#605

New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Hans Creek

Biological Assessment

2006 Survey

New York State
Department of Environmental Conservation

BIOLOGICAL STREAM ASSESSMENT

Hans Creek
Fulton and Saratoga Counties, New York
Upper Hudson River Basin

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Alexandria S. Kuhl
Brian Duffy
Alexander J. Smith
Robert W. Bode
Margaret A. Novak
Lawrence E. Abele
Diana L. Heitzman

Stream Biomonitoring Unit
Bureau of Water Assessment and Management
Division of Water
NYS Department of Environmental Conservation
Albany, New York

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Stream: Hans Creek, Fulton and Saratoga Counties, New York

Reach: Glenwild to Benedict, New York

NYS Drainage Basin: Upper Hudson

Background

The Stream Biomonitoring Unit and Alexandria Kuhl, a senior from Broadalbin-Perth High School under mentorship from DEC staff, sampled Hans Creek in Fulton and Saratoga counties, New York, on November 28, 2006, in order to assess overall water quality and establish baseline data for comparison to future results.

In riffle areas at four sites, a traveling kick sample for macroinvertebrates was taken using methods described in the Quality Assurance document (Bode et al., 2002) and summarized in Appendix I. The contents of each kick sample were field-inspected to determine major groups of organisms present and then preserved in alcohol for laboratory inspection of a 100-specimen subsample 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). Expected variability of results is stated in Smith and Bode (2004). Table 2 provides a listing of sampling sites and Table 3 provides a listing of all macroinvertebrate species collected in the present survey. This is followed by macroinvertebrate data reports, including the raw data for each site.

Results and Conclusions

1. Water quality in Hans Creek was non-impacted at all sites. Macroinvertebrate communities contained a diverse array of mayflies, stoneflies and caddisflies.

2. Indications of acid precipitation influence were seen at all four sites on Hans Creek. These sites are compared to four local streams to show faunal changes caused by acidic conditions.

Discussion

Hans Creek originates as the outflow of John West Vly, seven miles east of Glenwild in Saratoga County, New York. It flows 14 miles in a westerly direction before entering Great Sacandaga Lake near Benedict. The stream standards are as follows: C(T) from the mouth to below the Glenwild water intake for the City of Amsterdam and AA from the water intake to the source. Steele Creek, a tributary which joins Hans Creek just above the water intake, is classified as AA(T) (Appendix XII).

Hans Creek was previously sampled by the Stream Biomonitoring Unit at the most downstream site (Station-04) in 2001, and was assessed as non-impacted (Bode et al., 2004). The purpose of the present sampling is to establish baseline data for comparison to future results, and gain a watershed perspective on water-quality issues.

In the present study, water quality in Hans Creek and the tributary Steele Creek was assessed as non-impacted at all sites, using conventional biological methods for water quality assessment (Figure 1). Impact Source Determination (ISD) shows macroinvertebrate communities at all four Hans Creek sites to be most similar to natural communities (Table 2). The conventional metrics used in water quality assessments in New York State; species richness, EPT richness, biotic index, and percent model affinity, are not sensitive to acid impacts. The

Acid Biological Assessment Profile (AcidBAP, Appendix XI) was recently formulated using percent acid-intolerant mayflies and percent acid-tolerant individuals (Burns et al., 2008). Hans Creek sites showed non-impacted conditions using conventional metrics, but moderate to slight impact using acid-sensitive metrics (Figure 2).

In order to gain regional perspective on the status of Hans Creek, it was compared to four other local streams: Frenchmans Creek at Union Mills, Kayaderosseras Creek at Ballston Spa, Kenyetto Creek at Vail Mills, and Steele Creek at Glenwild. These streams were previously assessed as non-impacted using conventional macroinvertebrate metrics (unpublished data), as was Hans Creek. However, using the AcidBAP index, the acid impact at Hans Creek is moderate to slight, while the acid impact at the four other streams is non-impacted (Figure 2).

Two measures that are useful in assessing stream acidity are pH and acid-neutralizing capacity (ANC). ANC measures the ability of the water to buffer acid. A tiered system that assigns levels of concern to ANC values uses the following categories: low concern (ANC greater than 100 ueq/L), moderate concern (ANC 50-100 ueq/L), elevated concern (ANC 0-50 ueq/L), and acute concern (ANC less than 0 ueq/L) (Cosby et al., 2006). The corresponding expected biological effects for these tiers are: low concern - all species unaffected; moderate concern - reproducing brook trout populations remain unaffected, however diversity within macroinvertebrate communities and fish species richness begins to decline; elevated concern - brook trout populations are sensitive and variable, stream biodiversity decreases significantly, and the number of acidophilic aquatic families is expected to increase, and acute concern - lethal effects on brook trout populations are expected, fish species richness is depleted, biodiversity of all macroinvertebrates is dramatically reduced, and acidophilic aquatic insect families are found in large quanities. The pH value in Hans Creek is slightly less than neutral (7), indicating that it has an acceptable level of acidity. The ANC value of 41.7, however, places Hans Creek in the elevated concern category, and likely to be affected by episodic acidification (Driscoll, et al. 2001).

Hans Creek is the main water supply for the City of Amsterdam. The Glenwild Intake pumphouse is located between stations 01 and 02 (Figure 3). Although macroinvertebrate-based assessments cannot address many aspects of the suitability of water for drinking purposes, none of the data from the present study suggests that creek water should not be used as the city water supply.

Hans Creek serves as a sport-trout fishery, with both stocked and native trout. The determination of acid impacts and low ANC raise the question of possible adverse effects on trout populations in the creek. The presence of healthy tributaries to Hans Creek, such as Steele Creek (ANC measured at 175), make it possible for trout to retreat to a less acid environment during periods of elevated acidity. Trout populations in Hans Creek are expected to remain stable in the near future, but should be included in any future monitoring of the stream.

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.

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Burns, D.A., K. Riva-Murray, R.W. Bode, and S. Passy. 2008. "Changes in stream chemistry and biology in response to reduced levels of acid deposition during 1987-2003 in the Neversink River Basin, Catskill Mountains." Ecological Indicators 8: 191-203.

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Driscoll, C. T., G. B. Lawrence, et al. (2001). "Acidic Deposition in the Northeastern United States: Sources and Inputs, Ecosystem Effects, and Management Strategies." BioScience 51(3): 180-198.

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.

Table 1. Station locations for Hans Creek, Fulton and Saratoga Counties, 2006.

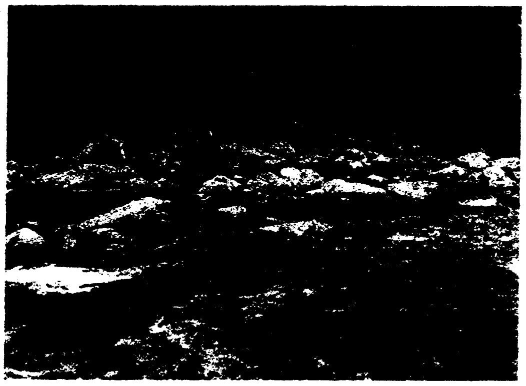
Station	Location	
HANC-01	Below Glenwild, NY Hans Creek Road, above Glenwild intake, 50m below bridge Latitude: 43.13075 Longitude: -74.0755 River Mile 4.4	
HANC-02	Below Glenwild, NY 30m above Sleezer Road bridge Latitude: 43.12305 Longitude: -74.0911 River Mile 3.1	
HANC-03	Above Benedict, NY 40m above Co Rte. 14 bridge Latitude: 43.1234 Longitude: -74.11945 River Mile 1.3	
HANC-04	Above Benedict, NY 10m above Rte. 110 bridge Latitude: 43.12056 Longitude: -74.13778 River Mile 0.2	

Figure 1. Biological Assessment Profile (BAP) of index values, streams of Hans Creek, 2006. Values are plotted on a normalized scale of water quality. The BAP is the mean of the four values for each site, representing species richness (Spp), EPT richness, Hilsenhoff Biotic Index (HBI), and Percent Model Affinity (PMA). See Appendix IV for a more complete explanation.

