

Appendix F

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
SURFACE WATER QUALITY DIVISION
JANUARY, 1990

STAFF REPORT

BIOLOGICAL SURVEY OF KAWKAWLIN RIVER, SOUTH BRANCH
BAY COUNTY, MICHIGAN
JULY 13, 1989

A biological survey of the South Branch of the Kawkawlin River was conducted on July 13, 1989 by staff of the Great Lakes and Environmental Assessment Section. The Kawkawlin River was included in the Water Quality Assessment Plan list in the Water Quality and Pollution Control in Michigan, 1988 Report, indicating potential Water Quality Standard violations in the waterbody. The objective of the Survey was to document the biological communities in the South Branch of the Kawkawlin River for the purpose of evaluating effects due to nonpoint sources.

FINDINGS AND CONCLUSIONS .

1. Results of the biosurvey indicate that conditions have improved in portions of the Kawkawlin River since 1987. However, overall stream quality remains fair to poor based on the biological communities found, water sampling results, and habitat observations. The results of this survey indicate that nonpoint sources throughout this reach contribute to the reduced stream quality found.
2. The benthic macroinvertebrate communities at all three stations surveyed were fair to poor, likely due to poor habitat (substrate) and the turbid water. The benthic communities at the two downstream stations (1 and 2) were slightly more diverse with larger populations present than at the upstream station. The benthic communities noted at Station 1, Mackinaw Road, have improved since the 1987 survey.
3. The two downstream stations (1 and 2) had higher quality fish habitat than the upstream station. The greatest number of fish and number of taxa were observed at Station 2. The fish community at Station 1 was less than expected, based on the quality of the habitat and results from a previous survey.
4. High levels of turbidity and suspended solids were evident at each station, indicating nonpoint source input of these parameters. The level of total dissolved solids at Station 1 was also elevated.

5. The results of the chemical characterization of water samples taken at each station indicate possible nonpoint source input of nitrogen and phosphorus between Station 3 and Station 2, nonpoint source input of oil and grease at Station 3, and sources of chloride and sulfate ions throughout the reach.

METHODS

Qualitative macroinvertebrate and fish collections and stream characteristic observations were made at three stations on the South Branch of the Kawkawlin River (Figure 1). Macroinvertebrates were sampled using a triangular dip net and by picking all available substrates. Sampling continued until no new taxa were found. Taxa were identified as collected with unknown taxa preserved and returned to the Water Quality Appraisal Unit (WQAU) laboratory for identification.

Fish were collected using a direct current stream shocking unit, consisting of a 6 foot fiberglass boat, portable generator, control box, probes and ground. Sampling was conducted for 40 minutes at Stations 2 and 3 and 20 minutes at Station 1. Taxa were identified and measured as collected with unknown taxa preserved and returned to the WQAU laboratory for identification.

Water samples were collected and preserved according to MDNR procedures (MDNR, 1981) and returned to the Environmental Laboratory in Lansing for analysis.

Stream observations were recorded on Stream Survey Cards (attached).

RESULTS AND DISCUSSION

The Kawkawlin River at Station 1, Mackinaw Road, was approximately 30 feet wide and 2 feet deep characterized by a predominantly silty substrate. The current velocity at the time of the survey was less than one foot per second. This station is downstream of the confluence with Culver Creek which receives discharge from a mine dewatering shaft. The water in the Kawkawlin River at this station was very turbid and only one species of aquatic macrophyte (*Potamogeton* sp.) and one species of green algae (*Cladophora* sp.) were observed. The macroinvertebrate community at Station 1 was more diverse (21 taxa) than at the two upstream stations and supported abundant populations of scuds, gerrids, corixids, dytiscids (larvae and adults) and hydrophilids (Table 1). A moderate-to-abundant population of mayflies (Ephemeroidea) was also noted. The macroinvertebrate habitat quality was fair.

An earlier survey conducted in August, 1987, at this same station found only 10 taxa of macroinvertebrates, including Haliplidae which were not found during the 1989 survey (Masterson, 1987). There were no mayflies noted during the 1987 survey. The relative abundances of the species was not indicated in the previous survey. Based on these data, the

benthic macroinvertebrate community has improved since the 1987 survey.

The fish community at Station 1 consisted of 7 taxa, including pike, carp, sunfish (2 species), and minnows (2 species) (Table 2). Fish habitat quality was fair. The fish survey was conducted for only 20 minutes (vs. 40 minutes at the two subsequent stations). The 1987 survey conducted at this same station found 9 taxa of fish, including largemouth bass, black crappie, brown bullhead, and alewife which were not found during this survey (Masterson, 1987). The number of fish of each species found in the earlier survey was not reported. Green sunfish and bluntnose minnows were found in the 1989 survey, but not in the 1987 survey.

The Kawkawlin River at Station 2, Eight Mile Road, was approximately 50 feet wide and averaged 4 feet in depth with some deeper pools. There was no discernable current velocity at this station and the water was turbid and brown. No aquatic plants were noted. The substrate was predominantly silt and clay with some detritus and logs. A drain emptied in to the stream at the downstream end of the survey area. The macroinvertebrate community at Station 2 was also fairly diverse (18 taxa), although species abundance were all in the sparse to moderate range (Table 1). Moderate populations of snails (*Physa* sp.), sowbugs, scuds, corixids, gerrids and chironomid larvae were observed. The macroinvertebrate habitat quality was low at this station. The fish community was dominated by sunfish (6 species) with some minnows and carp found (Table 2). The fish species diversity was greatest at this station (15 taxa).

Station 3, Beaver Road, was approximately 25 feet wide and 2 feet deep. Again, the water was brown colored and turbid with no apparent surface velocity. One species of aquatic macrophyte and one species of green algae were noted similar to Station 1, *Potamogeton* sp. and *Cladophora* sp. Flecks of oil were noted on the surface near the bridge. The substrate at this station was primarily sand with some silty areas. The quality of the macroinvertebrate habitat was low. Gerrids were the only abundant taxa noted; there were no mayflies observed at this station (Table 1). This station had the lowest abundance and the diversity (13 taxa) of the three stations surveyed. The fish habitat was also low. The fish community was dominated by sunfish (4 species); carp, minnows, perch and a sucker were also noted (Table 2). Although the stream was electrofished for approximately 40 minutes, the equipment was not functioning properly during this entire period.

Nutrient levels (ammonia and nitrite nitrogen, and phosphorus) and suspended solids increased substantially at Station 2 and remained elevated at station 1 (Table 3). These results are indicative of nonpoint source agricultural runoff. Station 3 showed elevated levels of oil and grease (58 mg/L), probably a result of surface runoff from the road as was noted near the bridge during the survey. Station 1, Mackinaw Road, downstream of the confluence with Culver Creek, had the highest levels of total dissolved solids, sulfate, conductivity, and chlorides of the three stations. These parameters increased consistently from upstream to downstream stations. Compared to the analysis of water samples taken at this site in the 1987 survey, levels

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of sulfate, conductivity, and chlorides were substantially reduced in the Kawkawlin River.

Analytical results for chlorinated hydrocarbons (Level of Detection = 0.10 ug/l, except 2-chloronaphthalene LOD = 0.20 ug/l and dichlorobenzenes LOD = 0.10 ug/l), PCBs (LOD = 0.050 ug/l) and organochlorine pesticides (LOD = 0.010 ug/l) (Scan 3) indicated no detectable contaminants in any of the three samples.

Field Work by: Michael Masterson, Scott Cornelius
Susan Benzie
Aquatic Biologists

Report by: Susan Benzie, Aquatic Biologist
Great Lakes & Environmental
Assessment Section
Water Quality Appraisal Unit

REFERENCES

- MDNR. 1981. Quality Assurance For Water and Sediment Sampling. Environmental Protection Bureau, publication # 3730-0028.
- Masterson. 1987. A Biological Assessment of Culver Creek and the Kawkawlin River in the Vicinity of Wolverine Mine #2 Dewatering Shaft, August 13, 1987. December, 1987. Staff Report # MI/DNR/SWQ-87/060.

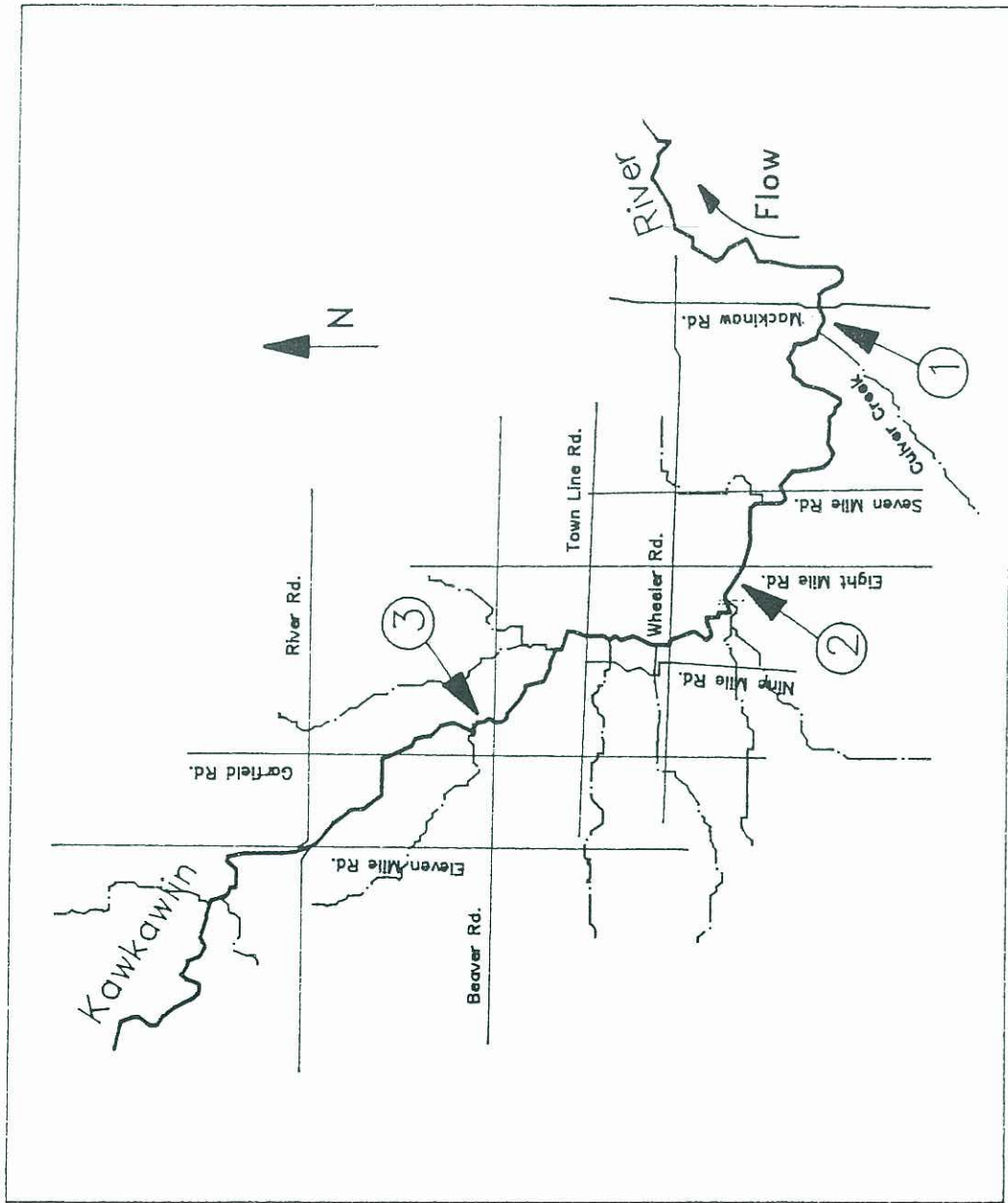


Figure 1. Biological survey stations on the Kawkawlin River, Bay County, Michigan, July 13, 1989.

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Table 1. Macroinvertebrates in Kawkawlin River, South Branch, Bay County, Michigan.
July 13, 1989.

Station Location Taxa	1 Mackinaw Rd.	2 Eight Mile Rd.	3 Beaver Road
Flatworms	S		
Leeches	S	S	S
Gastropoda (Snails)			
<u>Physa</u> sp.	S	M	S
<u>Helisoma</u> sp.	S	S	S
Pelecypoda (Clams)			
Unionidae	S		
Isopoda (Sowbugs)	M	M	S/M
Amphipoda (Scuds)	A	M	S
Decapoda (Crayfish)	S/M	S/M	
Ephemeroptera (Mayflies)			
Baetidae	S	S	
Ephemeridae	M/A		
Heptageniidae	S		
Odonata			
Anisoptera (Dragonflies)			S
Zygoptera (Damselflies)	S/M	S (L and A)	S
Hemiptera (True bugs)			
Corixidae	A	M	S
Gerridae	A	M	A
Veliidae		S	
Megaloptera			
<u>Sialis</u> sp.	S	S	S
Trichoptera (Caddisflies)			
Hydroptilidae	S		
Coleoptera (Beetles)			
Dytiscidae	A (L and A)	S (L and A)	S
Elmidae	S (L)	S (A)	
Gyrinidae	S	S/M	
Hydrophilidae	A	S (A)	S
Diptera (Flies, midges)			
Chironomidae	M	M	M
Culicidae		S	
Total Number of Taxa:	21	18	13
Overall habitat quality:	Medium	Medium	Poor

S = Sparse
M = Moderate
A = Abundant

Table 2. Fish Species in Kawkawlin River, South Branch, Bay County, Michigan. July 13, 1989.

Station Location Species	1 Mackinaw Rd.	2 Eight Mile Rd.	3 Beaver Rd.

Catostomidae (Suckers)			
<i>Catostomus commersonnii</i> (White sucker)			1
Cyprinidae (Minnows)			
<i>Cyprinus carpio</i> (Carp)	5	9	1
<i>Pimephales notatus</i> (Bluntnose minnow)	25	2	1
<i>Notropis cornutus</i> (Common Shiner)	1		1
<i>Notemigonus crysoleucas</i> (Golden Shiner)		1	
Cyprinodontidae (Killifishes)			
<i>Fundulus</i> sp. (Topminnow)		3	
Ictaluridae (Catfish)			
<i>Ictalurus natalis</i> (Yellow bullhead)	1	2	1
Umbridae (Mudminnow)			
<i>Umbra limi</i>		2	2
Esoxidae (Pike)			
<i>Esox lucius</i> (Northern Pike)	5	1	
Percidae (Perch)			
<i>Percina caprodes</i> (Logperch)			1
<i>Perca flavescens</i> (Yellow perch)		17	5
Centrarchidae (Sunfishes)			
<i>Lepomis cyanellus</i> (Green sunfish)	8	22	16
<i>Lepomis gibbosus</i> (Pumpkinseed)	22	51	18
<i>Lepomis macrochirus</i> (Bluegill)		19	15
<i>Micropterus dolomieu</i> (Smallmouth bass)			
<i>Micropterus salmoides</i> (Largemouth bass)		2	
<i>Pomoxis annularis</i> (White crappie)			1
<i>Pomoxis nigromaculatus</i> (Black crappie)		1	
<i>Ambloplites rupestris</i> (Rock bass)		1	
Percichthyidae (Temperature basses)			
<i>Morone chrysops</i> (White bass)		2	

Total Number of Fish:	67	135	63
Total Number of Taxa:	7	15	12
Length of Stream Shocked (Feet):	200	200	250*
Time Shocked (Minutes):	20	40	40
Fish Habitat Quality:	Fair	Fair	Low

*Note: Equipment problems.

Table 3. Chemical analysis of water samples in the Kawkawlin River, South Branch, Bay County, Michigan. July 13, 1989.

Station Location Parameter (units)	1 <u>Mackinaw Road</u>	2 <u>Eight Mile</u>	3 <u>Beaver Road</u>
Alkalinity of Water (mg CaCO ₃ /l)	187	207	146
Carbonate Alkalinity (mg CaCO ₃ /l)	K 5	K 5	36
Bicarbonate Alkalinity (mg CaCO ₃ /l)	187	207	110
BOD 5 Day Carb (mg/l)	5	4	2
Chloride in Water (mg/l)	97	72	49
COD (mg/l)	49	42	43
Conductivity of Water (umho/cm)	867	701	511
Nitrite (mg N/l)	.010	.030	.007
Nitrate + Nitrite (mg N/l)	.044	.29	T .008
Ammonia (mg N/l)	.097	.152	.020
Kjeldahl Nitrogen (mg N/l)	1.95	1.78	1.02
Oil & Grease-Water (mg/l)	K 2	2.9	58
pH of Water (s.u.)	7.77	7.9	8.69
Ortho Phosphate (mg P/l)	.019	.046	.013
Total Phosphorus (mg P/l)	.170	.182	.065
Suspended Solids (mg/l)	37	60	42
Total Dissolved Solids (mg/l)	640	488	348
Sulfate in Water (mg/l)	99	47	33
TOC (mg/l)	13.	13.	13.

K = Actual value is less than value given.

T = Value reported is less than the level of detection.

