New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Crane Brook

Biological Assessment

2004 Survey

New York State
Department of Environmental Conservation

BIOLOGICAL STREAM ASSESSMENT

Crane Brook
Cayuga County, New York

Survey dates: July 2002, August 2003, July 2004
Report date: October 27, 2004

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Stream Crane Brook, Cayuga County

Reach Mentz Church Road to East Loop Road, Port Byron, New York

Background

The Stream Biomonitoring Unit sampled Crane Brook in Port Byron, New York, on three separate occasions: July 17, 2002; August 1, 2003, and July 9, 2004. The sampling was initiated in 2002 in response to a reported fish kill on the brook, which was reported to be caused by potato-processing effluent from the Martens Companies, Port Byron, NY (NYSDEC Region 7, personal communication). Monitoring was conducted to determine if the discharge had impacted aquatic invertebrate life in Crane Brook.

The purpose of the sampling was to determine the condition of resident aquatic communities of benthic macroinvertebrates upstream and downstream of the Martens Companies discharge. Traveling kick samples were collected from riffle areas at one upstream site, and one downstream site. Methods used are described in the Quality Assurance document (Bode et al., 2002) and summarized in Appendix I. The contents of each sample were field-inspected to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of 100-specimen subsamples from each site. Macroinvertebrate community parameters used in the determination of water quality included: species richness, biotic index, EPT richness, and percent model affinity (see Appendices II and III). Amount of expected variability of results is stated in Smith and Bode (2004). Table 3 provides a listing of sampling sites, and Table 4 provides a listing of all species collected in the present survey. This is followed by macroinvertebrate data reports, including raw data from each site.

Results and Conclusions

1. Water quality at Station 1, upstream of the Martens Farm discharge was assessed as slightly impacted for all three sampling events. Impact Source Determination indicates impairment due to non-point source nutrient runoff. This is consistent with the predominantly agricultural land use in the watershed.

2. Station 2, located downstream of the Martens Farm discharge was assessed as severely impacted in 2002, and moderately impacted in 2003 and 2004. The initial recovery of the stream is attributed to removal of the point source discharge during the summer of 2002.

3. A greater degree of recovery was expected between the 2003 and 2004 samplings than was observed. Residual sources of impairment from the Martens Farm may be influencing the continued rate of recovery at this station. Further monitoring of both the Martens Farm waste removal practices and the stream is recommended.

Discussion

In July 2002, NYSDEC Region 7 staff requested the assessment of benthic macroinvertebrate communities in Crane Brook located in Port Byron, New York. The request came as a response to an identified illegal point source discharge originating at the Martens Companies farm in Port Byron. Effluent from potato-processing operations located at the Martens Farm entered Crane Brook through an old canal located just north of the NYS Thruway (Figure 5). DEC Region 7 Division of Water (DOW) staff became aware of the problem in June 2001, after area residents complained of a smell, black color, and a fish-kill in the stream (Figures 1 and 2). In July 2001 regional DOW staff visited the farm and informed the operation of its requirements to file for a SPDES permit. Contact with the Martens farm continued regarding their delinquency through May 2002. A consent order was sent to the Martens Company by Region 7 DOW staff in April 2003, but a SPDES permit has not yet been filed by the company (Pers. Comm. Kathleen Barone, NYSDEC Reg. 7). Sampling by the Stream Biomonitoring Unit for benthic macroinvertebrates was conducted on July 17, 2002. Follow-up monitoring of the stream was conducted in 2003 and 2004. Two stations along the stream were selected for monitoring the impact of the discharge; one upstream (Station 01) and one downstream (Station 02) from the entrance of the canal carrying the Martens Farm effluent. Water quality assessments of each station over the three-year period are summarized in Figure 4.

Figure 1. Crane Brook Station 2, downstream of the Martens Farm

The stream flows through a heavy agricultural district. Non-point nutrient runoff from the surrounding watershed plays an important role in structuring aquatic communities in the absence of more severe impairments such as the Martens Farm discharge. Station 1 (Figure 3) was assessed as slightly impacted all three years. Impact source determination (Table 2. and summarized in Appendix X.) consistently suggests each of the samples is affected by non-point source nutrient enrichment. The stream at this point was dominated by species of net-spinning caddisfly larvae, riffle beetles, and non-biting midge larvae. This structure of the benthic macroinvertebrate community commonly occurs in the presence of agricultural non-point source run-off. The collector-gatherer and filter feeding groups represented by the taxa at this station suggest the high degree of siltation, fine particulate organic matter, and algal growth typically found in this type of watershed.

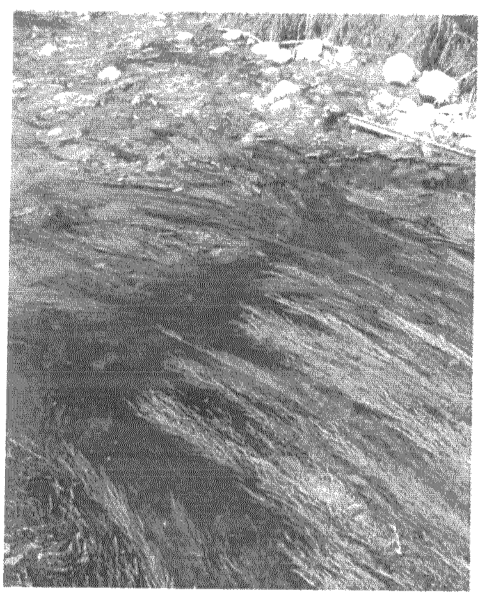


Figure 2. Crane Brook Station 2, Black-colored water and colorless rotting in-stream vegetation.

A third station was added during the second year of sampling (Station 01A, Figure 5), allowing the assessment of upstream benthic macroinvertebrate communities closer to the entrance of the discharge. This station was assessed as moderately impacted. This assessment is likely due to the station's proximity to the NYS Thruway, and Route 31. The stream at this point has a low gradient, and is subject to upstream influences from agricultural run-off. Conductivity measurements at this station were high (Table 1) and 14% of the sample was composed of the crustacean genus *Gammarus*; which is often associated with higher conductance and lower gradient. Impact source determination also suggests non-point source impairment at this station (Table 2).

Station 2, downstream of the Martens Farm discharge, was assessed as severely impacted in 2002. Black water, dying vegetation, and a smell of rotting organic matter were observed (Figures 1 and 2). Dead fish were noted floating in the stream. Field inspection of aquatic invertebrate life identified only 3 individuals; 1 chironomid larva, 1 worm, and 1 dipteran larva. Conductivity was extremely high (6979 micromhos/cm) and dissolved oxygen was very low (0.8 mg/l). The low dissolved oxygen and high conductivity were both direct results of decomposing organic potato waste, discharged by the Martens Farm. Processing of the sample showed all macroinvertebrate community metrics used to assess water quality worsened by at least a factor of 2 compared to the upstream site. The invertebrate community was dominated by tubificid worms, organisms tolerant of organic pollution and low dissolved oxygen.

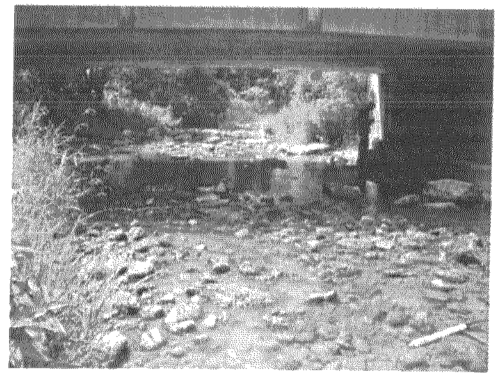


Figure 3. Crane Brook Station 1, Upstream of Martens Farm

Sampling of this same station in 2003 showed an increase in the number of species present and an absence of worms. Freshwater crustaceans, non-biting midge larvae, and other aquatic fly larvae were the dominant groups of organisms, with beetles present in lower abundance. Full recovery of the station did not occur, although some improvement did take place. Conductivity measurements were still very high (Table 1) and dead fish, although in less abundance than in 2002, could still be seen on the water surface. The degree of recovery was reflected in a shift of assessment from severely impacted (2002) to moderately impacted (2003).

After the changes observed in 2003, it was expected that more improvement would be noted in 2004, but only slight improvements were seen. The station was again assessed as moderately impacted. Conductivity measurements were still high (Table 1) and the abundance of crustaceans, non-biting midge larvae, and other aquatic fly larvae continued. Minor improvement in the invertebrate community was suggested by the presence of net-spinning caddisfly larvae. However, in general, the community metrics exhibited only small changes from the previous year. The biotic index score and percent model affinity did improve slightly, and although EPT richness increased, overall species richness decreased.

Crane Brook is subject to the effects of a highly agricultural watershed. Silt input, warm temperatures, and nutrient loads are continued stresses on the aquatic communities present. In the absence of the Martens Farm discharge it is probable water quality would be slightly impacted throughout most of the stream.

