Ohio Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of Kyger Creek and Select Tributaries

Gallia and Meigs Counties

OHIO EPA Technical Report EAS/2011-2-7

John Kasich, Governor
Scott J. Nally, Director

Biological and Water Quality Study of Kyger Creek and Selected Tributaries 2008

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TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

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 to also determine if the use is meeting the goals of the federal Clean Water Act. Eight streams in the Kyger Creek study area were evaluated for aquatic life and recreational use potential in 2008 (see Figure 1 and Table 1 for sampling locations). Two of the streams are assigned the Warmwater Habitat (WWH) aquatic life use designation in the Ohio Water Quality Standards and one previously undesignated stream is recommended Modified Warmwater Habitat – Mine Affected (MWH-M), and another remains undesignated (Table 3). While upper Kyger Creek is designated WWH, the lower reach, downstream from Jessie Creek, is assigned the Limited Resource Water (LRW) aquatic life use designation. Jessie Creek, Stingy Run, Turkey Run and Little Kyger Creek are also designated LRW. The two previously undesignated tributaries are also being recommended for the Primary Contact Recreation Use Class B. All remaining streams in this study should retain the Primary Contact Recreation use Class B, along with the Agricultural and Industrial uses.

Only three of the 18 sites were in attainment of their respective biological goals. The remaining sites were all in non-attainment related to acid mine drainage (AMD), industrial point source discharges, historical coal mining, livestock access to streams and landfill leachate.

AMD chemical effects were apparent in the lower portions of Kyger Creek, Little Kyger Creek, Turkey Run, Stingy Run, and the lower site on Jessie Creek. The chemical water quality at these sites contained elevated levels of manganese and aluminum, excessive conductivity, low pH, and a lack of alkalinity which are all indicative of AMD. In addition, Stingy Run showed elevated levels of iron. Only three sites did not show any elevated levels of AMD parameters. These sites are Kyger Creek RM 8.5, the unnamed tributary at RM 10.98 and Bell Lick Run RM 0.4.

The recreational use goals of the Clean Water Act were met at all 18 sites that were sampled for bacteria. Bacteria samples were not collected at the respective outfalls from the two industrial facilities in this study. While there are no central sewage collection systems within the basin, bacteria did not appear to pose any significant problems. It appears that respective on-lot sewage systems are either satisfactory, or not of the magnitude for bacteria to be detected at levels of concern in stream samples. The industrial facilities have extended aeration treatment systems to treat sanitary wastewater that is generated at each respective facility. Both facilities' sanitary wastewater treatment plants discharge to the Ohio River.

Specific point source and non-point source pollution related issues which should be addressed to improve water quality throughout the Kyger Creek basin include the following:

- Coal mining reclamation activities should be undertaken in areas of historical mining.

- Landfill leachate issues should be addressed along Kyger Creek.
- Sources of acid mine drainage and associated metals and sedimentation should be addressed in Kyger Creek and all affected tributaries.
- Discharge from fly ash ponds on Kyger Creek and Stingy Run should be remediated.
- Livestock access should be restricted in Bell Lick Run.

Table 1. Kyger Creek survey area sampling locations, 2008. Site number corresponds to sampling location on Figure 1. The color of the site number corresponds to the biological score; 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, but may meet the goals of less than CWA aquatic life uses including Modified Warmwater Habitat and Limited Resource Water).

SITE	STREAM	RIVER MILE	DRAIN. AREA (Mi^2)	LOCATION	LATITUDE	LONGITUDE
1	Kyger Creek	8.50	6.1	1.5 mile downstream Bell Lick Run, adjacent Van Zant Road	38.982800	-82.164400
2	Kyger Creek	8.42	6.8	Upstream Kyger at State Route 554	38.982500	-82.164200
3	Kyger Creek	4.80	17.3	Near Kyger, upstream. confluence of Stingy Run	38.960700	-82.129300
4	Kyger Creek	4.00	20.3	Near Cheshire, upstream Roush cemetery, downstream AEP 008	38.953646	-82.126773
5	Kyger Creek	3.40	22.5	1 mile west of Cheshire at Gravel Hill Road	38.945500	-82.127200
6	Kyger Creek	1.00	30.1	Near Addison, upstream power plant, downstream Little Kyger Creek	38.918700	-82.136600
7	Kyger Creek	0.60	30.7	Addison at State Route 7	38.912900	-82.136000
8	Bell Lick Run	0.35	1.6	Ward Road at mouth.	38.995400	-82.208000
9	Tributary to Kyger Creek (RM 10.98)	0.11	0.9	Near Kyger at Van Zant Road	38.997900	-82.202400
10	Tributary to Kyger Creek (RM 8.44)	0.30	4.5	Adjacent State Route 554 at abandoned road	38.979700	-82.168800
11	Jessie Creek	4.00	0.9	2.3 miles south of Langsville at Ward Road	39.014000	-82.190000
12	Jessie Creek	0.01	3.3	1 mile east of Kyger at mouth	38.979800	-82.141600
13	Stingy Run	0.20	0.6	near mouth at Stingy Run rd.	38.961900	-82.133200
14	Turkey Run	0.95	1.1	Near mouth at Turkey Run Road	38.942700	-82.139200
15	Turkey Run	0.40	1.6	Near mouth at footbridge near McCarty cemetery	38.942900	-82.133400
16	Little Kyger Creek	3.00	1.2	Jericho Hill Road (2nd crossing upstream)	38.946500	-82.171200
17	Little Kyger Creek	1.60	2.7	Adjacent Little Kyger Creek Road	38.930100	-82.156300
18	Little Kyger Creek	0.01	5.8	2 mile north of Addison at mouth	38.920100	-82.136600

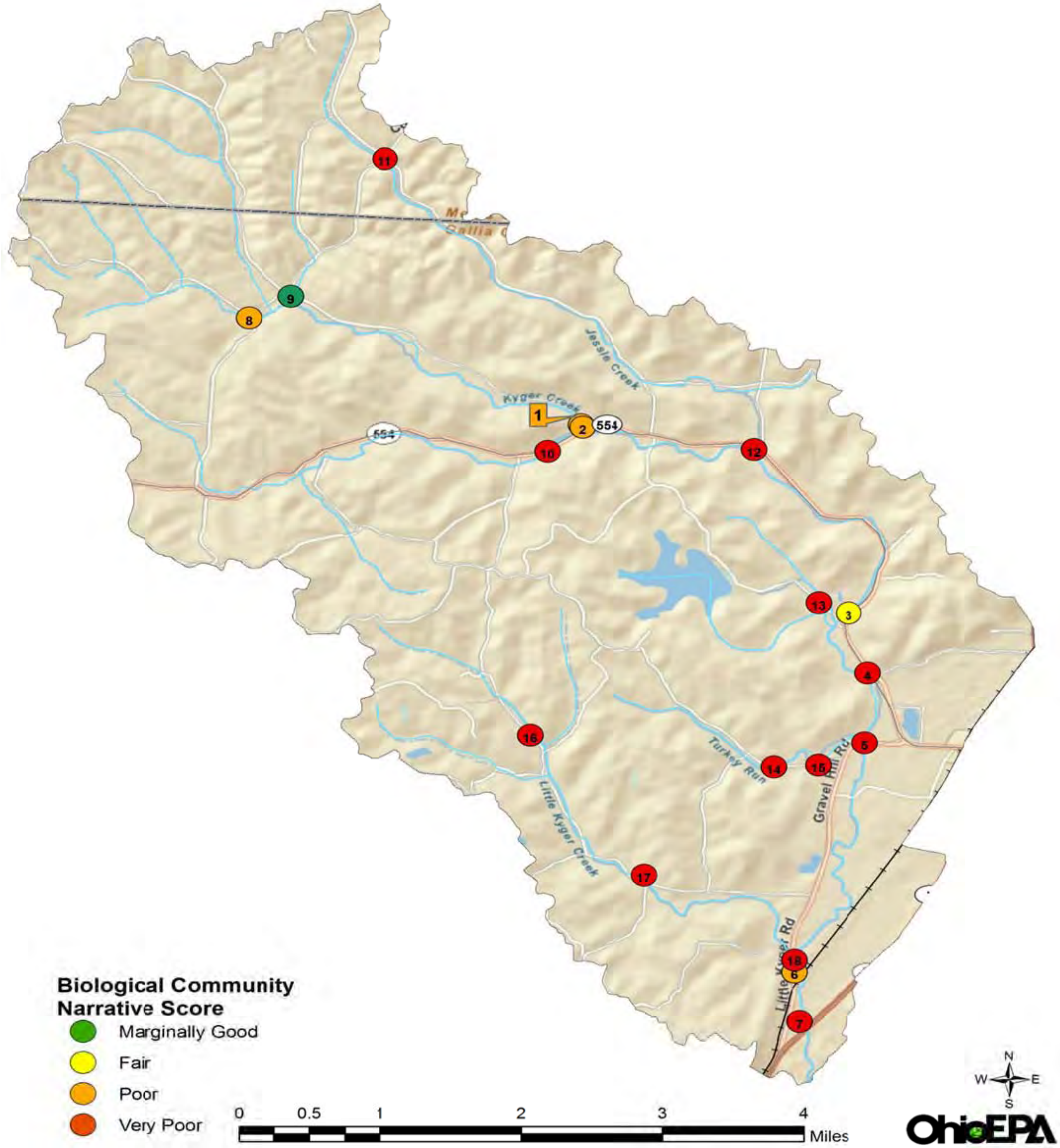

Figure 1. Kyger Creek basin sampling locations and biological community performance, 2008. Site numbers correspond to Table 1.

Table 2. Aquatic life use attainment status for stations sampled in the Kyger Creek study area based on data collected June-October 2008. 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 Kyger Creek basin is located in the Western Allegheny Plateau (WAP) 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
Kyger Creek (09-057-000)					**WWH EXISTING**				
Kyger Creek - 1.5 mile downstream Bell Lick Run, adjacent Van Zant Road	W03K06 (8.5)[H]	6.1	22*	N/A	F*	66.0	NON	Sedimentation/siltation	Channelization Coal mining
Kyger Creek - Upstream Kyger at State Route 554	W03S13 (8.42)[H]	6.8	19*	N/A	G(G)[E]	53.5	NON	Sedimentation/siltation	Channelization Coal mining
Kyger Creek (09-057-000)					**LRW EXISTING**				
Kyger Creek - Near Kyger, upstream. confluence of Stingy Run	W03S03 (4.8)[H]	17.3	30	N/A	F	52.0	FULL		
Kyger Creek - Near Cheshire, upstream Roush cemetery, downstream AEP 008	300593 (4.0)[W]	20.3	15*	4.0*	34 (P)[E]	64.0	NON	Sedimentation/siltation Manganese	Acid mine drainage Industrial point source discharge (landfill leachate)
Kyger Creek - 1 mile west of Cheshire at Gravel Hill Road	W03P48 (3.4)[W]	22.5	22	3.8*	28 (MG)[E]	62.5	NON	Sedimentation/siltation Manganese	Acid mine drainage Industrial point source discharge (landfill leachate)
Kyger Creek - Near Addison, upstream power plant, downstream Little Kyger Creek	W03S26 (1.0)[W]	30.1	22	5.1	14	57.0	FULL	Comment – Sedimentation and AMD negatively influence the aquatic communities at this location.	
Kyger Creek - Addison at State Route 7	W03S01 (0.6)[W]	30.7	17*	5.2	18	66.0	NON	Sedimentation/siltation Manganese	Acid mine drainage Industrial point source discharge
Bell Lick Run (09-062-000)					**WWH EXISTING**				
Bell Lick Run - Ward Road at mouth	W03S15 (0.35)[H]	1.6	20*	N/A	MG[NS]	56.0	NON	Sedimentation/siltation	Livestock access to stream Coal mining
Tributary to Kyger Creek at RM 10.98 (09-057-001)					**PHWH RECOMMENDED**				
Tributary to Kyger Creek (RM 10.98) - Near Kyger at Van Zant Road	W03P49 (0.11)[H]	0.9	--	--	MG[NS]	--	--		
Tributary to Kyger Creek at RM 8.44 (09-057-002)					**MWH-M RECOMMENDED**				
Tributary to Kyger Creek (RM 8.44) - Adjacent State Route 554 at abandoned road	300530 (0.3)[H]	4.5	12*	N/A	F*	54.0	NON	Sedimentation/siltation Manganese	Coal mining
Jessie Creek (09-061-000)					**LRW EXISTING**				

LOCATION	STORET (RM)[A]	DRAIN. (MI²)	IBI	MIWB[B]	ICI[C]	QHEI	STATUS[D]	CAUSES	SOURCES
Jessie Creek - 2.3 miles south of Langsville at Ward Road	300526 (4.0)[H]	0.9	12*	N/A	VP*	59.0	NON	Sedimentation/siltation	Acid mine drainage
Jessie Creek - 1 mile east of Kyger at mouth	W03P52 (0.01)[H]	3.3	18	N/A	VP*	41.0	NON	Sedimentation/siltation Manganese	Acid mine drainage
Stingy Run (09-060-000)					**LRW EXISTING**				
Stingy Run - near mouth at Stingy Run Road	300528 (0.2)[H]	0.6	18	N/A	P	40.0	FULL	Comment –The stream is maintaining the LRW aquatic life use despite excessive sedimentation/siltation along with evidence of elevated metals associated with acid mine drainage. The stream is also negatively influenced by discharge from the AEP- Gavin fly ash pond.	
Turkey Run (09-059-000)					**LRW EXISTING**				
Turkey Run - Near mouth at Turkey Run Road	W03S14 (0.95)[H]	1.1	12*	N/A	VP*	44.5	NON	Sedimentation/siltation, Manganese, pH	Acid mine drainage
Turkey Run - Near mouth at footbridge near McCarty cemetery	300529 (0.4)[H]	1.6	12*	N/A	VP*	49.0	NON	Sedimentation/siltation, Manganese, pH	Acid mine drainage Landfill leachate
Little Kyger Creek (09-058-000)					**LRW EXISTING**				
Little Kyger Creek - Jericho Hill Road (2nd crossing upstream)	300527 (3.0)[H]	1.2	12*	N/A	P	56.5	NON	Sedimentation/siltation, Manganese, pH	Acid mine drainage
Little Kyger Creek - Adjacent Little Kyger Creek Road	W03K07 (1.6)[H]	2.7	12*	N/A	VP*	72.0	NON	Sedimentation/siltation, Manganese, pH	Acid mine drainage
Little Kyger Creek - 2 mile north of Addison at mouth	W03P51 (0.01)[H]	5.8	12*	N/A	VP*	73.0	NON	Sedimentation/siltation, Manganese, pH	Acid mine drainage

A - River Mile (RM) represents the Point of Record (POR) for the station; the absolute location point (where actual sampling occurred) may be slightly different..

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 - First macroinvertebrate score is from sampling during July-August. Macroinvertebrate score in parentheses is from qualitative sampling in late September.

ns - Nonsignificant departure from EWH or WWH 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 for EWH or WWH). Underlined scores are in the Poor or Very Poor range.

B - Boat site.

H - Headwater site.

W - Wading site.

Biological Criteria Western Allegheny Plateau				
Index – Site Type	**EWH**	**WWH**	**MWH**[1]	**LRW**[2]
IBI – Headwaters	50	44	24	18
IBI – Wading	50	44	24	18
IBI – Boat	48	40	24	16
MIwb – Wading	9.4	8.4	6.2	4.5
MIwb – Boat	9.6	8.6	5.5	5.0
ICI	46	36	30	8

1 - Mine affected MWH-M

2 - Proposed LRW scoring breakpoints. These have not yet been adopted into rule.

RECOMMENDATIONS

The majority of streams listed in the Ohio Water Quality Standards for the study area are assigned the LRW aquatic life use designation (Table 3). This study used biological data to evaluate and establish aquatic life uses for the streams in the study area.

