New York State
Department of Environmental Conservation

Division of Water

Cassadaga Creek

Biological Assessment

2002 Survey

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

CASSADAGA CREEK

BIOLOGICAL ASSESSMENT

Chautauqua County, New York

Survey date: August 5, 2002
Report date: October 7, 2003

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CONTENTS

Stream: Cassadaga Creek, New York

Reach: Cassadaga to Falconer, New York

NYS Drainage Basin: Allegheny River

Background:

The Stream Biomonitoring Unit sampled Cassadaga Creek in the reach between Cassadaga and Falconer, New York on August 5, 2002. The purpose of the sampling was to assess general water quality, and determine the cause and spatial extent of any water quality problems. In the present survey, traveling kick samples for macroinvertebrates were taken in riffle areas at 4 sites, using methods described in the Quality Assurance document (Bode et al., 2002) and summarized in Appendix I. The contents of each sample were field-inspected to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of a 100-specimen subsample. Macroinvertebrate community parameters used in the determination of water quality included species richness, biotic index, EPT value, and NCO richness (see Appendices II and III). 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 individual site descriptions and raw invertebrate data from each site.

Results and Conclusions:

1. All sites on Cassadaga Creek were assessed as slightly impacted. Nonpoint nutrient enrichment from agricultural runoff is the likely source of impact in most of the creek.

2. The discharge of the Jamestown (C) Wastewater Treatment Facility had a slight effect on the instream macroinvertebrate community. The loss of caddisflies at the downstream site was possibly a result of elevated chlorine levels in the effluent.

Discussion

Previous macroinvertebrate sampling of Cassadaga Creek by the Stream Biomonitoring Unit includes site visits at Ross Mills in 1995 and 2001, and at Kabob in 2001. All assessments from these samplings indicated slight impact, with Impact Source Determination (ISD, Appendix X) showing the highest similarity to effects of nonpoint source nutrient enrichment. The present study was conducted to gain a spatially broader picture of the creek, and highlight any problem areas.

Based on the present sampling, Cassadaga Creek exhibits slightly impacted water quality for its entire length (Figure 1). The upstream reach from Cassadaga to South Stockton had slower current speeds and finer bottom sediments, composed mostly of sand and gravel rather than rubble. Criteria for sandy streams were used to evaluate macroinvertebrate data from these two sites (see Appendix XI). Downstream sites at Ross Mills and Falconer had rubble riffles, and data from these sites were evaluated with riffle criteria (Appendix II). The upstream sites could not be evaluated by ISD due to their sluggish nature, but the site at Ross Mills (Station 3) was indicated to be slightly impacted by nonpoint nutrient enrichment (Table 1). The watershed is largely agricultural.

The effluent from the Jamestown (C) Wastewater Treatment Facility enters Cassadaga Creek approximately 1.5 stream miles upstream of Station 4 in Falconer. Slight effects of the effluent were indicated by the macroinvertebrate community. Most indices worsened, but water quality was still in the category of slight impact. Impact Source Determination denoted municipal/industrial effects. The fauna at this site was dominated by *Gammarus*, a crustacean scud that often thrives below municipal/industrial effluent discharges. The most outstanding effect was the loss of caddisflies at this site, compared to 34% of the fauna at Station 3 being comprised of caddisflies. The loss of caddisflies downstream of a sewage effluent discharge, particularly of the family Hydropsychidae, has been shown to be an indicator of elevated chlorine levels in the effluent, due to damaging action on their tracheal gills by chlorine (Simpson, 1980). The Jamestown facility uses gas chlorination; chemical water column sampling at this site could determine whether elevated chlorine levels exist in 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.

Simpson, K. W. 1980. Abnormalities in the tracheal gills of aquatic insects collected from streams receiving chlorinated or crude oil wastes. Freshwater Biology 10:581-583.

Overview of field data

On the date of sampling, August 5, 2002, Cassadaga Creek at the sites sampled was 5-20 meters wide, 0.1-0.3 meters deep, and had current speeds of 50-100 cm/sec in riffles. Dissolved oxygen was 6.3-8.3 mg/l, specific conductance was 300-416 μmhos, pH was 7.4-7.6 and the temperature was 22.8-26.7 °C. Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, Cassadaga Creek, 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. For stations 0 and 1, the ◆ designate NCO values rather than PMA.