The Martens Farm discharge was reported to be remediated during the summer of 2002 (Pers. Comm. Kathleen Barone, NYSDEC Reg. 7). This would explain the improvements seen in the 2003 sampling of the aquatic invertebrate community at Station 2. Continued change was expected after the 2003 sampling, but only very minor improvements were observed in 2004. Because only a small increase in water quality was noted during the last sampling, influences from the Martens Farm may still be playing a role in limiting the rate of recovery.

Literature Cited

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman, and A. J. Smith. 2002. Quality assurance work plan for biological stream monitoring in New York State. New York State Department of Environmental Conservation, Technical Report, 115 pages.

Smith, A. J., and R. W. Bode. 2004. Analysis of variability in New York State benthic macroinvertebrate samples. New York State Department of Environmental Conservation, Technical Report, 43 pages.

Figure 4. Biological Assessment Profile of index values, Crane Brook, 2002 - 2004. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. See Appendix IV for more complete explanation.

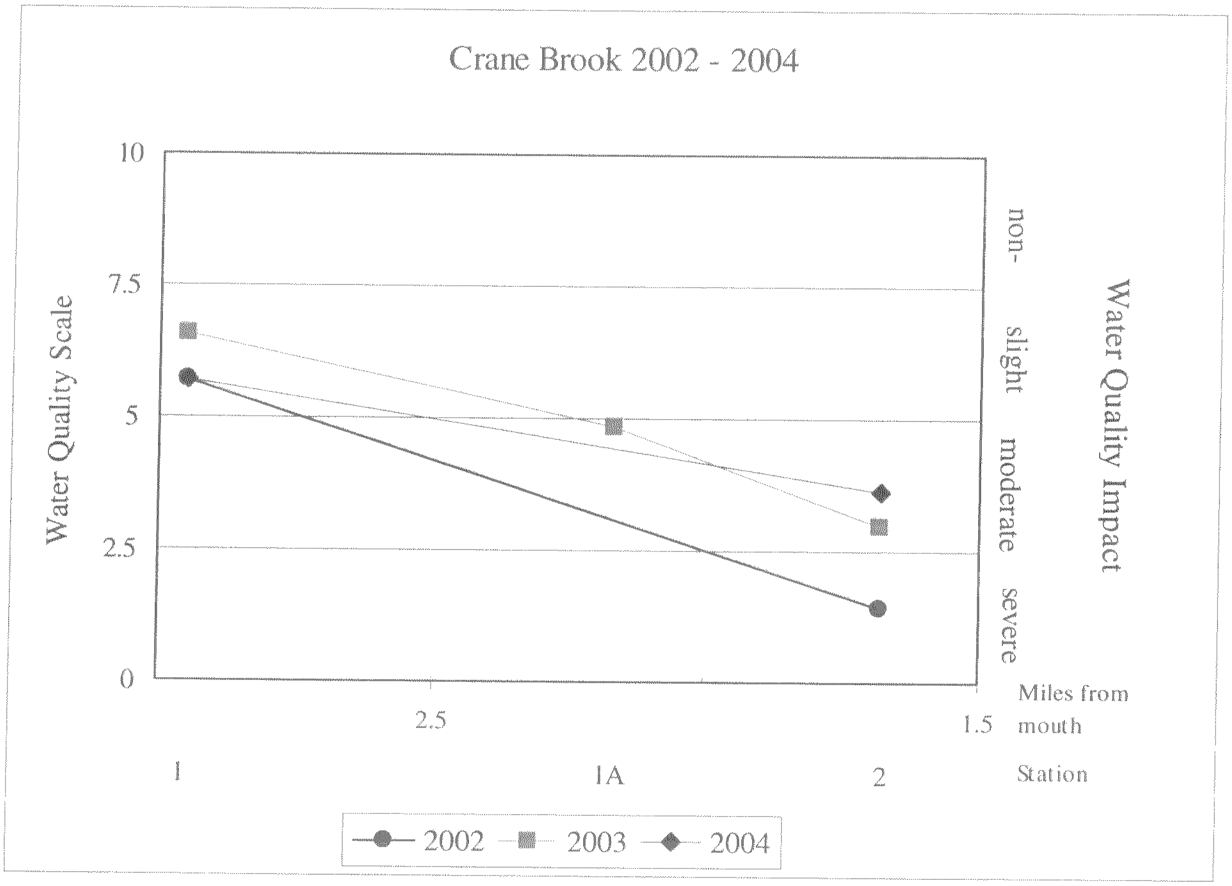


Table 1.Overview of field data

Station	Year	Depth (m)	Width (m)	Current (cm/sec)	Canopy (%)	Embeddedness (%)	Temp. (°C)	Conductance (micromhos/cm)	DO (mg/l)	DO Sat. (%)	pH
01	2002	0.1	6.0	45	40	20	26	484	8.5	107	8.0
02	2002	0.1	6.0	-	0	-	25	6979	0.8	10	7.6
01	2003	0.1	6.0	91	30	30	22	832	8.0	8.5	98
01A	2003	0.1	7.0	91	80	40	21	811	6.6	75	7.8
02	2003	0.1	6.0	83	5	50	21	5535	8.4	97	7.9
01	2004	0.4	5.0	143	25	40	19	706	10.3	109	8.0
02	2004	0.4	5.0	143	25	25	20	1303	9.7	112	7.9

\- indicates measurements not taken in the field.

Table 2. Impact Source Determination, Crane Brook, 2002 - 2004. Numbers represent similarity to community type models for each impact category. The highest similarities at each station are highlighted. Similarities less than 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix X for further explanation.

	STATION						
COMMUNITY TYPE	CRAN 01 (2002)	CRAN 01 (2003)	CRAN 01 (2004)	CRAN 01A (2003)	CRAN 02 (2002)	CRAN 02 (2003)	CRAN 02 (2004)
Natural: minimal human impacts	52	39	42	33	11	11	16
Nutrient additions; mostly non-point, agricultural	**75**	**62**	**61**	**59**	11	23	31
Toxic: industrial, municipal, or urban run-off	48	49	**56**	49	26	26	30
Organic: sewage effluent, animal wastes	40	52	40	26	40	**45**	**46**
Complex: municipal/industrial	43	46	35	36	**70**	39	**48**
Siltation	46	53	47	37	20	23	29
Impoundment	58	48	*65	52	46	*49	*57

STATION	YEAR	COMMUNITY TYPE
CRAN - 01	2002	Non-point nutrient
CRAN - 02	2002	Complex: municipal/industrial
CRAN - 01	2003	Non-point nutrient
CRAN - 01A	2003	Non-point nutrient
CRAN - 02	2003	Organic: sewage effluent, animal wastes
CRAN - 01	2004	Non-point nutrient / Toxic
CRAN - 02	2004	Organic: sewage effluent, animal wastes / Complex: municipal/industrial

* Indications of impoundment are considered spurious. No impoundments are present, and habitat was adequate for sampling.

TABLE 3. STATION LOCATIONS FOR CRANE BROOK, CAYUGA COUNTY, NY

STATION	LOCATION
01	Port Byron, New York Above Mentz Church Road Bridge Latitude/Longitude 43° 00' 47"; 76° 40' 16" 2.9 stream miles above mouth
01A	Port Byron, New York Off of Old Rte. 31 near New Rte. 31 Overpass Latitude/Longitude 43° 01' 04"; 76° 40' 55" 2.1 stream miles above mouth
02	Port Byron, New York 20 m above East Loop Road Bridge Latitude/Longitude 43° 01' 16"; 76° 41' 18" 1.6 stream miles above mouth

