State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of Salt Creek Watershed (Scioto River) 2005

Fairfield, Hocking, Jackson, Pickaway, Pike, Ross, Vinton Counties

December 4, 2008

Ted Strickland, Governor
Chris Korleski, Director

Biological and Water Quality Study of Salt Creek, Salt Lick Creek and Select Tributaries 2004 and 2005

Fairfield, Hocking, Jackson, Pickaway, Pike, Ross and Vinton Counties, Ohio

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NOTICE TO USERS

Ohio EPA incorporated biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1987), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio's surface water resources.

The following documents support the use of biological criteria by outlining the rationale for using biological information, the methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results:

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

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

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

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

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

Ohio Environmental Protection Agency. 2006a. 2006 updates to Biological Criteria for the Protection of Aquatic Life: Volume II and Volume II Addendum. Users manual for biological field assessment of Ohio surface waters. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 2006b. 2006 updates to Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 2006c. Methods for assessing habitat in flowing waters: Using the Qualitative Habitat Evaluation Index (QHEI). Ohio EPA Tech. Bull. EAS/2006-06-1. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. Ann. Assoc. Amer. Geogr. 77(1): 118-125.

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

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

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

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

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

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

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

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

Yoder, C.O. and M.A. Smith. 1999. Using fish assemblages in a State biological assessment and criteria program: essential concepts and considerations, pp. 17-63. in T. Simon (ed.). Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities. CRC Press, Boca Raton, FL.

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

Ohio EPA, Division of Surface Water
Ecological Assessment Section
4675 Homer Ohio Lane
Groveport, Ohio 43125
(614) 836-8798

or

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

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Copies of this report are located on the Ohio EPA internet web page (www.epa.state.oh.us/dsw/document_index/psdindx.html) or may be available on CD from:

Ohio EPA
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4675 Homer Ohio Lane
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FOREWORD

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

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

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

Hierarchy of Indicators
A carefully conceived ambient monitoring approach, using cost-effective indicators consisting of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach includes a hierarchical continuum from administrative to true environmental indicators (Figure 1). The six “levels” of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or

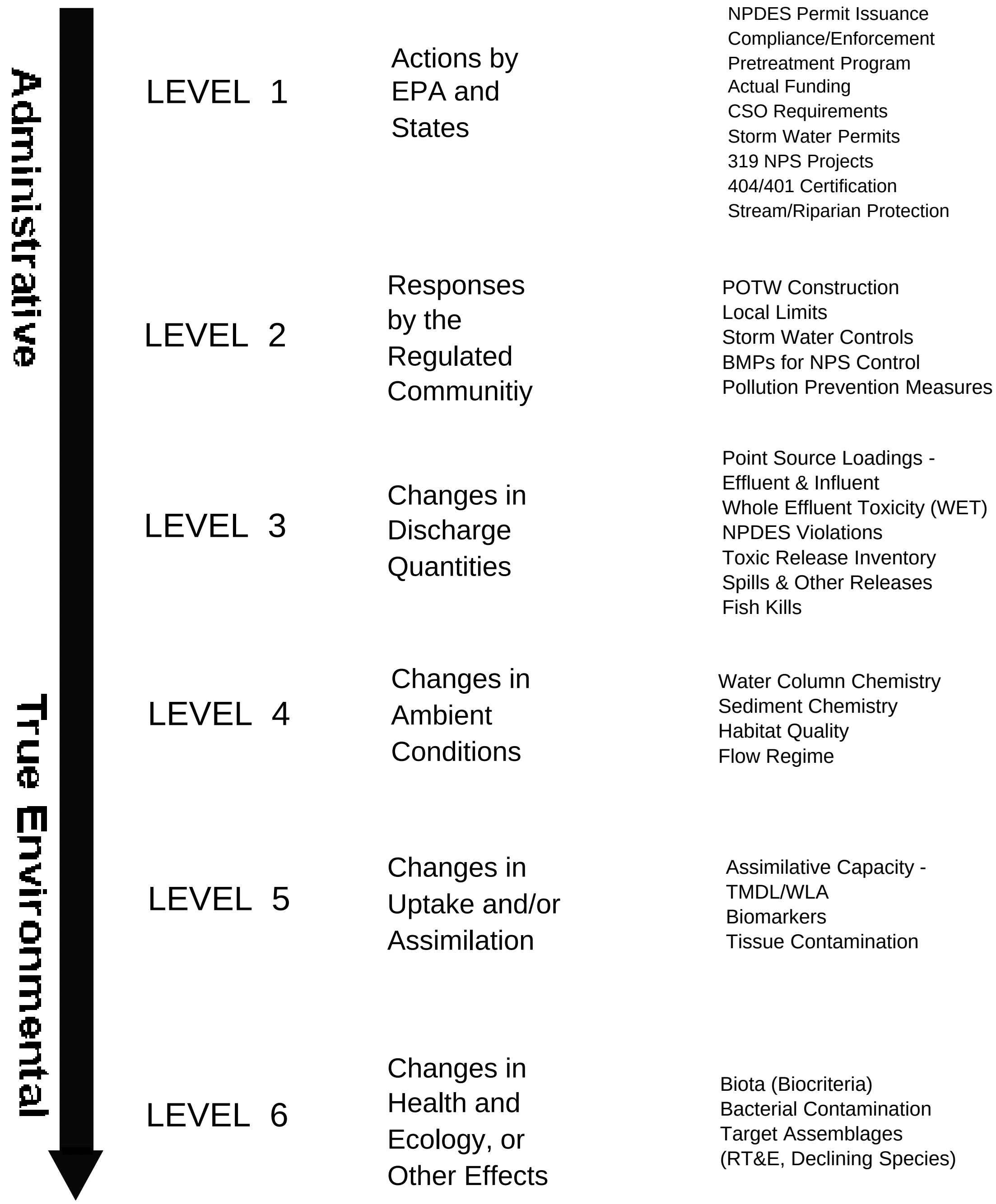

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by the U.S. EPA.

assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health, ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition. Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.,* rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreation uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

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

Ohio Water Quality Standards: Designated Aquatic Life Use

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

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

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

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

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

5) *Limited Resource Water (LRW)* - this use applies to small streams (usually <3 mi^2 drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.,* true ephemeral streams), or other irretrievably altered waterways.

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

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

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

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

MECHANISMS FOR WATER QUALITY IMPAIRMENT

The following paragraphs describe the various causes of impairment that were encountered during the Salt Creek study. While these perturbations are presented under separate headings, it is important to remember that they are often interrelated and cumulative in terms of the detrimental impact that can result.

Habitat and Flow Alterations

Habitat alteration, such as channelization and gravel mining, negatively impacts biological communities by limiting the complexity of living spaces available to aquatic organisms. Consequently, fish and macroinvertebrate communities are not as diverse. Indirect impacts include agricultural activities such as the removal of trees and shrubs adjacent to streams (described throughout this report as riparian vegetation/buffer) and field tiling to facilitate drainage. Urbanization impacts include removal of riparian trees, influx of stormwater runoff, straightening and piping of stream channels, and riparian vegetation removal. Following a rain event, most of the water is quickly removed from tiled fields or urban settings rather than filtering through the soil, recharging groundwater, and reaching the stream at a lower volume and more sustained rate. As a result, small streams more frequently go dry or become intermittent.

Tree shade is important because it limits the energy input from the sun, moderates water temperature, and limits evaporation. Removal of the tree canopy further degrades conditions because it eliminates an important source of coarse organic matter essential for a balanced ecosystem. Riparian vegetation aids in nutrient uptake, may decrease runoff rate into streams, and helps keep soil in place. Erosion impacts channelized streams more severely due to the lack of a riparian buffer to slow runoff, trap sediment, and stabilize banks. Deep trapezoidal channels lack a functioning flood plain and therefore cannot expel sediment as would occur during flood events along natural watercourses. Additionally, the confinement of flow within an artificially deep channel accelerates the movement of water downstream, exacerbating flooding of neighboring properties.

The lack of water movement under low flow conditions can exacerbate degradation from organic loading and nutrient enrichment by limiting reaeration of the stream. The amount of oxygen soluble in water decreases as temperature increases. This is one reason why tree shade is so important. The two main sources of oxygen in water are diffusion from the atmosphere and plant photosynthesis. Turbulence at the water surface is critical because it increases surface area and promotes diffusion, but channelization eliminates turbulence produced by riffles, meanders, and debris snags. Plant photosynthesis produces oxygen, but at night, respiration reverses the process and consumes oxygen. Conversely, oxygen concentrations can become supersaturated during the day, due to abnormally high amounts of photosynthesis, causing gas bubble stress to both fish and invertebrate communities. Oxygen is also used by bacteria that consume dead organic matter. Nutrient enrichment promotes the growth of nuisance algae that subsequently dies and serves as food for bacteria. Under these conditions, oxygen can be depleted unless it is replenished from the air.

Siltation and Sedimentation

Whenever the natural flow regime is altered to facilitate drainage, increased amounts of sediment are likely to enter streams either by overland transport or increased bank erosion. The removal of wooded riparian areas furthers the erosional process.

Channelization keeps all but the highest flow events confined within the artificially high banks. As a result, areas that were formerly flood plains and facilitated the removal of sediment from the primary stream channel no longer serve this function. As water levels fall following a rain event, interstitial spaces between larger rocks fill with sand and silt and the diversity of available habitat to support fish and macroinvertebrates is reduced. Silt also can clog the gills of both fish and macroinvertebrates, reduce visibility thereby excluding obligate sight-feeding fish species, and smother the nests of lithophilic fishes. Lithophilic spawning fish require clean substrates with interstitial voids in which to deposit eggs. Conversely, pioneering species benefit. They are generalists and best suited for exploiting disturbed and less heterogeneous habitats. The net result is a lower diversity of aquatic species compared with a typical warmwater stream with natural habitats.

Sediment also impacts water quality, recreation, and drinking water. Nutrients absorbed to soil particles remain trapped in the watercourse. Likewise, bacteria, pathogens, and pesticides which also attach to suspended or bedload sediments become concentrated in waterways where the channel is functionally isolated from the landscape.

Nutrient Enrichment

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

A characteristic of phosphorus discharged by nonpoint sources is that the impact is intermittent and is most often associated with stormwater runoff. Most of this phosphorus is bound tightly to soil particles and enters streams from erosion, although some comes from tile drainage. Phosphorus input from urban stormwater is more of a concern if combined sewer overflows are involved. Phosphorus load from rural stormwater varies depending on land use and management practices and includes contributions from livestock feedlots and pastures and row crop agriculture. Crop fertilizer includes granular inorganic types and organic types such as manure or sewage sludge. Pasture land is especially a concern if the livestock have access to the stream. Large feedlots with manure storage lagoons create the potential for overflows and accidental spills. Land management is an issue because erosion is worse on streams without any riparian buffer zone to trap runoff. The impact is worse in streams that are channelized because they no longer have a functioning flood plain and cannot expel sediment during flooding. Oxygen levels must also be considered, because phosphorus is released from sediment at higher rates under anoxic conditions.

There is no numerical phosphorus criterion established in the Ohio Water Quality Standards, but there is a narrative criterion that states phosphorus should be limited to the extent necessary to prevent nuisance growths of algae and weeds (Administrative Code, 3745-1-04, Part E). Phosphorus loadings from large volume point source dischargers in the Lake Erie drainage basin are regulated by the National Pollutant Discharge Elimination System (NPDES). The permit limit is a concentration of 1.0 mg/l in final effluent. Research conducted by the Ohio EPA indicates that a significant correlation exists between phosphorus and the health of aquatic communities (Miltner and Rankin, 1998). It was concluded that biological community performance in headwater and wadeable streams was highest where phosphorus concentrations were lowest. It was also determined that the lowest phosphorus concentrations were associated with the highest quality habitats, supporting the notion that habitat is a critical component of stream function. The report recommends WWH criteria of 0.08 mg/l in headwater streams (<20 mi^2 watershed size), 0.10 mg/l in wadeable streams (>20-200 mi^2) and 0.17 mg/l in small rivers (>200-1000 mi^2).

Organic Enrichment and Low Dissolved Oxygen
The amount of oxygen soluble in water is low and it decreases as temperature increases. This is one reason why tree shade is so important. The two main sources of oxygen in water are diffusion from the atmosphere and plant photosynthesis. Turbulence at the water surface is critical because it increases surface area and promotes diffusion. Drainage practices such as channelization eliminate turbulence produced by riffles, meanders, and debris snags. Although plant photosynthesis produces oxygen by day, it is consumed by the reverse process of respiration at night. Oxygen is also consumed by bacteria that decay organic matter, so it can be easily depleted unless it is replenished from the air. Sources of organic matter include poorly treated waste water, livestock waste, sewage bypasses, and dead plants and algae. Dissolved oxygen criteria are established in the Ohio Water Quality Standards to protect aquatic life. The minimum and average limits are tiered values and linked to use designations (Administrative Code 3745-1-07, Table 7-1).

Ammonia
Ammonia enters streams as a component of fertilizer and manure runoff and wastewater effluent. Ammonia gas (NH_3) readily dissolves in water to form the

compound ammonium hydroxide (NH_4OH). In aquatic ecosystems an equilibrium is established as ammonia shifts from a gas to undissociated ammonium hydroxide to the dissociated ammonium ion (NH_4^{+1}). Under normal conditions (neutral pH 7 and 25°C) almost none of the total ammonia is present as gas, only 0.55% is present as ammonium hydroxide, and the rest is ammonium ion. Alkaline pH shifts the equation toward gaseous ammonia production, so the amount of ammonium hydroxide increases. This is important because while the ammonium ion is almost harmless to aquatic life, ammonium hydroxide is very toxic and can reduce growth and reproduction or cause mortality.

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

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

Metals

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

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

Bacteria

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

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

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

Sediment Contamination

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

Sediment chemistry results are evaluated by Ohio EPA using a dual approach, first by ranking relative concentrations based on a system developed by Ohio EPA (1996) and then by determining the potential for toxicity based on guidelines developed by MacDonald et al (2000). The Ohio EPA system was derived from samples collected at ecoregional reference sites. Classes are grouped in ranges that are based on the median analytical value (non-elevated) plus 1 (slightly elevated), 2 (elevated), 4 (highly elevated), and 8 (extremely elevated) inter-quartile values. The MacDonald guidelines are consensus based using previously developed values. The system predicts that sediments below the threshold effect concentration (TEC) are absent of toxicity and those greater than the probable effect concentration (PEC) are toxic.

Sediment samples collected by the Ohio EPA are measured for a number of physical and chemical properties. Physical attributes included % particle size distribution (sand ≥60 µ, silt 5-59 µ, clay ≤4 µ), % solids, and % organic carbon. Fine grained sediments are deposited in flood plains of natural streams during periods of high flow. This scenario changes if the stream is impounded by a dam or channelized. Chemical attributes included metals, volatile and semi-volatile organic compounds, pesticides, and poly-chlorinated biphenyls (PCBs).

**Biological and Water Quality Study of
Salt Creek, Salt Lick Creek
and Select Tributaries
2004 and 2005**

Fairfield, Hocking, Jackson, Pickaway, Pike, Ross and Vinton Counties

State of Ohio Environmental Protection Agency
Division of Surface Water
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INTRODUCTION

Ambient biological, water column chemical, and sediment sampling occurred in the Salt Creek study area from June through September 2005. Sampling within the Salt Lick Creek portion of the watershed was conducted from June through October 2004. The Salt Creek watershed is located in southern Ohio (Figure 2), where its waters originate in Fairfield County, and flow through the town of Laurelville as it meanders southeast into Hocking County. Within Hocking County the stream arcs southwest and flows into Vinton County, joining the Scioto River in Ross County. As it flows toward the Scioto River it passes through the towns of Londonderry and Richmond Dale in Ross County. A list of the main stem and tributary sites evaluated in this study is included in Table 1.

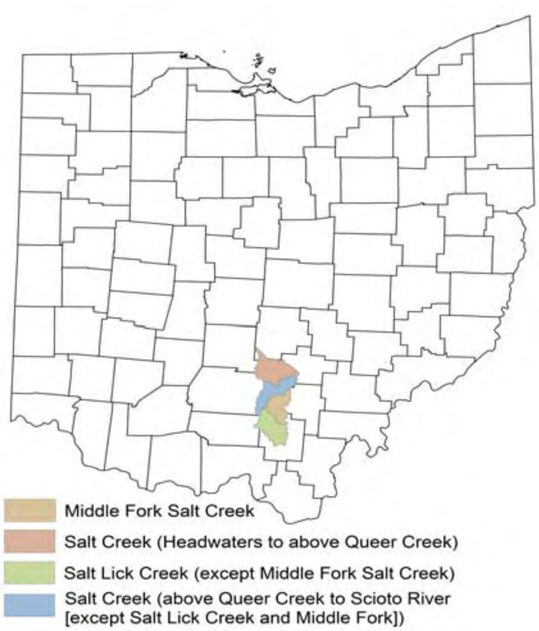


Figure 2. Salt Creek study area location.

Objectives of the study were to:

1) Monitor and assess the chemical, physical and biological integrity of the water bodies within the Salt Creek study area;

2) Assess the physical conditions in streams listed in the study plan to identify their potential to support aquatic biological communities;

3) Characterize the amount of aquatic resource degradation attributable to various land uses including agricultural practices, rural development, and urban and suburban community development;

4) Evaluate the biological potential to support the Warmwater Habitat (WWH)

aquatic life use designation in any subsequently identified candidate WWH stream;

5) Determine any aquatic impacts from known point sources including point source dischargers, wastewater treatment plants (WWTPs), and from unsewered communities; and

6) Conduct a water resource trend assessment where historical data exist.

The findings of this evaluation may factor into regulatory actions taken by the Ohio EPA (e.g., NPDES permits, Director's Orders, or the Ohio Water Quality Standards (OAC 3745-1)), and may eventually be incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d] report).

Table 1. Sampling locations and coordinates assessed during the Salt Creek study, 2005 and Salt Lick Creek, 2004.

River Mile	Drainage (mi^2)	Location	Longitude	Latitude
Salt Creek				
42.6	8.3	Dwnst. Wolf Creek, Dwnst. Heigle Rd	-82.7891	39.5874
38.2	17.6	Tarlton	-82.7714	39.5261
33.35	48	Spangler Road, near Tarlton Adelphi Road	-82.7508	39.4731
32.3	106	State Route 180	-82.7350	39.4631
25.9	174	Creamery Hill Road	-82.6425	39.4133
23.0	214	State Route 56	-82.6461	39.375
17.4	239	Narrows Road	-82.6978	39.3206
15.2	243	Pretty Run Road (CR 17)	-82.7269	39.3011
9.9	286	East of SR 327	-82.7647	39.2603
5.9	292	Dixon Mill Rd, upst. US 50	-82.7786	39.2308
1.5	551	West Junction Road	-82.8114	39.2000
Plum Run (Trib to Salt Creek at RM 34.62)				
0.3	5.4	Hayesville Adelphi Road	-82.7611	39.4833
Beech Fork (Trib to Salt Creek at RM 34.12)				
2.3	7.5	County Line Road	-82.7914	39.4703
1.1	18.5	Tarlton Adelphi Road	-82.7966	39.4786
Bull Creek (Trib to Beech Fork at RM 1.54)				
0.8	3.9	County Line Road	-82.777	39.4696
Laurel Run (Trib to Salt Creek at RM 33.10)				
9.6	6.5	Farm lane south of SR 180, upstream of Cola Creek	-82.6030	39.5194

River Mile	Drainage (mi²)	Location	Longitude	Latitude
7.8	15.9	State Route 374	-82.6245	39.4996
2.6	25.0	Defenbaugh Road, Downstream Middle Fork Laurel Run	-82.7097	39.4954
0.1	54.6	State Route 180 / 56	-82.7405	39.4743
Cola Creek (Trib to Laurel Run at RM 9.40)				
0.1	4.6	State Route 180/374	-82.6058	39.5185
Middle Fork (Trib to Laurel Run at RM 2.97)				
4.1	4.4	Middle Fork Road (CR 7)	-82.6778	39.5389
0.1	11.4	State Route 180	-82.7025	39.4972
Moccasin Creek (Trib to Laurel Run at RM 1.75)				
4.6	4.1	East of Moccasin Road, South of Pickaway County Line	-82.7326	39.5495
2.5	8.3	Armstrong Road, ford	-82.7385	39.5212
Brimstone Creek (Trib to Salt Creek at RM 32.25)				
0.35	4.2	Upstream WWTP	-82.741	39.4602
0.3	4.2	Mix Zone	-82.7399	39.4606
0.1	4.3	Downstream WWTP	-82.7349	39.4625
Sams Creek (Trib to Salt Creek at RM 29.4)				
0.3	4.3	Private road near mouth, off of Sams Creek Road	-82.7009	39.4378
Pine Creek (Trib to Salt Creek at RM 28.04)				
12.5	4.3	Big Pine Road, Downstream Blackjack Branch	-82.5169	39.4781
11.2	10.9	Big Pine Road, Upstream Little Rocky Branch	-82.5355	39.4694
8.8	17.4	Big Pine Road, Upstream Crane Hollow	-82.5662	39.4554
2.0	31	Jeep trail south of Bethel Church, off Big Pine Road	-82.6477	39.4445
Little Pine Creek (Trib to Pine Creek at RM 1.34				
1.9	4.6	Gravel road off of Little Pine Road	-82.6523	39.4622
0.6	7.9	Big Pine Road	-82.6619	39.447
Queer Creek (Trib to Salt Creek at RM 25.40)				
4.4	11.8	Steele Road	-82.5742	39.4256
0.8	34.2	Thomas Road, South of SR 56	-82.6258	39.4125
East Fork (Trib to Queer Creek at RM 2.57)				
3.9	9.2	Adjacent SR 56, Dwnst. trib	-82.5510	39.3959
1.7	12.6	Adjacent SR 56	-82.5761	39.4064
Trib to East Fork Queer Creek at RM 3.95				

River Mile	Drainage (mi²)	Location	Longitude	Latitude
0.9	4.9	Adjacent Amerine Road, South of SR 56	-82.5509	39.3835
Goose Creek (Trib to Queer Creek at RM 2.35)				
0.4	4.6	Goose Creek Road	-82.5994	39.4115
Pretty Run (Trib to Salt Creek at RM 18.55)				
3.5	5.6	Adjacent CR 17, Downstream tributary	-82.6248	39.3257
0.7	16.8	McGee Road, South of Pretty Run Road	-82.6717	39.3317
North Branch (Trib to Pretty Run at RM 2.35)				
0.4	5.8	Macedonia Road (County Road 47)	-82.6391	39.3357
Pike Run (Trib to Salt Creek at RM 14.09)				
5.7	9.1	SR 327, South of Jimtown	-82.7224	39.3523
4.5	17.7	Gravel lane east of SR 327, Downstream Conway Hollow	-82.7237	39.3370
East Fork (Trib to Pike Run at RM 5.6)				
0.2	5.0	Near mouth, Adjacent CR 12E at powerlines	-82.7186	39.3534
Poe Run (Trib to Salt Creek at RM 11.51)				
2.1	4.9	Poe Run Road, Downstream Timmons Cemetery	-82.7786	39.2991
Mulgee Run (Trib to Salt Creek at RM 5.55)				
0.1	5.2	Francis Lane	-82.7817	39.2279
Salt Lick Creek (Trib to Salt Creek at RM 4.5)				
27.9	6.2	Adjacent SR 93, upstream Four Mile Creek	-82.6420	39.0117
26.8	18.8	SR 93	-82.6122	39.0217
22.6	46	High Street, upstream Jackson WWTP	-82.6464	39.0594
22.1	50	Mix Zone	-82.6536	39.0619
20.6	71	Upstream Landfill	-82.0675	39.0739
20.4	71	Adjacent Landfill	-82.6709	39.0766
19.5	72	Adjacent Landfill	-82.6650	39.0839
18.2	75	Rock Run Road, Downstream Landfill	-82.6631	39.0933
16.7	79	Lloyds Bridge	-82.6744	39.1092
14.7	82	Adjacent to Caves Road	-82.6864	39.1258
7.2	100	TR 216, upstream Pigeon Creek	-82.7542	39.1678
0.5	247	Gravel Road at West Junction	-82.7683	39.2168
Four Mile Creek (Trib to Salt Lick Creek at RM 27.67)				
3.1	3.6	TR 272	-82.6359	38.9898

River Mile	Drainage (mi²)	Location	Longitude	Latitude
Sugar Run (Trib to Salt Lick Creek at RM 23.36)				
0.4	3.4	Railroad trestle near mouth	-82.6303	39.0586
Horse Run (Trib to Sat Lick Creek at RM 22.80)				
2.3	3.7	Gravel lane off SR 93	-82.6213	39.0815
Trib to Salt Lick Creek at RM 22.55 (Jisco Lake Tributary)				
0.8	4.0	CR 76	-82.6465	39.0710
Buckeye Creek (Trib to Salt Lick Creek at RM 21.28)				
3.8	9.2	CR 60	-82.7264	39.0517
0.42	18.6	Gravel lane to Buckeye Swamp	-82.6728	39.0636
Sour Run (Trib to Salt Lick Creek at RM 13.10)				
0.2	3.4	TR 742, upstream US 35	-82.7003	39.1295
Big Run (Trib to Pigeon Creek at RM 6.02)				
2.1	5.7	Adjacent Big Rock Road, Upstream Dry Run	-82.7792	39.1014
2.0	8.9	Big Rock Road, Downstream Dry Run	-82.7784	39.1020
Poplar Run (Trib to Pigeon Creek at RM 4.78)				
0.2	3.8	Lane at mouth	-82.7542	39.1230
Pigeon Creek (Trib to Salt Lick Creek at RM 6.35)				
6.1	7.4	Adjacent Limerick Road, Upstream Big Run	-82.7578	39.1086
6.0	18.1	Adjacent Limerick Road, Downstream Big Run	-85.7550	39.1094
0.9	29.4	TR 216	-82.7631	39.1625
Middle Fork (Trib to Salt Lick Creek at RM 1.25)				
22.0	4.9	CR 2, Downstream Bray Hollow	-82.5702	39.3121
19.7	9.4	Township Road 46 (Goosecreek Road)	-82.5887	39.2862
18.0	20.1	Carpenter Road (County Road 31), south of US 50	-82.6069	39.2705
14.9	32	Township Road 5, south of US 50	-82.6514	39.2678
4.7	58	SR 327, Upstream Pigeon Creek	-82.7150	39.2114
0.3	109	West Junction Road	-82.7617	39.2167
Tributary to Middle Fork Salt Lick Creek at RM 20.62				
0.1	1.1		-82.5869	39.2993
Riley Run (Trib to Middle Fork Salt Lick Creek at RM 18.1)				
0.3	5.4	Carpenter Road	-82.6048	39.2705
Kelly Branch (Trib to Middle Fork Salt Lick Creek at RM 15.73)				
1.5	4.5	Township Road 2, upstream	-82.6292	39.2527

River Mile	Drainage (mi²)	Location	Longitude	Latitude
		Headleg Hollow		
Trib to Middle Fork Salt Lick Creek at RM 13.00				
0.6	5.0	US 50	-82.6686	39.2705
Pigeon Creek (Trib to Middle Fork Salt Lick Creek at RM 4.37)				
13.1	4.5	Township Road 375, at town of Garfield	-82.6193	39.1237
12.3	8.9	Finley Chapel Road	-82.6189	39.1336
8.0	17.6	Beyers Winters Rd (CR 31), West of SR 327	-82.6299	39.1738
4.7	33	Woodrow Hale Rd (Township Rd 207), South of SR 327	-82.6565	39.1898
Trib to Pigeon Creek at RM 7.32				
2.4	5.5	Adjacent CR 6R, West of Richland Furnace	-82.5983	39.1868
0.1	8.8	SR 327, Downstream of Byer	-82.6273	39.1777
Skunk Hollow Creek (Trib to Pigeon Creek at RM 6.66)				
0.1	4.6	SR 327, West of Kelly Road	-82.6355	39.1856
Long Branch (Trib to Pigeon Creek at RM 3.16)				
0.1	4.1	Adjacent County Road 29	-82.6733	39.1939

CR- County Road; TR – Township Road

SUMMARY

The northernmost portion of the Salt Creek study area contains the headwaters of Salt Creek as if flows through Fairfield and Pickaway counties (Figure 3). The landscape lies within the Eastern Corn Belt Plains (ECBP) ecoregion, which is primarily rolling till plains with some end moraines. The deep well drained soils lend the land to agricultural activities, the overwhelming land use in the area (Woods, et al. 1998).

As Salt Creek flows toward the towns of Adelphi and Laurelville it enters the Western Alleghany Plateau (WAP) ecoregion. The WAP ecoregion is characterized by rugged narrow valleys and ridges. Coal is found in portions of the ecoregion and extraction often results in degradation to water quality. Mixed oak forests predominate the slopes, as agricultural activities are confined to livestock grazing in the valleys and ridges with row cropping limited to the relatively flat flood plains (Woods, et al. 1998).

Hocking Hills State Park stretches throughout the north-eastern portion of the watershed, helping to preserve the mixture of relic Hemlock forests intertwined with the native deciduous forests. Natural geologic formations within the area including Old Man's Cave, Ash Cave, Cedar Falls, Conkle's Hollow, Cantwell Cliffs and Rock House, are unique to Ohio. These areas provide numerous recreational opportunities with scenic vistas, natural caves and gorges easily accessed by the public. It is estimated that 2.5 million people visited the parks in

2006 and visitor expenditures in 2005 had an impact of $267.6 million in Hocking County alone. Additional information is available on the Hocking Hills Tourism Association website at: http://www.1800hocking.com/.

Forests mixed with crop fields and livestock pastures are the primary features of the watershed as one travels southward. Small towns such as Jimtown, Londonderry, Royal, Allensville, West Junction, Byer, and Richmond Dale dot the landscape. The City of Jackson is the largest metropolitan area, lying adjacent to Salt Lick Creek within the southernmost extent of the watershed.

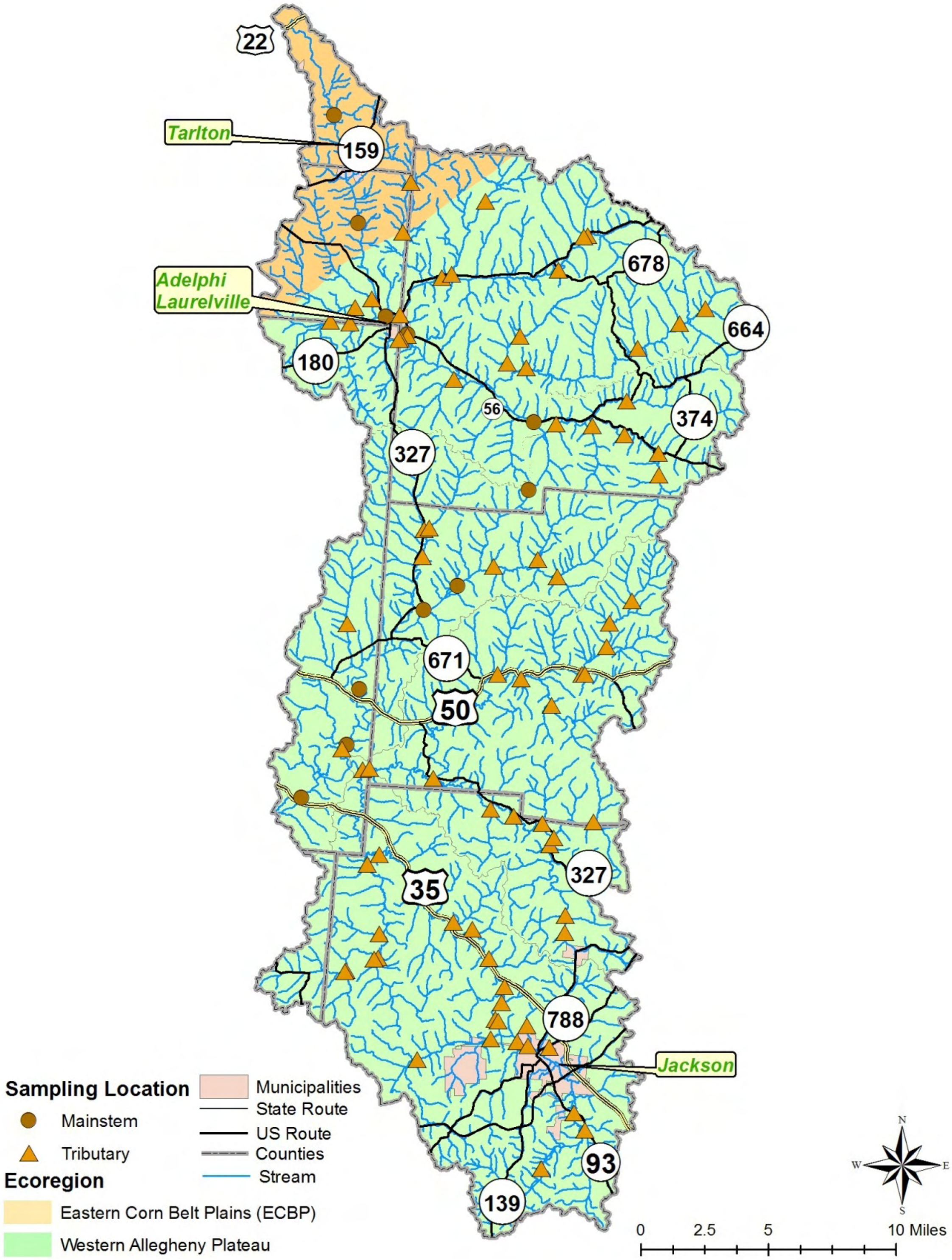


Figure 3. Ecoregions and sampling locations within the Salt Creek watershed**.**

Aquatic Life Use Attainment Status

Sampling within the four Hydrologic Unit Codes (HUC) that comprise the Salt Creek study area occurred during 2004 and 2005 (Table 2 and Figure 2). Sites within the Salt Lick Creek basin (HUC 05060002090) were collected in 2004, while streams within the three remaining HUCs, upper Salt Creek (HUC 05060002070), Middle Fork Salt Lick Creek (HUC 05060002080), and lower Salt Creek (HUC 05060002100) were sampled in 2005. Between the two field seasons, a total of 88,469 fish representing 83 species and nine hybrids were identified. Two state threatened species, bluebreast darter and Tippecanoe darter, were collected as were three species of concern, eastern sand darter, muskellunge and river redhorse. Numerically predominant fish species included central stoneroller minnow (22.0%) and creek chub (17.3%). Species that dominated in biomass included black redhorse (11.6%), golden redhorse (11.4%), northern hog sucker (10.3%) and creek chub (9.9%).

Assessment of aquatic life uses occurred at 80 sites ranging in drainage area from 1.1 mi^2 to 549 mi^2 (Table 1). The Aquatic Life Use (ALU) attainment table (Table 2) provides biological index scores for fish and macroinvertebrate community assessments along with causes and sources of impairment for each site. The Salt Creek main stem was meeting its Exceptional Warmwater Habitat (EWH) designation at all sites except for the headwater site at RM 42.6, which was found to only partially meet EWH standards. Nutrient enrichment and the loss of trees in the riparian corridor likely contributed to the partial attainment status for that site. Salt Lick Creek was in non-attainment of WWH criteria at its two uppermost sites due to agricultural influences. The next four downstream sites were in partial attainment of WWH due to problems associated with the City of Jackson's WWTP and sewage collection system. The Middle Fork Salt Lick Creek was in full attainment of WWH at all sites except for the site at RM 4.9. Refuse from bridge demolition at RM 4.8 impounded the area where macroinvertebrates were sampled, resulting in only partial attainment of WWH.

For tributary streams, 68.6% were in full attainment, while 21.5% were in partial attainment and 9.8% were in non-attainment of their designated ALU. Two tributaries were unassessed, Poe Run and a tributary to Salt Lick Creek at RM 22.55, because fish sampling did not occur. The primary sources leading to impairment in tributary streams were agricultural activities, such as livestock access to streams, channel modifications with loss of trees in the riparian zone, and straightening of the stream. Within the Salt Lick Creek basin, tributaries were also impaired from urbanization influences including accelerated storm water run-off.

Longitudinal plots of IBI scores versus river miles for the Salt Creek main stem are provided in Figure 4. Historical sampling of the upper Salt Creek main stem, from the headwaters to State Route 56 (RM 25.9) was completed in 1992 and 1983. Lower fish community scores are consistently noted where agricultural activities have modified habitat conditions in the headwaters. Further downstream, sampling near State Route 180 (RM 33.4) showed strong community integrity as it received an IBI=54, the same score recorded for the site in 1992. A total of 38 species were collected in 2005 compared to 31 species in 1992, indicating an increase in biodiversity near State Route 180 (RM 33.4).

Downstream from Laurelville, a drop in fish community performance was noted along Creamery Hill Road (RM 32.3). While still meeting EWH expectations, 45.56% of the sample collected was stoneroller minnows. Simple lithophils comprised only 18.5% of the community, while upstream at State Route 180 (RM 33.4) they comprised 41% and further downstream at Sams Creek Road (RM 29.9) they comprised 50% of the community. This reduction in simple lithophils abundance combined with the increased presence of stoneroller minnow indicates possible nutrient enrichment and increased siltation occurring downstream from Laurelville. Untreated sewage discharges for the Village of Adelphi, and the Laurelville WWTP not using the full complement of treatment units suggest these discharges to Brimstone Creek are having a negative effect on Salt Creek downstream from RM 32.2.

Dramatic improvement in fish community scores was noted in both the IBI and MIwb along Narrows Road (RM 23.0). The IBI continued to reflect increased biodiversity and overall stream integrity in a downstream direction. A dip in IBI scores was noted near Richmond Dale, though it was still improved over results from 1992. The apparent dip in MIwb from east of State Route 327 (RM 15.2) to West Junction Road (RM 5.9) is a result of difference in sampling gear. Boat electrofishing was used in 1984 at RM 9.9 and in 1992 for the sites between RM 11.0 to RM 6.0. In 2005, flows were lower and required the use of wading gear, not a boat. Therefore, sampling from all time periods indicate a strong fish community balance and abundance of species.

Macroinvertebrate community performance along the Salt Creek main stem was generally similar to the 1992 study (Figure 5). Community performance generally improved in a downstream direction from the headwaters. An increase in the EPT diversity in 2005 indicated a possible slight improvement in community performance since 1992. High diversities of mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa (EPT) and sensitive taxa were found at all stations except for the 2005 site downstream from West Junction Road (RM 5.9). The decline of ICI scores into the very good range was due to increases of tolerant taxa, primarily aquatic segmented worms. Siltation was observed to be a major threat to the biotic integrity in the lower Salt Creek during both sampling years.

Plum Run and Beech Fork in the upper Salt Creek basin showed dramatic drops in fish community performance in 2005. Channel modifications to the stream channels for agricultural purposes have begun to compromise the integrity of the fish communities in these streams. East Fork Queer Creek in the lower Salt Creek basin had a strong shift within its fish community as well. Steps should be taken to address the issues affecting these streams. Detailed descriptions of historical trends in tributaries are provided within each HUC summary below.

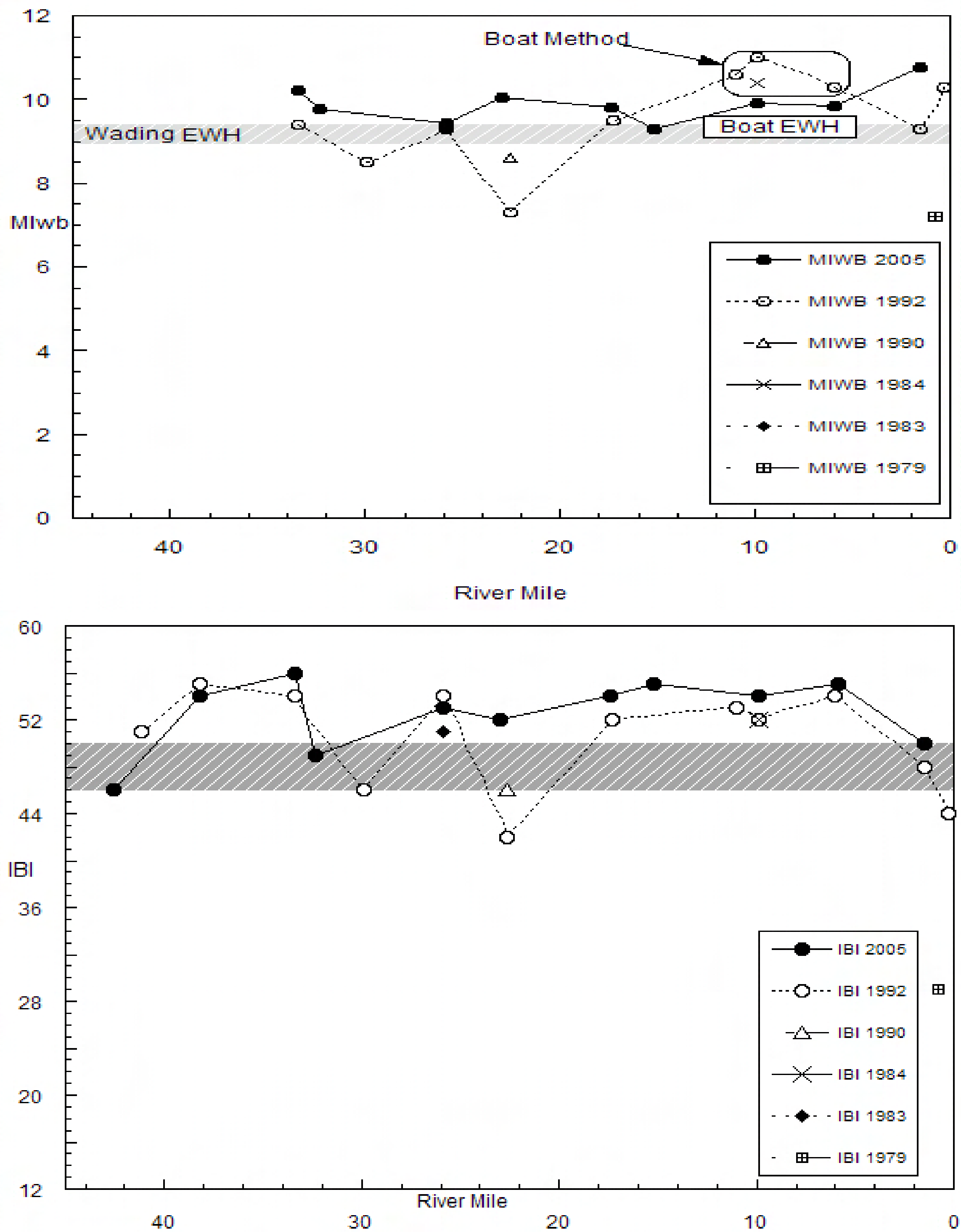


Figure 4. Longitudinal trend of IBI and MIwb for the Salt Creek main stem, 1979-2005.

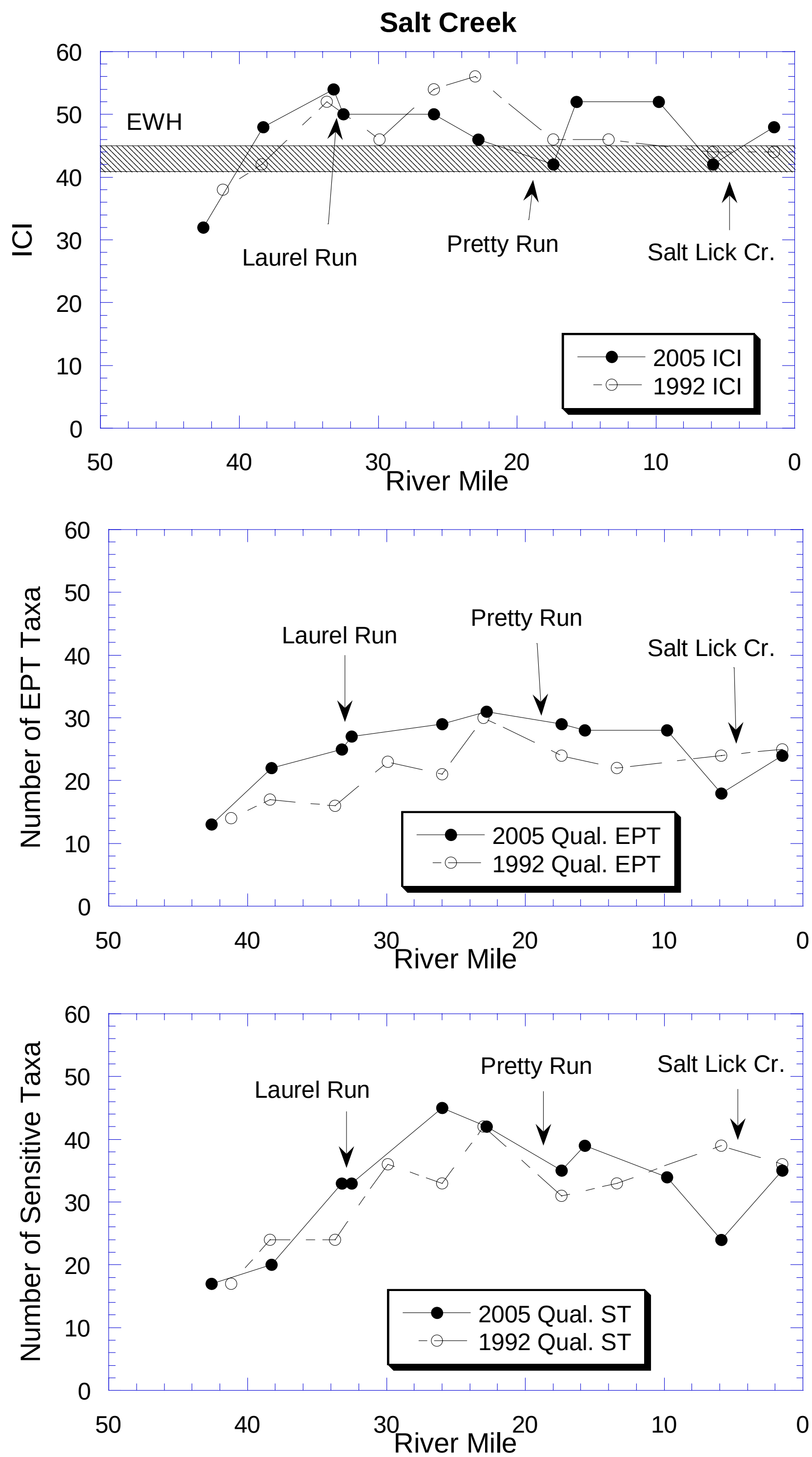


Figure 5. Longitudinal trend of the Invertebrate Community Index (ICI), qualitative EPT, and qualitative sensitive taxa (ST) in Salt Creek, 1992-2005.

Table 2. Aquatic life use attainment status for stations sampled in the Salt Creek basin based on data collected June-October 2004 and July-October 2005. *Sites collected in 2004 are in italics*. 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 to support a biotic community.

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/ Comments
Salt Creek		*ECBP Ecoregion - EWH Existing*					
42.6[H]	46[NS]	N/A	MG*	52.0	PARTIAL	Nutrient enrichment, loss of trees in riparian corridor, siltation	Agricultural activities, channel modifications
38.2[H]/38.3	54	N/A	E	53.0	FULL	Nutrient enrichment, siltation	Agricultural activities, septic systems, driving in stream channel
		WAP Ecoregion - EWH Existing					
33.35[W]/33.2	56	10.2	54	57.5	FULL		
32.3[W]/32.5	49[NS]	9.8	50	67.0	FULL		
25.9[W]/26.0	53	9.4	50	56.5	FULL		
23.0[W]/22.8	52	10.0	46	72.5	FULL		
17.4[W]	54	9.8	42[NS]	71.5	FULL		
15.2[W]/15.7	55	9.3[NS]	52	62.0	FULL		
9.9[W]/9.8	54	9.9	52	78.0	FULL		
5.9[W]	55	9.9	42[NS]	70.0	FULL		
1.5[W]	50	10.8	48	72.0	FULL		
Plum Run (Trib to Salt Creek at RM 34.62)				*ECBP Ecoregion - EWH Existing*			
0.3[H]	54	N/A	E	36.0	FULL		2 pt. IBI drop since 1992, six fewer species

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/ Comments
Beech Fork (Trib to Salt Creek at RM 34.12)					*ECBP Ecoregion - EWH Existing*		
2.3[H] /2.3	46[NS]	N/A	G*	24.0	PARTIAL	Nutrient enrichment, loss of trees in riparian corridor, siltation	Agricultural activities, channel modifications
1.1[H]	52	N/A	G*	36.5	PARTIAL	Nutrient enrichment, loss of trees in riparian corridor, siltation	Agricultural activities, channel modifications; 6pt drop in IBI since 1992, 13 fewer species
Bull Creek (Trib to Beech Fork at RM 1.54)					*ECBP Ecoregion – WWH Existing*		
0.8[H]/0.6	50	N/A	VG	58.5	FULL		
Laurel Run (Trib to Salt Creek at RM 33.10)					*WAP Ecoregion - EWH Existing and CWH Recommended*		
9.6[H]	46 [NS]	N/A	F*	63.0	PARTIAL	Siltation, loss of trees in riparian corridor	Channelization
					WAP Ecoregion - EWH Existing		
7.8[H]	58	N/A	MG*	69.0	PARTIAL	Siltation	Agricultural activities, channel modifications
2.6[W]/2.4	55	10.0	40*	68.5	PARTIAL	Siltation	Agricultural activities, channel modifications
0.1[W]	50	9.5	54	58.5	FULL	Loss of trees in riparian corridor, siltation	Channelization
Cola Run (Trib to Laurel Run at RM 9.40)					*WAP Ecoregion - WWH Existing /CWH Recommended*		
0.1[H]	48	N/A	G	44.0	FULL		
Middle Fork (Trib to Laurel Run at RM 2.97)					*WAP Ecoregion - EWH Existing*		
3.7[H]/3.8	54	N/A	G*	57.0	PARTIAL	Siltation	Unknown
0.1[H]/0.2	56	N/A	E	75.5	FULL		

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/ Comments
Moccasin Creek (Trib to Laurel Run at RM 1.75)					*WAP Ecoregion - WWH Existing /CWH Recommended*		
4.6[H]	50	N/A	G	65.0	FULL		
2.5[H]	42 [NS]	N/A	G	60.0	FULL		
Brimstone Creek (Trib to Salt Creek at RM 32.25)					*WAP Ecoregion - WWH Existing*		
0.35[H](Ust. WWTP)	50	N/A	G	65.5	FULL		
0.3(Mix Zone)	31	N/A	-	-	N/A	Avoidance occurs	
0.1[H]/0.15(Dst WWTP)	53	N/A	G	41.0	FULL	Siltation	Gravel removal from stream
Sams Creek (Trib to Salt Creek at RM 29.4)					*WAP Ecoregion - WWH Existing / EWH Recommended*		
0.3[H]	56/56		E/E	45.0	FULL/FULL		
Pine Creek (Trib to Salt Creek at RM 28.04)					*WAP Ecoregion - WWH Existing / CWH Recommended*		
12.5[H]	50	N/A	G	66.5	FULL		
11.2[H]	50	N/A	MG[NS]	71.5	FULL		
8.8[H]	42[NS]	N/A	F*	72.5	PARTIAL	Siltation	
2.0[W]	47	7.9[NS]	48	66.5	FULL		
Little Pine Creek (Trib to Pine Creek at RM 1.34)					*WAP Ecoregion - WWH Existing /CWH Recommended*		
1.9[H]/2.2	44	N/A	G	60.0	FULL		
					WAP Ecoregion - WWH Existing		
0.6[H]	54	N/A	G	53.0	FULL		
Queer Creek (Trib to Salt Creek at RM 25.40)					*WAP Ecoregion - EWH Existing and CWH Recommended*		
4.4[H]	54	N/A	E	65.0	FULL		
					WAP Ecoregion - EWH Existing		

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/ Comments
0.8[W]	58	10.0	E	74.0	FULL		
East Fork (Trib to Queer Creek at RM 2.57)					*WAP Ecoregion - EWH Existing and CWH Recommended*		
3.9[H]	52	N/A	E	52.5	FULL		
1.7[H]	54	N/A	44[NS]	72.5	FULL		
Trib to East Fork Queer Creek at RM 3.95					*WAP Ecoregion - Undesignated / CWH Recommended*		
0.9[H]	54	N/A	G	53.5	FULL		
Goose Creek (Trib to Queer Creek at RM 2.35)					*WAP Ecoregion - WWH Existing / EWH and CWH Recommended*		
0.4[H]	56/56	N/A	G/G*	69.5	FULL/ PARTIAL	Unknown (natural)	
Pretty Run (Trib to Salt Creek at RM 18.55)					*WAP Ecoregion - EWH Existing and CWH Recommended*		
3.5[H]/3.8	46[NS]	N/A	VG[NS]	45.0	FULL		
					WAP Ecoregion - EWH Existing		
0.7[H]	54	N/A	VG[NS]	60.0	FULL	Siltation, loss of trees in riparian corridor	Channelization, driving in stream channel
North Branch (Trib to Pretty Run at RM 2.35)					*WAP Ecoregion - WWH Existing / CWH Recommended*		
0.4[H]	54/54	N/A	MG[NS]/ MG[NS]	56.5	FULL/FULL	Siltation	
Pike Run (Trib to Salt Creek at RM 14.09)					*WAP Ecoregion - WWH Existing / EWH Recommended*		
5.7[H]	54/54	N/A	G/G*	63.0	FULL/ PARTIAL	Unknown	
4.5[H]	50/50	N/A	VG/ VG[NS]	63.0	FULL/FULL		

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/ Comments
East Fork (Trib to Pike Run at RM 5.60)					*WAP Ecoregion - WWH Existing*		
0.2[H]	52	N/A	G	58.5	FULL		
Poe Run (Trib to Salt Creek at RM 11.51)					*WAP Ecoregion - EWH Existing*		
2.1[H]/2.2	--	--	F*	-	-	Interstitial flow	Gravel removal from stream downstream from site
Mulgee Run (Trib to Salt Creek at RM 5.55)					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.1[H]	46	N/A	G	68.0	FULL		
Salt Lick Creek (Trib to Salt Creek at RM 4.5)					*WAP Ecoregion - WWH Existing*		
27.9[H]	12*	N/A	P*	23.5	**NON**	Channelization Loss of trees in riparian corridor Siltation	Row crop (Agriculture)
26.8[H]/27.0	34*	N/A	30*	52	**NON**	Channelization Siltation Nutrient/organic enrichment	Row crop (Agriculture) Livestock access to stream
22.6[W]/22.5	46	8.6	F*	66	PARTIAL	Nutrient/organic enrichment	Failing sewage collection system (City of Jackson) Run-off from OSCO, possible toxic sediment
22.1[W]	46	8.7	22*	61	PARTIAL	Nutrient/organic enrichment	Failing sewage collection system (City of Jackson)
20.6[W]	45	7.2*	36	62.5	PARTIAL	Nutrient/organic enrichment	Failing sewage collection system (City of Jackson)
20.4[W]	44	7.8*	30*	62.5	PARTIAL	Nutrient/organic enrichment	Failing sewage collection system (City of Jackson)

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/ Comments
19.5[W]	49	8.3[NS]	40	65.5	FULL		
18.2[W]	48	8.6	42	76.5	FULL		
16.7[W]/16.8	45	8.7	40	62.0	FULL		Historic Fish kills (IBI swing between passes)
14.7[W]/14.0	42[NS]	8.1[NS]	38	64.5	FULL		
7.2[W]/7.4	53	9.0	36	75.0	FULL		
--/0.5	--	--	36	55.5	(FULL)		
Four Mile Creek (Trib to Salt Lick Creek at RM 27.67)					*WAP Ecoregion - WWH Existing*		
3.1[H]	34*	N/A	F*	50.0	**NON**	Siltation Nutrient enrichment	Agriculture - Livestock
Sugar Run (Trib to Salt Lick Creek at RM 23.36)					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.4[H]/--	28*	N/A	F*	40.5	**NON**	Stormwater run-off	Urbanization
Horse Run (Trib to Salt Lick Creek at RM 22.80)					*WAP Ecoregion - Undesignated / WWH Recommended*		
2.3[H] /3.1	34*	N/A	F*	45.5	**NON**	Siltation	Residential run-off
Trib to Salt Lick Creek at RM 22.55 (Jisco Lake Tributary)					*WAP Ecoregion - EWH Existing / WWH Recommended*		
--/0.8	--	--	F*	49.5	-	Historic channelization Urban run-off	Urbanization SSO
Buckeye Creek (Trib to Salt Lick Creek at RM 21.28)					*WAP Ecoregion - EWH Existing / WWH Recommended*		
3.8[H]	34*/34*	N/A	G*/G	47.5	**NON**/ PARTIAL	Loss of trees in riparian corridor	Agriculture
0.42[H]	44*/44	N/A	F*/F*	60.5	**NON**/ PARTIAL	Siltation Urban run-off	Urbanization

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/ Comments
Sour Run (Trib to Salt Lick Creek at RM 13.10)					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.2[H]	44	N/A	MG[ns]	56.5	FULL		
Big Run (Trib to Pigeon Creek at RM 6.02)					*WAP Ecoregion - WWH Existing*		
2.1[H]	46	N/A	F*	59.0	PARTIAL	Low to interstitial flow Sedimentation	Agriculture Historical Mining
2.0[H]	52	N/A	F*	59.5	PARTIAL	Siltation Nutrient/organic enrichment	Livestock access to tributary stream
Poplar Creek (Trib to Pigeon Creek at RM 4.78)					*WAP Ecoregion - WWH Existing*		
0.2[H]	46	N/A	--	56.5	(FULL)		
Pigeon Creek (Trib to Salt Lick Creek at RM 6.35)					*WAP Ecoregion - Undesignated / WWH Recommended*		
6.5[H]/7.0	56	N/A	G	52.5	FULL		
6.4[H]	44	N/A	VG	59.5	FULL		
0.9[W]	46	8.6	G	70.5	FULL		
Middle Fork (Trib to Salt Lick Creek at RM 1.25)					*WAP Ecoregion - WWH Existing*		
22.0[H]	42[NS]	N/A	G	50.0	FULL	Interstitial flow	2nd pass fish indicated interstitial conditions (8pt. drop between passes) Sig. drop in scores since 1997, 1988 Gravel mining
19.7[H]	44	N/A	E	63.5	FULL		Gravel mining
18.0[W]	45	8.7	VG	65.5	FULL	Interstitial flow	
14.9[W]/14.7	47	9.3	48	65.0	FULL		
4.7[W]/4.9	54	9.5	28*	61.0	PARTIAL	Impounded stream conditions at RM 4.9, enrichment, low flow, siltation	Refuse from bridge demolition acting as impoundment at about RM 4.8, open pasture ust., channel modifications

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/ Comments
0.3[W]	54	9.3	40	73.5	FULL	Siltation	
Tributary to Middle Fork Salt Lick Creek at RM 20.62					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.1[H]	46	N/A	-	41.5	(FULL)	Siltation Substrate disturbance	Gravel mining
Riley Run (Trib Middle Fork Salt Lick Creek at RM 18.1)					*WAP Ecoregion - WWH Existing*		
0.3[H]	32*	N/A	F*	60.0	**NON**	Interstitial flow, siltation	Unknown
Kelly Branch (Trib to Middle Fork Salt Lick Creek at RM 15.73)					*WAP Ecoregion - WWH Existing / EWH and CWH Recommended*		
1.5[H]	52/52	N/A	VG/ VG[NS]	57.5	FULL/FULL		
Trib to Middle Fork Salt Lick Creek at RM 13.00					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.6[H]	42 [NS]	N/A	G	25.0	FULL	Loss of trees in riparian corridor	Agricultural activities (crop field)
Pigeon Creek (Trib Middle Fork Salt Lick Creek at RM 4.37)					*WAP Ecoregion - WWH Existing*		
13.1[H]	42[NS]	N/A	F*	35.5	PARTIAL	Siltation, nutrient/organic enrichment, loss of trees in riparian corridor	Cows in stream, channelization Coalton WWTP/Glen Roy
12.3[H]	44	N/A	G	52.0	FULL	Siltation, nutrient enrichment, loss of trees in riparian corridor	
8.0[H]/7.8	44	N/A	G	62.0	FULL		
4.7[W]/4.6	49	9.0	42	60.5	FULL		
Trib to Pigeon Creek at RM 7.32					*WAP Ecoregion - Undesignated / WWH Recommended*		
2.4[H]	30*	N/A	MG[NS]	58.0	PARTIAL	Low to interstitial flow, siltation	Gravel mining

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/ Comments
0.1[H]	30*	N/A	P*	45.0	**NON**	Siltation, channel modifications	Cows in stream, channelization
Skunk Hollow Creek (Trib to Pigeon Creek at RM 6.66)					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.1[H]	42[NS]	N/A	G	63.5	FULL	Low flow, siltation	
Long Branch (Trib to Pigeon Creek at RM 3.16)					*WAP Ecoregion - WWH Existing*		
0.1[H]	46	N/A	G	59.0	FULL	Low flow, channel modifications	

Ecoregion Biocriteria: Eastern Corn Belt Plain

	IBI			**MIwb**			**ICI**		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	40	50	24	N/A	N/A	N/A	36	46	22
Wading	40	50	24	8.3	9.4	4.0	36	46	22
Boat	42	48	24	8.5	9.6	4.0	36	46	22

Ecoregion Biocriteria: Western Allegheny Plateau

	IBI			**MIwb**			**ICI**		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	44	50	24	N/A	N/A	N/A	36	46	22
Wading	44	50	24	8.4	9.4	4.0	36	46	22
Boat	40	48	24	8.6	9.6	4.0	36	46	22

H - Headwater site.

W - Wading site.

B - Boat site.

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

b - 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 were not available or considered unreliable due to sampling constraints. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional

c - Attainment status is given for both existing and proposed use designations.

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

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

N/A - Not applicable.

