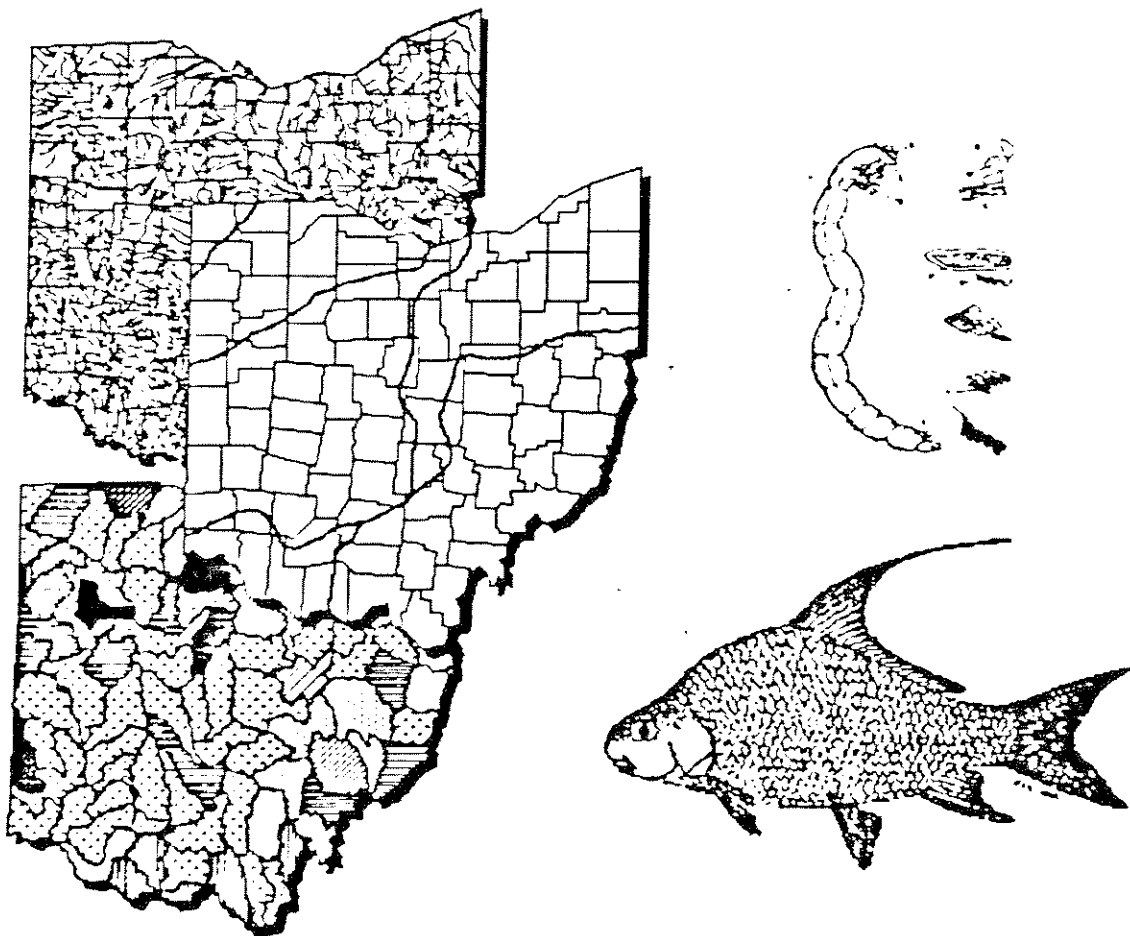


Biological and Water Quality Study of the Sandusky River & Selected Tributaries

Crawford, Wyandot, and Seneca
Counties (Ohio)



June 20, 1991

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Biological and Water Quality Survey of the Sandusky River (Crawford, Wyandot, and Seneca Counties)

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Introduction

The Sandusky River study area extended from upstream from Bucyrus (RM 116.3) to downstream from Tiffin (RM 31.9) and included sites on three tributaries; Rock Run, Negro Run, and Broken Sword Creek

Specific objectives of this evaluation were to:

- 1) monitor and assess chemical/ physical water quality and biological communities in the Sandusky River to determine the degree to which WWTPs for the cities of Bucyrus, Upper Sandusky and Tiffin were affecting the stream;
- 2) assess impacts due to nonpoint source runoff and habitat alteration;
- 3) determine the attainment status of current aquatic life use designations; and,
- 4) analyze long term trend in chemical, physical, and biological results to determine how ambient conditions have changed in the Sandusky River following improvements to the WWTPs.

The findings of this evaluation may factor into regulatory actions taken by Ohio EPA (e.g. Water Quality Standards, NPDES permits) and eventually be incorporated into the State Water Quality Management Plan and biennial Water Resource Inventory 305(b) report.

Conclusions

Based on the results of the 1990 monitoring effort, the following conclusions are made for the Sandusky River:

- * Water chemistry sampling produced numerous exceedences of the thirty day average fecal coliform bacteria criterion; these can be credited in part to the high flows encountered throughout the summer and the resultant discharge of combined sewer overflows (CSOs). The highest fecal coliform counts were recorded downstream from CSOs within the city of Bucyrus.
- * Ten polynuclear aromatic hydrocarbon compounds (PAHs) were detected in sediment downstream from Bucyrus, the source of which may be runoff from local railroad yards.
- * Outside of the Bucyrus, Upper Sandusky, and Tiffin urban areas the macroinvertebrate community was generally reflective of exceptional water quality; the one exception being RM 36.5, downstream from Tiffin, where the community was apparently negatively affected by an accumulation of organic material from upstream sources.
- * Based on fish community sampling results, the study area can be divided into two segments: 1) an upper segment extending from the upstream sampling site (RM 116.3) to downstream from Upper Sandusky RM (77.9), where fair community performance was indicated, and 2) a lower segment extending from RM 72.2 to downstream from Tiffin, where a good fish community was indicated (RM 72.2- 32.0). In the upper segment, fish communities were impaired by sedimentation and embeddedness of the river bottom substrate; and by CSOs in Bucyrus and the Bucyrus and Upper Sandusky WWTP effluents. The sedimentation and embeddedness problems are likely attributable to agricultural land use practices in combination with low stream gradient. The good performance of the fish community in the lower segment appeared due to increased stream gradient that reduced sedimentation and embeddedness. This segment supported a healthy population of pollution sensitive round bodied suckers.
- * The three WWTP mixing zones within the study area did not appear to have any acutely toxic impacts as evidenced by the condition of the fish and macroinvertebrate community associated with them.
- * Macroinvertebrate communities in Broken Sword Creek, Negro Run, and Rock Run were reflective of good to exceptional water quality. Good water quality was indicated by the Broken Sword Creek and Negro Run fish communities; Rock Run was considered to have a fair fish community that was impaired by sedimentation.
- * Based on a comparison of the present study and results from 1979 (OEPA 1981), significant improvement was realized in the macroinvertebrate community as a result of the upgrading of the Bucyrus WWTP, while only a slight improvement was noted in the fish community. CSOs within the city of Bucyrus continue to impact both fish and macroinvertebrates.

- * The greatest improvement in the fish community, compared to a 1981 study (OEPA 1982), was observed within and downstream from Tiffin and was attributed to improved treatment at the WWTP and correction of a sewer line break that discharged directly into the Sandusky River.
- * Based on responses of instream communities and derived biocriteria, a total of 24.7 miles of the Sandusky River fully attained the designated Warmwater Habitat aquatic life use (32% of the study area); 43.2 miles partially attained (51%) and 14.1 miles failed to attain (17%). As was discussed previously, the majority of the miles partially and non attaining were upstream from RM 72.2 where the fish community exhibited more impairment than the macroinvertebrates.

Recommendations

Use Designation Status

The current Warmwater Habitat aquatic life use should be maintained for the Sandusky River and the three tributaries that were monitored as part of this study.

Full attainment of the WWH use upstream from Tiffin appears to be largely dependant on lessening the sediment bed load contributed to the stream as a consequence of current agricultural practices. Control of CSO discharges within the city of Bucyrus should result in an improvement of the biological communities and a reduction in fecal coliform bacteria levels within and downstream from Bucyrus.

Future Monitoring Needs

Improved monitoring and reporting of CSO discharges:

Very little data was available on the frequency, magnitude, and duration of CSO events to aid in the interpretation of results. Future municipal NPDES permits should include provisions for improved CSO monitoring and reporting.

An evaluation of TSS and BOD contributed by the Tiffin WWTP:

The Tiffin WWTP presently is the major point source contributor of suspended solids (TSS) within the study area. An evaluation should be done to determine if a reduction of TSS and biochemical oxygen demand (BOD) could alleviate the non-attainment of the WWH biocriterion observed in the macroinvertebrate community at RM 36.5. This evaluation should include plant bypasses in the calculation of loadings. Bypassing may be a significant problem as evidenced by a black discharge during a rain event in October.

Evaluation of factors contributing to sedimentation and embeddedness of the substrates upstream from Tiffin:

Improvement of the fish community outside of the urban areas appears largely contingent on reducing the amount of sediment that enters the stream. Implementation of Best Management Practices should target sediment reduction. Protection and rehabilitation of the riparian zone is also needed for bank stabilization

Sediment sampling in the Bucyrus area:

Identification of sources and extent of PAH contamination in the sediment downstream from the Bucyrus WWTP requires additional sampling and source investigation.

Study Area

The study area is located in the following north-central Ohio counties: Seneca, Wyandot, and Crawford and includes RMs 116.3 to 31.9. Principal subbasins in the study area include: Tymochtee Creek, Honey Creek, and Sycamore Creek (ODNR, 1960).

The Sandusky River is a major tributary to Lake Erie occupying 1,420 square miles of predominantly agricultural land in North Central Ohio. The Sandusky River flows south to north discharging into Sandusky Bay, the largest embayment on the south shore of Lake Erie. The major urban areas in the basin include Fremont, Tiffin, Upper Sandusky and Bucyrus. The Sandusky River is an important water supply for public, industrial and agricultural uses and is a designated State Scenic River between RMs 47.8 and 19.0 (ODNR 1985).

The Sandusky River study area is situated within the Eastern Corn Belt Plain ecoregion. The Eastern Corn Belt Plain ecoregion is distinguished by a gently rolling glacial till plain with moraines, kames and outwash plains. Local relief is usually less than 50 feet. Half of the streams are perennial and many are channelized. The stream density is 0.5 mile/square mile. Seventy-five percent of the area of this ecoregion is used for cropland. The soils mainly are from glacial till and tend to be light in color and acidic (U.S. EPA 1988).

Agriculture and channelization are the predominant types of nonpoint source pollution in the basin. Other types of NPS pollution known or suspected in the basin include urban runoff, on-site wastewater treatment; and construction site erosion (Ohio EPA 1990).

Methods

All chemical, physical, and biological field, laboratory, data processing, and data analysis methods and procedures adhere to those specified in the OEPA Manual of Surveillance Methods and Quality Assurance Practices (OEPA 1989a) and Biological Criteria for the Protection of Aquatic Life, Volumes II - III (OEPA 1987a, 1989b, 1989c), and Rankin (1989) for aquatic habitat assessment.

Attainment/non-attainment of aquatic life uses is determined by using biological criteria (OEPA 1987a, 1987b, 1989b, 1989c). The biological community performance measures that are used include the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb), both of which are based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. Performance expectations for the basic aquatic life uses [Warmwater Habitat (WWH), Exceptional Warmwater Habitat (EWH)) and a proposed Modified Warmwater Habitat (MWH)] were developed using the regional reference site approach (Hughes et al. 1986; Omernik 1988). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981).

Attainment of an aquatic life use is FULL if all three indices (or those available) meet the applicable criteria, PARTIAL if one or more attains and at least one does not attain, and NON if all three (or those available) fail to meet the applicable criteria or when one of the two organism groups indicates poor or very poor performance, even if the other group is attaining the applicable criteria.

During this survey, macroinvertebrates were sampled using quantitative and qualitative techniques, and fish were sampled in the Sandusky River by electrofishing using either wading or boat methods. Tributary locations were electrofished using wading methods. Sampling locations are listed in Table 1.

