

7. Water Quality in the Lower Olentangy River Watershed

In the summer of 1999, the Ohio Environmental Protection Agency's Division of Surface Water carried out a detailed biological and water quality study of the Lower Olentangy River and select tributaries in Delaware and Franklin counties. The results of this study were officially released to the public as a report in July 2001 (Ohio EPA, 2001). The Ohio EPA, as part of its compliance with the federal Clean Water Act, has established its own system of water quality standards. Ohio EPA uses multiple chemical, physical, and biological measures to assess the health and integrity of Ohio's surface water resources, following a rotating five-year basin-monitoring schedule. Ohio is one of only a few states that uses biological criteria, primarily measures of the health and diversity of fish and macro-invertebrates in these streams, as indicators of water quality.

Ohio EPA's 1999 study included water quality chemical, sediment, and biological sampling carried out in the Lower Olentangy River watershed from June to October 1999. Flow conditions in the river at this time were low due to a prolonged drought period. The study area included the 32-mile stretch of the river from just downstream of the Delaware Dam to the river's confluence with the Scioto River in the city of Columbus plus sites on nine tributary streams. The objectives of the Ohio EPA study were to:

- 1) Monitor and assess the chemical, physical, and biological health of the Olentangy River mainstem and associated tributary streams in 1999.
- 2) Characterize the consequences of various land uses on water quality in the Olentangy River watershed.
- 3) Evaluate the influences of the Delaware and Olentangy Environmental Control Center wastewater treatment plants (WWTP) on the river's water quality and biological integrity.
- 4) Evaluate the potential impacts from spills, non-point sources of pollution (NPS), and habitat alterations on the receiving streams in the watershed.
- 5) Determine the attainment status of the current Warm-Water Habitat, Exceptional Warm-Water Habitat, and Modified Warm-Water Habitat aquatic life uses and other non-aquatic use designations for the studied portion of the Olentangy watershed and recommend changes if deemed necessary.

Definitions and the Basis for Evaluating Water Quality in Ohio Surface Waters

Use Attainment

Use attainment is another way of describing whether or not a stream is meeting Ohio's water quality standards. Ohio EPA has assigned a **use designation** -- or a specific set of

water quality standards -- to most major streams and rivers throughout the state by dividing each stream into segments and assigning each segment a specific use designation. Use attainment can be expressed in degrees (Table 32). While some streams may be meeting all of the water quality standards associated with its designation (**Full Attainment**), others may only be meeting some (**Partial Attainment**), and still others yet may not be meeting any (**Non-Attainment**).

Water Quality Standards

Many different sources and types of pollution constantly threaten surface water quality in Ohio. Under the federal Clean Water Act, Ohio must adopt water quality standards to protect, maintain, and improve the quality of the state's surface waters such that they will achieve the goal of being "swimmable/fishable" waters. Ohio's water quality standards include three major components: 1) beneficial use designations; 2) narrative "free froms"; and 3) numeric criteria for chemicals and aquatic life (fish and macro-invertebrates).

Beneficial Use Designations describe existing or potential uses of the water resource. They take into account the use and value of the waterway for Public Water Supplies (PWS), for protection and propagation of aquatic life (Aquatic Life Use), for recreation in and on the water (Recreational Use), for Agricultural Use (AWS) and for Industrial Uses (IWS). The Olentangy River throughout its lower reaches in Delaware and Franklin County is classified by Ohio EPA (Ohio EPA, 2001, Table 2) as being suitable for agricultural and industrial uses (AWS, IWS), as a public water supply (PWS in Liberty Township and at its confluence with the Scioto River), and as being suitable for "primary contact recreation" (PCR, *e.g.* full body contact =swimming, wading, canoeing, etc.). (See Appendix D.6).

Narrative "Free Froms" are general water quality criteria that apply to all Ohio surface waters. These state that all waters shall be "free from" sludge, floating debris, oil and scum, color- and odor-producing materials, toxic substances that are harmful to human and aquatic life, and nutrients in concentrations that may cause algal blooms.

Numeric Criteria are estimations of the concentrations of chemicals and the degree of aquatic life toxicity allowable in a waterbody without adversely impacting its beneficial uses. These are used primarily to regulate entities that discharge waste waters to the waters of the state through National Pollution Discharge Elimination System (NPDES) permitting.

These criteria include **chemical criteria**, which are concentration levels for a variety of individual chemicals (usually measured in micrograms/liter [$\mu\text{g}/\text{L}$] or parts per billion [ppb]) derived from laboratory studies of the sensitivity of aquatic organisms to specific chemicals or groups of chemicals. These are listed by Ohio EPA as **Aquatic Life and Human Health Water Quality Criteria** and are contained in Chapter 3745-1 of the Ohio Administrative Code. Currently, separate tables are used for the Lake Erie and the Ohio River drainage basins. The Olentangy River is part of the Ohio River drainage basin.

Biological criteria are based on aquatic community characteristics that are measured structurally and functionally. **Communities** are closely associated, interconnected populations of animals and plants living in a particular environment or habitat. These criteria

are especially important here in Ohio as they form the basis for the evaluation of the attainment of **Aquatic Life Use Designations**. The data collected in these assessments (e.g. the 1999 study of the Lower Olentangy River) are used to characterize aquatic life impairment and to help diagnose the cause(s) of this impairment. These biological measurements in Ohio consist of three “indices” of aquatic life use attainment: the **Index of Biotic Integrity (IBI)**, the **Modified Index of Well-Being (MIwb)**, and the **Invertebrate Community Index (ICI)**. The IBI and the MIWB apply to fish; the ICI applies to macro-invertebrates.

Index of Biological Integrity (IBI): is a measure of fish species diversity and species populations. The criteria used to establish the index for each of the five ecoregions in Ohio reflect the biological performance exhibited by natural or least-impacted habitats of each region based on specific reference sites. [The Olentangy River flows through the **Eastern Cornbelt Plains Ecoregion (ECPE)** and uses the reference sites sampled in this region as the measure to assign Aquatic Life Use Designations] The index is a number that reflects total native fish composition, indicator species composition, pollution-intolerant and tolerant species composition, and fish physical condition. Combined, the higher the calculated index, the healthier the aquatic ecosystem. Conversely, the lower the index, the poorer the health of the ecosystem. The highest score is 60.

Modified Index of Well-Being (MIwb): is based on the index of well being which is a calculation of fish biomass and density. The Modified Index of Well Being factors out 13 pollution tolerant fish species from the calculation. This prevents false high readings in polluted streams, which might have large populations of pollution-tolerant fish. A score of 10 or above is considered to be excellent.

Invertebrate Community Index (ICI): is based on measurements of the macro-invertebrate communities living in a stream or river. Macro-invertebrates are aquatic animals that lack a backbone and are easily visible with unaided eye. They include mollusks such as snails and mussels, worms, crustacean arthropods such as water fleas and sowbugs, and a variety of insect larvae or immature nymphs. The ICI is particularly useful in evaluating stream health because: 1) there are a wide variety of macro-invertebrates which are known to be pollution intolerant; and 2) there are a number of macro-invertebrates which are known to be pollution tolerant. Like the IBI, the ICI scale is from 0 to 60 with the higher scores representing the healthier macro-invertebrate communities and therefore a higher water quality stream.

Aquatic Life Use Designations

Aquatic Life Use Designations are based on the three biological indices listed above. These indices measure the populations and diversity of fish and invertebrates living in the stream. For each of the aquatic use designations, the criteria for each index are different. For each of the five ecoregions in Ohio, there are reference sections that have established the minimum index scores that define the Aquatic Life Use Designation for each stream or segment of a stream in that ecoregion.

Exceptional Warm-Water Habitat (EWH): is the most biological productive environment. These waters support “unusual and exceptional” assemblages of aquatic organisms, and are characterized by a high diversity of species, particularly those that are highly pollution-intolerant and/or rare, endangered, threatened, or of special status. These constitute Ohio’s best water resources and have more stringent standards for ammonia and dissolved oxygen than other use designations.

Warmwater Habitat (WWH): defines the “typical” warmwater assemblage of aquatic organisms for Ohio rivers and streams. It is the principal restoration target for the majority of water resource management efforts in Ohio. Criteria vary by ecoregion and site type.

