New York State
Department of Environmental Conservation

Division of Water

Indian River

Biological Assessment

2002 Survey

GEORGE E. PATAKI, *Governor* ERIN M. CROTTY, *Commissioner*

BIOLOGICAL STREAM ASSESSMENT

Indian River
Hamilton County, New York

Survey date: September 4, 2002
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CONTENTS

Stream: Indian River, Hamilton County, New York

Reach: vicinity of confluence with Hudson River

Background:

The Stream Biomonitoring Unit sampled the Indian River in the vicinity of its confluence with the Hudson River on September 4, 2002. The sampling was in response to a request by Mr. Richard Fenton, Division of Lands and Forests, to determine possible impacts of high summer dam releases to the biota of the river.

The purpose of the sampling was to determine the extent of any impact to resident aquatic communities of benthic macroinvertebrates, including comparison to 1993 baseline macroinvertebrate data prior to the beginning of summer releases in 1997. Triplicate traveling kick samples for macroinvertebrates were taken in riffle areas at 3 sites, using methods described in the Biological Impairment Criteria document (Bode et al., 1990). The contents of each sample were field-inspected to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of a 100-specimen subsample. Macroinvertebrate community parameters used in the determination of water quality included species richness, biotic index, EPT value, and percent model affinity (see Appendices II and III). Table 2 provides a listing of sampling sites and Figure 2 provides a map of sites. This is followed by macroinvertebrate data reports, including individual site descriptions and raw invertebrate data from each site.

Results and Conclusions:

1. The Hudson River undergoes a significant biological change downstream of the confluence with the Indian River. The loss of species and significant increase in species dominance exceeds criteria for biological impairment.

2. The Indian River is significantly poorer biologically than the Hudson River upstream of the confluence. Species richness is 41% less in the Indian River than in the Hudson River.

3. The Indian River was biologically poorer in 2001 and 2002 than in 1993. The primary changes were loss of species and loss of clean-water indicator species. This cannot be shown statistically however, because the 1993 sampling was not replicated sampling.

4. Two similar rivers in the area - the Boreas and Cedar Rivers- had faunas in 2001 that were similarly assessed as non-impacted in 1993, indicating that the Indian River change in this time period is likely due to factors other than natural processes.

Discussion

The present sampling was conducted to determine the extent of any impact caused by the Indian River releases to the downstream resident aquatic communities of benthic macroinvertebrates in the Indian River and Hudson River.

Three sites were sampled: one on the Indian River at 0.7 miles upstream of the confluence with the Hudson River (INDI-1), one site on the Hudson River at 0.4 miles upstream of the confluence with the Indian River (UHUD-X), and one site in the Hudson River directly below the confluence of the Indian River (UHUD-Y). The confluence site was situated to be in the middle of the mixing zone of the two rivers, using conductivity readings to locate equal contribution from the two rivers. Specific conductance was 68 µmhos/cm in the upstream Hudson River, 33 µmhos/cm in the Indian River, and 54 µmhos/cm at the confluence. Triplicate 2-minute kick samples were taken at each site. High-volume summer releases occur from Lake Abanakee to the Indian River, approximately 1.7 miles upstream of the INDI-1 site. Kick sampling was attempted at Hudson River sites further downstream of the confluence of the two rivers, but was not possible because of high water levels.

Based on resident macroinvertebrates, water quality in the Indian River was assessed as slightly impacted. Water quality at the upstream Hudson River site was assessed as non-impacted, and water quality at the confluence was assessed as slightly impacted (Figure 1).

Compared to the upstream Hudson River control site (UHUD-X), Biological Impairment Criteria (Bode et al, 1990) were exceeded for two metrics at the confluence site (UHUD-Y), denoting significant biological impact downstream of the Indian River confluence.

METRIC	UHUD-X	UHUD-Y	change	criterion exceedance?	
SPECIES RICHNESS	29	21	-8	-8	YES
BIOTIC INDEX	4.34	4.63	+0.29	+1.50	NO
EPT RICHNESS	13	11	-2	-4	NO
MODEL AFFINITY	73	57	-16	-20	NO
SPECIES DOMINANCE	18	38	+20	+15	YES

The Indian River macroinvertebrate fauna documented in 2001 sampling differed substantially from that sampled in 1993, when water quality was assessed as non-impacted. A comparison of the metrics between these two years shows substantial decreases in species richness and EPT richness. Because these were not replicated samples, statistical significance cannot be established in this comparison.

METRIC	INDI-1 (1993)	INDI-1 (2001)	change	criterion exceedance?	
SPECIES RICHNESS	27	15	-12	-8	YES
BIOTIC INDEX	4.89	4.54	-0.35	+1.50	NO
EPT RICHNESS	13	7	-6	-4	YES
MODEL AFFINITY	64	61	-3	-20	NO
SPECIES DOMINANCE	21	34	+13	+15	NO

Results of sampling at two other area rivers in both 1993 and 2001 - the Boreas River and the Cedar River- are presented to show comparison in the macroinvertebrate fauna in the same time period. As with the Indian River samples, the 1993 sampling was in July, and the 2001 sampling was in September. Although the Cedar River fauna showed a decrease of EPT between 1993 and 2001 that was equal to the exceedance level, this change is not considered substantial, because both values are clearly in the non-impacted range. The lack of significant change in these rivers indicates that the change observed in the Indian River during the same time period is likely due to factors other than natural processes.