Figure 5	Station Location Map	Crane Brook

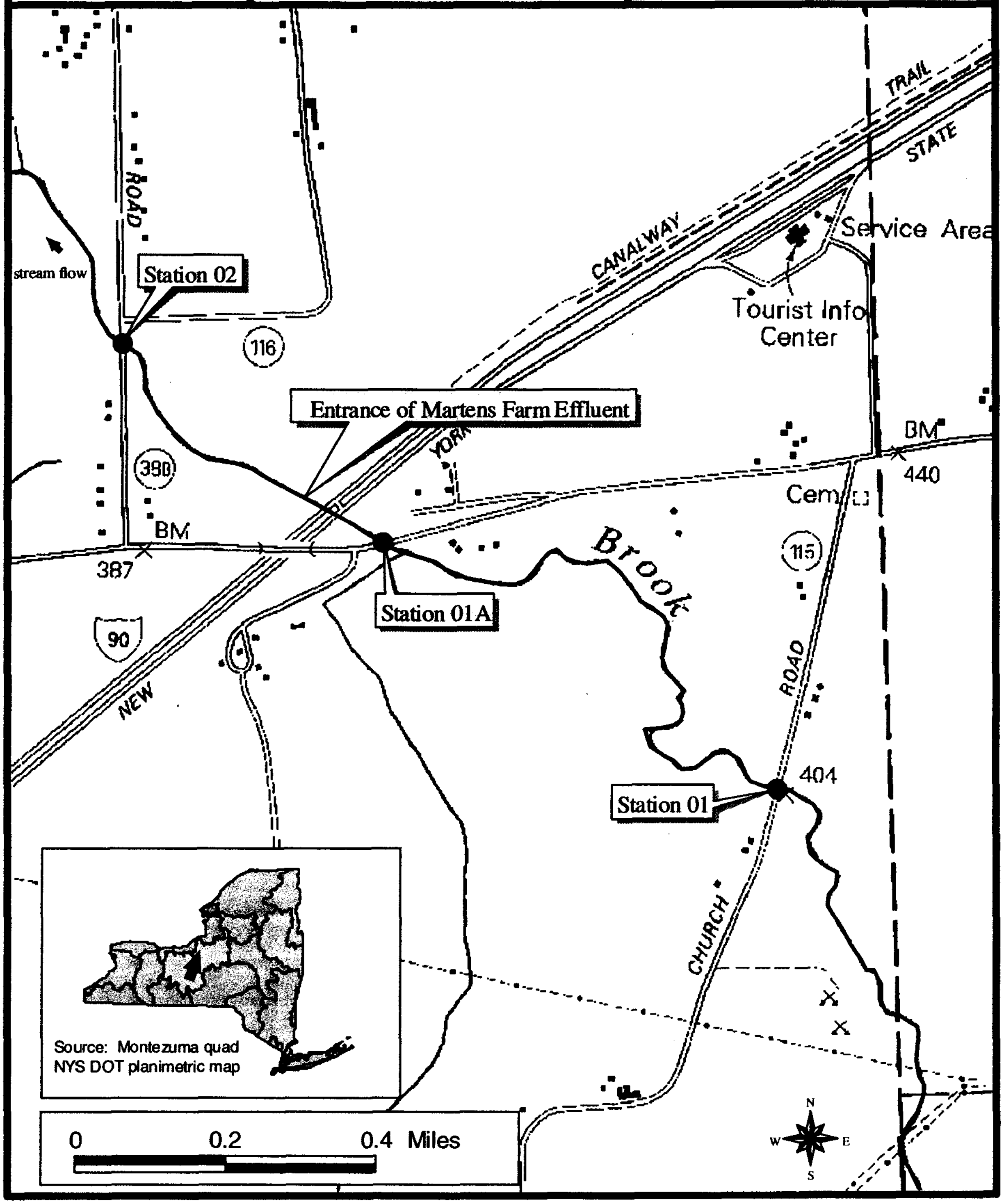


TABLE 4. MACROINVERTEBRATE SPECIES COLLECTED IN CRANE BROOK, CAYUGA COUNTY, NEW YORK, 2002 - 2004.

ANNELIDA
OLIGOCHAETA
TUBIFICIDA
Tubificidae
Limnodrilus hoffmeisteri
Undet. Tubificidae w/ cap. setae

MOLLUSCA
GASTROPODA
Physidae
Undetermined Physidae
Sphaeriidae
Sphaerium sp.

ARTHROPODA
CRUSTACEA
AMPHIPODA
Gammaridae
Gammarus sp.
Talitridae
Hyalella azteca

INSECTA
EPHEMEROPTERA
Baetidae
Acentrella sp.
Acerpenna macdunnoughi
Baetis flavistriga
Baetis intercalaris
Heptageniidae
Stenonema vicarium
Stenonema sp.
Caenidae
Caenis sp.

ODONATA
Coenagrionidae
Ischnura sp.

COLEOPTERA
Gyrinidae
Dineutus sp.
Dytiscidae
Undetermined Dytiscidae
Psephenidae
Psephenus herricki
Elmidae
Dubiraphia vittata
Optioservus fastiditus
Optioservus trivittatus
Stenelmis crenata
Stenelmis sp.

MEGALOPTERA
Corydalidae
Nigronia serricornis

TRICHOPTERA
Philopotamidae
Chimarra obscura
Hydropsychidae
Cheumatopsyche sp.
Hydropsyche betteni
Hydropsyche bronta
Hydropsyche sparna
Hydropsyche sp.
Hydroptilidae
Hydroptila sp.
Undetermined Hydroptilidae

DIPTERA
Tipulidae
Tipula sp.
Simuliidae
Simulium vittatum
Empididae
Hemerodromia sp.
Ephydridae
Ephydra sp.
Syrphidae
Eristalis sp.
Chironomidae
Pentaneura sp.
Thienemannimyia gr. spp.
Diamesa sp.
Cricotopus vierriensis
Eukiefferiella brehmi gr.
Parametriocnemus lundbecki
Tvetenia vitracies
Chironomus sp.
Cryptochironomus fulvus gr.
Dicrotendipes neomodestus
Microtendipes pedellus gr.
Polypedilum flavum
Polypedilum illinoense
Polypedilum laetum
Rheotanytarsus exiguus gr.
Rheotanytarsus pellucidus
Sublettea coffmani
Tanytarsus glabrescens gr.
Tanytarsus guerlus gr.

STREAM SITE: Crane Brook, Station 01
LOCATION: Mentz Church Road, Port Byron, NY
DATE: 2002 - 2004
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100

			2002	2003	2004
MOLLUSCA					
GASTROPODA					
	Physidae	Undetermined Physidae	.	.	1
	Sphaeriidae	*Sphaerium sp.*	.	.	4
ARTHROPODA					
CRUSTACEA					
AMPHIPODA	Gammaridae	*Gammarus sp.*	.	.	1
	Talitridae	*Hyalella azteca*	1		
INSECTA					
EPHEMEROPTERA	Baetidae	*Acentrella sp.*	2		
		Acerpenna macdunnoughi	3		
		Baetis flavistriga	.	.	5
		Baetis intercalaris	.	1	.
	Heptageniidae	*Stenonema vicarium*	.	1	.
		Stenonema sp.	.	.	1
	Caenidae	*Caenis sp.*	.	1	.
COLEOPTERA	Gyrinidae	*Dineutus sp.*	1	1	.
	Dytiscidae	Undetermined Dytiscidae	.	1	.
	Psephenidae	*Psephenus herricki*	4	2	1
	Elmidae	*Dubiraphia vittata*	2	2	3
		Optioservus fastiditus	13		
		Optioservus trivittatus	.	4	5
		Stenelmis crenata	32	21	40
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	.	4	1
TRICHOPTERA	Philopotamidae	*Chimarra obscura*	3	3	.
	Hydropsychidae	*Cheumatopsyche sp.*	12	20	14
		Hydropsyche betteni	1	1	4
		Hydropsyche bronta	1	1	.
		Hydropsyche sparna	1	4	2
	Hydroptilidae	*Hydroptila sp.*	.	.	2
		Undetermined Hydroptilidae	.	1	.
	Tipulidae	*Tipula sp.*	2		
	Simuliidae	*Simulium vittatum*	1		
DIPTERA	Empididae	*Hemerodromia sp.*	.	3	2
	Chironomidae	*Pentaneura sp.*	.	1	.
		Thienemannimyia gr. spp.	5	7	.
		Diamesa sp.	.	1	.
		Eukiefferiella brehmi gr.	.	.	1
		Parametriocnemus lundbecki	.	2	.
		Tvetenia vitracies	1	.	1
		Polypedilum flavum	13	10	4
		Polypedilum illinoense	.	1	.
		Rheotanytarsus exiguus gr.	2	4	4

		2002	2003	2004
Chironomidae	*Rheotanytarsus pellucidus*	.	1	.
	Sublettea coffmani	.	1	.
	Tanytarsus glabrescens gr.	.	.	1
	Tanytarsus guerlus gr.	.	1	3

	2002	2003	2004
SPECIES RICHNESS:	19	27	21
	(g)	(vg)	(g)
BIOTIC INDEX:	5.10	5.20	5.22
	(g)	(g)	(g)
EPT RICHNESS:	7	9	6
	(g)	(g)	(g)
MODEL AFFINITY:	49	50	49
	(p)	(g)	(p)
ASSESSMENT:	Slight	Slight	Slight

DESCRIPTION: This station is located above the bridge on Mentz Church Road in Port Byron. The aquatic invertebrate community during all three years of sampling was assessed as slightly impacted. The major negative influence on water quality at this station is agricultural non-point source runoff, indicated by the high percentage of Coleoptera, Trichoptera, and Chironomidae.

STREAM SITE:	Crane Brook, Station 01A
LOCATION:	Old Route 31, Port Byron, NY
DATE:	01 August 2003
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100

ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	14
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	2
		Baetis intercalaris	3
COLEOPTERA	Gyrinidae	*Dineutus sp.*	1
	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Dubiraphia vittata*	1
		Optioservus fastiditus	4
		Optioservus trivittatus	13
		Stenelmis crenata	40
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	1
TRICHOPTERA	Philopotamidae	*Chimarra obscura*	1
	Hydropsychidae	*Cheumatopsyche sp.*	9
DIPTERA	Simuliidae	*Simulium sp.*	1
	Empididae	*Hemerodromia sp.*	4
	Chironomidae	*Thienemannimyia gr. spp.*	1
		Polypedilum illinoense	1
		Polypedilum laetum	1
		Rheotanytarsus exiguus gr.	2

SPECIES RICHNESS:	18 (poor)
BIOTIC INDEX:	5.02 (good)
EPT RICHNESS:	4 (poor)
MODEL AFFINITY:	40 (poor)
ASSESSMENT:	Moderately impacted

DESCRIPTION: Station 01A was only sampled during the summer of 2003. Water quality was assessed as moderately impacted. The macroinvertebrate community at this station is structured by its proximity to the NYS Thruway, Route 31 and upstream agricultural influences.