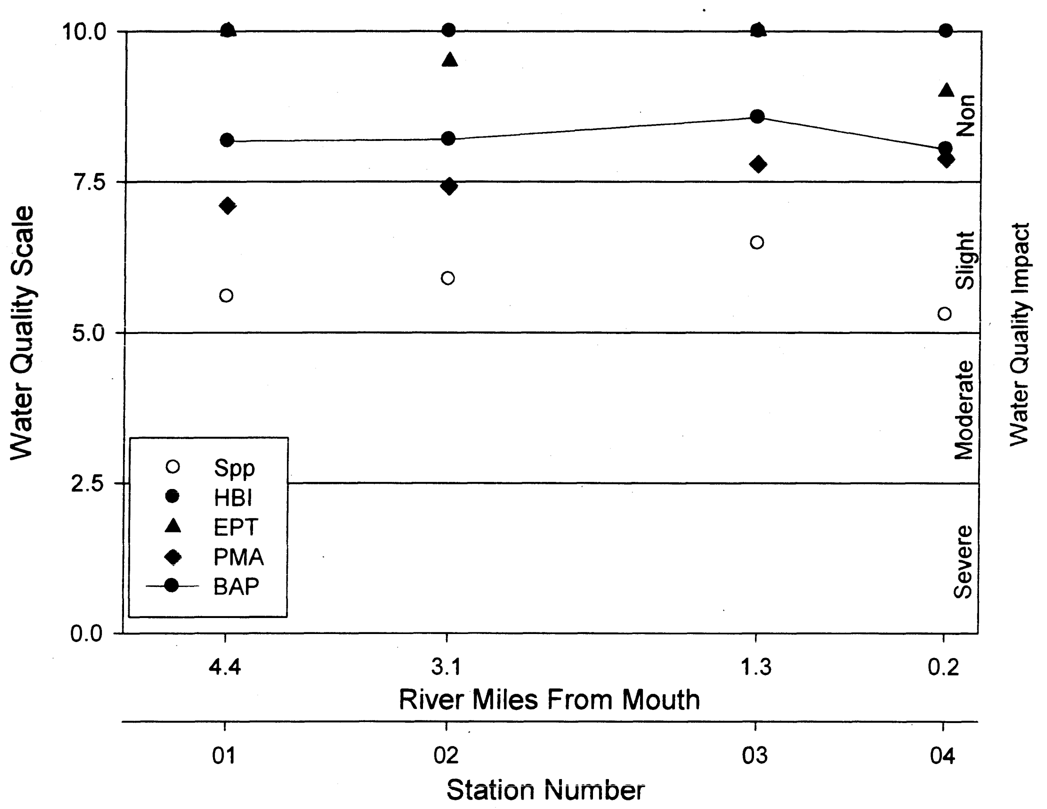


Figure 2. Acid impacts in Hans Creek compared to other local streams. See Appendix XI for derivation of the AcidBAP index.

