excessive siltation and extensively embedded substrates. The habitat of Peter's Run RM 0.45 had been channelized and continued to exhibit excessive siltation and embedded substrates (Table 5 and Appendix E).

Table 5. Stream physical habitat (QHEI) summarized results for the middle Scioto River and select tributaries, 2009-2010.

Stream	River Mile	Drain. (mi^2)	Location	QHEI	Comments
Scioto River	174.22	530	Downstream State Route 4	49.0	Impounded by dam
Scioto River	169.25	567	Near Prospect at Hoskins Road	75.5	
Scioto River	163.8	660	Downstream Fulton Creek at Mink Street (CR 177)	75.0	
Scioto River	157.1	764	South of Klondike, adjacent Klondike Road	74.0	
Scioto River	145.5	990	I-270 North of Dublin	82.0	
Scioto River	136.2	1049	Fifth Avenue in Columbus	85.5	
Scioto River	131.8	1,614	Downstream Olentangy River at Town Street	45.0	Impounded by dam
Scioto River	129.1	1,617	Greenlawn Avenue	83.0	
Scioto River	127.5	1,628	Frank Road	74.5	

Stream	River Mile	Drain. (mi^2)	Location	QHEI	Comments
Scioto River	126.0	1,636	Downstream Jackson Pike WWTP	84.5	
Scioto River	119.9	1,697	State Route 665 in Shadeville	84.0	
Scioto River	117.6	1,709	Downstream Columbus Southerly WWTP	73	
Scioto River	116.3	2,266	Downstream Picway power station	79.5	
Scioto River	109.4	2,311	State Route 316, upstream Walnut Creek	79.0	
Scioto River	105.3	2,615	One mile downstream Walnut Creek	79.5	
Scioto River	102.1	2,638	Upstream Circleville at Commercial Point Road	76.5	
Scioto River	99.8	3,217	Circleville at US 22	83.5	
Bokes Creek	27.22	32	Phelps Road	60.0	
Bokes Creek	22.2	41	State Route 47	57.0	Fair channel development
Bokes Creek	20.2	51.0	State Route 31	74.3	
Bokes Creek	14.73	61	Taylor-Claiborne Road	63.5	
Powderlick Run	3.4	1.8	State Route 739	52.0	Siltation and extensively embedded substrates
Powderlick Run	1.2	3.8	Powderlick Road	57.0	
Eversole Run	2.2	4.5	Concord Road	48.5	Intermittent stream; no riffle and only isolated pools available to sample.
Eversole Run	1.3	10.5	Downstream Cook Road	59.8	
North Fork Indian Run	5.2	5.6	Hyland Croy Road	54.0	False banks present and evidence of additional erosion downstream of zone.
North Fork Indian Run	1.8	10.2	Coffman Road	63.5	
South Fork Indian Run	1.3	6	Dublin Recreation Center entrance	68.5	
Hayden Run	0.83	7	Hayden Run Road	68.5	
Dry Run	1.4	7.2	Holton Park sewer crossing	73.5	
Trabue Run	0.28	5.9	McKinley Road	66.0	
Scioto Big Run	4.4	11.8	Big Run Road	56.0	
Scioto Big Run	2.9	17.6	Hardy Parkway	67.5	
Kian Run	0.45	9.3	Castle Road	35.0	Channelization with heavy silt and extensively embedded substrates.
Republican Run	1.38	5.7	Buckeye Parkway	78.5	Stream appears flashy from upstream stormwater; lots of trash throughout and eroding banks.
Grant Run	2.0	7.8	Buckeye Parkway	77.0	
Grant Run	0.2	14.1	Paul Talbot Drive	72.0	
Plum Run	0.72	7	South of Shadeville at State Route 665	64.5	
Peter's Run	1.75	7.2	State Route 762	35.5	Channelization with heavy silt and extensively embedded substrates.

Stream	River Mile	Drain. (mi^2)	Location	QHEI	Comments
Grove Run	1.58	5.6	Gibson Road	60.5	
Van Meter Run	1.0	5.8	State Route 104	66.5	
Dry Run	3.7	4.7	Belle Station Road	54.0	Evidence of flashy storm events. Only isolated pools available for sampling.
Dry Run	0.5	18.4	Island Road	57.5	
Griffy Run	1.1	4.9	Walnut Creek Pike	57.5	

General narrative ranges assigned to QHEI scores.				
Narrative Rating		QHEI Range		
		Headwaters (≤20 mi^2)	Larger Streams	Lacustuary
Excellent		≥70	≥75	≥80
Good		55 to 69	60 to 74	60 to 80
Fair		43 to 54	45 to 59	45 to 59
Poor		30 to 42	30 to 44	30 to 44
Very Poor		<30	<30	<30

Fish Community

A total of 30,908 fish representing 82 species were collected from the study area between June 2009 and September 2010. Fourteen very sensitive species were collected, reflecting the overall integrity of the middle Scioto River basin. Relative numbers and species collected per location are presented in Appendix G, and IBI and MIwb scores are presented in Appendix F. Sampling locations were evaluated using either Warmwater Habitat or Modified Warmwater Habitat (impounded or channel modification) biocriteria, according to the assigned or recommended aquatic life use designation. A summary of the fish data are presented in Table 6.

Scioto River main stem sites sampled during 2009 and 2010 achieved the applicable WWH biocriteria at all sixteen sites designated WWH. Exceptional fish communities were recorded at all WWH sites (average IBI=51 and average MIwb=11.1) except for RM 127.74 at Frank Road which was characterized as being very good (IBI=46 and MIwb=10.8). One additional site, Town Street RM 131.8, is designated MWH-I as it is impounded by the Greenlawn Avenue dam. The MWH-I fish biocriteria were achieved at this site with an IBI of 34 and MIwb of 8.4.

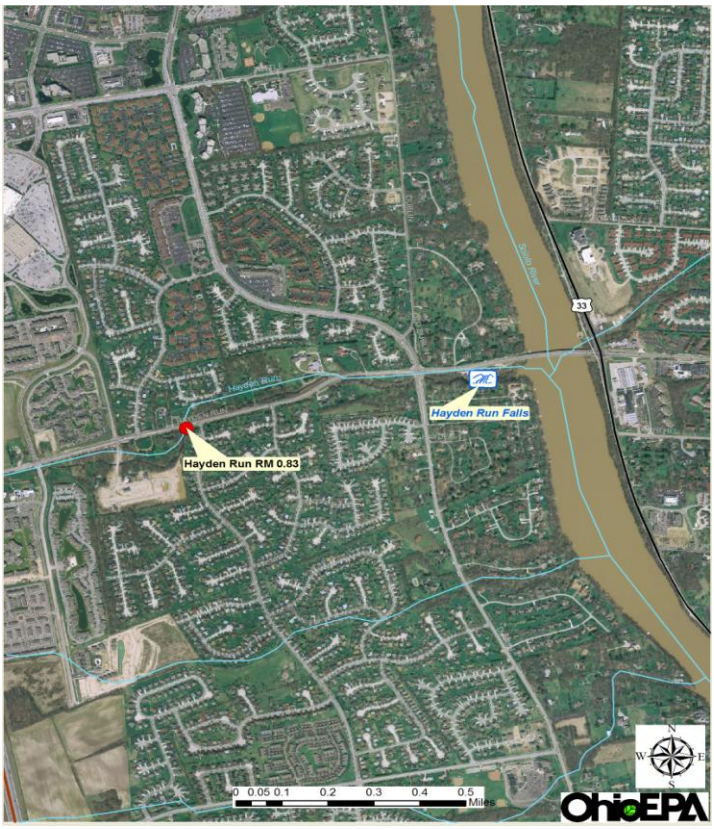


Figure 6. Proximity of sampling location Hayden Run RM 0.83 to Hayden Run Falls. Hayden Run Falls and Indian Run Falls act as barriers to upstream fish migration from the Scioto River.

Eighteen of twenty-seven (67%) middle Scioto tributary sites were in full attainment and the remaining nine (33%) fish sites were in non-attainment of the fish community biocriteria (Table 6). The fish communities of North Fork Indian Run RM 5.6, South Fork Indian Run RM 1.3 and Hayden Run RM 0.83 did not meet the WWH biocriterion due to suburban and urban influences including channelization, siltation, and stormwater. In addition, waterfalls located between these sites and the Scioto River have eliminated any possibility of fish recruitment upstream from the Scioto River (Figure 6). Therefore, the ability of the fish communities to recover from past or continuing sources of environmental degradation is limited. Even so, the site at North Fork Indian Run RM 1.8 received an IBI of 36, which was within non-significant departure of the biocriterion.

The fish communities of Dry Run RM 1.4, Trabue Run RM 0.28, and Republican Run RM 1.38 were negatively influenced by urban influences including organic enrichment indicative of sewage and altered flow regimes resulting in flashy stream flows. The fish communities of Dry Run RM 3.7 and Grant Run RM 0.2 were also negatively influenced by stormwater influences affecting the hydrologic regime. In addition, low biomass and diversity within the fish community of Grant Run RM 0.2 may be the result of poor recruitment due to a dam present downstream of the site. The fish community of Kian Run RM 0.45 was negatively influenced by a combination

of poor habitat characterized by a slow moving pool with no riffle and upstream urban sources resulting in excessive siltation and contaminated sediments.

The intensive urbanized landscape throughout portions of the middle Scioto River basin, characterized by flashy flow regimes, excessive siltation and sedimentation, and failing HSTS or CSOs, contributed to the overall impairments noted within the fish communities. Areas of industrial use, such as that upstream of Kian Run, led to excessive siltation and sedimentation (much of which was contaminated with PCBs) which impaired the fish community. Improved sewage treatment, both for HSTS and municipal WWTP infrastructure, would assist in improving the fish community integrity throughout the affected areas, while encouragement of improved stormwater abatement and water quality would benefit nearly all streams within the study area.

Trends

Since 1979, fish community sampling has occurred at various locations within the study area. Similar to many other areas sampled across the state of Ohio, water quality has generally improved over time. However, there are several areas where point sources are still a concern and nonpoint issues need to be addressed in order for full attainment of biocriteria to occur.

The fish community of the middle Scioto River main stem (Columbus to Circleville) has been extensively studied since 1979. The 1996 survey provided an in-depth summary of the fish community for the time period between1979-1996 (Ohio EPA 1999b). While the trend focus for the Scioto River main stem in this report will be for the time frame of 1996-2010, the significant improvements to water quality in the Scioto River since 1979 must not be overlooked (Figure 7 and Figure 8). As stated in the previous report, the earliest intensive surveys found significant use impairment for the river segment from the Greenlawn Ave. Dam (RM 129.6) to RM 102.0 (Commercial Point Rd.) due to the Whittier Street CSO, Jackson Pike WWTP, and the Columbus Southerly WWTP (including direct plant bypasses from both facilities) (Ohio EPA 1986). Modest improvements in the reach during the mid to late 1980's were associated with improved sludge handling at the Columbus Southerly WWTP.

Following treatment process upgrades, the implementation of pretreatment programs, and other process and/or operational improvements initiated at the Jackson Pike and Columbus Southerly WWTPs, improvements to ambient water quality and biological conditions of the Scioto River resulted in over 80% of the middle Scioto River main stem fully attaining WWH by 1991 (Ohio EPA 1999b). As the gross pollution problems identified in the past were rectified at these WWTPs, the periodic discharge of untreated sewage from the Whittier Street CSO was left as the most prominent source of aquatic life use impairment.

Since 1996, the fish community of the middle Scioto River main stem from Circleville at US 22 (RM 99.82) to the Town Street dam pool (RM 131.4) has continued to meet and often exceed EWH expectations. The negative water quality influence of the Whittier Street CSO and Jackson Pike WWTP are noted by a slight dip in the fish community average IBI from a 52.2 between Circleville (RM 99.82) and State Route 316 (RM 109.4) to 49.7 between Picway Power Station (RM 116.3) and Greenlawn Avenue (RM 129.48). Just upstream, the Town Street dam pool (RM 131.4) had the second lowest scores on the main stem with an IBI of 34 and MIwb of 8.4 in 2009. The remaining portion of the main stem from Fifth Avenue in Columbus (RM 136.5) to Prospect (RM 169.25) showed consistent improvement over past surveys, except for the other impounded reach near the town of Prospect (RM 174.22 with an IBI=24 and MIwb=7.1).

The improved water quality conditions throughout the Scioto River main stem over time are a direct result of concerted efforts to improve WWTPs efficiencies along with addressing CSOs. Additional improvement to water quality may occur through reduction of CSO events and removal of low head dams within the reach. Concerted efforts among communities and regulated entities to address water quality concerns are necessary for the high quality fish community of the middle Scioto River main stem to be maintained.

Many tributary streams have been sampled over time within the middle Scioto River study area. However, much of the historical sampling has occurred at significantly different drainage areas than sampling in 2010. Therefore, trends discussion is focused on streams with repeated sampling over time at sites within close geospatial proximity to one another.

Scioto Big Run has shown general improvement in the fish community over time (Figure 9). However, the significant increase in impervious surfaces associated with increased developed land has likely contributed to the dip in IBI scores between RMs 3.5-4.5 (NLCD, 1994 and 2006).

Bokes Creek and Powderlick Run (a tributary of Bokes Creek at RM 20.76) have been sampled numerous times since 1980 (Figure 9 , Figure 10, and Figure 11). The fish communities of Bokes Creek and Powderlick Run have steadily improved over time. The improvement is likely the combined result of improved agricultural practices and stream restoration efforts both in Bokes Creek and Powderlick Run. This area will have an intensive survey completed in 2013 which may delve deeper into the noticeable improvements in water quality.

Table 6. Fish community summaries based on pulsed D.C. electrofishing sampling conducted by Ohio EPA in the middle Scioto River study area from June 2009 – September 2010. Relative numbers and weight are per 1.0 km for boat sites and 0.3 km for wading and headwater sites.

Location	STORET (RM)	DRAIN. (MI²)	IBI	MIwb	QHEI	Total Fish Species	Relative Number	Relative Weights	Narrative Fish Evaluation
Scioto River at Newman, downstream State Route 4 - 2009	201830 (174.22)	530[B]	24*	7.1*	49.0	17	332	125.06	Poor
Scioto River near Prospect at Hoskins Road - 2009	601280 (169.25)	567[W]	36	9.0	75.5	24	695	54.46	Fair
Scioto River downstream Fulton Creek at Mink Street (CR 177) - 2009	V02P15 (163.8)	660[B]	41	9.5	75.0	33	1138	141.40	Marginally Good
Scioto River south of Klondike, adjacent Klondike Road - 2009	201823 (157.1)	764[B]	52	10.2	74.0	25	1918	155.25	Exceptional
Scioto River at I-270,north of Dublin -2009	V03P30 (145.7)	990[B]	52	10.7	82	24	1118	259.82	Exceptional
Scioto River at Fifth Avenue in Columbus -2009	V03W25 (136.5)	1049[B]	52	10.3	85.5	26	1242	147.37	Exceptional
Scioto River at Town Street, downstream Olentangy River - 2009	V07P16 (131.4)	1,614[B]	34	8.4	45	23	1090	131.78	Fair
Scioto River at Greenlawn Avenue - 2009	600860 (129.48)	1,617[B]	48	11.8	83.0	44	1408	222.35	Exceptional
Scioto River at Frank Road - 2010	600870 (127.74)	1,628[B]	47	10.8	74.5	38	764	232.37	Very Good
Scioto River, 0.7 mile dst. Jackson Pike WWTP, dst. Kian Run - 2010	V07P28 (126.4)	1,636[B]	47	10.5	83.5	38	527	308.77	Very Good
Scioto River dst. Jackson Pike WWTP – 2009	V07P28 (126.0)	1,636[B]	52	11.5	84.5	36	1168	492.08	Exceptional
Scioto River at State Route 665 in Shadeville - 2009	600810 (119.9)	1,697[B]	50	11.7	84.0	45	1366	221.16	Exceptional

Location	STORET (RM)	DRAIN. (MI²)	IBI	MIwb	QHEI	Total Fish Species	Relative Number	Relative Weights	Narrative Fish Evaluation
Scioto River dst. Columbus Southerly WWTP - 2009	V07W11 (117.6)	1,709[B]	52	11.1	73.0	37	1064	146.04	Exceptional
Scioto River dst. Picway power station - 2009	V07W28 (116.3)	2,266[B]	52	11.6	79.5	39	1166	424.06	Exceptional
Scioto River West of South Bloomfield at State Route 316, upstream Walnut Creek - 2009	600910 (109.4)	2,311[B]	54	11.7	79.0	41	860	230.33	Exceptional
Scioto River West of South Bloomfield at State Route 316, upstream Walnut Creek - 2010	600910 (109.4)	2,311[B]	50	11.1	88.3	34	796	142.16	Exceptional
Scioto River one mile downstream Walnut Creek - 2009	V07W45 (105.3)	2,615[B]	48	11.4	79.5	39	640	224.31	Exceptional
Scioto River ust.Circleville at Commercial Point Road - 2010	601340 (102.1)	2,638[B]	55	10.3	76.8	38	486	138.73	Exceptional
Scioto River at Circleville at US 22 - 2009	600960 (99.82)	3,217[B]	54	11.4	83.5	43	970	137.29	Exceptional
Bokes Creek at Phelps Road	V02S23 (27.22)	35.0[W]	47	8.6	60.3	29	757	11.25	Good
Bokes Creek at Summerville, State Route 47	30123 (22.23)	46.0[W]	48	8.7	56.8	26	824	12.50	Good
Bokes Creek at State Route 31	V02K05 (20.2)	51.0 [W]	50	8.1[NS]	74.3	27	680	9.32	Marginally Good
Bokes Creek at Taylor-Claiborne Road	V02S1 (14.73)	60.0[W]	46	9.2	63.0	29	2064	59.03	Very Good
Powderlick Run at State Route 739	V02K11 (3.4)	1.8[H]	32	N/A	54.0	13	1409	6.37	Fair
Powderlick Run at Powderlick Road	V02K09 (1.2)	3.5[H]	40	N/A	55.0	15	794	9.56	Good

Location	STORET (RM)	DRAIN. (MI²)	IBI	MIwb	QHEI	Total Fish Species	Relative Number	Relative Weights	Narrative Fish Evaluation
Eversole Run at Concord Road	300965 (2.20)	4.3[H]	36 NS	N/A	49.3	9	598	N/A	Marginally Good
Eversole Run dst. Cook Road	203160 (1.30)	10.5[H]	44	N/A	59.8	18	734	N/A	Good
North Fork Indian Run at Hyland Croy Road	300963 (5.20)	5.6[H]	32*	N/A	54.3	14	730	N/A	Fair
North Fork Indian Run at Coffman Road	300964 (1.80)	10.2[H]	36[NS]	N/A	63.8	11	830	10.69	Marginally Good
South Fork Indian Run at Dublin Rec Center entrance	300966 (1.3)	5.1[H]	26*	N/A	68.5	6	428	N/A	Poor
Hayden Run at Hayden Run Road	300802 (0.83)	7.0[H]	24*	N/A	68.8	5	970	N/A	Poor
Dry Run at Holton Park Sewer Crossing	V03K04 (1.40)	7.0[H]	26*	N/A	73.0	5	626	N/A	Poor
Trabue Run at McKinley Road	V03P11 (0.28)	6.6[H]	30*	N/A	64.0	12	394	N/A	Fair
Scioto Big Run at Big Run Road	300968 (4.40)	11.8[H]	48	N/A	55.8	15	702	N/A	Very Good
Scioto Big Run at Hardy Parkway	V07K11 (2.90)	17.6[H]	52	N/A	67.8	18	1472	N/A	Exceptional
Kian Run at Castle Road	300967 (0.45)	9.1[H]	24*	N/A	34.3	11	216	N/A	Poor
Republican Run at Buckeye Parkway	300969 (1.38)	5.7[H]	32*	N/A	79.5	11	2460	N/A	Fair
Grant Run at Buckeye Parkway	300803 (2.0)	7.8[H]	48	N/A	77.0	17	2352	N/A	Very Good
Grant Run at Paul Talbot Drive	300970 (0.2)	14.1[H]	24*	N/A	72.0	11	174	N/A	Poor
Plum Run at State Route 665, southwest of Shadeville	V07P23 (0.72)	7.0[H]	42	N/A	66.5	19	3572	30.32	Good
Peter's Run at State Route 762	300972 (1.75)	7.2[H]	40	N/A	35.8	11	1826	N/A	Good

Location	STORET (RM)	DRAIN. (MI^2)	IBI	MIwb	QHEI	Total Fish Species	Relative Number	Relative Weights	Narrative Fish Evaluation
Grove Run at Gibson Road	300973 (1.58)	5.6^{H}	42	N/A	60.5	16	3694	N/A	Good
Van Meter Run at State Route 104	300974 (1.0)	5.8^{H}	48	N/A	66.5	18	2910	N/A	Very Good
Dry Run at Belles Station Road	300975 (3.7)	4.7^{H}	28*	N/A	54.0	10	274	N/A	Fair
Dry Run at Island Road	300976 (0.5)	18.4^{H}	52	N/A	57.5	21	692	N/A	Exceptional
Griffy Run at Walnut Creek Pike	300977 (1.1)	4.9^{H}	44	N/A	58.0	13	2890	N/A	Good

ns - Nonsignificant departure from biocriterion ($\leq$4 IBI units; $\leq$0.5 MIwb units).
* - Significant departure from biocriterion (>4 IBI units; >0.5 MIwb units). Poor and very poor results are underlined.

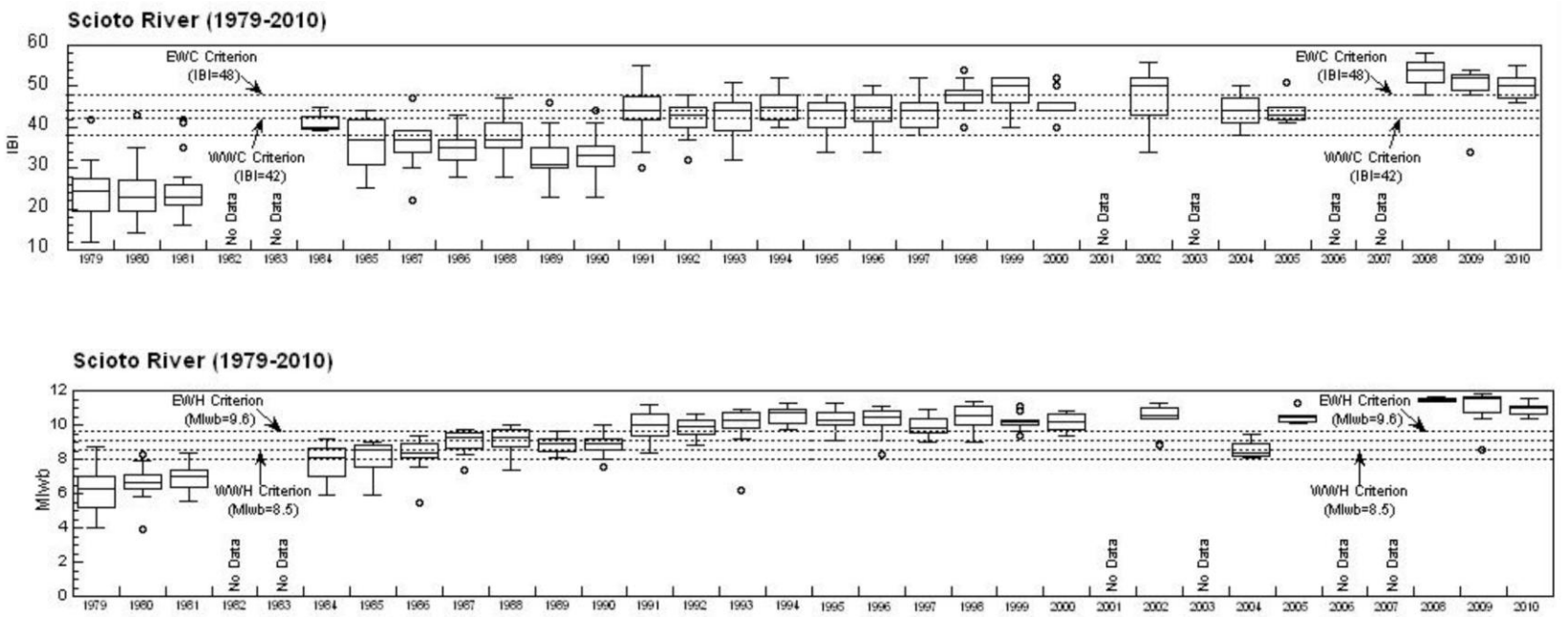


Figure 7. IBI and MIwb boxplots for the Scioto River main stem from river miles 99 to 175, 1979 - 2010.