Table 1. Sampling locations (effluent sample - E, water chemistry - C, sediment chemistry - S, benthos - B, fish - F, fish tissue - FT) in the Sandusky River study area, 1990.

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
<u>Sandusky River</u>				
116.3	F, FT	40°49'19"/ 82°55'44"	Upstream Kiess Rd.	Bucyrus
116.2	C, S	40°49'23"/ 82°55'50"	Kiess Rd.	Bucyrus
115.0	B	40°49'26"/ 82°55'45"	Upstream State Route 30	Bucyrus
114.4	B	40°48'05"/ 82°59'17"	Aumiller Park	Bucyrus
111.2	C	40°48'09"/ 82°59'38"	Upstream Bucyrus WWTP	Bucyrus
111.1	F, FT, B	40°48'10"/ 82°59'41"	Upstream Bucyrus WWTP	Bucyrus
111.0	E, C, B	40°48'13"/ 82°59'47"	Bucyrus WWTP effluent, mixing zone	Bucyrus
110.9	F	40°48'14"/ 82°59'50"	Bucyrus WWTP mixing zone	Bucyrus
110.8	F, B	40°48'13"/ 82°59'53"	Downstream Bucyrus WWTP	Bucyrus
110.5	F	40°48'16"/ 83°00'19"	Upstream Kerstetter Rd.	Oceola
110.4	C, S	40°48'13"/ 83°00'22"	Kerstetter Rd.	Oceola
109.8	F, C, B	40°48'12"/ 83°03'16"	Shupp Rd.	Oceola
98.8	F	40°44'49"/ 83°07'45"	Upstream State Route 231	Morrill
98.7	C, B	40°44'50"/ 83°07'50"	State Route 231	Morrill
92.2	B	40°45'16"/ 83°12'15"	Upstream County Rd. 127	Nevada
90.3	C, F	40°45'15"/ 83°13'14"	Twp. Rd. 124	Nevada
81.8	F, FT	40°49'47"/ 83°15'57"	Downstream U.S. 30	Upper Sandusky
80.1	C, B	40°50'32"/ 83°16'26"	Upstream Upper Sandusky WWTP	Upper Sandusky
80.0	F, C, B, E	40°50'37"/ 83°16'27"	Upper Sandusky WWTP effluent, mixing zone	Upper Sandusky
79.9	B	40°50'40"/ 83°16'28"	Downstream Up. Sandusky WWTP	Upper Sandusky
79.8	F	40°50'45"/ 83°16'24"	Downstream Up. Sandusky WWTP	Upper Sandusky
78.1	C	40°51'02"/ 83°15'23"	County Rd. 121	Upper Sandusky
78.0	B	40°51'02"/ 83°15'17"	Downstream Co. Rd. 121	Upper Sandusky
77.9	F, FT	40°51'02"/ 83°15'10"	Downstream County Rd. 121	Upper Sandusky
72.2	F, B	40°54'09"/ 83°14'31"	Upstream Twp. Rd. 40	Sycamore
72.1	C	40°54'10"/ 83°14'40"	Twp. Rd. 40	Sycamore
66.9	C	40°56'56"/ 83°15'29"	State Route 103	McCutchenville

Table 1. Continued.

<u>Stream/ River Mile</u>	<u>Type of Sampling</u>	<u>Latitude/Longitude</u>	<u>Landmark</u>	<u>USGS 7.5 min. Quad Map</u>
<u>Sandusky River</u>				
66.7	F	40°57'00"/ 83°15'28"	Downstream State Rt. 103	McCutchenville
65.1	B	40°57'42"/ 83°16'08"	Downstream County Rd. 16	McCutchenville
57.3	C,B	40°59'19"/ 83°12'14"	County Road 9	Sycamore
56.7	F	40°59'12"/ 83°09'31"	Adjacent Camp Pittenger	Sycamore
47.7	C,B	41°02'39"/ 83°11'42"	Scott Rd.	Tiffin South
47.6	F	41°02'48"/ 83°11'19"	Downstream Scott Rd.	Tiffin South
41.8	C,B	41°06'14"/ 83°11'12"	Ella St.	Tiffin South
41.6	F, FT	41°06'27"/ 83°10'59"	Downstream Ella St.	Tiffin South
39.9	S	41°07'25"/ 83°10'21"	Upstream dam along Water St.	Tiffin South
38.9	F	41°08'05"/ 83°09'48"	Upstream Tiffin WWTP	Tiffin North
38.8	C,B	41°08'10"/ 83°09'47"	Upstream Tiffin WWTP	Tiffin North
38.7	F,B,C,B	41°08'15"/ 83°09'45"	Tiffin WWTP effluent, mixing zone	Tiffin North
36.5	F,C,B	41°08'18"/ 83°09'44"	Downstream Tiffin WWTP	Tiffin North
36.5	C,B	41°10'03"/ 83°09'47"	County Road 38	Tiffin North
36.3	F	41°10'17"/ 83°09'51"	Downstream County Rd. 38	Tiffin North
32.0	F, FT, C	41°12'20"/ 83°09'48"	Twp. Rd. 143	Tiffin North
31.9	B	41°12'26"/ 83°09'49"	Downstream Twp. Rd. 143	Tiffin North
<u>Broken Sword Creek</u>				
0.9	C	40°46'29"/ 83°10'23"	County Rd. 62	Nevada
0.7	F,B	40°46'27"/ 83°10'31"	Downstream County Rd. 62	Nevada
<u>Rock Run</u>				
0.9	F,B	40°50'48"/ 83°14'26"	Upstream Twp. Rd. 51	Nevada
0.8	C	40°50'50"/ 83°14'26"	Twp. Rd. 51	Nevada
<u>Negro Run</u>				
0.6	F	40°53'18"/ 83°13'14"	Upstream County Rd. 124	Sycamore
0.5	C,B	40°53'20"/ 83°13'22"	County Rd. 124	Sycamore

Results and Discussion

Chemical Water Quality (Tables 2-4, Figure 1)

- * Twenty stations were sampled in the mainstem from upstream of Bucyrus to downstream of Tiffin (RM 116.2 - 32.0). Effluent samples were also collected at the Bucyrus, Upper Sandusky and Tiffin WWTPs. The results of the chemical sampling indicated substantial compliance with Ohio's Water Quality Standards (WQS) for Warm Water Habitat 30 day average criteria. Those parameters that exceeded criteria include:
 - Total Iron (95 of 120 river samples)
 - Fecal coliform (29 of 60 river samples)
 - Total Zinc (1 of 120 river samples)
 - Dissolved Oxygen (1 of 120 river samples)
- * Iron exceedences can be attributed to natural background conditions commonly found in Ohio's streams. However, extremely elevated concentrations may be indicative of excessive clayey sediments in runoff
- * Elevated fecal coliform counts were recorded throughout the study area. Above average rainfall and the resultant runoff from urban and rural areas and discharges from CSOs are likely all contributing factors. The highest values were associated with CSOs within the city of Bucyrus.
- * Excluding WQS exceedences of iron, heavy metals do not appear to be a problem in the Sandusky River. A single exceedance of acute Zinc criteria (185 ug/l) occurred just upstream of the Upper Sandusky WWTP (RM 80.1). This may be attributable to CSOs or another unidentified source.
- * Results of both daytime grab and Datasonde continuous measurements (Table 4) of dissolved oxygen (D.O.) indicated no significant problems with low D.O. However, there appears to be a slight D.O. "sag" downstream of Bucyrus (RM 110.4).
- * During the 1990 study period, the Sandusky River experienced relatively high mean monthly flows (Figure 2). USGS provisional flow data for the Sandusky River at Fremont, Ohio between June - September, 1990 recorded a minimum daily flow of 123 cfs. This flow is ten times higher than the calculated critical low flow (Q7,10) of 12 cfs. In addition, the minimum flow of 123 cfs is a value that has historically been exceeded only 45% of the time (from the period May-November).

Table 2. Exceedences of Ohio EPA Warmwater Habitat water quality criteria (OAC 3745-1) for chemical/physical parameters (excluding iron) measured in the Sandusky River study area, 1990.

Stream	River Mile	Exceedence: Parameter
Sandusky River	116.2	Fecal coliform(24000/100ml,1200/100ml)
	111.2	Fecal coliform(27000/100ml,1500/100ml,6600/100ml)
	110.4	Dissolved Oxygen(4.5 mg/ l*) Fecal coliform(22000/100ml,33000/100ml,26000/100ml)
	105.8	Fecal coliform(2600/100ml,27000/100ml,1600/100ml)
	98.7	Fecal coliform(1100/100ml,26000/100ml)
	90.3	Fecal coliform(1300/100ml,10000/100ml)
	80.1	Zinc(185 ug/l**) Fecal coliform(1500/100ml,8000/100ml)
	78.1	Fecal coliform(1100/100ml,5000/100ml)
	72.1	Fecal coliform(1500/100ml,6000/100ml)
	66.9	Fecal coliform(14000/100ml)
	57.3	Fecal coliform(3900/100ml)
	41.8	Fecal coliform(2600/100ml)
	38.8	Fecal coliform(3900/100ml,8300/100ml)
	38.5	Fecal coliform(14000/100ml)
	36.5	Fecal coliform(5700/100ml)
	32.0	Fecal coliform(11600/100ml)

* indicates an exceedence of numerical criteria for prevention of chronic toxicity (CCC).

** indicates an exceedence of numerical criteria for prevention of acute toxicity (CMC).

Table 3. Mean values (minimum & maximum values in parentheses) of selected chemical/physical parameters measured in the Sandusky River study area during 1990. Fecal coliform values are reported as geometric means. Less than detection limit values were set at the detection limit for calculating means.

River Mile	D.O. (mg/l)	BOD5 (mg/l)	Ammonia-N (mg/l)	Nitrate + Nitrite-N (mg/l)	Phos.-T (mg/l)	Lead-T (ug/l)	Fecal Coliform (#/100ml)
<i>Sandusky River</i>							
116.2	7.0 (5.8-9.2)	1.8 (<1.0-4.2)	0.05 (<0.05-<0.05)	2.61 (0.93-4.66)	0.13 (0.08-0.25)	3.2 (<2-6)	2511 (550-24000)
111.2	7.4 (6.5-9.3)	3.3 (1.2-5.5)	0.30 (<0.05-0.91)	2.51 (0.55-4.74)	0.18 (0.14-0.22)	5.5 (<2-12)	6441 (1500-27000)
111.0 Effluent	9.0 (8.4-10.2)	4.4 (1.3-9.6)	0.07 (<0.05-0.15)	10.66 (4.93-21.60)	0.20 (0.12-0.32)	2.0 (<2-<2)	13 (9-27)
111.0 Mixing zone	7.7 (6.8-9.6)	2.3 (<1.0-3.5)	0.19 (<0.05-0.47)	5.25 (3.03-11.60)	0.16 (0.11-0.20)	3.8 (<2-7)	29615 (18000-39000)
110.4	6.8 (4.5-9.3)	2.1 (<1.0-3.3)	0.11 (<0.05-0.33)	3.68 (2.49-4.85)	0.16 (0.13-0.21)	3.3 (<2-6)	26626 (22000-33000)
105.8	7.7 (6.7-9.3)	1.8 (<1.0-3.3)	0.05 (<0.05-0.05)	3.72 (2.69-4.84)	0.15 (0.09-0.21)	3.5 (<2-9)	4825 (1600-27000)
98.7	9.3 (7.2-13.3)	2.6 (<1.0-7.1)	0.05 (<0.05-<0.05)	3.25 (1.83-4.89)	0.15 (0.08-0.22)	3.5 (<2-9)	1419 (100-26000)
+ 90.3	8.8 (7.4-12.2)	2.4 (<1.0-6.2)	0.05 (<0.05-<0.05)	3.22 (0.58-5.82)	0.14 (0.08-0.25)	4.3 (<2-9)	1520 (270-10000)
80.1	8.7 (7.1-12.7)	2.3 (<1.0-5.9)	0.05 (<0.05-0.05)	3.05 (0.11-6.04)	0.15 (0.06-0.27)	3.3 (<2-9)	1754 (450-8000)
80.0 Effluent	8.3 (8.0-8.9)	13.7 (2.9-33.0)	3.50 (2.74-5.54)	7.17 (4.74-10.10)	0.28 (0.18-0.35)	3.8 (<2-10)	2442 (90-180000)
80.0 Mixing zone	8.1 (7.1-9.6)	2.8 (<1.0-6.2)	0.39 (<0.05-0.91)	4.65 (2.26-9.52)	0.17 (0.12-0.25)	3.2 (<2-9)	1584 (180-13000)
78.1	9.0 (7.2-13.7)	2.8 (<1.0-7.0)	0.05 (<0.05-<0.05)	3.20 (0.60-6.18)	0.15 (0.06-0.30)	3.7 (<2-11)	1140 (270-5000)

Table 3. Continued.

