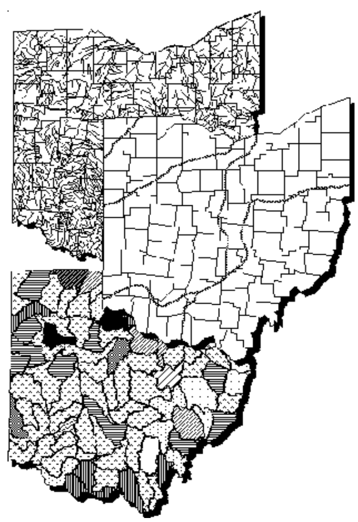
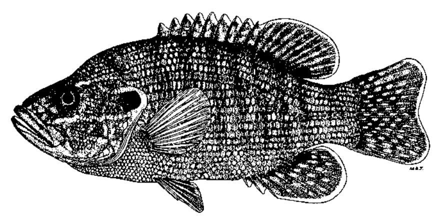
State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of the Toussaint River and Rusha Creek Basins

Ottawa, Sandusky and Wood Counties, Ohio





April 4, 2005

Bob Taft, Governor
Joseph P. Koncelik, Director

Biological and Water Quality Study of the Toussaint River, Toussaint Creek, Packer Creek, Rusha Creek, Martin Ditch and Gust Ditch 2003

Ottawa, Sandusky and Wood Counties

April 4, 2005

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NOTICE TO USERS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Ohio EPA, Division of Surface Water
Ecological Assessment Section
4675 Homer Ohio Lane
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ACKNOWLEDGMENTS

The following Ohio EPA staff are acknowledged for their contribution to this report:

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This evaluation and report was possible only with the assistance of the study team, many full and part time field staff and interns, and the chemistry analysis provided by the Ohio EPA Division of Environmental Services. Property owners who permitted access for sampling are also gratefully acknowledged for their cooperation.

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

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FOREWORD

What is a Biological and Water Quality Survey?

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

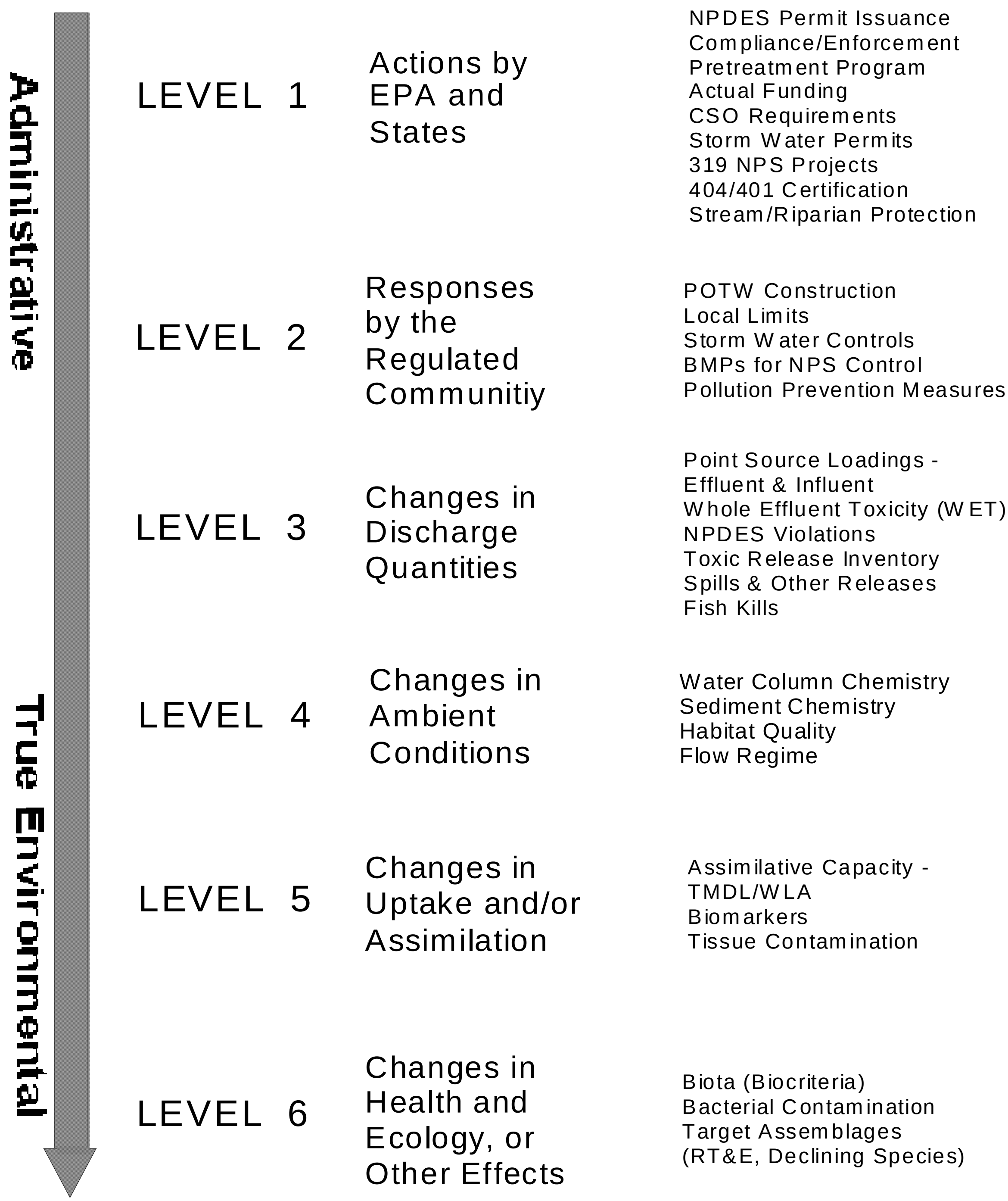
The Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives: 1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if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

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

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators consisting of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach includes a hierarchical continuum from administrative to true environmental indicators (Figure1). 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 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 Agricultural Water Supply (AWS) and Industrial Water Supply (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 are provided to present the varied causes of impairment that were encountered during the Toussaint basin and Rusha Creek study. While the various 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, impacts biological communities directly by limiting the complexity of living spaces available to aquatic organisms. Consequently, fish and macroinvertebrate communities are not as diverse. Indirect impacts include the removal of riparian trees and field tiling to facilitate drainage. Following a rain event, most of the water is quickly removed from tiled fields 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. Erosion impacts channelized streams more severely due to the lack of a riparian buffer to slow runoff, trap sediment and stabilize banks. Additionally, deep trapezoidal channels lack a functioning flood plain and therefore cannot expel sediment as would occur during flood events along natural watercourses.

The lack of water movement under low flow conditions can exacerbate impacts 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. Oxygen is also used by bacteria that decay dead organic matter. Nutrient enrichment can promote 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 allowed for 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 site 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-lot septic 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 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. Urban stormwater is more of a concern if combined sewer overflows are involved. The impact 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 run-off 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 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 be dangerous sources of infection. 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. Some types of viruses that are a concern include polio, hepatitis A, and encephalitis. Disease causing 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 septic 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 and it sometimes seeps into field tiles.

Bacteria criteria 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 cause 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.

The Ohio EPA evaluation of sediment chemistry results are evaluated 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. Due to the dynamics of flowing water, most streams do not contain a lot of sediment and samples often consist mostly of inert sand. 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).

NONPOINT SOURCE POLLUTION IMPACTS AND REMEDIATION PROJECTS

Nonpoint sources of pollution to a water resource are a direct function of surrounding land use. All land use contributes to nonpoint sources of pollution that impair Ohio watersheds. Land use impacts water resources by affecting stream flow, stream habitat, nutrient enrichment, and siltation. Since agriculture occupies about 77% of the land area in the Toussaint and Rusha Creek watersheds, agricultural land uses are responsible for much of the nonpoint source pollution in area streams (USGS-NLCD, 1994). Agricultural land use is a source of nonpoint source pollution as it may increase habitat alteration, nutrient enrichment, siltation and flow alteration. Nonpoint source pollution and land use impacts on water resources in the Toussaint and Rusha Creek watersheds include the following.

A. Impacts to Aquatic Life
- Failure to attain aquatic life uses set in Ohio Water Quality Standards
- Sedimentation impairment to in-stream habitat for fish and macroinvertebrates

C. Impacts to Recreational Water Use
- Primary and Secondary Contact Recreation Uses limited by high bacteria events
- Fish consumption advisory for the entire Toussaint and Rusha Creek watersheds
- Aesthetic impairment from sediment and algal blooms

D. Impacts to Lake Erie through pollutant loading
- Phosphorus loading to Lake Erie
- Suspended sediment degradation to Toussaint River, Rusha Creek and Lake Erie habitat
- Pesticides, nitrates, and other organic chemical pollutants transported by sediment

E. Impacts from Urban Land Use
- Impervious surfaces cause accelerated delivery and runoff volume to the river
- Failing septic systems
- Contaminated storm runoff

Over the past fifteen years, several programs for reducing nonpoint source pollution have been introduced within the Toussaint watershed, including the Conservation Reserve Program (CRP), the Conservation Reserve Enhancement Program (CREP), and Phase I and Phase II of the Toussaint Incentive Improvement Program.

The high amount of agricultural practices affecting water quality throughout the study area indicates that increased participation in these and similar programs is needed. Additional educational and outreach activities may help boost involvement in these programs and thereby reduce the impacts of agricultural practices on water quality.

Biological and Water Quality Study of the Toussaint River, Toussaint Creek, Packer Creek, Rusha Creek, Martin Ditch and Gust Ditch 2003

Ottawa, Sandusky and Wood Counties

State of Ohio Environmental Protection Agency
Division of Surface Water
Lazarus Government Center
122 South Front Street
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INTRODUCTION

During the 2003 field season (June thru October) chemical, physical, and biological sampling was conducted throughout the study area to assess and characterize all of the various potential sources of water quality impairment in the watershed. As a Total Maximum Daily Load (TMDL) basin, the survey incorporated a study design and some assessment techniques which are more comprehensive than a targeted sampling strategy alone would entail. The Toussaint basin and Rusha Creek study area included the Toussaint River, Toussaint Creek, Rusha Creek, Packer Creek, Martin Ditch and Gust Ditch. A map depicting the sampling locations and a list describing the sampling locations and associated road crossings are provided in Figure 1 and Table 1.

Sampling Objectives:

1) Monitor and assess the chemical, physical and biological integrity of the water bodies within the Toussaint River and Rusha Creek study area.

2) Assess the physical conditions present in streams listed in the study plan to identify those which likely function as habitat for fish communities.

3) Evaluate the biological potential in any subsequently identified candidate WWH stream in the study plan.

4) Characterize the amount of aquatic resource degradation attributable to various land uses including agricultural practices and rural community development.

5) Determine any aquatic impacts from identified sources including point source dischargers, and from unsewered communities.

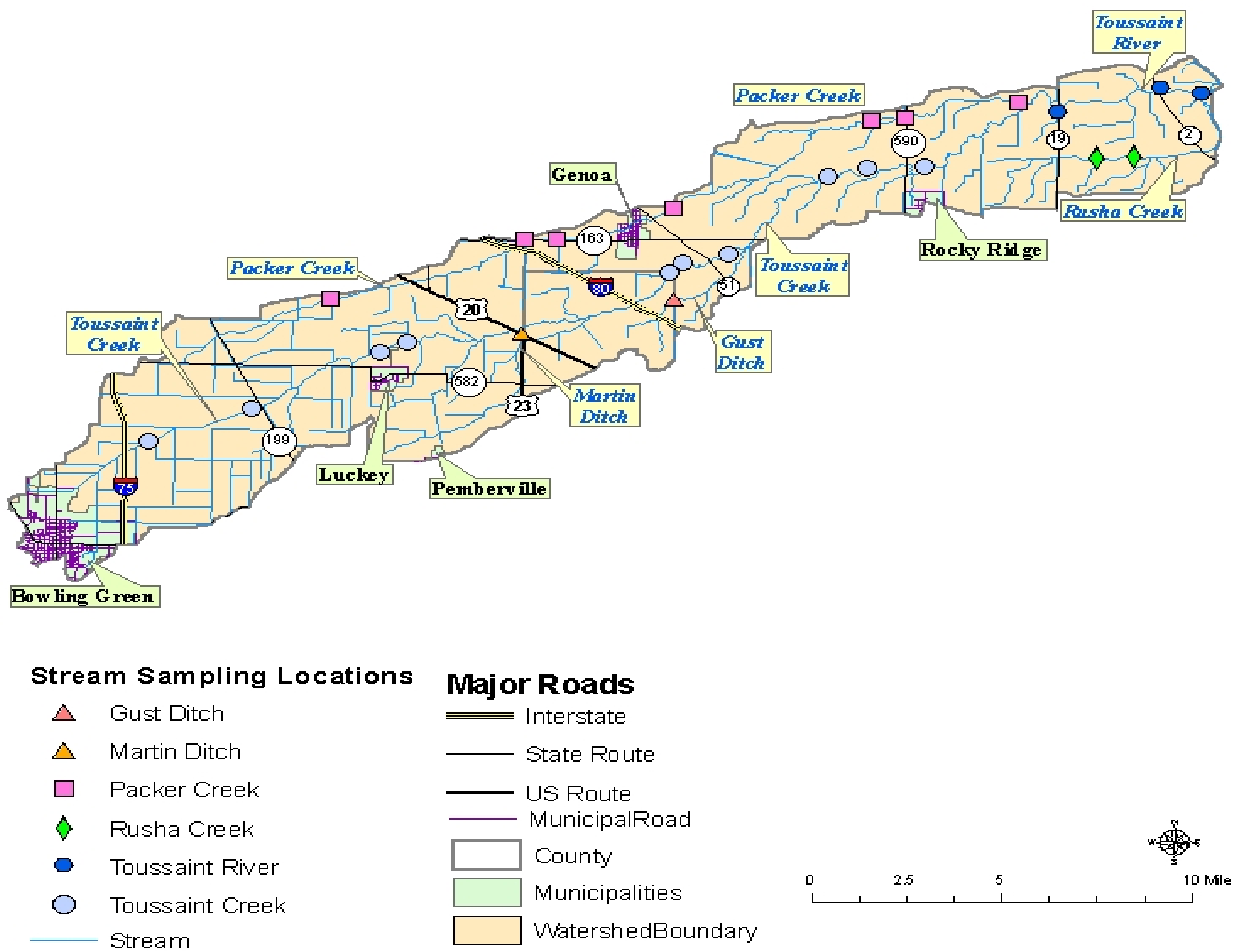


Figure 1. Sampling locations in the Toussaint and Rusha Creek watersheds, 2003.

Table 1. Sampling locations throughout the Toussaint and Rusha Creek Watersheds, 2002-2003. One site collected in 2002 is noted in **bold**

River Mile	Drainage (mi^2)	Site Name/Location
TOUSSAINT RIVER		
4.65	124	State Route 19
1.70	129	State Route 2
0.3	142	Mouth
Toussaint Creek		
36.46	8.0*	Simonds Road
33.52	18.0*	Webster Road
29.37	32	Luckey Road
28.55	34*	Lemoyne Road
20.20	60	Camper Road
19.65	61	Access Road off of Fulkert
18.40	62	Fulkert Road
13.88	76	Graytown Road
12.52	77	Downstream of Stange Road
10.45	81	Harder/Rocky Ridge Road
Gust Ditch (Trib to Toussaint Creek RM 17.85)		
2.76	2.1	Martin Wilson Road
Martin Ditch (Trib to Toussaint Creek RM 25.06)		
0.22	5.8*	Fostoria Road
Packer Creek		
21.16	8.0*	Stony Ridge Road
15.6	15.5*	State Route 163
14.73	16.0*	Billman Road
11.30	19.8	Martin Wilson Road
4.6	29.5	Stange Road
3.45	33	State Route 590
0.14	34	Toussaint North Road
Rusha Creek		
5.02	6.6	Behlman Road
4.0	7	Leutz Road
3.04	10.7	Toussaint South Road

* = Drainage areas are difficult to determine due to ditches crossing over watershed boundaries and connecting with other streams. These drainage areas are estimates based on BPJ.

SUMMARY

Study Area Description

General

The Toussaint basin and Rusha Creek watershed are located in northwest Ohio in portions of Wood, Sandusky, and Ottawa counties that were formerly covered by the Black Swamp. The study area is designated as hydrologic unit code (HUC) 04100010-020 and includes the Toussaint River, Toussaint Creek, Packer Creek, Martin Ditch, Gust Ditch and Rusha Creek. The mainstem of the river is 37 miles long and flows from the north side of Bowling Green in Wood County, northeasterly through Luckey, Genoa, Rocky Ridge and on to Lake Erie through Carroll Township in Ottawa County (Figure 1). In the 2003 biological and water quality survey, 24 sites were assessed in the 143.1 square mile drainage area.

Upstream from its confluence with Packer Creek, the Toussaint has historically been considered a creek. The Toussaint widens as it reaches lake elevation downstream from Toussaint-Portage Road (RM 4.7) in Ottawa County, where it is locally known to become a river. The historical distinction between the Toussaint River and Toussaint Creek will be used in this document to identify sampling locations along the Toussaint. Sites upstream from Toussaint-Portage Road (RM 4.7) will be referred to as existing along Toussaint Creek, while those downstream will be referred to as existing along the Toussaint River.

Several natural areas exist in the lower reach of the study area. One of these areas is the Toussaint Creek Wildlife Area which is managed by the Ohio Department of Natural Resources, Division of Wildlife (http://www.dnr.state.oh.us/wildlife/pdf/pub56.pdf). In addition, the Ottawa National Wildlife Refuge, managed by the US Fish and Wildlife Service, encompasses several federal and state managed marshes and wildlife or recreation areas. These coastal wetlands extend along the Lake Erie shoreline from the eastern boundary of Lucas County to the mouth of the Toussaint River (http://midwest.fws.gov/ottawa/ottfact.html).

Additional coastal marsh areas are located on private property owned by Toledo Edison at the Davis Besse Nuclear Power Station. The 900 acre station has over 700 acres dedicated as a wildlife preserve; this serves as an important migration route for waterfowl, including mallard ducks and Canada Geese (Toledo Edison brochure).

Ecoregion/Soils/Topography

The study area is located entirely in the Huron-Erie Lake Plains (HELP) ecoregion, and more specifically the Maumee Lake Plains. The HELP ecoregion is a broad, fertile, nearly flat plain. When the Great Black Swamp was drained in the late 1800s, northwest Ohio settlers discovered very fertile soils under the deciduous swamp forests. Today most of the area has been cleared and artificially drained for agricultural crop production. Stream habitat and water quality have been degraded by channelization and agricultural activities. In the sub-ecoregion of the Maumee Lake plains, the soils originated from clayey lake deposits and water-worked glacial till. Because of the geologic history of this area and the current land use, Lake Erie water quality experiences high suspended sediment and nutrient loads from northern Ohio agricultural runoff. In the headwaters of Toussaint and Packer creeks, soils formed on water-worked glacial till and are predominantly of the Hoytville, Nappanee, and Blount series. In the lower portion of the study area, Toledo and Latty soils formed in the clayey lake deposits near Lake Erie. These poorly drained soils are not well suited for home septic systems, and all three counties in the watershed report inadequate treatment and many failed onsite sewage systems for rural housing units (USGS, 1997).

Land Use

The study area is predominantly agricultural with 77% of the land in row crop production. Forest and pasture/hay land account for 5% and 11%, respectively, and about 3% of the watershed has been developed in urban or residential land use. Additionally there is approximately 2% open water, and another 2% of land covered by marshes and reconstructed wetlands in the Ottawa National Wildlife Refuge and near the mouths of the Toussaint River and Rusha Creek (USGS-NLCD, 1992).

According to the Census of Agriculture in 2002, land in agricultural use for either row crop or livestock production has been slowly declining since 1980. The number of farms has decreased, as has the number of livestock per operation. This watershed does not currently have any concentrated animal feeding operations over 1000 animal units. The decrease of land in crop production is due to rural development, and may also be reflected in land that has been taken out of production for conservation practices, such as riparian buffer strips, wetland and flood plain restorations (USDA, 1997; OSU Extension, 2002).

Point Sources/Nonpoint Sources/Unsewered Areas

The watershed includes several manufacturing facilities with treated wastewater discharges to area streams. In addition there are also two schools, three dolomite limestone quarries and the villages of Genoa and Luckey which have wastewater treatment facilities. These entities all have NPDES permits for industrial, sanitary, and/or storm water discharges. The Davis Besse Nuclear Power Station is located along the Lake Erie shoreline, near the mouth of the Toussaint River, but discharges all storm water and other treated process wastewater to the lake.

The former Brush Beryllium site in Luckey, now an abandoned industrial site, was evaluated for environmental restoration in 2000-2001. Ohio EPA's Division of Emergency and Remedial Response is working with the US Army Corps of Engineers and USEPA to implement a remedial action plan for cleanup of contamination on the property. A biosassessment was conducted in 2001 to support the remedial investigation of the site under the Formerly Used Sites Remedial Action Program (USACE, 2002).

Agricultural nonpoint sources of impairment include sedimentation, nutrient and organic enrichment, channelization, and physical habitat destruction. Bacteria and organic enrichment impairments were primarily caused by unsewered villages and failing home sewage systems in rural areas. Currently, the Locust Point-Long Beach area and villages of Rocky Ridge, Elliston, Graytown, and Sugar Ridge do not have centralized wastewater treatment facilities; and may be adversely affecting Toussaint Creek. The village of Lemoyne has untreated sewage discharging to Packer Creek from storm sewers. Other unincorporated areas that potentially impact the streams in this watershed include Sugar Ridge, Dunbridge, Dowling, and J&T Mobile Home Park. Critical areas for sewer extensions and septic system replacements are identified in the Home Sewage Treatment System plans for Ottawa and Wood counties (Wood HSTS Plan, 2004; Ottawa HSTS Plan, 2004).

319 grants

There have been two Clean Water Act Section 319 watershed implementation grants administered by TMACOG for riparian corridor restoration in the Toussaint River watershed.

Phase I of the Toussaint Incentive Improvement Program (July, 1997 to June, 2000; $275,000) began in 1997 with a concentrated focus on land adjacent to the main stem of the Toussaint River. Landowners were offered financial incentives to adopt agricultural conservation practices such as conservation tillage, setting aside flood plains, and establishing buffers in concentrated flow areas and stream banks along the 37 mile corridor.