Eight streams were evaluated for aquatic life and recreational use potential during 2008 (Tables 2 and 3). Significant findings include the following:

- The unnamed tributary to Kyger Creek at RM 8.44 was evaluated for the first time in 2008. Excessive siltation and sedimentation from coal mining activities resulted in poor to fair aquatic community performance. As a result, the MWH-M aquatic life use was deemed the most appropriate. The Agricultural Water Supply, Industrial Water Supply, and Primary Contact Recreation Class B uses are also recommended.

- The unnamed tributary to Kyger Creek at RM 10.98 is undesignated. It's small drainage area (<1mi^2) indicates a Primary Headwater Habitat (PHWH) designation is most appropriate. However, as of the date of this report, the PHWH aquatic life use designation is currently not available in the Ohio WQS. Therefore, this stream will remain undesignated.

- Biological sampling confirmed the WWH aquatic life use designation is appropriate for the upper reach of Kyger Creek and Bell Lick Run. Addressing sedimentation associated with coal mining, along with restricting livestock access to Bell Lick Run, would improve water quality in both streams.

- The remaining streams sampled within the study area should retain their associated designated aquatic life, Primary Contact Recreation, Agricultural Water Supply and Industrial Water Supply uses.

Table 3. Waterbody use designation recommendations for Kyger Creek and its tributaries based on sampling conducted in 2008. 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 (Δ) indicates a new recommendation based on the findings of this report.

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	
Kyger Creek-confluence with Jessie Creek to the mouth							+		+	+		+		Acid Mine Drainage
-headwaters to confluence with Jessie Creek		+							+	+		+		
Little Kyger Creek							+		+	+		*+		Acid Mine Drainage
Turkey Run							+		+	+		*+		Acid Mine Drainage
Stingy Run							+		+	+		*+		Acid Mine Drainage
Jessie Creek							+		+	+		*+		Acid Mine Drainage
Bell Lick Run		+							*+	*+		*+		
Unnamed Tributary at RM 8.44				Δ+					Δ+	Δ+		Δ+		WAP ecoregion – mine affected

INTRODUCTION

Creek

Eighteen stream sampling locations from eight streams were evaluated in the Kyger Creek watershed in Gallia and Meigs Counties in 2008. Sampling was conducted as part of the five-year basin approach for monitoring, assessment, issuance of National Pollution Discharge Elimination System (NPDES) permits and to facilitate a Total Maximum Daily Load (TMDL) assessment (Figures 2 & 3). This study area included seven sites on Kyger Creek starting at the headwaters and extending to the mouth at its confluence with the Ohio River. In addition, seven Kyger Creek tributaries were evaluated including Bell Lick Run, two unnamed tributaries to Kyger Creek, RMs 10.98 and 8.44, Jessie Creek, Stingy Run, Turkey Run, and Little Kyger Creek. Two industrial facilities discharge to Kyger Creek and its tributaries. The Ohio Valley Electric Company Kyger Creek Electric Generating Station and AEP-Gavin Electric Generating Station hold NPDES discharge permits for discharging treated effluent from their respective outfalls. Both companies also have outfalls that discharge to the Ohio River but those outfalls were not sampled or evaluated as part of this study. The study area was comprised of one subwatershed, Kyger Creek (HUC 05030202 09 01).

During the 2008 Kyger Creek study, Ohio EPA conducted a water resource assessment of 8 streams in the Kyger Creek watershed using standard Ohio EPA protocols as described in Appendix A. Included in this study were assessments of the biological, surface water and recreation (bacterial) condition. A total of 18 biological, 18 water chemistry, and 18 bacterial stations were sampled. All biological, chemical and bacteria results can be downloaded from the Ohio EPA GIS interactive maps at the following link: http://www.epa.state.oh.us/dsw/gis/index.aspx.

Specific objectives of this evaluation were to:

- Monitor and assess the chemical, physical and biological integrity of the streams within the 2008 Kyger Creek study area;
- Characterize the consequences of various land uses on water quality within the Kyger Creek watershed;
- Evaluate the effectiveness of mine and stream habitat reclamation on the receiving streams;
- Evaluate the potential impacts from spills, nonpoint source pollution (NPS), and habitat alterations on the receiving streams; and
- Determine the attainment status of the current designated aquatic life uses and non-aquatic use designations and recommend changes where appropriate.

STUDY AREA DESCRIPTION

The Kyger Creek watershed (31 mi^2 drainage area) is located in the Western Allegheny Plateau (WAP) ecoregion predominated by mixed oak and mixed temperate forests (Omernik, 1987). While the land is dominated by forest, numerous abandoned mines are present throughout the study area and contribute to water quality concerns (Figure 3). Kyger Creek is a direct tributary of the Ohio River, entering the Ohio River at RM 720.7, south of Cheshire and north of Gallipolis. Kyger Creek is currently listed WWH from the headwaters to Jessie Creek (RM 7.1) and LRW from Jessie Creek to the mouth. Bell Lick Run is the only other stream in the study area to be listed WWH. Jessie Creek, Stingy Run, Turkey Run, and Little Kyger Creek are listed as LRW due to acid mine drainage. The shift from WWWH in the headwaters to LRW aquatic life use potential in lower Kyger Creek and its tributaries corresponds with the loss of buffering capacity from upstream to downstream. Low buffering capacity can result in radical shifts in pH concentrations and metals toxicity and correspondingly severe biological impairments in the AMD influenced reaches. Higher buffering capacity in the headwaters is likely related to the presence of calcareous limestone. In addition to the LRW designated tributaries, the Tributary to Kyger Creek at RM 8.44 was recommended for MWH-M, while the Tributary to Kyger Creek at RM 10.98 was recommended for PHWH.

All designated streams in the Kyger Creek study area are currently assigned as Primary Contact Recreation (PCR) Class B, Agricultural Water Supply (AWS) and Industrial Water Supply (IWS). The findings of this evaluation factor into regulatory actions taken by the Ohio EPA (*e.g.*, NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1], Water Quality Permit Support Documents [WQPSDs]) and are incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d]).

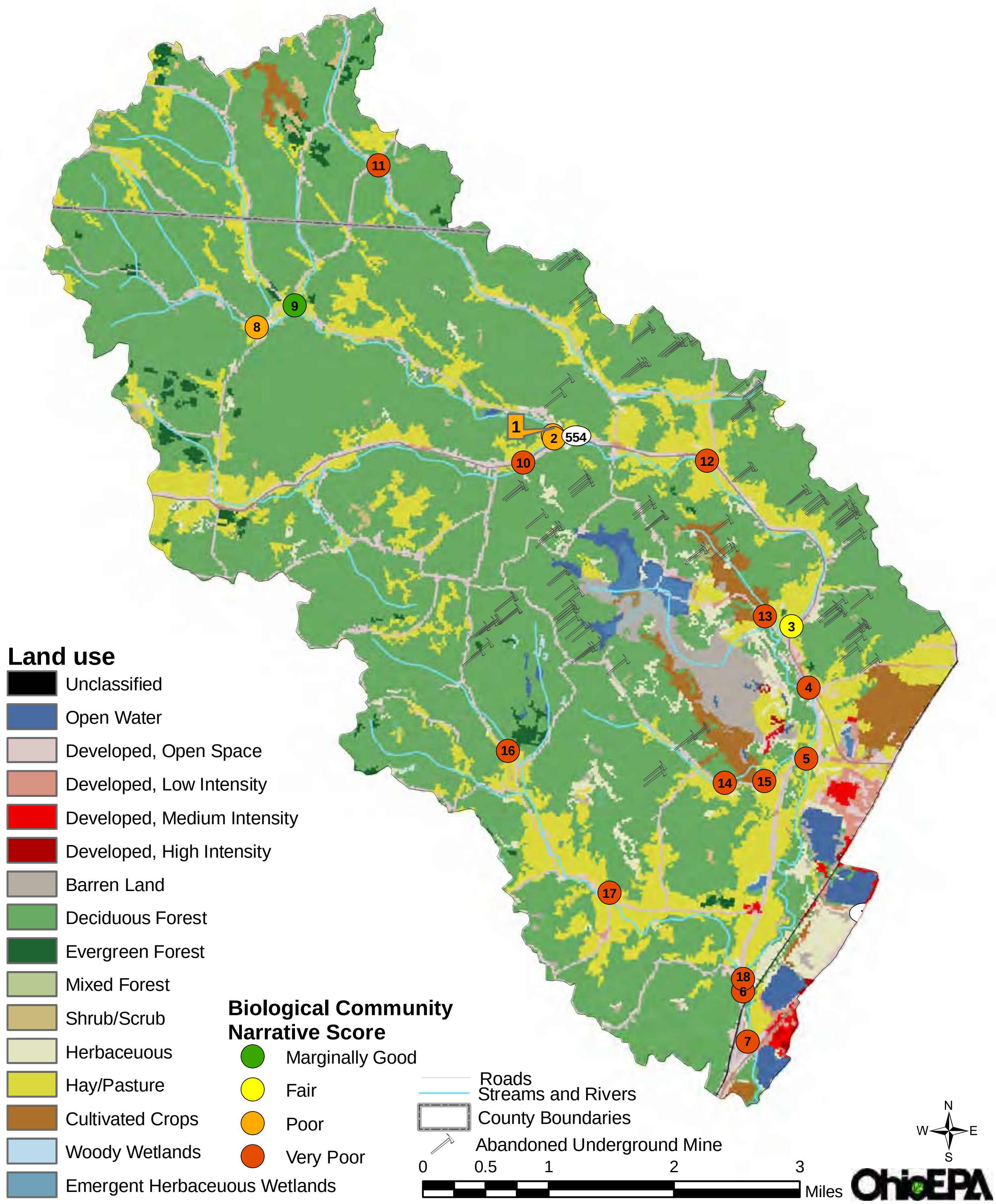

Figure 3. Land use, biological community narrative scores and abandoned mines in the Kyger Creek study area, 2008.

WATERSHED SUMMARY

The Kyger Creek study area was confined to one Watershed Assessment Unit (HUC 05030202 09 01) (Figure 3). Fish and macroinvertebrate sampling was conducted at 18 locations in the Kyger Creek watershed ranging in drainage area from 0.6 mi^2 to 30.7 mi^2 (Figure 3 and Table 1). The survey assessed aquatic life use attainment at 17 sites. Three sites fully met the existing aquatic life use, while the remaining 14 sites did not attain either their designated or recommended use (Figure 4).

Within the upper portion of the basin, upstream from Jessie Creek, siltation and sedimentation were the main cause for impairment. Channelization and legacy coal mining were the two main sources of the siltation and sedimentation noted along Kyger Creek near Van Zant Road (RM 8.5) and State Route 554 (RM 8.42). Livestock and legacy coal mining were the two main sources of siltation and sedimentation noted in Bell Lick Creek, while legacy coal mining was the main source of siltation and sedimentation along the State Route 554 (RM 0.3) sampling location on a Tributary to Kyger Creek at RM 8.44. Landfill leachate near Kyger Creek RMs 4.0 & 3.4 also contributed to water quality impairment. All remaining sites that were not in full attainment were strongly influenced by acid mine drainage.

Acid mine drainage (AMD) is the seepage or runoff of groundwater and precipitation which has come into contact with coal or coal mine waste materials called “gob”. Drainage from these materials is often acidic and discharges from underground mines, surface mines, or mine waste disposal areas. AMD is often associated with abandoned coal mine lands (AML). AMD in Ohio is typically characterized by low pH, high metal concentrations, and low buffering capacity because of the lack of alkalinity. AMD can have a devastating effect with varying severity upon the aquatic life of a stream or river.

Alkalinity is the water’s capacity to resist changes in pH that makes water more acidic. This capacity is known as “buffering capacity”. Alkalinity is the ability to neutralize acid. If the pH of a body of water is 6.0 and has an alkalinity of 0, the pH will immediately drop with the addition of acidic water. On the other hand, if the body of water has a pH of 6.0, with an alkalinity of 50, the pH will change very little, if at all.

The pH of a stream can be affected by the geology to which it makes contact. Natural alkalinity can be found in rocks that contain carbonate, bicarbonate, and hydroxide compounds, as well as borates, silicates, and phosphates. Water that flows over limestone will have a high alkalinity because of the carbonates that are contained in the limestone. Therefore, acidic water will tend to be more neutral and less affected in these types of areas.

Chemical and physical effects of AMD

The effect of AMD on a receiving stream will depend on the volume, frequency, and chemistry of the drainage, as well as the attenuating capacity of the receiving stream. AMD characteristics are created by the mineral composition of the rock strata over which it flows. Thus, if the local geology is rich in a particular mineral, the drainage is likely to reflect it. The water chemistry at any given location along an AMD-receiving stream can vary significantly, but often these water bodies include some or all of the following.

- The pH of the stream may be very low, especially if measured in close proximity to the drainage. However, the effect upon pH may be negligible if the stream is adequately buffered. In such situations, pH may not noticeably change downstream of the drainage, but an increase in acidity, and a decrease in alkalinity is sometimes observed.

- Elevated iron may be observed downstream of the discharge. When iron-bearing minerals in coal, such as pyrite (FeS_2), are exposed to oxygen and water, the iron oxidation is catalyzed and released to solution. Dissolved iron will be transported or precipitated, depending on the chemistry of the stream.

- Other elevated metal and semi-metal concentrations originate from impurities within the coal seam including aluminum, arsenic, cadmium, copper, lead, manganese, and zinc. These constituents may be observed at toxic levels downstream of AMD drainage. Elevated aluminum and manganese concentrations are nearly ubiquitously associated with AMD.

- Metal precipitates may be observed on the stream bed below the point of discharge. This is a result of dissolved metals in the drainage reacting with water to form various hydroxides. Precipitated manganese, aluminum, and iron oxides can reduce quality and quantity of habitat within a stream or river by filling macropores within the substrate. One such precipitate, ferric hydroxide, is responsible for the reddish-orange color commonly associated with AMD impacted streams. Ferric hydroxide is often called “yellow boy”. Precipitation of aluminum typically forms grayish-white solids, whereas, manganese precipitate is bluish-black.

- Elevated sulfate may be observed downstream of AMD. Sulfate is a byproduct of the iron oxidation of iron-bearing minerals and the production of AMD. Sulfate is generally considered to be non-toxic to aquatic life, except at extreme concentrations, but can be used as an indicator of AMD in a stream system. Elevated sulfate concentrations can create nuisance conditions to recreational waters because of noxious odors.

- Depletion of alkalinity as well as an increase in acidity, hardness, conductivity, total dissolved solids, and various other chemical parameters from AMD is very common. Generally, these parameters are secondary indicators of the previously-mentioned adverse water quality affects.

- Low dissolved oxygen (DO) may be observed in AMD streams as well. Similar to pH, low DO water quality is more likely in close proximity to the drainage. The oxidation of iron-bearing minerals and the further oxidation of ferrous iron in solution are significant oxygen-consumptive processes. Thus, where AMD discharges exist, the instream DO is typically significantly depleted. The depletion is created by the oxygen consumptive processes previously discussed. Because of natural re-aeration, depressed DO may increase over time and not be observed at far-field downstream locations.

AMD can have multiple adverse impacts upon a receiving stream. These impacts commonly include depletion of DO, reduction in pH, depletion of alkalinity buffering capacity, elevated heavy-metal concentrations, and degraded stream habitat. The magnitude of the impacts is dependent on many factors, including the AMD seep characteristics, and the hydrology as well as geology of the drainage area. Important specific factors of AMD impacts include the volume and frequency of the discharge, chemistry of the drainage, and attenuating capacity of the receiving stream and resultant precipitation during the discharge.

Effects of AMD upon aquatic life

AMD can have various chemical and physical effects upon the aquatic life of a stream or river. In some drainage basins of southern, southeastern, and eastern Ohio, AMD is the dominant cause of water quality impairment resulting in stream segments almost devoid of aquatic organisms. If less severe, AMD may be a secondary or tertiary cause of impairment, acting as one of several stressors impacting the biota of a stream.