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
SURFACE WATER QUALITY DIVISION

STREAM SURVEY CARD
(Revised - April 1989)

STORET NO.

STATION NUMBER 1 INVESTIGATOR (S): Masterson, Cornelius, Benzie DATE 7/13/89 TIME 10:30a

BODY OF WATER Kawkawlin LOCATION Mackinaw Rd. PHOTOGRAPHS: Y

COUNTY Bay TOWNSHIP _____ T _____ R _____ S _____ WATER SAMPLES: Y

SEDIMENT SAMPLE:

OTHER:

STREAM TYPE: () Coldwater (X) Warmwater REASON FOR SURVEY NPS

#CONDITIONS DURING SURVEY#

WEATHER: () Sunny (X) Partly Cloudy () Cloudy () Rainy AIR TEMP. 68 WATER TEMP. 72

LOCAL LAND USE: () Urban () Suburban (X) Agricultural () Grassland () Forest () Other

SURVEY REACH LENGTH: 200 ft. % STREAM SHADING: 0 CHANNELIZED: () Yes (X) No DAM u/s: () Yes (X) No _____ ft.

STREAMBANK VEG.: () Barren (X) Grasses () Herbaceous (X) Brush () Deciduous () Conifer () Other

Est. % Coverage 80 20

Vegetative Height (ft.) 0.5 - 1 5

BANK STABILITY: () Stable (X) Slightly Eroded () Moderately Eroded () Severely Eroded BANK MATERIAL:

(Peat)

DISCHARGE STABILITY: () Stable () Moderately Stable (X) Unstable () Severely Unstable UNDERCUT BANKS: (X) Yes () No

AVE. STREAM WIDTH 30 ft. AVE. STREAM DEPTH 2 ft. SURFACE VELOCITY 0.1 ft./sec. ESTIMATED FLOW: 6 cfs

BANKFULL HEIGHT 6 ft. BANKFULL WIDTH 50 ft. CHANNEL SLOPE _____ ft./mile

CHANNEL X - SECTION: () Rectangular () V-Shaped () U-Shaped (X) Other _____ % BANK SLOPE

TURBIDITY: () Clear () Slight (X) Turbid () Opaque SECCHI DISC TRANS: _____ ft. WATER COLOR: brown

SURFACE OILS: (X) None () Flecks () Globs () Sheen () Slick () Other _____ % Aerial Coverage

WATER ODORS: (X) Normal () Sewage () Petroleum () Chemical () Other

SEDIMENT OILS: (X) Absent () Slight () Moderate () Profuse DEPOSITS: () None () Sludge () Sand () Other

SEDIMENT ODORS: (X) Normal () Sewage () Petroleum () Chemical () Anaerobic () Other

UNDERSIDES OF IMBEDDED RUBBLE BLACK? (X) Yes () No LENGTH OF REACH AFFECTED _____ ft. % Reach Affected

INORGANIC SUBSTRATE	FLOW VELOCITY	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA	ORGANIC SUBSTRATE	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
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INORGANIC:

BOULDERS* _____ > 3 fps > 10 inch dia. 1

RUBBLE* _____ 2 fps 2.5 - 10 inch dia. 4

GRAVEL* _____ 1 fps 0.1 - 2.5 inch dia. _____

SAND _____ 0.7 fps 0.002 - 0.079 inch dia. _____

SILT _____ < 0.4 fps _____ 95

CLAY _____ Slick Texture

ORGANIC:

MUCK-MUD Black, very fine organic.

PULPY PEAT Indistinguishable plant parts. 90

FIBROUS PEAT Partially decomposed plant material.

DETRITUS Sticks, wood, coarse plant material. 8

LOGS, LIMBS _____ 2
100 %

BIOTA:

SLIMES _____ PERIPHYTON _____ FILAMENTOUS ALGAE _____ MACROPHYTES _____ MACROINVER. _____ FISH _____ OTHER _____

***** (S)Sparse (M)Moderate (A)Abundant (P)Profuse (N)Not Observed *****

AQUATIC PLANTS: % Aerial Coverage _____ FISH: ()Hand Wet ()Electrofishing Duration: _____ min.

MACROPHYTES	ATTACHED ALGAE	TAXA:	GAME	ROUGH	FORAGE
<u>Ceratophyllum</u> _____	<u>Batrachosperma</u> _____				
<u>Elodea</u> _____	<u>Cladophora</u> <u>M</u>				
<u>Lemma</u> _____	<u>Hydrodictyon</u>				
<u>Myriophyllum</u> _____	<u>Rhizoclonium</u>				
<u>Nasturtium</u> _____	<u>Spirogyra</u>				
<u>Potamogeton</u> <u>S</u>	<u>Vaucheria</u>				
<u>Ranunculus</u>					
<u>Vallisneria</u> _____		% Fish Type			

***** (S)Sparse (M)Moderate (A)Abundant (P)Profuse (N)Not Observed *****

MACROBENTHOS - QUALITATIVE SAMPLE - (INDICATE DOMINANT GROUPS *)

BRYOZOA _____	STONEFLIES _____	DRAGONFLIES _____	CADDISFLIES _____	ABQ. CATERPIL. _____
FLATWORMS <u>S</u>	Perliidae _____	DAMSELFLIES <u>S/M</u>	Brachycentridae _____	BEETLES _____
ROUNDWORMS _____	Pteronarcys _____	TRUE BUGS _____	Glossosomatidae _____	Dytiscidae <u>A (L&A)</u>
AQUATIC WORMS _____	Taeniopterigidae _____	Belostoma _____	Helicopsyche _____	Elmidae <u>S (L)</u>
LEECHES <u>S</u>	Periodidae _____	Corixidae <u>A</u>	Hydropsychidae _____	Gyrinidae <u>S</u>
SNAILS _____	MAYFLIES _____	Gerridae <u>A</u>	Hydroptilidae <u>S</u>	Hydrophilidae <u>A</u>
<u>Ferrissia</u> _____	Baetidae <u>S</u>	Lethocerus _____	Leptoceridae _____	Psephenidae _____
<u>Lyanea</u> _____	Baetisca _____	Naucoridae _____	Lepidostomatidae _____	TRUE FLIES _____
<u>Physa</u> <u>S</u>	Caenidae _____	Notonectidae _____	Limnephilidae _____	Atherix _____
<u>HELISOMA</u> <u>S</u>	Ephemerellidae _____	Pleiiidae _____	Pycnopsyche _____	Ceratopogonidae _____
CLAMS _____	Ephemeridae <u>M/A</u>	Valiidae _____	Neophylax _____	Chironomidae <u>M</u>
<u>Sphaeriidae</u> _____	Heptageniidae <u>S</u>	MEGALOPTERA _____	Molannidae _____	
<u>Unionidae</u> <u>S</u>	Leptophlebiidae _____	<u>Corydalus</u> _____	Odontoceridae _____	Empididae _____
SOMBUGS <u>M</u>	Potamoanthus _____	<u>Nigronia</u> _____	Philopotamidae _____	Simuliidae _____
SCUDS <u>A</u>	Siphonuridae _____	<u>Sialis</u> <u>S</u>	Phryganeidae _____	Tabanidae _____
GRAYFISH <u>S/M</u>	Tricorythidae _____	SPONGILLAFLIES _____	Polycentropidae _____	Tipulidae _____
WATER MITES _____	_____		Psychomyiidae _____	
OTHER _____			Rhyacophilidae _____	

***** (S)Sparse (M)Moderate (A)Abundant (P)Profuse *****

MACROINVERTEBRATE HABITAT QUALITY ? ()Low (X)Medium ()High FISH HABITAT QUALITY ? ()Low (X)Medium ()High

STATION SKETCH AND NOTES:

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STATION NUMBER 2 INVESTIGATOR (S): Masterson, Cornelius, Benzie DATE 7/13/89 TIME 3:30p

BODY OF WATER Kawkawlin LOCATION Eight Mile Rd.
COUNTY Bay TOWNSHIP _____ T _____ R _____ S _____

PHOTOGRAPHS:
WATER SAMPLES: Y
SEDIMENT SAMPLE:
OTHER:

STREAM TYPE: () Coldwater (X) Warmwater REASON FOR SURVEY NPS

#CONDITIONS DURING SURVEY#

WEATHER: () Sunny (X) Partly Cloudy () Cloudy (X) Rainy AIR TEMP. 62 WATER TEMP. 72

LOCAL LAND USE: () Urban () Suburban () Agricultural () Grassland (X) Forest (X) Other Racetrack

SURVEY REACH LENGTH: 200 ft. % STREAM SHADING: 20 CHANNELIZED: () Yes (X) No DAM w/s: () Yes (X) No _____ ft.

STREAMBANK VEG.: () Barren (X) Grasses () Herbaceous (X) Brush (X) Deciduous () Conifer () Other

Est. % Coverage

Vegetative Height (ft.) 2 4-5 25

BANK STABILITY: (X) Stable () Slightly Eroded () Moderately Eroded () Severely Eroded BANK MATERIAL:

(Peat)

DISCHARGE STABILITY: () Stable (X) Moderately Stable () Unstable () Severely Unstable UNDERCUT BANKS: (X) Yes () No

AVE. STREAM WIDTH 50 ft. AVE. STREAM DEPTH 4 ft. SURFACE VELOCITY 0 ft./sec. ESTIMATED FLOW: 0 cfs

BANKFULL HEIGHT 4 ft. BANKFULL WIDTH 50 ft. CHANNEL SLOPE _____ ft./mile

CHANNEL X - SECTION: () Rectangular () V-Shaped (X) U-Shaped (X) Other _____ % BANK SLOPE

TURBIDITY: () Clear () Slight (X) Turbid () Opaque SECCHI DISC TRANS: _____ ft. WATER COLOR: brown

SURFACE OILS: (X) None () Flecks () Globes () Sheen () Slick () Other _____ % Aerial Coverage

WATER ODORS: (X) Normal () Sewage () Petroleum () Chemical () Other

SEDIMENT OILS: (X) Absent () Slight () Moderate () Profuse DEPOSITS: () None () Sludge () Sand () Other

SEDIMENT ODORS: (X) Normal () Sewage () Petroleum () Chemical () Anaerobic () Other

UNDERSIDES OF IMBEDDED RUBBLE BLACK? () Yes (X) No LENGTH OF REACH AFFECTED _____ ft. % Reach Affected

INORGANIC SUBSTRATE	FLOW VELOCITY	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA	ORGANIC SUBSTRATE	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
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INORGANIC:				ORGANIC:		
BOULDERS*	> 3 fps	> 10 inch dia.		MUCK-MUD	Black, very fine organic.	
RUBBLE*	2 fps	2.5 - 10 inch dia.		PULPY PEAT	Indistinguishable plant parts.	
GRAVEL*	1 fps	0.1 - 2.5 inch dia.		FIBROUS PEAT	Partially decomposed plant material.	
SAND	0.7 fps	0.002 - 0.079 inch dia.		DETRITUS	Sticks, wood, coarse plant material.	<u>95</u>
SILT	< 0.4 fps		<u>50</u>	LOGS, LIMBS		<u>5</u>
CLAY		Slick Texture	<u>50</u>			<u>100</u> %

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BIOTA: SLIMES _____ PERIPHYTON _____ FILAMENTOUS ALGAE _____ MACROPHYTES _____ MACROINVER. _____ FISH _____ OTHER _____

***** (S)Sparse (M)Moderate (A)Abundant (P)Profuse (N)Not Observed *****

AQUATIC PLANTS: % Aerial Coverage _____ FISH: ()Hand Net (X)Electrofishing Duration: _____ 40 min.

MACROPHYTES	ATTACHED ALGAE	TAXA:	GAZE	ROUGH	FORAGE
<u>Ceratophyllum</u> _____	<u>Batrachosperma</u> _____				
<u>Elodea</u> _____	<u>Cladophora</u> <u>M</u>				
<u>Lemma</u> _____	<u>Hydrodictyon</u> _____				
<u>Myriophyllum</u> _____	<u>Rhizoclonium</u> _____				
<u>Najas</u> _____	<u>Spirogyra</u> _____				
<u>Potamogeton</u> <u>S</u>	<u>Vaucheria</u> _____				
<u>Sagunculus</u> _____					
<u>Vallisneria</u> _____					

% fish Type _____

***** (S)Sparse (M)Moderate (A)Abundant (P)Profuse (N)Not Observed *****

MACROBENTHOS - QUALITATIVE SAMPLE - (INDICATE DOMINANT GROUPS #)

BRYOZOA _____	STONEFLIES _____	DRAGONFLIES _____	CADDISFLIES _____	AQU. CATERPIL. _____
FLATWORMS <u>S</u>	Perlidae _____	DAMSELFLIES <u>S/M</u>	Brachycentridae _____	BEETLES _____
ROUNDWORMS _____	Pteronarcys _____	TRUE BUGS _____	Glossosomatidae _____	Dytiscidae <u>A (L&A)</u>
AQUATIC WORMS _____	Taeniopterigidae _____	<u>Belostoma</u> _____	Helicopsyche _____	Elmidae <u>S (L)</u>
LEECHES <u>S</u>	Periodidae _____	Corixidae <u>A</u>	Hydropsychidae _____	Gyrinidae <u>S</u>
SNAILS _____	MAYFLIES _____	Gerridae <u>A</u>	Hydroptilidae <u>S</u>	Hydrophilidae <u>A</u>
<u>Ferrissia</u> _____	Baetidae <u>S</u>	<u>Lethocerus</u> _____	Leptoceridae _____	Psephenidae _____
<u>Lymnaea</u> _____	<u>Baetisca</u> _____	Naucoridae _____	Lepidostomatidae _____	TRUE FLIES _____
<u>Physa</u> <u>S</u>	Caenidae _____	Notonectidae _____	Limnephilidae _____	Atherix _____
<u>HELISSOMA</u> <u>S</u>	Ephemerellidae _____	Pleidiidae _____	<u>Pycnopsyche</u> _____	Ceratopogonidae _____
CLANS _____	Ephemeridae <u>N/A</u>	Veliidae _____	<u>Neophylax</u> _____	Chironomidae <u>M</u>
Sphaeriidae _____	Heptageniidae <u>S</u>	MEGALOPTERA _____	Molannidae _____	
Unionidae <u>S</u>	Leptophlebiidae _____	<u>Corydalus</u> _____	Odontoceridae _____	Empididae _____
SNOWBUGS <u>M</u>	<u>Potomanthus</u> _____	<u>Nigronia</u> _____	Philopotamidae _____	Sialiididae _____
SCUDE <u>A</u>	Siphonuridae _____	<u>Sialis</u> <u>S</u>	Phryganeidae _____	Tabanidae _____
CRAYFISH <u>S/M</u>	Tricorythidae _____	SPONGILLAFLIES _____	Polycentropidae _____	Tipulidae _____
WATER MITES _____			Psychomyiidae _____	
OTHER _____			Rhyacophilidae _____	

***** (S)Sparse (M)Moderate (A)Abundant (P)Profuse *****

MACROINVERTEBRATE HABITAT QUALITY ? ()Low (X)Medium ()High FISH HABITAT QUALITY ? ()Low (X)Medium ()High

STATION SKETCH AND NOTES:

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
SURFACE WATER QUALITY DIVISION

STREAM SURVEY CARD
(Revised - April 1989)

STORET NO.

STATION NUMBER 3 INVESTIGATOR (S) Masterson, Cornelius, Benzie DATE 7/13/89 TIME 1:30p

BODY OF WATER Kawawlin R. South Branch LOCATION Beaver Rd.
COUNTY Bay TOWNSHIP _____ T _____ R _____ S _____

PHOTOGRAPHS:
WATER SAMPLES: X
SEDIMENT SAMPLE:
OTHER:

STREAM TYPE: () Coldwater (X) Warmwater REASON FOR SURVEY NPS

CONDITIONS DURING SURVEY

WEATHER: () Sunny (X) Partly Cloudy () Cloudy () Rainy AIR TEMP. 70 WATER TEMP. 74

LOCAL LAND USE: () Urban () Suburban (X) Agricultural () Grassland () Forest () Other

SURVEY REACH LENGTH: 250 ft. % STREAM SHADING: 25 CHANNELIZED: () Yes (X) No DAM u/s: () Yes (X) No _____ ft.

STREAMBANK VEG.: () Barren () Grasses () Herbaceous () Brush () Deciduous () Conifer () Other
Est. % Coverage
Vegetative Height (ft.)