METRIC	BORE-1 (1993)	BORE-1 (2001)	change	criterion	exceedance?
SPECIES RICHNESS	21	37	+16	-8	NO
BIOTIC INDEX	2.52	3.66	+1.14	+1.50	NO
EPT RICHNESS	15	21	+6	-4	NO
MODEL AFFINITY	70	71	+1	-20	NO
SPECIES DOMINANCE	21	16	-5	+15	NO

METRIC	CEDR-1 (1993)	CEDR-1 (2001)	change	criterion	exceedance?
SPECIES RICHNESS	26	33	+7	-8	NO
BIOTIC INDEX	2.32	3.36	+1.04	+1.50	NO
EPT RICHNESS	20	16	-4	-4	YES
MODEL AFFINITY	72	77	+5	-20	NO
SPECIES DOMINANCE	26	12	-14	+15	NO

A comparison is also made between the 2001 sampling of the Indian River and that of the present survey. These results were very similar, showing no change between these years.

METRIC	INDI-1 (2001)	INDI-1 (2002)	change	criterion	exceedance?
SPECIES RICHNESS	15	17	+2	-8	NO
BIOTIC INDEX	4.54	4.44	-0.10	+1.50	NO
EPT RICHNESS	7	10	+3	-4	NO
MODEL AFFINITY	61	54	-7	-20	NO
SPECIES DOMINANCE	34	24	+10	+15	NO

Impact Source Determination (Table 1, Appendix X) showed that the upstream Hudson River fauna was most similar to natural communities, the downstream Hudson River fauna was most similar to communities affected by impoundments, and the Indian River fauna was most similar to communities affected by nonpoint nutrient enrichment.

Literature Cited

Bode, R. W., M. A. Novak, and L. E. Abele. 1990. Biological impairment criteria for flowing waters in New York State. New York State Department of Environmental Conservation, Technical Memorandum, 110 pages.

Figure 1. Biological Assessment Profile of index values, Indian and Hudson Rivers, 2002. 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.