Recreation Use Attainment Status

All streams in the Salt Creek watershed are designated for Primary Contact Recreation (PCR) use in OAC Rule 3745-1-24. Water bodies with a designated recreational use of Primary Contact Recreation (PCR) "...are waters that, during the recreation season, are suitable for full body contact recreation such as ... swimming, canoeing, and SCUBA diving with minimal threat to public health as a result of water quality" [OAC 3745-1-07 (B)(4)(b)]. The recreational use water quality criteria applicable to the Salt Creek watershed are reported in Table 7-13 of OAC 3745-1-07. At least one of the two bacteriological standards (fecal coliform or *E. coli*) must be met. These criteria apply outside of the mixing zone. For the Primary Contact use, the following applies: fecal coliform - geometric mean fecal coliform content (either MPN or MF), based upon not less than five samples within a thirty-day period, shall not exceed 1,000 per 100 ml and fecal coliform content (either MPN or MF) shall not exceed 2,000 per 100 ml in more than ten percent of the samples taken during any thirty-day period. *E. coli* - geometric mean *E. coli* content (either MPN or MF), based upon not less than five samples within a thirty-day period, shall not exceed 126 per 100 ml and *E. coli* content (either MPN or M F) shall not exceed 298 per 100 ml in more than ten percent of the samples taken during any thirty-day period. Bacteriological results from environmental samples are typically reported as colony forming units (cfu) per 100 ml of water.

The recreation use attainment status for the main stem of Salt Creek (all sites), Middle Fork Salt Lick Creek (RM 0.27) and Salt Lick Creek (RM 3.9) were assessed by bacterial sampling. Results from the sampling indicate that these sites are in full attainment for recreation use (Table 3). All other sites had only two bacteria samples collected for screening level purposes. Each WAU summary provides detailed results from the sampling season.

As mentioned previously, fecal coliform bacteria are associated with warm blooded animals including human and animal sources throughout the Salt Creek watershed. In the Upper Salt Creek WAU (USCWAU), the headwater segment of Salt Creek has numerous home septic systems that discharge to the stream (Table 8). The unsewered Village of Adelphi has numerous failing septic systems discharging directly to the storm water sewers and therefore to tributaries to Salt Creek. Throughout portions of the Lower Salt Creek WAU (LSCWAU) and the Middle Fork Salt Creek WAU (MFSCWAU), failing home septic systems contribute to high bacteria results (Tables 37 and 18, respectively). In Salt Creek at RM 17.4 a popular swimming hole exists and this may be the cause of high bacteria results. In the Salt Lick Creek WAU (SLCWAU), the City of Jackson's old and failing sanitary sewer system and the WWTP are bacterial sources to Salt Lick Creek (Table 26). Additionally, failing home septic systems also contribute to high bacteria results in this watershed.

Animal sources of bacteria are usually more intermittent, as manure enters a stream via runoff associated with rainfall. However, if domestic livestock have direct access to streams, the effects on water quality are much greater. Each WAU had small livestock operations which provided cattle unrestricted access to streams. Allowing livestock to enter streams provides bacteria a direct route to stream systems. Water quality could improve throughout the study area by fencing livestock out of streams and by implementing proper manure management practices.

Table 3. Summary of bacteria sampling data for the main stem of Salt Creek and major tributaries. Attainment status is based on comparison of the geometric mean and 90th percentile values to the PCR criteria in Ohio Administrative Code (OAC 3745-1-07). The bold values exceed PCR maximum. All values in colony forming units (cfu) per 100 ml of water.

		Geometric Mean		**90th Percentile**		**Recreational**
Stream Name	**River mile**	**Fecal Coliform**	***E. coli***	**Fecal Coliform**	***E. coli***	**Attainment Status**
Salt Creek	42.6	256.7	256.7*	476	280	FULL
Salt Creek	38.26	691.6	**691.6**	892	**626**	FULL
Salt Creek	33.57	534.9	**534.9**	706	**512**	FULL
Salt Creek	32.28	424.1	424.1*	545	237	FULL
Salt Creek	25.9	75.3*	75.3*	146	141	FULL
Salt Creek	22.6	145	33	230	82	FULL
Salt Creek	17.44	311	**141**	518	**384**	FULL
Salt Creek	9.1	109	81	282	170	FULL
Salt Creek	6.0	270	105	326	176	FULL
Salt Creek	1.38	168	91	276	270	FULL
Middle Fork	0.27	111	68	422	260	FULL
Salt Lick Creek	3.9	270	117	444	**352**	FULL

* Only four samples evaluated.

Public Water Supplies

Water Quality Standards (WQS) established for the public drinking water supply (PDWS)beneficial use (OAC 3745-1-33) currently apply within 500 yards of an intake and for all publicly owned lakes. Ohio EPA is developing a new assessment methodology for this beneficial use which will focus assessments on source water contaminants not effectively removed through conventional treatment methods. Impaired source waters may contribute to increased human health risk or treatment costs. Public water systems must meet standards specified in the Safe Drinking Water Act (SDWA) including specific contaminant levels in the finished treated water. These treated water quality standards are defined as Maximum Contaminant Levels (MCLs) and represent the maximum allowable level of a contaminant that may be present without posing a high risk of health effects. Most of the surface water quality standards for protection of the PDWS beneficial use are referred to as drinking water standards and are defined as chemical criteria equivalent to the SDWA MCLs.

There is one public water system directly served by surface water within the Salt Creek watershed. Rose Lake is the source of drinking water for the Hocking Hills State Park. Rose Lake is a 16 acre impoundment formed by the construction of a dam on an unnamed tributary to Queer Creek in 1972. Maximum depth is about 55 feet. The water intake is about five feet below the normal lake surface.

The entire 192 acre Rose Lake watershed is owned by the State of Ohio, Hocking Hills State Park. There are no point source discharges in the watershed. The watershed land cover is 73% deciduous forest and 26% evergreen forest. The remaining 1% land use is roadways, berms and portions of the State Park campground. The highest point in the watershed is 1080 feet above sea level and the top of the dam is about 900 feet. The principal soil types within the watershed are the Shelocta-Dekalb-Lily association. These soils are generally described as deep and moderately deep, strongly sloping to very steep, well drained soils, derived from sandstone, siltstone and shale.

Rose Lake is managed by the Ohio Department of Natural Resources (ODNR), Divisions of Parks and Recreation and Wildlife. The lake has a normal warmwater assemblage of sport fish including largemouth bass, bluegill, redear sunfish, crappie, channel catfish, and bullhead. ODNR stocks trout in the spring for a put and take fishery. Fingerling channel catfish are stocked every other year. No motorized boats or swimming are allowed in the lake.

Rose Lake is designated Exceptional Warmwater Habitat. No exceedances of applicable water quality standards were observed. The results of bacteriological, trophic condition, inorganic, and organic parameters measured indicate that Rose Lake is oligotrophic with little anthropogenic contamination. The excellent condition of Rose Lake is a direct result of the forested watershed and lack of point source discharges.

Chemical Water Quality Status

Physical, chemical, and bacterial measurements were completed at 91 sites. Each site had at least five sets of grab samples collected at roughly two-week intervals during the each field season. Results that violated WQS criteria stipulated in Ohio Administrative Code (OAC) Chapter 3745-1 are detailed within each WAU exceedence table. The primary chemical causes of concern identified throughout the Salt basin were bacteria, nutrient enrichment (phosphorus and ammonia), and low dissolved oxygen. Bacterial results are briefly discussed under the Recreation Use Attainment Status section above, and detailed within each WAU. Variability among the chemicals of concern was noted between each WAU and may be associated with changes in land use.

Nutrient enrichment within the Salt Creek watershed was attributed primarily to the small unsewered communities, failing home septic systems and agricultural practices. In the SLCWAU, the City of Jackson’s WWTP has had repeated violations of the ammonia limit and a history of illegal bypasses of untreated sewage.

Sediment Quality

Sediment sampling was conducted at six Salt Creek main stem sites and eleven tributary sites including three Salt Lick Creek and five Middle Fork sites. Samples were analyzed for volatile and semivolatile organic compounds, pesticides, PCBs, and percent solids. Arsenic and magnesium were the only parameters above reference values collected in the USCWAU sediments. Concentrations in sediments did not appear to influence bottom dwelling organisms in the Salt Creek watershed.

Arsenic was above the threshold effect concentration at all Salt Creek main stem sites except at RM 17.4. The prevalence of arsenic in the watershed appears to be geologic in nature. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. Lead and nickel were the only other parameters above TEC in the watershed.

Fish Tissue

Throughout the state of Ohio there is a fish consumption advisory of no more than one meal per week of any sport fish due to mercury contamination. For the Salt Creek basin, there is an additional advisory of one meal per month for smallmouth bass. This advisory is specific for Salt Creek from Laurelville to the confluence with Queer Creek (6.9 miles). For additional information related to the Fish Consumption Advisory, please see the 2007 Ohio Sport Fish Consumption Advisory homepage at: http://www.epa.state.oh.us/dsw/fishadvisory.

Restoration and Protection Actions

Restoration and protection actions occur at many levels throughout the study area, primarily focusing on the rural landscape and natural geologic features. The rural landscape of the Salt Creek watershed had access to Federal programs such as the Scioto CREP directed by NRCS staff in the county agricultural offices. This and similar initiatives address erosion which causes soil particles to enter the stream system, likely carrying nutrients, herbicides and insecticides. The programs may subsidize the planting of trees and warm summer grasses which hold top soils and provide benefits for nearby streams including: shade, organic material as leaf fall, removal of chemical compounds such as nutrients via uptake by plants, woody debris, and habitat for birds (ODNR Scioto CREP).

Hocking Hills State Park contains over 2300 acres, Hocking State Forest encompasses over 9,600 acres, and Richland Furnace State Forest has 2,524 acres much of which lies within the Salt Creek watershed (ODNR State Forests & Recreation, ODNR State Parks). All areas promote responsible recreation within the natural beauty of southeastern Ohio while helping protect and sustain the natural formations and relic forest diversity from the glacial period. The increased tourism in the area should be managed to ensure the environmental integrity of the area remains intact.

RECOMMENDATIONS

Current and recommended aquatic life, water supply and recreation uses are presented in Table 4. A number of the tributary streams evaluated in this study were originally assigned aquatic life use designations in the 1978 and 1985 Ohio WQS based largely on best professional judgment, while others were left undesignated. The current biological assessment methods and numerical criteria did not exist then. This study, as an objective and robust evaluation of beneficial uses, is precedent setting in comparison to the 1978 and 1985 designations. Several sub-basin streams have been evaluated for the first time using a standardized biological approach as part of this study. Ohio EPA is obligated by a 1981 public notice to review and evaluate all aquatic life use designations outside of the Warmwater Habitat (WWH) use prior to basing any permitting actions on the existing, unverified use designations. Thus, some of the following aquatic life use recommendations constitute a fulfillment of that obligation.

Twenty-six streams were sampled for the first time by Ohio EPA during this study (Table 4). Eleven of the twenty-six streams were identified as having the potential to support WWH communities and have been recommended for WWH aquatic life use designations. Confirmation of the WWH designation based upon biological sampling was also completed for eight streams, five of which had not been previously sampled.

Coldwater Habitat (CWH) – Native Fauna Recommendations

The Salt Creek basin is known to have significant ground water inflow which is a glacial boundary phenomenon (Yoder, Pers. Comm.). This strong ground water connection is favorable for assemblages of coldwater organisms. Numerous streams in the Salt Creek basin have been recommended for the CWH designation as they supported assemblages of native coldwater organisms. These assemblages included at least four taxa of coldwater macroinvertebrates and/or a strong coldwater fish community consisting of at least two species of coldwater fish making up at least seven percent of the fish community.

The biological community of Kelly Branch, a tributary of Middle Fork Salt Creek, demonstrated coldwater communities with five coldwater macroinvertebrate taxa collected and the presence of mottled sculpin though no other coldwater fish species were noted near Township Road 2.

The upper portion of Pretty Run (headwaters to upstream Dry Branch at RM 1.9) and the North Branch Pretty Run site demonstrated the ability to support CWH assemblages. The former supported three coldwater macroinvertebrate taxa and two coldwater fish species, redside dace and mottled sculpin, which comprised approximately 9.5% of the fish community. The latter had five coldwater macroinvertebrate taxa and both redside dace and mottled sculpin were present.

Queer Creek and several of its tributaries also demonstrated strong coldwater communities. The headwaters of Queer Creek to Grove Road (RM 1.7) had five coldwater taxa. The East Fork Queer Creek had three coldwater macroinvertebrate taxa with 16% of the fish community comprised of redside dace and mottled sculpin. The tributary to East Fork Queer Creek at RM 3.95 supported six coldwater taxa and included redside dace and mottled sculpin within the fish community. Goose Creek had four coldwater macroinvertebrate taxa. The fish community included redside dace and mottled sculpin.

Pine Creek and Little Pine Creek both appeared capable of sustaining CWH communities. Pine Creek had at least four coldwater macroinvertebrate taxa present at each sampling site. Redside dace and mottled sculpin were present along Big Pine Road (RM 12.5). Little Pine Creek had two coldwater macroinvertebrate taxa with redside dace and mottled sculpin comprising 9.5% of the fish community.

The headwaters of Laurel Run to Toad Hollow Road (RM 9.0) supported coldwater fauna with the presence of five coldwater macroinvertebrate taxa and the presence of redside dace and mottled sculpin in the fish community. Cola Creek, a tributary to Laurel Run, had three coldwater macroinvertebrate taxa while 9.5% of the fish community was comprised of redside dace and mottled sculpin. Moccasin Creek, another tributary to Laurel Run, had at least five coldwater macroinvertebrate taxa collected at each site and redside dace were present within the fish community.

Exceptional Warmwater Habitat (EWH) Recommendations

Waters which support unusual and exceptional assemblages of aquatic organisms characterized by a high diversity of species, particularly those that are highly intolerant and/or rare, threatened, endangered or special status are candidates for the EWH designation. The Salt Creek main stem had previously received the EWH designation based largely upon best professional judgment. While sections of Salt Creek have been sampled over time, 2005 was the first time the entire main stem was sampled adequately to determine if the EWH designation was appropriate.

While the EWH designation is appropriate for Salt Creek, as the aquatic communities consistently exceeded exceptional thresholds, perturbations in the headwaters threaten its biodiversity and aquatic resource integrity. Excessive algal growth was an indication of nutrient enrichment at Heigle Road (RM 42.6), likely an artifact of the surrounding agricultural landscape. Embedded substrates, an indication of siltation, and the removal of the woody riparian buffer were additional potential causes of the aquatic life impairment. Though fully attaining EWH, threats to the integrity of Salt Creek were also noted near Adelphi

Road (RM 38.2). The remaining Salt Creek sites downstream to State Route 56 (RM 26.0) had exceptional macroinvertebrate communities with high diversities of EPT and sensitive taxa and strong fish communities. However, heavy siltation was observed at these stations and may contribute to future impairment if the observed practices of stream channel modifications, removal of the woody riparian and driving vehicles in the stream channel continue.

Further downstream, the presence of eastern sand darters (state species of special concern) and Tippecanoe darters (state threatened species) at five locations from Pretty Run Road (RM 17.4) to Richmond Dale (RM 1.5) along with bluebreast darters (state threatened status) at three locations within this same stretch of Salt Creek revealed the high quality and integrity of the fish community of Salt Creek. Biocriteria scores for Salt Creek were consistently within EWH expectations for both macroinvertebrates and fish, though highly embedded substrates at several sites highlight the threat siltation poses to the biotic integrity of the Salt Creek main stem.

In addition to the Salt Creek main stem, several tributaries are being recommended for the EWH designation. Pike Run received IBI scores in the exceptional range, 50 and 54, respectively, at the two sampled sites. Macroinvertebrate communities in Pike Run were in the good and very good range though organism density was low at both sites. However, overall stream habitat was very good at each site and appeared to be capable of supporting EWH communities. Sams Creek demonstrated EWH integrity with a fish community IBI score of 56 and macroinvertebrate community score in the exceptional range with high EPT (25) and sensitive taxa (29) diversities.

Two additional streams being recommended for EWH, Kelly Branch and Goose Creek, are also being recommended for CWH as discussed above. The EWH use is appropriate for Kelly Branch as it supported 25 sensitive macroinvertebrate taxa and received an IBI score of 52 for the fish community. However, siltation is a threat to the biotic integrity of the stream.

Goose Creek, a tributary to Queer Creek, is recommended for EWH in addition to the CWH designation discussed above. Goose Creek received an IBI score of 56, solidly within the EWH expectation for fish communities and included 25 species. The macroinvertebrate community received an overall rating of good. It is unclear what perturbation may be affecting the integrity of the macroinvertebrate community. Future studies should include an investigation of Goose Creek for activities which may be affecting the aquatic biological communities.

Two streams, Buckeye Creek and Jisco Creek, are being recommended for WWH, though each stream was originally assigned EWH through the 1978 and 1985 Ohio WQS based largely on best professional judgment. Habitat modifications to the streams through loss of trees in the riparian corridors and stormwater inputs from the surrounding urbanizing landscapes have created habitats best able to support WWH communities. Biological samplings at stations in both streams reflected communities not performing at even the WWH threshold.

Improvements may be made to water quality throughout the study area by addressing the causes and sources identified within the aquatic life use attainment table (Table 2). Causes and sources associated with agricultural practices may be addressed by improving riparian buffers, proper fertilizer and pesticide application, and ceasing of traditional ‘cleaning’ of streams. Funding opportunities should be sought to improve agricultural practices and could include any of the above listed improvements. Gravel mining in the streams should be discouraged, as should ATV recreation within stream channels. These local perturbations may potentially affect the long term integrity of the streams. Urbanization impairments could be addressed through a combination of regulatory, educational and funding actions including improvements at each WWTP, management of failing septic systems, advances in storm water management, controlled development and alternatives to traditional stream channelization and riparian removal.

Table 4. Waterbody use designations for the Salt Creek watershed. Designations based on Ohio EPA biological field assessments appear as a plus sign (+). Designated use based on 1978 water quality standards appear as an asterisk (*). Designations based on the 1978 and 1985 standards for which results of a biological field assessment are now available are displayed to the right of existing markers. Designated uses based on results other than Ohio EPA biological data are marked with a circle (o). 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	
Salt creek	*		*+						*+	*+		*+		
Whisky run	*	*							*	*		*		
Salt lick creek (little Salt creek) - bordering Lake Katherine nature preserve	*	+							+	+		+		
- all other segments		+							+	+		+		
Middle fork Salt creek (Tributary to Salt lick creek)	*	*+							*+	*+		*+		
Pigeon creek		*+							*+	*+		*+		
Long branch	*	*+							*+	*+		*+		
Skunk hollow creek		Δ							Δ	Δ		Δ		
Tributary to Pigeon creek at RM 7.52		Δ							Δ	Δ		Δ		
Glade run	*	*							*	*		*		
Stevens branch	*	*							*	*		*		
Tributary to Middle fork Salt creek at RM 13.00		Δ							Δ	Δ		Δ		

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	
Kelly branch	*	*	Δ			Δ			*+	*+		*+		
Riley run	*	*+							*+	*+		*+		
Tributary to Middle fork Salt creek at RM 20.6		Δ							Δ	Δ		Δ		
Pigeon Creek		Δ							Δ	Δ		Δ		
Poplar run	*	*+							*+	*+		*+		
Big run	*	*+							*+	*+		*+		
Dry run	*	*							*	*		*		
Sour run		Δ							Δ	Δ		Δ		
Rock run	*	*							*	*		*		
Buckeye creek		Δ	*						Δ	Δ		Δ		
Jisco lake tributaries	*		*						*	*		*		
Tributary to Salt Lick Creek at RM 22.55		Δ							Δ	Δ		Δ		
Horse Run		Δ							Δ	Δ		Δ		
Sugar Run		Δ							Δ	Δ		Δ		
Fourmile creek	*	*+							*+	*+		*+		
Goose creek	*	*							*	*		*		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SR W	W W H	E W H	M W H	S S H	C W H	L R W	P W S	A W S	I W S	B W	P C R	S C R	
Mulgee Run		Δ							Δ	Δ		Δ		
Poe run	*		+						*	*		+		
Bluelick run	*	*							*	*		*		
Cox run	*	*							*	*		*		
Pike run	*	*	Δ						*+	*+		*+		
East fork	*	*+							*+	*+		*+		
Pretty run (headwaters to upstream of Dry Branch (RM 1.9))	*		+			Δ			*+	*+		+		
Pretty run (Upstream of Dry Branch (RM 1.9) to mouth)	*		+						*+	*+		+		
Dry branch	*	*							*	*		*		
North branch	*	*+				Δ			*+	*+		*+		
Queer creek (headwaters to Grove Road (RM 1.7))	*		+			Δ			*+	*+		+		
Goose creek	*	*	Δ			Δ			*+	*+		*+		
East fork	*		+			Δ			*+	*+		+		
Tributary to East Fork Queer Creek at RM 3.95						Δ			Δ	Δ		Δ		
Queer creek (Grove Road (RM 1.7) to mouth)	*		+						*+	*+		+		
Blue creek	*	*							*	*		*		

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	
Pine creek	*	*+				Δ			*+	*+		*+		
Little Pine creek (headwaters to Wagner Road (RM 1.4))	*	*+				Δ			*+	*+		*+		
Little Pine creek (Wagner Road (RM 1.4) to mouth)	*	*+							*+	*+		*+		
Spruce run	*	*							*	*		*		
Rocky branch	*	*							*	*		*		
Little Blackjack branch	*	*							*	*		*		
Blackjack branch	*	*							*	*		*		
Sams creek	*	*	Δ						*+	*+		*+		
California branch	*	*							*	*		*		
Brimstone creek	*	*+							*+	*+		*+		
Laurel run (Headwaters to Toad Hollow (RM 9.0))	*		+			Δ			*+	*+		+		
Cola creek	*	*+				Δ			*+	*+		*+		
Little Cola creek	*	*							*	*		*		
Laurel run (Downstream of Toad Hollow (RM 9.0))	*		+						*+	*+		+		
Moccasin creek	*	*+				Δ			*+	*+		*+		
Dry run	*	*							*	*		*		
Middle fork	*		+						*+	*+		+		

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	
Long run	*	*							*	*		*		
Beech fork (Salt creek RM 34.1)			+						*+	*+		+		
Bull creek (Beech fork RM 1.54)	*	*+							*+	*+		*+		
Pikehole creek (Beech fork RM 1.9)	*	*							*	*		*		
Plum run	*		+						*+	*+		+		

METHODS

All physical, chemical, and biological field, laboratory, data processing, and data analysis methodologies and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989a) and Biological Criteria for the Protection of Aquatic Life, Volumes I-III (Ohio Environmental Protection Agency 1987a, 1987b, 1989b, 1989c), The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989, 1995) for aquatic habitat assessment, and the Ohio EPA Sediment Sampling Guide and Methodologies (Ohio EPA 2001). Sampling locations are listed in Table 1.

Determining Use Attainment Status

Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1). Assessing aquatic use attainment status involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-15). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multimetric biological indices including the IBI and MIwb, indices measuring the response of the fish community, and the ICI, which indicates the response of the macroinvertebrate community. Three attainment status results are possible at each sampling location - full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. An aquatic life use attainment table (Table 2) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile, the applicable biological indices, the use attainment status (*i.e.,* full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and a sampling location description.

Habitat Assessment

Physical habitat was evaluated using the QHEI developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the habitat characteristics used to determine the QHEI score which generally ranges from 20 to less than 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas whereas scores less than 45 generally cannot support a warmwater assemblage consistent with the WWH biological criteria. When a stream scores greater than 75, this frequently reflects habitat conditions which have the ability to support exceptional warmwater faunas.

Sediment and Surface Water Assessment

Fine grain sediment samples were collected in the upper 4 inches of bottom material at each location using decontaminated stainless steel scoops and excavated using nitrile gloves. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2001). Sediment grab samples were homogenized in stainless steel pans (material for VOC analysis was not homogenized), transferred into glass jars with teflon® lined lids, placed on ice (to maintain 4^{o}C) in a cooler, and shipped to Ohio EPA Division of Environmental Services. Sediment data is reported on a dry weight basis. Surface water samples were collected, preserved and delivered in appropriate containers to Ohio EPA Division of Environmental Services. Surface water samples were evaluated using comparisons to Ohio Water Quality Standards criteria, reference conditions, or published literature. Sediment evaluations were conducted using guidelines established in MacDonald *et al.* (2000) and Ohio Specific Reference Values (2003).

Recreational Use Assessment

Recreation use attainment was assessed by using fecal coliform and *E. coli* bacteria as test organisms. Their presence indicates that the water has been contaminated with feces from warm blooded animals. Counts are reported in colony forming units (CFU)/100 ml. To determine if criteria codified in OAC 3745-1-07 are met, a minimum of five samples must be collected within any 30-day period during the recreation season (May 1-October 15). Rules for the PCR use state that the fecal coliform geometric mean shall not exceed 1000 and not more than 10% of the samples shall exceed 2000 and that the *Escherichia coli* geometric mean shall not exceed 126 and not more than 10% of the samples shall exceed 298.

Macroinvertebrate Community Assessment

Macroinvertebrates were collected from artificial substrates and from the natural habitats. The artificial substrate collection provided quantitative data and consisted of a composite sample of five modified Hester-Dendy multiple-plate samplers colonized for six weeks. At the time of the artificial substrate collection, a qualitative multihabitat composite sample was also collected. This sampling effort consisted of an inventory of all observed macroinvertebrate taxa from the natural habitats at each site with no attempt to quantify populations other than notations on the predominance of specific taxa or taxa groups within major macrohabitat types (e.g., riffle, run, pool, margin). Detailed discussion of macroinvertebrate field and laboratory procedures is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989b).

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

Causal Associations
Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are used to judge aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria, within a weight of evidence framework, has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, land use data, and biological results (Yoder and Rankin 1995). Thus the assignment of principal causes and sources of impairment in this report represent the association of impairments (based on response indicators) with stressor and exposure indicators. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified, or have been experimentally or statistically linked together. The ultimate measure of success in water resource management is the restoration of lost or damaged ecosystem attributes including aquatic community structure and function. While there have been criticisms of misapplying the metaphor of ecosystem “health” compared to human patient “health” (Suter 1993), in this document we are referring to the process for evaluating biological integrity and causes or sources associated with observed impairments, not whether human health and ecosystem health are analogous concepts.

RESULTS

Upper Salt Creek Basin: HUC 05060002-070
Salt Creek headwaters to above Queer Creek

Includes tributaries: Plum Run, Beech Fork, Bull Creek, Laurel Run, Cola Run, Middle Fork Laurel Run, Moccasin Creek, Brimstone Creek, Sams Creek, Pine Creek, Little Pine Creek

Aquatic Life Use Attainment Status and Trends

The Salt Creek main stem was sampled in five locations and a total of twenty-two sites were sampled for aquatic life use assessment on tributaries (Table 5 and Figure 6). The Salt Creek main stem was in partial attainment of EWH designation in the headwaters near RM 42.6. Nutrient enrichment and siltation as a result of channel modifications for agricultural activities caused the impairment. Tree loss in the riparian corridor in conjunction with the channel modifications exacerbated the effects of the nutrient enrichment. The remaining four sites were in full attainment of EWH expectations, though nutrient enrichment and siltation from agricultural activities, septic systems and recreational driving within the stream channel were noted as potential concerns near RM 38.2.

Fifteen of the twenty-two sites were fully meeting their designated ALU. The remaining seven sites were in partial attainment of their designated ALU. Nutrient enrichment, siltation and loss of trees within the riparian corridor were the most common causes of impairment and occurred as a result of agricultural activities that included channel modifications.

Table 5. Aquatic life use attainment status for stations sampled in the Salt Creek basin based on data collected July-October 2005. 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 to support a biotic community.

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/Comments
Salt Creek		*ECBP Ecoregion - EWH Existing*					
42.6[H]	46[NS]	N/A	MG*	52.0	PARTIAL	Nutrient enrichment, loss of trees in riparian corridor, siltation	Agricultural activities, channel modifications
38.2[H]/38.3	54	N/A	E	53.0	FULL	Nutrient enrichment, siltation	Agricultural activities, septic systems, driving in stream channel
		WAP Ecoregion - EWH Existing					
33.35[W]/33.2	56	10.2	54	57.5	FULL		
32.3[W]/32.5	49[NS]	9.8	50	67.0	FULL		
25.9[W]/26.0	53	9.4	50	56.5	FULL		
Plum Run (Trib to Salt Creek at RM 34.62)				*ECBP Ecoregion - EWH Existing*			
0.3[H]	54	N/A	E	36.0	FULL		2 pt. IBI drop since 1992, six fewer species
Beech Fork (Trib to Salt Creek at RM 34.12)					*ECBP Ecoregion - EWH Existing*		
2.3[H] /2.3	46[NS]	N/A	G*	24.0	PARTIAL	Nutrient enrichment, loss of trees in riparian corridor, siltation	Agricultural activities, channel modifications
1.1[H]	52	N/A	G*	36.5	PARTIAL	Nutrient enrichment, loss of trees in riparian corridor, siltation	Agricultural activities, channel modifications; 6pt drop in IBI since 1992, 13 fewer species.

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/Comments
Bull Creek (Trib to Beech Fork at RM 1.54)					*ECBP Ecoregion – WWH Existing*		
0.8[H]/0.6	50	N/A	VG	58.5	FULL		
Laurel Run (Trib to Salt Creek at RM 33.10)					*WAP Ecoregion - EWH Existing and CWH Recommended*		
9.6[H]	46 [NS]	N/A	F*	63.0	PARTIAL	Siltation, loss of trees in riparian corridor	Channelization
					WAP Ecoregion - EWH Existing		
7.8[H]	58	N/A	MG*	69.0	PARTIAL	Siltation	Agricultural activities, channel modifications
2.6[W]/2.4	55	10.0	40*	68.5	PARTIAL	Siltation	Agricultural activities, channel modifications
0.1[W]	50	9.5	54	58.5	FULL	Loss of trees in riparian corridor, siltation	Channelization
Cola Run (Trib to Laurel Run at RM 9.40)					*WAP Ecoregion - WWH Existing /CWH Recommended*		
0.1[H]	48	N/A	G	44.0	FULL		
Middle Fork (Trib to Laurel Run at RM 2.97)					*WAP Ecoregion - EWH Existing*		
3.7[H]/3.8	54	N/A	G*	57.0	PARTIAL	Siltation	
0.1[H]/0.2	56	N/A	E	75.5	FULL		
Moccasin Creek (Trib to Laurel Run at RM 1.75)					*WAP Ecoregion - WWH Existing /CWH Recommended*		
4.6[H]	50	N/A	G	65.0	FULL		
2.5[H]	42 [NS]	N/A	G	60.0	FULL		
Brimstone Creek (Trib to Salt Creek at RM 32.25)					*WAP Ecoregion - WWH Existing*		
0.35[H](Ust. WWTP)	50	N/A	G	65.5	FULL		

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/Comments
0.3(Mix Zone)	31	N/A	-	-	N/A	Avoidance occurs	
0.1[H]/0.15(Dst WWTP)	53	N/A	G	41.0	FULL	Siltation	Gravel removal from stream
Sams Creek (Trib to Salt Creek at RM 29.4)					*WAP Ecoregion - WWH Existing / EWH Recommended*		
0.3[H]	56/56		E/E	45.0	FULL/FULL		
Pine Creek (Trib to Salt Creek at RM 28.04)					*WAP Ecoregion - WWH Existing / CWH Recommended*		
12.5[H]	50	N/A	G	66.5	FULL		
11.2[H]	50	N/A	MG[NS]	71.5	FULL		
8.8[H]	42[NS]	N/A	F*	72.5	PARTIAL	Siltation	
2.0[W]	47	7.9[NS]	48	66.5	FULL		
Little Pine Creek (Trib to Pine Creek at RM 1.34)					*WAP Ecoregion - WWH Existing /CWH Recommended*		
1.9[H]/2.2	44	N/A	G	60.0	FULL		
					WAP Ecoregion - WWH Existing		
0.6[H]	54	N/A	G	53.0	FULL		

Ecoregion Biocriteria: Eastern Corn Belt Plain

	IBI			**MIwb**			**ICI**		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	40	50	24	N/A	N/A	N/A	36	46	22
Wading	40	50	24	8.3	9.4	4.0	36	46	22
Boat	42	48	24	8.5	9.6	4.0	36	46	22

Ecoregion Biocriteria: Western Allegheny Plateau

	IBI			**MIwb**			**ICI**		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	44	50	24	N/A	N/A	N/A	36	46	22
Wading	44	50	24	8.4	9.4	4.0	36	46	22
Boat	40	48	24	8.6	9.6	4.0	36	46	22

H - Headwater site.

W - Wading site.

B - Boat site.

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

b - 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 were not available or considered unreliable due to sampling constraints. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional

c - Attainment status is given for both existing and proposed use designations.

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

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

N/A - Not applicable.

Table 6. Exceedences of Ohio Water Quality Standards (WQS) criteria (Ohio Administrate Code 3745-1) for chemical and bacterial parameters in the USCWAU found during the 2005 field season. D.O. results are in mg/l, pH is in S.U. and *E. coli* and fecal coliform are in cfu/100 ml. Use designations within Upper Salt Creek basin include: Aquatic Life – Exceptional Warmwater Habitat (EWH); Warmwater Habitat (WWH); Agricultural Water Supply (AWS); Industrial Water Supply (IWS); Primary Contact Recreational (PCR) and State Resource Water (SRW).

Stream River mile	**(use designation) Parameter (value)**	**Biological Attainment**	**QHEI Score**
Upper Salt Creek (HUC 05060002 070)			
Salt Creek	(SRW, EWH, AWS, IWS, PCR)		
46.2	D.O. (4.84[a])	PARTIAL	52.0
38.26	*E. coli* (446.3[b], 626[c])	FULL	53.0
33.57	*E. coli* (338.62[b], 512[c])	FULL	57.5
Plum Run (to Salt Creek)	(SRW, EWH, AWS, IWS, PCR)		
0.3	*E. coli* (1414[c])	FULL	36.0
Beech Fork (to Salt Creek)	(EWH, AWS, IWS, PCR)		
1.09	*E. coli* (443[c])	FULL	24.0
0.74	*E. coli* (480[c])	FULL	36.5
Bull Run (to Beech Fork)	(SRW, EWH, AWS, IWS, PCR)		
0.74	Fecal coliform(3030[c]), *E. coli* (2250[c])	FULL	58.5
Laurel Run (to Salt Cr.)	(SRW, EWH, AWS, IWS, PCR)		
9.55	pH (6.11[d]), *E. coli* (1556[c])	PARTIAL	63.0
7.57	Fecal coliform(3978[c]), *E. coli* (2313[c])	PARTIAL	69.0
2.67	Fecal coliform(3500[c]), *E. coli* (3334[c])	PARTIAL	68.5
0.05	pH (9.19[d]), *E. coli* (350[c])	FULL	58.5
Cola Run (to Laurel Run))	(SRW, EWH, AWS, IWS, PCR)		
0.05	*E. coli* (3320[c])	FULL	44.0
Middle Fork (to Laurel Run)	(EWH, AWS, IWS, PCR)		
3.63	*E. coli* (883[c])	PARTIAL	57.0
0.15	Fecal coliform(2607[c]), *E. coli* (646[c])	FULL	75.5
Moccasin Creek (to Laurel Run))	(SRW, EWH, AWS, IWS, PCR)		
4.68	*E. coli* (1054[c])	FULL	65.0
UT to Salt Creek Adelphi storm sewer			
	D.O. (3.74[a])		
Sams Creek (to Salt Cr.)	(SRW, WWH, AWS, IWS, PCR)		
0.28	D.O. (3.24[a])	FULL	45.0
Pine Creek (to Salt Cr.)	(SRW, WWH, AWS, IWS, PCR)		
12.38	pH (6.45[d]), *E. coli* (869[c])	FULL	66.5
11.7	pH (6.3, 6.29[d]), *E. coli* (1177[c])	FULL	71.5
8.76	pH (6.45[d])	PARTIAL	72.5
1.97	pH (6.39[d])	FULL	66.5
Little Pine Creek (to Pine Cr.)	(SRW, WWH, AWS, IWS, PCR)		
1.84	*E. coli* (477[c])	FULL	60.0
0.54	pH (6.45[d])	FULL	53.0

a Below the minimum criterion for the protection of aquatic life.

b Exceeds the PCR 30 day geometric mean
c Exceeds the PCR 30 day maximum
d Exceeds the minimum (6.5) or maximum (9.0) WQS.

Table 7. Facilities regulated by an individual NPDES permit in USCWAU. There are no General NPDES permits in USCWAU.

Facility Name	OEPA Permit No.	Receiving Stream	RM	Wastewater and Treatment Type
Laurelville WWTP	0PA00013	Brimstone Creek	0.3	sanitary 0.20 mgd tertiary lagoon plant
Old Man's Cave Chalets	0PR00114	UT Lt Blackjack Branch	0.9	sanitary 2500 gpd package plant
Resort at Blackjack Lake*	0PR00123	Blackjack Branch	~1.1	sanitary 3000 gpd package plant

* NPDES application submitted but not issued.

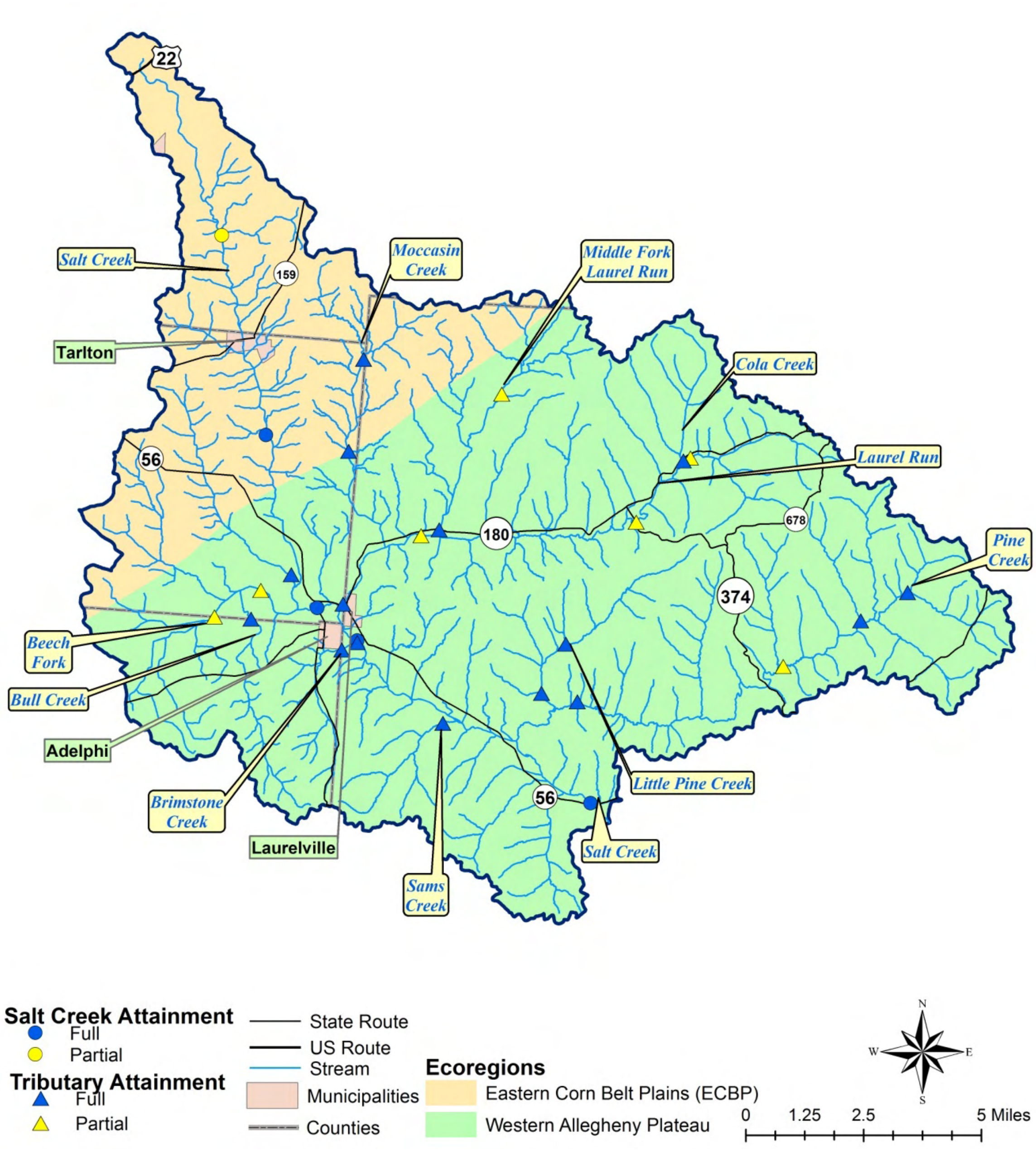


Figure 6. Attainment status of sampling locations within the upper Salt Creek basin based on 2005 data.

Recreation Use Attainment Status

Fecal coliform bacteria are microscopic organisms that are present in large quantities in the feces of humans and warm blooded animals. E.coli comprises a significant amount of the bacterial organisms found in human feces (Dufour 1977). Fecal coliform and E. coli enter the waterways through partially treated or untreated sanitary wastewater or animal manures. Letting grazing animals have direct access to streams for watering allows deposition of fecal matter into the stream. Storm water runoff from pasture land and areas that have manure stored also contribute to elevated fecal coliform and E. coli concentrations in streams. The presence of fecal coliform and E. coli in streams indicates the possible presence of disease causing pathogens. These organisms become a concern to humans when the stream is used for recreation, whether wading, swimming or other water/body contact pursuits.

Salt Creek sites at RM 38.26 and 33.57 had a water quality violation for *E. coli* for the sampling period of June 16th through July 13th. Both sites violated the *E. coli* 30 geometric mean and 30 day maximum, although these sites still maintain the recreational use **(**Tables 6 and 9). The fecal coliform results were elevated, but were below the WQS. This upper portion of the assessment unit is comprised of mostly agriculture and home septic systems. *E. coli* exceeded WQS for PCR in Salt Creek at RM 33.57. The unsewered Village of Adelphi and the sewered Village of Laurelville are located along this stream.

Most of the smaller tributary streams to upper Salt Creek had *E. coli*. Bull Run, Middle Fork of Laurel Run (RM 0.15), and Laurel Run (RMs 7.57 and 2.67) are in non-attainment for the recreational use designation (Table 9). These sites had *E. coli* and fecal coliform above the 90th percentile thirty day maximum. All tributary sites were only sampled two times, so actual geometric mean standards could not be determined.

Laurel Run exceeded *E. coli* and fecal coliform PCR maximum value at all four sampling locations. At Laurel Run RMs 2.67 and 7.57 fecal coliform exceeded the PCR maximum values as well, placing these two sites in non-attainment for the recreational use designation. The elevated nutrient and bacterial results were due in part to home septic systems and manure runoff from animal pastures. Also contributing to the high bacteria concentrations was the re-suspension of sediment solids during rain events. Sediments in the stream system can contain large amounts of pathogenic organisms and bacteria which can lead to increased bacteria counts in the stream (Ohio EPA 2006b).

Cola Run exceeded the *E. coli* PCR maximum. These high values may be a result of rain events re-suspending bacteria from the sediment or from washing manure and septage out of drainage ways and into Cola Run during the sampling events. Both Middle Fork sites exceeded the *E. coli* PCR maximum and at RM 0.15 fecal coliform exceeded the PCR maximum values as well, placing this site in non-attainment for the recreational use designation. The Moccasin Creek sub-watershed has more homes than others in the Laurel Run watershed all of which are on home septic treatment systems. E. coli was above the PCR maximum at the Moccasin Creek RM 4.68.

The Village of Adelphi has approximately 375 people. Ohio EPA had received and investigated complaints regarding unsanitary conditions in the Village. Two Adelphi storm sewers were sampled. Walnut Street and Poplar Street storm sewers were discovered to be discharging raw sewage. The Village of Adelphi's Poplar Street storm sewer discharges to an unnamed tributary to Brimstone Creek upstream of the Laurelville WWTP discharge. The two fecal coliform results from the Poplar Street storm sewer were 60,000 and 65,000 cfu/100 ml exceeding the 1000 cfu/100 ml PCR maximum. The Walnut Street storm sewer discharges to an unnamed tributary to Salt Creek, near Salt Creek RM 33.57. The two fecal coliform results from the storm sewer were 555,000 and 215,000 cfu/100 ml. The resolution to the unsanitary conditions is further discussed in the Brimstone Creek.

Pine Creek sites at river miles 1.97, 11.2 and 12.4 and Little Pine Creek RM 1.84 all exceeded the 90th percentile *E. coli*. The elevated bacteria counts are a result predominately from failing home septic systems with some live stock contributions.

Spills

Pollutant discharges from spills, overflows and other unauthorized releases can be significant sources of lethal and sub-lethal stresses to the aquatic communities in Salt Creek watershed. Sixteen spills were reported to the Ohio EPA Emergency Response Section from January 2000 through April 2007. Four spills were related to sanitary or agricultural waste water. Five spills reported were petroleum related materials. No spills were reported to be associated with a fish kill.

Ecoregion, Soils, and Topography

The 174 mi^2 upper Salt Creek watershed is located within two ecoregions. The westerly portions of the watershed, including the Salt Creek headwaters and extending near Laurel Run, Plum Run and Beech Fork are within the ECBP. The remainder, more eastern and southern portions of the watershed including Laurel Run and Pine Creek, are in the WAP. Middle Fork (watershed) of Laurel Run is within the Illinoian ground moraine region and Laurel Run tributary Moccasin Creek is in a Wisconsin outwash valley (1999 ODNR).

The ECBP are rolling till plains with some end moraines. The deep well drained soils are developed from the limey Wisconsin glacial deposits. Beach, oak, ash, elm and maple forests are indigenous. Much of the land now supports corn, soybean and livestock production (Woods, *et al*., 1998).

Soil regions of the ECBP within the watershed are Clermont, Rossmoyne, Avonburg, and Cincinnati. The Clermont series consists of very deep, poorly drained, soils on Illinoian till plains. These soils typically are on broad level areas or shallow depressions of the till plains, but slopes range from 0 to 2 percent. They are usually cultivated with corn, soybeans, and wheat, though pastures and forests are also present. Native vegetation consists primarily of mixed hardwoods, mainly pin oak, soft maple, ash, and elm. The Rossmoyne series consists of very deep moderately well drained soils that are moderately deep and used for general farming. Cultivated crops are mainly corn, wheat, soybeans, grass and legumes, and tobacco. Some Rossmoyne soils are used for pasture or woodland, and a small portion is idle. Native vegetation is deciduous hardwoods including beech, white and red oaks, maple, hickory, and tulip poplar. The Avonburg series consists of very deep, somewhat poorly drained soils that formed in loess and the underlying paleosol in till. Avonburg soils are on summits of loess-covered till plains. While slopes range from 0 to 6 percent, most areas are being used to grow corn and soybeans, though occasional areas are used for growing small grain, mainly wheat, hay and pasture or woodland. Native vegetation is mixed hardwood forest, similar to the Clermont series. The Cincinnati series consists of very deep, well drained soils that are moderately deep. These soils are used for growing corn, wheat, soybeans, tobacco, and forages, both grasses and legumes. A considerable percentage of the Cincinnati soils is used for pasture or woodland, or is idle. Native vegetation is deciduous mixed hardwoods, including oaks, hickory, tulip poplar, maple, and beech (NRCS, 2004).

The WAP ecoregion is characterized by rugged narrow valleys and ridges. The region is underlain with Mississippian shale and limestone. Coal is found in portions of the ecoregion and extraction often results in degradation of water quality. Mixed oak forests are indigenous. Row cropping is limited to relatively flat floodplains adjacent to streams. Cattle are primarily grazed in the valleys and ridges. Forests predominate the slopes (Woods, *et al*., 1998).

Soils of the Western Allegheny Plateau region of the watershed are of the Shelocta, Brownsville, Latham, and Steinsburg series. The Shelocta series consists of deep and very deep, well drained, moderately permeable soils. They are on steep concave mountain sides, foot slopes, and benches, and therefore are primarily forested, with only small areas cleared for pastures or agricultural cultivation. The Brownsville series consists of deep, well drained soils found on hillsides and summits within the WAP. Due to their geographic setting, they are primarily associated with forests, though occasionally are cleared for pasture. The Latham series consists of moderately deep, moderately well drained soils found to either be located within forests of oaks and hickory species, or to have been cleared for pasture and crops of corn, wheat, and oats. Soils of the Steinsburg series are moderately deep and well drained which makes them agreeable to the primary land use of cropland and pasture. The few wooded areas present with Steinsburg soils are dominated by oak, maple and ash species (NRCS, 2004).

As described by the soil classifications above, land use throughout the upper Salt Creek basin is primarily a mixture of forest and agriculture (Table 8). The predominant land use is forest (60.5%), with cultivated crops (20.4%), and grassland/hay (14.3%) comprising over a 1/3 of the land. Developed areas and open water comprise the smallest areas, 4.7% and 0.1%, respectively. While land use is primarily forest when the land use is examined for the entire watershed, an examination of land within the 14 digit subwatersheds shows great variation. Subwatersheds within the ECBP are dominated by row crops. The Salt Creek Headwaters to Tarlton portion are 70.9% cultivated crop. Meanwhile, most of the WAP region is dominated by forest cover. Pine Creek is 88.6% forest.

Table 8. Upper Salt Creek land use as derived from National Land Cover Database (NLCD 2001).

14-Digit HUC	Narrative Description	Open Water	Developed	Barren Land	Forest	Shrubs/ Scrubs	Grassland/ Hay	Cultivated Crop	Wetland	Total Acres
05060002070010	Salt Creek headwaters down to Tarlton at St. Rt. 159	0.0%	6.3%	0.0%	20.8%	0.0%	1.9%	70.9%	0.0%	7,366.1
05060002070020	Salt Creek below Tarlton at St. Rt. 159 to above Beech Fork	0.0%	4.7%	0.0%	16.9%	0.0%	26.0%	52.3%	0.0%	10,366.2
05060002070030	Beech Fork Salt Creek headwaters to Salt Creek	0.0%	3.9%	0.0%	18.3%	0.1%	32.2%	45.4%	0.0%	12,714.3
05060002070040	Salt Creek below Beech Fork to above Queer Cr. [except Laurel Run & Pine Cr.]	0.3%	5.2%	0.0%	74.0%	0.1%	11.9%	8.6%	0.0%	20,490.5
05060002070050	Laurel Run [except Middle Fork & Moccasin Cr.]	0.1%	5.3%	0.0%	77.2%	0.0%	13.7%	3.7%	0.0%	20,309.7
05060002070060	Middle Fork	0.1%	5.0%	0.0%	73.9%	0.0%	15.5%	5.5%	0.0%	7,301.2
05060002070070	Moccasin Creek	0.1%	3.5%	0.0%	38.5%	0.0%	17.3%	40.6%	0.0%	7,335.2
05060002070080	Pine Creek	0.0%	3.8%	0.0%	88.6%	0.0%	5.7%	1.8%	0.0%	25,887.3
	Upper Salt Cr. aggregate	0.1%	4.7%	0.0%	60.5%	0.0%	14.3%	20.4%	0.0%	111,770.5

Chemical Water Quality and Sediment Quality

The Ohio EPA is currently developing nutrient criteria based on stream size and aquatic life use designation. This will be a deviation from the current WQS for ammonia which is based on the relationship between temperature and pH. The Ohio River basin does not have a WQS for phosphorus. Public and industrial waste water treatment plants (WWTP) are to monitor phosphorus and ammonia based on the Ohio EPA's July 2002 guidance document. Nutrients are a primary chemical cause of impairment. To date, Ohio EPA uses target values as guidelines (Ohio EPA, 1999) based on the relationship between watershed size, IBI scores and ecoregion. Watershed size is defined as: headwater streams (≤20 miles^2), wadeable streams (>20miles^2≤200 miles^2), small rivers (>200miles^2≤1000 miles^2), and large rivers (>1000miles^2). There are no large rivers segments in the Salt Creek watershed.

Salt Creek

The upper segment of Salt Creek begins at State Route 22, near the Pickaway and Fairfield County line and the upper segment ends below State Route 56, at the confluence of Queer Creek and Salt Creek at RM 33.55. The USCWAU drains about 174 square miles (ODNR 2001). Salt Creek is designated as an Outstanding State Water based on exceptional ecological values as promulgated in Ohio Administrative Code (OAC) 3745-1-05. Outstanding State Water designation requires that the director shall reserve seventy per cent of the remaining available pollutant assimilative capacity for all regulated pollutants for which water quality criteria have been adopted in or developed. Five main stem sites were sampled to evaluate chemical, biological and bacterial conditions.

The upper most portion of the USCWAU is within the glaciated Eastern Corn Belt Plateau (ECBP) ecoregion and land use is mostly row crop agriculture and animal grazing. At RM 46.2, there are numerous houses along the stream which may contribute to elevated bacteria and nutrient enrichment through poorly operating and/or failing home septic systems. The sample results show elevated nutrients, though they are below the target range, except for ammonia (Figures 7). Due to the habitat alteration of the stream in this area, the stream may not have the physical ability to assimilate the nutrient discharges. There is a scattering of small concentrated residential communities in the upper watershed. Tarlton, located at RM 40.0, is the largest community at an estimated 296 people. The Village of Tarlton has obtained the necessary permits from Ohio EPA to correct unsanitary conditions within the Village. However these permits have expired because Tarlton was unable to secure funding. The sampling conducted in 2005 did show an impact downstream of Tarlton with ammonia above the targeted 0.05 mg/l. Phosphorus and Total Kjehldahl Nitrogen (TKN) were elevated, but below the targets of 0.07 and 0.40 mg/l respectively. *Escherichia coli* (*E.coli*) exceeded PCR criteria in Salt Creek at RMs 38.26 and 33.57, while fecal coliform met PCR criteria.

Datasonde© continuous monitors were deployed from June 21st through 23rd 2005 and recorded hourly dissolved oxygen (D.O.) concentration, D.O. percent saturation, temperature, pH and conductivity for five sites in USCWAU. A summary of the D.O. data is presented in Figure 8 and Table10. All Datasonde© D.O. concentrations remained above the applicable any time minimum water quality criteria (4.0 mg/l for WWH and 5.0 mg/l for EWH) and the minimum 24-hour average criteria (5.0 mg/l for WWH and 6.0 mg/l for EWH). Typically, lower D.O. values were recorded during the night when algal respiration uses dissolved oxygen.

At the Spangler Road site, (Salt Creek RM 38.26), the D.O. fluctuations were more extreme with a maximum D.O. of 11.01 mg/l recorded at 2:00 pm June 21st and a minimum D.O. of 5.82 at 1:00 am June 23rd. The first 24-hour sampling period had a 4.7 mg/l swing and the second 24-hour period had a 5.1 mg/l difference. There is mounting evidence that dissolved oxygen concentrations that fluctuate more than 5 mg/l (minimum/maximum) over a diurnal period have a negative impact on aquatic life. The D.O. fluctuation causes stress to aquatic organisms and significantly reduces IBI and EPT scores (MN PCA, 2003). The D.O. saturation reached well into the 130 percent range in the afternoon and evening and then fell into the 60-70 percent range at night and morning. Maximum values are important if they are at supersaturated levels. This phenomenon results in a fish ailment known as gas bubble disease. Initially, it causes gas bubbles to form on external surfaces and blocks the flow of water across the gills. As the disease progresses, it causes bubbles to form behind the eyes (pop-eyed) and in the blood. This can restrict or stop blood flow, damage tissues and eventually cause mortality. Supersaturation levels of 115 to 125 percent are lethal for most fish. (Tchobanoglous, 1985).

Temperatures at RM 38.2 had a maximum of 26.1^{o}C and minimum 18.3 ^{o}C. The Salt Creek site at RM 25.9 had a much smaller D.O. variation with a maximum of 8.84 mg/l and a minimum of 5.9 mg/l. Temperature variation had a maximum of 28^{o}C and a minimum of 21.1 ^{o}C. Higher temperatures in stream reduce the amount of D.O. available to the aquatic inhabitants. The D.O. saturation range at RM 25.9 reached a maximum of 108.7% and a minimum of 71% over the sampling period. The smaller changes in D.O. and temperature over the two day sampling period at river mile 25.9 are due to the larger size of the stream and the natural cover (riparian cover) along the stream (Figure 8 and Table 9).

The D.O. fluctuations in the upper portion of this Salt Creek are attributed, in part, to the high nutrients. The nutrients provide food for algae in the stream which in turn consumes the D.O. during the periods of respiration. Ammonia was consistently above the 0.05 mg/l target level. Phosphorus and TKN were below the targeted values but were elevated and contributed to the algae growth. Iron and manganese levels in the USCWAU main stem are well within the target values although some tributaries (within the WAP ecoregion) have higher than target levels for iron and manganese.

Salt Creek enters the WAP region at RM 33.55 along the Lattaville glacial (ODNR 1985) terminal moraine from the Wisconsin glaciation. Row crop agriculture is intensive along the wide stream valley. From this point to RM 25.9, Salt Creek has ammonia concentrations consistently above the 0.05 mg/l target level. TKN was detected above the 0.30 mg/l target, but the median for the field season was below that level. Agricultural, unsewered communities and failing home septic systems are the mostly sources of high nutrients.

Plum Run
The Plum Run watershed drains approximately 5.46 square miles. Plum Run is within the ECBP ecoregion and is heavily impacted by large, intensive row crop farms. All nutrient measurements were within target values. One iron (400 ug/l) and three manganese samples (146, 110, and 95 ug/l) were above the 220 ug/l iron target value and 95 ug/l manganese target value for ECBP headwaters.

Beech Fork
The Beech Fork watershed drains approximately 19.74 square miles. Beech Fork is listed as a Superior High Quality Water (SHQW) in the OAC 3745-1-05 (Antidegradation Rule). SHQW designation requires that the director shall reserve thirty-five per cent of the remaining available pollutant assimilative capacity for all regulated pollutants for which water quality criteria have been established. Beech Fork is within the ECBP ecoregion and is heavily impacted by large, intensive row crop farms. Beech Fork had some sampling results above the targets for TKN, phosphorus and ammonia, but the median results were below the target values. The nitrate-nitrite levels were above the 1.25 mg/l target 3 out of 6 times and two of the other results were above 1 mg/l.

Bull Run (to Beech Fork)
The Bull Run watershed drains approximately 4.06 square miles and has a recommended use designation of SRW, WWH and PCR based on 1978 water quality standards. Bull Run had some nutrients that were above the targeted values, but the sampling location was in the lower reach of the stream which is heavily cultivated. The upper reach is fully within the WAP ecoregion while the lower section is in the ECBP ecoregion.

Laurel Run
The Laurel Run watershed drains approximately 54.96 square miles. Laurel Run is listed as a SHQW in the OAC 3745-1-05. Laurel Run is located within the WAP ecoregion with large row crop farms in the wide valley and steep wooded hills surrounding the stream valley. Homes are sparsely built throughout the watershed, the number of recreational rental cabins has significantly increased in the headwaters of Laurel Run near the Hocking Hills State Forest and Hocking Hills State Park. The local

health department oversees the design, construction and operation of these small sanitary treatment units at the cabins.

In the upper most portion of Laurel Run (RM 9.55) ammonia was detected from 0.06 to 0.177 mg/l (WWH target 0.05 mg/l) and TKN was over the target of 0.3 mg/l in two samples. At Laurel Run RM 7.57, ammonia exceeded the target in all six samples and TKN twice (Figures 9). The lower section of Laurel Run (RM 2.67 and 0.05) had elevated ammonia results above the target concentration.

A Datasonde© continuous monitor (Figure 8 and Table 8) was deployed from June 21st through 23rd 2005 at RM 0.05. All Datasonde© D.O. concentrations remained above the applicable minimum, any time, water quality criteria (5.0 mg/l for EWH) and the minimum 24-hour average criteria (6.0 mg/l for EWH). A 2.6 mg/l D.O. fluctuation was recorded over the total continuous monitoring period.

The eastern section of the WAP ecoregion, which includes Hocking, Vinton and Jackson Counties, is underlain by sandstone. The sandstone is composed of small grains of mineral quartz which is cemented together by silica or iron oxide. This type of sandstone is very resistant to weather, but due to rainwater, the freeze/thaw cycle and the chemical action of weak natural acids, the sandstone breaks down. Some sandstone in the region has pyrite as a component. Pyrite is sulfur and iron mineral which when dissolved in the presence of oxygen can create sulfuric acid (H_2SO_4).

Iron and manganese were consistently above the target values of 665 and 105 mg/l in the upper reaches of the watershed. Iron was detected from 679 to 3930 mg/l in the upper two sites and manganese was detected from 55 to 1190 ug/l. Iron and manganese diminished in the lower sections, but iron was still in the 800 to 600 ug/l range (Figure 10). The iron may be a result of the sandstone geology of the area. Acidity values throughout the watershed were below the laboratory detection level of 5.0 mg/l. In areas where coal mining has occurred, acidity is typically elevated due to acid mine drainage. Iron and manganese also appear in higher than normal concentrations in the mined areas. Therefore the high iron and manganese results are assumed naturally occurring and not from coal mining activities. The Ohio Department of Natural Resources Mineral Resource Management (ODNR-MRM) mining maps do not show any coal mining in this watershed. The mining maps are not 100 % complete since some information has been lost or was not recorded. A pH value of 6.11 was collected at river mile 9.55. The average pH was 7.2 SU over the field sampling period at this site. WQS for pH is 6.5 SU (minimum) and 9.0 SU (maximum). The low pH may again be attributed to the pyretic sandstone geology. At RM 0.05 a pH of 9.19 SU (this is a glaciated outwash area) was collected during chemistry sampling and the Datasonde© pH averaged 8.1 SU during the 46 hour sampling period at this site.

Cola Run
The Cola Run watershed drains approximately 4.68 square miles. There were repeated exceedances of the target of 0.05 mg/l for ammonia in Cola Run. One TKN value was above the target and one phosphorus sample was 0.456 mg/l. The phosphorus target value is 0.05 mg/l. WWH targeted values were exceeded for iron and manganese.

Middle Fork
The Middle Fork watershed drains approximately 11.8 square miles. Middle Fork is listed as a SHQW in the OAC 3745-1-05. Middle Fork is listed as being in the WAP ecoregion but is clearly within the Illinoian ground moraine region. The watershed has farming in the glacial till stream valley surrounded by steep wooded hills. There are homes sparsely placed throughout the watershed with home septic systems. There were several slight exceedances of target values for nutrients, as well as elevated iron values.

Moccasin Creek
The Moccasin Creek watershed drains approximately 11.44 square miles. Moccasin Creek is listed as being within the WAP, but clearly is within a late-Wisconsin glacial outwash valley. As a result of this geologic setting, there were no iron or manganese sampling results above the WWH targets. The Moccasin Creek sub-watershed has more homes than others in the Laurel Run watershed all of which are on home septic treatment systems. There were several exceedances of target values for nutrients, but only slightly over the targets.

Brimstone Creek and Adelphi tributaries
The Brimstone Creek watershed drains approximately 4.38 square. Brimstone Creek is within the WAP ecoregion and enters Salt Creek at RM 32.25. Both the Laurelville WWTP and the south Adelphi storm sewers discharge to Brimstone Creek.