Phase II of the Program (October, 2000 to June, 2004; $300,000) continued these conservation buffer incentives, extending the project area to include all streams in the Toussaint watershed and Rusha Creek. This second grant also provided funds for the Wood County and Ottawa County health departments to develop Home Sewage Treatment System (HSTS) plans to identify critical areas for repair and replacement of rural septic systems that degrade water quality. The grant also offered homeowner education on maintenance of HSTSs, and partial rebates on septic tank pumping for over 100 households.

Over the course of the seven years of grant activities, nearly 75 miles of stream bank in the watershed have been protected with buffers that will reduce sediment and nutrient runoff and improve the water quality and instream habitat. Over 300 contracts for conservation practices were signed with landowners in Ottawa, Wood, and Sandusky counties. The majority of flood plain set aside was accomplished on the lake plains alluvial soils in Ottawa County. Landowners in the small tributaries and headwaters of the Toussaint and Packer installed filter strips along nearly 346,000 lineal feet of stream bank. In Wood County, the Commissioners offered an additional one time incentive of $20 per acre to landowners who signed up for other state and federal buffer programs in 2001. In addition to the 319 filter strips, there was a good response to the Conservation Reserve Enhancement Program (CREP), which was introduced in the western basin of Lake Erie in 2000 and the ongoing buffer improvement Conservation Reserve Programs (CRP) in all three counties.

Watershed Groups

The Section 319 grants were sponsored by the Rural Runoff Action Group of the Maumee RAP. The RAP is a Remedial Action Plan for restoration of the Lower Maumee River, one of 42 Great Lakes Areas of Concern. The Rural Runoff action group is a partnership of more than one dozen agencies and private organizations who contributed cash and in-kind service match for the grants.

A watershed action plan is being developed for the Toussaint and Packer watersheds along with four other subwatersheds of the Lower Maumee River Basin. The effort is led by the Maumee River watershed coordinator, with collaboration from several agencies and Maumee RAP partners. The draft plan was submitted in December 2004 for State endorsement by ODNR and Ohio EPA. The watershed action plan will be revised or updated as needed when additional water quality or TMDL assessment information is available. It is anticipated that implementation of recommendations in the watershed plans may reduce the number or extent of TMDLs required by USEPA for watersheds other than the Toussaint and Packer which are not scheduled for assessment until 2011.

Aquatic Life Use Attainment Status and Trends

During the 2003 field sampling, an assessment of aquatic life uses occurred at 24 sites ranging in drainage area from 2.1 mi^2 to 142 mi^2 (Table 1). The Aquatic Life Use Attainment table (Table 2) provides biological metric scores along with causes and sources of impairment for each site. Eleven (45.83%) of the sites fully met either the currently designated or the recommended use. Two (8.33%) of the sites partially met and eleven (45.83%) of the sites were not attaining their designated or recommended use (Figure 2 and Table 3). The primary sources leading to impairment were high intensity agricultural land use activities, failing septic systems and the Luckey wastewater treatment plant.

The Watershed Assessment Unit (WAU) spatial attainment score was 36.11, the WAU linear attainment score was 29.65 and the overall WAU aquatic life use attainment score based on data collected in 2003 was 32.88 (Table 3). An overall attainment score of 0 would reflect 0 sites meeting designated or recommended aquatic life uses in the WAU while a score of 100 would reflect all sites meeting designated or recommended aquatic life uses. The linear attainment score, spatial attainment score and overall attainment score were calculated according to the protocol established in the 2004 Integrated Water Quality Monitoring and Assessment Report, which is available at:
http://www.epa.state.oh.us/dsw/tmdl/2004IntReport/2004OhioIntegratedReport.html

Several data sets were available to assess environmental condition of the Toussaint mainstem over time. These data included fish survey results from 1979, 1987, 1993, and 2003 (Figure 3a and 3b). Historically, sampling was limited to discrete portions of the mainstem and no previous efforts evaluated the entire Toussaint mainstem. Therefore, the analysis of trends examined several historical segments and stations and compared the results with similar river reaches or stations evaluated in 2003.

Longitudinal plots of biological community index scores versus river miles for all the years sampled show a few areas consistently performing below WWH expectations

(Figure 3a). The biological communities present in the headwaters do not meet WWH criteria due to the historical and current habitat alterations through agricultural practices including channelization and riparian removal activities. The second area of impairment was noted downstream from the Luckey wastewater treatment plant. A third area of impairment was observed between Elliston and Graytown. Recent channelization and 'cleaning' activities may be partially responsible for the low biological scores. However, this area should be investigated for potential unknown point sources that may be affecting water quality. The lacustuary area showed the final area of impairment, which is a cumulative result of upstream agricultural activities occurring throughout the watershed.

The stretch of Toussaint Creek from Camper Road (RM 20.3) to Fulkert Road (RM 18.4) included the most frequently sampled sites in the Toussaint basin (Figure 3b). These sites bracket the Genoa wastewater treatment plant. An examination of the IBI and MIwb scores for this area indicates that biological communities have generally improved over time. Genoa began a ten year project to separate combined sewers in the early 1990s. This project was completed in 2002. While individual sites in this area have improved over time, biological community performance continues to decline downstream from the Genoa wastewater treatment plant. This may be partially attributed to the wastewater treatment plant itself, but also may be attributed to failing on-site septic systems, a decrease in habitat quality and siltation.

An examination of QHEI scores by drainage area of the Toussaint and Rusha Creek watersheds indicates that the majority of very poor habitat areas may be found in streams with $<10mi^2$ drainage area (Figure 4). Agricultural practices, including riparian cover removal, channelization, and dredging, have resulted in a degradation of available habitat to instream biological communities. The effects of these practices are noted not just where they occur in the headwaters, but also in the historically altered lacustuary areas. Though habitat quality improves as drainage area increases, the only sites scoring as 'good' were on Toussaint Creek near Fulkert Road (RM 19.7). The highly modified conditions present throughout the majority of the study area have resulted in a degradation of available habitat to instream biological communities.

Very little earlier macroinvertebrate data were available for the study area. The one regional reference site sampled in 1999 in Toussaint Creek at RM 20.0 reflected good community conditions based on multi-habitat qualitative sampling. A 2003 site sampled just upstream at RM 20.4 scored an ICI of 42 (Very Good). The 2003 score reflected an incremental improvement in community quality which was likely attributed to the work ongoing in the Toussaint River watershed. With the high level of participation in the Toussaint River Improvement Incentive Programs, an estimated 68-69,000 tons of sediment have been prevented from reaching the river since 1997 (via filter strips, decreased flows, and conservation tillage). An estimate of 274 tons of phosphorus and 56 tons of nitrogen has been kept on the farmland and out of the river and Lake Erie (Toussaint River Improvement Incentive Programs, 2004). With continued conservation efforts and habitat improvements, water quality in the upper and middle Toussaint watershed will continue to improve.

The historical lacustuary data showed macroinvertebrate quality was habitat and location dependent. Two lower lacustuary sites (RMs 0.3 and 0.6) were sampled in 1995 and 1996, respectively. These lower sites supported much better communities (ICI score = 28 and 30) due to influence from encroaching Lake Erie water which lessens some of the sediment and nutrient effects from upstream. Sites further upstream were in extensive mud flats (RMs 1.4 and 3.4 in 1996 and 1995, respectively) and scored ICI values of 10 and 12, respectively (poor). Extensive sedimentation and nutrient enrichment limited community diversity and macroinvertebrates were predominated by pollution tolerant aquatic worms. The sample at RM 4.7 in 2003 also scored a 12 (poor) with a nutrient enriched community predominated by more midges than worms. Decreased inputs of point and nonpoint sources of nutrients and sediment need to continue along with habitat restoration in the upstream areas of the watershed to improve the downstream lacustuary macroinvertebrate communities.

Recreation Use Attainment Status

The recreation use status throughout the Toussaint watersheds was assessed by bacterial sampling. The recreation use evaluation table (Table 4) lists exceedances of the recreation use criteria, and not necessarily violations of the Ohio Water Quality Standards criteria. The results from the sampling indicated elevated bacterial levels throughout each watershed, potentially impairing the designated or recommended recreation use.

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 from on-lot septic systems, are a more continuous problem. Exceedances noted throughout Genoa indicated potential concerns with on-site septic systems. The Luckey WWTP is known to combine storm water with sanitary wastewater resulting in discharges of raw or partially treated sewage to Toussaint Creek. The village of Luckey has submitted plans to Ohio EPA to separate their wastewater collection system. In addition, failing septic systems near unsewered communities including Elliston, Graytown, and Rocky Ridge likely influenced the high bacterial counts noted throughout the study area.

Animal sources 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. Though no large livestock farms were noted during the survey, such operations do 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 and may seep into field tiles.

Public Water Supplies

None of the public water supplies within the study area receive water directly from surface waters within the Toussaint and Rusha Creek basins. At this time, the Public Water Supply designation does not apply to any surface waters within the study area. Therefore, an assessment of this use was not completed. However, as many communities receive their drinking water supplies from Lake Erie, into which the Toussaint and Rusha

Creek drain, improvements in water quality throughout the study area should benefit downstream water quality.

Chemical Water Quality

Chemical and physical water quality was assessed at 19 locations throughout the Toussaint basin. The chemical water quality of Rusha Creek was not assessed as the stream is strongly influenced by seiches. Surface water grab samples were analyzed for organic, inorganic metals and nutrients. Dissolved oxygen levels, pH and temperatures were recorded in the field at each sampling location. At the majority of sites, six sampling runs were conducted on two-week intervals. Organic samples were only collected twice at selected sites. Fecal coliform bacteria samples were collected three times at most sites during the survey. Chemical water quality values which exceeded established criteria but did not necessarily represent violations of the Ohio WQS are presented in Table 5. However, exceedances do indicate potential for aquatic life and recreation use impairments.

Overall, the free flowing segments of the Toussaint mainstem and its tributaries exhibited fair chemical water quality, though high nutrients, low dissolved oxygen (D.O.) and fecal contamination were noted in several areas. High nutrient measurements and low D.O. were associated with sewered communities such as Luckey, but also the unsewered communities of Elliston, Graytown, and Rocky Ridge. In these areas, water quality has been adversely influenced by elevated nutrient concentrations and fecal coliform bacteria levels. Heptachlor epoxide was detected at several locations, but was consistently below the Tier I criterion for the protection of human health. The organochlorine pesticide alpha-BHC was detected at several locations, but was above the Tier I criterion for the protection of human health at only one location. Strontium levels exceeded the Tier II, Outside Mixing Zone Maximum (OMZM) at numerous sites. Though the presence of strontium was likely a result of natural background conditions, sites with higher concentrations were likely influenced by groundwater discharge from stone quarry operations.

The lacustuary sites of Packer Creek and the Toussaint River exhibited better chemical water quality overall than the free flowing portions of the study area. Nitrate+nitrite median values were at or below the ecoregional target value of 0.1 mg/l as determined by Ohio EPA (Ohio EPA, 1999). Strontium levels still exceeded the Outside Mixing Zone Average (OMZA) criterion, but were typical of background conditions within HELP ecoregion.

Sediment Quality

Sediment data were evaluated using guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald *et al*. 2000). The consensus-based sediment guidelines define two levels of ecotoxic effects. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed. In addition, the Ohio Sediment Reference Value represents ecoregion background conditions based on data collected at Ohio reference sites.

The chemical sediment quality was assessed at 6 locations throughout the Toussaint and Rusha Creek basins. Sediments selected for sampling consisted mainly of fine silts and clays, which are generally associated with persistent environmental contaminants. Chemical quality of sediment is a concern because many pollutants bind strongly to soil particles, are persistent in the environment, and accumulate in the food chain.

Sediment grab samples were analyzed for inorganic metals, semi-volatile organics, polychlorinated biphenyls (PCBs), and pesticides. Sediments with chemical concentrations reported above the Consensus-Based Probable Effect Concentration (PEC) and/or the Ohio Sediment Reference Value may result in negative environmental impacts and warrant further evaluation. Results of sediment samples are summarized in Table 7. Organic parameters were only reported if detected above the analytical method detection limits. No semi-volatile organics were detected.

Throughout the Toussaint and Rusha Creek watersheds, sediment quality was good with little to moderate chemical contamination. Though exceedances of various metals occurred, no indications of potential significant environmental impairment from metals contained in sediment were noted. However, one organochlorine pesticide, 4,4'-DDE, was recorded at a concentration of 14.8µg/l which exceeded the TEC. DDE is a breakdown product of the insecticide DDT and was identified in Rusha Creek at Toussaint South Road (RM 3.04).

Fish Tissue

Throughout the state of Ohio, there is a limit of no more than <u>one meal per week</u> of any sport fish due to mercury contamination. At the time of this report, no additional advisories are in place for the Toussaint and Rusha Creek basins. For additional information related to the Fish Consumption Advisory, see the 2004 Fish Consumption Advisory report available at **http://www.epa.state.oh.us/dsw/fishadvisory/index.html**.

Spills

Four spills were reported from 1995-2005 within the study area, though only two were reported to have resulted in fish kills (Figure 5). The spills primarily involved the loss of petroleum products, though one also involved an over-turned tanker which lost its load of chlorine tablets into Packer Creek. The majority of the spills occurred as a result of equipment failures and traffic accidents. Both fish kills occurred near Packer Creek, one from a traffic accident along the stream at RM 14.7 (the over-turned tanker truck) and the other involving diesel fuel leaked from a tank at a residence and pumped into a tributary along Packer Creek near RM 8.9. Another traffic accident released motor oil into a tributary of the Toussaint River near Duffa Washa Road and the final spill report involved an unknown substance present in Toussaint Creek near Lemoyne Road (RM 28.6).

Table 2. Aquatic life use attainment status for stations sampled in the Toussaint and Rusha Creek basins based on data collected July-October 2003. One site collected in 2002 (noted in **bold**) is included for a lacustuary site not sampled in 2003. 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] (LICI)[c]**	**QHEI**	**Attainment Status[d]**	**Causes**	**Sources**
Toussaint Creek			*WWH*				
36.5^{H}	20*	NA	F*	25.5	**NON**	Habitat alterations, Nutrient and organic enrichment Siltation	Riparian removal /Channelization-Ag. Failing septic systems
33.5^{H}/33.6	30	NA	38	42.5	FULL		
29.4^{W}	28^{ns}	7.2	32^{ns}	59.0	FULL		Luckey WWTP inputs raw sewage
28.6^{W}/28.5	27*	8.0	VG	49.5	**NON**	Siltation Nutrient and organic enrichment	Agriculture - Row crop Luckey WWTP
20.2^{W}/20.4	33	6.9^{ns}	42	57.5	FULL		
19.7^{W}/19.6	34	7.3	42	71.5	FULL		
18.4^{W}/18.5	29^{ns}	6.4*	$38/32^{ns}$	42.0	PARTIAL	Siltation	Agriculture - Row crop Genoa Quarry
13.9^{W}/14.0	27*	5.9*	24*	50.5	**NON**	Habitat alterations (channelization) Possible historical fish kill?	Channelization Unknown source, see page 7
12.5W/12.6	28^{ns}	5.7*	32^{ns}	34.0	**NON**	Siltation Habitat alteration Nutrient Enrichment	Recent woody removal and dredging Septic systems
10.5W	35	8.2	36	51.5	**FULL**		
Toussaint River			*WWH (Lacustuary)*				
--/**4.7**			(12*)		(**NON**)	Siltation Nutrient enrichment	Agriculture - Row crop
1.7^{O}	22.5*	6.2*			(**NON**)	Siltation Nutrient enrichment	Agriculture - Row crop
0.3^{O}	38	8.2^{ns}			(FULL)		

Table 2 (continued)

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI[b] (LICI)[c]	QHEI	Attainment Status[d]	Causes	Sources
Packer Creek			*WWH*				
21.2[H]	21*	NA	G		**NON**	Siltation Nutrient enrichment	Agriculture - Row crop Channelization
15.6[H]/--	18*	NA	---	29.0	**(NON)**	Siltation Nutrient and organic enrichment	Failing septic systems?
14.7[H]	32	NA	G	27.0	FULL		
11.3[H]	30	NA	G	28.0	FULL		
–/4.6	–	–	36	51.0	FULL		
3.5[W]	36	9.1	44	42.0	FULL		
0.2[A]	23*	7.4*	F	26.5	**NON**	Siltation Nutrient enrichment	Agriculture NPS run-off Channelization
Rusha Creek			*WWH Existing/Recommended MWH*				
5.0[H]/--	18*	NA	F*	29.0	**NON**	Siltation Nutrient enrichment	Channelization Agriculture - Row crop
4.0[A]/3.0	21*	4.8	(F*)	16.0	**NON**	Siltation Nutrient enrichment	Channelization
Martin Ditch		*Undesignated/Recommended WWH*					
0.2[H]	24[ns]	NA	MG[ns]	27.5	FULL		
Gust Ditch		*Undesignated/ Recommended PHWH [g]*					
2.8[H]	16	NA	NA	44.5	--	Natural	Ephemeral stream (Class 1 PHWH)

Ecoregion Biocriteria: Huron-Erie Lake Plain

	IBI			MIwb			ICI		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	28	50	20				34	46	22
Wading	32	50	22	7.3	9.4	5.6	34	46	22
Boat	34	48	20	8.6	9.6	5.7	34	46	22

H - Headwater site.
W - Wading site.
B - Boat straight electrode array.
O - Boat electro-sphere
a - MIwb is not applicable to headwater streams with drainage areas ≤ 20 mi^2.
b - A qualitative narrative evaluation based on best professional judgment and sampling attributes such as community composition (e.g., abundance of pollution sensitive taxa), EPT taxa richness, and total taxa richness scores was used when quantitative data were not available or considered unreliable due to sampling considerations (e.g., inadequate current velocity).
c - Lacustuary Invertebrate Community Index (LICI)
d - Attainment status is given for both existing and proposed use designations; status based on one organism group is parenthetically expressed.
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.
e - Low flows precluded use of boat method on the second pass.
f - Modified Warmwater Habitat criteria for channel modified habitats.
g - This small stream can be best characterized as a Class III Primary Headwater Habitat (PHWH) water body as defined by a recent Ohio EPA technical document (Ohio EPA 2002). As such, no attempt has been made to determine attainment status since this use has not yet been promulgated in the Ohio Water Quality Standards. When the PHWH use becomes codified, this stream will be assigned an appropriate aquatic life use utilizing the Ohio EPA rulemaking process established for designating aquatic life uses for Ohio streams.

Table 3. Aquatic life use attainment status for the Toussaint Watershed Assessment Unit - 04100010 020 based on sampling conducted in 2003. The assessment unit score is an average grade of aquatic life use status. The method of calculation is presented in the 2004 Integrated Water Quality Monitoring and Assessment Report (www.epa.state.oh.us/dsw/tmdl/2002). The attainment status of recommended uses was used in lieu of existing uses when calculating the WAU score, when applicable. A maximum assessment unit score of 100 is possible if all monitored sites meet designated aquatic life uses.

WAU: **04100010 020,** Toussaint Watershed (Toussaint mainstem, Packer Creek and Rusha Creek)

Stream Names: *Toussaint Creek, Rusha Creek and Packer Creek*

Data Collected:2003. Integrated Report (IR) category: **5**

04100010 020 Toussaint Watershed (Toussaint mainstem, Packer Creek and Rusha Creek)			
Attainment Categories for sites ≤50mi²	Data Group 1 ≤5mi²	Data Group 2 >5mi² to ≤20mi²	Data Group 3 >20mi² to ≤50mi²
Number of sites in FULL attainment	0(a)	4(a)	2(a)
Total Number of sites	0(b)	9(b)	4(b)

WAU Spatial Attainment Score Calculation:

Data Group 1 ≤ 5 mi²	Data Group 2 > 5 mi² to ≤ 20 mi²	Data Group 3 > 20 mi² to ≤ 50 mi²	Spatial Score

$$\frac{\frac{(a/b + a/b)}{2} + (a/b)}{2} * 100 = c$$

where
a = number of sites in full attainment
b = number of sites in data group
c = spatial attainment score for WAU

WAU Spatial Attainment Score = **36.11**

WAU Linear Attainment Score

04100010 020 Toussaint Watershed (Toussaint mainstem, Packer Creek and Rusha Creek)			
Attainment Categories for sites ≥50mi²	Total number of miles >50mi²	Number of miles >50mi² in FULL attainment	Percent of miles >50mi² in FULL attainment
Toussaint mainstem, 0.3 to 20.20	19.9(a)	5.9(b)	**29.65%**

WAU Linear Attainment Score is calculated by the following expression: (a/b)*100
The Linear Attainment Score for WAU 04100010 020 is **29.65**.

The WAU Attainment Score is calculated by averaging the WAU Linear Attainment Score with the WAU Spatial Attainment Score. For WAU 04100010 020, the overall attainment score is **32.88**.

04100010 020 Toussaint Watershed (Toussaint mainstem, Packer Creek and Rusha Creek)							
Site size vs. type	Total	EWH	WWH	MWH	LRW	CWH or SSH	Mix Zone(s) (excluded from assessment)
Number of sites ≤50mi²	14*	0	12	2	0	0	0
Number of sites ≥50mi²	9	0	9	0	0	0	0
Size of smallest sampled drainage area in HUC: 2.1 mi²				Size of largest sampled drainage area in HUC: 142 mi²			

* Gust Ditch is not included in the total, as it will remain undesignated since Ohio does not have PHWH aquatic life use designations available for these small streams.

Table 4. Recreational use exceedances of the Ohio Water Quality Standards criteria (Ohio Administrative Code 3745-1-07, Table 7-13). Units for fecal coliform bacteria are #/100 ml. Recreational use designations within the study area include: Primary Contact Recreation (PCR).

Stream/River Mile	**Use Designation**	**Fecal Coliform Result**
Toussaint Creek		
20.20	PCR	4000 [a], 1200 [b], 1300 [b]
19.65	PCR	1500 [b]
18.40	PCR	1800 [b], 1400 [b]
13.88	PCR	1400 [b], 1500 [b], 1000 [b]
Toussaint River		
10.45	PCR	2200 [a]
Packer Creek		
21.16	PCR	1000 [b]
Martin Ditch		
0.22	none	2200[a], 5200 [a], 1600[b]

a – Exceeds PCR maximum criteria for protection of recreational use.
b – Exceeds PCR geometric mean criteria for protection of recreational use.