The primary effect of AMD on aquatic life is related to pH and the concentration of toxic dissolved metals. Depressed DO, osmotic disturbance due to high dissolved solids, and habitat degradation due to metal precipitation also impact aquatic life. Several of the dominant chemical and physical effects of AMD on aquatic life are discussed in more detail below.

- If pH is severely low, it will be the primary cause of toxicity to aquatic organisms. Most aquatic organisms have a defined range of pH tolerance. Standard units of pH below the acceptable range may result in an imbalance of sodium and chloride ions in the blood of organisms, as hydrogen ions are taken into cells and sodium is expelled. The pH also affects the speciation of heavy metals originating from AMD seeps. Low pH values typically drive toxic heavy metals into a dissolved form, creating increased impairment from these metals.

- The presence of heavy metals in AMD increases its toxicity to aquatic organisms. When metals are in the dissolved form, they are the most bioavailable and therefore, the most toxic. Aluminum, iron, and manganese are the major heavy metals in acidic drainage. Aluminum is believed to have the most pronounced impact, though each metal may disrupt the biochemistry of an organism. Other trace metals, such as cadmium, copper, and zinc, may also be present in AMD, and are extremely toxic at low concentrations.

- AMD can have physical effects upon the aquatic community as well. Most notable is degradation of habitat quality due to the deposition of metal precipitates. This deposition can fill interstitial spaces between larger substrate materials, reducing the diversity of habitat available to benthic macroinvertebrates. Metal precipitates can affect fish populations by accumulating on gills and other tissues, thus reducing overall vitality, or by smothering eggs, impacting reproduction, and reducing predation.

Several natural characteristics of a stream can mitigate the effect of AMD upon aquatic life. These include the potential for dilution, buffering capacity, hardness, and dissolved organic matter. These factors are discussed below.

- The potential for dilution in the receiving stream is perhaps the simplest and most important mitigating factor. Small headwater streams are the most likely to be devastated by AMD, whereas large rivers may have sufficient flow to assimilate the drainage with negligible effect.

- Buffering capacity, as measured by total alkalinity, describes the water's ability to assimilate low pH inflows without significantly lowering the instream pH. Adequately buffered receiving waters help maintain pH within a tolerable range for aquatic life. Additionally, heavy metals are typically less soluble in near-neutral water, so they more readily precipitate in well-buffered streams, reducing their toxic impact because of reduced bioavailability.

- A receiving stream with elevated hardness, as measured by the concentration of calcium and magnesium, is more protective of aquatic species from AMD than from soft waters. This is believed to be due to a competitive effect between calcium, magnesium, and heavy-metal cations for binding sites on the tissue of aquatic organisms.

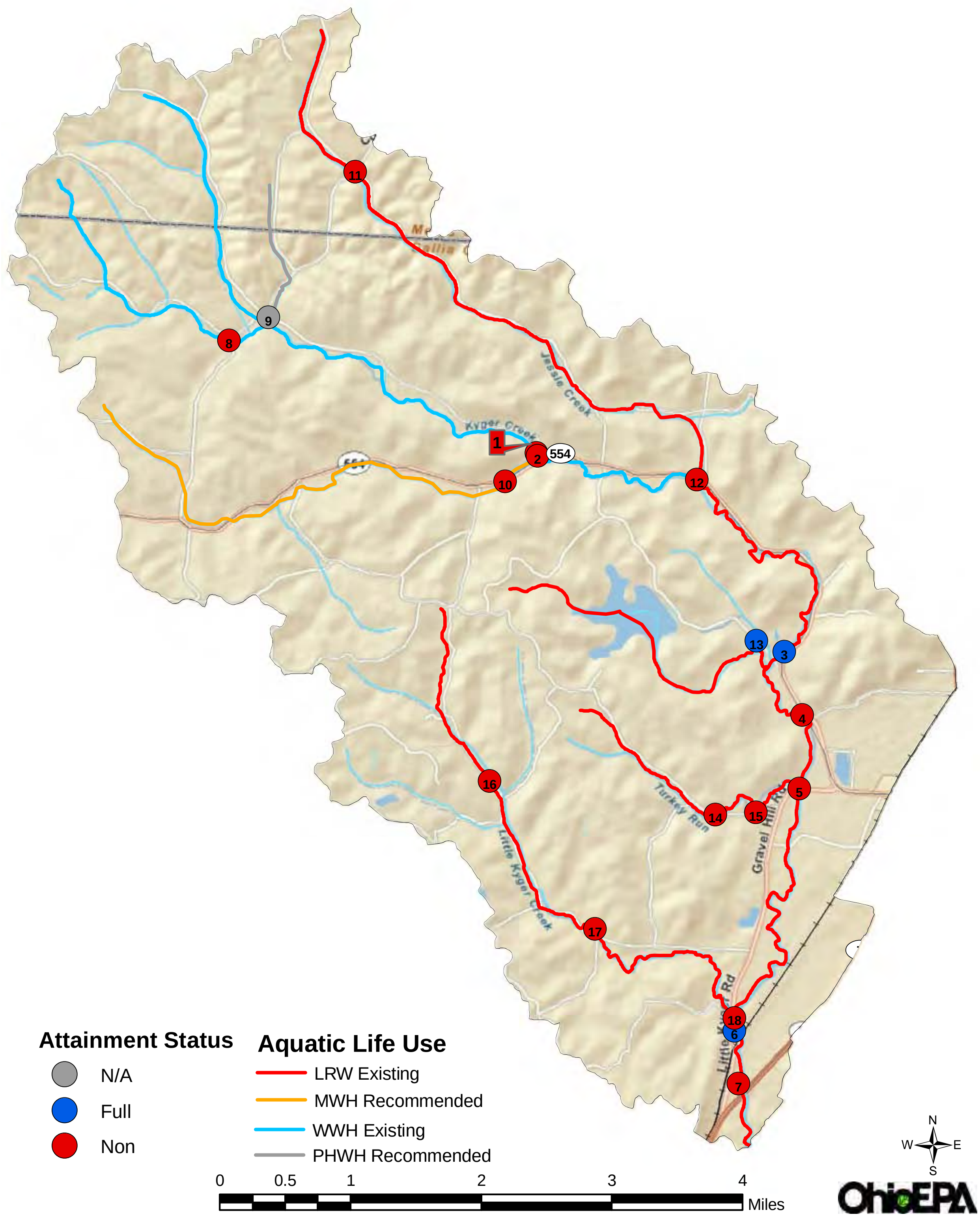

Figure 4. Aquatic life use designations and attainment status of sampling locations within Kyger Creek survey area, 2008.

RESULTS

WATER CHEMISTRY

Surface water samples were collected five times in the Kyger Creek watershed at 18 stream locations and from five industrial outfalls, between July and October 2008. Stations were established in free-flowing stream sections and were primarily at bridge crossings. Surface water samples were collected directly into appropriate containers, preserved, and delivered to Ohio EPA's Environmental Services laboratory in Reynoldsburg, Ohio. Samples were preserved using appropriate methods, as outlined in Parts II and III of the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices, updated edition (Ohio EPA 2008).

Since no gaging stations are located on Kyger Creek, summer 2008 flow conditions were evaluated based on the near-by Raccoon Creek USGS gage near Rio Grande. Flow conditions during summer 2008 ranged from above normal in the beginning to below normal as the season progressed. June began as an extremely wet month. Despite dropping over the summer sampling season, flows remained higher than the historical period of record through August, then dropped below typical ranges in September (Table 4). The monthly flows for this period are shown in Table 4, and may be compared to the average for the given months, based on 84 years of data.

Table 4. *Flow comparison of data recorded at Raccoon Creek at Adamsville*

Date (month)	2008 Flow (cfs)	Average
June	906	200
July	288	120
August	135	80
September	23	45

Surface water samples were analyzed for metals, nutrients, bacterial contamination, field parameters, and solids (Appendix B). Parameters which exceeded Ohio WQS criteria are reported in Table 5.

Metals were analyzed at all sampling locations with 17 parameters tested. All results can be found in Appendix B, and exceedances of typical parameters found in acid mine drainage impacted streams are found in Table 6. The values presented in Table 6 are averages of all samples collected, so there may be individual elevated values in Appendix B, which are not present in Table 6. Reference values are based on Western Allegheny Plateau data, using the 90th percentile of background data collected from reference sites. AMD chemical effects were apparent in the lower portions of Kyger Creek, Little Kyger Creek, Turkey Run, Stingy Run, the Tributary to Kyger Creek at RM 8.44, and the lower site on Jessie Creek. The chemical water quality at these sites contained elevated levels of manganese and aluminum, excessive conductivity, low pH, high acidity, and a lack of alkalinity which are all indicative of AMD. In addition, Stingy Run showed elevated levels of iron. Only three sites did not show any elevated levels of AMD parameters. These sites are Kyger Creek RM 8.5, the Tributary to Kyger Creek at RM 10.98 and Bell Lick Run RM 0.4.

Large portions of the Kyger Creek study area contain abandoned coal mines (Figure 3) and much of the watershed was mined before reclamation laws were instituted. Prior to 1977, coal mining did not have to return the ground to its original condition, and instead large piles of coal waste (gob) were left along with highwalls, mine pits of toxic water and underground mine discharges to surface waters. These remaining mining wastes and discharges contribute large amounts of AMD which can include high levels of acidity, iron, aluminum, manganese, nickel, zinc, total dissolved solids, and low pH levels.

Samples were also analyzed for nutrients to document any stream enrichment issues. Phosphorus can cause increased growth of algae in streams, which can deplete available oxygen for aquatic life. Ammonia can be detrimental, even toxic at elevated levels, to the biological community of a stream. Table 7 shows that several sites exceeded the 90^{th} percentile for ammonia, based on criteria from reference sites within the WAP ecoregion. Four of seven mainstem sites exceeded the ammonia target values, while both sites on Turkey Run, Stingy Run, and one of the three Little Kyger Creek sites also exceeded the target value. Ammonia is commonly used in treating coal waste, and is also used at power plants with scrubbers for air pollution control. The high levels of ammonia found at these locations are likely attributable to treating coal wastes and the power plants. In 2009, a fish kill on Kyger Creek was associated with an ammonia spill at the OVEC plant. Only one site, Kyger Creek RM 0.3, had elevated phosphorus levels. Results of nitrate-nitrite showed no elevated levels at any of the sites.

Field chemistry was also conducted at all the locations at the same time that grab water samples were collected. These parameters include pH, temperature, dissolved oxygen and conductivity. The results can also be found in Appendix B, along with the rest of the water chemistry results. Low pH levels (below 6.5 S.U.) were found at all three Little Kyger Creek locations on every sampling event. Turkey Run at McCarty Cemetery, below Gavin's 007 outfall, had low pH on two sampling events, while the uppermost Turkey Run site had low pH from every sample collected. All dissolved oxygen levels were screened in Table 5, using the warmwater criteria of 4.0/5.0 mg/l. These results are indicative of the acid mine drainage conditions discussed above.

***Table 5**. Exceedances of Ohio Water Quality Standards criteria (OAC3745-1) for chemical/physical parameters measured in the Kyger Creek study area, 2008. Values are S.U. for pH, mg/l for D.O. and metals are ug/l.*

Stream/RM	**Location**	**Parameter**
Kyger Creek		
8.5	Kyger Creek upst. SR 554	pH (6.37)[b]
8.14	Kyger Creek at ford off SR 554	
5.1	Kyger Creek upst. Stingy Run	
4.0	Kyger Creek at Roush Cemetery dst. Stingy Run	pH (6.28)[b] TDS (3290, 2140)[b]
3.0	Kyger Creek dst Turkey Run	Selenium (9,28,14.5)[b]
1.0	Kyger Creek dst. Little Kyger	pH (5.71, 6.41, 5.95, 6.19)[b] TDS (1850, 2210)[b]
0.5	Kyger Creek at SR 7	
Tributary to Kyger Creek at RM 10.98		
0.1	VanZant/Ward Road	
Bell Lick Run		
0.35	Ward Road	D.O. (3.99, 2.82)[a]
Tributary to Kyger Creek at RM 8.44		
0.3	Adj. SR 554 at abandoned road crossing	
Jessie Creek		
4.0	Jessie Creek/Ward Road	D.O. (4.07)[b]
0.1	Bridge at SR 554	pH (6.31, 5.45)[b]
Stingy Run		
0.2	at Stingy Run Road	pH (6.19)[b] Iron (21,300)[c]
Turkey Run		
0.8	Turkey Run Road upst. Gavin outfall 007	pH (4.54, 4.78, 4.77, 5.16, 5.0)[b]
0.4	Footbridge near McCarty Cemetery	pH (5.71, 5.85)[b] TDS (2110, 2100, 2060, 3360, 6710, 5900)[b]
Little Kyger Creek		
3.0	2nd bridge crossing upst. Jericho Hill Road	pH (4.33, 4.63, 4.79, 3.96,5.11)[b] Nickel (239, 249, 256)[b,c] Zinc (481,435)[a]
1.6	Little Kyger Creek Road	pH (6.29, 4.97, 5.03, 4.85, 4.84)[b]
0.1	Upstream Gravel Hill Road	pH (5.98, 4.85, 5.58,5.4, 5.17)[b]

[a] Exceedance of aquatic life Outside Mixing Zone Maximum water quality criterion (below minimum for DO)

[b] Exceedance of aquatic life Outside Mixing Zone Average water quality criterion (below average for DO)

[c] Exceedance of Statewide water quality criteria for the protection of agricultural uses.

[d] Exceedance of Human Health Drinking Water criteria

***Table 6**. Summary statistics for select AMD inorganic water quality parameters sampled in Kyger Creek study area, 2008. The 90th percentile value from reference sites from the Western Allegheny Plateau ecoregion is shown for comparison[a]. Values above reference conditions or developed values are shaded in yellow.*

		Iron	Manganese	Conductivity	Sodium	Sulfate	Acidity[1]	Alkalinity[2]	Aluminum[3]
Units		µg/l	µg/l	umhos/cm	mg/l	mg/l	mg/l	mg/l	µg/l
Stream	River Mile	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Kyger Creek upst. SR 554	8.5	1025	874	405	9.3	96.9	<5.0	98.5	289
Kyger Creek @ ford off SR 554	8.14	681	966	516	10	170	<5.0	70.6	277
Kyger Creek upst. Stingy Run	5.1	619	1503	621	15.6	256	5.5	39.3	508
Kyger Creek at Roush Cemetery dst. Stingy Run	4.0	783	2442	2021	149	564	5.5	41.8	501
Kyger Creek dst Turkey Run	3.0	625	2504	1782	126	521	5.5	42.3	360
Kyger Creek dst. Little Kyger	1.0	763	3474	1570	90	506	6	32	494
Kyger Creek @ SR 7	0.5	579	748	946	51	333	<5.0	69.4	2220
Bell Lick Run	0.35	242	344	294	13	25.9	<5.0	118	256
Tributary to Kyger Creek at RM 10.98	0.1	365	207	337	6	52	<5.0	115	295
Tributary to Kyger Creek at RM 8.44	0.3	460	1991	654	9.8	265	<5.0	57	220
Jessie Creek	4.0	1095	835	471	7.3	170	5.4	47.3	613
Jessie Creek	0.1	687	3282	673	15	299	9.8	21.6	719
Stingy Run	0.2	4605	3041	840	37	329	6.6	43.6	2713
Turkey Run	0.8	911	8382	843	8.8	430	32.0	<5.0	4260
Turkey Run	0.4	647	4638	4312	214	752	7.2	19.6	711
Little Kyger Creek	3.0	803	10,850	1084	9.8	634	58.4	<5.0	8622
Little Kyger Creek	1.6	668	9904	1011	10	582	30.9	5.4	3650
Little Kyger Creek	0.1	1055	10,124	937	11.2	499	20.2	8.7	929
Reference Values[a]		2494	1230	750	21.5	622	-67	67	750

1 A net acidity of -67 mg/l was developed in the Sunday Creek TMDL (OEPA, 2005) to help determine the WWH use designation.