A Datasonde© continuous monitor was deployed from June 21st through 23rd 2005 at RM 0.1 (Figure 8). All Datasonde© D.O. concentrations remained above the applicable minimum, any time, water quality criteria of 4.0 mg/l for WWH and the minimum 24-hour average criteria of 5.0 mg/l for WWH. Typically, lower D.O. values were recorded during the night when algal respiration uses dissolved oxygen. A 6.2 mg/l D.O. fluctuation was recorded over the second 24-hour recording period. D.O. saturation well exceeded 100% (reaching 150%) in the afternoon and evening and fell into the 60-70% range at night and in the morning. The maximum values are important since they are above the supersaturated levels which can lead to an ailment known as gas bubble disease. Fish mortality can occur when saturation reaches 140% and lesser impacts can happen at levels as low as 104%.

The Village of Laurelville has approximately 550 people, with numerous small commercial businesses, churches and a school. The Village of Laurelville's WWTP plant discharges to Brimstone Creek at RM 0.3. The entire community is serviced by the sanitary sewers. The WWTP was built in 1980 to serve Laurelville and Adelphi and is designed to treat 200,000 gallons per day of sanitary wastewater. Laurelville averages 100,000 gpd during normal, non-rain, operations. Although Laurelville has infiltration and inflow problems, this has not resulted in operational problems. The WWTP is comprised of an influent pump station, bar screen/cumminator (grinder), four aerated lagoons, Aquamat® nutrient removal units, two sand filters and a cascade aeration discharge. The WWTP had a complete rebuild in 1992.

In early 2004, the Village of Laurelville determined that in order to cut costs and continue to meet effluent limits at the WWTP, the Village discontinued the use of the Aquamat® nutrient removal system. The Aquamat® system consists of two large concrete tanks that have a fibrous mat material hanging from wires into the tanks. Effluent from the lagoons is pumped into the tanks and flows through the suspended mats. Additionally, nitrifying bacteria are injected into the tanks and attach to the mat material. As colonies of bacteria grow, they consume nitrogen (ammonia) and phosphorus. Without the Aquamat® in service, Laurelville WWTP had nine NPDES permit limit violations for ammonia. In April 2006, the Village of Laurelville began using the Aquamat® system and operating the WWTP as it was designed.

Effluent sampling results from the Laurelville WWTP during the 2005 field season for arsenic ranged from 3.1ug/l to 6.4ug/l, in contrast, upstream samples results were below the 2.0 ug/l WWH target. One effluent sample from the WWTP for copper was 12 ug/l while up and downstream samples were below the 10.0 ug/l WWH target value. There were no effluent limit exceedences for ammonia at the WWTP during the sampling season, but the sampling results for nutrients were all above the WWH target levels. Downstream sampling results for nutrients were also all above the WWH target values. All fecal coliform samples from the WWTP, upstream and downstream of the WWTP were below the PCR criteria. The Village of Adelphi's Poplar Street storm sewer discharges to an unnamed tributary to Brimstone Creek upstream of the WWTP discharge. The one sampling result from the storm sewer was 1.86 mg/l for nitrate-nitrite; 6.97 mg/l for ammonia; 8.96 mg/l for TKN and 1.37 mg/l for phosphorus. The two fecal coliform results were in the 60,000 range at the Poplar Street storm sewer.

The Village of Adelphi has approximately 375 people. The Village had originally planned to connect to the Laurelville WWTP in 1980. Adelphi later decided to withdraw from the agreement. Ohio EPA had received and investigated complaints regarding unsanitary conditions in the Village. Two Adelphi storm sewers were sampled. Walnut Street and Poplar Street storm sewers were discovered to be discharging raw sewage (Walnut St. storm sewer results Table 11). In 1996, Adelphi approached Ohio EPA to start the process of installing sewers and connecting to the Laurelville WWTP. In 1997 Adelphi received a Permit to Install for sanitary sewers and began construction of the sewer system in 1999. Numerous problems occurred during construction and renegotiation of the contract with Laurelville for wastewater treatment service delayed further progress. To date, Adelphi has not completed the contract agreement with Laurelville and has not completed the sanitary sewer system. On March 14, 2007 the Chief of the Division of Surface Water sent a letter to Adelphi outlining a timeframe for correcting the unsanitary conditions caused by the Village.

Sams Creek

Sams Creek enters Salt Creek at RM 29.4 and drains 4.34 square miles. The watershed is sparsely populated and heavily wooded. Three iron samples were above the 460 mg/l WWH target value and one manganese sample was above the 130 mg/l WWH target. Only two ammonia samples (0.058 and 0.061 mg/l) were above the 0.05 mg/l target.

Pine Creek

The Pine Creek watershed drains 40.6 square miles. Pine Creek is listed as a SHQW in the OAC 3745-1-05. Ammonia was consistently above the WWH target value of 0.05 mg/l throughout the watershed as shown in Figure 11. The other nutrient values were above the WWH targets. A Datasonde© continuous monitor was deployed from June 21st through 23rd 2005 (Figure 8 and Table 10). The D.O. saturation had no real fluctuation. D.O. maximum was 6.8 mg/l and minimum was 5.78 mg/l, both within the WWH WQS any time value of 4.0 and 24-hour average of 5.0 mg/l. D.O. percent saturation varied from 76% to 64%. The field chemistry sampling results on June 21st and July 19th for D.O. were recorded at 2.78 mg/l and 3.89 mg/l respectively (Table 6). The Datasonde© pH was within the WQS of 9.0 SU maximum and 6.5 SU minimum. On June 21st and July 7th pH values at RM 11.17 and 12.38 were below the WQS of 6.5 SU. On June 21st at RM 1.97 pH was 6.39 SU and July 7th at RM 8.76 pH was 6.45 SU. All other pH values were within the WQS. The low pH values may be a result of the predominance of sandstone in the watershed. Iron and manganese levels were typically above WWH target values throughout the watershed (Figures 12). Acidity was below the laboratory detection value indicating geologic causes for low pH and high iron and manganese values.

One NPDES permitted WWTP facility is located in the Pine Creek watershed. Another facility, Resort at Blackjack Lake (RBL), has an NPDES permit application on file, but the permit has not been issued to date. The RBL is currently in full seasonal operation. RBL is located in the headwaters of Blackjack Branch. This is a campground and cabin rental facility that provides sanitary waste water treatment at an extended aeration package plant.

Near the mouth of Blackjack Branch is Blackjack Lake which was built in the 1920s. Over the years it had filled with sediment. The property owners claim that coal strip mining conducted in the headwaters and poor reclamation were the main cause of the sediment. ODNR-MRM maps show that approximately 100 acres of coal strip mining was done after the 1976. In 1977 the Surface Mining Control and Reclamation Act was passed and the act required strip mines to be reclaimed. In 1996 Blackjack Lake dam breeched under the stream right abutment and discharged large volumes of sediment into Pine Creek at RM 12.4 and then into Salt Creek (Figures 13 and 14). The property

Figure 13. Looking upstream into the drained Blackjack Lake.

Figure 14. Salt Creek, downstream of the Pine Creek confluence, note sediment plume.

owners around the lake looked at a repair, but the repair estimate was very expensive. Grass has since covered much of the lake bed.

Old Mans Cave Chalets (OMCC) WWTP discharges to an unnamed tributary to Little Blackjack Branch. OMCC is a campground and cabin rental facility with a swimming pool. The WWTP has an NPDES permit and has had repeated NPDES permit limit violations due to poor WWTP operation. In 2005, OMCC had fourteen NPDES permit limit violations for ammonia.

Little Pine Creek

The Little Pine Creek watershed drains 8.02 square miles. Ammonia, iron and manganese were above the WWH targeted values (Figures 11 and 12). One pH value was below 6.5 SU WQS at RM 0.54.

Sediment Quality

Sediment samples were collected at two Salt Creek main stem sites and one site on Laurel Run during the 2005 field season. The sediment samples, within the Salt Creek survey, were analyzed for metals, ammonia and phosphorus. The results show that arsenic was above the Threshold Effect Concentration at Salt Creek RM 39.9 and 25.9 and Laurel Run RM10.05 (Table 12). Nickel was above the TEC at Salt Creek RM 39.9. These results do not appear to have affected the macroinvertebrate communities at these sites.

Table 9. Summary of bacteria data for the upper Salt Creek watershed sites (HUC 070). Values are based on comparison of the geometric mean and 90th percentile values to the PCR criteria in Ohio Administrative Code (OAC 3745-1-07). The bold values exceed PCR maximum. All values in colony forming units (cfu) per 100 ml of water.

		Geometric Mean		**90th Percentile**		**Potential Sources**
Stream Name	**River mile**	**Fecal Coliform**	***E. coli***	**Fecal Coliform**	***E. coli***	
Salt Creek	42.6	256.7	256.7*	476	280	HS
Salt Creek	38.26	691.6	**691.6**	892	**626**	HS
Salt Creek	33.57	534.9	**534.9**	706	**512**	HS, Ag
Salt Creek	32.28	424.1	424.1*	545	**237**	HS, UC
Salt Creek	25.9	75.3*	75.3*	146	141	HS, Ag
Plum Run	0.3	452	984	1097	**1414**	Ag
Bull Creek	0.74	2191	1491	**3030**	**2250**	HS, Ag
Beech Fork	1.09	404	307	466	**443**	Ag
Beech Fork	0.74	500	250	615	**480**	Ag
Cola Run	0.05	2550	2439	1700	**3320**	HS, LS
Middle Fork	3.63	1296	810.6	900	**883**	HS
Middle Fork	0.15	1560	647	**2607**	**646**	HS
Moccasin Creek	4.68	917	839	1320	**1054**	HS
Moccasin Creek	2.53	52	41	244	154	HS
Laurel Run	9.55	625	665	1376	**1556**	HS
Laurel Run	7.57	890	678	**3978**	**2313**	HS, Ag, LS
Laurel Run	2.67	2508	1840	**3500**	**3334**	HS, Ag, LS
Laurel Run	0.05	184	108	316	**350**	
Adelphi South Sewer - Popular St.	0.17	62450	19799	**64500**	**72490**	Unsewered Community
Adelphi North Sewer - Walnut St.	0.35	191311	13564 7	**555000**	**215000**	Unsewered Community
Brimstone Creek	0.36	235	120	247	153	
Laurelville WWTP	0.3	17	10	28	10	
Brimstone Creek	0.02	215	75	311	79	
Sams Creek	0.28	22	36	46	118	LS, HS
L. Pine Creek	1.84	400	303	740	**477**	HS
Pine Creek	12.4	335	219	1447	**869**	HS
Pine Creek	11.2	564	302	593	**1177**	HS
Pine Creek	1.97	449	375	551	**552**	HS

* Only four samples evaluated.
N/A – Discharge point therefore not applicable.
HS - Home Septic; Ag. – Agricultural Practices; LS – Livestock; UC – Unsewered community

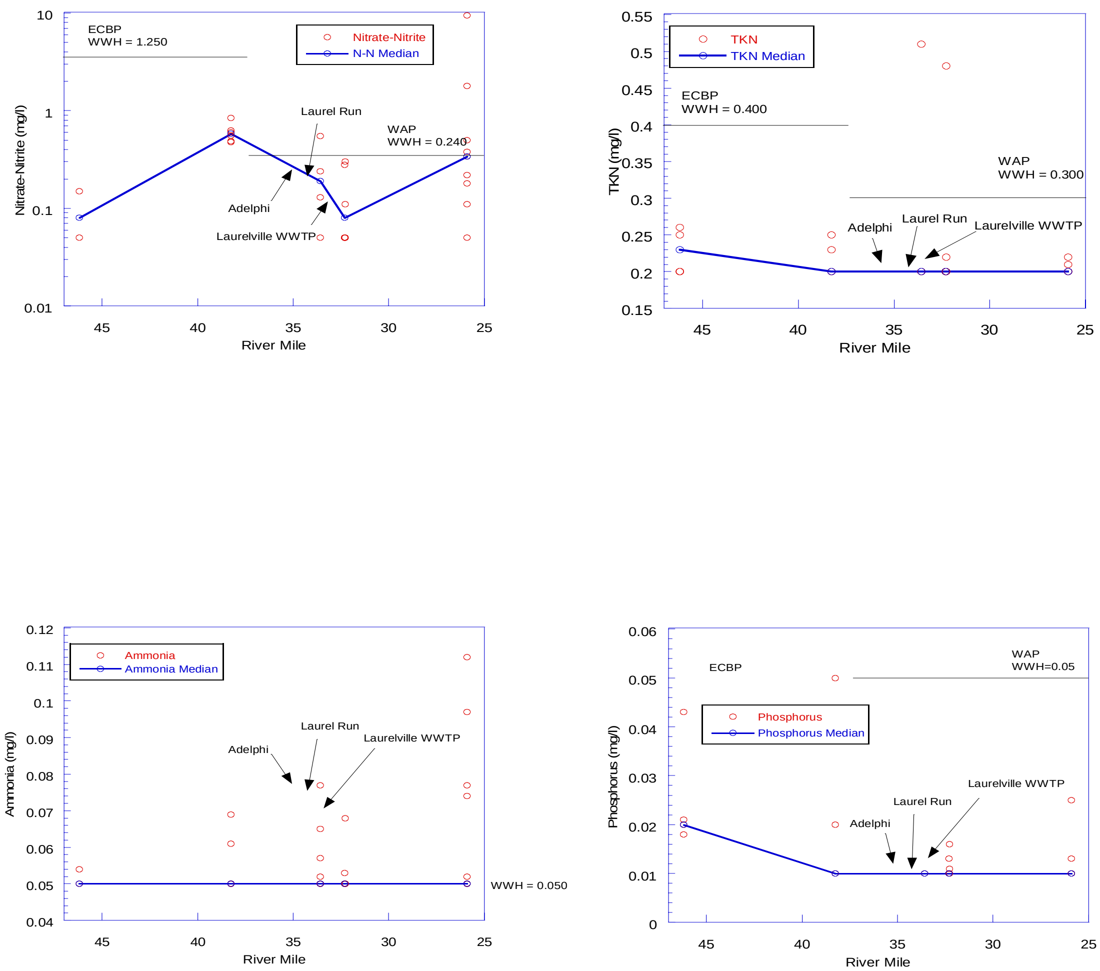


Figure 7. Nutrient concentrations found in the upper Salt Creek main stem. The WWH target values are noted for the WAP ecoregion headwater and wadeable streams (Ohio EPA, 1999).

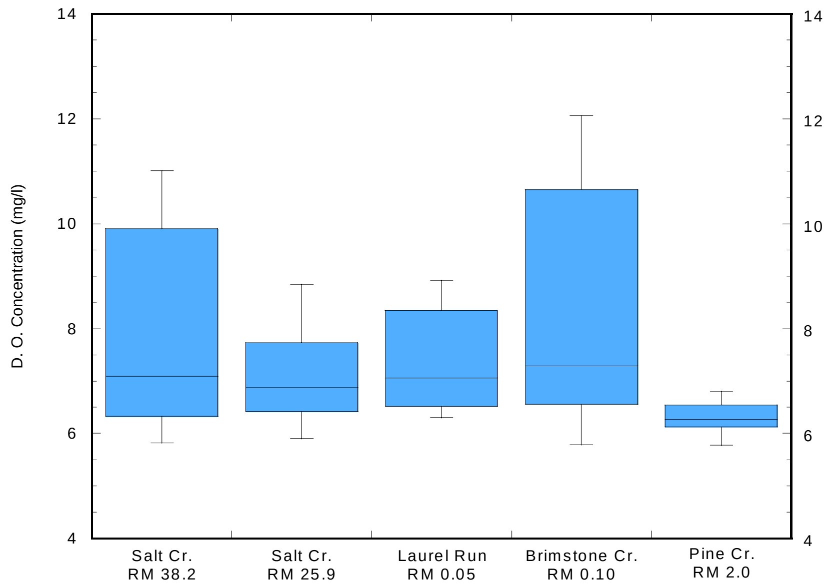


Figure 8. Box plots of hourly dissolved oxygen measurements from upper Salt Creek and tributaries. Aquatic life warmwater habitat water quality criteria are 4 mg/l minimum and 5 mg/l average (Brimstone and Pine Creeks) and for exceptional warmwater habitat are 5 mg/l minimum and 6 mg/l average in Salt Creek and Laurel Run.

Table 10. Summary of hourly dissolved oxygen measurements (mg/L) recorded by Datasonde© continuous monitors in the upper Salt Creek.

Stream	**River Mile**	**Hours Logged**	**Mean D.O.**	**Median D.O.**	**Minimum D.O.**	**Maximum D.O.**
June 21 - 23, 2005						
Salt Creek	38.2	46	7.94	7.09	5.82	11.01
Salt Creek	25.9	45	7.07	6.875	5.9	8.84
Laurel Run	0.05	46	7.39	7.06	6.3	8.92
Brimstone Creek	0.1	47	8.34	7.29	5.79	12.06
Pine Creek	2.0	46	6.31	6.27	5.78	6.8

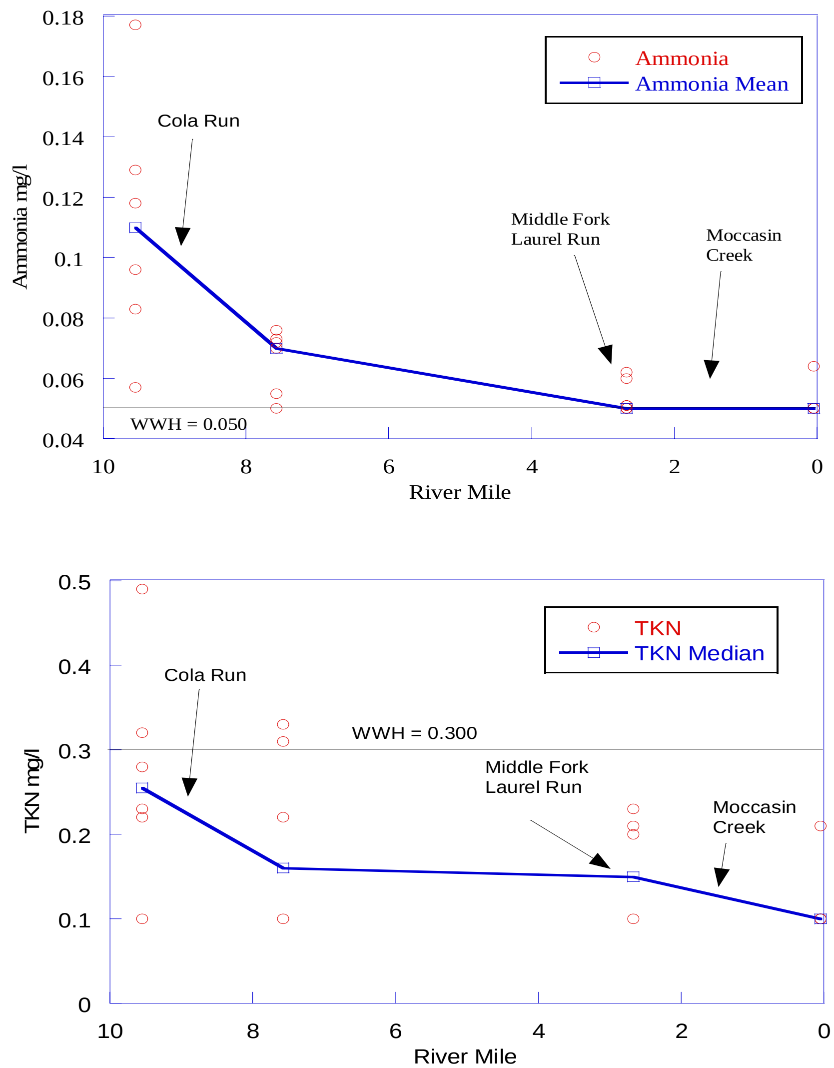


Figure 9. Ammonia and TKN concentration values in Laurel Run main stem. The WWH target values are noted for the WAP ecoregion headwater and wadeable streams (Ohio EPA, 1999).

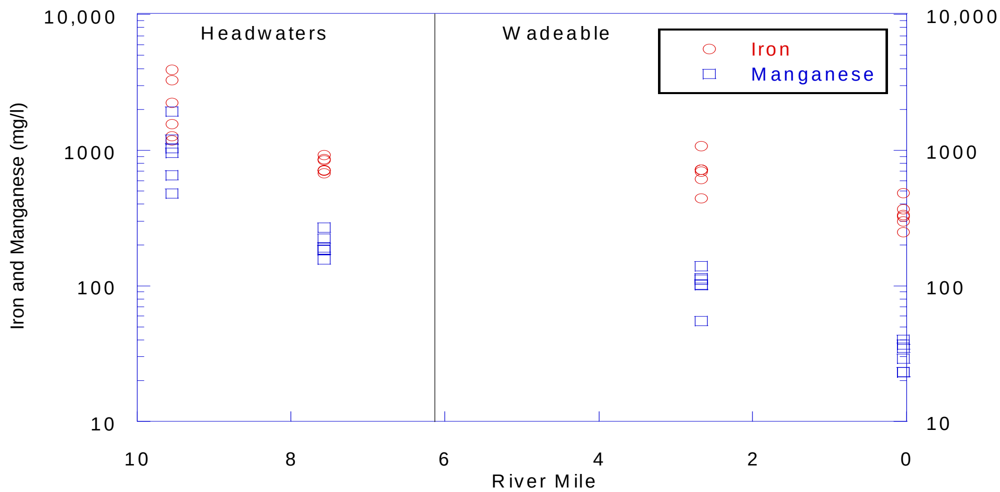


Figure 10. Iron and manganese concentrations found in Laurel Run during the 2005 field season. The WAP WWH iron target is 460 mg/l for wadeable and 665 mg/l for headwater streams. The WAP WWH manganese target is 220 mg/l for wadeable and 130 mg/l for headwater streams.

Table11. Sample results from the Village of Adelphi's Walnut Street storm sewer.

Parameter	Sample Result	Target Value
Arsenic	6.7 ug/l	2.0 ug/l
Cadmium	0.62 ug/l	0.20 ug/l
Copper	47 ug/l	45.5 ug/l*
Lead	21.2 ug/l	2.0 ug/l
Iron	12,100 ug/l	460 ug/l
Manganese	947 ug/l	130 ug/l
Zinc	193 ug/l	10.0 ug/l
Barium	311 ug/l	200 ug/l
Ammonia	22.6 mg/l	9.1 mg/l*
Phosphorus	4.36 mg/l	0.05 mg/l
TKN	30.3 mg/l	0.3 mg/l
Fecal coliform	610,000; 60,000 cfu	2000 cfu*
E. coli	230,000; 80,000 cfu	298 cfu*

* Water Quality Standard value. Ammonia WQS value determined at 19.64^{o}C and 8.04 S.U. (pH).

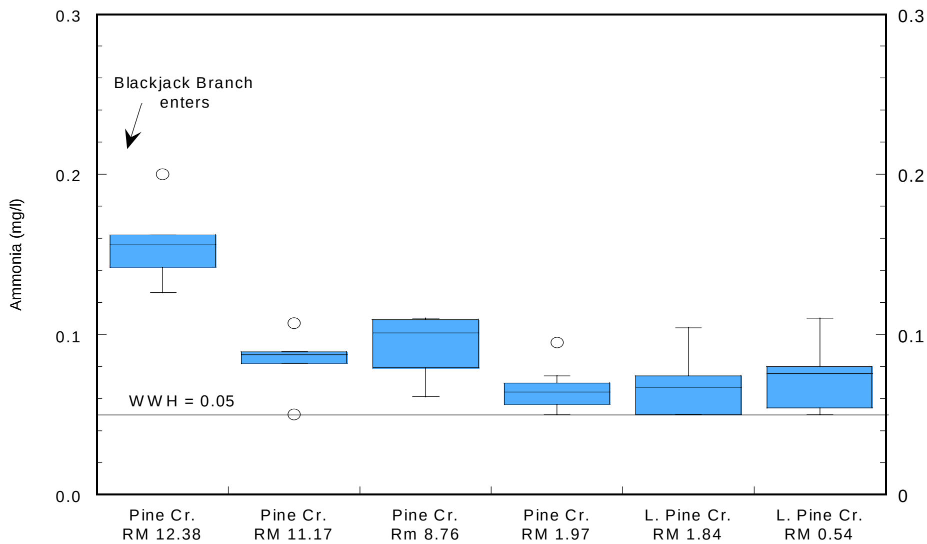
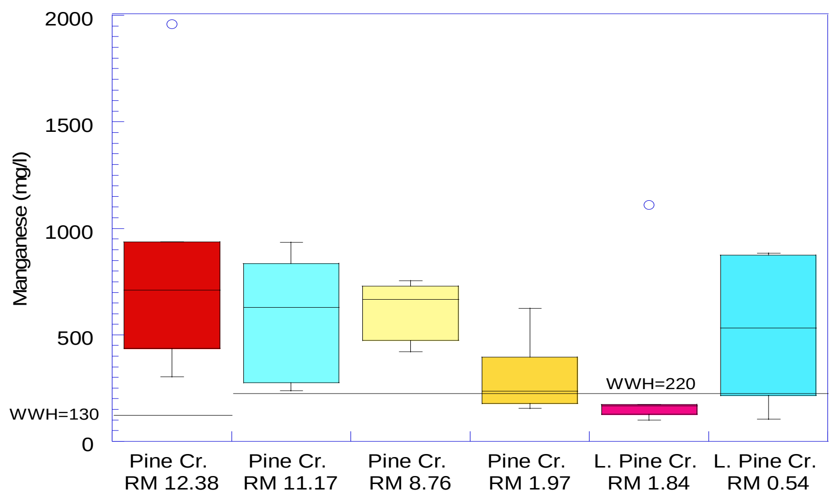


Figure 11. Ammonia concentrations found in Pine Creek and Little Pine Creek. The WWH ammonia target value for WAP ecoregion is noted for headwater and wadeable streams (Ohio EPA, 1999).



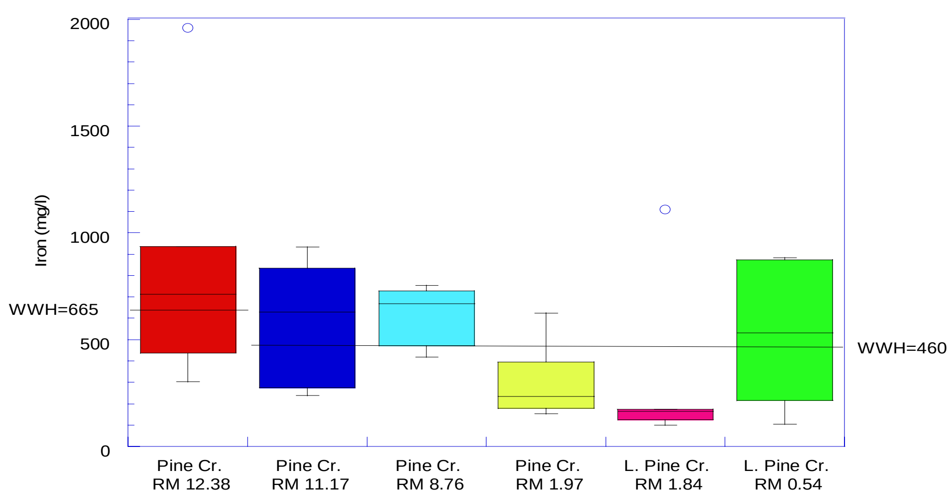


Figure 12. Iron and manganese concentration values in the Pine Creek watershed. The WWH target values are noted for WAP ecoregion headwater and wadeable streams (Ohio EPA,1999).

Table 12. Metal and chemical concentrations and physical quality in sediment samples collected from the USCWAU in the 2005.

Stream Segment	**Salt Creek**	**Salt Creek**	**Laurel Run**
River mile	38.3	25.9	0.05
PARAMETER	**Sample Results**		
Aluminum	21300	9820	14000
Arsenic	20.6[TEC]	15.8 [TEC]	13.8 [TEC]
Barium	192	70.7	118
Cadmium	0.482	0.156	0.226
Calcium	17100	12400	34300
Chromium	24	14	18
Copper	14.8	5.3	11.3
Iron	23900	18900	16200
Lead	23	19	22
Magnesium	6580	5160	10700
Manganese	670	318	586
Mercury	0.028	0.028	0.033
Nickel	23 [TEC]	19	22
Potassium	5020	2600	3260
Selenium	1.16	0.93	1.11
Strontium	41	22	50
Zinc	143	45	76.9
% Solids*	56.6	71.5	59
Ammonia*	92	15	12
Sodium*	2900	2330	2780
%Total Organic Carbon*	4	1.3	4.3
Total Phosphorus*	874	265	285

All parameters in mg/kg except %.
[TEC] Value above the threshold effect concentration (MacDonald *et al.* 2000).
Underlined values indicate concentrations below method detection limit.
* Does not have SRV (sediment reference value) or TEC association.

Physical Habitat

The physical habitat of 27 locations within the upper Salt Creek basin was evaluated with the QHEI. As Figure 14 shows, the majority of sites scored within the fair to good range. Five of the six sites that scored less than fair were <10 mi^2 in drainage area. Channelization activities, both recent and historic, appeared to be the primary cause of the lower habitat scores. In addition, Salt Creek RM 38.2 and Brimstone Creek RM 0.1 were impacted by gravel mining. The only site >10 mi^2 in drainage area that received a QHEI score in the poor range was Beech Fork RM 1.1. The low habitat score was a direct result of channel modifications for agricultural purposes.

The average QHEI=57.2 (range of 52 to 67) for main stem sites and similarly, the tributaries had an average QHEI=57.1, though the range of scores extended from 24 to 75.5. The majority of habitat conditions indicate the ability of streams within the upper Salt Creek basin to support WWH communities, however, channel modifications through agricultural activities and gravel mining along with use by ATVs may negatively affect biological community performance.

Salt Creek

The physical habitat of Salt Creek was evaluated in five locations in the upper Salt Creek basin. Agricultural activities influenced the quality of habitat available to aquatic life at the upper two sites, RM 42.6 and 38.2. This reach of Salt Creek was recovering from past channelization activities with poor to fair channel development and low stability. Row crops extended to the stream bank at each location and the only wooded riparian buffers were narrow (5-10m) and present along residential homes. The remaining sites along Salt Creek were recovered from past channelization activities or did not show any evidence of having been altered. QHEI scores for the uppermost two sites were 52.0 and 53.0, respectively. The remaining sites along Salt Creek ranged from 57.5 to 67.0, with an average score of 61.3.

Plum Run

The physical habitat of Plum Run was evaluated near Hayesville-Adelphi Road (RM 0.3). The streambed was derived from sandstone and tills. Sand and silt dominated the streambed, though areas of hardpan and gravel were also observed. Moderate to heavy amounts of silt blanketed the substrates, limiting the amount of interstitial spaces available for aquatic organisms. The lack of recovery from channelization activities was evident by the numerous false banks, poor channel development and low stream stability though a moderately high amount of sinuosity was also noted. Only sparse amounts of instream cover was present and included undercut banks, overhanging vegetation, shallows and the occasional rootwad and woody debris. No riparian buffers were present adjacent to the stream. Land use beyond the stream was a mixture of homes and crop fields, though cows were noted in a pasture downstream of the sampling location.

The highly modified conditions of Plum Run resulted in a QHEI score of 38.0, which is a 26 point drop in QHEI from the score of 62.0 at the same site in 1992. In 1992, the stream appeared to have recovered from past channelization activities with good channel development and moderate amounts of instream cover. Present conditions indicate that channelization or maintenance activities have occurred in the recent past, as the stream channel showed no recovery from channelization activities with poor development and only sparse amounts of instream cover.

Beech Fork

The physical habitat of Beech Fork was evaluated near County Line Road (RM 2.3) and Tarlton-Adelphi Road (RM 1.1). The streambed originated from tills and hardpan. Sand and gravel dominated the substrates present with areas of hardpan, silt and riprap. Substrates were extensively embedded and silt was present in moderate amounts. The channel appeared to be recovering from past channelization activities with low sinuosity, poor to fair development and low stability. Instream cover was nearly absent with only overhanging vegetation and shallows providing refuge for aquatic organisms. Crop fields extended to each stream bank without any riparian buffers present.

The QHEI scores for Beech Fork reflected the highly modified conditions present, with a low score of 24.0 near County Line Road (RM 2.3) and 36.5 near Tarlton-Adelphi Road (RM 1.1). In 1992, the site near Tarlton-Adelphi Road (RM 1.1) received a QHEI score of 64.0. At that time, diverse streambed substrates included boulders, cobble, gravel, sand and hardpan with moderate amounts of embeddedness. Instream cover was present in moderate amounts and included undercut banks, overhanging vegetation, shallows, deep pools (>70 cm), rootwads, and woody debris. In 2005, substrates were less diverse, extensively embedded and instream cover was nearly absent, resulting in lower quality habitat available for aquatic life. These factors, likely a result of continued stream maintenance activities, resulted in a 27.5 point drop in QHEI scores over time.

Bull Creek

The physical habitat of Bull Creek was evaluated near Kingston-Adelphi Road (RM 0.8). The streambed originated from a mixture of tills and sandstone. Gravel dominated the substrates though cobble, hardpan, silt and rip-rap were also present. Normal amounts of silt were present and substrates appeared to be normally to moderately embedded. Instream cover for aquatic organisms was provided by moderate amounts of undercut banks, overhanging vegetation, shallows, rootmats, rootwads and woody debris. The channel appeared to have mostly recovered from past channelization activities with low to moderate sinuosity, fair development and moderate stability. Agricultural fields extended along either bank beyond very narrow (<5 m) to moderate (10-50 m) buffers. Bull Run received a QHEI score of 58.5.

Laurel Run

The physical habitat of Laurel Run was evaluated in four locations from upstream of Cola Creek along a farm lane off of State Route 180 (RM 10.1) to State Route 180/56 within Laurelville (RM 0.1). The streambed of Laurel Run originated from sandstone. The upper reach had silt in moderate abundance, though substrates near the farm lane (RM 10.1) were primarily sand with small areas of cobble and silt while primarily sand and cobble intermixed with boulders, gravel and bedrock provided diverse substrates near State Route 374 (RM 7.8). Moderate amounts of instream cover was provided by undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads, boulders and woody debris throughout the upper reach. The site near the farm lane (RM 10.1) appeared to have recovered from past channelization activities with high sinuosity, poor to fair channel development and low stability. Near State Route 374 (RM 7.8), the channel appeared free from channelization activities with low to moderate sinuosity, fair to good channel development and high stability. Riparian buffers were narrow (5-10 m) near the farm lane which had residential homes and old fields near it, while the riparian buffers extended into forested areas near State Route 374 except near a residential yard which was mowed up to the stream bank.

The streambed of the lower reach of Laurel Run was comprised of a mixture of gravel and cobble interspersed with occasional boulders and sand, though large portions of the substrates were covered with algae at the most downstream site near State Route 180/56 (RM 0.1). Moderate amounts of instream cover was provided by undercut banks, overhanging vegetation, shallows, rootmats, boulders, woody debris and occasional deep pools (>70 cm), and rootwads. The entire lower reach of Laurel Run appeared very straight with no sinuosity, and moderate stability. Channel development was fair to good near Defenbaugh Road (RM 3.6) and poor to fair near State Route 180/56 (RM 0.1). Crop fields and a fenced pasture were present beyond very narrow (<5 m) riparian buffers near Defenbaugh Road (RM 3.6). The agricultural setting transitioned to a more urban setting with Laurel Run flowing through Laurelville near State Route 180/56 (RM 0.1).

QHEI scores for Laurel Run ranged from 58.5 near State Route 180/56 (RM 0.1) to 69.0 near State Route 374 (RM 7.8). The average QHEI score was 65.0.

Cola Creek

The physical habitat of Cola Creek was evaluated near State Route 180/374 (RM 0.1). The streambed appeared to have originated from sandstone with gravel and sand the dominant substrates present, though several areas of silt were also noted. Past channelization activities left the stream with low sinuosity, poor development and low stability. Moderate amounts of silt resulted in moderately embedded substrates, limiting the interstitial spaces available for aquatic organisms. Sparse to moderate amounts of instream cover was only provided by overhanging vegetation, shallows, and occasional woody debris. Crop fields were present along the left descending bank and had only very narrow (<5 m) buffers, if any buffers were even present. An old field extended beyond a moderate buffer (10-50 m) along the right descending bank. The QHEI score for Cola Creek was 44.0, reflecting the modified conditions of little instream cover, low sinuosity, poor channel development and low stability.

Middle Fork Laurel Run

The physical habitat of Middle Fork Laurel Run was evaluated near Middle Fork Road (RM 3.7) and State Route 180 (RM 0.1). The streambed originated from sandstone and appeared dominated by gravel and sand throughout the areas examined. Cobble, hardpan and silt were streambed types also observed. Moderate amounts of silt extended over normally embedded substrates in the upper reach. The upper reach appeared to be recovering from channelization activities with moderate sinuosity, poor development and low stability. A moderate amount of instream cover in the upper reach was provided by undercut banks, overhanging vegetation, shallows, rootmats, rootwads, and woody debris. Currents were primarily moderate to slow, as the only riffles were comprised of sand and appeared to be unstable. The combination of forest, residential and new field land covers had very narrow (<5 m) to moderate (10-50 m) riparian buffers in the upper reach.

The lower reach appeared to contain more intact physical habitat characteristics than the upper reach. No evidence of channelization was apparent as the stream exhibited moderate stability and good development. Silt was present in normal to moderate amounts as were the embedded substrates. Moderate amounts of instream cover was provided by overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads, boulders and woody debris. Currents ranged from slow and moderate to fast with occasional eddies. QHEI scores increased in a downstream direction, reflecting the physical habitat available for aquatic organisms. The QHEI score for the upper reach was 57.0, reflecting the modified conditions of the channel and lack of diverse current structure. The lower reach scored 75.5 reflecting the natural conditions with diverse instream cover and flow conditions.

Moccasin Creek

The physical habitat of Moccasin Creek was evaluated near Ellis Road, south of the Pickaway County line (RM 4.6) and near Armstrong Road (RM 2.5). The streambed appeared to have originated from a combination of tills and sandstone with gravel and cobble the most dominant substrates present. Areas of boulder, hardpan, silt, sand and bedrock were also observed. Silt and embedded substrates increased from normal to moderate amounts in a downstream direction. Instream habitat quality decreased in a downstream direction from moderate amounts of overhanging vegetation, shallows, rootmats, boulders and woody debris near the Pickaway County line (RM 4.6) to sparsely moderate amounts of shallows and boulders near Armstrong Road (RM 2.5). No evidence of channelization was apparent in Moccasin Creek as the stream exhibited low to moderate sinuosity, fair to good channel development and moderate to high stability. Moderate (10-50 m) to wide (>50 m) buffers extended to forest and agricultural reaches along the stream, though the buffers became very narrow (<5 m) near agricultural fields along Armstrong Road (RM 2.5). The increased siltation and decrease in riparian buffer width and instream cover resulted in a QHEI score of 60.0 near Armstrong Road (RM 2.5), five points lower than the QHEI score of 65.0 reported near the Pickaway County line (RM 4.6).

Brimstone Creek

The physical habitat of Brimstone Creek was sampled upstream and downstream of the Laurelville WWTP effluent discharge. The physical habitat of Brimstone Creek declined in quality in a downstream direction. The upper reach was dominated by gravel and cobble substrates intermixed with silt and sand. Silt was moderate to heavy and substrates were moderately embedded. Moderate amounts of instream cover was provided by undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads and woody debris. The upper reach appeared to be recovering from past channelization activities with moderate sinuosity, fair to good development and moderate stability. Old field, row crops and the WWTP were present beyond narrow (5-10m) to moderate (10-50 m) riparian buffers.

The streambed of the lower reach was dominated by gravel though areas of cobble and silt were also observed. A ½" layer of silt covered most substrates, limiting the amount of interstitial spaces available for aquatic life. Only sparse amounts of instream cover consisting of overhanging vegetation, shallows and occasional woody debris were observed. Excessive amounts of algae indicated the potential for nutrient enrichment in the lower reach. Evidence of heavy machinery within the stream channel was observed, likely used to remove gravel for a home being built on an adjacent property. The machinery had left the channel with low sinuosity, poor to fair development and low stability. Riparian buffers were narrow (5-10 m) where present, though in several areas no riparian cover was present. Land use adjacent to the stream was a combination of hay fields and old fields.

The combination of moderate amounts of diverse instream cover and partial recovery from past channelization activities resulted in a QHEI of 65.5 for the upper reach. The gravel mining in the lower reach had
decimated the habitat available for aquatic life resulting in a QHEI score of 41.0 for the lower reach.

Sams Creek

The physical habitat of Sams Creek was evaluated along a private drive off of Sams Creek Road (RM 0.3). The streambed appeared to originate from sandstone with gravel intermixed with cobble, silt and sand present as substrates. Silt was present in moderate amounts and substrates were extensively embedded. Sparse amounts of instream cover were provided by undercut banks, overhanging vegetation, shallows, rootmats and little woody debris. The channel appeared to be recovering from past channelization with low sinuosity and poor channel development accompanied moderate stability. The stream was bordered by row crops downstream of a house, outbuildings and fenced pasture. Only a very narrow (<5 m) riparian buffer was present. A pile of manure was observed adjacent to the stream (Figure 15). Landowners throughout the watershed should be encouraged to practice appropriate manure management techniques. Past channelization activities, poor riparian cover and sparse instream cover resulted in a QHEI score of 45.0 for Sams Creek.

Figure 15. Manure pile adjacent to Sams Creek RM 0.3.

Pine Creek

The physical habitat of Pine Creek was evaluated in 4 locations as it flowed along Big Pine Road. The streambed origin appeared to be sandstone throughout its length. In the upper reach, from downstream of Blackjack Road (RM 12.5) to upstream of Little Rocky Branch (RM 11.2), the stream shifted from being dominated primarily by gravel intermixed with cobble and sand to being dominated by a mixture of gravel and sand with small areas of cobble and silt also noted. Sandy silt was present in normal to moderate amounts, which moderately embedded the substrates. Light algae were present in sunny areas near Blackjack Road, indicating the possibility of excessive nutrients in the stream system. Moderate amounts of instream cover was provided by undercut banks, overhanging vegetation, shallows, rootmats, rootwads, woody debris and occasional deep pools (>70 cm). No evidence of channelization activities was apparent, as the stream exhibited moderate to high amounts of sinuosity with poor to fair development and high stability. Residential lawns extended to the stream bank upstream of Little Rocky Branch, providing no buffer to stormwater entering the stream. However, the majority of the land adjacent to this portion of Pine Creek is forest, which provides moderate (10-50 m) to wide (>50 m) buffers for the stream.

The lower reach of Pine Creek, from upstream of Crane Hollow (RM 8.8) to south of Bethel Church (RM 2.0), had a streambed dominated by sand with areas of cobble, gravel, bedrock, and silt also noted. Silt was present in moderate to heavy amounts while substrates were normally to moderately embedded. Undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads, and woody debris provided moderate to extensive amounts of instream cover. Much of the instream cover near Crane Hollow (RM 8.8) was woody debris which likely reached the stream via beavers. Evidence of beavers was noted throughout the area, and included a dam just upstream of the area sampled. No evidence of channelization activities was apparent, as the stream exhibited low to moderate sinuosity with fair to good development and low to moderate stability. Moderately eroding banks were noted along the right descending bank at both locations, though roughly eight cars had been placed along the left descending bank near Crane Hollow (RM 8.8). Pine Creek flowed through state forests and therefore a wide (>50 m) wooded buffer and low intensity land use surrounded the stream. Further downstream near Bethel Church, crop fields with narrow (5-10 m) to nonexistent buffers extended along the right descending bank, while a forest along the left descending bank provided a wide (>50m) buffer.

QHEI scores for the upper reach of Pine Creek increased in a downstream direction with a 66.0 near Blackjack Road (RM 12.5) and a 71.5 upstream of Little Rocky Branch (RM 11.2) as the stream flowed into a primarily forested area. In the lower reach, QHEI scores decreased from a 72.5 within the state forest near Crane Hollow (RM 8.8) to a 64.5 near Bethel Church (RM 2.0) where the buffers were reduced and land use intensified into agricultural fields.

Little Pine Creek

The physical habitat of Little Pine Creek was sampled near Little Pine Creek Road (RM 1.9) and Big Pine Road (RM 0.6). Sandstone appeared to be the streambed origin. Near Little Pine Creek Road (RM 1.9) sand dominated the substrates with gravel and silt also present. Moderate amounts of silt moderately embedded substrates. Undercut banks, overhanging vegetation, shallows, rootmats, rootwads and woody debris provided moderate amounts of instream cover. No evidence of channelization was apparent as the stream exhibited high sinuosity with fair development and low stability. Heavy amounts of erosion were noted along the left descending bank with occasional false banks noted along the right descending bank. Wide buffers (>50 m) extended into forests while residential lawns reached to the stream banks, eliminating any riparian buffers.

The streambed of the lower reach of Little Pine Creek near Big Pine Road (RM 0.6) was primarily gravel with areas of sand though a light covering of silt was present on almost all substrates. Only portions of the riffles were clear of silt. Sparse amounts of instream cover was provided by undercut banks, overhanging vegetation, shallows, deep pools (>70 cm) and woody debris. Though no evidence of channelization was apparent, the stream exhibited low sinuosity with poor development and low stability. Moderate eroding banks were present along both banks; vegetated false banks were evident along either stream bank. Shrubs and dense herbaceous plants were the only buffer adjacent to the row crops extending outward from each bank.

QHEI scores decreased in a downstream direction as land use intensified. For the upper reach, the QHEI score was 60.0 while the lower reach received a QHEI score of 53.0.

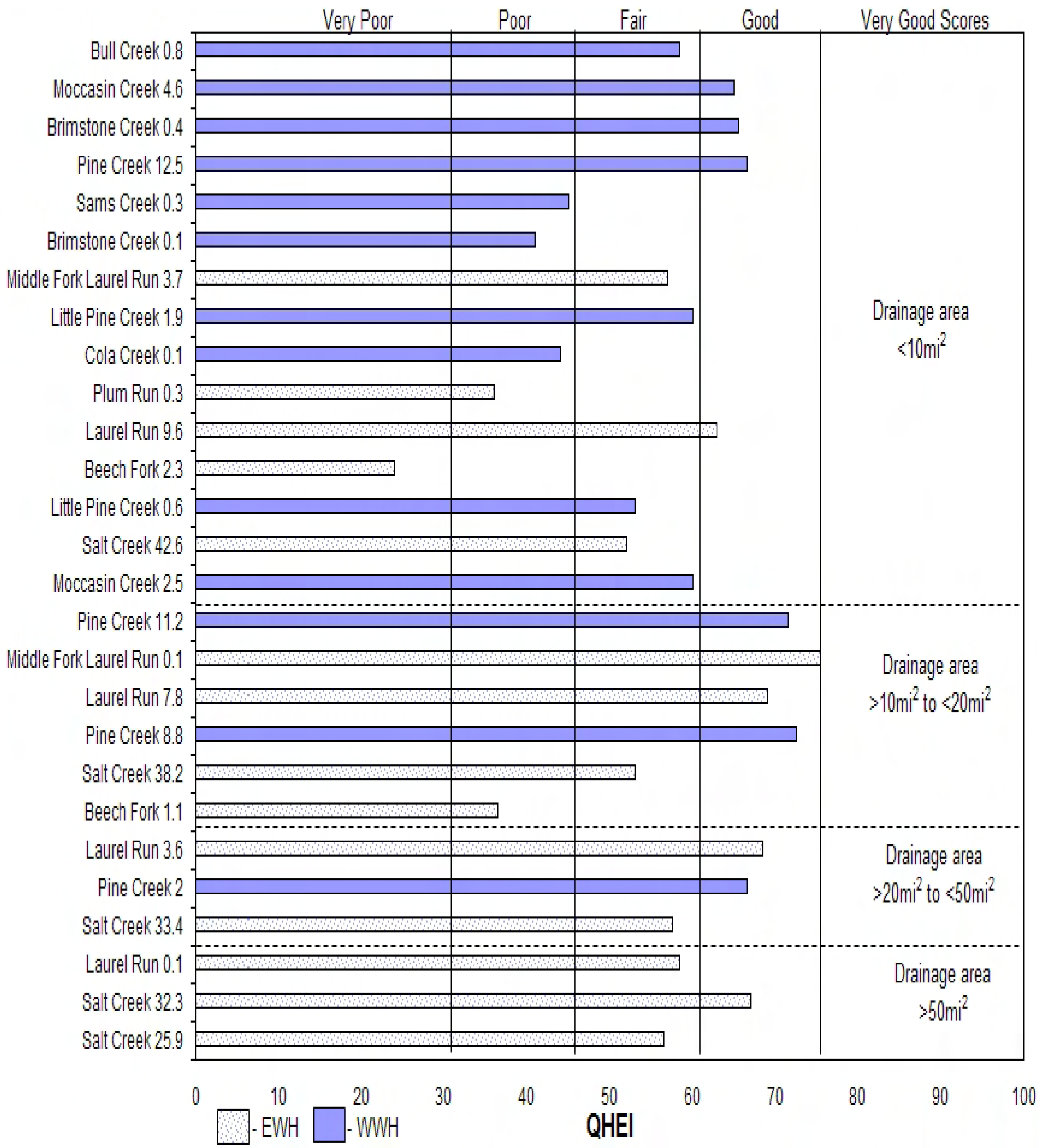


Figure 14. QHEI scores by drainage area for the upper Salt Creek basin. Exisitng or proposed aquatic life use designtations were Exceptional Warmwater Habitat (EWH) and Warmwater Habitat (WWH).

Biological Assessment: Fish Communities

The fish communities of 27 locations within the upper Salt Creek basin were sampled during 2005. As Figure 16 shows, the fish communities for the five Salt Creek main stem sites generally performed better than indicated by habitat conditions. All of the main stem sites scored within EWH expectations for the IBI, though habitat scores generally indicated less than EWH expectations. Fish communities of tributary streams showed a similar trend, with most sites receiving IBI scores within EWH expectations regardless of QHEI scores.

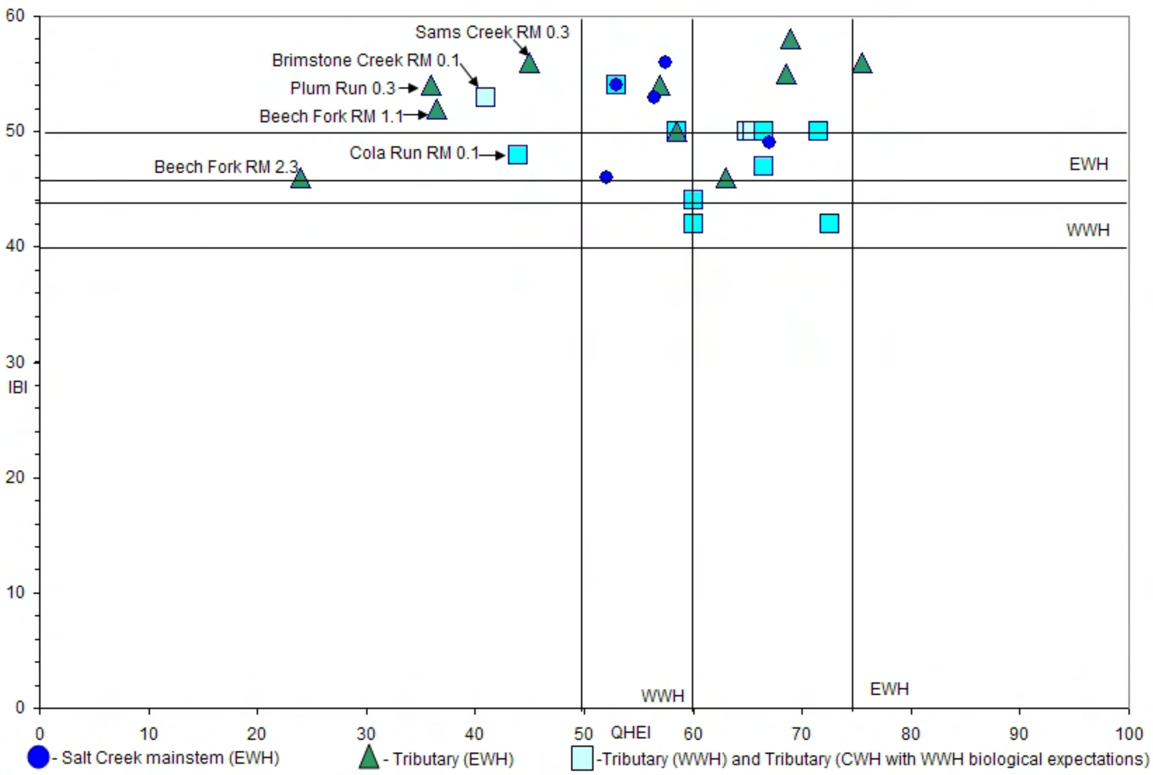


Figure 16. QHEI by IBI scores for the upper Salt Creek basin, HUC 05060002070.

While this seems to indicate a disconnect between habitat and fish communities, a closer look at each stream and overall watershed characteristic reveals this is not necessarily the case. Beech Fork and Plum Run were both sampled historically and performed better in the past. While their scores are still within EWH expectations, shifts in the fish communities were apparent and discussed under each stream below. Fish were observed swimming into Brimstone Creek from Salt Creek during the sampling event. Migration from Salt Creek may yield the higher IBI score at the lower site, along with recognition that the habitat scored low due to small local perturbations from gravel mining in the lower portion of the sampling zone. No other habitat alterations were observed in Brimstone Creek. Cola Run is being recommended for CWH designation due the presence of CWH macroinvertebrate taxa and two coldwater fish species. In

Ohio, streams designated CWH have strong groundwater connections. Often times a significant contribution of ground water will ameliorate the effects of poor habitat or pollutant contributions to a stream.

The integrity of the Salt Creek watershed as a whole may also be influencing the consistently high fish community scores independent of habitat conditions. It has been shown that a positive relationship exists between basinwide estimates of habitat quality and site biological integrity (Davis and Simon, 1995). Therefore, localized perturbations to habitat in a few small areas of a basin may be overcome by the biological communities if basinwide community integrity is strong. The EWH designation for Salt Creek and its ability to attain this designation demonstrates its high biological integrity.

In addition, streams and rivers along the line of glaciation in Ohio, such as Salt Creek, are known to receive flow augmentation from the glacial deposits in the area (Yoder, pers. comm.). Increased groundwater flow from glacial deposits may ameliorate some of the impacts from localized habitat alterations noted in the area. This factor combined with the high biological integrity of Salt Creek watershed explains why a more significant drop in IBI scores did not occur with such low QHEI scores.

The average QHEI of 57.2 (range of 52 to 67) for main stem sites was similar to the average tributary QHEI score of 57.1, though the range of scores for tributary sites extended from 24 to 75.5. The majority of habitat conditions indicates the ability of streams within the upper Salt Creek WAU to support WWH and in some instances, CWH and EWH communities; however, continued channel modification through agricultural activities and gravel mining may negatively affect biological community performance in the future. All shifts in fish community performance that have already been noticed in specific streams are discussed below.

Salt Creek

The fish community of Salt Creek was evaluated in five locations in the upper Salt Creek basin, from Heigle Road (RM 42.6) to State Route 56 (RM 25.9). The upper portion of Salt Creek met or exceeded EWH expectations at all locations. The headwaters near Heigle Road (RM 42.6) received the lowest IBI score, 46, which reflected the agricultural influence on habitat. A total of 16 species were collected at this location though only two sensitive species, rainbow darter and sand shiner, were collected. Stoneroller minnow comprised 40.78% of the relative number of individuals, indicating possible nutrient enrichment from the surrounding agricultural fields. Conditions improved downstream, with 20 species including six sensitive species collected near Spangler Road (RM 38.2). Sampling near State Route 180 (RM 33.4) showed strong community integrity as it received an IBI=54, the same score recorded for the site in 1992. A total of 38 species were collected in 2005 compared to 31 species in 1992, indicating an increase in biodiversity near State Route 180 (RM 33.4).

Downstream of Laurelville, a drop in fish community performance was noted along Creamery Hill Road (RM 32.3). While still meeting EWH expectations, 45.56% of the sample collected were stoneroller minnows. Simple lithophils, species requiring clean substrates to spawn, comprised only 18.5% of the community, while upstream at State Route 180 (RM 33.4) they comprised 41% and further downstream at Sams Creek Road (RM 29.9) they comprised 50% of the community. This shift in the percentage of simple lithophils combined with the increased presence of stoneroller minnow indicates possible nutrient enrichment and increased siltation occurring downstream of Laurelville. The ammonia and phosphorus levels were elevated at Creamy Hill Road site due to the Laurelville WWTP and storm water run-off. The source of the nutrients here are from consistent and continual discharges to the stream. Additionally, there are large D.O. fluctuations in Brimstone Creek just up-stream of the site.

Plum Run
The fish community of Plum Run was evaluated near Hayesville-Adelphi Road (RM 0.3). Species richness and quality have decreased in Plum Run since 1992. Currently, twenty species were collected and included the intolerant banded darter (0.17%) and four moderately intolerant species; sand shiner (0.99%), rainbow darter (0.66%), smallmouth bass (0.66%) and northern hog sucker (0.17%). Intolerant and moderately intolerant species comprised approximately 2.7% of the relative number of individuals in 2005, as compared to 9.3% in 1992. A total of 24 species were collected in 1992, and included two intolerant species; black redhorse (0.91%) and rosyface shiner (0.54%) and five moderately intolerant species; longear sunfish (3.27%), northern hog sucker (2.18%), rainbow darter (1.09%), sand shiner (0.91%) and smallmouth bass (0.36%).

In addition to a decrease in pollution sensitive species, central stoneroller minnow, an herbaceous species known for thriving in eutrophic streams with abundant algae, comprised 58.71% of the relative number of individuals in 2005 as compared to comprising only 7.80% of the population in 1992. The abundance of central stoneroller minnow in 2005 is also reflected in the increase in the total number of fish caught, an increase from 551 individuals in 1992 to 1,211 individuals in 2005. The IBI score for Plum Run was 54, which meets EWH expectations, but is a 2 point drop since 1992. The drop in species diversity, increase in central stoneroller abundance and drop in IBI are all reflective of the decrease in habitat quality discussed in the Physical Habitat section above and may reflect a potential shift in water quality as well.

Beech Fork
The fish community of Beech Fork was evaluated near County Line Road (RM 2.3) and Tarlton-Adelphi Road (RM 1.1). IBI scores and species diversity increased in a downstream direction from an IBI of 46 and 14 species near County Line Road to an IBI of 52 and 18 species near Tarlton-Adelphi Road. The abundance of sensitive species also increased in a downstream direction. Only four moderately intolerant species

comprising 5.76% of the relative number of individuals were collected at the upstream location while three intolerant species (comprising 1.26% of the relative number of individuals) and five moderately intolerant species (comprising 11.73% of the relative number of individuals) were collected at the downstream location. While it is not surprising that diversity increased as drainage area increased, the abundance of central stoneroller minnow also increased with drainage area, from comprising 19.92% of the population at the upstream location to comprising 54.15% of the population at the downstream location. This indicates possible increased nutrient enrichment at the downstream location which may be attributable to the surrounding agricultural landscape.

While an increase in IBI scores and biodiversity was noted as drainage area increased, a comparison of historical data (1992) to current data (2005) shows a drop in IBI and biodiversity. The site near Tarlton-Adelphi Road (RM 1.1) was sampled in both 1992 and 2005. Species diversity decreased from 35 species in 1992 to 18 in 2005. Four intolerant species comprised 11.59% of the community and ten moderately intolerant species comprised 28.92% of the community in 1992. The fish community in 2005 included only two intolerant species comprising 1.26% of the population and only four moderately intolerant species comprising 11.73% of the relative number of individuals. These significant drops in pollution intolerant species indicate serious changes in habitat quality since 1992. Insectivorous species comprised only 28% of the individuals collected in 2005, compared to 55% in 1992. The increased presence of the central stoneroller minnow, from comprising 27.90% of the relative number of individuals in 1992 to comprising 54.15% of the relative number of individuals in 2005 indicates increased nutrient enrichment in the surrounding watershed.

Bull Creek

The fish community of Bull Creek was evaluated near Kingston-Adelphi Road (RM 0.8). Fourteen species were collected and included the moderately intolerant rainbow darter (0.71%) and smallmouth bass (0.14%). The presence of mottled sculpin (5.09%) and southern redbelly dace (0.28%) indicate that a strong ground water connection may be present in the stream. The IBI score for Bull Creek was 50.

Laurel Run

The fish community of Laurel Run was evaluated in four locations from upstream of Cola Creek along a farm lane off State Route 180 (RM 10.1) to State Route 180/56 within Laurelville (RM 0.1). Fish community diversity varied from 19 species at the most upstream location to 34 species near Defenbaugh Road (RM 2.6). IBI scores ranged from 46-58 with an average IBI=52. The site with the lowest IBI score, upstream of Cola Creek at RM 10.1 (IBI=46), barely met EWH expectations due to a predominance in the community by pollution tolerant species including; creek chub (54.30%), blacknose dace (5.15%), white sucker (4.81%), bluntnose minnow (1.72%), green sunfish (0.34%), and yellow bullhead (0.17%). The predominance of these species in this area reflects the increased siltation and embeddedness noted in the QHEI. The presence of coldwater species, including mottled sculpin (7.73%) and redside dace (4.12%), indicate a strong groundwater connection. The remaining sites showed robust diversity and included pollution intolerant species such as: black redhorse, bigeye chub, rosyface shiner, mimic shiner, stonecat madtom, brindled madtom, banded darter and variegate darter. MIwb scores for the two most downstream sites reflect strong fish community balance with an MIwb of 10.0 near RM 2.6 and an MIwb of 9.5 near RM 0.1.

Laurel Run was sampled once historically, near RM 1.8 in 1992. Though sampling did not occur at this site in 2005, community diversity and integrity has remained fairly consistent over time. In 1992, the fish community received an IBI=56 and included 32 species. The total relative number of individuals has increased since 1992, when a relative number of 630 individuals were collected compared to an average relative number of 3,124 individuals near RM 0.10 and a relative number of 1,616 individuals near RM 2.6. A drop in top carnivores from 10.5% in 1992 to <2% in 2005 at the sites upstream and downstream of RM 1.8 was also noted.