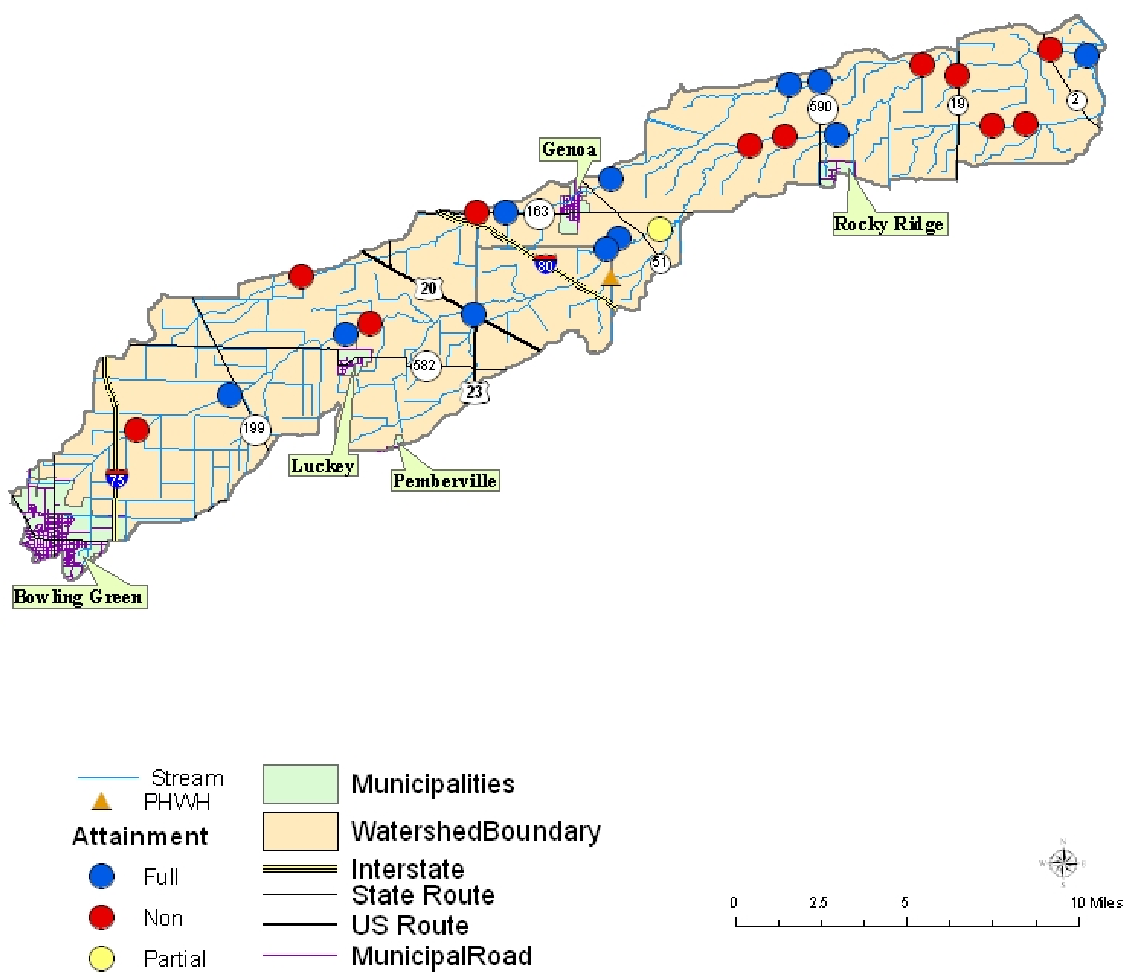


Figure 2. Toussaint and Rusha Creek basins sampling sites color coded by aquatic life use attainment status.

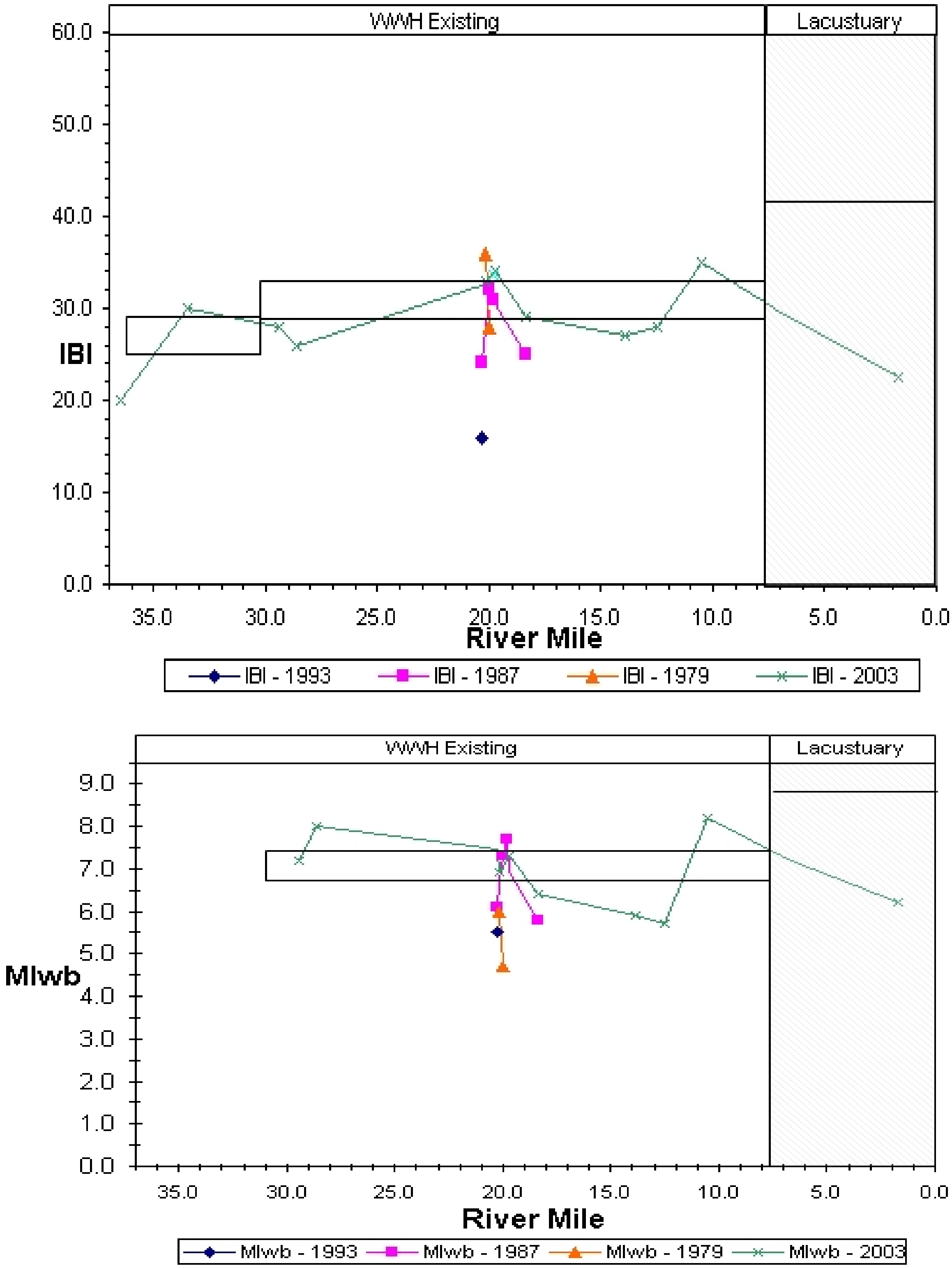
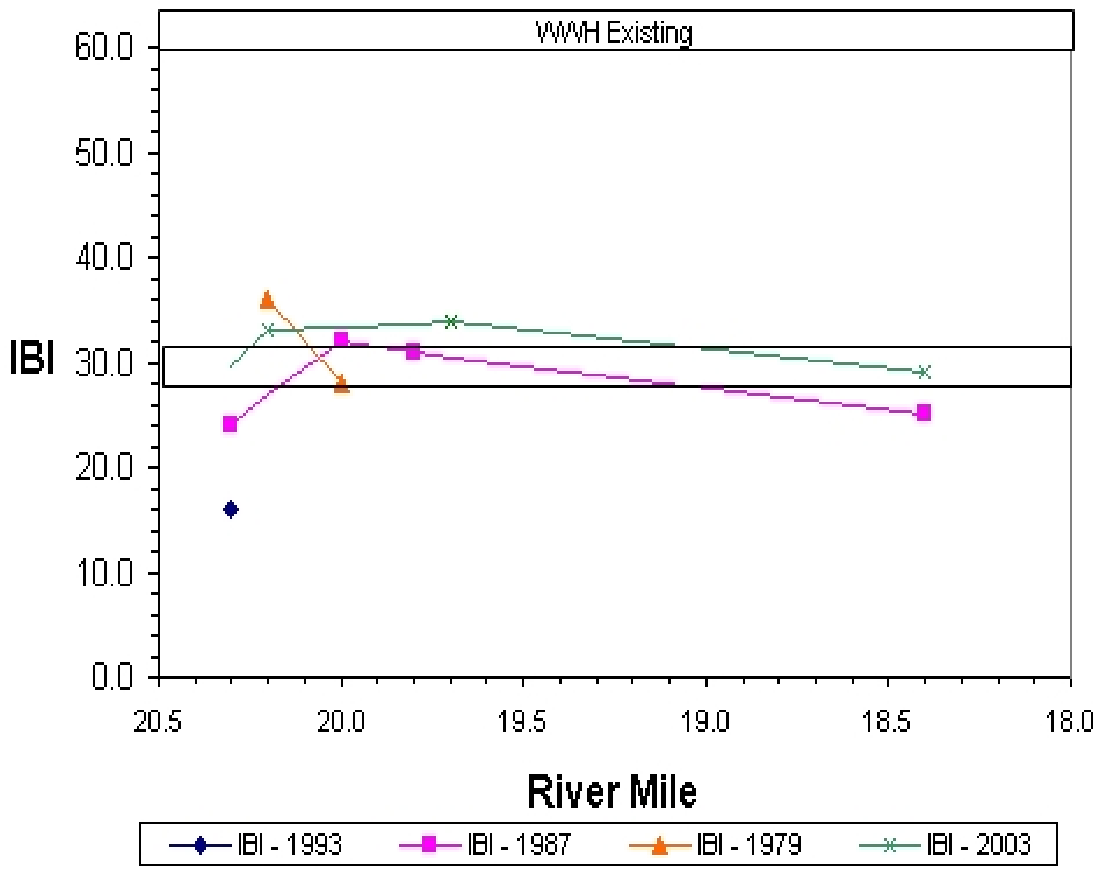


Figure 3a. Longitudinal plots of fish biological community scores versus river mile of the Toussaint mainstem for 1979, 1987, 1993, and 2003.



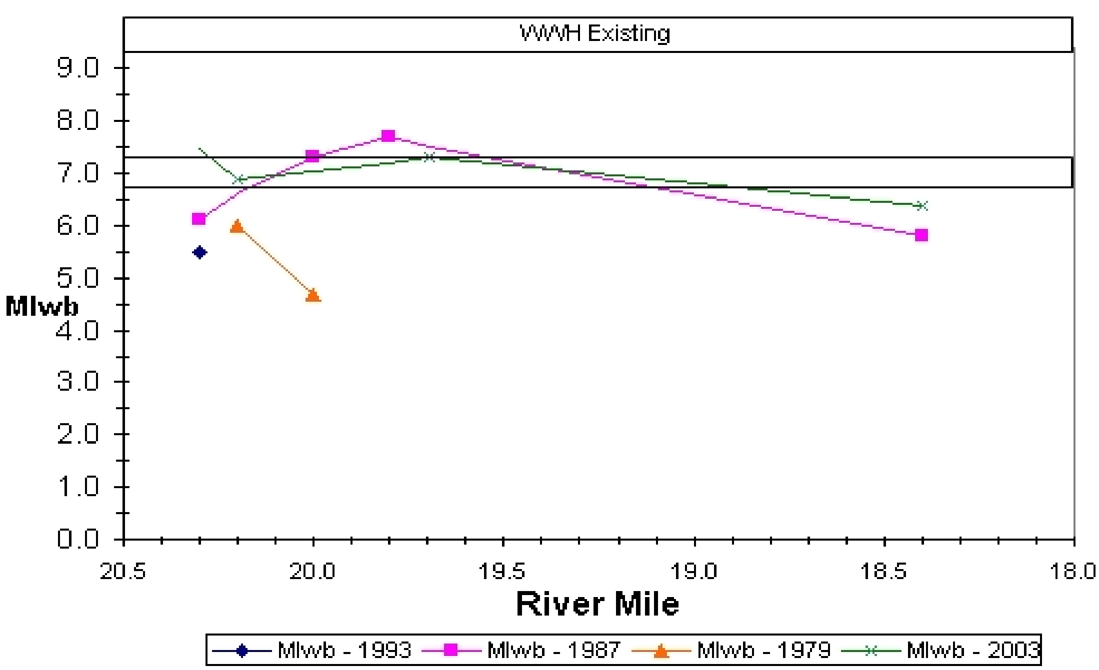


Figure 3b. Longitudinal plots of fish biological community scores versus river mile of the Toussaint mainstem between river miles 18.0 and 20.5 for 1979, 1987, 1993, and 2003.

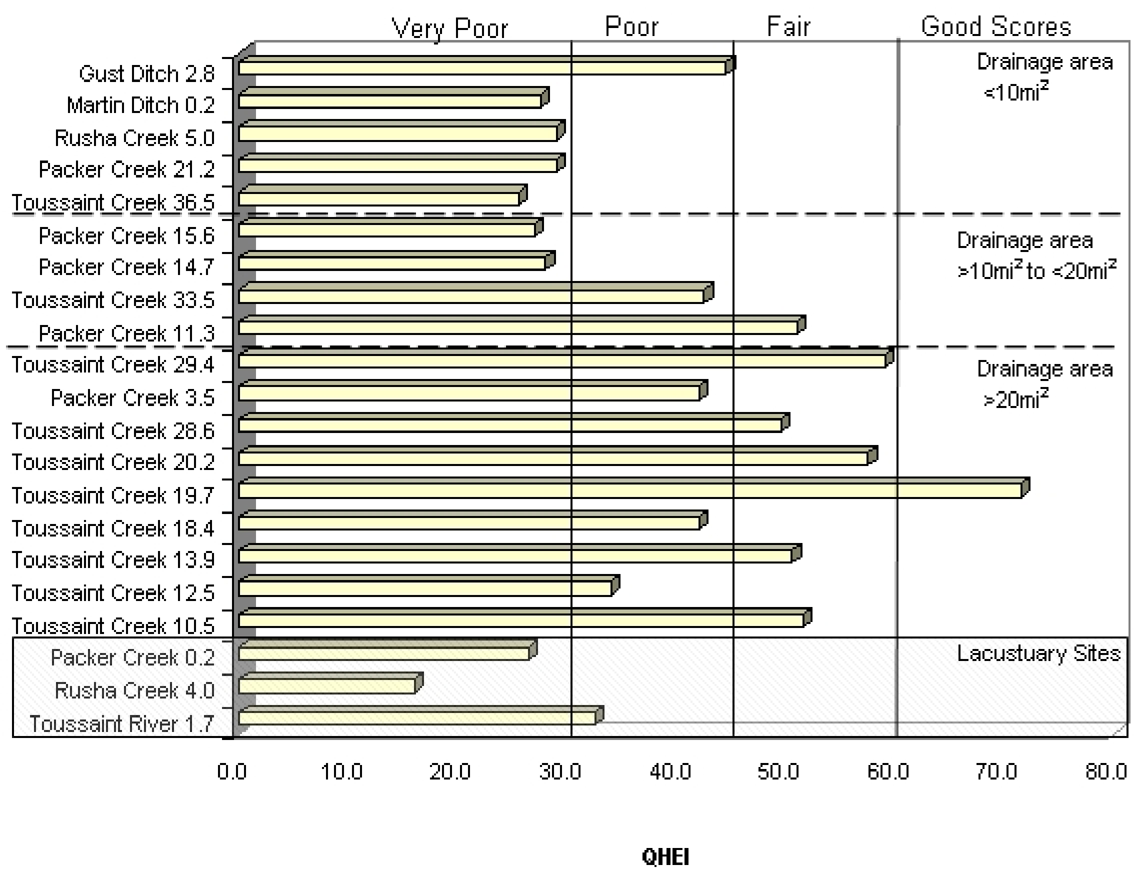


Figure 4. QHEI scores of the Toussaint and Rusha Creek basins arranged by drainage area. Poor habitat conditions occur most often in streams with <10mi^2, or the lacustuary.

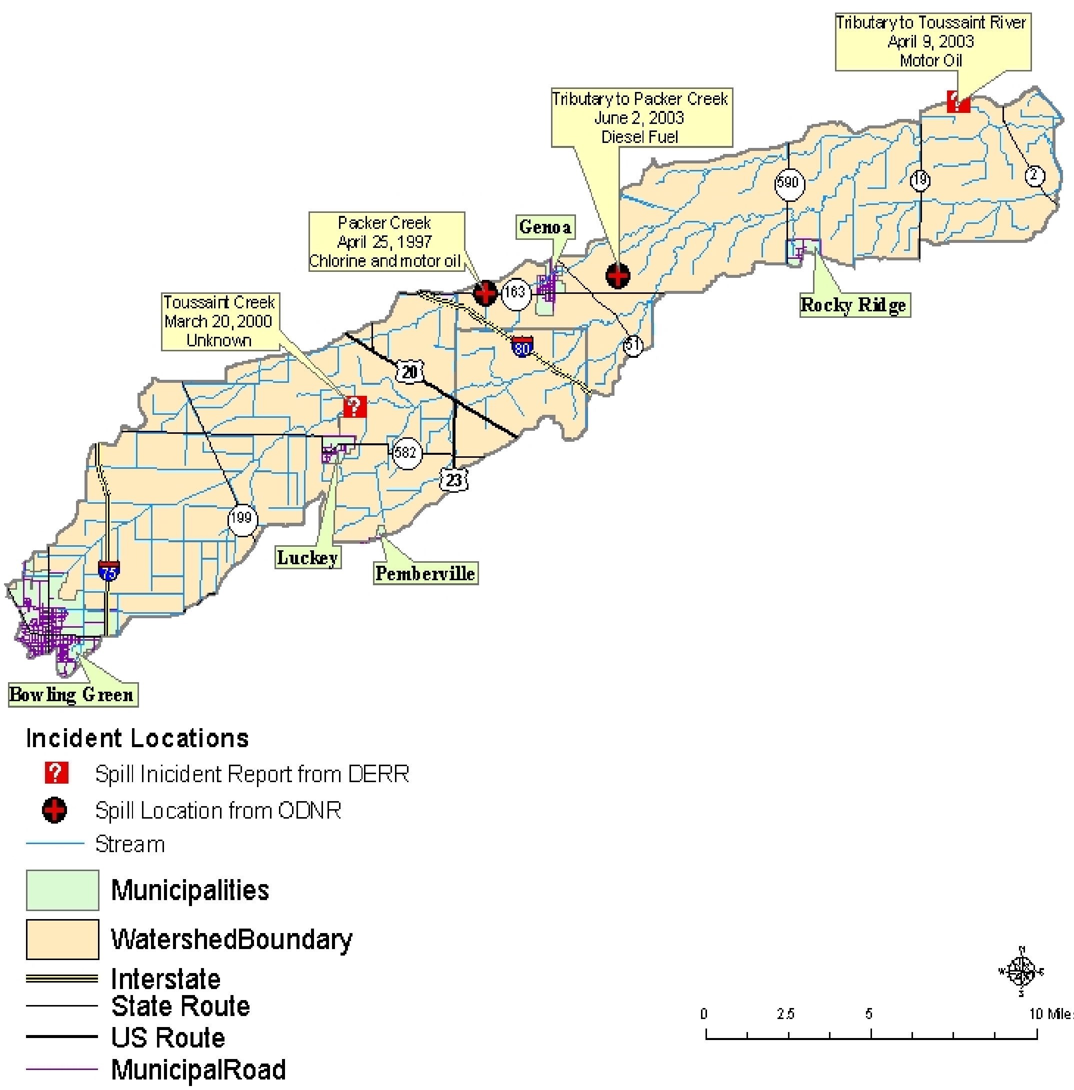


Figure 5. Reported spills and fish kills within the study area from 1995 – 2003.

RECOMMENDATIONS

Current and recommended aquatic life, water supply and recreation uses are presented in Table 8. 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 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.

This survey is the first time the Toussaint mainstem and basin has been thoroughly sampled so that a use attainability analysis may be completed. The existing Warmwater Habitat aquatic life use designation for Toussaint Creek and the Toussaint River was based on 1978 and 1985 Ohio WQS. The results of this survey indicate that the entire Toussaint mainstem should have the Warmwater Habitat aquatic life use. Use attainability analyses of Packer Creek indicate that the existing Warmwater Habitat aquatic life use designation is appropriate.

The Modified Warmwater Habitat (MWH) aquatic life use was established for those waters where poor habitat quality resulted in poor biological community performance and where the habitat was unlikely to improve in the foreseeable future. Streams that have been maintained through channelization, riparian removal and dredging for agricultural drainage purposes have often been assigned MWH. Recent advances in stream design, such as the two-stage channel, may address both the water quantity concerns of agricultural drainage and the water quality issues associated with the Clean Water Act's swimmable and fishable goals. Such technological advances would mean that many streams historically designated as MWH could be managed to support WWH aquatic communities in the foreseeable future. As Ohio EPA works with farming representatives and interested stakeholders to investigate the applicability, usefulness and effectiveness of these techniques, it will refrain from assigning the MWH use to any additional streams assessed in Ohio. However, the purpose of this section of this report is to provide recommendations for aquatic life uses based on the data collected. Recommendations will be made, though it is understood that any stream recommended for MWH will remain undesignated until the issues mentioned above are resolved.

Use attainability analysis of Rusha Creek resulted in the recommended designation of MWH as poor habitat quality was unlikely to improve in the foreseeable future. Rusha Creek has been channelized and maintained to facilitate agricultural activities and offers only monoculture vegetative habitat. The stream has been diked on either side and maintains a predominantly straight flow pattern within its trapezoidal confines. The slow glide flows allowed for settling of silt, nutrients and other fine sediments. Throughout the upper reach water levels were only a few inches, while the deposited silt was 1-3 feet in depth. Restoration efforts could include reconnection to a floodplain and establishment of a treed riparian corridor.