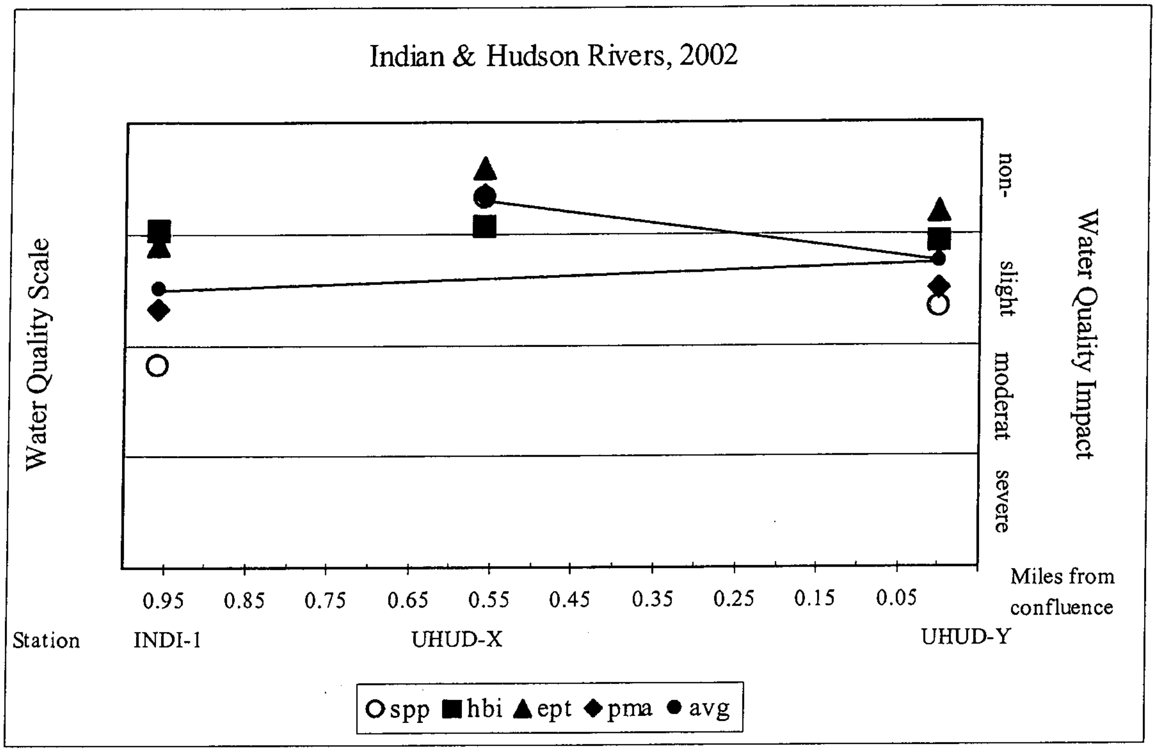


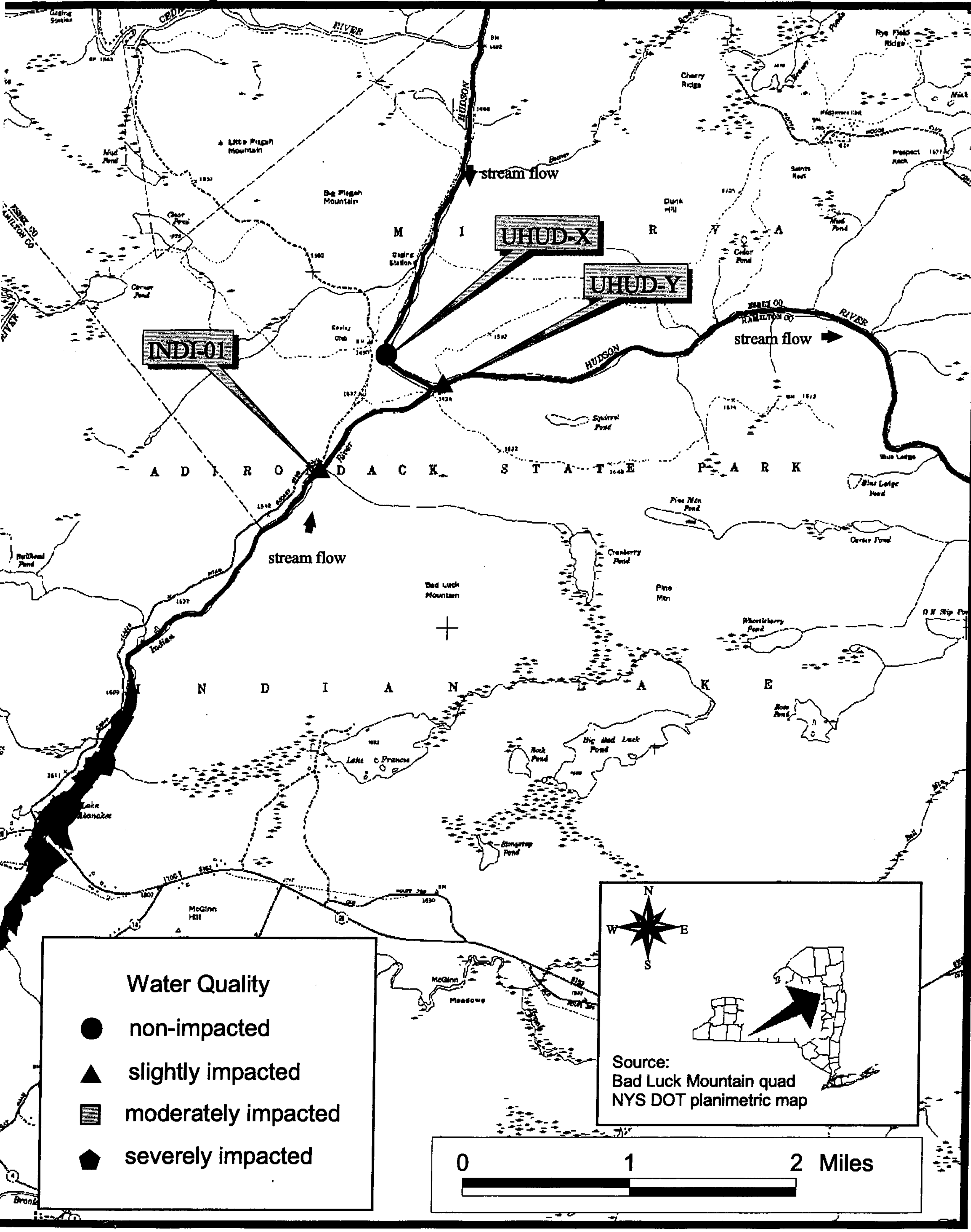
Table 1. Impact Source Determination, Indian River and Hudson River, 2002. Numbers represent similarity to community type models for each impact category. The highest similarities at each station are highlighted. Similarities less than 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix X for further explanation.

	STATION		
Community Type	UHUD-X	UHUD-Y	INDI-1
Natural: minimal human impacts	46	42	41
Nutrient additions; mostly nonpoint, agricultural	40	34	52
Toxic: industrial, municipal, or urban run-off	30	25	40
Organic: sewage effluent, animal wastes	38	30	36
Complex: municipal/industrial	24	22	43
Siltation	37	30	34
Impoundment	41	47	45

TABLE 2. STATION LOCATIONS FOR HUDSON RIVER AND INDIAN RIVER SITES

STATION	LOCATION
INDI-01	Indian River near Indian Lake, New York Chain Lakes Rd., 2.4 miles below dam Latitude/longitude 43 49 00/ 74 12 21
UHUD-X	Upper Hudson River near Indian Lake, New York Opposite Gooley Club, Gooley Club Road Latitude/longitude 43 49 35/ 74 11 56
UHUD-Y	Upper Hudson River near Indian Lake, New York At confluence with Indian River, Chain Lakes Rd. Latitude/longitude 43 49 27/ 74 11 25

Figure 2 | Site Location Map | Indian & Hudson Rivers



STREAM SITE: Upper Hudson River, Station X
LOCATION: Opposite Gooley Club, Gooley Club Rd., Indian Lake, New York
DATE: September 4, 2002
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