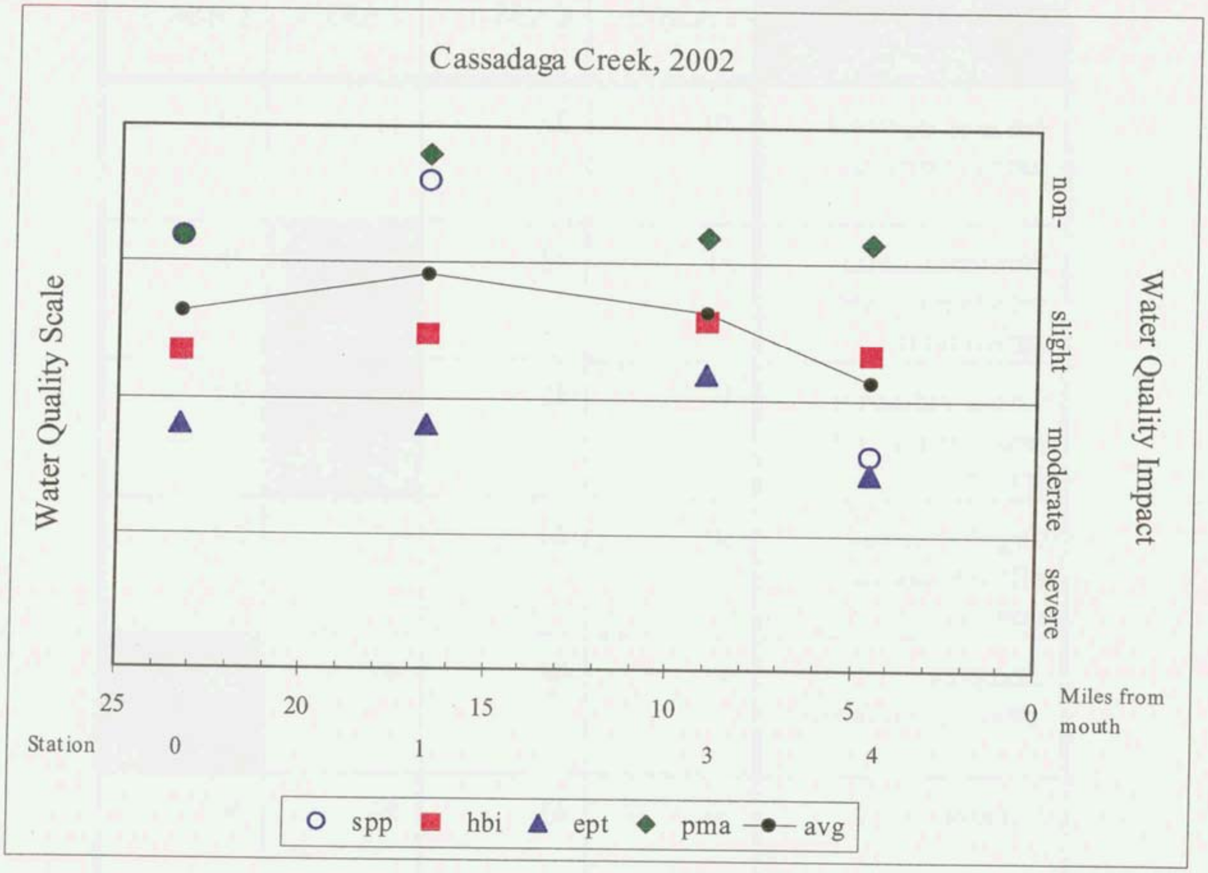


Table 1. Impact Source Determination, Cassadaga Creek, 2002 Numbers represent similarity to community type models for each impact category. The highest similarities at each station are highlighted. Similarities less than 50% are less conclusive. Highest numbers represent probable type of impact. See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

	STATION			
Community Type	CASS-0	CASS-1	CASS-3	CASS-4
Natural: minimal human impacts	20	27	51	44
Nutrient additions; mostly nonpoint, agricultural	31	38	63	36
Toxic: industrial, municipal, or urban run-off	32	41	62	37
Organic: sewage effluent, animal wastes	30	44	47	29
Complex: municipal/industrial	46	48	49	58
Siltation	30	43	50	36
Impoundment	31	36	54	53

STATION	COMMUNITY TYPE
CASS-0	Inconclusive, due to sand/gravel habitat
CASS-1	Inconclusive, due to sand/gravel habitat
CASS-3	Nonpoint nutrient, toxic
CASS-4	Complex, impoundment

TABLE 2. STATION LOCATIONS FOR CASSADAGA CREEK, CHAUTAUQUA COUNTY, NY

STATION	LOCATION
00	Cassadaga, New York 30 meters below Luce Road bridge Latitude/Longitude 42° 18' 43"; 79° 17' 55" 23.3 stream miles above mouth
01	South Stockton, New York 80 meters below Rte. 56 closed bridge Latitude/Longitude 42° 14' 40"; 79° 18' 25" 16.7 stream miles above mouth
03	Ross Mills, New York 30 meters below Rte. 63 bridge Latitude/Longitude 42° 09' 17"; 79° 13' 24" 9 stream miles above mouth
04	Falconer, New York 80 meters below Dolloff Road bridge Latitude/Longitude 42° 05' 48"; 79° 09' 24" 4.5 stream miles above mouth