BANK STABILITY: () Stable () Slightly Eroded () Moderately Eroded () Severely Eroded BANK MATERIAL:

DISCHARGE STABILITY: () Stable () Moderately Stable () Unstable () Severely Unstable UNDERCUT BANKS: () Yes () No

AVG. STREAM WIDTH 25 ft. AVG. STREAM DEPTH 2 ft. SURFACE VELOCITY 0 ft./sec. ESTIMATED FLOW: 0 cfs

BANKFULL HEIGHT _____ ft. BANKFULL WIDTH _____ ft. CHANNEL SLOPE _____ ft./mile

CHANNEL X - SECTION: () Rectangular () V-Shaped (X) U-Shaped () Other _____ % BANK SLOPE

TURBIDITY: () Clear () Slight (X) Turbid () Opaque SECCHI DISC TRANS: _____ ft. WATER COLOR: Brown

SURFACE OILS: () None (X) Flecks () Globes () Sheen () Slick () Other _____ % Aerial Coverage
(Near bridge)

WATER ODORS: (X) Normal () Sewage () Petroleum () Chemical () Other

SEDIMENT OILS: (X) Absent () Slight () Moderate () Profuse DEPOSITS: () None () Sludge () Sand () Other

SEDIMENT ODORS: (X) Normal () Sewage () Petroleum () Chemical () Anaerobic () Other

UNDERSIDES OF IMBEDDED RUBBLE BLACK? () Yes (X) No LENGTH OF REACH AFFECTED _____ ft. % Reach Affected

INORGANIC SUBSTRATE	FLOW VELOCITY	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA	ORGANIC SUBSTRATE	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
BOULDERS*	> 3 fps	> 10 inch dia.	_____	MUCK-MUD	Black, very fine organic.	_____
RUBBLE*	2 fps	2.5 - 10 inch dia.	_____	PULPY PEAT	Indistinguishable plant parts.	_____
GRAVEL*	1 fps	0.1 - 2.5 inch dia.	_____	FIBROUS PEAT	Partially decomposed plant material.	_____
SAND	0.7 fps	0.002 - 0.079 inch dia.	<u>75</u>	DETRITUS	Sticks, wood, coarse plant material.	<u>100</u>
SILT	< 0.4 fps		<u>25</u>	LOGS, LIMBS		<u>100 %</u>
CLAY		Slick Texture				

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BIOTA:

SLIMES _____ PERIPHYTON _____ FILAMENTOUS ALGAE _____ MACROPHYTES _____ MACROINVER. _____ FISH _____ OTHER _____

***** (S)Sparse (M)Moderate (A)Abundant (P)Profuse (N)Not Observed *****

AQUATIC PLANTS: % Aerial Coverage _____ FISH: ()Hand Net ()Electrofishing Duration: _____ min.

MACROPHYTES	ATTACHED ALGAE	Taxa:	GAME	ROUGH	FORAGE
Ceratophyllum _____	Batrachospermum _____				
Elodea _____	Cladophora _____ M				
Lemna _____	Hydrodictyon _____				
Hyriophyllum _____	Rhizoclonium _____				
Nasturtium _____	Spirogyra _____				
Potamogeton M _____	Vaucheria _____				
Ranunculus _____					
Vallisneria _____					

% Fish Type

***** (S)Sparse (M)Moderate (A)Abundant (P)Profuse (N)Not Observed *****

MACROBENTHOS - QUALITATIVE SAMPLE - (INDICATE DOMINANT GROUPS *)

BRYOZOA _____	STONEFLIES _____	DRAGONFLIES \$ _____	CADDISFLIES _____	AQU. CATERPIL. _____
FLATWORMS _____	Perlidae _____	DAMSELFLIES \$ _____	Brachycentridae _____	BEETLES _____
ROUNDWORMS _____	Pteronarcys _____	TRUB BUGS _____	Glossosomatidae _____	Dytiscidae \$ _____
AQUATIC WORMS _____	Taeniopterigidae _____	Belostoma _____	Helicopsyche _____	Elmidae _____
LEECHES \$ _____	Perlodidae _____	Corixidae \$ _____	Hydropsychidae _____	Gyrinidae _____
SNAILS _____	MAYFLIES _____	Gerridae A _____	Hydroptilidae _____	Hydrophilidae \$ _____
Ferrissia _____	Baetidae _____	Lethocerus _____	Leptoceridae _____	Psephenidae _____
Lymnea _____	Baetiaca _____	Naucoridae _____	Lepidostomatidae _____	TRUE FLIES _____
Physa \$ _____	Caenidae _____	Notonectidae _____	Limnephilidae _____	Atherix _____
Helisoma \$ _____	Ephemerellidae _____	Pleidiidae _____	Pycnopsyche _____	Ceratopogonidae _____
CLAMS _____	Ephemeridae _____	Veliidae _____	Neophylax _____	Chironomidae M _____
Sphaeriidae _____	Heptageniidae _____	MEGALOPTERA _____	Molannidae _____	
Unionidae _____	Leptophlebiidae _____	Corydalus _____	Odontoceridae _____	
SOWBUGS S/M _____	Potomanthus _____	Nigronia _____	Philopotamidae _____	Empididae _____
SCUDS \$ _____	Siphonuridae _____	Sialia \$ _____	Phryganeidae _____	Simuliidae _____
CRAYFISH _____	Tricorythidae _____	SPONGILLAFLIES _____	Polycentropidae _____	Tabanidae _____
WATER MITES _____			Psychomyiidae _____	Tipulidae _____
OTHER _____			Rhyacophilidae _____	

***** (S)Sparse (M)Moderate (A)Abundant (P)Profuse *****

MACROINVERTEBRATE HABITAT QUALITY ? (X)Low ()Medium ()High FISH HABITAT QUALITY ? (X)Low ()Medium ()High

STATION SKETCH AND NOTES:

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MICHIGAN DEPARTMENT OF NATURAL RESOURCES
SURFACE WATER QUALITY DIVISION
DECEMBER, 1994

STAFF REPORT

A BIOLOGICAL SURVEY OF THE NORTH BRANCH KAWKAWLIN RIVER,
BAY COUNTY
JULY 20, 1993

As part of the nonpoint source surveillance activity, staff of the Great Lakes and Environmental Assessment Section (GLEAS) conducted a biological survey of the North Branch Kawkawlin River. The biological survey was performed according to GLEAS Procedure #51 (available upon request). Additional macroinvertebrate and water chemistry data for the North Branch Kawkawlin River have been reported by the EPA Environmental Research Laboratory-Duluth Minnesota (Arthur, et al., 1992) and MDNR (Lundgren, et al., 1992).

The objective of the biological survey was to evaluate the current impact of land use practices on the fish and macroinvertebrate community and physical habitat conditions of the North Branch Kawkawlin River. The survey was also conducted to generate follow-up biological data to fish kills reported May 24, 1989, April 30, 1990 and July 8, 1993.

SUMMARY

1. The locations of the biological sampling stations are shown in Figure 1. Note the extensive wetland in the vicinity of Stations 1 and 2.
2. Fish and macroinvertebrate community, physical habitat and water chemistry data generated at these stations are presented in Tables 1-4, respectively.
3. The fish community was rated "good" (slightly impaired) at both stations. A total of 8 fish taxa, which included 5 game fish taxa, were found during the survey. The North Branch Kawkawlin River is an important walleye spawning area (James Baker, MDNR Fisheries Biologist-personal communication) and also appeared to provide northern pike spawning habitat. However, only five fish taxa were found at Station 2 compared to seven taxa at Station 1 and the mud minnow (Umbra limi) overwhelmingly dominated the fish community at Station 2. The mud minnow is very tolerant to low dissolved oxygen concentrations.

Holden, S. 1994. Dissolved Oxygen Measurements in the North Branch Kawkawlin River, July 21-August 1, 1993. Personal Communication.

Lundgren, R., J. Rossio and R. Wood. 1992. Fixed Station Monitoring, 1991 Annual Report. MDNR Report # MI/DNR/SWQ-92/263.

Schrouder, K. 1993. North Branch Kawkawlin River July 8, 1993 Fish Kill Report. Notes and References, July 8, 1993.

Field Work by: Douglas F. Morse, Aquatic Biologist
Sylvia Heaton, Aquatic Biologist
Great Lakes and Environmental Assessment Section

Report by: Douglas F. Morse, Aquatic Biologist
Water Quality Appraisal Unit, North
Great Lakes and Environmental Assessment Section

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Table 1A. Qualitative fish sampling results for North Branch
Kawkawlin River, Bay County, Michigan, July 20, 1993.

TAXA	8 Mi Rd STATION 1	Beaver Rd STATION 2
Umbridae (mudminnows)		
<i>Umbra limi</i> (Central mudminnow)	6	147
Esocidae (pikes)		
<i>Esox lucius</i> (Northern Pike)		1
Ictaluridae (Bullhead, Catfish)		
<i>Ictalurus melas</i> (Black bullhead)	1	
<i>Ictalurus nebulosus</i> (Brown bullh.)	3	
Aphredoderidae (pirate perch)		
<i>Aphredoderus sayanus</i> (Pir. perch)	1	7
Centrarchidae (sunfish)		
<i>Lepomis cyanellus</i> (Green sunfish)	48	5
<i>Lepomis gibbosus</i> (Pumpkinseed)	42	2
Percidae (perch)		
<i>Etheostoma exile</i> (Iowa darter)	2	
TOTAL INDIVIDUALS	103	162
NUMBER OF ANOMALIES	0	0
SQUARE FOOT SAMPLED	3900	3250
DENSITY OF INDIVIDUALS (#/SF)	0.026	0.050

Table 1B. Fish metric evaluation of North Branch Kawkawlin River, Bay
County, Michigan, July 20, 1993.

METRIC	STATION 1		STATION 2	
	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	7	3	5	3
NUMBER OF DARTER SPECIES	1	3	0	1
NUMBER OF SUNFISH SPECIES	2	5	2	5
NUMBER OF SUCKER SPECIES	0	1	0	1
PERCENT CARP, G.SUNFISH, W.SUCKER	46.6	1	3.1	5
PERCENT OMNIVORES	0.0	5	0.0	5
PERCENT INSECTIVO. CYPRINIDS	0.0	1	0.0	1
PERCENT PISCIVORES	0.0	1	0.6	1
DENSITY OF INDIVIDUALS	0.026	5	0.050	5
PERCENT ANOMALIES	0.0	5	0.0	5
TOTAL SCORE		30		32
FISH COMMUNITY CATEGORY		GOOD (SLIGHTLY IMPAIRED)		GOOD (SLIGHTLY IMPAIRED)

Table 2B. Macroinvertebrate metric evaluation of North Branch
Kawkawlin River, Bay County, Michigan, July 20, 1993.

METRIC	SECOND ORDER STN		SECOND ORDER STN	
	STATION 1		STATION 2	
	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	28	6	16	4
NUMBER OF MAYFLY TAXA	4	6	0	0
NUMBER OF CADDISFLY TAXA	3	4	1	0
NUMBER OF STONEFLY TAXA	0	0	0	0
PERCENT MAYFLY COMP.	15.9	0	0.0	0
PERCENT CADDISFLY COMP.	2.6	0	1.9	0
PERCENT CONTR. DOM. TAXON	13.2	6	19.1	6
PERCENT ISOPOD, SNAIL, LEECH	24.5	0	24.8	0
PERCENT SURFACE AIR BREATHERS	15.9	4	21.0	2
TOTAL SCORE		26		12
MACROINVERTEBRATE COMMUNITY CATEGORY	FAIR (MODERATELY IMPAIRED)		FAIR (MODERATELY IMPAIRED)	

Table 4. Water Chemistry Data for the North Branch Kawkawlin River, Bay County, July 20, 1993.

Test	Units	Station 1	Station 2
		N.Br. Kawkawlin R. 8 Mile	N.Br. Kawkawlin R. Beaver
BOD 5 Day Carb	mg/l	2 LC	K 2 LC
BOD 5 Day Total	mg/l	2 LC	3 LC
COD	mg/l	42	51
Nitrite	mg N/l	.022	.013
Nitrate + Nitrite	mg N/l	.63	.076
Ammonia	mg N/l	.081	.23
Kjeldahl Nitrogen	mg N/l	1.26	1.39
Ortho Phosphate	mg P/l	.060	.172
Total Phosphorus	mg P/l	.139	.26
Suspended Solids	mg/l	13	8
Total Dissolved Solids	mg/l	220	290
TOC	mg/l	16	22

gpb: 1/4/95

MI/DNR/SWQ-94/026

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
SURFACE WATER QUALITY DIVISION
DECEMBER, 1994

STAFF REPORT

A BIOLOGICAL SURVEY OF THE NORTH BRANCH KAWKAWLIN RIVER,
BAY COUNTY
JULY 20, 1993

As part of the nonpoint source surveillance activity, staff of the Great Lakes and Environmental Assessment Section (GLEAS) conducted a biological survey of the North Branch Kawkawlin River. The biological survey was performed according to GLEAS Procedure #51 (available upon request). Additional macroinvertebrate and water chemistry data for the North Branch Kawkawlin River have been reported by the EPA Environmental Research Laboratory-Duluth Minnesota (Arthur, et al., 1992) and MDNR (Lundgren, et al., 1992).

The objective of the biological survey was to evaluate the current impact of land use practices on the fish and macroinvertebrate community and physical habitat conditions of the North Branch Kawkawlin River. The survey was also conducted to generate follow-up biological data to fish kills reported May 24, 1989, April 30, 1990 and July 8, 1993.

SUMMARY

1. The locations of the biological sampling stations are shown in Figure 1. Note the extensive wetland in the vicinity of Stations 1 and 2.
2. Fish and macroinvertebrate community, physical habitat and water chemistry data generated at these stations are presented in Tables 1-4, respectively.
3. The fish community was rated "good" (slightly impaired) at both stations. A total of 8 fish taxa, which included 5 game fish taxa, were found during the survey. The North Branch Kawkawlin River is an important walleye spawning area (James Baker, MDNR Fisheries Biologist-personal communication) and also appeared to provide northern pike spawning habitat. However, only five fish taxa were found at Station 2 compared to seven taxa at Station 1 and the mud minnow (Umbra limi) overwhelmingly dominated the fish community at Station 2. The mud minnow is very tolerant to low dissolved oxygen concentrations.

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Great Lakes and Environmental Assessment Section

Report by: Douglas F. Morse, Aquatic Biologist
Water Quality Appraisal Unit, North
Great Lakes and Environmental Assessment Section

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Kawkawlin River, Bay County, Michigan, July 20, 1993.

TAXA	8 Mi Rd STATION 1	Beaver Rd STATION 2
Umbridae (mudminnows)		
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<i>Esox lucius</i> (Northern Pike)		1
Ictaluridae (Bullhead, Catfish)		
<i>Ictalurus melas</i> (Black bullhead)	1	
<i>Ictalurus nebulosus</i> (Brown bullh.)	3	
Aphredoderidae (pirate perch)		
<i>Aphredoderus sayanus</i> (Pir. perch)	1	7
Gentrarchidae (sunfish)		
<i>Lepomis cyanellus</i> (Green sunfish)	48	5
<i>Lepomis gibbosus</i> (Pumpkinseed)	42	2
Percidae (perch)		
<i>Etheostoma exile</i> (Iowa darter)	2	
TOTAL INDIVIDUALS	103	162
NUMBER OF ANOMALIES	0	0
SQUARE FOOT SAMPLED	3900	3250
DENSITY OF INDIVIDUALS (#/SF)	0.026	0.050

Table 1B. Fish metric evaluation of North Branch Kawkawlin River, Bay
County, Michigan, July 20, 1993.

METRIC	STATION 1		STATION 2	
	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	7	3	5	3
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PERCENT CARP, G.SUNFISH, W.SUCKER	46.6	1	3.1	5
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PERCENT PISCIVORES	0.0	1	0.6	1
DENSITY OF INDIVIDUALS	0.026	5	0.050	5
PERCENT ANOMALIES	0.0	5	0.0	5
TOTAL SCORE		30		32
FISH COMMUNITY CATEGORY		GOOD (SLIGHTLY IMPAIRED)		GOOD (SLIGHTLY IMPAIRED)

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Table 2B. Macroinvertebrate metric evaluation of North Branch
Kawkawlin River, Bay County, Michigan, July 20, 1993.

METRIC	SECOND ORDER STN		SECOND ORDER STN	
	STATION 1		STATION 2	
	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	28	6	16	4
NUMBER OF MAYFLY TAXA	4	6	0	0
NUMBER OF CADDISFLY TAXA	3	4	1	0
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PERCENT CONTR. DOM. TAXON	13.2	6	19.1	6
PERCENT ISOPOD, SNAIL, LEECH	24.5	0	24.8	0
PERCENT SURFACE AIR BREATHERS	15.9	4	21.0	2
TOTAL SCORE		26		12
MACROINVERTEBRATE COMMUNITY CATEGORY	FAIR (MODERATELY IMPAIRED)		FAIR (MODERATELY IMPAIRED)	

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Table 4. Water Chemistry Data for the North Branch Kawkawlin River, Bay County, July 20, 1993.

Test	Units	Station 1	Station 2
		N.Br. Kawkawlin R. 8 Mile	N.Br. Kawkawlin R. Beaver
BOD 5 Day Carb	mg/l	2 LC	K 2 LC
BOD 5 Day Total	mg/l	2 LC	3 LC
COD	mg/l	42	51
Nitrite	mg N/l	.022	.013
Nitrate + Nitrite	mg N/l	.63	.076
Ammonia	mg N/l	.081	.23
Kjeldahl Nitrogen	mg N/l	1.26	1.39
Ortho Phosphate	mg P/l	.060	.172
Total Phosphorus	mg P/l	.139	.26
Suspended Solids	mg/l	13	8
Total Dissolved Solids	mg/l	220	290
TOC	mg/l	16	22

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
SURFACE WATER QUALITY DIVISION
APRIL 1996

GLEAS Original

STAFF REPORT

BIOLOGICAL SURVEY OF SELECTED TRIBUTARIES OF THE KAWKAWLIN RIVER,
BAY COUNTY
SEPTEMBER 21, 1995

As part of the point and nonpoint source surveillance activities, staff of the Great Lakes and Environmental Assessment Section (GLEAS) conducted a biological survey of selected tributaries of the Kawkawlin River, Bay County. The biological survey was performed according to GLEAS Procedure #51 (available upon request).