STREAM SITE: Crane Brook, Station 02
LOCATION: East Loop Road, Port Byron, NY
DATE: 2002 - 2004
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100

			2002	2003	2004
OLIGOCHAETA					
TUBIFICIDA	Tubificidae	*Limnodrilus hoffmeisteri*	15	.	.
		Undet. Tubificidae w/ cap. setae	75	.	.
ARTHROPODA					
CRUSTACEA					
AMPHIPODA	Gammaridae	*Gammarus sp.*	.	35	40
INSECTA					
ODONATA	Coenagrionidae	*Ischnura sp.*	.	1	.
COLEOPTERA	Psephenidae	*Psephenus herricki*	.	.	1
	Elmidae	*Dubiraphia vittata*	2	1	.
		Optioservus trivittatus	.	1	1
		Stenelmis crenata	.	.	6
		Stenelmis sp.	.	4	.
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	3	.	1
		Hydropsyche bronta	1	.	.
		Hydropsyche sparna	2	.	.
		Hydropsyche sp.	.	.	1
DIPTERA	Simuliidae	*Simulium vittatum*	.	40	35
		Simulium sp.	.	1	.
	Ephydridae	*Ephydra sp.*	1	.	.
	Syrphidae	*Eristalis sp.*	1	.	.
	Chironomidae	*Pentaneura sp.*	.	1	.
		Thienemannimyia gr. spp.	.	1	1
		Diamesa sp.	.	.	1
		Cricotopus vierriensis	.	.	1
		Chironomus sp.	.	1	.
		Cryptochironomus fulvus gr.	.	1	1
		Dicrotendipes neomodestus	.	1	.
		Microtendipes pedellus gr.	.	1	.
		Polypedilum flavum	.	1	9
		Polypedilum illinoense	.	7	.
		Polypedilum laetum	.	.	2
		Rheotanytarsus exiguus gr.	.	1	.
		Tanytarsus guerlus gr.	.	2	.
		SPECIES RICHNESS:	8	17	13
			(vp)	(p)	(p)
		BIOTIC INDEX:	9.63	6.51	6.24
			(vp)	(p)	(g)
		EPT RICHNESS:	3	0	2
			(p)	(vp)	(p)
		MODEL AFFINITY:	15	33	35
			(vp)	(vp)	(p)
		ASSESSMENT:	Severe	Moderate	Moderate

DESCRIPTION: This station had a very depauperate invertebrate community in 2002. The sample was dominated by tolerant Oligochaeta. The 2003 sample indicated some recovery. Species richness and the biotic index indicated recovery. In 2004 the sample was very similar without any drastic improvements in the community. The station was again assessed as moderately impacted.

FIELD DATA SUMMARY				
STREAM NAME: Crane Brook	DATE SAMPLED: 7/17/02, 8/1/03, 7/9/04			
REACH: Mentz Church Road to Route 31, Port Byron, New York				
FIELD PERSONNEL INVOLVED: Novak, Smith, Garry				
STATION ARRIVAL TIME AT STATION	01 (2002) 2:45	01 (2003) 1:00	01 (2004) 4:10	01A (2003) 1:25
LOCATION	Mentz Ch. Rd.	Mentz Ch. Rd.	Mentz Ch. Rd.	Rte. 31
PHYSICAL CHARACTERISTICS				
Width (meters)	6	6	5	7
Depth (meters)	0.1	0.1	0.4	0.1
Current speed (cm per sec.)	45	91	143	91
Substrate (%)				
Rock (>25.4 cm, or bedrock)	0	0	0	0
Rubble (6.35 - 25.4 cm)	40	30	30	10
Gravel (0.2 - 6.35 cm)	30	30	30	40
Sand (0.06 - 2.0 mm)	10	20	30	30
Silt (0.004 - 0.06 mm)	20	20	20	20
Embeddedness (%)	20	30	40	40
CHEMICAL MEASUREMENTS				
Temperature (^{o} C)	26	22	19	21
Specific Conductance (umhos)	484	832	706	811
Dissolved Oxygen (mg/l)	8.5	8.5	10.3	6.6
pH	8.0	8.0	8.0	7.8
BIOLOGICAL ATTRIBUTES				
Canopy (%)	40	30	25	80
Aquatic Vegetation				
algae - suspended				
algae - attached, filamentous		X		
algae - diatoms		X		X
macrophytes or moss		X		
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)				
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)	X	X	X	X
Megaloptera(dobsonflies, alderflies)	X	X	X	X
Odonata (dragonflies, damselflies)	X			
Chironomidae (midges)	X	X	X	
Simuliidae (black flies)		X		
Decapoda (crayfish)	X	X	X	X
Gammaridae (scuds)				X
Mollusca (snails, clams)				
Oligochaeta (worms)			X	
Other	X	X	X	
FAUNAL CONDITION	Good	Good	Good	Poor

FIELD DATA SUMMARY			
STREAM NAME: Crane Brook	**DATE SAMPLED: 7/17/02, 8/1/03, 7/9/04**		
REACH: East Loop Road, Port Byron, New York			
FIELD PERSONNEL INVOLVED: Novak, Smith, Garry			
STATION	02 (2002)	02 (2003)	02 (2004)
ARRIVAL TIME AT STATION	2:45	12:15	3:30
LOCATION	East Loop Rd	East Loop Rd	East Loop Rd.
PHYSICAL CHARACTERISTICS			
Width (meters)	6	6	5
Depth (meters)	0.1	0.1	0.4
Current speed (cm per sec.)		83	143
Substrate (%)			
Rock (>25.4 cm, or bedrock)		0	0
Rubble (6.35 - 25.4 cm)		30	30
Gravel (0.2 - 6.35 cm)		20	20
Sand (0.06 - 2.0 mm)		20	20
Silt (0.004 - 0.06 mm)		30	30
Embeddedness (%)		50	25
CHEMICAL MEASUREMENTS			
Temperature (^{o}C)	25	21	20
Specific Conductance (umhos)	6979	5535	1303
Dissolved Oxygen (mg/l)	0.8	8.4	9.7
pH	7.6	7.9	7.9
BIOLOGICAL ATTRIBUTES			
Canopy (%)	0	5	25
Aquatic Vegetation			
algae - suspended			
algae - attached, filamentous		X	
algae - diatoms			
macrophytes or moss	X	X	
Occurrence of Macroinvertebrates			
Ephemeroptera (mayflies)			
Plecoptera (stoneflies)			
Trichoptera (caddisflies)			X
Coleoptera (beetles)			X
Megaloptera (dobsonflies, alderflies)		X	
Odonata (dragonflies, damselflies)			
Chironomidae (midges)	X	X	X
Simuliidae (black flies)		X	X
Decapoda (crayfish)			
Gammaridae (scuds)		X	X
Mollusca (snails, clams)			
Oligochaeta (worms)	X		X
Other	X		
FAUNAL CONDITION	Very Poor	Poor	Poor

APPENDIX I. BIOLOGICAL METHODS FOR KICK SAMPLING

A. Rationale. The use of the standardized kick sampling method provides a biological assessment technique that lends itself to rapid assessments of stream water quality.

B. Site Selection. Sampling sites are selected based on these criteria: (1) The sampling location should be a riffle with a substrate of rubble, gravel, and sand. Depth should be one meter or less, and current speed should be at least 0.4 meters per second. (2) The site should have comparable current speed, substrate type, embeddedness, and canopy cover to both upstream and downstream sites to the degree possible. (3) Sites are chosen to have a safe and convenient access.

C. Sampling. Macroinvertebrates are sampled using the standardized traveling kick method. An aquatic net is positioned in the water at arms' length downstream and the stream bottom is disturbed by foot, so that the dislodged organisms are carried into the net. Sampling is continued for a specified time and for a specified distance in the stream. Rapid assessment sampling specifies sampling 5 minutes for a distance of 5 meters. The net contents are emptied into a pan of stream water. The contents are then examined, and the major groups of organisms are recorded, usually on the ordinal level (e.g., stoneflies, mayflies, caddisflies). Larger rocks, sticks, and plants may be removed from the sample if organisms are first removed from them. The contents of the pan are poured into a U.S. No. 30 sieve and transferred to a quart jar. The sample is then preserved by adding 95% ethyl alcohol.