Figure 2 | Site Overview Map | Cassadaga Creek

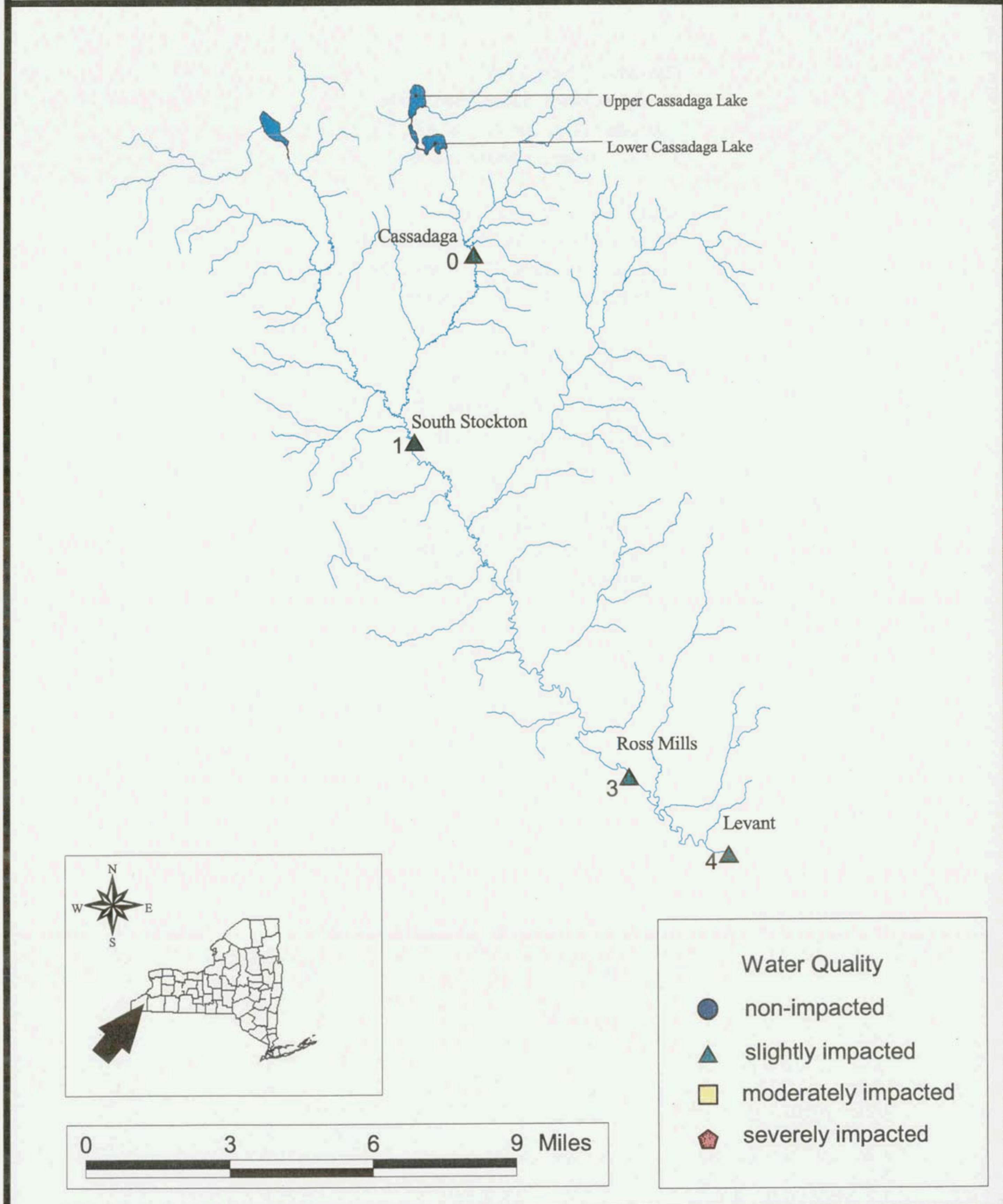
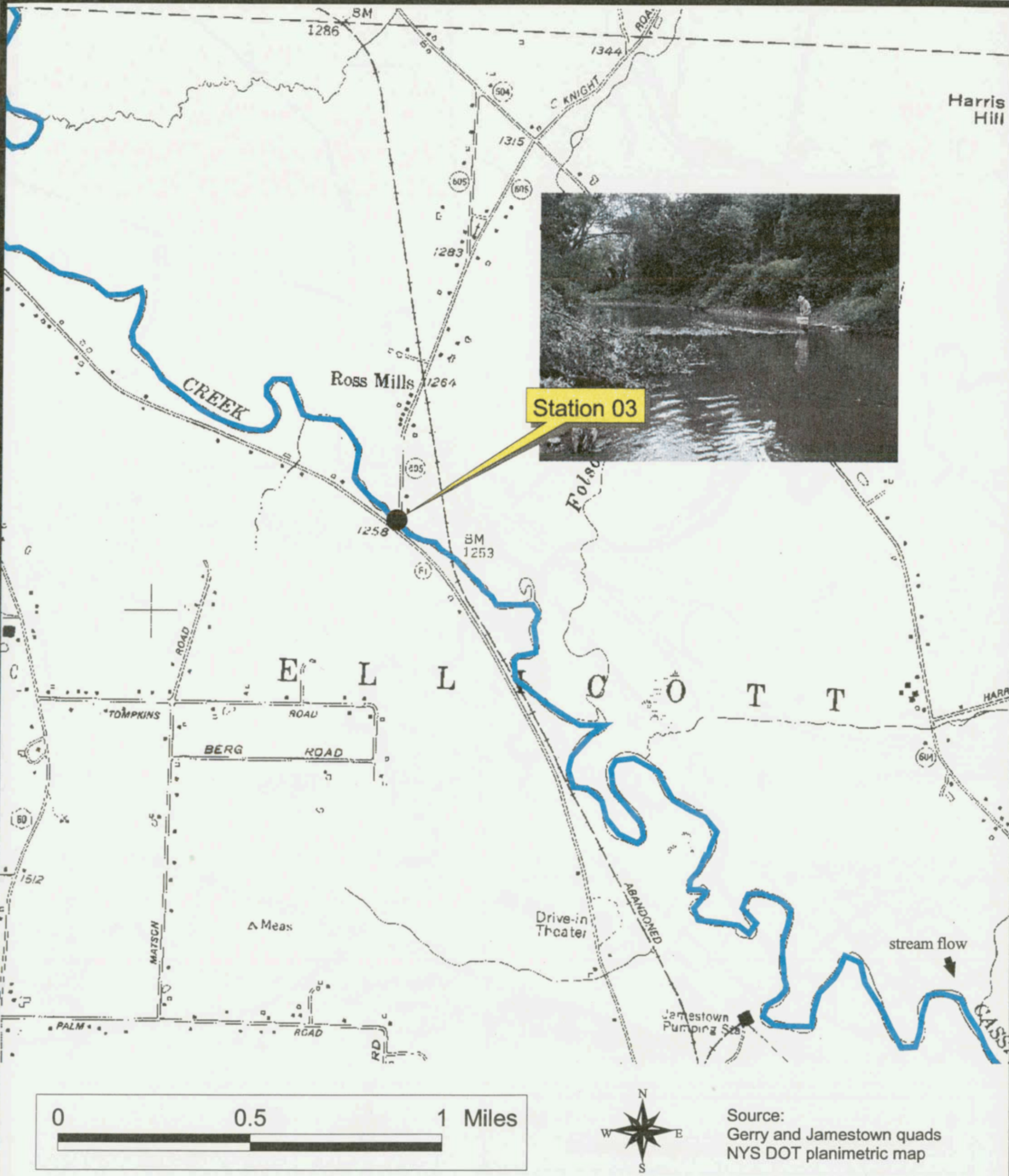