Cola Run
The fish community of Cola Run was sampled near State Route 180/374 (RM 0.1). Twelve species were collected and included the pollution intolerant redside dace (5.38%) and silver shiner (0.77%). Pioneering species that are also considered pollution tolerant comprised 62% of the community and included creek chub (35.77%), blacknose dace (22.31%), and white sucker (4.23%). As the site is <5.0mi^2 in drainage area, it is not surprising to see the majority of fish classified as pioneering. The IBI score for Cola Run was 48.

Middle Fork (Tributary to Laurel Run at RM 2.97)
The fish community of Middle Fork was evaluated near Middle Fork Road (RM 3.7) and State Route 180 (RM 0.1). Fish community performance increased in a downstream direction with an IBI=54 at the most upstream location and an IBI=56 at the most downstream location. A total of twenty-nine species were collected at the two locations and included five pollution intolerant and eight moderately pollution intolerant species. Evenness throughout the community was evident by the combination of species present, which included ten minnow species, seven darter species, four sunfish species, three sucker species, two catfish species, one lamprey species and one sculpin species.

The fish community near State Route 180 (RM 0.1) was sampled previously in 1992. The IBI score at that time, 56, was the same as reported in 2005. Similar numbers and types of species were collected in both years. This shows strong integrity within the fish community of Middle Fork over time.

Moccasin Creek

The fish community of Moccasin Creek was evaluated near Ellis Road, south of the Pickaway County line (RM 4.6) and near Armstrong Road (RM 2.5). IBI scores decreased in a downstream direction with the upstream location scoring a 50 and the downstream location scoring a 42. The same twelve species were collected at each location with the exception that redside dace were collected at the upstream location and striped shiner were collected at the downstream location. Redside dace is a coldwater species that is also considered pollution intolerant and pioneering in its behavior. The loss of this species and lack of replacement by a species with similar pollution sensitive characteristics resulted in a loss of 4 points in the IBI score at the downstream location. The lack of an increase in species number with increased drainage area is another indication of a weakened community structure in the downstream location. Improved habitat conditions at the downstream location could potentially increase biodiversity and thereby increase community integrity and IBI scores in the future.

Brimstone Creek

The fish community of Brimstone Creek was sampled upstream of the Laurelville WWTP effluent discharge (RM 0.35) and downstream of the Laurelville WWTP effluent discharge (RM 0.1). Fish were noted to avoid the effluent stream. Fourteen species were collected at the upstream location and included juveniles of the moderately intolerant golden redhorse. Though twenty-six species were collected at the downstream reach, the fish community was likely strongly influenced by the fish present in Salt Creek. Central stoneroller minnow comprised 41.42% of the relative number of individuals (average of two passes) in the lower reach indicating possible nutrient enrichment from the Laurelville WWTP, as the community in the upper reach was comprised of only 18.52% central stoneroller minnow. The IBI scores for Brimstone Creek increased marginally in a downstream direction and were 50 and 53, respectively.

Sams Creek

The fish community of Sams Creek was evaluated along a private drive off of Sams Creek Road (RM 0.3). Fourteen species were collected and included the pollution intolerant banded darter and the moderately pollution intolerant smallmouth bass and rainbow darter. The presence of mottled sculpin and southern redbelly dace indicate the likelihood of a strong groundwater connection, which could explain the strong fish community score (IBI=56) in the presence of less than ideal habitat conditions (QHEI=45).

Pine Creek

The fish community of Pine Creek was evaluated in 4 locations as it flowed along Big Pine Road. A total of 35 species were collected within Pine Creek and included pollution intolerant species such as black redhorse, bigeye chub, redside dace, rosyface shiner, banded darter, and variegate darter. Cool water species included redside dace, southern redbelly dace and mottled sculpin. IBI scores ranged from 42 to 50 with a mean value of 47. The lowest score, IBI=42, was collected upstream of Conkle's Hollow (RM 8.8). Beaver activity was present throughout this area and potentially contributed to the decrease in fish community biodiversity. Three darter species were collected at this location, as compared to five darter species collected upstream at RM 11.2 and seven darter species collected downstream at RM 2.0. Many darter species inhabit shallow, swift moving waters and require silt free areas to reproduce. The majority of the zone near Conkle's Hollow was pool environment, and only two short riffles were observed in the stream.

Fish community integrity in 2005 appeared similar to that recorded in past sampling efforts, with the exception of the site near Conkle's Hollow (RM 8.8). In 1997 two sites were sampled, one near RM 12.5 (IBI=52) and the other just upstream at RM 12.6 (IBI=56). The site near RM 12.5 was also sampled in 2005 and received an IBI score of 50. Seven fewer species were collected in 2005, but the majority of the community composition was similar in regards to percent tolerant fish, omnivores, and pioneering fishes. Aside from these changes, the fish community performed similarly in both years at this location. In 1992, the fish community was sampled near RM 7.1 and included 27 species with an IBI score of 42. Though a site was not sampled near here in 2005, the species present in 1992 are similar to those collected in other years. The lower score in 1992 appears attributable to a lack of intolerant species and a significant number of DELTs. Intolerant or sensitive species were collected at each site in 2005 and DELTs were not an issue at any site.

Little Pine Creek

The fish community of Little Pine Creek was sampled near Little Pine Creek Road (RM 1.9) and Big Pine Road (RM 0.6). Twenty-three species were collected and IBI scores increased in a downstream direction from an IBI of 44 near Little Pine Creek Road (RM 1.9) to an IBI of 54 near Big Pine Road (RM 0.6). Near Little Pine Creek Road (RM 1.9), tolerant fish comprised 70% of the fish collected. However, cool water species including redside dace, southern redbelly dace and mottled sculpin were also present at this location. Though the only cool water species collected further downstream near Big Pine Road (RM 0.6) was mottled sculpin, tolerant fish presence decreased to 36% of the fish community.

Biological Communities: Macroinvertebrate Community

Macroinvertebrate communities were evaluated at 27 stations in the upper Salt Creek assessment unit (Table 13). The community performance was evaluated as exceptional at nine stations, very good at one, good at 12, marginally good at three, and fair at two stations. The station with the highest total mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa richness (EPT) was on Salt Creek at SR 56 (RM 26.0) with 32 taxa. The station with the highest number of total sensitive taxa was on Salt Creek at SR 56 (RM 26.0) with 50 taxa. Sensitive taxa found in this assessment unit which are noteworthy because they are not commonly collected were the mayflies *Acentrella parvula* in Salt Cr. (RM 38.3) and M. Fk. Laurel Run (RM 0.2), *Acentrella turbida* in Salt Cr. (RMs 33.2, 32.5, 26.0), Laurel Run (RM 0.1), and M. Fk. Laurel Run (RM 0.2), *Acerpenna macdunnoughi* in Bull Cr. (RM 0.7), M. Fk. Laurel Run (RM 3.8), and Brimstone Cr. (RM 0.35), and *Paracloeodes* sp. 3 in Salt Cr. (RM 38.3), Plum Run (RM 0.3), and Beech Fork (RMs 2.3, 1.1); the stoneflies *Acroneuria carolinensis* in M. Fk. Laurel Run (RM 0.2) and Brimstone Cr. (RM 0.35), *Acroneuria lycorias* in Salt Cr. (RMs 33.2, 32.5, 26.0), Laurel Run (RMs 2.4, 0.1), and Pine Cr. (RM 2.0), and *Eccoptura xanthenes* in Laurel Run (RM 9.6); the caddisfly *Hydropsyche frisoni* in Salt Cr. (RMs 33.2, 32.5, 26.0), Laurel Run (RM 0.1), and Pine Cr. (RM 2.0); and the midges *Demicryptochironomus* sp. in M. Fk. Laurel Run (RM 0.2) and *Sublettea coffmani* in Salt Cr. (RM 32.5).

Salt Creek

The macroinvertebrate community collected from the upstream most station on Salt Creek (RM 42.6, dst. Heigle Rd.) did not have the EPT (13) and sensitive taxa (17) diversity or relative abundance expected for an EWH stream. Excessive algal growth was an indication of nutrient enrichment at this site. Embedded substrates, an indication of siltation, and removal of the woody riparian were additional potential causes of impairment at this station. These conditions were undoubtedly exacerbated by low stream flow conditions present at the time of collection. The community at the station downstream from Tarlton (RM 38.3, ust. Spangler Rd.) contained increased numbers of EPT taxa (22) and the intolerant mayfly taxa *Acentrella parvula* and *Paracloeodes* sp. 3, which support an exceptional evaluation. However, the number of sensitive taxa (20) was lower than the EPT and relatively high abundance of pollution facultative blackflies in the riffle habitat were indications of continued stress. This site was threatened by the same factors as the upstream station with the addition of people driving in the stream channel. However, this station did have adequate stream flow, which was undoubtedly an important mitigating factor.

The remaining Salt Creek stations in this assessment unit had exceptional macroinvertebrate communities with high diversities of EPT and sensitive taxa (Fig. 5 and Table 13). However, heavy siltation was observed at these stations and may contribute to future impairment if the observed practices of stream channel modifications, removal of the woody riparian, and driving vehicles in the stream channel continues.

Plum Run

The macroinvertebrate community sampled in Plum Run (RM 0.3) was performing at an exceptional level with high diversities of EPT (27) and sensitive taxa (29). This station is threatened by channelization, nutrient enrichment, removal of the woody riparian, and siltation. It is presumed that sufficient groundwater recharge was mitigating the negative impacts to this station. The original designation of this stream as EWH was based on fish collections.

Beech Fork

The macroinvertebrate communities sampled in Beech Fork (RMs 2.3, 1.1) were not meeting the EWH expectations assigned to this stream. EPT and sensitive taxa diversity were just short of the range expected for very good evaluations and sensitive community components that were absent or scarce included heptageniid mayflies, net-spinning caddisflies of the families Philopotamidae and Polycentropodidae, and case-building caddisflies of the families Limnephilidae, Uenoidae, and Helichopsychidae. The original designation of this stream as EWH was based entirely on fish collections. These stations were impaired by channelization, nutrient enrichment, removal of the woody riparian, and siltation. The communities were performing at a high good level which makes this stream a good candidate for restoration.

Bull Creek

Very good macroinvertebrate communities were present in Bull Creek (RM 0.7) including the intolerant mayfly taxa *Acerpenna macdunnoughi* and *Leucrocuta sp*. Embedded substrates and heavy silt deposits were threats to the resource quality in this stream.

Laurel Run

Macroinvertebrate communities in the headwaters of Laurel Run (RMs 9.6, 7.8) were not meeting the EWH expectation assigned to this stream. The original designation of this stream as EWH was based entirely on fish collections. The EPT diversity and predominance were low. There was no strong indication of enrichment. The causes of the below expected performance of this stream are not certain. This stream has had historic channel modifications, which in conjunction with siltation and loss of woody riparian in areas may be negatively affecting the biota. The community sampled at the upstream most station (RM 9.6) was indicative of coldwater habitat with five coldwater macroinvertebrates taxa. The EPT diversity improved into the exceptional range at RM 2.4 with 22 taxa in the qualitative part of the sample, even though the ICI was only in the good range (ICI=40). Siltation and to a lesser extent historic channel modifications, removal of the woody riparian and livestock in the stream channel were observed to be threats to the biotic integrity. EPT diversity (24) and the ICI score (54) were indicative of an exceptional community at the station near the mouth (RM 0.1).

Cola Run

The macroinvertebrate community sampled in Cola Run was meeting WWH expectations with a good evaluation. Three coldwater taxa were collected including two “strong” indicator taxa.

Middle Fork Laurel Run
The macroinvertebrate community in the headwaters of Middle Fork Laurel Run (RM 3.8) was not meeting the EWH expectation assigned to this stream. The original designation of this stream as EWH was based entirely on fish collections. EPT diversity (13) and predominance were relatively low. Thick deposits of silt in association with past channel modifications appeared to be major causes of impairment at this station. The macroinvertebrate community collected from the station near the mouth (RM 0.2) improved into the exceptional range.

Moccasin Creek
Macroinvertebrate communities sampled in Moccasin Creek were evaluated as good. However, indications of community imbalance were the absence of sensitive case-building caddisflies at both sites and the absence (RM 4.6) or scarcity (RM 2.5) of net-spinning caddisflies of the families Philpotamidae and Polycentropodidae. Siltation and nutrient enrichment were observed to be potential threats to the biotic integrity in this stream. The communities sampled in Moccasin Creek were indicative of CWH with five (RM 4.6) and six (RM 2.5) coldwater taxa collected. This stream, along with a single record from Bull Creek, were the only records of the coldwater hydropsychid caddisfly *Hydropsyche slossonae* in the Salt Creek basin. Both of these streams are just on the edge of the Eastern Corn Belt Plains and the Western Allegheny Plateau ecoregions.

Brimstone Creek
Macroinvertebrate communities were sampled in Brimstone Creek upstream (RM 0.35) and downstream (RM 0.15) from the Laurelville WWTP (~RM 0.3). Both sampled communities were evaluated as good with no decline in EPT or sensitive taxa diversity. However, there was an enrichment effect from the WWTP discharge as evidenced by the loss of sensitive taxa (*Maccaffertium vicarium*, *Acroneuria carolinensis*, *Chimarra aterrima*) that were common upstream and an increase in the abundance of tolerant aquatic segmented worms (Oligochaeta) at the downstream station. Other threats to this stream were from siltation (embedded substrates and excessive silt deposits on substrates), background nutrient enrichment (excessive algal growth), and gravel mining near the mouth (RM 0.1).

Sams Creek
The macroinvertebrate community sampled in Sams Creek (RM 0.3) was evaluated as exceptional with high EPT (25) and sensitive taxa (29) diversities.

Pine Creek
The macroinvertebrate community performance in Pine Creek declined from a good evaluation in the headwaters (RM 12.5) to fair just downstream from Big Pine Road, upstream from Crane Hollow (RM 8.8). Throughout this reach overall densities were low and mayfly diversity and relative abundance in particular were low. Siltation was observed to be a threat to biotic integrity throughout this stream. The larger substrates

were covered top and bottom with a black substance that in other locations was associated with high sulfate concentrations. The community improved into the exceptional range by RM 2.0. The communities sampled in Pine Creek were indicative of CWH with four or more coldwater taxa collected from each site.

Little Pine Creek

The macroinvertebrate communities sampled in Little Pine Creek were meeting WWH expectations. Two “strong” coldwater indicator taxa were collected at the upstream most site (RM 2.2).

Table 13. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the upper Salt Creek study area, July to October, 2005.

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI[a]	Narrative Evaluation
Salt Creek (02-600)										
42.6	8.3	-	60	13	17	M	1	Hydropsychid caddisflies (F,MI), *Caenis* mayflies (F)	-	Marg. Good
38.3	17.1	-	58	22	20	M-H	1	Hydropsychid caddisflies (MI,F), midges (F,MI), blackflies (F)	-	Exceptional
33.2	48	-	67	25 / 28	33 / 41	M / 944	1	Caddisflies (F,MI), midges (MI,F)	54	Exceptional
32.5	106	-	68	27 / 28	33 / 41	M / 501	2	Caddisflies (MI,F), midges (MI,F), mayflies (MI)	50	Exceptional
26.0	174	-	72	29 / 32	45 / 50	M / 1032	1	Caddisflies (F,MI), midges (MI,F), mayflies (MI)	50	Exceptional
Plum Run (02-648)										
0.3	5.4	-	65	27	29	M	1	Hydropsychid caddisflies (MI,F), mayflies (F,I), midges (F)	-	Exceptional
Beech Fork (02-650)										
2.3	7.5	-	62	17	17	L-M	1	Midges (F), hydropsychid caddisflies (MI,F), *Caenis* mayflies (F)	-	Good
1.1	18.5	-	58	17	21	M	1	Midges (MI,F), hydropsychid caddisflies (F,MI), baetid mayflies (F,I)	-	Good
Bull Creek (02-647)										
0.7	3.8	-	53	20	26	M	3	Caddisflies (MI,F), midges (F,MI), baetid mayflies (F,I)	-	Very Good
Laurel Run (02-640)										
9.6	6.5	-	41	9	14	L	5	Midges (F,MI), hydropsychid caddisflies (F)	-	Fair
7.8[b]	15.9	16	27	11	~12	L-M	1	Heptageniid mayflies (MI), Midges (F,MI)	-	Marg. Good
2.4	40.5	-	67	22 / 24	29	L-M / 296	2	Midges (F,MI), mayflies (MI,F), hydropsychid caddisflies (MI,F)	40	Good

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI[a]	Narrative Evaluation
0.1	54.6	-	61	24 / 25	28	L-M / 403	1	Caddisflies (MI,F), mayflies (MI,F), midges (MI,F)	54	Exceptional
Cola Run (02-645)										
0.1	4.6	-	58	16	27	L-M	3	Hydropsychid caddisflies (F,MI), midges (F,MI)	-	Good
Middle Fork Laurel Run (02-643)										
3.8	4.4	-	45	13	23	L-M	1	*Antocha* craneflies (MI), midges (MI,F), water mites (F)	-	Good
0.2	11.4	-	62	22	28	M	2	Hydropsychid caddisflies (MI,F), baetid mayflies (I,F)	-	Exceptional
Moccasin Creek (02-641)										
4.6	4.1	-	49	15	16	M	5	Hydropsychid caddisflies (MI,F), baetid mayflies (F,MI)	-	Good
2.5	8.3	-	55	18	21	M	6	Hydropsychid caddisflies (MI,F), baetid mayflies (F)	-	Good
Brimstone Creek (02-638)										
0.35	4.2	-	48	16	21	L-M	3	Hydropsychid caddisflies (MI,F), midges (MI,F)	-	Good
0.15	4.3	-	59	18	21	M	3	Hydropsychid caddisflies (MI,F), midges (F,MI), baetid mayflies (F)	-	Good
Sams Creek (02-636)										
0.3	4.3	-	67	25	29	L-M	2	Hydropsychid caddisflies (MI,F), midges (MI,F)	-	Exceptional
Pine Creek (02-630)										
12.5	4.3	-	56	14	20	L	6	Midges (MI,F), hydropsychid caddisflies (F)	-	Good
11.2	10.9	-	48	12	19	L	5	Midges (MI,F), hydropsychid caddisflies (F)	-	Marg. Good
8.8	17.4	-	53	7	21	L-M	5	Midges (MI,F), hydropsychid caddisflies (F)	-	Fair
2.0	31.0	-	60	23 / 25	30 / 38	L-M / 329	4	*Chimarra* caddisflies (MI), midges (MI,F)	48	Exceptional

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI[a]	Narrative Evaluation
Little Pine Creek (02-631)										
2.2	4.6	9	46	17	21	L-M	2	Hydropsychid caddisflies (MI,F)	-	Good
0.6	7.9	-	51	18	22	L	0	Midges (MI,F), Hydropsychid caddisflies (F,MI)	-	Good

RM: River Mile.
Dr. Ar.: Drainage Area
Data Codes: 8=Non-Detectable Current, 9=Intermittent or Near-Intermittent Flow Conditions, 15=Current >0.0 fps but <0.3 fps, 16=Collected after 30 September.
Ql.: Qualitative sample collected from the natural substrates.
Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List as MI (moderately intolerant) or I (intolerant).
Qt.: Quantitative sample collected on Hester-Dendy artificial substrates, density is expressed in organisms per square foot.
Qualitative sample relative density: L=Low, M=Moderate, H=High.
CW: Number of Coldwater Macroinvertebrate Taxa.
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant
[a] ICI values in parentheses are invalidated due to insufficient current speed over the artificial substrates. The station evaluation is based on the qualitative sample narrative evaluation.
[b] Sample was collected on 12 December 2006.

Middle Fork Salt Creek Basin: HUC 05060002-080
Middle Fork Salt Creek
Includes tributaries: Tributary to Middle Fork Salt Lick Creek at RM 20.62, Riley Run, Kelly Branch, Tributary to Middle Fork Salt Lick Creek at RM 13.00, Pigeon Creek, Tributary to Pigeon Creek at RM 7.32, Skunk Hollow, Long Branch

Aquatic Life Use Attainment Status and Trends

The aquatic life use of seventeen locations within the Middle Fork Salt Creek basin was assessed using fish and macroinvertebrates (Figure 17 and Table 16). One stream, the tributary to Middle Fork Salt Lick Creek at RM 20.62, was assessed with fish only. This stream was not originally planned for sampling, so macroinvertebrate sampling did not occur here.

All six sites sampled on Middle Fork Salt Lick Creek were in full expectations of WWH except for the site near RM 4.9. Refuse from bridge demolition within this stretch of stream impounded a portion of the stream. Fish were sampled downstream of the impoundment and found to meet WWH expectations. Macroinvertebrates were sampled within the impounded area and found to be below WWH expectations. Removal of the impoundment to allow reestablishment of natural flow regimes should greatly improve the macroinvertebrate community performance in the future. Interstitial conditions were noted near RMs 22.0 and 18.0. While this may be a natural phenomenon in the area, the 8 point drop in IBI scores between passes at RM 22.0 indicates a possible unstable community structure. In addition, significant drops in IBI scores over time were noted for this location and are discussed in further detail below.

Five of the tributaries, tributary to Middle Fork Salt Lick Creek at RM 20.62, Kelly Branch, tributary to Middle Fork Salt Lick Creek at RM 13.00, Skunk Hollow, and Long Branch, fully met their existing or recommended ALU designations. Pigeon Creek met WWH expectation at three of four sampling locations. Partial attainment of WWH expectations occurred in the headwaters (RM 13.1) of Pigeon Creek due to siltation and nutrient/organic enrichment from livestock access to the stream and loss of trees in the riparian corridor due to channelization activities. Riley Run was in non attainment of WWH criteria though the source of impairment is unknown. The tributary to Pigeon Creek at RM 7.32 was in partial attainment of WWH near RM 2.4 and in non attainment of WWH near RM 0.1. Siltation from livestock access to the stream appeared to be the primary cause of the poor community performance.

Table 14. Exceedences of Ohio Water Quality Standards (WQS) criteria (Ohio Administrate Code 3745-1) for chemical parameters in MFSCWAU found during the 2005 field season. The dissolved oxygen (D.O.) results are in mg/l and pH is in S.U. and *E. coli* and fecal coliform are in cfu/100 ml. Use designations within MFSCWAU include: Aquatic Life –Warmwater Habitat (WWH); Agricultural Water Supply (AWS); Industrial Water Supply (IWS); Primary Contact Recreational (PCR) and State Resource Water (SRW).

Stream River mile	**(use designation) Parameter (value)**	**Biological Attainment**	**QHEI Score**
Middle Fork Salt Creek (HUC 05060002 080)			
Middle Fork (to Salt Lick Creek)	(WWH, AWS, IWS, PCR, SRW)		
21.9	D.O. (3.23[a])	FULL	50.0
19.7	D.O. (2.78[a]), pH (6.33[b])	FULL	63.5
18.0	D.O. (2.42[a])	FULL	65.5
14.9	D.O. (3.47, 3.77[a])	FULL	65.0
4.75	D.O. (3.51, 2.49, 2.18, 2.4[a])	PARTIAL	61.0
0.27	D.O. (2.96, 2.89[a])	FULL	73.5
UT (to Middle Fork)	(WWH Recommended)		
0.65	Fecal coliform (2417[c]), *E. coli* (1697[c])	FULL	41.5
Kelly Branch (to MFSL)	(SRW, WWH, AWS, IWS, PCR)		
1.45	D.O. (3.04, 3.2[a])	FULL	57.5
Pigeon Creek (to MFSL)	(WWH, AWS, IWS, PCR)		
13.1	D.O. (3.28[a]), Fecal coliform (4697[c]), *E. coli* (749[c])	PARTIAL	35.5
12.3	D.O. (3.65[a]), Fecal coliform (1819[c]), *E. coli* (1350[c])	FULL	52.0
4.72	D.O. (3.85, 3.01[a]) F. coliform (1496[c]), *E. coli* (489[c])	FULL	60.5
UT* to Pigeon Creek	(SRW, WWH, AWS, IWS, PCR)		
2.17	D.O. (2.52[a])	PARTIAL	58.0
0.04	D.O. (3.9, 3.17, 3.73[a])	NON	45.0
Skunk Hollow (to Pigeon Cr.)	(WWH recommended)		
0.05	D.O. (2.88[a]), Fecal coliform (1054[c]), *E. coli* (1162[c])	FULL	63.5
Long Branch (to Pigeon Cr.)	(SRW, WWH, AWS, IWS, PCR)		
0.1	D.O. (3.5, 3.1[a])	FULL	59.0

a Exceeds the minimum criterion for the protection of aquatic life.
b Violates the minimum (6.5) criterion for the protection of aquatic life.
c Exceeds the PCR 30 day maximum.

Table 15. Facilities regulated by an individual and general NPDES permit in MFSCWAU.

Facility Name	**Ohio EPA Permit No.**	**Receiving Stream**	**River mile**	**Wastewater and Treatment Type**
Coalton WWTP	0PA00012	Pigeon Creek	13.6	sanitary 0.05 mgd Biolac© plt.
West Ele. Sch. WWTP	Proposed general permit	MFSC	17.8	Sanitary 7000 gpd package plant
Vinton Local West Ele. Sch.	0GC00496*AG	MFSC	17.8	General Construction Storm Water

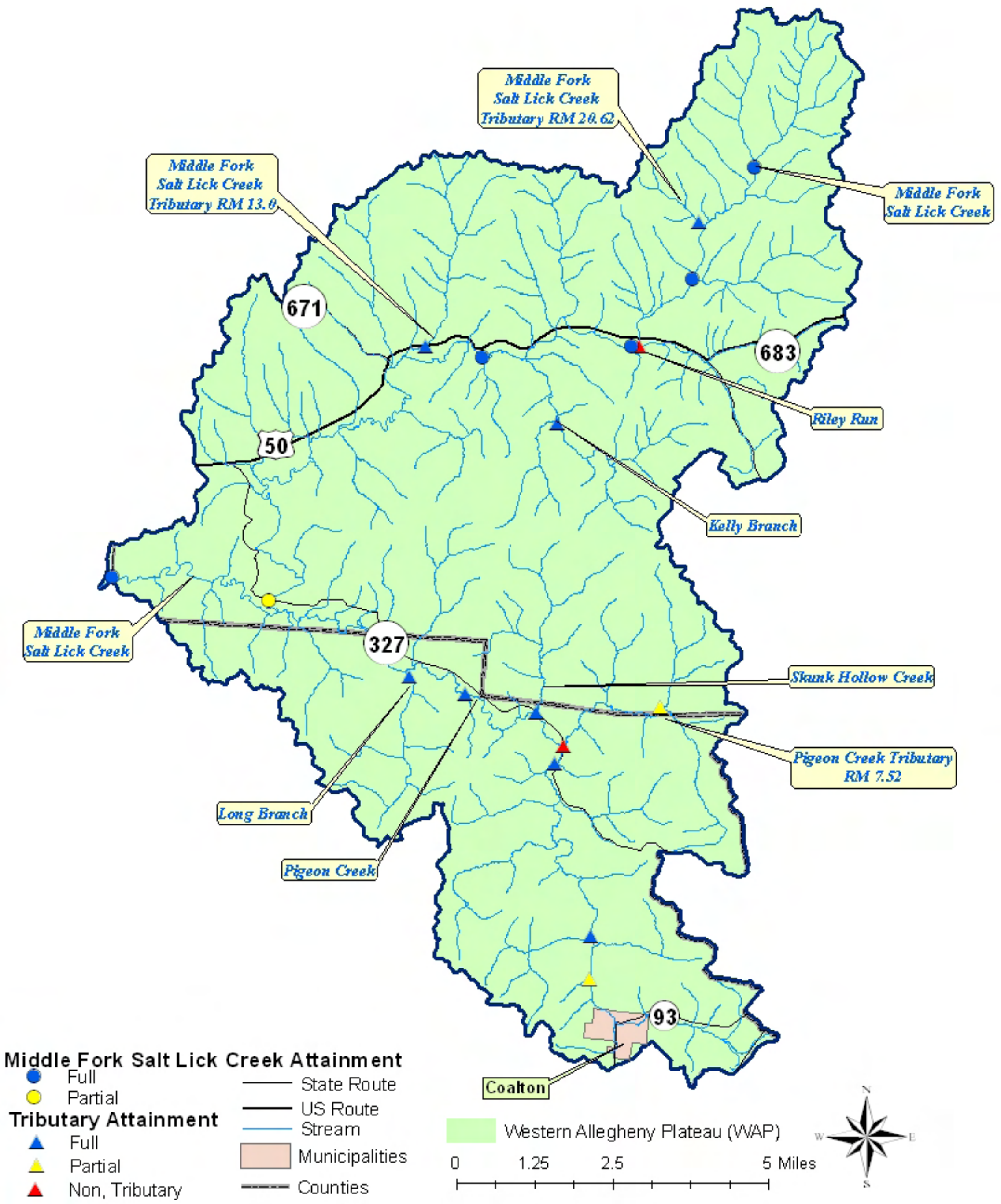


Figure 17. Attainment status of sampling locations with the Middle Fork Salt Creek basin, 2005.

Table 16. Aquatic life use attainment status for stations sampled in the Middle Fork Salt Creek basin based on data collected June-October 2004 and July-October 2005. 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 to support a biotic community.

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/Comments
Middle Fork (Trib to Salt Lick Creek at RM 1.25)					*WAP Ecoregion - WWH Existing*		
22.0[H]	42 [NS]	N/A	G	50.0	FULL	Interstitial flow	2nd pass fish indicated interstitial conditions (8pt. drop between passes) Sig. drop in scores since 1997, 1988 Gravel mining
19.7[H]	44	N/A	E	63.5	FULL		Gravel mining
18.0[W]	45	8.7	VG	65.5	FULL	Interstitial flow	
14.9[W]/14.7	47	9.3	48	65.0	FULL		
4.7[W]/4.9	54	9.5	28*	61.0	PARTIAL	Impounded stream conditions at RM 4.9, enrichment, low flow, siltation	Refuse from bridge demolition acting as impoundment at about RM 4.8, open pasture ust., channel modifications
0.3[W]	54	9.3	40	73.5	FULL	Siltation	
Tributary to Middle Fork Salt Lick Creek at RM 20.62					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.1[H]	46	N/A	-	41.5	(FULL)	Siltation Substrate disturbance	Gravel mining
Riley Run (Trib Middle Fork Salt Lick Creek at RM 18.1)					*WAP Ecoregion - WWH Existing*		
0.3[H]	32*	N/A	F*	60.0	**NON**	Interstitial flow, siltation	Unknown

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/Comments
Kelly Branch (Trib to Middle Fork Salt Lick Creek at RM 15.73) *WAP Ecoregion - WWH Existing / EWH and CWH Recommended*							
1.5[H]	52/52	N/A	VG/ VG[NS]	57.5	FULL/FULL		
Trib to Middle Fork Salt Lick Creek at RM 13.00					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.6[H]	42 [NS]	N/A	G	25.0	FULL	Loss of trees in riparian corridor	Agricultural activities (crop field)
Pigeon Creek (Trib to Middle Fork Salt Lick Creek at RM 4.37)					*WAP Ecoregion - WWH Existing*		
13.1[H]	42[NS]	N/A	F*	35.5	PARTIAL	Siltation, nutrient/organic enrichment, loss of trees in riparian corridor	Cows in stream, channelization Coalton WWTP/Glen Roy, home septic systems
12.3[H]	44	N/A	G	52.0	FULL	Siltation, nutrient enrichment, loss of trees in riparian corridor	
8.0[H]/7.8	44	N/A	G	62.0	FULL		
4.7[W]/4.6	49	9.0	42	60.5	FULL		
Trib to Pigeon Creek at RM 7.32					*WAP Ecoregion - Undesignated / WWH Recommended*		
2.4[H]	30*	N/A	MG[NS]	58.0	PARTIAL	Low to interstitial flow, siltation	Gravel mining
0.1[H]	30*	N/A	P*	45.0	**NON**	Siltation, channel modifications	Cows in stream, channelization
Skunk Hollow Creek (Trib to Pigeon Creek at RM 6.66)					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.1[H]	42[NS]	N/A	G	63.5	FULL	Low flow, siltation	
Long Branch (Trib to Pigeon Creek at RM 3.16)					*WAP Ecoregion - WWH Existing*		
0.1[H]	46	N/A	G	59.0	FULL	Low flow, channel modifications	

Ecoregion Biocriteria: Western Allegheny Plateau

	IBI			**MIwb**			**ICI**		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	44	50	24	N/A	N/A	N/A	36	46	22
Wading	44	50	24	8.4	9.4	4.0	36	46	22
Boat	40	48	24	8.6	9.6	4.0	36	46	22

H - Headwater site.

W - Wading site.

B - Boat site.

a - MIwb is not applicable to headwater streams with drainage areas ≤ 20 mi^2.

b - 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 were not available or considered unreliable due to sampling constraints. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional

c - Attainment status is given for both existing and proposed use designations.

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

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

N/A - Not applicable.

Recreation Use Assessment
The main stem of the Middle Fork Salt Creek had no bacteria results over the PCR WQS. The unnamed tributary to Middle Fork, the Skunk Hollow site, Pigeon Creek sites at RMs 13.1, 12.3 and 4.72 were determined to be in non-attainment for the PCR use designation for *E. coli* (Table 19). This was based on the 90th percentile calculation. It appears that the elevated bacteria counts are a result of failing home septic systems and animal grazing. Cows were noted in the stream numerous times at Pigeon Creek RM 13.1. Poor animal grazing practices are causing numerous degradations in the Middle Fork watershed. The high bacteria results at the UT to Middle Fork and Skunk Hollow were due to the home septic systems at the site. The UT to Pigeon Creek and Long Branch exceeded the PCR for *E. coli* maximum. Again, primary sources are poor livestock practices and failing home septic systems.

Spills
Pollutant discharges from spills, overflows and other unauthorized releases can be a significant sources of lethal and sub-lethal stresses to the aquatic communities in the Middle Fork Salt Creek watershed. Seven spills were reported by the Ohio EPA Emergency Response Section from January 2000 through April 2007. Two reported spills were from the Coalton WWTP. Four spills reported were petroleum related materials. One ammonia spill was reported form an unknown origin. No spills were reported to be associated with a fish kill.

Ecoregion, Soils, and Topography
The 109 mi^2 Middle Fork Salt Creek basin lies entirely within the WAP ecoregion. True to the description of the WAP ecoregion found above, the Middle Fork Salt Creek flows from the eastern coal bearing region to the west through rugged and narrow valleys containing a mixture of forests and limited row cropping and pastures before entering Salt Lick Creek at river mile 1.3. In portions, the valley floor can extend to nearly a mile wide, creating niches for agricultural activities. The tributaries are typically very narrow with steep slopes and narrow ridges.

Soils of the Western Allegheny Plateau region of the watershed are of the Shelocta, Brownsville, Latham, and Steinsburg series. The Shelocta series consists of deep and very deep, well drained, moderately permeable soils. They are on steep concave mountain sides, foot slopes, and benches, and therefore are primarily forested, with only small areas cleared for pastures or agricultural cultivation. The Brownsville series consists of deep, well drained soils found on hillsides and summits within the WAP. Due to their geographic setting, they are primarily associated with forests, though occasionally are cleared for pasture. The Latham series consists of moderately deep, moderately well drained soils found to either be located within forests of oaks and hickory species, or to have been cleared for pasture and crops of corn, wheat, and oats. Soils of the Steinsburg series are moderately deep and well drained which makes them agreeable to the primary land use of cropland and pasture. The few wooded areas present with Steinsburg soils are dominated by oak, maple and ash species (NRCS, 2004).

The predominant land use in the Middle Fork Salt Creek basin was forest (83.5%), with pasture areas in the form of grassland/hay (8.6%), developed areas (5.9%) and cultivated crops (2.0%) comprising the remaining land use (Table 17). The grassland and cultivated crops are concentrated in the main stem valley. Cattle are frequently raised in the narrow valleys immediately adjacent to the streams and are not normally excluded from the streams.

Table17. Middle Fork land use as derived from National Land Cover Database (NLCD 2001).

14-Digit HUC	Narrative Description	Open Water	Developed	Barren Land	Forest	Shrubs/ Scrubs	Grassland/ Hay	Cultivated Crop	Wetland	Total Acres
05060002080010	Middle Fork Salt Creek [except Pigeon Cr.]	0.1%	5.9%	0.0%	84.4%	0.0%	6.5%	3.1%	0.0%	40,152.6
05060002080020	Pigeon Creek	0.0%	5.8%	0.0%	82.3%	0.1%	11.5%	0.4%	0.0%	29,605.3
	Middle Fork aggregate	0.0%	5.9%	0.0%	83.5%	0.0%	8.6%	2.0%	0.0%	69,757.9

Chemical Water Quality and Sediment Quality

Middle Fork

The Middle Fork Salt Creek begins at approximately RM 24.7 in Brays Hollow, Jackson Township, Vinton County and joins Salt Lick Creek at RM 1.25. Middle Fork drains over 110 square miles and is completely within the WAP ecoregion. Six main stem sites were sampled to evaluate chemical, biological and bacterial conditions. Middle Fork is listed as a SHQW in the OAC 3745-1-05.

The Middle Fork watershed consists of steep wooded hills and agriculture in the wide valleys. In the Brays Hollow portion of MFSC, the valley is heavily forested and narrow and the population is sparse. The upper portion of the watershed had very little coal strip mines. Mining maps and USGS topography maps show small strip mines, all are along the watershed boundary. Iron and manganese sample results are typically above the headwater stream target values 665 mg/l and 220 mg/l respectively (Figure 18). Further downstream iron and manganese continue to exceed the wadeable target values as well. Acidity values throughout the watershed were below the laboratory detection level of 5.0 mg/l. Acidity is typically elevated in coal acid mine drainage areas along with iron and manganese. At RM 19.7 the pH was below the WQS once during the entire sampling period. Again the lower than neutral pH results may be caused by the geology of the area and not from acid mine drainage.

Datasonde© continuous monitors were deployed June 21st through 23rd 2005 and recorded hourly D.O. concentration, D.O. percent saturation, temperature, pH and conductivity for three sites in MFSCWAU. The continuous monitors were deployed at river miles 19.7, 18.0 and 0.03. All Datasonde© D.O. concentrations remained above the applicable minimum any time water quality criteria (4.0 mg/l WWH) and the minimum 24-hour average criteria (5.0 mg/l WWH) (Table 18). The D.O. percent saturation varied only 20% over any 24 hour period and never reached above 98.1%. Supersaturation conditions were not recorded at any of the three sampling sites.

Nutrients in the headwaters of Middle Fork Salt Creek were lower than the downstream section. The headwaters section has little farming and is very sparsely populated. After RM 18.5, the MFSC valley opens into a wide agricultural flood plain. Ammonia levels were at the target level of 0.05 mg/l in the headwaters and reached a median of 0.155 mg/l at RM 4.75. At this point, RM 4.75, the valley tightens and agriculture and housing are limited. Also the ammonia levels drop to near targets levels after RM 4.75. Phosphorus and TKN peak at RM 4.75 and then diminish downstream (Figure 19). All bacteria samples were within WQS (Table 19).

Organic water column compound samples were collected at RM 0.27. The samples were analyzed for volatile and semivolatile organic compounds, pesticides, and herbicides. Most results were below laboratory detectable levels (Table 20). Those parameters detected are in Table 20. Very low levels of herbicides and pesticides were detected, but no WQS violations were observed.

Sediment samples were collected at five Middle Fork main stem sites during the 2005 field season. The sediment samples, within the MFSC survey, were analyzed for metals, ammonia and phosphorus. The results show that arsenic was above the Threshold Effect Concentration at RM 22.1 (Table 21). Figure 32 shows the ICI for this site was meeting the WWH criteria.

Riley Run
Riley Run is approximately three miles long, and drains 5.42 square miles. The watershed in heavily wooded with little agriculture, sparse population and some previous coal strip mining. During the sampling season the stream was dry 4 out the 6 sampling events. The stream bed is extremely porous. The two sampling events resulted in no exceedences of target values or WQS.

Kelly Branch
Kelly Branch is approximately four miles long, and drains 7.82 squares miles. The watershed is heavily wooded with little agriculture, sparse population and some previous coal strip mining. Sampling revealed no exceedences of target values or WQS.

Unnamed Tributary to Middle Fork Salt Creek
The UT to Middle Fork is a small hill side tributary with a 5 square mile watershed. Nutrients were typically at or above the target values for WAP ecoregion. This is due to the home septic system at the UT sampling site.

Pigeon Creek
Pigeon Creek begins at RM 17.3, upstream of Glen Roy on State Route 788, Jackson County and ends at Middle Fork Salt Creek at RM 4.37. Four main stem sites were sampled to evaluate chemical, biological and bacterial conditions.

Glen Roy is located at Pigeon Creek RM 16. This is a small unsewered, unincorporated community located two miles east of Coalton. Ohio EPA sampled for fecal coliform in May and June of 2004. The fecal coliform sampling revealed unsanitary conditions (Table 19). The Village of Coalton and Glen Roy are both working with the Jackson County Commissioners to secure funding, install sewers and connect to Coalton's WWTP.

Coalton is located at Pigeon Creek RM 14. Coalton has a population of 545 (2000 census) and is served by separated sewer system and 55,000 gpd WWTP built in 1989. The WWTP is located at river mile 13.6. The WWTP is a Bio-lac© (activated sludge) plant. This is a small diameter sanitary sewer system, meaning each house has a septic tank and the effluent then is conveyed by a small (2 to 3 inch) diameter gravity sewer. The WWTP consists of an influent pump station, bar screen, Bio-lac© extended aeration lagoons, clarifier, chlorination and dechlorination, and sludge holding. Coalton is currently proposing to increase the treatment capacity allowing them to accept Glen Roy's sewage. The Coalton WWTP has had numerous NPDES permit effluent violations and is a major contributor to the nutrient loading of the stream (Figure 20). The loadings from the WWTP for $CBOD_5$ and NH_3 have varied from year to year, but as shown in Figure 20 these loads indicate poor treatment and/or operations.

Pigeon Creek is mostly forested hillsides with homes and animal pasture land in the creek valley. At RM 13.1, in Garfield, cattle were in the stream numerous times during the sampling season. There are few homes located further away from the stream bed. Glen Roy, Coalton, animal grazing and failing home septic systems in the upstream portion of Pigeon Creek result in the ammonia levels above the target value of 0.05 mg/l. Due to the small size of Pigeon Creek in this area, the stream may not have the physical ability to assimilate the nutrient discharges. Phosphorus was above the WWH target value of 0.05 mg/l. Ammonia, TKN and phosphorus decrease as you go downstream. Ammonia and phosphorus stay above the WWH target values throughout the watershed while TKN decreases to below the 0.30 mg/l target at RM 7.85 and 4.72. Ammonia and TKN values are shown in Figure 21. Three of the four sites on Pigeon Creek were above the *E. coli* PCR value, although only two samples were taken.

Underground coal mining was prevalent in the head waters of Pigeon Creek. There were no obvious indications of acid mine drainage during the 2005 field season. Iron and manganese were at or above the WWH target values. This may be due to the geological setting.

Dissolved oxygen results increase from RM 13.1 to RM 12.3 to above 5 mg/l then decline below 5 mg/l further downstream resulting in WQS violations (Table 14). Pigeon Creek is a low gradient stream with a fall of only 9.1 feet per mile. In addition, the low D.O. concentrations may be further reduced by algae blooms as a result from high nutrients.

Unnamed Tributary to Pigeon Creek

The watershed to the UT to Pigeon Creek is approximately eight square miles and located almost entirely within Richland Furnace State Forest. Ammonia was above the WWH target values at RM 2.17 and 0.1, although phosphorus and TKN were below target values. The source of high ammonia in the upper section is unknown. The upper section is forested with no agriculture. At RM 0.1, near the confluence with Pigeon Creek, a livestock pasture abuts the stream and there are a few homes. Cows were observed in the stream at this location. Iron and manganese were consistently over the target values.

Skunk Hollow
The Skunk Hollow watershed is approximately 5 square miles and is mostly forested. Nutrients are typically within targeted values even though there a many homes in the area of the sampling site and along the stream. Iron and manganese had some exceedences of the target values.

Long Branch
The Long Branch watershed is approximately 4.12 square miles and is a mixture of pasture, forest and agricultural fields. TKN and ammonia were above the target values, but phosphorus was below the target value. Iron and manganese were above the target values.

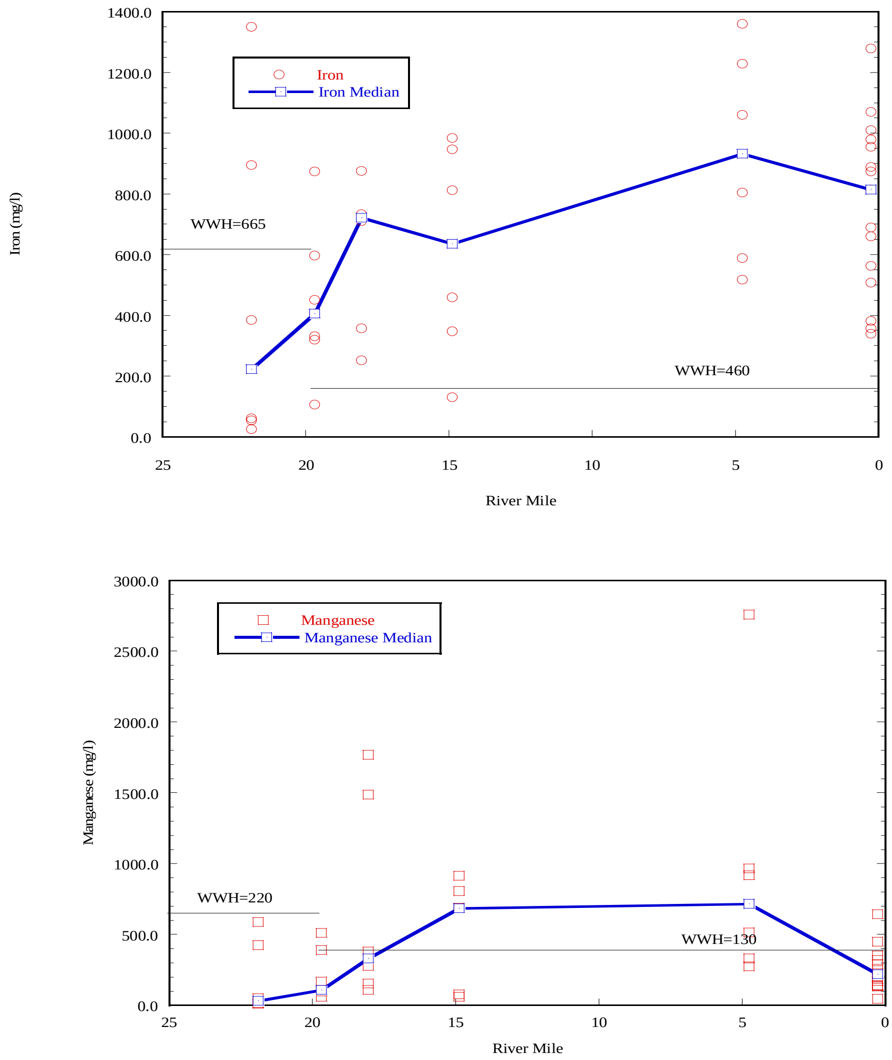


Figure 18. Iron and manganese concentrations found in the main stem of Middle Fork Salt Creek. The WWH target values are noted for WAP ecoregion headwater and wadeable streams (Ohio EPA 1999).

Table 18. Summary of hourly dissolved oxygen measurements (mg/L) recorded by continuous monitors in the Middle Fork Salt Creek.

Stream	River Mile	Hours	Mean	Median	Minimum	Maximum
June 21 - 23, 2005						
Middle Fork	19.7	44	6.94	6.85	6.0	7.97
Middle Fork	18	47	6.00	5.935	5.389	6.81
Middle Fork	0.3	47	6.47	6.43	6.0	7.04

Figure 19. Summary of bacteria data for the Middle Fork Salt Creek sites (HUC 080). Values are based on comparison of the geometric mean and 90th percentile values to the PCR criteria in Ohio Administrative Code (OAC 3745-1-07). The underlined values exceed PCR maximum. All values in colony forming units (cfu) per 100 ml of water.

		Geometric Mean		90th Percentile		Potential Cause
Stream	River Mile	Fecal Coliform	*E. coli*	Fecal Coliform	*E. coli*	
Middle Fork	21.9	144	90*	157	90*	
Middle Fork	18.05	674	73*	703	73*	
Middle Fork	14.88	501	*	582	*	
Middle Fork	4.75	297	253	332	275	
Middle Fork	0.27	111**	68**	422**	260**	
Riley Run	0.01	200	*	120	*	
UT Middle Fork	0.65	1415	1177	**2417**	**1697**	HS
Kelly Branch	1.45	38.72	70*	91.5	70*	
Pigeon Creek	13.1	940	703	**4697**	**749**	HS,LS,STP
Pigeon Creek	12.3	616	1122	**1819**	**1350**	HS, LS
Pigeon Creek	7.85	385	219	438	286	
Pigeon Creek	4.72	947	391	**1496**	**489**	HS, LS, Ag
UT Pigeon Creek	2.17	130	105	258	203	
UT Pigeon Creek	0.04	398	305	465	**317**	LS, HS
Skunk Hollow	0.05	461	880	**1054**	**1162**	HS
Long Branch	0.1	464	520	485	**610**	HS, Ag

* Only one sample evaluated or no data available.
** Five samples evaluated, thus full attainment for Recreational Use.
HS - Home Septic
STP – Sewage Treatment Plant
Ag. – Agricultural Practices
LS – Livestock

Table 20. Organic chemical compounds detected in stream samples collected by Ohio EPA from the Middle Fork Salt Creek, 2005 (units in ug/l).

Middle Fork Salt Creek	
River Mile 0.27	
Semivolatiles-Herbicides	
bis(2-Ethylhexl)phthalate	0.57
Benzoic Acid	0.4
Hexadecanoic acid	0.4
Octadecanoic acid	0.4
Ethanol, 2-[2-[4-(1,1,3,3-tetramethylbutyl) phenoxy]ethoxy]	1.0
Pesticides	
α-BHC	0.00031
δ-BHC	0.0026

BHC – benzene hexachloride. Gamma-BHC or γ-BHC (Lindane).

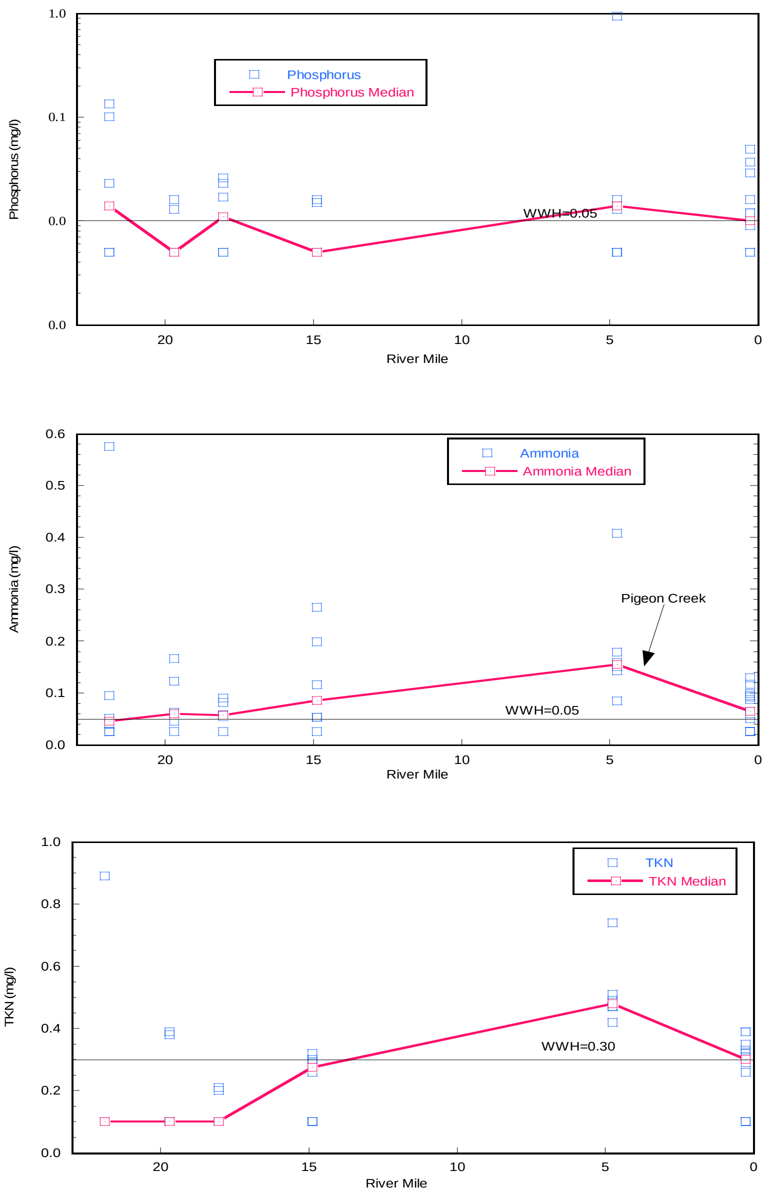
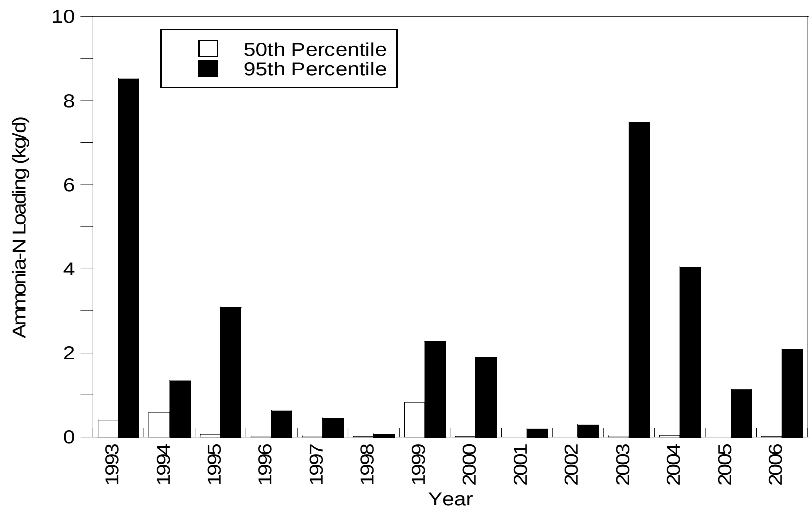


Figure 19. Nutrient concentration values in the main stem of Middle Fork Salt Creek. The WWH target values are noted WAP headwater and wadeable streams (Ohio EPA 1999).



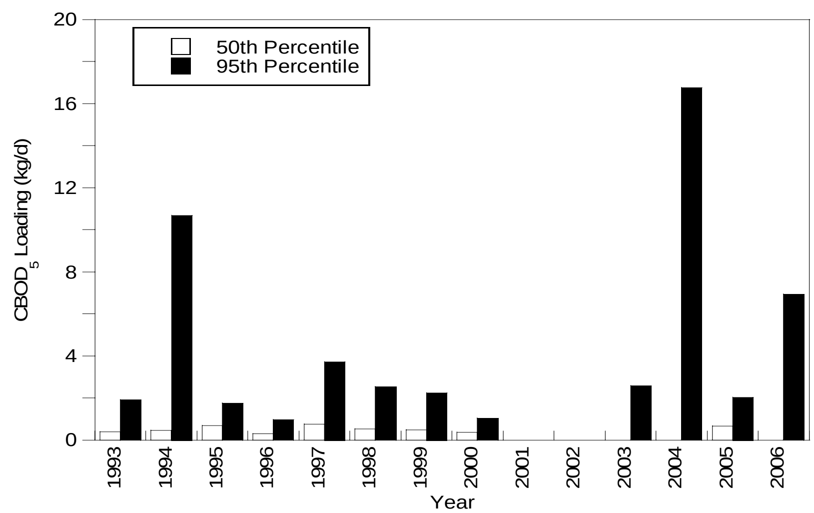
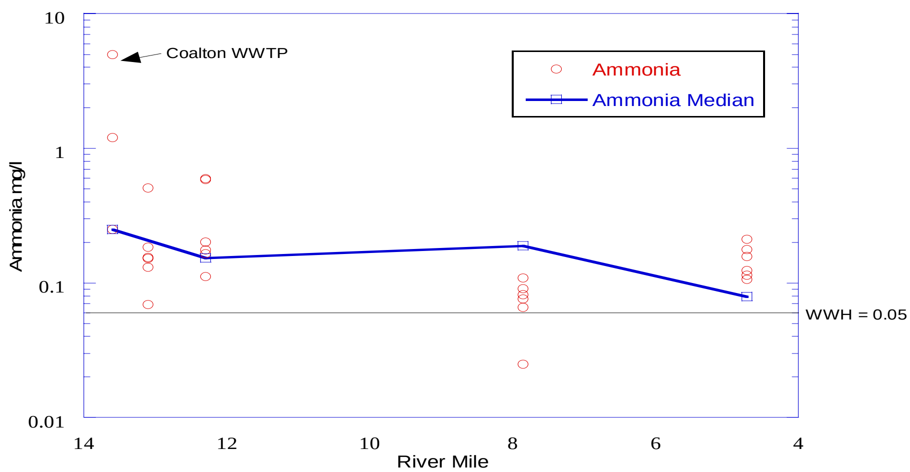


Figure 20. Annual median and 95th percentile loading concentrations for ammonia and $CBOD_5$ reported by the Coalton WWTP, 1993-2006.



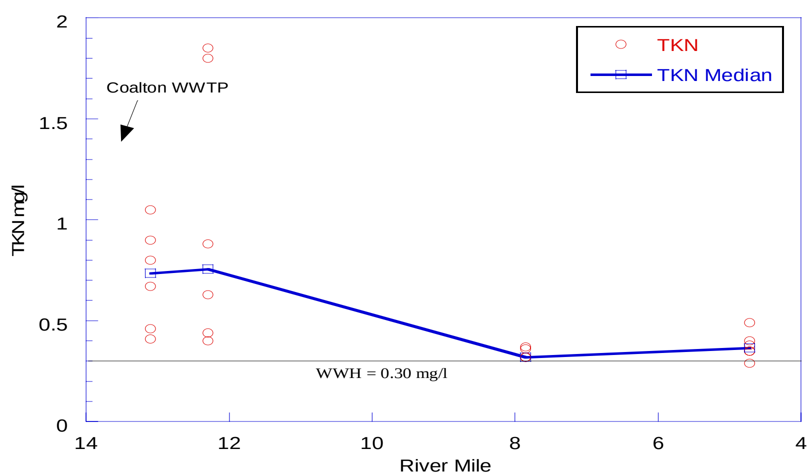


Figure 21. Ammonia and TKN concentration values for the Pigeon Creek main stem. TKN was not sampled by the Coalton WWTP during the sampling season. Ammonia value of 25 mg/l from the Coalton WWTP on June 29th was used in the calculations median. The WWH target values are noted WAP headwater and wadeable streams (Ohio EPA 1999).

Table 21.Chemical compounds detected in sediment samples collected by Ohio EPA in the Middle Fork Salt Creek, 2005.

Stream Segment	**Middle Fork**	**Middle Fork**	**Middle Fork**	**Middle Fork**	**Middle Fork**
River Mile	**22.1**	**19.7**	**18**	**4.7**	**0.3**
PARAMETER	**Sample Results**				
Aluminum	15600	11100	14400	14200	10900
Arsenic	12.8 [TEC]	5.01	8.1	7.8	6.51
Barium	104	71.3	93.3	99.6	81.2
Cadmium	0.127	0.117	0.147	0.142	0.107
Calcium	1210	1170	1270	1090	2060
Chromium	20	18	18	15	15
Copper	6.1	5.9	5.9	4.7	4.9
Iron	18600	12800	17000	14200	10900
Lead	24	23	24	19	20
Magnesium	1370	1130	1280	1420	1750
Manganese	284	172	519	509	647
Mercury	0.032	0.028	0.026	0.029	0.028
Nickel	24	23	24	19	20
Potassium	2920	2270	2710	2760	2340
Selenium	1.21	1.17	1.19	0.94	0.98
Strontium	18	18	18	17	15
Zinc	49.7	39.2	51.9	36.9	33.2
% Solids*	65.9	64.4	67.4	72.4	71.3
Ammonia*	28	11	26	13	10
Sodium*	3030	2930	2970	2340	2460
TOC*	1.1	0.6	1.3	0.6	0.8
Total Phosphorus*	206	141	210	151	172

All parameters in mg/kg except %.
[TEC] Value above the threshold effect concentration (MacDonald *et al.* 2000).
Underlined values indicate concentrations below method detection limit.
* Does not have SRV (sediment reference value) or TEC association.

Physical Habitat

The physical habitat of 18 locations within the Middle Fork Salt Creek basin was evaluated with the QHEI. As Figure 22 shows, the majority of sites scored within the fair to good range. All three sites that scored less than fair were <10 mi^2 in drainage area. Livestock access to the streams, cropping up to the stream bank and instream gravel mining appeared to be the primary causes of the lower habitat scores. Habitat destruction from ATVs was noted in Pigeon Creek at RM 4.7, and in both sampling locations along the tributary to Pigeon Creek at RM 7.52. All of the sites >10mi^2 in drainage area scored in the good range, indicating that the majority of habitat modifications occur in smaller streams.

The average QHEI=63.1 (range of 50 to 73.5) for Middle Fork Salt Creek main stem sites and similarly, the tributaries had an average QHEI=51.6, though the range of scores extended from 25 to 63.5. The majority of habitat conditions indicate the ability of streams within the Middle Fork Salt Lick Creek basin to support WWH communities, however, channel modification through agricultural activities and gravel mining may negatively affect biological community performance.

Middle Fork Salt Creek

The physical habitat of Middle Fork Salt Creek was evaluated in six locations between County Road 2 (RM 22.1) and West Junction Road (RM 0.3). Evidence of recent gravel mining was apparent in the upper reach from County Road 2 (RM 22.1) to Goose Creek Road (RM 19.7). Sandstone was the underlying geologic substrate throughout Middle Fork Salt Creek, though the dominant substrate present in the upper reach was gravel intermixed with areas of cobble, silt, sand and hardpan. Silt was present in normal to moderate amounts and substrates were embedded in normal amounts. Sparse to moderate amounts of instream cover was provided by undercut banks, overhanging vegetation, shallows, rootmats, rootwads, and woody debris. Channel morphology improved in a downstream direction throughout the upper reach, with the uppermost site exhibiting low sinuosity with poor channel development and moderate stability while the next downstream site had improved channel development though still low sinuosity and moderate stability were apparent. Riparian buffers were non-existent to very narrow (<5 m) adjacent to residential homes, very narrow (<5 m) adjacent to crop fields, narrow (5-10 m) along an old field, and wide along a forested portion near Goose Creek Road (RM 19.7).