Modified Warmwater Habitat (MWH): applies to streams with extensive and irretrievable physical habitat modifications. The biological criteria for warmwater habitat are not attainable. The activities contributing to the modified warmwater habitat have been sanctioned or permitted by state or federal law. Included are streams affected by acid mine run-off, streams that have been heavily channelized, and streams that are impounded by dams. The representative aquatic biotas are generally composed of species tolerant of low dissolved oxygen, silt, nutrient enrichment, and poor habitat quality.

The minimum scores for the three biological indices that define the various Aquatic Life Use Designations in the Eastern Cornbelt Plains Ecoregion are listed in Table 33.

Measures of Physical Stream Habitat

Besides the use of chemical and biological criteria to assess water quality in Ohio’s rivers and streams, Ohio EPA also has devised a measurement evaluating the condition and type of physical habitat characteristic of a particular stream segment. Ohio EPA Division of Surface Water staff has demonstrated that habitat plays a major role in the occurrence and maintenance of viable populations of both fish and macro-invertebrates with habitat conditions largely being dependent upon local geography and the nature and extent of man-made modifications of the aquatic environment (Rankin, 1995). The latter include obvious features such as hydromodification of the stream, including dams, straightening of stream channels, and culvertization as well as more subtle impacts such as sedimentation and substrate embeddness, the nature of stream substrates, bank stability, and the nature and condition of adjacent riparian areas.

This measurement, termed the **Qualitative Habitat Evaluation Index (QHEI)**, is a numerical index based on visual estimates of stream habitat features. These include substrate quality, in-stream cover, channel morphology, riparian zone and bank quality, pool and riffle quality, and stream gradient. As with the IBI and ICI, the higher the total index score, the better the quality of the habitat along the studied stretch of the stream or river. High quality sections of rivers and streams in Ohio typically have QHEI scores in excess of 75. Streams with QHEI scores less than 45 generally cannot sustain a warm-water biota consistent with Warm-Water Habitat biological criteria.

Another important tool in measuring health of a stream is to look at stream morphology- the stability of the stream channel. In a healthy system a stream has access to its floodplain. No

stream morphology data has been obtained on the Olentangy River or its tributary streams to date. This data will need collected in the future and should be an action item in the Action Plan. What we do know is that along the mainstem of the River the banks are flanked with earthen dams a.k.a levees, so most of the River does not have access to its floodplain.

Measures of Chemical Water Quality:

Chemical water quality of a stream includes critical parameters such as dissolved oxygen (DO) and nutrient levels (ammonia, nitrate, and phosphorus), as well as measured levels of potentially toxic substances, including organic compounds, pesticides, and heavy metals. Also included in this category are concentrations of fecal coliform and *E. coli* bacteria detected in stream surface waters.

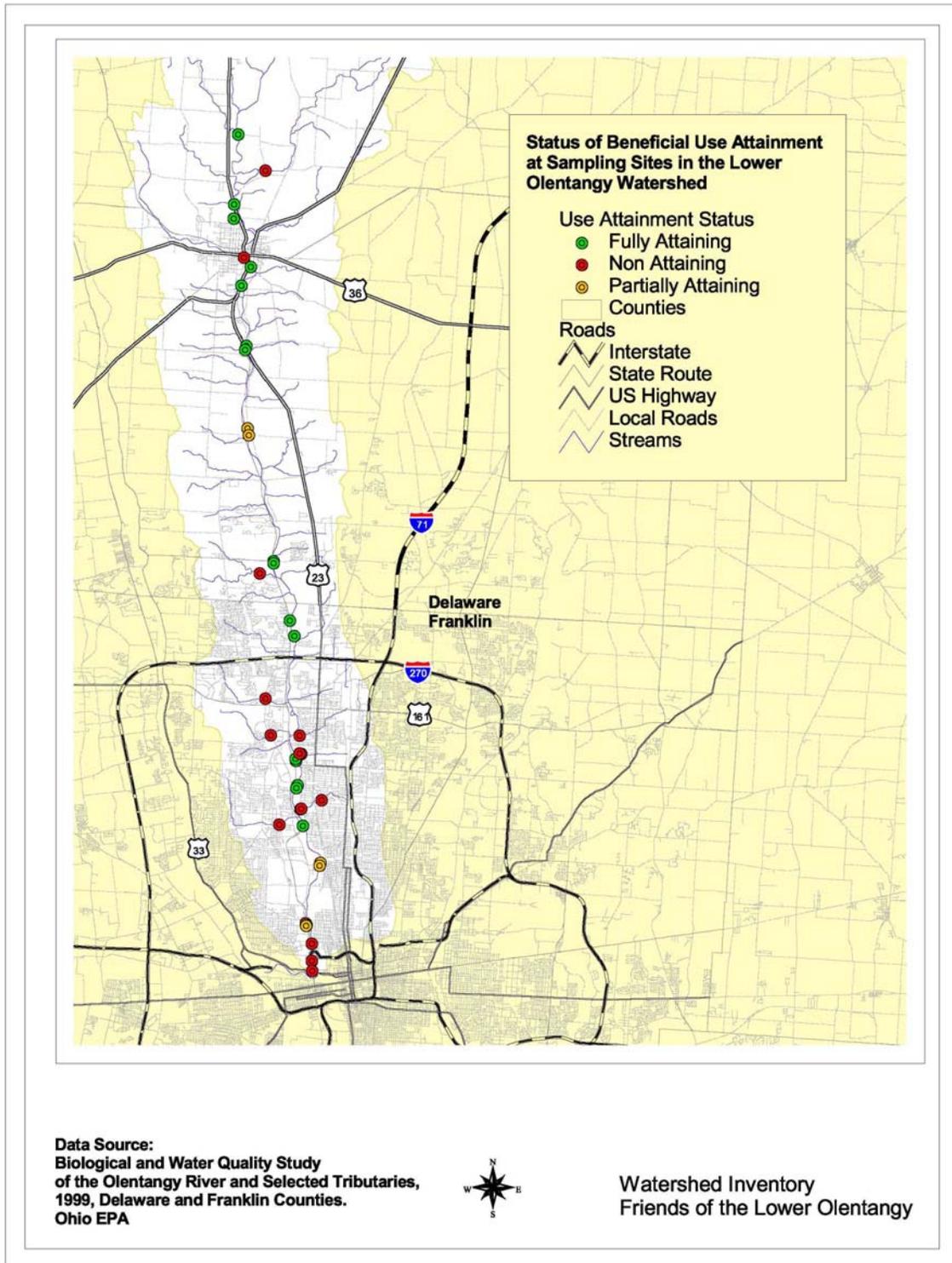


Figure 7-1: Ohio EPA 1999 Lower Olentangy River Sampling Site Attainment Map

The 2002 Ohio EPA Integrated Report lists the following causes and sources of water quality impairments in the Lower Olentangy Watershed:

Causes- unknown, unknown toxicity, pesticides (banned), priority organics, metals, other inorganics, nutrients, organic enrichment / DO, flow alteration, other habitat alterations.

Sources- municipal point sources, nonirrigated crop production, urban runoff / storm sewers, channelization-development, spills, contaminated sediments, natural.

Summary of Specific Causes / Sources of Impairments organized by 14-Digit Sub-Watershed

(summarizing the not-meeting (red dots) and partially meeting (yellow dots) from the sampling sites map- Figure 7-1) for the Lower Olentangy Watershed.

14 Digit Watershed: 05060001120010

Delaware Run (1.2 Limestone Park , 0.2 Henry Street) not meeting WWH due to phosphorus, bacteria, contaminated sediments, fair fish and poor macro scores because of urban runoff, habitat modification, sewage.

14 Digit Watershed: 05060001120020

Olentangy River at river mile 19.6/19.4 Hyatts Rd partially meeting EWH due to multiple stressors (Delaware WWTP, urban runoff, development)

14 Digit Watershed: 05060001120030

Bartholomew Run (1.0 Bennett Rd) not meeting WWH due to bacteria and suspended solids which are indicative of impacts from soil disturbing development and to fair habitat and macro scores because of development (flashy flows and bank erosion).

14 Digit Watershed: 05060001120040

Rush Run (0.4 / 0.3 Walnut Grove Cemetery) not meeting WWH due to exceedences of bacteria standards, nutrient enrichment, contaminated sediments and poor habitat, fish and fair macro scores from channel modifications and the impervious landscape.