Figure 3a. Site Location Map Cassadaga Creek

Source:
Cassadaga quad
NYS DOT planimetric map

Figure 3b.	Site Location Map	Cassadaga Creek

Figure 3c.	Site Location Map	Cassadaga Creek



Source:
Gerry and Jamestown quads
NYS DOT planimetric map

Figure 3d.	Site Location Map	Cassadaga Creek

TABLE 3. MACROINVERTEBRATES COLLECTED IN CASSADAGA CREEK, CHAUTAUQUA COUNTY, NY, 2002

ANNELIDA
OLIGOCHAETA
TUBIFICIDA
Tubificidae
Aulodrilus pluriseta
Branchiura sowerbyi
Limnodrilus hoffmeisteri
Undet. Tubificidae w/o cap. setae
HIRUDINEA
Glossiphoniidae
Undetermined Hirudinea
Physidae
Physella sp.
MOLLUSCA
GASTROPODA
Bithyniidae
Undetermined Bithyniidae
PELECYPODA
Sphaeriidae
Sphaerium sp.
Undetermined Sphaeriidae
ARTHROPODA
CRUSTACEA
ISOPODA
Asellidae
Caecidotea racovitzai
Caecidotea sp.
AMPHIPODA
Gammaridae
Gammarus sp.
DECAPODA
Cambaridae
Undetermined Cambaridae
INSECTA
EPHEMEROPTERA
Baetidae
Acentrella sp.
Baetis flavistriga
Baetis intercalaris
Heptageniidae
Stenacron interpunctatum
Stenonema sp.
Caenidae
Caenis sp.
HEMIPTERA
Corixidae
Undetermined Corixidae
ODONATA
Calopterygidae
Undetermined Calopterygidae
COLEOPTERA
Elmidae
Dubiraphia vittata
Dubiraphia sp.
Macronychus glabratus
Optioservus sp.
Stenelmis crenata
Stenelmis sp.
TRICHOPTERA
Philopotamidae
Chimarra obscura
Hydropsychidae
Cheumatopsyche sp.
Leptoceridae
Undetermined Leptoceridae
DIPTERA
Tipulidae
Hexatoma sp.
Simuliidae
Simulium sp.
Tabanidae
Undetermined Tabanidae
Athericidae
Atherix sp.
Stratiomyidae
Undetermined Stratiomyidae
Empididae
Hemerodromia sp.
Chironomidae
Natarsia baltimorea
Thienemannimyia gr. spp.
Cricotopus bicinctus
Orthocladius annectens
Orthocladius obumbratus
Tvetenia vitracies
Chironomus sp.
Cryptochironomus fulvus gr.
Glyptotendipes lobiferus
Microtendipes pedellus gr.
Polypedilum flavum
Polypedilum illinoense
Polypedilum scalaenum gr.
Micropsectra aristata gr.
Saetheria sp.
Cladotanytarsus daviesi
Rheotanytarsus exiguus gr.

STREAM SITE:	Cassadaga Creek - Station 00
LOCATION:	Cassadaga, NY, 30 meters below Luce Rd. Bridge
DATE:	05 August 2002
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100individuals

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	6
HIRUDINEA			
	Glossiphoniidae	Undetermined Hirudinea	1
MOLLUSCA			
GASTROPODA	Physidae	Physella sp.	1
ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	Caecidotea racovitzai	2
AMPHIPODA	Gammaridae	Gammarus sp.	13
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	1
		Baetis intercalaris	2
HEMIPTERA	Corixidae	Undetermined Corixidae	11
COLEOPTERA	Elmidae	Stenelmis sp.	3
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	2
DIPTERA	Simuliidae	Simulium sp.	1
	Stratiomyidae	Undetermined Stratiomyidae	1
	Chironomidae	Thienemannimyia gr. spp.	4
		Cricotopus bicinctus	1
		Tvetenia vitracies	1
		Cryptochironomus fulvus gr.	20
		Microtendipes pedellus gr.	1
		Polypedilum flavum	13
		Polypedilum illinoense	4
		Polypedilum scalaenum gr.	1
		Cladotanytarsus daviesi	7
		Rheotanytarsus exiguus gr.	4

SPECIES RICHNESS:	22 (very good)
BIOTIC INDEX:	6.49 (good)
EPT RICHNESS:	3 (poor)
NCO RICHNESS	11 (very good)
ASSESSMENT:	slightly impacted

DESCRIPTION: This upstream site was slow-moving and had a sand-gravel substrate; therefore sandy-stream criteria were used to evaluate the data. The macroinvertebrate fauna was dominated by midges, with backwimmers and scuds also abundant. Based on the metrics, water quality was assessed as slightly impacted.