The mixture of forest, residential and agricultural land uses continued throughout the lower reach of Middle Fork Salt Creek from Carpenter Road (RM 18.0) to West Junction Road (RM 0.3). Gravel and sand were the predominant substrates present, though areas of boulder, cobble and silt were also noted. Moderate amounts of silt moderately embedded substrates, limiting the amount of interstitial spaces available for aquatic life. Moderate to extensive amounts of instream cover was provided by undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads, boulders, aquatic macrophytes and woody debris. Recovery from past channelization activities varied throughout the lower reach with less recovered areas exhibiting low sinuosity with fair development and low stability while more natural reaches were characterized by moderate to high sinuosity with fair to good development and moderate to high stability. Riffles and runs were primarily comprised of large gravel and were relatively free of embeddedness.

QHEI scores for Middle Fork Salt Creek had an average value of 63 and ranged from 50.0 at the most upstream site near County Road 2 (RM 22.1) to 73.5 at the most downstream site near West Junction Road (RM 0.3). The QHEI scores reflect the likelihood that the majority of Middle Fork Salt Creek should be able to support WWH communities.

Pigeon Creek

The physical habitat of Pigeon Creek was sampled in four locations from the headwaters near Township Road 375 (RM 13.1) to Woodrow Hale Road (RM 4.7). The primary substrate origin appeared to be sandstone. Gravel and sand were the dominant substrates present at the uppermost site, though areas of cobble, hardpan and silt were also noted. The headwaters near Township Road 375 (RM 13.1) exhibited signs of recent channel modifications as low sinuosity with poor development and low stability were noted. Cows had access to the stream downstream of Township Road 375 and according to a citizen, the county had dipped out a portion of the stream within the last few weeks. Piles of sediment from the recent dipping activity were observed along the right descending bank while false banks were noted along each bank (Figure 23). The dipping activities likely contributed to the heavy silt present which resulted in moderately embedded substrates. Instream cover was reduced to sparse amounts of undercut banks, overhanging vegetation, shallows and little woody debris. The headwater site was located within an open pasture, so no riparian corridor was present.

Figure 23. False banks and substrate piles from recent dipping activities of Pigeon Creek RM 13.1.

Further downstream, gravel and sand were the dominant substrates present with areas of cobble, hardpan, silt and rip-rap also noted. Silt was present in moderate to heavy amounts and substrates were normally to moderately embedded. Undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), aquatic macrophytes and woody debris along with occasional pieces of rip-rap in the stream provided moderate amounts of instream cover. The middle reach appeared to be recovering from dipping activities with moderate sinuosity but poor to fair channel development and low to moderate stability. Small areas of heavy erosion were noted near Finley Chapel Road (RM 12.3) and State Route 327 (RM 8.0), likely exacerbated by the dipping activities (Figure 24). Riffles and runs were nearly non-existent as the stream was primarily a long pool/glide. A combination of residential homes surrounded by old and new fields bordered the stream with very narrow (<5 m) to narrow (5-10 m) buffers.

The sandy substrate of the lower reach of Pigeon Creek contained areas of cobble, gravel, and silt in addition to the sand. Silt was present in normal amounts and substrates were normally to moderately embedded. Sparse amounts of instream cover was provided by undercut banks, overhanging vegetation, shallows, deep pools (>70 cm), and woody debris. Moderate sinuosity with fair development and moderate stability characterized the lower reach, though evidence of high flows and 4x4 vehicle tracks were noted within the stream channel. A fenced pasture and residential home extended past a moderate (10-50 m) riparian buffer along the left descending bank while a new field and residential homes extended beyond very narrow (<5 m) to narrow (5-10m) buffer along the right descending bank. According to a property owner near Woodrow Hale Road (RM 0.3), mud eels (lamprey) and water moccasins have not inhabited the stream since a gasoline spill from an upstream neighbor occurred several years earlier. He also mentioned that bleach was dumped in the stream by a person in retaliation for not being allowed access to fish the stream.

Figure 24. Eroding banks of Pigeon Creek near State Route 327 (RM 8.0).

The recent dipping activities in the headwaters of Pigeon Creek near Township Road 375 (RM 13.1) resulted in the lowest QHEI score for Pigeon Creek (QHEI=35.5). The QHEI scores for the remaining sites had a median value of 58.0 and a range of 51.5 to 61.5.

Long Branch
The physical habitat of Long Branch was evaluated near County Road 29 (RM 0.1). Sandstone was the substrate of origin and sand was the dominant substrate. Hardpan, gravel, detritus and silt were also present. Moderate amounts of silt resulted in moderately embedded substrates. Undercut banks, overhanging vegetation, shallows, deep pools (>70 cm), and woody debris provided moderate amounts of instream cover to aquatic life. Moderate sinuosity with poor to fair development and low stability were noted. Little erosion was noted as the stream wound through a forest with moderate (10-50 m) buffers, but as the stream entered a mixture of residential homes with old and new fields and non-existent buffers, eroding banks were moderate to severe. The combination of diverse substrates and moderate amounts of instream cover with a mixture of land use and buffers resulted in a QHEI score of 59.

Tributary to Middle Fork Salt Creek at RM 13.0
The physical habitat of a tributary to Middle Fork Salt Creek (RM 13.0) was evaluated near State Route 50 (RM 0.6). Sand and silt were the dominant substrates with hardpan and gravel also present. Heavy amounts of silt overlaid substrates resulting in extensive embeddedness. The maintained condition of the stream resulted in no sinuosity, poor channel development and low stability (Figure 25). Instream cover was nearly absent, as only sparse overhanging vegetation and shallows were present. Moderate to heavy erosion occurred along each bank as vegetation was inhibited from growing by mowing activities and the steep banks of the channel. The lack of riparian buffers extended to a mowed road easement along the right descending bank and row crops along the left descending bank.

Figure 25. Channelized conditions of tributary to Middle Fork Salt Creek located at RM 13.0.

Skunk Hollow Creek
The physical habitat of Skunk Hollow Creek was evaluated near State Route 32 (RM 0.1). The streambed appeared to originate from sandstone, and sand was the dominant substrate present though areas of gravel were also noted. Normal amounts of silt were

present and substrates were embedded in normal amounts. Moderate amounts of instream cover was provided by undercut banks, overhanging vegetation, shallows, deep pools (>70 cm), and woody debris. Though no evidence of channelization was apparent, the stream exhibited low sinuosity, fair development and low stability. Currents were only slow to moderate as the only riffles were made of sand and gravel. Moderate (10-50 m) buffers extended to a mixture of residential and industrial (automotive junkyard) along the left descending bank. A residential lawn provided no buffer along a portion of the right descending bank, while a moderate (10-50 m) buffer extended to a forest along the remaining portion of the right descending bank. The QHEI score for Skunk Hollow Creek was 63.5.

Tributary to Pigeon Creek (RM 7.52)
The physical habitat of the tributary to Pigeon Creek (RM 7.52) was evaluated adjacent to County Road 6R near Richland Furnace (RM 2.4) and downstream of Byer (RM 0.1). The streambed appeared to originate from sandstone, though the types of substrates present differed greatly between the two sites. The streambed of the upper reach was dominated by cobble which was intermixed with boulders, silt, gravel and sand. In stream gravel mining or channel widening was evident in the upper reach. Off road vehicles, including four wheelers had been driven through the stream and overturned the cobble and gravel so there was little embeddedness and only sparse instream cover provided by overhanging vegetation, shallows, boulders and woody debris. Paths for the vehicles had beaten down the banks and went through the stream. The stream channel exhibited moderate sinuosity, fair channel development and moderate stability. Except where the paths extended, the upper reach had a wide riparian buffer that extended into the forest. The heavy use of the stream by recreational off-road vehicles had left the riffles unstable and compromised the habitat integrity of the stream resulting in a QHEI score of 58.0.

Figure 26. Trampled banks from cattle along the tributary to Pigeon Creek (RM 7.52) located downstream of Byer (RM 0.1).

Further downstream, the lower reach was impacted by agricultural activities as it flowed through a cow pasture. A mixture of sand and silt dominated the substrates, though small areas of gravel were also noted. The heavy amounts of silt moderately embedded substrates, limiting the amount of interstitial spaces available for aquatic life. Instream cover was provided in moderate amounts by undercut banks, overhanging vegetation, shallows, rootmats, and woody debris. False banks and severe erosion were noted along the left descending bank from trampling by livestock (Figure 26). Sinuosity was low, channel development was poor and stability low as a result of the constant access to the stream by the livestock. Riparian buffers varied from non-existent through the majority of the pasture to moderate (10-50 m) along a portion of the right descending bank which extended into a forested hillside. The highly modified conditions resulted in a QHEI score of 45.0.

Kelly Branch
The physical habitat of Kelly Branch was evaluated near Township Road 2 (RM 1.5). The streambed appeared to originate from sandstone and was dominated by cobble and gravel intermixed with sand and bedrock. Normal amounts of silt and embedded substrates provided interstitial spaces for aquatic organisms. Flows were quite low on July 6, 2005 with ≤1.5" of water present in several pools and other portions of the stream appearing dry. Therefore, only sparse amounts of instream cover including undercut banks, overhanging vegetation, shallows, rootwads and woody debris were even available to aquatic organisms. Channel development was fair with low sinuosity and low stability. Wide (>50 m) buffers extended into forests along the left descending bank which thinned to old fields and residential homes without any buffers. Along the right descending bank, old fields and residential homes had non-existent to narrow (5-10m) buffers. No riffles or runs were present as a result of the low flow conditions. Kelly Branch received a QHEI score of 57.5.

Riley Run
The physical habitat of Riley Run was evaluated along Carpenter Road (RM 0.1) as it flowed adjacent to residential homes with non-existent to narrow buffers (5-10m). Sandstone was the origin of the streambed. Gravel dominated the substrate types present, though areas of silt and sand were also observed. Moderate amounts of silt were present though substrates were only normally embedded. A moderate amount of instream cover was provided by undercut banks, overhanging vegetation, shallows, rootwads and woody debris. Moderate sinuosity with fair development and low stability characterized the channel. No evidence of any channelization activities was observed, though moderate amounts of stream bank erosion were observed along the left descending bank. The physical habitat of Riley Run received a QHEI score of 59.0, indicating the stream could potentially support a WWH community.

Tributary to Middle Fork Salt Creek at RM 20.6
The physical habitat of this tributary to Middle Fork Salt Creek was evaluated along Goose Creek Road (RM 0.1). The sandstone geology of the stream was dominated by

cobble and gravel. Areas of silt, sand and bedrock were also present. Heavy amounts of silt moderately embedded substrates. Instream cover was nearly absent and consisted of small amounts of overhanging vegetation, shallows, rootmats, and occasional rootwads and woody debris. Gravel mining activities had severely altered the channel morphology (Figure 27). Cobble and gravel substrates had been cleared to reveal bedrock upstream of the bridge and numerous piles of gravel were present along either stream bank.

Outside of the stream channel, residential yards extended to stream banks in several areas and the widest riparian buffers were less than 10m in width. The extreme channel disturbance from the gravel mining operations resulted in a QHEI score of 41.5.

Figure 27. Evidence of gravel mining within the tributary to Middle Fork Salt Creek located at RM 20.6.

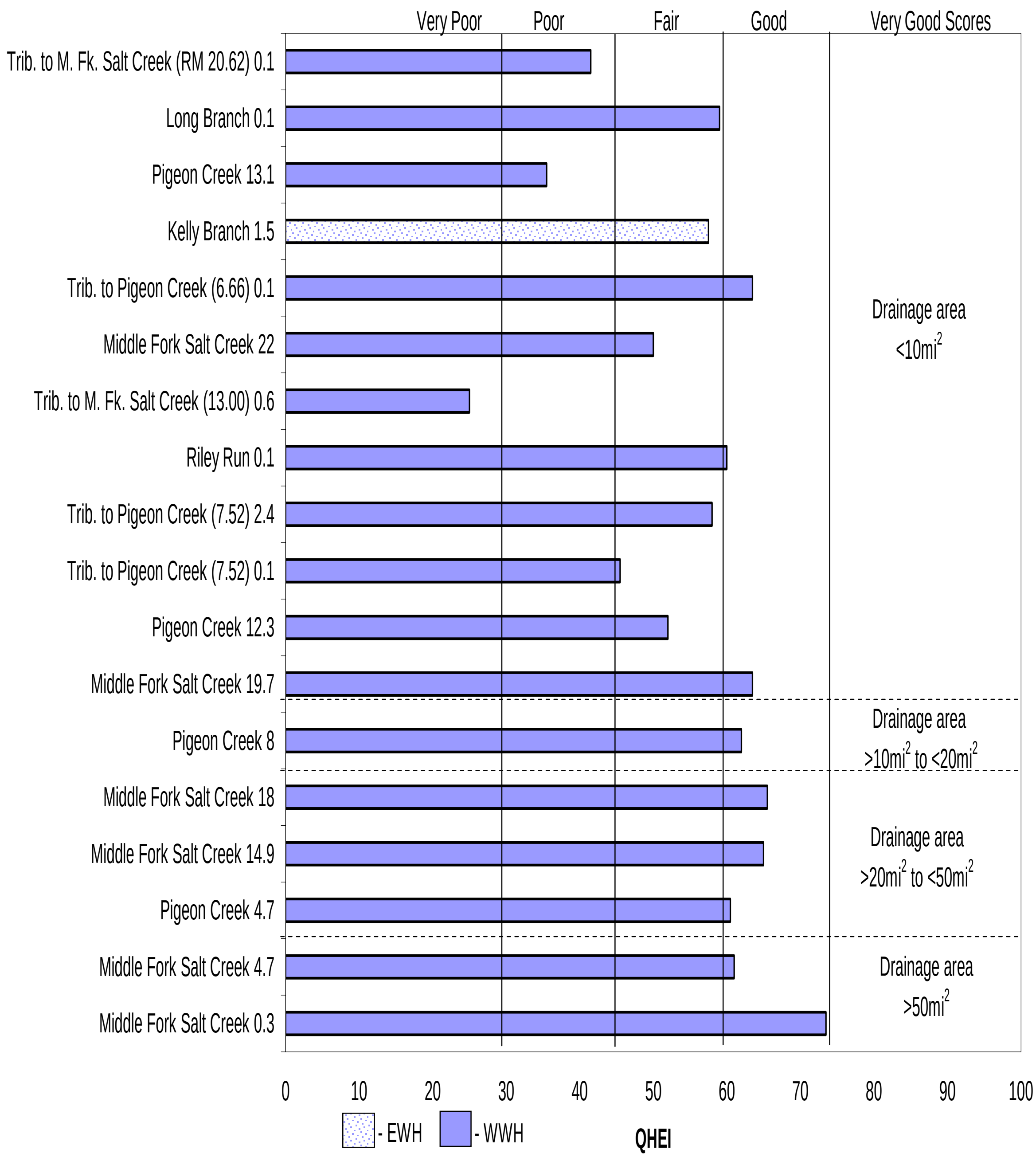


Figure 22. QHEI scores, by drainage area, for sites within Middle Fork Salt Creek basin. Exisitng or proposed aquatic life use designtations were Exceptional Warmwater Habitat (EWH) and Warmwater Habitat (WWH).

Biological Communities: Fish

The fish communities of 18 locations within the Middle Fork Salt Creek basin were sampled during 2005. The fish community scores for the five Middle Fork Salt Creek main stem sites correlated with habitat performance (Figures 28). Fish communities of tributary streams were mixed in their relationship with QHEI scores. The tributary to Pigeon Creek at RM 7.62 showed fair community performance significantly below WWH standards which reflected the channel modifications noted in the habitat evaluation. Riley Run and the site at RM 2.4 along the tributary to Pigeon Creek at RM 7.62 had marginal habitat quality, but the fish community was significantly below WWH expectations. In contrast, several fish communities performed well despite less than optimal habitat conditions: tributary to Middle Fork Salt Lick Creek at RM 20.62, tributary to Middle Fork Salt Lick Creek at RM 13.0, and Pigeon Creek RM 13.1. The relatively intact integrity of habitat across the Middle Fork Salt Lick Creek basin results in high biological community performance in the face of small scale habitat perturbations.

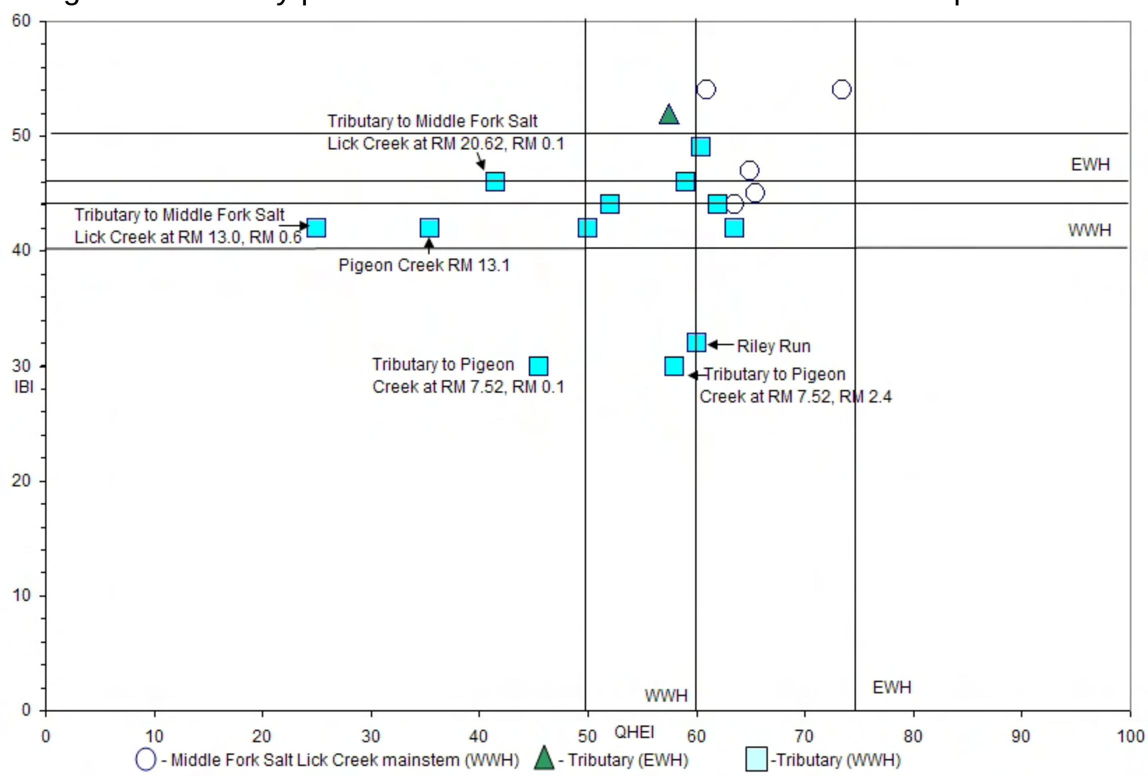


Figure 28. IBI scores by QHEI for sites within Middle Fork Salt Creek basin, HUC 05060002080.

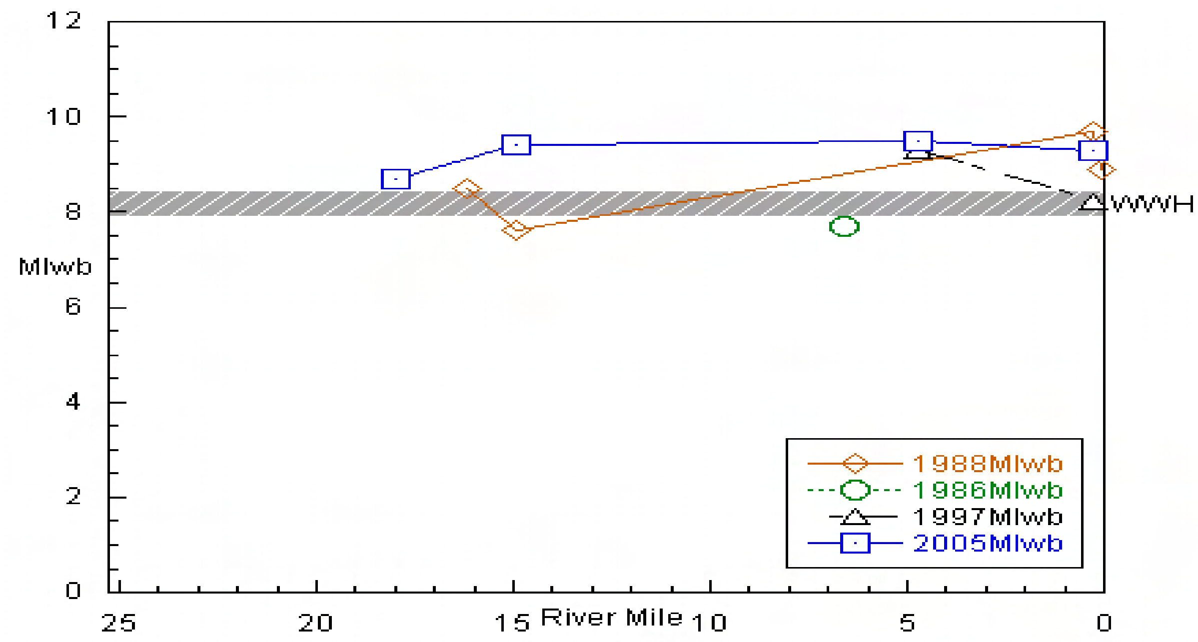
The IBI averaged 47.7 (range of 42 to 54) for Middle Fork Salt Creek main stem sites while the tributaries had a lower average (IBI=41.6) with a wider range of scores (range of 30 to 52). The majority of habitat conditions indicate the ability of streams within the Middle Fork Salt Creek basin to support WWH communities, however, continued channel modification and livestock access to streams for agricultural purposes and gravel mining may more strongly affect biological community performance in the future.

Middle Fork Salt Creek

The fish community of Middle Fork Salt Creek was evaluated in six locations between County Road 2 (RM 22.1) and West Junction Road (RM 0.3). Community scores increased in a downstream direction, from an IBI of 42 near County Road 2 (RM 22.1) to an IBI of 55 at the two most downstream sites. Presence of tolerant individuals also decreased in a downstream direction, from an average of 60% of the community at the most upstream site to comprising only 11% of the community at the most downstream collection. A total of 9 pollution intolerant species were collected throughout the stream and included black redhorse, river redhorse, silver shiner, mimic shiner, rosyface shiner, stonecat madtom, brindled madtom, banded darter and variegate darter.

Figure 29. Evidence of gravel mining in Middle Fork Salt Creek located at RM 22.1.

Middle Fork Salt Creek has been sampled in 1986, 1988 and 1997. While the stream has historically maintained WWH scores for the IBI and MIwb, the headwaters appear to have declined in fish community performance since 1997 (Figure 30). Evidence of gravel mining was noted near RM 19.7 and 22.1 in 2005 (Figure 29). If this activity has become extensive in the area, it could be responsible for the drop in fish community performance. The single site sampled in 1986 may have been impacted by historical mining activities, as several abandoned mines are known to exist in the area (Figures 30 & 31).



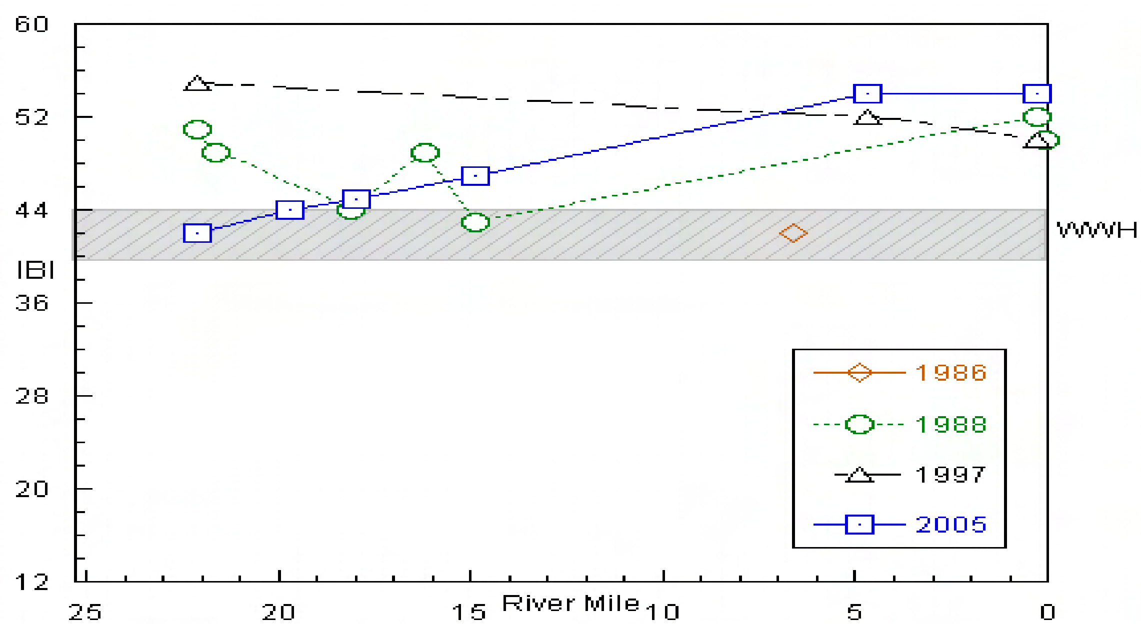


Figure 30. IBI and MIwb scores are shown for Middle Fork Salt Creek over time. MIwb does not apply to sites with <20mi[2] drainage area.

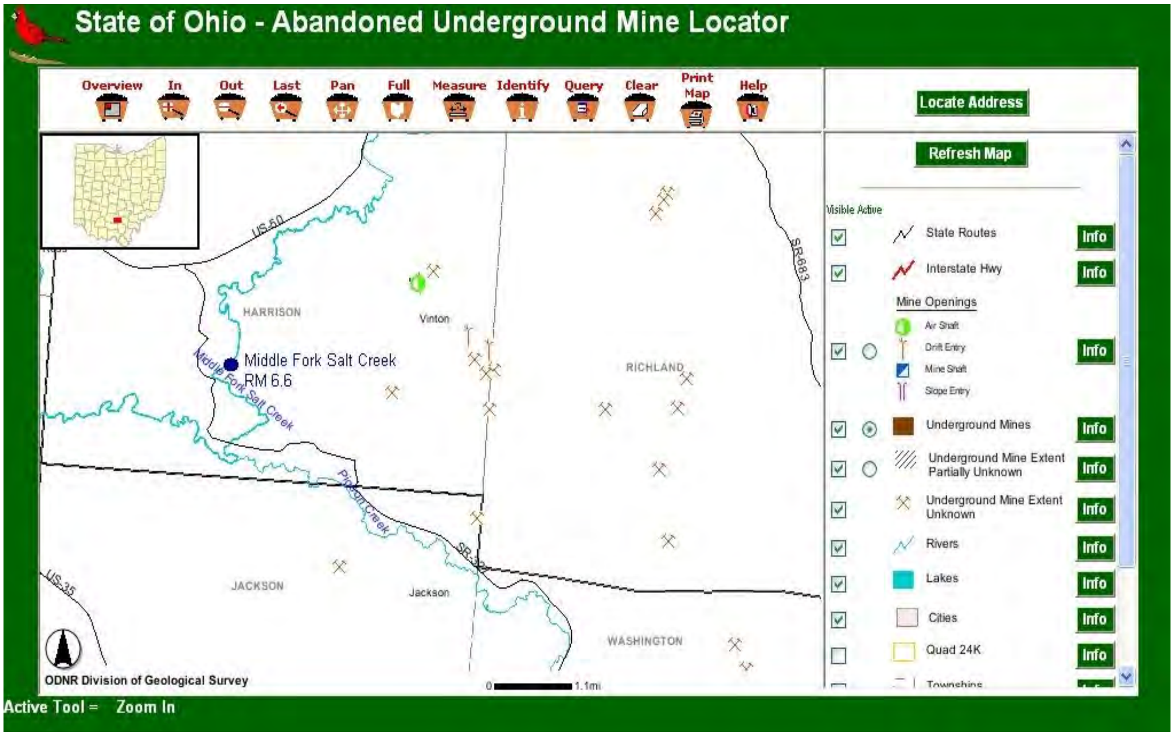


Figure 31. Map of abandoned mine locations adapted from ODNR's existing database of abandoned mines, www.ohiodnr.com/news/jul05/0725oldmines.htm.

Tributary to Middle Fork Salt Creek at RM 20.62

The fish community of this tributary to Middle Fork Salt Creek was evaluated along Goose Creek Road (RM 0.1). Eleven species were collected and included three darter species. Tolerant species comprised 73% of the relative number of individuals. This is likely a result of the highly modified conditions noted in the habitat section of this report. The IBI score for this stream was 46.

Riley Run

The fish community of Riley Run was evaluated along Carpenter Road (RM 0.1). Ten species were collected though tolerant individuals comprised 81% of the relative number of fish. Riley Run received an IBI score of 32.

Kelly Branch

The fish community of Kelly Branch was evaluated near Township Road 2 (RM 1.5). Eighteen species were collected and included three moderately pollution intolerant species: golden redhorse, northern hog sucker and scarlet shiner. The diversity of fish species present and balance within the fish community structure resulted in an IBI of 52 for Kelly Branch.

Tributary to Middle Fork Salt Creek at RM 13.00
The fish community of this tributary to Middle Fork Salt Creek at RM 13.0 was evaluated near State Route 50 (RM 0.6). Thirteen species were collected and included three moderately pollution intolerant species. The IBI score was 42.

Pigeon Creek
The fish community of Pigeon Creek was sampled in four locations from the headwaters near Township Road 375 (RM 13.1) to Woodrow Hale Road (RM 4.7). The number of species collected increased in a downstream direction, from 17 near Township Road 375 (RM 13.1) to 28 species in one pass near Woodrow Hale Road (RM 4.7). IBI scores also increased in a downstream direction, from 42 at the most upstream site to 49 at the most downstream site with an average of 45.

Historical sampling in Pigeon Creek occurred near RM 10.3 in 1986. At that time, the fish community was described as, "…typical of a nonimpacted headwater stream" (Albeit, 1986). The IBI in 1986 was 41, slightly below the scores of 44 recorded upstream (RM 12.3) and downstream (RM 8.0) in 2006. The consistent performance of biological communities in Pigeon Creek indicates a strong balanced system. However, steps should be taken to reduce the agricultural influences in the headwaters to assure future attainment of WQS.

Tributary to Pigeon Creek at RM 7.52
The fish community of the tributary to Pigeon Creek (RM 7.52) was evaluated adjacent to County Road 6R near Richland Furnace (RM 2.4) and downstream of Byer (RM 0.1). The fish community at each site was comprised primarily of tolerant, pioneering species such as creek chub, white sucker, blacknose dace, and bluntnose minnow. While this is common in small headwater streams with interstitial flow, the low community composition by sensitive species and darter species indicates the community is influenced by human disturbance in the area. No sensitive species were collected near Richland Furnace (RM 2.4) and only two sensitive species, southern redbelly dace and blackside darter, were collected downstream of Byer (RM 0.1). Both sites received an IBI score of 30.

Skunk Hollow
The fish community of Skunk Hollow Creek was evaluated near State Route 32 (RM 0.1). Fourteen species were collected and included the pollution intolerant silver shiner and moderately pollution intolerant rainbow darter and longear sunfish. Skunk Hollow received an IBI score of 42.

Long Branch
The fish community of Long Branch was evaluated near County Road 29 (RM 0.1). Eighteen species were collected and included two moderately pollution intolerant species, scarlet shiner and longear sunfish. Long Branch received an IBI score of 46.

Biological Assessment: Macroinvertebrate Community

Macroinvertebrate communities were evaluated at 17 stations in the Middle Fork Salt Creek assessment unit (Table 22). The community performance was evaluated as exceptional at two stations, very good at three, good at seven, marginally good at one, fair at three, and poor at one station. The station with the highest total mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa richness (EPT) was on Middle Fork Salt Creek at Township Road 46 (RM 22.0) with 23 taxa. The station with the highest number of total sensitive taxa was on the Middle Fork Salt Lick Creek at West Junction Road (RM 0.3) with 35 taxa. Sensitive taxa found in this assessment unit which are noteworthy because they are not commonly collected were the stoneflies *Acroneuria lycorias* in Middle Fork Salt Creek (RM 14.7) and *Eccoptura xanthenes* in Kelly Branch (RM 1.4).

Middle Fork Salt Creek

Macroinvertebrate community performance in Middle Fork Salt Creek was generally good to exceptional with the exception of the collection site located upstream from SR 327 (RM 4.9) which was in an impoundment. EPT diversity was highest downstream from Township Road 46 (RM 19.7) with 23 taxa. In general, the qualitative EPT diversity was highest at the three upstream most stations and the qualitative sensitive taxa diversity was highest at the two upstream most stations (Table 22, Figure 32). This trend is opposite of the expected increase in EPT and sensitive taxa diversity with increased drainage area. Observed conditions that may be stressing the biological communities were low flows from the headwaters to Township Road 5 (RM 14.7), iron precipitation on the substrates at Township Road 5 (RM 14.7), cows in the stream channel upstream from SR 327 (RM 4.9), stream impounded by the remains of an old abandoned bridge crossing at about RM 4.8, and siltation at RMs 4.9 and 0.3.

The macroinvertebrate community trend in the Middle Fork Salt Creek was generally similar to previous sampling (Figure 33). This trend in the quality of the macroinvertebrate communities suggests that the biotic integrity of the Middle Fork Salt Creek has remained stable since 1986.

Riley Run

The macroinvertebrate community performance in Riley Run (RM 0.1) was not meeting WWH expectations. EPT (7) and sensitive taxa (11) diversity were lower than expected and the community structure was disturbed with primarily facultative organisms predominant in the riffle habitat. Interstitial flow and siltation were the observed threats to the biological integrity at this site.

Kelly Branch

Macroinvertebrate community performance in Kelly Branch (RM 1.4) was evaluated as very good. However, one indication of community imbalance was the absence of baetid mayflies from the riffle habitat. Siltation was observed to be a threat to the biotic integrity at this site. This station had the five coldwater taxa *Leuctra sp., Eccoptura xanthenes*, *Nigronia fasciatus*, *Parametriocnemus sp.,* and *Polypedilum (U.) aviceps*.

Tributary to Middle Fork Salt Creek at RM 13.00
Macroinvertebrate community performance in Tributary to Middle Fork Salt Creek @ RM 13.00 (RM 0.7) was evaluated as good. EPT (15) and sensitive taxa (19) diversities were within the range expected for a WWH stream, however, the community structure was disturbed with primarily facultative organisms predominant in the riffle habitat and the caddisflies usually found on the underside of the larger substrates (*Chimarra*, polycentropids) were absent. Siltation was observed to be a threat to the biotic integrity at this site.

Pigeon Creek
The station located in the headwaters of Pigeon Creek (RM 13.1) was impacted by nutrient/organic enrichment and siltation due to cows in stream, channelization, and removal of the woody riparian. Macroinvertebrate community performance was evaluated as fair due to lower than expected EPT (9) and sensitive taxa (8) diversity and predominance of the community by facultative and tolerant taxa. Community performance at the downstream stations improved into the good range. However, observed siltation continued to be a threat to the biotic integrity in this stream.

Tributary to Pigeon Creek at RM 7.52
The macroinvertebrate community sampled at the upstream station (RM 2.4) on Tributary to Pigeon Creek at 7.52 was evaluated as marginally good. The EPT diversity (13) was within the range expected for a WWH stream but the sensitive taxa diversity (12) was lower than expected and the community was predominated by facultative taxa. Interstitial flow and siltation were the observed threats to the biotic integrity at this site. The downstream station (RM 0.1) was highly degraded by siltation, limited habitat, and possibly organic enrichment from cows with unrestricted access to the stream and channelization. The macroinvertebrate community was considered poor due to very low EPT (3) and sensitive taxa (6) diversity and predominance of the tolerant midge taxa *Procladius (Holotanypus) sp.* and *Chironomus decorus* group.

Skunk Hollow Creek
Macroinvertebrate community performance in Skunk Hollow Creek (RM 0.1) was evaluated as good. EPT (14) and sensitive taxa (15) diversities were within the range expected for a WWH stream, however, the community structure was disturbed with only facultative caddisflies present in the riffle habitat. Low flow and siltation were observed to be threats to the biotic integrity at this site.

Long Branch

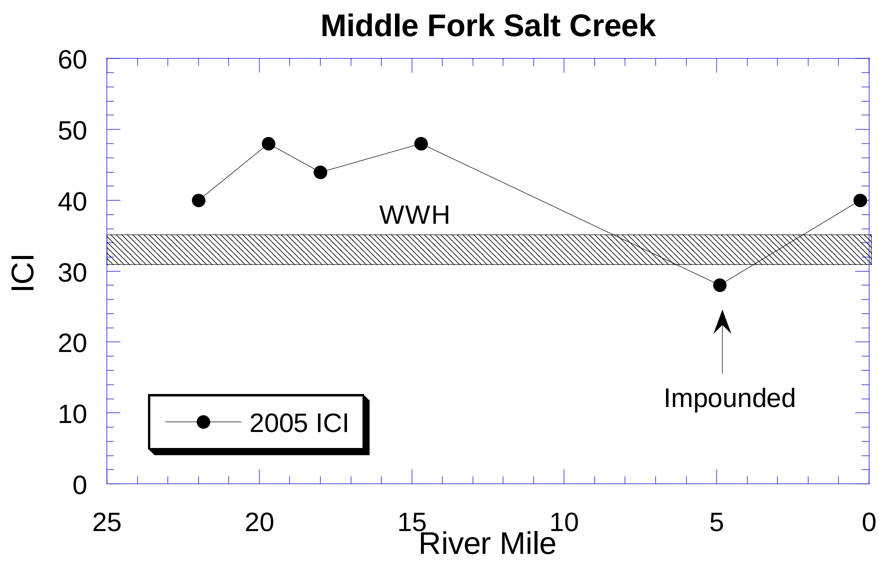
Macroinvertebrate community performance in Long Branch (RM 0.1) was evaluated as good. EPT (17) and sensitive taxa (22) diversities were within the range expected for a WWH stream, however, the community structure was disturbed with primarily facultative organisms predominant in the riffle habitat. Low flow and channel modifications were observed to be threats to the biotic integrity at this site.

Table 22. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Salt Creek study area, July to October, 2005.

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI[a]	Narrative Evaluation
Middle Fork Salt Creek (02-611)										
22.0	4.9	9	56	18	27	L-M	2	Midges (MI,F)	-	Good
19.7	9.4	-	46	23	27	L-M	2	*Chimarra* caddisflies (MI), mayflies (MI), midges (MI)	-	Exceptional
18.0	15.1	9	44	20	19	L	1	Mayflies (MI), midges (F,MI), caddisflies (MI,F)	-	Very Good
14.7	32	15	52	15 / 17	20 / 31	L / 354	0	Midges (F,MI), caddisflies (MI,F)	48	Exceptional
4.9	58	8	51	7 / 11	17 / 30	L-M / 590	0	Midges (F,T,MI), snails (T,MT), fingernail clams (F)	28	Fair
0.3	109	15	47	13 / 16	23 / 35	L-M / 100	0	Caddisflies (F,MI), mayflies (MI), midges (MI)	40	Good
Riley Run (02-617)										
0.1	5.4	9	30	7	11	L	1	Midges (MI,F)	-	Fair
Kelly Branch (02-616)										
1.4	4.5	-	54	19	25	L	5	Midges (MI,F), hydropsychid caddisflies (F,MI)	-	Very Good
Trib. to M. Fk. Salt Creek @ RM 13.00 (02-667)										
0.7	5.0	-	48	15	19	L	0	Midges (F,MI), *Caenis* mayflies (F), water mites (F)	-	Good
Pigeon Creek (02-612)										
13.1	4.5	-	53	9	8	M	0	Midges (F,T,MI), hydropsychid caddisflies (F)	-	Fair
12.3	8.9	-	64	14	21	M	0	Hydropsychid caddisflies (F), midges (F,T,MI), baetid mayflies (F)	-	Good
7.8	17.6	-	64	13	22	L	0	Midges (F,MI), caddisflies (MI,F), mayflies (MI)	-	Good
4.6	33.0	-	51	12 / 13	25 / 31	L-M	0	Caddisflies (F,MI), mayflies (MI)	42	Good

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI[a]	Narrative Evaluation
Trib. to Pigeon Creek @ RM 7.52 (02-669)										
2.4	5.5	9	37	13	12	L	0	Hydropsychid caddisflies (F)	-	Marg. Good
0.1	8.8	-	33	3	6	L	0	Midges (T,MT,F)	-	Poor
Skunk Hollow Creek (Trib. to Pigeon Creek @ RM 6.66) (02-668)										
0.1	4.6	-	34	14	15	L	1	Hydropsychid caddisflies (F), midges (MI,F), heptageniid mayflies (MI)	-	Good
Long Branch of Pigeon Creek (Trib. to Pigeon Creek @ RM 3.16) (02-613)										
0.1	4.1	-	54	17	22	M	0	Hydropsychid caddisflies (F), midges (F,MI)-	-	Good

RM: River Mile.
Dr. Ar.: Drainage Area
Data Codes: 8=Non-Detectable Current, 9=Intermittent or Near-Intermittent Conditions, 15=Current >0.0 fps but <0.3 fps.
Ql.: Qualitative sample collected from the natural substrates.
Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List as MI (moderately intolerant) or I (intolerant).
Qt.: Quantitative sample collected on Hester-Dendy artificial substrates, density is expressed in organisms per square foot.
Qualitative sample relative density: L=Low, M=Moderate, H=High.
CW: Number of Coldwater Macroinvertebrate Taxa.
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant



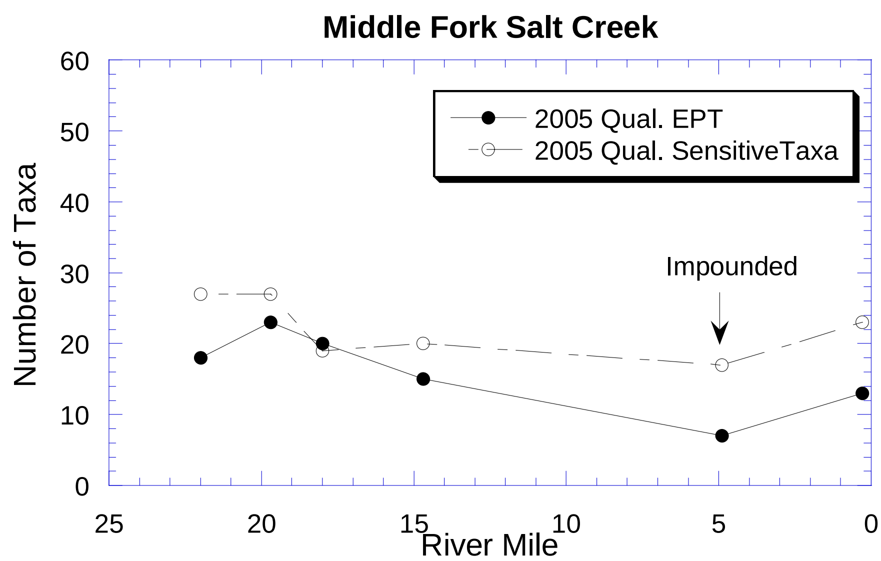


Figure 32. Longitudinal trend of the Invertebrate Community Index (ICI), qualitative EPT, and qualitative sensitive taxa are shown for Middle Fork Salt Creek, 2005. The stations at RMs 22.0, 19.7, and 18.0 were collected using qualitative methods only, so the ICI values used in the graph are approximations based on the narrative evaluations.

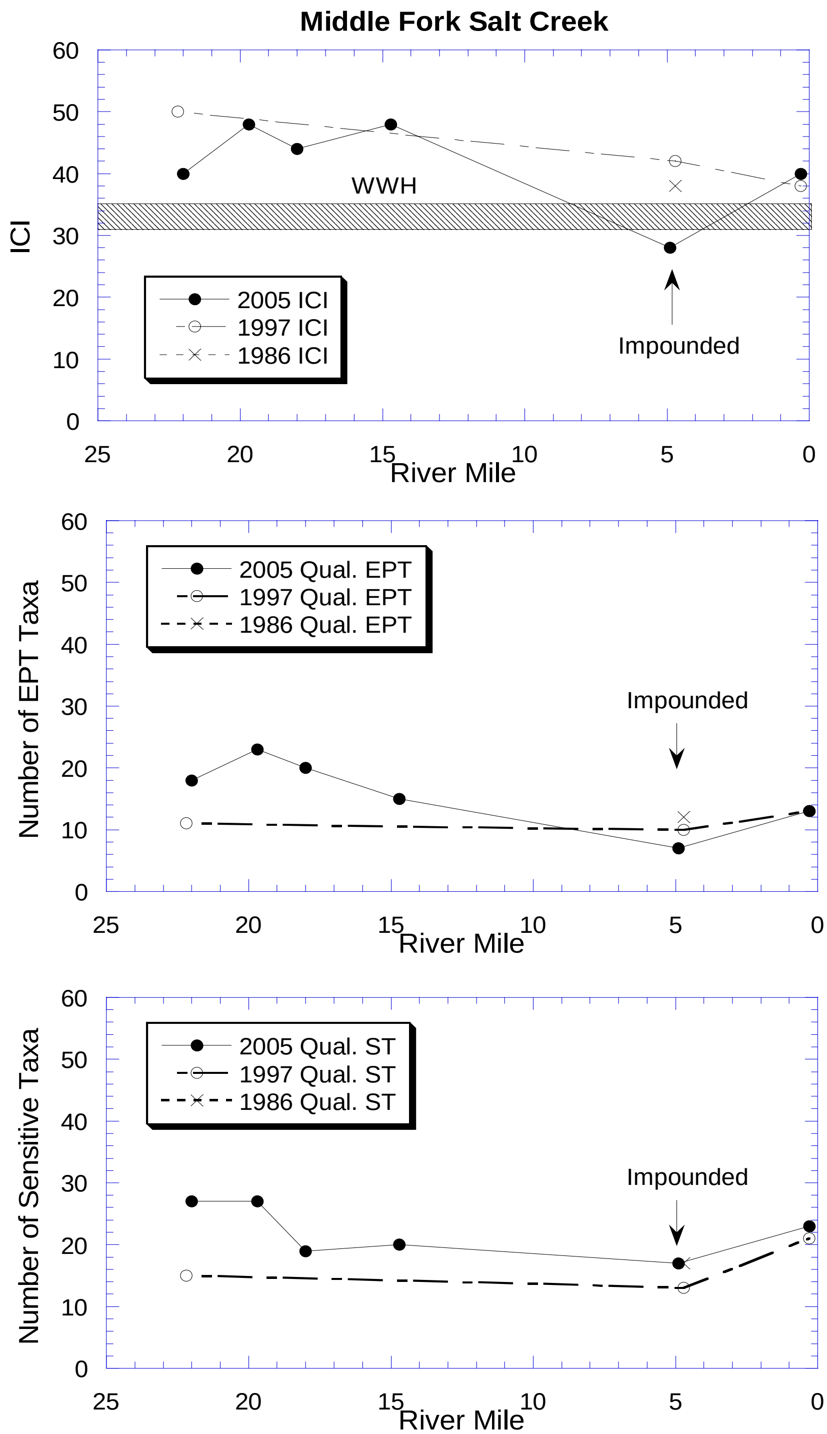


Figure 33. Longitudinal trend of the Invertebrate Community Index (ICI), qualitative EPT, and qualitative sensitive taxa are shown Middle Fork Salt Creek, 1986-2005. The stations at RMs 22.0, 19.7, and 18.0 (collected in 2005) were collected using qualitative methods only, so the ICI values used in the graph are approximations based on the narrative evaluations.

Salt Lick Creek Basin: HUC 05060002-090
Salt Lick Creek

Includes tributaries: Four Mile Creek, Sugar Run, Horse Creek,
UT to Salt Lick Creek, Buckeye Creek, Sour Run, Pigeon Creek Big Run,
Popular Creek

Aquatic Life Use Attainment Status and Trends

The aquatic life use attainment status of 24 locations within the Salt Lick Creek basin were evaluated based on data collected in 2004 (Table 23 and Figure 34). The headwaters of Salt Lick Creek (RMs 27.9 and 26.8) were in non attainment of WWH criteria due to channelization and siltation from row crop agriculture and livestock access to the stream. Throughout and below the City of Jackson (RMs 22.6, 22.1, 20.6, and 20.4) Salt Lick Creek was in partial attainment of WWH criteria as a result of nutrient/organic enrichment from the failing sewage collection system within the City of Jackson. The macroinvertebrate community was identified as fair near RM 22.5, likely suffering from toxics associated with run-off from OSCO.

Three tributaries, Sour Run, Poplar Creek, and Pigeon Creek were all in full attainment of their designated or recommended ALU. Buckeye Creek was in partial attainment of the WWH designation at both sampling locations, though the cause of impairment in the upper portion was related to the loss of trees in the riparian corridor from agricultural activities while in the lower stretch siltation and urban run-off contributed to the only fair community performance. Big Run was also in partial attainment of the WWH designation though agricultural activities were the primary source of impairment by causing increased nutrient/organic enrichment, and siltation. Four Mile Creek was in non attainment of the WWH designation due to siltation and nutrient enrichment from livestock activities. Sugar Run and Horse Run were in non attainment of the WWH designation due to the effects of storm water run-off and siltation from the surrounding residential and urbanized areas. The tributary to Salt Lick Creek at 22.55 was not assessed for ALU attainment as only a narrative macroinvertebrate score was calculated. However, the macroinvertebrate community was categorized as fair and noted to be influenced by the urban run-off and historical channelization from the surrounding storm sewer overflows of the urbanized landscape.

Longitudinal plots of IBI and MIwb versus river mile for Salt Lick Creek are provided in Figure 35. Historical sampling of the Salt Lick Creek main stem shows that fish community performance has improved since the stream was first sampled in 1986. However, the consistent dip in scores around and downstream of Jackson indicate that improvements in the handling and treatment of sanitary wastes is still needed. As mentioned in the Spills section below, fish kills were documented along Salt Lick Creek in 1998, 2003, and 2007. The dip in MIwb scores along with low biomass of fish collected reflect the known historical problems, while the ability of Salt Lick Creek to still partially meet WWH standards downstream of Jackson is attributable to strong recruitment from the high quality Salt Creek main stem and its associated tributaries. Future surveys should include sampling at similar locations to determine if recovery from problems with the Jackson WWTP and its collection system has occurred.

The macroinvertebrate community trend in Salt Lick Creek was generally similar to previous sampling (Figure 36). A depressed community was present upstream from Jackson which then declined further within Jackson. The Jackson WWTP appeared to have only minimal further impact on community health. Community performance gradually improved downstream from Jackson.

Table 23. Aquatic life use attainment status for stations sampled in the Salt Lick Creek basin based on data collected June-October 2004. *Sites collected in 2004 are in italics*. 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 to support a biotic community.

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/Comments
Salt Lick Creek (Trib to Salt Creek at RM 4.5)					*WAP Ecoregion - WWH Existing*		
27.9[H]	12*	N/A	P*	23.5	**NON**	Channelization Loss of trees in riparian corridor Siltation	Row crop (Agriculture)
26.8[H]/27.0	34*	N/A	30*	52	**NON**	Channelization Siltation Nutrient/organic enrichment	Row crop (Agriculture) Livestock access to stream
22.6[W]/22.5	46	8.6	F*	66	PARTIAL	Nutrient/organic enrichment Possible toxics	Failing sewage collection system (City of Jackson) Run-off from OSCO, possible toxic sediment
22.1[W]	46	8.7	22*	61	PARTIAL	Nutrient/organic enrichment	Failing sewage collection system (City of Jackson)
20.6[W]	45	7.2*	36	62.5	PARTIAL	Nutrient/organic enrichment	Failing sewage collection system (City of Jackson)
20.4[W]	44	7.8*	30*	62.5	PARTIAL	Nutrient/organic enrichment	Failing sewage collection system (City of Jackson)
19.5[W]	49	8.3[NS]	40	65.5	FULL		
18.2[W]	48	8.6	42	76.5	FULL		

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/Comments
16.7[W]/16.8	45	8.7	40	62.0	FULL		Historic Fish kills (IBI swing between passes)
14.7[W]/14.0	42[NS]	8.1[NS]	38	64.5	FULL		
7.2[W]/7.4	53	9.0	36	75.0	FULL		
--/0.5	--	--	36	55.5	(FULL)		
Four Mile Creek (Trib to Salt Lick Creek at RM 27.67)					*WAP Ecoregion - WWH Existing*		
3.1[H]	34*	N/A	F*	50.0	**NON**	Siltation Nutrient enrichment	Agriculture - Livestock
Sugar Run (Trib to Salt Lick Creek at RM 23.36)					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.4[H]/--	28*	N/A	F*	40.5	**NON**	Stormwater run-off	Urbanization
Horse Run (Trib to Salt Lick Creek at RM 22.80)					*WAP Ecoregion - Undesignated / WWH Recommended*		
2.3[H] /3.1	34*	N/A	F*	45.5	**NON**	Siltation	Residential run-off
Trib to Salt Lick Creek at RM 22.55 (Jisco Lake Tributary)					*WAP Ecoregion - EWH Existing / WWH Recommended*		
--/0.8	--	--	F*	49.5	-	Historic channelization Urban run-off	Urbanization SSO
Buckeye Creek (Trib to Salt Lick Creek at RM 21.28)					*WAP Ecoregion - EWH Existing / WWH Recommended*		
3.8[H]	34*/34*	N/A	G*/G	47.5	**NON**/ PARTIAL	Loss of trees in riparian corridor	Agriculture
0.42[H]	44*/44	N/A	F*/F*	60.5	**NON**/ PARTIAL	Siltation Urban run-off	Urbanization
Sour Run (Trib to Salt Lick Creek at RM 13.10)					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.2[H]	44	N/A	MG[ns]	56.5	FULL		

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/Comments
Big Run (Trib to Pigeon Creek at RM 6.02)					*WAP Ecoregion - WWH Existing*		
2.1[H]	46	N/A	F*	59.0	PARTIAL	Low to interstitial flow Sedimentation	Agriculture Historical Mining
2.0[H]	52	N/A	F*	59.5	PARTIAL	Siltation Nutrient/organic enrichment	Livestock access to tributary stream
Poplar Creek (Trib to Pigeon Creek at RM 4.78)					*WAP Ecoregion - WWH Existing*		
0.2[H]	46	N/A	--	56.5	(FULL)		
Pigeon Creek (Trib to Salt Lick Creek at RM 6.35)					*WAP Ecoregion - Undesignated / WWH Recommended*		
6.5[H]/7.0	56	N/A	G	52.5	FULL		
6.4[H]	44	N/A	VG	59.5	FULL		
0.9[W]	46	8.6	G	70.5	FULL		

Ecoregion Biocriteria: Western Allegheny Plateau

	IBI			MIwb			ICI		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	44	50	24	N/A	N/A	N/A	36	46	22
Wading	44	50	24	8.4	9.4	4.0	36	46	22
Boat	40	48	24	8.6	9.6	4.0	36	46	22

H - Headwater site.

W - Wading site.

B - Boat site.

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

b - 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 were not available or considered unreliable due sampling constraints. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional

c - Attainment status is given for both existing and proposed use designations.

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

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

N/A – Not applicable.

Table 24. Exceedences of Ohio Water Quality Standards (WQS) criteria (OAC 3745-1) for chemical and bacterial parameters in SLCWAU found during the 2004 field season. D.O. results are presented by mg/l, pH is in S.U. and *E. coli* and fecal coliform are in cfu/100 ml. Use designations within Salt Lick Creek basin include: Aquatic Life – Exceptional Warmwater Habitat (EWH); Warmwater Habitat (WWH); Agricultural Water Supply (AWS); Industrial Water Supply (IWS); Primary Contact Recreational (PCR) and State Resource Water (SRW).

Stream **River mile**	**(use designation)** **Parameter (value)**	**Biological Attainment**	**QHEI Score**
Salt Lick Creek (HUC 05060002 090)			
Salt Lick Creek	(SRW, WWH, AWS, IWS, PCR)		
27.9	D.O. (4.84[a]), pH (6.37[b]), *E. coli* (346[c])	NON	23.5
26.8	D.O. (3.94, 3.83, 3.74, 3.77, 3.68, 3.91, 3.03[a]), *E. coli* (666[c])	NON	52.0
22.6	D.O. 3.09[a,d])	PARTIAL	66.0
7.25	D.O. (2.93[a])	FULL	75.0
Four Mile Creek	(to Salt Lick Creek) (SRW, WWH, AWS, IWS, PCR)		
3.1	D.O. (3.96, 3.96, 3.14, 1.93[a])	NON	49.0
Sugar Run	(to Salt Lick Creek) (WWH recommended)		
0.1	D.O. (2.69[a])	NON	39.5
Horse Creek	(to Salt Lick Creek) (SRW, WWH, AWS, IWS, PCR)		
2.3	D.O. (3.09[a])	NON	45.0
UT* to Salt Lick Creek	(WWH recommended)		
0.8	Fecal coliform (2719[c]),	----	49.5
Buckeye Creek	(to Salt Lick Creek) (SRW, EWH, AWS, IWS, PCR)		
4.1	pH (6.3, 6.29[b]), Fecal coliform (4172[c]), *E. coli* (518[c])	PARTIAL	46.5
0.4	pH (6.43[b]), *E. coli* (1042)	PARTIAL	59.5
Sour Run	(to Salt Lick Creek) (WWH recommended)		
0.2	*E. coli* (324[c])	FULL	56.5
Pigeon Creek	(to Salt Lick Creek) (WWH recommended)		
6.5	*E. coli* (446[c])	FULL	52.5
6.4	*E. coli* (498[c])	FULL	59.5
0.9	pH (6.4[b])	FULL	70.5
Big Run	(to Pigeon Creek) (SRW, WWH, AWS, IWS, PCR)		
2.0	pH (6.39[b]), D.O. (3.94, 3.54,1.72[a]), F. C. (6820[c]), *E. coli* (3760[c])	PARTIAL	59.5
Poplar Creek	(to Pigeon Creek) (SRW, WWH, AWS, IWS, PCR)		
0.2	D.O. (2.9[a])	(FULL)	56.5

a Below the minimum criterion for the protection of aquatic life.
b Exceeds the minimum (6.5) or maximum (9.0) criterion.
c Exceeds the PCR 30 day maximum.
d Datasonde© results for D.O. show 44 readings below minimum criterion.
* UT – unnamed tributary

Table 25. Facilities regulated by an individual NPDES permit in SLCWAU.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River mile	Wastewater and Treatment Type
City of Jackson WWTP	0PD00008	Salt Lick Creek	22.1	sanitary 22.1 mgd secondary plant
Meridian Automotive Sys.	0IQ00002	Salt Lick Creek	Approx. 24.0	Industrial storm water 250,000 gpd
AluChem	0IN00068	Buckeye Creek	1.0	sanitary 1000 gpd package plant
BP Jackson Bulk Plant	0IN00224	Salt Lick Creek	23.09	Industrial storm water 24 gpd
OSCO Industries Inc.	0GN00001 0GC00176	Horse Creek	0.30	General NCCW General industrial storm water

* NCCW – Non-Contact Cooling Water

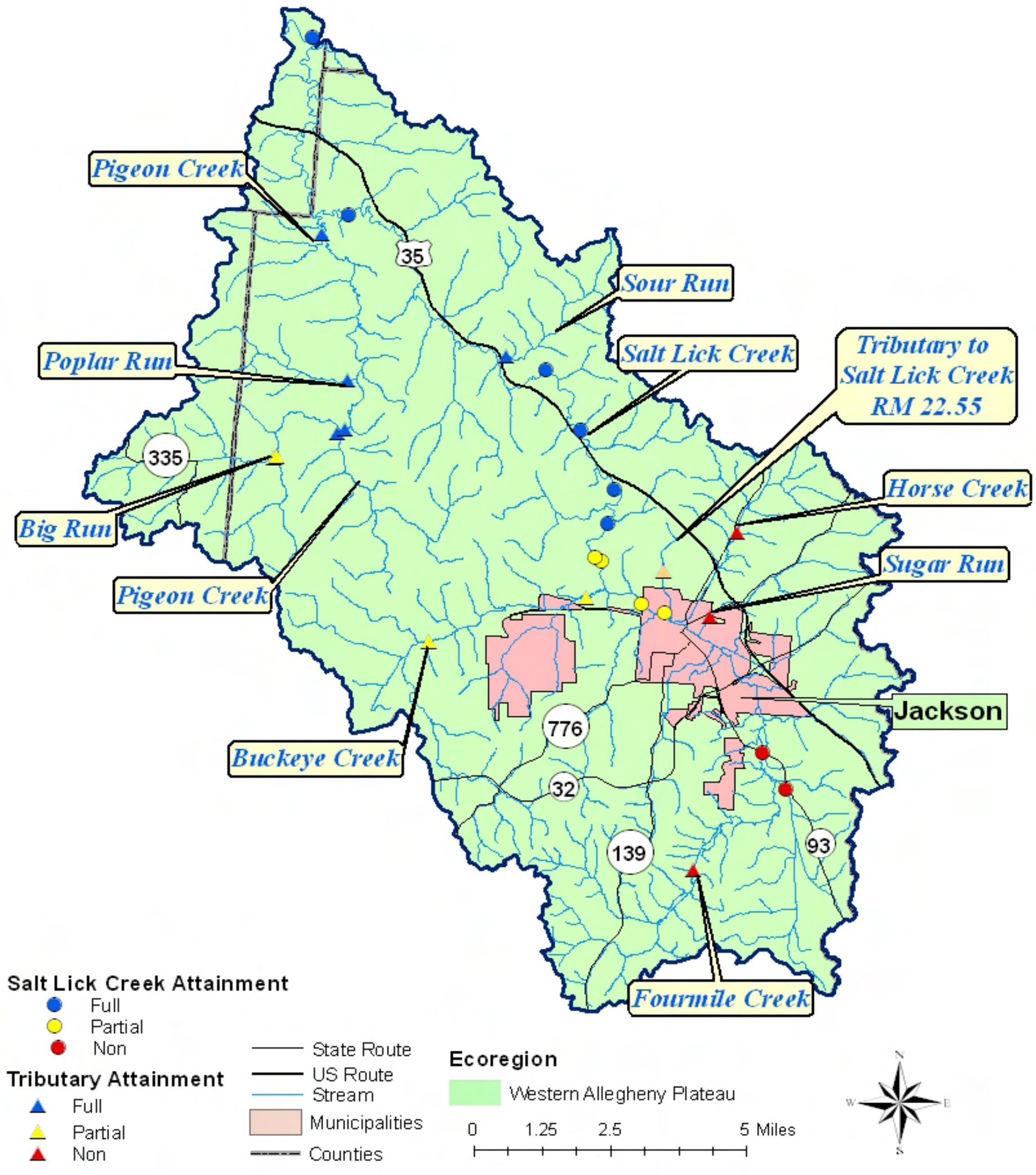


Figure 34. Attainment status of sampling locations with Salt Lick Creek basin based on 2004 data.