2 Minimum of 67 mg/l of alkalinity was developed in the Sunday Creek TMDL (OEPA, 2005) to help determine the WWH use designation.

3 U.S. EPA maximum criterion.

***Table 7**. Summary statistics for select nutrient water quality parameters sampled in the Kyger Creek study area, 2008. The 90th percentile value from reference sites from the Western Allegheny Plateau ecoregion is shown for comparison[a]. Values above reference conditions are shaded in yellow.*

		Ammonia—N (mg/l)	Nitrate+Nitrite-N (mg/l)	Phosphorus-T (mg/l)
Stream	River Mile	Mean	Mean	Mean
Kyger Creek upst. SR 554	8.5	<0.05	<0.10	0.025
Kyger Creek @ ford off SR 554	8.14	0.05	<0.10	0.014
Kyger Creek upst. Stingy Run	5.1	0.065	0.126	0.01
Kyger Creek at Roush Cemetery dst. Stingy Run	4.0	0.176	0.288	0.036
Kyger Creek dst Turkey Run	3.0	0.08	0.336	0.017
Kyger Creek dst. Little Kyger	1.0	<0.05	0.254	0.014
Kyger Creek @ SR 7	0.5	0.141	0.70	0.164
Tributary to Kyger Creek at RM 10.98	0.1	<0.05	0.103	0.012
Bell Lick Run	0.35	<0.05	0.108	0.012
Tributary to Kyger Creek at RM 8.44	0.3	0.05	0.136	0.019
Jessie Creek	4.0	<0.05	0.108	0.03
Jessie Creek	0.1	0.053	0.118	<0.01
Stingy Run	0.2	0.061	0.218	0.039
Turkey Run	0.8	0.187	0.156	<0.01
Turkey Run	0.4	1.05	0.25	<0.010
Little Kyger Creek	3.0	0.056	0.12	0.04
Little Kyger Creek	1.6	0.084	0.116	<0.01
Little Kyger Creek	0.1	0.056	0.10	<0.01
Reference Values[a]		0.060 (Headwater) 0.060 (Wading)	0.606 (Headwater) 1.054 (Wading)	0.090 (Headwater) 0.110 (Wading)

Recreational Use

Water quality criteria for determining attainment of recreation uses are established in the Ohio Water Quality Standards (Table 7-13 in OAC 3745-1-07) based upon the presence or absence of bacteria indicators (*Escherichia coli*) in the water column.

Escherichia coli (*E. coli*) bacteria are microscopic organisms that are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals. *E. coli* typically comprises approximately 97 percent of the organisms found in the fecal coliform bacteria of human feces (Dufour, 1977). However, 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 practicable. These microorganisms can enter water bodies where there is a direct discharge of human and animal wastes, or may enter water bodies along with runoff from soils where these wastes have been deposited.

Pathogenic (disease causing) organisms are typically present in the environment in such small amounts that it is impractical to monitor them directly. Fecal 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 source or another. Swimming or other recreational-based contact with water having a high fecal coliform or *E. coli* count may result in ear, nose, and throat infections, as well as stomach upsets, skin rashes, and diarrhea. Young children, the elderly, and those with depressed immune systems are most susceptible to infection.

The Kyger Creek basin is designated as a Primary Contact Recreation (PCR) use in OAC 3745-1-16. Water bodies with a designated recreational use of PCR "….are waters that, during the recreation season, 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)]. The recreational use water quality criteria applicable to the Kyger Creek basin are reported in Table 7-13 of OAC 3745-1-07. There are three classes of PCR use to reflect differences in the potential frequency and intensity of use. Streams designated PCR Class A typically have identified public access points and support primary contact recreation. Streams designated PCR Class B support, or potentially support, occasional primary contact recreation activities. The Kyger Creek mainstem and all other streams assessed during this survey are designated Class B PCR waters. The *E. coli* criteria that apply to PCR Class B streams include a geometric mean of 161 cfu/100 ml, and a maximum value of 523 cfu/100 ml, respectively. The geometric mean is based on two or more samples and is used as the basis for determining attainment status when more than one sample is collected. The complete bacteria dataset is reported in Appendix B. Downloadable bacteria results are also available from the Ohio EPA GIS interactive maps at the following link: http://www.epa.ohio.gov/dsw/gis/index.aspx .

The results did not show any elevated levels of bacteria following two samples. There were no concentrated population locations within the sampling areas and farmland was very minimal. The most concentrated area was the small settlement of Kyger, along SR 554, adjacent Kyger Creek, which included approximately 20 homes. Samples bracketing Kyger at RMs 8.14 and 5.1 showed low bacteria counts at both locations. Therefore, no further samples were collected as a part of this study. Should bacterial/recreational concerns arise in the future, additional sampling may be initiated.

NPDES Permitted Facilities

Two NPDES permitted facilities discharge sanitary wastewater, industrial process water, and/or industrial storm water into the Kyger Creek watershed. Ohio Power-Gavin Electric Generating Station has outfalls on Kyger Creek and two of its tributaries, while Ohio Valley Electric Corporation (OVEC) Kyger Creek Electric Generating Station has one significant discharge to lower Kyger Creek. All other outfalls from the Kyger Creek facility discharge to the Ohio River or a fly ash pond.

Ohio Power-Gavin Electric Generating Station (Ohio EPA Permit # 0IB00006)
AEP-Gavin has outfalls located on Kyger Creek and two of its tributaries, Stingy Run and Turkey Run. Outfalls from Ohio Valley Electric Corporation (OVEC) are considered to be interactive with the AEP-Gavin Plant, located on the Ohio River.

There are discharges from the fly ash pond, the reclaim pond, the sewage treatment plant, and the FGD (flue gas desulfurization) dewatered sludge leachate systems. There are also several individual "non-contact" stormwater outfalls in the Coal Combustion Products area and landfill area, which are monitored when discharging. These stormwater outfalls will not be discussed as part of this report. The discharge from outfall 002 is from the sewage treatment plant that went in-line on October 1993. This discharge flows into the Ohio River. Outfalls 003, 004 and 005 are stormwater outfalls from various areas of the plant and discharge to the Ohio River. These discharges undergo no treatment. The outfall 006 is from the Reclaim Pond (Bottom Ash) that discharges to the Ohio River. These outfalls were not part of the 2008 Kyger Creek study, since they discharge directly into the Ohio River, and will not be discussed further.

Outfall 001 is from the fly ash pond and discharges to Stingy Run (RM 0.81). With the installation of the FGD system for scrubbers on both generating units 1 & 2, the fly ash handling system has been converted to a dry system. Fly ash is mixed with the FGD cake to stabilize it. It is then sent by the conveyor to the FGD landfill. All of the flow at outfall 001 is now due to runoff from precipitation reaching the fly ash pond and watershed inputs. Treatment currently involves sedimentation, skimming and neutralization. Sodium hydroxide is being added at the discharge point to raise the pH of the water, which is reportedly low due to the acid mine drainage input from the surrounding area. Stingy Run, above this fly ash pond, is only surface water contribution, and is surrounded by previously mined areas. Above the pond, Stingy Run has intermittent flow, at best.

Outfall 007 is the FGD landfill surface water runoff and leachate treatment pond #1 discharge that flows to Turkey Run (RM 0.6), then into Kyger Creek (RM 3.45).

Outfall 008 is the FGD landfill surface water runoff and leachate treatment pond #2 discharge that flows to Kyger Creek (RM 4.2).

Outfall 009 is the FGD Landfill surface water runoff and leachate treatment pond #3 discharge. This outfall flows to a ditch that leads to Kyger Creek at RM 4.6.

Treatment for outfalls 007, 008 and 009 involves sedimentation and neutralization. Following this process, the water is discharged to the respective receiving streams.

Ohio EPA conducted bioassays in July 2006 on the AEP-Gavin 001 and 008 effluents. Outfall 001 was acutely toxic to *Ceriodaphnia dubia* as mortality ranged from 95% to 100% in each sample (i.e., Day 1 grab, Day 2 grab, Composite). In contrast, fathead minnow (*Pimephales promelas*) mortality was only 5% in the first day grab and effluent composite samples. No other minnow mortality was noted. Outfall 008 effluents were acutely toxic to both test organisms with 100% mortality in all effluents tested. Within the 008 manual mixing zone, Ceriodaphnia mortality was 10% and a single fathead minnow died. Results for March 2011 WET testing for Kyger Creek Outfall 005 indicated no evidence of acute toxicity. There was slight toxicity (10% mortality) to *C. dubia* in upstream dilution water and 5% mortality in the mixing zone sample. No other mortality was noted in the effluents.

Ohio Valley Electric Company-Kyger Creek Electric Generating Station (OVEC) (Ohio EPA Permit # 0IB00005)

The facility is located on State Route 7, near Cheshire, in Addison Twp., Gallia County, Ohio. Previously, it has wastewater discharges authorized under NPDES permit 0IB00005*MD, with the effective date January 1, 2008, and expiration date June 30, 2008. While this permit expired prior to the beginning of the sampling period, old limits remained in effect until a new permit was developed. The current NPDES permit 0IB00005*ND has an effective date of July 1, 2009 and an expiration date of January 31, 2013.

The OVEC Electric Generating Station is currently undergoing the installation of a Flue Gas Desulfurization (FGD) system or “scrubber” system. A new wastewater stream or source referred to as the FGD chloride purge stream (CPS) will be created by operation of the FGD system. The chloride purge stream is a direct purge from the scrubber vessels. This wastewater source will be treated in a new wastewater treatment plant prior to being discharged to the existing fly ash pond treatment system (existing NPDES outfall 0IB00005005). The new wastewater treatment plant will be known as the FGD CPS wastewater treatment plant. The treatment system will have mercury removal equipment. It is intended to minimize the incremental pollutant loading from the existing fly ash pond Outfall 005. For the purposes of this report, 005 is the only significant discharge to the Kyger Creek basin. All other outfalls from the Kyger Creek facility discharge to the Ohio River or to the fly ash pond, and therefore, warrant no further discussions. Several interim, temporary discharges occurred to an unnamed tributary of Little Kyger Creek during the construction phase.

005 is the major process outfall from this facility, and discharges to Kyger Creek just about 0.2 miles downstream of the confluence of Little Kyger Creek, at RM 0.89. It receives waste from fly ash sluice water, boiler room sumps, miscellaneous low-volume wastewater, coal storage drainage, precipitator drainage sump water, and precipitation. The fly ash pond also receives the sewage treatment plant discharge and the chloride purge stream wastewater treatment system discharge.

Currently, an FGD sludge (also referred to as coal combustion product or CCP) landfill of approximately 100 acres with both a liner system and leachate collection system is under construction. Contact and noncontact runoff water in the FGD landfill area will be routed to a series of settling treatment ponds to be discharged to new NPDES outfalls. New wastewater treatment facilities are being constructed that will be associated with the scrubber installation. This project is scheduled for completion in early 2012.

Ohio EPA bioassay results from the OVEC Plant are as follows: outfall 005 effluents were not acutely toxic to either *C. dubia* or *P. promelas* in April 2006. Minor mortality was noted in the effluent grab samples from both the first and second days of testing. Results from an April 2011 test are not yet available.

Fish Kill on Kyger Creek-July 2009

A fish kill occurred as a result of an ammonia release at the Ohio Valley Electric Company plant in late July 2009, one year after the initial Ohio EPA survey. A solution of ammonia was drained from the recycle tank to the fly ash pond due to high levels in the tank. This, in turn, discharged from the fly ash pond, through permitted outfall 005, to Kyger Creek. Plant personnel believe the solution short-circuited within the pond due to an elevated amount of solids, rather than mixing with the pond contents, and discharged directly through the outfall. On Monday morning, OVEC personnel noted several dead fish in the pond and took precautions to discontinue the excess disposal of ammonia and added stop logs at the discharge. Ohio EPA received a phone call later that day from an anonymous person, noting dead fish in Kyger Creek. Ohio DNR responded to the kill, notifying Ohio EPA of the results. Dead fish were apparent downstream from the fly ash pond discharge to the Ohio River, but nothing was noted above the discharge. Samples were collected at the 005 outfall, upstream of the outfall just above any influence of the discharge, and downstream of the outfall, approximately 500 feet downstream of the FGD beltline crossing of Kyger Creek.

Ohio DNR counted nearly 5,000 dead fish, including carp, channel and flathead catfish, drum, shad, suckers, and sunfish. Discussions between Ohio EPA and the facility are presently underway concerning the release and fish kill.

Sampling conducted on July 28 showed elevated levels of ammonia and TKN in the 005 discharge and downstream sampling location, but low or below detection limits above the outfall (Table 8). Ammonia was approximately 10 times the Water Quality Standards, based on temperature and pH (from Table 7-2 of OAC 3745-1-07). The subsequent samples, taken on August 5, showed indication of recovery as the discharge at 005 had dropped significantly in levels of ammonia and TKN.

Table 8. Chemistry results following the fish kill on Kyger Creek. All units are in mg/l.

Parameter/location	Kyger Creek upst. 005	OVEC 005 outfall	Kyger Creek dst. 005
July 28, 2009	Results/limits[1]	Results/limits[2]	Results/limits[1]
Ammonia	<0.05/13.0	13.2/-	11.7/1.7
Nitrate-nitrite	0.24/1.054	0.98/-	0.88/ 1.054
Total Kjeldahl nitrogen	0.53/-	29.1/-	23.1/-
August 5, 2009			
Ammonia	<0.05/12.6	2.19/-	1.52/10.7
Nitrate-nitrite	0.19/1.054	1.63/-	5.22/1.054
Total Kjeldahl nitrogen	0.50/-	4.37/-	3.34/-

[1]Ammonia limits based on Water Quality Standards and nitrate-nitrite based on 90th % for ecoregion

[2] There are no NPDES limits for these parameters

Sediment Quality

Surficial sediment samples were collected at seven locations in the Kyger Creek basin in September, 2008. Four sites were located on Kyger Creek while the remaining samples were taken from Little Kyger Creek, Jessie Run, and Turkey Run. The sediments were analyzed for metals, semi-volatile organics, organochlorinated pesticides, PCB's and particle size (Appendix C). Sediment data were evaluated using Ohio Sediment Reference Values (Ohio EPA 2003), along with guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald *et.al*. 2000), and *Ecological Screening Levels (ESLs)* (USEPA 2003). The consensus-based sediment guidelines define two levels of ecotoxic effects. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed. ESL values, considered protective benchmarks, were derived by USEPA, Region 5 using a variety of sources and methods. Exceedences of the values contained in the reference documents cited above are highlighted in Appendix C.

Sediment samples were conservatively sampled by focusing on depositional areas of fine grain material (silts and clays). These areas typically are represented by higher contaminant levels, compared to coarse sands and gravels. Fine grained depositional areas were not a predominant substrate type at all sites; however, fine substrates were commonly found along the stream margins.

Metals were notably above the values in the SQG/TEC level and reference values criteria at Kyger Creek downstream Little Kyger Creek and Kyger Creek at SR 7. Little Kyger Creek and Turkey Run both exceeded SQG values for arsenic, while Jessie Creek exceeded the SQG for nickel. An arsenic concentration of 41.5 mg/kg at Kyger

Creek RM 1.0, downstream Little Kyger Creek, was the only metal that exceeded PEC guidelines (33 mg/kg).

Organic parameters were all below detectable limits, with the exception of phenanthrene (0.63 mg/kg) at Kyger Creek upstream Stingy Run (RM 4.0) and bis(2-ethylhelxy)phthalate (0.93 mg/kg) at Kyger Creek downstream from Little Kyger Creek (RM 1.0). The source(s) of these parameters are unknown. PCB compounds analyzed were all below detectable limits.