Bill Moose (0.3 /0.2 Kenny Park) not meeting WWH due to bacteria and fair fish and macro scores due to SSOs and urbanized landscape.

Linworth Run (0.9 Linworth Rd) not meeting WWH due to bacteria and phosphorus exceedences, poor fish scores, fair macro scores and marginal habitat because of urbanized landscape and runoff.

Kempton Run (0.9 Linworth Rd) not meeting WWH due to bacteria, phosphorus, nitrogen exceedences; poor fish scores and marginal habitat because of urbanized landscape and runoff.

14 Digit Watershed: 05060001120050

Olentangy River at river mile 4.0 /3.9 Dodridge Rd partially meeting WWH due to urbanized character of the watershed, altered habitat (downstream of a dam) resulting in insufficient flow.

Adena Brook (1.0 Overbrook Driver and 0.1 Whetstone Park) not meeting WWH due to exceedences of bacteria standards (SSO) and dissolved oxygen standards (urbanized landscape & spills)

Turkey Run (0.7 Shattuck Ave) not meeting WWH due to exceedences of bacteria standards, contaminated sediments, poor fish and macro scores due to excessive nutrients and toxicity associated with urban runoff and septic discharges in addition to altered flow patterns (dam at OSU golf course).

14 Digit Watershed: 05060001120060

Olentangy River at river mile 2.0 Ust. 5th Ave Dam not meeting MWH due to impoundment, silty/mucky substrate, CSO/SSO discharges and contaminated sediment.

Olentangy River at river mile 1.9/1.8 Dst. 5th Ave Dam partially meeting MWH due to artificial substrates

Olentangy River at river mile 0.6/0.7 Railroad Bridge partially meeting WWH due to slow current, limited habitat and urban impacts.

Olentangy River at river mile 0.2/0.3 Near Mouth non meeting MWH due to impoundment on the Scioto, silty/mucky substrate, CSO/SSO discharges and contaminated sediment.

Summary Results of 1999 Ohio EPA Olentangy River Study

Mainstem of the Lower Olentangy River

With regard to the chemical water quality of the mainstem of the river, Ohio EPA, based on its 1999 field study, judged the Lower Olentangy River to have generally good water quality (Ohio EPA, 2001). The only violations of Ohio Water Quality Standards consisted of excessive bacteria counts (above the Primary Contact Recreation criterion) from the river below the Delaware WWTP in the city of Delaware (RM 24.5) and in the lower reaches of the river within the Columbus city limits, including RM 5.5 adjacent to the east North Broadway bridge, RM 4.0 below the Dodridge Street dam, and at RM 0.6 below the Third Avenue bridge and above the river's confluence with the Scioto (Figure 7-2). Ohio EPA inferred these violations resulted from storm water runoff and contributions from combined sewer overflows (CSOs) and faulty sanitary sewer lines concentrated in these urban areas (Ohio EPA, 2001). Additional violations included exceedences of Aquatic Life Criteria for the pesticides Lindane and Dieldrin in the upper part of the Lower Olentangy River at RM 22.3 (U.S. Rt. 23 bridge).

Dissolved Oxygen and Nutrient Enrichment

Mean dissolved oxygen levels were above 6 mg/L (ppm) all along the entire stretch of the river studied by Ohio EPA in 1999 with DO levels ranging from 6.1 to 9.0 mg/L. The Aquatic Life Standard for DO in Ohio surface waters is 4.0 mg/L. DO levels in the mainstem are in the good to exceptional range over the length of the river studied.

Nutrient levels in the mainstem of the Lower Olentangy River show elevated ammonia levels at the most upstream sites just below the Delaware Dam, but very low levels in the remainder of the river to the confluence. Ammonia (NH_4) is highly toxic to aquatic life and elevated levels just downstream of municipal wastewater treatment plants (WWTPs) were a major factor impacting biotas in the river in the past (Ohio EPA, 2001, Table 23). Nitrate and phosphorus levels in the mainstem show an inverse distribution compared to the ammonia, being low in the upstream localities and increasing significantly downstream of the city of Delaware below the Delaware city WWTP (Figure 6-3). Nitrate and phosphorus levels below the Delaware WWTP exceed proposed statewide criteria for these nutrients, both for Exceptional Warmwater Habitats (EWH) and for Warmwater Habitats (WWH) (Figure 6-4). However, with the exception of downstream portions of the river within modified stream segments (behind lowhead dams), designated aquatic life uses were typically fully attained (see Tables 33, 34). Ohio EPA (2001) has indicated that elevated nutrient levels and exceptional aquatic communities can co-exist if beneficial habitat and land use practices are present. As a result, biotas in flowing portions of the river remain viable and diverse in spite of this nutrient enrichment.

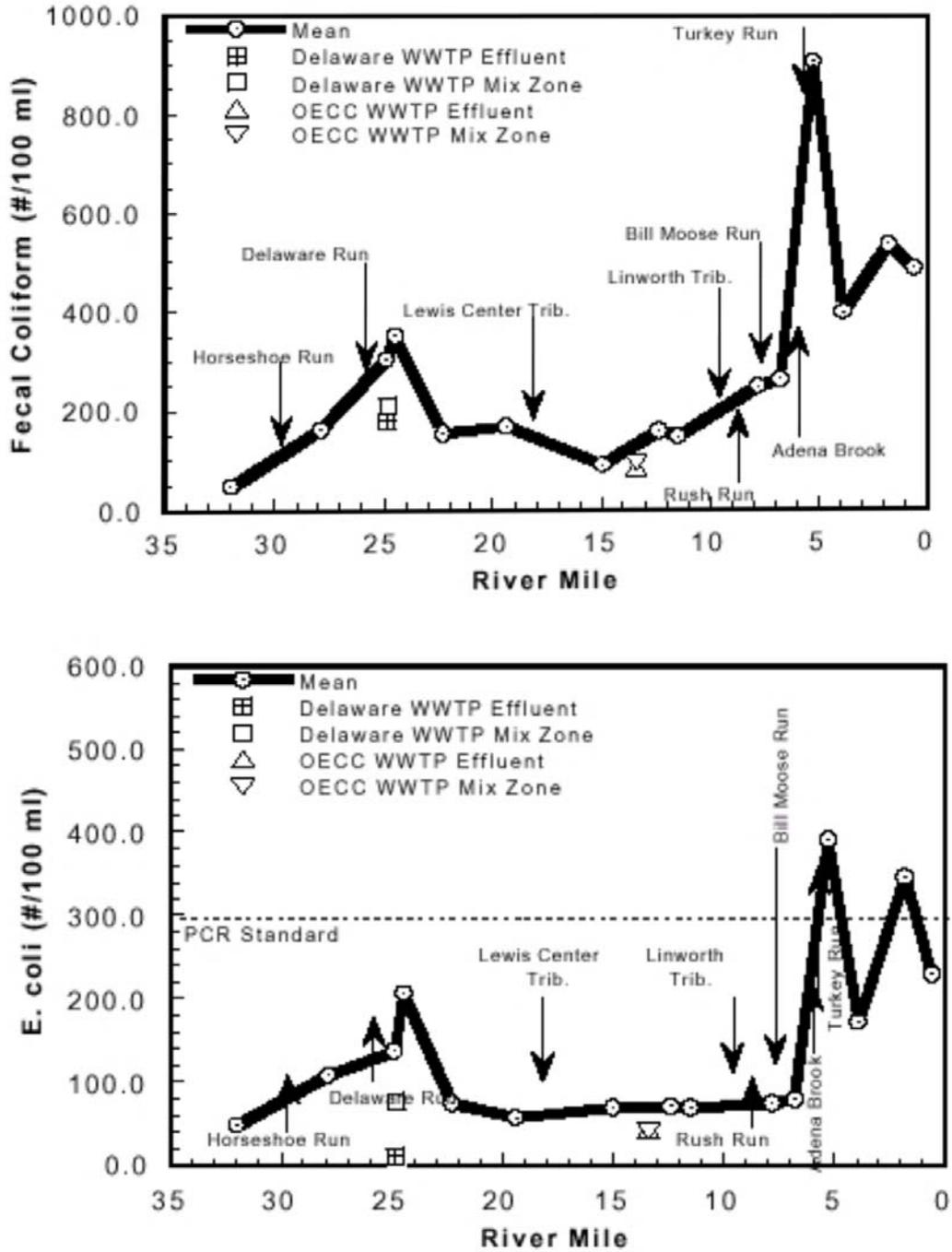


Figure 7-2: *E. coli* and Fecal Coliform Trends in the Mainstem.
 Source Ohio EPA, Technical Support Document 1999. "Longitudinal mean concentrations of fecal coliform and *E. coli* from the Olentangy River, 1999."