The objective of the biological survey was to evaluate the current impact of the land use practices on the fish and macroinvertebrate community and physical habitat conditions of the S. Branch Kawkawlin and N. Branch Kawkawlin Rivers and Culver Creek. This survey is subsequent to planning and implementation projects in the S. Branch Kawkawlin River watershed funded by Section 319 grants and the Federal PL-566 Watershed Protection Program. Biological surveys have previously been conducted in the N. Branch Kawkawlin River (Morse, 1994), S. Branch Kawkawlin River and Culver Creek (Masterson, 1987) and the S. Branch Kawkawlin River (Benzie, 1990).

SUMMARY

1. The locations of the biological sampling stations are shown in Figure 1.
2. Fish and macroinvertebrate community, physical habitat evaluation and water chemical data are presented in Tables 1-4, respectively.
3. The fish community was rated "good" (slightly impaired) at both S. Branch Kawkawlin River stations. A total of 20 fish taxa, which included 9 game fish taxa, were found. The walleye were six inches long and the northern pike was 10 inches long, suggesting successful use of the S. Branch Kawkawlin River by walleye and pike for reproduction. The fish community was similar to that found in 1989 by Benzie (1990), however, 7 more taxa were found in 1995, including walleye and two species of darters.

The fish community at the N. Branch Kawakawin River station was very sparse and only 26 individuals were collected. This was despite a sampling area (14700 square feet) that was approximately twice the size of the other stations. This suggests that the sporadically oxygen deficient conditions reported by Morse (1994) continue to impair the fish community of the lower N. Branch Kawakawin River.

The macroinvertebrate community was rated "fair" (moderately impaired), at all stations surveyed except Station 2 (Culver Creek), where the macroinvertebrate community was rated "poor" (severely impaired). The macroinvertebrate communities found at the S. Branch Kawakawin River stations in 1995 were very similar to those found in 1989 by Benzie (1990). The macroinvertebrate community found at the N. Branch Kawakawin River station in 1995 were very similar to that found at a station a short distance upstream in 1993 by Morse (1994).

The impaired macroinvertebrate communities were related to moderately to severely impaired physical habitat conditions at the stations surveyed.

Habitat was rated "poor" (severely impaired) at all stations except at N. Branch Kawakawin River, where habitat was rated "fair". Excessive embeddedness and sparse available habitat were present at all stations. Excessive bottom deposition was also evident at the Culver Creek and the S. Branch Kawakawin River stations.

Improper land use practices, such as livestock free access sites and lack of buffer strips between the cultivated fields and tributary streams, are contributing to the impaired habitat conditions.

6. Total phosphorus concentrations found in water samples collected from both the S. Branch Kawakawin and N. Branch Kawakawin Rivers suggests that nutrient inputs into this system are excessive (Table 4). Benzie (1990) also found elevated total phosphorus concentrations in the S. Branch Kawakawin River at Mackinaw Road. Excessive growths of the alga, *Cladophora* sp., were present in the S. Branch Kawakawin River at Mackinaw and in Culver Creek. Nuisance levels of submerged and floating attached aquatic plants were present downstream from the confluence of the N. Branch Kawakawin and S. Branch Kawakawin Rivers.

The total dissolved solids (TDS) concentration (580 mg/l) found in the water sample collected at the S. Branch Kawakawin River, Mackinaw Road location suggests that discharges to Culver Creek may continue to impair the S. Branch Kawakawin River as found in 1987 by Masterson (1987) and in 1989 by Benzie (1990). More sampling would be needed to determine if Michigan Water Quality Standards are exceeded for TDS at this location.

REFERENCES

- Benzie, S. 1990. Biological Survey of Kawkawlin River, South Branch, Bay County, Michigan, July 13, 1989, Report MI/DNR/SWQ-90/081.
- Masterson, M. 1987. A Biological Assessment of Culver Creek and the Kawkawlin River in the Vicinity of Wolverine Mine #2 Dewatering Shaft, Bay County, Michigan, August 13, 1987, Report MI/DNR/SWQ-87-060.
- Morse, D. F. 1994. A Biological Survey of the North Branch Kawkawlin River, Bay County, July 20, 1993, Report MI/DNR/SWQ-94/026.

Field Work by: Douglas F. Morse, Aquatic Biologist
Jack Wuycheck, Aquatic Biologist
Great Lakes and Environmental Assessment Section

Report by: Douglas F. Morse, Aquatic Biologist
Water Quality Appraisal Unit - North
Great Lakes and Environmental Assessment Section

Figure 1. Biological Survey Stations in the S. Branch Kawkawlin and N. Branch Kawkawlin Rivers, Sept. 20-21, 1995.



Table 1A. Qualitative fish samples for the S. Br. Kawkawlin and N. Br. Kawkawlin Rivers, Bay County, September 20, 1995.

TAXA	STATION 1 S. Br. Kawkawlin R. Beaver Rd.	STATION 3 S. Br. Kawkawlin R. Mackinaw Rd.	STATION 4 N. Br. Kawkawlin R. Chip Dr.
Amiidae (bowfins)			
<i>Amia calva</i> (Bowfin)			2
Clupeidae (herrings)			
<i>Dorosoma cepedianum</i> (Gizz. shad)	47	20	
Umbridae (mudminnows)			
<i>Umbrina limi</i> (Central mudminnow)	1	15	
Esocidae (pikes)			
<i>Esox lucius</i> (Northern Pike)	1		
Cyprinidae (minnows and carps)			
<i>Cyprinus carpio</i> (Carp)	10		
<i>Notemigonus crysoleucas</i> (Golden)		3	
<i>Luxilus cornutus</i> (Common shiner)	3		
<i>Pimephales notatus</i> (Bluntnose m.)	10	91	
Carlotomidae (suckers)			
<i>Carlotomus commersoni</i> (W. sucker)	4		
Ictaluridae (Bullhead, Catfish)			
<i>Ameiurus natalis</i> (Yellow bullh.)	2	1	
<i>Noturus gyrinus</i> (Tadpole madtom)			1
Aphredoderidae (pirate perch)			
<i>Aphredoderus sayanus</i> (Pir. perch)	4	3	1
Centrarchidae (sunfish)			
<i>Ambloplites rupestris</i> (Rock bass)			1
<i>Lepomis cyanellus</i> (Green sunfish)	8	2	
<i>Lepomis gibbosus</i> (Pumpkinseed)	37	19	5
<i>Lepomis macrochirus</i> (Bluegill)	2	3	
<i>Pomoxis nigromaculatus</i> (Bick cr.)		1	
<i>Micropterus salmoides</i> (Lm. bass)	5	10	
Percidae (perch)			
<i>Etheostoma nigrum</i> (Johnny darter)	1	5	5
<i>Percina maculata</i> (Blackside d.)	4	1	3
<i>Percina caprodes</i> (Logperch)	1		1
<i>Perca flavescens</i> (Yellow perch)	1	11	7
<i>Stizostedion vitreum v.</i> (Walleye)	1	1	
TOTAL INDIVIDUALS	142	186	26
NUMBER OF ANOMALIES	0	0	0
SQUARE FOOT SAMPLED	7200	9675	14700
DENSITY OF INDIVIDUALS (#/SF)	0.020	0.019	0.002

Table 1B. Qualitative fish samples for the S. Br. Kawkawlin and N. Br. Kawkawlin Rivers, Bay County, September 20, 1995.

METRIC	FIRST ORDER STN STATION 1		SECOND ORDER STN STATION 2		SECOND ORDER STN STATION 4
	Value	Score	Value	Score	Value
TOTAL NUMBER OF TAXA	18	5	15	5	9
NUMBER OF DARTER SPECIES	2	3	2	5	2
NUMBER OF SUNFISH SPECIES	3	5	4	5	2
NUMBER OF SUCKER SPECIES	1	3	0	1	0
PERCENT CARP, G.SUNFISH, W.SUCKER	15.492958	3	1.0752688	5	0
PERCENT OMNIVORES	50	1	61.290323	1	0
PERCENT INSECTIVO. CYPRINIDS	2.1126761	1	0	1	0
PERCENT PISCIVORES	5.6338028	5	11.827957	5	38.461538
DENSITY OF INDIVIDUALS	0.0197222	3	0.0192248	3	0.0017687
PERCENT ANOMALIES	0	5	0	5	0
TOTAL SCORE		34		36	
FISH COMMUNITY CATEGORY		GOOD (SLIGHTLY IMPAIRED)		GOOD (SLIGHTLY IMPAIRED)	Not Rated

Table 2A. Qualitative macroinvertebrate sampling for selected Kawkawlin River Tributaries, Bay County, September 20, 1995.

TAXA	STATION 1 S. Br. Kawkawlin R. Beaver Rd.	STATION 2 Culver Ck. Wolverine Rd.	STATION 3 S. Br. Kawkawlin R. Mackinaw Rd.	STATION 4 N. Br. Kawkawlin R. Chip Dr.
PORIFERA (sponges)	1	1		1
PLATYHELMINTHES (flatworms)				
Turbellaria				
BRYOZOA (moss animals)	5	5		3
ANNELIDA (segmented worms)	2			1
Hirudinea (leeches)		1		
Oligochaeta (worms)	1	1		
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	5	5	3	
Decapoda (crayfish)				
Isopoda (sowbugs)	5	10	5	
Insecta				
Ephemeroptera (mayflies)				
Caenidae				
Ephemeridae	1		1	
Heptageniidae	2			
Odonata				
Anisoptera (dragonflies)		2		
Aeshnidae				
Libellulidae			2	
Zygoptera (damselflies)	6		1	
Coenagrionidae				
Hemiptera (true bugs)			15	25
Belostomatidae	1	1		
Corixidae	20	25	10	3
Gerridae	2	5	10	7
Nepidae	1		10	2
Notonectidae	1	1		1
Megaloptera		1		2
Stalidae (sailer flies)	2		2	
Trichoptera (caddisflies)				4
Hydropsychidae				
Hydrophilidae				5
Leptoceridae			5	
Phryganeidae	1			4
Coloptera (beetles)				
Gyrinidae (adults)	10			
Halipidae (adults)	15	15		
Hydrophilidae (larvae)				
Dryopidae				
Elmidae			1	1
Gyrinidae (larvae)				2
Halipidae (larvae)			10	4
Diptera (flies)			5	12
Chironomidae	12	3	5	4
Culicidae				1
Tabanidae	1	1		

MOLLUSCA

Gastropoda (snails)									
Campeloma									10
Ferrissia (limpet)									2
Helisoma			2						
Lymnaea									3
Physa			7			4			
Stagnicola			5						
Pelecypoda (bivalves)									
Sphaeriidae (clams)									
Sphaerium	5		3						
TOTAL INDIVIDUALS	98		108			79			98

Table 2B. Macroinvertebrate metric evaluation of selected Kawkawin River Tributaries, Bay County, September 20, 1995.

METRIC	FIRST ORDER STN STATION 1		FIRST ORDER STN STATION 2		SECOND ORDER STN STATION 3		SECOND ORDER STN STATION 4	
	Value	Score	Value	Score	Value	Score	Value	Score
	TOTAL NUMBER OF TAXA	20	4	19	4	13	2	20
NUMBER OF MAYFLY TAXA	2	4	0	0	1	2	0	0
NUMBER OF CADDISFLY TAXA	1	0	0	0	1	0	2	2
NUMBER OF STONEFLY TAXA	0	0	0	0	0	0	0	0
PERCENT MAYFLY COMP.	3.06122449	0	0	0	1.265822785	0	0	0
PERCENT CADDISFLY COMP.	1.020408163	0	0	0	6.329113924	0	9.183673469	0
PERCENT CONTR. DOM. TAXON	20.40816327	4	23.14814815	4	18.98734177	6	25.51020408	4
PERCENT ISOPOD, SNAIL, LEECH	5.102040816	0	23.14814815	0	5.063291139	0	15.30612245	0
PERCENT SURFACE AIR BREATHERS	51.02040816	0	57.40740741	0	25.3164557	2	16.32653061	4
TOTAL SCORE		12		8		12		14
MACROINVERTEBRATE COMMUNITY CATEGORY		FAIR (MODERATELY IMPAIRED)		POOR (SEVERELY IMPAIRED)		FAIR (MODERATELY IMPAIRED)		FAIR (MODERATELY IMPAIRED)

Table 3. Habitat evaluation for Selected Kawkawlin River Tributaries, Bay County, September 20, 1995.

HABITAT METRIC	Bottom Substrate	Avail. Cover (20):	Embeddedness (20):	Velocity: Depth (20):	Flow Stability (15):	Bottom Depos. (15):	Pools-Riffles-	Runs-Bends (15):	Bank Stability (10):	Bank Vegetative	Stability (10):	Stream Cover (10):	TOTAL SCORE (135)	HABITAT CONDITION	CATEGORY
STATION 1 S. Br. Kawkawlin R. Beaver Rd.	5	5	7	4	1	1	3	5	8	9	6	40	POOR (SEVERELY IMPAIRED)	Sept. 20, 1995 Warmwater Cloudy first HELP	Date: Stream Type: Weather: Stream Order: Ecoregion: Air Temperature: Water Temperature: Ave. Stream Width: Ave. Stream Depth: Surface Velocity: Estimated Flow: 71 Deg. F. 58 Deg. F. 36 Feet 1.5 Feet 0.1 Ft./Sec. 5.4 CFS
STATION 2 Culver Ck. Wolverine Rd.	6	3	8	10	3	10	3	5	8	9	8	60	POOR (SEVERELY IMPAIRED)	Sept. 20, 1995 Warmwater first HELP	Date: Stream Type: Weather: Stream Order: Ecoregion: Air Temperature: Water Temperature: Ave. Stream Width: Ave. Stream Depth: Surface Velocity: Estimated Flow: Deg. F. 56 Deg. F. 5 Feet 0.2 Feet 0.1 Ft./Sec. 0.1 CFS
STATION 3 S. Br. Kawkawlin R. Mackinaw Rd.	4	3	11	7	2	7	2	5	9	9	9	59	POOR (SEVERELY IMPAIRED)	Sept. 21, 1995 Warmwater second HELP	Date: Stream Type: Weather: Stream Order: Ecoregion: Air Temperature: Water Temperature: Ave. Stream Width: Ave. Stream Depth: Surface Velocity: Estimated Flow: 52 Deg. F. 54 Deg. F. 42 Feet 10 Feet 0.25 Ft./Sec. 105 CFS
STATION 4 N. Br. Kawkawlin R. Chip Dr.	10	11	6	6	9	6	9	5	8	9	6	70	FAIR (MODERATELY IMPAIRED)	Sept. 21, 1995 Warmwater second HELP	Date: Stream Type: Weather: Stream Order: Ecoregion: Air Temperature: Water Temperature: Ave. Stream Width: Ave. Stream Depth: Surface Velocity: Estimated Flow: 52 Deg. F. 54 Deg. F. 52 Feet 1 Feet 0.1 Ft./Sec. 5.2 CFS

Table 4. Water Chemistry Data for S. Br. Kawkawlin River (Mackinaw Road)		
and N. Br. Kawkawlin River, Bay County, September 20, 1995.		
S. Br. Kawkawlin R. N. Br. Kawkawlin R.		
Mackinaw Road		Chip Drive
Parameter	Station 3	Station 4
Calcium (ug/l)	84	61
Chemical Oxygen Demand (mg/l)	31	42
Hardness (mg/l)	320	235
Magnesium (mg/l)	27	20
Nitrite (mg/l)	0.007	0.005
Nitrate + Nitrite (mg/l)	0.074	0.113
Ammonia (mg/l)	0.04	0.025
Kjeldahl Nitrogen (mg/l)	1.52	1.09
Ortho Phosphate (mg/l)	0.028	0.111
Total Phosphate (mg/l)	0.143	0.161
Suspended Solids (mg/l)	20	6
Total Dissolved Solids (mg/l)	580	400
Total Organic Carbon (mg/l)	10	18
Turbidity (NTU)	12	2

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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER BUREAU
FEBRUARY 2006

STAFF REPORT

A BIOLOGICAL AND CHEMICAL SURVEY OF THE KAWKAWLIN RIVER
BAY COUNTY, MICHIGAN
SEPTEMBER 2000

INTRODUCTION

Qualitative biological sampling of a selected station on the North Branch of the Kawkawlin River and one station on Culver Creek was conducted by staff of the Surface Water Assessment Section during September 2000. The biological surveys were conducted according to the former Great Lakes and Environmental Assessment Section (GLEAS) Procedure #51 (MDEQ, 1990). Water samples were collected and preserved following appropriate procedures (MDNR, 1994) and transported to the Michigan Department of Environmental Quality (MDEQ) Environmental Laboratory for chemical analyses. The survey objectives were to document current conditions and assess stream quality through biological, physical, and chemical evaluations.