			B	C	D
ANNELIDA					
OLIGOCHAETA	Lumbriculidae	Undet. Lumbriculidae	.	.	1
	Lumbricina	Undet. Lumbricina	1	1	.
	Naididae	Nais variabilis	1	.	.
MOLLUSCA					
PELECYPODA	Sphaeriidae	Sphaerium sp.	15	22	18
ARTHROPODA					
INSECTA					
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	12	7	8
	Baetidae	Acentrella sp.	5	1	3
		Baetis intercalaris	2	1	.
	Heptageniidae	Epeorus sp.	2	1	2
		Leucrocuta sp.	.	1	2
		Stenonema sp.	8	2	11
	Leptohyphidae	Tricorythodes sp.	.	.	1
ODONATA	Gomphidae	Undet. Gomphidae	1	.	.
PLECOPTERA	Perlidae	Acroneuria abnormis	1	4	3
		Paragnetina immarginata	.	1	.
		Paragnetina media	.	.	1
COLEOPTERA	Elmidae	Optioservus ovalis	.	.	1
		Promoresia sp.	.	1	.
		Stenelmis concinna	6	7	4
		Stenelmis crenata	.	.	5
MEGALOPTERA	Corydalidae	Corydalus cornutus	2	6	2
TRICHOPTERA	Philopotamidae	Chimarra obscura	.	1	.
		Chimarra sp.	6	9	9
	Polycentropodidae	Neureclipsis sp.	.	.	5
	Hydropsychidae	Cheumatopsyche sp.	1	.	4
		Hydropsyche betteni	.	2	.
		Hydropsyche bronta	5	6	4
		Macrostemum sp.	1	.	2
	Hydroptilidae	Hydroptila sp.	.	1	1
	Brachycentridae	Brachycentrus appalachia	1	.	.
		Micrasema sp.	.	1	.
	Leptoceridae	Oecetis sp.	.	.	1
DIPTERA	Tipulidae	Dicranota sp.	1	.	.
	Ceratopogonidae	Undet. Ceratopogonidae	1	.	.
	Simuliidae	Simulium tuberosum	.	1	.
	Athericidae	Atherix sp.	2	1	1
	Empididae	Hemerodromia sp.	3	5	1
	Chironomidae	Potthastia gaedii gr.	.	.	1
		Camptocladius sp.	.	1	.
		Cricotopus bicinctus	1	.	.
		Cricotopus vierriensis	.	.	1
		Eukiefferiella brehmi gr.	3	1	.
		Nanocladius (Plecopteracoluthus) branchiolus	1	.	2
		Orthocladius nr. dentifer	.	1	.
		Parachaetocladius sp.	1	.	.

Rheocricotopus robacki	2	.	1
Tvetenia vitracies	4	12	5
Polypedilum flavum	2	.	.
Micropsectra dives gr.	5	1	.
Rheotanytarsus pellucidus	1	2	.
Stempellina sp. 1	3	.	.

SPECIES RICHNESS (ave. = 29, very good)	31	28	28
BIOTIC INDEX (ave. = 4.34, very good)	4.19	4.56	4.28
EPT RICHNESS (ave. = 13, very good)	11	14	15
MODEL AFFINITY (ave. = 73, very good)	78	65	72
ASSESSMENT OF IMPACT	non-	non-	non-
IMPACT SOURCE	Natural (46%)		

DESCRIPTION: the kick samples were taken in the Hudson River opposite the Gooley Club house, upstream of the bend in the river. The substrate included many large rocks, which somewhat impeded the kick sampling procedure. The samples contained mayflies, stoneflies, caddisflies, and hellgrammites, but were judged to be low in biomass. All metric values averaged from the three samples were within the range of non-impacted water quality.

STREAM SITE:	Indian River Station 01
LOCATION:	Chain Lakes Rd., 2.4 mi. below dam , Indian Lake, New York
DATE:	September 4, 2002
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

			A	B	C
NEMERTEA		Prostoma graecense	1	1	2
ANNELIDA					
OLIGOCHAETA	Lumbriculidae	Undet. Lumbriculidae	.	1	1
MOLLUSCA					
GASTROPODA	Physidae	Physella sp.	.	1	.
	Ancylidae	Ferrissia sp.	.	.	1
PELECYPODA	Sphaeriidae	Sphaerium sp.	14	12	24
ARTHROPODA					
INSECTA					
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	10	10	11
	Baetidae	Acentrella sp.	6	13	10
		Baetis flavistriga	2	1	2
	Heptageniidae	Epeorus sp.	.	.	1
		Stenonema sp.	.	1	1
PLECOPTERA	Perlidae	Acroneuria abnormis	3	2	2
COLEOPTERA	Psephenidae	Ectopria nervosa	.	.	1
	Elmidae	Optioservus ovalis	4	.	1
		Optioservus sp.	.	1	.
		Promoresia sp.	4	1	.
MEGALOPTERA	Corydalidae	Corydalus cornutus	1	.	.
TRICHOPTERA	Philopotamidae	Chimarra obscura	12	8	7
		Chimarra sp.	3	.	1
	Hydropsychidae	Hydropsyche morosa	1	.	1
		Hydropsyche sparna	30	19	22
		Macrostemum carolina	7	15	7
	Glossosomatidae	Glossosoma sp.	.	1	4
DIPTERA	Empididae	Hemerodromia sp.	.	4	.
	Chironomidae	Eukiefferiella brehmi gr.	2	.	1
		Tvetenia vitracies	.	8	.
		Sublettea coffmani	.	1	.

	A	B	C
SPECIES RICHNESS (ave. = 17, poor)	15	18	19
BIOTIC INDEX (ave. = 4.44, very good)	4.47	4.37	4.48
EPT RICHNESS (ave. = 10, good)	9	9	12
MODEL AFFINITY (ave. = 54, good)	51	59	51
ASSESSMENT OF IMPACT	slight	slight	slight
IMPACT SOURCE	Nutrient enrichment (52%)		

DESCRIPTION: the sampling site was off Chain Lakes Road, opposite the gate, 3.2 miles from Route 28. The stream substrate was adequate, although high embeddedness somewhat impeded the kick sampling process. The samples contained mayflies, stoneflies, and caddisflies, but were judged to be very low in biomass. Filtering caddisflies dominated the samples, and fingernail clams were also numerous. Based on the metrics, water quality was assessed as slightly impacted.