River Mile	D.O. (mg/l)	BOD5 (mg/l)	Ammonia-N (mg/l)	Nitrate + Nitrite-N (mg/l)	Phos.-T (mg/l)	Lead-T (ug/l)	Fecal Coliform (#/100ml)
<u>Sandusky River</u>							
72.1	7.8 (6.9-8.8)	2.8 (<1.0-5.0)	0.08 (<0.05-0.23)	3.22 (0.25-6.45)	0.16 (<0.05-0.29)	3.8 (<2-12)	965 (100-6000)
66.9	7.3 (6.7-8.6)	2.4 (<1.0-4.8)	0.05 (<0.05-<0.05)	3.29 (0.14-6.84)	0.26 (<0.05-0.83)	3.3 (<2-9)	1434 (260-14000)
57.3	7.4 (6.2-8.5)	2.0 (<1.0-3.6)	0.05 (<0.05-<0.05)	3.70 (1.00-8.58)	0.15 (<0.05-0.23)	2.8 (<2-5)	724 (120-3900)
47.7	8.0 (7.3-8.6)	2.1 (<1.0-3.7)	0.05 (<0.05-0.05)	3.82 (0.92-10.10)	0.11 (<0.05-0.16)	3.0 (<2-8)	376 (130-820)
41.8	8.6 (7.5-11.6)	2.3 (<1.0-5.2)	0.05 (<0.05-<0.05)	3.89 (0.72-10.10)	0.11 (<0.05-0.17)	2.8 (<2-7)	340 (27-2600)
38.8	9.2 (8.2-11.3)	2.6 (<1.0-6.2)	0.05 (<0.05-0.05)	3.90 (0.46-10.60)	0.13 (<0.05-0.18)	2.2 (<2-3)	1572 (120-8300)
38.7 Effluent	7.6 (6.4-8.7)	5.3 (1.6-8.9)	0.18 (<0.05-0.72)	9.26 (6.52-10.90)	0.69 (0.50-0.80)	3.8 (<2-13)	131 (90-250)
38.7 Mixing zone	9.6 (8.1-13.0)	1.9 (<1.0-4.5)	0.05 (<0.05-<0.05)	3.87 (0.47-10.00)	0.14 (0.11-0.17)	3.0 (<2-8)	1679 (590-7300)
38.5	9.7 (8.3-12.1)	2.5 (1.2-5.4)	0.05 (<0.05-<0.05)	3.68 (0.50-10.00)	0.12 (<0.05-0.17)	2.0 (<2-<2)	1240 (220-14000)
36.5	10.0 (8.4-13.0)	3.3 (1.0-7.0)	0.05 (<0.05-0.06)	3.87 (0.62-9.97)	0.12 (<0.05-0.17)	2.0 (<2-<2)	599 (140-5700)
32.0	9.0 (7.6-12.1)	2.8 (1.2-7.4)	0.05 (<0.05-<0.05)	4.01 (0.51-10.50)	0.12 (<0.05-0.16)	3.2 (<2-9)	379 (36-11600)
<u>Broken Sword Creek</u>							
0.9	7.9 (6.1-9.8)	1.1 (<1.0-1.3)	0.05 (<0.05-<0.05)	3.81 (2.12-6.56)	0.07 (<0.05-0.09)	2 (<2-<2)	592 (500-700)
<u>Rock Run</u>							
0.8	8.1 (7.3-9.4)	1.0 (<1.0-1.0)	0.05 (<0.05-<0.05)	4.77 (2.43-8.00)	0.07 (<0.05-0.10)	2 (<2-<2)	693 (480-1000)
<u>Negro Run</u>							
0.5	9.8 (9.0-11.4)	1.7 (<1.0-3.2)	0.11 (<0.05-0.23)	1.47 (0.14-4.05)	0.06 (<0.05-0.08)	2.0 (<2-<2)	365 (190-700)

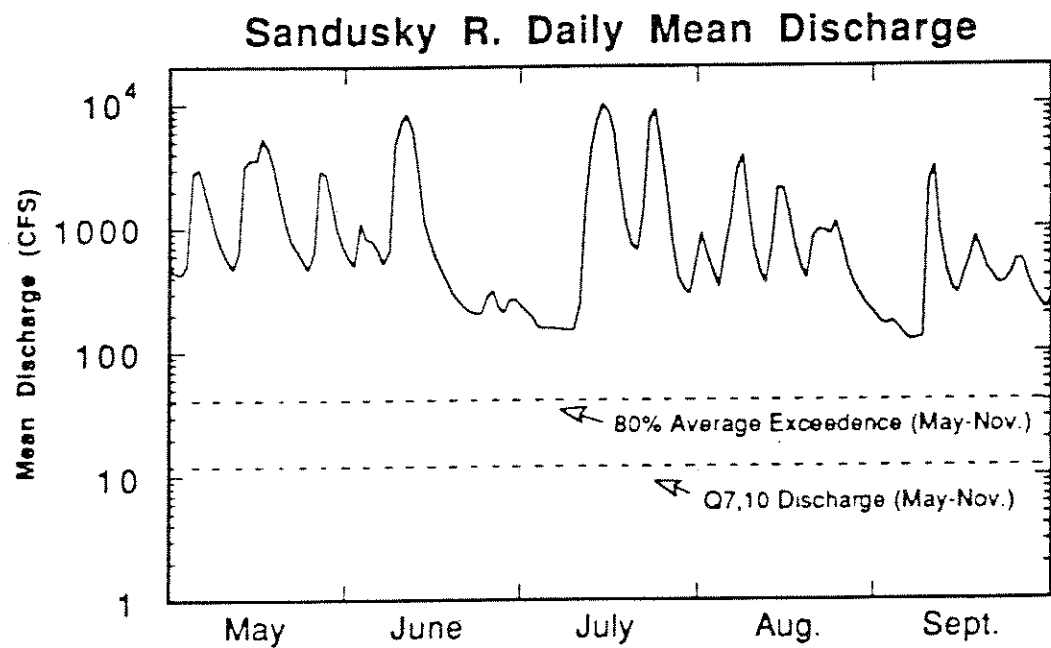


Figure 2. Flow hydrograph for the Sandusky River near Fremont, Ohio (RM 20.2); May through Sept., 1990. $Q_{7,10}$ (12cfs) and 80% Average Exceedance (41cfs) flow (May through November for the period of record 1935 to 1978) are indicated on the flow hydrograph as dashed lines.

Table 4. Summary of continuous D.O.(mg/l) data recorded with Datasonde monitors at ten locations in the Sandusky River during July 5-6 and July 10-11, 1990.

RM	N ^a	Mean	Max.	Min.	25th %ile
111.4	18	12.1	17.8	8.4	9.7
110.4	20	10.1	13.6	6.5	7.3
105.8	20	12.0	18.0	7.8	8.5
95.7	21	10.6	17.4	6.7	7.6
80.1	24	11.9	17.3	7.3	8.6
41.8	20	6.9	8.9	6.0	6.3
38.8	19	6.7	10.1	5.6	5.7
38.1	20	6.4	10.8	5.2	5.3
37.5	20	7.2	11.7	6.1	6.3
36.4	19	6.3	9.7	5.3	5.5

^a number of hourly readings

Table 5. Concentrations (mg/kg dry weight) of heavy metals in sediment of the Sandusky River at three locations. All parameter concentrations, excluding nickel, were ranked based on a stream sediment classification system described by Kelly and Hite (1984).

River Mile	Arsenic	Cadmium	Sediment Concentration (mg/kg dry weight)				Nickel	Zinc
			Chromium	Copper	Iron	Lead		
116.2	3.93 ^a	0.36 ^a	6.93 ^a	13.60 ^a	10,900 ^a	16.60 ^a	12.70	54.90 ^a
110.4	3.39 ^a	0.74 ^b	11.10 ^a	21.40 ^a	9,580 ^a	67.2 ^d	11.60	78.30 ^a
39.9	4.02 ^a	0.40 ^a	8.21 ^a	20.00 ^a	11,700 ^a	29.00 ^b	13.20	65.40 ^a

^a Non-elevated

^b Slightly elevated

^c Elevated

^d Highly elevated

^e Extremely elevated

Table 6. Concentrations(mg/kg) of priority organic compounds detected in sediments at three sites in the Sandusky River study area, 1990.

Compound	Concentration (mg/ kg)		
	RM 116.2	RM 110.4	RM 39.9
Benzo(A)Anthracene		1.3	
Benzo(B)Fluoranthene		1.2	
Benzo(K)Fluoranthene		1.4	0.9
Benzo(G,H,J)Perylene		1.1	
Benzo(A)Pyrene		1.0	
Chrysene		1.2	
Fluoranthene		2.9	1.2
Indeno(1,2,3-CD)Pyrene		1.3	
Phenanthrene		2.3	0.7
Pyrene		2.8	0.8
Number of Non-Priority Pollutants Detected	5	7	10

Sediment Chemistry (Tables 5,6)

- * Sediment samples were collected at three stations and analyzed for heavy metals and organics.
- * Metals were generally non-elevated, based on a stream sediment classification system described by Kelly and Hite (1984). Sediments appeared to be most contaminated downstream of Bucyrus (RM 110.4) where cadmium was slightly elevated (29.0 mg/kg) and lead was highly elevated (67.2 mg/kg). Lead was also slightly elevated in the Tiffin dam pool (RM 39.9). The presence of these metals is likely associated with urban runoff.
- * Organics were also found in the highest concentrations downstream of Bucyrus (RM 110.4). Ten priority pollutants were identified at this station. No priority pollutants were identified upstream of Bucyrus (RM 116.2). The priority pollutants detected are classified as Polynuclear Aromatic Hydrocarbons (PAHs) and though not highly elevated, their presence in the sediment is of some concern. One possible source of PAHs is urban nonpoint source runoff particularly from local railroad yards where creosote is used as a wood preservative. Four PAH compounds were also detected in the Tiffin dam pool (RM 39.9), all in lower concentrations than at RM 110.4.

Physical Habitat for Aquatic Life (Table 7)

- * Within the study area, the Sandusky River is predominantly unmodified and free flowing except for impoundments located in Tiffin (RM 39.9 and RM 42.1) and downstream from Upper Sandusky (Indian Mill - RM 76.4). Minor channel modifications have occurred at RM 110.8, downstream from the Bucyrus WWTP.
- * A majority of the Sandusky River is predominated by bottom substrates of cobble, gravel and boulders. However, upstream from station RM 41.6 moderate to extensive embeddedness of pool and riffle areas was documented as well as a moderate to heavy covering of silt material. This segment had gradients of 2-6 feet/mile and several sites lacked fast current. These characteristics make the habitat vulnerable to silt deposition and substrate embeddedness when subjected to excessive amounts of eroded soil entering the stream.
- * A five mile segment of the Sandusky River (RM 35-40) consists of shallow riffles and runs and a convoluted bedrock bottom with some boulders, cobble and gravel. This area has a higher gradient and fast currents which help to keep the substrate free from heavy silt deposition.

- * QHEI scores for tributaries ranged between 69 and 81. Predominant substrates at tributary sampling locations included gravel, cobble, boulder and bedrock. Negro Run and Rock Run had moderate levels of silt cover and embeddedness and Broken Sword Creek was relatively free of silt.
- * Qualitative Habitat Evaluation Index (QHEI) scores in the Sandusky River ranged from 81.5 to 45, with a mean score of 67. The ratio of MWH/WWH attributes was generally less than 1.0 with only one site greater than 2.0 (RM 110.8). A predominance of ratios less than 1.0 generally indicates that habitat is suitable to support the WWH use.