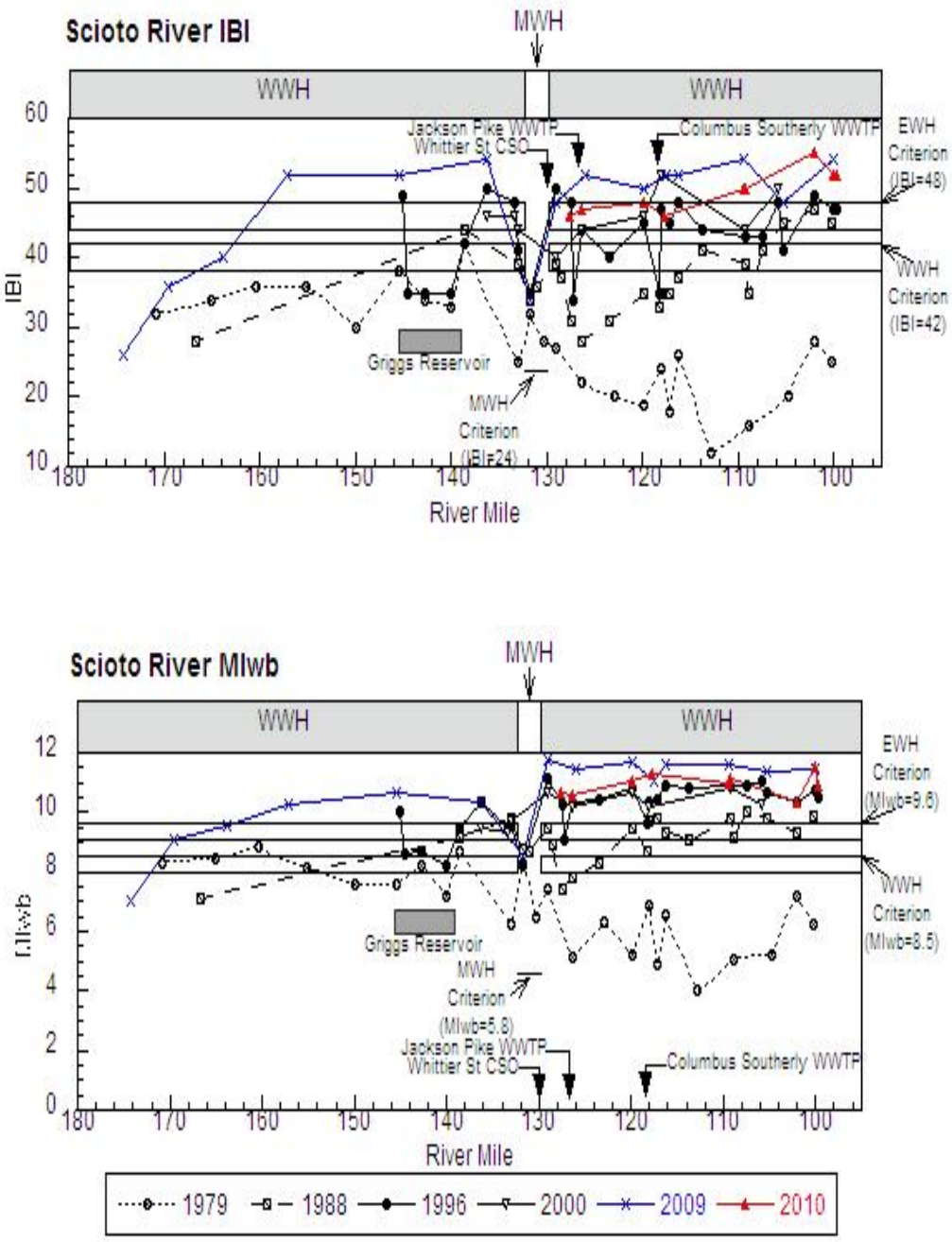


Figure 8. IBI and MIwb scores for the Scioto River main stem, 1979, 1988, 1996, 2000, 2009, and 2010.

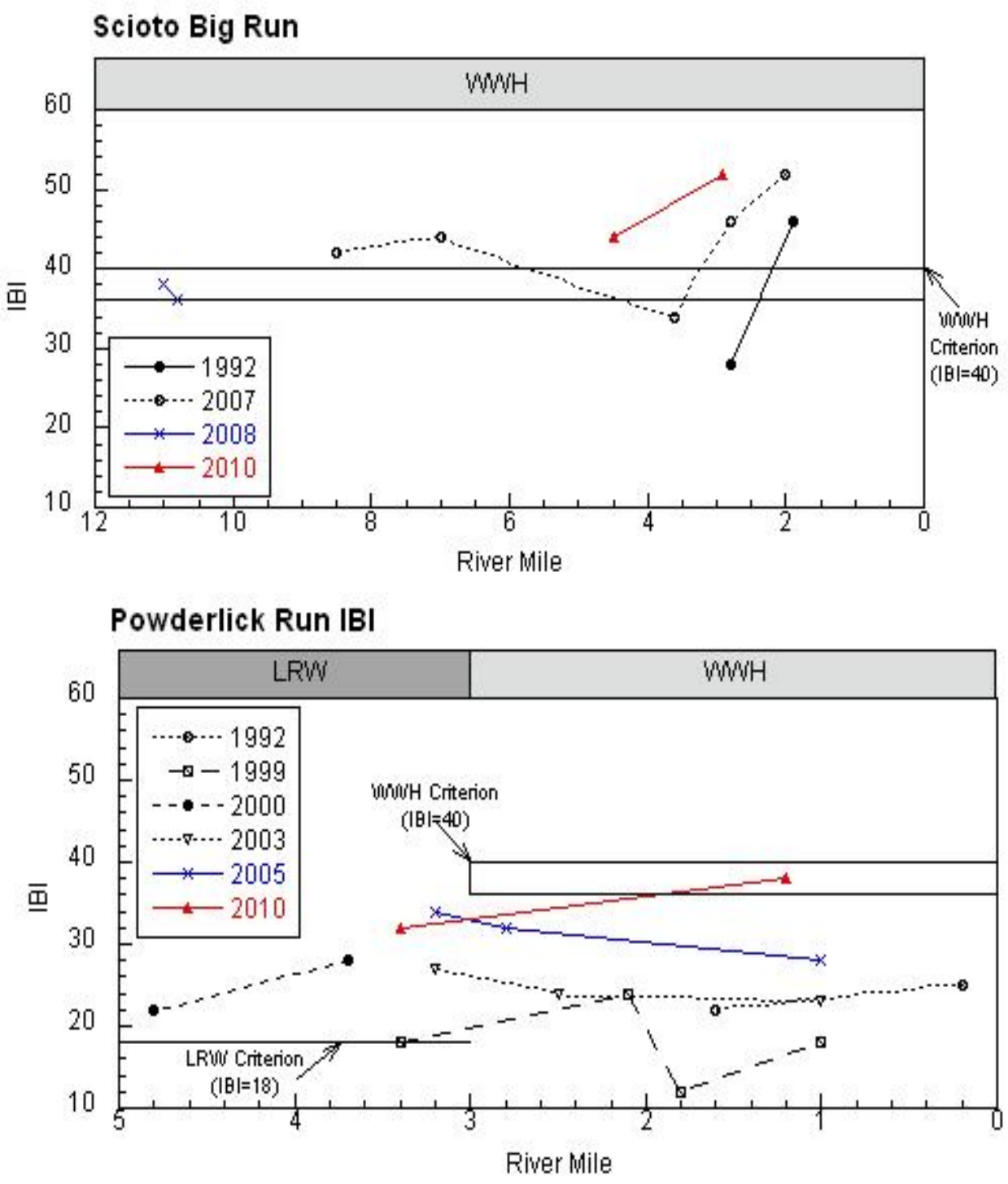


Figure 9. Fish community IBI scores over time for Scioto Big Run and Powderlick Run.

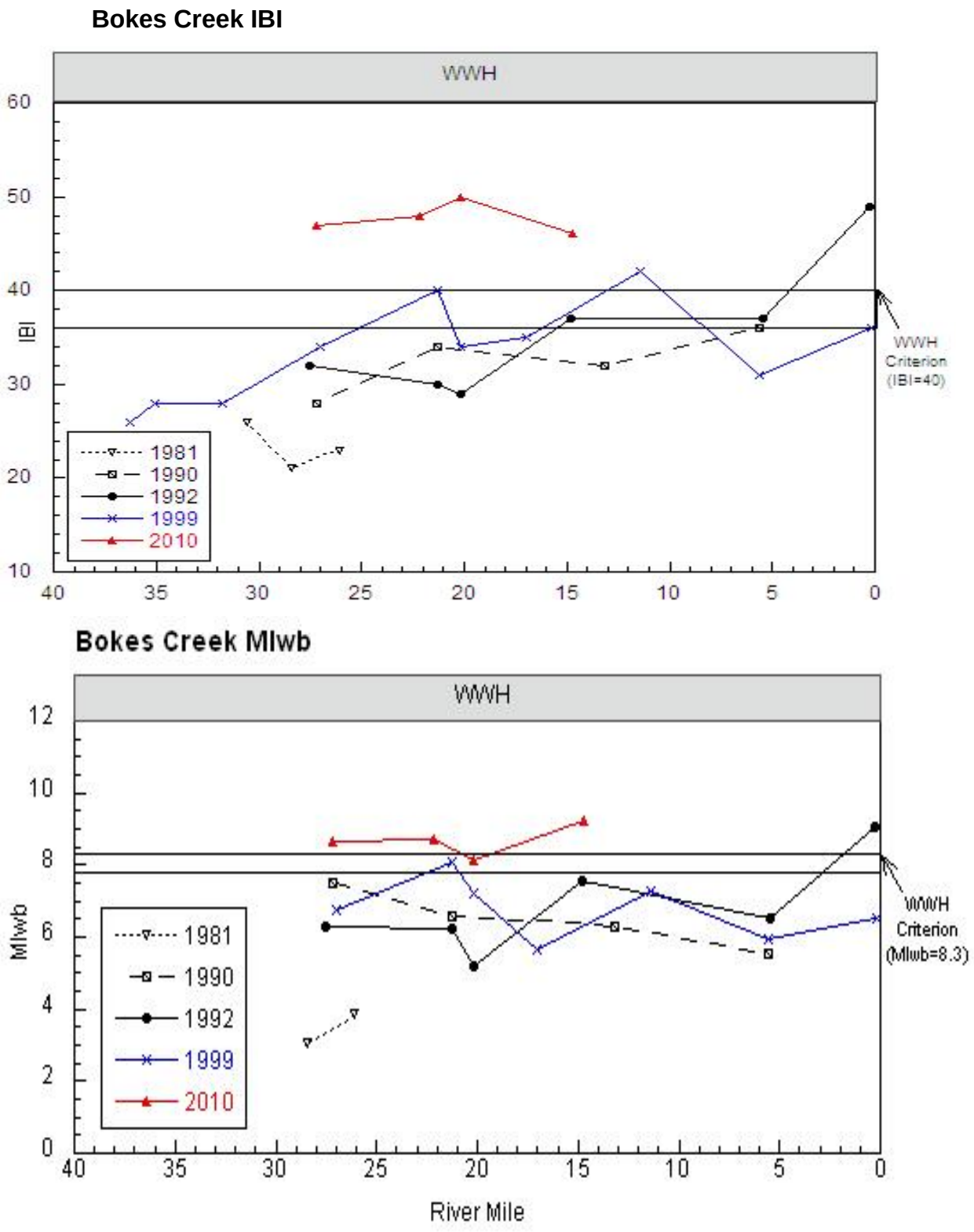


Figure 10. Fish community IBI and MIwb plots over time for Bokes Creek.

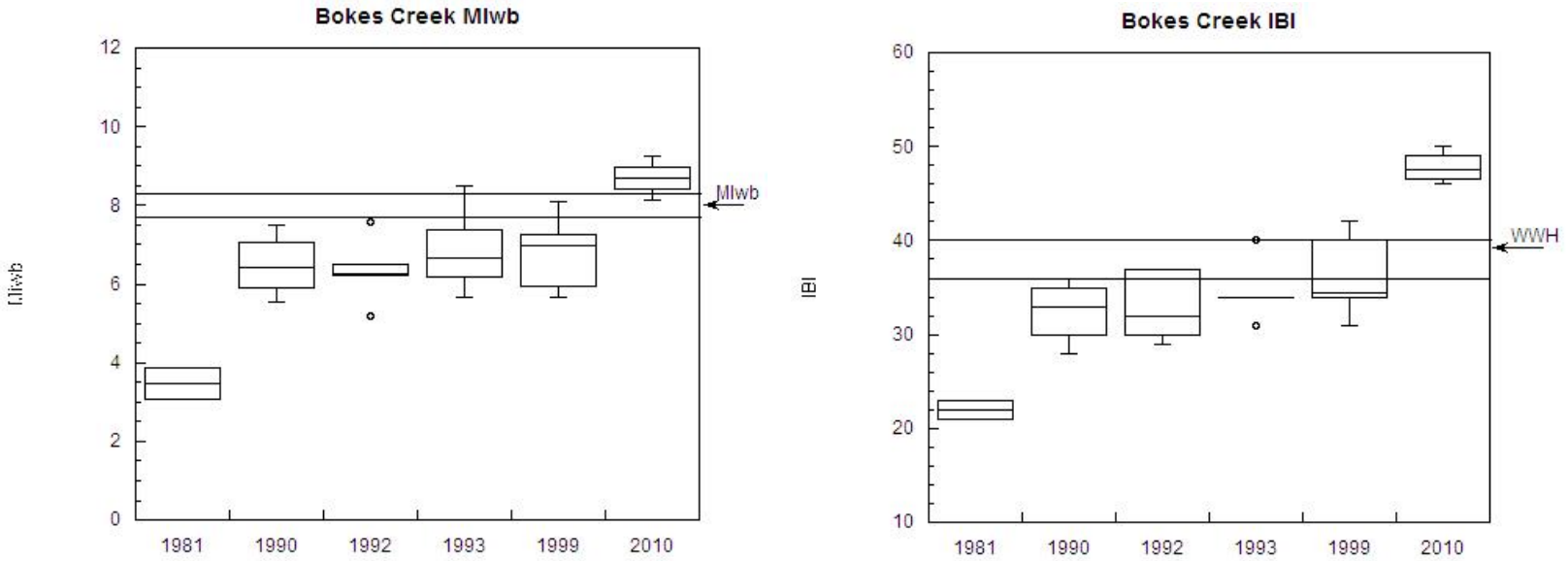


Figure 11. Bokes Creek fish community MIwb and IBI boxplots over time, 1981 – 2010.

Point Source Pollutant Loadings - NPDES

A total of 42 National Pollutant Discharge Elimination System (NPDES) individual permitted facilities discharge sanitary wastewater, industrial process water and/or industrial storm water into streams in the middle Scioto River watershed study area (Table 7). Included in this list are two major municipal dischargers, Jackson Pike WWTP and Southerly WWTP (city of Columbus). Each facility is required to monitor their discharges according to sampling and monitoring conditions specified in the individual NPDES permit and report results to the Ohio EPA in a Discharge Monitoring Report (DMR). Each permit includes a detailed list of each parameter to be monitored and the specific limits for both concentration and loading rate. They also include monthly average limits and daily or weekly limits, depending on monitoring requirements. The DMR data can be used to track compliance as well as to evaluate historic trends.

Additional facilities regulated by an Ohio EPA general NPDES permit in the study area may be found at: http://epa.ohio.gov/dsw/permits/gpfact.aspx.

City of Columbus Jackson Pike WWTP (4PF00000)

The Jackson Pike wastewater plant is an advanced treatment facility with an average design flow of 68 million gallons per day (MGD). Wet stream processes at Jackson Pike include screening, influent pumping, grit removal, primary settling, activated sludge aeration, secondary clarification, chlorination, post aeration, dechlorination and effluent pumping (when necessary). The final effluent is discharged through outfall 001.

There are two bypasses at the Jackson Pike plant - Station 002 (gravity flow at wet well) and Station 003 (pumped flow at headworks). The use of these stations is expected to decrease as upgrades come on line during 2010 that will increase the plant's wet weather treatment capacity from 102 MGD to 150 MGD. These upgrades are part of the 2010 Interim Plan from the City's "Wet Weather Management Plan" (see below).

Solid stream processes for primary sludge are gravity thickening followed by either anaerobic digestion, dewatering by centrifugation, and disposal by land application/composting; or dewatering by centrifugation and disposal by incineration. Processes for waste activated sludge are thickening by centrifugation, anaerobic digestion, dewatering by centrifugation, and disposal by either land application/composting or incineration. Incinerator ash is sluiced to an ash lagoon, which discharges through outfall 030. If necessary, dewatered sludge can be hauled to a landfill.

The Jackson Pike collection system includes both areas with combined sewers and areas with separate sanitary and storm sewers. There are 31 CSOs on the Columbus collection system. Thirty of these are authorized in the Jackson Pike NPDES permit. The other one is authorized in the NPDES permit for the Southerly wastewater treatment plant (permit number 4PF00001). An interactive map showing the locations of Columbus' CSOs is available at the following Ohio EPA Web page: http://wwwapp.epa.ohio.gov/dsw/gis/cso/index.php. Select "Columbus" from the drop down list.

Storm water discharges from the City's collection system are regulated under an individual MS4 storm water permit. The Ohio EPA permit number is 4PI00000*BD and U.S. EPA's permit number is OH0106267. The current permit is available at the following Ohio EPA Internet site:

http://epa.ohio.gov/dsw/storm/ms4_index.aspx .

The City of Columbus implements an Ohio EPA approved industrial pretreatment program. Based on the program's 2009 annual report, 49 categorical industrial users and 40 significant non-categorical industrial users discharge to the city's collection system.

Wet Weather Management Plan to Address CSOs and SSOs

On March 3, 2008, the City of Columbus submitted to Ohio EPA a "Combined Sewer Long Term Control Plan - Interim (2010) Plan update" pursuant to the requirements of Consent Decree Case Numbers 02-CVH-05-5768 and 04-CVH-05-5336, filed in Franklin County Common Pleas Court. This plan was approved by the Director on March 7, 2008 as Plan Approval number 650187. On July 1, 2005, the City Columbus submitted a "Wet Weather Management Plan" (July 1, 2005) pursuant to the "Combined Sewer Overflow" Consent Order (Court of Common Pleas, Franklin County, Ohio; Case No. 04-CVH-05-5336; September 17, 2004) and the "Sanitary Sewer Overflow" Consent Order, (Court of Common Pleas, Franklin County, Ohio; Case No. 02-CVH-05-5768; August 1, 2002). This plan was approved by the Director on January 26, 2009 as Plan Approval number PTI 01-302-PW. The current NPDES permit requires that the City implement both of these approved plans. In addition, the City submitted an "Overflow Emergency Response and Notification Plan (March 31, 2009)" on April 23, 2009. This plan was approved by the Director on July 8, 2009, and the City is required to implement this plan consistent with the provisions of this NPDES permit.

(Facility Description excerpted from Ohio EPA Permit Document / Fact Sheet 2010 available at: http://wwwapp.epa.ohio.gov/dsw/permits/permit_list.php)

Effluent Sampling

During the 2010 survey, periodic final effluent grab sampling was conducted at the Jackson Pike WWTP (RM 127.1). The eight samples collected for analysis had an average dissolved oxygen level of 9.20 mg/l with a minimum of 8.06 mg/l. Total ammonia nitrogen geometric mean was 0.091 mg/l with a maximum of 0.497 mg/l recorded. The geometric mean for total phosphorus and nitrate+nitrite was 2.38 mg/l and 8.72 mg/l respectively. The geometric mean for *E. coli* was 48 cfu/100 ml.

Bioassay Testing

Whole effluent toxicity testing performed by the city of Columbus in accordance with the NPDES permit has been below detection for the period 2006 to 2009. This data indicates that the effluent does not currently present a toxicity problem. Ohio EPA toxicity screening in 2008 indicated effluent was not acutely toxic.

Compliance summary

A review of DMR data from 2007 thru 2010 revealed five NPDES permit limit violations. In August 2008 there was a fecal coliform violation and in March 2009 there were four minor pH violations.

Loadings

Jackson Pike WWTP annual loadings (kg/day) of selected pollutants were evaluated and are presented in Figure 12. Also included is an evaluation of bypass and CSO events for Jackson Pike WWTP (Figure 13). WWTP flow for the period 2000 to 2010 has remained steady with median flows for the most recent years (2008 to 2010) less than the average daily design flow of 68 mgd. $CBOD_5$ (5-day Carbonaceous Biochemical Oxygen Demand) median loadings have fluctuated over this same period with the lowest median loading (less than 500 kg/day) occurring in 2010. TSS (Total Suspended Solids) median loadings showed a similar fluctuation with 2010 also having the lowest median loading (less than 1000 kg/day). Total ammonia nitrogen median loadings have remained steady from 2010 to 2011. However, 95^{th} percentile loadings in 2009 and 2010 were remarkably higher than those previously observed. Median nutrient loadings for total phosphorus and nitrate+nitrite have fallen slightly the past three years (2008 to 2010).

A review of Jackson Pike WWTP bypass events (hours discharged) indicates that 2005 had the most hours bypassed with 152.70. This was followed in 2006 with the least number of hours bypassed at 9.30. From 2007 to 2010, the number of hours bypassed has ranged from 13.5 hours (2009) to 50.90 hours (2008).

The most significant CSO events in the middle Scioto River watershed result from the Whittier Street Storm Tanks (CSO 18 and CSO 19) and from two discharge locations along the Scioto Mile in downtown Columbus. These two locations near Bicentennial Park include CSOs 41, 43, 45, 46, 47 and 50. From 2005 to 2010, the Whittier St. Storm tanks have averaged 1.69 billion gallons released annually. The highest annual release during this period occurred in 2008 with 2.4 billion gallons discharged. The lowest volume occurred during 2009 with 1.28 billion gallons released. The majority of the release occurred from CSO 18 (discharge). Average annual pollutant release concentrations from CSO 18 from 2005 to 2010 include total ammonia nitrogen at 5.75 mg/l. $CBOD_5$ averaged 63.1 mg/l and TSS averaged 64.9 mg/l over the same period. The annual CSO release volume from two discharge locations in the Scioto Mile has ranged from a high of 46.4 million gallons (2008) to a low of 23.2 million gallons (2010) during the 6 year period from 2005 to 2010. The 6-year average annual release volume was 31.2 million gallons.