Martin Ditch and Gust Ditch, two small tributaries to Toussaint Creek, were sampled for the first time by Ohio EPA during this study. Based on the data collected, Martin Ditch should be assigned a Warmwater Habitat aquatic life use designation. During the first fish pass, it was noted that Gust Ditch was likely ephemeral, as the majority of water was near the bridge and terrestrial vegetation was observed growing within the channel. The only water present in late August was likely due to the very wet spring and summer conditions and was only a shallow pool of water < 10 feet long near the bridge. The most appropriate classification for Gust Ditch based on the lack of water and habitat would involve a Primary Headwater Habitat (PHWH). At this time, Ohio does not have PHWH aquatic life use designations available for these small streams. Therefore, Gust Ditch will remain undesignated.

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). The 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. Non-agricultural impairments could be addressed through a combination of regulatory, educational and funding actions including improvements at the Luckey WWTP, management of failing septic systems, and alternatives to traditional stream channelization and riparian removal.

Table 8. Waterbody use designations for the Toussaint River and Rusha Creek basins. Designations based on Ohio EPA biological field assessments appear as a plus sign (+). Designated use based on the 1978 water quality standards appear as an asterik (*). 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 an 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	
Toussaint River		*+							*+	*+		*+		
- Rusha Creek		*		Δ					*+	*+		*+		
- Toussaint Creek		*+							*+	*+		*+		
- Packer Creek		*+							*+	*+		*+		
- Martin Ditch		Δ							Δ	Δ		Δ		

SRW = state resource water; WWH = warmwater habitat; EWH = exceptional warmwater habitat; MWH = modified warmwater habitat; SSH = seasonal salmonid habitat; CWH = coldwater habitat; LRW = limited resource water;

PWS = public water supply; AWS = agricultural water supply; IWS = industrial water supply;

BW = bathing water; PCR = primary contact recreation; SCR = secondary contact recreation.

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-IV (Ohio Environmental Protection Agency 1987a, 1987b, 1989b, 1989c, *In Draft*), The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989, 1995) for aquatic habitat assessment, Methods of Assessing Habitat in Lake Erie Shoreline Waters Using the Qualitative Habitat Evaluation Index (QHEI) Approach (Thoma, 2004), and the Ohio EPA Sediment Sampling Guide and Methodologies (Ohio EPA 2001). Sampling locations are listed in Table 2.

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 Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), indices measuring the response of the fish community, and the Invertebrate Community Index (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 Qualitative Habitat Evaluation Index (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. Scores greater than 75 frequently typify 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. 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^oC) in a cooler, and shipped to an Ohio EPA contract lab. Sediment data is reported on a dry weight basis. Surface water samples were collected, preserved and delivered in appropriate containers to either an Ohio EPA contract lab or the 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).

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

Chemical Water Quality

Chemical and physical water quality was assessed at 19 locations throughout the Toussaint study area. The chemical water quality of Rusha Creek was not assessed, as the two sites chosen for aquatic life use assessment were strongly affected by seiches and existed within the lacustuary (flooded Lake Erie river mouth) zone. Surface water grab samples were analyzed for organic, inorganic metals and nutrients. Dissolved oxygen (D.O.) levels, pH and temperatures were recorded in the field at each sampling location. At the majority of sites, six sampling runs were conducted at two-week intervals. Organic surface water grab samples were only collected twice at selected sites. Fecal coliform bacteria samples were collected three times at most sites during the survey. Results were assessed against Ohio WQS criteria for those parameters with codified criteria and, for some select parameters (primarily nutrients), against ecoregional target values derived by Ohio EPA (1999).

Toussaint Mainstem

Water quality samples were collected at 12 locations from the Toussaint mainstem. Two of the sites were located within the lacustuary (flooded Lake Erie river mouth) zone. The remaining sites were located in free flowing segments. Sample results that exceeded the Ohio Water Quality Standards (WQS) numerical criteria are present in Table 5. Strontium concentrations exceeded the Tier II, Outside Mixing Zone Average (OMZA) criterion for the protection of aquatic life at every sampling location. At several locations, sample results indicated that strontium levels exceeded the Tier II, OMZM (Outside Mixing Zone Maximum) and approached the IMZM (Inside Mixing Zone Maximum) concentration of 14,000 (mg/l) as displayed in Figure 6. Though the presence of strontium was likely a result of natural background conditions, sites where higher concentrations were detected are likely influenced by the discharge of groundwater from stone quarry operations. Elevated nutrients were observed at several sites, indicating the possibility of nutrient enrichment from failing septic systems, WWTPs and agricultural activities (Table 6).

Upstream from the Village of Luckey the following three sampling locations were assessed. Simonds Road (RM 36.46), Webster Road (RM 33.52) and Luckey Road (RM 29.37).

Strontium was the only parameter to exceed WQS criteria at these sites. Observed nutrient levels for this segment did not appear to be elevated, even though intense agricultural land use was evident. Evaluation of nitrate+nitrite results indicated the median value was slightly elevated above the target value of 1.0 (mg/l), while the total phosphorus median concentration was below the target value of 0.1 (mg/l) as presented in Figures 7 & 8. The organochlorine pesticide alpha-BHC was detected above the method detection limit at Luckey Road (RM 29.37), but the concentration was below the Tier I criteria for the protection of human health. This persistent compound is an isomer of lindane, which was once widely used as an insecticide but is no longer manufactured in the United States. However, lindane is still imported into this country for use as an ingredient in shampoo for lice treatment and as seed treatment for grain crops.

Downstream from the Village of Luckey, surface water grab samples were collected at Lemoyne Road (RM 28.55). Strontium was the only parameter to exceed the WQS criteria. Again, the organochlorine pesticide alpha-BHC was detected above the method detection limit at 0.0029 (*u*g/l), but below the Tier I criterion for the protection of human health. Nutrient levels were slightly elevated compared to upstream sites. Median nitrate + nitrite and total phosphorus levels were elevated above the target value as displayed in Figures 7 and 8. Diurnal D.O. levels sagged below the WWH 24-hour average criterion of 5.0 mg/l. D.O. values collected from a Datasonde® which was deployed from August 19 to August 21, 2003, are presented in Figure 9. Increased nutrients and low D.O. levels were likely influenced by untreated and poorly treated sewage from the Village of Luckey. The existing wastewater collection system combines storm water with sanitary wastewater which results in discharges of raw or untreated sewage to Toussaint Creek during rain events. On November 12, 2004, the Village of Luckey submitted engineering plans to the Ohio EPA for the separation of the wastewater collection system. It is anticipated that implementation of the sanitary sewer separation project will occur in the near future and result in significant water quality improvements.

Three sampling locations were selected in close vicinity of the Village of Genoa. Samples were collected at Camper Road (RM 20.20) upstream from the discharge from the Genoa WWTP, downstream from the discharge adjacent to Fulkert Road (RM 19.65) and at Fulkert Road (RM 18.40). D.O. concentrations collected from Datasondes® which were deployed from August 19 to August 21, 2003, at the two upstream sample locations indicated that diurnal dissolved oxygen level sagged below the WWH 24-hour average criterion concentration of 5.0 mg/l. D.O. data collected at these sites are presented in Figures 10 and 11. Increased nitrate+nitrite and phosphorus concentrations were observed downstream from the Genoa WWTP as presented in Figures 7 and 8. At Camper Road (RM 20.20), fecal coliform bacteria levels exceeded the PCR recreational OMZA criterion on two occasions and the OMZM criterion once. Because Genoa's sanitary sewer system does not extend south to Camper Road, the most likely source of fecal coliform bacteria contamination was poorly treated sewage from failed on-lot septic systems. Strontium levels were elevated and approached the Tier II, IMZM criterion of 14,000 mg/l on one occasion. The elevated strontium levels were likely influenced by the discharge of groundwater from the Martin Marietta Materials, Inc. limestone quarry operation located upstream from the sampling site.

Downstream from the wastewater treatment plant adjacent to Fulkert Road (RM 19.65), sample results indicated one fecal coliform bacteria exceedance of the PCR criterion. The organochlorine pesticide alpha-BHC was detected above the method detection limit at 0.0068 *u*g/l, which exceeded the Tier I criterion for the protection of human health. Strontium levels were again elevated and likely influenced by groundwater discharged from both the Martin Marietta facility and Graymont Dolime, Inc. Graymont Dolime, Inc. is a limestone quarry operation that discharges to a ditch that enters Toussaint Creek at RM 20.0. At Fulkert Road (RM 18.40), fecal coliform bacteria exceeded the PCR criterion on two occasions. Strontium levels were still elevated and the statewide total dissolved solids (TDS) criterion was exceeded once.

Results of samples collected at Graytown Road (RM 13.88) recorded exceedances of the fecal coliform bacteria PCR criterion on three occasions; strontium levels remained elevated. Nitrate+nitrite and phosphorus were elevated well above their respective target value as represented in Figures 7 and 8. Total suspended solids (TSS) continued to be elevated and were occasionally >75th percentile. The elevated bacteria and nutrient levels were likely influenced by failed on-lot septic systems resulting in poorly treated sewage entering the stream from the Villages of Elliston and Graytown.

At Stange Road (RM 12.52), with the exception of strontium, no WQS criterion exceedances were documented. The organochlorine pesticide alpha-BHC was detected above the method detection limit at 0.0030 *u*g/l, but below the Tier I criterion for the protection of human health. Heptachlor epoxide, a breakdown product of the pesticide heptachlor, was detected above the laboratory detection limit at 0.0045 *u*g/l. Nitrate+nitrite and phosphorus concentrations remained elevated well above the respective target levels. Further downstream at Rocky Ridge Road (RM 10.45), fecal coliform bacteria levels exceeded the PCR criterion on one occasion and strontium levels remained elevated. Bacteria levels were likely influenced by the discharge of poorly treated sewage from the unsewered Village of Rocky Ridge.

Samples collected in the Lake Erie affected zone at State Route 19 (RM 4.65) and State Route 2 (RM 1.70) exhibited improved water quality characteristics. Nitrate+nitrite median values were below the target value of 0.1 mg/l (Figure 7). Median phosphorus levels were below the respective target value (Figure 8). Strontium levels, although still exceeding the OMZA criterion of 770 *u*g/l, were typical of background levels within the HELP ecoregion as presented in Figure 6.

Packer Creek

Water quality samples were collected at 5 locations from Packer Creek. One site was located within the lacustuary (flooded Lake Erie river mouth) zone. The remaining sites were located in free flowing segments. Sample results that exceeded the WQS numerical criteria are presented in Table 5. Strontium concentrations exceeded the Tier II, OMZA criterion for the protection of aquatic life at every sampling location. At State Route 590 (RM 3.45), sample results indicated that strontium levels exceeded the Tier II criterion.

At Stony Ridge Road (RM 21.16), median nitrate+nitrite values were slightly above the target value of 1.0 (mg/l) and median phosphorus values were below the target of 0.1 (mg/l) as displayed in Figures 7 and 8, respectfully. Fecal coliform bacteria levels exceeded the PCR criterion of 1000 (#/100 ml) on one occasion. Strontium levels were elevated above the OMZA criterion, but at levels which appear to be representative of background concentrations. Nitrate-nitrite levels were well above the target value further downstream at Billman Road (RM 14.73) and were likely the result of intense agricultural land use. Median phosphorus levels remained below the respective target value (Figure 9). At Martin Wilson Road (RM 11.30) nitrate+nitrite decreased compared to levels upstream at RM 14.73, but remained above the target value. Median phosphorus levels approached the target value of 0.1 ug/l. Strontium exceeded the OMZA criterion, but remained at background levels. At State Route 590 (RM 3.45) median nitrate+nitrite levels decreased to near the target value. Phosphorus levels increased above the target value. Strontium concentrations increased and during two sampling events levels were well above the IMZM criterion of 14,000 ug/l. Strontium levels were likely influenced by groundwater discharged from the Stoneco, Inc. quarry operation located south of Packer Creek on State Route 590. Just upstream from the confluence with the Toussaint River at Toussaint North Road (RM 0.14) median nutrient levels were at their respective target concentrations (Figures 8 and 9). Strontium levels appeared to be at background levels; however concentrations still exceeded the OMZA criterion for the protection of aquatic life.

Martin Ditch

One location was sampled on Martin Ditch at Fostoria Road (RM 0.22). Fecal coliform bacteria results exceeded the PCR criterion on two occasions and the SCR criterion during one sampling event. D.O. levels were below the minimum criterion on one occasion. Strontium levels appeared to be at background levels; however concentrations still exceeded the OMZA criterion for the protection of aquatic life.

Gust Ditch

Gust Ditch was sampled at Martin Willston Road (RM 2.76). Because of intermittent flow conditions, the site was only sampled on four occasions. Strontium exceeded the OMZA criterion in all samples, but appeared to be at background levels. No other WQS criteria exceedances were documented.

Table 5. Exceedances of Ohio Water Quality Standards criteria (Ohio Administrative Code 3745-1) documented within the Toussaint Basin study area 2003. Strontium and a-BHC results are presented in µg/l, fecal coliform bacteria are #/100 ml and dissolved oxygen (DO) is in mg/l. Use designations within the Toussaint River Basin include: Aquatic Life - Warmwater Habitat (WWH); Agricultural Water Supply (AWS); Industrial Water Supply (IWS), Recreation - Primary Contact (PCR).

Stream River Mile	(use designation) Parameter (value)
Toussaint Creek	(WWH, AWS, IWS, PCR)
36.46	Sr (4220^{e}, 4230^{e}, 2170^{e}, 2650^{e}, 3840^{e}, 4110^{e})
33.52	Sr (2060^{e}, 1990^{e}, 1340^{e}, 1930^{e}, 2560^{e}, 1810^{e})
29.37	Sr (1380^{e}, 2070^{e}, 1370^{e}, 1050^{e}, 1750^{e}, 1810^{e})
28.55	Sr (1420^{e}, 2070^{e}, 1350^{e}, 982^{e}, 1770^{e}, 1800^{e})
20.20	FC (4000^{b}, 1200^{c}, 1300^{c}); Sr (2870^{e},1900^{e}, 3610^{e}, 3130^{e}, 13900^{f}, 3480^{e})
19.65	FC (1500^{c}); Sr (4610^{e}, 6930^{f}, 3630^{e}, 3410^{e}, 7500^{c}); a-BHC (0.0068^{d})
18.40	FC (1800^{c}, 1400^{c});TDS (1620^{a}); Sr (10100^{f},13400^{f},6150^{e}, 3680^{e}, 3510^{e}, 7030^{f})
13.88	FC (1400^{c}, 1500^{c}, 1000^{c}); Sr (10400^{f}, 5060^{e}, 2930^{e}, 2350^{e}, 4580^{e}, 7800^{f})
12.52	Sr (3030^{e}, 4950^{e}, 6520^{e}, 4060^{e}, 2900^{e}, 8600^{f})
Toussaint River	(WWH, AWS, IWS, PCR)
10.45	FC (2200^{b}); Sr (9420^{f}, 4760^{e}, 3300^{e}, 2260^{e}, 6800^{e}, 3860^{e})
4.65	Sr (3370^{e}, 1940^{e}, 3470^{e}, 3660^{e}, 2280^{e}, 2850^{e})
1.70	Sr(1520^{e}, 989^{e}, 1120^{e}, 2120^{e}, 981^{e})
Gust Ditch	
2.76	Sr (3720^{e}, 5000^{e}, 4030^{e}, 5580^{e})
Martin Ditch	
0.22	FC (2200^{b}, 5200^{b}, 1600^{c}); Sr (3690^{e}, 4980^{e}, 2480^{e}, 3820^{e}, 5480^{e}, 4520^{e}); D.O (3.3^{h})
Packer Creek	(WWH, AWS, IWS, PCR)
21.16	FC (1000^{c}); Sr (1060^{e}, 1200^{e}, 844^{e}, 1610^{e}, 1280^{e}, 1180^{e})
14.73	Sr (1980^{e}, 1500^{e}, 1810^{e}, 2020^{e}, 1090^{e}, 1800^{e})
11.30	Sr (3180^{e}, 1940^{e}, 3040^{e}, 3000^{e}, 1600^{e}, 1810^{e})
3.45	Sr (19600^{g}, 21700^{g}, 1920^{e}, 2630^{e}, 1510^{e}, 1760^{e})
0.14	Sr (5800^{e}, 4790^{e}, 1820^{e}, 2920^{e}, 7190^{f}, 2470^{e})

a Exceeds state wide criterion for protection of aquatic life.
b Exceeds PCR maximum criterion for protection of recreation use.
c Exceeds PCR geometric mean criterion for protection of recreation use.
d Exceeds Tier I value for protection of human health/nondrinking/drinking.
e Exceeds Tier II value for protection of aquatic life, outside mixing zone average.
f Exceeds Tier II value for protection of aquatic life, outside mixing zone maximum.
g Exceeds Tier II value for protection of aquatic life, inside mixing zone maximum.
h Exceeds the minimum criterion for the protection of aquatic life.

Table 6 . Comparison of background nutrient and demand parameter concentrations with those found in the Toussaint Basin study area, 2003. Comparisons are made to HELP ecoregion background 50th percentile (median), 75th, 90th and 95th percentile values for headwaters, wadeable and small river sites. Units are mg/l for all parameters.

Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) Code
Toussaint Creek		25.5	36.46	8.0	TSS	N/A
					Ammonia	(0.053, *0.098*, 0.067)
					Nitrite	(0.043, **0.100**, **0.064**, **0.054**)
					TKN	(0.55, *0.76*, 0.55, *0.68*, *0.79*)
					TP	(*0.079*, *0.055*, *0.095*, *0.076*)
		42.5	33.52	18.0	TSS	(21)
					Ammonia	(0.059, 0.064, 0.051)
					Nitrite	(0.047, **0.102**, **0.061**, 0.022)
					TKN	(0.48, *0.61*, 0.81, *0.65*, 1.00, 0.84)
					TP	(0.047, *0.088*, **0.167**, 0.046, *0.059*)
		59.0	29.37	32.0	TSS	(23)
					Ammonia	(0.052, 0.069, 0.050)
					Nitrite	(*0.024*, *0.060*, 0.093, *0.048*)
	Luckey WWTP		29.15		TKN	(0.84, 0.90, 0.83, 0.67)
					TP	(*0.176*, 0.123)
		49.5	28.55	34.0	TSS	(*29*)
					Ammonia	(*0.104*, 0.059, 0.053, 0.057)
					Nitrite	(*0.065*, *0.033*, 0.109, *0.051*)
	Martin Marietta		21.8		TKN	(*1.06*, 0.92, 0.81)
					TP	(0.120, 0.128, *0.187*, *0.200*, 0.095)
		57.5	20.20	60.0	TSS	(*34*, 13)
	Graymont Dolime		20.0		Ammonia	(0.051)
					Nitrite	(0.020, *0.027*, *0.033*, **0.121**, *0.036*)
	Genoa WWTP		19.90		TKN	(0.82, 0.98)
					TP	(*0.131*, 0.098, 0.226, 0.104, *0.148*)
		71.5	19.65	61.0	TSS	(16, *31*, 19)
					Ammonia	(*0.080*, 0.063, *0.079*)
					Nitrite	(*0.026*, 0.**127**, *0.034*, *0.031*)
					TKN	(0.85, 0.71)
					TP	(1.07, 0.225, 0.091, **0.491**, *0.186*)
		42.0	18.40	62.0	TSS	(15, *37*)
					Ammonia	(0.056, 0.051)
					Nitrite	(*0.023*, 0.090, *0.037*, *0.030*)
					TKN	(0.75, 0.73, 0.88, 0.85, 0.75)
					TP	(**0.676**, 0.227, *0.208*, *0.157*, *0.159*)

Table 6 continued

Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) Code
Toussaint Creek		50.5	13.88	76	TSS Ammonia Nitrite TKN TP	(16, *48*,18, 15) (*0.073*, *0.072*, 0.051) (*0.034*, *0.040*, <u>0.092</u>, *0.021*) (0.84, 0.84, 0.71) (**0.541**, 0.123, 1.34, *0.143*, <u>0.278</u>)
		34.0	12.52	77.0	TSS Ammonia Nitrite TKN TP	(<u>73</u>, 14, 23, 19) (*0.093*, 0.054, *0.079*, 0.055, 0.061) (<u>0.088</u>, *0.033*, *0.024*) (**2.20**, 0.91, 0.82, 0.77) (*0.182*, *0.158*, *0.147*, *0.165*, <u>0.292</u>, <u>0.318</u>)
Toussaint River		51.5	10.45	81.0	TSS Ammonia Nitrite TKN TP	(13, *46*, 20, 14 N/A (*0.024*, *0.023*, <u>0.093</u>, 0.020) (0.83) (0.121, *0.166*, 0.170, <u>0.358)</u>
			4.65	124.0	TSS Ammonia Nitrite TKN TP	(*55*, **90**, *64*, <u>72</u>) (*0.122*) (*0.021*, <u>0.108</u>, **0.184**, *0.022*) (0.78, 0.77, *1.10*, 0.77) (*0.152*, *0.148*, *0.162*, 0.108, 0.136, *0.159*)
			1.70	129	TSS Ammonia Nitrite TKN TP	(*61*, **108**, **86**, **86**, *49*) (*0.095*, *0.080*, 0.062) (*0.033*, *0.027*, **0.144**, *0.043*, *0.059*) (0.090) (0.087, <u>0.244</u>, 0.080)
Gust Ditch (17.85)		44.5	2.76	2.1	TSS Ammonia Nitrite TKN TP	(*38*) (0.052) (**0.145**) (<u>1.08</u>, **1.20**, *0.80*, **1.28**) (**0.155**, **0.116**, 0.035, **0.163**)
Martin Ditch (25.06)		27.5	0.22	5.8	TSS Ammonia Nitrite TKN TP	N/A (0.075, *0.101*) (**0.064**, **0.140, 0.104**, 0.028) (*0.89*, <u>1.14</u>, *0.75*, <u>0.82</u>, <u>1.02</u>, *0.59*) (0.034, *0.056*, 0.040, *0.077*, *0.082*, *0.063*)

Table 6 continued.