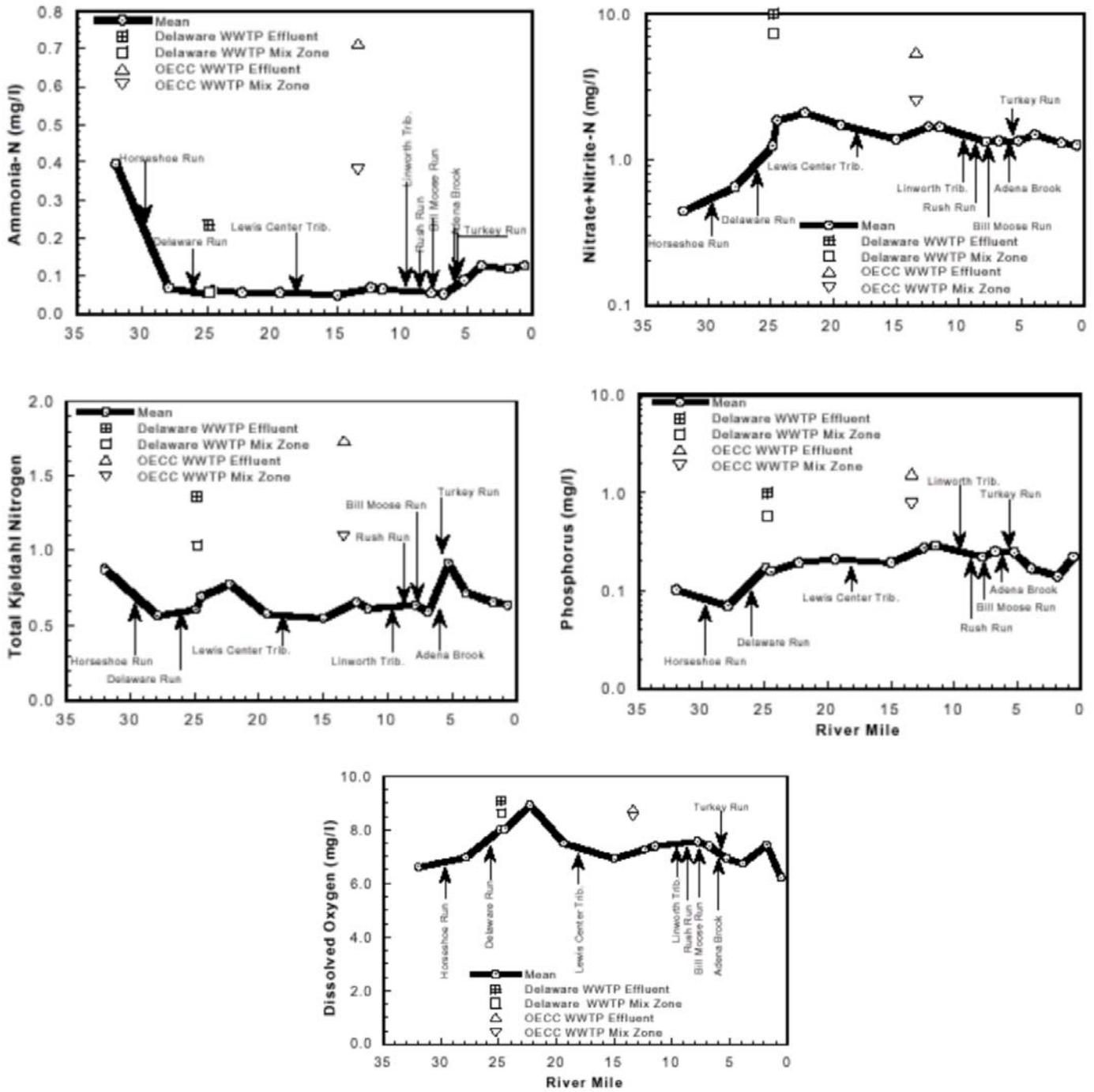


Figure 7-3: Ammonia, Nitrate, Phosphorus, and Dissolved Oxygen in Mainstem.
 Source (Ohio EPA 1999) "Longitudinal trend of mean concentrations of ammonia, nitrate and nitrite, total Kjeldahl nitrogen, phosphorus, and dissolved oxygen."

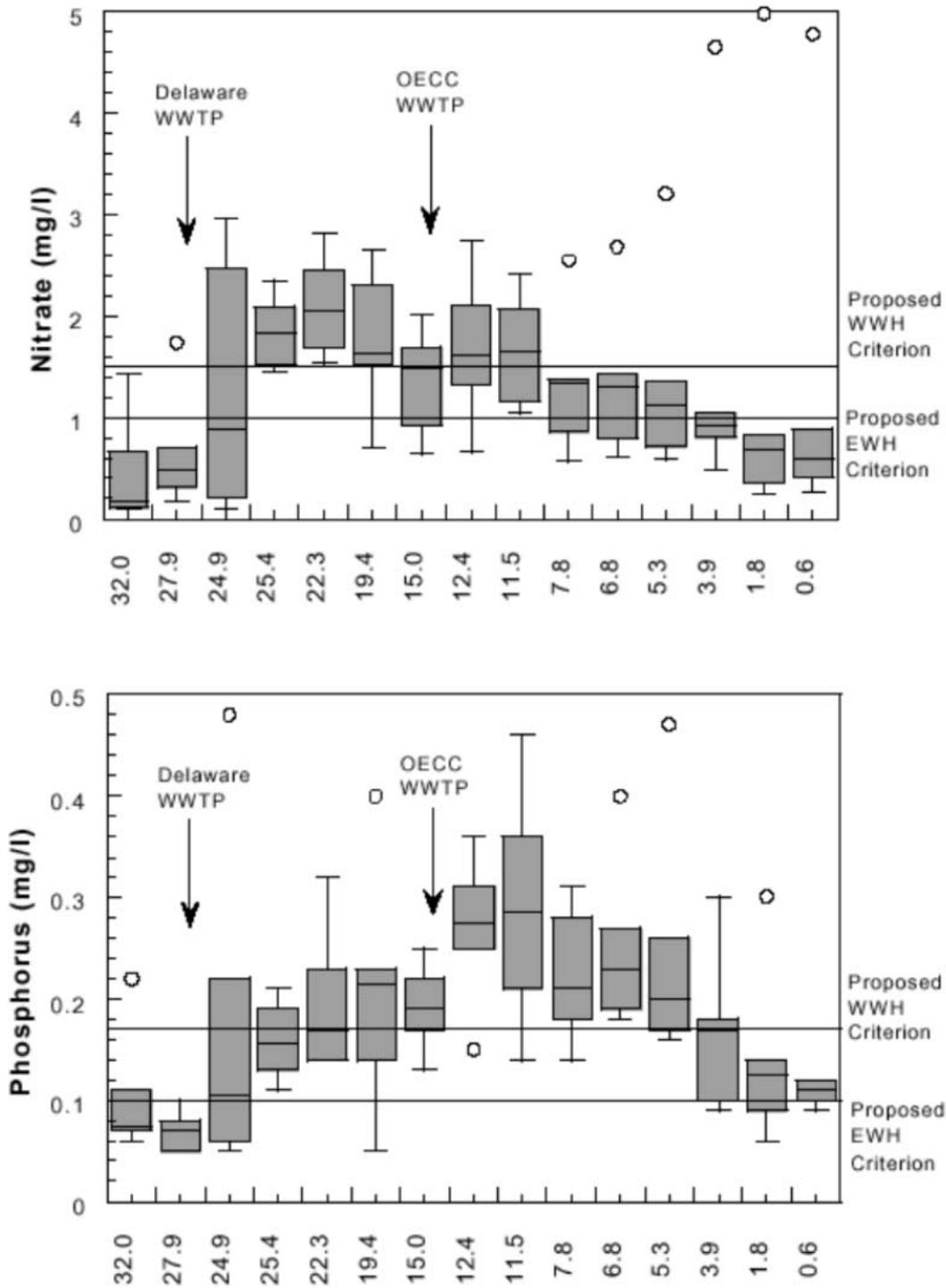


Figure 7-4: Nitrate and Phosphorus Concentrations in Mainstem

Source (Ohio EPA 1999): “Nitrate and phosphorus concentrations versus river mile for the Olentangy River, June to October, 1999. Boxes enclose the 25 th and the 75 th percentiles, outliers deviate more then two times the interquartile range from the median. Proposed criteria values are included for reference purposes and do not reflect violation of current water quality standards.”