STREAM SITE: Upper Hudson River, Station Y
LOCATION: Below Indian River confluence, Chain Lakes Rd., Indian Lake, New York
DATE: September 4, 2002
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

			A	B	C
ANNELIDA					
OLIGOCHAETA	Lumbricina	Undet. Lumbricina	1	.	.
	Naididae	Nais variabilis	1	.	.
MOLLUSCA					
GASTROPODA	Physidae	Physella sp.	1	1	1
		Undet. Physidae	2	.	.
PELECYPODA	Sphaeriidae	Sphaerium sp.	40	35	40
ARTHROPODA					
INSECTA					
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	12	16	12
	Baetidae	Acentrella sp.	.	1	.
		Baetis flavistriga	3	.	7
		Baetis sp.	.	1	.
	Heptageniidae	Epeorus sp.	3	4	1
		Leucrocuta sp.	.	.	1
		Stenonema sp.	1	3	1
ODONATA	Gomphidae	Undet. Gomphidae	3	.	.
PLECOPTERA	Perlidae	Acroneuria abnormis	1	.	1
		Paragnetina sp.	.	.	2
COLEOPTERA	Elmidae	Stenelmis concinna	2	.	.
		Stenelmis crenata	3	.	6
		Stenelmis sp.	.	6	.
MEGALOPTERA	Corydalidae	Corydalus cornutus	5	2	1
TRICHOPTERA	Philopotamidae	Chimarra sp.	2	5	2
	Polycentropodidae	Neureclipsis sp.	.	1	.
	Hydropsychidae	Cheumatopsyche sp.	1	.	.
		Hydropsyche bronta	.	5	2
		Hydropsyche morosa	3	.	.
		Hydropsyche sparna	3	8	5
		Macrostemum sp.	.	1	2
	Hydroptilidae	Oxyethira sp.	.	.	1
	Brachycentridae	Brachycentrus appalachia	.	1	9
DIPTERA	Ceratopogonidae	Undet. Ceratopogonidae	1	.	.
	Empididae	Hemerodromia sp.	3	2	.
	Chironomidae	Cricotopus vierriensis	.	2	.
		Eukiefferiella brehmi gr.	1	1	1
		Rheocricotopus robacki	1	.	.
		Tvetenia vitracies	6	4	4
		Polypedilum aviceps	.	1	.
		Micropsectra dives gr.	1	.	.
		Rheotanytarsus pellucidus	.	.	1

	A	B	C
SPECIES RICHNESS (ave. = 21, good)	24	20	20
BIOTIC INDEX (ave. = 4.63, good)	4.92	4.69	4.29
EPT RICHNESS (ave. = 11, very good)	9	11	13
MODEL AFFINITY (ave. = 57, good)	55	59	57
ASSESSMENT OF IMPACT	slight	slight	slight
IMPACT SOURCE	Impoundment (47%)		

DESCRIPTION: the samples were taken at the confluence of the Indian River with the Upper Hudson River, as determined by conductivity readings. The substrate was adequate, although it contained many large rocks. Replicate samples contained mayflies, stoneflies, caddisflies, and hellgrammites, but all metric values worsened compared to the upstream Hudson River samples. Based on the metrics, overall water quality was assessed as slightly impacted.

STREAM SITE:	Indian River Station 01
LOCATION:	Chain Lakes Rd., 2.4 mi. below dam , Indian Lake, New York
DATES:	July 7, 1993 and September 19, 2001
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

			1993	2001
NEMERTEA		Prostoma graecense	2	7
ANNELIDA				
OLIGOCHAETA	Lumbriculidae	Undet. Lumbriculidae	3	1
	Naididae	Nais variabilis	8	.
		Pristinella osborni	1	.
MOLLUSCA				
PELECYPODA	Sphaeriidae	Sphaerium sp.	7	34
ARTHROPODA				
INSECTA				
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	7	24
	Baetidae	Acentrella sp.	5	3
		Baetis flavistriga	.	5
		Baetis intercalaris	.	6
	Heptageniidae	Heptagenia sp.	2	.
	Ephemerellidae	Drunella cornutella	4	.
		Drunella tuberculata	4	.
		Serratella sp.	2	.
ODONATA	Aeschnidae	Boyeria sp.	.	4
PLECOPTERA	Perlidae	Agnetina capitata	1	.
		Paragnetina media	3	.
COLEOPTERA	Hydrophilidae	Undet. Hydrophilidae	.	1
	Elmidae	Optioservus sp.	.	1
MEGALOPTERA	Corydalidae	Nigronia sp.	.	4
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	15	.
	Hydropsychidae	Hydropsyche sparna	21	1
		Macrostemum carolina	.	4
	Rhyacophilidae	Rhyacophila fuscula	.	1
	Hydroptilidae	Hydroptila nr. albicornis	1	.
		Ithytrichia sp.	1	.
	Brachycentridae	Micrasema sp. 1	1	.
DIPTERA	Simuliidae	Simulium tuberosum	1	.
	Chironomidae	Cricotopus bicinctus	1	4
		Rheocricotopus robacki	2	.
		Tvetenia bavarica gr.	1	.
		Tvetenia vitracies	2	.
		Polypedilum aviceps	2	.
		Paratanytarsus dimorphis	1	.
		Rheotanytarsus exiguus gr.	1	.
		Rheotanytarsus pellucidus	1	.