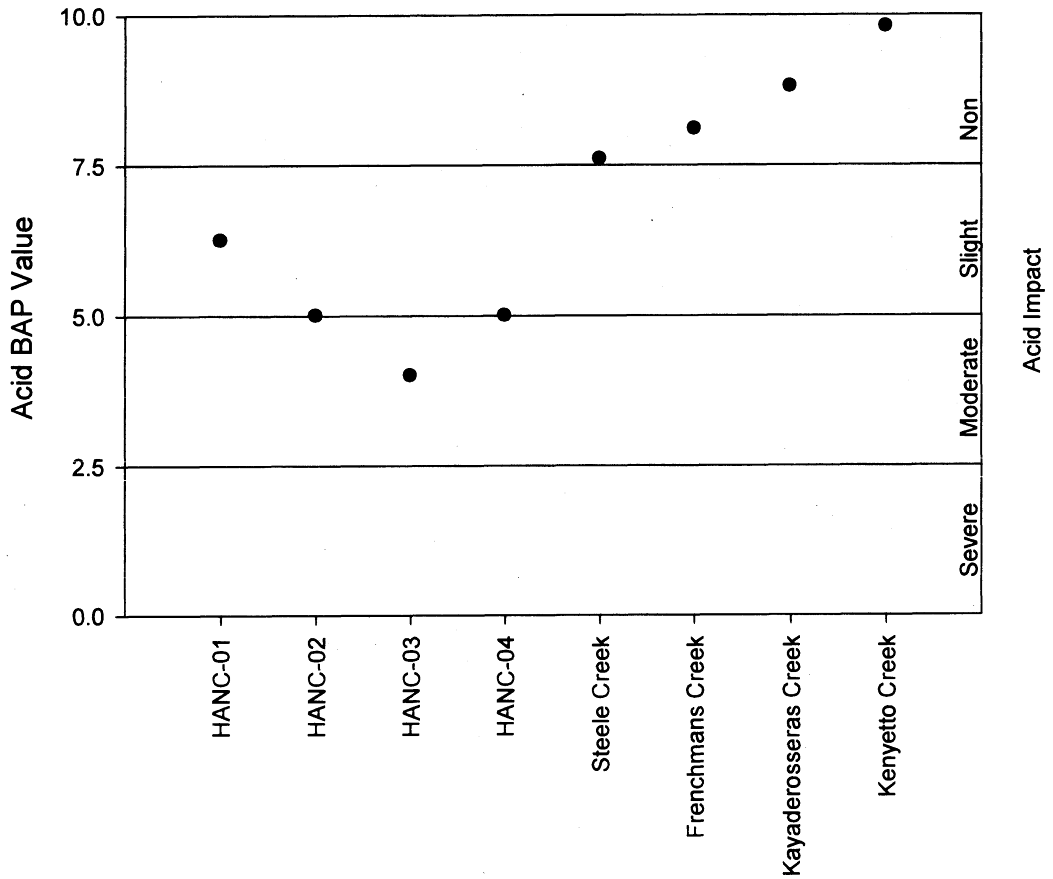


Figure 3. Overview map

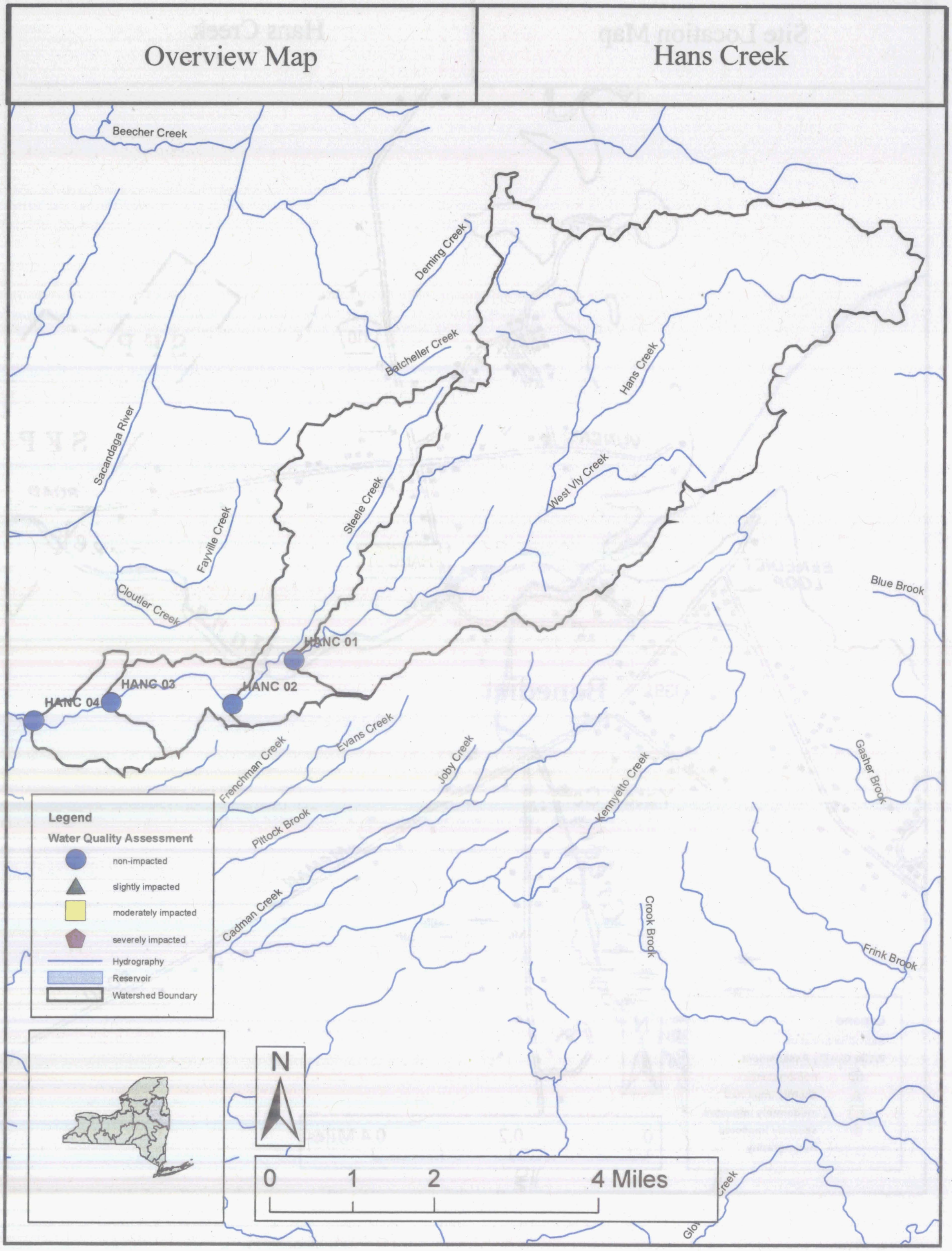


Figure 4. Site location maps
Fig. 4a. HANC-01

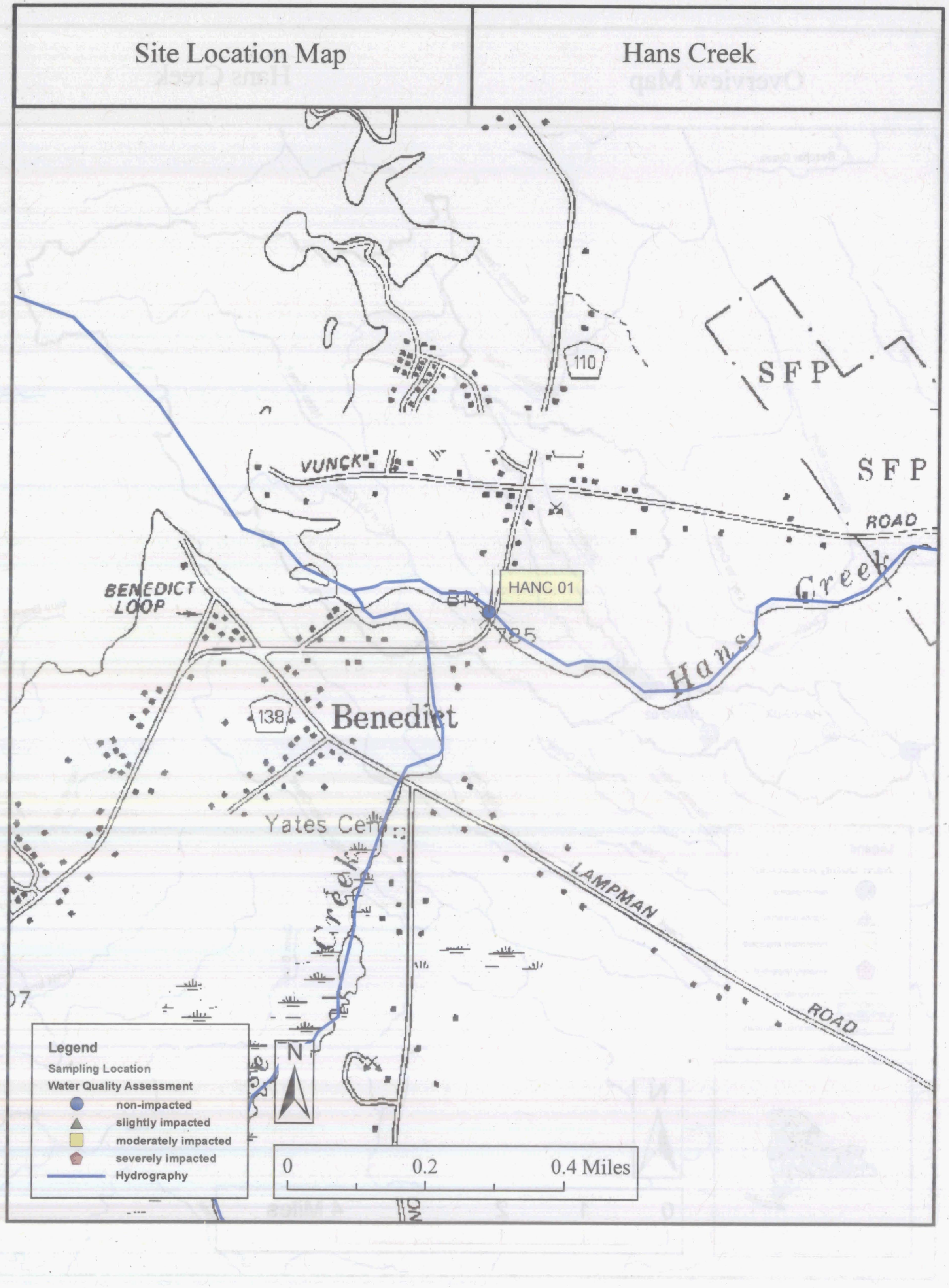


Fig. 4b. HANC-02

Site Location Map	Hans Creek

Fig. 4c. HANC-03

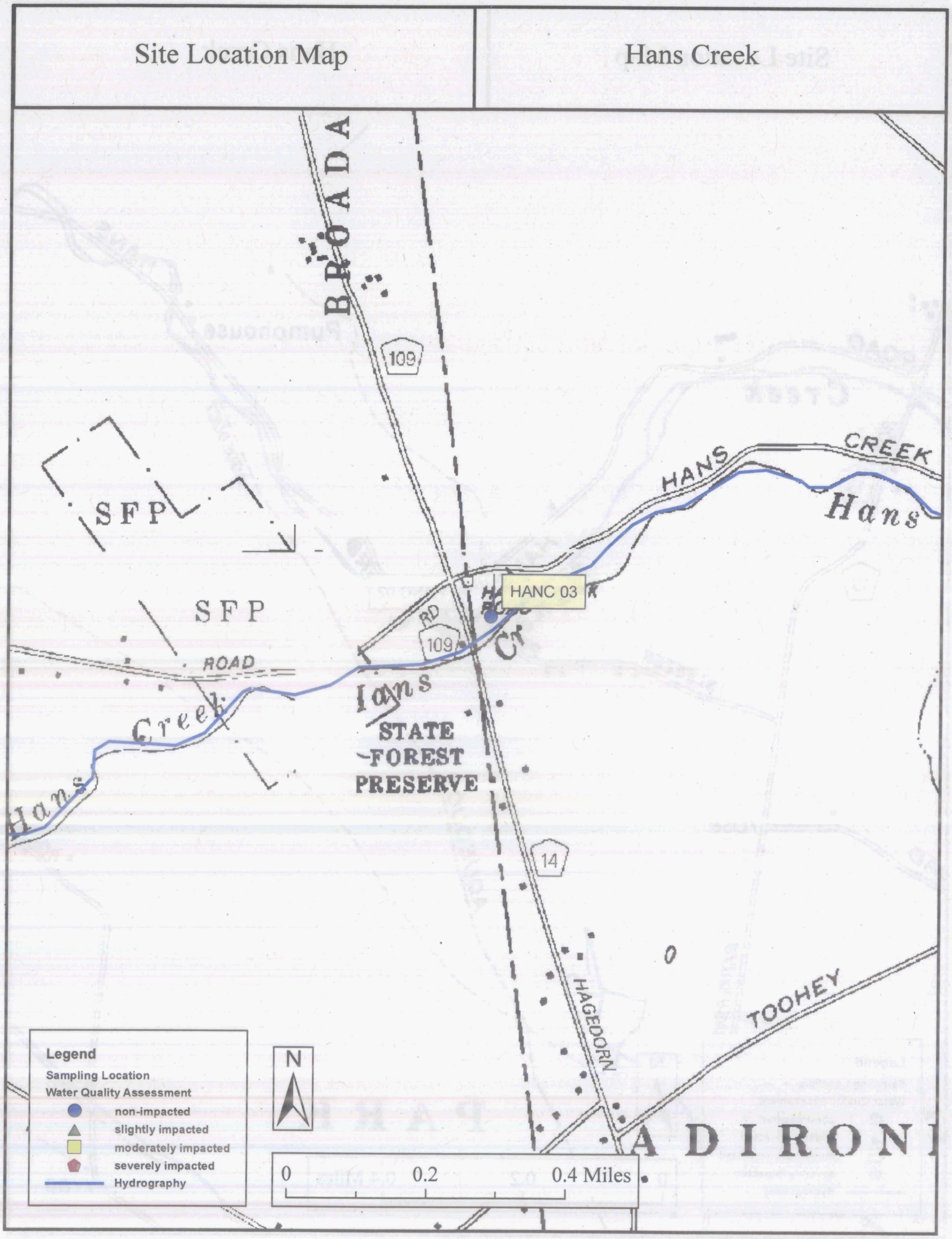


Fig. 4d. HANC-04

Table 2. Impact Source Determination (ISD) for Hans Creek, 2007. Numbers represent percent similarity to community type models for each impact category. Highest similarities at each station are shaded. Similarities of less than 50 percent are less conclusive. Highest numbers represent probable stressor(s) to the community. See Appendix XI for further explanation.

Community Type	Station			
	01	02	03	04
Natural: minimal human disturbance	39	38	43	40
Nutrient Enrichment: mostly nonpoint, agricultural	16	18	17	18
Toxic: industrial, municipal, or urban run-off	11	11	12	19
Organic: sewage effluent, animal wastes	17	19	20	21
Complex: municipal/industrial	13	14	15	20
Siltation	26	29	30	31
Impoundment	17	15	19	19

Due to a collection date (11/28/06) outside the normal sampling period, ISD models may be less accurate.
Impact Source Determinations (ISD) are intended as supplemental data to macroinvertebrate community assessments.