Sediment

Ohio EPA sampled sediments as well as water in the mainstem of the river in 1999. Sediments are often “sinks” for a variety of toxic chemicals that are often short-lived in the water column but persistent in bottom sediments. Especially persistent in sediments are *polycyclic aromatic hydrocarbons (PAHs)*, some pesticides (such as DDT), *polychlorinated biphenyls (PCBs)*, and some heavy metals (cadmium, chromium, lead). The PCBs and pesticides such as DDT are not only persistent in sediments, but can also bioaccumulate in tissues up the food chain, potentially leading to body burdens of these chemicals in top-of-the-line predators like sport fish. Standards for aquatic and human exposures with regard to toxics in sediments are not well established. Ohio EPA has used guidelines established by the province of Ontario which establish a “Severe Effect Level” (SEL) for each chemical that indicates the level at which the chemical can be expected to have severe effects on bottom-dwelling organisms (Ohio EPA, 2001, p. 55). Any chemical concentrations above the SEL guidelines are considered to be highly contaminated and likely to have significant adverse effects on measured ICI values.

Contaminated sediments were concentrated in urban portions of the river in Delaware and Columbus. The last couple of miles of the river upstream of its confluence in Columbus were the most severely impacted, having excessive levels of both heavy metals and organic compounds.

Ohio EPA detected a metals spike in river sediments at RM 22.3 at the U.S. Rt. 23 Bridge with highly elevated levels of aluminum, barium, and chromium (Table 33). Ohio EPA speculated that possibly these high levels of metals might be the result of leachate derived from a former General Castings foundry sand disposal site upstream of the sample site. Curiously, these high metals levels in the sediment appear to have had no effect on benthic biotas in the areas as ICI scores for this locality were in the excellent range at 50.

High to extremely high metals levels (aluminum, barium, cadmium, chromium, copper, and zinc) and the PAHs fluoranthene, phenanthrene, and pyrene, plus lower levels of PCBs were detected in river sediments in the lower two miles of the river in Columbus (Table 35). Ohio EPA suggested that these contaminants in the sediments along this stretch of the river were likely to be the result of a combination of factors, including run-off from city streets and highways, the former Gowdy Landfill near Goodale, and discharges from storm and sanitary sewer lines. Unlike the U.S. Rt. 23 bridge locality, ICI scores for this section of the river were poor to very poor (Table 36). It is difficult to determine if this was the result of the toxics in the sediments or other effect of other human impacts on stream habitat along this stretch of the river. However, Ohio EPA gave QHEI scores of 61.5 and 65.5 for this stretch of the river, scores indicating a habitat that supported reasonably good bottom biotas elsewhere in the river (Table 36).

Olentangy Tributary Streams

In contrast to the good to excellent chemical water quality documented for most of the Lower Olentangy River mainstem, the chemical water quality of many or most of the sampled tributary streams in Delaware and Franklin counties was judged to be only fair or poor (Ohio EPA, 2001). The most frequent exceedences of Ohio Water Quality Standards in these streams were for fecal coliform and *E. coli* bacteria, symptomatic of sewage releases, commonly from CSOs and SSOs. Poor water quality in these streams may also have been exacerbated by drought conditions that existed during the 1999 Ohio EPA field season. These drought conditions led to reduced or non-existent stream flow in these ephemeral waterways, possibly concentrating bacteria and nutrients in isolated stretches of the stream that still retained pooled water.

Highly elevated levels of *E. coli* bacteria exceeding both Primary and Secondary Contact Recreation criterion ($>575/100$ mL) were found in all of the sampled tributaries (Table 37). Bacterial counts ranged from 570 to 6,800/100 mL. The highest levels of both *E. coli* and fecal coliform bacteria were detected near the mouth of Turkey Run [6,800 and 59,000 colonies/100 mL, respectively] in Columbus downstream of the OSU golf course.

Dissolved Oxygen and Nutrient Enrichment

DO levels below the minimum standards for Warm-Water Habitats were detected in Horseshoe Run in Delaware County (3.9 mg/L) and in Adena Brook in Clintonville, Franklin County (2.9-3.6 mg/L). Ohio EPA's proposed statewide criteria for nitrates and phosphorus in WWH stream [Nitrates = 1.0 mg/L; Phosphorus = 0.08 mg/L] were exceeded in most of the tributaries sampled (Table 38). The pesticide Dieldrin was detected in Turkey Run surface water at concentrations exceeding the Ohio EPA Aquatic Life Criteria for this chemical.

Sediments

Elevated levels of heavy metals were detected in sediments of several tributaries. In particular, high concentrations of aluminum, barium, and cadmium were detected in sediments in Rush Run in Worthington and cadmium and zinc in sediments in Adena Brook in Clintonville (Table 39).

Pollution Spills And Fish Kills

Ohio EPA recorded 11 unpermitted releases of toxic or oxygen-demanding substances that occurred in 1999 in the Olentangy River study area. Additional releases since that time include:

- A spill of 4,500 gallons of vinegar from the Marzetti facility into storm sewers leading to Adena Brook in January 15, 2001.

- A May 12, 2000 release of 300 tons of alum sludge from a City of Columbus pipeline break near Bethel Road, impacting an unnamed tributary stream and a roughly $\frac{1}{4}$ to $\frac{1}{2}$ mile stretch of the mainstem of the river across from Kenny Park at Graceland.
- A May 15, 2001 release of 50 gallons of diesel fuel from an overturned dump truck into the Olentangy River mainstem at the Powell Road Bridge just upstream of High Banks Metro Park.
- A September 20, 2001 release of waste oil to the river below the Third Avenue Bridge via a storm drain linking the river to the Timken Company facility to the east off of Cleveland Avenue.

These spills represented potential acute threats to water quality and to the aquatic and terrestrial life that lives in or along these portions of the river and its tributaries.

The Ohio Department of Natural Resources (ODNR) reported six fish kills in the Lower Olentangy River watershed between 1990 and 1999. As can be seen from Table 40, two of these occurred in the Olentangy River mainstem in Delaware County, two occurred in Adena Brook, and two occurred in Turkey Run, with both of the latter two within the Columbus city limits. Fish killed in the two tributary streams were dominated by pollution-tolerant species that make up the bulk of the fish biota in these streams.

Stream Habitat Quality in the Lower Olentangy River Watershed

Lower Olentangy River Mainstem

Ohio EPA evaluated stream habitat [QHEI] at all stations studied along the mainstem of the Lower Olentangy River from the Delaware Dam to the river's confluence with the Scioto River in Columbus. These stretches of the river scored above the Warm-Water Habitat threshold [QHEI = 60] at all sites in Delaware County and at most sites in the northern portion of Franklin County above RM 5.0 (Figure 6-5/Fig. 14 OEPA 2001). The highest habitat scores [QHEI > 75] were obtained at RM 27.9 at Hudson Road, upstream of the Delaware water plant and at RM 19.4 adjacent to the Hyatts Road Bridge along the Scenic River portion of the river, both in Delaware County (Table 34). Habitat quality declines [QHEI < 60] in downstream portions of the river within the Columbus city limits. Some stretches of the river in this area are classified as "Modified Warm-Water Habitats" mainly due to the impacts of low-head dams and local channelization of the river. The lowest habitat score [QHEI = 29] occurred at RM 2.0, immediately upstream of the 5th Avenue dam and adjacent to the OSU campus (Table 34). This stretch of the river has been slowed, straightened, broadened, and deepened, taking on the appearance of a stagnant, mud-bottom pond or lake rather than a free-flowing river.