	1993	2001
SPECIES RICHNESS	27	15
BIOTIC INDEX	4.89	4.54
EPT RICHNESS	13	7
MODEL AFFINITY	64	61
ASSESSMENT OF IMPACT	non-	slight

DESCRIPTION: this site was sampled in July, 1993 and September, 2001. The 1993 sampling revealed a fauna typical of non-impacted water quality, dominated by caddisflies and mayflies. The 2001 sampling showed a fauna with a high number of fingernail clams, with greatly reduced species richness and EPT species.

FIELD DATA SUMMARY				
STREAM NAME: Indian River REACH: Dam @ Lake Abanakee to confluence with Indian River FIELD PERSONNEL INVOLVED:Abele, Bode, Fenton	DATE SAMPLED: 9/4/2002			
STATION	UHUD-X	UHUD-Y	INDI-01	
ARRIVAL TIME AT STATION	10:55	12:45	2:30	
LOCATION	above Indian River confluence	below Indian River confluence	Chain Lakes Rd @ gate	
PHYSICAL CHARACTERISTICS				
Width (meters)	70	100	25	
Depth (meters)	0.5	0.3	0.3	
Current speed (cm per sec.)	100	100	110	
Substrate (%)				
Rock (>25.4 cm, or bedrock)	30	30	20	
Rubble (6.35 - 25.4 cm)	30	30	40	
Gravel (0.2 – 6.35 cm)	20	10	20	
Sand (0.06 – 2.0 mm)	20	20	20	
Silt (0.004 – 0.06 mm)	10	10	0	
Embeddedness (%)	30	20	30	
CHEMICAL MEASUREMENTS				
Temperature (° C)	21.5	22.6	22.9	
Specific Conductance (umhos)	68	54	33	
Dissolved Oxygen (mg/l)	8.4	8.5	8.3	
pH	5.9	6.6	6.6	
BIOLOGICAL ATTRIBUTES				
Canopy (%)	0	5	10	
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous	X			
algae - diatoms	XX	X		
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	
Plecoptera (stoneflies)	X	X	X	
Trichoptera (caddisflies)	X	X	X	
Coleoptera (beetles)	X	X		
Megaloptera(dobsonflies,alderflies)	X	X	X	
Odonata (dragonflies, damselflies)	X	X	X	
Chironomidae (midges)	X		X	
Simuliidae (black flies)	X			
Decapoda (crayfish)				
Gammaridae (scuds)				
Mollusca (snails, clams)		X	X	
Oligochaeta (worms)				
Other				
FAUNAL CONDITION	NON	NON	NON	

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. NYS DEC 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

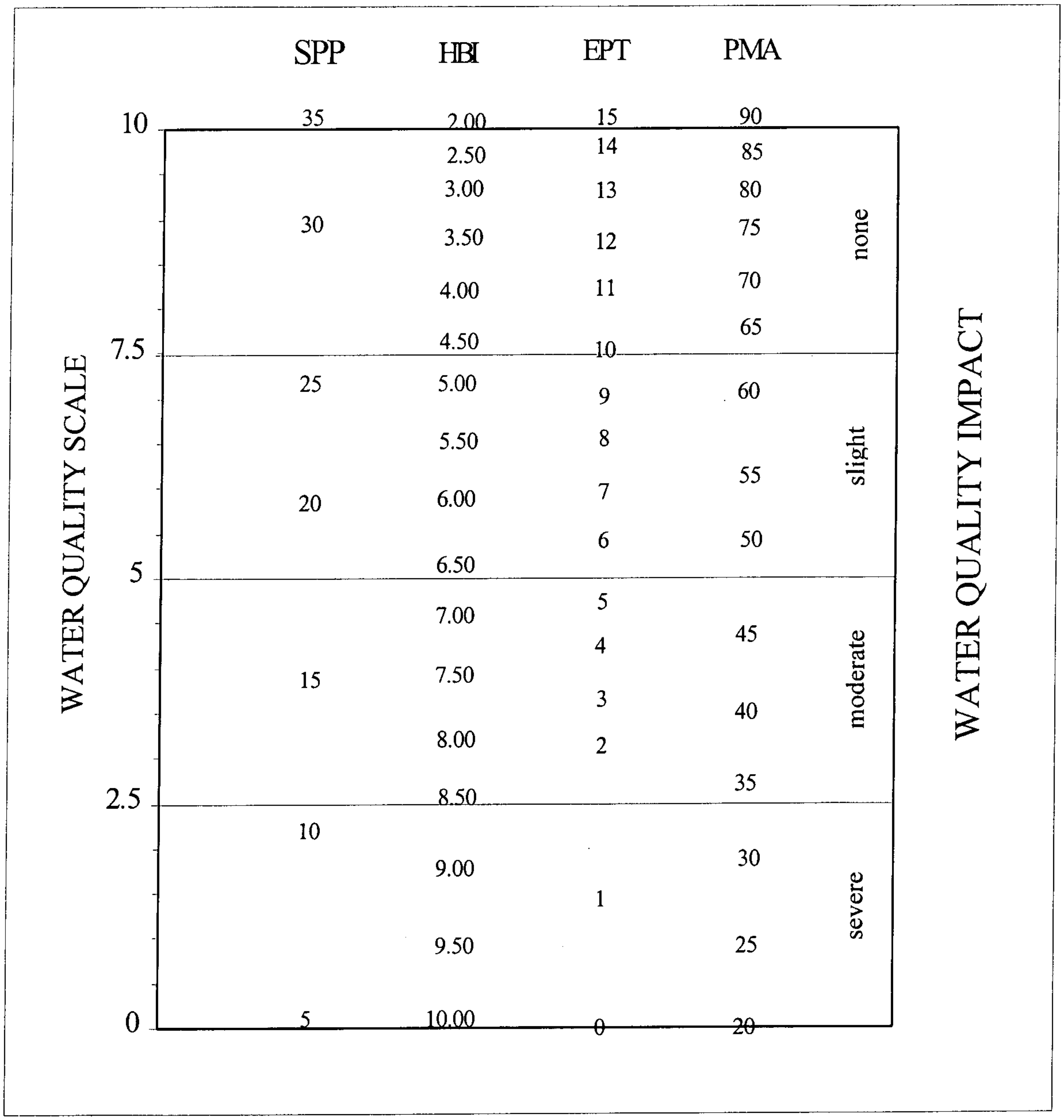
Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT value is 2-5. The biotic index value is 6.51-8.50. 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, NYS DEC, 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