Table 3. Macroinvertebrate species collected in Hans Creek, Fulton and Saratoga Counties, NY.

ANNELIDA
OLIGOCHAETA
LUMBRICULIDA
Lumbriculidae
Undetermined Lumbriculidae

TUBIFICIDA
Enchytraeidae
Undetermined Enchytraeidae

ARTHROPODA
INSECTA
EPHEMEROPTERA
Heptageniidae
Epeorus (Iron) sp.
Stenonema luteum
Stenonema vicarium
Stenonema sp.
Leptophlebiidae
Paraleptophlebia sp.
Ephemerellidae
Ephemerella subvaria
Ephemerella sp.
Serratella sp.

PLECOPTERA
Leuctridae
Leuctra sp.
Taeniopterygidae
Taenionema sp.
Taeniopteryx nivalis
Perlidae
Acroneuria carolinensis
Agnetina capitata
Paragnetina immarginata
Paragnetina media
Chloroperlidae
Alloperla sp.
Undetermined Chloroperlidae
Perlodidae
Isoperla namata
Isoperla sp.

COLEOPTERA
Psephenidae
Psephenus herricki
Elmidae
Promoresia sp.
Stenelmis sp.

MEGALOPTERA
Corydalidae
Undetermined Corydalidae

TRICHOPTERA
Philopotamidae
Chimarra sp.
Dolophilodes sp.
Hydropsychidae
Hydropsyche sparna
Rhyacophilidae
Rhyacophila fuscula
Glossosomatidae
Lepidostomatidae
Lepidostoma sp.

DIPTERA
Tipulidae
Antocha sp.
Dicranota sp.
Simuliidae
Simulium vittatum
Athericidae
Atherix sp.
Chironomidae
Diamesa sp.
Eukiefferiella brehmi gr.
Parachaetocladius sp.

CRUSTACEA
DECAPODA
Cambaridae
Orconectes propinquus

INSECTA
PLECOPTERA
Perlodidae
Isoperla nana

Table 4. Macroinvertebrate Data Reports (MDRs)

Table 4a. HANC-01

STREAM SITE:	Hans Creek, Station 01
LOCATION:	NY
DATE:	11/28/2006
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA INSECTA			
EPHEMEROPTERA	Heptageniidae	*Epeorus (Iron)* sp.	17
		Stenonema vicarium	20
	Leptophlebiidae	*Paraleptophlebia* sp.	4
	Leuctridae	*Leuctra* sp.	5
PLECOPTERA	Taeniopterygidae	*Taenionema* sp.	6
		Taeniopteryx nivalis	3
	Perlidae	*Paragnetina media*	8
	Chloroperlidae	*Alloperla* sp.	1
COLEOPTERA	Elmidae	*Promoresia* sp.	1
MEGALOPTERA	Corydalidae	Undetermined Corydalidae	2
TRICHOPTERA	Philopotamidae	*Chimarra* sp.	4
		Dolophilodes sp.	1
	Hydropsychidae	*Hydropsyche sparna*	6
	Rhyacophilidae	*Rhyacophila fuscula*	4
	Glossosomatidae	*Glossosoma* sp.	3
	Lepidostomatidae	*Lepidostoma* sp.	10
	Simuliidae	*Simulium vittatum*	2
DIPTERA	Chironomidae	*Eukiefferiella brehmi gr.*	1
CRUSTACEA DECAPODA	Cambaridae	*Orconectes propinquus*	1
INSECTA PLECOPTERA	Perlodidae	*Isoperla nana*	1
		SPECIES RICHNESS:	20
		BIOTIC INDEX:	1.92
		EPT RICHNESS:	15
		MODEL AFFINITY:	62
		ASSESSMENT:	non

DESCRIPTION: This site was located 0.5 mile upstream of the water intake for the City of Amsterdam. The substrate was quite embedded, and it was difficult to take a kick sample. The macroinvertebrate community was dominated by mayflies, caddisflies and stoneflies, and the overall assessment was non-impacted water quality.

Table 4b. HANC-02

STREAM SITE:	Hans Creek, Station 02
LOCATION:	NY
DATE:	11/28/2006
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA			
	Heptageniidae	*Epeorus (Iron)* sp.	40
		Stenonema sp.	12
	Leptophlebiidae	*Paraleptophlebia* sp.	4
	Ephemerellidae	*Ephemerella subvaria*	1
		Ephemerella sp.	2
		Serratella sp.	1
PLECOPTERA	Leuctridae	*Leuctra* sp.	5
	Taeniopterygidae	*Taenionema* sp.	3
	Perlidae	*Acroneuria carolinensis*	7
		Paragnetina media	2
	Perlodidae	*Isoperla namata*	4
COLEOPTERA	Elmidae	*Stenelmis* sp.	1
MEGALOPTERA	Corydalidae	Undetermined Corydalidae	2
TRICHOPTERA	Hydropsychidae	*Hydropsyche sparna*	8
	Rhyacophilidae	*Rhyacophila fuscula*	1
	Lepidostomatidae	*Lepidostoma* sp.	1
DIPTERA	Tipulidae	*Antocha* sp.	1
		Dicranota sp.	1
	Simuliidae	*Simulium vittatum*	2
	Chironomidae	*Diamesa* sp.	1
		Parachaetocladius sp.	1
		SPECIES RICHNESS:	21
		BIOTIC INDEX:	1.56
		EPT RICHNESS:	14
		MODEL AFFINITY:	64
		ASSESSMENT:	non

DESCRIPTION: The kick sample was taken 30 meters upstream of the Sleezer Road bridge. Many large boulders were present in the stream, most with growths of diatoms. The macroinvertebrate community was heavily dominated by mayflies, with stoneflies and caddisflies also present. Overall water quality was assessed as non-impacted.

Table 4c. HANC-03

STREAM SITE:	Hans Creek, Station 03
LOCATION:	NY
DATE:	11/28/2006
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA			
	Heptageniidae	*Epeorus (Iron)* sp.	30
		Stenonema luteum	3
		Stenonema sp.	7
	Leptophlebiidae	*Paraleptophlebia* sp.	5
	Ephemerellidae	*Ephemerella* sp.	1
PLECOPTERA	Taeniopterygidae	*Taenionema* sp.	2
		Taeniopteryx nivalis	1
	Perlidae	*Acroneuria carolinensis*	1
		Agnetina capitata	1
		Paragnetina immarginata	2
	Chloroperlidae	Undetermined Chloroperlidae	6
	Perlodidae	*Isoperla* sp.	8
COLEOPTERA	Elmidae	*Stenelmis* sp.	1
MEGALOPTERA	Corydalidae	Undetermined Corydalidae	2
TRICHOPTERA	Philopotamidae	*Dolophilodes* sp.	2
	Hydropsychidae	*Hydropsyche sparna*	9
	Rhyacophilidae	*Rhyacophila fuscula*	4
	Glossosomatidae	*Glossosoma* sp.	1
	Lepidostomatidae	*Lepidostoma* sp.	5
DIPTERA	Tipulidae	*Dicranota* sp.	2
	Simuliidae	*Simulium vittatum*	2
	Athericidae	*Atherix* sp.	2
	Chironomidae	*Diamesa* sp.	3
		SPECIES RICHNESS:	23
		BIOTIC INDEX:	1.8
		EPT RICHNESS:	17
		MODEL AFFINITY:	67
		ASSESSMENT:	non

DESCRIPTION: This sampling location was 40 meters upstream of the County Route 14 bridge. Diatoms and moss were noted on the stream rocks. Mayflies, stoneflies, and caddisflies dominated the macroinvertebrate community, and water quality was assessed as non-impacted.

Table 4d. HANC-04

STREAM SITE:	Hans Creek, Station 04
LOCATION:	NY
DATE:	11/28/2006
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA			
	Lumbriculidae	Undetermined Lumbriculidae	1
TUBIFICIDA	Enchytraeidae	Undetermined Enchytraeidae	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Heptageniidae	*Epeorus (Iron)* sp.	33
		Stenonema vicarium	3
		Stenonema sp.	4
	Leptophlebiidae	*Paraleptophlebia* sp.	16
	Ephemerellidae	*Ephemerella* sp.	3
PLECOPTERA	Taeniopterygidae	*Taenionema* sp.	3
	Perlidae	*Agnetina capitata*	2
	Chloroperlidae	*Alloperla* sp.	1
	Perlodidae	*Isoperla namata*	3
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
TRICHOPTERA	Philopotamidae	*Chimarra* sp.	1
		Dolophilodes sp.	2
	Hydropsychidae	*Hydropsyche sparna*	9
	Lepidostomatidae	*Lepidostoma* sp.	7
DIPTERA	Tipulidae	*Dicranota* sp.	1
	Simuliidae	*Simulium vittatum*	8
	Chironomidae	*Parachaetocladius* sp.	1
		SPECIES RICHNESS:	19
		BIOTIC INDEX:	1.98
		EPT RICHNESS:	13
		MODEL AFFINITY:	68
		ASSESSMENT:	non

DESCRIPTION: The kick sample was taken 10 meters upstream of the Route 110 bridge at Benedict, 0.2 mile upstream of the streams mouth at Great Sacandaga Lake. Mayflies heavily dominated the macroinvertebrate community, and water quality was assessed as non-impacted.