PHYSICAL HABITAT

Stream habitat was evaluated at 17 fish sampling locations (Table 9). QHEI scores and a breakdown of warmwater habitat and modified habitat attributes documented for each site are provided in Table 10. The ten sites on the mainstem of Kyger Creek and Little Kyger Creek ranged in habitat quality from fair to good. In contrast some of the small tributaries displayed habitat ranging in quality from fair to poor. A discussion of habitat quality and it's potential for impacting instream biological community performance is provided below proceeding from the headwaters to the mouth of Kyger Creek.

Bell Lick Run and the Kyger Creek tributary at RM 8.44

These two small tributaries at the very headwaters of Kyger Creek had fairly similar QHEIs, in the fair range. In this range of scores a closer analysis of habitat attributes is necessary to accurately determine these streams' potential for supporting aquatic life. Bell Lick Run possessed only one high influence (or strongly negative) modified habitat attribute – sparse cover. The surplus of sand and silt clogging the stream channel contributed to the slightly lowered QHEI score. The Tributary to Kyger Creek at RM 8.44 had two high influence modified habitat attributes - sparse cover and inadequate pool depth. The downstream half of the zone had been relocated to accommodate the construction of the adjacent roadway and the channel was constrained into a fairly straight course. The increased gradient associated with the shortened channel has resulted in the bed being scoured down to bedrock. Regardless these tributaries possessed habitat capable of supporting marginal WWH fish communities.

Jessie Creek

Two sites were sampled on Jessie Creek. Habitat quality at the two sites was markedly different with the upstream site RM 4.0 at Ward Road almost in the good range and the site at RM 0.1, upstream from SR 554 in the poor range. The upstream site possessed many positive habitat attributes including a moderate amount of a variety of instream cover types, moderate sinuosity and good development. Sand, which appeared to have mainly originated from upstream, was overwhelming the natural substrates increasing the extensiveness of overall and riffle/run embeddedness and lowering pool volumes. This had the consequence of marginally lowering the QHEI score.

The lower site in contrast was a stream channel in the process of recovering from channelization. Reshaping of the stream channel had left its cross section as a uniform flat bottomed U. All evidence of the type and character of the original stream substrates were masked by the overlying bedload of sand which currently clogs the stream channel.

Stingy Run

Stingy Run is a straight incised ditch that largely follows the alignment of the adjacent roadbed. The substrate was primarily sand with lesser amounts of clayey silts and fine gravel. The monotony of the instream habitat resulted in the poor QHEI score of 40. Four high influence modified habitat attributes including channelization, no sinuosity, sparse cover and shallow depths and five additional moderate influence modified habitat attributes document that this small stream is not suitable for supporting warmwater habitat aquatic communities.

Turkey Run

Two sites were sampled on Turkey Run to bracket the Gavin 007 outfall. Habitat ranged from poor to barely into the fair range. The upstream site although not channelized had low sinuosity, sparse cover and shallow residual pool volumes. The stream channel was so clogged with fine sand that from the top of the bank it looked like silt. The stream bed was fairly uniformly blanketed by this loose and unconsolidated material that it effectively masked any available habitat. The downstream site possessed a more natural meander pattern and consequently was marginally better in handling the massive sediment bedload. The mean QHEI for the two sites was 46.5 and with enough negative habitat attributes to not be able to support warmwater habitat communities.

Kyger Creek

The mean QHEI of the mainstem was 60.1. Stream segments that exhibit QHEI scores in this range typically can support WWH instream biological communities in the absence of other water quality impacts. The majority of the sites on the mainstem had a predominance of WWH attributes including good substrates, moderate sinuosity, moderate amounts of instream cover, good ranges of current velocities owing to its relatively steep stream bed slope and deep pools. Deep pools are important stream features to protect biological communities during the winter months and periods of drought. This is not to suggest that there aren't issues on the mainstem. Stream relocation activities at a couple of the sites coupled with resource extraction over large portions of the watershed and the constructions of several massive landfills has yielded a higher than normal bedload of sand and silt to the stream channel. This has lowered the amount of cover available, lowered the stream development, increased the silt cover and resulted in moderate to extensive riffle and overall embeddedness. ODNR – Division of Resource Management in recognition of this problem and its potential to result in roadway flooding constructed a two-stage channel (approximately 3,000 linear feet) allowing the stream access to its floodplain adjacent to SR 554. Six rock cross vanes and two rock J-hook vanes were also installed in Kyger Creek as part of the project. The cross vanes and J-hook vanes redirect flow away from the stream banks, which helps reduce erosion along the road embankments. In addition, they may create a diversity of instream habitat structure as scour pools are created and the vanes act as rifle/run areas (Flowers, pers. comm.).

Little Kyger Creek

The mean QHEI of Little Kyger Creek was 67.2 which puts it in the ranges of scores capable of supporting WWH communities. The upstream sampling site was split between two distinct types of habitat. The upstream half of the sampling zone had been straightened to permit the construction of Little Kyger Creek Road and yielded ditch-like characteristics. The downstream end of the zone meandered through an area of forested wetlands and yielded a marginally good QHEI of 56.5. In contrast, the other two downstream sites possessed much higher quality instream habitat with a moderately meandering watercourse and good development. Sand bedload contributed from sources upstream have reduced pool volumes and covered natural stream substrates reducing what normally would have been an extremely high habitat quality stream to one with average quality.

Table 9. Stream physical habitat (QHEI) summarized results for the Kyger Creek basin2008.

STREAM	RIVER MILE	DRAIN. AREA (Mi^2)	LOCATION	QHEI	COMMENTS
Kyger Creek	8.50	6.1	1.5 mile downstream Bell Lick Run, adjacent Van Zant Road	66.0	High sand bedload
Kyger Creek	8.42	6.8	Upstream Kyger at State Route 554	53.5	High sand bedload
Kyger Creek	4.80	17.3	Near Kyger, upstream. confluence of Stingy Run	52.0	High sand bedload
Kyger Creek	4.00	20.3	Near Cheshire, upstream Roush cemetery, downstream AEP 008	64.0	High sand bedload
Kyger Creek	3.40	22.5	1 mile west of Cheshire at Gravel Hill Road	62.5	High sand bedload
Kyger Creek	1.00	30.1	Near Addison, upstream power plant, downstream Little Kyger Creek	57.0	High sand bedload
Kyger Creek	0.60	30.7	Addison at State Route 7	66.0	High sand bedload
Bell Lick Run	0.35	1.6	Ward Road at mouth.	56.0	High sand bedload and sparse instream cover
Tributary to Kyger Creek (RM 8.44)	0.30	4.5	Adjacent State Route 554 at abandoned road	54.0	High sand bedload and sparse instream cover
Jessie Creek	4.00	0.9	2.3 miles south of Langsville at Ward Road	59.0	High sand bedload
Jessie Creek	0.01	3.3	1 mile east of Kyger at mouth	41.0	High sand bedload and recovering from channelization
Stingy Run	0.20	0.6	near mouth at Stingy Run rd.	40.0	Incised and channelized
Turkey Run	0.95	1.1	Near mouth at Turkey Run Road	44.5	High sand bedload
Turkey Run	0.40	1.6	Near mouth at footbridge near McCarty cemetery	49.0	High sand bedload
Little Kyger Creek	3.00	1.2	Jericho Hill Road (2nd crossing upstream)	56.5	Historically channelized
Little Kyger Creek	1.60	2.7	Adjacent Little Kyger Creek Road	72.0	High sand bedload
Little Kyger Creek	0.01	5.8	2 mile north of Addison at mouth	73.0	High sand bedload

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

Kyger Creek basin QHEI scores from 2008.

Key QHEI Components

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-Normal Riffle Embeddedness	Total WWH Attributes	MWH Attributes, High Influence: Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW)	Total H.I. MWH Attributes	MWH Attributes, Moderate Influence: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(09-047) Trib. to Kyger Creek (RM 8.44)																																			
Year: 2008																																			
0.3	54.0	22.22	■			■			■				3			◆	◆	◆	3		●			●					●	●		4	1.00	2.00
(09-057) Kyger Creek																																			
Year: 2008																																			
8.5	66.0	9.22	■			■	■	■	■		■		6						0		●								●	●		3	0.14	0.57
8.1	53.5	9.22					■	■	■		■		4			◆	◆		2	●	●			●					●	●		5	0.60	1.60
5.1	52.0	5.75						■	■		■		3	◆		◆	◆		3		●			●					●	●		4	1.00	2.00
4.0	64.0	5.75				■	■	■	■		■		5	◆					1	●	●								●	●		4	0.33	1.00
3.0	62.5	8.23	■			■	■		■		■		5				◆		1		●			●	●				●	●		5	0.33	1.17
1.0	57.0	1.33	■			■	■	■	■		■		6				◆		1		●			●	●				●		●	5	0.29	1.00
0.5	66.0	1.33	■	■			■	■	■		■		6						0		●			●	●				●	●		5	0.14	0.86
(09-058) Little Kyger Creek																																			
Year: 2008																																			
3.0	56.5	33.33	■	■		■			■		■		5	◆		◆	◆		3		●			●					●	●		4	0.67	1.33
1.6	72.0	29.41	■			■	■	■	■		■		6						0		●								●	●		3	0.14	0.57
0.1	73.0	16.81	■			■	■	■	■		■		6						0		●								●	●		3	0.14	0.57
(09-059) Turkey Run																																			
Year: 2008																																			
0.8	44.5	31.75	■						■				2			◆	◆	◆	3		●			●					●	●		4	1.33	2.67
0.4	49.0	50.00	■			■	■		■		■		5				◆		1		●		●	●					●	●		5	0.33	1.17
(09-060) Stingy Run																																			
Year: 2008																																			
0.2	40.0	13.61							■				1	◆		◆	◆	◆	4		●			●		●			●	●		5	2.50	5.00
(09-061) Jessie Creek																																			
Year: 2008																																			
4.0	59.0	46.51	■			■	■	■	■		■		6						0		●								●	●		3	0.14	0.57
0.1	41.0	16.53							■				1			◆	◆	◆	3	●	●			●					●	●		5	2.00	4.50
(09-062) Bell Lick Run																																			
Year: 2008																																			
0.4	56.0	35.09	■			■	■	■			■		5				◆		1		●							●	●	●		4	0.33	1.00

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Table 10. QHEI WWH and MWH attributes for sites in the Kyger Creek study area, 2008.

FISH COMMUNITY

Fish communities of the Kyger Creek watershed were collected from 17 locations spanning a cumulative sampling distance of 2.07 km. A total of 635 individuals representing 28 species and 3 hybrids were collected in the Kyger Creek mainstem between June and September, 2008 (Appendix D). A comparison of fish community scores with QHEI scores, which ranks instream and riparian habitat quality, revealed that in general fish communities did not perform to the potential inherent in the quality of the instream habitat present (Figure 5). Indeed, the highest fish community score was recorded at the site that received the lowest habitat evaluation. This observation strongly implicates water quality stresses as capping fish community performance.

Relative numbers and species collected per location are presented in Appendix D and IBI and MIwb scores are presented in Appendix E. Sampling locations were evaluated using biocriteria for the designated or recommended Warmwater Habitat and Modified Warmwater Habitat aquatic life uses and a performance target for the designated or recommended Limited Resource Water use. A summary of the fish data are presented in Table 11. Kyger Creek survey area biological and habitat data from 2008 are available on Ohio EPA interactive maps at the following link:
http://www.epa.ohio.gov/dsw/gis/index.aspx

Based on fish community performance and the current aquatic life use designations in the basin, the Kyger Creek survey area and results discussion were divided into two sections:

1) Upper Kyger Creek Basin: Headwaters, tributaries and mainstem to the Jessie Creek confluence at RM 8.0 (undesignated or designated WWH) and,

2) Lower Kyger Creek Basin: Kyger Creek mainstem and tributaries from Jessie Creek confluence at RM 8.0 to the Ohio River RM 0.0 (designated LRW).

Upper Kyger Creek Basin

Kyger Creek Mainstem

Fish sampling was conducted at a total of seven locations along the length of the Kyger Creek mainstem. The two upstream most sites (RM 8.5, upstream from State Route 554 and RM 8.1 at the ford off of State Route 554) were located in a stream segment that is currently designated as WWH. Neither of these sites performed at the WWH level. Both sites had poor fish community performance with IBIs of 22 and 19, respectively. Very few fish were collected at either site with pioneering species representing a significant portion of the catch. Habitat was judged adequate at the upstream site despite the presence of sand, silt and hardpan substrates. The site at RM 8.1 was recovering from channelization and consequently had simplified instream habitat. The sand and silt bed load was a more prominent habitat masking feature downstream. There were indications of acid mine impacts present in the stream bed at both sites. These indicators were more apparent downstream with a thin layer of sulfite deposits noticed on a significant percentage of the rocks in the zone.

Bell Lick Run

Bell Lick Run was sampled at RM 0.35 up and downstream from Ward Road. Despite possessing instream habitat that was marginally suitable for supporting WWH aquatic communities (i.e. QHEI = 56) Bell Lick Run yielded an IBI of 20, solidly in the poor range. An overwhelming majority of the fishes collected at the site were tolerant, pioneering species of fairly small size. This stream probably is subject to periodic water quality problems which prevent the establishment of a stable and diverse fish community. Water chemistry results confirm the diagnosis of episodic problems. Two of the dissolved oxygen values were at low enough concentrations (e.g., 2.82 mg/l on 9/10/8) to adversely affect aquatic life. The reddish brown precipitate noted on recently fallen leaves and the surface of the streambed on July 1, 2008 appeared to be deposits of iron compounds perhaps associated with other metal complexes. Water chemistry results again verified that there were periodic releases of elevated metals particularly manganese and aluminum.

Kyger Creek Trib @ RM 8.44

This very small unnamed tributary was sampled at RM 0.1 adjacent to State Route 554. Although instream habitat was not optimal for supporting WWH aquatic communities (i.e., QHEI of 54 and < target QHEI of 60) the total absence of fish was noteworthy and indicative of a severe water quality impact. Aluminum precipitate was noticed being discharged from a small tributary upstream from the bridge. A thin layer of yellowish “silt” had covered portions of the stream substrates. Coal fines and coal chunks were also noted. This evidence points to the source of origin of the water quality impact as being related to coal mining. Instream water chemistry results did not reveal any levels significantly beyond regional expectations. This water chemistry problem also appears to be episodic in nature.

<u>Lower Kyger Creek Basin</u>

The lower reaches of the Kyger Creek basin included the mainstem and tributaries downstream from Jessie Creek (RM 7.2); all are currently designated LRW. Although the upper watershed was impacted, the lower basin was significantly more degraded. Impacts were considered primarily the result of acid mine drainage (particularly in tributaries), excessive sedimentation, and a series of large industrial point source discharges along Kyger Creek.

Kyger Creek Mainstem

The stream segment from Jessie Creek downstream to the mouth is currently designated Limited Resource Water based on previous intensive survey results. But ODNR – DMRM has devoted considerable effort and resources to reclaim abandoned mine land and stream projects to provide stream access to the active flood plain and permit side casting of stream bed sediments. In 2008 the fish community was rated as fair downstream from Jessie Run. The other four sites yielded either poor or very poor scores. Habitat potential for these five sites based on the segment mean QHEI of 60.3

suggest the physical ability to support WWH aquatic communities. Clearly water quality problems are the major source of impairment to the degraded fish communities.

To better understand the ability of streams in the vicinity of Kyger Creek to support aquatic life, an inspection was made of sampling results from the adjacent Campaign Creek watershed. Sampling at a site in 1993 of comparable drainage area and similar habitat quality yielded fish communities in the fair range. At the time of the survey it was thought that sedimentation from non-acidic mine drainage was preventing higher scores. Regardless fish communities were performing at a higher level just one watershed away supporting the contention that water chemistry problems were contributing additional stress and further driving down the integrity of the aquatic communities.