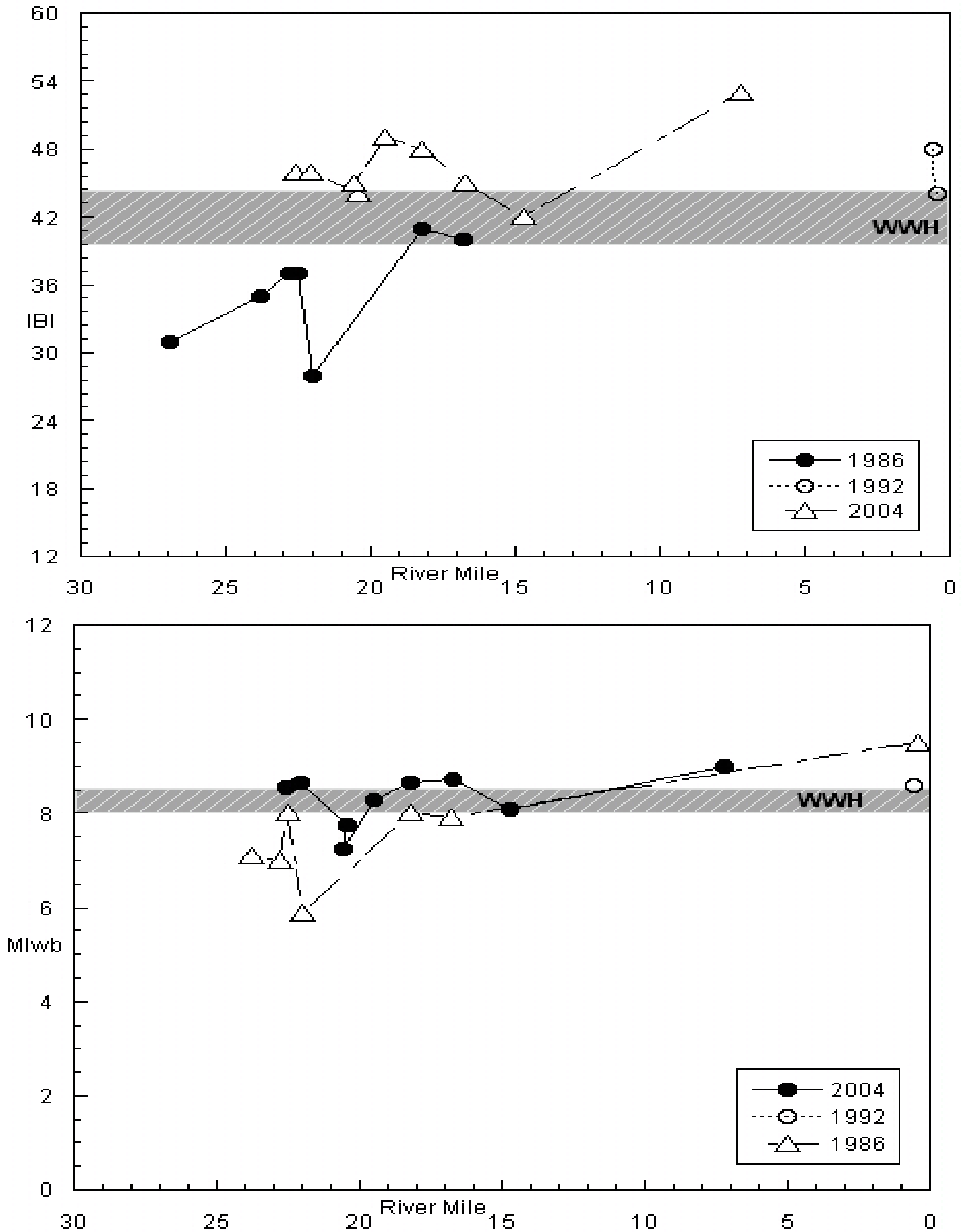


Figure 35. Historical trend for IBI and MIwb for Salt Lick Creek main stem.

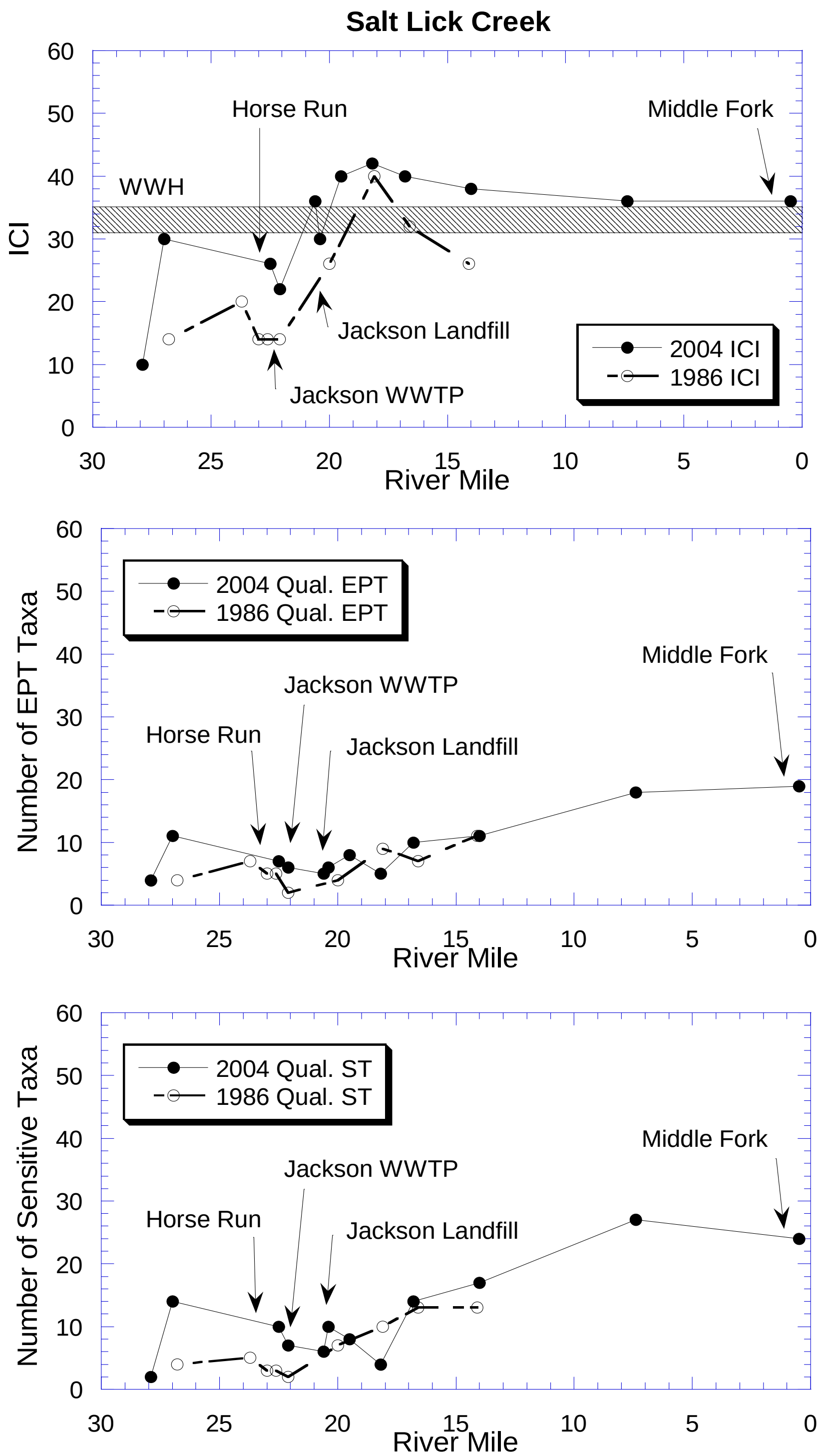


Figure 36. Longitudinal trend of the Invertebrate Community Index (ICI), qualitative EPT, and qualitative sensitive taxa are shown for Salt Lick Creek, 1986-2004. The stations at RMs 27.9 and 22.5 collected in 2004 were collected using qualitative methods only, so the ICI values used in the graph are approximations based on the narrative evaluations.

Recreation Use Assessment

The main stem of the Salt Lick Creek had two bacteria results over the PCR WQS at RM 26.8 and 22.6. Buckeye Creek RM 3.85 and Big Run RM 2.0 were determined to be in non-attainment for the PCR use designation for *E. coli* (Table 28). This was based on the 90th percentile calculation. It appears that the elevated bacteria counts are a result of failing home septic systems and animal grazing. The high bacteria results at the UT to Salt Lick Creek and the storm sewer from OSCO (Table 30) were due to the City of Jackson's sanitary sewer system problems. Salt Lick Creek RM 3.9, Buckeye Creek RM 0.42, Sour Run and Pigeon Creek RM 6.5 and 6.4 exceeded the PCR for *E. coli* maximum. Again, primary sources are poor livestock practices and failing home septic systems.

Spills

Pollutant discharges from spills, overflows and other unauthorized releases can be a significant source of lethal and sub-lethal stress to the aquatic communities in the Salt Lick Creek watershed. The following list does not include reported bypasses from the Jackson WWTP addressed above. Thirty-eight spills were reported to the Ohio EPA Emergency Response Section (ERS) from January 2000 through April 2007. Three spills were a result of sanitary sewers overflowing in the City of Jackson. Nineteen spills were of petroleum related materials and four spills were agricultural products. Luigino's Inc. reported releasing food wastewater. Two spills reported were of unknown substances. The City of Jackson utilities department reported spilling 75.0 gallons of transformer oil on September 24, 2004 and 10 gallons of PCB oil on August 5, 2002. The ERS report states that both spills were to the land surface, all contaminated material, including soils, were removed and there was no release to the waterway.

Three sewage spills were investigated by Ohio EPA from the City of Jackson's sanitary sewer collection system in September 2007. A sanitary sewer was connected to a storm sewer which discharged to Mc Dowells Run. The resident near the sewer reported the continual discharge. It had discharged for an indeterminate amount of time. Mc Dowells Run was dry due to little rainfall so the majority of flow was sewage. Jackson provided a temporary fix by redirecting the flow from the storm sewer to a sanitary sewer.

Figure 37. Sewage plume in Salt Lick Creek located downstream of the sewer/manhole break.

The City of Jackson is currently working with an engineer to determine a final solution. The City of Jackson has proposed an estimated one million dollar project to rehabilitate and separate the storm and sanitary sewer in this area. No fish were observed.

Earlier in September, Ohio EPA was informed by ODNR-Wildlife that a fish kill occurred on Salt Lick Creek. Ohio EPA's investigation determined that the source was a sewer/manhole connection break on the bank of Salt Lick Creek at RM 23.6 (Figure 37). The connection break receives waste water from Luigino's Inc. which has high volume flows during cleanup or when operating at full production. Also in September 2007, a sewer stream crossing at the Broad Street bridge, RM 23.4, was found to have an instream break. This sewer only has few small volume users and the City is investigating how to better provide service without an instream crossing (see *City of Jackson* below for sewer/WWTP discharge information).

Ecoregion, Soils and Topography

The 138 mi^2 Salt Lick Creek watershed lies entirely within the WAP ecoregion and originates in broad, flat, poorly drained lands and wetlands. It then flows through the City of Jackson with municipal discharges, impervious surfaces and channelization. Downstream of Jackson, the tributaries are more typical of the WAP with narrow valleys and ridges with steep hillsides, and Salt Lick Creek flows generally northwest to enter Salt Creek at RM 4.5.

The WAP ecoregion is characterized by rugged narrow valleys and ridges. The region is underlain with Mississippian shale and limestone. Coal is found in portions of the ecoregion and extraction often results in degradation of water quality. Mixed oak forests are indigenous. Row cropping is limited to relatively flat floodplains adjacent to streams. Cattle are primarily grazed in the valleys and ridges. Forests predominate the slopes (Woods, *et al*., 1998).

Soils of the Western Allegheny Plateau region of the watershed are of the Shelocta, Brownsville, Latham, and Steinsburg series. The Shelocta series consists of deep and very deep, well drained, moderately permeable soils. They are on steep concave mountain sides, foot slopes, and benches, and therefore are primarily forested, with only small areas cleared for pastures or agricultural cultivation. The Brownsville series consists of deep, well drained soils found on hillsides and summits within the WAP. Due to their geographic setting, they are primarily associated with forests, though occasionally are cleared for pasture. The Latham series consists of moderately deep, moderately well drained soils found to either be located within forests of oaks and hickory species, or to have been cleared for pasture and crops of corn, wheat, and oats. Soils of the Steinsburg series are moderately deep and well drained which makes them agreeable to the primary land use of cropland and pasture. The few wooded areas present with Steinsburg soils are dominated by oak, maple and ash species (NRCS, 2004).

Table 26 provides information related to land use and shows the predominant land use in the Salt Lick Creek watershed is forest (70.5%). The remaining land uses are grassland/hay (15.8%), developed (8.5%) and cultivated crops (3.3%). The grassland and cultivated crops are concentrated in the main stem valley. Cattle are frequently raised in the narrow valleys immediately adjacent the streams and are not normally excluded from the streams. The landscape of the upper portion of the watershed is distinctly different than the remainder of Salt Lick Creek. Upstream of Jackson the watershed is distinct in that it is relatively flat with 33% grassland/hay land use. The 14 digit watersheds that include the City of Jackson are 24.7 and 14.5% developed. The urban environment includes NPDES permitted discharges, wet weather bypasses, sewer line stream crossings, dry weather sewer discharges, impervious surfaces and channelized streams.

Table 26.Salt Lick Creek land use as derived from National Land Cover Database (NLCD 2001).

14-Digit HUC	Narrative Description	Open Water	Developed	Barren Land	Forest	Shrubs/ Scrubs	Grassland/ Hay	Cultivated Crop	Wetland	Total Acres
010	Salt Lick Creek headwaters to below Four Mile Cr.	0.2%	5.8%	0.0%	55.2%	2.1%	33.6%	3.2%	0.0%	11,688.4
020	Salt Lick Cr. below Four Mile Cr. to US 35 at Jackson	0.1%	24.7%	0.1%	47.4%	0.7%	22.3%	4.7%	0.1%	9,841.8
030	Salt Lick Cr. below US 35 at Jackson to Salt Lick Cr. near Jackson [except Buckeye Cr.]	0.8%	14.5%	0.0%	69.8%	0.3%	13.2%	1.4%	0.0%	15,032.3
040	Buckeye Creek	1.5%	6.7%	0.0%	61.2%	0.3%	24.2%	6.2%	0.0%	12,206.5
050	Salt Lick Cr. below Jackson to Salt Cr.[except Pigeon Cr. & Middle Fork Salt Cr.]	0.3%	7.0%	0.0%	80.7%	0.0%	10.0%	1.9%	0.0%	20,589.2
60	Pigeon Creek (Trib. to Salt Lick Cr.)	0.3%	4.1%	0.2%	86.9%	0.2%	4.6%	3.7%	0.0%	19,298.9
	Salt Lick Cr. aggregate	0.5%	8.5%	0.1%	70.5%	0.5%	15.8%	3.3%	0.0%	88,657.1

Chemical Water Quality and Sediment Quality

Salt Lick Creek

Salt Lick Creek begins in Franklin Township in the unincorporated Village of Camba and joins Salt Creek at RM 4.50. The SLCWAU drains about 247 square miles. Twelve main stem sites were sampled to evaluate chemical, biological and bacterial conditions.

The entire Salt Lick Creek watershed is located within the WAP ecoregion. The upper most portion of Salt Lick Creek is comprised of low gradient wetland streams. The drop in elevation over the 28.6 miles in length of Salt Lick creek is 4.4 feet per mile (ODNR, 2001). Low gradient streams have less assimilative capacity for nutrients and typically have lower dissolved oxygen content. Datasonde© continuous monitors were deployed August 24-26, 2004 and recorded hourly D.O. concentration, D.O. percent saturation, temperature, pH and conductivity for five sites in SLCWAU. A summary of the data is presented in Figure 40 and Table 27. The Datasonde© sampling site at RM 26.8 shows an average value over a 47 hour period for D.O. of 5.2 mg/l although D.O. was recorded below 4.0 mg/l for six hours in the early morning resulting in numerous WQS violations (Table 24). The D.O. any time minimum water quality criteria is 4.0 mg/l and the minimum 24-hour average criterion is 5.0 mg/l for WWH. Supersaturation conditions were not detected. Percent saturation levels varied from a maximum of 84.9% to a minimum of 42.7%.

The headwaters area is mostly agriculture with sparse housing. Ammonia and TKN were above target values while phosphorus values were below target values in the upper two sampling locations (Figure 42). At the headwater sampling site iron and manganese concentrations were typically double the target values. Acidity was below detection. According to available coal mining information only 10 acres of land has been strip mined on the headwater watershed boundary.

Salt Lick Creek enters the City of Jackson at RM 24.5 (Figure 41). The city has approximately 6250 residents. Jackson has some light industrial activity which includes the food manufacturer Luigino's Inc. and Ohio Precious Metals. Both industries have process waste water discharges to the Jackson WWTP. Luigino's Inc. has continually violated the Indirect Dischargers Permit. Direct dischargers include an iron foundry, OSCO, and the plastic mold automotive parts manufacturer Meridian Automotive Systems (Table 25). The City of Jackson lies over numerous old underground coal mines. Typically these coal mines consisted of rooms or tunnels where the coal was extracted with pillars of coal left for support. Some of the mining maps show underground mining occurred under portions of Salt Lick Creek. Old room and pillar coal mines do occasionally subside or collapse causing property damage.

At RM 22.6 the D.O. levels recorded on the Datasonde© continuous monitors deployed from August 24-26, 2004 show extremely low results. The Datasonde© results show 44 values below the 4.0 mg/l any time minimum water quality criteria for WWH (Table 24). The source of these low D.O. results is unknown although this site is below the OSCO discharge and other possible sanitary sewer discharges.

City of Jackson WWTP

The City of Jackson's WWTP discharges to Salt Lick Creek at RM 22.1 (Figure 41). The existing WWTP is an advanced wastewater treatment facility that has a design flow of 2.21 million gallons per day (MGD) and a hydraulic capacity of 6.0 MGD. A facility upgrade in 1984 retained the trickling filter / activated sludge system, and added a parallel oxidation ditch plant. The last major modification of the treatment plant occurred in 1993 and 1994 which gave the WWTP the flexibility to operate the treatment trains in series or parallel and included sludge processing and storage units.

As wastewater enters the treatment plant, it flows through an aerated grit removal tank, muffin monster (influent grinder) and a hycor roto screen. After preliminary treatment the flow can be split and run through the old plant ("plant 1") or the new plant ("plant 2"), then recombined for tertiary filter treatment, chlorination, dechlorination and post-aeration. Flow can also be run through plant 1 then plant 2 (in series). Plant 1 includes primary clarifiers, trickling filters, aeration tanks, final clarifiers, and anaerobic sludge digestion. Currently, the aeration tanks and the final clarifiers in the old system are not in use except to provide flow equalization during storm events. Plant 2 includes oxidation ditches, final clarifiers, tertiary filters, and aerobic sludge. An equalization basin is also available for use during flows greater than 2.21 MGD.

In addition to aerobic and anaerobic sludge digestion, sludge processing also includes sludge drying beds, a gravity belt thickener, and a sludge storage tank. The sludge is recycled at agronomic rates under a sludge management plan approved in 1994.

The City of Jackson's collection system was thought to be 100 percent separate from the storm water collection system. Recent sanitary sewer evaluation has determined that portions of the downtown area have combined sanitary and storm water sewers. The City of Jackson has inflow and infiltration problems with the sanitary sewer system which have historically caused treatment problems at the WWTP. Approximately 99.5 percent of the city service area has sanitary sewer service.

The City of Jackson has an approved pretreatment program, which regulates eleven industrial users, three non-categorical significant users and one categorical user discharging to the collection system. These industries include a food processing facility and a facility which refines and recovers precious metals. The total industrial waste water flow to the collection system is estimated at 0.59 MGD while non-categorical significant users provide the majority of this flow at 0.57 MGD. Due to the consistent influent flow rate near or exceeding the design capacity of the facility, and in order to more effectively process wastewater from industrial sources, the City of Jackson has proposed to expand the WWTP from 2.21 MGD to 3.79 MGD.

Figure 38. Outfall 001 from the Jackson WWTP. Note the white sewage fungus.

The ODNR- Department of Wildlife has received complaints, typically in the fall months, concerning fish kills in Salt Lick Creek in previous years. Ohio EPA was informed of a fish kill on October 16, 2003. Ohio EPA discovered that the WWTP's operator was illegally bypassing untreated wastewater from the facility on a regular basis. Ohio EPA concluded that septic conditions in the stream, discoloration of the water, and the fish kills were a direct result of Jackson's discharge of untreated sewage (Figure 38). It is suspected that the bypasses were occurring for some time prior to October 2003 since the sewage fungus was so prevalent at the WWTP discharge point. Sewage fungus is typically found in slow moving waterways where poorly treated or raw waste water that is highly enriched with organics is discharged. The sewage fungus is white, long, slimy growths of fungus, bacteria and protozoa combining into a complex community (SEPA, 2002) (Figure 39). The monthly operating reports (MOR) submitted to Ohio EPA each month were falsified in order to hide the bypassing of treatment by the operator.

Figure 39. Directly downstream of Jackson's outfall 001 in Salt Lick Creek. Note the long white, stringy, sewage fungus.

The Jackson WWTP has typically discharged large $CBOD_5$ loadings as shown in Figure 53. Luigino's Inc. had previously discharged untreated food production wastewater which was extremely high in $CBOD_5$. The median $CBOD_5$ concentration influent data for the Jackson WWTP was between 330 mg/l to 480 mg/l for the years of 2000 through 2005. In January 2006, Luigino's Incorporation installed a pretreatment system to reduce the $CBOD_5$ load to the WWTP. After that installation, the Jackson WWTP median influent value for 2006 was 104.5 mg/l. For the first five months of 2007, the median influent value was 96 mg/l. Sanitary WWTPs are normally designed to treat domestic wastewater which typically averages 200 mg/l (Green Book, 1993). The high $CBOD_5$ influent discharges from Luigino's Inc. and resulting bypasses of partially treated wastewater were a contributing factor to the septic stream conditions. The septic conditions in the stream lowered the D.O. which resulted in the fish kill.

The unreported bypasses continued until December 11, 2003. After which, the City of Jackson WWTP's operator began reporting each bypass. The MOR data reported by the facility prior to October 2003 reflect the total flow discharged by the WWTP (the flow at outfall 001 and the flow from the plant's bypass). However, the reported sampling results for the chemical wastewater parameters ($CBOD_5$, total suspended solids, ammonia, metals, etc.) during this time period reflect only the discharge from treated wastewater, not the bypassed, untreated wastewater. After discovery of the bypass, Ohio EPA required Jackson to sample both the bypassed wastewater and treated wastewater separately and report both sets of results. The bypassed flow is chlorinated and dechlorinated before combing with the treated effluent and discharging to Salt Lick Creek. Since December 11, 2003, Jackson has reported each bypass date, duration, volume and chemical characteristics. The bypass data, when reported, show that over a 41 month period Jackson bypassed treatment on 249 days. The volume of untreated wastewater reported for this period was over 300 MGD (Table 28). On August 1, 2006 Jackson's NPDES permit was renewed and the permit now requires the bypass data be reported in the MORs. In addition to WWTP bypasses, a number of the reported bypasses were overflows within the collection system such as sewage surcharging sanitary sewers resulting in wastewater flow out of manholes, from force main breaks and pump station surcharge or pump failure resulting in overflows. All bypasses of treatment or overflows within the sewer collection system are prohibited by law and are not permitted under coverage of the NPDES permit. The NPDES permit does require that all unauthorized discharges be reported to Ohio EPA. In 2007 the State of Ohio and City of Jackson entered into a Consent Order (C.O.). The C.O. requires the City correct problems within the WWTP and collection system. The C.O. also levies fines for unauthorized discharges from the WWTP and collection system. The Jackson WWTP operator in charge at the time of the bypass discovery has had his wastewater treatment operator's Class IV license suspended and a fine was levied against the City of Jackson. That operator is not longer employed with the City of Jackson.

Only one bioassay conducted on the Jackson WWTP outfall 001 by Ohio EPA shows toxicity. In 1999, a bioassay conducted by Jackson, showed that the Jackson WWTP effluent was toxic to *Ceriodaphnia dubia*. Subsequent testing and investigation concluded that the cause of the toxicity was due to a polymer used to facilitate settling in the WWTP clarifiers. Based upon these findings, an alternative polymer was selected and used at the WWTP. The bioassay conducted after changing to a different polymer has not revealed any evidence of effluent toxicity. Toxicity testing was conducted by Ohio EPA in January and June 1997, January 2003 and January 2004. The Jackson WWTP plant has reported numerous effluent limitation violations for $CBOD_5$, total suspended solids, ammonia and metals. $CBOD_5$ and total suspended solids comprise most of the violations and are a result for the high strength food processor waste water. Ammonia limits were also exceeded numerous times. Many of the treated effluent violations occurred during times Jackson WWTP was bypassing untreated effluent.

The current expansion plans will replace plant 1's trickling filter/aeration tank with a membrane bioreactor (MBR) system. Flow from all sources will receive pretreatment. Flow will then be split between the two treatment trains, upgraded plant 1 and existing plant 2. The upgraded plant 1 will then consist of primary clarifiers, new fine screening, the MBR units, chlorination and post-aeration. Plant 2's treatment train will consist of the existing oxidation ditches (with new effluent control), two existing final clarifiers, tertiary filters, chlorination and post-aeration. The effluent from both treatment trains will then re-combine for dechlorination and sampling before discharging to Salt Lick Creek. On August 1, 2009 the City of Jackson will need to meet effluent limits for phosphorus. Currently, only phosphorus monitoring is required.

Meridian Automotive Systems discharges to Salt Lick Creek at approximately RM 24.0. Meridian's waste water stream is composed of storm water and non-contact cooling water (NCCW). Oil and grease have been the pollutants of concern and Meridian has taken strides to eliminate O&G discharges.

OSCO Industrial Incorporated (the old Ohio Stove Company) discharges into Horse Creek at RM 0.30 and possibly from a storm sewer to Salt Lick Creek at RM 23.09 in the City of Jackson. OSCO is an iron casting foundry capable of making 13 tons per hour of iron parts. OSCO manufactures parts for different industries including: air conditioning and refrigeration, automotive, power transmission equipment, pumps and valves. As part of the manufacturing process, OSCO uses NCCW for a water jacket around an open iron cupola. The hot water from the water jacket goes into the Storm Water Reservoir (SWR) which is then pumped into the Hot Water Reservoir and is pumped into a cooling tower before returning into the water jacket. City drinking water and facility storm water are used to "make up" water losses in the system.

Under normal operating procedures the NCCW is recycled. However, if a power outage occurs, the facility automatically switches to once through city water until the power outage is over. Typically the recycled NCCW discharges at this time to the storm water sump in the parking lot. When the sump fills up it discharges to a manhole on in the front parking lot near Athens Street, then joins the city storm sewer, which discharges to Salt Lick Creek. Ohio EPA considers this recycled water blowdown, which is not authorized to be discharged under the NCCW general permit. In addition, OSCO uses cooling water additives to reduces problems within the cooling water system. Ohio EPA has required that OSCO received the required approval from Ohio EPA in order to continue use or before using any new additives. Some cooling water additives have been found to be toxic and therefore cannot be discharged under the NCCW NPDES permit.

OSCO has proposed to revise their NCCW system to eliminate the discharge of the recycled NCCW. A valve will be installed to divert recycled NCCW to a holding tank, allowing a switch to once through NCCW to occur without being contaminated with the recycled water. The recycled NCCW will no longer be discharged. Then the once through NCCW is eligible for coverage under the NCCW General Permit.

On May 16, 2007 Ohio EPA conducted compliance sampling during a rain event. Four locations were sampled: Site 1) Storm water discharge to Salt Lick Creek (drains storm water from OSCO manhole and from the City of Jackson); Site 2) OSCO Manhole; Site 3) Storm Water Reservoir (pit); Site 4) Storm water discharge to Horse Creek.

OSCO Site 1: The storm water outfall to Salt Lick Creek is a combination of water from OSCO and storm water collected from the city of Jackson. Elevated metals include aluminum, iron, manganese, and zinc. Oil and grease, phenols and pentachlorophenols (wood preservative) were also detected at Site 1 (Table 30). Some of the metals were also found at the OSCO manhole which discharges to this storm water outfall. However, many of the metals found in the storm water outfall were of a much higher concentration than the OSCO manhole indicating that metals are probably entering the storm water outfall from other locations. Phenols were about the same level in both the OSCO manhole and the storm water outfall which indicates that OSCO is contributing most of the phenols to the storm water outfall to Salt Lick Creek.

Elevated levels of both *E. coli* and fecal coliform bacteria were detected at the storm water outfall to Salt Lick Creek. The presence of bacteria is evidence of the presence of human or animal waste. Water from the storm water outfall to Salt Lick Creek was gray and had a septic smell which also suggests untreated sewage. The elevated bacteria levels were most likely not from OSCO but instead are from a failing septic system which is illegally connected to this storm sewer. Elevated levels of nitrate+nitrite and ammonia are also an indication that untreated sewage is being discharged to this storm water outfall.

OSCO Site 2: Metals detected in the OSCO manhole include iron, arsenic, zinc, cadmium, lead, copper, manganese, and aluminum. Zinc and copper were above the OMZM WQS (Table 29). Oil and grease, ammonia, and nitrate+nitrite-N, were also found in OSCO manhole sample.

OSCO Site 3: The water quality of the OSCO storm water reservoir was generally poor with low dissolved oxygen, high conductivity, elevated metals including lead, aluminum, iron, manganese, arsenic, strontium, and zinc and the detection of oil and grease, ammonia and phenols. Zinc and copper were above the OMZM WQS (Table 30). While this storm water reservoir is not supposed to discharge to waters of the state, previous rain events and power outages have caused the reservoir to overflow into Horse Creek.

OSCO Site 4: The OSCO storm water discharge to Horse Creek was found to have the highest levels of oil and grease of the four locations sampled. Some metals were found in the storm water including arsenic, iron, manganese, and zinc but the concentrations were generally low (Table 30).

The first mile downstream from the City of Jackson's WWTP is in non-attainment due in large part to nutrient enrichment. Median nutrient values downstream from the City of Jackson were consistently above Ohio EPA targeted values (Figure 42). The median nitrite value drops below the target value at Salt Lick Creek RM 1.0 and ammonia median concentration meets the target value at RM 1.0. The annual 95th percentile loads for ammonia and TKN from the Jackson WWTP (Figure 43) show a sporadic trend, possibly due to bypasses and faulty MOR data reporting. The reported data still show high loads for ammonia and TKN. Datasonde© continuous monitors show high D.O. values downstream from the WWTP at RM 18.2. At RM 14.1 D.O. drops to a median value of 4.54 mg/l. This D.O. drop is due in part to the high $CBOD_5$ discharges from Jackson WWTP. The lowest IBI score was found at RM 14.1. Then D.O. results increase to a median value of 5.42 mg/l at RM 7.25.

An additional biological assessment of 3.4 miles of Salt Lick Creek was conducted in 2004, approximately two miles downstream from the Jackson WWTP, to determine the water quality impact from the closed Jackson County Landfill. The study found that although biological communities within the study segment of Salt Lick Creek have improved since 1986, moderately enriched conditions were noted based on elevated nitrate and phosphorus levels. This study also found that 1.1 miles of Salt Lick Creek were in partial attainment and 2.3 miles were in full attainment of the warmwater habitat aquatic life use. The partial attainment of the biological community appears largely associated with past fish kills occurring in Salt Lick Creek resulting from the Jackson WWTP's bypassing treatment.

Sediment samples were collected at three Salt Lick Creek sites, one site on Horse Creek and one site on Pigeon Creek during the 2004 field season. The sediment samples within the Salt Lick Creek survey were analyzed for metals, ammonia and phosphorus. The results revealed that only lead was above the Threshold Effect Concentration at Horse Creek RM 2.3 (Table 31).

Organic water column compound samples were collected on May 23, 2005 at RM 3.9, on August 24, 2004 at RMs 3.9 and 7.25 and on June 9, 2004 at RMs 7.25 and 18.2. The samples were analyzed for volatile and semivolatile organic compounds, pesticides, and herbicides. Most results were below laboratory detectable levels. Parameters detected are provided in Table 32.

Four Mile Creek

The Four Mile Creek watershed drains approximately 11.6 square miles. Four Mile Creek is located in the headwater area of Salt Lick Creek. Siltation and riparian destruction contribute to the non-attainment of WQS. Additionally, the watershed is sparsely populated with agriculture and grazing in the valley areas. Nutrients were above targeted levels which were attributed to home septic systems and grazing livestock (Figure 44). A D.O. concentration of 3.09 mg/l was detected probably as a result of the impairment listed above. Iron and manganese were above targeted values (Figure 45).

Sugar Run
The Sugar Run watershed drains approximately 4.0 square miles. Sugar Run is in a heavily populated area with the lower section within the City of Jackson. Siltation, channelization, low D.O. and nutrient enrichment contribute to Sugar Run not being in attainment of WQS. On September 2, 2004 an employee of the Institute for Local Government and Rural Development observed a foul odor and white milky color in the stream. The BOD_5 sampling result at that time was 95 mg/l. All other BOD_5 results were below detection. Nutrients were much higher than other parameters sampled. The D.O. was also low at 2.93 mg/l. The apparent cause for this was a possible sewer overflow.

Horse Creek
Horse Creek is in a densely populated area and the lower section is within the City of Jackson. Siltation, channelization low D.O. and nutrient enrichment contribute to Horse Creek not being in attainment of WQS.

Unnamed Tributary to Salt Lick Creek
The UT to Salt Lick is in a heavily populated area and the lower section is within the City of Jackson. Urban runoff and channelization contribute to the UT not being in attainment of WQS. Nutrient enrichment is less of an impact to the non-attainment in the watershed.

Buckeye Creek
The Buckeye Creek watershed drains approximately 19.12 square miles. Buckeye Creek has many past surface strip and underground coal mines and clay mining for brick production. Buckeye Creek was sampled at RM 0.4 and RM 4.1 and both sites are in partial attainment of WQS. The upper watershed shows impacts from agriculture and riparian removal. The lower section shows impacts from urbanization. Both sampling locations had pH values below the 6.5 S.U. WQS. This may be a result of poor reclamation for the coal strip mines or the local geology. Acidity results were below detectable values and the sampling location did not have the typical orange stream sediments associated with AMD.

Sour Run

Nutrients in Sour Run were at or below targeted values. Sour Run had 41 acres of coal strip mine. Iron and manganese levels were above targeted values.

Pigeon Creek

The Pigeon Creek watershed drains approximately 30 square miles. Pigeon Creek was sampled at RMs 0.9, 6.4 and 6.5 and each site was below targets for nutrients. The watershed is sparsely populated and heavily wooded with very little agriculture.

Big Run

The Big Run watershed drains approximately 19.12 square miles. Big Run has many closed coal strip mines. Big Run was sampled at RM 2.0 and RM 2.1 and both sites are in partial attainment of WQS. Sedimentation is the primary cause of impairment, may be in large part from barren coal strip mines or poor coal mine reclamation. Additionally, gravel mining has taken place in the stream. The watershed is sparsely populated and heavily wooded. Big Run had a low pH and several D.O WQS violations (Table 23).

Poplar Creek

The Poplar Creek watershed drains approximately 4.0 square miles. The watershed is sparsely populated and heavily wooded. Poplar Run was sampled at RM 0.2 and this site was below targets for nutrients.

Table 27. Summary of bacteria data for the Salt Lick Creek sites (HUC 090). Values are based on comparison of the geometric mean and 90th percentile values to the PCR criteria in Ohio Administrative Code (OAC 3745-1-07). The bold values exceed PCR maximum. All values in colony forming units (cfu) per 100 ml of water.

		Geometric Mean		**90th Percentile**		**Potential Causes**
Stream	**River Mile**	**Fecal coliform**	***E. coli***	**Fecal coliform**	***E. coli***	
Salt Lick Creek	26.8	38.7	146	462	**346**	Ag, LS
Salt Lick Creek	22.6	288	113	642	**666**	Ag, LS
Salt Lick Creek	22.07	260	55	420	93	
Salt Lick Creek	18.5	26	20	146	66	
Salt Lick Creek	16.7	115	25	188	46	
Salt Lick Creek	14.1	31	24	86	60	
Salt Lick Creek	7.25	208	18	352	28	
Salt Lick Creek	3.9	270*	117*	444	**352**	HS
Four Mile Creek	1.5	352	62	552	343	
Sugar Creek	0.02	340	64	642	144	
Horse Creek	2.3	398	124	716	**352**	SO
UT to SLC	0.8	755	2719	42	163	SO
Buckeye Creek	3.85	690	110	**4172**	**518**	HS
Buckeye Creek	0.42	197	51	900	**1042**	HS
Sour Creek	0.2	215	43	506	**324**	HS
Pigeon Creek	6.5	330	206	766	**446**	HS
Pigeon Creek	6.4	271	115	626	**498**	HS
Pigeon Creek	0.9	175	49	564	217	
Big Run	2.1	35	23	39	46	
Big Run	2.0	2283	524	**6820**	**3760**	HS
Poplar Run	0.2	375	56	856	252	

* Five samples evaluated, all other sites were less than five samples evaluated.
HS - Home Septic, SO – Sewer overflows; Agricultural Practices; LS - Livestock

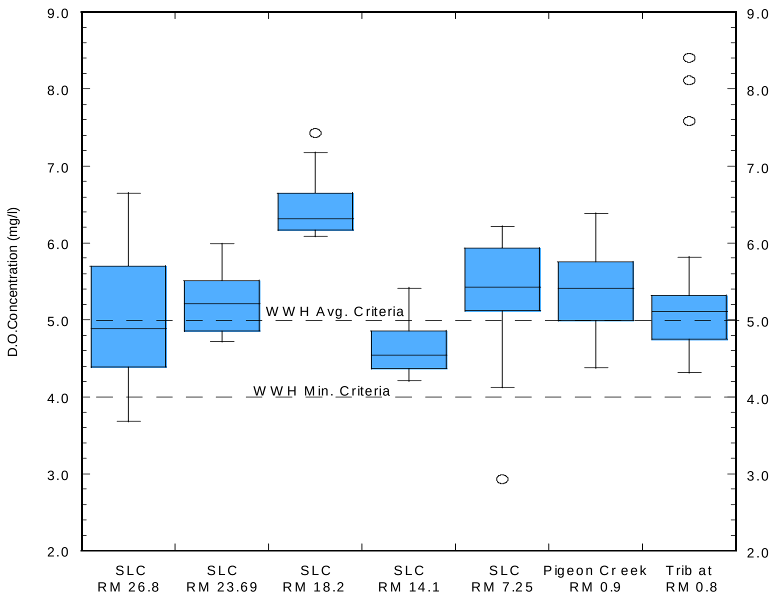


Figure 40. Box plots of hourly dissolved oxygen measurements from Salt Lick Creek (SLC) and tributaries to Salt Lick Creek collected August 24-26, 2004. Aquatic life warmwater habitat (WWH) water quality criteria are noted (Ohio EPA, 1999).

Table 28. Summary of hourly dissolved oxygen measurements (mg/L) are shown for Salt Lick Creek.

Stream	RM	Hours	Mean	Median	Minimum	Maximum
August 24 – 26, 2004						
Salt Lick Creek	26.8	47	5.02	4.89	3.68	6.63
Salt Lick Creek	22.6	46	0.54	0.16	0.15	6.24
Salt Lick Creek	18.2	47	6.44	6.31	6.09	7.43
Salt Lick Creek	14.1	48	4.63	4.54	4.21	5.41
Salt Lick Creek	7.25	48	5.4	5.42	2.93	6.21
Salt Lick Creek	3.9	47	5.24	5.21	4.72	5.99
Pigeon Creek	0.9	48	5.39	5.41	4.38	6.38
UT to SLC	0.8	47	5.2	5.11	4.32	8.4

D.O. data lost at Jackson WWTP mixing zone RM 22.1.

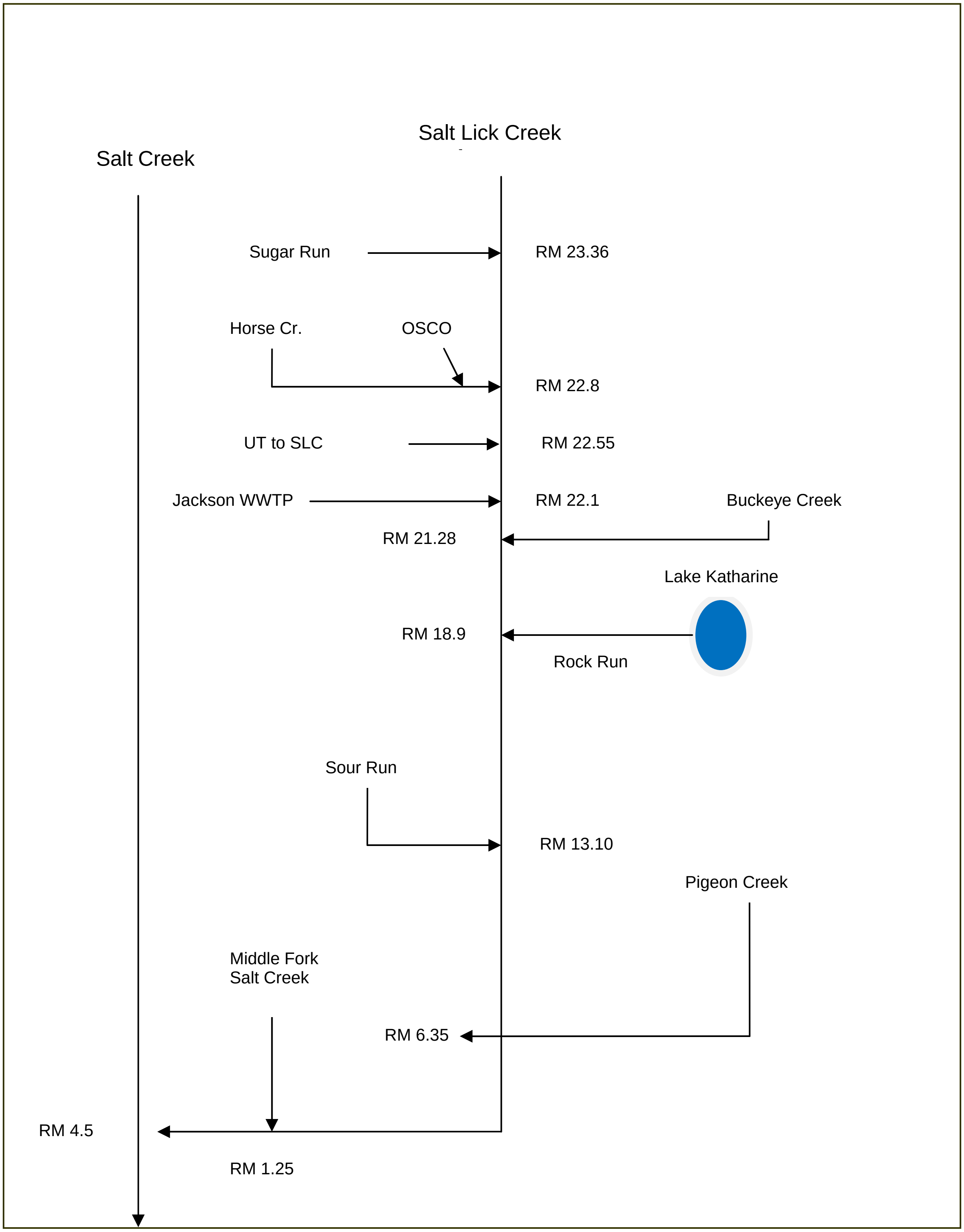


Figure 41. Middle and lower Salt Lick Creek showing known dischargers.

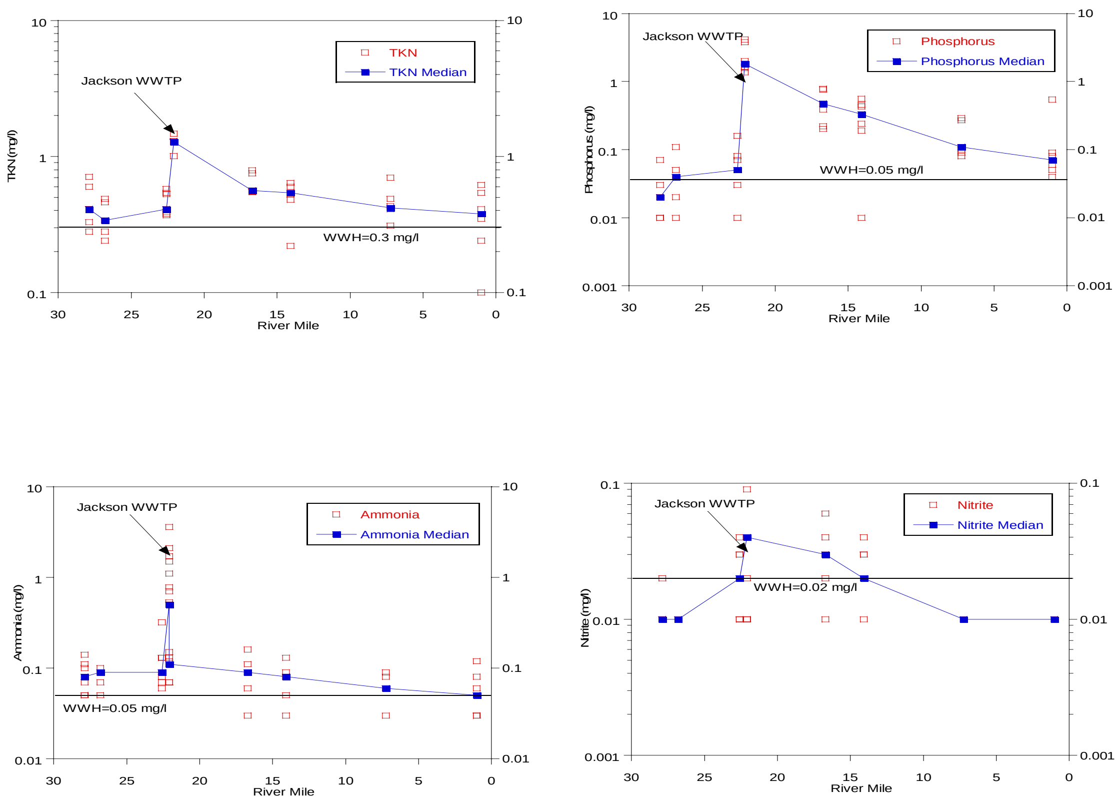


Figure 42. Nutrient concentration values for Salt Lick Creek main stem. The WWH target values are noted for WAP ecoregion headwater and wadeable streams (Ohio EPA 1999).

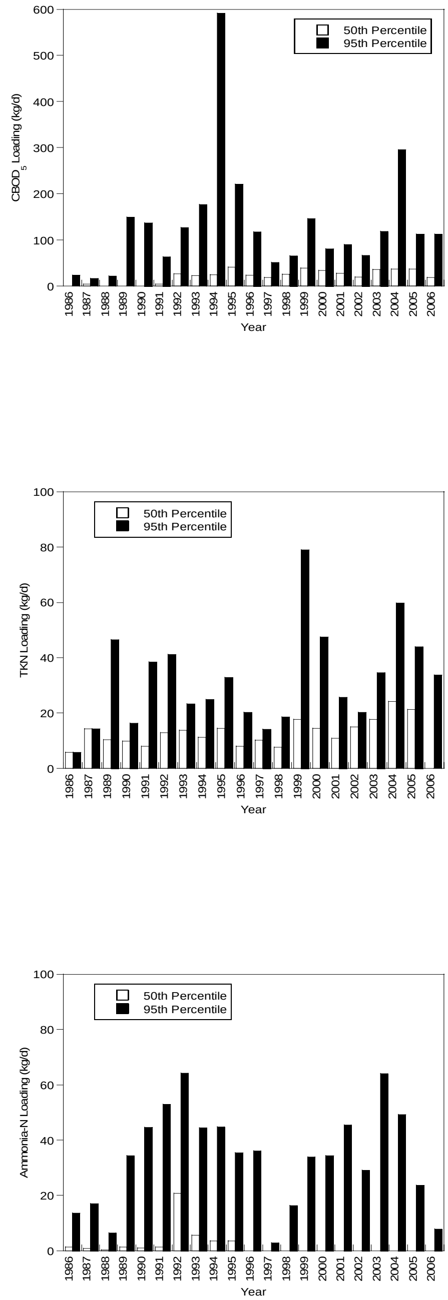


Figure 43. Annual median and 95th percentile loading discharge concentrations reported by the Jackson WWTP, 1986-2006. By-pass data not included.

Table 29. City of Jackson WWTP bypass of treatment reported to Ohio EPA after bypass discovery by Ohio EPA in October 2003.

Month	# Days	Total Flow Bypassed (MGD)
December 2003	15	53.1
January 2004	20	83.2
February 2004	17	63.9
March 2004	12	*
April 2004	13	*
May 2004	6	*
June 2004	6	*
September 2004	5	*
October 2004	3	0.90
November 2004	20	7.24
December 2004	18	11.83
January 2005	18	*
February 2005	25	8.27
March 2005	13	12.82
April 2005	7	8.725
May 2005	8	4.21
October 2005	6	4.58
November 2005	3	2.27
December 2005	**	
January 2006	5	*
February 2006	2	1.104
March 2006	4	8.23
April 2006	1	*
May 2006	1	0.64
June 2006	1	2.154
September 2006	1	0.298
October 2006	4	3.87
November 2006	**	
December 2006	**	
January 2007	3	4.10
February 2007	6	11.09
March 2007	3	4.48
April 2007	3	3.40
33 Months	**249 days**	**300.411 MGD reported bypass**

*No flow data reported by entity.

**No bypasses for the month.

Table 30. Compliance Sampling Data for OSCO collected by Ohio EPA on May 16, 2007.

Site Number & Location	Time	pH (S.U.)	Temp (EC)	D.O. (mg/l)	% Sat.	Cond. µmhos/cm
1 Stormwater to Salt Lick Creek	10:55 am	7.61	17.25	7.68	80	562
2 OSCO Manhole	9:51 am	8.27	20.47	8.12	90.2	149
3 Slag Water Reservoir (pit)	10:18 am	8.50	19.37	3.67	40	1075
4 Stormwater to Horse Creek	10:45 am	7.73	18.03	6.86	72.6	205

PARAMETER	UNITS	Site 1 Storm water to SLC	Site 2 OSCO Manhole	Site 3 OSCO SWR (pit)	Site 4 OSCO storm water to Horse Cr.
TSS	mg/l	104	28	107	126
TDS	mg/l	398	130	784	22
Oil & Grease	mg/l	7.4	8.0	13	22
Ammonia	mg/l	0.277	0.409	1.22	<0.050
Nitrate-nitrite	mg/l	2.40	1.43	1.65	1.15
Nitrite	mg/l	0.048	0.116	0.487	0.155
TKN	mg/l	1.18	1.39	4.37	0.21
Phos., tot.	mg/l	0.206	0.114	0.433	0.103
Aluminum, tot	µg/l	1010	300	1230	<200
Barium, tot	µg/l	68	<15	61	19
Arsenic, tot	µg/l	<2.0	3.2	3.0	2.2
Nickel, tot	µg/l	<40	<40	<40	<40
Zinc, tot	µg/l	105	168	257	53
Cadmium, tot	µg/l	0.47	0.21	0.97**J**	<0.2
Lead, tot	µg/l	2.1	17.7	33.8**J**	<2.0

PARAMETER	UNITS	Site 1 Storm water to Salt Lick Creek	Site 2 OSCO Manhole	Site 3 OSCO SWR (pit)	Site 4 OSCO storm water to Horse Cr.
Chromium, tot	mg/l	<30	<30	<30	<30
Copper, tot	µg/l	12	22	53	<10
Chrom, hex.	µg/l	<10	<10	<10	<10
Mercury	µg/l	<0.20	<0.20	<0.20	<0.20
Iron	µg/l	3740	2140	10500	474
Magnesium	µg/l	11	6	46	3
Manganese	µg/l	338	340	1290	232
Strontium	µg/l	364	54	438	59
Hardness	mg/l	300	82	442	67
Chloride	mg/l	31.6	<5.0	64.2	6.3
Selenium	mg/l	<2.0	<2.0	6.5**J**	<2.0
Fecal Coliform	#/100 ml	3200	--	--	--
E. Coli	#/100 ml	1500 **JL**	--	--	--
BOD_5	mg/l	6.5	6.4	16	11
Phenols	µg/l	15.7	13.2	10.2	8.4
Pentachloro-phenol	µg/l	15.1	<10.6	<10.3	<11.9

JL-The reported result is estimated because it has been computed using a colony count that is not within the acceptable count range
J-Cadmium, lead and selenium estimated due to poor matrix spike recovery.
Underlined values indicate violations of the WQS.

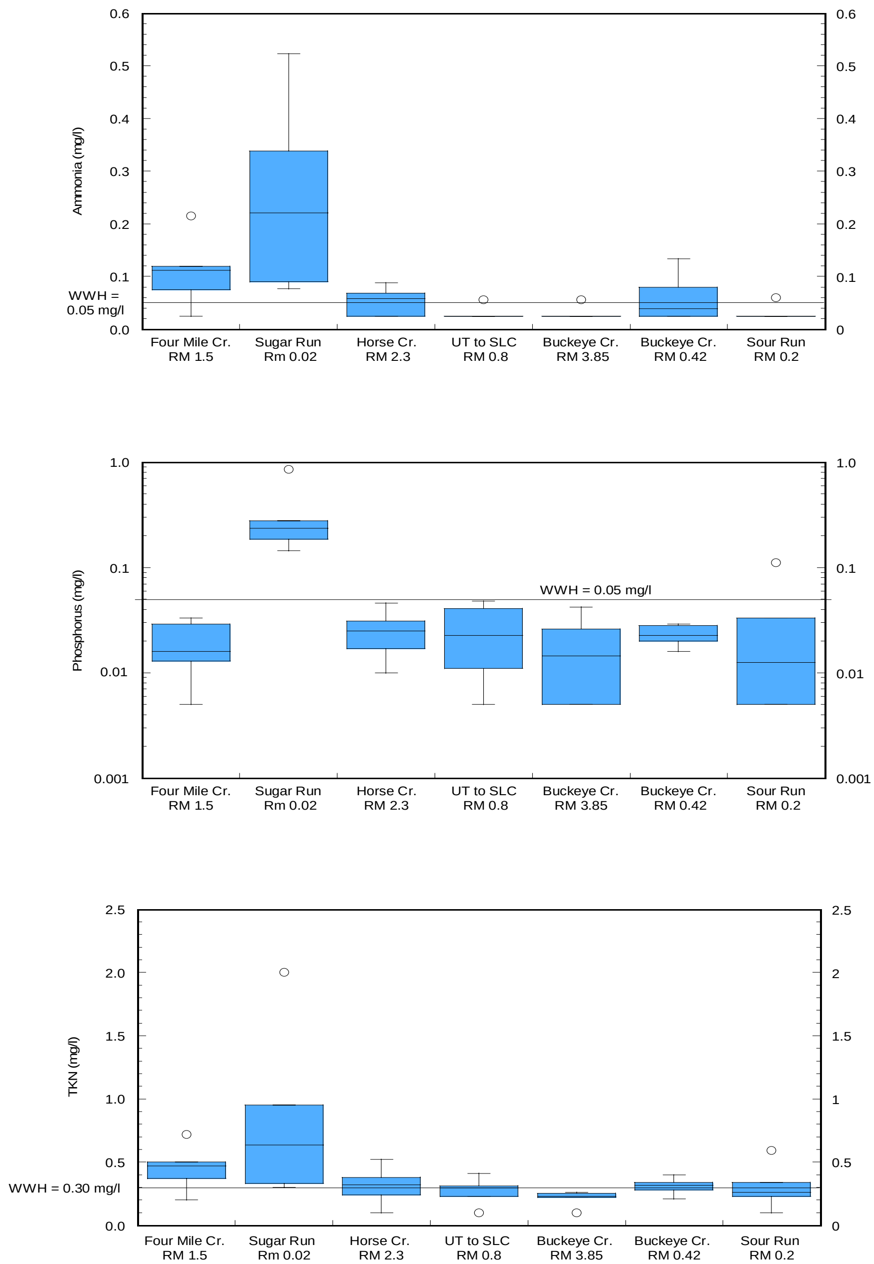
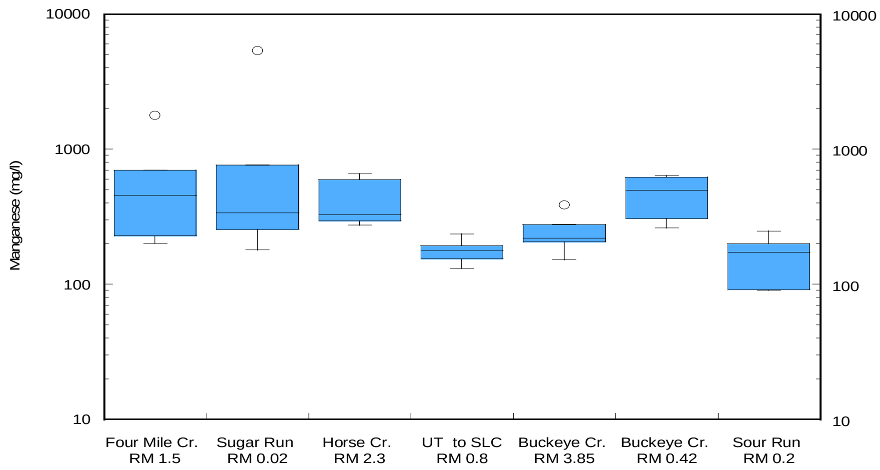


Figure 44. Ammonia, phosphorus and TKN concentration values in the tributaries to Salt Lick Creek. The WWH target values for WAP ecoregion for headwater and wadeable streams (Ohio EPA, 1999).



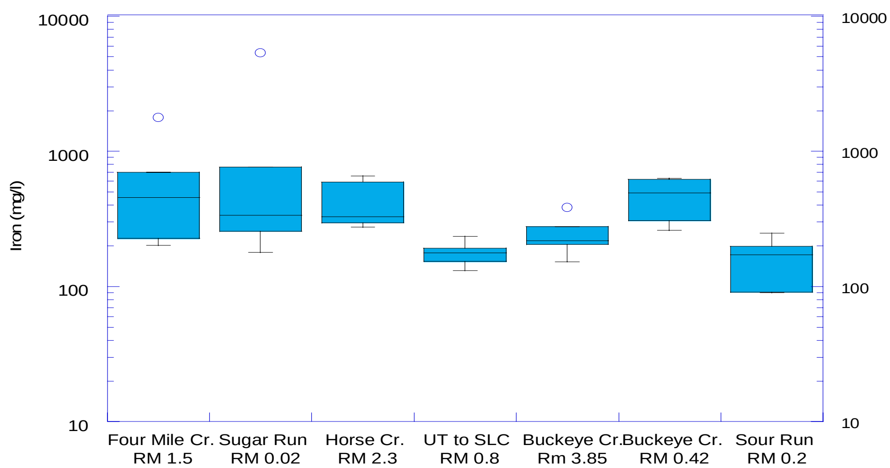


Figure 45. Iron and manganese concentration values for the tributaries to Salt Lick Creek. The WWH target value for iron is 665 mg/l and 460 mg/l for headwater and wadeable streams respectively. The WWH target value for manganese is 130 mg/l and 220 mg/l for headwater and wadeable streams respectively (Ohio EPA, 1999).

Table 31. Chemical compounds detected in sediment samples collected by Ohio EPA from Salt Lick Creek, 2004.

Stream Segment	**SLC**	**SLC**	**SLC**	**Horse Creek**	**Pigeon Creek**
River Mile	**26.8**	**22.1**	**7.25**	**2.3**	**0.9**
PARAMETER	**Sample Result**				
Aluminum	12400	20900	16900	19200	5780
Arsenic	5.89	4.91	5.99	7.93	6.36
Barium	113	142	124	123	60.7
Cadmium	0.186	0.221	0.133	0.18	<u>0.100</u>
Calcium	2270	2400	1120	1230	<u>998</u>
Chromium	<19	18	18	22	<u>15</u>
Copper	11.6	15	6.9	11.3	5.3
Iron	22500	15000	14400	24600	11400
Lead	<u>25</u>	33	<u>22</u>	37 [TEC]	<u>20</u>
Magnesium	1970	1690	1430	1270	799
Manganese	742	447	482	1020	286
Mercury	<u>0.033</u>	0.044	<u>0.023</u>	<u>0.029</u>	<u>0.029</u>
Nickel	<u>25</u>	<u>20</u>	<u>22</u>	<u>23</u>	<u>20</u>
Potassium	1790	3790	3250	3030	<u>998</u>
Selenium	<u>1.27</u>	<u>1.02</u>	<u>1.10</u>	<u>1.13</u>	<u>1.00</u>
Strontium	<19	25	19	22	<u>15</u>
Zinc	76.5	80.4	49.7	78.3	49.2
% Solids*	59.5	62.5	68.4	72	65.7
Ammonia*	42	110	46	29	<u>11</u>
Sodium*	<u>3170</u>	<u>2540</u>	<u>2760</u>	<u>2830</u>	<u>2500</u>
%TOC*	1.2	2.2	0.8	1.2	1.4
Total Phosphorus*	430	1100	326	269	193

All parameters in mg/kg except %.
[TEC] Value above the threshold effect concentration (MacDonald *et al.* 2000).
<u>Underlined</u> values indicate concentrations below method detection limit.
* Does not have SRV (sediment reference value) or TEC association.

Table 32. Organic chemical compounds detected in stream samples collected by Ohio EPA from Salt Lick Creek, 2004 and 2005 (units are ug/l).