Table 5. Laboratory data summary

LABORATORY DATA SUMMARY				
STREAM NAME: Hans Creek				
DATE SAMPLED: 11/28/2006				
SAMPLING METHOD: Kick				
LOCATION	HANC	HANC	HANC	HANC
STATION	01	02	03	04
DOMINANT SPECIES / %CONTRIBUTION / TOLERACE / COMMON NAME				
Tolerance Definitions:	1. Stenonema vicarium 20 % intolerant mayfly	Epeorus (Iron) sp. 40 % intolerant mayfly	Epeorus (Iron) sp. 30 % intolerant mayfly	Epeorus (Iron) sp. 33 % intolerant mayfly
Intolerant = not tolerant of poor water quality	2. Epeorus (Iron) sp. 17 % intolerant mayfly	Stenonema sp. 12 % intolerant mayfly	Hydropsyche sparna 9 % facultative caddisfly	Paraleptophlebia sp. 16 % intolerant mayfly
Facultative = occurring over a wide range of water quality	3. Lepidostoma sp. 10 % intolerant caddisfly	Hydropsyche sparna 8 % facultative caddisfly	Isoperla sp. 8 % intolerant stonefly	Hydropsyche sparna 9 % facultative caddisfly
Tolerant = tolerant of poor water quality	4. Paragnetina media 8 % intolerant stonefly	Acroneuria carolinensis 7 % intolerant stonefly	Stenonema sp. 7 % intolerant mayfly	Simulium vittatum 8 % facultative black fly
	5. Taenionema sp. 6 % intolerant stonefly	Leuctra sp. 5 % intolerant stonefly	Undetermined Chloroperlidae 6 % intolerant stonefly	Lepidostoma sp. 7 % intolerant caddisfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	1 (1.0)	2 (2.0)	3 (1.0)	1 (1.0)
Trichoptera (caddisflies)	28 (6.0)	10 (3.0)	21 (5.0)	19 (4.0)
Ephemeroptera (mayflies)	41 (3.0)	60 (6.0)	46 (5.0)	59 (5.0)
Plecoptera (stoneflies)	24 (6.0)	21 (5.0)	21 (7.0)	9 (4.0)
Coleoptera (beetles)	1 (1.0)	1 (1.0)	1 (1.0)	1 (1.0)
Oligochaeta (worms)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.0)
Mollusca (clams and snails)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Crustacea (crayfish, scuds, sowbugs)	1 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other insects (odonates, diptera)	4 (2.0)	6 (4.0)	8 (4.0)	9 (2.0)
Other (Nemertea, Platyhelminthes)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
SPECIES RICHNESS	20	21	23	19
BIOTIC INDEX	1.92	1.56	1.8	1.98
EPT RICHNESS	15	14	17	13
PERCENT MODEL AFFINITY	62	64	67	68
FIELD ASSESSMENT	VG	VG	VG	VG
OVERALL ASSESSMENT	non-impacted	non-impacted	non-impacted	non-impacted

Table 6. Field data summary

FIELD DATA SUMMARY				
STREAM NAME: Hans Creek	**DATE SAMPLED:** 11/28/2006			
REACH: Glenwild to Benedict				
FIELD PERSONNEL INVOLVED: Bode/Kohl/Heitzman				
STATION	01	02	03	04
ARRIVAL TIME AT STATION	2:25	1:50	1:10	12:20
LOCATION	HANC	HANC	HANC	HANC
PHYSICAL CHARACTERISTICS				
Width (meters)	15	12	10	10
Depth (meters)	0.2	0.2	0.2	0.2
Current speed (cm per sec.)	100	100	100	100
Substrate (%)				
Rock (>25.4 cm, or bedrock)	30	30	20	
Rubble (6.35 - 25.4 cm)	30	30	40	40
Gravel (0.2 - 6.35 cm)	30	30	30	40
Sand (0.06 - 2.0 mm)	10	10	10	20
Silt (0.004 - 0.06 mm)				
Embeddedness (%)	30	30	30	10
CHEMICAL MEASUREMENTS				
Temperature (°C)	5.9	5.93	6.1	6.14
Specific Conductance (umhos)	20	21	26	28
Dissolved Oxygen (mg/l)	11.32	11.4	11.4	11.6
pH	4.56	4.54	5.26	4.84
BIOLOGICAL ATTRIBUTES				
Canopy (%)	70	70	70	60
Aquatic Vegetation				
Algae - suspended				
Algae - attached, filamentous	X	X	X	X
Algae - diatoms	X	X	X	X
Macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)	X	X	X	X
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)				X
Megaloptera (dobsonflies, damselflies)	X	X	X	
Odonata (dragonflies, damselflies)				
Chironomidae (midges)			X	
Simuliidae (black flies)				
Decapoda (crayfish)	X			
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)		X		
Other				X
FAUNAL CONDITION	VG	VG	VG	VG

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 meter 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 organisms are dislodged and carried into the net. Sampling is continued for a specified time and distance in the stream. Rapid assessment sampling specifies sampling for five minutes over a distance of five meters. The contents of the net 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 are recorded on a data sheet. All organisms from the subsample are archived (either slide-mounted or preserved in alcohol). If the results of the identification process 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: the total number of species or taxa found in a sample. For subsamples of 100-organisms each that are taken from kick samples, expected ranges in most New York State streams are: greater than 26, non-impacted; 19-26, slightly impacted; 11-18, moderately impacted, and less than 11, severely impacted.

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

3. Hilsenhoff Biotic Index: a measure of the tolerance of organisms in a 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 the purpose of characterizing species' tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. Tolerance 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 Quality Assurance document, Bode et al. (2002). Impact ranges 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: a measure of similarity to a model, non-impacted community based on percent abundance in seven major macroinvertebrate groups (Novak and Bode, 1992). Percentage abundances in the model community are: 40% Ephemeroptera; 5% Plecoptera; 10% Trichoptera; 10% Coleoptera; 20% Chironomidae; 5% Oligochaeta; and 10% Other. Impact ranges are: greater than 64, non-impacted; 50-64, slightly impacted; 35-49, moderately impacted, and less than 35, severely impacted.

5. Nutrient Biotic Index: a measure of stream nutrient enrichment identified by macroinvertebrate taxa. 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 with assigned tolerance values. Tolerance values ranging from intolerant (0) to tolerant (10) are based on nutrient optima for Total Phosphorus (listed in Smith, 2005). Impact ranges are: 0-5.00, non-impacted; 5.01-6.00, slightly impacted; 6.01-7.00, moderately impacted, and 7.01-10.00, severely impacted.

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 richness, biotic index, and percent model affinity (see Appendix II). The consensus is based on the determination of the majority of the parameters. Since parameters measure different aspects of the macroinvertebrate community, they cannot be expected to always form unanimous assessments. The assessment ranges given for each parameter are based on subsamples of 100-organisms each that are taken from macroinvertebrate riffle kick samples. These assessments 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; EPT richness is greater than 10. The biotic index value is 4.50 or less. Percent model affinity is greater than 64. Nutrient Biotic Index is 5.00 or less. 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.