The Kawkawlin River drains approximately 224 square miles of predominately agricultural land (MI/DEQ/SWQ-99/033). The North Branch of the Kawkawlin River near Kawkawlin has a 7 day 10 year low flow of 0 cubic feet per second. Furthermore, depending on the wind conditions of Saginaw Bay, the flow of the Kawkawlin River may be reversed and water from Saginaw Bay will flow up the Kawkawlin River (MI/DEQ/SWQ-99/033). The entire Kawkawlin River Watershed is located within the Huron Erie Lake Plain (HELP) ecoregion (Omernik and Gallant, 1988). Biological surveys were conducted, and water chemistry samples were collected at two stations during this survey. Visual surveys of tributaries to the Kawkawlin River were conducted at 51 additional locations. However, these locations were dry, stagnant or nonwadeable and because of these conditions biological surveys were not conducted at these locations.

SUMMARY

Locations of macroinvertebrate community sampling, physical habitat evaluations, and chemical sampling are indicated in Figure 1. The macroinvertebrate community and physical habitat data are presented in Tables 1 and 2, respectively. Water chemistry data is presented in Table 3.

Rating of the macroinvertebrate communities was conducted using a scoring system with a scale from +9 to -9. Stations with a score greater than or equal to +5 are considered excellent. Stations with a score less than or equal to -5 are classified as poor (severely impaired). Stations with a score of -4 through +4 are classified as acceptable (moderately impaired).

Macroinvertebrate communities were evaluated at two stations during this survey. The macroinvertebrate community of the North Branch of the Kawkawlin River at Beaver

Culver Creek (Station 1) was rated as acceptable and the macroinvertebrate community of Culver Creek at North Union Road (Station 2) was rated as poor. Stream habitat was evaluated at two stations using a scoring system, which ranged in values from 0 (poor) to 135 (excellent). The habitat of the North Branch of the Kawawin River at Beaver Road (Station 1) was rated as fair (moderately impaired). The habitat of Culver Creek at North Union Road (Station 2) was also rated as fair (moderately impaired).

The fish communities of these water bodies were not evaluated during this survey. Historically, fish kills on the North Branch of the Kawawin River at Beaver Road (Station 1), downstream of a large wetland complex, have been reported and were likely caused by low dissolved oxygen concentrations (Morse, 1994). The wetland complex provides important walleye and northern pike spawning habitat during the spring of the year. However, during the summer months, the fish community tends to be dominated by mud minnows, a species that is very tolerant to low dissolved oxygen concentrations. The survey in 2000 documented a macroinvertebrate community that would be considered acceptable at Station 1, and was dominated by amphipods, damselflies and midge larvae. However, there were four taxa of mayflies and two taxa of caddisflies, organisms that would be indicative of good water quality.

Overall, the habitat of the North Branch of the Kawawin River was considered fair, moderately impaired. The stream lacked stable habitat and was very homogeneous in nature, lacking the diversity of pools, riffles, runs and bends. The deposition of sediment has covered existing stable habitat and does not provide the niche spaces necessary for a well balanced, diverse macroinvertebrate community.

Culver Creek

Masterson (1987) reported the discharge of a mine dewatering shaft to Culver Creek that was significantly impacting the water quality, biota, and habitat of Culver Creek. The macroinvertebrate community of Culver Creek was evaluated again in 1995 and continued to support a biological community that was considered poor (severely impaired) (Morse, 1996). During this survey, 21 taxa of tolerant macroinvertebrates were documented and received an overall rating of poor. The absence of taxa that are indicators of good water quality such as stoneflies, mayflies, and caddisflies reflect the modified stream characteristics resulting from a combination of factors such as agriculturally dominated land uses, a lack of riparian zone along the stream corridor, and a lack of stable habitat within the stream.

The physical habitat was considered fair, moderately impaired and lacked the diversity of stable habitats that would support a healthy macroinvertebrate community. The highly variable stream flows are leading to unstable, eroding banks along the river that is contributing additional sediment to the stream further limiting the availability of niche space.

Nonpoint Source (NPS) Summary

Several general NPS concerns were identified during this survey including; a lack of riparian buffer zones along many of the water bodies, and a substantial amount of run-off originating from farm fields and field tiles contributing sediment and nutrients to the streams. Furthermore, the predominance of agriculture within the watershed, field tiles, and highly modified water bodies in this area of the state contribute to the highly variable flow regimes observed during the survey. The elevated flows during wet events in conjunction with the very low, to zero flows, during the summer periods limit the biological integrity of the streams.

Water Chemistry Results

Water samples were collected at three locations, and the results of the sampling are presented in Table 3. All three stations examined during this survey had nutrient levels, including ammonia and total phosphorus present at levels exceeding the average values and the range of values documented at reference sites within the HELP ecoregion (Lundgren, 1994). The reference sites for the HELP ecoregion are located on the Au Gres River and are sites that are considered to be minimally impacted by anthropogenic sources. The average value of total phosphorus in this ecoregion was 0.014 milligrams per liter (mg/L) and the range of values was 0.009-0.019 mg/L. The average value of ammonia nitrogen in this ecoregion was 0.016 mg/L and the range of values was 0.010-0.020 mg/L. The elevated levels of nutrients within the North and South Branches of the Kawkawlin River and Culver Creek may in part be due to the predominance of agricultural land within the watershed, the highly modified nature of tributaries to the Kawkawlin River along with the narrow riparian zones associated with the water bodies. No exceedance of Michigan's Water Quality Standards was documented during this survey.

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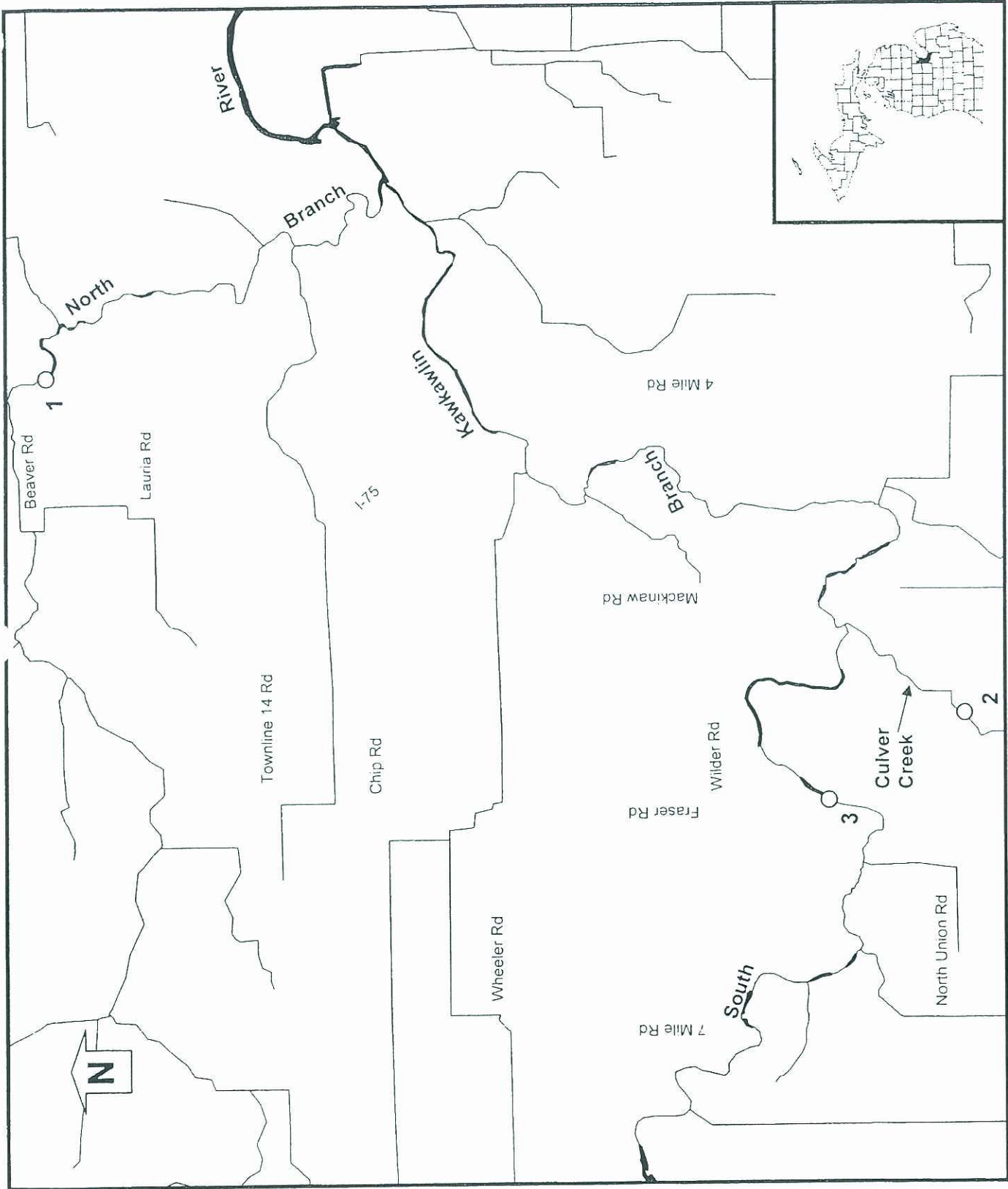


Figure 1: Sampling locations on the North and South Branch Kawkawlin River and selected tributary, Bay County.

Table 1A. Qualitative macroinvertebrate sampling results for the Kawakawin River, Bay County, September 19, 2000.

TAXA	STATION 1 N Br Kawakawin River at Beaver Rd 9/19/2000	STATION 2 Cuber Creek at North Union Rd 9/19/2000
PORIFERA (sponges)	1	1
PLATYHELMINTHES (flatworms)	3	1
Turbellaria		
ANNELIDA (segmented worms)		
Hirudinea (leeches)	1	2
ARTHROPODA		
Crustacea		
Amphipoda (scuds)	15	25
Decapoda (crayfish)		1
Isopoda (sowbugs)	5	25
Insecta		
Ephemeroptera (mayflies)	2	
Baetidae		
Ceriodontidae	4	
Hemiptera (true bugs)	10	4
Coleoptera (beetles)		
Hydrophilidae (total)	9	2
Hydrophilidae (adults)	3	3
Dytiscidae (total)	1	
Dytiscidae (total)	3	3
Hydrophilidae (total)	4	5
Elmidae	1	
Diptera (flies)	14	10
Chironomidae		
Culicidae	1	
Tabanidae		
MOLUSCS		
Gastropoda (snails)		2
Ancylidae (limpets)	1	1
Hydrobiidae	3	
Physidae	2	2
Pleuroceridae	1	3
Pelecypoda (bivalves)		
Sphaeriidae (clams)	1	2
TOTAL INDIVIDUALS	95	99

Table 1B. Macroinvertebrate metric evaluation of the Kawkawlin River, Bay County.

METRIC	STATION 1 N Br Kawkawlin River at Beaver Rd 9-19-2000		STATION 2 Culver Creek at North Union Rd 9-19-2000	
	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	28	0	21	0
NUMBER OF MAYFLY TAXA	4	1	0	-1
NUMBER OF CADDISFLY TAXA	2	0	0	-1
NUMBER OF STONEFLY TAXA	0	-1	0	-1
PERCENT MAYFLY COMP.	8.42	-1	0.00	1
PERCENT CADDISFLY COMP	4.21	0	0.00	-1
PERCENT DOMINANT TAXON	15.79	1	25.25	-1
PERCENT ISOPOD, SNAIL, LEECH	13.68	-1	35.35	-1
PERCENT SURF AIR BREATHERS	25.26	-1	16.16	0
TOTAL SCORE		-2		-7
MACROINV. COMMUNITY RATING		ACCEPT		POOR

Table 2. Habitat evaluation for the Kawakawine River, Bay County, September, 19, 2000.

HABITAT METRIC (MAX)		STATION 1 N B Kawakawine River Beaver Rd	STATION 2 Culver Creek North Union Rd
Bottom Substrate	6	8	2
Avail. Cover (20):	6	8	2
Embeddness (20):	8	8	8
Velocity:Depth (20):	6	6	6
Flow Stability (15):	9	9	4
Bottom Depos. (15):	8	8	5
Pools-Riffles-			
Runs-Bends (15):	3	3	2
Bank Stability (10):	8	8	2
Bank Vegetative			
Stability (10):	9	9	6
Stream Cover (10):	7	7	2
TOTAL SCORE (135):	64	64	37
HABITAT RATING:	FAIR	FAIR	FAIR
	(MODERATELY IMPAIRED)	(MODERATELY IMPAIRED)	(MODERATELY IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Date:	Weather:	Air Temperature:	Water Temperature:	Ave. Stream Width:	Ave. Stream Depth:	Surface Velocity:	Estimated Flow:	Stream Modifications:	Nuisance Plants (Y/N):	Report Number:	STORET No.	Stream Name:	Road Crossing/Location:	County Code:	TRRS:	Latitude (dd):	Longitude (ddd):	Elevation:	Stream Type:	1 SGS Basin Code:	COMMENTS:
9/19/2000	Sunny	78 Deg. F	60 Deg. F	39 Feet	1.5 Feet	0.212 Ft./Sec.	12.402 CFS	None	N	90262	N B Kawakawine River	Beaver Rd	09	15N04E35	43 66J61	-83 96472	43.60962	HELP	Warmwater	4080102	
9/19/2000	Sunny	70 Deg. F	58 Deg. F	13 Feet	0.5 Feet	0.227 Ft./Sec.	1.4755 CFS	None	N	90270	Culver Creek	North Union Rd	09	14N04E16	43 60962	-84 00386	43.60962	HELP	Warmwater	4080102	

Table 3. Results of water chemistry analyses of grab samples collected from the Kawkawlin River and Culver Creek in Bay County, September 19, 2000.

Parameter	Units	Station 1	Station 2	Station 3
		N. Br. Kawkawlin River at Beaver Road	Culver Cr at N. Union Rd	S. Br. Kawkawlin River at Frasier Road
Ammonia	mg N/L	0.047 HT	0.046 HT	0.052 HT
Antimony	µg/L	K 1.0	K 1.0	K 1.0
Arsenic	µg/L	1.2	1.3	1.6
Barium	µg/L	30	48	60
Boron	µg/L	35	87	73
Cadmium	µg/L	K 0.2	K 0.2	K 0.2
Calcium	mg/L	62.9	134	81.8
Chromium	µg/L	K 1.0	K 1.0	1.8
COD	mg/L	51	22	26
Conductivity	umho/cm	493	991	898
Copper	µg/L	K 1.0	2.5	19
Hardness	mg/L	225	480	300
Iron	µg/L	72	130	220
Lead	µg/L	K 1.0	K 1.0	9.4
Lithium	µg/L	K 10	K 10	K 10
Magnesium	mg/L	16.7	35	22.8
Manganese	µg/L	186	6.7	63
Mercury	µg/L	K 0.2	K 0.2	K 0.2
Molybdenum	µg/L	K 25	K 25	K 25
Nickel	µg/L	5.3	7.9	19
Nitrate + Nitrite	mg/L	0.023 HT	6.6 HT	2.2 HT
Nitrogen-Kjeldahl	mg/L	1.22 HT	0.90 HT	1.08 HT
Ortho Phosphate	mg/L	0.061	0.054	0.033
Phosphorus-Total	mg/L	0.105 HT	0.078 HT	0.123 HT
Potassium	mg/L	3.82	4.18	26
Selenium	µg/L	K 1.0	1.3	K 1.0
Silver	µg/L	K 0.5	K 0.5	K 0.5
Sodium	mg/L	12.3	27.3	62.8
Suspended Solids	mg/L	8	K 4	50
Dissolved Solids	mg/L	370	710	580
Thallium	µg/L	K 2.0	K 2.0	K 2.0
TOC	mg/L	21	7.1	8.6
Vanadium	µg/L	K 10	K 10	K 10

K = Not detected at noted concentration
HT = Sample holding time was exceeded

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER BUREAU
APRIL 2007

STAFF REPORT

A BIOLOGICAL AND CHEMICAL SURVEY OF SELECTED TRIBUTARIES TO
SAGINAW BAY: ARENAC, BAY, AND TUSCOLA COUNTIES
MICHIGAN, AUGUST 2005

INTRODUCTION

Qualitative biological sampling of selected tributaries to Saginaw Bay was conducted by staff of the Surface Water Assessment Section during August 2005. The survey objectives were to document current conditions and assess stream quality through biological, physical, and chemical evaluations. The biological surveys were conducted according to the former Great Lakes and Environmental Assessment Section (GLEAS) Procedure #51 (MDEQ, 2002). Water samples were collected and preserved following appropriate procedures (MDNR, 1994) and transported to the Michigan Department of Environmental Quality (MDEQ) Environmental Laboratory for chemical analyses.