Stream (River Mile of Tributary)	**NPDES Discharge**	**QHEI**	**River Mile**	**Drainage Area**	**Parameter**	**(Value) Code**
Packer Creek		29.0	21.16	8.0	TSS	(15, *46*)
					Ammonia	(0.068, **0.248**, *0.115*, 0.060)
					Nitrite	(*0.037*, **0.077, 0.146, 0.112**, *0.037*)
					TKN	(*0.75*, 0.97, *0.79*, **1.35**, *0.73*, 0.54)
					TP	(0.043, **0.225**, **0.124**, **0.126**)
		28.0	14.73	16.0	TSS	(**62**, **56**)
					Ammonia	(*0.084*, *0.085*)
					Nitrite	(**0.084, 0.068**, **0.144**, **0.075**, 0.022, 0.042)
					TKN	(0.96, **1.34**, 1.05, *0.77*, 1.04, *0.61*)
					TP	(*0.060*, *0.080*, **0.267**, 0.043, *0.069*)
		51.0	11.30	19.8	TSS	(18, *32*, 19)
					Ammonia	(0.063, 0.072, *0.077*, *0.091*, 0.062)
					Nitrite	(0.048, **0.134**, *0.030*, *0.032*)
					TKN	(*0.78*, 1.01, 0.92, 0.87, *0.76*, *0.69*)
					TP	(*0.089*, *0.087*, 0.091, **0.139**, **0.105**, **0.118**)
	Stoneco quarry		3.5			
		42.0	3.45	33	TSS	(16, 21, **113**, 21, *41*, 16)
					Ammonia	(*0.119*, 0.082)
					Nitrite	(0.024, 0.107, *0.021*)
					TKN	**(3.48**, 0.78, *0.74*)
					TP	(*0.148*, *0.180*, 0.293)
			0.14	34	TSS	(*55*, *34*, 21, 70 , *54*)
					Ammonia	*(0.103*, *0.115*, *0.110*, *0.081*)
					Nitrite	(**0.150**, *0.044*, **0.181**, **0.142**, *0.026*)
					TKN	(*1.05*, 0.75
					TP	(0.091, 0.100, *0.160*, 0.102

TSS = Total Suspended Solids, TKN = Total Kjeldahl Nitrogen, TP = Total Phosphorus
Normal print values exceed the 50th percentile background.
Italic print values exceed the 75th percentile background.
Underlined values exceed the 90th percentile background.
Bold printed values exceed the 95th percentile background.

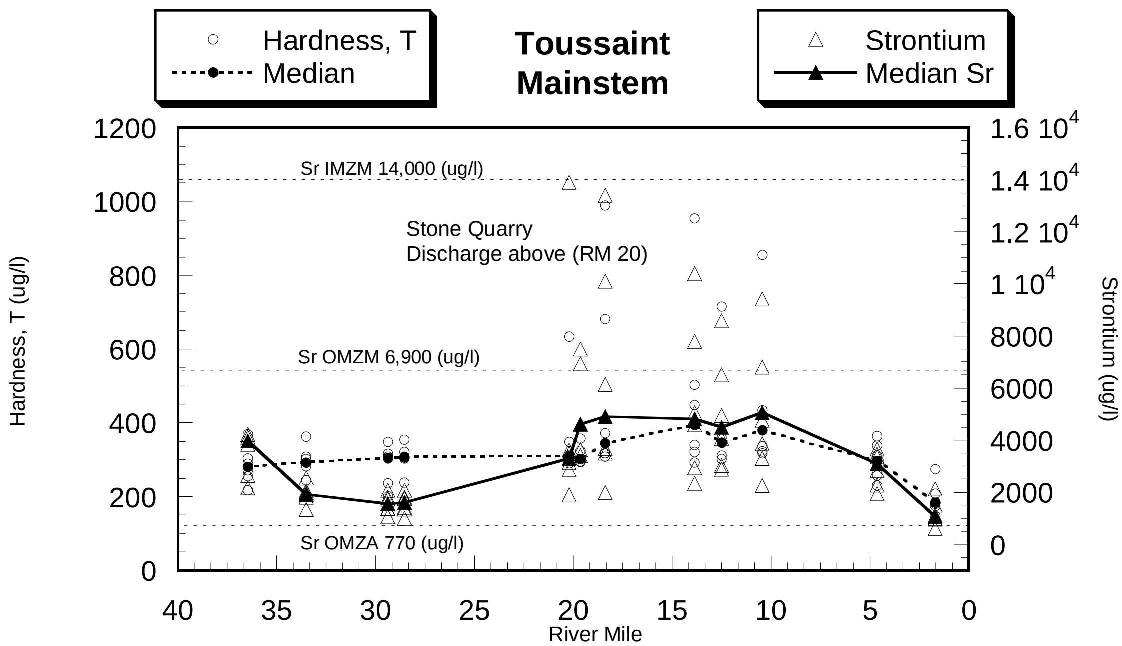


Figure 6. Strontium and hardness values from Toussaint mainstem. June - September 2003.

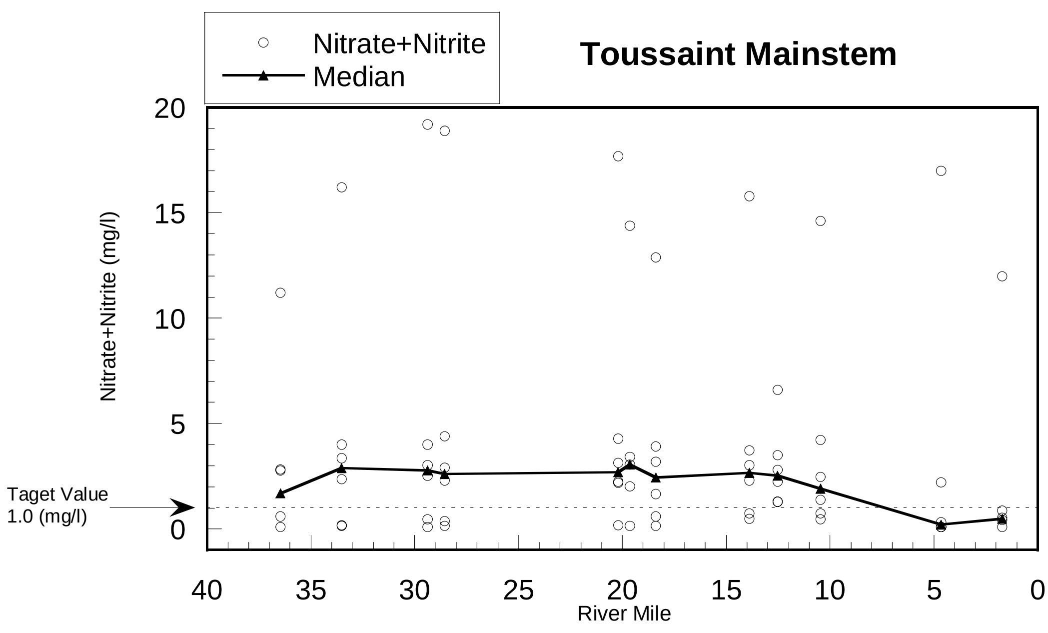


Figure 7. Nitrate+nitrite values from Toussaint mainstem. June - September, 2003. Rational for nutrient target values are described in the publication; Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams (Ohio EPA, 1999.)

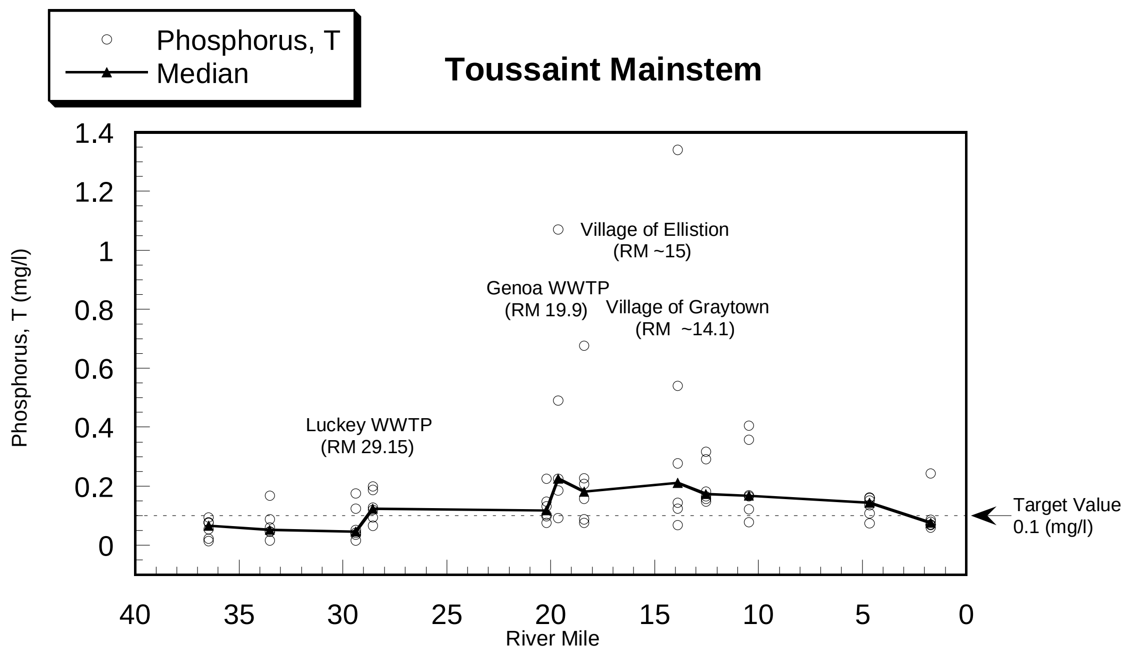


Figure 8. Total phosphorus values from Toussaint mainstem. June - September, 2003. Rational for nutrient target values are described in the publication; Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams (Ohio EPA, 1999.)

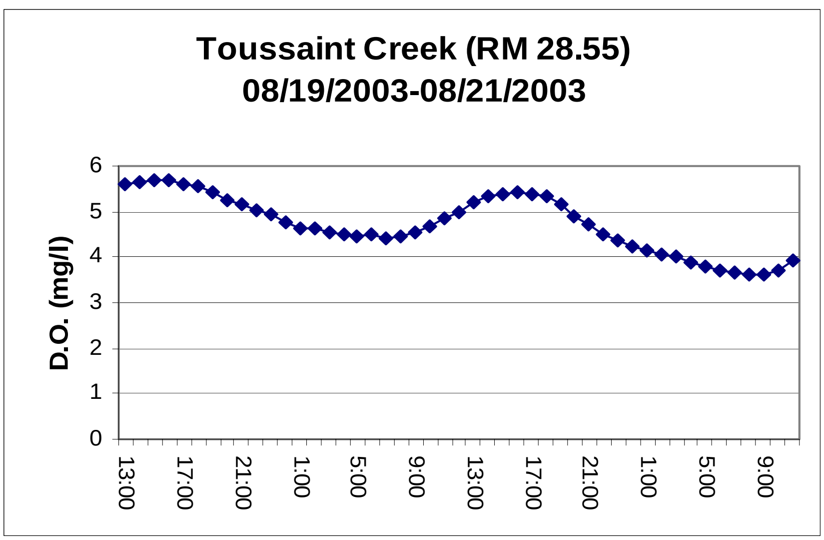


Figure 9. Diurnal dissolved oxygen measurements recorded from Toussaint Creek at Lemoyne Road, August 19-21, 2003.

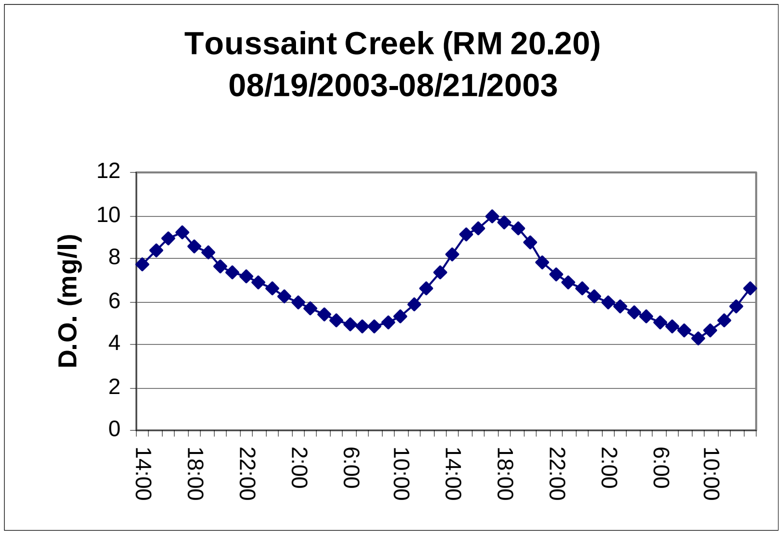


Figure 10. Diurnal dissolved oxygen measurements recorded from Toussaint Creek at Camper Road, August 19-21, 2003.

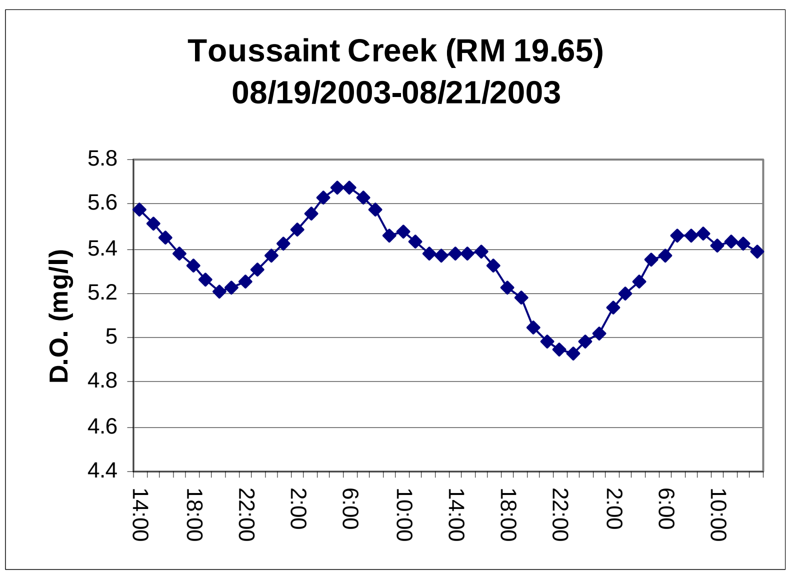


Figure 11. Diurnal dissolved oxygen measurements recorded from Toussaint Creek downstream from the Genoa WWTP, August 19-21, 2003.

Sediment Quality

Chemical sediment quality was assessed at 6 locations throughout the Toussaint and Rusha Creek basins. Sediments selected for sampling consisted mainly of fine silts and clays, which are generally associated with persistent environmental contaminants. Sediment grab samples were analyzed for inorganic metals, semi-volatile organics, polychlorinated biphenyls (PCBs), and pesticides. To evaluate analytical results, concentrations were compared to Consensus-Based Sediment Quality Guidelines as described by MacDonald et al. (2000). Inorganic metal results were also compared to Ohio Specific Sediment Reference Values (SRV) (Ohio EPA 2003) which represents ecoregion background conditions. Sample results reported below the Consensus-Based Threshold Effect Concentration (TEC) and/or below the Ohio SRV values are likely not an environmental concern. Sediments with chemical concentrations reported above the Consensus-Based Probable Effect Concentration (PEC) and/or the Ohio SRV values may result in negative environmental impacts and warrant further evaluation. Results of sediment samples are summarized in Table 7. The only organochlorine pesticide detected above the laboratory method detection limit was 4,4'-DDE at a concentration of 14.8 *u*g/l which exceeded the TEC. DDE is a break down product of the insecticide DDT. This sediment grab sample was collected from Rusha Creek at Toussaint South Road (RM 3.04). No semi-volatile organics were detected. In general, sediment quality within the study area was good with little to moderate chemical contamination.

Toussaint Mainstem

Four sediment grab samples were collected from the Toussaint mainstem. Evaluation of the results from samples collected at Luckey Road (RM 29.37), Lemoyne Road (RM 28.55) and Camper Road (RM 20.20) indicated that all chemical concentrations were below both the SRV and the TEC sediment quality guidelines. Results of samples collected at State Route 2 (RM 1.70) exceeded the SRV for aluminum and selenium, while arsenic exceeded the TEC. All other chemical parameters were below the sediment quality guidelines.

Packer Creek

One sediment grab sample was collected from Packer Creek at Toussaint North Road (RM 0.14). Strontium and selenium exceeded the SRVs. All other measured parameters were below the sediment quality guidelines.

Rusha Creek

One sediment grab sample was collected from Rusha Creek at Toussaint South Road (RM 3.04). Chromium, copper, nickel, arsenic and cadmium values exceeded the SRVs and TECs, though all were below the PEC. Zinc and 4,4'-DDE exceeded the TECs. All other measured parameters were below the sediment quality guidelines.

Table 7. Metal concentrations (mg/kg) in sediments collected from the Toussaint and Rusha Creek basins in 2003. Values preceded by a < were below the reporting limit. Those followed by an (*) exceeded the Threshold Effect Concentration (TEC) described by MacDonald et al (2000). Values followed by a (+) exceeded Ohio-specific Sediment Reference Values (SRVs).

Toussaint Creek @ Luckey Road (RM 29.37)

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
21200	104J	42300	24J	13.5	16200	<20	9370	397
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<20	6210J	<2500	126	49.0	<0.030	6.27	0.261	<1.00

Toussaint Creek @ Lemoyne Road (RM 28.55)

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
24600	112	34400	25J	15.8	17200	<24	8490	363
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<24	6620J	<3040	128	68.6	0.029	6.44	0.606	<1.22

Toussaint Creek @ Camper Road (RM 20.20)

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
20500	89.3J	25700	22J	12.2	14800	<24	7540	<2960
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<24	5450J	<2960	232	65.5	0.056	5.36	0.418	<1.18

Toussaint River @ State Route 2 (RM 1.70)

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
43000 +	186	22500	41	29.6	27400	<36	10200	351
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<36	10000	<4500	186	115	0.075	10.4 *	0.639	1.84+

Parker Creek @ Toussaint North River Road (RM 0.14)

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
29100	144	29400	32	24.6	22800	<32	9070	384
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
<32	7250	<4040	451+	90.1	0.062	7.17	0.522	1.67+

Rusha Creek @ Toussaint South Road (RM 3.04)

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
61600 +	264 +	17800	59 *+	42.7 *+	35100	<40	12900	301
Ni	**K**	**Na**	**Sr**	**Zn**	**Hg**	**As**	**Cd**	**Se**
42 *+	14900	<4960	126	148 *	0.087	12.1 *+	1.05 *+	<1.98

Luckey Beryllium Site History/Bioassessment

The facility, located on the west side of the Village of Luckey was owned by the Defense Plant Corporation from 1942 to 1945 as a magnesium reduction facility that produced metallic magnesium. In the late 1940s, Brush Beryllium Company leased the site from the Atomic Energy Commission to be utilized for the production of beryllium. In 1958, Brush Beryllium Company moved the operation to Elmore, Ohio. The current owner, Hayes Lemmerz International, Inc. leases the property to Uretech International, Inc. which produces urethane components for the automotive and health care industries.

As part of a remedial investigation (RI) of the Luckey Site, the United States Army Corp of Engineers (USACE) conducted a bioassessment of Toussaint Creek in the vicinity of the Village of Luckey, Ohio. Primary contaminants of concern were beryllium and lead and their potential impacts to Toussaint Creek. The study consisted of an assessment of the chemical, physical and biological conditions of the Toussaint Creek in the vicinity of the site; sampling adhered to Ohio EPA methods and protocols. Sampling occurred at seventeen locations during the summer of 2001.

The study concluded that habitat modifications, nonpoint pollution impacts and discharge of untreated/poorly treated sewage from the Village of Luckey were the primary sources of impairment. Additionally, the study determined that beryllium may be a secondary biological stressor but to a much lesser degree. In March 2002, EnviroScience, Inc. produced a final report "Biological and Water Quality Study of Toussaint Creek and Select Tributaries" (EnviroScience, Incorporated, 2002). Ohio EPA reviewed the report and generally agreed with several of the findings. However, Ohio EPA disagreed with the recommendation within the report that the aquatic life use designation should be changed to MWH. Based on QHEI scores near or above 50, the stream should be capable of supporting a WWH biological community. Chemical, physical and biological assessment conducted by the Ohio EPA during the summer of 2003 revealed similar findings to the study conducted in 2001 for the USACE.

Physical Habitat for Aquatic Life

The physical habitat of 18 locations within the study area was evaluated with the Qualitative Habitat Evaluation Index (QHEI). The QHEI was developed by Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995). The QHEI involves scoring various attributes of the habitat based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. QHEI scores greater than 60 are generally conducive to the existence of warmwater fauna whereas scores less than 45 generally can not support a warmwater assemblage consistent with the WWH biological criteria. QHEI scores greater than 75 frequently typify habitat conditions which have the ability to support exceptional warmwater faunas.

The lacustuary QHEI was used to evaluate 4 sites within the study area. The term "lacustuary" was coined to specify the zone where Lake Erie water levels have intruded into tributary river channels. Lacustuary QHEI scores greater than 60 are generally conducive to the existence of warmwater fauna whereas scores less than 45 generally can not support a warmwater assemblage consistent with the WWH biological criteria. Lacustuary QHEI scores greater than 80 frequently typify habitat conditions which have the ability to support exceptional warmwater faunas.

Toussaint River

The physical habitat of the Toussaint River was evaluated near State Route 2 (RM 1.7). The Toussaint River originated primarily from lacustrine and wetlands, though rip-rap was present in much of the area. Cobble, rip-rap, hardpan, and detritus were intermixed with areas dominated by silt and muck. Organic and clay silt was present in heavy amounts, limiting the amount of interstitial spaces available for aquatic organisms. Moderate amounts of submerged habitat were provided by aquatic vegetation, logs and small shallows. Aquatic vegetation included pond lilies, bulrush, pond weeds, cattail and reed grass. The stream appeared to have recovered from past channelization activities with high sinuosity, excellent development and high stability. Average depth throughout the area sampled was < 50cm with an average shore to stream bottom slope of <15°.

Outside of the stream channel, narrow (5-10m) buffers extended to residential and conservation tillage land use. Though little bank erosion was observed, the banks were heavily rip-rapped and diked. The combination of heavy silt, few types of submerged habitat and high intensity land used resulted in a lacustuary QHEI score of 32.5.

Toussaint Creek

The physical habitat of Toussaint Creek was evaluated from Simmonds Road (RM 36.45) to Rocky Ridge Road (RM 10.45). The upper reach of Toussaint Creek, from Simmonds Road (RM 36.45) to Lemoyne Road (RM 28.55) originated primarily from tills. Sand, gravel and silt were the predominant substrate types, though occasional areas of cobble were also noted. Silt was heavy and embedded substrates were extensive at most sites in the upper reach, except near Webster Road (RM 33.52) and Luckey Road (RM 29.37) where silt was present in moderate to normal amounts, respectively, and substrates were embedded in moderate amounts.