D. Sample Sorting and Subsampling. In the laboratory, the sample is rinsed with tap water in a U.S. No. 40 standard sieve to remove any fine particles left in the residues from field sieving. The sample is transferred to an enamel pan and distributed homogeneously over the bottom of the pan. A small amount of the sample is randomly removed with a spatula, rinsed with water, and placed in a petri dish. This portion is examined under a dissecting stereomicroscope and 100 organisms are randomly removed from the debris. As they are removed, they are sorted into major groups, placed in vials containing 70 percent alcohol, and counted. The total number of organisms in the sample is estimated by weighing the residue from the picked subsample and determining its proportion of the total sample weight.

E. Organism Identification. All organisms are identified to the species level whenever possible. Chironomids and oligochaetes are slide-mounted and viewed through a compound microscope; most other organisms are identified as whole specimens using a dissecting stereomicroscope. The number of individuals in each species, and the total number of individuals in the subsample is recorded on a data sheet. All organisms from the subsample are archived, either slide-mounted or preserved in alcohol. Following identification of a subsample, if the results are ambiguous, suspected of being spurious, or do not yield a clear water quality assessment, additional subsampling may be required.

APPENDIX II. MACROINVERTEBRATE COMMUNITY PARAMETERS

1. Species richness. This is the total number of species or taxa found in the sample. Expected ranges for 100-specimen subsamples of kick samples in most streams in New York State are: greater than 26, non-impacted; 19-26, slightly impacted; 11-18, moderately impacted; less than 11, severely impacted.

2. EPT value. EPT denotes the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in an average 100-organism subsample. These are considered to be mostly clean-water organisms, and their presence generally is correlated with good water quality (Lenat, 1987). Expected ranges from most streams in New York State are: greater than 10, non-impacted; 6-10, slightly impacted; 2-5, moderately impacted; and 0-1, severely impacted.

3. Biotic index. The Hilsenhoff Biotic Index is a measure of the tolerance of the organisms in the sample to organic pollution (sewage effluent, animal wastes) and low dissolved oxygen levels. It is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals. On a 0-10 scale, tolerance values range from intolerant (0) to tolerant (10). For purposes of characterizing species' tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. Values are listed in Hilsenhoff (1987); additional values are assigned by the NYS Stream Biomonitoring Unit. The most recent values for each species are listed in the Quality Assurance document (Bode et al., 1996). Ranges for the levels of impact are: 0-4.50, non-impacted; 4.51-6.50, slightly impacted; 6.51-8.50, moderately impacted; and 8.51-10.00, severely impacted.

4. Percent Model Affinity is a measure of similarity to a model non-impacted community based on percent abundance in 7 major groups (Novak and Bode, 1992). Percentage similarity is used to measure similarity to a community of 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta, and 10% Other. Ranges for the levels of impact are: >64, non-impacted; 50-64, slightly impacted; 35-49, moderately impacted; and <35, severely impacted.

Bode, R.W., M.A. Novak, and L.E. Abele. 1996. Quality assurance work plan for biological stream monitoring in New York State. NYSDEC technical report, 89 pp.

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. The Great Lakes Entomologist 20(1): 31-39.

Lenat, D. R. 1987. Water quality assessment using a new qualitative collection method for freshwater benthic macroinvertebrates. North Carolina DEM Tech. Report. 12 pp.

Novak, M.A., and R.W. Bode. 1992. Percent model affinity: a new measure of macroinvertebrate community composition. J. N. Am. Benthol. Soc. 11(1):80-85.

APPENDIX III. LEVELS OF WATER QUALITY IMPACT IN STREAMS

The description of overall stream water quality based on biological parameters uses a four-tiered system of classification. Level of impact is assessed for each individual parameter, and then combined for all parameters to form a consensus determination. Four parameters are used: species richness, EPT value, biotic index, and percent model affinity. The consensus is based on the determination of the majority of the parameters; since parameters measure different aspects of the community, they cannot be expected to always form unanimous assessments. The ranges given for each parameter are based on 100-organism subsamples of macroinvertebrate riffle kick samples, and also apply to most multiplate samples, with the exception of percent model affinity.

1. Non-impacted

Indices reflect very good water quality. The macroinvertebrate community is diverse, usually with at least 27 species in riffle habitats. Mayflies, stoneflies, and caddisflies are well-represented; the EPT value is greater than 10. The biotic index value is 4.50 or less. Percent model affinity is greater than 64. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges which minimally alter the biota.

2. Slightly impacted

Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness usually is 19-26. Mayflies and stoneflies may be restricted, with EPT values of 6-10. The biotic index value is 4.51-6.50. Percent model affinity is 50-64. Water quality is usually not limiting to fish survival, but may be limiting to fish propagation.

3. Moderately impacted

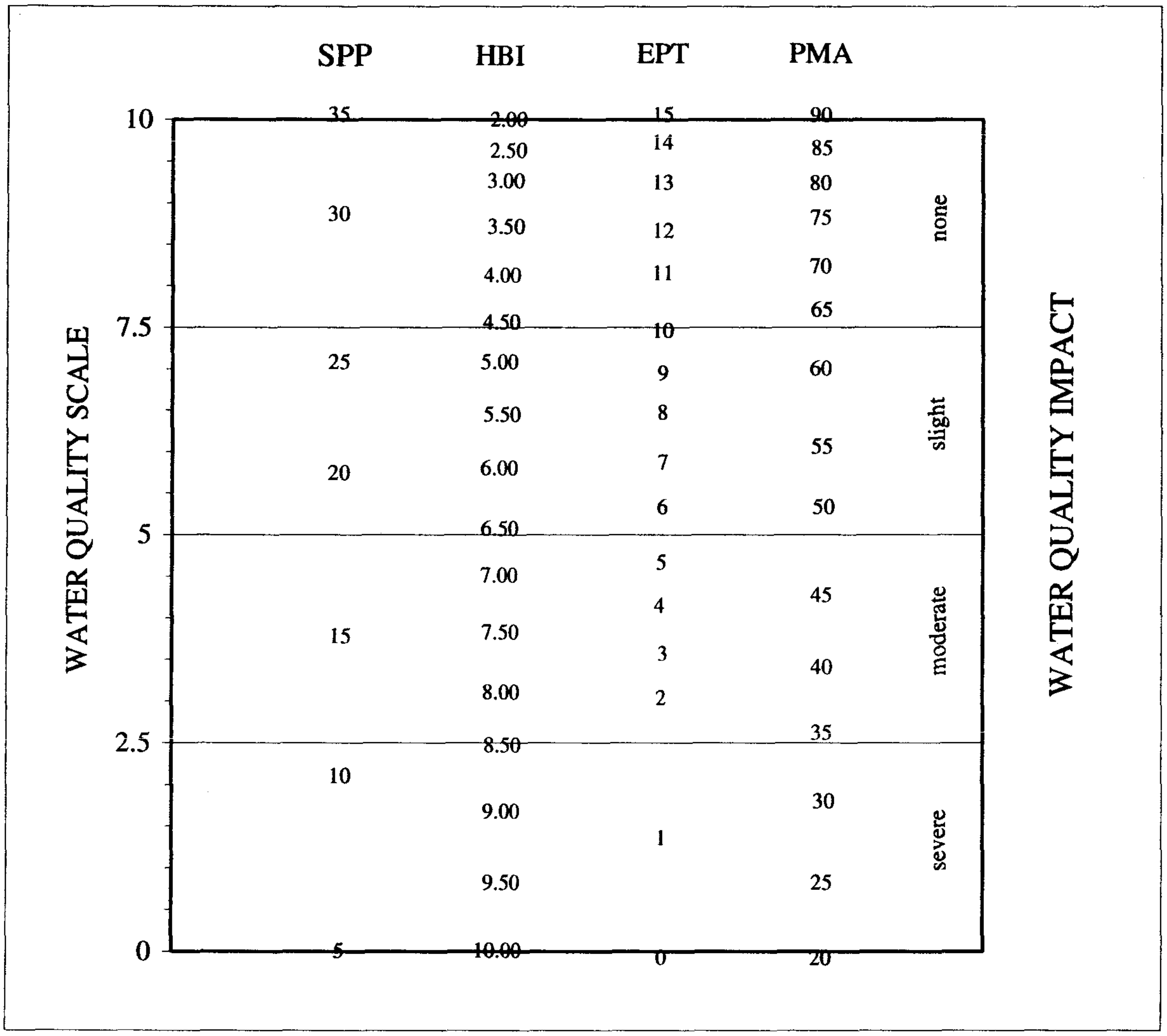
Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT value is 2-5. The biotic index value is 6.51-8.50. The percent model affinity value is 35-49. Water quality often is limiting to fish propagation, but usually not to fish survival.

4. Severely impacted

Indices reflect very poor water quality. The macroinvertebrate community is limited to a few tolerant species. Species richness is 10 or less. Mayflies, stoneflies, and caddisflies are rare or absent; EPT value is 0-1. The biotic index value is greater than 8.50. Percent model affinity is less than 35. The dominant species are almost all tolerant, and are usually midges and worms. Often 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

APPENDIX IV. BIOLOGICAL ASSESSMENT PROFILE OF INDEX VALUES

The Biological Assessment Profile of index values, developed by Mr. Phil O'Brien, Division of Water, NYSDEC, is a method of plotting biological index values on a common scale of water quality impact. Values from the four indices defined in Appendix II are converted to a common 0-10 scale as shown in the figure below.