Many of the tributaries to Saginaw Bay that were evaluated during this survey have had historical and on-going impacts to water quality due to the intensive agricultural use of the land within the watershed. Improper land use practices and channelization of the tributaries in this intensively farmed region were primarily responsible for the impaired physical habitat conditions that were observed during a biological survey in 1990 (Morse, 1992).

All streams surveyed during this survey were located within the Huron Erie Lake Plain (HELP) ecoregion (Omernik and Gallant, 1988) and all streams are managed for a warm water fishery. The following tributaries to Saginaw Bay were examined during this survey: Pine River, Saganing River, Selleck Drain, Pinconning River, Johnson Drain, Railroad Drain, Kawkawlin River, North West Drain, and the Wiscoggin Drain. Biological surveys were conducted and water chemistry samples were collected at 12 stations. An additional 4 water samples were collected at other locations during this survey (Appendix A). Visual assessments of the Quanicassee River, Tebo Drain, Gregory Drain and White Feather Creek were also conducted but due to a dry stream channel and/or stagnant conditions biological surveys were not conducted at these locations.

SUMMARY

Locations of macroinvertebrate community sampling, physical habitat evaluations, and chemical sampling are indicated in Figure 1. The macroinvertebrate community and physical habitat data are presented in Tables 1 and 2, respectively. Water chemistry data is presented in Table 3.

Rating of the macroinvertebrate communities was conducted using a scoring system with a scale from +9 to -9. Stations with a score greater than or equal to +5 are considered excellent. Stations with a score less than or equal to -5 are classified as poor (severely impaired). Stations with a score of -4 through +4 are classified as acceptable (moderately impaired).

Macroinvertebrate communities were evaluated at 12 stations throughout the Saginaw Bay Watershed during this survey. The macroinvertebrate community was rated as excellent at 1 station, acceptable at 6 survey locations, and the 5 remaining stations received a rating of poor.

The physical habitat of the North Branch of the Pine River at this location was considered marginal, the stream appeared to have highly variable flows and the flashiness of the stream has led to severe bank erosion in excess of 5 feet. The bank erosion is contributing a portion of the large bed load of sand to the stream which is smothering other available habitat, including riffles that could be utilized by the macroinvertebrate community. Furthermore, the stream channel lacked large and small woody debris because high stream flows had deposited all woody structure in the floodplain outside of the stream channel.

The macroinvertebrate community of the North Branch of the Pine River at Focco Road (Station 1) was considered acceptable and contained representative mayflies, stoneflies, and caddisflies, which would be indicative of good water quality. However, the macroinvertebrate community was dominated by amphipods, isopods, and midge larvae, which are tolerant organisms. The lack of desirable habitats and niche spaces is potentially limiting the biological community.

The stream and to aid in the development of future water quality based effluent limits. Wastewater Treatment Plant (WWTP) during this survey to determine the current condition of North Branch of the Pine River were assessed upstream and downstream from the Standish these locations. The macroinvertebrate community, physical habitat, and water chemistry of the were either dry or stagnant and not flowing, therefore, biological surveys were not conducted at of the road/stream crossings where the Middle and South Branches of the Pine were observed North Branch also had flow during base flow conditions when this survey was conducted. Many riparian zones were typically larger than observed on the other branches of the Pine River. The poor (Morse, 1992). The North Branch of the Pine contained more forested areas and the macroinvertebrate community that was considered fair and physical habitat that was considered the Pine River in 1990 documented a fish community that was considered good, a Saginaw Bay within the Wigwam Bay Wildlife Area. Previous biological surveys conducted on South Branches of the Pine River converge downstream from Standish and then flow into portion of Bay County and the southern portion of Arenac County. The North, Middle, and The Pine River, a warmwater stream, arises in a predominately agricultural area in the northern

Pine River

Tributaries to Saginaw Bay

Many of the water bodies examined during this survey have been highly modified to facilitate the rapid drainage of water from surrounding land. The predominance of agricultural land use activities in this portion of the state coupled with a lack of riparian buffer zones along the streams tends to contribute nutrients and sediment to the streams. Recent drain maintenance activities including dredging of the channel and herbicide applications to woody vegetation growing along the ditch banks were also observed. Several streams were observed with moderate to severe bank erosion that was contributing sediment to the stream.

Several general NPS problems were identified during this survey. The extent of these problems will be briefly summarized in this section with more detail following in the discussion of specific water bodies.

NONPOINT SOURCE (NPS) PROBLEM SUMMARY

The fish communities of these water bodies were not evaluated during this survey. Stream habitat was also evaluated at 12 stations using a scoring system, which ranged in values from 0 (poor) to 200 (excellent). The habitat at 5 stations was rated as good (slightly impaired) and 7 stations were rated as marginal.

The North Branch of the Pine River was also evaluated at Arenac State Road (Station 2), downstream from the Standish WWTP. The Middle Branch of the Pine River converges with the North Branch just upstream from the road crossing. At the time of the survey, the Middle Branch was not flowing and could be characterized as standing pools of water containing prolific amounts of cladophora. The macroinvertebrate community of the North Branch was rated as excellent and contained a diverse and well-balanced assemblage of aquatic insects, representing 27 taxa. Mayflies and caddisflies were identified at this location and are indicative of good water quality. The physical habitat was considered marginal (moderately impaired) and is, in part, a reflection of the total lack of a riparian zone and no vegetative protection due to a golf course along both stream banks. During this survey the discharge from the Standish WWTP did not appear to be impacting the biological community of the North Branch of the Pine River. Visual observations were conducted from Station 2 downstream to Saginaw Bay. The flows appeared to be very minimal and influenced by the wind on Saginaw Bay. Aquatic vegetation and a limited amount of algae was present along the stream edges; however, the growths were not prolific in nature.

Saganing River

The Saganing River was surveyed at Worth Road (Station 3) to determine the current condition of the stream. The stream flows within this water body were minimal with an estimated flow of 1 cubic foot per second or less. Several visual observations were made upstream of the survey location to further evaluate the heavy agricultural areas of the watershed. Historically, many of the tributaries appeared to have been channelized to facilitate better drainage of the surrounding landscape. Many of the areas upstream of Interstate 75 were either dry or stagnant. The macroinvertebrate community was rated acceptable, and contained 2 different taxa of caddisflies and 4 taxa of mayflies. The physical habitat of this stream was rated as good (slightly impaired) and there was a fair amount of gravel and cobble upstream of the Worth Road Bridge. The riparian zone consisted of mowed yards along both stream banks, offering minimal protection from the surrounding land uses. Based upon this data, when the Saganing River has flowing water, it is capable of supporting a macroinvertebrate community that would be considered acceptable.

Selleck Drain

The macroinvertebrate community and physical habitat of Selleck Drain was evaluated at Arenac State Road (Station 4) because there was no existing biological or habitat information regarding this ditch. The entire stretch of this stream has been channelized to drain water from the surrounding land and there was a minimal amount of flow present in the stream at the time of the survey. The macroinvertebrate community was rated as poor and was composed of 14 taxa of aquatic organisms. No mayflies, caddisflies, or stoneflies were identified at this location. The majority of the organisms identified would be classified as tolerant and/or surface dependant organisms. The physical habitat was rated as marginal and did not provide the necessary stable habitat to support a healthy, diverse assemblage of aquatic organisms. At the survey location, the stream had been channelized and there were 10-12 foot high banks along the ditch from historic dredging operations. Upstream from the survey location, the woody vegetation along the ditch bank had been treated with herbicide to aid in the maintenance of the ditch. Considering the limit amount of available habitat within this water body and the highly modified nature of the system, it is unlikely that the biological community will improve.

Pinconning River

The Pinconning River arises from a series of smaller drains in the intensively farmed area along the western edge of Saginaw Bay. The entire Pinconning River, with the exception of the bottom 2.2 miles of the river, is considered intermittent in nature, and does not contain flow

The Railroad Drain is composed of a series of smaller agricultural drains west of Linwood. The Railroad Drain has been included on the 2006 305(B) report as requiring further evaluation due to a macroinvertebrate community that is considered poor, nuisance vegetation, and heavy silt deposits within the stream. The mouth of Railroad Drain enters Saginaw Bay at Hoyle's Marina, which is a major recreational marina on Saginaw Bay. The North and South Branches of the Railroad Drain were evaluated to determine the current condition. The North Branch was dry and the South Branch was stagnant and only contained standing pools of water. An erosional gully along M-13 was observed at the North Branch of Railroad Drain and the NPS efforts may be able to focus on correcting this problem which is contributing sediments to the drain. A biological survey of the Railroad Drain was not conducted due to the stagnant, nonflowing condition of the stream. However, a water sample was collected and the results are presented in Table 3.

Railroad Drain

The physical habitat was rated as marginal (moderately impaired) and there was less than 10 percent stable habitat within the stream to be utilized by the biological community. The drain has historically been channelized; however, this stretch of the drain had several large trees and shrubs along the banks, which would indicate that there has not been any recent drain maintenance in this portion of the water body.

Previous during a biological survey in 1990 on the Johnson Drain, the macroinvertebrate community was considered fair, and did not contain mayflies, caddisflies, or stoneflies (Morse, 1992). During this survey at Station 7, the macroinvertebrate community contained 21 taxa of aquatic insects but did not contain caddisflies or stoneflies. However, 1 taxa of mayfly was discovered. Overall, the macroinvertebrate community was rated as poor and is a reflection of the dominance of organisms that are surface air breathers. The presence of a "manure" type odor was noticed in the sediments and may, in part, be due to the decomposition of organic material such as algae and/or aquatic plants in the stream.

Johnson Drain

A biological assessment was not conducted on this water body due to the intermittent nature of the stream. Visual observations revealed heavy growths of algal mats downstream from the Pinconning WWTP. Due to a lack of flow in the stream, the effluent from the WWTP was standing in pools in the stream channel creating prime conditions for the growth of algae.

of potential NPS inputs to the Pinconning River, upstream from the Pinconning WWTP, may be warranted. chemistry data for the Pinconning River is presented in Table 3. Additional detailed evaluations dissolved solids were higher upstream from the point source than downstream. Further water WWTP, when compared to the upstream value for sulfate, 71 mg/L versus 45 mg/L. The total survey. The sulfate levels increased slightly downstream from the point source of the milligrams per liter (mg/L) as compared to 284 mg/L upstream from the WWTP, at the time of the impacts to the stream. The chloride levels downstream of the WWTP were at 192 downstream from the Pinconning WWTP to evaluate NPS inputs versus point source inputs and (Station 5), upstream from the Pinconning WWTP and at Pinconning Road (Station 6), increased chlorides and sulfates in the stream. Water samples were collected at Water Street Pinconning River has been listed as requiring further evaluation due to occasional fish kills and of water in the stream channel approximately 1 mile upstream from Pinconning. The during base flow conditions. Visual observations during August of 2005 revealed the absence

Lower Kawkawlin River

The physical habitat and the macroinvertebrate community of the Lower Kawkawlin River were not evaluated during this survey due to the size and depth of the Kawkawlin River in the lower reaches. The former GLEAS Procedure #51 can only be used to evaluate the physical habitat and macroinvertebrate communities of wadeable streams. Therefore, water samples were collected at Euclid Road (Station 13) and analyzed for multiple parameters to aid in the development of water-quality based effluent limits, if needed. No exceedance of the Michigan Water Quality Standards was documented during this survey in the lower reach of the Kawkawlin River. At the time of the visual observation and sample collection, the Kawkawlin River was flowing upstream due to the effect of wind on Saginaw Bay.

Kawkawlin River

The Kawkawlin River has been included in the nonattainment list because previous work has documented low dissolved oxygen levels that do not attain the water quality standard for a warm water stream. The Kawkawlin River Watershed drains approximately 224 square miles of predominately agricultural land northwest of Bay City (MDEQ, 1999). The soils in the lower reaches of the watershed have low infiltration rates and are only able to absorb 1 to 2 inches of water per hour. Therefore, the system is dependent upon runoff water to sustain flow during the summer months. Because of this soil characteristic the 7 day 10 year low flow of the North Branch of the Kawkawlin River near Kawkawlin is 0 cubic feet per second. The flow duration curve for the Kawkawlin River denotes highly variable flows derived almost entirely from surface runoff (MDEQ, 1999).

In general, the headwater reaches of the Kawkawlin River have been straightened and dredged to facilitate the rapid drainage of water during rain events. Evidence of recent drain maintenance activities were observed at several locations during this survey. The water that was in the river channel typically was very turbid, and there was not much discernable flow at any location during this survey. The riparian zones along the Kawkawlin River were typically very narrow and provided minimal benefit to the river during rain events. Bank scour was evident at all survey locations and would be anticipated due to the highly variable flow regime of this river. However, the bank scour tended to be less severe in the upper reaches of the watershed when compared to the lower reaches of the Kawkawlin River.

Biological surveys were conducted at 2 locations on the North Branch of the Kawkawlin River and at 2 locations on the main branch of the Kawkawlin River to evaluate the integrity of the biological communities. The macroinvertebrate community of the North Branch of the Kawkawlin River at 8 Mile Road (Station 9) was considered poor and dominated by surface air breathing organisms. The habitat was considered good, slightly impaired despite the absence of a desirable riparian zone. The lack of observable flow at this location coupled with the high suspended solid load created poor conditions for a desirable macroinvertebrate community. The physical habitat that may have been available for macroinvertebrates was covered by a layer of silts thereby reducing the benefit of the habitat. Downstream, the North Branch of the Kawkawlin River was again evaluated at Beaver Road (Station 10). Previously, in 1993 the macroinvertebrate community at this location received a rating of fair (moderately impaired) (Morse, 1994) and a rating of acceptable in 2000 (Rockafellow, 2006). This location continued to support a minimally acceptable macroinvertebrate community that was dominated by tolerant organisms; however, several mayflies and caddisflies were also identified at this location.

Two biological surveys were also conducted on the main branch of the Kawkawlin River. The biological community and habitat was evaluated at Wheeler Road (Station 11). The river at this location contained a very high level of suspended solids that was measured at 25 mg/L. This was the most elevated level of suspended solids documented at any location during this survey.

The visibility into the water was approximately 3 inches. Carp were observed in the large pools upstream and downstream of the Wheeler bridge crossing and were likely contributing to the elevated suspended solids level that was documented at this location. The macroinvertebrate community was considered poor and was dominated by organisms that depend upon surface air for respiration. The high levels of suspended solids in the water would have a tendency to clog the gills of invertebrates that depend upon oxygen in the water for respiration. The habitat at this location was considered marginal and did not provide the necessary stable habitat to support a desirable biological community. Erosional scars along the banks in excess of 4 feet would be indicative of highly variable flows and would contribute sediment and suspended solids to the system. The substrate was dominated by mud, sand, and small balls of clay providing minimal benefit to the biological communities.

Visual observations were conducted on Culver Creek from the confluence with the Kawkawlin River upstream for approximately 300 to 400 yards. Culver Creek has been listed on the nonattainment list due to a macroinvertebrate community that would be considered poor. Previously, impacts to Culver Creek from an abandoned coal mine dewatering shaft had been documented (Masterson, 1987). Impacts from the dewatering shaft were traceable in Culver Creek from the point of discharge downstream to the confluence with the Kawkawlin River. Impacts included a limited macroinvertebrate community, iron deposits, and bright orange slime and silt covering the bottom of Culver Creek downstream to the Kawkawlin River (Masterson, 1987). During the survey in 2005, none of the above conditions were observed in Culver Creek. Furthermore, Culver Creek had been highly modified in this area and appeared to be intermittent in nature. The nearly dry and highly modified stream channel would not be expected to support a healthy and diverse macroinvertebrate community. Due to these conditions, a biological survey was not conducted on Culver Creek.

A biological survey of the Kawkawlin River was conducted immediately downstream from the confluence of Culver Creek (Station 12). The macroinvertebrate community was considered acceptable and contained 3 various taxa of mayflies and 2 taxa of caddisflies, which would be indicative of acceptable water quality. The physical habitat was rated as good, slightly impaired, despite the absence of gravel and cobble within the stream. Mud, clay, and sand was the dominate substrate within the stream with some heavier sand deposits apparently originating from Culver Creek. The water at this location was relatively clear when compared to other locations on the Kawkawlin and visibility into the water of 2-3 feet was possible and the water chemistry data revealed a measured suspended solid level of 4 mg/L (Table 3). The stream also provided a diverse variety of pool habitats for the biological community including large shallow pools, large deep pools, and small shallow and small deep pools. The fish community of the Kawkawlin River was not evaluated at this location, but numerous fish were observed during the survey.

Northwest Drain

The Northwest Drain arises as a series of highly maintained agricultural ditches in the northwest portion of Tuscola County. The drain flows in a northerly direction to Saginaw Bay at the Fish Point Wildlife Area. During 2005, the drain was surveyed at Dickerson Road (Station 14) to determine the condition of the stream. At this location, the water body was at the bottom of a very steep and deep ditch, approximately 15-20 feet down. Small dead standing trees were observed growing from the ditch bank and were likely sprayed with herbicide during routine drain maintenance activities. At the time of the survey, water from Saginaw Bay was actually flowing upstream from the Bay, due to wind conditions on the Bay. The macroinvertebrate community was considered poor and contained 20 taxa of aquatic organisms. However, the surface air breathing organisms comprised 35 percent of the macroinvertebrate community at this location. The habitat was rated as marginal and is a reflection of the highly modified nature of the stream.