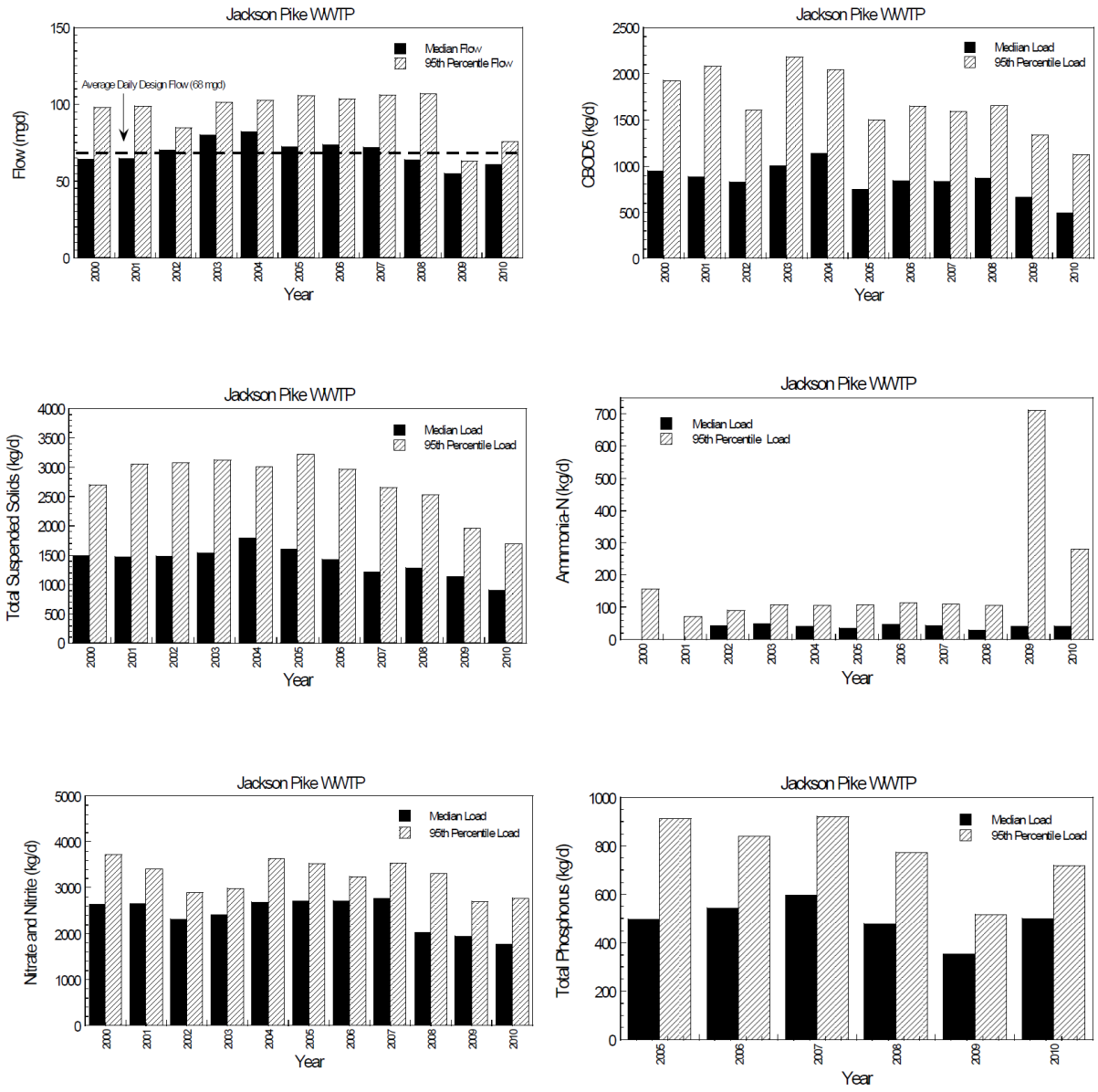


Figure 12. Annual loadings for select parameters from Jackson Pike WWTP, 2000-2010.

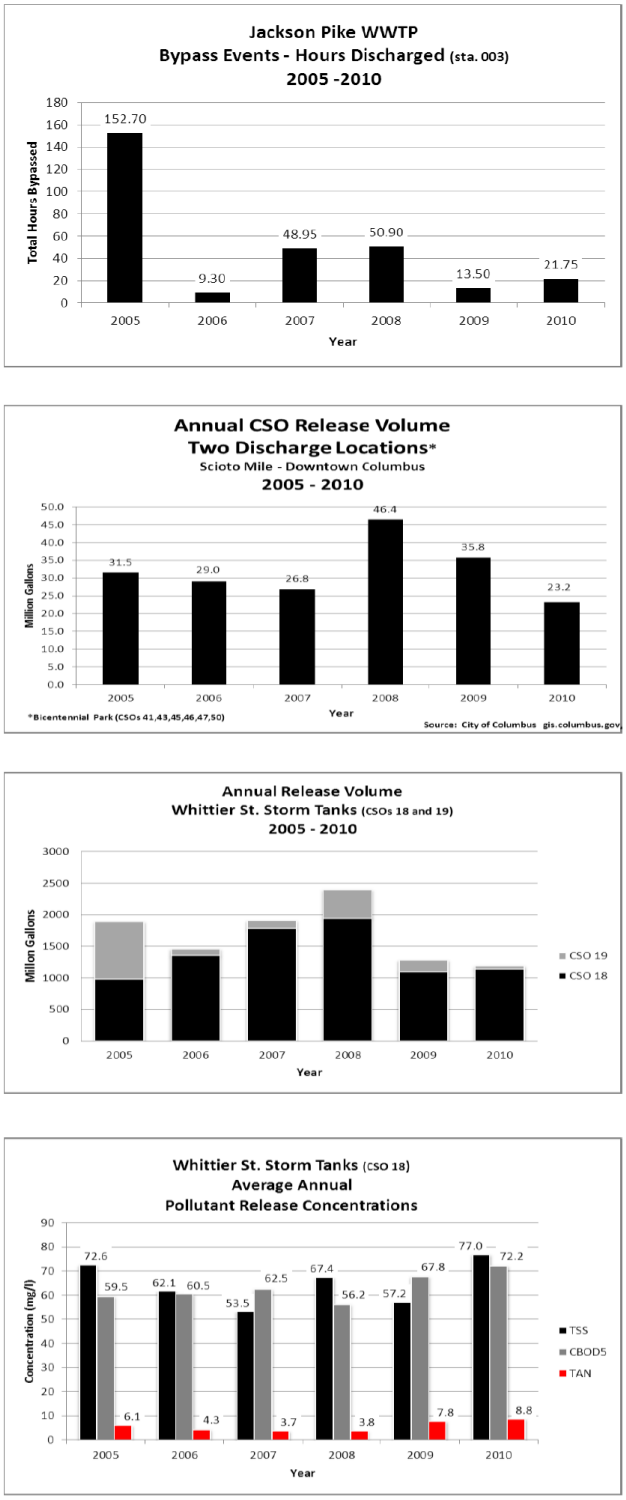


Figure 13. Bypass events for Jackson Pike WWTP and CSO discharge statistics upstream from Jackson Pike WWTP's discharge, 2005-2010.

City of Columbus Southerly WWTP

The Southerly wastewater plant is an advanced treatment facility with an average design flow of 114 MGD. Wet stream processes are screening, influent pumping, grit removal, primary settling, activated sludge aeration, secondary clarification, chlorination, post aeration and dechlorination. The final effluent is discharged through outfall 001. The Southerly plant has a raw sewage bypass located at its headworks (station 002). The use of this station is expected to decrease as upgrades come on line during 2010 that will increase the plant's wet weather treatment capacity from 225 MGD to 330 MGD. These upgrades are part of the 2010 Interim Plan from the City's "Wet Weather Management Plan" (see below).

Solid stream processes include gravity thickening of primary sludge, centrifuge thickening of waste activated sludge, sludge blending, dewatering by centrifugation, and disposal by composting. Dewatered sludge may also be disposed of by incineration or hauling to a landfill. Incinerator ash is sluiced to an ash lagoon, which discharges through outfall 007. The Southerly plant's collection system includes both areas with separate sanitary and storm sewers (approximately 99 percent) and areas with combined sewers (1 percent). There are 31 CSOs on the Columbus collection system. One of these is authorized in the Southerly NPDES permit. The other 30 are authorized in the NPDES permit for the Jackson Pike wastewater treatment plant (permit number 4PF00000). An interactive map showing the locations of Columbus' CSOs is available at the following Ohio EPA Web page:
http://wwwapp.epa.ohio.gov/dsw/gis/cso/index.php. Select "Columbus" from the drop down list.

Storm water discharges from the City's collection system are regulated under an individual MS4 storm water permit. The Ohio EPA permit number is 4PI00000*BD. U.S. EPA's permit number is OH0106267. The current permit is available at the following Ohio EPA Internet site: http://epa.ohio.gov/dsw/storm/ms4_index.aspx.

The City of Columbus implements an Ohio EPA approved industrial pretreatment program. Based on the program's 2009 annual report, 49 categorical industrial users and 40 significant non-categorical industrial users discharge to the city's collection system.

Wet Weather Management Plan to Address CSOs and SSOs (Sanitary Sewer Overflows)

On March 3, 2008, the City of Columbus submitted to Ohio EPA a "Combined Sewer Long Term Control Plan - Interim (2010) Plan update" pursuant to the requirements of Consent Decree Case Numbers 02-CVH-05-5768 and 04-CVH-05-5336, filed in Franklin County Common Pleas Court. This plan was approved by the Director on March 7, 2008 as Plan Approval number 650187. On July 1, 2005, the City of Columbus submitted a "Wet Weather Management Plan" (July 1, 2005) pursuant to the "Combined Sewer Overflow" Consent Order (Court of Common Pleas, Franklin County, Ohio; Case No. 04-CVH-05-5336; September 17, 2004) and the "Sanitary Sewer Overflow" Consent Order, (Court of Common Pleas, Franklin County, Ohio; Case No. 02-CVH-05-5768; August 1, 2002). This plan was approved by the Director on January 26, 2009 as Plan Approval number PTI 01-302-PW. The current NPDES permit requires that the City implement both of these approved plans.

In addition, the City submitted an "Overflow Emergency Response and Notification Plan (March 31, 2009)" on April 23, 2009. This plan was approved by the Director on July 8, 2009. The City is required to implement this plan consistent with the provisions of this NPDES permit.

(Facility Description excerpted from Ohio EPA Permit Document / Fact Sheet 2010 available at: http://wwwapp.epa.ohio.gov/dsw/permits/permit_list.php)

Effluent Sampling

Periodic final effluent grab sampling was conducted at the Southerly WWTP (RM 118.4) during the 2010 survey. A minimum of eight samples was collected for analysis. The average dissolved oxygen level was 9.20 mg/l with a minimum of 8.06 mg/l. The total ammonia nitrogen geometric mean was 0.046 mg/l with a maximum of 0.092 mg/l recorded. The geometric mean for total phosphorus and nitrate+nitrite was 1.63 mg/l and 9.28 mg/l respectively. The geometric mean for *E. coli* was 31 cfu/100 ml.

Bioassay Testing

Whole effluent toxicity testing performed by the city of Columbus in accordance with the NPDES permit has been below detection for the period 2006 to 2009. This data indicates that the effluent does not currently present a toxicity problem. Ohio EPA toxicity screening in 2008 indicated effluent was not acutely toxic.

Compliance Summary

A review of DMR data for the period of 2007 thru 2010 revealed three NPDES permit limit violations. In October 2007 there was one dissolved oxygen violation, in June 2009, one total residual chlorine violation and in November 2010 there was a pH violation.

Loadings

Southerly WWTP annual loadings (kg/day) of selected pollutants were evaluated and are presented in Figure 14. Also included is an evaluation of bypass events. Annual flows have been steady for the period 2000 to 2010 with median flows less than the average daily design flow of 114 mgd. $CBOD_5$ and TSS median loadings have remained less than 1000 kg/day for much of that period. Median total ammonia nitrogen loadings peaked in 2007 and 2008 before falling to levels previously observed. Median nutrient loadings for total phosphorus and nitrate+nitrite have also fallen slightly the past three years (2008 to 2010).

A review of Southerly WWTP bypass events (hours discharged) indicates that 2005 had the most hours bypassed with 334. 2010 had the least hours bypassed with 138. Between those years the number of hours bypassed ranged from 168 (2006) to 214 (2008).

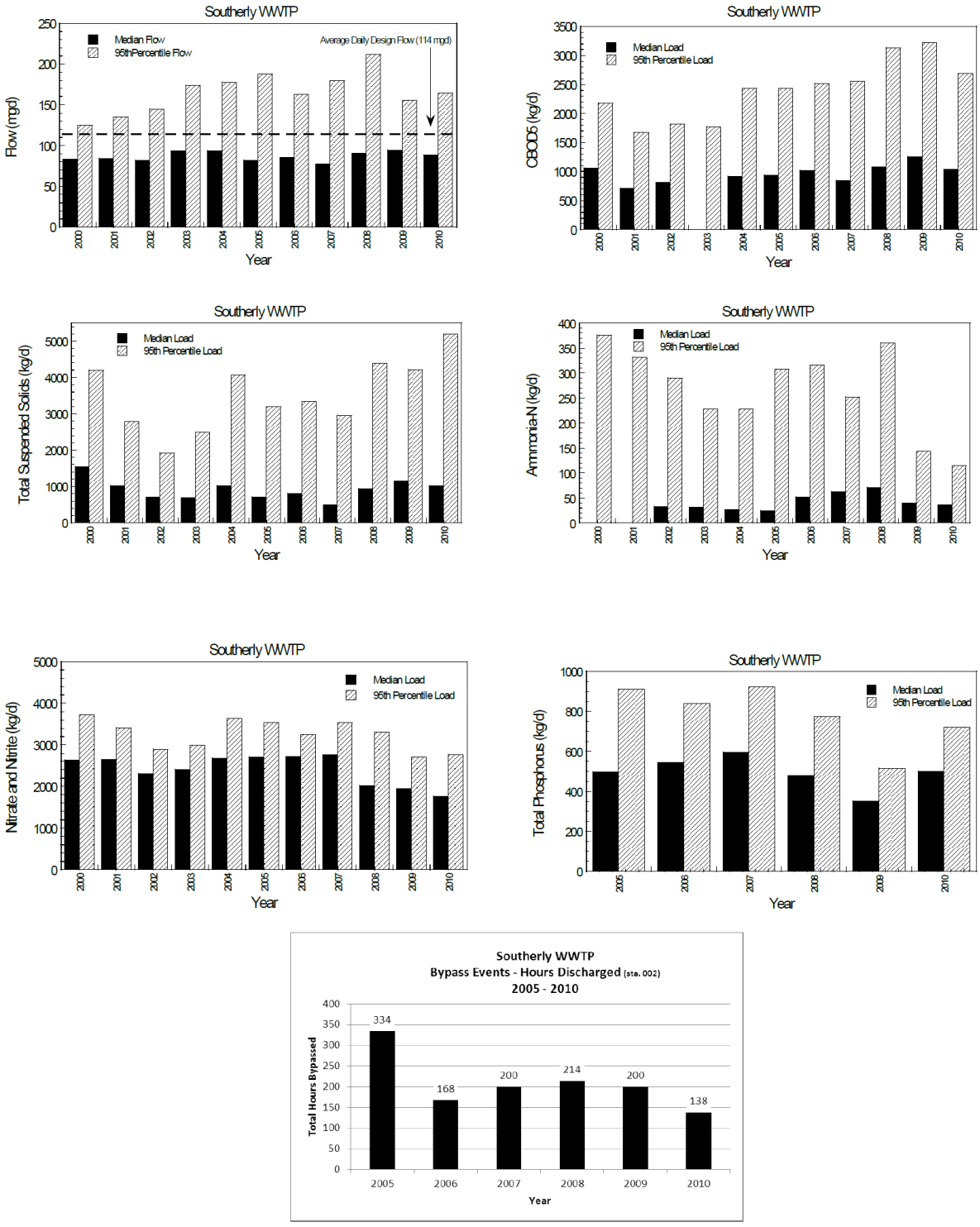


Figure 14. Annual loadings for select parameters, 2000-2010, and bypass events, 2005-2010, for Columbus Southerly WWTP.

Table 7. National Pollutant Discharge Elimination System (NPDES) dischargers' outfalls in the middle Scioto River watershed.

Permit #	FACILITY	STA	TYPE[1]	RIVER MILE	STREAM	Design Flow MGD	Avg. Daily Flow 2009 MGD	COUNTY
4IM00106	Advanced Machining Inc	1	IND	1.2	UT Scioto Big Run (3.33)	0.0015	0.001	Franklin
4IJ00020	Agg Rock Materials Div of WSG	1	SW	1.95	Scioto Big Run	NA	2.62	Franklin
4IN00027	BP Products North America Inc Columbus	1	IND	0.3	UT Dry Run	NA	0.02	Franklin
4IN00049	Buckeye Terminals - Columbus East Terminal	1	IND	3.5	Dry Run	NA	0.01	Franklin
4IN00049	Buckeye Terminals - Columbus East Terminal	2	IND	3.6	Dry Run	NA	0.01	Franklin
4IN00062	Buckeye Terminals LLC Columbus West Terminal	2	IND	1.6	NB Dry Run	NA	0.02	Franklin
4IF00011	Capital Resin Corp	2	SW/NCCW	1.23	Kian Run (storm sewer)	NA	0.19	Franklin
4IF00011	Capital Resin Corp	3	SW	1.23	Kian Run (storm sewer)	NA	AH	Franklin
4IF00011	Capital Resin Corp	4	NCCS	1.23	Kian Run (storm sewer)	NA	AH	Franklin
4PV00108	Carter's MHP	1	SAN	1.3	UT Scioto Big Run (3.33)	0.01	0.01	Franklin
4IN00048	CITGO Petroleum	1	IND	4.6	SF Indian Run	NA	AH	Franklin
4IB00000	Columbus & So Ohio Electric Pick Gen Station	1	IND	116.46	Scioto River	NA	46	Pickaway
4PF00001	Columbus Southerly WWTP	1	SAN	118.4	Scioto River	114	106	Franklin
4PF00001	Columbus Southerly WWTP	7	SAN	118.6	Scioto River	NA	AH	Franklin
4IN00043	Columbus Steel Castings Co	1	SW	1.1	Kian Run	NA	0.36	Franklin
4IN00043	Columbus Steel Castings Co	2	NCCW	0	UT Kian Run (storm sewer)	NA	AH	Franklin
4PB00107	Commercial Point WWTP	1	SAN	115.35	Scioto River	0.43	0.23	Franklin
4PY00006	Country Side MHP	1	SAN	3.01	Hayden Run (storm sewer)	0.018	0.01	Franklin
4IF00010	DeLille Oxygen Co	1	SW	128.35	Scioto R (storm drain)	NA	AH	Franklin
4IW00030	Dublin Rd WTP	1	WTP	133.4	Scioto R (quarry lake)	NA	3.24	Franklin
4IW00030	Dublin Rd WTP	2	WTP	133.1	Scioto R (pilot area)	NA	1.97	Franklin
4PH00005	Enchanted Acres MHP	1	SAN	124.39	Scioto R (storm drain)	0.1	0.06	Franklin
4PX00042	Foxfire Golf Club	1	SAN	3.65	Peters Run	0.006	AH	Pickaway
4IN00072	Franklin County Sanitary Landfill	3	SW	3	UT Grant Run	NA	0.29	Franklin
4IN00072	Franklin County Sanitary Landfill	4	SW	3.3	UT Grant Run	NA	0.5	Franklin
4IN00072	Franklin County Sanitary Landfill	5	SW	2.4	UT Grant Run	NA	0.03	Franklin
4IN00072	Franklin County Sanitary Landfill	6	SW	2.5	UT Grant Run	NA	AH	Franklin
4IN00072	Franklin County Sanitary Landfill	7	SW	3.1	UT Grant Run	NA	AH	Franklin
4IE00006	GFS Chemicals Inc	2	NCCW/SW	132.8	Scioto R (storm sewer)	NA	0.005	Franklin
4IE00006	GFS Chemicals Inc	3	NCCW	132.8	Scioto R (storm sewer)	NA	AH	Franklin
4IE00006	GFS Chemicals Inc	4	NCCW	132.8	Scioto R (storm sewer)	NA	AH	Franklin
4IE00006	GFS Chemicals Inc	5	NCCW	132.8	Scioto R (storm sewer)	NA	AH	Franklin

Permit #	FACILITY	STA	TYPE[1]	RIVER MILE	STREAM	Design Flow MGD	Avg. Daily Flow 2009 MGD	COUNTY
4IE00006	GFS Chemicals Inc	6	NCCW	132.8	Scioto R (storm sewer)	NA	AH	Franklin
4IE00006	GFS Chemicals Inc	7	SW	132.8	Scioto R (storm sewer)	NA	0.005	Franklin
4PV00110	Hayden Heights MHP	1	SAN	5.7	Hayden Run	0.04	0.06	Franklin
4PF00000	Jackson Pike WWTP	30	SAN	127.2	Scioto River	NA	AH	Franklin
4PF00000	Jackson Pike WWTP	1	SAN	127.1	Scioto River	68	50	Franklin
4PV00003	Lockbourne Lodge MHP	0	SAN	3.35	UT Scioto R. (114.21)	0.054	0.06	Pickaway
4PK00004	Lower Scioto WRF	1	SAN	153.3	Scioto River	0.2	AH	Delaware
4IN00011	Marathon fka SemMaterials	1	SW	3.75	Dry Run	NA	AH	Franklin
4IN00020	Marathon Petroleum LLC Columbus Terminal	1	SW	3.85	Dry Run	NA	0.02	Franklin
4IN00065	Marathon Petroleum LLC Columbus Terminal	1	IND	1.6	NB Dry Run	NA	0.07	Franklin
4IJ00005	Marble Cliff Limestone Inc	1	SW	138.2	Scioto River	NA	0.37	Franklin
4IJ00005	Marble Cliff Limestone Inc	2	SW	137.4	Scioto River	NA	AH	Franklin
4IJ00005	Marble Cliff Limestone Inc	3	SW	138.3	Scioto River	NA	0.46	Franklin
4PY00003	Meadowbrook MHP	1	SAN	3.35	UT Scioto R (114.21)	0.03	0.02	Pickaway
4IZ00052	North Area WTP	1	WTP	105.2	Scioto River	0.029	AH	Pickaway
4IN00026	Ohio Dept of Youth Scioto Village	1	SAN	151.3	Scioto River	0.2	0.02	Delaware
4PV00011	Ponderosa Mobile Home Est	1	SAN	2.6	UT Scioto R storm (143.6)	0.015	0.0145	Franklin
4IN00085	Rickenbacker International Airport	8	IND	4.9	UT Scioto (114.21)	NA	AH	Pickaway
4PX00005	Rte 23 Truck Stop	1	SAN	1	Dry Run	0.004	0.004	Pickaway
4PC00101	South Bloomfield WWTP No 2	1	SAN	109.29	Scioto River	0.5	0.18	Pickaway
4IN00056	Sunoco M & T LP Columbus West Terminal	1	IND	1.15	NB Dry Run	NA	0.01	Franklin
4IN00056	Sunoco M & T LP Columbus West Terminal	2	IND	1.15	NB Dry Run	NA	0.03	Franklin
4IN00021	Sunoco Partners Marketing & Terminals Columbus	1	IND	1.7	UT Dry Run	NA	0.01	Franklin
4IN00021	Sunoco Partners Marketing & Terminals Columbus	2	IND	1.7	UT Dry Run	NA	0.03	Franklin
4IN00057	T Marzetti Allen Division	1	NCCW	3.6	Scioto Big Run (storm d.)	NA	0.04	Franklin
4IJ00112	The Olen Corp	2	SW	121.47	Scioto River	NA	AH	Franklin
4IJ00112	The Olen Corp	3	SW	120.1	Scioto River	NA	AH	Franklin
4IJ00112	The Olen Corp	1	SW	122.55	Scioto River	NA	AH	Franklin
4IJ00016	The Shelly Co Columbus Limestone Inc	1	SW	126.7	Scioto River	NA	AH	Franklin
4IJ00016	The Shelly Co Columbus Limestone Inc	2	SW	126.85	Scioto River	NA	11.49	Franklin
4IJ00016	The Shelly Co Columbus Limestone Inc	3	SW	127.6	Scioto River	NA	0.12	Franklin
4IJ00016	The Shelly Co Columbus Limestone Inc	4	SW	125.5	Scioto River	NA	111	Franklin
4IJ00016	The Shelly Co Columbus Limestone Inc	5	SW	125.12	Scioto River	NA	29	Franklin
4IJ00016	The Shelly Co Columbus Limestone Inc	6	SW	125.02	Scioto River	NA	AH	Franklin
4PR00012	Tinks Restaurant	1	SAN	0.4	Dry Run (RR ditch)	0.0025	AH	Pickaway

Permit #	FACILITY	STA	TYPE[1]	RIVER MILE	STREAM	Design Flow MGD	Avg. Daily Flow 2009 MGD	COUNTY
4PX00011	Walker Station	1	SAN	0.3	UT Scioto R (RM 155.0)	0.0036	0.00007	Delaware

IND = Industrial
SAN = Sanitary
SW = Storm water or surface runoff
NCCW = Noncontact cooling water
WTP = Water Treatment Plant

NA – not available AH – not reported
Source: Ohio EPA GIS Karta Layer (NPDES Facilities, River Mile Maps), SWIMS.