STREAM SITE:	Cassadaga Creek - Station 01
LOCATION:	South Stocton, NY, 80 meters below Rte. 56 (closed bridge)
DATE:	05 August 2002
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Tubificidae	Limnodrilus hoffmeisteri	11
MOLLUSCA			
PELECYPODA	Sphaeriidae	Undetermined Sphaeriidae	2
ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	Caecidotea racovitzai	8
AMPHIPODA	Gammaridae	Gammarus sp.	13
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis intercalaris	6
	Caenidae	Caenis sp.	1
HEMIPTERA	Corixidae	Undetermined Corixidae	1
ODONATA	Calopterygidae	Undetermined Calopterygidae	1
COLEOPTERA	Elmidae	Dubiraphia vittata	7
		Macronychus glabratus	8
		Optioservus sp.	1
		Stenelmis sp.	4
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	5
DIPTERA	Tipulidae	Hexatoma sp.	1
	Tabanidae	Undetermined Tabanidae	8
	Chironomidae	Orthocladius annectens	1
		Cryptochironomus fulvus gr.	5
		Microtendipes pedellus gr.	1
		Polypedilum flavum	6
		Polypedilum illinoense	1
		Polypedilum scalaenum gr.	5
		Saetheria sp.	1
		Cladotanytarsus daviesi	2
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS:	24 (very good)
BIOTIC INDEX:	6.29 (good)
EPT RICHNESS:	3 (poor)
NCO RICHNESS:	14 (very good)
ASSESSMENT:	slightly impacted

DESCRIPTION: The sample was taken downstream of Route 56, a closed bridge site. The bottom had much detritus and woody material. Similar to the upstream site, sandy-stream criteria were used to evaluate the data. The fauna was similar to that at the upstream site, and water quality was similarly assessed as slightly impacted.

STREAM SITE:	Cassadaga Creek - Station 03
LOCATION:	Ross Mills, NY, 30 meters below Rte. 63 bridge
DATE:	05 August 2002
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

MOLLUSCA			
GASTROPODA	Bithyniidae	Undetermined Bithyniidae	2
PELECYPODA	Sphaeriidae	Sphaerium sp.	7
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	Gammarus sp.	1
DECAPODA	Cambaridae	Undetermined Cambaridae	1
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis intercalaris	12
	Heptageniidae	Stenacron interpunctatum	6
		Stenonema sp.	2
COLEOPTERA	Elmidae	Dubiraphia sp.	1
		Macronychus glabratus	1
		Stenelmis sp.	7
TRICHOPTERA	Philopotamidae	Chimarra obscura	11
	Hydropsychidae	Cheumatopsyche sp.	22
	Leptoceridae	Undetermined Leptoceridae	1
DIPTERA	Athericidae	Atherix sp.	2
	Simuliidae	Simulium sp.	1
	Empididae	Hemerodromia sp.	2
	Chironomidae	Thienemannimyia gr. spp.	1
		Orthocladius obumbratus	1
		Cryptochironomus fulvus gr.	2
		Microtendipes pedellus gr.	1
		Polypedilum flavum	11
		Micropsectra aristata gr.	1
		Rheotanytarsus exiguus gr.	4

SPECIES RICHNESS:	23 (good)
BIOTIC INDEX:	5.36 (good)
EPT RICHNESS:	6 (good)
MODEL AFFINITY:	69 (very good)
ASSESSMENT:	slightly impacted

DESCRIPTION: Sampling was conducted downstream of the Route 63 bridge in Ross Mills. The riffle habitat was acceptable for kick sampling. The macroinvertebrate community was dominated by caddisflies and mayflies, and most metrics were within the range of slightly impacted water quality.

STREAM SITE:	Cassadaga Creek - Station 04
LOCATION:	Falconer, NY, 80 meters below Dolloff Road bridge
DATE:	05 August 2002
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Tubificidae	Aulodrilus pluriseta	2
		Branchiura sowerbyi	1
ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	Caecidotea sp.	2
AMPHIPODA	Gammaridae	Gammarus sp.	40
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis flavistriga	4
		Baetis intercalaris	29
	Heptageniidae	Stenacron interpunctatum	3
COLEOPTERA	Elmidae	Stenelmis crenata	8
DIPTERA	Chironomidae	Natarsia baltimorea	1
		Thienemannimyia gr. spp.	1
		Chironomus sp.	1
		Glyptotendipes lobiferus	3
		Polypedilum flavum	1
		Polypedilum illinoense	1
		Polypedilum scalaenum gr.	3

SPECIES RICHNESS:	15 (poor)
BIOTIC INDEX:	5.83 (good)
EPT RICHNESS:	3 (poor)
MODEL AFFINITY:	68 (very good)
ASSESSMENT:	slightly impacted

DESCRIPTION: The site was downstream of Dolloff Road, Falconer, approximately 1.5 stream miles downstream of the effluent of the Jamestown (C) Wastewater Treatment Facility. The fauna shifted compared to Station 3, with a substantial reduction in species and loss of caddisflies. Based on the metrics, water quality declined, but was still within the category of slight impact.