Macroinvertebrates (Tables 8, 9; Figure 2)

- * Twenty two stations were sampled on the mainstem from upstream from Bucyrus to downstream from Tiffin (RM 115.0- 31.9). ICI scores ranged from 16 (Fair) in the Tiffin mixing zone (RM 38.7) to 50 (Exceptional) at RMs 98.7 and 31.9. Macroinvertebrate sampling sites that did not show attainment of the WWH aquatic life use were the Bucyrus, Upper Sandusky, and Tiffin WWTP mixing zones(RMs 111.0, 80.0, and 38.7, respectively); RM 79.9, immediately downstream from the Upper Sandusky WWTP; and RM 36.5, 2.2 miles downstream from the Tiffin WWTP. ICI scores exceeding the EWH criteria was noted at 12 sampling locations. These high scoring sites were in rural/agricultural land-use areas.
- * ICI values were in the exceptional range at the two upstream sampling stations (RMs 115.0 and 111.4). Numerous CSOs located upstream from RM 111.4 were having no observable impact on the macroinvertebrate community at this site. The macroinvertebrate community upstream from the Bucyrus WWTP (RM 111.1) was reflective of only marginally good water quality. An ICI score of 34 at this site coincided with an increase in the predominance of pollution tolerant taxa, suggesting a moderate impact associated with CSOs and urban runoff. The source of impact was apparently CSOs and /or stormwater discharges located between RM 111.4 and 111.1.
- * The ICI score of 26 (fair) in the Bucyrus WWTP mixing zone can be partially attributed to a lack of sufficient flow over the artificial substrates, the result of a build up of woody debris during the six week colonization period rather than toxicity in the effluent. This reasoning is substantiated by qualitative sampling in the mixing zone that produced a result similar to the adjacent sites. The Bucyrus WWTP did not appear to have any additional impact on the macroinvertebrate community downstream (RM 110.8), however an ICI score of 34 (marginally good) indicated that degradation from upstream sources continued.
- * The site at RM 105.8 (5.2 miles downstream from the Bucyrus WWTP) was identified in 1979 as being within the zone of minimum D.O. The ICI at this site scored in the exceptional range in 1990 suggesting that low D.O. is no longer a significant problem and is a reflection of improvements to the Bucyrus WWTP.

Table 7. Matrix of QHEI scores and corresponding Warmwater and Modified Warmwater Habitat attributes from the Sandusky River study area 1990.

		WWH Attributes										MWH Attributes																				
												High Influence					Moderate Influence															
River Mile	QHEI	Gradient (ft/mile)	WWH Attributes										MWH Attributes																			
			No Channelization or Recovered Bank/Channel/Gravel Silt/Trunks	Silt Free Substrates	Good Excellent Development	Mouth High Sinuosity	Extensive/Moderate Cover	Fast Current/ Eddies	Low/Normal Embankment	Max Depth >40 cm	Low/No Filling Embankment	Total WWH Attributes	Channelized or No Recovery Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW)	Total (High Influence) MWH Attributes	Recovering Channel	Heavy/Mod Silt Cover	Sand Substrates (DI)	Hardpan Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod Embankment	Ext/Mod Filling Embankment	No Filling	Total (Moderate Influence) MWH Attributes	MWH (High)/WWH Attributes	MWH (Mod.)/WWH Attributes
SANDUSKY RIVER																																
Year 91																																
92.1	67.5	3.00	■	■	■	■	■	■	■	■	■	8	●		1	▲				▲										3	.22	.66
86.5	76.0	7.10	■	■	■	■	■	■	■	■	■	8			0									▲						1	.11	.22
81.3	78.0	2.18	■	■	■	■	■	■	■	■	■	9			0	▲														1	.20	.20
Year 90																																
116.3	62.0	2.16	■	■	■	■	■	■	■	■	■	6			0	▲				▲				▲	▲	▲				5	.14	.86
111.1	67.5	5.78	■		■	■	■	■	■	■	■	5			0	▲	▲							▲	▲	▲				5	.17	1.00
110.9	57.5	5.78	■		■	■	■	■	■	■	■	5			0	▲	▲			▲				▲	▲	▲	▲			6	.17	1.17
110.8	51.5	5.78					■				■	2	●		1	▲				▲	▲			▲	▲	▲				6	.67	2.67
110.5	74.0	5.78	■	■	■	■	■	■	■	■	■	6			0	▲								▲	▲	▲				4	.14	.71
109.3	67.0	3.79	■	■	■	■	■	■	■	■	■	6			0	▲								▲	▲	▲				4	.14	.71
98.3	81.5	7.14	■	■	■	■	■	■	■	■	■	8			0	▲										▲				2	.11	.33
90.3	45.0	2.61	■	■		■					■	4	●		1	▲				▲				▲	▲	▲	▲			6	.40	1.60
81.3	55.5	2.18	■	■		■					■	4			0	▲				▲	▲			▲	▲		▲			6	.20	1.40
79.3	51.5	2.18	■		■	■					■	4			0	▲				▲				▲	▲		▲			5	.20	1.20
77.9	71.0	2.18	■	■	■	■	■	■	■	■	■	8			0	▲										▲				2	.11	.33
72.2	65.5	5.68	■	■	■	■	■	■	■	■	■	8	●		1	▲														1	.22	.33
66.7	56.5	2.43	■	■		■	■				■	5			0	▲				▲				▲	▲		▲			5	.17	1.00
56.7	63.0	.93	■		■	■	■	■	■	■	■	5			0	▲	▲							▲	▲		▲			5	.17	1.00
47.6	76.0	1.72	■	■	■	■	■				■	6			0	▲								▲	▲	▲				4	.14	.71
41.6	80.0	2.16	■	■	■	■	■	■	■	■	■	8			0	▲				▲										2	.11	.33
38.9	66.0	12.50	■	■	■		■	■	■	■	■	8			0					▲	▲	▲								3	.11	.44
38.7	55.0	12.50	■					■	■	■	■	5	●		1					▲	▲	▲								3	.33	.83
38.5	55.0	12.50	■					■	■	■	■	5	●		1					▲	▲	▲								3	.33	.83
36.3	54.0	12.50	■			■	■	■	■	■	■	6	●		1	▲				▲	▲	▲								4	.29	.86
32.0	74.0	2.99	■	■	■	■	■				■	6			0	▲								▲	▲	▲				4	.14	.71

Table 8. Aquatic life use attainment status for the Warmwater Habitat (WWH) use designation in the Sandusky River and select tributaries based on data collected during July - October, 1990.

RIVER MILE		Modified			Attainment	
Fish/Invert.	IBI	Iwb	ICIA ^a	QHEI ^b	Status ^c	Comment
Sandusky River						
116.3/ 115.0	30*	6.3*	48	62	PARTIAL	Upstream Bucyrus
- / 111.4	-	-	48	-	(FULL)	Upstream Bucyrus
111.1/ 111.1	<u>26*</u>	6.6*	34 ^{ns}	68	NON	Ust. WWTP/ Dst. CSOs
110.9/ 111.0	29*	6.6*	26*	58	* *	WWTP mixing zone
110.8/ 110.8	<u>25*</u>	<u>5.3*</u>	34 ^{ns}	52	NON	Dst. Bucyrus WWTP
110.5/ -	28*	6.6*	-	74	(NON)	
105.8/ 105.8	32*	6.9*	48	67	PARTIAL	1981 D O sag zone
98.8/ 98.7	37 ^{ns}	8.5	50	81	FULL	Ambient Water Quality
90.3/ 90.4	<u>27*</u>	<u>6.0*</u>	46	45	NON	Ambient Water Quality
81.8/ 80.1	28*	6.9*	44	55	PARTIAL	Ust. Upper Sandusky WWTP
80.0/ 80.0	27*	6.6*	28*	52	* *	Up. Sand. WWTP mixing zone
79.8/ 79.9	27*	<u>6.0*</u>	26*	52	NON	Dst. Upper Sandusky WWTP
77.9/ 78.0	29*	7.4*	46	72	PARTIAL	Recovery/ Dst. WWTP
72.2/ 72.2	39 ^{ns}	7.6*	48	67	PARTIAL	Ambient Water Quality
66.7/ -	37*	8.2 ^{ns}	-	57	(PARTIAL)	
- / 65.1	-	-	48	-	(FULL)	
56.7/ 57.2	36*	8.2 ^{ns}	48	63	PARTIAL	
47.6/ 47.7	43	8.4 ^{ns}	48	76	FULL	Regional Reference Site
41.6/ 41.8	44	9.4	38	80	FULL	
38.9/ 38.8	44	8.9	36	67	FULL	Ust. Tiffin WWTP/ Dst. CSOs
38.7/ 38.7	35*	9.3	16*	55	* *	Tiffin WWTP mixing zone
38.5/ 38.5	43	8.9	38	55	FULL	Dst. Tiffin WWTP
36.3/ 36.5	48	9.5	30*	59	PARTIAL	Ambient Water Quality
32.0/ 31.9	44	8.9	50	74	FULL	Regional Reference Site

Table 8. Continued.

RIVER MILE			Modified		Attainment	
Fish/Invert.	IBI	Iwb	ICI ^a	QHEI ^b	Status	Comment
<u>Broken Sword Creek</u>						
0.7/ 0.8	44	9.5	Good	81	FULL	
<u>Negro Run</u>						
0.6/ 0.5	42	-	Good	74	FULL	
<u>Rock Run</u>						
0.9/ 0.9	34*	-	Good	70	PARTIAL	Siltation/ embeddness

* - Significant departure from ecoregion biocriteria; poor and very poor results are underlined.

** - Biocriteria not applied to mixing zones.

ns. Nonsignificant departure from biocriterion (4 IBI or ICI units; 0.5 Iwb units).

^a - Narrative macroinvertebrate evaluation given when ICI score not available.

^b - All Qualitative Habitat Evaluation Index (QHEI) values are based on the most recent version (Rankin 1989).

^c - Use attainment status based on one organism group is parenthetically expressed

Ecoregion Biocriteria: Eastern Corn Belt Plain (ECBP)

<u>INDEX - Site Type</u>	<u>WWH</u>	<u>EWB</u>
IBI - Wading/Headwaters	40	50
IBI - Boat	42	48
Mod. Iwb - Wading	8.3	9.4
Mod. Iwb - Boat	8.5	9.6
ICI	36	46

- * No impact was realized on the invertebrate community from urban nonpoint sources, including CSOs, upstream from the Upper Sandusky WWTP (RM 80.1). ICI scores were non-attaining within the mixing zone and immediately downstream from the Upper Sandusky WWTP, and demonstrated a significant but relatively localized impact. An ICI score in the very good range at RM 78.8 indicated full recovery 1.2 miles downstream from the Upper Sandusky WWTP.
- * ICI scores dropped from the exceptional range upstream from Tiffin (RM 47.7) to the good range within the urban area and upstream from the WWTP (RMs 41.8 and 38.8, respectively). The changes that occurred in the macroinvertebrate community were reflective of organic enrichment and may be attributed to the effect of low-head dams located at RMs 42.1 and 39.9 and/or CSOs located throughout the city of Tiffin. The slowed current velocity upstream from low-head dams can promote the growth of phytoplankton that subsequently serves as a food source for large numbers of organisms downstream; discharges from CSOs would also be a source of additional enrichment.
- * The only location that offered adequate water depth for placing the artificial substrates immediately downstream from the Tiffin WWTP (RM 38.7) was within the "zone of initial dilution". This site scored an ICI in the fair range. The depression in the macroinvertebrate community was reflective of organic enrichment rather than toxicity. The ICI scored in the good range 0.2 miles downstream (RM 38.5); however, on the collection date it was apparent that the Tiffin WWTP effluent was not completely mixed with river water. Instead the effluent flowed along the left bank of the river, occupying only about 10-20% of the width and probably did not consistently influence colonization of the artificial substrates at this site.
- * An ICI score of 30 (Fair) at RM 36.5, 2.2 miles downstream from the Tiffin WWTP, was due in part to increased oligochaete density and lower mayfly diversity on the artificial substrates, and suggested an impact caused by the breakdown of organic materials from upstream sources. This was the only site outside of an urban area or a WWTP mixing zone that did not score an ICI in the very good or exceptional range. The macroinvertebrate community at RM 31.9, the downstream limit of this survey, was considered to reflect exceptional water quality (ICI=50).
- * Qualitative samples from Negro Run, Rock Run and Broken Sword Creek revealed macroinvertebrate communities typical of small warmwater streams in Ohio. Each sample included several relatively pollution sensitive taxa. Nonpoint sources were having, at most, a minor impact on the invertebrates of Negro Run and Broken Sword Creek. Rock Run was nearly intermittent on the sampling date (Sept. 28). Based on qualitative sampling, the current Warmwater Habitat Aquatic Life Use seems appropriate for these streams.