Chemical Water Quality

Surface water chemistry samples were collected from 32 sites in the middle Scioto River watershed and 6 sites in the Bokes Creek watershed (Figure 1). All sites were sampled on a minimum of five separate occasions, typically at two week intervals, from June 2010 to August 2010. Nine sentinel sites throughout the middle Scioto watershed were also sampled more frequently (typically monthly) from January 2010 to November 2010. Samples were analyzed for a variety of parameters including bacteria, nutrients and metals. Sites were sampled from free-flowing sections of streams and were primarily collected from bridge crossings. Surface water samples were collected in appropriate containers, preserved and delivered to Ohio EPA's Division of Environmental Services (DES) laboratory for analysis. Sample collection followed the methods as outlined in Parts I and II of the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA 2009).

For analysis of water chemistry results, data is often compared to Ohio WQS criteria or target values/percentile concentrations from least impacted regional reference sites of similar size (Ohio EPA 1999a). For the latter situation, statistical data were segregated by ecoregion and further stratified by three ranges of stream and river sizes for this analysis as follows: headwater streams (0-20 mi²); wadeable streams (20-200 mi²); and small rivers (200-1000 mi²).

Generally, chemical water quality sampling was conducted to capture a wide variety of stream flow conditions. Data from the United States Geological Survey (USGS) gage station at Columbus, Ohio (Frank Road) was examined to show flow trends in the middle Scioto watershed during the 2010 survey (Figure 15, upper). For samples collected in the Bokes Creek watershed, the closest USGS gage was at Mill Creek near Bellpoint (Figure 15, lower). Dates when surface water chemistry samples were collected during the summer of 2010 are noted on the graphs. Samples captured a variety of flow conditions during the study. However, a majority of samples collected during the summer of 2010 were collected at or near the historical median.

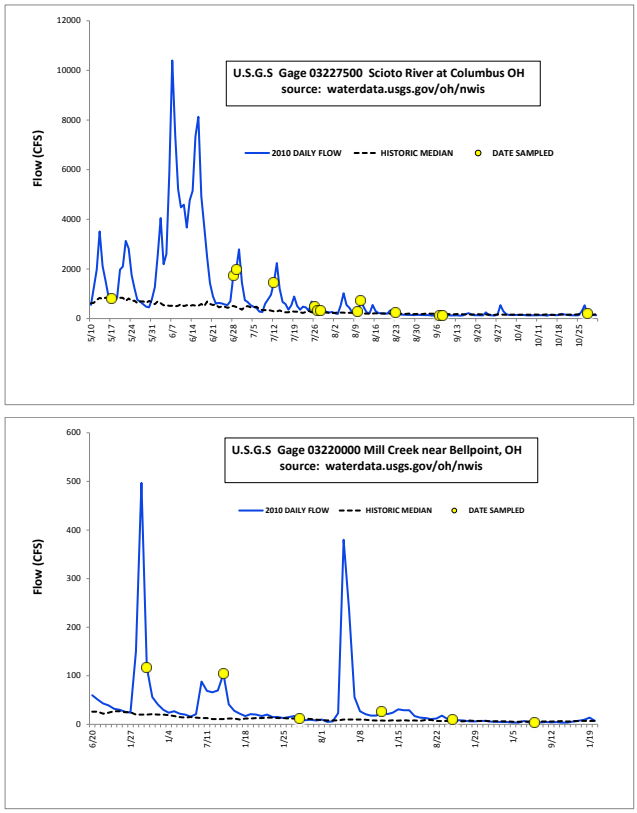


Figure 15. Flow conditions in the middle Scioto River watershed (upper) and Bokes Creek watershed (lower) during the 2010 sampling season.

Scioto River

Six locations on the Scioto River main stem were sampled and evaluated. The sites were located from Hoover Park (RM 138.5) to near Circleville (RM 102.14). There were no exceedances of Ohio WQS identified during survey sampling. Nutrient results for total

phosphorus and nitrate+nitrite were higher downstream from metropolitan Columbus and the Jackson Pike WWTP and Southerly WWTP (Appendix B). At these locations, a majority of samples were elevated above the 90th percentile state-wide reference value for these parameters (Ohio EPA 1999a).

Other notable findings included lower dissolved oxygen readings and higher total ammonia nitrogen concentrations immediately downstream from Columbus (Appendix B). In this reach, CSOs and the Jackson Pike WWTP effluent discharge are dominant influences on stream chemistry. Organic enrichment caused partial aquatic life use impairment at two sites in this reach. More discussion on the city of Columbus WWTPs and CSOs are provided in the Point Source Loadings – NPDES section.

Diel dissolved oxygen, temperature, pH and conductivity data were collected with YSI Datasonde© continuous sampling units during July 2010 at four sites (Appendices C and D) In general, results recorded were satisfactory and showed typical variation of dissolved oxygen levels. Dissolved oxygen ranges were less than 4.5 mg/l with minimum concentrations above 6.0 mg/l. The only exception to this was found in the Scioto River at Frank Road (RM 127.7). Here, the dissolved oxygen range was 8.4 mg/l, which is indicative of enriched conditions. This site is downstream from Columbus CSO outfalls, including the Whittier Street Storm Tanks.

Scioto River Trends

Trends in water quality data were studied for the middle Scioto River reach and included data from the Ohio EPA 1996 stream survey (Ohio EPA 1999b). For nutrients, including total phosphorus and total inorganic nitrogen, the overall trend was comparable or slightly lower in 2010 through this reach (Figure 16). Dissolved oxygen concentrations were slightly improved with means above 1996 results excluding one site, Scioto River near SR 665 (RM 119.9). This site is located downstream from the Columbus urbanized area and would include impairment caused by the Jackson Pike WWTP and the Whittier Street CSO. Here, 2010 results were lower than those recorded in 1996. Further downstream, the dissolved oxygen levels rebounded with 2010 results improved from those found in 1996 (Figure 16).

Other notable findings include lower zinc and copper results in 2010 compared to 1996 (Figure 16). This may be attributed to diligent industrial pretreatment and NPDES program regulation, improved industrial storm water practices, and manufacturing decline in the central Ohio area.

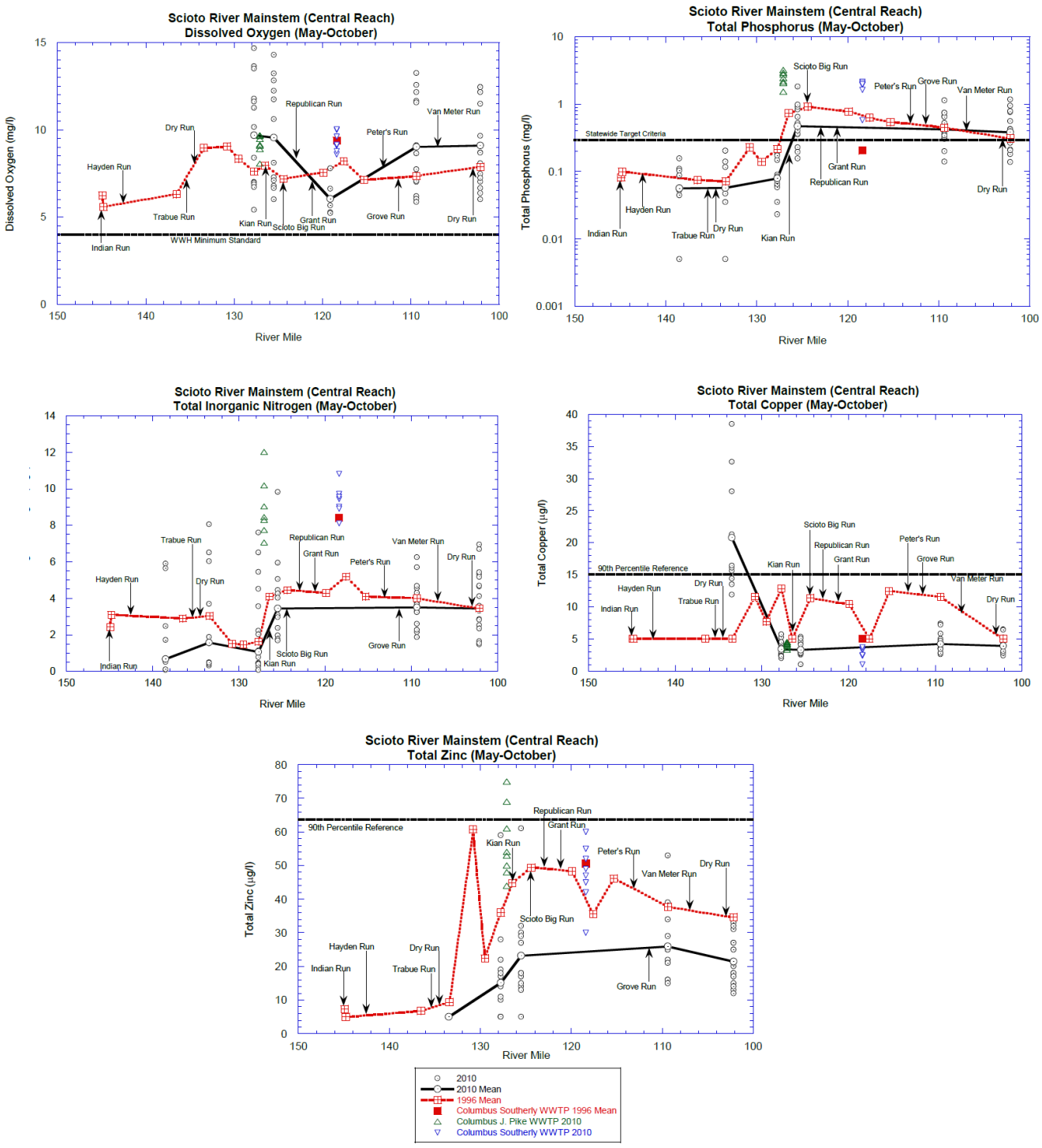


Figure 16. Longitudinal plots of dissolved oxygen, total phosphorus, inorganic nitrogen, copper and zinc for the middle Scioto River, 1996 and 2010.

Bokes Creek (HUC 050600010702 and HUC 050600010703)

Four locations on Bokes Creek were sampled for water chemistry beginning at Phelps Road (RM 27.22) and ending at Taylor-Claibourne Road (RM 14.73). Several violations of Ohio WQS for dissolved oxygen were recorded in this segment (Table 8). Median dissolved oxygen results remained above the 4.0 mg/l minimum WWH standard. Near the end of this segment dissolved oxygen concentrations rebounded exceeding the EWH minimum criterion of 5.0 mg/l (Figure 17).

Of the nutrients studied, total phosphorus concentrations were most elevated with geometric mean results for the four sites studied all exceeding the statewide target criteria (0.10 mg/l) for wadeable streams (Table 9). Nitrate+nitrite concentrations were reflective of an agricultural landscape with results extremely elevated during runoff events. Overall, geometric mean results for nitrate+nitrite were below the 1.6 mg/l statewide target criteria. Nutrient concentrations were comparable to previous Ohio EPA survey results recorded in 1999 (Figure 17).

Other notable results for this segment included mean concentrations of total dissolved solids (TDS), chloride and sulfate less than the 90th percentile ecoregion reference value for wadeable WWH streams (Figure 17). Concentrations of these substances typically trended lower than those observed in 1999. All sites studied in this Bokes Creek segment fully met applicable biological criteria.

Powderlick Run (HUC 050600010703)

Two sites on Powderlick Run were studied at State Route 739 (RM 3.40) and at Powderlick Road (RM 1.20). The current aquatic life use at the upper site (RM 3.40) is LRW. The site at RM 1.20 is immediately downstream of Day Lay Egg Farm and the Powderlick Run restoration project (Section 319 grants). Poultry concentrated animal feeding operations (CAFOs) regulated by the Ohio Department of Agriculture and Ohio EPA dominate this watershed.

Water quality concerns for Powderlick Run continue to include enrichment, chlorides and TDS. WQS criteria exceedances for Powderlick Run included those for dissolved oxygen and TDS (Table 8). Poor dissolved oxygen concentrations (mean = 3.61 mg/l) were clearly evident at the downstream site while high TDS concentrations were present at the upstream site (mean = 1526 mg/l).

Organic and nutrient enrichment indicators included high total ammonia levels and total phosphorus concentrations (geometric mean all results = 0.44 mg/l) that easily exceeded statewide target criteria. Chloride and sulfate sample results often were over 90th percentile reference stream values (Appendix B). Biological communities met LRW benchmarks at the upstream site but were in partial attainment of WWH biological criteria at the downstream site.

Table 8. Summary of Ohio WQS exceedances for Bokes Creek and Powderlick Run, 2010.

Stream	Date	Parameter	Result	Criteria
Bokes Creek (RM 27.2)	8/12/2010	Dissolved Oxygen	2.85 mg/l	4.0 mg/l AL[1]
Bokes Creek (RM 27.2)	8/25/2010	Dissolved Oxygen	3.69 mg/l	4.0 mg/l AL
Bokes Creek (RM 27.2)	9/9/2010	Dissolved Oxygen	3.94 mg/l	4.0 mg/l AL
Bokes Creek (RM 21.29)	8/12/2010	Dissolved Oxygen	3.25 mg/l	4.0 mg/l AL
Bokes Creek (RM 20.20)	8/12/2010	Dissolved Oxygen	3.64 mg/l	4.0 mg/l AL
Bokes Creek (RM 20.20)	9/9/20110	Dissolved Oxygen	3.48 mg/l	4.0 mg/l AL
Powderlick Run (RM 3.2)	7/28/2010	Dissolved Solids	2130 mg/l	1500 mg/l AL
Powderlick Run (RM 3.2)	8/12/2010	Dissolved Solids	1530 mg/l	1500 mg/l AL
Powderlick Run (RM 3.2)	8/25/2010	Dissolved Solids	2760 mg/l	1500 mg/l AL
Powderlick Run (RM 1.0)	7/28/2010	Dissolved Oxygen	2.99 mg/l	4.0 mg/l AL
Powderlick Run (RM 1.0)	8/12/2010	Dissolved Oxygen	1.52 mg/l	4.0 mg/l AL
Powderlick Run (RM 1.0)	8/25/2010	Dissolved Oxygen	3.41 mg/l	4.0 mg/l AL

[1] - Aquatic Life criteria

Table 9. Summary geometric mean nutrient results (May 1 –October 30) for select tributary streams sampled in the Bokes Creek watershed (2010). Results shaded are above statewide recommended criteria (OEPA, 1999). Results reported in mg/l.

Stream	Drainage Area (square miles)	River Mile	Ammonia	Nitrate+Nitrite	Phosphorus
Bokes Creek	32.0	27.22	0.07	0.46	0.26
Bokes Creek	41.0	21.29	0.16	0.70	0.21
Bokes Creek	45.0	20.20	0.09	0.64	0.24
Bokes Creek	61.0	14.73	0.08	0.47	0.18
Statewide Criteria WWH Drainage Area 20 miles² < 200 miles²			***NA***	***1.6***	***0.10***
Powderlick Run	1.8	3.4	0.87	0.64	0.65
Powderlick Run	3.8	1.2	0.06	0.29	0.32
Statewide Criteria WWH Drainage Area <20 miles²			***NA***	***1.0***	***0.08***

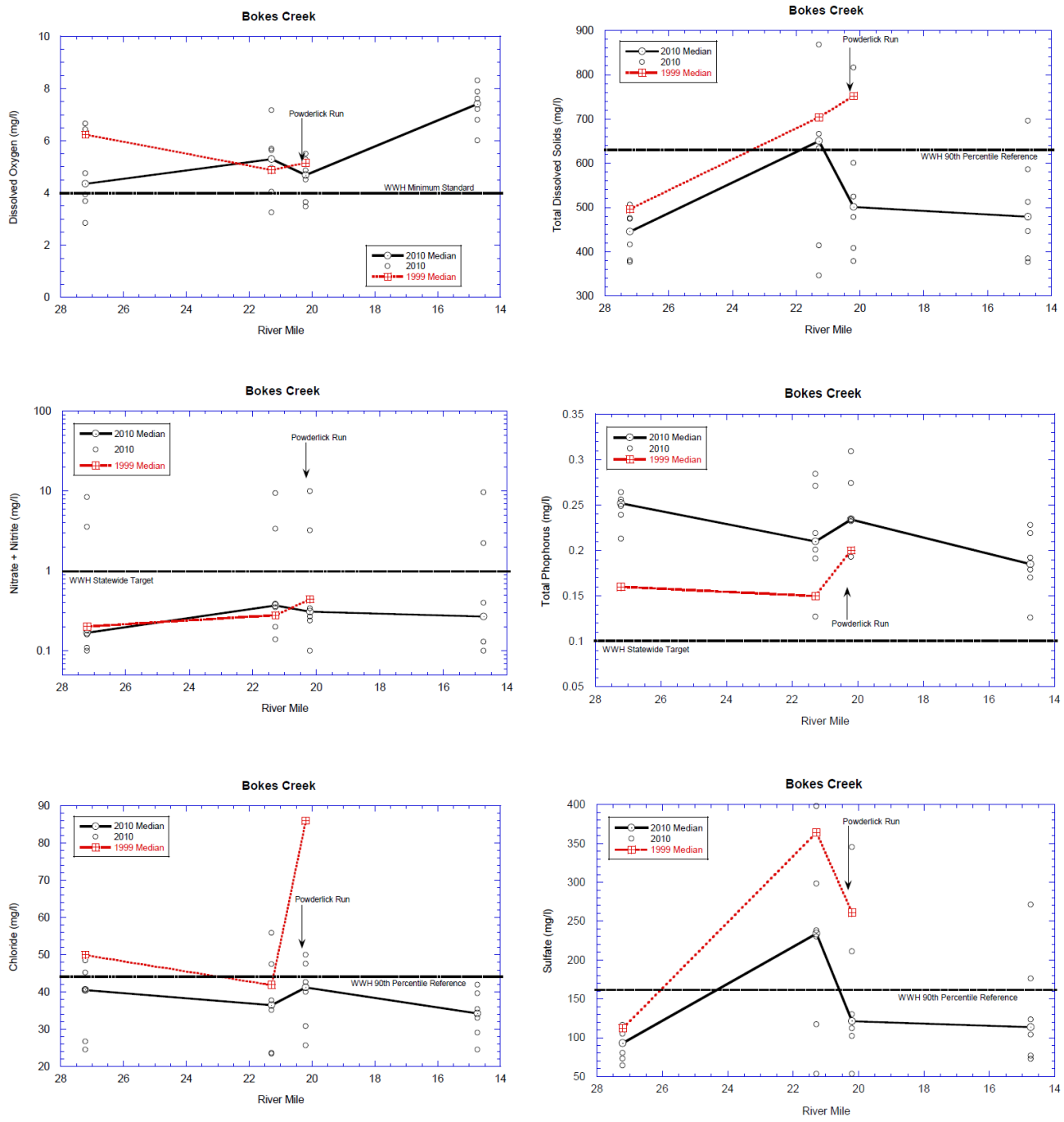


Figure 17. Longitudinal plots of dissolved oxygen, total dissolved solids, total nitrate, total phosphorus, chloride, and sulfate for Bokes Creek. 1999 and 2010.

Eversole Run (HUC 0506000112 01)

Two locations on Eversole Run were evaluated for water chemistry conditions at Concord Road (RM 2.20) and Cook Road (RM 1.30). Exceedances of WQS criteria observed for this assessment unit included a dissolved oxygen measurement below the minimum standard at RM 2.20 during late summer due to low flow conditions. Iron concentrations were above the WQS criterion of 5000 µg/L for the protection of the Agricultural Water Supply during several rain events (Table 10). Summer nutrient results for this watershed were comparable to other assessment units studied with similar land use conditions (Appendix B). Sampling results near the mouth were elevated above the statewide target for total phosphorus (Table 11). Biological communities were in full attainment in this assessment unit.

Indian Run (HUC 0506000112 03)

Two locations on North Fork Indian Run and one location on South Fork Indian Run were sampled in this watershed unit. One WQS criterion exceedance for dissolved oxygen was recorded at South Fork Indian Run at Coffman Park (RM 1.30) on September 7, 2010 (Table 10) as late summer low flows were approaching.

Water chemistry results for this unit suggested nutrient and organic enrichment conditions. Geometric mean total phosphorus results approached the statewide target (0.08 mg/l) on North Fork and was above the target on South Fork (Table 11). The geometric mean result on South Fork (0.61 mg/l) was among the highest observed in any stream sampled in the survey. Benthic algae were also present at this site late in the summer. Diel dissolved oxygen readings on South Fork and at the upper site on North Fork at Highland-Croy Road (RM 5.2) further revealed enriched conditions via widely variable dissolved oxygen ranges (7.62 mg/l and 10.95 mg/l respectively) (Appendices C and D). Enriched conditions were verified by the presence of elevated concentrations of bacteria recorded at all three sites sampled in this watershed unit (Appendix B and Table 12). Enrichment, along with poor habitat characteristics (including substrate siltation/sedimentation), were leading causes of biological impairment in this subwatershed due to mixed land use conditions (54.3% developed, 40.2% agricultural).

Hayden Run (HUC 0506000112 04)

Hayden Run adjacent to Dexter Falls Road, RM 0.83, was evaluated for stream chemistry in this unit. No WQS criteria exceedances were found at this sentinel site during grab sampling from January 2010 to November 2010. Nutrient enrichment and natural conditions (waterfalls) contributed to impairment of the fish and macroinvertebrate communities found at this site. Elevated nutrient concentrations were present at this site. Geometric mean total phosphorus (0.081 mg/l) was slightly elevated above the statewide target. Nitrate+nitrite results also were elevated early in the season (Table 11). Dissolved oxygen concentrations were very good with a mean summer value of 9.03 mg/l (Appendix Scioto Chem). Diel dissolved oxygen conditions were also normal (Appendices C and D).

Dry Run (HUC 0506000112 05)

Sample sites in this watershed unit included Dry Run at Holton Park (RM 1.40) and Trabue Run at McKinley Avenue (RM 0.28). Organic enrichment is a leading cause of biological impairment found in this watershed. Water chemistry results were mostly satisfactory but bacteriological sampling and field observations indicated sewage releases to both streams (Appendix B and Table 12). Unsewered areas and sanitary sewer overflows are documented sources of pollution

within this watershed unit. Flow regime alterations in this highly developed watershed (94.6% of the land area is developed) are also a contributing cause to impairment. This watershed had the highest percentage of land in development found in the study area.