FIELD DATA SUMMARY

STREAM NAME: Cassadaga Creek	DATE SAMPLED: 8/5/2002
REACH: Cassadaga to Falconer	
FIELD PERSONNEL INVOLVED: Abele, Bode	

STATION	00	01	03	04
ARRIVAL TIME AT STATION	1:45	2:25	3:25	4:00
LOCATION	Cassadaga	South Stockton	Ross Mills	Falconer
PHYSICAL CHARACTERISTICS				
Width (meters)	10	5	12	20
Depth (meters)	0.1	0.3	0.2	0.3
Current speed (cm per sec.)	50	75	100	80
Substrate (%)				
Rock (>25.4 cm, or bedrock)			10	
Rubble (6.35 - 25.4 cm)	10		40	20
Gravel (0.2 – 6.35 cm)	40	30	20	40
Sand (0.06 – 2.0 mm)	30	30	10	20
Silt (0.004 – 0.06 mm)	20	40	20	20
Embeddedness (%)	40	40	20	30
CHEMICAL MEASUREMENTS				
Temperature (° C)	22.8	24.3	25.3	26.7
Specific Conductance (umhos)	367	416	360	300
Dissolved Oxygen (mg/l)	7.5	7.6	8.3	6.3
pH	7.4	7.4	7.6	7.5
BIOLOGICAL ATTRIBUTES				
Canopy (%)	0	10	10	20
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous				
algae - diatoms				
macrophytes or moss	X			
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)			X	X
Plecoptera (stoneflies)				
Trichoptera (caddisflies)			X	X
Coleoptera (beetles)		X	X	X
Megaloptera(dobsonflies,alderflies)				
Odonata (dragonflies, damselflies)				
Chironomidae (midges)		X		X
Simuliidae (black flies)				
Decapoda (crayfish)	X	X	X	X
Gammaridae (scuds)	X			X
Mollusca (snails, clams)			X	
Oligochaeta (worms)				
Other	X			X
FAUNAL CONDITION	POOR	POOR	GOOD	GOOD

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

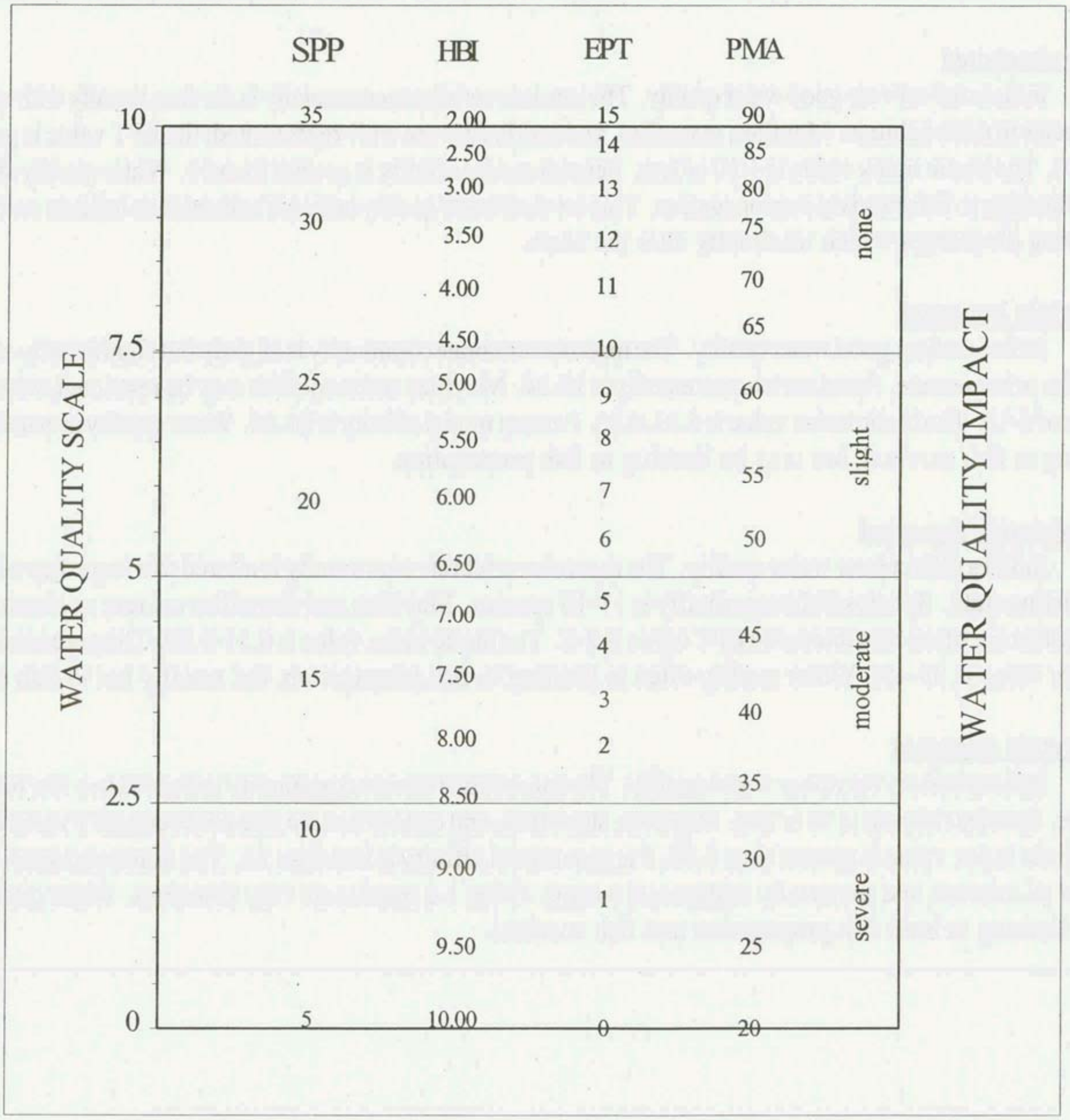
Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT value is 2-5. The biotic index value is 6.51-8.50.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