Lower Kyger Creek Basin Tributaries

Mine drainage impacts were severe in the three major tributaries within this reach; Jessie Creek, Turkey Run, and Little Kyger Creek. Fish community health was considered “Very Poor” at all seven sampling sites within these tributaries. Stream substrates were almost uniformly composed of unstable iron-stained sands, coal fines and acid-mine precipitate (*i.e.,* yellow-boy), yielding population densities that were consistently extremely low.

Jessie Creek

Jessie Creek was sampled at two locations: RM 4.0, adjacent to Jessie Creek Road and RM 0.1, upstream from State Route 554. No fish were present at the upstream site. Clearly this site was subject to severe water quality impacts. It is now very rare to encounter sites with no fish, particularly when the habitat present is judged high enough in quality to support WWH aquatic communities (i.e., QHEI = 59). Typically, only sites subject to acidic mine runoff or sites immediately downstream from a significant chemical spill yield no fish. There were also physical indications that this site was downstream from strip mining activities. A substantial sand bedload had decreased pool volume and was smothering coarser substrates in the riffles.

The downstream site was sampled twice and on the first occasion yielded only 11 small creek chubs leading to a very poor IBI of 12. The subsequent sampling yielded several more species (i.e. a total of nine), but they were small individuals and of predominantly tolerant and pioneering species, yielding a poor IBI of 24 and an average IBI of 18. The origin of most of these fish was probably Kyger Creek, given its close proximity. A combination of episodic water quality problems and habitat impairments including channelization and extensive sand bedload associated with strip mine runoff led to the depauperate fish community documented at the lower site on Jessie Creek.

Stingy Run

Stingy Run was sampled at RM 0.2, adjacent to Stingy Run Road and downstream from the outfall of the 300 acre fly ash disposal landfill. Habitat quality was an issue for the fish community in this small stream. Stingy Run, where sampled, had been channelized in the past and been converted to a ditch trapped between the road side and a wetland used to treat leachate/effluent from the fly ash disposal landfill. This habitat disruption yielded a QHEI of 40, narratively in the poor range. Absent any water quality problems, biological communities would still be expected to perform at less than Clean Water Act goal levels. The fish community did far worse performing in the poor to very poor range. Clearly water quality impacts emanating from the fly ash landfill were a significant contributor to the measured impairment. Grab water chemistry samples collected in early October, 2008 yielded very high concentrations of aluminum and iron.

Turkey Run

Turkey Run was sampled at two locations: RM 0.8 upstream from the Turkey Run Road bridge and RM 0.4, adjacent to the McCarty Cemetery. Fish communities at both sites were severely impaired yielding IBIs of 12, the lowest possible IBI score. Although impaired habitat was a contributing factor with both sites having QHEIs in the fair to poor range, deficient habitat alone was not sufficient to explain the extremely poor scores. The choking of the stream channel with sand suggests strip mine impacts, and the water chemistry data indicate acid mine drainage.

Little Kyger Creek

Little Kyger Creek was sampled in three locations: RM 3.0 - up and downstream from Little Kyger Creek Road, RM 1.6 - up and downstream from Little Kyger Creek Road, and RM 0.1 – near the mouth. Neither of the upstream sites supported any fish. The site at RM 1.6 was resampled in September to verify the absence of fish to the same result, documenting the severity of the water quality problems in the upper subwatershed. The site at the mouth, although not devoid of fish, only produced three and five species of fish during its two samplings, respectively. The tolerant and pioneering biased composition of the fish community coupled with the very low numbers of fish collected yielded very poor IBIs of 12. Ironically, the quality of the instream habitat suggested that this small stream should have been capable of supporting WWH aquatic communities. Clearly the impacts to the fish communities were associated with water chemistry problems.

TRENDS

Biological communities have been sampled in the Kyger Creek watershed several times over the course of the last 26 years. The Ohio EPA first sampled Kyger Creek in 1982 at the behest of American Electric Power. Subsequent samplings have occurred in 1990 and most recently in 2008. Consultants for American Electric Power sampled portions of the watershed in 2003. Unfortunately, exact sampling locations were not replicated over the years making direct one-to-one comparisons difficult. However, generalizations can be made about portions of the watershed based on the results presented in Appendix F.

The 1982 sampling was conducted well outside the normal Ohio EPA sampling index period, in mid-November. That late in the year many fish have moved into deeper water to overwinter and due to the colder water temperatures are slower to respond to the effects of electrofishing. Despite these shortcomings some general statements can be made about those sampling results. Notes taken on the field data sheets provided strong indications that the water chemistry regime and habitat in Kyger Creek in 1982 was different than that encountered in the most recent sampling. Beaver dams had partially impounded the upper site and coupled with the fine sediments and nutrient enriched conditions yielded a poor fish community. All sites downstream had noticeable physical manifestations of acid mine runoff including yellow boy in backwater areas and loose iron stained sands. Index scores along the length of Kyger Creek revealed almost uniformly very poor fish communities with marginally higher scores at the very headwaters and the mouth.

Little, if any, improvement over time is noted in the fish community scores of tributary streams including Little Kyger Creek, Turkey Run, Stingy Run, Jessie Creek, and Bell Lick Run. While the sampling conducted in 1982 was completed with seines rather than electrofishing gear, the poor fish community results have been consistent over time. Little Kyger Creek, Turkey Run, Stingy Run and Jessie Creek are designated LRW and the very poor to poor fish community results over time reflect the long-term, detrimental effects of coal mining on water quality in these streams. The poor fish community of Bell Lick Run, a WWH designated stream, reflects the ongoing issues associated with historical coal mining and livestock access to the stream.

Table 11. Fish community summaries based on pulsed D.C. electrofishing sampling conducted by Ohio EPA in the Kyger Creek survey area, 2008. Relative numbers and weight are per 0.3 km for wading and headwater sites.

LOCATION	STORET (RM)[A]	DRAIN. (MI^2)	Total Fish Species	Relative Number	Relative Weight	IBI	MIWB[B]	ICI[C]	QHEI	Narrative Evaluation
Kyger Creek (09-057-000)	**WWH EXISTING**									
Kyger Creek - 1.5 mile downstream Bell Lick Run, adjacent Van Zant Road	W03K06 (8.5)[H]	6.1	6	30	N/A	22*	N/A	F*	66.0	Poor
Kyger Creek - Upstream Kyger at State Route 554	W03S13 (8.42)[H]	6.8	12	140	N/A	19*	N/A	G(G)[E]	53.5	Poor
Kyger Creek (09-057-000)	**LRW Existing**									
Kyger Creek - Near Kyger, upstream. confluence of Stingy Run	W03S03 (4.8)[H]	17.3	18	101	N/A	30	N/A	F	52.0	Fair
Kyger Creek - Near Cheshire, upstream Roush cemetery, downstream AEP 008	300593 (4.0)[W]	20.3	12	88	1.47	15*	4.0*	34 (P)[E]	64.0	Very Poor
Kyger Creek - 1 mile west of Cheshire at Gravel Hill Road	W03P48 (3.4)[W]	22.5	11	73	0.41	22	3.8*	28 (MG)[E]	62.5	Very Poor
Kyger Creek - Near Addison, upstream power plant, downstream Little Kyger Creek	W03S26 (1.0)[W]	30.1	8	59	2.42	22	5.1	14	57.0	Very Poor
Kyger Creek - Addison at State Route 7	W03S01 (0.6)[W]	30.7	13	113.57	5.75	17*	5.2	18	66.0	Very Poor
Bell Lick Run (09-062-000)	**WWH Existing**									
Bell Lick Run - Ward Road at mouth	W03S15 (0.35)[H]	1.6	6	48	N/A	20*	N/A	MG[NS]	56.0	Poor
Tributary to Kyger Creek at RM 8.44 (09-057-002)	**MWH Recommended**									
Tributary to Kyger Creek (RM 8.44) - Adjacent State Route 554 at abandoned road	300530 (0.3)[H]	4.5	0	0	N/A	12*	N/A	F*	54.0	Very Poor
Jessie Creek (09-061-000)	**LRW EXISTING**									
Jessie Creek - 2.3 miles south of Langsville at Ward Road	300526 (4.0)[H]	0.9	0	0	N/A	12*	N/A	VP*	59.0	Very Poor
Jessie Creek - 1 mile east of Kyger at mouth	W03P52 (0.01)[H]	3.3	9	90	N/A	18	N/A	VP*	41.0	Very Poor
Stingy Run (09-060-000)	**LRW Existing**									
Stingy Run - near mouth at Stingy Run Road	300528 (0.2)[H]	0.6	7	76	N/A	18	N/A	P	40.0	Very Poor
Turkey Run (09-059-000)	**LRW EXISTING**									

LOCATION	STORET (RM)[A]	DRAIN. (MI²)	Total Fish Species	Relative Number	Relative Weight	IBI	MIWB[B]	ICI[C]	QHEI	Narrative Evaluation
Turkey Run - Near mouth at Turkey Run Road	W03S14 (0.95) [H]	1.1	0	0	N/A	12*	N/A	VP*	44.5	Very Poor
Turkey Run - Near mouth at footbridge near McCarty cemetery	300529 (0.4) [H]	1.6	1	4	N/A	12*	N/A	VP*	49.0	Very Poor
Little Kyger Creek (09-058-000)	**LRW Existing**									
Little Kyger Creek - Jericho Hill Road (2nd crossing upstream)	300527 (3.0) [H]	1.2	0	0	N/A	12*	N/A	P	56.5	Very Poor
Little Kyger Creek - Adjacent Little Kyger Creek Road	W03K07 (1.6) [H]	2.7	0	0	N/A	12*	N/A	VP*	72.0	Very Poor
Little Kyger Creek - 2 mile north of Addison at mouth	W03P51 (0.01) [H]	5.8	6	38	0.43	12*	N/A	VP*	73.0	Very Poor

A - River Mile (RM) represents the Point of Record (POR) for the station; the absolute location point (where actual sampling occurred) may be slightly different.

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.

E - First macroinvertebrate score is from sampling during July-August. Macroinvertebrate score in parentheses is from qualitative sampling in late September.

ns - Nonsignificant departure from EWH or WWH 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 for EWH or WWH). Underlined scores are in the Poor or Very Poor range.

H - Headwater site.

W - Wading site.

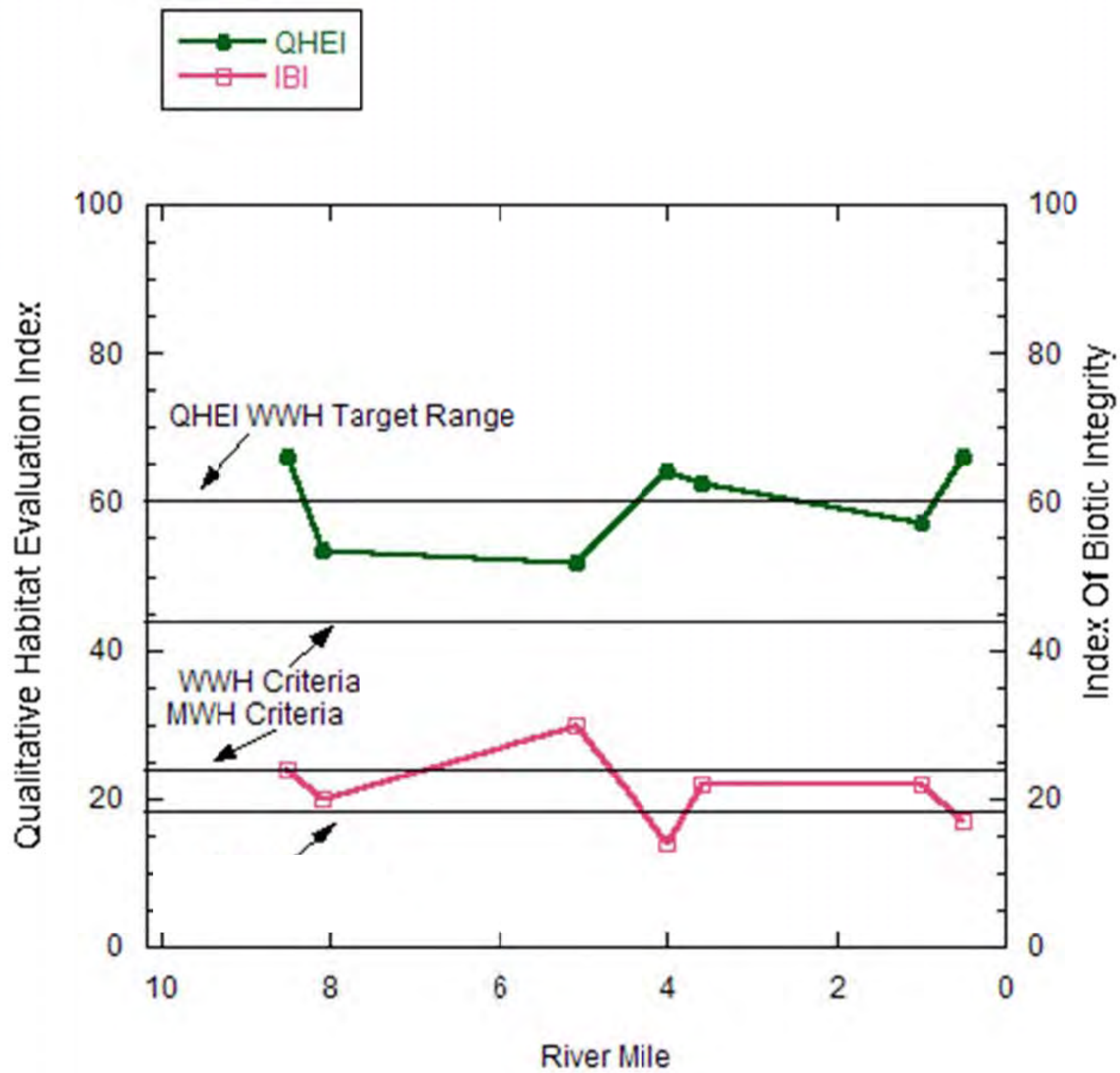

Figure 5. Kyger Creek IBI and QHEI scores from 2008. The fish community consistently underperforms the habitat available.

MACROINVERTEBRATE COMMUNITIES

Macroinvertebrate sampling within the Kyger Creek basin was conducted at 18 sites (Table 12). Artificial substrate samplers were retrieved from the four most downstream Kyger Creek locations between RMs 4.0 and 0.5 while qualitative sampling from the natural substrates was conducted at the remainder of sites. Artificial substrate data from RM 5.2 was invalidated after the samplers were discovered buried in sand. In addition, three Kyger Creek stations were resampled in late September at RMs 8.14, 4.0, and 3.0 to evaluate potential variation in quality over the summer. ICI metric scores and lists of all taxa found at each 2008 site can be found in Appendix G.

Based on macroinvertebrate quality and the current aquatic life use designations in the basin, the Kyger Creek survey area and results discussion can be divided into two sections:

1) Upper Kyger Creek basin: Headwaters and mainstem upstream from the Jessie Creek confluence at RM 8.0 (undesignated or designated WWH) and,

2) Lower Kyger Creek basin: Kyger Creek mainstem and tributaries from Jessie Creek to the Ohio River, (designated LRW).

Upper Kyger Creek Basin

In the upper Kyger Creek basin, stream channels were mostly natural or affected by past alteration associated with agriculture and mining. Adjacent land usage was primarily forest, rolling pasture, and wetland drainage with scattered sections of abandoned strip mine lands. The majority of mine lands were located within the Tributary to Kyger Creek (RM 8.44) drainage with additional disturbance along the north side of Kyger Creek, upstream from RM 8.5. Headwater tributaries were relatively high gradient, averaging 28.7 ft/mi. while the mainstem along the valley floor was more sluggish (9.22 ft/mi.).