Scioto Big Run (HUC 0506000123 01)

Scioto Big Run at Big Run Road (RM 4.40) and Scioto Big Run at Hardy Parkway (RM 2.90) were studied in this watershed unit. The upstream site at RM 4.40 was impaired by organic enrichment. Like Dry Run, bacteriological sampling and field observations revealed impairment from sewage (Table 12). Otherwise, water chemistry results were generally satisfactory, although nutrient concentrations were slightly elevated (Table 11).

The downstream site at RM 2.90 was impacted by flow regime alterations and substrate embeddedness that was not reflected by water chemistry results. Not surprisingly, land use for this watershed is highly urbanized.

Kian Run (HUC 0506000123 02)

Kian Run was studied at one site near the mouth (RM 0.45) adjacent to Castle Road. The recommended aquatic life use for this stream is MWH-C due to past channelization. It is the only stream studied in this survey falling into the MWH category. Past channelization and other limited habitat features impact biological community performance here. Historic sediment contamination found here also significantly impairs the biology (see Sediment Chemistry Section).

Elevated stream zinc levels were reflected in a mean concentration of 117 ug/l (Appendix B). An Ohio WQS criteria violation for zinc during summer grab sampling was also recorded (168 µg/l) (Table 10). Sulfate, conductivity and total dissolved solids were also elevated. Surprisingly, stream dissolved oxygen levels were healthy with grab sample results averaging 8.60 mg/l and a typical diel pattern observed (Appendices C and D). Impervious surfaces (86.7% developed), industrial point sources and storm water runoff strongly influence stream chemistry conditions found here.

Grant Run (HUC 0506000123 03)

Four sites in the Grant Run watershed unit were assessed, including two sites on Grant Run and individual sites on Republican Run and Plum Run. This watershed is characterized by mixed land use conditions (54.7% agriculture, 33.8% developed). The more developed nature of the watershed in the Grove City area impacted stream chemistry conditions found there. One WQS criterion exceedance for TDS occurred during winter sampling on Grant Run at Buckeye Parkway (RM 2.0) (Table 10). This was attributed to road deicing (salt application) during snowfall. Otherwise, stream chemistry conditions found on the upper site of Grant Run were characterized by excellent dissolved oxygen levels (summer mean = 6.88 mg/l) and nutrient inputs comparable to reference conditions (Table 11). Biological communities were in attainment at this site. Grant Run near the mouth (RM 0.2) was affected by flow regime alterations due to a sewer crossing that affected fish passage. Fish communities did not meet WWH expectations at this site.

Unsewered homes in the Briarwood Hills subdivision and White Road area contributed to organic enrichment found in Republican Run. Geometric mean concentrations for total

phosphorus (0.101 mg/l) and *E.coli* (2952 cfu/100ml) were the highest values recorded for tributary streams in the study (Tables 11 and 12). The enrichment conditions combined with impervious surfaces and construction impacts (e.g. White Road project) resulted in impairment of biological communities.

Macroinvertebrate communities in Plum Run were impacted by natural conditions (low flow) as water chemistry results were mostly satisfactory with generally low nutrient inputs and healthy dissolved oxygen conditions. Summer stream temperatures (mean of 17.04°C) for Plum Run were the lowest of all streams studied in the survey (Appendix B).

Grove Run (HUC 0506000123 04)

Peter's Run at State Route 762 (RM 1.2), Grove Run at Gibson Road (RM 2.0) and Van Meter Run at State Route 104 (RM 1.0) were studied in this largely agricultural watershed. Single dissolved oxygen WQS criterion exceedances were recorded during late summer grab samples at Grove Run and Peters Run (Table 10). Low stream flow conditions influenced these results. Continuous 24-hour diel dissolved oxygen monitoring at each site was satisfactory with minimum levels above 4.8 mg/l and ranges less than 3.6 mg/l (Appendices C and D). Nutrient concentrations easily met statewide targets (Table 11). Biological communities were found in full attainment at both sites.

Van Meter Run had the highest geometric mean (1.61 mg/l) for nitrate+nitrite among streams in the study and failed to meet the statewide target of 1.0 mg/l. In contrast, total phosphorus levels (geometric mean = 0.038 mg/l) were among the lowest of the streams studied and more comparable to reference conditions (Table 11). Like Grove Run and Peter's Run, Van Meter Run also exhibited normal diel dissolved oxygen conditions with a minimum of 6.50 mg/l and range of 2.95 recorded (Appendices C and D). Nutrient enrichment was not evident in field observations and biological communities fully attained WWH biocriteria.

Dry Run (HUC 0506000123 05)

Two sites on Dry Run and a single site on Griffy Run were studied for stream chemistry in this watershed unit. Land use conditions in this watershed (80.8% agriculture) were comparable to the Grove Run subwatershed. Likewise, stream chemistry conditions were also similar. Dissolved oxygen concentrations were excellent (mean = 7.72 mg/l) and total phosphorus concentrations met statewide target criteria. Nitrate+nitrite grab samples included some elevated results but geometric mean values were under the 1.0 mg/l statewide target (Appendix B, Table 11).

Dry Run at the upper site on Bell Station Road was impacted by lack of flow during part of the summer. This is due to both flow regime alteration (agriculture) and natural causes. This site failed to meet biological criteria for fish. Griffy Run and the lower Dry Run site were in full biological attainment.

Table 10. Summary of Ohio EPA Water Quality Standards criteria exceedances found from grab sampling events during the 2010 middle Scioto River survey.

Stream	Date	Parameter	Result	Criteria
Eversole Run (RM 2.2)	8/10/2010	Dissolved Oxygen	3.57 mg/l	4.0 mg/l AL[1]
Eversole Run (RM 2.2)	6/28/2010	Iron	12,400 ug/l	5,000 ug/l AWS
Eversole Run (RM 1.30)	1/26/2010	Iron	6,210 ug/l	5,000 ug/l AWS[3]
Eversole Run (RM 1.30)	6/28/2010	Iron	12,600 ug/l	5,000 ug/l AWS
S.F. Indian Run (RM 2.65)	9/7/2010	Dissolved Oxygen	2.65 mg/l	4.0 mg/l AL
Grove Run	9/8/2010	Dissolved Oxygen	3.64 mg/l	4.0 mg/l AL
Peters Run (RM 1.75)	9/8/2010	Dissolved Oxygen	3.73 mg/l	4.0 mg/l AL
Kian Run (0.45)	7/12/2010	Zinc	168 ug/l	57 ug/l AL[2]
Grant Run (RM 2.0)	2/23/2010	TDS	2,090 mg/l	1,500 mg/l AL[1]

[1] - Aquatic Life criteria

[2] - Aquatic Life criteria – hardness dependent

[3] - Agricultural Water Supply criteria

Table 11. Summary geometric mean nutrient results (May 1 –October 30) for select tributary streams sampled in the middle Scioto River watershed (2009). Results shaded are above statewide recommended targets (Ohio EPA, 1999). Results reported in mg/l.

Stream	Drainage Area mi^2	River Mile	Ammonia	Nitrate+Nitrite	Phosphorus
Eversole Run	4.3	2.20	0.52	0.24	0.058
Eversole Run	10.5	1.30	0.033	0.38	0.097
N.F. Indian Run	5.6	5.20	0.078	0.34	0.077
N.F. Indian Run	10.2	1.80	0.033	0.13	0.057
S.F. Indian Run	6.0	1.30	0.050	0.22	0.61
Hayden Run	7.0	0.83	0.025	0.54	0.081
Dry Run (Cols.)	7.2	1.40	0.025	0.21	0.048
Trabue Run	5.9	0.28	0.025	0.50	0.038
Scioto Big Run	11.8	4.40	0.032	0.23	0.056
Scioto Big Run	17.6	2.90	0.025	0.42	0.076
Grant Run	7.8	2.00	0.027	0.38	0.045
Grant Run	14.1	0.20	0.025	0.24	0.048
Republican Run	5.7	1.38	0.025	0.60	0.101
Plum Run	4.9	0.72	0.030	0.27	0.031
Peter's Run	7.2	1.75	0.059	0.62	0.022
Grove Run	5.6	1.58	0.030	0.22	0.056
Van Meter Run	5.8	1.00	0.025	1.61	0.038
Dry Run (Pick.)	4.7	3.70	0.025	0.94	0.041
Dry Run (Pick.)	18.4	0.50	0.025	0.64	0.029
Griffy Run	4.9	1.10	0.025	0.49	0.043
Statewide Recommended Criteria (WWH Headwater)			***NA***	***1.0***	***0.08***

Recreation Use

Water quality criteria for determining attainment of the recreation use are established in the Ohio Water Quality Standards (Table 7-13 in OAC 3745-1-07) based upon the quantities of bacteria indicators (*E. coli*) present in the water column.

E. coli bacteria are microscopic organisms that are normally 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). 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 feasible. 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 every type of pathogen. Fecal indicator bacteria by themselves, including *E. coli*, are usually not pathogenic. However, some strains of *E. coli* can be pathogenic, capable of causing serious illness. Although not necessarily agents of disease, fecal indicator bacteria such as *E. coli* may indicate the potential presence of pathogenic organisms that enter the environment through the same pathways. When *E. coli* are present in high numbers in a water sample, it invariably means that the water has received fecal matter from one or multiple sources. Swimming or other recreation-based contact with water having a high *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.

Streams in the middle Scioto River watershed are designated as Primary Contact Recreation (PCR) in OAC Rule 3745-1-09. Water bodies with a designated recreation use of PCR "...are suitable for one or more full-body contact recreation activities such as, but not limited to, wading, swimming, boating, water skiing, canoeing, kayaking, and scuba diving" [OAC 3745-1-07 (B)(4)(b)]. There are three classes of PCR use to reflect differences in the potential frequency and intensity of use. Streams designated PCR class A support, or potentially support, frequent primary contact recreation activities. Streams designated PCR class B support, or potentially support, occasional primary contact recreation activities. Streams designated as PCR class C support, or potentially support, infrequent primary contact recreation activities. Streams designated as SCR use are rarely used for water-based recreation.

In addition, some waters that are used heavily for swimming can be designated as bathing waters. The geometric mean criterion for bathing waters is ≤126 colony forming units (cfu) per 100 ml. There are no waters designated as bathing waters in the study area.

The *E. coli* criterion that applies to PCR class A streams is a geometric mean of ≤126 cfu/100 ml. The *E. coli* criterion that applies to PCR class B streams is a geometric mean of ≤161 cfu/100 ml. The criterion that applies to PCR class C streams is a geometric mean of ≤206 cfu/100 ml. The criterion that applies to SCR streams is ≤1,030 cfu/100 ml. The geometric mean is based on two or more samples and is used as the basis for determining the attainment status of the recreation use.

Summarized bacteria results are listed in Table 12 and the complete dataset is reported in Appendix B. Downloadable bacteria results are also available from the Ohio EPA geographic information systems (GIS) interactive maps at the following link: http://www.epa.ohio.gov/dsw/gis/index.aspx.

Twenty-eight locations in the watershed were tested for *E. coli* levels five to eleven times between May and October 2010. Evaluation of *E. coli* results revealed that 26 of the 28 locations sampled failed to attain the applicable geometric mean criterion, indicating an impairment of the recreation use at these locations, as depicted in Table 12 and Figure 18. Sources of elevated bacteria concentrations were ubiquitous and most likely due to a variety of inputs depending on the site location. In more rural locations, such as Eversole Run (Delaware County), Grove Run and Dry Run (Pickaway County), agricultural activities, including livestock production and land application, are more common and likely sources. In the central portion of the watershed, WWTP, CSOs, SSOs and unsewered areas are documented sources. In mixed land use watershed areas such as Grant Run watershed (Grove City area), HSTS and agricultural activities likely combine to contribute to bacteria contamination.

Sample results at two popular Scioto River recreational areas, O'Shaughnessy Reservoir and Griggs Reservoir, did not exceed the PCR Class A criterion. These sites are located upstream from the impacts of the city of Columbus Jackson Pike WWTP and Southerly WWTP effluent discharges and collection system CSOs and SSOs. Bacterial contamination in most streams was present during both wet and dry weather events. This indicates that strategies to reduce bacteria levels in streams should include both nonpoint source and point source measures.

Table 12. A summary of E.coli data for 28 locations in the middle Scioto River watershed, May 1-October 31, 2010. Recreation use attainment based on comparing the geometric mean to Primary Contact Recreation (PCR) criteria (OAC 3745-1-07). All values are expressed in colony forming units (CFUs) per 100 ml of water. For PCR Class A streams, E.coli geometric mean <126 cfu/100ml. For PCR Class B streams, geometric mean <161 cfu/100ml. For PCR Class C streams, geometric mean <206 cfu/100ml. For Secondary Contact Recreation (SCR), geometric mean <1030 cfu/100ml.

Location	River Mile	# Samples	PCR Class	Geometric Mean	Maximum Value	Attainment Status	Possible Source(s)[1] of Bacteria
Scioto River Large River Assessment Unit HUC 05060001							
Scioto R.	148.9	11	A	21	270	**FULL**	
Scioto R.	138.9	10	A	21	440	**FULL**	
Scioto R.	127.74	9	A	447	8600	**NON**	WWTPS, CSOs, SSOs, Urban
Scioto R.	125.5	8	A	8639	15000	**NON**	WWTPS, CSOs, SSOs, Urban
Scioto R.	119.1	5	A	1678	4500	**NON**	WWTP, CSOs, AG
Scioto R.	109.37	11	A	739	17000	**NON**	AG
Scioto R.	102.14	11	A	589	15000	**NON**	AG
Eversole Run HUC 05060001 12 01							
Eversole Run	2.0	6	B	461	18000	**NON**	AG, HSTS
Eversole Run	1.3	9	B	284	14000	**NON**	AG, HSTS
Indian Run HUC 05060001 12 03							
N.F. Indian Run	5.2	5	B	1020	11000	**NON**	AG, HSTS
N. F. Indian Run	1.8	5	B	1466	15000	**NON**	AG, HSTS
S.F. Indian Run	1.3	6	B	8500	304	**NON**	AG, HSTS

Location	River Mile	# Samples	PCR Class	Geometric Mean	Maximum Value	Attainment Status	Possible Source(s)[1] of Bacteria
Hayden Run HUC 05060001 12 04							
Hayden Run	0.83	9	B	699	10000	**NON**	AG, HSTS, WWTPs
Dry Run Columbus HUC 05060001 12 05							
Dry Run	1.4	6	B	1171	3700	**NON**	SSOs, HSTS
Trabue Run	0.25	6	B	1094	8200	**NON**	SSOs
Scioto Big Run HUC 05060001 23 01							
Scioto Big Run	4.4	6	B	1094	8200	**NON**	HSTS
Scioto Big Run	2.9	9	B	1303	10000	**NON**	HSTS
Kian Run HUC 05060001 23 02							
Kian Run	0.45	6	B	806	5000	**NON**	CSOs, SSOs
Grant Run HUC 05060001 23 03							
Republican Run	1.38	6	B	2952	68000	**NON**	HSTS
Grant Run	2.00	9	B	804	6300	**NON**	AG, HSTS
Grant Run	0.2	6	B	1236	8900	**NON**	AG, HSTS
Plum Run	0.72	6	B	443	1300	**NON**	AG, HSTS
Grove Run HUC 05060001 23 04							
Peter's Run	1.75	6	B	793	1800	**NON**	AG, WWTP

Location	River Mile	# Samples	PCR Class	Geometric Mean	Maximum Value	Attainment Status	Possible Source(s)[1] of Bacteria
Grove Run	1.58	6	B	1174	15000	**NON**	AG, HSTS
Van Meter Run	1.00	6	B	416	770	**NON**	AG, HSTS
Dry Run HUC 05060001 23 05							
Dry Run	3.70	5	A	666	2100	**NON**	AG, HSTS
Dry Run	0.50	6	B	1100	540	**NON**	AG
Griffy Run	1.10	6	B	831	1200	**NON**	AG, HSTS

[1] - Possible Sources:
AG – Agriculture
HSTS – Home Sewage Treatment Systems
WWTP – Wastewater Treatment Plants
CSOs – Combined Sewer Overflows
SSOs – Sanitary Sewer Overflows
Urban – Urban runoff

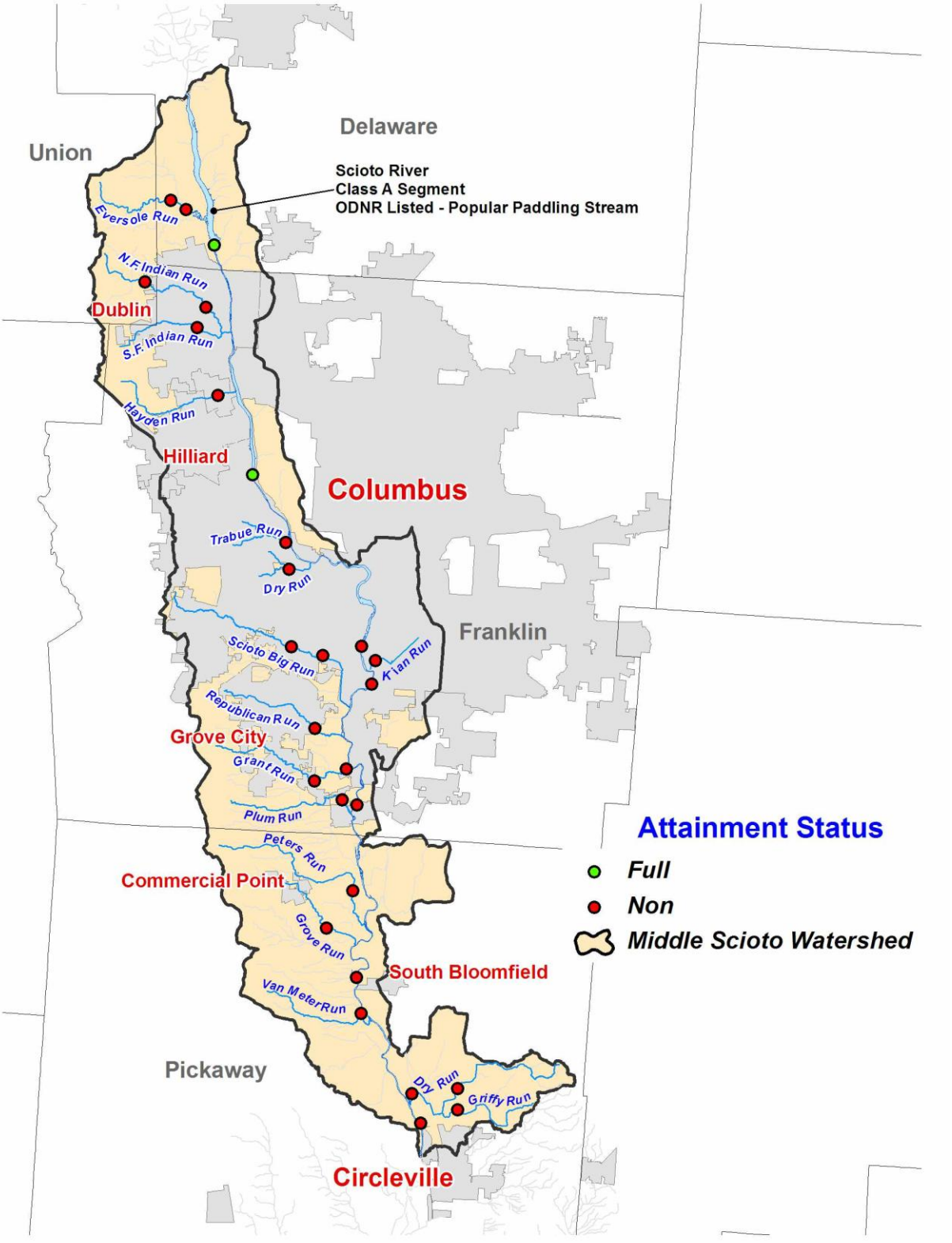


Figure 18. Recreation use attainment by location in the middle Scioto River watershed, 2010.

Sediment Chemistry

Sediment samples were collected from nine sites in the middle Scioto River watershed by Ohio EPA in the fall of 2010 and are summarized in Table 13. Samples were analyzed for metals, organics, nutrients, total organic carbon (TOC) and particle size. Sediment sample results were evaluated using published guidelines discussed below.

Sediments were sampled by focusing on depositional areas of fine grain material (silts and clays). These areas are typically represented by higher contaminant levels, compared to sands and gravels. All sediment sampling occurred in areas along the stream bank, which were represented by sparse deposits of fine grained material. These near bank areas comprised only a small fraction of the bottom substrates of the streams surveyed. Bottom substrates at many sites surveyed were dominated by cobble, gravel and sand. At each sample location, 130 organic parameters were tested, including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and pesticides. Sediment sample results for organics were evaluated using guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald et. al. 2000).

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, and is comparable to background conditions. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed. At six of the nine sites (66%), organic parameters were detected in stream sediments.

The highest concentrations of organics were detected from sites located in the Columbus urbanized area. Scioto River sites from RM 127.7 (Frank Rd.) to RM 109.4 (SR 316) had several PAH sediment results exceeding the PEC. Fine grain sediments, however, were not predominant throughout these reaches, and therefore may be less likely to have a noticeable impact of the benthic community.

Kian Run had the highest concentrations of PAHs found in the study area. Several compounds, including benz(a)anthracene, chrysene and phenanthrene exceeded the PEC. Extreme siltation and embeddedness dominated this stream. With these observations, it is reasonable to conclude that toxic sediment levels are a contributing source of impairment within the macroinvertebrate community found at this MHW site.

At most sites studied, concentrations of metals found in sediment were at or below Ohio EPA *Sediment Reference Values* (Ohio EPA 2008b). The Ohio SRVs represent ecoregion background conditions based on data collected at Ohio reference sites. Similarly, most metal sediment results were below the PEC guidelines. Predictably, sites below CSOs had higher levels of sediment metal concentrations. It is worth noting that Kian Run had sediment metal concentrations for chromium, lead and zinc greater than the Ohio SRVs and PEC guidelines. These results, combined with the PAH results for Kian Run, provides further evidence of toxic sediment levels at this site.

Nutrient sediment sampling included total organic carbon (TOC) at all sites and total phosphorus (3 sites only) in the study area. These results were evaluated using guidelines established by Persuad et.al. (1993). This includes the Lowest Effect Level (LEL) and the Severe Effect Level (SEL). The LEL is a level of sediment concentration that can be tolerated

by a majority of benthic organisms. The SEL is a concentration considered harmful to most benthic organisms. For sample sites in this study, only the site at Scioto River RM 126.4 (downstream Jackson Pike WWTP) exceeded the SEL (total carbon). Total phosphorus at three Scioto River sites tested were below the SEL.

Previous stream sediment sampling in the middle Scioto River watershed occurred in 1996. Comparison of results from 1996 to 2010 is available for only one site, Scioto River at Frank Road (RM 127.8). This comparison is summarized in Table 14. The results indicate that 2010 sediment metal concentrations were significantly lower than those found in 1996. The 2010 sediment PAH values are also roughly 30 to 60% lower than those found in 1996. However, most PAH sediment values remain above the PEC. The closing of industrial sources (e.g. Techneglas in 2004) and improvement of industrial storm water practices may account for some of the lower concentrations now found at this site.

Table 13. Selected results of chemical/physical sediment sampling in the middle Scioto River study area, 2010. Compared to guidelines established by MacDonald et. al. 2000, Ohio EPA 2008 and Persuad et. al. 1993.