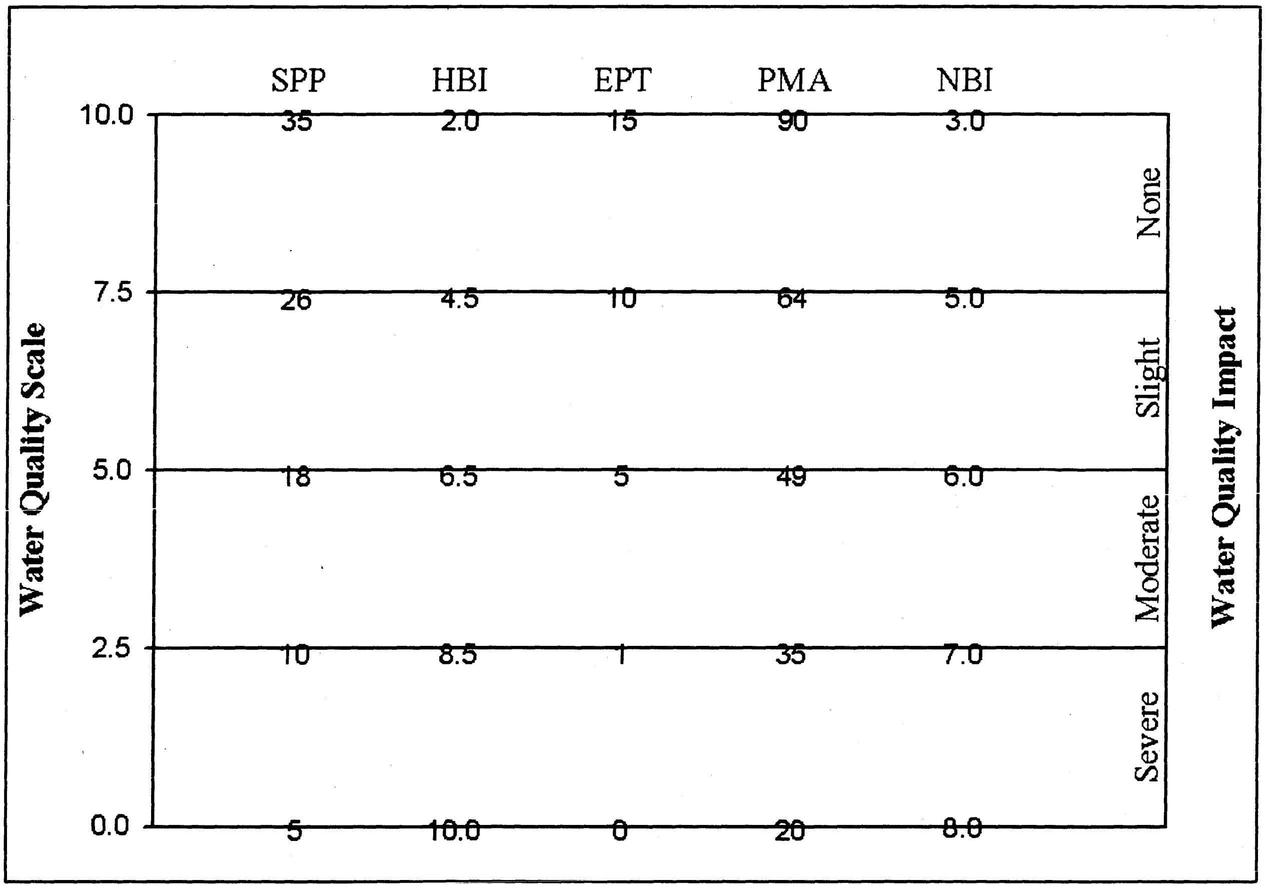
2. *Slightly impacted*: Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness is usually 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50. Percent model affinity is 50-64. Nutrient Biotic Index is 5.01-6.00. 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 is usually 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT richness is 2-5. The biotic index value is 6.51-8.50. Percent model affinity is 35-49. Nutrient Biotic Index is 6.01-7.00. 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 fewer. Mayflies, stoneflies and caddisflies are rare or absent; EPT richness is 0-1. The biotic index value is greater than 8.50. Percent model affinity is less than 35. Nutrient Biotic Index is greater than 7.00. 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-A. Biological Assessment Profile: Conversion of Index Values to a 10-Scale

The Biological Assessment Profile (BAP) of index values, developed by 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 five indices -- species richness (SPP), EPT richness (EPT), Hilsenhoff Biotic Index (HBI), Percent Model Affinity (PMA), and Nutrient Biotic Index (NBI)-- defined in Appendix II are converted to a common 0-10 scale using the formulae in the Quality Assurance document (Bode, et al., 2002), and as shown in the figure below.



Appendix IV-B. Biological Assessment Profile: Plotting Values

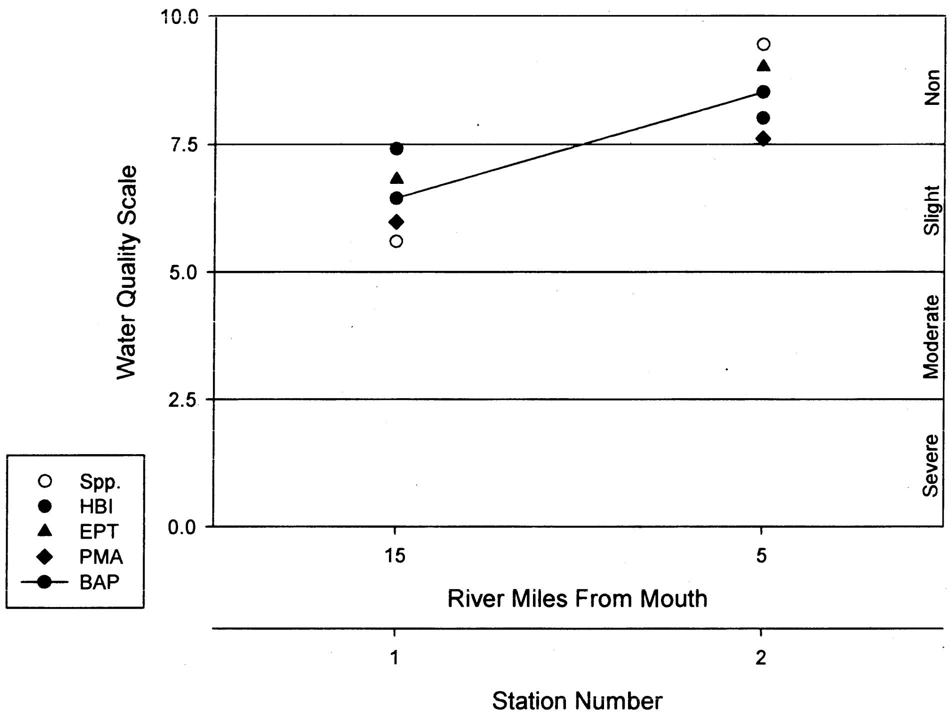
To plot survey data:

1. Position each site on the x-axis according to miles or tenths of a mile upstream of the mouth.
2. Plot the values of the four indices for each site as indicated by the common scale.
3. Calculate the mean of the four values and plot the result. This represents the assessed impact for each site.

Example data:

	Station 1		Station 2	
	metric value	10-scale value	metric value	10-scale value
Species richness	20	5.59	33	9.44
Hilsenhoff Biotic Index	5.00	7.40	4.00	8.00
EPT richness	9	6.80	13	9.00
Percent Model Affinity	55	5.97	65	7.60
Average		6.44 (slight)		8.51 (non-)

Sample BAP plot:



Appendix V. Water Quality Assessment Criteria

Non-Navigable Flowing Waters

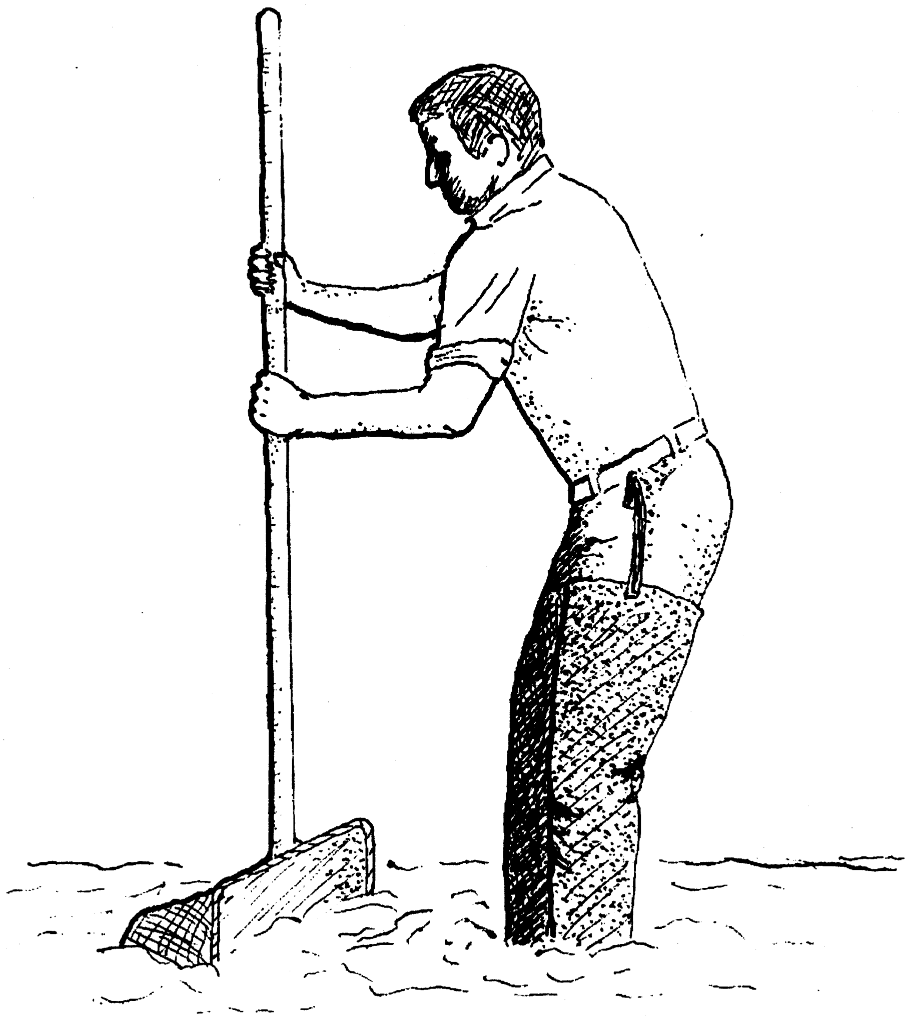
	Species Richness	Hilsenhoff Biotic Index	EPT Value	Percent Model Affinity*	Diversity **
Non-Impacted	>26	0.00-4.50	>10	>64	>4
Slightly Impacted	19-26	4.51-6.50	6-10	50-64	3.01-4.00
Moderately Impacted	11-18	6.51-8.50	2-5	35-49	2.01-3.00
Severely Impacted	0-10	8.51-10.00	0-1	<35	0.00-2.00