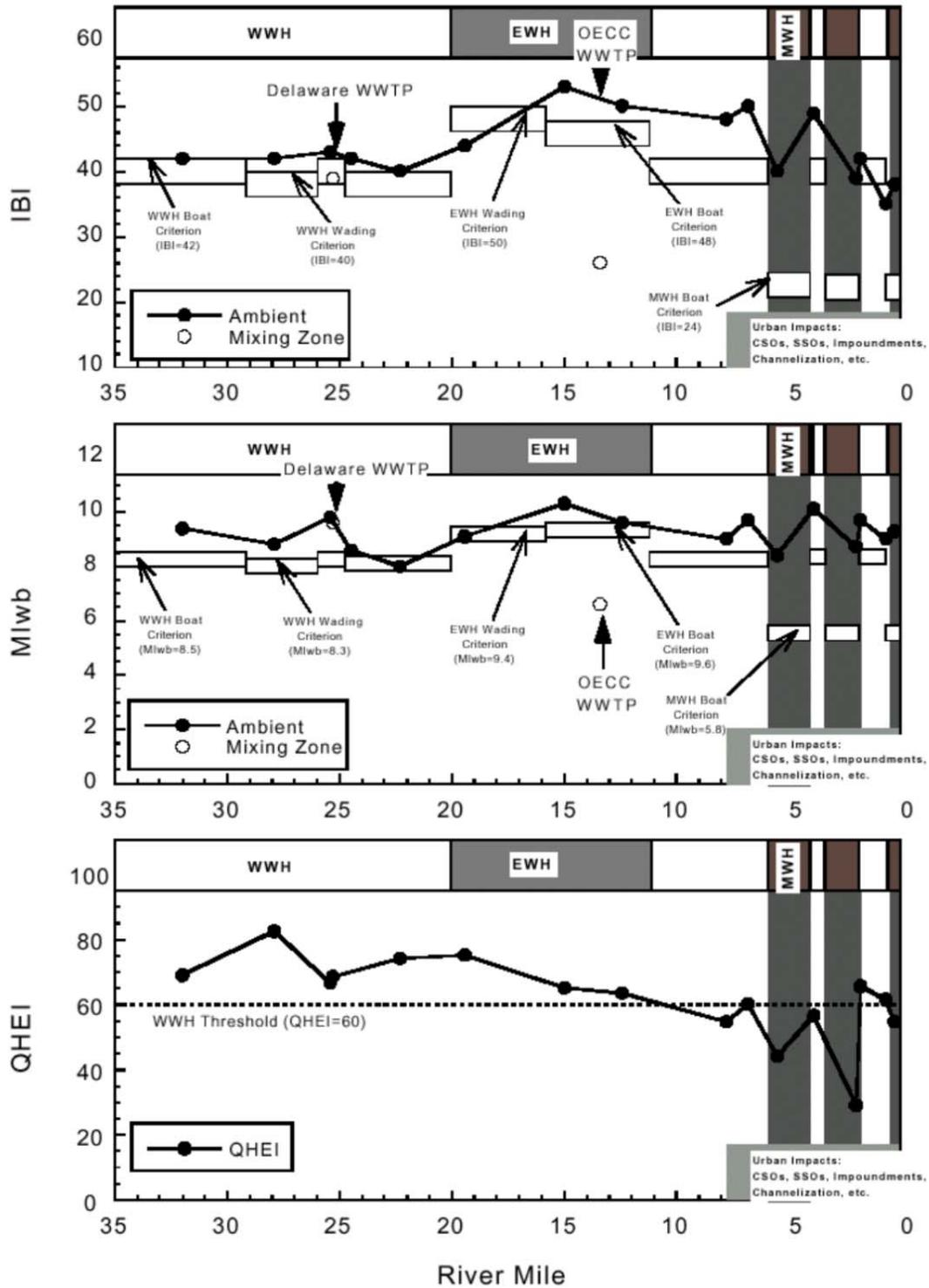


Figure 7-5: IBI, MIwb, and QHEI Scores Longitudinally in the Mainstem
 Source Ohio EPA 1999: "Longitudinal performance of the Index of Biotic Integrity (IBI), Modified Index of well-being (MIwb), and Qualitative Habitat Evaluation Index (QHEI) for the lower Olentangy River, 1999. Solid lines represent the prescribed biocriteria and area of nonsignificant departure supporting the various aquatic life use designations."

Lower Olentangy River Tributaries

Olentangy River tributary streams studied by Ohio EPA in 1999 had highly variable habitat scores. Habitat quality at or just above the WWH minimum [QHEI = 60] was recorded for Horseshoe Run, the upper reaches of Delaware Run, the Lewis Center tributary, all in Delaware County, and for Bill Moose Run in Franklin County (Table 36). All of these streams had unmodified or recovered channels, pool depths > 40 cm, and abundant coarse-grained bottom sediments. All except Horseshoe Run were perennial with stream flow all year round.

Habitat quality was more marginal [QHEI just below 60] for Kempton Run, Linworth Run, and the lower part of Adena Brook, all in Franklin County (Table 36). Kempton Run has a very small drainage area and lacks a diversity of in-stream features. Linworth Run and the lower stretch of Adena Brook during the 1999 field summer season were bone dry without even subsurface interstitial flow and were surrounded by an impervious urbanized landscape.

Habitat quality was judged to be poor [QHEI < 50] for studied portions near the mouth of Delaware Run in the city of Delaware [QHEI = 40], along the studied portion of Rush Run [QHEI = 48.5] in Worthington, and in the upper reaches of Adena Brook in Columbus [QHEI = 43.5]. These studied stream courses were negatively impacted by significant hydromodifications (i.e. channelization) and by their surrounding impervious urban landscapes.

Biological Water Quality in the Lower Olentangy River Watershed

As indicated above, Ohio EPA uses biological criteria as a critical indicator of the water quality of Ohio's rivers and streams. These include measures of fish diversity, abundance, and health -- Index of Biological Integrity (IBI) and the Modified Index of Well Being (MIwb); plus a measure of the diversity and abundance of pollution-sensitive, bottom-dwelling macroinvertebrates (Invertebrate Community Index/ ICI). Fish and invertebrates were sampled and collected from 17 locations along the Lower Olentangy River mainstem and 12 samples were collected from 10 Olentangy tributary streams. These measures were used to evaluate the level of aquatic use attainment for these stretches of the river (Tables 34 to 36, Figure 7-5).

Delaware County River Mainstem

The mainstem of the Olentangy River from just below the Delaware Dam at Main Road (RM 32) to the U.S. Rt. 23 Bridge south of Delaware (RM 22) is classified by Ohio EPA as a Warm-Water Habitat (WWH). Based on collections made during the 1999 Ohio EPA field study, IBI, MIwb, and ICI scores all indicated that this stretch of the river is in full attainment of its Aquatic Life Use designation (Table 34).

The "Scenic River" portion of the mainstem in Delaware County, from the Hyatt Road bridge (RM 20) to just above the I-270 Bridge is classified by Ohio EPA as an Exceptional

Warm Water Habitat (EWH). Two out of three locations studied by Ohio EPA in 1999, the river at the Powell Road Bridge (RM 15) and just above Mt. Air (RM 12.6), were in full attainment of their EWH designation. The Hyatt Road bridge location (RM 19.5) was only in partial attainment of the EWH designation due to slightly subpar fish scores below the EWH minimum. The departure from full attainment of the EWH designation was of a minor nature with the collected fish assemblage judged to be good to very good with a slightly lower number of fish species compared to the other sampled stretches, especially in terms of pollution-sensitive round-bodied suckers and bottom-dwellers including darters, madtoms, and the Northern Hogsucker. Possible causes for this slight decrease in diversity cited by Ohio EPA (2001) included residual effects of effluents from the Delaware WWTP, increased urbanization and suburbanization of upstream portions of the river and its attendant increases in stormwater runoff and sedimentation, plus possibly the effects of the low flow in mainstem due to drought conditions for much of the 1999 field season.

Franklin County River Mainstem

The effects of increasing urbanization along this stretch of the river are evident in the declining index scores and the lack of attainment of aquatic life use designations as you go downstream into the city of Columbus. Ohio EPA did not sample stretches of the Olentangy River in northernmost Franklin County in the Worthington area in 1999. The northernmost locality fully sampled by Ohio EPA was the stretch of the river at Kenny Park, just west of the Graceland Shopping Center, between Worthington and Clintonville.