Parameter	Units	Eversole Run @ Cook Rd.	Kian Run @ Castle Rd.	Scioto Big Run @ Hardy Pkwy.	Grant Run @ Buckeye Pkwy.	Plum Run @ SR 665	Scioto River @ Frank Rd.	Scioto R. nr. Williams Rd	Scioto River @ SR 316	Scioto River @ Comm. Pt. Rd.
NUTRIENTS										
Total Organic Carbon	%	3.8	7.1	3.5	3.5	3.1	7.1	11.0	5.8	2.6
Solids	%	62.7	48.7	67.9	52.9	60.9	47.1	39.0	40.6	64.8
Ammonia	mg/kg		66					160	200	60
Phosphorus	mg/kg							1490	1720	814
METALS										
Aluminum	mg/kg	5700	8460	2850	7560	4230	7980	7720	6960	7190
Arsenic	mg/kg	12.7	12.3	8.27	11.3	12.7	8.41	11	9.16	12.6
Barium	mg/kg	40.3	145	31.3	84.2	61.5	141	140	111	92.7
Cadmium	mg/kg	0.529	2.82	0.432	0.660	0.480	1.12	1.760	1.380	1.090
Calcium	mg/kg	114000	115000	88800	78700	59600	89400	90200	43900	20400
Chromium	mg/kg	8.19	115	5.95	12.50	6.87	21.6	24.70	16.80	9.50
Copper	mg/kg	12.6	97.7	11.80	19.20	12.50	44.6	60.10	35.00	15.50
Iron	mg/kg	21100	31800	12100	21400	17900	19700	22100	20100	22900
Lead	mg/kg	9.97	142	12.60	13.90	12.30	66.1	85.90	44.0	18.40
Magnesium	mg/kg	29700	30200	26300	24900	21000	20900	28800	14900	7930
Manganese	mg/kg	364	503	329	503	283	323	312	351	511
Nickel	mg/kg	16.4	33.9	14.0	19.6	14.6	20.9	22.2	21.5	20.0
Mercury	mg/kg		0.250				0.132	0.354		
Potassium	mg/kg									
Selenium	mg/kg									
Sodium	mg/kg									
Strontium	mg/kg	159	117	89	196	73	308	194	133	58
Zinc	mg/kg	60.1	1030	90.7	110	63.1	228	324.0	253	93.3
ORGANICS										
Solids	%	69.0	56.7	78.0	58.7	70.8	54.6	46.6	43.4	71.3
α-Chlordane	µg/kg							10.9		
γ-Chlordane	µg/kg							11.1		
Total Chlordane	*µg/kg*							*22.0*		
PCB-1242	µg/kg		43.4				56.2	57.2	61.9	
PCB-1260	µg/kg		130.0	47.7			65.7	83.2	68.7	
Total PCB	*µg/kg*		*173.4*	*47.7*			*121.9*	*140.4*	*130.6*	
Anthracene	µg/kg		700				1330			
Benz[a]anthracene	µg/kg		4660	610			4600	2610	1380	
Benzo[a]pyrene	µg/kg		6530	630			4340	2760	1930	
Benzo[b]fluoranthene	µg/kg		6840	750			4700	2280	2060	
Benzo[g,h,i]perylene	µg/kg		5000				2760	1570	1580	
Benzo[k]fluoranthene	µg/kg		5610	660			5180	2480	1870	
Chrysene	µg/kg		6650	960			5230	2870	2030	
Dibenz[a,h]anthracene	µg/kg		1670							
Fluoranthene	µg/kg		1090	1790	830		9420	5590	3280	
Indeno[1,2,3-cd]pyrene	µg/kg		4580				2590	1480	1420	
Phenanthrene	µg/kg		5160	780			5820	3460	1460	
Pyrene	µg/kg		8950	1430			8550	4530	2770	
Total PAH	*µg/kg*		*57440*	*7610*	*830*		*54520*	*29630*	*19780*	
bis(2-ethylhexyl)phthalate	µg/kg		1.89				1.86	1.67	1.07	
Phenol	µg/kg		0.93							

Value greater than Lowest Effect Level, from Persaud and Jaagumagi (1993)
Value greater than Severe Effect Level, from Persaud and Jaagumagi (1993)
Value greater than Sediment Reference Value, from Ohio EPA (2003)
Indicates sample not analyzed within holding time due to analyst error
Value greater than threshold effect concentration, from MacDonald, et. al. (2000)
Value greater than probable effect concentration, from MacDonald, et. al. (2000)
Blank spaces indicate compound or element was less than the reporting limit.

Table 14. Selected results of chemical sediment sampling at Scioto River Frank Road (RM 127.7) in 1996 vs. 2010. Compared to guidelines established by MacDonald et. al. 2000.

Parameter	Units	1996	2010
METALS			
Aluminum	mg/kg		7980
Arsenic	mg/kg	23	8.41
Barium	mg/kg		141
Cadmium	mg/kg	**28**	1.12
Calcium	mg/kg		89400
Chromium	mg/kg	**361**	21.6
Copper	mg/kg	**448**	44.6
Iron	mg/kg	36900	19700
Lead	mg/kg	**753**	66.1
Magnesium	mg/kg		20900
Manganese	mg/kg		323
Nickel	mg/kg	**144**	20.9
Mercury	mg/kg	**4**	0.132
Potassium	mg/kg		
Selenium	mg/kg		
Sodium	mg/kg		
Strontium	mg/kg		308
Zinc	mg/kg	**1910**	228
ORGANICS			
Solids	**%**		54.6
α-Chlordane	µg/kg		
γ-Chlordane	µg/kg		
Total Chlordane	*µg/kg*		
PCB-1242	µg/kg		56.2
PCB-1260	µg/kg	610	65.7
Total PCB	*µg/kg*		*121.9*
Anthracene	µg/kg	**2500**	**1330**
Benz[a]anthracene	µg/kg	**6700**	**4600**
Benzo[a]pyrene	µg/kg	**6300**	**4340**
Benzo[b]fluoranthene	µg/kg	6300	4700
Benzo[g,h,i]perylene	µg/kg	4800	2760
Benzo[k]fluoranthene	µg/kg	7000	5180
Chrysene	µg/kg	**10800**	**5230**
Dibenz[a,h]anthracene	µg/kg		
Fluoranthene	µg/kg	**16000**	**9420**
Indeno[1,2,3-cd]pyrene	µg/kg	5500	2590
Phenanthrene	µg/kg	**13700**	**5820**
Pyrene	µg/kg	**13300**	**8550**
Total PAH	µg/kg		***54520***
bis(2-ethylhexyl)phthalate	µg/kg		1.86
Phenol	µg/kg		

	indicates sample not analyzed within holding time due to analyst error
	value greater than threshold effect concentration, from MacDonald, et. al. (2000)
	value greater than probable effect concentration, from MacDonald, et. al. (2000)
	Blank spaces indicate compound or element was less than the reporting limit.

Public Drinking Water Supplies

The public drinking water supply (PDWS) beneficial use in the WQS (OAC 3745-1-33) currently applies within 500 yards of drinking water intakes and for all publicly owned lakes. Ohio EPA has developed an assessment methodology for this beneficial use which focuses on source water contaminants not effectively removed through conventional treatment methods. The 2010 Integrated Water Quality Monitoring and Assessment Report describes this methodology and is available on OEPA's website: http://www.epa.state.oh.us/dsw/tmdl/OhioIntegratedReport.aspx.

Impaired source waters may contribute to increased human health risk or treatment costs. For the case when stream water is pumped to a reservoir, the stream and reservoir will be evaluated separately. These assessments are designed to determine if the quality of source water meets the standards and criteria of the Clean Water Act. Monitoring of the safety and quality of treated finished drinking water is regulated under the Safe Drinking Water Act and evaluated separately from this assessment. For those cases when the treatment plant processes do not specifically remove a source water contaminant, the finished water quality data may be considered representative of the raw source water directly feeding into the treatment plant.

One public water system (Columbus) is directly served by surface water sources within the study area. Columbus has an intake on the Scioto River at river mile 133.45. Table 15 provides a summary of the data collected to evaluate the PWS use.

City of Columbus

The city of Columbus operates a community public water system that serves a population of approximately 1,152,390 people through 274,611 service connections. The City operates three water treatment plants, but only the Columbus Dublin Road water treatment plant draws water from the Scioto River. The Dublin Road plant's treatment capacity is approximately 65 million gallons per day. The Dublin Road plant's treatment processes include lime softening, coagulation, sedimentation, stabilization, fluoridation, sand filtration, and disinfection. Powdered activated carbon is also added when source water quality is poor.

Since water from the Scioto River feeds directly into the water treatment plant and the current treatment processes do not remove nitrate, the finished water quality compliance data can be used to evaluate the nitrate levels in the stream. In May 2006 the finished water from the Dublin Road plant exceeded the Maximum Contaminant Level (MCL) of 10.0 mg/L for nitrate three times and Columbus received a Safe Drinking Water Act water quality violation. The Scioto River was assessed in the 2012 Integrated Report in full attainment of the nitrate indicator since the MCL exceedances occurred in the same month (exceedances must be at least 30 days apart to be indicative of extended water quality problems and trigger an impairment). However, since at least one sample exceeded 8 mg/L the assessment unit was placed on a nitrate watch list. To help avoid future violations, the City of Columbus diligently monitors its raw water quality and avoids pumping water into the plant when nitrate concentrations are elevated. Since the City of Columbus now selectively pumps this intake, additional raw water quality data will be necessary to determine future impairments. Unfortunately the raw water quality data the City collects are not Level 3 status under Ohio EPA's credible data rules so additional sampling must be conducted by Ohio EPA for regulatory purposes.

Ohio EPA collected a total of ten water quality samples at the Dublin Road plant's intake on the Scioto River in 2010 to assess nitrate levels for the PDWS beneficial use determination. Nitrate ranged from 0.29 mg/L to 8.02 mg/L and averaged 2.91 mg/L. Since data from only one

sampling year is available, additional samples are needed to complete a full assessment of the PDWS beneficial use. Since at least one sample exceeded 8 mg/L the assessment unit will, at a minimum, remain on the nitrate watch list.

Ohio EPA collected a total of ten water quality samples at the Dublin Road plant's intake on the Scioto River in 2010 to assess pesticide levels for the PDWS beneficial use determination. Atrazine ranged from 0.55 ug/L to 4.99 ug/L and, although two samples were above the WQS criterion, the overall average was 1.76 ug/L and below the WQS criterion of 3.0 ug/L (assessed as an annual average). The Dublin Road water treatment plant's powdered activated carbon treatment processes remove pesticides, and therefore the finished water quality pesticide data is not indicative of the raw water quality in the Scioto River. Since representative raw water data is only available for one sample year additional data will need to be collected to make an impairment determination.

Ohio EPA's Division of Drinking and Ground Waters is planning on conducting storm event sampling at the Dublin Road intake in 2013 to fulfill the data requirements for assessing the PDWS beneficial use.

Table 15. Summary of available Ohio EPA collected raw water quality data for parameters of interest at sampling sites near Columbus' Dublin Road water treatment plant.

Location(s)	PDWS Parameters of Interest			
	Nitrate-Nitrite WQC = 10 mg/L[1, 2]		Atrazine WQC = 3.0 ug/L[2]	
	Average/ (sample count)	Maximum (# samples >WQC)	Average / (sample count)	Maximum
Scioto River at Columbus Intake (RM 133.45)	2.91 mg/L (n=10)	8.02 mg/L (0)	1.76 ug/L (n=10)	4.99 ug/L

1 Nitrate WQC are evaluated as maximum value not to be exceeded, impaired waters defined as having two or more exceedancess about the criteria at least thirty days apart. The exceedances in 2006 cannot be considered for assessing the beneficial use for the 2014 Integrated Report because the exceedances will fall outside of the 5 year sampling window.

2 Insufficient data available to assess the PDWS beneficial use. Need at least two years represented and a minimum of 10 samples collected during the critical period when the contaminant is typically detected.

Lake Sampling

Inland Lakes Monitoring

Ohio EPA has implemented a sampling strategy that focuses on evaluating the water quality conditions present in the epilimnion of inland lakes. The sampling target consists of an even distribution of a total of ten sampling events divided over a two-year period and collected during the summer months. Key water quality parameters sampled include total phosphorus, total nitrogen, chlorophyll a, Secchi depth, ammonia, dissolved oxygen, pH, total dissolved solids, and various metals such as lead, mercury, and copper. Details of the sampling protocol are outlined in the Inland Lakes Sampling Procedure Manual, available on Ohio EPA's web page at: http://www.epa.ohio.gov/dsw/inland_lakes/index.aspx

Water Quality Standards for the Protection of Aquatic Life in Lakes

Presently, lakes in Ohio are designated as Exceptional Warmwater Habitat (EWH) with respect to the aquatic life habitat use designation. Revisions to Ohio's WQS that would change the aquatic life use from EWH to Lake Habitat (LH) were proposed for adoption in December, 2011, but were subsequently withdrawn. A future rulemaking is anticipated but the timeframe is unknown. A primary reason for this revision is that in Ohio, a set of biological criteria applies to rivers and streams, whereas no biocriteria apply to lakes. The numeric chemical criteria to protect the LH use will remain the same as the criteria to protect the EWH use that currently applies to lakes, with a suite of nutrient criteria added. A set of numeric criteria that applies to all surface waters for the protection of aquatic life, regardless of specific use designation, will also apply to inland lakes and are referred to as "base aquatic life use criteria" in the proposed WQS rules. The base aquatic life use criteria will be the same aquatic life numeric criteria that currently apply to lakes. Examples include various metals such as copper, lead, and cadmium as well as organic chemicals such as benzene and phenol. Specific details concerning the progress of revisions to Ohio's Water Quality Standards involving the proposed Lake Habitat aquatic life use and associated criteria can be found at the following Ohio EPA web site as information becomes available: http://www.epa.ohio.gov/dsw/rules/draftrules.aspx. The chemical criteria specific to the LH aquatic life use in the proposed Water Quality Standards rules are presented in Table 16.

O'Shaughnessy Reservoir

A water quality survey of O'Shaughnessy Reservoir was conducted by Ohio EPA in 2009 and 2010 as a part of the Division of Surface Water's Inland Lakes Monitoring Program. O'Shaughnessy Reservoir is located in central Ohio, north of the City of Columbus, in Delaware County.

O'Shaughnessy Reservoir was built by the city of Columbus in 1925. The reservoir, created by damming the Scioto River, provided a needed water source for the city. The reservoir is 912 acres in size and has 18.4 miles of shoreline. Maximum depth is over 40 feet near the dam, although much of the water is 20 feet or less. The watershed for the reservoir is about 770 square miles and is composed of mostly agricultural land. Bottom composition is made up of rock in the south section and mud and silt in the north (Ohio DNRa).

Table 16. Proposed Lake Habitat use criteria. Note: All criteria are outside mixing zone averages unless specified differently. Note - As of the finalization of this report, the proposed Lake Habitat use and these criteria have not been adopted into the Ohio Water Quality Standards and all discussion of such use and criteria in this report should be considered as examples of how the adopted use and criteria would be applied.

Parameter **Lake type**	**Form**[1]	**Units**[2]	**Statewide criteria**	**Ecoregional criteria**				
				ECBP	EOLP	HELP	IP	WAP
Ammonia	T	mg/l	Table 43-4	--	--	--	--	--
Chlorophyll a[3]								
Dugout lakes	T	µg/l	6.0	--	--	--	--	--
Impoundments	T	µg/l	--	14.0	14.0	14.0	14.0	6.2
Natural lakes	T	µg/l	14.0	--	--	--	--	--
Upground reservoirs	T	µg/l	6.0	--	--	--	--	--
Dissolved oxygen[4] All lake types	T	mg/l	5.0 OMZM 6.0 OMZA	--	--	--	--	--
Nitrogen[3]								
Dugout lakes	T	µg/l	450	--	--	--	--	--
Impoundments	T	µg/l	--	930	740	930	688	350
Natural lakes	T	µg/l	638	--	--	--	--	--
Upground reservoirs	T	µg/l	1,225	--	--	--	--	--
pH								
All lake types	--	s.u.	A	--	--	--	--	--
Phosphorus[3]								
Dugout lakes	T	µg/l	18	--	--	--	--	--
Impoundments	T	µg/l	--	34	34	34	34	14
Natural lakes	T	µg/l	34	--	--	--	--	--
Upground reservoirs	T	µg/l	18	--	--	--	--	--
Secchi disk transparency[5]								
Dugout lakes	--	m	2.60	--	--	--	--	--
Impoundments	--	m	--	1.19	1.19	1.19	1.19	2.16
Natural lakes	--	m	1.19	--	--	--	--	--
Upground reservoirs	--	m	2.60	--	--	--	--	--
Temperature								
All lake types	--	--	B	--	--	--	--	--

1 T = total.

2 m = meters; mg/l = milligrams per liter (parts per million); µg/l = micrograms per liter (parts per billion); s.u. = standard units.

3 These criteria apply as lake medians from May through October in the epilimnion of stratified lakes and throughout the water column in unstratified lakes.

4 For dissolved oxygen, OMZM means outside mixing zone minimum and OMZA means outside mixing zone minimum twenty-four-hour average. The dissolved oxygen criteria apply in the epilimnion of stratified lakes and throughout the water column in unstratified lakes.

5 These criteria apply as minimum values from May through October.

A pH is to be 6.5-9.0, with no change within that range attributable to human-induced conditions.

B At no time shall the water temperature exceed the average or maximum temperature that would occur if there were no temperature change attributable to human activities.

The diverse bottom composition and cover from stumps and fallen trees provide excellent habitat for a number of sport fish. Black and white crappie, largemouth bass, smallmouth bass, saugeye, white bass, and channel catfish all provide fishing opportunities for anglers. Saugeye and hybrid striped bass are stocked on an annual basis (Ohio DNR).

Water chemistry samples and bacteria samples were collected 11 times in 2009 and 2010. Sediment samples were collected once in 2010. No exceedances of Ohio WQS for arsenic, cadmium, chromium, copper, lead, nickel, selenium, zinc were found. All bacteria samples for O'Shaughnessy Reservoir were below the recreation use criteria (geometric average <126 cfu/100ml and <298 cfu/100ml as a maximum sample value for Class A Primary Contact Recreation, Table 17).

In 2010, O'Shaughnessy Reservoir displayed the profiles of a classically stratified lake at the L-1 site at the deepest point near the dam. In Figure 19 (upper), the temperature profiles indicate that a thermocline set up early in the year, and persisted for much of the year. As a result of this thermocline, dissolved oxygen levels were strongly influenced (Figure 19, middle and lower).

A surprising feature of these data is that even at the surface, dissolved oxygen dropped significantly by the end of the sampling season. This may be from the importation of organic material, as this lake is heavily influenced by the Scioto River, as shown by a Residence Time Index (RTI) (Ohio EPA 2008a) of only 1.85. Nonetheless, assessment of attainment status for this lake would be using epilimnion data only because of this pronounced stratification. Assessment for chlorophyll-a, average epililimnetic dissolved oxygen, nitrogen and bacteria (recreational use) are all shown in Table 17.

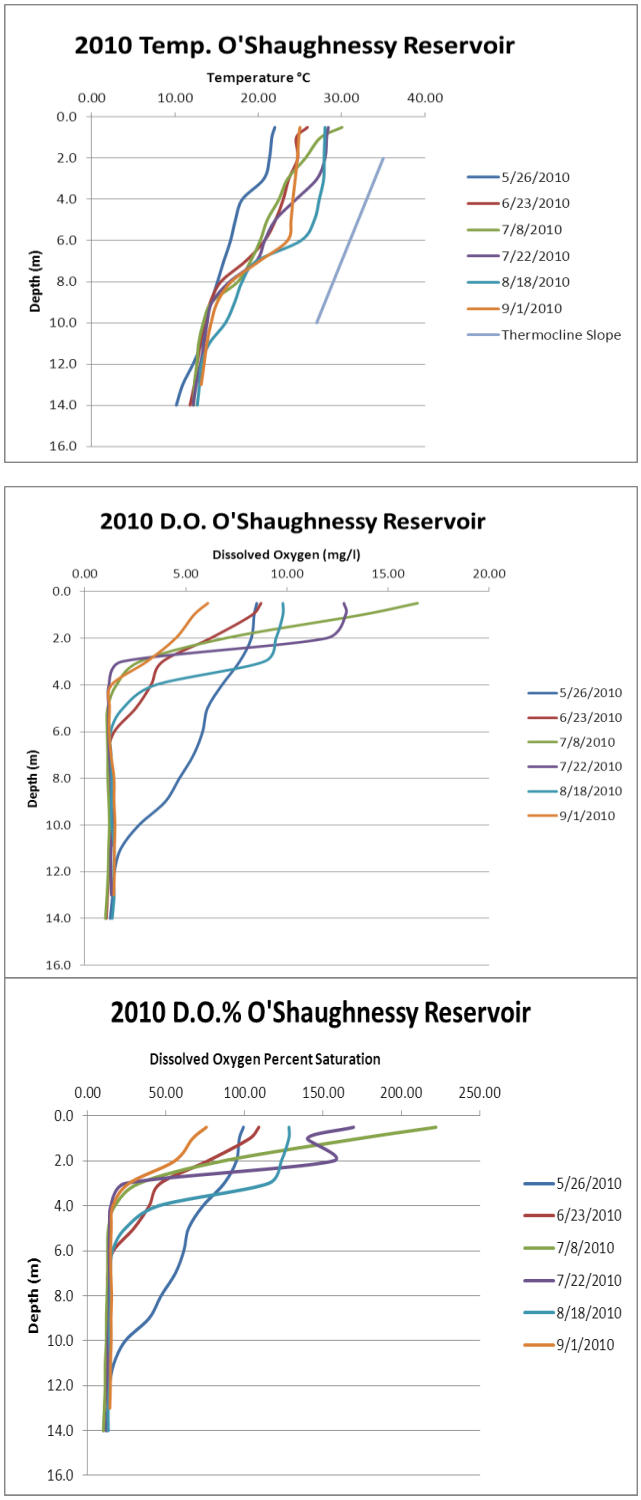


Figure 19. Temperature, dissolved oxygen, and dissolved oxygen % in O'Shaughnessy Reservoir, 2010.

O'Shaughnessy Reservoir is impaired for the LH use by excessive chlorophyll-a, and for low dissolved oxygen. Anecdotal incidents of near zero dissolved oxygen in O'Shaughnessy from the previous National Lakes Assessment supplement this finding. Given that O'Shaughnessy Reservoir is deemed to be impaired by algal growth in response to nutrients, as evidenced by elevated chlorophyll-a concentrations, it seems appropriate to examine this issue further.

In reviewing the data for 2009, chlorophyll-a response to nutrients seemed to be limited by available total phosphorus concentrations. This was in part due to the ample available nitrogen in the form of NO_2-NO_3 (Figure 20, upper).

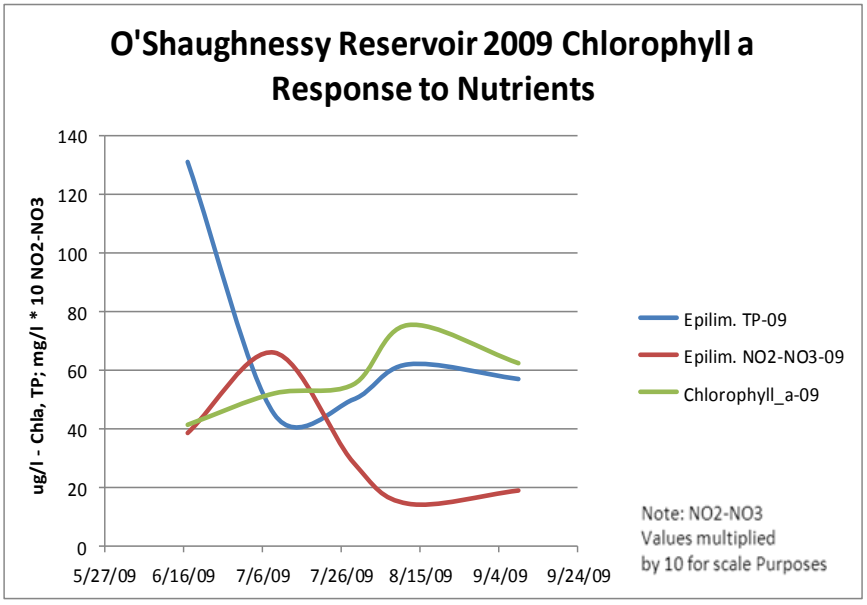
In contrast to 2009, during the summer of 2010, chlorophyll-a response in the late summer seemed to be limited by a lack of available nitrogen, in the form of NO_2-NO_3. Values of less than 0.1 mg/l were not sufficient to sustain chlorophyll-a production, and concentrations began to decline later in the season. This decline in chlorophyll-a occurred in spite of an increase in total phosphorus in the epilimnion (Figure 20, lower).