To plot survey data, each site is positioned on the x-axis according to river miles from the mouth, and the scaled values for the four indices are plotted on the common scale. The mean scale value of the four indices represents the assessed impact for each site.

APPENDIX V. WATER QUALITY ASSESSMENT CRITERIA

non-navigable flowing waters

	Species Richness	Hilsenhoff Biotic Index	EPT Value	Percent Model Affinity#	Diversity*
Non-Impacted	>26	0.00-4.50	>10	>64	>4
Slightly Impacted	19-26	4.51-6.50	6-10	50-64	3.01-4.00
Moderately Impacted	11-18	6.51-8.50	2-5	35-49	2.01-3.00
Severely Impacted	0-10	8.51-10.00	0-1	<35	0.00-2.00

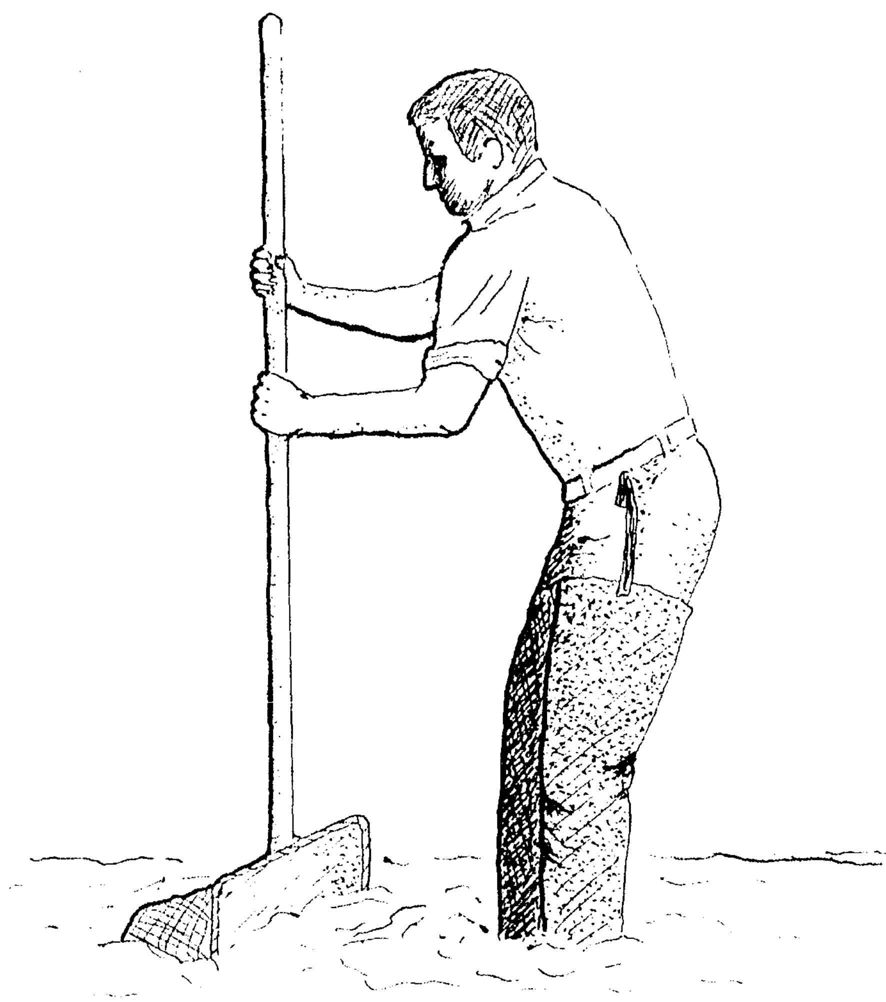
Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
* Diversity criteria are used for multiplate samples but not for traveling kick samples.

WATER QUALITY ASSESSMENT CRITERIA
for navigable flowing waters

	Species Richness	Hilsenhoff Biotic Index	EPT Value	Diversity
Non-Impacted	>21	0.00-7.00	>5	>3.00
Slightly Impacted	17-21	7.01-8.00	4-5	2.51-3.00
Moderately Impacted	12-16	8.01-9.00	2-3	2.01-2.50
Severely Impacted	0-11	9.01-10.00	0-1	0.00-2.00

APPENDIX VI.

THE TRAVELING KICK SAMPLE



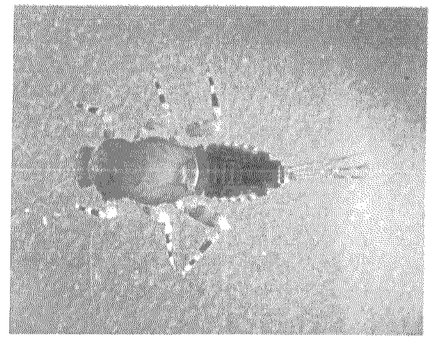
← current

Rocks and sediment in the riffle are dislodged by foot upstream of a net; organisms dislodged are carried by the current into the net. Sampling is continued for five minutes, as the sampler gradually moves downstream to cover a distance of five meters.

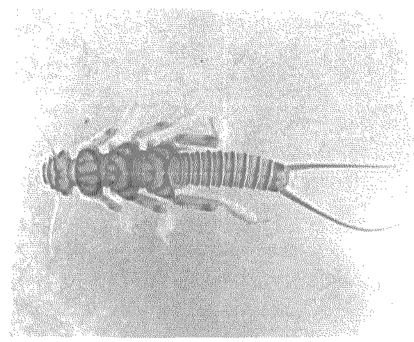
APPENDIX VII. A.

AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

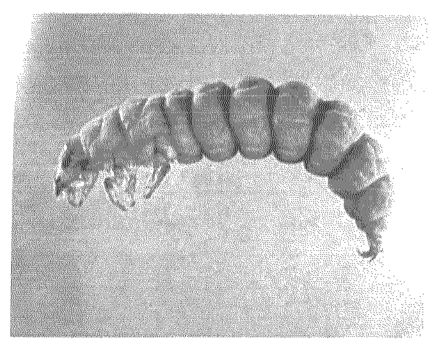
Mayfly nymphs are often the most numerous organisms found in clean streams. They are sensitive to most types of pollution, including low dissolved oxygen (less than 5 ppm), chlorine, ammonia, metals, pesticides, and acidity. Most mayflies are found clinging to the undersides of rocks.



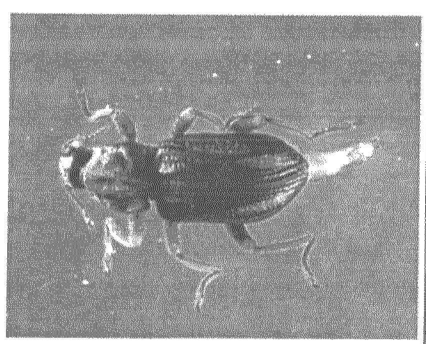
Stonefly nymphs are mostly limited to cool, well-oxygenated streams. They are sensitive to most of the same pollutants as mayflies, except acidity. They are usually much less numerous than mayflies. The presence of even a few stoneflies in a stream suggests that good water quality has been maintained for several months.

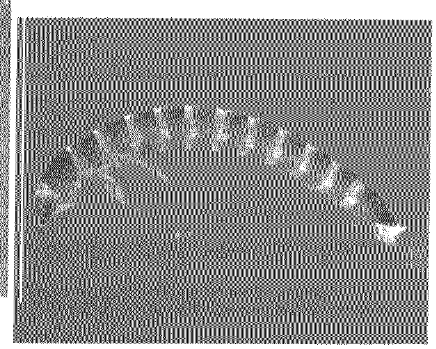


Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in nutrient-enriched stream segments.



The most common beetles in streams are riffle beetles and water pennies. Most of these require a swift current and an adequate supply of oxygen, and are generally considered clean-water indicators.

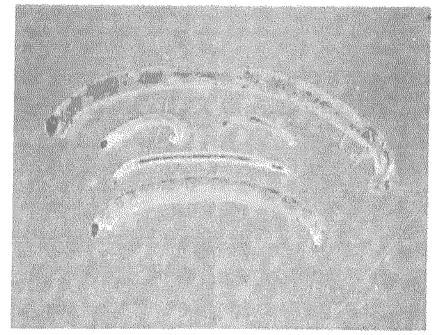




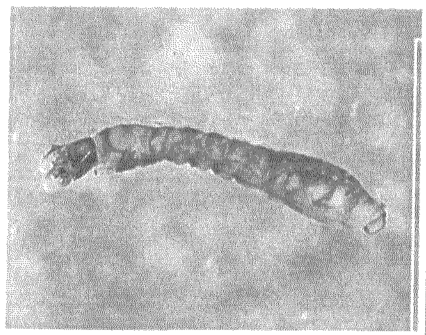
APPENDIX VII. B.