Table 9. Summary of macroinvertebrate data collected from artificial substrates (quantitative) and natural substrates (qualitative) in the Sandusky River study area, August to October, 1990.

Stream River Mile	Narrative Evaluation ^a	Quantitative Evaluation			Qual. Eval.	
		No. ICI	Quant. Taxa	Relative Density	No. Qual. Taxa	Qual. EPT ^b
<u>Sandusky River</u>						
115.0	Exceptional	48	40	370	40	12
111.4	Exceptional	48	38	752	46	14
111.1	Marginally good	34 ^{ns}	39	551	50	11
111.0	Fair	26*	37	326	49	12
110.8	Marginally good	34 ^{ns}	43	398	33	10
105.8	Exceptional	48	43	1208	37	12
98.7	Exceptional	50	50	457	33	15
92.2	Very good	46	30	1999	52	15
80.1	Very good	44	38	589	44	15
80.0	Fair	28*	46	479	33	7
79.9	Fair	26*	38	381	40	10
78.8	Very good	46	29	881	49	15
72.2	Exceptional	48	34	1499	50	16
65.1	Exceptional	48	40	630	34	13
57.3	Exceptional	48	33	546	47	14
47.7	Exceptional	48	31	848	43	16
41.8	Good	38	27	1308	27	13
38.8	Good	36	21	1409	36	11
38.7	Fair	16*	20	557	20	7
38.5	Good	38	38	1121	16	5
36.5	Fair	30*	32	849	25	10
31.9	Exceptional	50	36	483	32	14

Stream River Mile	Narrative Evaluation	Qualitative Evaluation			Predominant Organisms
		No. Qual. Taxa	Qual. EPT ^b	Relative Density	
<u>Broken Sword Cr.</u>					
0.7	Good	44	13	Low-Mod.	Caddisflies, Mayflies, Midges
<u>Negro Run</u>					
0.5	Good	60	13	Moderate	Caddisflies, Mayflies, Midges, Riffle Beetles
<u>Rock Run</u>					
0.9	Good	43	10	Low-Mod	Caddisflies, Mayflies, Isopods, Amphipods

^a - A qualitative narrative evaluation is based on best professional judgement and is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores.

^b - EPT= total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies).

* - Significant departure from ecoregion biocriteria (>4 ICI units); poor and very poor results are underlined.

^{ns} - Nonsignificant departure from biocriterion (<4 ICI units)

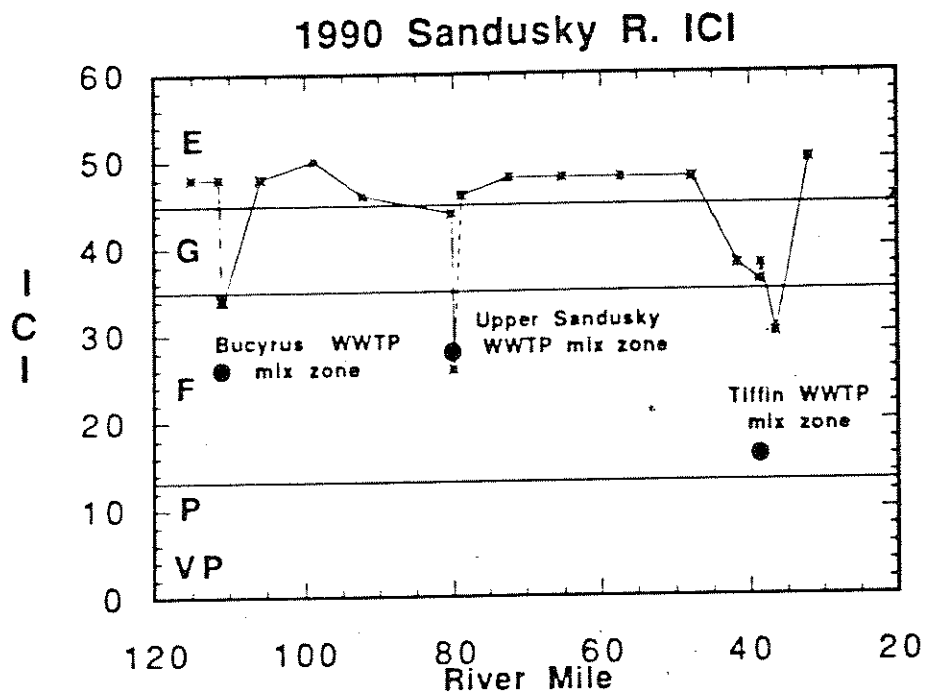


Figure 2. Longitudinal trend of the Invertebrate Community Index (ICI) in the Sandusky River study area, 1990. E denotes exceptional invertebrate communities (meets EWH criteria), G denotes good invertebrate communities (meets WWH criteria), and F, P, and VP denote fair, poor, and very poor invertebrate communities (non-attainment of aquatic life use).

Fish Community (Tables 8,10; Figures 3,4)

- * For the Sandusky River, a total of 14,599 fish representing 48 species and five hybrids were collected in the 84.3 mile study area. Silt and pollution tolerant species dominated the fish community. Numerically, green sunfish (13.6%), white sucker (12.9%), spotfin shiner (12.3%) and common carp (8.0%) predominated. By weight, common carp (44.6%) predominated the fish community, with black redhorse (an intolerant species) also well represented (14.7%).
- * Upstream from Bucyrus (RM 116.3), fish communities were in the fair range with an MIwb of 6.3 and an IBI of 30. Species tolerant of pollutional impacts and habitat perturbation were abundant while intolerant fish were absent. Nonpoint source impacts were evident as noted in extensive stream substrate embeddedness (pool and riffle areas) and siltation.
- * Continued impairment of the fish community (RM 111.1) was observed downstream from the Bucyrus combined sewer overflows (CSOs). IBI (26) and MIwb (6.6) scores were in the fair range, and as noted at RM 116.3, tolerant species were common and intolerant fish were absent. In addition, a significant reduction in the number and abundance of darter species was documented downstream from the CSO discharges.
- * The most degraded fish community in the study area was recorded at RM 110.8, 0.2 miles downstream from the Bucyrus WWTP. IBI (25) and MIwb (5.3) scores were in the poor range. Reported ammonia and biochemical oxygen demand concentrations in the Bucyrus WWTP effluent were low; however, significant amounts of foam were observed in the effluent, suggesting potentially high levels of surfactant material. A review of past and present WWTP operation practices should be conducted to insure no additional sources of impact existed. CSOs were probably also having an affect given their proximity to the sampling location. This site has been channelized and siltation and embeddedness were extensive; however the fact that the lowest minimum and average D.O. values were recorded at RM 110.4 further suggests that habitat alone was not the only reason for the poor performance of the fish community at RM 110.8.
- * Fish assemblages downstream from Bucyrus to upstream from the Upper Sandusky WWTP (RM 110-81.8) were strongly influenced by physical habitat conditions and nonpoint sources of pollution. This portion of the Sandusky River consists of a series of long pools separated by short higher gradient sections with runs and riffles. Previous OEPA surveys have demonstrated in streams with relatively well defined series of pool, riffle and run habitats that the fish indices will attain the WWH biocriteria at relatively unimpacted pooled sampling sites. However, it is in pooled areas that problems associated with excessive sediment loading are first evident. In areas with low gradient, finer particles along with suspended solids are transported to pool and shallow riffle areas where settling occurs. The settling of silt and suspended solids is detrimental to fish communities because finer materials cover the existing

substrate and greatly decrease habitat diversity and suitability. QHEI values of the four sampling sites located in this reach ranged between 45 and 81.5. The site with a QHEI of 81.5 (RM 98.8) was the least impacted by sedimentation due to the extensive riffle/run habitat and correspondingly had the highest IBI (37) and MIwb (8.5) scores in the upper Sandusky River. However, these scores, particularly the IBI, are lower than the potential suggested by the high QHEI score. At the other three sites (RMs 105.8, 90.3 and 81.8) pool habitat was predominant and the substrates were moderately to extensively embedded and siltation was moderate to heavy; fish community indices were in the fair and poor range.

- * A minor decline in the fish community was observed downstream from the Upper Sandusky WWTP. The MIwb score immediately downstream from the effluent discharge (RM 79.8) was in the poor range, a decline from the fair range upstream. Slightly elevated ammonia-N concentrations were documented at RM 79.8 and as was observed further upstream near Bucyrus, stream bed sedimentation was substantial.
- * To summarize, between RM 116.3-77.9, the fish communities were generally reflective of fair water quality conditions. Causes for this include: CSO influences in Bucyrus, effluent discharges from the Bucyrus WWTP and Upper Sandusky WWTP, and significant impacts from nonpoint sources of pollution (*i.e.* sedimentation of the river bottom substrates). Within this segment, pollution and silt tolerant white suckers predominated the fish community in comparison to other more sensitive round-bodied suckers (Figure 3), and darter species were significantly reduced in both numbers of species and their abundance.
- * In the lower segment of the study area (RM 72.2-32.0), the fish communities gradually improved and were reflective of reduced impact from sedimentation and embeddedness. No appreciable impact on the Sandusky River fish community was observed downstream from the Tiffin WWTP effluent discharge (outside of the WWTP mixing zone). Physical habitat from RM 47.6 (9 miles upstream from the Tiffin WWTP) to RM 32.0 included moderate to high gradient and extensive bedrock substrate; the fish community in this area was fully attaining the Warmwater Habitat biological criteria (IBI 43-48, MIwb 8.3-9.5).
- * As was documented during the 1981 study of the lower Sandusky River (OEPA 1982), a unique and healthy population of pollution sensitive round-bodied suckers (Figure 3) occurs within the lower segment of the Sandusky River study area. This important sucker community includes greater, river, shorthead, black, golden and silver redhorses, along with northern hog sucker and spotted sucker. The Sandusky River is the only area where Ohio EPA has collected all six redhorse (genus Moxostoma) species indigenous to Ohio. The river and greater redhorse are considered "special interest" and "endangered", respectively, on the Ohio DNR list of rare, endangered and threatened species.
- * Fish assemblages indicated that no acute toxicity was present in any of the WWTP mixing zones; however, a decline in the IBI did occur in the Tiffin WWTP mixing zone compared to surrounding sampling locations. This decline was attributed to organic enrichment.

- * Fish communities were sampled in the lower mile of three tributaries which directly discharge into the Sandusky River. Broken Sword Creek (RM 0.7) and Negro Run (RM 0.6) fish communities attained the WWH biological criteria and were representative of good water quality. Non point source influences appear minimal within these two streams. Rock Run (RM 0.9) sampling results reflected fair water quality (IBI=34). The sampling site bottom substrates were moderately embedded and covered with an extensive layer of silt. Sensitive fish species were present in low numbers, while tolerant fish (creek chub, bluegill, and green sunfish) were very abundant. The failure to achieve scores above the WWH criteria appeared to be associated with sedimentation of the stream bottom.