Internal regeneration of nutrients from the hypolimnion of O'Shaughnessy Reservoir will be a factor in trying to understand the functioning of this system. Hypolimnetic generation of ammonia during stratification will be rapidly converted to nitrate (NO_2-NO_3) upon autumnal mixing. Likewise, the sequestration of total phosphorus, and the generation of orthophosphorus during periods of anoxia in the hypolimnion will affect overall nutrient budgets. Charts illustrating the functioning of the hypolimnion in 2009 and 2010 are depicted in Figure 21.

Table 17. Assessment of lake data collected from O'Shaughnessy Reservoir, 2009 and 2010, using the proposed Lake Habitat aquatic life use and associated criteria. Note - As of the finalization of this report, the proposed Lake Habitat use and these criteria have not been adopted into the Ohio Water Quality Standards and the assessments provided in this table should be considered as examples of how the adopted use and criteria would be applied.

Tiered Aquatic Life Criteria							**Recreation Use**
Parameter	Secchi depth (m)	Chlorophyll a (µg/l)	Total Nitrogen (µg/l)	Total Phosphorus (µg/l)	D.O (mg/l)	NH3 (mg/l)	*E. coli*
Criteria	1.19 minimum	14 median	930 median	34 median	6.0	temperature dependent	126 cfu/100ml.
6/17/2009	1.2	41.4	4820	131		<	40
7/9/2009	0.84	52.1	6800	45		<	10
7/29/2009	0.9	55.1	3760	50		<	270
8/12/2009	0.54	75.4	2650	62		<	10
9/9/2009	0.89	62.4	1190	57		<	10
5/26/2010	0.41	29.8	1234	134	8.2	<	40
6/23/2010	0.57	34.5	9030	147	5.5	<	220
7/8/2010	0.71	70.5	4600	50	15.1	<	30
7/22/2010	0.92	60.4	2370	<10	9.9	<	<10
8/18/2010	0.76	52.1	1440	83	7.2	<	10
9/1/2010	0.89	30.3	820	44	3.0	<	<10

Parameter	Secchi depth (m)	Chlorophyll a (µg/l)	Total Nitrogen (µg/l)	Total Phosphorus (µg/l)	D.O (mg/l)	NH3 (mg/l)	*E. coli*
Median	0.84	52.1	3760	57	2 of 11	Below detect	25.4 geomean
Narrative	watch list	impaired	watch list	watch list	impaired	meets std	meets std



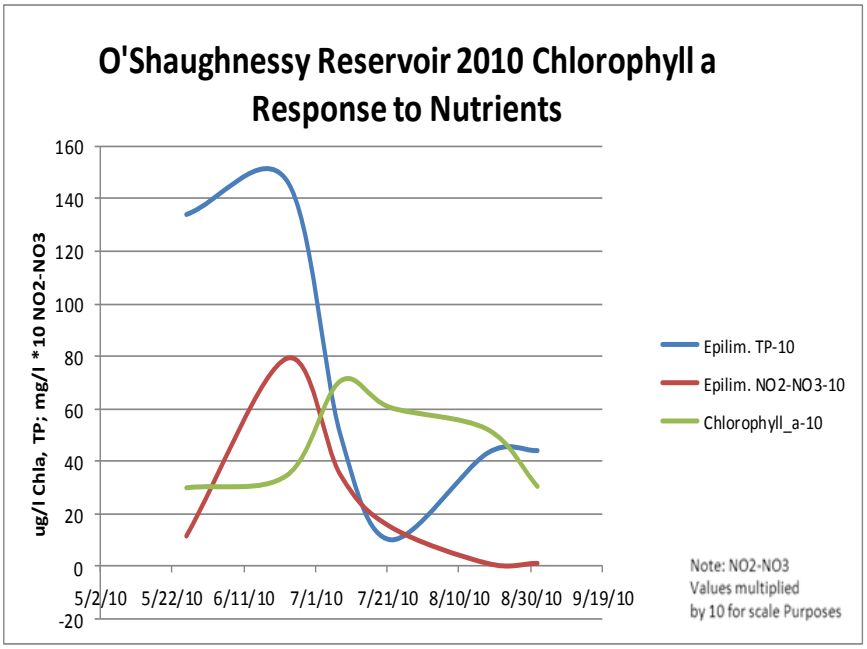
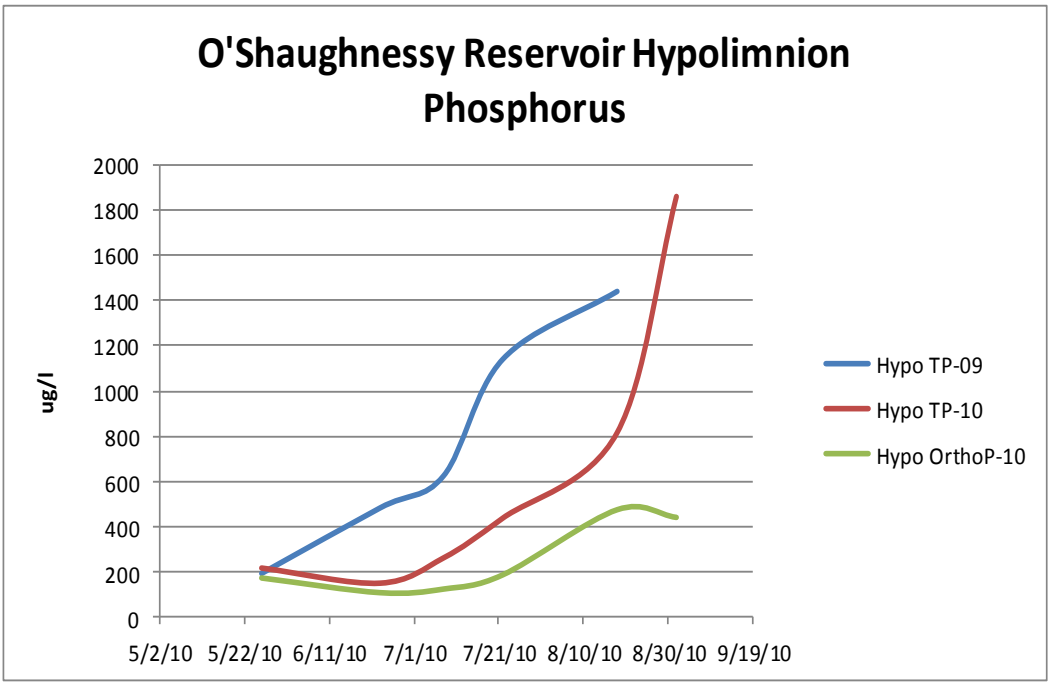


Figure 20. Chlorophyll-a response to nutrients in O'Shaughnessy Reservoir, 2009 and 2010.



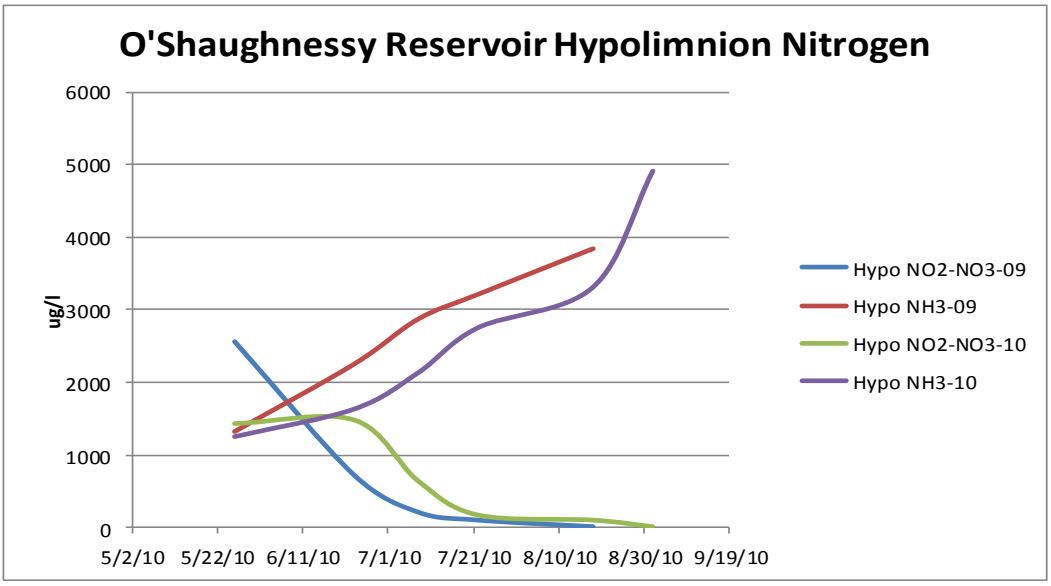


Figure 21. Hypolimnion phosphorus and nitrogen in O'Shaughnessy Reservoir, 2009 and 2010.

While the graphs in Figure 21 show some evidence of nitrogen being the limiting factor in O'Shaughnessy Reservoir, a more effective lake management strategy would be to target reduction in total phosphorus levels. The reasoning for this is that a focus on reduction in nitrogen levels may shift the system to a situation that favors blue-green algae (cyanobacteria) production, which would have an advantage because of their ability to fix atmospheric nitrogen as a nitrogen source. Reduction in total phosphorus will limit all chlorophyll-a producers, and will aid in the recovery of O'Shaughnessy Reservoir to full LH use attainment status.

While urbanization of the shores of O'Shaughnessy Reservoir is not as intense as in downstream Griggs Reservoir, it is a significant lakeside land use. A determined shift to the use of phosphorus free lawn fertilizing blends will reduce the urban/suburban contribution of total phosphorus through storm water runoff. Spot use of phosphorus-containing fertilizers for flower beds, and only where necessary for healthy plant growth, is a contribution that every lakeside and watershed home owner can accomplish at relatively low expense. Lakeside buffer zones of natural woody or tall grass vegetation will help in intercepting run off, increase lakeside nutrient assimilation, and discourage nuisance geese populations. Once again, this is a relatively inexpensive way to reduce nutrient inputs into O'Shaughnessy Reservoir.

Completion of modeling that identifies and apportions input loads is underway. This will assist in identifying the most significant loads that must be curtailed in order for the lake to regain full LH use attainment status.

Griggs Reservoir

A water quality survey of Griggs Reservoir was conducted by Ohio EPA in 2009 and 2010 as a part of the Division of Surface Water's Inland Lakes Monitoring Program. Griggs Reservoir is located in central Ohio in the city of Columbus, Franklin County. Griggs Reservoir is maintained and operated by the city of Columbus Division of Watershed Management as a source for municipal water supply. The dam was constructed on the Scioto River in 1904, creating a long, narrow lake that runs north to south for approximately six miles, creating 387 surface acres of water. The lake is generally clear, but is influenced heavily by rain events and can become very turbid. Depths can exceed 20 feet near the dam, but most of the reservoir is between 10 and 15 feet deep (Ohio DNRb). The watershed for Griggs Reservoir has a drainage area of 1040 square miles (Ohio EPA, 2008a).

Water chemistry samples and bacteria samples were collected 11 times in 2009 and 2010. Sediment samples were collected once in 2010. No exceedances of Ohio WQS criteria for arsenic, cadmium, chromium, copper, lead, nickel, selenium or zinc were found. The majority of bacteria samples from Griggs Reservoir were below the recreation use criteria (geometric average <126 cfu/100ml for Class A Primary Contact Recreation) with a geometric average *E. coli* value of 13 cfu/100ml. However, the result of the sample collected on September 8, 2009 yielded a result of 440 cfu/100ml, which exceeds the maximum single sample criterion for *E. coli* of 298 cfu/100 ml. Sampling results are shown in Table 18.

In 2009, Griggs Reservoir appeared to thermally stratify very weakly and at a deep depth, as shown in Figure 22 (upper). In spite of the weak temperature stratification, dissolved oxygen maintained a fairly consistent stratification in the bottom two meters of the reservoir (Figure 22, lower). This stratification was marked enough that attainment for dissolved oxygen was assessed based on epilimnion values, rather than calling the whole reservoir unstratified.

In 2010, Griggs Reservoir again appeared to stratify relatively weakly from a temperature perspective (Figure 23, upper). This is likely a function of the relatively short turn over time anticipated by the very low Residence Time Index (RTI). In fact the Griggs Reservoir RTI of 0.5 was determined to be the low cut-off between a lake and a run of river impoundment. However, the low RTI and relatively weak temperature stratification does not prevent the reservoir from behaving as a functional lake from the perspective of the dissolved oxygen regime. As seen in Figure 23 (middle and lower), the dissolved oxygen and the dissolved oxygen percent saturation stratify strongly in comparison to the weak temperature stratification. When considering these results, it appears as though Griggs Reservoir should be assessed for aquatic life using the proposed LH use rather than a tiered use established for Ohio streams and rivers. The use attainment assessment is shown in Table 18.

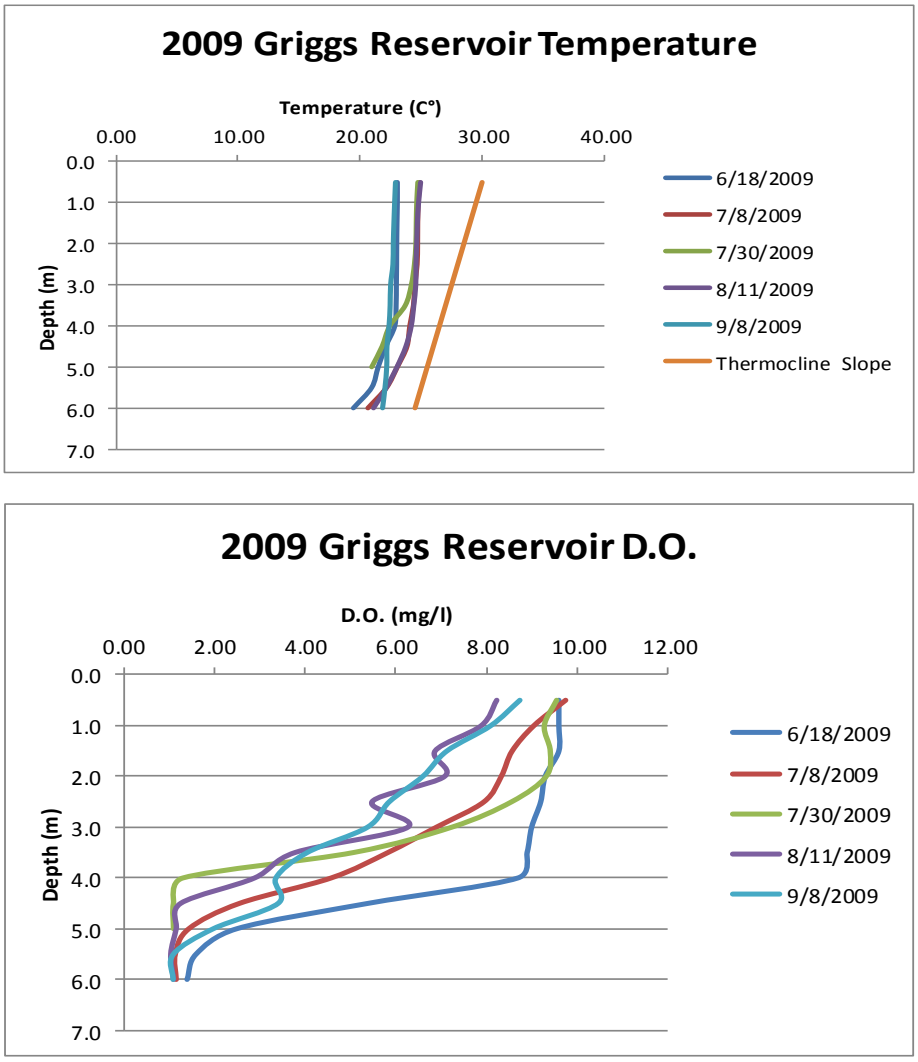
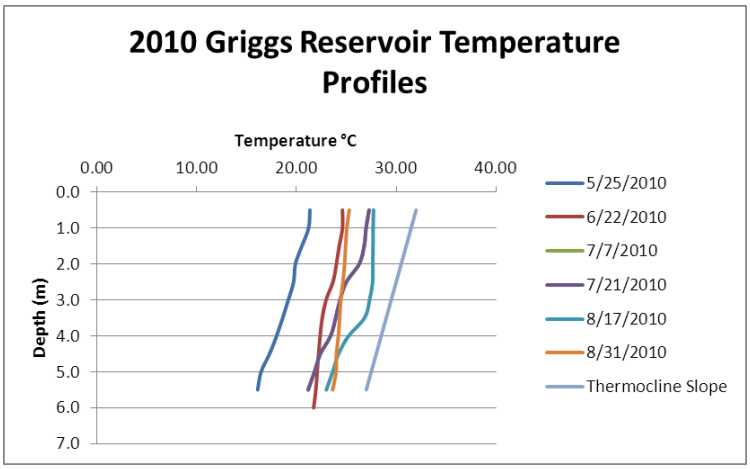
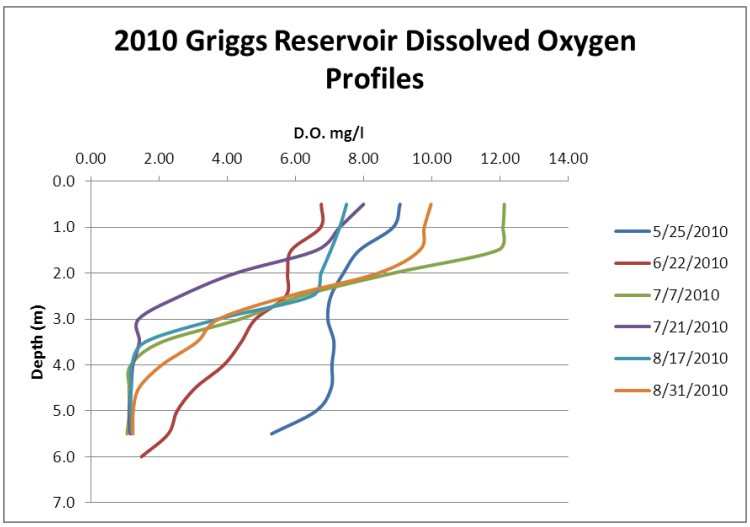


Figure 22. Temperature and dissolved oxygen in Griggs Reservoir, 2009.





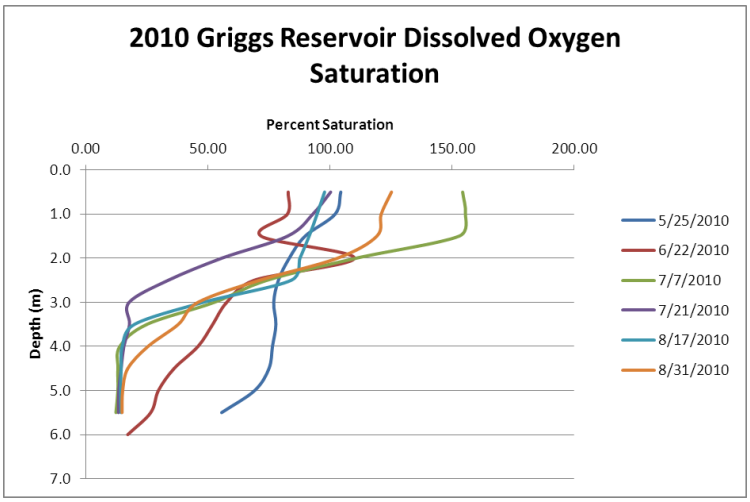


Figure 23. Temperature, dissolved oxygen and dissolved oxygen saturation in Griggs Reservoir, 2010.

Table 18. Assessment of lake data collected from Griggs Reservoir, 2009 and 2010, using the proposed Lake Habitat aquatic life use and associated criteria. Note - As of the finalization of this report, the proposed Lake Habitat use and these criteria have not been adopted into the Ohio Water Quality Standards and the assessments provided in this table should be considered as examples of how the adopted use and criteria would be applied.

Tiered Aquatic Life Criteria							Recreation Use
Parameter	Secchi depth M.	Chlorophyll a µg/l	Total Nitrogen µg/l	Total Phosphorus µg/l	D.O mg/l	Nh3 mg/l	*e. coli*
Criteria	1.19 minimum	14 median	930 median	34 median	6.0	temperature dependent	126 cfu/100ml.
6/18/2009	1.2	37.9	2460	40	8.81	<	60
7/8/2009	0.75	117.0	7417	749	7.06	0.95**	<10
7/30/2009	0.95	64.1	3587	79	8.35	<	<10
8/11/2009	0.83	43.1	2403	83	5.53	<	20
9/8/2009	0.82	50.6	620	<10	4.73*	<	**440*** **
5/25/2010	0.73	32.2	9678	115	8.61	<	40
6/22/2010	0.056	13.3	8125	163	6.17	<	70
7/7/2010	0.92	229.0	5019	92	11.26	<	10
7/21/2010	1.045	107.0	3052	136	6.55	<	10
8/17/2010	0.73	68.9	2014	389	5.77	<	<10
8/1/31/2010	--	46.9	800	50	5.13	<	****
Median	0.83	50.6	3052	92	4 of 11	Below detect	13.0
Narrative	watch list	impaired	watch list	watch list	impaired	meets standard	meets standard

* Griggs Reservoir was not stratified on this date.
** Exceeds Outside Mixing Zone Average (OMZA) water quality criterion.
***Exceeds Single Value Maximum *E.coli* criteria for Class A recreational waters of 298 cfu/100ml.
****Lab Accident, no value available.

Chlorophyll-a response to nutrient inputs over the two seasons was examined. At times there were remarkably elevated total phosphorus levels: 740 ug/l on July 8, 2009 and 389 ug/l August 17, 2010. The former number is extremely elevated, and more than twice all but one value recorded in hypereutrophic Grand Lake St. Mary's in 2010. The one value is on a par with the latter sample value. Chlorophyll-a values did not seem entirely responsive to these extreme spikes of phosphorus, which may be indicative of a situation where nitrogen is the limiting factor in this reservoir.

Figure 24 shows the response of chlorophyll-a to nutrient concentrations. Values in the charts are transformed using natural logs for unity in scale. In 2009, chlorophyll-a in Griggs Reservoir appeared responsive to available NO_s-NO_3 concentrations until later in the season where levels seemed to plateau, possibly due to a nitrogen limitation. In 2010, the response was more complex. There seemed to be a mid-season spike in chlorophyll-a that could have been brought about by relatively high concentrations of available NO_2-NO_3 and total phosphorus. Following that, chlorophyll-a seemed to trend downwards on a similar slope as NO_s-NO_3

concentrations, and did not seem to respond to a rather large (seasonal high) spike in total phosphorus. (Note: the apparent uptick in NO_2-NO_3 shown in the 2010 chart near the end of season is an artifact of the curve smoothing software; the last two seasonal values are identical below detections).

Hypolimnetic nutrient trends reflected the weak and inconsistent stratification in Griggs Reservoir. Figure 25 indicates that hypolimnetic buildup of ammonia was interrupted at several times during 2009. In addition, the hypolimnion did not seem to function as a phosphorus sink in 2009. Unfortunately, orthophosphorus was not sampled in the hypolimnion in 2009.