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

Navigable Flowing Waters

	Species Richness	Hilsenhoff Biotic Index	EPT Richness	Species 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

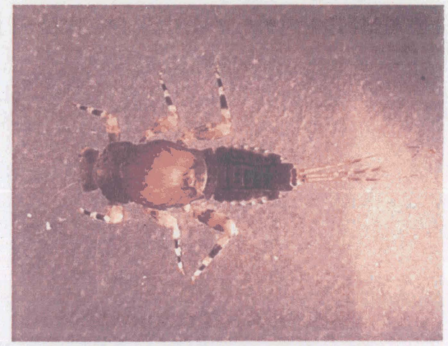


← current

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

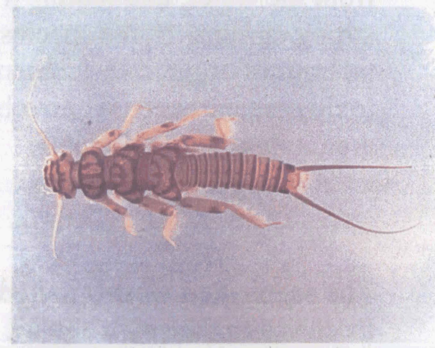
Appendix VII-A. Aquatic Macroinvertebrates Usually Indicative of Good Water Quality

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.



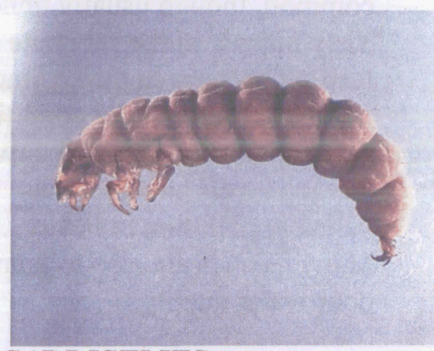
MAYFLIES

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 (adult and larva pictured) and water pennies (not shown). Most of these require a swift current and an adequate supply of oxygen, and are generally considered clean-water indicators.

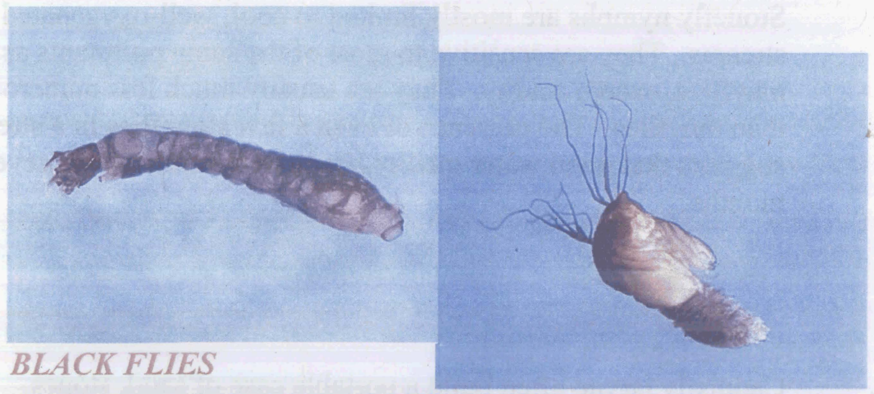
BEETLES

Appendix VII-B. Aquatic Macroinvertebrates Usually Indicative of 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.

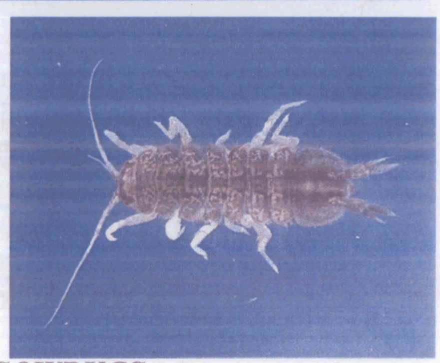


BLACK FLIES

The segmented worms include the leeches and the small aquatic worms. 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 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 that they:

- are sensitive to environmental impacts
- are less mobile than fish, and thus cannot avoid discharges
- can indicate effects of spills, intermittent discharges, and lapses in treatment
- are indicators of overall, integrated water quality, including synergistic effects
- are abundant in most streams and are relatively easy and inexpensive to sample
- are able to detect non-chemical impacts to the habitat, e.g. siltation or thermal changes
- are vital components of the aquatic ecosystem and important as a food source for fish
- are more readily perceived by the public as tangible indicators of water quality
- can often provide an on-site estimate of water quality
- can often be used to identify specific stresses or sources of impairment
- can be preserved and archived for decades, allowing for direct comparison of specimens
- 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

Anthropogenic: caused by human actions

Assessment: a diagnosis or evaluation of water quality

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

Bioaccumulate: accumulate contaminants in the tissues of an organism

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

Electrofishing: sampling fish by using electric currents to temporarily immobilize them, allowing capture

EPT richness: the number of taxa of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) in a sample or subsample

Eutrophic: high nutrient levels normally leading to excessive biological productivity

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

Longitudinal trends: upstream-downstream changes in water quality in a river or stream

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

Mesotrophic: intermediate nutrient levels (between oligotrophic and eutrophic) normally leading to moderate biological productivity

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

Non Chironomidae/Oligochaeta (NCO) richness: the number of taxa neither belonging to the family Chironomidae nor the subclass Oligochaeta in a sample or subsample

Oligotrophic: low nutrient levels normally leading to unproductive biological conditions

Organism: a living individual

PAHs: Polycyclic Aromatic Hydrocarbons, a class of organic compounds that are often toxic or carcinogenic.

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 taxa 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

Synergistic effect: an effect produced by the combination of two factors that is greater than the sum of the two factors

Tolerant: able to survive poor water quality

Trophic: referring to productivity

Appendix X. Methods for Calculation of the Nutrient Biotic Index

Definition: The Nutrient Biotic Index (Smith et al., 2007) is a diagnostic measure of stream nutrient enrichment identified by macroinvertebrate taxa. The frequency of occurrences of taxa at varying nutrient concentrations allowed the identification of taxon-specific nutrient optima using a method of weighted averaging. The establishment of nutrient optima is possible based on the observation that most species exhibit unimodal response curves in relation to environmental variables (Jongman et al., 1987). The assignment of tolerance values to taxa based on their nutrient optimum provided the ability to reduce macroinvertebrate community data to a linear scale of eutrophication from oligotrophic to eutrophic. Two tolerance values were assigned to each taxon, one for total phosphorus, and one for nitrate (listed in Smith, 2005). This provides the ability to calculate two different nutrient biotic indices, one for total phosphorus (NBI-P), and one for nitrate (NBI-N). Study of the indices indicates better performance by the NBI-P, with strong correlations to stream nutrient status assessment based on diatom information.

Calculation of the NBI-P and NBI-N: Calculation of the indices [2] follows the approach of Hilsenhoff (1987).

$$\text{NBI Score}_{(\text{TP or NO3}^-)} = \sum (a \times b) / c$$

Where ***a*** is equal to the number of individuals for each taxon, ***b*** is the taxon's tolerance value, and ***c*** is the total number of individuals in the sample for which tolerance values have been assigned.

Classification of NBI Scores: NBI scores have been placed on a scale of eutrophication with provisional boundaries between stream trophic status.

Index	Oligotrophic	Mesotrophic	Eutrophic
NBI-P	< 5.0	> 5.0 - 6.0	> 6.0
NBI-N	< 4.5	> 4.5 - 6.0	> 6.0

Jongman, R. H. G., C. J. F. ter Braak and O. F. R. van Tongeren. 1987. Data analysis in community and landscape ecology. Pudoc Wageningen, Netherlands, 299 pages.

Smith, A.J., R. W. Bode, and G. S. Kleppel. 2007. A nutrient biotic index for use with benthic macroinvertebrate communities. Ecological Indicators 7(200):371-386.