Salt Lick Creek (5/23/2005)	
River Mile	**3.9**
Semivolatiles/Herbicides	
Benzoic Acid	6
Nonanoic acid	4
Hexadecanoic acid	4
Ethanol, 2-[2-[4-(1,1,3,3-tetramethylbutyl) phenoxy]ethoxy]	2
Pesticides	
a-BHC	0.0031
y-BHC	0.0029
Heptachlor epoxide	0.002

Salt Lick Creek (8/24/2004)	
River Mile	**3.9**
BNA	
Squalene	2
Pesticides	
a-BHC	0.0068
Dieldrin	0.0032

Salt Lick Creek (6/9/2004)	
River Mile	**7.25**
Semivolatiles-Herbicides	
Atrazine (AAtrex)	0.24
bis(2-Ethylhexl)phthalate	0.78
Propanoic acid, 2-methyl-, 1-(1,1-dimethyl)	0.7
Caffeine	0.9
Ethanol, 2-[2-[4-(1,1,3,3-tetramethylbutyl) phenoxy]ethoxy]	0.7

Salt Lick Creek (8/24/2004)	
River Mile	**7.25**
BNA	
Squalene	4
Pesticides	
a-BHC	0.0067
Dieldrin	0.0025

Salt Lick Creek (6/9/2004)	
River Mile	**18.2**
BNA	
Squalene	2
Semivolatiles-Herbicides	
bis(2-Ethylhexl)phthalate	1.57
Phenol, 2,6-dibromo-	0.3
Ethanol, 2-[2-[4-(1,1,3,3-tetramethylbutyl) phenoxy]ethoxy]	0.3
Pesticides	
a-BHC	0.0036
Dieldrin	0.0024
Heptachlor epoxide	0.004

Salt Lick Creek (6/9/2004)	
River Mile	**22.1**
Semivolatiles-Herbicides	
bis(2-Ethylhexl)phthalate	0.69
Tri(2-chloroethyl) phosphate	0.9

Trade name in parenthesis.
BHC – benzene hexachloride has several stereoisomeric derivatives of which gamma-BHC or γ-BHC (Lindane) is in common use. Alpha-BHC (α-BHC) and delta-BHC (δ-BHC) are manufacturing by-products with no agricultural use.

Physical Habitat

The physical habitat of 25 locations within the Salt Lick Creek basin was evaluated with the QHEI (Figure 46). All sites >20 mi^2 drainage area scored within the good to very good range. All of the sites between >10 mi^2 and <20 mi^2 were within the fair range, while eight of the 10 sites <10mi^2 drainage area scored within the fair range. Salt Lick Creek RM 27.9 scored in the very poor range as a result of channelization and riparian removal for agricultural purposes and Sugar Run RM 0.42 scored within the poor range due to channelization activities and siltation associated with urbanization.

QHEI scores for tributary streams ranged from 40.5 to 70.5 with an average QHEI score of 54.4. Impacts to tributary habitats occurred primarily from channel modifications associated with agricultural activities and urbanization. The Salt Lick Creek main stem received an average QHEI score of 60.5, with QHEI scores ranging from 23.5 to 76.5. The majority of the Salt Lick Creek main stem had adequate amounts of diverse instream cover with a variety of substrates. The upper portion of Salt Lick Creek, upstream of Jackson, showed evidence of channelization while the majority of sites downstream of Jackson appeared from of channel modifications. The combination of these factors with mixed intensity land use and riparian buffers provided a variety of niches for aquatic life.

Salt Lick Creek

The physical habitat of Salt Lick Creek was evaluated in twelve locations from south of Jackson along State Route 93 (RM 27.9) to near the town of West Junction approaching West Junction Road (RM 1.0). The two uppermost sites were severely impacted by agricultural activities. The site near State Route 93 (RM 27.9) was a swamp type stream that had been channelized and was maintained with hayfields along each bank. Extensive amounts of wetland vegetation was present within the stream channel and the dominant substrates were muck and silt in this area. Livestock had access to the next downstream site, RM 26.8, which combined with the slow recovery of the stream from past channelization activities to negatively affect the upper reach's integrity. The majority of sites further downstream were either free from channelization or had further recovered than the two uppermost sites. The lower portion of Salt Lick Creek contained diverse combinations of substrates including boulder, cobble, hardpan, gravel, sand and a little bedrock. A diverse assemblage of undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), logs with woody debris and occasional rootwads and boulders provided moderate amounts of instream cover for aquatic organisms throughout the lower portion of Salt Lick Creek.

QHEI scores for Salt Lick Creek reflected the habitat conditions present. The modified conditions at the two upper sites described above resulted in a QHEI of 23.5 for the site at RM 27.9 and a QHEI score of 52.0 for the site at RM 27.9. In contrast, the average QHEI score for the remaining sites was 65.1, with a range in value of 55.5 to 76.5.

Sugar Run
The physical habitat of Sugar Run was evaluated near State Route 93 (RM 0.4). Sand and cobble sized pieces of concrete were the dominant substrate types present, though areas of cobble, boulder, silt and gravel were also noted. Silt and embedded substrates were present in moderate amounts. Sparse amounts of instream cover were provided by overhanging vegetation, shallows, rootmats, rootwads, boulders, and woody debris. The channel appeared to be recovering from past channelization activities as low sinuosity with fair channel development and moderate stability were observed. Very narrow (<5 m) to narrow (5-10 m) riparian buffers provided little shading and storm water filtering from the surrounding urbanized landscape. The poor riparian corridor and sparse instream habitat resulted in a QHEI score of 40.5 for Sugar Run.

Four Mile Creek
Four Mile Creek appeared to originate from sandstone origins. Sand and silt were the predominant substrates present, though areas of hardpan, gravel and detritus were also noted. Moderate amounts of silt resulted in moderately embedded substrates. Instream cover was sparse and consisted of overhanging vegetation, undercut banks, shallows, rootmats, rootwads, and woody debris. The stream channel exhibited no evidence of channelization and had low to moderate sinuosity with fair channel development and moderate stability. Very narrow (<5 m) riparian buffers extended to old fields. The unaltered channel morphology and variety of substrates combined with only sparse amounts of instream cover resulted in a QHEI score of 50.0 for Four Mile Creek.

Horse Run
The physical habitat of Horse Run was evaluated near State Route 93 (RM 2.3). Substrates appeared to originate from wetlands and sandstone. Sand and silt were the dominant substrates present, though areas of gravel and detritus were also observed. The moderately heavy amounts of silt resulted in moderately extensive amounts of embedded substrates. Sparse amounts of instream cover were provided by undercut banks, overhanging vegetation, shallows, rootmats, rootwads, and woody debris. Low sinuosity with fair channel development and moderate stability characterized the natural appearance of the stream channel. Very narrow (<5 m) to narrow (5-10 m) riparian buffers were extended to a mixture of residential homes and shrubby fields along either stream bank. The combination of sparse instream cover, heavily embedded substrates and poor buffer depth resulted in a QHEI score of 45.5 for Horse Run.

Tributary to Salt Lick Creek at RM 22.55
The physical habitat of this tributary to Salt Lick Creek was evaluated near County Road 76 (RM 0.8) and appeared to be derived from a combination of wetland and sandstone geography. Sand and silt were the dominant substrates present with cobble, gravel and detritus also observed. Substrates were moderately to extensively embedded with silt.

Sparse to moderate amounts of instream cover was provided by undercut banks, overhanging vegetation, rootmats, rootwads, and woody debris. The stream appeared free from channelization activities as low sinuosity with fair channel development and low to moderate stability were noted. Riparian buffers were narrow (5-10 m) at best, and extended to shrubby old fields along either bank. The combination of embedded substrates and poor riparian buffers resulted in a QHEI score of 49.5.

Buckeye Creek

The physical habitat of Buckeye Creek was evaluated along Hunter Road (RM 3.8) and near Buckeye Swamp (RM 4.9). The substrate origin of the upper portion of Buckeye Creek near Hunter Road (RM 3.8) appeared to be derived from sandstone. Sand was the dominant substrate present though areas of silt and gravel were also noted. Normal to moderate amounts of silt and embedded substrates were observed. Sparse amounts of instream cover consisted of undercut banks, overhanging vegetation, shallows, rootmats, rootwads, and woody debris. The stream appeared unaltered in its formation with low to moderate sinuosity, fair channel development and low to moderate stability. Hay fields were sown to within 5m of the stream bank, eliminating any functional riparian corridor. The combination of sparse instream cover and few substrate types resulted in a QHEI score of 47.5 for the upper reach of Buckeye Creek.

The downstream portion of Buckeye Creek appeared to be derived from wetlands and sandstone. The streambed was dominated by sand and silt and contained a variety of substrates including boulder, cobble, gravel, and detritus. Moderate amounts of silt resulted in moderately embedded substrates, limiting the amounts of interstitial spaces available for aquatic life. A small rock dam was noted upstream of the bridge, and it appeared to be holding back a brown oily substance on top of the water, though no odor was noticed. A truck ramp was located just downstream of the rock dam and a path to it led to a home adjacent to the stream. It is possible that the property owner may be dumping material into the stream at this location, as concrete debris was noted in the area. Downstream of the rock dam, the stream appeared free from any channelization with low to moderate sinuosity, fair channel development and moderate stability. Riparian width varied from wide (>50 m) adjacent to forested areas along either side to very narrow (<5 m) adjacent to residential and construction areas. The combination of diverse substrates and mixed land use intensity resulted in a QHEI score of 60.5 for the lower reach of Buckeye Creek.

Sour Run

The physical habitat of Sour Run was evaluated near Township Road 742 (RM 0.2) and appeared to be derived from a mixture of wetlands and sandstone geology. Gravel and sand were the dominant substrates present, though areas of hardpan, silt and detritus were also noted. Moderate amounts of silt and moderately to heavily embedded substrates limited the interstitial spaces available for aquatic organisms. Sparse amounts of instream cover were provided by undercut banks, overhanging vegetation, shallows, rootmats, rootwads and woody debris. The stream channel appeared unaltered and had low to moderate sinuosity with fair development and low to moderate stability. Very narrow (<5 m) to narrow (5-10 m) riparian buffers were extended into residential yards along either stream bank. The combination of sparse instream cover with unaltered stream morphology resulted in a QHEI score of 56.5 for Sour Run.

Big Run
The physical habitat of Big Run was evaluated upstream (RM 2.1) and downstream (RM 2.1) of Dry Run. The streambed materials of Big Run appeared derived from sandstone, with sand as the dominant substrate present. However, additional substrates present included cobble, silt, gravel and detritus. Silt was present in normal to moderate amounts and substrates appeared moderately embedded. Sparse to moderate amounts of instream cover included undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads and woody debris. The stream appeared free from channelization with moderate sinuosity, fair channel development and low to moderate stability. Riparian buffers were wide (>50 m) adjacent to a forest along the right descending bank in the upper reach, while the majority were very narrow (<5 m) to narrow (5-10 m) adjacent to fenced and open pastures. The QHEI score for the upper reach was 59.0 and for the lower reach it was 59.5.

Poplar Creek
The physical habitat of Poplar Creek was evaluated along Poplar Road (RM 0.2). The streambed appeared to originate from sandstone. Gravel and sand were the dominant substrates present, though areas of silt and detritus were also noted. Normal to moderate amounts of silt resulted in normal to moderately embedded substrates. Sparse instream cover consisted of undercut banks, overhanging vegetation, shallows, rootmats, rootwads, and woody debris. The stream appeared free from channelization with moderate sinuosity, fair channel development and moderate stability. Very narrow (<5 m) to narrow (5-10 m) riparian buffers were extended to residential homes along each bank. The QHEI score for Poplar Creek was 56.5.

Pigeon Creek (Tributary to Salt Lick Creek)
The physical habitat of Pigeon Creek was evaluated in three locations: Limerick Road (RM 6.1), downstream of Big Run (RM 6.0), and along Township Road 216 (RM 0.9). Pigeon Creek appeared to originate from a combination of tills and sandstone. Gravel and sand were the dominant substrates present in the stream, though stretches of cobble, hardpan and boulder were also noted. Silt was heaviest downstream of Big Run, resulting in moderately embedded substrates in that stretch. Upstream of Big Run, silt and embedded substrates were present in normal amounts and at the most downstream site, the stream was free of silt and there was no evidence of embedded substrates. Sparse to moderate amounts of instream cover was provided throughout Pigeon Creek by undercut banks, overhanging vegetation, shallows, rootmats, rootwads, boulders, woody debris and occasional deep pools (>70 cm), though the

deep pools were only at the most downstream site. The upper two sites appeared to be at various stages of recovery from channelization activities. Sinuosity varied from low to high with fair to good channel development and low stability. The lower site appeared free from channelization and exhibited low sinuosity, fair to good development and moderate to high stability.

Surrounding land use appeared to have an effect on the stability of the stream banks within each site. At the uppermost site, fenced pastures and old fields had no riparian corridor adjacent to them and consequently, erosion was heavy in several areas. The site below Big Run had very narrow (<5 m) riparian buffers adjacent to old fields and open pasture. Erosion was moderately heavy in several areas. For the most downstream site, very narrow (<5 m) to narrow (5-10 m) buffers were extended to old field and open pasture. The lower site had minimal amounts of erosion along each bank. QHEI scores increased in a downstream direction; 52.5, 59.5, and 70.5, respectively.

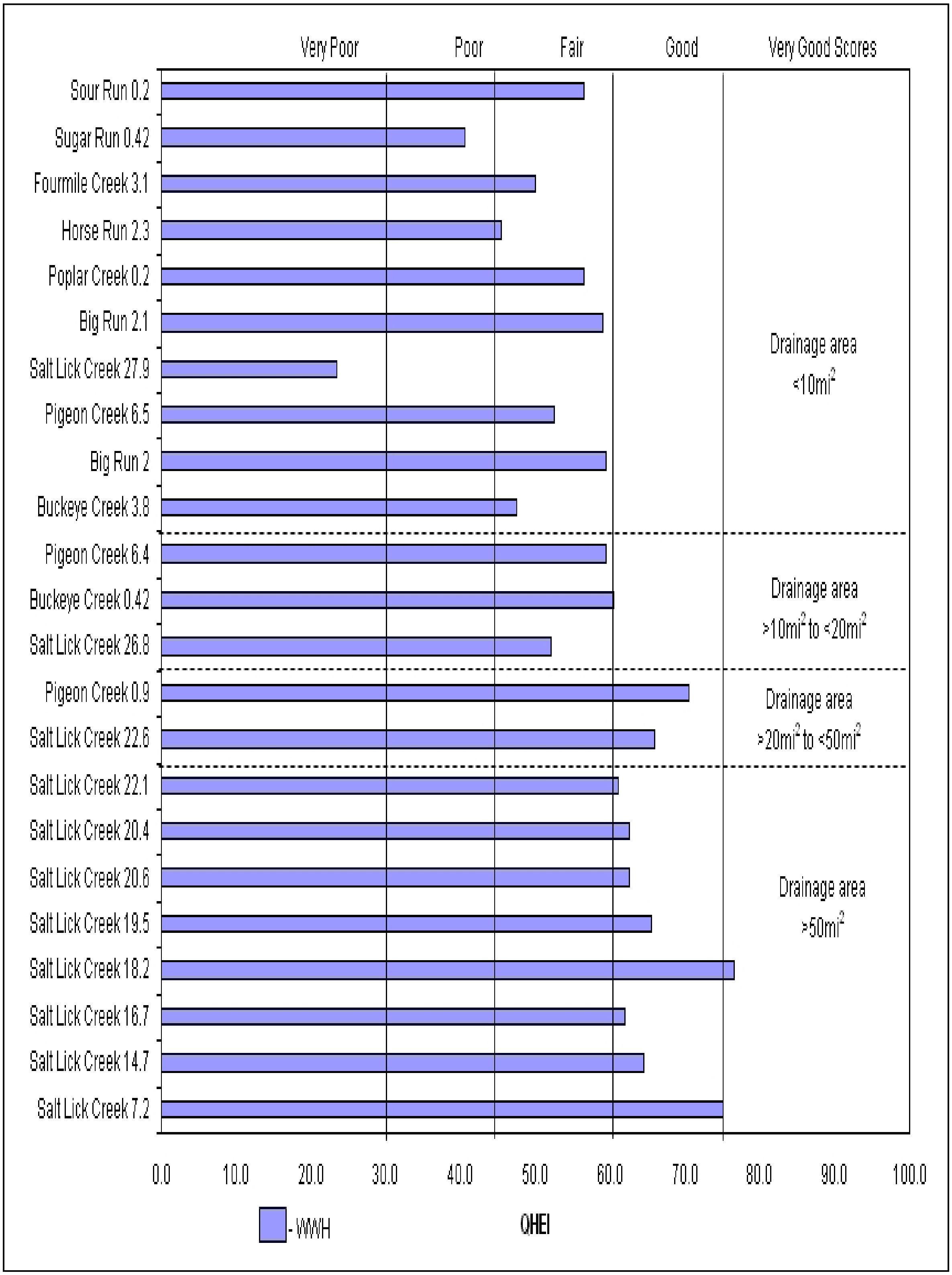


Figure 46. QHEI by drainage area for sites sampled within the Salt Lick Creek watershed, HUC 05060002090.

Biological Assessment: Fish Community

The fish communities of 23 locations within the Salt Lick Creek basin were sampled during 2004. As Figure 47 shows, the fish communities for the eleven Salt Lick Creek main stem sites correlated strongly with habitat conditions. Where habitat conditions were poor, such as Salt Lick Creek RM 27.9, the fish community reflected the poor habitat with an IBI of 12. Similarly, higher habitat scores, such as a QHEI of 75.0 at Salt Lick Creek RM 7.2, were associated with higher fish community performance as that site received an IBI of 53 and MIwb of 9.0 (Figure 47). Fish communities of tributary streams also showed IBI scores correlating strongly with QHEI scores.

Figure 47. IBI by QHEI for Salt Lick Creek basin, HUC 05060002090.

The average IBI of 42.2 (range of 12 to 53) and average MIwb of 8.3 (range of 7.2 to 9.0) for Salt Lick Creek main stem sites were similar to the tributaries, which had an average IBI of 42.3, though the range of scores extended from 28 to 56. These scores indicate that while many streams within the Salt Lick Creek basin have the ability to support WWH communities, impacts from agricultural activities, and urbanized areas (Jackson sewage collection and treatment system) have negatively affected biological community performance.

Salt Lick Creek

The fish community of Salt Lick Creek was evaluated in twelve locations from south of Jackson along State Route 93 (RM 27.9) to near the town of West Junction approaching West Junction Road (RM 1.0). The two uppermost sites were severely impacted by agricultural activities with IBI scores in the very poor (IBI of 12 for Salt Lick Creek RM 27.9) and fair (IBI of 34 for Salt Lick Creek RM 26.8) ranges. Historical problems associated with Jackson's sewage collection system and treatment plant were reflected in the MIwb scores between RM 20.6 and 19.5 (Figure 35). The MIwb measures relative number, weight, and how evenly relative number and weight is distributed among species. It is sensitive to the total number and biomass of fish excluding tolerant species and to the uneven distribution of individuals and biomass within the community assemblage. As mentioned in the Spills section above, fish kills were documented along Salt Lick Creek in 1998, 2003 and 2007. The dip in MIwb scores along with low biomass of fish collected reflect the known historical problems, while the ability of Salt Lick Creek to still partially meet WWH standards downstream of Jackson is attributable to strong recruitment from the high quality Salt Creek main stem and its associated tributaries.

Four Mile Creek

The fish community of Four Mile Creek was comprised of 16 species, though two pollution tolerant species, creek chub (58.70%) and bluntnose minnow (11.74%), numerically made up 70% of the community. Dominance of the community by these species shows an imbalance which may be attributed to the increased siltation and nutrient enrichment mentioned in the habitat section above. Four Mile Creek achieved an IBI=34.

Sugar Run

The fish community of Sugar Run was evaluated near State Route 93 (RM 0.4). Only ten species were collected, one of which was the moderately pollution intolerant longear sunfish. Pollution tolerant fish comprised 57% of the relative number of individuals. The predominance by pollution tolerant fish and lower number of total fish species reflects the fair IBI score of 28.

Horse Run

The fish community of Horse Run was evaluated near State Route 93 (RM 2.3). Eleven species including the moderately pollution intolerant longear sunfish were collected. However, even though the site was <5 mi^2 in drainage area, no headwater species were collected and only one species of darter was collected. The lack of headwater species and few sensitive and darter species resulted in an IBI of 34 for Horse Run.

Buckeye Creek

The fish community of Buckeye Creek was evaluated along Hunter Road (RM 3.8) and near Buckeye Swamp (RM 4.9). Fish community diversity and overall integrity increased in a downstream direction. Seventeen species, with longear sunfish as the only moderately pollution intolerant species present, were collected at the upstream site. Twenty-two species including the pollution sensitive banded darter and three moderately pollution intolerant species were collected at the downstream site. However, pioneering fish comprised >60% of the relative number of individuals at both sites, indicating anthropogenic stresses as described in the physical habitat section above. IBI scores increased from 34 at the upstream location to 44 at the downstream location.

Historically, Buckeye Creek was sampled near RM 1.4 in 1986. Though this site was not repeated in 2004, the IBI scores (24 for first pass and 30 for second pass) are lower than scores recorded at either site in 2004. The site at RM 1.4 has a similar drainage area (18.0 mi^2) as the site at RM 0.4 (18.6 mi^2). Fewer total species were collected in 1986 (nineteen first pass and fifteen second pass) than in 2004, and only an average of two minnow species were collected (one first pass and four second pass) in 1986, whereas eight minnow species were collected near RM 0.4 and seven minnow species were collected near RM 3.8 in 2004. While it appears that the quality of the fish community has improved over time, anthropogenic stresses need to be eliminated for further improvement to occur.

Sour Run

The fish community of Sour Run was evaluated near Township Road 742 (RM 0.2). Eighteen species were collected and included one pollution intolerant species and two moderately pollution intolerant species. The IBI score for Sour Run was 44, but the integrity of the fish community is potentially at risk of anthropogenic influence from the surrounding residential landscape. While the number of species collected indicates a diverse community, 60.29% of the relative number of individuals was creek chub, indicating an imbalance in the community.

Big Run

The fish community of Big Run was evaluated upstream (RM 2.1) and downstream (RM 2.1) of Dry Run. Twenty-one species total were collected at the two sites, though only three moderately pollution intolerant species were collected. Community structure appeared nearly balanced with insectivorous fish comprising an average of 49.5% (47% upstream and 52% downstream) of the relative number of individuals. Tolerant fish comprised <45% of the relative number of individuals at each site (44% upstream and 39% downstream), while omnivorous fish comprised only 12% of the relative number of individuals at each site. IBI scores increased in a downstream direction, from a 46 upstream of Dry Run (RM 2.1) to a 52 downstream of Dry Run.

Poplar Creek

The fish community of Poplar Creek was evaluated along Poplar Road (RM 0.2). Sixteen species including the pollution intolerant redside dace were collected.

However, pollution tolerant fish comprised 71% of the fish collected. Creek chubs alone comprised 69.51% of the relative number of individuals, indicating a potential imbalance within the community structure. Poplar Creek received an IBI score of 46.

Pigeon Creek (Tributary to Salt Lick Creek)
The fish community of Pigeon Creek was evaluated in three locations: Limerick Road (RM 6.1), downstream of Big Run (RM 6.0), and along Township Road 216 (RM 0.9). The total number of fish species decreased from 23 upstream of Big Run to 20 downstream of Big Run. Increased agricultural land use directly adjacent to the lower portion of Big Run may be influencing the water quality of Big Run. Therefore, it is negatively affecting the fish community downstream of the confluence with Pigeon Creek. IBI scores also decreased below Big Run; the upstream location received an IBI=56 and the downstream location received an IBI=44. The number of minnow species decreased from 10 to 6 as did the number of simple lithophils. The collection of fewer species partially contributed to the decline in the IBI score downstream of Big Run.

Further downstream, along Township Road 216 (RM 0.9), the total number of fish species increased to 26. However, no common pollution intolerant species were collected and only four moderately pollution intolerant species were collected. This increased intensity of land use with little riparian buffer adjacent to the stream in the lower stretch is likely attributable to the lower fish community performance along Township Road 216. The fish community along Township Road 216 received an IBI=46.

Biological Assessment: Macroinvertebrate Community
Macroinvertebrate communities were evaluated at 24 stations in the Salt Lick Creek assessment unit (Table 33 and Figure 48). Nine of these stations were collected and identified by a contract lab outside the Ohio EPA and are indicated in Table 14 with the data code 20. The community performance was evaluated as very good at one station, good at 10, marginally good at one, fair at 11, and poor at one station. The stations with the highest total mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa richness (EPT) were on Saltlick Creek downstream from railroad bridge near mouth (RM 0.5) and on Pigeon Creek downstream from Limerick Road (RM 6.4) with 19 taxa each. The station with the highest number of total sensitive taxa was on Salt Lick Creek at Township Road 216 (RM 7.4) with 35 taxa. Sensitive taxa found in this assessment unit which are noteworthy because they are not commonly collected were the mayfly *Acerpenna macdunnoughi* in Salt Lick Creek (RMs 27.0, 20.6, 19.5) and Pigeon Creek (RM 7.0), the stonefly *Eccoptura xanthenes* in Salt Lick Creek (RM 16.8, 14.0) and Buckeye Creek (RM 4.1), the caddisfly *Goera sp.* in Pigeon Creek (RM 6.4), and the midges *Lipiniella sp.* in Pigeon Creek (RM 6.4) and *Saetheria species 1* in Salt Lick Creek (RM 27.0). The state endangered freshwater mussel *Villosa lienosa* (little spectaclecase) was collected from Salt Lick Creek, Buckeye Creek, and Pigeon

Creek in the mid-1960s. This is the northern most known population of this species in North America. The current status of this species in the Salt Lick Creek basin is unknown.

Salt Lick Creek

The macroinvertebrate community sampled in the headwaters of Salt Lick Creek (RM 27.9) was very limited due to the wetland like conditions of the stream channel, *i.e.* slow current, thick growths of aquatic macrophytes, and soft substrates caused in part by channel modifications. Stream channel habitat improved at the next downstream station (ust. SR 93 at RM 27.0) so that more of the typical riffle and pool habitats were present. Macroinvertebrate community performance improved to the high fair range. The EPT diversity collected from the natural substrates (11) was in the range of a marginally good community, however, high numbers of aquatic segmented worms (Oligochaeta) on the artificial substrates and the scarcity of sensitive caddisflies were indications of impairment. Community performance declined within Jackson (Table 33 and Figure 48). The station located downstream from High Street (RM 22.5) exhibited declines in qualitative EPT (7) and sensitive taxa (10) diversity and had only facultative taxa predominant in the riffle habitat. The sediments at this station had an organic chemical smell which is an indication of the complex variety of possible impact types at this site. The community remained impaired downstream from the Jackson WWTP at RM 22.1 with a similar community structure to the upstream station. Qualitative EPT and sensitive taxa diversity remained depressed at the next four stations which were adjacent to the Jackson Landfill. A 2005 Ohio EPA report did not attribute any impacts to these four stations by the landfill. One positive note on the communities at these four sites was that at least low numbers of the following common sensitive taxa were present at each of these sites: the mayflies *Maccaffertium vicarium* and either *Isonychia sp.* or the uncommon *Acerpenna macdunnoughi* and the caddisfly *Chimarra obscura*. The ICI at these stations increased into the WWH range at three of the four stations due to a decline in the relative abundance of tolerant organisms and slight increases in the diversity and relative abundance of mayflies and caddisflies. Starting at the Lloyds Bridge site (RM 16.8) the qualitative EPT and sensitive taxa diversity increased at successive stations in a downstream direction. These stations were evaluated as good, however, low relative abundance of sensitive mayfly and caddisfly taxa was an indication of community imbalance.

Fourmile Creek

Macroinvertebrate community performance in Fourmile Creek at Township Road 272 (RM 3.1) was evaluated as fair. EPT (6) and sensitive taxa (5) diversities were below the range expected for a WWH stream. Channel modifications, siltation, removal of the woody riparian, and enrichment from livestock were observed to be threats to the biotic integrity at this site.

Sugar Run
Macroinvertebrate community performance in Sugar Run near its confluence with Salt Lick Creek within Jackson (RM 0.1) was evaluated as fair. EPT (5) and sensitive taxa (4) diversities were below the range expected for a WWH stream. Urban runoff, channel modifications, siltation, enrichment, and potential low flows were observed to be threats to the biotic integrity at this site.

Horse Run
Macroinvertebrate community performance in Horse Run adjacent to SR 93 (RM 3.1) was evaluated as fair. EPT (8) and sensitive taxa (5) diversities were below the range expected for a WWH stream. Siltation was observed to be a threat to the biotic integrity at this site.

Tributary to Salt Lick Creek at RM 22.55
Macroinvertebrate community performance in the Tributary to Salt Lick Creek at RM 22.55 at County Road 76 (RM 0.8) was evaluated as fair. EPT (7) and sensitive taxa (6) diversities were below the range expected for a WWH stream. Channel modifications and siltation were observed to be threats to the biotic integrity at this site.

Buckeye Creek
Macroinvertebrate community performance in Buckeye Creek at the lane to Buckeye Swamp (RM 4.1) was evaluated as good. EPT (11) and sensitive taxa (14) diversities were just below the range expected for a WWH stream. Many community components expected in a stream of this size were missing, however, the presence of the following sensitive taxa was a positive indication of community health: the mayflies *Maccaffertium vicarium* and *Ephemera sp.,* the stonefly *Eccoptura xanthenes*, and the caddisfly *Pycnopsyche sp*. Low flow, channel modifications, and siltation were observed to be threats to the biotic integrity at this site. The community was further impacted at County Road 60 (RM 0.4) with declines in EPT (5) and sensitive taxa (7) diversity.

Sour Run
Macroinvertebrate community performance in Sour Run at Township Road 742 (RM 0.2) was evaluated as marginally good. EPT (9) and sensitive taxa (12) diversities were below the range expected for a WWH stream, however, the sensitive mayfly *Maccaffertium vicarium* was listed as predominant in the riffle habitat, which is a positive indication of community health. It is apparent to this author that all the contractor macroinvertebrate data had unusually low EPT, sensitive taxa, and overall diversity, likely due to under collecting. Therefore, this site and the upstream Buckeye Creek site evaluations were given the “benefit of doubt” which pushed them into their evaluations. Siltation and low flow were observed to be threats to the biotic integrity at this site.

Pigeon Creek
Good to very good macroinvertebrate communities existed in Pigeon Creek. Community components absent from the riffle/run habitat in these sites were sensitive baetid mayflies from RMs 6.4 and 0.9, sensitive hydropsychid caddisflies from all three sites and sensitive case building caddisflies from RMs 7.0 and 0.9. There was no discernible impact from the confluence of Big Run.

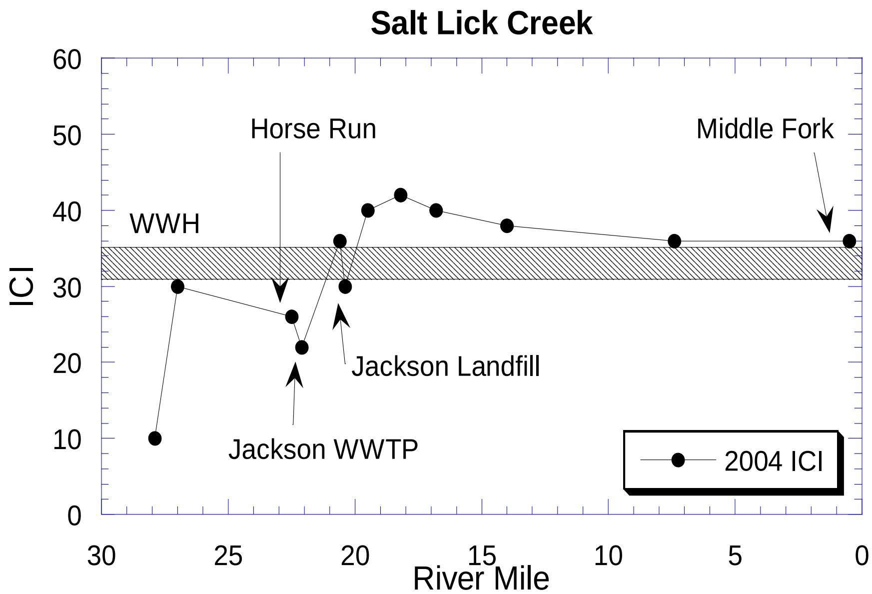
Big Run
Macroinvertebrate community performances in Big Run upstream from Dry Run (RM 2.1) and downstream from Dry Run (RM 2.0) were evaluated as fair. EPT and sensitive taxa diversities were below the range expected for a WWH stream. Low flow, enrichment from livestock, and siltation were observed to be threats to the biotic integrity in this stream.

Table 33. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Salt Creek study area, July to October, 2004.

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI[a]	Narrative Evaluation
Salt Lick Creek (02-610)										
27.9	6.2	-	44	4	2	H	0	Scuds (F,MT), odonates (F,T)	-	Poor
27.0	18.8	-	51	11 / 11	14 / 24	L / 242	4	Hydropsychid caddisflies (F)	30	Fair
22.5	46.0	-	48	7	10	L	1	Midges (F)	-	Fair
22.1	50	-	34	6 /6	7 / 12	L / 416	0	Hydropsychid caddisflies (F), midges (T,F)	22	Fair
20.6	71	-	29	5 / 9	6 / 18	M / 461	2	Hydropsychid caddisflies (F)	36	Good
20.4	71	-	39	6 / 9	10 / 15	M / 331	1	Hydropsychid caddisflies (F)	30	Fair
19.5	72	-	30	8 / 16	8 / 22	L / 294	2	Hydropsychid caddisflies (F)	40	Good
18.2	75	-	22	5 / 11	4 / 18	H / 352	1	Heptageniid mayflies (MI,F)	42	Good
16.8	79	-	43	10 / 13	14 / 23	L / 581	1	Hydropsychid caddisflies (F), midges (MI,F)	40	Good
14.0	83	-	57	11 / 12	17 / 23	L-M / 767	2	Caddisflies (F,MI), midges (F)	38	Good
7.4	100	15	59	18 / 18	27 / 35	L-M / 235	0	Midges (F,MI), *Macronychus* riffle beetles (MI)	36	Good
0.5	247	-	49	19 / 19	24 / 33	L-M / 255	1	Midges (F,MI), *Macronychus* riffle beetles (MI), flatworms (F)	36	Good
Fourmile Creek (02-623)										
3.1	8.1	20	24	6	5	-	0	-	-	Fair
Sugar Run (02-629)										
0.1	3.5	20	17	5	4	-	0	Odonates (F)	-	Fair
Horse Run (02-665)										
3.1	~3.7	20	24	8	5	M	0	Odonates (F)	-	Fair
Tributary to Salt Lick Creek (RM 22.50) (02-664)										
0.8	4.0	20	27	7	6	-	0	-	-	Fair

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI[a]	Narrative Evaluation
Buckeye Creek (02-622)										
4.1	9.2	20	37	11	14	-	1	-	-	Good
0.4	18.6	20	28	5	7	-	1	-	-	Fair
Sour Run (02-663)										
0.2	3.4	20	32	9	12	L	0	Heptageniid mayflies (MI)	-	Marg. Good
Pigeon Creek (02-662)										
7.0	~7.4	-	53	15	28	L-M	4	Midges (MI,F), caddisflies (F,MI), mayflies (MI,I,F)	-	Good
6.4	18.1	-	54	19	25	L	2	Midges (F,MI)	-	Very Good
0.9	29.4	-	57	14	26	L	1	Midges (F,MI), mayflies (MI)	-	Good
Big Run (02-618)										
2.1	5.7	20	25	5	6	L	0	Heptageniid mayflies (F,MI)	-	Fair
2.0	8.9	20	25	4	6	-	0	-	-	Fair

RM: River Mile.
Dr. Ar.: Drainage Area
Data Codes15=Current >0.0 fps but <0.3 fps, 20=Contractor Data.
Ql.: Qualitative sample collected from the natural substrates.
Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List as MI (moderately intolerant) or I (intolerant).
Qt.: Quantitative sample collected on Hester-Dendy artificial substrates, density is expressed in organisms per square foot.
Qualitative sample relative density: L=Low, M=Moderate, H=High.
CW: Number of Coldwater Macroinvertebrate Taxa.
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant



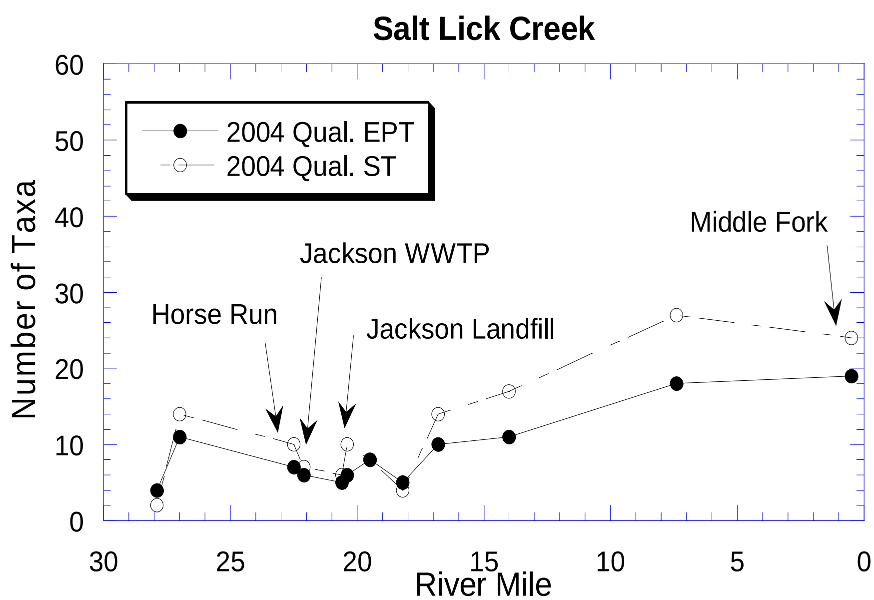


Figure 48. Longitudinal trend of the Invertebrate Community Index (ICI), qualitative EPT, and qualitative sensitive taxa are shown for Salt Lick Creek, 2004. The stations at RMs 27.9 and 22.5 were collected using qualitative methods only, so the ICI values used in the graph are approximations based on the narrative evaluations.

Lower Salt Creek Basin: HUC 05060002-100
Salt Creek above Queer Creek to Scioto River
Includes tributaries: Queer Creek, East Fork Queer Creek,
Tributary to East Fork Queer Creek at RM 3.95, Goose Creek, Pretty Run,
North Branch Pretty Run, Pike Run, East Fork Pike Run, Poe Run, Mulgee Run

Aquatic Life Use Attainment Status and Trends

A total of 19 locations were sampled to assess the ALU designations of streams within the lower Salt Creek basin (Table 34 and Figure 49). The lower stretch of Salt Creek was in full attainment of the EWH designation at all six sampling locations. Seven of the tributaries were in full attainment of their designated or recommended ALU. Goose Creek was in partial attainment of EWH, though it is unknown what the source of impairment was to the macroinvertebrate community, which was similar to the conditions found in Pike Run. The upper portion of Pike Run was in partial attainment of EWH due to less than EWH performance by the macroinvertebrate community influenced by an unknown source. The lower portion of Pike Run was in full attainment of the EWH designation. Poe Run had interstitial conditions and therefore only a qualitative macroinvertebrate collection was completed and fish were not collected. The qualitative evaluation of Poe Run showed a fair community influenced negatively by the gravel removal activities within the stream. Educational outreach to address gravel mining and off-road vehicle use within stream channels may help protect the high quality biological communities present within the lower Salt Creek basin.

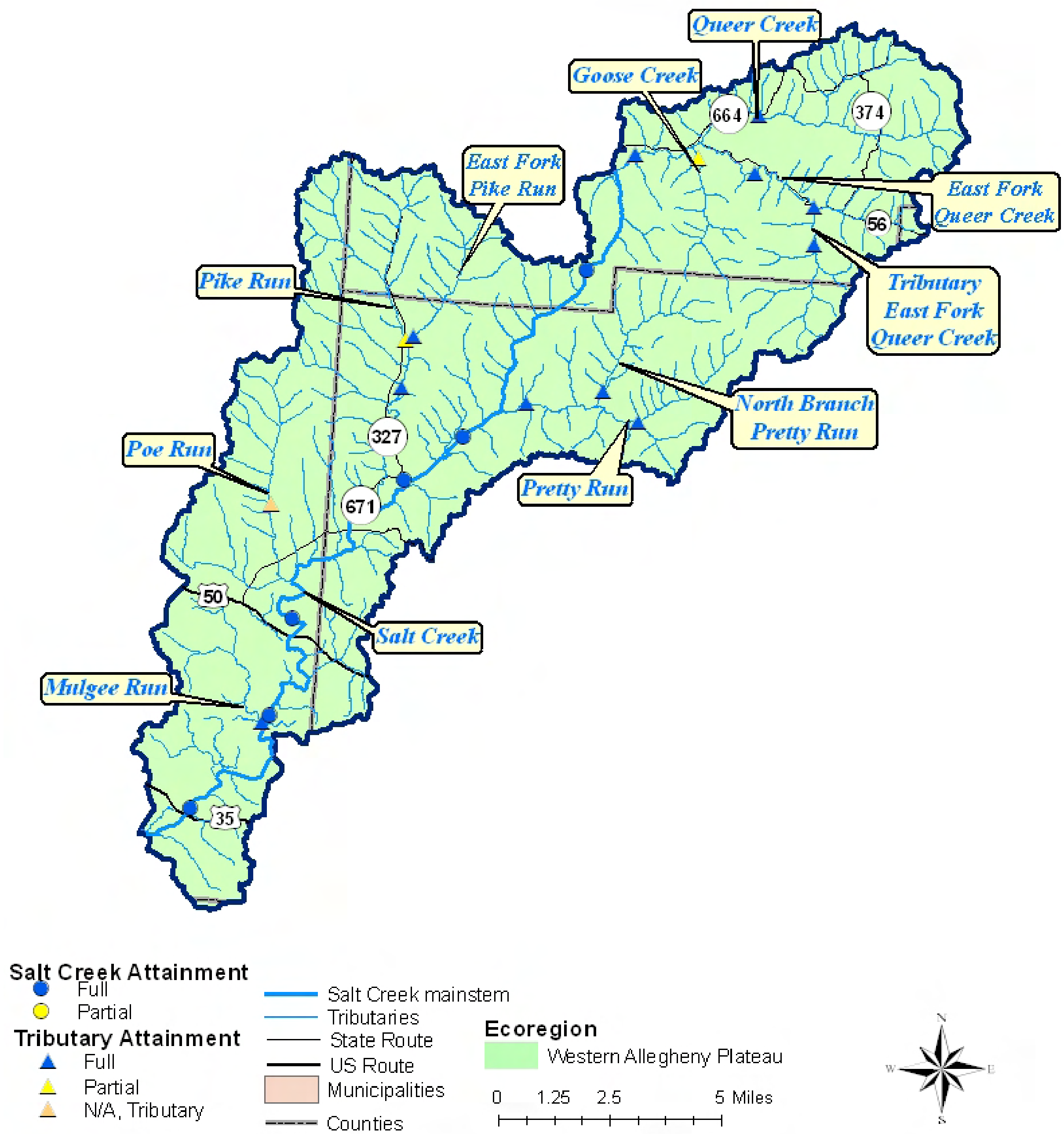


Figure 49. Attainment status of sampling locations within the lower Salt Creek basin based on 2005 data.

Table 34. Aquatic life use attainment status for stations sampled in the Salt Creek basin based on data collected June-October 2004 and July-October 2005. 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 to support a biotic community.

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/Comments
Salt Creek		*WAP Ecoregion - EWH Existing*					
23.0[W]/22.8	52	10.0	46	72.5	FULL		
17.4[W]	54	9.8	42[NS]	71.5	FULL		
15.2[W]/15.7	55	9.3[NS]	52	62.0	FULL		
9.9[W]/9.8	54	9.9	52	78.0	FULL		
5.9[W]	55	9.9	42[NS]	70.0	FULL		
1.5[W]	50	10.8	48	72.0	FULL		
Queer Creek (Trib to Salt Creek at RM 25.40)					*WAP Ecoregion - EWH Existing and CWH Recommended*		
4.4[H]	54	N/A	E	65.0	FULL		
					WAP Ecoregion - EWH Existing		
0.8[W]	58	10.0	E	74.0	FULL		
East Fork (Trib to Queer Creek at RM 2.57)					*WAP Ecoregion - EWH Existing and CWH Recommended*		
3.9[H]	52	N/A	E	52.5	FULL		
1.7[H]	54	N/A	44[NS]	72.5	FULL		
Trib to East Fork Queer Creek at RM 3.95					*WAP Ecoregion - Undesignated / CWH Recommended*		
0.9[H]	54	N/A	G	53.5	FULL		
Goose Creek (Trib to Queer Creek at RM 2.35)					*WAP Ecoregion - WWH Existing / EWH and CWH Recommended*		
0.4[H]	56/56	N/A	G/G*	69.5	FULL/ PARTIAL	Unknown (natural)	
Pretty Run (Trib to Salt Creek at RM 18.55)					*WAP Ecoregion - EWH Existing and CWH Recommended*		
3.5[H]/3.8	46[NS]	N/A	VG[NS]	45.0	FULL		

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status[c]	Causes	Sources/Comments
					WAP Ecoregion - EWH Existing		
0.7[H]	54	N/A	VG[NS]	60.0	FULL	Siltation, loss of trees in riparian corridor	Channelization, driving in stream channel
North Branch (Trib to Pretty Run at RM 2.35)					*WAP Ecoregion - WWH Existing / CWH Recommended*		
0.4[H]	54/54	N/A	MG[NS]/ MG[NS]	56.5	FULL/FULL	Siltation	
Pike Run (Trib to Salt Creek at RM 14.09)					*WAP Ecoregion - WWH Existing / EWH Recommended*		
5.7[H]	54/54	N/A	G/G*	63.0	FULL/ PARTIAL	Unknown	
4.5[H]	50/50	N/A	VG/ VG[NS]	63.0	FULL/FULL		
East Fork (Trib to Pike Run at RM 5.60)					*WAP Ecoregion - WWH Existing*		
0.2[H]	52	N/A	G	58.5	FULL		
Poe Run (Trib to Salt Creek at RM 11.51)					*WAP Ecoregion - EWH Existing*		
2.1[H]/2.2	--	--	F*	-	-	Interstitial flow	Gravel removal from stream downstream from site
Mulgee Run (Trib to Salt Creek at RM 5.55)					*WAP Ecoregion - Undesignated / WWH Recommended*		
0.1[H]	46	N/A	G	68.0	FULL		

Ecoregion Biocriteria: Western Allegheny Plateau

	IBI			MIwb			ICI		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	44	50	24	N/A	N/A	N/A	36	46	22
Wading	44	50	24	8.4	9.4	4.0	36	46	22
Boat	40	48	24	8.6	9.6	4.0	36	46	22

H - Headwater site.

W - Wading site.

B - Boat site.

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

b - 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 were not available or considered unreliable due sampling constraints. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional

c - Attainment status is given for both existing and proposed use designations.

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

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

N/A – Not applicable.

Table 35. Exceedences of Ohio Water Quality Standards (WQS) criteria (OAC 3745-1) for chemical and bacterial parameters in LSCWAU found during the 2005 field season. D.O. results are presented by mg/l, pH is in S.U. and *E. coli* and fecal coliform are in cfu/100 ml. Use designations within Salt Creek basin include: Aquatic Life – Exceptional Warmwater Habitat (EWH); Coldwater Habitat; Warmwater Habitat (WWH); Agricultural Water Supply (AWS); Industrial Water Supply (IWS); Primary Contact Recreational (PCR) and State Resource Water (SRW).

Stream River mile	**(use designation) Parameter (value)**	**Biological Attainment**	**QHEI Score**
Lower Salt Creek (HUC 05060002 070)			
Salt Creek	(SRW, EWH, AWS, IWS, PCR)		
17.44	*E. coli* (141[a] and 384[b])	FULL	71.5
5.95	D.O. (4.46[c])	FULL	70.0
1.38	D.O. (4.01, 4.8[c])	FULL	72.0
Queer Creek (to Salt Creek) (EWH existing and CWH recommended)			
4.42	Fecal coliform (1901[b]), *E. coli* (1621[b])	FULL	65.0
East Fork (to Queer Creek) (EWH existing and CWH recommended)			
4.23	*E. coli* (577[b])	FULL	52.5
2.9	*E. coli* (470[b])	FULL	72.5
UT* to East Fork Queer Creek (to Queer Creek) (CWH recommended)			
0.9	pH (5.8, 5.6[d])	FULL	53.5
East Fork (to Queer Creek) (SRW, EWH, AWS, IWS, PCR; CWH recommended)			
4.23	pH (6.14[d])	FULL	52.5
2.9	pH (6.45[d])	FULL	72.5
Goose Creek (to Queer Creek) (WWH; EWH and CWH recommended)			
0.34	D.O. (4.09[c]), *E. coli* (726[b])	FULL/PARTIAL	69.5
North Branch (to Pretty Run) (WWH; EWH recommended)			
0.43	pH (6.36, 6.38[d])	FULL	56.5
Pretty Run (to Salt Creek) (EWH; CWH recommended)			
3.54	D.O. (4.01[c])	FULL	45.0
Pike Run (to Salt Cr.) (WWH; EWH recommended)			
4.46	D.O. (4.01[c])	FULL	63.0
Poe Run (to Salt Creek) (EWH, AWS, IWS, PCR			
2.12	D.O. (4.05[c])	--	--
Muglee Run (to Salt Creek) (WWH recommended)			
0.13	Fecal coliform (1390[b]), *E. coli* (1982[b])	FULL	68.0

a Exceeds the PCR 30 day geometric mean.
b Exceeds the PCR 30 day maximum.
c Below the minimum criterion for the protection of aquatic life.
d Exceeds the minimum (6.5) or maximum (9.0) criterion for the protection of aquatic life.
* UT – unnamed tributary

Table 36. Facilities regulated by an individual and general NPDES permit in LSLWAU.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River mile	Wastewater and Treatment Type
ODNR Hocking Hills SP Campground WWTP	0PP00016	UT to Queer Creek	0.4	sanitary 26,000 gpd package plant
ODNR Hocking Hills SP Cabin&Lodge WWTP	0PP00017	UT to Queer Creek	0.2	sanitary 100,000 gpd package plant
Hocking Hills Ele. School WTP	0IY00101	UT to Queer Creek	2.7	1,800 gpd drinking water treatment plant
ODNR Tar Hollow SP WWTP	0PP00037	UT to Pike Run	1.2	sanitary 12,000 gpd package plant
ODNR Hocking Hills SP Service Bldg. WWTP*	0PP00065	UT to Queer Creek	1.4	Septic tank and aeration unit

* NPDES application submitted.

Recreation Use Assessment
The main stem of lower Salt Creek is in full attainment for the recreational use designation, although, the Pretty Run Road site on Salt Creek had a water quality violation of 140.85 cfu for *E. coli* for the sampling period of June 16th through July 13th. The fecal coliform results were well below the WQS (Table 38). There is no obvious source other than this is a very popular swimming location. The unincorporated Village of Richmond Dale at Salt Creek RM 1.5 did not cause any WQS violations for fecal coliform, but two samples taken for *E. coli* were over the 126 cfu standard (Table 39).

Queer Creek RM 4.42 and Mulgee Run RM 0.13 were determined to be in non-attainment for the PCR use designation (Table 38). This was based on the 90th percentile calculation. The high bacteria results at the East Fork of Queer Creek sites and Goose Creek site exceeded the PCR for *E. coli* maximum. The primary source of bacteria at these sites is due to failing home septic systems.

Spills
Pollutant discharges from spills, overflows and other unauthorized releases can be significant sources of lethal and sub-lethal stresses to the aquatic communities in the Salt Lick watershed. Eleven spills were reported to the Ohio EPA Emergency Response Section from January 2000 through April 2007. Eight spill reports were a result of the Tar Hollow State Park WWTP. Three spills reported were petroleum related materials. No spills were reported to be associated with a fish kill.

Ecoregion, Soils and Topography
The 133 mi^2 lower Salt Creek basin lies along the western boundary of the WAP. Salt Creek downstream of Queer Creek passes through a gorge like section along Narrows Road for about four miles before entering a broad valley. The main stem valley floor is up to a mile wide, making it suitable for agricultural activities. The tributary watersheds are more typical of WAP topography with narrow valleys, steep slopes and narrow ridges.

Soils of the Western Allegheny Plateau region of the watershed are of the Shelocta, Brownsville, Latham, and Steinsburg series. The Shelocta series consists of deep and very deep, well drained, moderately permeable soils. They are on steep concave mountain sides, foot slopes, and benches, and therefore are primarily forested, with only small areas cleared for pastures or agricultural cultivation. The Brownsville series consists of deep, well drained soils found on hillsides and summits within the WAP. Due to their geographic setting, they are primarily associated with forests, though occasionally are cleared for pasture. The Latham series consists of moderately deep, moderately well drained soils found to either be located within forests of oaks and hickory species, or to have been cleared for pasture and crops of corn, wheat, and oats. Soils of the Steinsburg series are moderately deep and well drained which makes them agreeable to the primary land use of cropland and pasture. The few wooded areas present with Steinsburg soils are dominated by oak, maple and ash species (NRCS, 2004).

The predominant land use in the lower Salt Creek basin is forest (83%), which is similar to the Middle Fork Salt Creek and Salt Lick Creek basins (Table 37). The remainder is grassland/hay (6.4%), cultivated crop (5.2%), and developed (4.2%). The grassland/ hay is found in the valleys, mild slopes and some ridges. Cattle are frequently raised in the narrow valleys immediately adjacent to the streams and are not normally excluded from the streams. The cultivated crops are primarily found in the broad valley along the main stem. Salt Creek watershed from Pike Run to Salt Lick Creek is 15.5% row crops and Salt Creek watershed from Salt Lick Creek to the Scioto River is 9.5% row crops.

Table 37. Lower Salt Creek land use as derived from National Land Cover Database (NLCD 2001).

14-Digit HUC	Narrative Description	Open Water	Developed	Barren Land	Forest	Shrubs/ Scrubs	Grassland/ Hay	Cultivated Crop	Wetland	Total Acres
05060002100010	Queer Creek above E. Fk. Queer Cr.	0.2%	5.8%	0.0%	87.3%	0.0%	4.3%	2.3%	0.0%	8,582.6
05060002100020	East Fork Queer Creek	0.0%	4.3%	0.0%	89.7%	0.2%	2.6%	3.3%	0.0%	8,856.4
05060002100030	Queer Creek below E. Fk. Queer Cr. to Salt Creek	0.0%	6.3%	0.0%	89.8%	0.0%	2.6%	1.2%	0.0%	4,993.9
05060002100040	Salt Creek below Queer Cr. to above Pike Run [except Pretty Run]	1.3%	2.8%	0.1%	88.1%	0.0%	4.4%	3.4%	0.0%	10,829.3
05060002100050	Pretty Run	0.0%	5.0%	0.0%	92.3%	0.0%	1.5%	1.2%	0.0%	11,267.8
05060002100060	Pike Run headwaters to below Tar Hollow Cr.	0.3%	5.1%	0.0%	94.0%	0.0%	0.6%	0.0%	0.0%	4,038.7
05060002100070	Pike Run below Tar Hollow Cr. to Salt Cr.	0.1%	3.8%	0.0%	88.6%	0.0%	3.7%	3.8%	0.0%	10,958.2
05060002100080	Salt Creek below Pike Run to above Salt Lick Cr. [except Poe Run]	0.9%	5.5%	0.0%	60.2%	0.0%	17.8%	15.5%	0.0%	12,444.5
05060002100090	Poe Run	0.2%	2.9%	0.0%	82.2%	0.0%	7.8%	6.9%	0.0%	6,921.6
05060002100100	Salt Creek below Salt Lick Cr. to Scioto River	1.5%	6.3%	0.6%	66.4%	1.5%	14.2%	9.5%	0.0%	6,289.3
Lower Salt Creek aggregate		0.5%	4.2%	0.1%	83.0%	0.1%	6.4%	5.2%	0.0%	85,182.2

Chemical Water Quality and Sediment Quality

Salt Creek

The lower section of Salt Creek starts at the confluence of Salt creek and Queer Creek, at RM 25.4 in Salt Creek Township and joins the Scioto River at RM 51.10. LSCWAU drains approximately 553 square miles, including upper Salt Creek, Salt Lick Creek and Middle Fork of Salt Lick Creek. Salt Creek is designated as an Outstanding State Water based on exceptional ecological values as promulgated in OAC 3745-1-05. Five main stem sites were sampled to evaluate chemical, biological and bacterial conditions.

The entire LSCWAU is located in the WAP ecoregion. Beginning at the confluence with Queer Creek, Salt Creek enters a recent, long narrow breach in the Appalachian hills. Salt Creek stream valley then widens into broad rolling agricultural fields. Datasonde© continuous monitors were deployed from June 21st through 23rd 2005 and recorded hourly D.O. concentration, D.O. percent saturation, temperature, pH and conductivity for five sites in LSCWAU. A summary of the data is presented in Figure 51 and Table 40. All Datasonde© D.O. concentrations remained above the applicable any time minimum water quality criteria (4.0 mg/l for WWH and 5.0 mg/l for EWH) and the minimum 24-hour average criteria (5.0 mg/l for WWH and 6.0 mg/l for EWH). Typically, lower D.O. values were recorded during the night when algal respiration uses dissolved oxygen.

At the Pretty Run Road site, (Salt Creek RM 17.4), the D.O. fluctuations were not extreme with a 2.73 mg/l swing over the recording period. The D.O. saturation reached the lower range of the lethality level at 118%. But the over-all range was 76% to 118%. This does indicate a supersaturation condition. This segment has a lower gradient than the narrows section and may have been channelized to accommodate agriculture. These factors may exacerbate the D.O. fluctuation. At the Main Case Road site in the Village of Richmond Dale (Salt Creek RM 1.5) the D.O. fluctuation was 2.18 mg/l over the sampling period. The D.O. saturation level was not recorded.

Throughout the main stem of lower Salt Creek iron and manganese are below the target levels of 745 mg/l and 150 mg/l, respectively, for small rivers. Acidity was below detectable levels and pH was within the WQS range. TKN and phosphorus remain below target levels throughout the main stem. Ammonia increased above the target level of 0.05 mg/l at RM 5.95 and RM 1.5 possibly due to agricultural influences (Figure 52).

The unincorporated Village of Richmond Dale is an unsewered community located at Salt Creek RM 1.5. Richmond Dale has formed a sewer district and has applied for a NPDES permit. Richmond Dale will need to secure funding to install sewers and a WWTP. Sample results from Richmond Dale show that home sewage systems are discharging sewage to drainage ditches and storm sewers (Table 39).

Organic water column compound samples were collected at RMs 1.38 and 23.0. The samples were analyzed for volatile and semivolatile organic compounds, pesticides, and herbicides. Most results were below laboratory detectable levels. Those parameters detected are in Table 41. Very low levels of herbicides and pesticides were detected, but no WQS violations were observed (Table 40).

Sediment samples were collected at four Salt Creek main stem sites during the 2005 field season. The sediment samples, within the Salt Creek survey, were analyzed for metals, ammonia and phosphorus. The results show that arsenic was above the Threshold Effect Concentration at RM 9.9, 5.9 and 1.5 (Table 42).

Queer Creek

The Queer Creek watershed drains 35 square miles. Queer Creek is listed as a SHQW in the OAC 3745-1-05. The watershed is heavily forested and sparsely populated.

Hocking Hills State Park is located in the upper portion of Queer Creek. The park encompasses 2356 acres and operates a 169 site campground with shower/toilet facilities going to a WWTP. The park also has 40 cabins and a restaurant lodge connected to an additional WWTP. Both waste water treatment plants have had numerous effluent violations, mostly for ammonia. The Division of Parks has received permits for the installation of flow equalization and UV disinfection at both of Hocking Hills State Park's WWTP. Installation of these two treatment units should correct these problems.

The failing house sewage systems may be the leading cause of the higher than target values for ammonia in Queer Creek (Figure 53). Due to the hilly terrain and thin soils, non-discharging home septic systems are hard to install.

East Fork

The East Fork of Queer Creek watershed drains 13.74 square miles. East Fork is listed as a SHQW in the OAC 3745-1-05. The watershed is heavily forested and sparsely populated (Figure 50). The elevated ammonia level may be due to the lack of assimilative capacity of the stream along with failing home septic systems (Figure 53). Datasonde© continuous monitors were deployed from June 21st through 23rd 2005 and

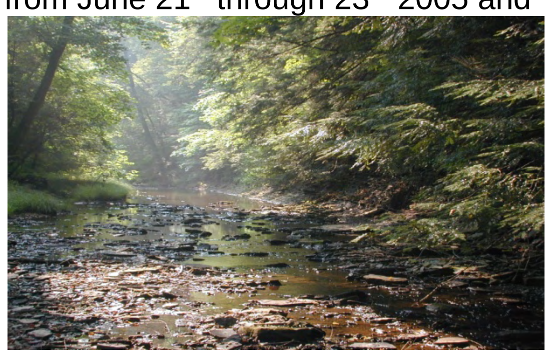


Figure 50. East Fork upstream of sampling site.

recorded hourly D.O. concentration, D.O. percent saturation, temperature, pH and conductivity. A summary of the data is presented in Figure 51 and Table 39. All Datasonde© D.O. concentrations remained above the applicable any time minimum water quality criteria (4.0 mg/l for WWH and 5.0 mg/l for EWH) and the minimum 24-hour average criteria (5.0 mg/l for WWH and 6.0 mg/l for EWH).

Unnamed tributary to East Fork of Queer Creek
Low pH was observed during the 2005 field season in the UT to East Fork of Queer Creek. This may be due the sandstone geology.

Goose Creek
The Goose Creek watershed drains 4.7 square miles. The watershed is heavily forested and sparsely populated. Low D.O. and high bacterial results are due to failing home septic systems along the stream.

Pretty Run
The Pretty Run watershed drains 17.64 square miles. Pretty Run is listed as a SHQW in the OAC 3745-1-05. The watershed is heavily forested and sparsely populated. One D.O. WQS exceedence was observed during the 2005 field season. Ammonia levels for Pretty Run were primarily at the target values (Figure 54).

North Branch
The North Branch of Pretty watershed drains 1.2 square miles. Two low pH observations were made during the 2005 field season. This may be due to the sandstone geology.