In 2010, the level of stratification seemed stronger from mid-July until August, before finally breaking down in early September. Ammonia levels climbed during this period, as well as total phosphorus and orthophosphorus, indicating that the hypolimnion was functioning. In September, the reduction in ammonia, uptick in NO_s-NO_3, and the slight drop in orthophosphorus indicated dissolved oxygen levels were high enough for bacteria to function in an aerobic state by the early autumn. Again, this seemed to indicate that stratification in Griggs Reservoir was weak overall, and likely easily influenced by inflows from the Scioto River and surrounding urban areas.

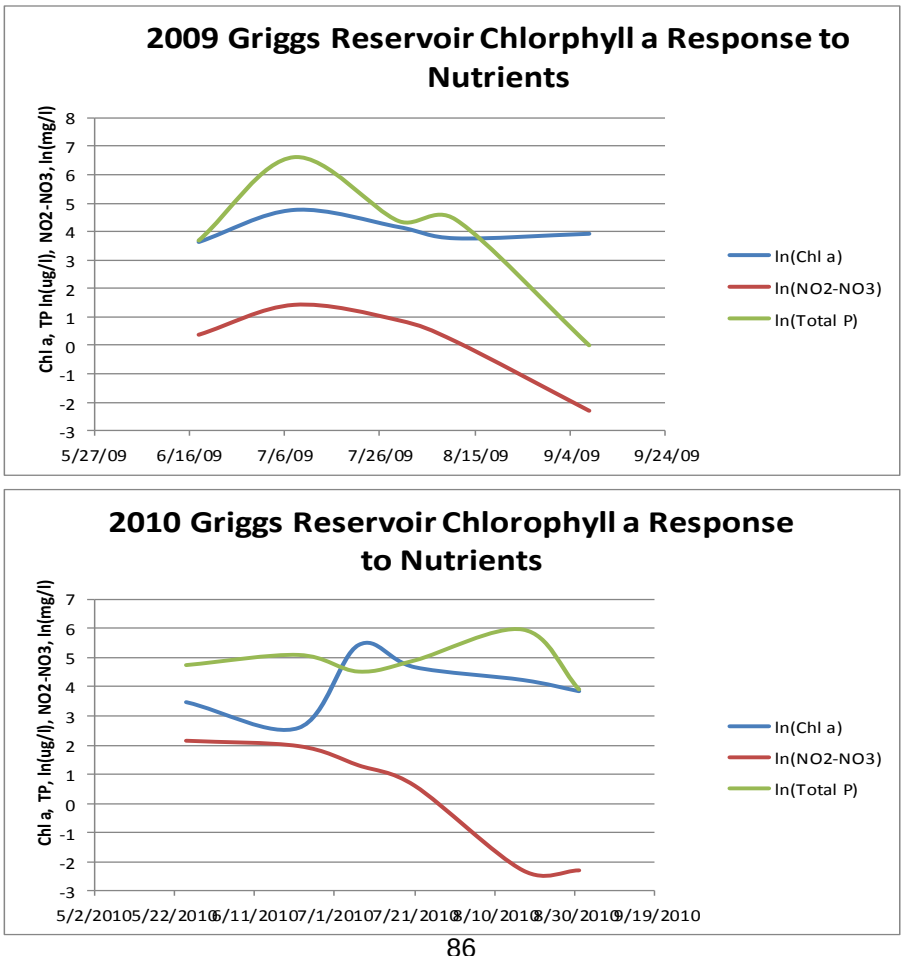
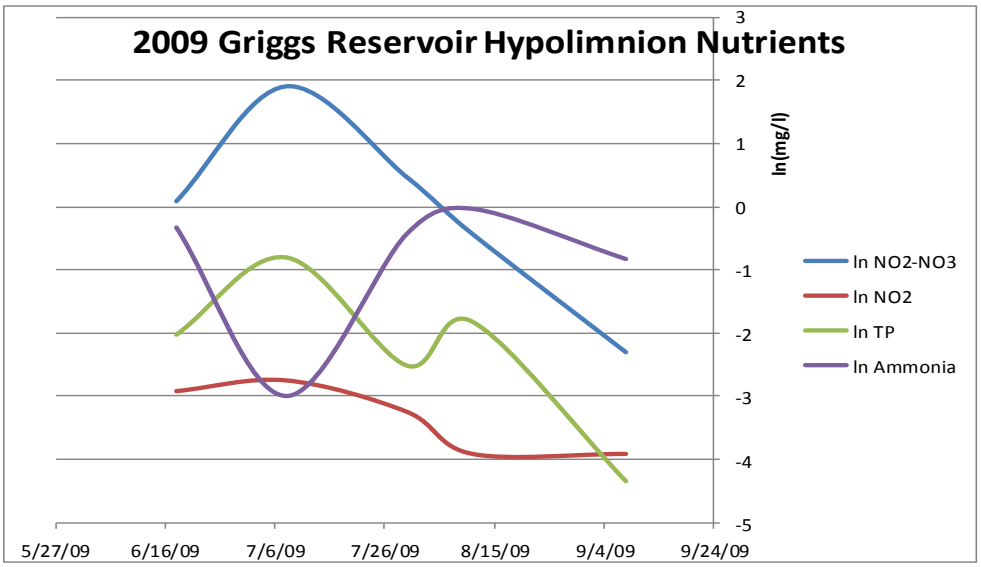


Figure 24. Chlorophyll-a response to nutrients in Griggs Reservoir, 2009 and 2010.



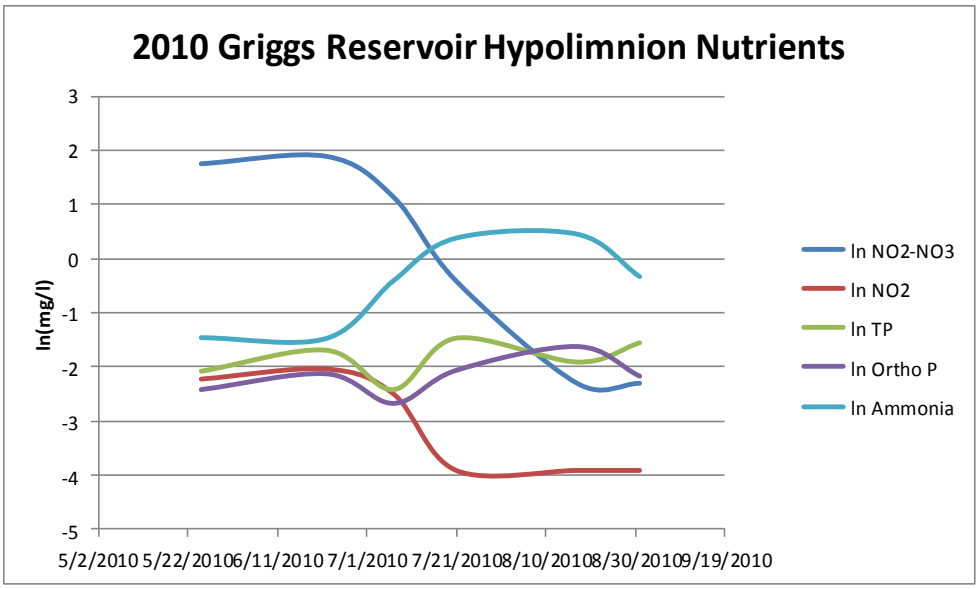


Figure 25. Hypolimnion nutrients in Griggs Reservoir, 2009 and 2010.

Like O'Shaughnessy Reservoir, Griggs Reservoir experienced a late season total phosphorus spike in 2010. The fact that both lakes experienced this spike emphasizes the flow-through nature of these reservoirs. The quality of the Scioto River flowing into and through these lakes dominates their nature.

Griggs Reservoir, with the low threshold RTI, shows its rapid turnover nature via weak temperature stratification. Dissolved oxygen response indicates the stratification is somewhat stronger than would be indicated by temperature, but true hypolimnetic properties of very low dissolved oxygen to anoxia, as well as functioning as a sink for total phosphorus, do not seem to occur every year.

Extremely elevated total phosphorus values early in the monitoring period in 2009 were not reflected in the data for O'Shaughnessy Reservoir, and thus are a function of the immediate watershed and land use adjacent to Griggs Reservoir. Due to the urban nature of the local watershed, an emphasis on urban storm water management is important for reducing these types of spikes. Repeated spikes of nutrients such as these could lead to serious water quality problems, including blue-green algae blooms.

A shift to phosphorus free lawn fertilizers in the immediate watershed is a low cost alternative that will result in reduced phosphorus loading to Griggs Reservoir. Care in management of pet waste, improving riverside buffers to control nuisance geese populations, and improved storm water volume management will also help to reduce loadings to the reservoir from its immediate drainage area.

Water quality modeling is underway to further identify and quantify sources of total phosphorus loadings to Griggs Reservoir, and to assign loading reductions to various sources. This will aid in prioritizing management strategies.

Fish Tissue Contamination

Ohio has been sampling streams annually for sport fish contamination since 1993. Fish are analyzed for contaminants that bioaccumulate in fish and that could pose a threat to human health if consumed in excessive amounts. Contaminants analyzed in Ohio sport fish include mercury, PCBs, DDT, mirex, hexachlorobenzene, lead, selenium, and several other metals and pesticides. Other contaminants are sometimes analyzed if indicated by site-specific current or historic sources. For more information about chemicals analyzed, how fish are collected, or the history of the fish contaminant program, see State of Ohio Cooperative Fish Tissue Monitoring Program Sport Fish Tissue Consumption Advisory Program, Ohio EPA, January 2010 (http://www.epa.state.oh.us/portals/35/fishadvisory/FishAdvisoryProcedure10.pdf).

Fish contaminant data are primarily used for three purposes: 1) to determine fish advisories; 2) to determine attainment of the human health beneficial use based on Ohio Water Quality Standards criteria; and 3) to examine trends in fish contaminants over time.

Fish Advisories

Fish contaminant data are used to determine a meal frequency that is safe for people to consume (e.g., two meals a week, one meal a month, do not eat), and a fish advisory is issued for applicable species and locations. Because mercury mostly comes from nonpoint sources, primarily aerial deposition, Ohio has had a statewide one meal a week mercury advisory for most fish since 2001. Most fish are assumed to be safe to eat once a week unless specified otherwise in the fish advisory, which can be viewed at:
http://www.epa.state.oh.us/dsw/fishadvisory/index.aspx.

The minimum data requirement for issuing a fish advisory is three samples of a single species from within the past ten years. For the middle Scioto River, common carp, channel catfish, flathead catfish, freshwater drum, largemouth bass, rock bass, saugeye, smallmouth bass, and spotted bass met the requirement. Common carp, channel catfish, flathead catfish, and freshwater drum are all in the one meal a month advisory category due to PCB contamination. Freshwater drum and rock bass are in the one meal a month advisory category due to mercury contamination. Largemouth bass, saugeye, smallmouth bass, and spotted bass are all in the one meal a week category due to mercury contamination, as well as PCB contamination for saugeye and smallmouth bass.

Inadequate data were collected in 2010 from Griggs and O'Shaughnessy reservoirs to determine specific advisories. However, no PCBs were detected in any fish from either reservoir, and mercury levels from all fish collected were in the two meals per week advisory range, except for largemouth bass, which were in the one meal a week advisory range. Therefore, the statewide advisory of one meal per week for most fish, and two meals per week for sunfish, applies to both reservoirs.

For a listing of fish tissue data collected from the middle Scioto River in support of the advisory program, see Table 20. The advisory information for the middle Scioto River presented in this section differs from the information given in Ohio's fish consumption advisory because of a difference in years of data and sites included in the analysis. The two segments referred to in the Ohio fish consumption advisory include areas upstream from Warrensburg and downstream to U.S. Route 35 in Chillcothe and look at data collected between 2000 and 2009; for this

document, only data taken in 2010 from adjacent Klondike Road downstream to Big Darby Creek were used.

Human Health (Fish Contaminants)

In addition to determining safe meal frequencies, fish contaminant data are also used to determine attainment with the human health WQS criteria pursuant to OAC Rules 3745-1-33 and 3745-1-34. The human health criteria are presented in water column concentrations of µg/Liter, and are then translated into fish tissue concentrations in mg/kg. [See Ohio's 2010 Integrated Report, Section E: http://www.epa.state.oh.us/portals/35/tmdl/2010IntReport/Section_E.pdf for further details of this conversion.]

In order to be considered in attainment of the Ohio Water Quality Standards criteria, the sport fish caught within an assessment unit (HUC-12 or Large River) in the Ohio River basin must have a weighted average body burden concentration of the geometric means for all species below 1.0 mg/kg for mercury, and below 0.054 mg/kg for PCBs. These are the only two parameters of concern which routinely trigger human health beneficial use impairments in Ohio rivers, lakes, and streams.

Fish tissue data collected between 2003 and 2010 were adequate to determine attainment status for the two Large River assessment units (LRAUs) in the middle Scioto River basin study area. At least four fish tissue samples, consisting of two samples from trophic level three fish and two samples from trophic level four fish, are needed, and PCB and mercury data collected from the Scioto River (Little Scioto River to Olentangy River) and the Scioto River (Olentangy River to Big Darby Creek) met that data requirement. For all other HUC-12 assessment units in this survey, no fish tissue data were available. Within the two LRAUs, mercury data did not trigger an impairment (*i.e.*, no weighted average body burdens with > 1.0 mg/kg mercury), but PCB data, while barely above the threshold in the upper LRAU, did trigger non-attainment in both LRAUs within the study area (Table 19)

Table 19. Human health (fish contaminants) beneficial use attainment status of Large River assessment units sampled within the middle Scioto River basin study area. PCB tissue burdens (mg/kg) are based on the weighted average concentration of the geometric means for all species collected from the assessment units from 2001 through 2010.

Large River	PCB Criterion (mg/kg)	PCBs Measured (mg/kg)	Attainment
05060001 90 01 Scioto River (Little Scioto River to Olentangy River)	0.054	0.055	**Non**
05060001 90 02 Scioto River (Olentangy River to Big Darby Creek)	0.054	0.157	**Non**

For Griggs and O'Shaughnessy reservoirs, specifically, no PCBs were detected in fish from either reservoir based on the most recent data collected in 2010, and both reservoirs were in attainment for mercury, with mercury levels in fish of 0.074 and 0.065 mg/kg, respectively. However, both reservoirs are included as part of the LRAU which is listed as impaired for PCBs.

Fish Contaminant Trends

Fish contaminant levels can be used as an indicator of pollution in the water column at levels lower than laboratory reporting limits for water concentrations but high enough to pose a threat to human health from eating fish. Most bioaccumulative contaminant concentrations are decreasing in the environment because of bans on certain types of chemicals like PCBs, and because of stricter permitting limits on dischargers for other chemicals. However, data show that PCBs continue to pose a risk to humans who consume fish, and mercury concentrations have been increasing in some locations because of increases in certain types of industries for which mercury is a byproduct that is released to air and/or surface water.

For this reason, it is useful to compare the results from the survey presented in this report with the results of the previous survey(s) done in the study area. Recent data can be compared against historical data to determine whether contaminant concentrations in fish tissue appear to be increasing, decreasing, or staying the same in a water body or watershed.

Fish tissue had previously been collected in the middle Scioto River in 1990, 1992, 1997, 1999, and 2003. Fish were collected along approximately the same stretch of river as in 2010, from near O'Shaughnessy Reservoir at river mile 153.8 to Circleville at river mile 100. Mercury levels in fish appear to have risen slightly in the middle Scioto River since 1990-1999, from a weighted average of 0.102 mg/kg to 0.126 mg/kg in 2010. That change in mercury concentrations may be attributable, at least in part, to an increase in the size of the average fish caught in the middle Scioto River, from 386 mm in 1990-1999, to 440 mm in 2010, since mercury concentration tends to increase in fish with increasing length. PCBs appeared to decrease in the middle Scioto River from 1990-1999 to 2010, from a weighted average of 308 ppb in 1990-1999, to 150 ppb in 2010.

Fish tissue had previously been collected in Griggs and O'Shaughnessy reservoirs in 1992 and 2000. PCB levels in fish have decreased since 1992 and 2000 in both reservoirs. Weighted average PCB concentrations in fish in Griggs Reservoir in 1992 were 0.03 mg/kg, and no PCBs were detected in fish in 2000 and 2010. Weighted average PCB concentrations in fish in O'Shaughnessy Reservoir in 1992 were 0.055 mg/kg, and 0.044 mg/kg in 2000; in 2010, no PCBs were detected in fish. Mercury levels in fish tissue have gone down slightly in both reservoirs since the 1992 and 2000 fish tissue sampling events, from a weighted average of 0.105 mg/kg in 1992, to 0.076 mg/kg in 2000, down to 0.074 mg/kg in 2010 in Griggs Reservoir. In O'Shaughnessy Reservoir, weighted average mercury concentrations in fish have gone from 0.086 mg/kg in 1992, to 0.097 mg/kg in 2000, down to 0.065 mg/kg in 2010.

Table 20. Select fish tissue data (mg/kg) collected from middle Scioto River sampling stations, 2010.

Year Collected	Location	River Mile	Species	Mercury	PCBs
2010	Scioto River downstream Big Darby Creek	100	Channel Catfish	0.160	0.306
2010	Scioto River downstream State Route 316	107.1	Channel Catfish	0.102	0.198
2010	Scioto River downstream State Route 316	107.1	Channel Catfish	0.095	0.338
2010	Scioto River upstream State Route 762	115.6	Channel Catfish	0.220	0.385
2010	Scioto River upstream State Route 762	115.6	Channel Catfish	0.098	0.235
2010	Scioto River at State Route 665	120	Channel Catfish	0.065	0.353
2010	Scioto River at State Route 665	120	Channel Catfish	0.075	0.602
2010	Scioto River downstream Greenlawn Avenue	129	Channel Catfish	0.091	0.418
2010	Scioto River downstream Greenlawn Avenue	129	Channel Catfish	0.054	0.109
2010	Scioto River downstream State Route 161	144.6	Channel Catfish	0.054	<0.05
2010	Scioto River downstream State Route 161	144.6	Channel Catfish	0.111	<0.05
2010	Scioto River downstream State Route 161	144.6	Channel Catfish	0.068	<0.05
2010	Scioto River adjacent Klondike Road	157.1	Channel Catfish	0.164	0.080
2010	Scioto River adjacent Klondike Road	157.1	Channel Catfish	0.284	0.133
	Averages			**0.117**	**0.236**
2010	Scioto River downstream Big Darby Creek	100	Common Carp	0.099	0.256
2010	Scioto River downstream State Route 316	107.1	Common Carp	0.072	<0.05
2010	Scioto River upstream State Route 762	115.6	Common Carp	0.169	1.239
2010	Scioto River at State Route 665	120	Common Carp	0.239	0.700
2010	Scioto River downstream Greenlawn Avenue	129	Common Carp	0.068	0.350
2010	Scioto River at Greenlawn Dam Pool	130.4	Common Carp	0.07	0.179
2010	Scioto River at Greenlawn Dam Pool	130.4	Common Carp	0.04	0.094
2010	Scioto River upstream Olentangy River	132.5	Common Carp	0.086	0.261
2010	Scioto River downstream State Route 161	144.6	Common Carp	0.099	<0.05
2010	Scioto River downstream State Route 161	144.6	Common Carp	0.118	<0.05
2010	Scioto River adjacent Klondike Road	157.1	Common Carp	0.245	<0.05
	Averages			**0.119**	**0.298**

Year Collected	Location	River Mile	Species	Mercury	PCBs
2010	Scioto River upstream State Route 762	115.6	Flathead Catfish	0.811	0.337
2010	Scioto River at State Route 665	120	Flathead Catfish	0.139	1.285
2010	Scioto River at State Route 665	120	Flathead Catfish	0.037	0.228
2010	Scioto River downstream Greenlawn Avenue	129	Flathead Catfish	0.284	0.539
	Averages			**0.318**	**0.597**
2010	Scioto River downstream Big Darby Creek	100	Freshwater Drum	0.138	0.189
2010	Scioto River downstream State Route 316	107.1	Freshwater Drum	0.2	0.330
2010	Scioto River downstream State Route 316	107.1	Freshwater Drum	0.08	0.482
2010	Scioto River upstream State Route 762	115.6	Freshwater Drum	0.317	0.127
2010	Scioto River at State Route 665	120	Freshwater Drum	0.247	0.392
2010	Scioto River at State Route 665	120	Freshwater Drum	0.141	0.274
2010	Scioto River downstream Greenlawn Avenue	129	Freshwater Drum	0.118	0.089
	Averages			**0.177**	**0.269**
2010	Scioto River at Greenlawn Dam Pool	130.4	Largemouth Bass	0.105	<0.050
2010	Scioto River at Greenlawn Dam Pool	130.4	Largemouth Bass	0.211	<0.050
2010	Scioto River upstream Olentangy River	132.5	Largemouth Bass	0.142	<0.050
2010	Scioto River downstream State Route 161	144.6	Largemouth Bass	0.139	<0.050
2010	Scioto River adjacent Klondike Road	157.1	Largemouth Bass	0.097	<0.050
	Averages			**0.139**	<0.050
2010	Scioto River upstream Olentangy River	132.5	Rock Bass	0.136	<0.050
2010	Scioto River downstream State Route 161	144.6	Rock Bass	0.198	<0.050
2010	Scioto River adjacent Klondike Road	157.1	Rock Bass	0.4	<0.050
2010	Scioto River adjacent Klondike Road	157.1	Rock Bass	0.273	<0.050
	Averages			**0.252**	<0.050
2010	Scioto River downstream Big Darby Creek	100	Saugeye	0.22	0.155
2010	Scioto River at State Route 665	120	Saugeye	0.177	<0.050
2010	Scioto River downstream Greenlawn Avenue	129	Saugeye	0.103	<0.050
2010	Scioto River downstream Greenlawn	129	Saugeye	0.106	0.178

Year Collected	Location	River Mile	Species	Mercury	PCBs
	Avenue				
2010	Scioto River upstream Olentangy River	132.5	Saugeye	0.272	<0.050
2010	Scioto River adjacent Klondike Road	157.1	Saugeye	0.068	<0.050
	Averages			**0.158**	**0.089**
2010	Scioto River downstream Big Darby Creek	100	Smallmouth Bass	0.228	0.073
2010	Scioto River downstream State Route 316	107.1	Smallmouth Bass	0.126	<0.050
2010	Scioto River at Greenlawn Dam Pool	130.4	Smallmouth Bass	0.131	<0.050
2010	Scioto River upstream Olentangy River	132.5	Smallmouth Bass	0.182	<0.050
2010	Scioto River upstream Olentangy River	132.5	Smallmouth Bass	0.113	<0.050
2010	Scioto River downstream State Route 161	144.6	Smallmouth Bass	0.203	<0.050
2010	Scioto River adjacent Klondike Road	157.1	Smallmouth Bass	0.125	<0.050
2010	Scioto River adjacent Klondike Road	157.1	Smallmouth Bass	0.261	<0.050
	Averages			**0.171**	**0.053**
2010	Scioto River downstream Big Darby Creek	100	Spotted Bass	0.272	<0.050
2010	Scioto River downstream State Route 316	107.1	Spotted Bass	0.244	<0.050
2010	Scioto River downstream State Route 316	107.1	Spotted Bass	0.081	<0.050
2010	Scioto River upstream State Route 762	115.6	Spotted Bass	0.222	<0.050
2010	Scioto River at State Route 665	120	Spotted Bass	0.133	<0.050
	Averages			**0.190**	<0.050

The shading indicates the advisory category that applies. Green = two meals per week, yellow = one meal per week, orange = one meal per month, red = one meal every two months. Unshaded cells had reporting limits above the one meal per week threshold, and so could not be determined.

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