The maintained channelized conditions of the headwaters (RM 36.45) resulted in sparse instream cover provided by overhanging vegetation, shallows and aquatic macrophytes. The stream exhibited low stability with poor channel development and low to moderate stability in this area, with very narrow (<5m) buffer strips adjacent to row crops. Further downstream, from Webster Road (RM 33.52) to Lemoyne Road (RM 28.55), the stream was in various stages of recovery from past channelization activities with at most low sinuosity, fair to good development and low stability. Moderate instream cover was provided by undercut banks, overhanging vegetation, shallows, rootmats, deep pools (>70cm), rootwads, backwaters, aquatic macrophytes, and woody debris with logs. Buffers extended as very narrow (<5m) strips adjacent to row crops to moderate (10-50m) buffers adjacent to old fields.

The lower reach of Toussaint Creek was similar to the upper reach as it contained silt in moderate to heavy amounts and moderately to extensively embedded substrates. The lower portion of Toussaint Creek originated from a combination of tills and lacustrine substrates. Gravel, sand, silt and cobble were the most predominant substrate types, though areas of detritus, and occasional boulders were observed. The bed load of fine materials, including sand and silt, was excessive and smothered the functional substrates, limiting the presence of any interstitial spaces. Moderate instream cover was provided by deep pools (>70cm), undercut banks, overhanging vegetation, shallows, rootmats, rootwads, boulders, and logs throughout most of the reach. However, the historical and recent channelization activities from Graytown Road (RM

13.88) to Stange Road (RM 12.52) resulted in only sparse amounts of instream cover and low sinuosity with poor to fair channel development. The remaining portion of the lower reach was in various stages of recovery from channelization activities as demonstrated by the low to moderate sinuosity, poor to good development and moderate to high stability. Outside of the lower reach, primarily very narrow (<5m) buffers were present adjacent to row crops and very narrow (<5m) to wide (>50m) buffers extended adjacent to residential and new field areas. One forested area with wide (>50m) buffers existed near Fulkert Road (RM 19.65) and helped to reduce the effects of the surrounding agricultural landscape.

Eroding banks were present throughout both the upper and lower reaches of Toussaint Creek, though severity ranged from little to moderate. QHEI scores for the upper reach ranged between 25.5 (RM 36.5) to 59.0 (RM 29.4) with an average QHEI score of 44. The lack of treed riparian areas and adequate vegetative buffers adjacent to the high intensity agricultural areas contributed to the very poor to fair quality habitat noted throughout the upper reach. QHEI scores for the lower reach ranged from 34.0 (RM 12.5) to 71.5 (RM 19.7) with an average QHEI score of 51. The wide buffers and abundant instream cover contributed to the high score of 71.5, while the poor riparian cover and sparse instream cover resulted in the low score of 34.0 (Figure 12). The majority of streams within the lower reach scored between 42.0 and 57.5, indicating the limited ability of the lower reach to support WWH communities.

Figure 12. The upper sampling site, Toussaint Creek RM 19.7, had a QHEI = 71.5, the highest score in the study area. The lower sampling site, Toussaint Creek RM 12.5, had a QHEI = 34.0, the lowest score among sampling sites with drainage areas > 20mi^2. Forested corridors at the upper site extended greater than 150 feet from stream edge, while those in the lower site were usually less than 100 feet in width.

Rusha Creek

Figure 13. Rusha Creek (RM 5.02). Note the extensive amount of vegetative cover.

The physical habitat of Rusha Creek was evaluated near Behlman Road (RM 5.02) and Leutz Road (RM 4.0). Rusha Creek was derived from tills and lacustrine substrates, though silt and muck were the dominant substrates present and were intermixed with occasional areas of sand. Near Behlman Road (RM 5.02), the stream was more of a linear wetland, with hydrophytic vegetation, hydric soils and shallow waters (Figure 13). Though water levels were predominantly <20cm, silt was present in heavy amounts causing one to sink 40-70cm deep in silt when attempting to wade through the stream. An extensive amount of instream cover was provided by the aquatic macrophytes, overhanging vegetation and shallows. The maintained channelized conditions of the stream were noted by the lack of sinuosity, poor development and low stability. The adjacent row crops extended to the dike present on either stream bank.

The wetland conditions present near Behlman Road (RM 5.02) continued along Leutz Road (RM 4.0), though the strong lake effect present required the downstream site to be scored using the lacustuary QHEI (Figure 14). The silt present in the lower reach was derived from clay and was present in heavy amounts. Moderate amounts of instream cover were provided by submerged vegetation, overhanging vegetation, shallows and occasional logs.

Figure 14. Lacustuary portion of Rusha Creek RM 4.0.

The channelized conditions of the stream were apparent by the lack of sinuosity, fair development and low stability. Riprap was present in several areas, indicating an attempt to increase bank stability by local landowners. Buffer widths varied from very narrow (<5m) adjacent to residential homes to wide (>50m) along forests and old field areas.

The wetland characteristics of the upper reach resulted in a QHEI score of 29.0, indicating the very poor stream habitat conditions present. The lower reach received a lacustuary QHEI score of 16.0, indicating the poor habitat quality available for aquatic life throughout the lacustuary portion of Rusha Creek.

Packer Creek

The physical habitat of Packer Creek was evaluated from the headwaters near Stony Ridge Road (RM 21.16) to the mouth near Toussaint North Road (RM 0.14). The upper reach of Packer Creek, from Stony Ridge Road (RM 21.16) to State Route 163 (RM 14.73), was derived primarily from tills and lacustrine substrates. Silt, gravel and sand were present in mixed amounts throughout the upper reach, with occasional areas of detritus and muck also present. Silt was present in moderate to heavy amounts, while embedded substrates ranged from moderate to extensive. Instream cover decreased in abundance from moderate amounts of logs, undercut banks, overhanging vegetation and shallows in the headwaters (RM 21.16) to nearly absent cover provided by overhanging vegetation and boulders along State Route 163 (RM 14.73). The entire upper reach had not recovered from past channelization activities as there was no sinuosity, only poor development and low to moderate stability observed. Adjacent to the stream channel, agricultural fields extended up to the stream bank in several locations with the widest buffers extending less than 5m.

Similar to the upper reach, the lower reach of Packer Creek was derived from a combination of lacustrine and shale substrates, though the lacustuary portion near Toussaint North Road (RM 0.14) contained rip-rap as well. Outside of the lacustuary, gravel and sand were the dominant substrate types, though areas of detritus, silt, cobble and boulder were also noted. Silt was present in moderate to heavy amounts and embedded substrates were present in normal to extensive amounts. The lower reach appeared to be in various stages of recovery from channelization as moderate sinuosity with poor to good development and moderate to high stability were observed. Nonexistent to narrow (<10m) buffers existed along residential homes near Martin Willston Road (RM 11.3), while a narrow (<10m) buffer existed along agricultural fields near State Route 590 (RM 3.45). Flows were moderate to slow throughout the lower reach.

The lacustuary portion of Packer Creek contained predominantly hardpan and silt substrates though areas of cobble were observed. Silt originating from clay was present in heavy amounts. Sparse amounts of logs, submerged aquatic vegetation and overhanging vegetation provided refuge for aquatic organisms. The lacustuary appeared to have recovered from past modifications as high shore sinuosity with fair to good development and high stability were observed. Agricultural fields extended beyond the narrow (5-10m) to moderate (10-50m) buffers.

The QHEI scores for the upper reach of Packer Creek ranged from 27.0 to 28.0, reflecting the channelized conditions with few areas of adequate refuge for aquatic organisms and insufficient buffers adjacent to high impact land uses. The lower reach of Packer Creek received QHEI scores between 42 and 51, reflecting the increase in stream cover, substrate types and slightly improved conditions for aquatic communities. The lacustuary of Packer Creek received a lacustuary QHEI of 26.5 indicating limited diverse habitat for aquatic communities.

Gust Ditch

The physical habitat of Gust Ditch was evaluated near Martin Willston Road (RM 2.76). The stream was derived from lacustrine and tills substrates, though silt and sand with occasional areas of gravel were the substrate types present. Silt was present in normal to moderate amounts and substrates were embedded in moderate amounts. Extensive instream cover was provided by overhanging vegetation, shallows, rootmats, rootwads, aquatic macrophytes and logs, though the stream was intermittent/ephemeral in nature, as trees were growing in the middle of the channel and it was dry later in the summer. Moderate sinuosity with poor channel development and low stability characterized the recovering status of the stream from past channelization activities. Very narrow (<5m) buffers were adjacent to old fields and active row crops. The QHEI score of 44.5 depicts the limited ability of the stream to support WWH communities.

Martin Ditch

The physical habitat of Martin Ditch was examined along Fulkert Road (RM 0.22). The stream originated from tills substrates. Silt and sand intermixed with cobble were the only substrate types present. Silt was present in moderate amounts and substrates were extensively embedded. Moderate instream cover consisting of overhanging vegetation and shallows were apparent. Recent channelization activities resulted in low sinuosity with poor development and low channel stability. No buffers reduced the effects of the high intensity residential and agricultural use adjacent along the right and left descending banks, respectively. The QHEI score of 44.5 characterized the maintained conditions of the stream.

Biological Communities: Fish

Fish sampling throughout the Toussaint basin was conducted using pulsed DC electrofishing methods as described 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 1989c). The MIwb and IBI were used to evaluate the condition of the fish assemblage throughout the majority of the Toussaint basin. A few sites within the basin were located within lacustuary areas, and were therefore evaluated with the Lacustuary IBI and MIwb.

A total of 18,076 fish, comprising 46 species and 7 hybrids, were collected throughout the Toussaint study area. No endangered or threatened species were collected during the sampling effort, though five moderately intolerant species, including smallmouth bass, brook silverside, sand shiner, logperch darter and greenside darter, were collected. Numerically predominant fish species included bluntnose minnows (18.63%), fathead minnow (13.11%), and stoneroller minnow (10.64%). Species that dominated in biomass included common carp (52.91%), creek chub (7.56%) and largemouth bass (3.85%).

Toussaint River

The fish community of the Toussaint River was evaluated at three sites between the mouth (RM 0.2) and State Route 2 (RM 1.7). This portion of the Toussaint River is directly affected by Lake Erie and therefore the proposed Lacustuary IBI and MIwb indexes were used to evaluate these sites. Community index and narrative evaluations ranged from poor (IBI=22.5 and MIwb= 8.2 at RM 1.7) to fair (IBI=38 and MIwb=6.2 at RM 0.2). The fish communities sampled at the upstream site, near State Route 2 (RM 1.7), may be classified as poor as a result of agriculture practices. A total of 12 native species and 5 centrarchid species were collected at the upstream site, though 19 native species and 8 centrarchid species were collected further downstream. No moderately intolerant species were collected at the upstream site, though the moderately intolerant smallmouth bass and logperch darter were collected at the downstream site. The percent top carnivores also increased in a downstream direction, from an average 5.05% of the total population at the upstream location to 35% of the total population at the downstream site. Improved water quality near the mouth is reflected by the improved diversity of the fish community.

Toussaint Creek

The fish community of the upper reach of Toussaint Creek was evaluated between Simonds Road (RM 36.46) and Lemoyne Road (RM 28.55). Community index and narrative evaluations for the headwaters (RM 36.46) were poor (IBI=20) and mirrored the highly modified conditions noted during the sampling event. Only 51 fish representing 7 species were collected at RM 36.46, and tolerant species comprised 92% of the total number of fish collected. As habitat conditions improved downstream, so did the diversity of the fish communities. Between 12 and 18 species were collected at each of the further downstream sites within the upper reach. Community index and narrative evaluations for the downstream sites improved to fair with an average IBI=28 (range of 27-30) and an average MIwb=7.6 (range of 7.2-8.0).

The fish communities of the lower reach of Toussaint Creek were sampled in 6 locations from Camper Road (RM 20.2) to Rocky Ridge Road (RM 10.45). Community index and narrative evaluations ranged from marginally good (IBI=35) to poor (IBI=27) with an average IBI=31. Species richness dropped sharply from 15-17 species between Camper Road (RM 20.2) and Fulkert Road (RM 18.4) to 11 species near Graytown Road (RM 13.88). The relative number of total fish caught near Graytown Road averaged only 134, while the average for the upstream sites ranged from 555-1,293 total fish. The upstream sites also contained fish of varying age groups, while only single age classes were noted near Graytown Road. Though no fish kills or spills have been reported in this area, the paucity of total fish and lack of older, larger fish are traits common to areas that have experienced fish kills from spills. This area should be investigated further to determine if a source affecting water quality can be identified.

Further downstream along Stange Road (RM 12.45), fish species numbers increased to an average of 13, but the average number of fish collected was only 150. However, the stream channel had been dredged within the last few years and riparian cover had been removed. This likely inhibited the ability of the stream to recover from the influences further upstream. The QHEI score dropped from 50.5 near Graytown Road (RM 13.88) to 34.0 near Stange Road (RM 12.45). Along Rocky Ridge Road (RM 10.45) the fish community appeared to improve as community indices and narrative evaluations increased to marginally good (IBI=35). An average of 688 fish representing twenty species was collected here.

Rusha Creek

The fish community of Rusha Creek was evaluated between Behlman Road (RM 5.02) and Leutz Road (RM 4.0). The downstream portion of Rusha Creek is directly affected by Lake Erie and, therefore, the proposed Lacustuary IBI and MIwb indexes were used to evaluate the Leutz Road site. The community index and narrative evaluations for the headwater site near Behlman Road (RM 5.0) were poor (IBI=18) and reflected the maintained and channelized conditions. Goldfish, mud minnow, fathead minnow and green sunfish were the only fish species collected and all are considered tolerant. A total of 15 species were collected in the lacustuary portion of Rusha Creek near Leutz Road (RM 4.0), though six of the species were only represented by one individual. A majority of the species (62%) was considered tolerant, and only one moderately sensitive species, smallmouth bass, was collected. The modified conditions present in the lacustuary portion of Rusha Creek resulted in IBI and MIwb scores representing a poor community (IBI=21 and MIwb=4.8).

Packer Creek
The fish community of Packer Creek was evaluated from Stony Ridge Road (RM 21.16) to near the mouth (RM 0.14). The upper stretch of Packer Creek, from Stony Ridge Road (RM 21.16) to State Route 163 (RM 15.6), was evaluated as poor (IBI = 21 and 18, respectively) by the community index and narrative evaluations. Tolerant fish species comprised between 95-97% of the populations in the headwaters, with >73% of the fish species being omnivores and/or pioneering species at each site. The populations present in the headwaters reflected the poor habitat conditions present.

Further downstream, fish communities indicated improvements in habitat conditions as community index and narrative evaluations scored within the fair to marginally good range (IBI range of 30-36). Insectivorous species increased in abundance to 68% near State Route 163 (RM 14.73) while the omnivorous and pioneering species decreased in abundance to 16% and 20% respectively. A total of 30 species were collected near State Route 590 (RM 3.45) with tolerant species comprising between 28%-52% of the population present. The increased diversity of fish species reflected the slightly improved habitat conditions available in the lower reach.

The site near the mouth of Packer Creek (RM 0.14) is directly affected by Lake Erie and, therefore, the proposed Lacustuary IBI and MIwb indexes were used to evaluate this site. The lacustuary community and narrative index generated scores that depict a fair to poor community (IBI=23 and MIwb=7.4). Tolerant species comprised between 35%-43% of the population with top carnivores representing <3% of the total population. The fair to poor fish communities reflected the poor habitat present in the lacustuary portion of Packer Creek.

Gust Ditch
The fish community of Gust Ditch was evaluated near Martin-Willston Road (RM 2.76). Community index and narrative evaluations of the community scored very poor (IBI=16), reflecting the intermittent/ephemeral nature of the stream. Only four species of fish were collected in the stream, and all were collected within twenty feet of the bridge crossing. Three of the four species, fathead minnow, carp and bluntnose minnow, are considered tolerant. Orangespotted sunfish was the only non-minnow species collected at the site.

Martin Ditch
The fish populations of Martin Ditch were evaluated near Fulkert Road (RM 0.22). Community index and narrative evaluations of the community reflected poor conditions with an IBI value of 24. Tolerant species comprised 57%-66% of the community, with insectivorous species comprising <2% of the species collected. Fathead minnow, bluntnose minnow and stoneroller minnow comprised >92% of the population, mirroring the highly modified conditions observed.

Biological Communities: Macroinvertebrates

A total of 21 macroinvertebrate monitoring sites were sampled and collected in the Toussaint and Rusha Creek watersheds from July to September 2003 (Table 9). Streams sampled included Toussaint Creek, Toussaint River, Packer Creek, Martin Ditch, Rusha Creek, and Gust Ditch. Seventeen were lotic stream samples, and three were lake lacustuary (lentic) sites. One was determined to be an ephemeral Class I primary headwater habitat stream. A total of 208 separate taxa were collected cumulatively in the watershed during the field sampling. There were 56 moderately intolerant or sensitive taxa which comprised 27% of the total taxa collected. A total of 45 pollution-tolerant (moderately tolerant, tolerant, or very tolerant) taxa were collected and comprised approximately 22% of the total taxa collected.

The lotic stream sites on Toussaint Creek, Packer Creek, and Martin Ditch (all with existing or recommended WWH use designation) achieved the macroinvertebrate WWH biocriterion at fourteen of sixteen sites (Table 9). The attaining macroinvertebrate scores ranged from marginally good (≥30-32) to 44 (very good). The highest scores were Packer Creek at RM 3.5 (44) and two Toussaint Creek sites (RM 20.4 to 19.6) which both scored an ICI of 42 (very good). The fair scores (24 and 26) not attaining the WWH macroinvertebrate biocriterion were on Toussaint Creek in the headwaters at RM 36.5 and downstream at RM 14.0. The modified upper Rusha Creek site (recommended to be MWH) at RM 5.0 was assessed as low fair and did not meet MWH expectations.

The lacustuary sites on the Toussaint River at RM 4.7 (ICI=12; poor) and Rusha Creek at RM 3.0 (narrative assessment of marginally fair) did not achieve minimum lacustuary performance expectations. Packer Creek at the mouth (lacustuary site) did meet the minimum lacustuary performance expectations based on narrative macroinvertebrate community assessment of marginally good. More natural substrates in the Packer Creek lacustuary benefited the macroinvertebrate community. Woody debris with submerged and emergent aquatic plants in the shallower margin habitat allowed for more colonization stability and greater macroinvertebrate community richness and diversity.

Toussaint Mainstem

Ten sites were sampled in the free-flowing reaches of the Toussaint - nine in Toussaint Creek between RM 36.5 and RM 12.6 and one in the Toussaint River at RM 10.5. One lacustuary site was sampled at RM 4.7 in the Toussaint River. Eight of ten lotic sites sampled attained the WWH macroinvertebrate biocriterion.

Figure 15. Toussaint Creek at Simmonds Road (RM 36.5). The lack of shading allows for excess algal or plant production. The excess biomass can cause limiting low nighttime dissolved oxygen concentrations from decomposition and respiration which is harmful to aquatic insects, crayfish and fish.

The uppermost sample site at RM 36.5 did not achieve the minimum WWH macroinvertebrate performance. Toussaint Creek at this locale was impaired by physical habitat alteration and excess nutrient chemical inputs (Figure 15). The channelized and straightened streambed contained a monotonous run of 10-12 inches depth with limited hard substrates consisting of a few scattered pieces of rubble and cobble. Bottom substrates were primarily sand and silt overlying clay sediments with little or no woody debris present. Grass and arrow plant (*Peltandra* sp.) were along the margins which indicated the water level was likely shallower much of the time. Grass and small weeds or shrubs were on the trapezoidal banks which provided only limited stream shading and an open canopy over the stream. Grass strips comprised most of the riparian corridor with some small shrubs or weeds observed. Only a very few, very small trees were present. Periodically, drain tile pipes from adjacent agricultural fields were evident along the stream. This lack of shading and nutrient inputs contributed to increased instream temperatures and allowed for excess primary production. The combination of limited physical habitat and nutrient enriched conditions pointed toward the potential for low dissolved oxygen conditions occurring during nighttime decomposition and respiration.

A high density of tolerant or facultative macroinvertebrate taxa was present at the Simonds Road sample site (RM 36.5) that were nutrient-loving, resistant to lower D.O. levels, and/or margin organisms. Damselflies, tolerant midges like *Cricotopus (C.) bicinctus* and *Polypedilum (P.) illinoense*, *Berosus* beetles, and several types of leeches indicated lower aquatic community performance and a fair assessment (Figure 16). The number of EPT taxa and the number of sensitive taxa were both low (four each) with only facultative or moderately tolerant mayflies and caddisflies present (Figure 16). The lowest number of total taxa collected in the free-flowing reach was at this site, as was the lowest Qualitative Community Tolerance Value (QCTV) score of 32.6 (Figure 17). This lower quality community condition was typical of a nutrient-enriched reach that could be limited by low nighttime dissolved oxygen concentrations.

Table 9. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) from the Toussaint mainstem and tributaries sampled in the Toussaint and Rusha Creek watersheds, June - October, 2003. (Aquatic life uses listed are those currently designated in the Ohio Water Quality Standards or proposed use changes).