Pike Run
The Pike Run watershed drains 23 square miles. The watershed is heavily forested in the head waters and valley hills and is sparsely populated. Near the mouth the valley broadens into a flat flood plain. No water quality concerns were noted except a single D.O sample 4.46 mg/l, which may be due to low flow conditions.

Tar Hollow State Park is in the headwater portion of the watershed and has a campground, general store and park managers residence/office that are connected to a WWTP discharging to an unnamed tributary to Pike Run. The WWTP has had effluent violations but does not appear to be affecting the main stem.

East Fork
The East Fork of Pike Run watershed drains 5.04 square miles. The watershed is heavily forested in the head waters and valley hills and is sparsely populated. No water quality issues were observed during the 2005 field season.

Poe Run
The Poe Run watershed drains 10.74 square miles. The watershed is heavily forested in the head waters and valley hills and is sparsely populated. No water quality concerns were noted except a single D.O sample 2.12 mg/l, which is due to low flow conditions. After mid-July, during the field sampling season, the bridge sampling site was mined for gravel. This completely disturbed the stream bed and no flowing water was observed for the rest of the sampling season.

Mulgee Run
The Mulgee Run watershed drains 5.2 square miles and is listed in the WAP ecoregion although the watershed geology is an Illinioan glacial outwash. Nutrient results were typically at or above target values. This is due to the sampling site being located just downstream from a discharging home septic system.

Figure 38. Summary of bacteria data for the lower Salt Creek sites (HUC 100). Values are based on comparison of the geometric mean and 90th percentile values to the PCR criteria in OAC 3745-1-07. The bold values exceed PCR maximum. All values in colony forming units (cfu) per 100 ml of water.

		Geometric Mean		90th Percentile		Potential Causes
Stream	**River Mile**	**Fecal coliform**	***E. coli***	**Fecal coliform**	***E. coli***	
Salt Creek	22.6	145	33	230	82	
Salt Creek	17.44	311	**141**	518	**384**	HS, Ag
Salt Creek	9.1	109	81	282	170	
Salt Creek	6.0	270	105	326	176	
Salt Creek	1.38	168	91	276	270	
Queer Creek	4.42	481	134	**1901**	**1621**	HS
Queer Creek	0.82	510	1900*	1190	1900*	HS
E.F. Queer Cr.	4.23	433	251	700	**577**	HS
E.F. Queer Cr.	2.9	194	88	493	**470**	HS
UT E.F. Queer Creek	0.9	87	220*	175	220*	
Goose Creek	0.34	276	666	863	**726**	HS
Pretty Run	3.54	14	10*	19	10*	
Pretty Rin	0.68	132	44	232	172	
North Branch	0.43	57	39	102	48	
Pike Run	5.72	385	117	539	213	
Pike Run	4.46	287	187	510	273	
East Fork	0.19	319	220	336	228	
Poe Run	2.12	202	80	318	170	
Mulgee Run	0.13	2929	3230	**1390**	**1982**	HS

* One sample evaluated.
HS – Home Septic; Ag – Agricultural Practices

Table 39. Samples taken within the Village of Richmond Dale.

Date	Location	TOC	COD	Fecal colifom
May 26, 2004	SE corner Church & Jackson St.	----	----	44,000
May 26, 2004	Manhole @ Main & Water St.	<2.0	<10	4,000
May 26, 2004	Discharge pipe off Water St.	15	54	92,000
May 26, 2004	Manhole @ Sevan Hardesty property	2.3	<10	700
May 26, 2004	Drainage ditch @ Main St. and SR 35	6.9	14	2,000

Table 40. Summary of hourly dissolved oxygen measurements (mg/L) recorded by continuous monitors in the lower Salt Creek.

Stream	River Mile	Hours	Mean	Median	Minimum	Maximum
June 21 - 23, 2005						
Salt Creek	17.4	44	7.62	7.37	6.53	9.26
Salt Creek	1.38	48	8.05	8.26	6.81	8.99
East Fork Queer Creek	2.8	45	6.02	6.08	4.94	6.61

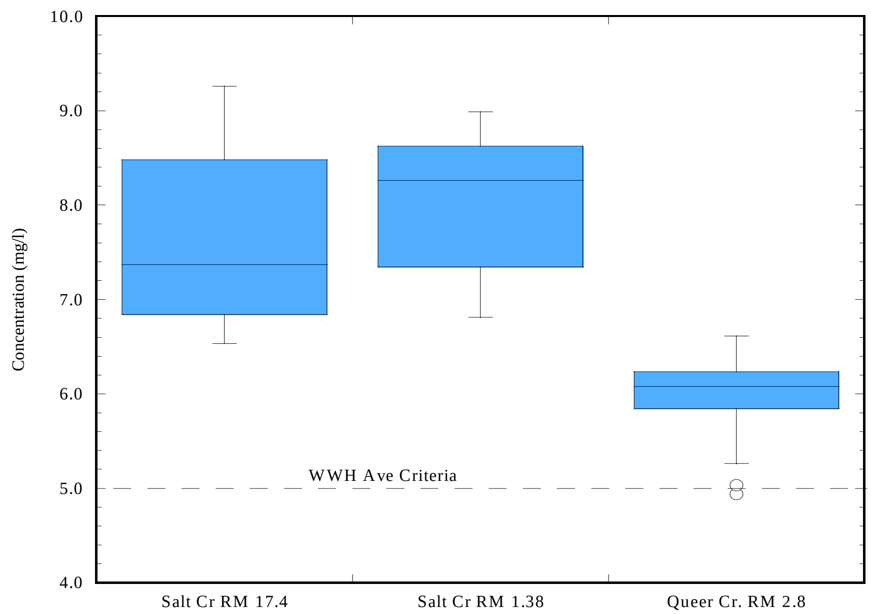


Figure 51. Box plot of hourly dissolved oxygen measurements from lower Salt Creek and Queer Creek collected June 21-23, 2005. Aquatic life warmwater habitat water quality criteria are 4 mg/l minimum and 5 mg/l average.

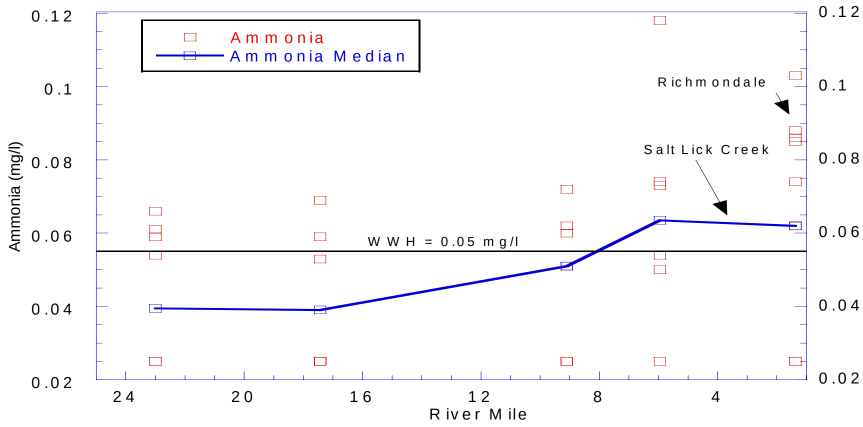


Figure 52. Ammonia concentration values in Salt Creek. One sample at Richmond Dale was 0.95 mg/l (included in median calculation only). The WWH target value is noted for the WAP ecoregion small rivers (Ohio EPA, 1999).

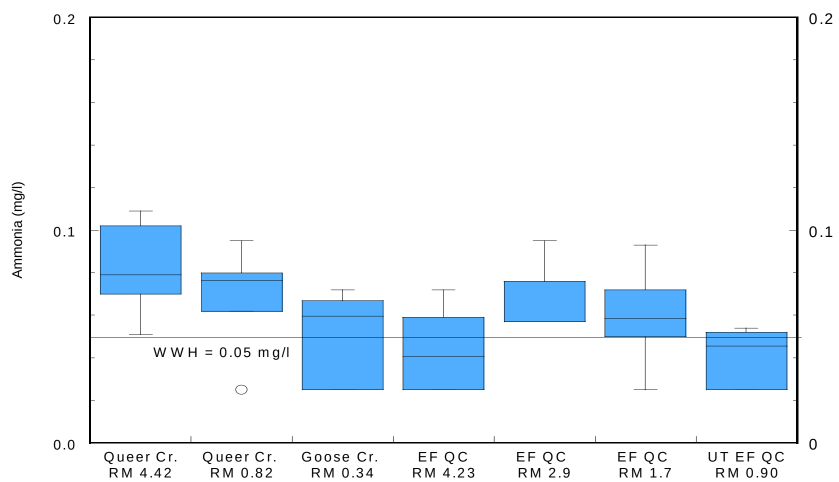


Figure 53. Ammonia concentration values in Queer Creek and tributaries Goose Creek, E. Fork of Queer Creek (EF QC) and UT to East Fork of Queer Creek during the 2005

field season. The WWH target values are noted for the WAP ecoregion headwater and wadeable streams (Ohio EPA, 1999).

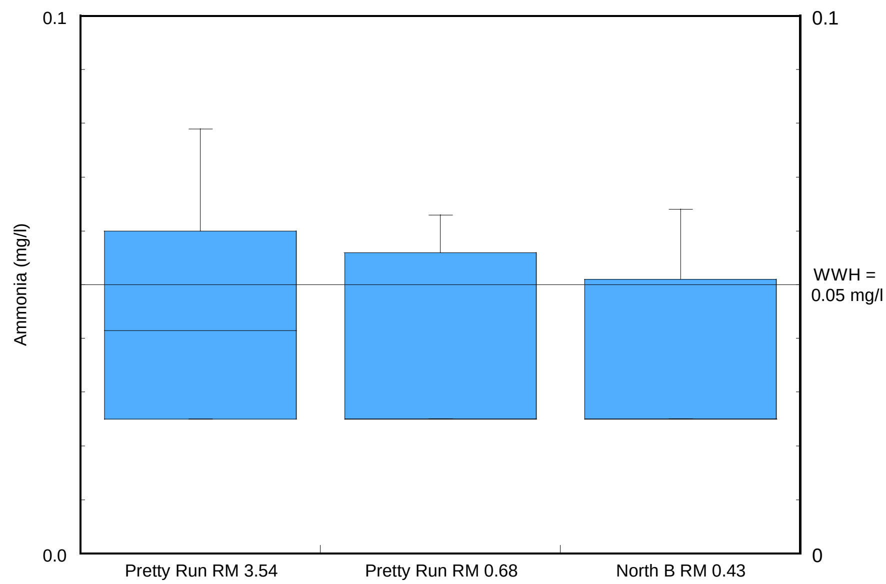


Figure 54. Ammonia concentration values in Pretty Run and tributary Middle Branch during the 2005 field season. The WWH target values are noted for the WAP ecoregion headwater and wadeable streams (Ohio EPA, 1999).

Table 41. Organic chemical compounds detected in stream samples collected by Ohio EPA from the Lower Salt Creek, 2005 (units in ug/l).

Salt Creek	
River Mile 1.38	
Semivolatiles-Herbicides	
Atrazine (AAtrex)	0.26
bis(2-Ethylhexl)phthalate	0.53
Metolachlor (Dual)	0.2
Nonanal	0.3
Benzoic Acid	0.3
Nonanoic acid	0.7
Phenol, 2,6-dibromo-	0.6
Hexadecanoic acid	0.4
Octadecanoic acid	0.3
Pesticides	
Aldrin	0.0021
α-BHC	0.00031
δ-BHC	0.0035
γ-BHC	0.0032
Heptachlor epoxide	0.00029

Salt Creek	
River Mile 23	
Semivolatiles-Herbicides	
Atrazine (AAtrex)	0.3
Phenol, 2,6-dibromo-	0.3
Ethanol, 2-[2-[4-(1,1,3,3-tetramethylbutyl) phenoxy]ethoxy]	0.3
Pesticides	
α-BHC	0.003
δ-BHC	0.0028
γ-BHC	0.0025

Trade names in parenthesis.
BHC – benzene hexachloride has several stereoisomeric derivatives of which gamma-BHC or γ-BHC (Lindane) is i n common use. Alpha-BHC (α-BHC) and delta-BHC (δ-BHC) are manufacturing by-products with no agricultural use.

Table 42. Chemical compounds detected in sediment samples collected by Ohio EPA from the Lower Salt Creek, 2005.

Stream Segment	**Salt Creek**	**Salt Creek**	**Salt Creek**	**Salt Creek**
River Mile	**17.4**	**9.2**	**5.9**	**1.5**
PARAMETER	**Sample Results**			
Aluminum	12900	11700	13800	23200
Arsenic	9.51	10.8 [TEC]	10.8 [TEC]	11.7 [TEC]
Barium	85.8	90.6	102	148
Cadmium	0.103	0.141	0.141	0.192
Calcium	9180	7980	7340	5980
Chromium	15	16	17	24
Copper	4.7	5.5	5.4	9.5
Iron	13100	14500	14100	18500
Lead	17	22	18	25
Magnesium	3940	3720	3730	4450
Manganese	303	458	330	635
Mercury	0.024	0.026	0.027	0.034
Nickel	17	22	18	25
Potassium	3040	2850	3280	5110
Selenium	0.85	1.09	0.92	1.24
Strontium	20	18	20	28
Zinc	34.9	40.8	41.7	68.6
% Solids*	72.3	73.3	71.3	63.2
Ammonia*	28	15	15	17
Sodium*	2130	2730	2300	3100
%TOC*	1	1	0.8	1.3
Total Phosphorus*	165	229	267	280

All parameters in mg/kg except %.
[TEC] Value above the threshold effect concentration (MacDonald *et al.* 2000).
Underlined values indicate concentrations below method detection limit.
* Does not have SRV (sediment reference value) or TEC association.

Physical Habitat

The physical habitat of 19 locations within the lower Salt Creek basin was evaluated with the QHEI (Figure 57). All sites >10 mi^2 drainage area scored within the good to very good range. Five of the eight sites <10 mi^2 drainage area scored within the fair range while the rest scored within the good range. This is the only basin within the entire Salt Creek watershed that did not have any sites score below the fair category, indicating that there is potentially less habitat disturbance occurring in this portion of the watershed than the other basins.

QHEI scores for tributary streams ranged from 45.0 to 74.0 with an average QHEI score of 61.6. The tributary sites that scored in the fair range received habitat impacts primarily from channel modifications associated with roadway improvements, gravel mining and riparian removal. A higher range of scores were recorded for the Salt Creek main stem, with QHEI scores ranging from 62.0 to 78.0 with an average QHEI score of 71.0. The common habitat features associated with this portion of the Salt Creek main stem included adequate amounts of diverse instream cover, a variety of substrates with low amounts of embeddedness, and diverse flow regimes. The combination of these factors with mixed intensity land use and riparian buffers provided a consistent level of quality habitat for aquatic life.

Pike Run

The physical habitat of Pike Run was evaluated just south of Jimtown along State Route 327 (RM 5.7) and east of State Route 327 downstream of Conway Hollow adjacent to Pike Run Mud Bog (RM 4.5). The streambed appeared to originate from a combination of sandstone and shale in the upper reach with gravel as the dominant substrate present. Cobble, sand and silt also provided substrate habitat along the stream bottom. The silt noted along the streambed was present in moderate amounts and moderately embedded the other substrates. Moderate amounts of instream cover was provided by overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads, and woody debris. No evidence of channelization was apparent, though the stream exhibited low sinuosity with poor to fair channel development and moderate stability. Current flowed only in a slow manner, as no riffles or runs were present. The right descending bank partially bordered a treed hillside, providing a moderate (10-50 m) riparian corridor along that side. However, no riparian buffer was present along the left descending bank adjacent to residential homes.

The lower reach of Pike Run originated from sandstone and sand was the predominant substrate present, though areas of cobble and gravel were also noted. Moderate amounts of silt resulted in moderately embedded substrates. Instream cover was provided by moderate amounts of undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads and woody debris. Evidence of gravel removal by heavy machinery was noted within the stream channel, and several cars had been placed along the left descending bank (Figure 55). Despite these alterations,

Figure 55. Cars placed along Pike Run RM 4.5. The cars were placed there to prevent the banks from further eroding. However, this is not a stable form of stream bank protection.

the stream exhibited moderate sinuosity with good channel development, though stability was low. One small riffle was observed, but otherwise the channel was primarily a combination of pool and glide habitat. The lack of riparian buffers along the left descending bank likely contributed to the moderate erosion noted. Some moderate (10-50 m) buffers were noted along the right descending bank, though several areas were mowed up to the stream edge. The combination of multiple instream cover types but poor variation of flow resulted in QHEI scores of 63.0 for both sites along Pike Run.

East Fork Pike Run

The physical habitat of East Fork Pike Run was sampled along County Road 12E near power lines (RM 0.2). The streambed appeared to originate from sandstone, as sand and gravel were the dominant substrate types present, though areas of cobble were also noted. Moderate amounts of silt were present, likely exacerbated by heavy equipment which was noted by various tracks within the stream channel. Moderate amounts of instream cover was provided by undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads and woody debris. A large amount of trash including tires and scrap wood from dumping was also observed. Evidence of recent channel modifications, possibly some filling and reshaping, was noted in the downstream portion of the site. Overall, the stream exhibited low to moderate sinuosity with fair development and low stability. The non-existent to very narrow (<5 m) riparian buffers combined with the channel reshaping activities likely contributed to the moderate amounts of erosion noted along each stream bank. Slow to moderate stream flow and moderately stable riffles did provide some variety of condition for aquatic organisms. The QHEI score for the East Fork Pike Run was 58.5.

Pretty Run

The physical habitat of Pretty Run was sampled in two locations. The upper reach was sampled near County Road 17 (RM 3.5) while the lower reach was sampled near McGee Road (RM 0.7). The streambed of the upper reach was derived from sandstone with gravel as the main substrate type interspersed with areas of cobble, sand and bedrock. Silt and embedded substrates were present in normal amounts, allowing adequate interstitial spaces for aquatic life. However, recent gravel mining activities had demolished instream channel conditions (Figure 56). Sparse amounts of instream habitat consisted of undercut banks, overhanging vegetation, shallows, occasional rootwads and woody debris. Low sinuosity, poor channel development and low channel stability characterized the physical conditions of the stream channel. A new field mowed up to either stream bank was present along most of the upper reach, however, a wide (>50 m) riparian buffer was present along a portion of the right descending bank.

Figure 56. Evidence of gravel mining in Pretty Run**.**

The lower reach of Pretty Run (RM 0.7) also originated from sandstone, but was dominated by a mixture of cobble and gravel with areas of boulders, silt and sand. Moderate amounts of silt were present, though substrates appeared to be embedded in normal amounts. Sparse amounts of instream cover was provided by overhanging vegetation, shallows, deep pools (>70 cm), rootwads, boulders, and woody debris. This portion of the stream had not recovered from past channelization activities as low sinuosity, poor to fair development and moderate stability were noted. Row crops extended up to the stream bank along both banks except where an old field provided a narrow (5-10m) buffer along a portion of the left descending bank. The highly modified conditions of the upper reach resulted in a QHEI score of 45.0, while the lower reach received a QHEI score of 60.0.

Queer Creek
The physical habitat of Queer Creek was evaluated as it flowed through forests along Steele Road (RM 4.4) and through forests and a mowed pipeline easement along Thomas Road (RM 0.8). The streambed appeared to have originated from sandstone. Gravel and sand were the predominant substrates present though areas of cobble, hardpan, and silt were also noted. Undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads and woody debris provided moderate amounts of instream cover. The upper reach appeared to have recovered from past channelization with low sinuosity, fair development and moderate to high stability. The upper reach appeared recently modified within the pipeline easement where the stream bank was severely eroding. Away from the pipeline easement, the stream channel exhibited high sinuosity with good development though still low stability. QHEI scores

for Queer Creek increased in a downstream direction from 65.0 near Steele Road (RM 4.4) to 74.0 near Thomas Road (RM 0.8). Historical habitat evaluations indicate that habitat integrity has decreased in the upper reach while it has remained stable in the lower reach. The upper reach received a QHEI of 73.0 in 1992, eight points higher than the 65.0 received in 2005. Increased siltation and erosion with a reduction in riparian buffer along the right descending bank contributed to the drop in overall habitat quality. In contrast, the site near Thomas Road received a QHEI of 73.5 in 1992, just a 0.5 point difference from the 74.0 received in 2005. The consistent quality of the habitat over time is also reflected in the IBI scores for the fish community, which showed only a 2 point change over time.

Goose Creek

The physical habitat of Goose Creek was evaluated along Goose Creek Road (RM 0.4). The streambed appeared to have originated from sandstone. Gravel was the dominant substrate type though it was intermixed with boulders, cobble, silt, sand and bedrock. Surprisingly, the moderate to heavy amounts of silt present resulted in only normally embedded substrates. Undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads, boulders and logs with woody debris provided moderate amounts of instream cover to aquatic organisms. No evidence of channelization was apparent as moderate amounts of sinuosity with fair to good development and moderate stability were observed. A forest provided a wide (>50 m) buffer along the left descending bank below residential homes with very narrow (<5 m) buffers. A residential home along the right descending bank had a lawn mowed up to the stream bank. No buffer was present. Along the right descending bank downstream of Goose Creek Road, a mowed field with a dirt and gravel parking area appeared to be used to store heavy equipment. Several piles of concrete and loose dirt were noted adjacent to the stream and parking area. The combination of diverse substrates and instream cover resulted in a QHEI score of 69.5 for Goose Creek.

East Fork Queer Creek

The physical habitat of East Fork Queer Creek was sampled near State Route 56 (RM 3.9) and along Deep Woods Farm off of State Route 56 (RM 1.7). Sandstone was the substrate of origin at both locations, though shale was also present at the downstream location. The streambed at the upstream site was dominated by gravel intermixed with cobble and sand. Silt and embedded substrates were present in normal amounts. Extremely low flow was noted at the upstream site and only sparse amounts of instream cover was provided by overhanging vegetation, shallows, rip-rap, and woody debris. Recent bridgework had modified the stream channel, though it still exhibited moderate sinuosity and high stability further away from the bridge. Instream development was poor, as no riffles or runs were present, though this may be partially attributed to the low flow conditions. A forest extended along either side of the stream both upstream and downstream of the bridge, though a significant area on either side of the bridge had been cleared of trees leaving no riparian buffer.

Similar to the upper reach, the lower reach of East Fork Queer Creek was surrounded by forest which provided a dense riparian cover along most of the area. A pipeline easement did cross the stream upstream of the sampling location, and the buildings associated with Deep Woods Farm were located >400 m from the right descending bank. Sand and bedrock were the dominant substrates present with areas of boulder, cobble and gravel also noted. Silt and embedded substrates were present in normal amounts. Moderate amounts of instream cover was provided by undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70 cm), rootwads, boulders, and woody debris. The stream appeared free from channelization activities with low sinuosity, good channel development and moderate stability. The combination of dense riparian cover and natural channel morphology in the lower reach resulted in a QHEI score of 72.5. In contrast, the upper reach received a QHEI score of 52.5 due to the sparse amounts of instream cover and poor instream development.

Historical habitat evaluations of East Fork Queer Creek occurred near RM 2.8 in 1999 and RM 0.3 in 1992. Though neither site was repeated in 2005, habitat scores, a QHEI of 78.0 at RM 2.8 and a QHEI of 74.5 at RM 0.3, are similar to that of RM 1.7 (QHEI=72.5). This would seem to indicate that habitat integrity has been maintained in East Fork Queer Creek over time.

Tributary to East Fork Queer Creek (RM 4.26)

The physical habitat of the tributary to East Fork Queer Creek (RM 4.26) was evaluated near Amerine Road (RM 0.9). Tills and sandstone were the originating streambed materials with sand and gravel dominating the substrates though areas of cobble were also noted. The stream was aesthetically pleasing with a large natural rock face wall along the right descending bank, though the channel appeared to be recovering from channelization activities associated with development of a road adjacent to it, as low sinuosity with fair to poor channel development and low stability was observed. Sparse amounts of instream cover consisted of undercut banks, shallows, rootmats, deep pools (>70 cm) and occasional woody debris. No riparian buffer was present along the left descending bank as mowed grass extended to the road beyond which land use was a mixture of forest and residential homes. The natural rock face wall along the right descending bank extended into a forested area. The mixture of land use and poor channel development resulted in a QHEI score of 53.5.

Mulgee Run

The physical habitat of Mulgee Run was evaluated near Francis Lane (RM 0.1). The streambed appeared to originate from sandstone with a mixture of sand and cobble dominating the streambed materials present. Hardpan and gravel were also present. Silt and embedded substrates were present in normal amounts by which aquatic organisms were able to utilize interstitial spaces. Moderate amounts of instream cover were provided by undercut banks, overhanging vegetation, shallows, rootmats, rootwads, and woody debris. No evidence of channelization was observed as the stream exhibited moderate to high sinuosity, fair to good development and low stability. Very narrow (<5 m) riparian buffers extended to a mixture of land use including row crops, forest and a residential home. Riffles appeared young and unstable, though many did contain some cobble. Currents varied from slow to moderate and fast, combining with the instream cover to provide numerous niches for fish. The QHEI score for Mulgee Run was 68.0.

North Branch Pretty Run
The physical habitat of North Branch Pretty Run was evaluated near Macedonia Road (RM 0.4). Silt was the predominant substrate present though areas of gravel were also noted. The heavy silt moderately embedded the substrates, though areas of clean gravel were observed. Moderate amounts of algae, indicating potential nutrient enrichment, were noted in several areas. Undercut banks, overhanging vegetation, shallows, rootmats, rootwads and woody debris provided moderate amounts of instream cover for aquatic life. ATV tracks were noted throughout the stream reach and trash dumping was noted in the upper portion of the stream. The lower portion of the stream appeared to be recovering from past channelization while recent gravel mining had modified the channel morphology in the upper portion of the stream. A wide riparian corridor extended into forests along each descending bank except where residential homes with narrow buffers were present. The mixture of abundant instream cover and modified stream morphology resulted in a QHEI score of 56.5.

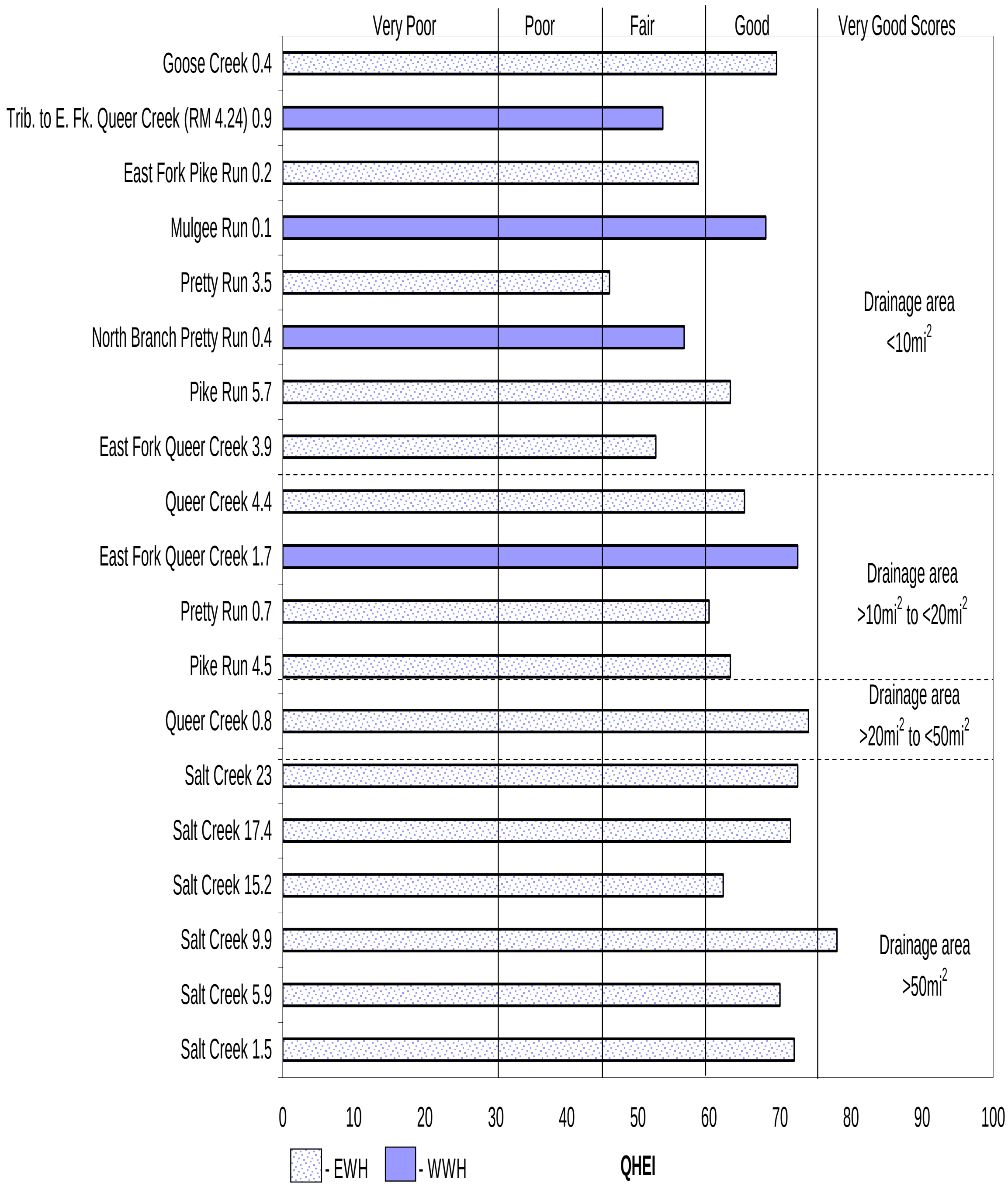


Figure 57. QHEI scores by drainage area for streams within HUC 05060002100.

Biological Assessment: Fish

The fish communities of 19 locations within the lower Salt Creek basin were sampled during 2005. As Figure 58 shows, the fish communities for the six Salt Creek main stem sites performed within or above EWH expectations. Tributary streams showed a similar pattern, with all sites performing within or above EWH expectations. The two sites with the lowest IBI scores (Mulgee Run RM 0.1 and Pretty Run RM 3.5) still met EWH expectations. The lower IBI score at Pretty Run RM 3.5 is likely attributable to the less than ideal habitat conditions discussed above. Steps should be taken to eliminate gravel mining and other habitat perturbations in Pretty Run, as a downward trend in fish community integrity has been noted over time. Mulgee Run is likely strongly influenced by the Salt Creek main stem.

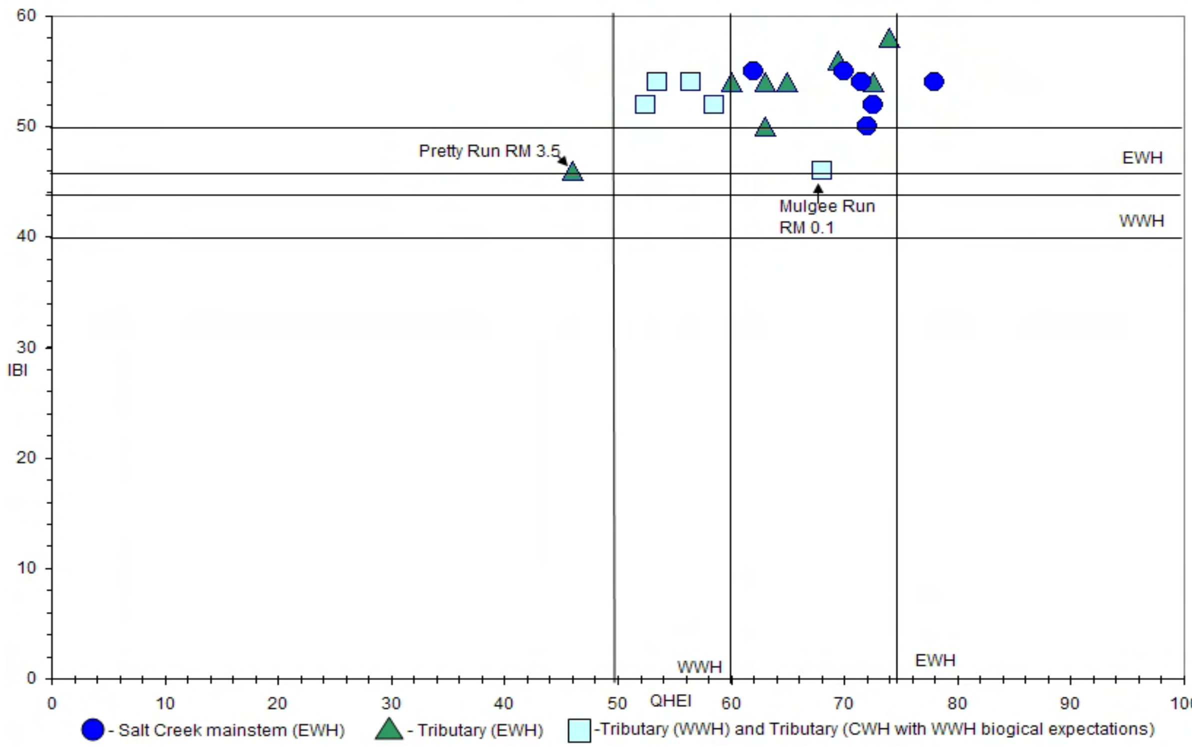


Figure 58. IBI score by QHEI for lower Salt Creek, HUC 05060002100.

Salt Creek

The fish community of the lower 23 miles of Salt Creek was evaluated in six locations. IBI scores ranged from 50 to 55 (average of 53.3) demonstrating the strong integrity of Salt Creek. MIwb scores corroborated with the IBI, with a range of scores from 9.3 to 10.8 (average of 10.0). Tolerant fish comprised <10% of the fish community at each site except for the most downstream site near Richmond Dale (RM 1.50) which was still comprised of only 14% tolerant species. Insectivorous fish species comprised >55% of the fish communities at each site, reconfirming the strong integrity of Salt Creek and the appropriateness of the EWH designation.

Queer Creek

The fish community of Queer Creek was evaluated as it flowed through forests along Steele Road (RM 4.4) and through forests and a mowed pipeline easement along Thomas Road (RM 0.8). IBI scores increased in a downstream direction from 54 near Steele Road (RM 4.4) to 58 near Thomas Road (RM 0.8). Forty species were collected throughout Queer Creek and included the following intolerant species: black redhorse, bigeye chub, silver shiner, rosyface shiner, stonecat madtom, banded darter, and variegate darter. Coolwater species include mottled sculpin and southern redbelly dace.

Historical sampling has occurred at both sites sampled in 2005. Along Steele Road (RM 4.4) sampling occurred in 1999 and resulted in an IBI of 60. The drop to an IBI of 54 in 2005 was from a slight increased presence of omnivorous and pioneering fish and a drop in insectivorous individuals. In addition, redside dace, a coldwater species, comprised 3.6% of the relative number of individuals in 1999 but was not collected in 2005. Habitat quality also decreased from a QHEI of 73.0 in 1999 to a QHEI of 65.0 in 2005. The decrease in habitat quality is primarily a result of increased siltation and erosion and a decreased riparian width along the right descending bank. Increased siltation may limit the efficiency of sight feeding fish. The decreased efficiency could lead to an increase in omnivorous species, as increased presence of these

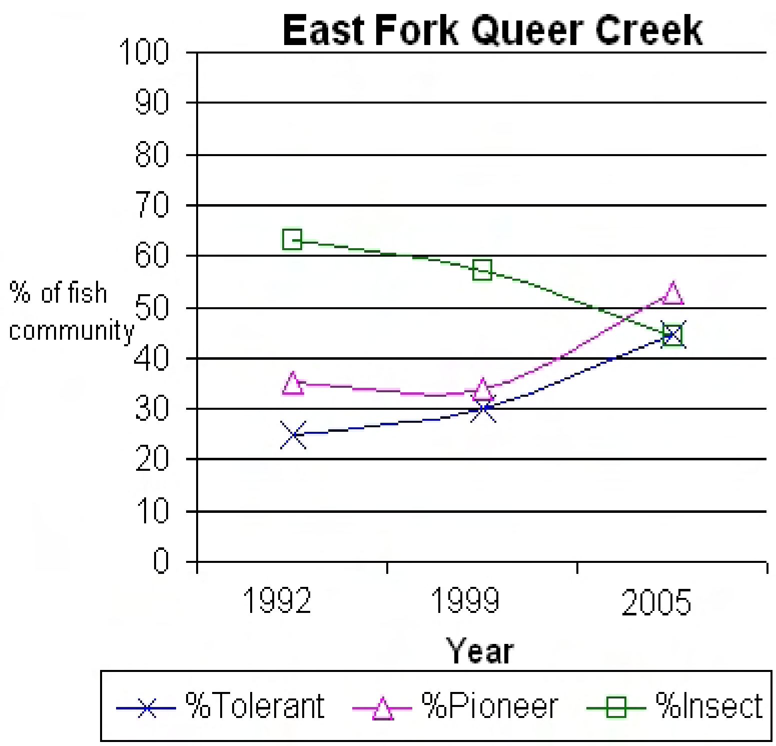


Figure 59. Metrics for %Tolerant fish, %Pioneering fish, and %Insectivorous fish over time in East Fork Queer Creek. Graph shows metric scores for RM 0.3 in 1992, RM 2.8 in 1999 and an average of RM 3.9 (one pass) and RM 1.7 (two pass) in 2005. The range of scores for the 2005 data was 41-46% for %Tolerant fish, 52-53% for %Pioneering fish, and 42-46% for %Insectivorous fish.

generalists indicates a disruption in the food base. Degraded riparian buffers may allow additional sunlight to reach the stream, thereby increasing water temperatures. Increased temperatures could negatively influence coldwater species.

Previous sampling along Thomas Road (RM 0.8) indicates consistent fish community integrity over time. In 1992, 31 species including three intolerant species were collected and resulted in an IBI of 56 and a MIwb of 9.0. Most recent sampling in 2005 showed an increase in biodiversity with 37 species collected including seven intolerant species and resulted in an IBI of 58 and a MIwb of 9.8. Consistent habitat quality and overall integrity in the lower reach is indicated by the mere 0.5 point change in QHEI score between 1992 and 2005.

East Fork Queer Creek

The fish community of East Fork Queer Creek was sampled near State Route 56 (RM 3.9) and along Deep Woods Farm off of State Route 56 (RM 1.7). Species diversity and IBI scores increased in a downstream direction from 16 (1 pass) to 30 (2 passes) species and IBI scores of 52 and 54, respectively. The lower score at the upstream location occurred due to the presence of only five sensitive species while the downstream location had an average of eight sensitive species. Coolwater species included redside dace, southern redbelly dace and mottled sculpin.

East Fork Queer Creek has been sampled historically, but not in the same locations sampled in 2005. In 1992, the stream was sampled near RM 0.3 and in 1999 it was sampled near RM 2.8. IBI scores from these time periods are similar to present conditions, with an IBI of 54 for each site. However, the presence of tolerant fish and pioneering species within communities seems to be increasing over time. This also corresponds to a decrease in insectivores (Figure 59). The increased presence of pollution tolerant individuals and pioneering fish may indicate potential anthropogenic stress, and the decreased presence of insectivorous fish indicates a potential disruption in the food base, i.e. macroinvertebrate community integrity. Care should be taken to preserve the overall integrity of East Fork Queer Creek.

Tributary to East Fork Queer Creek at RM 3.95

The fish community of the tributary to East Fork Queer Creek at RM 3.95 was evaluated near Amerine Road (RM 0.9). Twelve species including three coolwater species; redside dace, southern redbelly dace and mottled sculpin, comprised the sample collected. One pollution sensitive species, redside dace, was collected as were two moderately pollution intolerant species: scarlet shiner and rainbow darter. Overall community balance appeared stable with 28% of individuals characterized as pioneering fish and only 1% of individuals categorized as omnivorous. The IBI score for this tributary to East Fork Queer Creek was 54.

Goose Creek
The fish community of Goose Creek was evaluated along Goose Creek Road (RM 0.4). A total of twenty-five species including three intolerant species; redside dace, silver shiner and rosyface shiner were collected. In addition, two coldwater species and six darter species were collected. The overall high diversity and community balance was reflected in the IBI score of 56.

Pretty Run
The fish community of Pretty Run was sampled in two locations. The upper reach was sampled near County Road 17 (RM 3.5) while the lower reach was sampled near McGee Road (RM 0.7). Species diversity increased in a downstream direction, as eleven species including the pollution sensitive and coldwater indicative redside dace was collected at the upstream location. Twenty species were collected at the downstream location and included seven moderately pollution intolerant species. IBI scores increased in a downstream direction with the upstream location receiving an IBI of 46 and the downstream location receiving an IBI of 54.

Historically, the site near McGee Road (RM 0.7) was sampled in 1992. A slight decline in fish community diversity is apparent at this site over time. In 1992, twenty-two species including two pollution intolerant species and five moderately pollution intolerant species were collected. Only moderately pollution sensitive species were collected in 2005. The IBI score has remained consistent over time, scoring an IBI of 54 in both 1992 and 2005.

North Branch Pretty Run
The fish community of North Branch Pretty Run was evaluated near Macedonia Road (RM 0.4). Thirteen species including two pollution sensitive species were collected. In addition, the coldwater indicative redside dace was also collected. The well balanced and diverse fish community in North Branch Pretty Run received an IBI of 54.

Pike Run
The fish community of Pike Run was evaluated just south of Jimtown along State Route 327 (RM 5.7) and east of State Route 327 downstream of Conway Hollow adjacent to Pike Run Mud Bog (RM 4.5). Species diversity increased in a downstream direction increasing from 15 to 25 species. However, the structure of the fish community was actually better at the upstream location. Tolerant fish comprised only 29% of the population upstream while they comprised 40% of the population further downstream. Similarly, the percent of pioneering fish increased from 29% to 40% of the population in a downstream direction. IBI scores reflected the differences in fish community structure with the upstream location scoring an IBI of 54 and the downstream location receiving an IBI of 50.

Historical sampling has been limited in Pike Run. One sample was collected in 1992 at RM 1.3. While this site is several miles from the sites sampled in this study, the drainage area at RM 1.3 is 22 mi^2, which is similar to the drainage area at RM 4.5 of 17.7 mi^2. The site at RM 1.3 received an IBI of 54 in 1992, which shows a consistency in fish community integrity in Pike Run over time.

East Fork Pike Run

The fish community of East Fork Pike Run was sampled along County Road 12 E near some power lines (RM 0.2). Fourteen species including, two moderately pollution sensitive species (northern hog sucker and rainbow darter) were collected. This tributary of Pike Run received an IBI of 52.

Mulgee Run

The fish community of Mulgee Run was evaluated near Francis Lane (RM 0.1). Nineteen species were collected and included two pollution intolerant species and four moderately pollution intolerant species. However, over 62% of the community was comprised of creek chub (37.78%) and central stoneroller minnow (24.72%). Several of the species collected comprised <1% of the relative number of individuals; scarlet shiner (0.28%), brindled madtom (0.28%), spotted bass (0.28%), longear sunfish (0.28%), and greenside darter (0.28%). While this may be interpreted as an imbalance in the fish community structure, it is more likely an artifact of recruitment from Salt Creek, as sampling occurred near the confluence of Mulgee Run and Salt Creek. Mulgee Run received an IBI of 46.

Biological Assessment: Macroinvertebrates

Macroinvertebrate communities were evaluated at 20 stations in the lower Salt Creek assessment unit (Table 43). The community performance was evaluated as exceptional at seven stations, very good at six, good at five, marginally good at one, and fair at one station. The station with the highest total mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa richness (EPT) was on Salt Creek adjacent to Narrows Road (RM 22.8) with 34 taxa. The station with the highest number of total sensitive taxa was on Salt Creek adjacent to Narrows Road (RM 22.8) with 51 taxa. Sensitive taxa found in this assessment unit which are noteworthy because they are not commonly collected were the mayflies *Acentrella parvula* in Salt Creek (RMs 22.8, 17.4, 15.7, 9.8) and Queer Creek (RM 0.8); *Acentrella turbida* in Salt Creek (RMs 22.8, 17.4, 15.7, 9.8), Queer Creek (RM 0.9), and Pretty Run (RM 3.8); *Acerpenna macdunnoughi* in E. Fk. Queer Creek (RM 3.9), Trib. to E. Fk. Queer Creek (RM 0.9), Goose Creek (RM 0.3), Pretty Run (RM 3.8), N. Br. Pretty Run (RM 0.4), and E. Fk. Pike Run (RM 0.2); *Paracloeodes* sp. 2 or 3 in Salt Creek (RM 5.9) and E. Fk. Pike Run (RM 0.2); *Plauditus cestus* in Salt Creek (RM 5.9) and Pretty Run (RM 0.7); and *Brachycercus* sp. in Salt Creek (RMs 17.4, 9.8); the stoneflies *Acroneuria carolinensis* in Pike Run (RM 4.5) and E. Fk. Pike Run (RM 0.2), *Acroneuria lycorias* in Salt Creek

(RMs 22.8, 17.4, 15.7, 9.8, 5.9, 1.5) and Queer Creek (RM 0.8); *Eccoptura xanthenes* in Queer Creek (RM 4.4), and *Neoperla clymenae* complex in Salt Creek (RMs 22.8, 17.4, 15.7, 5.9), Queer Creek (RM 0.8), Pretty Run (RM 0.7), and Pike Run (RM 4.5); the caddisfly *Hydropsyche frisoni* in Salt Creek (RMs 22.8, 15.7, 9.8, 5.9); and the midges *Demicryptochironomus* sp. in Queer Creek (RM 4.4); *Stelechomyia perpulchra* in Queer Creek (RM 4.4); and *Sublettea coffmani* in Salt Creek (RMs 22.8, 17.4, 9.8). This assessment unit had a high number of uncommonly collected sensitive taxa which is an indication of the exceptional resource quality of the Salt Creek basin.

Lower Salt Creek
Macroinvertebrate community performance in the lower Salt Creek was generally exceptional with high EPT and sensitive taxa diversity (Table 43, Figure 60). However, there was a gradual decline in diversity from a high adjacent to Narrows Road (RM 22.8) to a low downstream from West Junction Road (RM 5.9). The relatively low ICI scores (42) attained at RMs 17.4 and 5.9 were due in part to relatively high abundance of tolerant aquatic segmented worms (Oligochaeta). The station downstream from West Junction Road was observed to have highly embedded substrates which highlights the threat siltation poses to the biotic integrity of the Salt Creek main stem. Siltation in this reach was propagated by the agricultural activities of stream channel relocation, removal of the woody riparian, and farming up to the stream banks. The local practice of driving vehicles in the stream channel is probably also detrimental to the habitat quality.

The macroinvertebrate community trend in the lower Salt Creek was generally similar to the 1992 study (Figure 61). High diversities of EPT and sensitive taxa were found at all stations except for the 2005 site downstream from West Junction Road (RM 5.9). The decline of ICI scores into the very good range was due to increases of tolerant taxa, primarily aquatic segmented worms. Siltation was observed to be a major threat to the biotic integrity in the lower Salt Creek during both sampling events.

Queer Creek
The macroinvertebrate communities sampled in Queer Creek were evaluated as performing at an exceptional level. This stream basin is in the Hocking Hills area, which is highly wooded with many small tributaries that flow through wooded ravines (Hollows). The station at RM 4.4 had five coldwater macroinvertebrate taxa.

East Fork Queer Creek
The macroinvertebrate communities sampled in East Fork Queer Creek were evaluated as performing at an exceptional level at RM 3.9 and very good at RM 1.7. Both stations had five coldwater macroinvertebrate taxa. The station at RM 1.7 contained an oligotrophic community with notably low organism density (86 organisms/ft^2). This site is located in the Deep Woods property which is the location of an all taxa biotic inventory. Based on the collections records Ohio EPA has, a total of 197

macroinvertebrates have been documented from the East Fork Queer Creek including 20 taxa of mayflies, 13 taxa of stoneflies, 13 taxa of caddisflies, and 115 taxa of midges. These organisms were collected on multiple visits during all seasons with an emphasis on the midges.

Tributary to East Fork Queer Creek
The macroinvertebrate community sampled in the Tributary to East Fork Queer Creek was evaluated as performing at a good level. This station had six coldwater macroinvertebrate taxa.

Goose Creek
The macroinvertebrate community sampled in Goose Creek was evaluated as performing at a good level. This station had four coldwater macroinvertebrate taxa.

Pretty Run
The macroinvertebrate communities sampled in Pretty Run were evaluated as performing at a very good level. The existing EWH use designation was based entirely on fish collections. Siltation and vehicles driving in the stream channel were observed to be threats to biotic integrity at the McGee Road site (RM 0.7). Both stations had three coldwater macroinvertebrate taxa, RM 3.8 with all three strong indicators.

North Branch Pretty Run
The macroinvertebrate community sampled in North Branch Pretty Run was evaluated as performing at a marginally good level. Siltation was extremely heavy at this site, apparently from upstream gravel removal. This station had five coldwater macroinvertebrate taxa.

Pike Run
The macroinvertebrate communities sampled in Pike Run were evaluated as performing at a good level at RM 5.7 and very good at RM 4.5. Organism density was low at both stations, it was hard to find organisms in the riffle and run habitats except for the stonefly *Leuctra* sp. Overall stream habitat was very good at both stations, even siltation did not appear to pose a threat, except possibly to the downstream site.

East Fork Pike Run
The macroinvertebrate community sampled in East Fork Pike Run was evaluated as performing at a good level. EPT (17) and sensitive taxa (23) diversity were meeting WWH expectations, however, indications of community imbalance were the low predominance of sensitive EPT in the riffle habitat and the absence of sensitive *Chimarra* caddisflies and case building caddisflies in the families Limnephilidae and Helichopsychidae. Observed excessive algal growth and embedded substrates were indications that nutrient enrichment and siltation are threats to the biotic integrity at this site.

Poe Run

The macroinvertebrate community sampled in Poe Run was evaluated as performing at a fair level. The stream flow at the time of collection (21 July 2005) was interstitial, which undoubtedly limited the diversity at this site. There was a gravel removal area downstream from the collection area near the Poe Run Road bridge.

Mulgee Run

The macroinvertebrate community sampled in Mulgee Run was evaluated as performing at a good level. EPT (12) and sensitive taxa (16) diversity were at the lower end of WWH expectations, however, indications of community imbalance were the absence of sensitive baetid mayflies, *Chimarra* caddisflies, and case building caddisflies in the families Limnephilidae, Uenoidae, and Helichopsychidae. Heavy siltation observed at this site was probably impacting the biotic integrity in this stream.

Table 43. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Salt Creek study area, July to October, 2005.

Stream RM	**Dr. Ar. (sq. mi.)**	**Data Codes**	**Qual. Taxa**	**EPT Ql. / Total**	**Sensitive Taxa Ql. / Total**	**Density Ql. / Qt.**	**CW Taxa**	**Predominant Organisms on the Natural Substrates With Tolerance Category(ies)**	**ICI[a]**	**Narrative Evaluation**
Salt Creek (02-600)										
22.8	214	8	71	31 / 34	42 / 51	M / 415	0	Mayflies (MI,I), caddisflies (MI,F), midges MI,F)	46	Exceptional
17.4	239	-	70	29 / 31	35 / 47	L / 406	0	*Chimarra* caddisflies (MI), baetid mayflies (I)	42	Very Good
15.7	242	-	64	28 / 33	39 / 45	M / 931	0	Mayflies (MI), caddisflies (MI,F), midges MI,F)	52	Exceptional
9.8	286	-	65	28 / 29	34 / 44	M / 547	0	Caddisflies (MI), midges (MI,F), mayflies (MI)	52	Exceptional
5.9	292	-	53	18 / 23	24 / 34	L-M / 725	0	Caddisflies (MI,F), midges (MI,F), mayflies (MI)	42	Very Good
1.5	551	-	68	24 / 25	35 / 39	M / 1052	0	Caddisflies (F,MI), midges (MI,F)	48	Exceptional
Queer Creek (02-625)										
4.4	11.8	-	60	22	27	L	5	Midges (MI,F), craneflies (F,MI)	-	Exceptional
0.8	34.2	15	52	24	28	L-M / 181	3	Caddisflies (F,MI), mayflies (MI)	(36)	Exceptional
East Fork Queer Creek (02-627)										
3.9	9.2	-	54	21	26	L-M	5	*Leuctra* stoneflies (I), midges (MI,F), mayflies (MI,I)	-	Exceptional
1.7	12.6	15	56	17 / 18	23 / 33	L / 86	5	Caddisflies (F,MI), midges (MI,F), heptageniid mayflies (MI)	44	Very Good
Trib. to E. Fk. Queer Creek @ RM 3.95 (02-654)										
0.9	4.9	9	44	16	20	L-M	6	Midges (MI,F), *Leuctra* stoneflies (I)	-	Good
Goose Creek (02-626)										
0.3	4.6	-	51	16	23	L	4	*Leuctra* stoneflies (I), heptageniid mayflies (MI)	-	Good
Pretty Run (02-608)										

Stream RM	Dr. Ar. (sq. mi.)	Data Codes	Qual. Taxa	EPT Ql. / Total	Sensitive Taxa Ql. / Total	Density Ql. / Qt.	CW Taxa	Predominant Organisms on the Natural Substrates With Tolerance Category(ies)	ICI[a]	Narrative Evaluation
3.8	5.4	-	38	20	20	L-M	3	Midges (MI,F), *Leuctra* stoneflies (I)	-	Very Good
0.7	16.8	-	43	19	21	L	3	Midges (MI,F), hydropsychid caddisflies (MI)	-	Very Good
North Branch Pretty Run (02-670)										
0.4	5.8	-	34	11	17	L-M	5	*Leuctra* stoneflies (I), midges (MI,F)	-	Marg. Good
Pike Run (02-606)										
5.7	9.1	-	36	14	20	L	1	Midges (MI,F), *Leuctra* stoneflies (I)	-	Good
4.5	17.7	-	48	20	23	L	3	Midges (MI,F), *Leuctra* stoneflies (I), hydropsychid caddisflies (MI,F)	-	Very Good
East Fork Pike Run (02-607)										
0.2	5.0	-	45	17	23	L	3	Midges (MI,F), water mites (F)	-	Good
Poe Run (02-603)										
2.2	4.9	9	35	9	14	L-M	1	Midges (F,MI), *Lype* caddisflies (MI), *Caenis* mayflies (F)	-	Fair
Mulgee Run (02-666)										
0.1	5.2	-	47	12	16	L-M	1	Baetid mayflies (F), midges (MI,F), hydropsychid caddisflies (F)	-	Good

RM: River Mile.
Dr. Ar.: Drainage Area
Data Codes: 8=Non-Detectable Current, 9=Intermittent or Near-Intermittent Conditions, 15=Current >0.0 fps but <0.3 fps.
Ql.: Qualitative sample collected from the natural substrates.
Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List as MI (moderately intolerant) or I (intolerant).
Qt.: Quantitative sample collected on Hester-Dendy artificial substrates, density is expressed in organisms per square foot.
Qualitative sample relative density: L=Low, M=Moderate, H=High.
CW: Number of Coldwater Macroinvertebrate Taxa.
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant
[a] ICI values in parentheses are invalidated due to insufficient current speed over the artificial substrates. The station evaluation is based on the qualitative sample narrative evaluation.

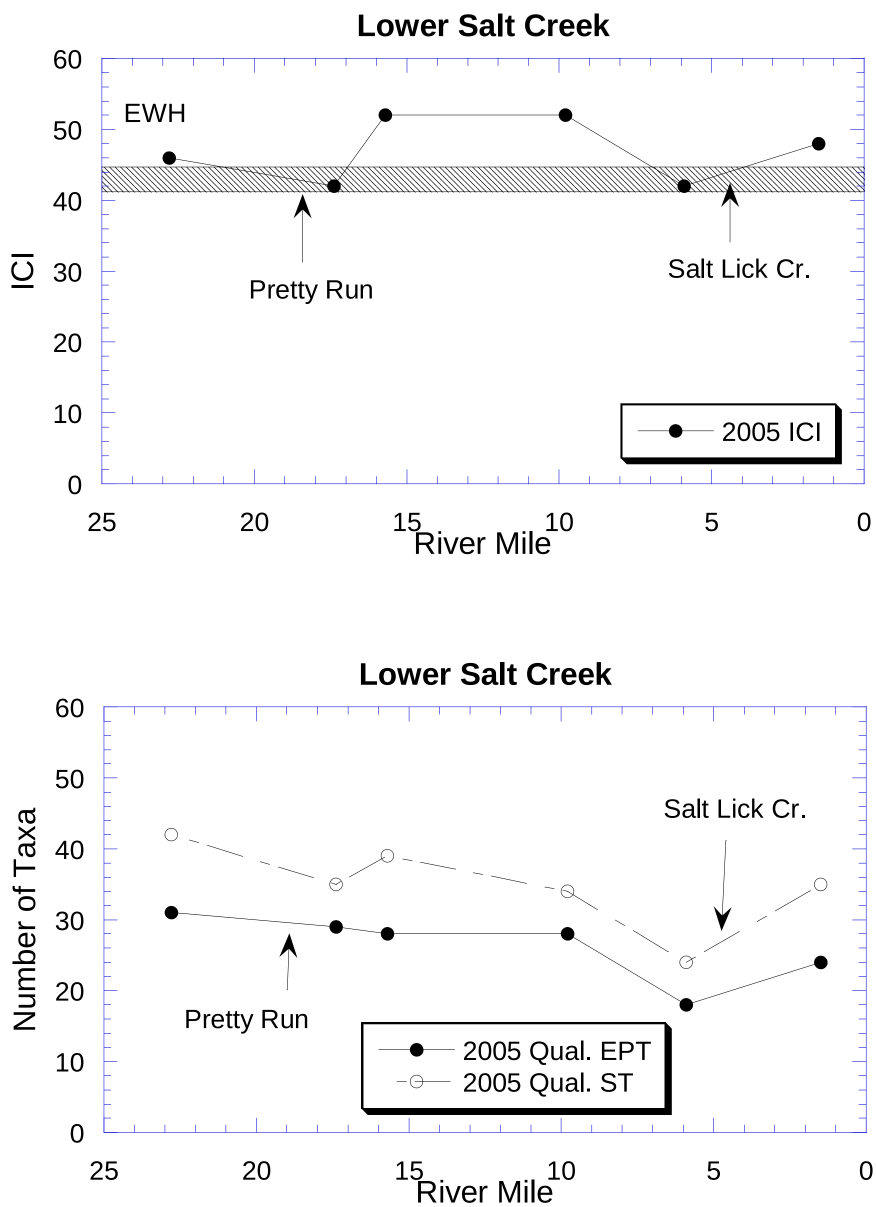


Figure 60. Longitudinal trend of the Invertebrate Community Index (ICI), qualitative EPT, and qualitative sensitive taxa are shown for the lower Salt Creek, 2005.

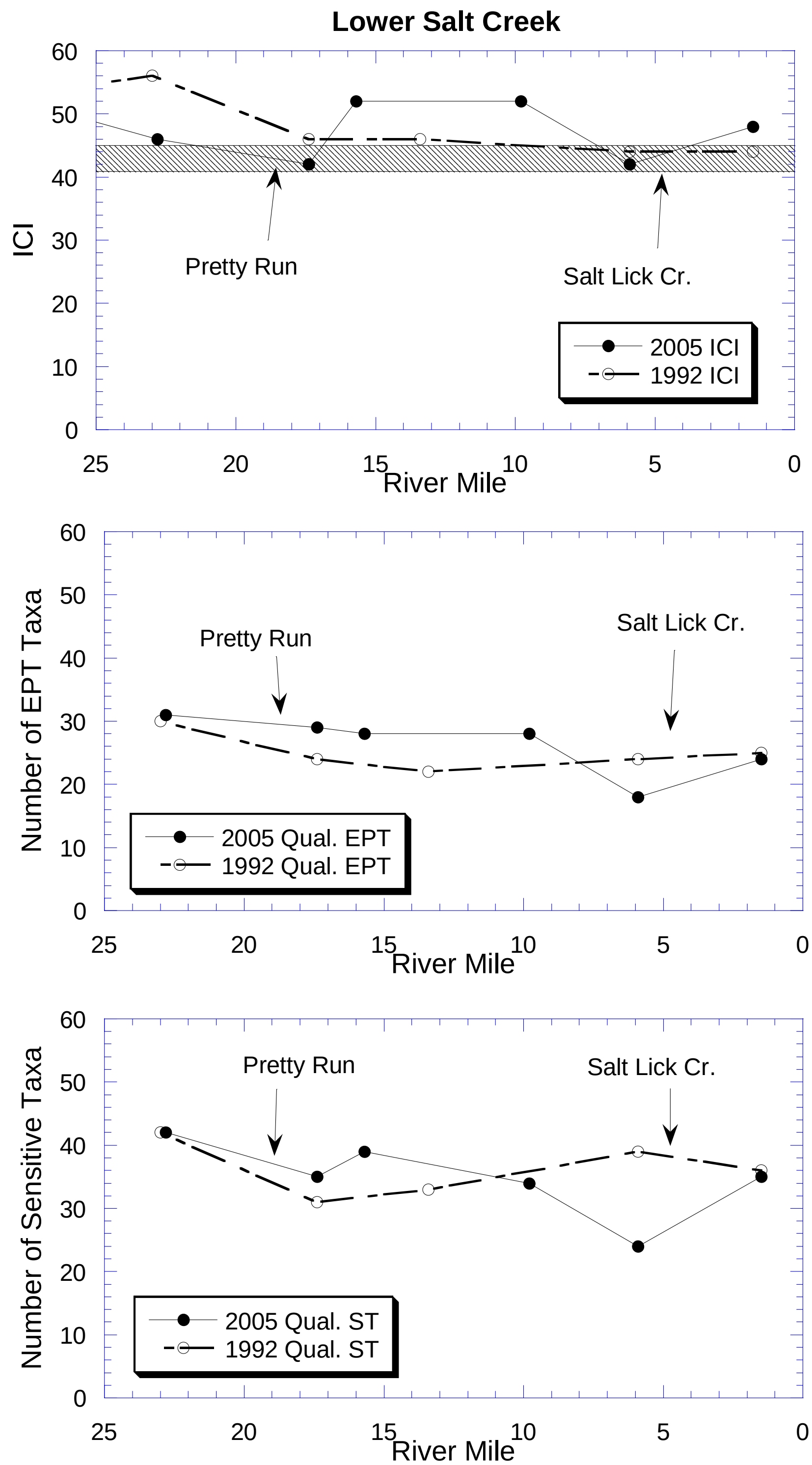


Figure 61. Longitudinal trend of the Invertebrate Community Index (ICI), qualitative EPT, and qualitative sensitive taxa are shown for the lower Salt Creek, 1992-2005.

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