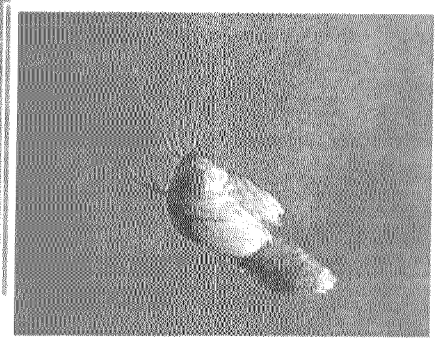
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE POOR WATER QUALITY

Midges are the most common aquatic flies. The larvae occur in almost any aquatic situation. Many species are very tolerant to pollution. Large, red midge larvae called "bloodworms" indicate organic enrichment. Other midge larvae filter plankton, indicating nutrient enrichment when numerous.

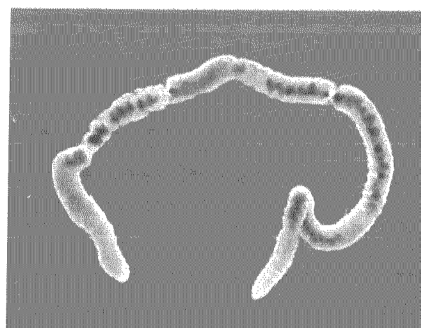


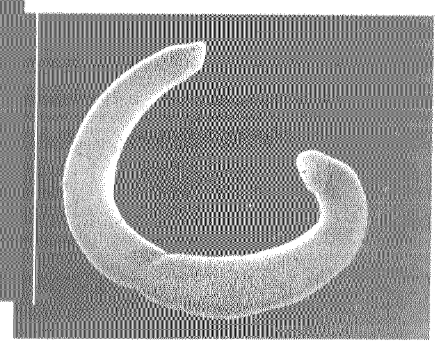
Black fly larvae have specialized structures for filtering plankton and bacteria from the water, and require a strong current. Some species are tolerant of organic enrichment and toxic contaminants, while others are intolerant of pollutants.



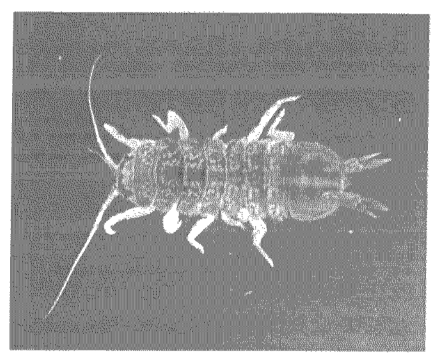


The segmented worms include the leeches and the small aquatic earthworms. The latter are more common, though usually unnoticed. They burrow in the substrate and feed on bacteria in the sediment. They can thrive under conditions of severe pollution and very low oxygen levels, and are thus valuable pollution indicators. Many leeches are also tolerant of poor water quality.





Aquatic sowbugs are crustaceans that are often numerous in situations of high organic content and low oxygen levels. They are classic indicators of sewage pollution, and can also thrive in toxic situations.



Digital images by Larry Abele, New York State Department of Environmental Conservation, Stream Biomonitoring Unit.

APPENDIX VIII. THE RATIONALE OF BIOLOGICAL MONITORING

Biological monitoring as applied here refers to the use of resident benthic macroinvertebrate communities as indicators of water quality. Macroinvertebrates are larger-than-microscopic invertebrate animals that inhabit aquatic habitats; freshwater forms are primarily aquatic insects, worms, clams, snails, and crustaceans.

Concept

Nearly all streams are inhabited by a community of benthic macroinvertebrates. The species comprising the community each occupy a distinct niche defined and limited by a set of environmental requirements. The composition of the macroinvertebrate community is thus determined by many factors, including habitat, food source, flow regime, temperature, and water quality. The community is presumed to be controlled primarily by water quality if the other factors are determined to be constant or optimal. Community components which can change with water quality include species richness, diversity, balance, abundance, and presence/absence of tolerant or intolerant species. Various indices or metrics are used to measure these community changes. Assessments of water quality are based on metric values of the community, compared to expected metric values.

Advantages

The primary advantages to using macroinvertebrates as water quality indicators are:

1) they are sensitive to environmental impacts
2) they are less mobile than fish, and thus cannot avoid discharges
3) they can indicate effects of spills, intermittent discharges, and lapses in treatment
4) they are indicators of overall, integrated water quality, including synergistic effects and substances lower than detectable limits
5) they are abundant in most streams and are relatively easy and inexpensive to sample
6) they are able to detect non-chemical impacts to the habitat, e.g. siltation or thermal changes
7) they are vital components of the aquatic ecosystem and important as a food source for fish
8) they are more readily perceived by the public as tangible indicators of water quality
9) they can often provide an on-site estimate of water quality
10) they can often be used to identify specific stresses or sources of impairment
11) they can be preserved and archived for decades, allowing for direct comparison of specimens
12) they bioaccumulate many contaminants, so that analysis of their tissues is a good monitor of toxic substances in the aquatic food chain

Limitations

Biological monitoring is not intended to replace chemical sampling, toxicity testing, or fish surveys. Each of these measurements provides information not contained in the others. Similarly, assessments based on biological sampling should not be taken as being representative of chemical sampling. Some substances may be present in levels exceeding ambient water quality criteria, yet have no apparent adverse community impact.

APPENDIX IX. GLOSSARY

assessment: a diagnosis or evaluation of water quality

benthos: organisms occurring on or in the bottom substrate of a waterbody

biomonitoring: the use of biological indicators to measure water quality

community: a group of populations of organisms interacting in a habitat

drainage basin: an area in which all water drains to a particular waterbody; watershed

EPT value: the number of species of mayflies, stoneflies, and caddisflies in a sample

facultative: occurring over a wide range of water quality; neither tolerant nor intolerant of poor water quality

fauna: the animal life of a particular habitat

impact: a change in the physical, chemical, or biological condition of a waterbody

impairment: a detrimental effect caused by an impact

index: a number, metric, or parameter derived from sample data used as a measure of water quality

intolerant: unable to survive poor water quality

macroinvertebrate: a larger-than-microscopic invertebrate animal that lives at least part of its life in aquatic habitats

multiplate: multiple-plate sampler, a type of artificial substrate sampler of aquatic macroinvertebrates

organism: a living individual

rapid bioassessment: a biological diagnosis of water quality using field and laboratory analysis designed to allow assessment of water quality in a short turn-around time; usually involves kick sampling and laboratory subsampling of the sample

riffle: wadeable stretch of stream usually with a rubble bottom and sufficient current to have the water surface broken by the flow; rapids

species richness: the number of macroinvertebrate species in a sample or subsample

station: a sampling site on a waterbody

survey: a set of samplings conducted in succession along a stretch of stream

tolerant: able to survive poor water quality

APPENDIX X. METHODS FOR IMPACT SOURCE DETERMINATION

Definition Impact Source Determination (ISD) is the procedure for identifying types of impacts that exert deleterious effects on a waterbody. While the analysis of benthic macroinvertebrate communities has been shown to be an effective means of determining severity of water quality impacts, it has been less effective in determining what kind of pollution is causing the impact. Impact Source Determination uses community types or models to ascertain the primary factor influencing the fauna.

Development of methods The method found to be most useful in differentiating impacts in New York State streams was the use of community types, based on composition by family and genus. It may be seen as an elaboration of Percent Model Affinity (Novak and Bode, 1992), which is based on class and order. A large database of macroinvertebrate data was required to develop ISD methods. The database included several sites known or presumed to be impacted by specific impact types. The impact types were mostly known by chemical data or land use. These sites were grouped into the following general categories: agricultural non-point, toxic-stressed, sewage (domestic municipal), sewage/toxic, siltation, impoundment, and natural. Each group initially contained 20 sites. Cluster analysis was then performed within each group, using percent similarity at the family or genus level. Within each group four clusters were identified, each cluster usually composed of 4-5 sites with high biological similarity. From each cluster a hypothetical model was then formed to represent a model cluster community type; sites within the cluster had at least 50 percent similarity to this model. These community type models formed the basis for Impact Source Determination (see tables following). The method was tested by calculating percent similarity to all the models, and determining which model was the most similar to the test site. Some models were initially adjusted to achieve maximum representation of the impact type. New models are developed when similar communities are recognized from several streams.

Use of the ISD methods Impact Source Determination is based on similarity to existing models of community types (see tables following). The model that exhibits the highest similarity to the test data denotes the likely impact source type, or may indicate "natural", lacking an impact. In the graphic representation of ISD, only the highest similarity of each source type is identified. If no model exhibits a similarity to the test data of greater than 50%, the determination is inconclusive. The determination of impact source type is used in conjunction with assessment of severity of water quality impact to provide an overall assessment of water quality.

Limitations These methods were developed for data derived from 100-organism subsamples of traveling kick samples from riffles of New York State streams. Application of the methods for data derived from other sampling methods, habitats, or geographical areas would likely require modification of the models.