Wiscoggin Drain

The Wiscoggin Drain arises from several agricultural drains in the predominately agricultural area south of Unionville and enters Saginaw Bay at the Fish Point State Wildlife Area. The drain was evaluated at 2 locations to determine the current condition of the drain. The Wiscoggin Drain at Dickerson Road (Station 15) supported a macroinvertebrate community that was considered acceptable and the habitat was rated as good, slightly impaired. Further downstream at Huron Line Road (Station 16) the water body continued to support a macroinvertebrate community that was considered acceptable and the habitat was rated as marginal. Both of these survey locations were in heavily agricultural areas and at both locations the stream had been straightened and dredged to facilitate the drainage of water. The banks of the drain lacked any woody vegetation such as shrubs or trees.

Visual Observations

Visual observations were conducted at several locations on the Tebo Drain, Gregory Drain, and White Feather Creek. These water bodies have been highly modified to effectively drain water from the surrounding land and at the time of observation the channels were dry. Therefore, based upon the intermittent nature of these water bodies, it is unlikely that they will ever support a desirable biological community. Visual observations were also conducted at several locations on the Quanicassee River. The lower reaches of this river were influenced by water levels in the Bay, and at the time of the survey had water. However, a short ways upstream from the Bay the channel was dry. In areas where water was in the channel, there was a heavy growth of duckweed on the water surface and there was no observable flow. Farmers in the area were using water from the Quanicassee River to irrigate potato crops in the immediate vicinity.

Water Samples

Water samples were collected at 16 survey locations, and the results of the sampling are presented in Table 3. All stations examined during this survey had nutrient levels, including ammonia and/or total phosphorus present at levels exceeding the range of values documented at reference sites within the HELP ecoregion (Lundgren, 1994). The Saganing River, Johnson Drain, Railroad Drain, Kawkawlin River at Wheeler Road, and the Pinconning River had levels of total dissolved solids that exceeded the standard as established by the Part 4 Water Quality Standards, Rule 323.1051. Further sampling of these water bodies may be warranted to further characterize the potential source, and major constituents of the total dissolved solids.

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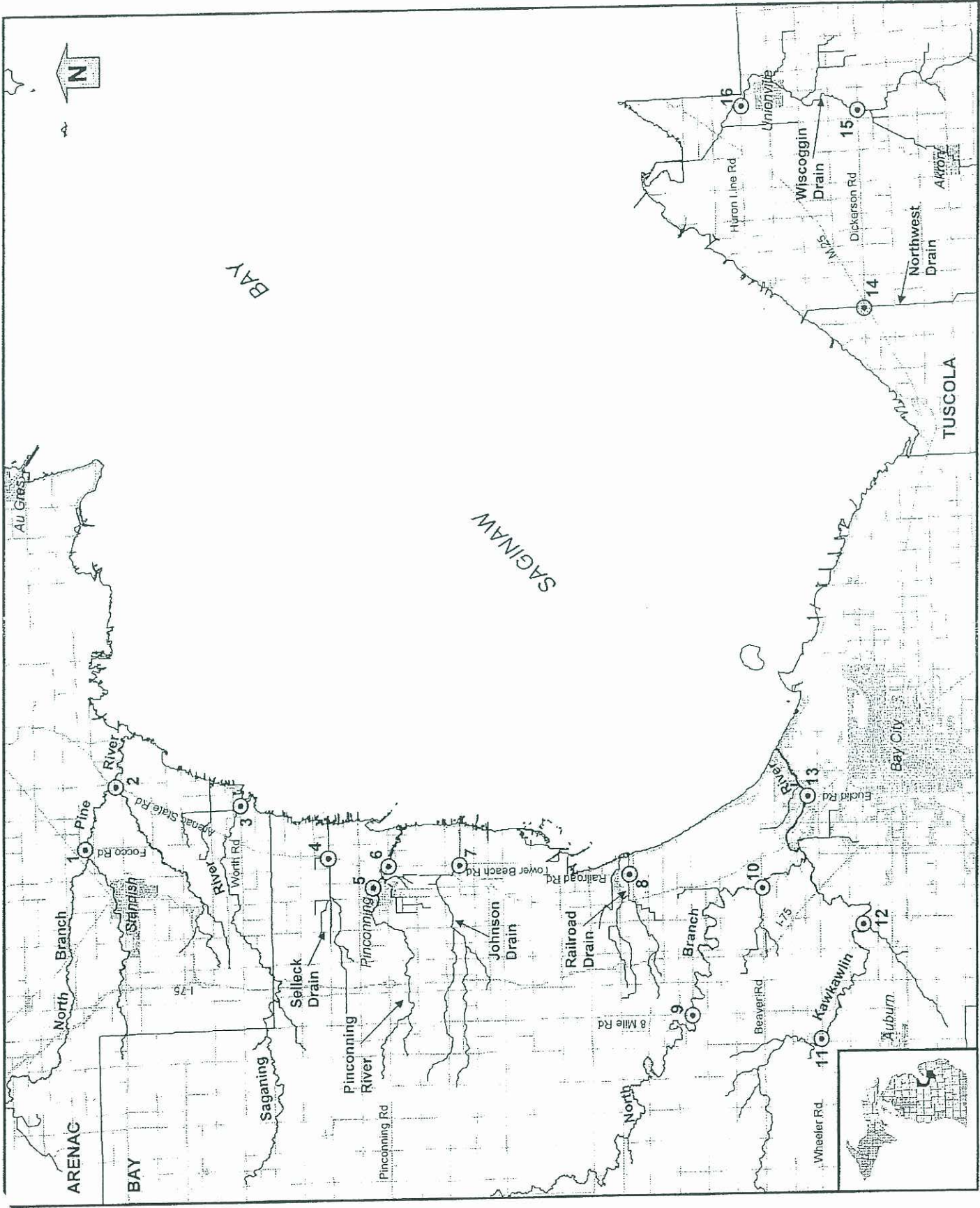


Figure 1: Select station locations on tributaries to Saginaw Bay, Arenac, Bay and Tuscola Counties, August 2005.

Appendix A. Summary of station locations and ratings of the macroinvertebrate communities and physical habitat for selected stations on tributaries to Saginaw Bay, August 2005.

Station Number	Station Location	Lat	Long	Macro Rating	Habitat Rating
1	N. Br. Pine River at Focco Rd	44.0017	83.927	Acceptable	Marginal
2	N. Br. Pine R. at Arenac St Rd	43.9855	83.888	Acceptable	Marginal
3	Saganing River at Worth Rd	43.9250	83.9037	Excellent	Marginal
4	Selleck Drain at Arenac St. Rd	43.8824	83.9395	Acceptable	Good
5	Pinconning R at Water St	43.8606	83.9595	Poor	Marginal
6	Pinconning R at Pinconning Rd	43.8528	83.9460	---	---
7	Johnson Dr at Tower Beach Rd	43.8180	83.9471	---	---
8	Railroad Dr at Elevator Rd	43.7336	83.958	Poor	Marginal
9	N. Br. Kawkawlin R. at 8 MI Rd	43.7042	84.0480	---	---
10	N. Br. Kawkawlin R at Beaver Rd	43.6676	83.9702	Poor	Good
11	Kawkawlin R. at Wheeler Rd	43.6396	84.0661	Acceptable	Good
12	Kawkawlin R d/s Culver Creek	43.6175	83.9953	Poor	Marginal
13	Kawkawlin R at Euclid Rd	43.6434	83.9134	Acceptable	Good
14	North West Dr at Dickerson Rd	43.6094	83.9134	---	---
15	Wisconsin Drain at Dickerson Rd	43.6103	83.6042	Poor	Marginal
16	Wisconsin Drain at Huron Line Rd	43.6677	83.4741	Acceptable	Good

--- = Parameter not evaluated

Visual Assessments Conducted at the Following Locations:
 E. Branch Quanicasssee River at Van Buren Road
 Quanicasssee River at Cotter Road
 Tebo Drain at M-13
 Gregory Drain at Tower Road
 White Feather Crk at Armstrong Road

Table 1A. Qualitative macroinvertebrate sampling results for selected stations on tributaries to Saginaw Bay, Arenac, Bay, and Tuscola Counties, August 2005.

TAXA	N B Pine River Focco Rd. 8/15/2005 STATION 1	N B Pine River Arenac State Rd. 8/15/2005 STATION 2	Saginaw River Worth Rd. 8/16/2005 STATION 3	Selleck Drain Arenac State Rd. 8/16/2005 STATION 4
ANNELIDA (segmented worms)				
Hirudinea (leeches)				4
Oligochaeta (worms)	1	1	2	
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	20	6	7	
Decapoda (crayfish)	2	2	3	4
Isopoda (sowbugs)	20	2	5	6
Arachnoidea				
Hydracarina		3	2	1
Insecta				
Ephemeroptera (mayflies)				
Baetidae	2	10	3	
Caenidae		2	2	
Ephemeridae		2	1	
Heptageniidae	3	2	4	
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	2	6	2	15
Gomphidae	2	6		
Libellulidae			1	1
Zygoptera (damselflies)				
Calopterygidae		8	6	
Plecoptera (stoneflies)				
Perlidae	2			
Hemiptera (true bugs)				
Belostomatidae			4	
Corixidae		3	14	15
Gerridae	2	2	2	15
Nepidae			1	
Notonectidae				2
Megaloptera				
Corydalidae (dobson flies)	1			
Trichoptera (caddisflies)				
Brachycentridae	1	1		
Helicopsychidae	3	4	1	
Hydropsychidae	6	2		
Leptoceridae		1		
Limnephilidae	1		2	
Molannidae	2			
Coleoptera (beetles)				
Gyrinidae (adults)		2		2
Haliphidae (adults)			6	2
Dryopidae			2	
Elmidae	1	3	1	
Diptera (flies)				
Athericidae	2	2		
Ceratopogonidae	3	5	2	
Chironomidae	12	15	15	2
Culicidae		1		
Dixidae			1	
Tipulidae		2		
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)			1	
Lymnaeidae	2			10
Physidae	2	2	8	15
Planorbidae			3	
Pelecypoda (bivalves)				
Sphaeriidae (clams)	3	1	2	
TOTAL INDIVIDUALS	95	96	103	94

Table 1B. Macroinvertebrate metric evaluation of selected stations on tributaries to Saginaw Bay, Arenac, Bay, and Tuscola Counties, August 2005.

METRIC	Value	Score	Value	Score	Value	Score	Value	Score
N B Pine River	23	0	27	1	28	0	14	0
Focco Rd.	2	0	4	1	4	1	0	-1
8/15/2005	5	1	4	1	2	0	0	-1
STATION 1	1	1	0	-1	0	-1	0	-1
N B Pine River	5.26	-1	16.67	0	9.71	-1	0.00	-1
PERCENT MAYFLY COMP.	13.68	0	8.33	0	2.91	-1	0.00	-1
PERCENT CADDISFLY COMP.	21.05	0	15.63	1	14.56	1	15.96	1
PERCENT DOMINANT TAXON	25.26	-1	4.17	1	16.50	-1	37.23	-1
PERCENT ISOPOD, SNAIL, LEECH	2.11	1	8.33	1	26.21	-1	38.30	-1
PERCENT SURF. AIR BREATHERS								
TOTAL NUMBER OF TAXA	23	0	27	1	28	0	14	0
NUMBER OF MAYFLY TAXA	2	0	4	1	4	1	0	-1
NUMBER OF CADDISFLY TAXA	5	1	4	1	2	0	0	-1
NUMBER OF STONEFLY TAXA	1	1	0	-1	0	-1	0	-1
PERCENT MAYFLY COMP.	5.26	-1	16.67	0	9.71	-1	0.00	-1
PERCENT CADDISFLY COMP.	13.68	0	8.33	0	2.91	-1	0.00	-1
PERCENT DOMINANT TAXON	21.05	0	15.63	1	14.56	1	15.96	1
PERCENT ISOPOD, SNAIL, LEECH	25.26	-1	4.17	1	16.50	-1	37.23	-1
PERCENT SURF. AIR BREATHERS	2.11	1	8.33	1	26.21	-1	38.30	-1
TOTAL SCORE		1		5		-3		-6
MACROINV. COMMUNITY RATING		ACCEPT.		EXCELLENT		ACCEPT.		POOR

Table 1A (cont.). Qualitative macroinvertebrate sampling results for selected stations on tributaries to Saginaw Bay, Arenac, Bay, and Tuscola Counties, August 2005.

TAXA	Johnson Drain	N B Kawkawlin River	N B Kawkawlin River	Kawkawlin River
	E of Tower Beach Rd./N of Alameda Beach Rd. 8/16/2005 STATION 7	8 Mile Rd. 8/16/2005 STATION 9	Beaver Rd. 8/16/2005 STATION 10	Wheeler Rd. 8/17/2005 STATION 11
ANNELIDA (segmented worms)				
Hirudinea (leeches)	2	4	2	
Oligochaeta (worms)		2	1	2
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	15	12	15	12
Decapoda (crayfish)	2	1		
Isopoda (sowbugs)	10	10	12	
Arachnoidea				5
Hydracarina				
Insecta				
Ephemeroptera (mayflies)				
Baetidae		2	1	2
Caenidae	1	1	9	6
Heptageniidae		1		
Odonata				
Anisoptera (dragonflies)		2	3	3
Aeshnidae	6	2		
Cordulegastridae		2		
Libellulidae		1	1	1
Zygoptera (damselflies)				
Calopterygidae	10	12	6	5
Coenagrionidae			2	2
Hemiptera (true bugs)				
Belostomatidae	6	2	1	
Corixidae	15	20	19	30
Gerridae	5	2	2	3
Mesoveliidae				1
Nepidae	1	1		1
Notonectidae	3	2	4	
Megaloptera				
Sialidae (alder flies)		1		
Trichoptera (caddisflies)				
Limnephilidae		1	5	1
Coleoptera (beetles)				
Dytiscidae (total)	2	2	1	
Gyrinidae (adults)	5	2	1	1
Halplidae (adults)	2		2	2
Elnidae	1		1	6
Diptera (flies)				
Ceratopogonidae		1	1	3
Chironomidae	15	10	10	10
Culicidae	1	1		1
MOLLUSCA				
Gastropoda (snails)				
Lymnaeidae	2	1	5	
Physidae	6	5		
Planorbidae	3		2	
TOTAL INDIVIDUALS	114	101	97	97

Table 1B (cont.). Macroinvertebrate metric evaluation of selected stations on tributaries to Saginaw Bay, Arenac, Bay, and Tuscola Counties, August 2005.

METRIC	Johnson Drain		N B Kawkawlin River		N B Kawkawlin River		Kawkawlin River	
	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	21	0	26	0	23	0	20	0
NUMBER OF MAYFLY TAXA	1	-1	3	0	2	0	2	-1
NUMBER OF CADDISFLY TAXA	0	-1	1	-1	1	-1	1	-1
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1	0	-1
PERCENT MAYFLY COMP.	0.88	-1	3.96	-1	10.31	-1	8.25	-1
PERCENT CADDISFLY COMP.	0.00	-1	0.99	-1	5.15	0	1.03	-1
PERCENT DOMINANT TAXON	13.16	1	19.80	0	15.46	1	30.93	-1
PERCENT ISOPOD, SNAIL, LEECH	20.18	-1	19.80	-1	21.65	-1	0.00	1
PERCENT SURF. AIR BREATHERS	35.96	-1	31.68	-1	21.65	0	40.21	-1
TOTAL SCORE		-6		-6		-3		-6
MACROINV. COMMUNITY RATING		POOR		POOR		ACCEPT.		POOR

Table 1A (cont.). Qualitative macroinvertebrate sampling results for selected stations on tributaries to Saginaw Bay, Arenac, Bay, and Tuscola Counties, August 2005.