Tolerance values assigned to taxa for calculation of the Nutrient Biotic Indices

TAXON	TP T-Value	NO3 T-Value
Acentrella sp.	5	5
Acerpenna pygmaea	0	4
Acroneuria abnormis	0	0
Acroneuria sp.	0	0
Agnetina capitata	3	6
Anthopotamus sp.	4	5
Antocha sp.	8	6
Apatania sp.	3	4
Atherix sp.	8	5
Baetis brunneicolor	1	5
Baetis flavistriga	7	7
Baetis intercalaris	6	5
Baetis sp.	6	3
Baetis tricaudatus	8	9
Brachycentrus appalachia	3	4
Caecidotea racovitzai	6	2
Caecidotea sp.	7	9
Caenis sp.	3	3
Cardiocladius obscurus	8	6
Cheumatopsyche sp.	6	6
Chimarra aterrima?	2	3
Chimarra obscura	6	4
Chimarra socia	4	1
Chimarra sp.	2	0
Chironomus sp.	9	6
Cladotanytarsus sp.	6	4
Corydalus cornutus	2	2
Cricotopus bicinctus	7	6
Cricotopus tremulus gr.	8	9
Cricotopus trifascia gr.	9	9
Cricotopus vierriensis	6	5
Cryptochironomus fulvus gr.	5	6
Diamesa sp.	10	10
Dicranota sp.	5	10
Dicrotendipes neomodestus	10	4
Dolophilodes sp.	4	3
Drunella cornutella	4	4
Ectopria nervosa	10	9
Epeorus (Iron) sp.	0	0
Ephemerella sp.	4	4
Ephemerella subvaria	4	1
Ephoron leukon?	1	1
Eukiefferiella devonica gr.	9	9
Ferrissia sp.	9	5
Gammarus sp.	8	9
Glossosoma sp.	6	0
Goniobasis livescens	10	10
Helicopsyche borealis	1	2
Hemerodromia sp.	5	6
Heptagenia sp.	0	0
Hexatoma sp.	0	1
Hydropsyche betteni	7	9
Hydropsyche bronta	7	6
Hydropsyche morosa	5	1
Hydropsyche scalaris	3	3
Hydropsyche slossonae	6	10
Hydropsyche sp.	5	4
Hydropsyche sparna	6	7
Hydroptila consimilis	9	10
Hydroptila sp.	6	6
Hydroptila spatulata	9	8
Isonychia bicolor	5	2
Lepidostoma sp.	2	0
Leucotrichia sp.	6	2
Leucrocuta sp.	1	3
Macrostemum carolina	7	2
Macrostemum sp.	4	2
Micrasema sp. 1	1	0
Micropsectra dives gr.	6	9
Micropsectra polita	0	7
Micropsectra sp.	3	1
Microtendipes pedellus gr.	7	7
Microtendipes rydalensis gr.	2	1
Nais variabilis	5	0
Neoperla sp.	5	5
Neureclipsis sp.	3	1
Nigronia serricornis	10	8
Nixe (Nixe) sp.	1	5
Ophiogomphus sp.	1	3
Optioservus fastiditus	6	7
Optioservus ovalis	9	4
Optioservus sp.	7	8
Optioservus trivittatus	7	6
Orthocladius nr. dentifer	3	7
Pagastia orthogonia	4	8
Paragnetina immarginata	1	2
Paragnetina media	6	3
Paragnetina sp.	1	6
Paraleptophlebia mollis	2	1
Paraleptophlebia sp.	2	3
Parametriocnemus lundbecki	8	10
Paratanytarsus confusus	5	8
Pentaneura sp.	0	1
Petrophila sp.	5	3
Phaenopsectra dyari?	4	5
Physella sp.	8	7
Pisidium sp.	8	10
Plauditus sp.	2	6
Polycentropus sp.	4	2
Polypedilum aviceps	5	7
Polypedilum flavum	9	7
Polypedilum illinoense	10	7
Polypedilum laetum	7	6
Polypedilum scalaenum gr.	10	6
Potthastia gaedii gr.	9	10
Promoresia elegans	10	10
Prostoma graecense	2	7
Psephenus herricki	10	9
Psephenus sp.	3	4

NBI tolerance values (cont'd)

TAXON	TP T-Value	NO3 T-Value
Psychomyia flavida	1	0
Rheocricotopus robacki	4	4
Rheotanytarsus exiguus gr.	6	5
Rheotanytarsus pellucidus	3	2
Rhithrogena sp.	0	1
Rhyacophila fuscula	2	5
Rhyacophila sp.	0	1
Serratella deficiens	5	2
Serratella serrata	1	0
Serratella serratoides	0	1
Serratella sp.	1	1
Sialis sp.	5	6
Simulium jenningsi	6	2
Simulium sp.	7	6
Simulium tuberosum	1	0
Simulium vittatum	7	10
Sphaerium sp.	9	4
Stenacron interpunctatum	7	7
Stenelmis concinna	5	0
Stenelmis crenata	7	7
Stenelmis sp.	7	7
Stenochironomus sp.	4	3
Stenonema mediopunctatum	3	3
Stenonema modestum	2	5
Stenonema sp.	5	5
Stenonema terminatum	2	3
Stenonema vicarium	6	7
Stylaria lacustris	5	2
Sublettea coffmani	3	5

TAXON	TP T-Value	NO3 T-Value
Synorthocladius nr. semivirens	6	9
Tanytarsus glabrescens gr.	5	6
Tanytarsus guerlus gr.	5	5
Thienemannimyia gr. spp.	8	8
Tipula sp.	10	10
Tricorythodes sp.	4	9
Tvetenia bavarica gr.	9	10
Tvetenia vitracies	7	6
Undet. Tubificidae w/ cap. setae	10	8
Undet. Tubificidae w/o cap. setae	7	7
Undetermined Cambaridae	6	5
Undet. Ceratopogonidae	8	9
Undet. Enchytraeidae	7	8
Undet. Ephemerellidae	3	6
Undetermined Gomphidae	2	0
Undet. Heptageniidae	5	2
Undetermined Hirudinea	9	10
Undetermined Hydrobiidae	6	7
Undetermined Hydroptilidae	5	2
Undet. Limnephilidae	3	4
Undet. Lumbricina	8	8
Undet. Lumbriculidae	5	6
Undetermined Perlidae	5	7
Undetermined Sphaeriidae	10	8
Undetermined Turbellaria	8	6
Zavrelia sp.	9	9

Appendix XI. Impact Source Determination Methods and Community Models

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. ISD 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 was 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 ISD (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 percent, 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 subsamples of 100-organisms each that are taken from traveling kick samples of New York State streams. Application of these methods for data derived from other sampling methods, habitats, or geographical areas would likely require modification of the models.

ISD 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

ISD Models (cont'd)

	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
Isonychia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	5	-	-	-	5	-	10	10	15	10	20	-	-	5
HEPTAGENIIDAE	5	-	-	-	-	-	-	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Promoresia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	-	-	-	20	10	-	20	-	-	-	5
EMPIDIDAE	-	5	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE														
Tanypodinae	-	10	-	-	5	15	-	-	5	10	-	-	-	25
Cardiocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	5	10	20	-	5	10	5	5	15	10	25	10	5	10
Eukiefferiella/ Tvetenia	-	-	-	-	-	-	-	-	-	-	20	10	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (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

ISD Models (cont'd)

	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

Appendix XII. Classification of Waters

All waters of the state are provided a class and standard designation based on existing or expected best usage of each water or waterway segment.

- The classification AA or A is assigned to waters used as a source of drinking water.
- Classification B indicates a best usage for swimming and other contact recreation, but not for drinking water.
- Classification C is for waters supporting fisheries and suitable for non - contact activities.
- The lowest classification and standard is D and its best use is fishing. Due to such natural conditions as intermittency of flow, water conditions not conducive to propagation of game fishery, or stream bed conditions, the waters will not support fish propagation.

Waters with classifications A, B, and C may also have a standard of (T), indicating that it may support a trout population, or (TS), indicating that it may support trout spawning. Special requirements apply to sustain these waters that support these valuable and sensitive fisheries resources.

Small ponds and lakes with a surface area of 10 acres or less, located within the course of a stream,. are considered to be part of a stream and are subject to regulation under the stream protection category of Protection of Waters.

Certain waters of the state are protected on the basis of their classification. Streams and small water bodies located in the course of a stream that are designated as C(T) or higher (i.e., C(TS), B, or A) are collectively referred to as "protected streams," and are subject to the stream protection provisions of the Protection of Waters regulations.

NYSDEC. 1999. *Water Quality Regulations, Surface Water and Groundwater, Classifications and Standards, New York State Codes, Rules and Regulations, Title 6, Chapter X Parts 700-706.* New York State Department of Environmental Conservation, Albany, NY.