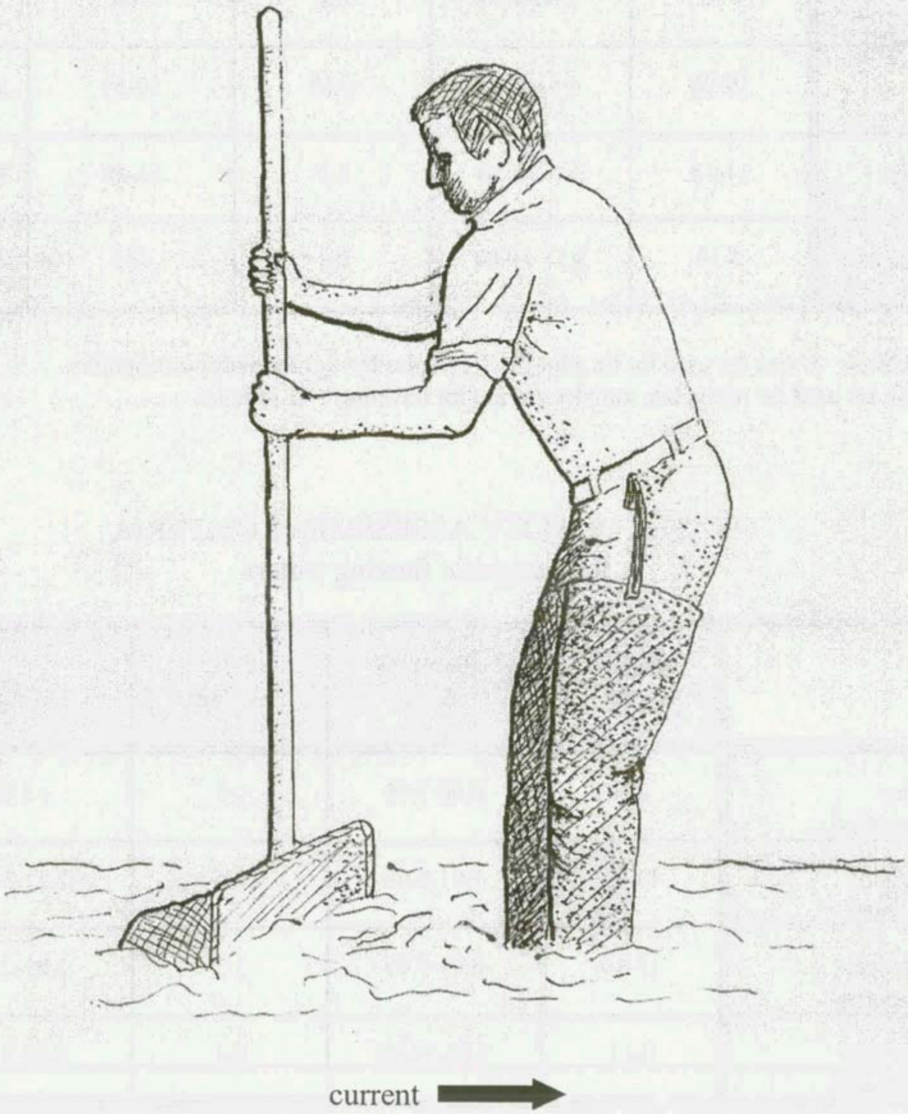
Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
* Diversity criteria are used for multiplate samples but not for traveling kick samples.

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

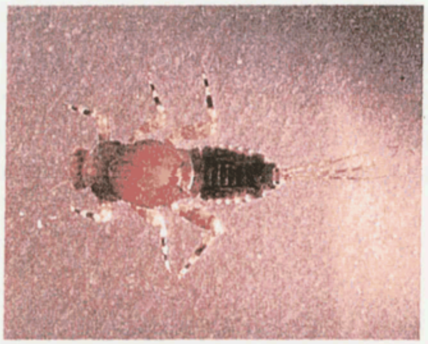


Rocks and sediment in the riffle are dislodged by foot upstream of a net; organisms dislodged are carried by the current into the net. Sampling is continued for five minutes, as the sampler gradually moves downstream to cover a distance of five meters.

APPENDIX VII. A.

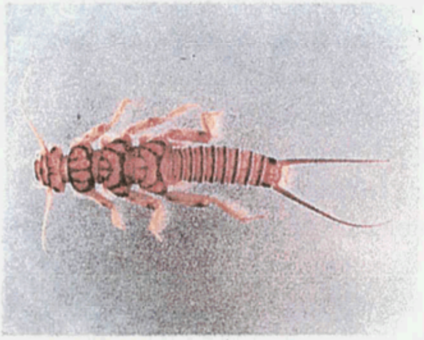
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

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.