TAXA	STATION 12 Kawkawin River d/s Culver Creek 8/17/2005	STATION 14 M-25 Northwest Drain 8/17/2005	STATION 15 Dickerson Rd. Wisconsin Drain 8/17/2005	STATION 16 Loomis Rd. Wisconsin Drain 8/17/2005
PLATYHELMINTHES (flatworms)	2		3	5
Turbellaria				4
ANNELIDA (segmented worms)				1
Hirudinea (leeches)				1
Oligochaeta (worms)				1
ARTHROPODA				1
Crustacea				1
Amphipoda (scuds)	6	12		1
Decapoda (crayfish)		1		
Isopoda (sowbugs)	4	7	12	2
Arachnida				2
Hydracarina	5			4
Insecta				4
Ephemeroptera (mayflies)	6	12	5	4
Baetidae				
Cenidae	12			
Ephemerehlidae		1		
Ephemeridae	3			
Hepiaemididae		1		
Odonata				
Anisoptera (dragonflies)	2	1		1
Aeshnidae				1
Libellulidae	1	1	1	1
Zygoptera (damselflies)	10	6	7	2
Coenagrionidae	1			4
Hemiptera (true bugs)	4	2	4	4
Belostomatidae	15	5	15	15
Coridae	3	2	2	2
Mesoveliidae	2			2
Nepidae		1	1	2
Notonectidae	3			
Trichoptera (caddisflies)				
Leptoceridae	3	6		4
Limnephilidae	1		2	4
Coleoptera (beetles)	7			2
Dytiscidae (tota)	1			5
Gyrinidae (adults)	1	25	3	6
Haliphidae (adults)	1	1	10	2
Dryopidae			2	2
Elmidae	2		2	2
Diptera (flies)				
Athericidae	1	3		1
Ceratopogonidae	10	2	6	2
Culicidae		1		12
Simuliidae			4	1
Stratiomyidae				4
MOLLUSCA				3
Gastropoda (snails)	4	15	10	10
Physidae				
Planorbidae				
Pelecypoda (bivalves)	1		4	
Sphaeriidae (clams)			2	
TOTAL INDIVIDUALS	110	105	107	106

Table 1B (cont.). Macroinvertebrate metric evaluation of selected stations on tributaries to Saginaw Bay, Arenac, Bay, and Tuscola Counties, August 2005.

METRIC	Kawkawlin River d/s Culver Creek 8/17/2005 STATION 12		Northwest Drain M-25 8/17/2005 STATION 14		Wiscoggin Drain Dickerson Rd. 8/17/2005 STATION 15		Wiscoggin Drain Loomis Rd. 8/17/2005 STATION 16	
	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	26	0	20	0	21	1	28	0
NUMBER OF MAYFLY TAXA	3	0	3	1	2	1	1	-1
NUMBER OF CADDISFLY TAXA	2	0	1	-1	1	-1	2	0
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1	0	-1
PERCENT MAYFLY COMP.	19.09	0	13.33	-1	14.02	-1	3.77	-1
PERCENT CADDISFLY COMP.	3.64	0	5.71	0	1.87	-1	5.66	0
PERCENT DOMINANT TAXON	13.64	1	23.81	-1	14.02	1	14.15	1
PERCENT ISOPOD, SNAIL, LEECH	9.09	0	20.95	-1	27.10	-1	16.04	-1
PERCENT SURF. AIR BREATHERS	32.73	-1	35.24	-1	34.58	-1	37.74	-1
TOTAL SCORE		-1		-5		-3		-4
MACROINV. COMMUNITY RATING		ACCEPT.		POOR		ACCEPT.		ACCEPT.

Table 2. Habitat evaluation for selected stations on tributaries to Saginaw Bay, Arenac, Bay, and Tuscola Counties, August 2005.

HABITAT METRIC	STATION 1 N B Pine River Focco Rd.	STATION 2 N B Pine River Arenac State Rd.	STATION 3 Saginaw River Worth Rd.	STATION 4 Sellick Drain Arenac State Rd.	STATION 7 Johnson Drain E of Tower Beach Rd/N of Alameda Beach Rd GLIDEPOOL
Substrate and Instream Cover	5	7	11	2	5
Epifaunal Substrate/ Avail Cov	7	10	10	4	12
Embeddness*	13	7	13	5	5
Velocity/Depth Regime**	13	7	13	5	11
Pool Substrate Characterization**	13	7	13	5	11
Pool Variability**	13	7	13	5	11
Channel Morphology	7	10	13	5	11
Sediment Deposition	7	10	13	5	11
Flow Status - Maint. Flow Volt	6	6	2	7	8
Flow Status - Flashiness	0	3	6	3	8
Channel Alteration	19	19	19	8	11
Frequency of Riffles/Bends*	7	8	12	8	3
Riparian and Bank Structure	1	5	7	6	7
Bank Stability (L)	1	5	7	6	7
Bank Stability (R)	1	5	7	6	7
Vegetative Protection (L)	6	6	4	9	7
Vegetative Protection (R)	6	6	4	9	7
Riparian Veg. Zone Width (L)	7	1	1	9	3
Riparian Veg. Zone Width (R)	10	1	1	9	3
TOTAL SCORE (200)	95	92	113	90	97
HABITAT RATING:	MARGINAL (MODERATELY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Date:	Weather:	Air Temperature:	Water Temperature:	Ave. Stream Width:	Ave. Stream Depth:	Surface Velocity:	Estimated Flow:	Stream Modifications:	Report Number:	STORET No.:	Stream Name:	Road Crossing/Location:	County Code:	TRIS:	Latitude (dd):	Longitude (dd):	Ecoregion:	Stream Type:	USGS Basin Code:	COMMENTS:
8/15/2005	Sunny	83 Deg. F.	68 Deg. F.	18 Feet	0.4 Feet	0.5 Ft./Sec.	3.6 CFS	None	N	60108	N B Pine River	Focco Rd.	06	15N04E36	44.0017	-83.927	HELP	Warmwater	4080102	** Applies only to Riffle/Run stream Surveys
8/15/2005	Sunny	83 Deg. F.	76 Deg. F.	8 Feet	0.3 Feet	1 Ft./Sec.	2.4 CFS	None	N	60107	N B Pine River	Arenac State Rd.	06	18N05E05	43.9855	-83.838	HELP	Warmwater	4080102	** Applies only to Riffle/Run stream Surveys
8/16/2005	Partly Cloudy	75 Deg. F.	65 Deg. F.	17 Feet	0.3 Feet	0.1 Ft./Sec.	0.51 CFS	None	N	60109	Saginaw River	Worth Rd.	06	18N05E29	43.925	-83.9037	HELP	Warmwater	4080102	** Applies only to Riffle/Run stream Surveys
8/16/2005	Sunny	80 Deg. F.	67 Deg. F.	7 Feet	0.4 Feet	0.1 Ft./Sec.	0.28 CFS	Dredged	N	90282	Sellick Drain	Arenac State Rd.	09	17N04E12	43.8824	-83.9395	HELP	Warmwater	4080102	** Applies only to Riffle/Run stream Surveys
8/16/2005	Sunny	82 Deg. F.	72 Deg. F.	1.4 Feet	1 Feet	0.05 Ft./Sec.	0.7 CFS	Dredged	N	50266	Johnson Drain	E of Tower Beach Rd/N of Alameda Beach Rd	09	16N04E01	43.81747	-83.94533	HELP	Warmwater	4080102	** Applies only to Riffle/Run stream Surveys

Table 2 (cont.). Habitat evaluation for selected stations on tributaries to Saginaw Bay, Arenac, Bay, and Tuscola Counties, August 2005.

	N B Kawkawlin River 8 Mile Rd GLIDE/POOL STATION 9	N B Kawkawlin River Beaver Rd GLIDE/POOL STATION 10	Kawkawlin River Wheeler Rd. GLIDE/POOL STATION 11	Kawkawlin River d/s Culver Creek GLIDE/POOL STATION 12	Northwest Drain M-25 GLIDE/POOL STATION 14
HABITAT METRIC					
Substrate and Instream Cover					
Epiifaunal Substrate/ Avail Cove Embeddedness*	7	8	5	8	5
Velocity/Depth Regime*					
Pool Substrate Characterization [†]	16	15	9	14	5
Pool Variability**	15	15	12	18	8
Channel Morphology					
Sediment Deposition	12	11	7	9	17
Flow Status - Maint. Flow Volu	9	9	7	9	9
Flow Status - Flashiness	5	2	2	2	7
Channel Alteration	19	15	19	20	0
Frequency of Riffles/Bends*					
Channel Sinuosity**	13	11	13	14	0
Riparian and Bank Structure					
Bank Stability (L)	6	6	4	6	7
Bank Stability (R)	6	6	2	6	7
Vegetative Protection (L)	3	8	3	9	5
Vegetative Protection (R)	3	8	8	9	5
Riparian Veg. Zone Width (L)	2	5	3	10	1
Riparian Veg. Zone Width (R)	2	5	7	10	1
TOTAL SCORE (200):	118	124	101	144	77
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Date:	8/16/2005	8/16/2005	8/17/2005	8/17/2005	8/17/2005
Weather:	Sunny	Sunny	Sunny	Sunny	Sunny
Air Temperature:	85 Deg. F.	85 Deg. F.	80 Deg. F.	85 Deg. F.	86 Deg. F.
Water Temperature:	78 Deg. F.	72 Deg. F.	69 Deg. F.	69 Deg. F.	72 Deg. F.
Ave. Stream Width:	24 Feet	30 Feet	25 Feet	30 Feet	12 Feet
Ave. Stream Depth:	1 Feet	1.5 Feet	1.5 Feet	1.5 Feet	0.5 Feet
Surface Velocity:	0.2 Ft./Sec.	0.1 Ft./Sec.	0.2 Ft./Sec.	0.2 Ft./Sec.	0.1 Ft./Sec.
Estimated Flow:	4.8 CFS	4.5 CFS	7.5 CFS	9 CFS	0.6 CFS
Stream Modifications:	None	Dredged	None	None	Dredged
Nuisance Plants (Y/N):	N	N	N	N	N
Report Number:					
STORET No.:	90263	90262	90009	90283	790135
Stream Name:	N B Kawkawlin River	N B Kawkawlin River	Kawkawlin River	Kawkawlin River	Northwest Drain
Road Crossing/Location:	8 Mile Rd	Beaver Rd	Wheeler Rd.	d/s Culver Creek	M-25
County Code:	09	09	09	09	79
TRS:	15N04E12	15N04E35	14N03E01	14N04E16	14N07E14
Latitude (dd):	43.71472	43.66361	43.6396	43.6175	43.60667
Longitude (dd):	-84.054	-83.96472	-84.0661	-83.9953	-83.604448
Ecoregion:	HELP	HELP	HELP	HELP	HELP
Stream Type:	Warmwater	Warmwater	Warmwater	Warmwater	Warmwater
USGS Basin Code:	4080102	4080102	4080102	4080102	4080102

* Applies only to Riffle/Run stream Surveys
 ** Applies only to Glide/Pool stream Surveys

COMMENTS:

Table 2 (cont.). Habitat evaluation for selected stations on tributaries to Saginaw Bay, Arenac, Bay, and Tuscola Counties, August 2005.

HABITAT METRIC		HABITAT RATING:	
		GOOD	(SLIGHTLY IMPAIRED)
		108	(MODERATELY IMPAIRED)
TOTAL SCORE (200):		81	
Substrate and Instream Cover	8	5	8
Epifaunal Substrate/ Avail Cove	12	5	8
Embeddedness*	12	5	8
Velocity/Depth Regime*	12	5	8
Pool Substrate Characterization**	10	5	8
Pool Variability*	9	5	8
Channel Morphology	11	5	8
Sediment Deposition	7	5	8
Flow Status - Maint. Flow Volum	7	5	8
Flow Status - Flashiness	2	5	8
Channel Alteration	3	5	8
Frequency of Riffles/Bends*	7	5	8
Channel Sinuosity**	1	5	8
Riparian and Bank Structure	7	5	8
Bank Stability (L)	7	5	8
Bank Stability (R)	7	5	8
Vegetative Protection (L)	7	5	8
Vegetative Protection (R)	7	5	8
Riparian Veg. Zone Width (L)	6	5	8
Riparian Veg. Zone Width (R)	6	5	8
<hr/>			
Wisconsin Drain	STATION 15		
Dickerson Rd.	RFFLE/RUN		
Wisconsin Drain	STATION 16		
Loomis Rd.	GLDE/POOL		
Wisconsin Drain	STATION 16		

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Date:	8/17/2005	8/17/2005
Weather:	Sunny	Sunny
Air Temperature:	85 Deg. F.	85 Deg. F.
Water Temperature:	80 Deg. F.	80 Deg. F.
Ave. Stream Width:	9 Feet	9 Feet
Ave. Stream Depth:	0.3 Feet	0.3 Feet
Surface Velocity:	0.3 Ft./Sec.	0.3 Ft./Sec.
Estimated Flow:	0.81 CFS	0.81 CFS
Stream Modifications:	Dredged	Dredged
Nuisance Plants (Y/N):	N	N
Report Number:	790167	790154
STORET No.:	790167	790154
Stream Name:	Wisconsin Drain	Wisconsin Drain
Road Crossing/Location:	Dickerson Rd.	Loomis Rd.
County Code:	14N08E24	14N08E36
TRS:	79	79
Latitude (dd):	43.6103	43.6671
Longitude (dd):	-83.48	-83.47417
Region:	HELP	HELP
Stream Type:	Warmwater	Warmwater
USGS Basin Code:	4080103	4080103

* Applies only to Riffle/Run stream Surveys
 ** Applies only to Glide/Pool stream Surveys

COMMENTS:

Table 3. Water chemistry data for selected tributaries to Saginaw Bay, August 2005.

Parameter	Units	Station 1	Station 2	Station 3	Station 4	Station 7	Station 8	Station 9
		N Br Pine R at Focco Rd	N Br Pine R at Arenac St Rd	Saganing R at Worth Rd	Selleck Dr at Arenac St Rd	Johnson Dr at Tower Beach Rd	Railroad Dr at Elevator Rd	N Br Kawkawlin R at Eight Mi Rd
COD	mg/L	19	21	31	47	45	44	44
T. Dissolved Solids	mg/L	410	370	770	450	690	540	210
Kjeldahl Nitrogen	mg/L	0.197	0.37	0.665	1.83	1.16	0.949	0.782
Total Phosphorus	mg/L	0.026	0.019	0.044	0.124	0.274	0.268	0.084
Nitrite	mg/L	0.009	0.012	0.006	0.071	0.005	0.006	0.011
Ortho Phosphate	mg/L	0.011	0.007	0.011	0.069	0.134	0.22	0.034
Conductance	umhos	648	576	1194	712	1103	921	331
Suspended Solids	mg/L	ND	4	5	17	5	ND	5
TOC	mg/L	5.8	7.2	11	19	18	16	16
Ammonia	mg/L	ND U	ND U	0.03	0.03	ND U	ND U	ND U
Nitrate + Nitrite	mg/L	1.55	0.907	0.044	3.32	0.012	0.013	0.051

Parameter	Units	Station 10	Station 11	Station 13	Station 14	Station 15	Station 16
		N Br Kawkawlin R at Beaver Rd	Kawkawlin R at Wheeler Rd	Kawkawlin R at Euclid Rd	North West Dr at Dickerson Rd	Wiscogin Dr at Dickerson Rd	Wiscogin Dr at Huron Line Rd
COD	mg/L	56	37	42	27	25	27
T. Dissolved Solids	mg/L	340	720	380	320	280	320
Kjeldahl Nitrogen	mg/L	0.954	1.19	1.06	0.948	0.68	0.926
Total Phosphorus	mg/L	0.268	0.131	0.193	0.039	0.058	0.055
Nitrite	mg/L	0.007	0.015	0.009	0.013	0.004	0.012
Ortho Phosphate	mg/L	0.122	0.041	0.09	0.028	0.03	0.024
Conductance	umhos	493	1260	612	555	505	580
Suspended Solids	mg/L	ND	25	7	19	5	22
TOC	mg/L	24	12	16	9.7	7.8	9.2
Ammonia	mg/L	ND U	0.007 J	ND U	0.021	ND U	ND U
Nitrate + Nitrite	mg/L	0.062	0.096	0.043	0.047	0.016	0.047

ND = Result was not detected at the reporting limit.
 U = The analyte was not detected between the reporting limit and the MDL.

Table 3 (continued). Water chemistry data for selected tributaries to Saginaw Bay, August 2005.

Parameter	Units	Station 5	Station 6	Station 12
		Pinconning R at Water St	Pinconning R Pinconning Rd	Kawkawlin R d/s Culver Crk
Alkalinity-Bicarbonate	mg/L	343	180	202
Alkalinity-Carbonate	mg/L	ND	ND	ND
Alkalinity (CaCO3)	mg/L	343	180	202
Chloride	mg/L	284	192	107
Sulfate	mg/L	45	71	18
COD	mg/L	48	30	26
T. Dissolved Solids	mg/L	1000	690	460
Kjeldahl Nitrogen	mg/L	1.5	0.603	0.656
Total Phosphorus	mg/L	0.319	0.564	0.081
Nitrite	mg/L	0.049	0.007	0.011
Ortho Phosphate	mg/L	0.188	0.42	0.04
Conductance	umhos	1585	1144	769
pH	pH	7.46	8.1	7.86
Suspended Solids	mg/L	4	ND	4
TOC	mg/L	17	9.8	8.8
Ammonia	mg/L	0.516	ND U	ND U
Nitrate + Nitrite	mg/L	0.241	0.026	0.077
Mercury	µg/L	ND	ND	ND
Arsenic	µg/L	2.7	2	2
Barium	µg/L	67	30	39
Cadmium	µg/L	ND	ND	ND
Chromium	µg/L	ND	ND	ND
Copper	µg/L	1.4	1.6	1.5
Lead	µg/L	ND	ND	ND
Selenium	µg/L	ND	ND	ND
Silver	µg/L	ND	ND	ND
Zinc	µg/L	ND	19	ND

ND = Result was not detected at the reporting limit.

U = The analyte was not detected between the reporting limit and the MDL.