1990 Use Attainment Summary

- * A total of 24.7 miles of the Sandusky River fully attained the WWH aquatic life use (32% of the study area); 43.2 miles partially attained (51%) and 14.1 miles did not meet the biological criteria for the designated use (17%). The majority of miles partially and non-attaining were upstream from RM 72.2 where the fish community was impaired by sedimentation and embeddedness of the river bottom substrate, and locally by CSOs in Bucyrus and the Bucyrus and Upper Sandusky WWTP effluents. The macroinvertebrate community was not affected as severely as the fish community; nevertheless, impacts attributable to Bucyrus CSOs, the Bucyrus WWTP, as well as impoundments and CSOs in Tiffin and the Tiffin WWTP, were observed.
- * The biological communities sampled in Broken Sword Creek and Negro Run indicated full attainment of WWH. The fish community in Rock Run did not meet the WWH biocriteria; sedimentation was suggested as the source of the impairment. The macroinvertebrate community in Rock Run did not appear to be negatively affected. Taken together, biological sampling results reflected partial attainment of WWH for Rock Run.

Table 10. Fish community indices based on electrofishing samples at 25 locations sampled by Ohio EPA in the Sandusky River study area during June - October, 1990.

Stream River Mile	Cum. Species	Mean Rel. Number	Mean Rel. Weight	Mod. Index of Well Being (Iwb)	Index of Biotic Integrity QHEI ^a	Narrative Evaluation ^b
<u>Sandusky River</u>						
116.3	25	348	19.0	6.3*	30*	62 Fair
111.1	23	983	65.2	6.6*	26*	68 Marginally Fair
110.9	20	960	70.1	6.6	29	58 Mixing zone - Fair
110.8	21	337	34.7	<u>5.3*</u>	<u>25*</u>	52 Poor
110.5	19	522	18.6	6.6*	28*	74 Fair
105.8	21	668	17.9	6.9*	32*	67 Fair
98.8	23	765	22.5	8.5	37ns	80 Good-Marginally Good
90.3	18	198	16.4	6.0*	27*	45 Fair-Marginally Poor
81.8	21	413	42.5	6.9*	28*	56 Fair
80.0	14	1013	86.7	6.6	27	52 Mixing zone - Fair
79.8	18	663	86.4	<u>6.0*</u>	27*	52 Fair-Poor
77.9	23	681	77.2	7.4*	29*	71 Fair
72.2	25	246	19.6	7.6*	39ns	66 Marginally Good-Fair
66.7	21	301	79.7	8.2ns	37*	57 Marginally Good-Fair
56.7	20	179	56.7	8.2ns	36*	63 Marginally Good-Fair
47.6	23	212	31.3	8.4ns	43	76 Good - Marginally Good
41.6	25	315	71.5	9.4	44	80 Very Good
38.9	23	558	176.1	8.9	44	66 Good
38.7	16	933	322.8	9.3	35*	55 Mixing zone - Marg. Good
38.5	19	593	161.2	8.9	43	55 Good
36.3	25	666	191.3	9.5	48	54 Very Good -Exceptional
32.0	20	321	82.9	8.9	44	74 Good
<u>Negro Run</u>						
0.6	19	1535	24.1	NA	42	74 Good
<u>Rock Run</u>						
0.9	15	573	6.2	NA	34*	69 Fair
<u>Broken Sword Creek</u>						
0.7	23	969	18.1	9.5	44	81 Very Good-Exceptional

NA Headwater site, MIwb not applicable.

* Significant departure from applicable biocriteria; poor and very poor results are underlined.

ns Nonsignificant departure from biocriteria (4 IBI units; 0.5 Iwb units).

a QHEI - Qualitative Habitat Evaluation Index.

b Based on MIwb and IBI scores

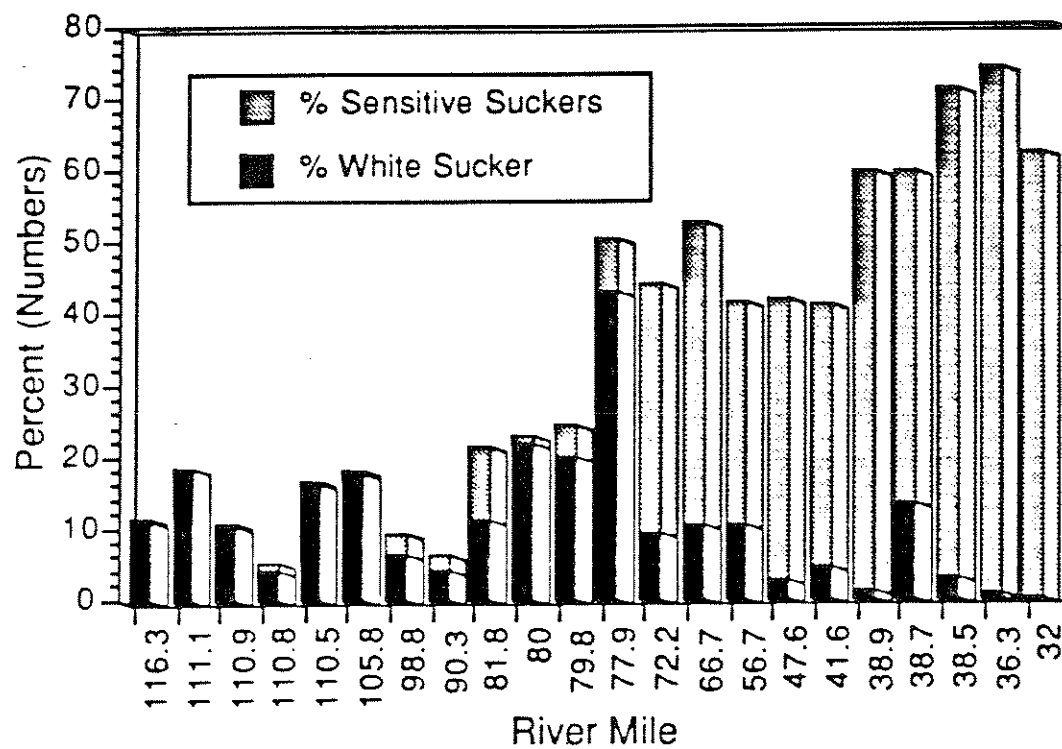


Figure 3. Longitudinal trend (percent of the total relative number) of pollution tolerant white sucker and pollution sensitive round-bodied suckers in the Sandusky River during 1990

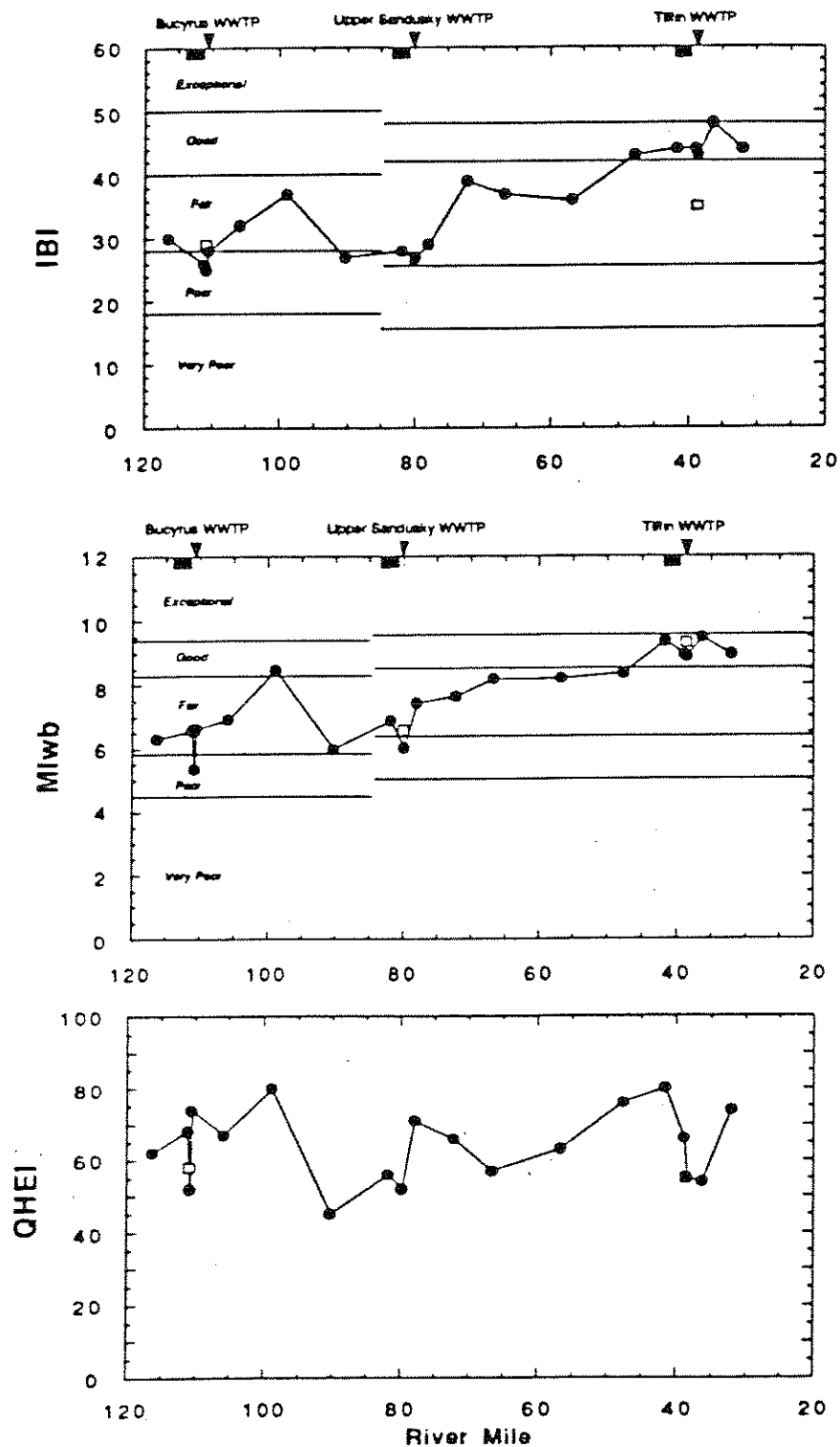


Figure 4. Longitudinal trend of the Modified Index of Well-Being (MIwb), Index of Biotic Integrity (IBI) and the Qualitative Habitat Evaluation Index (QHEI) in the Sandusky River during 1990. Mixing zone samples are indicated with a square. Combined sewer overflow areas are shaded blocks adjacent to WWTP arrows.

Trend Assessment

- * Portions of the 1990 study area were included in two previous surveys conducted by Ohio EPA. A survey conducted in 1979 (OEPA 1981) extended from immediately downstream from the confluence of Paramour Creek (RM 129.9) to downstream from Upper Sandusky (RM 69.3). Data is also available from a 1981 survey (OEPA 1982) between river miles 47.8 and 31.9.

Physical/ Chemical Water Quality (Figures 5 and 6)

- * The June - September mean monthly flow in the Sandusky River at Fremont during 1981 (2582 cfs) was double the flow recorded during 1990 (1275 cfs). These flows were significantly higher than flows recorded during 1979 (749 cfs). All three years (June - September period) recorded average flows substantially above normal.
- * Diurnal D.O. levels below 5 mg/l and frequently below 2 mg/l occurred in 1979 between RM 115.4 and 105.8 (within and downstream from Bucyrus). Datasonde units placed at RMs 111.4, 110.4, and 105.8 recorded minimum D.O. levels of over 6.5 mg/l in 1990. Along with improved oxygen levels, decreases in phosphorus, BOD, ammonia, and lead and an increase in nitrate-nitrite were noted in 1990 compared to 1979. Improvements to the Bucyrus WWTP are credited for these changes in water quality.
- * Although there has been a general improvement in fecal coliform bacteria levels since 1979, high counts are still occurring, particularly downstream of the CSOs within Bucyrus.
- * Only one set of chemical samples was collected by OEPA in 1979 in the Upper Sandusky area; the concentrations reported were largely within the range of values reported in 1990. Third quarter ammonia values reported by the Upper Sandusky WWTP show a slight increase in loadings between 1979 and 1990 (Figure 5).
- * No significant differences were detected in chemical water quality in the Tiffin area between 1981 and 1990. An upgrade to the Tiffin WWTP took place in 1984-85 that expanded the operation to fully treat 4MGD with capacity for primary treatment and chlorination of an additional 8MGD of combined stormwater and wastewater. Despite this expanded capacity, the plant is apparently still overwhelmed during rainfall events. On October 9, OEPA fish crew members observed the effluent rapidly change from relatively clear to black with a high solids load following a series of morning rain showers. Since 1984, reported third quarter ammonia loadings have been significantly reduced; non-filterable suspended solids loadings have remained at approximately the same level (Figure 6).