for 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

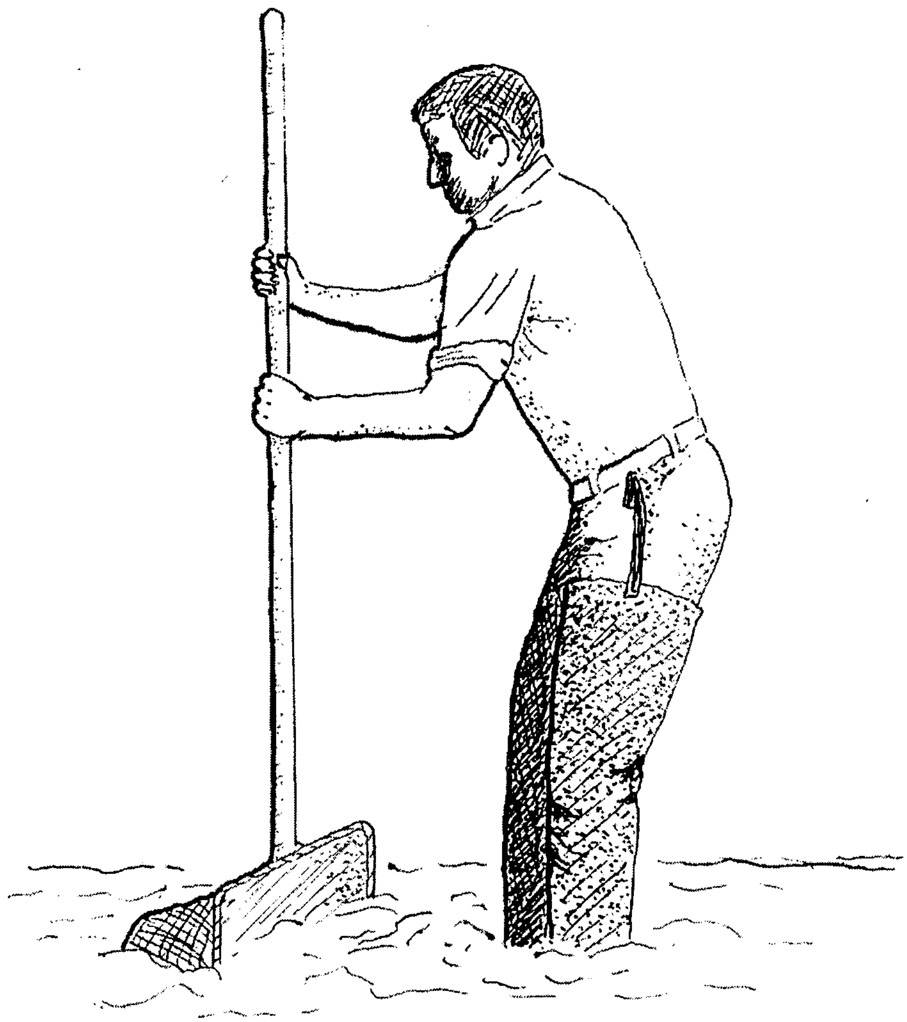
Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
* Diversity criteria are used for multiplate samples but not for traveling kick samples.

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



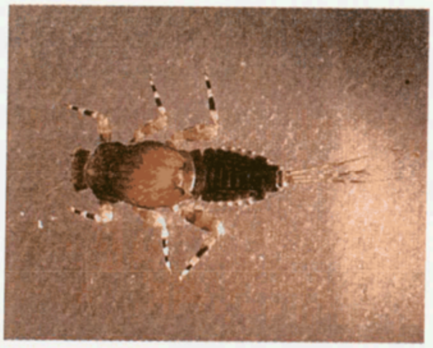
← current

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.