Stream River Mile	Drainage Area (mi.^{2})	Relative Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Total No. Taxa	Qual. EPT[a] Taxa	Total EPT Taxa	Predominant Organisms	QCTV[b]	ICI[c,d] (LICI)	Narrative Evaluation
Toussaint mainstem (16-215) (HELP) – (WWH)											
36.5	8.0	Mod-High	--	37	37	4	4	21,34,27,22	32.6	F*	Fair
33.6	18.0	408	--	49	67	8	11	18,22,57,11,25,6,5,7	34.8	38	Good
29.4	32.0	310	--	48	68	9	10	22,27,4,6,28	37.8	32[ns]	Marginally Good
28.5	34	Mod-Low	--	54	54	11	11	7,18,8	36.2	VG	Very Good
20.4 R	60	148	25	35	49	9	10	6,14,18,3	36.9	42	Very Good
19.6	61	118	41	25	48	7	8	7,26,6,10,18,22	36.6	42	Very Good
18.5	62	108	36	37	56	6	7	6,26,18,3	33.2	38	Good
14.0	76	116	32	24	43	4	4	6,18,10,28	39.0	24*	Fair
12.6	77	96	26	31	48	6	7	10,6,26,3,27	36.6	32[ns]	Marginally Good
10.5	81	184	27	36	46	5	5	6,27,3,9	36.6	36	Good
Toussaint River (16-215) (HELP) – (WWH) Lacustuary Zone											
4.7	122	2892	11	18	23	1	1	18,16,29	26.8	(12*)	Poor
Packer Creek (16-216) (HELP) – (WWH)											
21.2	8.0	Mod-Low	--	38	38	7	7	23,5,27,22,21,6	33.8	G	Good
14.7	16	Mod-High	--	55	55	12	12	9,29,5,27,19,15,8,6	35.5	G	Good

Stream River Mile	Drainage Area (mi.^{2})	Relative Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Total No. Taxa	Qual. EPT[a] Taxa	Total EPT Taxa	Predominant Organisms	QCTV[b]	ICI[c,d] (LICI)	Narrative Evaluation
11.3	19.8	Mod-High	--	43	43	9	9	3,29,11,22,6,29,25	33.3	G	Good
4.6	29.5	265	40	52	68	13	13	9,8,3,6,22,28	39.4	36	Good
3.5	31.3	339	35	35	56	9	15	18,6,20,8,51,52	36.8	44	Very Good
Packer Creek (16-216) (HELP) – (WWH) Lacustuary Zone											
0.1	34	865	19	25	37	4	7	60,51,52,59,41,27	29.0	(28)	High Fair
Martin Ditch (16-228) (HELP) – (WWH)											
0.2	5.8	Mod-High	--	42	42	7	7	11,29,25,24,23,21 32	33.1	32[ns]	Marginally Good
Rusha Creek (16-214) (HELP) – (proposed MWH)											
5.0	6.6	Mod-Low	--	28	28	3	3	27,58,25,51	24.8	F*	Marginally Fair
Rusha Creek (16-214) (HELP) – (WWH) Lacustuary Zone											
3.0	10.7	Moderate	--	28	28	2	2	21,31,59	28.4	(F*)	Marginally Fair

Ecoregion Biocriteria: Huron Erie Lake Plain				
Index	EWH	WWH	MWH	LRW
ICI	46	34	22	8

Lacustuary Scoring Benchmarks		
Index	WWH	Intermediate Goal for WWH
LICI	42	34

a EPT=total Ephemeroptera (mayflies), Plecoptera (stoneflies), & Trichoptera (caddisflies) taxa richness.
b Qualitative Community Tolerance Value (QCTV) is derived as the median of the tolerance values calculated for each qualitative taxon present.
c Qualitative narrative evaluation is based on best professional judgment utilizing sample attributes such as taxa richness, EPT richness, and QCTV score and is used when quantitative data are not available to calculate an Invertebrate Community Index (ICI) score.
d Qualitative narrative assessment used in lieu of quantitative score due to lack of requisite current velocity, loss and/or vandalism of artificial substrates.
Narrative evaluation assessments: Very Poor, Poor, Fair, Marginally Good, Good, Very Good, and Exceptional.
Lacustuary narrative evaluations: Very Poor, Poor, Fair, High Fair (Marginal), Good, Exceptional.
R Regional reference site
* Significant departure from ecoregion biocriterion (>4 ICI units); poor and very poor results are underlined.
ns Nonsignificant departure from ecoregion biocriterion (≤4 ICI units).

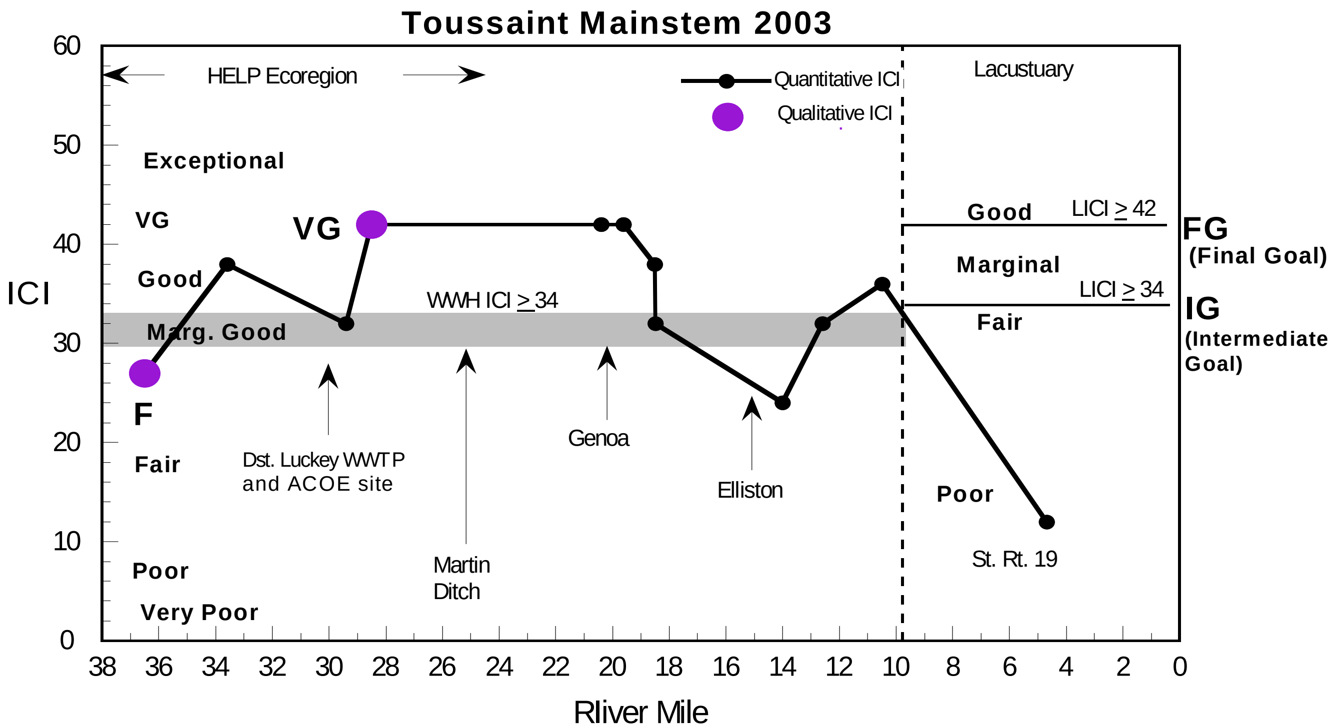
Predominant organism code list

1 *Isonychia* mayflies	12 water pennies	23 burrowing mayflies	34 Argia damselflies	45 *Neophylax* caddisflies	56 tipulids/cranefly
2 *Chimarra* caddisflies	13 pond (LH) snails	24 various beetles	35 limpet snails	46 *Protoptila* caddisflies	57 planorbid snails
3 hydropsychid caddisflies	14 moth larvae	25 isopods	36 helgrammites	47 *Ceraclea* caddisflies	58 ceratopogonids
4 snail-cased caddisfly	15 blackflies	26 scuds / shrimp	37 *Sialis* sp	48 *Oecetis* caddisflies	59 glass shrimp
5 tanytarsini midges	16 aquatic worms	27 midges	38 *Helichus* beetles	49 *Ancyronyx* beetles	60 sponge
6 flathead mayflies	17 *Tricorythodes*	28 crayfish	39 tabanids	50 freshwater mussels	
7 nonred midges	18 red midges	29 flatworms	40 stoneflies	51*Peltodytes* beetles	
8 baetid mayflies	19 Bryozoa	30 tipulids	41 polycentropids	52 *Berosus* beetles	
9 riffle beetles	20 *Caenis* mayflies	31 corixids	42 *Dubiraphia* beetles	53 hydrobiid snails	
10 river (RH) snails	21 damselflies	32 dragonflies	43 *Macronychus* beetles	54 *Fossaria* snails	
11 cased caddisflies	22 fingernail clams	33 leeches	44 *Optioservus* beetles	55 ephemerellid mayflies	

The majority of nitrite concentrations at this location were greater than the 95th percentile value of the HELP ecoregional site concentrations (Table 6). Nitrite is a short-lived intermediate ammonia nitrification product, so repeated collections in excessive amounts indicates severe nutrient enrichment. Nitrite may also be toxic to aquatic life at concentrations >.50 ppm. The high nitrite concentration inputs, the open canopy conditions, and the resultant algal and plant production and decomposition indicated that summer time low nighttime D.O. concentrations are likely commonplace occurrences in this reach. Decreasing the amount of maintenance, such as eliminating mowing along the sloped banks and within the stream channel, would allow for some riparian corridor maturity and habitat development within the channel that would benefit the macroinvertebrate community. Increased sinuosity within the channel might allow for rudimentary development of riffle / run / pool complexes, diversifying the habitat available to aquatic life. These improvements would likely help decrease the excess algal production, as some absorption and shading should limit photosynthetic production rates and thus help decrease the number and duration of nighttime low D.O. episodes.

Downstream at RM 33.6 (Webster Road), there was substantial habitat recovery though some residual channelization effects remained. Habitat variety improved, as the run contained more firm, rocky substrates and submerged aquatic macrophytes increasing the presence of mayflies (located on rocks) and microcaddisflies (attached to rocks and submerged plants). Despite very high flows prior to sample retrieval which flushed out much of the aquatic plants, 11 taxa of mayflies or caddisflies were collected. Fourteen sensitive taxa, which was the highest number collected at one site in Toussaint Creek, were present here. Notable organisms present were the moderately intolerant (MI) Creeper mussel (*Strophitus undulatus*) and two intolerant (I) mayflies (*Leucrocuta* sp. and *Pseudocloeon frondale*).

Downstream from the Luckey WWTP (RM 29.4), an improved wooded riparian habitat and channel helped to ameliorate the effects of the effluent quality and nutrient inputs of the treated wastewater. Similar types and numbers of sensitive taxa (14) and total taxa (68, the highest of all sample sites) indicated that WWH biological performance was being met. The midge community appeared more balanced and of higher quality, as a varied tanytarsini midge community was observed and a number of sensitive midges were collected here for the first time. The ICI of 32 (marginally good) documented marginal attainment of the macroinvertebrate WWH biocriterion. The shaded canopy buffered the effects of the green algal-filled wastewater inputs near the discharge point, limiting the amount of overall density of macroinvertebrates to appropriate levels.



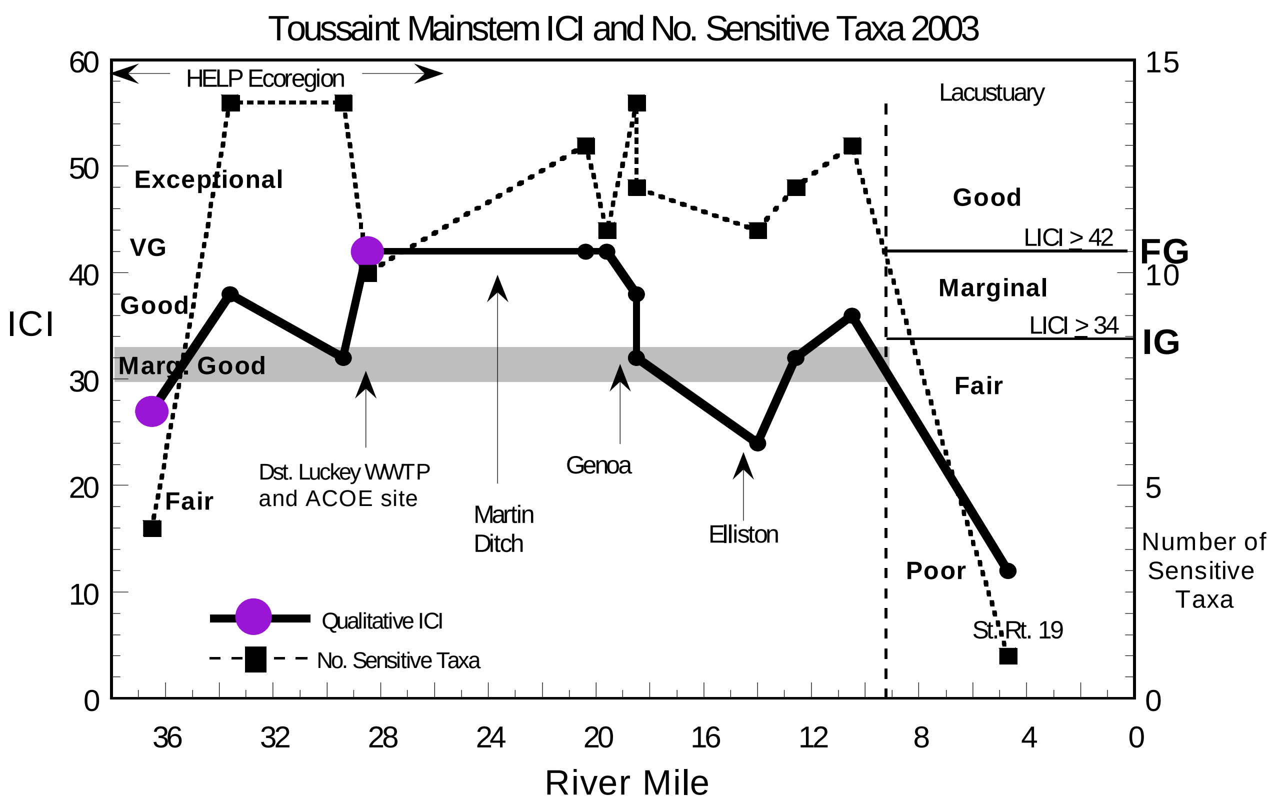


Figure 16. Longitudinal ICI graph for the Toussaint mainstem and a longitudinal comparison of the number of sensitive (intolerant or moderately intolerant) taxa for the 2003 macroinvertebrate survey study in the Toussaint basin.

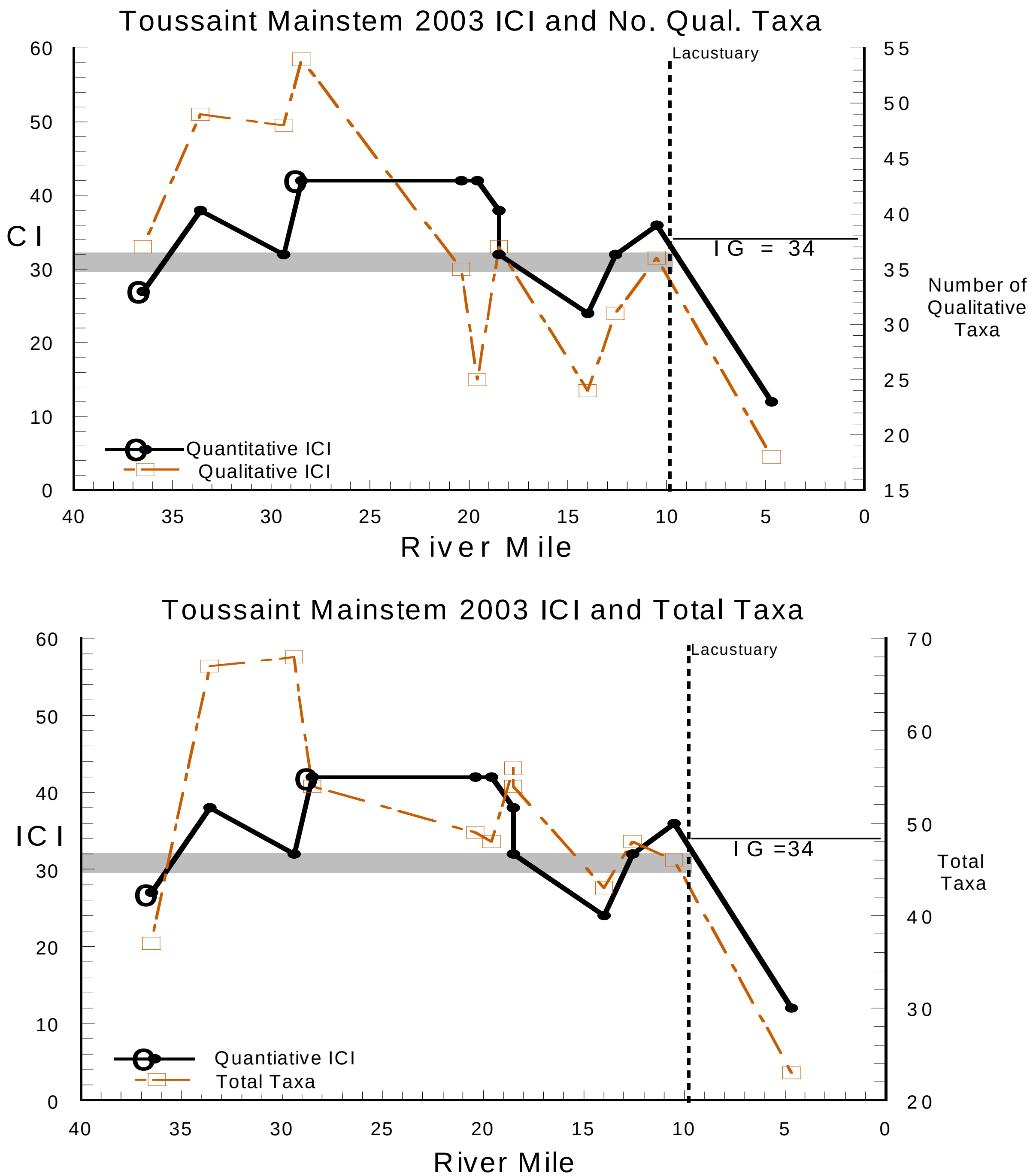


Figure 17. Longitudinal ICI graph for the Toussaint Creek / River and the number of qualitative taxa and the number of total taxa for the 2003 macroinvertebrate survey study in the Toussaint basin.

The Lemoyne Road sample site (RM 28.5), which was adjacent to an established conservation buffer area, appeared to be recovering from past channelization activities with increased amounts of woody debris in the channel. This allowed formation of plunge pools, deeper runs, and faster stick and wood-filled riffles. As a result of better habitat and faster flows, baetid mayflies increased in number and were predominant along with filtering genus *Polypedilum* midges. Filter-feeding genus *Cheumatopsyche* caddisflies increased and were common with more stable woody substrates and available suspended food particulates from upstream primary production. Some small population density increases indicated slight enrichment from sources in or near Luckey, but it did not substantially affect community quality *except* in the pools due to more lotic conditions at the sample site. The eleven different EPT taxa collected during qualitative sampling were the most of any Toussaint Creek site, and mayfly populations collected indicated a much higher representation in the community population. The increases in mayfly and caddisfly populations *also* indicated more stable, permanent and diverse habitat (wood and rocky substrates), including minimum and variable stream depths and stream velocities in the reach.

The lower density and diversity in the pools was likely partially attributable to the lower nighttime D.O. levels occurring as a result of excess production upstream. The excess production results in biomass accumulation, decomposition and respiration thus lowering the dissolved oxygen concentrations instream. Lower nighttime dissolved oxygen concentrations (< 4 ppm for ~seven hours) were documented at Lemoyne Road on August 21, 2003. This periodic low D.O. condition instream was recorded both upstream from Lemoyne Road and downstream from the Luckey WWTP discharge, where treated wastewater was already highly concentrated with algae.

Very good macroinvertebrate performance continued downstream as the Toussaint mainstem flowed through Genoa and downstream from its WWTP. Wider riparian corridor was abundant through this segment. A regional reference site at RM 20.4 (adjacent Camper Road) was sampled and scored an ICI of 42. A natural gradient line and constriction in the river at the reference site formed a deep run with faster flows composed of a good amount of larger rocky substrates (stone remains of possibly a bridge or mill walls). Predominant organisms were genus *Stenonema* mayflies, the intolerant moth genus *Petrophila*, genus *Stictochironomus* midges, and hydropsychid (ney-spinning) caddisflies. Other sensitive mayflies collected included the intolerant genus *Leucrocuta*, the moderately intolerant (MI) genus *Isonychia,* and the intolerant baetid mayfly species, *Acerpenna pygmaea*.

Downstream from the Genoa WWTP discharge there was a similar community with like numbers of sensitive taxa (11), total taxa (48 compared to 49 upstream) and only slightly lower EPT taxa totals (8 compared to 10 upstream). There were higher numbers of filter-feeders (e.g., *Polypedilum flavum* midges and *Simulium* blackflies) present in the population probably due to the nutrient or particulate inputs from the Genoa WWTP discharge. There did not seem to have been any large effect on stream water quality immediately downstream from the Genoa discharge at the sample site (RM 19.6). The macroinvertebrate community continued to benefit from a wide riparian corridor upstream and through this reach. The occasional elevated phosphorous and nitrite concentrations recorded downstream from the Genoa WWTP were expressed ecologically downstream near Fulkert Road (RM 18.5) where a reduced canopy increased sunlight and temperature conditions resulting in green algal blooms (Table 6).

The overall riparian widths decreased in a downstream direction as more intensive agriculture activities were prevalent. Heavier amounts of silt were noted in the depositional areas of the reach near Fulkert Road (RM 18.5). In several areas, less diverse habitat was observed, but where rocky substrates (rubble and cobble) were still persistently present, a fairly diverse macroinvertebrate community was documented. Better reaches contained constricting gravel side bars that formed shallow riffles and short rocky run/glides with a variety of margin habitat. The artificial substrates collected at RM 18.5 within this better habitat region scored an ICI of 38, which met the WWH ICI biocriterion. Similar numbers of sensitive taxa (13) were collected here as were collected at the regional reference site. There were three species of mussels collected in this reach, particularly near the protected area downstream from the gravel bars. A fresh dead specimen of the moderately intolerant Wabash Pigtoe mussel (*Fusconaia flava*) was only collected at this location during the 2003 sampling season. The presence of mussels and the moderately intolerant *Elimia* river snails indicated that this reach has not been disturbed or radically changed recently, as these organisms require stable substrates and habitat. Care should be taken to leave intact the thin wooded riparian corridor currently present and allow for some expansion. This would reduce stream temperatures, NPS sediment inputs, and algal blooms (with possible accompanying variable instream low D.O. incidents) from upstream discharges and agricultural NPS nutrient inputs.

At Graytown (RM 14.0), the reach sampled upstream had not recovered from past channelization activities. Little habitat variety or development was present – mostly incised, 1.5 to 2 feet deep slow runs with clay bottoms and some rocky substrates. Occasionally, a deeper pool with mostly soft depositional substrates was observed. Small amounts of woody debris were present – mostly small diameter. Insufficient flows and lack of habitat variety negatively affected taxa diversity and a non-attaining ICI score of 24 (fair) was documented. Baetid mayfly species were no longer present due to the decreased current flows and likely the lack of stable wood structure, while limited caddisfly diversity could be attributed to the limited habitat diversity. The reduced presence of these species lowered the community quality considerably. Only four EPT taxa and low taxa totals were documented upstream from Graytown Road (Figures 16 and 17). Two tributaries merge into Toussaint Creek, one at RM 14.23 and one at RM 14.13, and also the Penn Central Railroad (RM 14.11) crosses the mainstem just upstream from the sampled reach. A third tributary (containing Gust Ditch) has its confluence farther upstream (RM 17.85) but below the last upstream sample site. All need to be considered as possible sources of negative nonpoint source inputs.