The stretch of the river in Clintonville between Kenny Park and Whetstone Park (RM 7.7 to RM 6.8), upstream of the North Broadway Bridge, is given a Warm-Water Habitat aquatic use designation by Ohio EPA and was deemed to be in Full Attainment of this classification based on the 1999 field studies. IBI, MIWB, and ICI scores were at or very close to exceptional levels for both of these sites (Table 35). Ohio EPA staff (2001, p. 67) stated that these scores “exceeded ecoregion expectations and were in the range of non-significant departure from Exceptional Warm-water Habitat use criteria.” Specimens of the state-threatened “Bluebreast Darter” were collected from this stretch of the river.

In contrast, just downstream of Whetstone Park and upstream of the North Broadway Bridge at RM 5.5, the river is classified as a Modified Warm-water Habitat. This is due to the some channelization of the river and the ponding effects of a lowhead dam downstream of the North Broadway Bridge. Ohio EPA determined that this stretch of the river was in Full Attainment of its MWH usage designation. Fish scores (IBI =40; MIwb=8.4) were good and just above the minimum level for Warm-water Habitats. The ICI score (= 22), however, was poor, right at the minimum score for MWH, reflecting poor in-stream habitat (QHEI = 44) and the deeper, low-energy silt and muck bottom in this section of the river (Table 35).

Downstream of the Dodridge Road lowhead dam (RM 4.0), the river has a WWH Use designation. At this locality, there is only Partial Attainment of this designation. IBI and MIwb fish scores were in the very good to excellent range but the ICI score (=26) was significantly below the ICI minimum for WWH (ICI=36). Ohio EPA linked the poor ICI score to the increasingly urban nature of the watershed and poor in-stream habitat with the

only shallow areas with good flow being the artificial riprap boulders below the lowhead dam.

At RM 2.0, upstream of the 5th Avenue dam, fish scores were in the good range (39/8.7) but again; the bottom community was greatly impaired (ICI=12). Although this section of the river was given the lesser Modified Warm-Water Habitat designation, it failed to score high enough to meet even this use classification. The river in this area is highly modified, dammed, straightened and channeled, and converted to a stagnant pond adjacent to the OSU campus rather than a free-flowing stream. The impounded, deepening of the river; the effects of CSO/SSO discharges to the river, plus the reduced flow and low-energy bottom conditions again caused this section of the river to be in Non-Attainment of its use designation.

Downstream of the 5th Avenue dam (RM 1.9), the river develops better in-stream habitat with a QHEI score of 65.5 and a WWH designation from Ohio EPA. Although fish scores are very good to exceptional (ICI=42; MIwb=9.7), the river here is only in Partial Attainment of its use designation as the result of an ICI score (=20) significantly below WWH minimum (ICI=36). Bottom biotas are dominated by pollution-tolerant midges and aquatic worms leading Ohio EPA to suggest that the impairment along this stretch of the river was likely due to effects from upstream CSO/SSO outflows and the heavily-urbanized nature of the surrounding land areas.

Downstream portions of the river to its confluence with the Scioto (RM 0.6 to RM 0.2) are designated as WWH by Ohio EPA. The river at the sampled sites, however, was only in Partial or in Non- Attainment of its aquatic use designation at these two sites, respectively. Fish scores were in the good range (IBI = 35/40; MIwb=8.9/9.7) but again; ICI scores were significantly below the WWH minimum (28/12 compared to 36). Ohio EPA attributed the lack of attainment along this stretch of the river to be result of the low current flow, limited in-stream habitat, and silty-muck bottoms typical of this section of the river. The dominance of pollution-tolerant midges and worms and the low numbers of pollution-intolerant EPT taxa again indicate the adverse impacts of sewer and storm-water run-off and possibly discharge of oxygen poor groundwater from the defunct A.C. Humko plant along this heavily urbanized section of the Olentangy River.

While the pollution-intolerant state special interest River Redhorse was collected at RM 0.7, other fish collected along this heavily-urbanized portion of the river show a dramatic increase in “*DELT*” anomalies, deformities, eroded fins, lesions, and tumors (Figure 7-6). Ohio EPA associates the increased presence of these DELTs in fish to increased levels of sub-lethal stress. As indicated in Figure 6-6, the incidence of these anomalies in fish from the Olentangy River shows a longitudinal increase with the highest numbers recorded for fish from the lower-most stations closest to the river’s mouth. Again, this reflects the deleterious effects of intensive urbanization, including general urban run-off, CSOs, and SSOs, on water quality and on the aquatic biotas in the river.

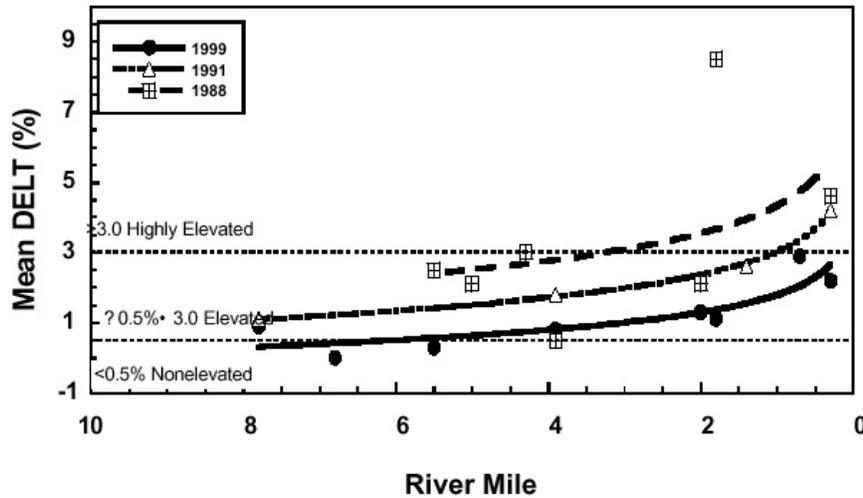


Figure 18 Longitudinal distribution of Deformities, Eroded fins and/or barbels, Lesions, and Tumors (DELT anomalies) throughout the entire length of the lower Olentangy River, 1988-99. Solid lines represent the magnitude of the occurrence based on ecoregional expectations, and calibrated by sample type (Ohio EPA 1989).

Figure 7-6: Distribution of DELTs in Fish in the Olentangy Mainstem.

Source: Biological and Water Quality Study of the Olentangy River and Selected Tributaries, 1999, Delaware and Franklin Counties. Ohio EPA.

Lower Olentangy River Tributaries

The nature of the tributary streams in the Lower Olentangy River watershed (high gradient streams with often ephemeral flows running on impermeable shale bottoms through urban-suburban neighborhoods) causes stressful conditions leading to these streams being home to fish biotas dominated by pollution-tolerant and/or “pioneering” species tolerant of fluctuating marginal water quality conditions. As a result, only one tributary stream, Horseshoe Run in Delaware County, possesses a fish biota consistent with the WWH designation applied by Ohio EPA to these tributary streams. All other Olentangy tributaries studied by Ohio EPA in 1999 failed to support a WWH fish biota with IBI scores evenly split between fair (IBI=30-34) or poor (IBI scores <26).

“Fair” sites included Delaware Run, the Lewis Center tributary, Bill Moose Run, and the lower portion of Adena Brook. Environmentally-sensitive fish species are lacking or rare, with 62% of the collected fish being pollution-tolerant species (Ohio EPA, 2001). All of these streams had perennial flows, even during drought periods like the summer of 1999.

“Poor” fish communities characterized Linworth Run, Kempton Run, Rush Run, Turkey Run, and the upper part of Adena Brook. Fish biotas in these streams had IBI scores that departed significantly from WWH criteria. All stream sites sampled had low diversity faunas with poorly organized fish communities comprised up to 98% by pollution-tolerant species. While several of these streams were ephemeral with intermittent stream flow during summer

months, Ohio EPA (2001) believed that the numerous non-point pollution sources identified adjacent to these largely urban streams were the most important factors impacting these fish biotas.

Quantitative ICI scores were not used to measure the status of macroinvertebrate biotas in the sampled tributary streams. Instead, a qualitative approach based on sampling and observations of faunas on natural substrates was used. This approach focused on the abundance and diversity of pollution-sensitive “EPT” biotas (mayflies, stoneflies, and caddisflies) and a calculated median pollution tolerance measure grading the biotas as good, fair, or poor.