Macroinvertebrate health at five stations in the upper drainage ranged from good (Kyger Creek RM 8.14) to fair (Kyger Creek RM 8.5, Unnamed Tributary at RM 8.44). Benthic communities at each site averaged 35 total taxa, 8 EPT (Ephemeroptera, Plecoptera, Trichoptera), and 10.5 pollution sensitive taxa. While regional expectations for these populations may vary with drainage and ecoregion, upper basin assemblages reflected performance levels that nearly or marginally met WWH (*i.e.*, *upper fair* to *lower good* ranges).

Besides reflecting only modest impacts from nonpoint sources, upper basin macroinvertebrate communities contained an average of two coldwater taxa. No sites reached the CWH (coldwater habitat) designation minimum of four but the widespread presence of these indicator species suggests an influx of ground-water and sustained stream flows. The presence of coldwater specimens in both early July and late September samples at Kyger Creek RM 8.14 suggests headwater flows were sustained throughout the summer.

At both fair quality sites, impairments appeared primarily related to siltation and sedimentation associated with channelization (*i.e.*, Kyger Creek RM 8.5) or mining (*i.e.*, Unnamed Tributary at RM 8.44). Kyger Creek RM 8.5 was located immediately upstream from the Unnamed Tributary at RM 8.44. Here the creek was silty, sluggish and historically channelized. Macroinvertebrates reflected the marginal conditions with only a modest number of EPT and sensitive species present (6 each). However, acidophilic populations were absent and the community was predominated by facultative and sensitive varieties of mayflies and caddisflies. In addition to historical channelization, unrestricted cattle access, wetland drainage, and abandoned mine lands were located upstream from the site. In the Unnamed Tributary at RM 8.44, a flocculent, white mine drainage discharge was observed a short distance upstream. However, the macroinvertebrate community included 7-8 EPT or pollution sensitive taxa and none of the populations surveyed were particularly acidophilic. Rather, the very low population densities and presence of deep, unstable sand substrates were more suggestive of non-acidic runoff and sedimentation.

Lower Kyger Creek Basin

The lower reaches of Kyger Creek basin included the mainstem and tributaries downstream from Jessie Creek (RM 7.2); all are currently designated LRW. In contrast to the upper watershed, the lower basin was significantly more degraded. Impacts were considered primarily the result of acid mine drainage (particularly in tributaries), excessive sedimentation, and a series of large industrial point source discharges along Kyger Creek.

Lower Kyger Creek Basin Tributaries

Mine drainage impacts were most severe in the three major tributaries within the reach; Jessie Creek, Turkey Run, and Little Kyger Creek. Community health was considered poor (Little Kyger Creek RM 3.0) or very poor at the seven tributary sampling sites. Stream substrates were almost uniformly composed of unstable iron-stained sands, coal fines and acid-mine precipitate (*i.e.,* yellow-boy), yielding population densities that were consistently and extremely low. Total taxa richness was also very low, averaging only 10 per site while EPT and sensitive taxa were virtually absent, accounting for only 0.3 and 0.6 taxa per site, respectively. In fact, mayflies and caddisflies were absent from all tributary samples except for the facultative, coldwater caddisfly, *Diplectrona modesta*, in the uppermost reaches of Little Kyger Creek. *Diplectrona* have been described as tolerant of iron precipitate and ph less than 5.0 (Earle and Callaghan, 1997).

Two acidophilic midge taxa, *Polypedilum (P) tritum* and *Polypedilum (P) sp 2*, were also found in each AMD impacted tributary. From Ohio EPA collection records, these species are considered strong AMD indicators and are rarely found in unimpacted stream segments. Occasional specimens were also found in lower Kyger Creek, immediately downstream from the acid impacted tributaries. In contrast, acidophilic taxa were virtually absent from stations in the upper basin.

Somewhat surprisingly, the most common organisms in the mine impacted tributaries were small, immature crayfish. The few considered large enough for identification were the facultative species, Cambarus (Cambarus) sp A (formerly, Cambarus (Bartonii) cavatus). A literature search regarding the crayfish and mine drainage found that the Ohio EPA collections were very similar to those encountered by Galloway and Humman (1991) in Big Four Creek, a moderately polluted mine drainage stream near Lake Hope in Vinton County Ohio. From the article, crayfish were historically considered quite sensitive to mine drainage by the prevailing literature (Warner, 1971, Ortman 1909, Francois 1959). However, juveniles from the impacted Big Four Creek sites were the most common organisms found, “entering the stream after spring rains have washed out acid that has accumulated in the soil”. This late spring, early summer migration period would match the Ohio EPA collections from early July. Galloway and Humman concluded the crayfish had a greater tolerance to higher conductivity levels and lower carbonate buffering capacity in the mine impacted segments. The more tolerant populations were considered either acclimated, or genetically adapted to higher levels of mine drainage pollution. The strong similarity between the Big Four Creek and Ohio EPA collections suggests a similar phenomenon may occur in the Kyger Creek basin.

In addition to obvious AMD impacts in the Turkey Run basin (Table 11), station RM 0.4 was immediately downstream from the Gavin 007 landfill leachate discharge at RM 0.6. Deposits of whitish, flocculent solids were observed in the margins and the water had a milky, blackish green cast not observed upstream. Sections of the sand substrates were blackened and concreted together, breaking off from the bottom in hard chunks. Despite the very poor and acidic conditions encountered upstream, population density and diversity appeared even lower downstream from the discharge.

Stingy Run is a small, ditched stream that receives discharge from the Gavin 001 fly ash reservoir at RM 0.81. Community health was considered poor but populations did not reflect the severe AMD impacts encountered in other, lower basin tributaries. Rather, the channel was largely covered with a thick layer of fine solids and those few organisms present were restricted to a riffle habitat where current limited sediment deposition. Riffle collections were predominated by the facultative, filter-feeding caddisflies, *Cheumatopsyche sp.* and *Hydropsyche depravata* group; both taxa are among the more tolerant varieties of Trichoptera and are often associated with moderate mine drainage impacts, elevated conductivity and TDS, and high suspended solids levels (Earle and Callaghan, 1997, Pond et.al, 2006, Wiggins 1996,).

Lower Kyger Creek (Jessie Creek to mouth)

Excessive sedimentation originating in the AMD impacted tributaries extended downstream into Kyger Creek; substrates in the lower reach were almost entirely composed of loose, iron-stained sands with coal fines and a thin, but pervasive layer of silt and yellow-boy precipitate. Localized deposits of coarse rubble or boulders were encountered at RM 4.0 and RM 3.0, and a large amount of rip-rap was deposited under the SR 7 Bridge at RM 0.5. However, these larger substrates were often embedded by sand and, in the case of RM 0.5, were caked with flocculent, grey solids. Substrates at RM 3.0 and RM 4.0 were often covered with a crusty layer of black sulfite-like mineral deposits, commonly observed in mine drainage streams. These encrusted substrates offered a very poor colonizing surface for macroinvertebrates (Figure 6). Under most circumstances, deployment of artificial substrate samplers tends to dampen the influence of sedimentation in collections, as the samplers are tied to a cinder block and suspended in the water column, above the stream bed.

Figure 6. A rubble substrate from Kyger Creek RM 4.0 covered with a black, sulfite-like crust. The site was downstream from Jessie Creek, Stingy Run and the Gavin 008 landfill leachate outfall.

Macroinvertebrate quality in the lower reaches of Kyger Creek reflected both longitudinal and temporal variability. ICI scores fell in the marginally good (34) to lower fair ranges (14) between Jessie Creek and the mouth and from marginally good to poor at RM 4.0, based on two sampling events in August and late September (Figure 7, Table 11). Lowest ICI scores were encountered at RM 1.0, immediately downstream from the AMD impacted Little Kyger Creek, and at RM 0.5, immediately downstream from the Kyger Creek 005 fly ash discharge at RM 0.89. In most instances, benthic community performance from lower Kyger Creek was below WWH standards but exceeded LRW criteria.

At most sites, artificial substrate community performance was marginally better than the qualitative collections, mostly attributable to the poor quality of the natural substrates, discussed above. However, even with the benefit of an introduced colonizing surface, artificial substrate populations were deficient compared to warmwater habitat expectations. Mayfly populations are particularly sensitive to mine drainage and TDS (Pond, et. al, 2006) and populations were virtually absent from lower Kyger Creek; the few taxa present were either facultative or tolerant varieties. Population densities were also considered abnormally low from artificial substrate samplers with an average of only 59 organisms per square foot. In contrast, densities from similar sized reference sites (20-50 mi^2) in the WAP ecoregion averaged over six times higher (369 orgs./ft^2; n=22). Closer to the Kyger Creek watershed, 1990 collections from the adjacent Campaign Creek basin scored in the exceptional range (ICI = 54) with 438 orgs./ft^2. Campaign Creek was not in reference condition and associated fish collections were in the fair range attributed to siltation from non-acidic mine drainage. Despite the background mining influence, macroinvertebrate community health and composition was markedly better compared to the point and nonpoint source impacted Kyger Creek.

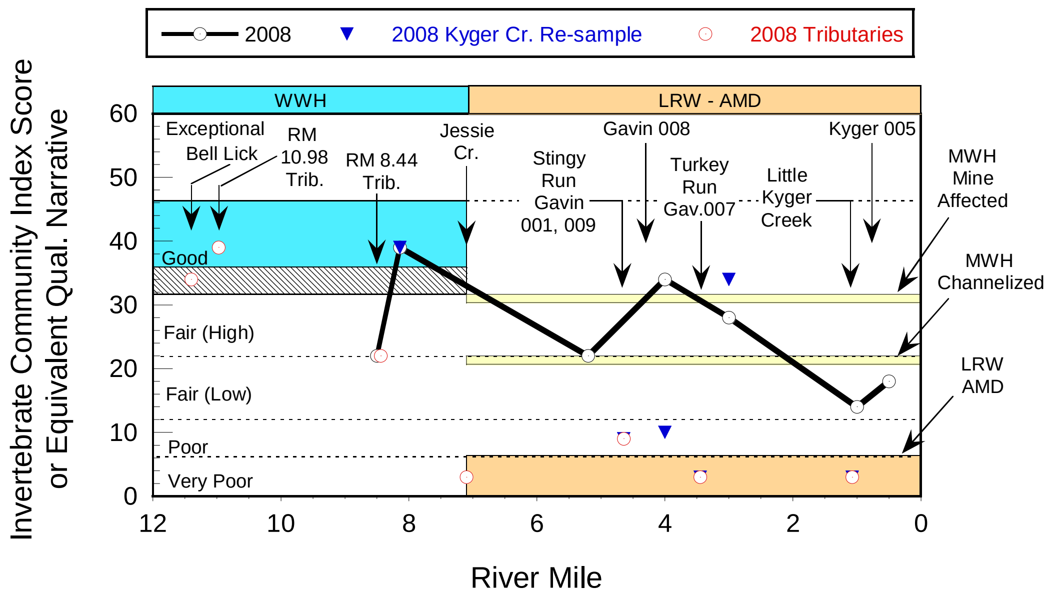

Figure 7. Macroinvertebrate community health and ICI scores from the Kyger Creek basin, 2008. Where only qualitative data were collected, an ICI score based on the narrative equivalent has been inserted.

Kyger Creek RM 5.2 was located downstream from Jessie Creek but upstream from Stingy Run and all other industrial point source discharges. The very low population densities and low taxa richness (19 taxa present) reflected fair performance and impacts associated with mine runoff and a heavy, shifting sand bedload. However, collections included three mayfly taxa, two of which are considered pollution sensitive. Their presence suggests water quality conditions were not *extremely* acidic or as severely impaired as in the tributaries.

Kyger Creek RM 4.0 was located downstream from the 001 fly ash discharge on Stingy Run (confluence RM 4.6) and the Gavin 008 landfill leachate outfall at RM 4.2. Initial sampling in August found an ICI score in the marginally good range but densities from both the natural and artificial substrate samples (49 orgs./ft^2) were extremely low. Natural substrates were highly embedded with a heavy bedload of iron-stained sand, coal fines and yellow boy with black sulfite-like deposits on the rocks (Figure 6). Still, most benthic populations were not strongly acidophilic; rather, communities were characterized by an abundance of mostly facultative taxa present in low numbers. Pollution sensitive populations (primarily midges) were most common on the artificial substrates but these taxa were usually represented by only one or two specimens. The marginally good ICI score (34) technically met minimum WWH criteria but it was obvious the reach was a very difficult environment for macroinvertebrates.

When re-sampled on September 24th, qualitative collections from RM 4.0 did not appear dramatically different from August (*i.e.,* low densities and diversity) but "midges" predominated each habitat. When the specimens were lab-identified, the bulk of individuals were *Goeldichironomus holoprasinus,* one of the most tolerant species in the Ohio EPA database. Out of 36 collection records for the midge, only 3 sites exceeded WWH and 23 were considered Poor or Very Poor. Upon further inspection, 27 of 36 sites were near a point source or anthropogenic type discharge (*e.g.,* WWTP outfalls, CSOs, urban sewers, septic tanks, waste lagoons, CAFOs, rendering operations, mining discharges, tailings ponds). In addition to *Goeldichironomus*, the number of tolerant taxa increased sharply, from 8 to 15, between the August and September sampling periods.

Goeldichironomus larvae prefer lentic habitats and "favour [sic] floating and drifting vegetation of small standing water bodies" (Wiederholm 1983). A web search describes nuisance control of this species in "shallow sewage oxidation ponds" (http://www.insects.ucr.edu/ebeling/ebel9-4.html#midges) and "In Florida, the larvae are abundant in small and large natural lakes, waste water channels, sewage oxidation and settling ponds, and residential-recreational lakes" (http://edis.ifas.ufl.edu/IG092). In Kyger Creek, the larvae have not been found in any other sample from the basin. The sudden and localized appearance of these uncommon stream inhabitants suggests a point source origin. The close proximity to the Gavin industrial waste treatment works makes the plant a probable source and points to a short-term, slug-type release or change in discharge characteristics immediately upstream.

Macroinvertebrates at Kyger Creek RM 3.0, downstream from Turkey Run and the Gavin 007 discharge, were in the marginally good to upper fair (ICI=28) ranges during two summer sampling events (Table 12). The site included a small section of comparatively good habitat immediately downstream from a series of galvanized steel culverts that lay across the stream on the Gavin Plant property (Figure 8). The pooled habitat behind the culverts seemed to blunt the severe, sand bedload movement, and the short, high gradient stretch immediately downstream resulted in a localized area of improved habitat. A total of 9 EPT and 13 sensitive taxa were found, numbers that approached the quality of collections in the upper mainstem. Artificial substrate densities remained comparatively low (100 orgs./ft^2) and typical of the lower Kyger Creek LRW stream reach. Overall, no obvious, additional impacts were detected downstream from mine drainage and the Gavin 007 discharge via Turkey Run.

ICI scores declined to the lower fair range at RMs 1.0 and 0.5 (14 and 18, respectively). Station RM 1.0 was immediately downstream from the acid mine impacted Little Kyger Creek and RM 0.5 was located 0.2 miles downstream from the Kyger Creek Plant Outfall 005 fly ash pond discharge. EPT and sensitive taxa richness followed the ICI trend and declined sharply at RM 1.0 (see Figure 9). This trend continued at RM 0.5 with low EPT and sensitive taxa richness from both quantitative and qualitative collections. Artificial substrate density was also quite low, averaging only 43 orgs./ft^2 per site. Acid mine drainage and sedimentation were the primary sources of impact at

RM 1.0 while excessive levels of TDS and solids, coupled with the extensive sedimentation, appeared the primary sources of impairment at RM 0.5.

Figure 8. Riffle habitat at Kyger Creek RM 3.0, looking upstream towards haul road bridge on Gavin Plant property. Note series of galvanized metal culverts that carry flow under bridge.

Table 12. A summary of macroinvertebrate collections and field observations from the Kyger Creek basin, 2008.