Macroinvertebrate community quality improved to marginally good (ICI = 32) downstream at Stange Road (RM 12.6) despite new bridge work. A good macroinvertebrate community was associated with the abundance of large rocky substrates and small woody debris in the margins. A more predominant and diverse mayfly community with a greater variety of tanytarsini midges and caddisflies illustrated the improvement. The percentage of tolerant taxa in the macroinvertebrate community decreased dramatically compared to upstream. High numbers of mayflies were utilizing the large rocky habitat. Larvae of the moth genus *Petrophila* were present on the rubble and boulders in the run. The future expectation would be for greater diversity as habitat conditions stabilize downstream from the recent instream work. The more open canopy upstream allowed for increased primary production, as there was a more greenish color to the stream here. High densities of scuds in the margins and *Elimia* river snails in the run indicated enrichment was occurring, though densities did not increase in the quantitative samples. Improving the riparian corridor and reducing the nutrient inputs should improve conditions for macroinvertebrate communities.

Better and more stable stream development at Rocky Ridge Road (RM 10.5) has been a haven for the largest population of mussels observed in the Toussaint survey. The typical habitat encountered was stick and wood riffles and runs with more sand and gravel and some larger rocky substrates than in other areas. Caddisflies, riffle beetles, mayflies, *Elimia* river snails, and midges were predominant. Mayflies comprised 63 percent of the sampled population, and the number of sensitive taxa increased. Four mussel species, including the intolerant Fawnsfoot mussel (*Truncilla donaciformis*), and the predominant mayfly population were evidence of the improved and more stable instream habitat. Wider riparian corridors upstream from the sample area helped maintain the good (ICI=36) macroinvertebrate community that was present.

Toussaint River

Downstream from Rocky Ridge Road, the Toussaint River rapidly becomes functionally lentic, as the mainstem is more influenced by Lake Erie with some fluctuating levels and current. The lacustuary site at State Route 19 (RM 4.7) yielded poor quality conditions (Lacustuary ICI=12) and did not meet the minimum performance expectations (Intermediate LICI goal = 34). Tolerant and nutrient-loving midges, oligochaete worms, corixids, and flatworms were predominant and comprised 95 percent of the individuals collected from the artificial substrates. Population density increased dramatically to 3000 organisms/ft^2. The margin community, qualitatively sampled among the aquatic plants, grasses, occasional log, and rip rap along the more protected shore, was of better quality. However, the community ecology is driven by the algal production in the open lacustuary, and subsequently the tolerant filterers or grazers dominated the macroinvertebrate community. Decreased nutrient inputs and sediment upstream would decrease algal inputs into the lacustuary and into Lake Erie. Riverine width and depth affect macroinvertebrate diversity by the presence or absence of margin or lacustuarine habitat. Margin habitat (submerged plants and stable woody debris) will maintain or improve in quality if the river was more sheltered. Possible live munitions present in downstream reaches of the Toussaint River prevented further macroinvertebrate sampling between State Route 19 and the mouth.

Packer Creek

Six sites were sampled in Packer Creek. There were five lotic sites from Stony Ridge Road (RM 21.2) to State Route 590 (RM 3.5). All five lotic sites attained the WWH macroinvertebrate biocriterion. The lacustuary (more lentic) site was at RM 0.1 (Toussaint North Road) and achieved the lacustuary intermediate goal based on a narrative assessment of high fair.

A good macroinvertebrate community was sampled at Stony Ridge Road (RM 21.2) despite the past ditching practices and open canopy (little or no trees). Grass banks provided some protection, but occasional heavy rains have caused some destabilization. A few runs and pools had developed within the bottom of the channel. Where rocks were not embedded caddisflies and mayflies were common. Most bottom substrates were largely clay and hardpan, and two different species of burrowing mayflies (*Hexagenia* spp.) were predominant. Excess sunlight and nutrient inputs (NH_3, nitrite, TKN, and TP) increased primary production and macrophyte growth instream, so filtering organisms, with moderate to high population densities, were also predominant. Increased riparian width and bank stabilization would likely improve conditions further.

Packer Creek had been allowed to meander slightly within the deeply entrenched channel along State Route 163 (RM 14.7). The north bank has revegetated, thus a small thin wood and grass riparian buffer area has developed on the left bank. State Route 163 was being widened at the time of sampling in 2003. Suspended solids from runoff, here at Billman Road and State Route 163, was the highest measured values in the survey (62 and 56 mg/l, respectively). Agricultural drainage ditches delivered excess NPS agricultural inputs (nitrites, TKN, and TP). Population densities increased with these inputs, and facultative taxa increased in response to increased biomass (flatworms and blackflies). However the partially shaded conditions, low stream temperature (20.5^{o}C), and more rocky riffles and runs supported a good macroinvertebrate community. Sensitive taxa and total EPT taxa increased including the intolerant mayfly *Leucrocuta* sp. and the moderately intolerant caddisflies *Ceratopsyche (C.) morosa* group and *Chimarra obscura* (Figure 17). Live Giant Floater mussels (*Pyganodon grandis*) inhabited this reach. Increasing the stream canopy coverage and decreasing nutrient inputs should decrease organism density and further improve quality in the macroinvertebrate community.

Downstream from Genoa at Martin-Willston Road (RM 11.3), the stream had recovered from channelization with more instream development and chemistry results indicated that nutrient inputs had decreased slightly except for phosphorous (likely municipal nonpoint inputs). Good macroinvertebrate community quality was still present. Instream habitat improvements, better canopy cover, and slightly decreased nutrients triggered an increased percentage of mayflies and caddisflies. Well developed riffles were present with rocky runs that contained largely hard substrates. Facultative population of isopods and flatworms that had responded to increased nutrient enrichment decreased in this reach compared to upstream. Occasional scoured margin edges indicated stormwater runoff effects from Genoa and possibly the road construction activities.

Good habitat typified Packer Creek at Stange Road (RM 4.6). This more shaded reach consisted of rocky riffles and slower runs with woody and rocky debris along with a diverse and varied margin habitat. There seemed to be a related decrease in nutrient inputs, as population densities decreased to 265 organisms/ft.^{2}, much lower than upstream. The highest survey numbers of total taxa (68), qualitative EPT taxa (13) and sensitive macroinvertebrate taxa (20) were collected at this site. The intolerant mayflies *Acerpenna pygmaea* and *Leucrocuta*, and midges *Tvetenia discoloripes* group and *Thienemanniella similis* were some of the sensitive and unique taxa collected at RM 4.6. The highest QCTV of the survey (39.4) was in this reach of Packer Creek (Table 9). The macroinvertebrate ICI of 36 (good) was likely under representative because the bridge was torn down and rebuilt during the colonization period of the artificial substrates. This highly diverse macroinvertebrate community persisted through bridge rebuilding and very high water during the summer of 2003.

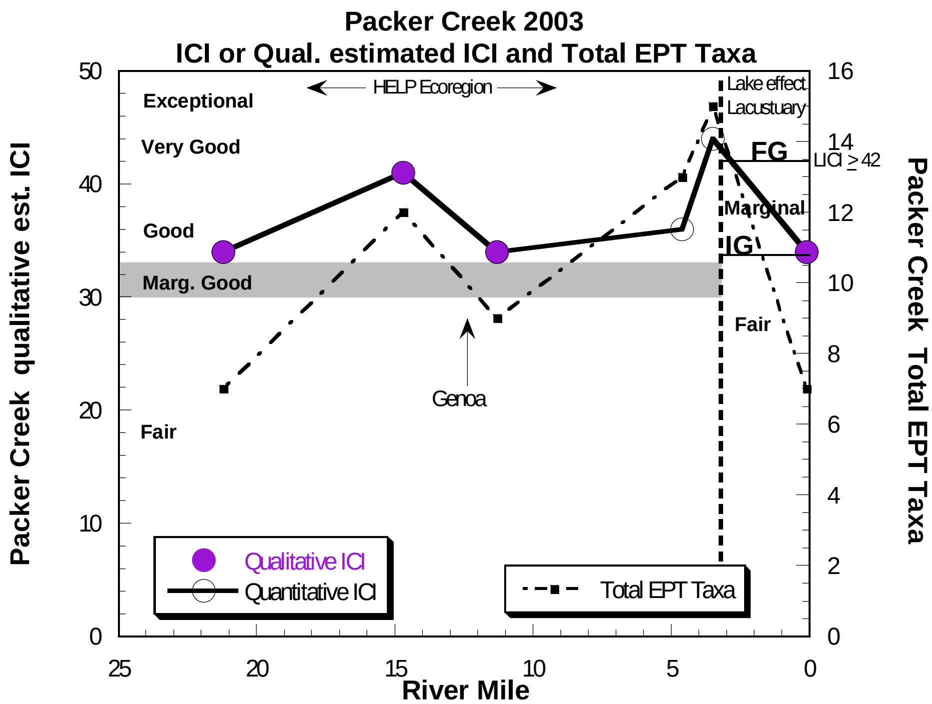


Figure 18. Packer Creek ICI and Total EPT Taxa for 2003.

A very good macroinvertebrate community (ICI=44) was present at the last lotic site at State Route 590 (RM 3.5). At this site, Packer Creek was primarily a deep run with large rubble and coarse and fine gravel interspersed on a clay / hardpan bottom. A diverse mayfly community was present with the highest total EPT taxa collected at any Toussaint survey site.

Downstream from State Route 590 (RM 3.45), the lacustuary reach of Packer Creek had begun, as it is more influenced by Lake Erie with fluctuating levels and current. Based mostly on the qualitative field sample and direct observations, the lacustuary site adjacent to State Route 19 (RM 0.1) was given a narrative quality assessment of high fair (based on the LICI score of 28) which minimally achieved lacustuary expectations (Intermediate LICI goal = 34). Seven total EPT taxa (five mayflies and two caddisflies) and five sensitive taxa were among the 37 total macroinvertebrate taxa collected from Packer Creek at this site. The five mayfly taxa present included the moderately intolerant mayfly *Procloeon*. Improvements to the existing margin habitat would increase plant nutrient uptake, decrease the percentage of open water, and decrease algal production. Less maintenance of the channel, decreasing river depth (by removal or allowing breaks in dikes or levees or development of braided channels) and more riparian margin restoration (an increase in submerged plants and woody debris) should improve habitat quality and the macroinvertebrate community. More submergent growth in the shallower portions should also assimilate more nutrients and decrease algal production. This change would positively improve macroinvertebrate diversity and quality.

Martin Ditch

Martin Ditch is a historically channelized small stream with little shaded canopy except for taller weeds and shrubs or an occasional sapling. Excess agricultural nutrient inputs were evident, as nitrites and TKN were at or above the 90^{th} and 95^{th} percentile compared to HELP ecoregional sites. Excess algal production caused extreme diurnal D.O. swings with nighttime low D.O. concentrations below 2ppm (Table 5). Some meandering of the stream had occurred in the bottom of the channel. Despite the lack of riparian corridor or canopy and nutrient enrichment, the presence of the moderately intolerant burrowing mayflies *Hexagenia limbata* and *H. bilineata* and different cased caddisflies were positive macroinvertebrate attributes. However, the abundance and predominance of isopods and flatworms reflected the enriched conditions. Despite these negative aspects, the macroinvertebrate community was qualitatively assessed as marginally good and minimally achieved WWH performance expectations. Improving the riparian cover would benefit the biological community by increasing nutrient absorption/uptake along the stream and by providing shade which would decrease the water temperatures and algal production.

Gust Ditch

Gust Ditch was, upon examination, an ephemeral stream that dried out soon after macroinvertebrate sampling in late August. The water that was still present during sampling was likely due to the very wet spring and summer conditions. Only a shallow pool of water <10 feet long was present. Only 13 macroinvertebrate taxa were collected and no mayflies or caddisflies were observed. Between the two fish passes, Gust Ditch was completely dry except for a small pool near the bridge along Martin-Willston Road. Based on the ephemeral nature of the ditch, it was determined that Gust Ditch was best classified as a Primary Headwater Habitat Class 1 stream.

Rusha Creek

Rusha Creek at Behlman Road (RM 5.0) was mostly a channelized, diked stream filled with sediments and vegetation throughout the channel. While formerly a low gradient wetland / estuary stream, it had been modified for flood control for adjacent agriculture (Figure 13). A marginally fair community was documented with midges, biting midges, beetles, and isopods predominant. No sensitive taxa were present, and only three EPT taxa were collected. The community performance did not meet WWH or MWH expectations. The free-flowing section of Rusha Creek through this reach is recommended to be designated MWH.

The Rusha Creek lacustuary was sampled at Toussaint South Road (RM 3.0). It was channelized, leveed, and deepened, but some riparian margin habitat was still present. Shallows, grass, emergents, woody debris, and rip rap habitats comprised fair to good margin habitat. However, only two EPT taxa and one sensitive bryozoan were collected here. Fair macroinvertebrate performance did not meet lacustuary expectations. Beetles, damselflies, glass shrimp, and bryozoa were predominant. More treed canopy would help natural bank stabilization, shade the channel, and decrease water temperatures (recorded at 28^{o} C.). The increased woody riparian corridor would help facilitate the recolonization of more sensitive benthic organisms. Decreasing depth (no channel maintenance) would improve the biological community by allowing expansion of submergent and emergent vegetation which would increase habitat opportunities for recolonization and use by macroinvertebrates and fish.

Drainage Area Comparisons

Macroinvertebrate sites were grouped into drainage areas of 6-8, 15, 30, 60 and 80 square miles for comparison (lotic reaches only). More non-attainment or lower performance (assessment of fair to marginally good water quality conditions) was observed in the sampled reaches with smaller drainage areas (6-8 $mi.^2$). The stream quality progressively improved until the reaches in the approximately 80 square mile drainage range where nutrient inputs increased (more tributary inputs) and habitat alteration and sedimentation more greatly determined community quality. These altered conditions and accumulated nutrients in portions of the lacustuary reaches were even more pronounced (Figure 19).

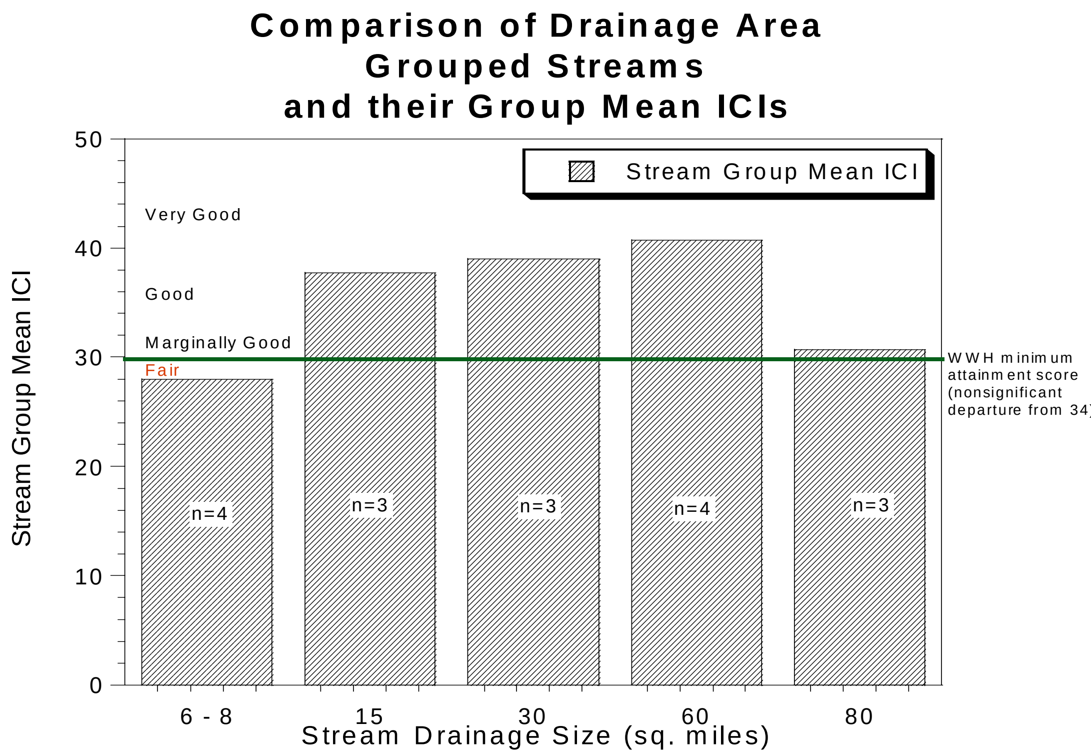


Figure 19. Drainage areas, grouped streams and groupd mean ICIs.

Two of the four smaller streams did not meet WWH performance expectations (Figure 19). Most of the upper mainstem of Toussaint Creek had filter strips and some had riparian buffers, as owners had participated in the Toussaint River Incentive Program. There was still approximately 20-30 percent (based on 2004 coverage map from the Phase I and II final results of the Toussaint River Improvement Incentive Program) of the smaller tributaries of Toussaint Creek in the upper watershed that were unshaded and/or without filter strips. Nonpoint nutrients and sediment still entered the upper mainstem in excess amounts from these and other sources. Some of the riparian corridors (with increased shade canopy) were small or still developing. Several reaches had established filter strips but woody trees and shrubs were removed. The filter strips in combination with other soil conservation practices have greatly diminished soil loss and reduced nonpoint nutrient inputs. However, nutrients from upstream and other small tributaries to the upper mainstem of Toussaint Creek have the potential to produce excess algal and plant biomass

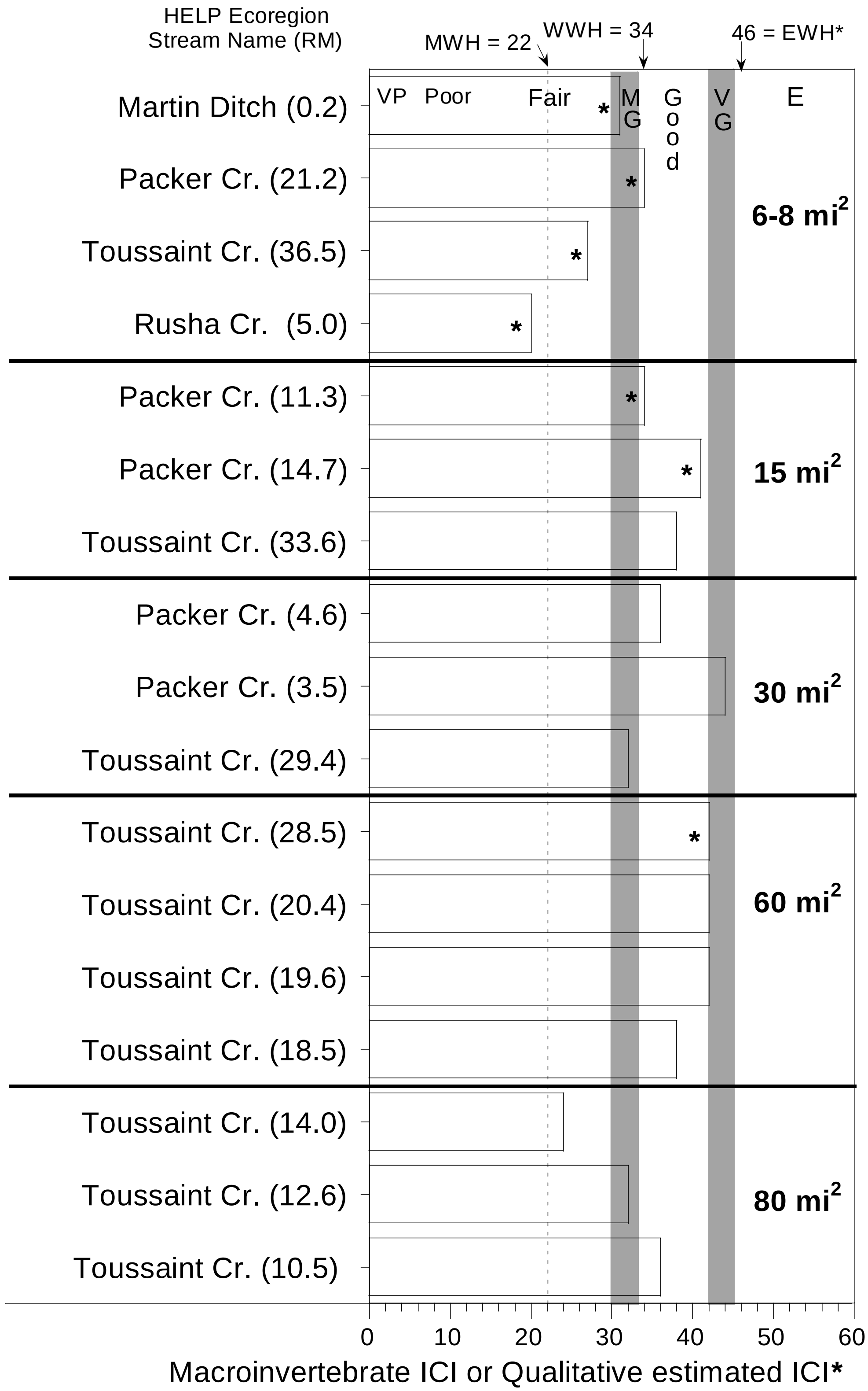


Figure 20. Bar graphs of the ICI scores or the qualitative estimated ICI scores for sites in grouped drainage areas from the 2003 Toussaint Creek / River basin survey.

which can cause low nighttime D.O. concentrations (2 to <4 mg/l, e.g., in Martin Ditch). This could continue to limit biological quality in the upper Toussaint Creek basin.

The middle drainage area sites (15 to 60 mi^2) mostly had generally sufficient flow, habitat, and woody riparian corridor widths with adjacent filter strips (from the Toussaint River Improvement Incentive Program) to offset the sporadic reaches where excess sedimentation or nutrients and open conditions allowed excess primary production. Downstream from the Luckey WWTP discharge this balance was exceeded and excess algal production and subsequent low nighttime D.O. concentrations around 2 mg/l occurred. A more complete canopy adjacent to the creek would protect against such extremes. The highest diversity and biological community scores were in these drainage area reaches.

Instream habitat losses (channelization effects including woody removal) and tributary and other possible nonpoint nutrient inputs affected the more pooled or deep slow run reaches in the 80 mi^2 drainage category. Further downstream, nonpoint inputs seemed to begin to increase (more tributary inputs) and habitat alteration and sedimentation more greatly determined community quality. These altered conditions, with more open water, less margin habitat, and accumulated nutrients in portions of the lacustuary reaches, were even more pronounced.

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