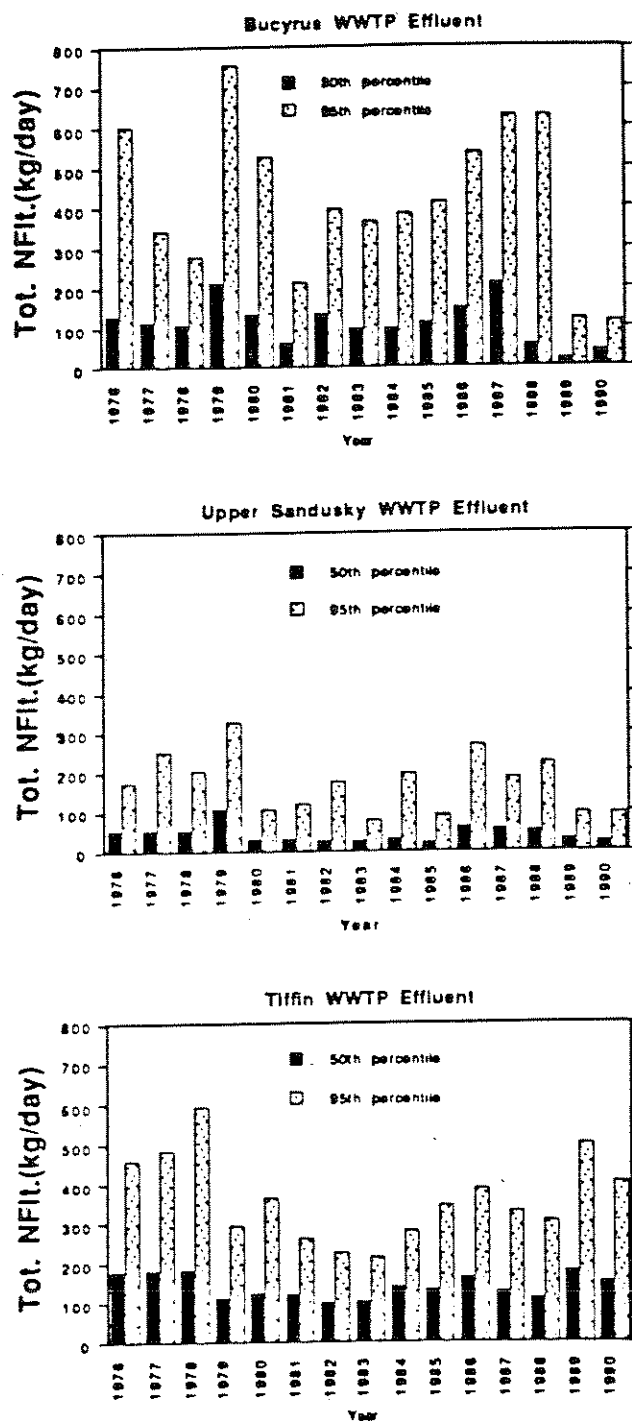


Figure 5. Annual (December-November) effluent loadings of Total Non-Filterable Solids from the Bucyrus, Upper Sandusky and Tiffin WWTPs during 1976-1990.

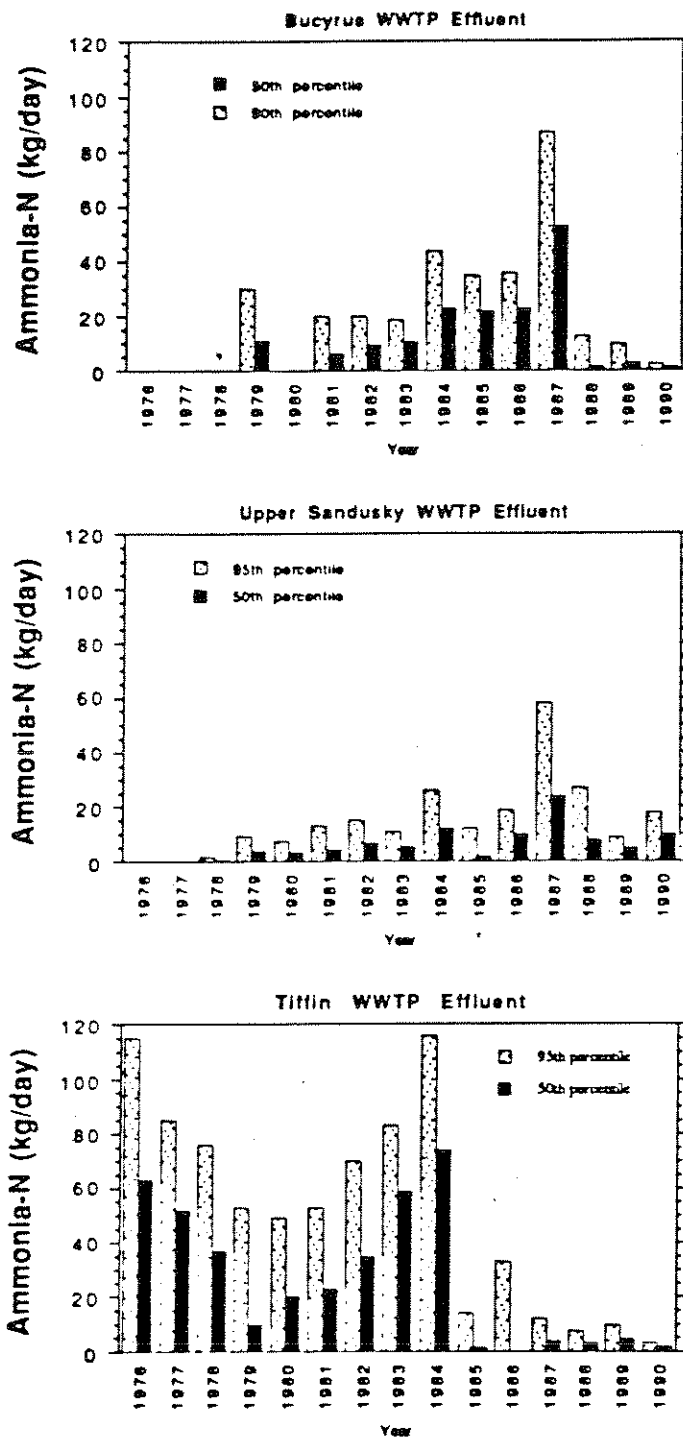


Figure 6. Third-quarter (July-September) effluent loadings of ammonia-N discharged from the Bucyrus, Upper Sandusky and Tiffin WWTP's during 1976-1990.

Biological Communities

Macroinvertebrates (Figure 7)

- * Comparison of ICI values and Area of Degradation Values (ADV; Rankin and Yoder 1991) are the primary tools for evaluating trends in the macroinvertebrate communities. Unfortunately, little historical quantitative data has been collected for the Sandusky River within the study area. In place of using quantitative data, comparison of the number of qualitatively collected Ephemeroptera, Trichoptera, and Plecoptera (EPT) and Average Tolerance Values (OEPA 1991) were calculated to aid in assessing trends in the macroinvertebrate community. Both of these metrics are currently under development by WQP&A Ecological Assessment Section. An Average Tolerance Value is calculated for a qualitative sample as the mean of tolerance values for the taxa collected. A tolerance value for a taxon is defined as the weighted mean of the ICI scores of those sites in Ohio where the taxon has been collected in the past. A minimum of six ICI scores are needed to calculate a tolerance value for each taxon. A higher tolerance value means that the taxon has been associated with higher ICI scores.
- * The macroinvertebrate community showed a significant improvement in water quality downstream from the Bucyrus WWTP in 1990 compared to 1979 and correlates well with reductions in organic pollutant loadings when the plant was upgraded in 1988. In 1979 the macroinvertebrate community was reflective of a severely degraded condition downstream from the WWTP outfall followed by gradual recovery for approximately ten miles downstream. Sampling in 1990 showed no significant impact attributable to the WWTP. CSOs within Bucyrus were identified in 1979 as a concern and 1990 macroinvertebrate data indicated that they continue to be a source organic degradation that moderately impacts the invertebrates. Average Tolerance Values and EPT scores both demonstrate an improvement in the macroinvertebrate community following the upgrade of the Bucyrus WWTP (Figure 7).
- * No significant impact was attributed to the Upper Sandusky WWTP in the 1981 narrative evaluation (OEPA 1981). However, comparison of Average Tolerance Values and EPT scores from 1979 and 1990 downstream from the Upper Sandusky WWTP (RM 78.8- 65.1) suggest the WWTP was having a slight impact; and that a somewhat more pollution sensitive macroinvertebrate assemblage was present in 1990.
- * The ICI exhibited similar patterns in 1981 and 1990 within the stream reach between RMs 47.8 and 31.9 including nonattainment of the WWH biocriteria at RM 36.5. This result is despite an upgrade of the Tiffin WWTP (RM 38.7) in 1984-85 and indicates that additional treatment may be necessary. The adequacy of primary treatment of stormwater, in particular, should be investigated given the black effluent that was observed following a rain event in October.

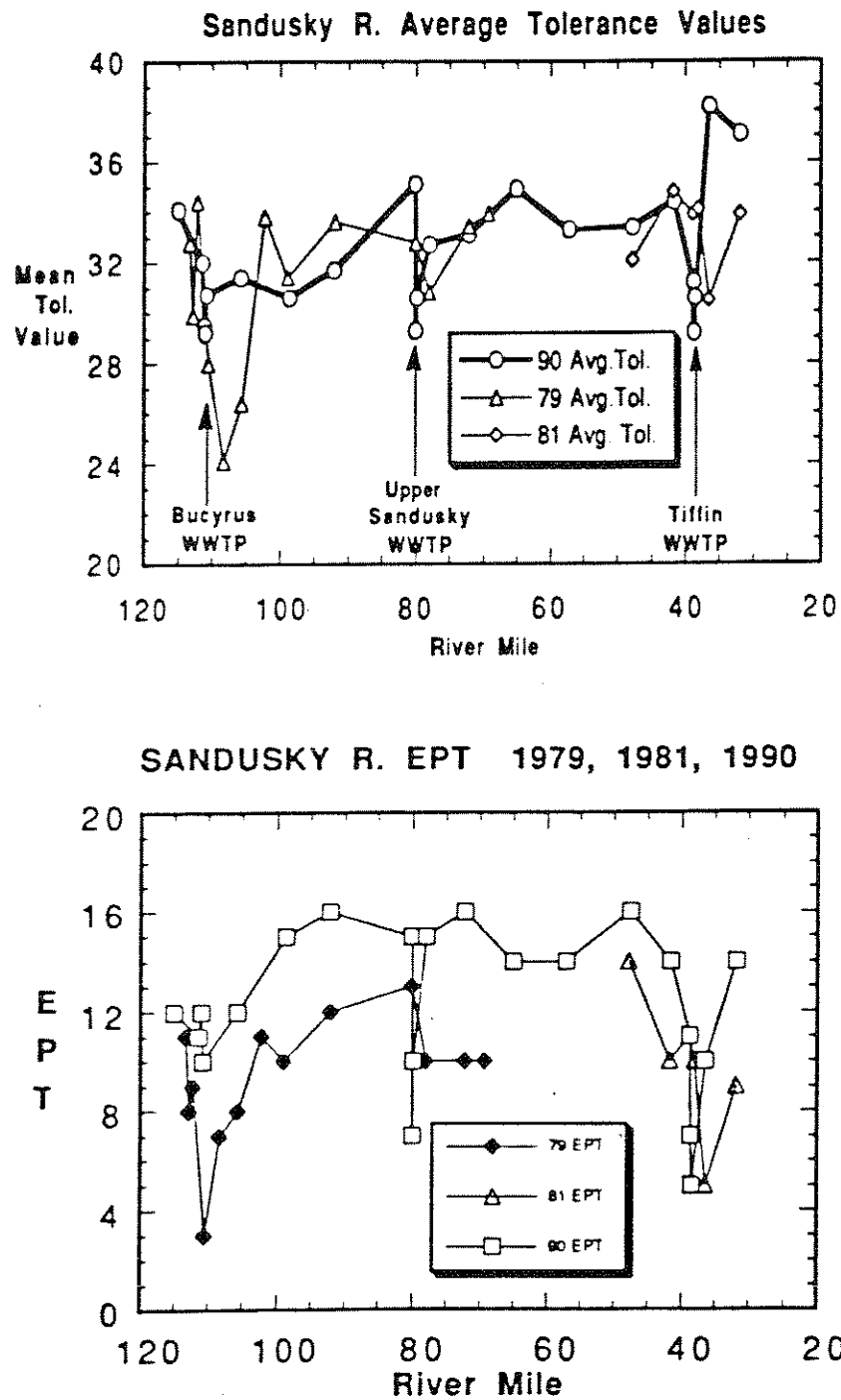


Figure 7. Average Tolerance Values and Number of Ephemeroptera, Plecoptera and Trichoptera taxa calculated from 1979, 1981 and 1990 qualitative data for the Sandusky River study area.