The best stream with regard to ICI scores was the Lewis Center Tributary in Delaware County which was classified as being “Good” with a diverse invertebrate fauna of 36 species, dominated by more pollution-tolerant isopods and flatworms, but with nine identified EPT species (Table 36).

Four tributary sample sites, including Bartholomew Run in Delaware County and Linworth Run, Rush Run, and Bill Moose Run in Franklin County, were judged to have “Fair” invertebrate biotas with moderate diversities (15-25 species) dominated by isopods, midge larvae, and net-spinning caddisflies, with lesser number of EPT taxa (< 4 species).

Poor sites with regard to bottom-dwelling invertebrate biotas included Delaware Run in Delaware, and Turkey Run and the upstream site on Adena Brook, both within Columbus in Franklin County. Biotas were of low diversity (< 15 species) with very few (1-3) EPT species, and were dominated by pollution-tolerant forms including black fly larvae, flatworms, midge larvae, and air-breathing snails.

Table 32: Aquatic Life Use Designations and Minimal Biological Index Scores for the Eastern Cornbelt Plains Ecoregion

Ohio EPA Aquatic Life Use Designations	Index of Biological Integrity (IBI)	Modified Index of Well Being (MIWB)	Invertebrate Community Index (ICI)
Exceptional Warm-Water Habitat	50	9.4/9.6	46
Warm-Water Habitat	40/42	8.3/8.5	36
Modified Warm-Water Habitat	24	5.8/6.2	22

**Table 33: Concentrations of Heavy Metals and Organic Compounds
In Sediments (Parts Per Million) in the Lower Olentangy River Mainstem,
(Ohio EPA, 2001)**

River Mile	Location	Al	Ba	Cd	Cr	Zn	PCBs	Total PAHs
32	Main Road below Delaware Dam	18,300	84.8	0.28	17.4	68.5		
25	Upstrm Delaware WWTP	10,300	75.5	0.27	13.5	65.6		5.78
22.3	U.S. Rt. 23 bridge	46,700**	257*	0.38	46.5*	149		
19.4	Hyatts Road bridge	18,500	126	0.24	22.4	84.5		25.7
13.4	OECC WWTP Mixing Zone	25,100*	156	0.39	28.9	112		
12.4	Upstrm of Mt. Air at county line	14,200	115	0.22	20	69.4		
6.8	Henderson Road bridge	20,900	164	0.73	28.6	187		22.3
2.1	Upstrm 5 th Ave. Dam at OSU	21,800	133	0.67	28.2	177	165	26.6
1.8	Dwnstrm 5 th Ave Dam, Columbus	23,500*	186	0.86	33.2	293*	86.2	549**
0.6	Railroad bridge dwnstrm 3 rd Ave	32,800*	235*	1.31*	46*	292*	315	29.3

* = Highly elevated

** = Extremely elevated

**Table 34: Biological and Water Quality Data for the Olentangy River Mainstem,
Delaware County (Ohio EPA, 2001)**

Rm	Location	IBI	MIwb	ICI	QHEI	Use Design	Attmnt Status	Comments
32	Main Road below dam	42	9.4	34	69	WWH	Full	
25.4	Upstrm city WWTP	43	9.8	n/a		66.5	Full	
25.3	Dwnstrm city WWTP	39	9.6	n/a	n/a	n/a	n/a	Acute toxicity in 4/99; no evidence of neg. impacts
24.5	Olentangy Ave. in Delaware	42	8.6	40	69	WWH	Full	
22.3	US RT 23 bridge	40	7.9	50	74	WWH	Full	Except. ICI, metals spike
19.5	Hyatts Road bridge	44	9.0	52	75	EWH	Partial	Except. ICI & good QHEI
15	Powell Road bridge HBMP	53	10.3	50	65	EWH	Full	Except. Scores all across
13.4	Mixing zone -dwnstrm OECC	26	6.6	n/a	n/a	n/a	n/a	Poor fish scores, no other data, no use/attainment data

n/a: data not available

**Table 35: Biological and Water Quality Data for the Olentangy River Mainstem,
Franklin County (Ohio EPA, 2001)**

RM	Location	IBI	MIwb	ICI	QHEI	Use Design	Atmnt Status	Comments
12.6	Upstrm of Mt. Air	50	9.6	44	63.5	EWB	Full	Except. fish scores +Good ICI
7.7	Kenny Park at Graceland	48	9.0	42	54.5	WWH	Full	Urban impact on QHEI, good IBI +ICI; <i>E. camurum</i>
6.8	Upstrm of Henderson Road bridge	50	9.7	44	60	WWH	Full	Except. fish scores, very good ICI
5.5	Upstrm of N. Broadway bridge	40	8.4	22	44	MWH	Full	Impacted by lowhead dam; very high bacteria
4.0	Dwnstrm of Dodridge Road dam	49	10.1	26	56.5	WWH	Partial	Good fish scores but poor ICI; high <i>E. coli</i>
2.0	Upstrm of 5 th Ave. Dam at OSU campus	39	8.7	12	29	MWH	Non	Urban impacted habitat-poor ICI & QHEI
1.8	Dwnstrm of 5 th Ave. Dam	42	9.7	20	65.5	WWH	Partial	CSO impacts on ICI, toxics in sediment
0.6	Upstrm of RR bridge; upstrm of Long Street	35	8.9	28	61.5	WWH	Partial	Urban impacts, hi <i>E. coli</i> & metals spike in sediment
0.2	Upstrm of confluence with Scioto River	38	9.3	12	54.5	WWH	Non	Fish OK but ICI poor, urban impacts: toxic sediments

**Table 37: Chemical Water Quality in Sampled Olentangy River Tributaries
(Ohio EPA, 2001)**

Tributary	Dissolved Oxygen	Nitrate	Phosphorus	<i>E. coli</i> bacteria	Fecal coliform bacteria
Water Quality Standards (mg/L)	4.0	1.5	0.175	575/100 mL	2,000/100 mL
Horseshoe Run, Delaware Co.	3.9	2.15	0.37	685	
Delaware Run at Delaware		1.16	0.64	697	
Lewis Center Trib, Orange Twp.		2.44	1.35		
Kempton Run,		2.01	0.19	3,100	17,000
Bartholomew Run, Liberty Twp.		0.98	0.15	809	11,818
Linworth Run, Worthington			0.26	1,296	
Rush Run, Worthington			0.13	1,150	
Bill Moose Run, Clintonville			0.16	624	10,636
Turkey Run, Arlington			0.25	6,800	59,000
Adena Brook, Clintonville	2.97	2.32	0.16	945	12,500

Table 38: Chemical Contaminants (Persistent Organics and Metals) in Sediments (Parts Per Million) in Tributary Streams (Ohio EPA, 2001)

Tributary Stream	Al	Ba	Cd	Cr	Zn	PCBs	PAHs
Horseshoe Run	24,800*	166	0.29	22.7	79		
Delaware Run	29,700*	185	0.56	34.5	167		56.7
Bartholomew Run	17,600	105	0.25	22.3	83.6		9.8
Linworth Run	5,670	38.2	0.14	14.7	37.2		
Rush Run	22,600*	267*	1.32*	29.4	224		85.6
Bill Moose Run	4,110	24.6	0.16	13.6	40	131	29.8
Turkey Run	15,800	155	0.87	26.4			96
Adena Brook	17,600	174	1.90**	34.9	353*		141.6

* = Highly Contaminated

** = Extremely Contaminated

Table 39: Fish Kills in the Lower Olentangy River Watershed, 1990-1999 (Ohio EPA, 2001)

Watercourse	River Mile	Known Number of Fish Killed	Date	Chemical and Source
Olentangy River	2.6	10	12/23/92	Unknown chemical whose source was OSU campus
Turkey Run	1.2	142	5/14/93	Fertilizer runoff from an unknown source
Adena Brook	0.9	59	7/15/93	Unknown product and source
Turkey Run	1.2	30	7/20/94	Runoff from the extinguishing of a fire
Olentangy River	26.3	26	9/19/94	Release of chlorinated water from pool at Mingo Park, city of Delaware
Adena Brook	0.4	60	7/05/96	Sewer line break at Whetstone Park