NATURAL

	A	B	C	D	E	F	G	H	I	J	K	L	M
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	-	5	-	5	-	5	5	-	-	-	5	5
HIRUDINEA -	-	-	-	-	-	-	-	-	-	-	-	-	
GASTROPODA	-	-	-	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMMARIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
Isonychia	5	5	-	5	20	-	-	-	-	-	-	-	-
BAETIDAE	20	10	10	10	10	5	10	10	10	10	5	15	40
HEPTAGENIIDAE	5	10	5	20	10	5	5	5	5	10	10	5	5
LEPTOPHLEBIIDAE	5	5	-	-	-	-	-	-	5	-	-	25	5
EPHEMERELLIDAE	5	5	5	10	-	10	10	30	-	5	-	10	5
Caenis/Tricorythodes -	-	-	-	-	-	-	-	-	-	-	-	-	
PLECOPTERA	-	-	-	5	5	-	5	5	15	5	5	5	5
Psephenus	5	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus	5	-	20	5	5	-	5	5	5	5	-	-	-
Promoresia	5	-	-	-	-	-	25	-	-	-	-	-	-
Stenelmis	10	5	10	10	5	-	-	-	10	-	-	-	5
PHILOPOTAMIDAE	5	20	5	5	5	5	5	-	5	5	5	5	5
HYDROPSYCHIDAE	10	5	15	15	10	10	5	5	10	15	5	5	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	5	5	-	-	-	20	-	5	5	5	5	5	-
SIMULIIDAE	-	-	-	5	5	-	-	-	-	5	-	-	-
Simulium vittatum	-	-	-	-	-	-	-	-	-	-	-	-	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	5	-	-	-	-
CHIRONOMIDAE													
Tanypodinae	-	5	-	-	-	-	-	-	5	-	-	-	-
Diamesinae	-	-	-	-	-	-	5	-	-	-	-	-	-
Cardiocladius	-	5	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	5	5	-	-	10	-	-	5	-	-	5	5	5
Eukiefferiella/ Tvetenia	5	5	10	-	-	5	5	5	-	5	-	5	5
Parametriocnemus	-	-	-	-	-	-	-	5	-	-	-	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps -	-	-	-	-	20	-	-	10	20	20	5	-	
Polypedilum (all others)	5	5	5	5	5	-	5	5	-	-	-	-	-
Tanytarsini	-	5	10	5	5	20	10	10	10	10	40	5	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100

NON-POINT NUTRIENTS, PESTICIDES

	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	-	-	5	-	-	-	-	-	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	-
GAMMARIDAE	-	-	-	5	-	-	-	-	-	-
Isonychia	-	-	-	-	-	-	-	5	-	-
BAETIDAE	5	15	20	5	20	10	10	5	10	5
HEPTAGENIIDAE	-	-	-	-	5	5	5	5	-	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	5	-	-
Caenis/Tricorythodes -	-	-	-	5	-	-	5	-	5	
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
Psephenus	5	-	-	5	-	5	5	-	-	-
Optioservus	10	-	-	5	-	-	15	5	-	5
Promoresia	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	15	-	10	15	5	25	5	10	5
PHILOPOTAMIDAE	15	5	10	5	-	25	5	-	-	-
HYDROPSYCHIDAE	15	15	15	25	10	35	20	45	20	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	5	-	15	5	5	-	-	-	40	-
Simulium vittatum	-	-	-	-	-	-	-	-	5	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	-	5
CHIRONOMIDAE										
Tanypodinae	-	-	-	-	-	-	5	-	-	5
Cardiocladius	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	10	15	10	5	-	-	-	-	5	5
Eukiefferiella/ Tvetenia	-	15	10	5	-	-	-	-	5	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-
Microtendipes	-	-	-	-	-	-	-	-	-	20
Polypedilum aviceps -	-	-	-	-	-	-	-	-	-	
Polypedilum (all others)	10	10	10	10	20	10	5	10	5	5
Tanytarsini	10	10	10	5	20	5	5	10	-	10
TOTAL	100	100	100	100	100	100	100	100	100	100

	MUNICIPAL/INDUSTRIAL								TOXIC					
	A	B	C	D	E	F	G	H	A	B	C	D	E	F
PLATYHELMINTHES	-	40	-	-	-	5	-	-	-	-	-	-	5	-
OLIGOCHAETA	20	20	70	10	-	20	-	-	-	10	20	5	5	15
HIRUDINEA	-	5	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	5	-	-	-	5	-	-	-	5
SPHAERIIDAE	-	5	-	-	-	-	-	-	-	-	-	-	-	-
ASELLIDAE	10	5	10	10	15	5	-	-	10	10	-	20	10	5
GAMMARIDAE	40	-	-	-	15	-	5	5	5	-	-	-	5	5
<u>Isonychia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	5	-	-	-	5	-	10	10	15	10	20	-	-	-
HEPTAGENIIDAE	5	-	-	-	-	-	-	-	-	-	-	-	-	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Caenis/Tricorythodes</u> -	-	-	-	-	-	-	-	-	-	-	-	-	-	
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Psephenus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Optioservus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Promoresia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Stenelmis</u>	5	-	-	10	5	-	5	5	10	15	-	40	35	5
PHILOPOTAMIDAE	-	-	-	-	-	-	-	40	10	-	-	-	-	-
HYDROPSYCHIDAE	10	-	-	50	20	-	40	20	20	10	15	10	35	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Simulium vittatum</u>	-	-	-	-	-	-	20	10	-	20	-	-	-	5
EMPIDIDAE	-	5	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE														
Tanypodinae	-	10	-	-	5	15	-	-	5	10	-	-	-	25
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus/ Orthocladius</u>	5	10	20	-	5	10	5	5	15	10	25	10	5	10
<u>Eukiefferiella/ Tvetenia</u>	-	-	-	-	-	-	-	-	-	-	20	10	-	-
<u>Parametriocnemus</u>	-	-	-	-	-	-	-	-	-	-	-	5	-	-
<u>Chironomus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum aviceps</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum</u> (all others)	-	-	-	10	20	40	10	5	10	-	-	-	- -	5
Tanytarsini	-	-	-	10	10	-	5	-	-	-	-	-	-	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100

SEWAGE EFFLUENT, ANIMAL WASTES

	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	5	35	15	10	10	35	40	10	20	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	10	-	-	-	-	-	-
ASELLIDAE	5	10	-	10	10	10	10	50	-	5
GAMMARIDAE	-	-	-	-	-	10	-	10	-	-
Isonychia	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	10	5	-	-	-	-	5	-
HEPTAGENIIDAE	10	10	10	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	5	-
Caenis/Tricorythodes -	-	-	-	-	-	-	-	-	-	
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	-	10	10	-	-	-	-	-	-
PHILOPOTAMIDAE	-	-	-	-	-	-	-	-	-	-
HYDROPSYCHIDAE	45	-	10	10	10	-	-	10	5	-
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	25	10	35	-	-	5	5
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE										
Tanypodinae	-	5	-	-	-	-	-	-	5	5
Cardiocladius	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	-	10	15	-	-	10	10	-	5	5
Eukiefferiella/ Tvetenia	-	-	10	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	10	-	-	60
Polypedilum aviceps -	-	-	-	-	-	-	-	-	-	
Polypedilum (all others)	10	10	10	10	60	-	30	10	5	5
Tanytarsini	10	10	10	10	-	-	-	10	40	-
TOTAL	100	100	100	100	100	100	100	100	100	100

	SILTATION					IMPOUNDMENT									
	A	B	C	D	E	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	10	-	10	-	5	-	50	10	-
OLIGOCHAETA	5	-	20	10	5	5	-	40	5	10	5	10	5	5	-
HIRUDINEA	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	10	-	5	5	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-	-	-	5	25	-
ASELLIDAE	-	-	-	-	-	-	5	5	-	10	5	5	5	-	-
GAMMARIDAE	-	-	-	10	-	-	-	10	-	10	50	-	5	10	-
Isonychia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	20	5	-	-	5	-	5	-	-	5	-	-	5
HEPTAGENIIDAE	5	10	-	20	5	5	5	-	5	5	5	5	-	5	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis/Tricorythodes 5	20	10	5	15	-	-	-	-	-	-	-	-	-	-	
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Optioservus	5	10	-	-	-	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis	5	10	10	5	20	5	5	10	10	-	5	35	-	5	10
PHILOPOTAMIDAE	-	-	-	-	-	5	-	-	5	-	-	-	-	-	30
HYDROPSYCHIDAE	25	10	-	20	30	50	15	10	10	10	10	20	5	15	20
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
SIMULIIDAE	5	10	-	-	5	5	-	5	-	35	10	5	-	-	15
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE															
Tanypodinae	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-
Cardiocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	25	-	10	5	5	5	25	5	-	10	-	5	10	-	-
Eukiefferiella/ Tvetenia	-	-	10	-	5	5	15	-	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Polypedilum (all others)	10	10	10	5	5	5	-	-	20	-	-	5	5	5	5
Tanytarsini	10	10	10	10	5	5	10	5	30	-	-	5	10	10	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100