- * EPT and Average Tolerance Values proved useful in identifying the trend of improvement in the macroinvertebrate community downstream from the Bucyrus WWTP between 1979 and 1990; however, they individually lacked the resolution needed to discern more subtle changes such as the nonattainment of the ICI at RM 36.5. This result points out the importance of acquiring quantitative data and using multi-metric evaluation tools (i.e. ICI) to provide additional sensitivity for evaluating water quality.

Fish Community (Figure 8)

- * In the Sandusky River upstream from Bucyrus, a marginal decline in the IBI was observed between 1979 (IBI=36) and 1990 (IBI=30). A shift to a more tolerant fish community occurred in 1990, resulting in non-attainment of the WWH IBI and MIwb criteria.
- * Combined sewer overflows in Bucyrus continue to cause impairment of the fish community in the Sandusky River. No appreciable improvement in the fish community was recorded within and downstream from CSO discharges between 1979 and 1990.
- * A small incremental improvement in IBI scores was observed between 1979 and 1990 downstream from the Bucyrus WWTP (average improvement at two sites - 5 IBI units). This improvement can be partially attributable to reduced loadings of ammonia-N from the Bucyrus WWTP. Additional improvement in the fish community is possible as the time interval since the 1988 upgrade of the WWTP increases. It is not unusual for recovery in the fish communities lag behind improvements in water chemistry and in the macroinvertebrate community.
- * The fish assemblage has remained relatively constant 12.2 miles downstream from the Bucyrus WWTP; RM 98.8 was sampled both years and had a QHEI score of 80. IBI scores were nearly identical and fell in the marginally good range.
- * Significantly lower IBI scores were recorded at sites located between RM 92.1 and RM 81.3 in 1990 versus 1979. The primary reason for the increased impact on fish assemblages within this stream segment was apparently the greater susceptibility of the 1990 sampling locations to the affects of sedimentation and embeddedness. The sites sampled in 1979 (RMs 92.1, 86.5, and 81.3) had well developed riffle areas and sufficient flow velocity to keep the substrate relatively free of silt. Marginally good to good fish communities were present. QHEI scores were calculated at RMs 92.1, 86.5, and 81.3 on 19 June, 1991 and were 67.5, 76 and 78, respectively (Table 7). The two 1990 sites (RMs 90.3 and 81.8) were pooled; QHEI scores were 45 and 56, respectively, and the fish communities were in the marginally fair to poor range. The fact that the RM 90.3 and 81.8 sites were largely pooled and had relatively low QHEI scores does not alone account for the nonattainment of the fish community. This portion of the Sandusky River consists of a series of long pools separated short higher

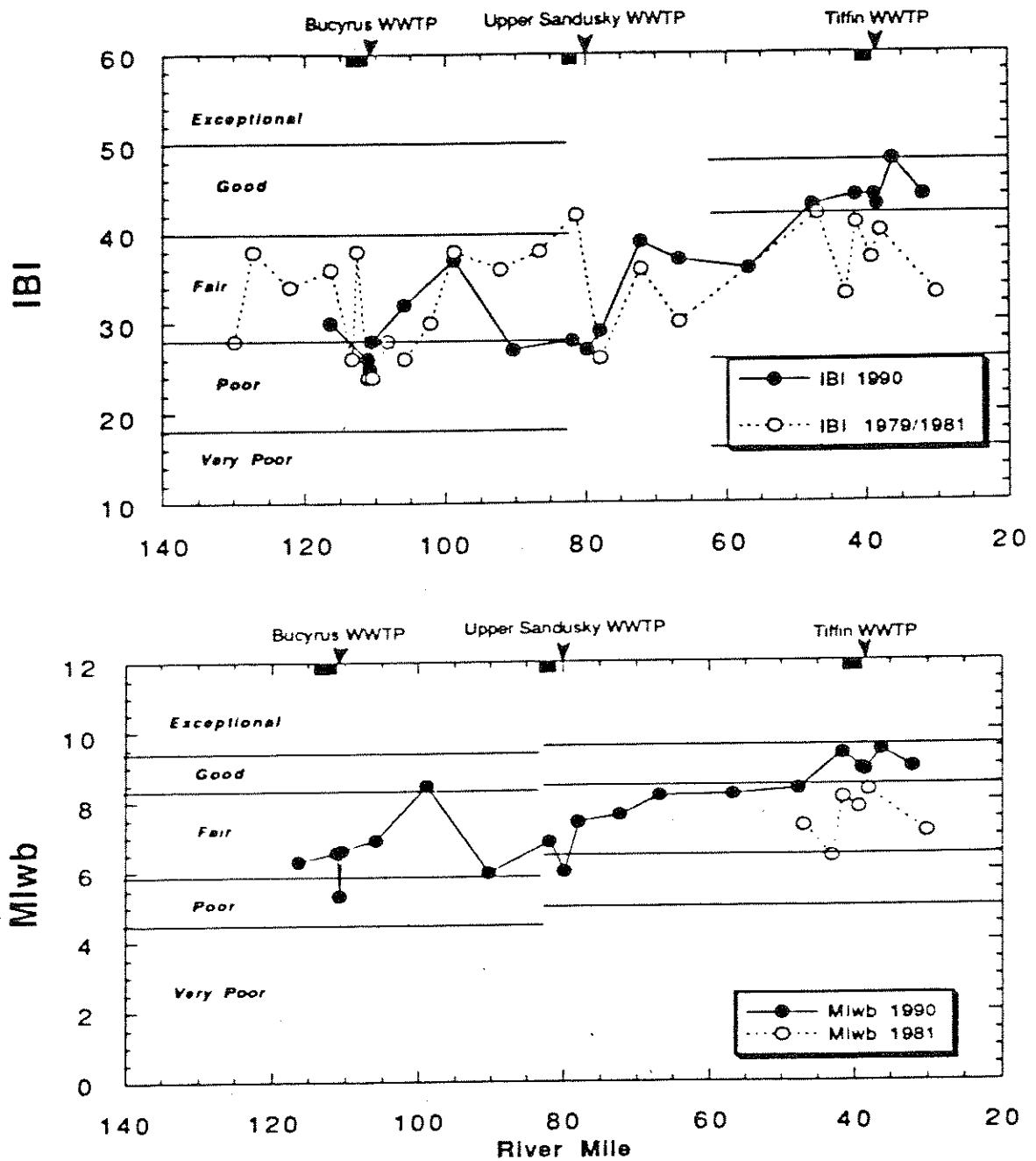


Figure 8. Longitudinal trend of the Modified Index of Well-Being (MIwb), and the Index of Biotic Integrity (IBI) in the Sandusky River between 1979 and 1990. Combined sewer overflow areas are shaded blocks adjacent to WWTP arrows.

gradient sections with runs and riffles. Previous OEPA surveys have demonstrated in streams with relatively well defined series of pool, riffle and run habitats that the fish indices will attain at relatively unimpacted pooled sampling sites. However, it is in pooled areas that problems associated with excessive sediment loading is most evident. An improvement in the water resource in this portion of the Sandusky River appears contingent on the implementation of Best Management Practices to reduce the amount of sediment entering the stream.

- * Downstream from the Upper Sandusky WWTP, comparable fish results were noted between 1979 and 1990 indicating little response to any changes at the WWTP
- * Comparison of fish community results (MIwb and IBI) from RM 47.0 to 30.0 showed 1990 values were higher than 1981 scores at all similarly sampled locations. Within this 17 mile segment, average MIwb and IBI scores increased an average of 1.2 and 5 units, respectively. Of the five similarly sampled locations, two sites were attaining the WWH biocriteria for the IBI and MIwb during 1981. Sampling results from 1990 revealed that *all five sites* were attaining the WWH criteria. The improvements in the fish community corresponds well with reduced ammonia-N loadings from the Tiffin WWTP (Figure) and improved control of CSO discharges.
- * Overall results revealed that the greatest improvement in the fish community occurred within and downstream from the City of Tiffin. Although some improvement was noted downstream from the Bucyrus WWTP, continued CSO discharges, potential toxic pollutants in the effluent (e.g. extensive foaming in the effluent), and extensive sedimentation need to be addressed for the upper Sandusky River to reach its full biological potential.
- * Due to differences in sampling method between 1979 and 1990, ADV analysis for trends was limited to the IBI for RMs 116.3- 72.2. A significant increase in the ADV was the result; ADV/ mile increased from 34.1 in 1979 to 65.9 in 1990. The greatest proportion of this increase was due to lower IBI scores at RMs 90.3 and 81.8 (upstream from Upper Sandusky) compared with three sites located within this reach in 1979 (Figure 8). The net result in aquatic life use attainment status between 1979 and 1990 was a shift to partial attainment (from 32% to 65%) with a relatively large decrease in miles nonattaining (from 57% to 30%) and a smaller decrease in miles of full Attainment (from 11% to 5%).
- * The ADV decreased between 1981 and 1990 for the stream reach between RM 47.6 and 31.9 (from 82 to 3). The improvement in the fish community resulted in an increase in the miles of stream fully attaining the WWH Aquatic Life Use (82% attaining and 18% partial in 1990 versus 55% attaining and 45% partial in 1981).

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LIST OF APPENDIX TABLES

APPENDIX B - MACROINVERTEBRATE DATA

Macroinvertebrate Methods

Table B-1. Organisms collected from artificial substrate samplers and from natural substrates in Sandusky River study area, 1990.

Table B-2. Macroinvertebrate sampling station characteristics for the Sandusky River study area, 1990.

Table B-3. ICI metric values by RM for the Sandusky River study area.

APPENDIX F - FISH DATA

Table F-1. Characteristics of electrofishing sampling methods most frequently used by the Ohio EPA to sample fish communities.

Table F-2. Relative numbers of fish collected at twenty five locations in the Sandusky River study area, 1990.

Table F-3. Relative weights (KG./0.3 km) of fish collected at twenty five locations in the Sandusky River study area, June- October, 1987.

* Table F-4. Evaluation of the fish community in the Sandusky River study area during July- September, 1987 using the Index of Biological Integrity modified for application to Ohio waters. Scores of 5, 3, or 1 are assigned to each metric according to whether it: approximates (5), partially deviates from (3), or strongly deviates from (1) an ecological grouping expected in a relatively undisturbed stream. Numbers in parentheses are numbers of species, individuals, or proportion of individuals, as indicated.

Table F-5. The presence of external anomalies observed on fish from six locations in the Sandusky River study area, June- October, 1990.

Table F-6. Fish species documented in the Sandusky River study area as reported in Trautman (1981) and collected by the Ohio EPA during 1990.

Ohio EPA Fish Evaluation Group Site Description Sheets.

Appendix Tables available upon written request by contacting:

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