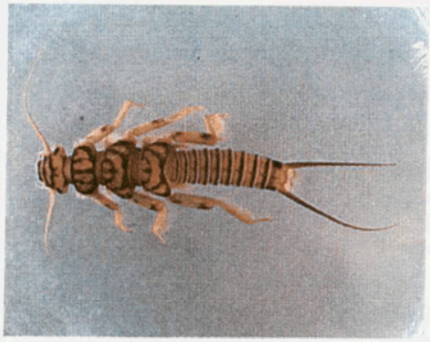
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

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.



MAYFLIES

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.



STONEFLIES

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.

CADDISFLIES

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.

BEETLES

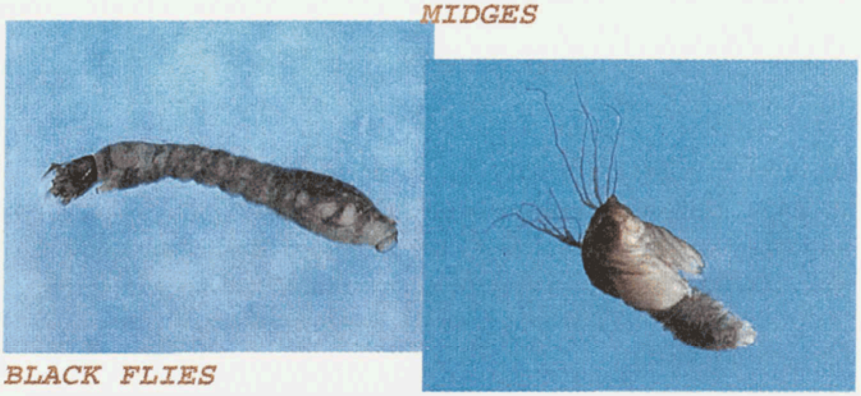
APPENDIX VII. B.

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.


MIDGES

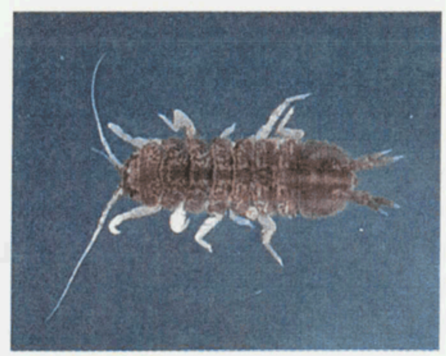
Black fly larvae have specialized structures for filtering plankton and bacteria from the water, and require a strong current. Some species are tolerant of organic enrichment and toxic contaminants, while others are intolerant of pollutants.


BLACK FLIES

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.


WORMS

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.


SOWBUGS

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 nonpoint, 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

NONPOINT 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	1[illegible]
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	-	-	5
HEPTAGENIIDAE	5	-	-	-	-	-	-	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Caenis</u>/<u>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	1[illegible]
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Simulium vittatum</u>	-	-	-	-	-	-	20	10	-	20	-	-	-	5
EMPIDIDAE	-	5	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE														
Tanypodinae	-	10	-	-	5	15	-	-	5	10	-	-	-	2[illegible]
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus</u>/ <u>Orthocladius</u>	5	10	20	-	5	10	5	5	15	10	25	10	5	1[illegible]
<u>Eukiefferiella</u>/ <u>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	1[illegible]

SEWAGE EFFLUENT, ANIMAL WASTES

	A	B	C	D	E	F	G	H	I	J
ATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
IGOCHAETA	5	35	15	10	10	35	40	10	20	15
UDINEA -	-	-	-	-	-	-	-	-	-	
STROPODA	-	-	-	-	-	-	-	-	-	-
IAERIIDAE	-	-	-	10	-	-	-	-	-	-
ELLIDAE	5	10	-	10	10	10	10	50	-	5
MMARIDAE	-	-	-	-	-	10	-	10	-	-
ychia	-	-	-	-	-	-	-	-	-	-
ETIDAE	-	10	10	5	-	-	-	-	5	-
PTAGENIIDAE	10	10	10	-	-	-	-	-	-	-
TOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
IEMERELLIDAE	-	-	-	-	-	-	-	-	5	-
nis/Tricorythodes	-	-	-	-	-	-	-	-	-	-
COPTERA	-	-	-	-	-	-	-	-	-	-
phenus	-	-	-	-	-	-	-	-	-	-
ioservus	-	-	-	-	-	-	-	-	5	-
moresia	-	-	-	-	-	-	-	-	-	-
ielmis	15	-	10	10	-	-	-	-	-	-
ILOPOTAMIDAE	-	-	-	-	-	-	-	-	-	-
DROPSYCHIDAE	45	-	10	10	10	-	-	10	5	-
LICOPSYCHIDAE/ ACHYCENTRIDAE/ YACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
IULIIDAE	-	-	-	-	-	-	-	-	-	-
ulium vittatum	-	-	-	25	10	35	-	-	5	5
PIDIDAE	-	-	-	-	-	-	-	-	-	-
RONOMIDAE										
ypodinae	-	5	-	-	-	-	-	-	5	5
diocladius	-	-	-	-	-	-	-	-	-	-
otopus/ thocladius	-	10	15	-	-	10	10	-	5	5
iefferiella/ etenia	-	-	10	-	-	-	-	-	-	-
metriocnemus	-	-	-	-	-	-	-	-	-	-
onomus	-	-	-	-	-	-	10	-	-	60
pedilum aviceps	-	-	-	-	-	-	-	-	-	-
pedilum (all others)	10	10	10	10	60	-	30	10	5	5
ytarsini	10	10	10	10	-	-	-	10	40	-
AL	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