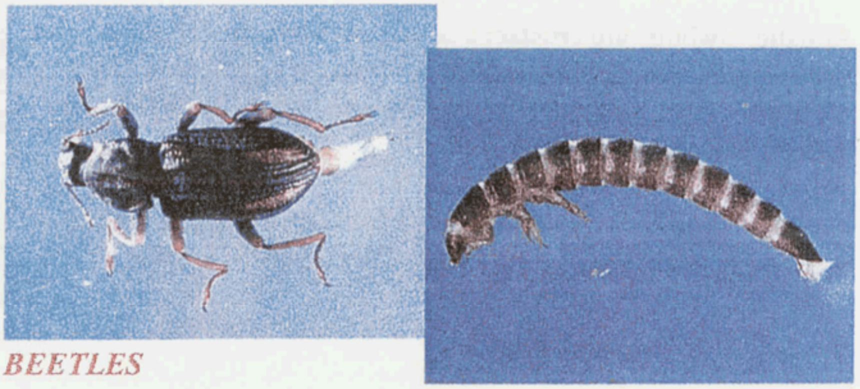


STONEFLIES

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

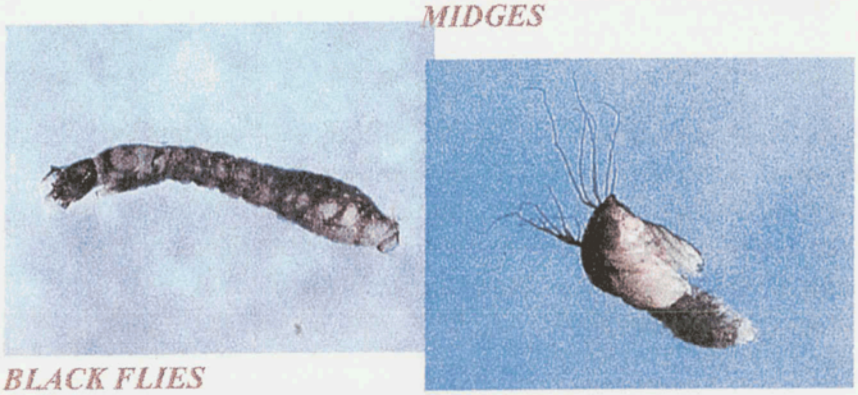
APPENDIX VII. B.

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.

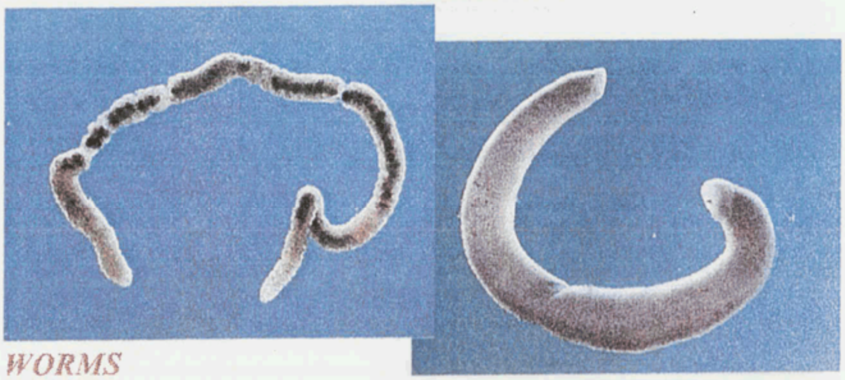
MIDGES

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.



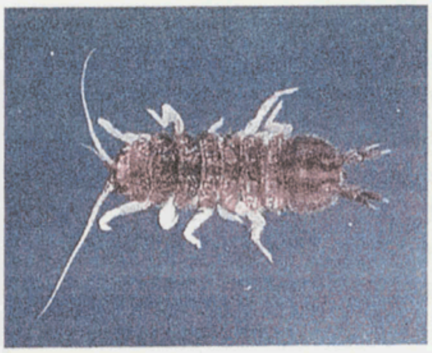
BLACK FLIES

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, such as 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

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	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

	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 XI. MACROINVERTEBRATE COMMUNITY PARAMETERS FOR SANDY STREAMS

Stream habitats dominated by slow current speeds and smaller overall sediment particle size, mostly gravel, sand, and silt, require different methods of data analysis compared to streams with rubble/gravel riffles. The criteria used to interpret the invertebrate data and assess water quality were selected to account for habitat influences in order to separate water quality influences. The following indices and scales were used:

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 are: greater than 21, non-impacted; 17-21, slightly impacted; 12-16, moderately impacted; less than 12, severely impacted.

2. EPT richness. EPT denotes the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in an average 100-organism subsample. The scale for navigable waters was also used for this index. Expected ranges are: greater than 5, non-impacted; 4-5, slightly impacted; 2-3, moderately impacted; and 0-1, severely impacted.

3. Biotic index. The Hilsenhoff Biotic Index, the average tolerance value for all the organisms in the sample, ranges from intolerant (0) to tolerant (10). The scale of expected values set for slow sandy streams is: 0-5.50, non-impacted; 5.51-7.00, slightly impacted; 7.01-8.50, moderately impacted; and 8.51-10.00, severely impacted.

4. NCO richness. NCO denotes the total number of species of organisms other than those in the groups Chironomidae and Oligochaeta. Since Chironomidae and Oligochaeta are generally the most abundant groups in impacted communities, NCO taxa are considered to be less pollution tolerant, and their presence would be expected to be more indicative of good water quality. The scale used for slow sandy streams is: greater than 10, non-impacted; 6-10, slightly impacted; 2-5, moderately impacted; and 0-1, severely impacted.

These scales were developed using Long Island data in addition to data from several statewide sites with habitats similar to the Long Island streams. The scales were adjusted to make the indices corroborative, leading to accurate water quality assessments. Overall water quality is assigned by normalizing the four index values on a common ten-scale, and calculating the average of the four indices. Percent model affinity was not selected as an index, because there was no single prevailing community composition among the sites.