River	RM	Drain. Area	Qual Total	Qual EPT	Qual Sens.	Density Qual. or #/sq. ft.	ICI	Predominant Populations (tolerance)
Exceptional								
None								
Very Good								
None								
Good								
Kyger Creek	8.14 a	6.8	49	9	14	Mod.	--	Blackflies (moderate); midges, baetid mayflies (sensitive)
Kyger Creek	8.14 b	6.8	46	10	14	Mod.	--	Blackflies (mod.); damselflies (mod.-tolerant)
Marginally Good								
Bell Lick Run	0.35	1.6	38	8	13	Mod.	--	Riffle beetles, isopods (mod.); baetid mayflies (sens.)
Kyger Cr. Trib @ 10.98	0.11	0.9	20	8	8	Low	--	Riffle beetles (mod.-sens.); crayfish (mod), stoneflies (sens.)
Kyger Creek	3.0b	22.6	49	8	11	Mod	--	Caddisflies (mod.-sensitive), damselflies (mod.-tolerant)
Fair								
Kyger Creek	8.5	6.1	32	6	6	Low	--	Baetid mayflies (mod.- sensitive), immature crayfish (mod.)
Kyger Cr. Trib @ 8.44	0.1	4.5	27	7	8	Low	--	Riffle beetles (mod.)
Kyger Creek	5.2	17.0	19	4	3	Very Low	--	Odonates (mod.-tolerant)
Kyger Creek	4.0a	20.3	36	6	12	49	34	Damselflies (mod.-tolerant)
Kyger Creek	3.0a	22.6	33	6	4	100	28	Caddisflies (mod.- sensitive), damselflies (mod.-tolerant)
Kyger Creek	1.0	30.1	19	1	3	57	14	Scuds (mod.), damselflies (mod.-tolerant)
Kyger Creek	0.5	30.7	15	3	2	29	18	Net-spinning caddisflies, scuds (mod.), damselflies (mod.-tol.)
Poor								
Stingy Run	0.2	0.6	12	1	2	Low	--	Net-spinning caddisflies, (mod.), immature crayfish (mod.)
Kyger Creek	4.0b	20.3	41	4	6	Very Low	--	Red midges (very tolerant), damselflies (mod.-tolerant)
Little Kyger Creek	3.0	1.2	9	1	1	Very Low	--	Net-spinning caddisflies, immature crayfish (mod.)
Very Poor								
Jessie Creek	4.0	0.9	12	0	2	Low	--	Red midges (tolerant- sensitive), immature crayfish (mod.)

River	RM	Drain. Area	Qual Total	Qual EPT	Qual Sens.	**Density** Qual. or #/sq. ft.	ICI	Predominant Populations (tolerance)
Very Poor (Continued)								
Jessie Creek	0.1	3.3	13	0	1	Very Low	--	Immature crayfish (mod.)
Turkey Run	0.95	1.1	13	0	0	Very Low	--	Red midges (tolerant/acidophilic)
Turkey Run	0.4	1.5	9	0	0	Very Low	--	Immature crayfish (mod.)
Little Kyger Creek	1.6	2.7	7	0	0	Very Low	--	Immature crayfish (mod.)
Little Kyger Creek	0.1	5.8	7	0	0	Very Low	--	Immature crayfish (mod.)

TRENDS

Historical sampling in the Kyger Creek basin included a qualitative survey of ten sites in the mainstem and tributaries from 1982 and artificial substrate collections at four mainstem sites in lower Kyger Creek between RM 5.1 and the mouth in 1990 (Figure 9).

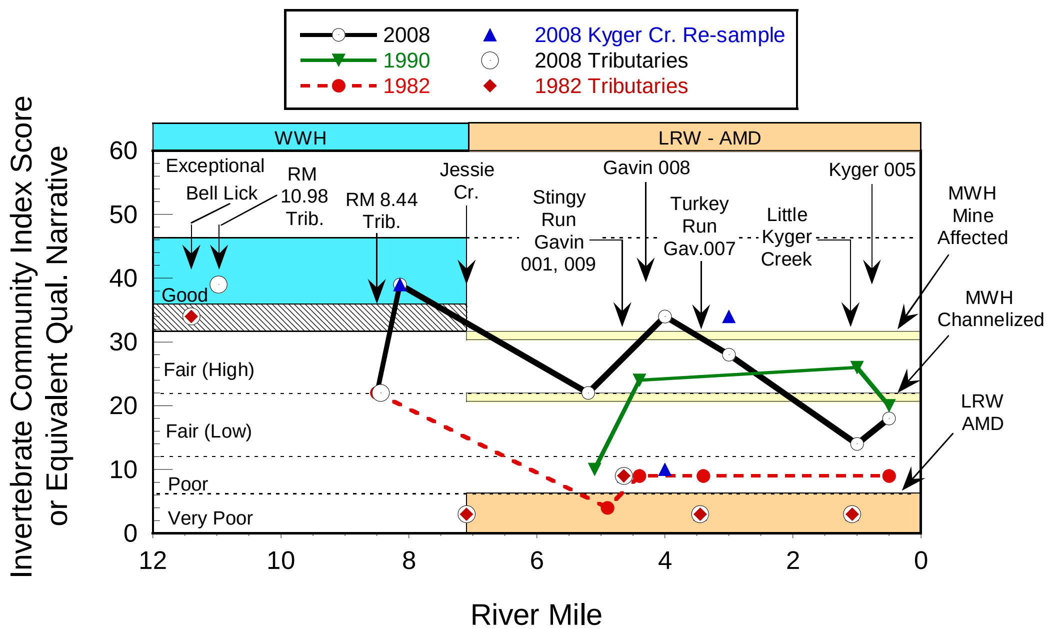

Figure 9. Macroinvertebrate community trends in the Kyger Creek basin, 1982-2008. Where only qualitative data were collected, an ICI score based on the narrative equivalent has been inserted. **Note:** Due to the late November sampling period, changes in taxonomy and sampling methodologies, plus time and manpower constraints, historical results from 1982 may not be directly comparable to the more intensively conducted sampling in 1990 and 2008.

Headwaters

Sampling in the WWH designated headwaters of Kyger Creek suggests similar conditions or modest improvement over the last 26 years. Bell Lick Run sampling showed substantial increases in total taxa (15 to 38), sensitive taxa (2 to 13) and EPT taxa (4 to 8) between surveys. However, lower taxa richness in 1982 is more likely a reflection of intermittent flow and sampling limitations (noted above in Figure 9 caption), not a significant change in water quality. The 1982 Bell Lick Run community was predominated by pollution sensitive mayflies of the genus *Leptophlebia* and reflected substantially better quality than the AMD impacted sites downstream. Community health in both 1982 and 2008 samples was considered “marginally good”.

Collections from Kyger Creek RM 8.5 have remained fair and only moderately improved between surveys. Siltation and past channelization continued to be the primary sources of impairment; these negative influences were exacerbated by the presence of numerous beaver dam impoundments in 1982.

Since 1982, AMD impacted tributaries from the lower basin have not demonstrated any meaningful improvement. Collections in 2008 continue to reflect poor or very poor performance with EPT and sensitive taxa virtually absent (Figure 10). Aesthetically, the extent of yellow-boy deposition appeared reduced at some locations and pH measurements suggest the acutely acid conditions may have lessened over time. Still, community health remains severely degraded and not substantially different than in 1982. In addition to chemical water quality impacts, tributary populations were also severely impacted by sedimentation.

Flow volume in Stingy Run has been greatly reduced since 1982 as the fly ash impoundment in the headwaters has gradually filled with solids. According to AEP, the flow volume to Stingy Run was primarily reduced by the cessation of routing fly ash sluice water to the fly ash reservoir in 1995. Regardless, 1982 and 2008 samples remained similar with the collection of two caddisfly taxa and only one sensitive taxon in each survey. Both samples were considered poor but adequate to meet LRW criteria.

Kyger Creek mainstem

Macroinvertebrate communities from lower Kyger Creek have shown some improvement since earlier surveys but remain degraded by point and nonpoint source discharges.

Beginning downstream from Jessie Creek but upstream from all point sources (station RMs 4.9-5.2), communities improved from very poor (1982) to poor (1990) to fair by 2008. The presence of 3 mayfly taxa in 2008 compared to none in previous surveys was the main evidence of improvement. Still, the 2008 collections represent a significant decline compared to conditions upstream and the channel remains overwhelmed by a heavy bedload of loose sand. The slight improvement in 2008 may reflect a modest, far-field improvement following ODNR reclamation activity or natural attenuation in abandoned mined lands upstream.

Between Stingy Run and Little Kyger Creek (RMs 4.6-1.1), macroinvertebrate quality was often quite variable but has shown improvement (Figure 9). Even in 1982, conditions improved slightly below Stingy Run due to the dominating flow and more basic pH associated with the fly ash reservoir discharge. Mayfly taxa remained absent but the higher pH permitted a few facultative caddisflies to inhabit the reach. By 2008, some additional mayflies and Tanytarsini midges (considered sensitive as a group) were found and community organization was occasionally sufficient for ICI scores to meet minimum WWH expectations. However, the quality of natural substrate communities rarely matched the artificial substrates (Figure 11) and both collections reflected the harsh physical habitat and water quality conditions. In addition, wide fluctuations in community health at the same location on different dates in 2008, points to variable stream quality and potential impacts from slug-type releases. Overall, 2008 sampling at RM 3.0, upstream from Little Kyger and downstream from Turkey Run, represented the highest quality location in lower Kyger Creek.

Lowest quality communities and least improvement in lower Kyger Creek was found downstream from Little Kyger Creek and the Kyger Creek 005 fly ash discharge. ICI scores from both 1990 and 2008 were in the fair range but lower in 2008 (Figure 9).

Qualitative collections from RM 0.5 show little change since 1982 with low total taxa (15 to 7), low sensitive taxa (2; Figure 11) and low EPT taxa richness (3) during each survey. Mine drainage and point source loading in the lower mile continue to impact the reach with no significant improvements over historical results.

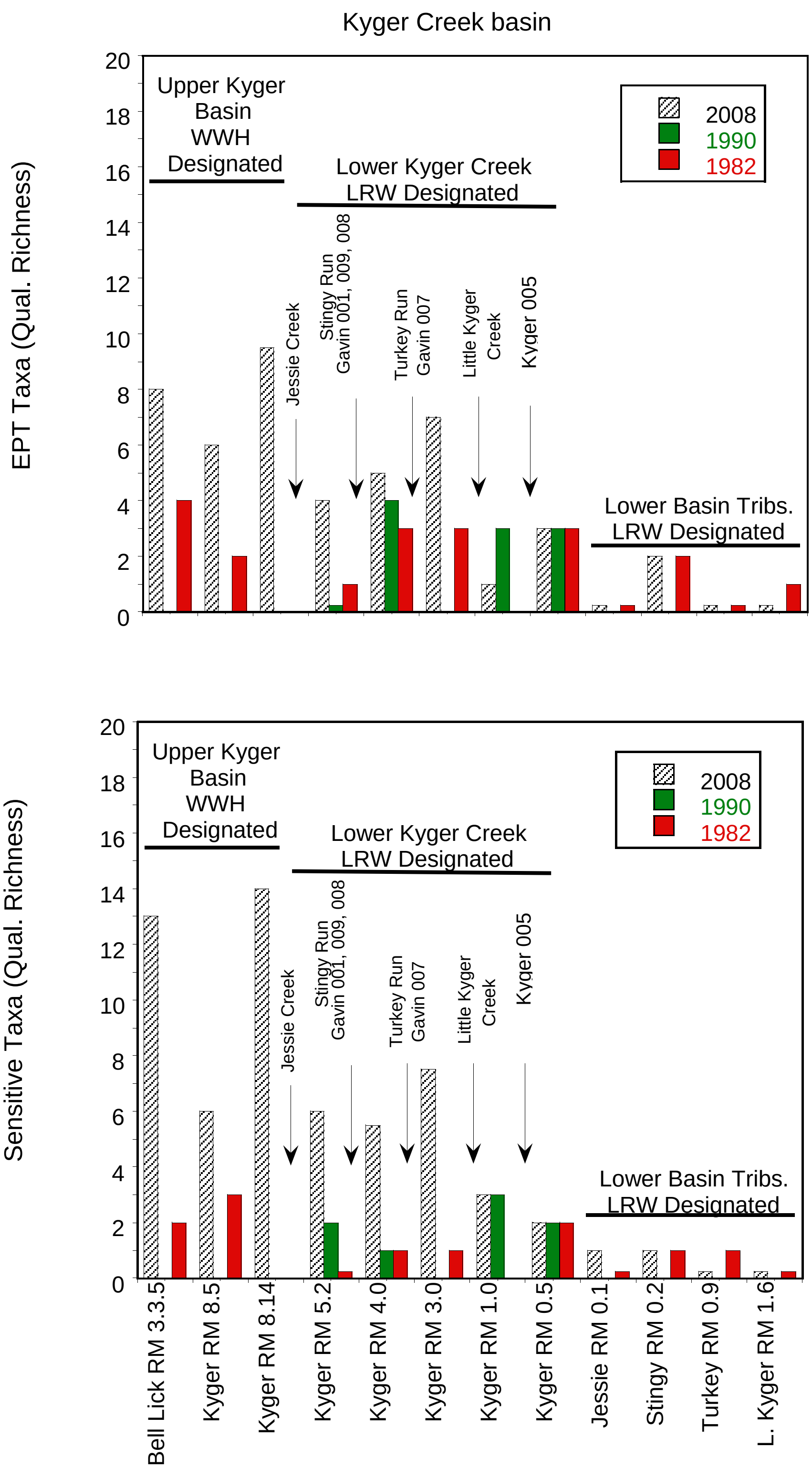

Figure 10. Pollution sensitive and EPT (Ephemeroptera, Plecoptera, and Trichoptera) taxa richness trends from qualitative (natural substrate) collections at the Kyger Creek basin sites, 1982-2008.

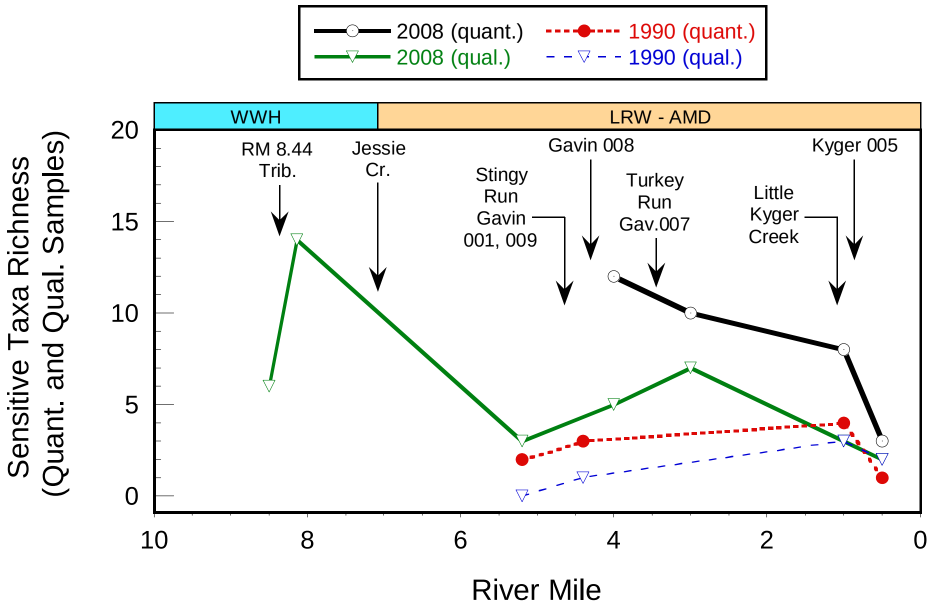

Figure 11. Longitudinal trends in pollution sensitive taxa richness from quantitative (artificial substrate) and qualitative (natural substrate) collections at Kyger Creek sites from 1990 and 2008.

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*Some of the references not in the report can be found in Appendix A which includes Biosurvey Background Information.