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New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Canandaigua Outlet

Biological Assessment

2005 Survey

New York State
Department of Environmental Conservation

George E. Pataki, Governor Denise M. Sheehan, Commissioner

Canandaigua Outlet

BIOLOGICAL ASSESSMENT

Seneca-Oneida-Oswego Rivers Basin
Ontario County, New York

Survey date: July 26, 2005
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CONTENTS

Stream: Canandaigua Outlet, Ontario County, New York

Reach: Canandaigua to Manchester Center, New York

NYS Drainage Basin: Seneca-Oneida-Oswego Rivers

Background:

The Stream Biomonitoring Unit sampled the Canandaigua Outlet in Ontario County, New York, on July 26, 2005. The purpose of the sampling was to assess overall water quality, compare it to previous results and, at the request of New York State Department of Environmental Conservation (NYSDEC) Region 8, evaluate the effectiveness of the City of Canandaigua Sewage Treatment Plant.

In riffle areas at six 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 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 raw data from each site.

Results and Conclusions:

1. Water quality in Canandaigua Outlet ranged from non-impacted to moderately impacted, longitudinally improving from the lake to the mouth.

2. Water quality was similar to assessments made in previous years. The City of Canandaigua Sewage Treatment Plant appears to provide adequate wastewater treatment, based on downstream biological communities.

Discussion:

Canandaigua Outlet begins at the outlet of Canandaigua Lake in Ontario County, New York, and flows approximately 34 miles in a northeasterly direction before flowing into the Erie Canal at Lyons. The stream is classified as C except for the reach from the State Route 88 bridge at Phelps to the Port Gibson Road bridge (County Route 7) at Manchester Center, which is classified as C(T). A classification of C means that the best water use is for fishing, and fish propagation. The stream is stocked annually with brown trout. Stations-1 and -2 are located on the Feeder Canal which joins the Outlet approximately 0.5 mile downstream of Station-2.

The purpose of the present study was to assess overall water quality, and compare it to previous assessments, especially in relation to effects from the Canandaigua [C] Sewage Treatment Plant. The survey was requested by NYSDEC Region 8 to evaluate the current effectiveness of the treatment plant. Canandaigua Outlet was previously sampled by the NYSDEC Stream Biomonitoring Unit on several occasions from 1984-2002 (Table 2). Most of these assessments showed slight impact at Station-1, moderate impact at Station-2 and slight impact at Stations 3-8.

In the present study, water quality in the Canandaigua Outlet ranged from moderately impacted at Canandaigua to non-impacted at Manchester Center (Figure 1). Longitudinal trends show improving water quality from the lake to the mouth. Water quality is initially heavily influenced by impoundment effects from Canandaigua Lake. The Canandaigua [C] Sewage Treatment Plant, located 0.5 mile upstream of Station-2, exerts multiple possible influences on the water quality at Station-2, including nutrient enrichment, organic wastes, municipal/industrial and impoundment effects (Table 2). Water quality at this site is actually worse than Station-1, but it appears improved from Station-1 because of waning impoundment effects from the lake.

Water quality trends were very similar to the 1986 study, except that non-impacted conditions below Manchester (Stations -6 and -8) were not reached in 1986 (Figure 2). Both studies showed gradually improving water quality from the lake to the mouth. The City of Canandaigua Sewage Treatment Plant appears to provide adequate wastewater treatment, based on downstream biological communities and similarity to 1986 conditions. If less feeder canal water were provided for the dilution of the sewage treatment effluent, biological impacts would likely increase.

The presence of zebra mussels in the 2005 samples is new since 1986. Zebra mussels were first reported to be established in the lake in 1994 (O'Neill, 1994). Also notable is the high number of clean-water mayflies, especially at the Chapin site (Station-3). Mayflies comprised 68% of the sample from Station-3 in the present sampling, compared to 13% in 1986.

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.

O'Neill, C.R., Jr., 1994, Sightings: North American range of the zebra mussel as of 30 September 1994. Aquatic Invaders, National Aquatic Nuisance Species Clearinghouse 5(4):6.

Smith, A.J., 2005, Development of a Nutrient Biotic Index for use with benthic macroinvertebrates. SUNY Albany, Masters Thesis, 70 pages.

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

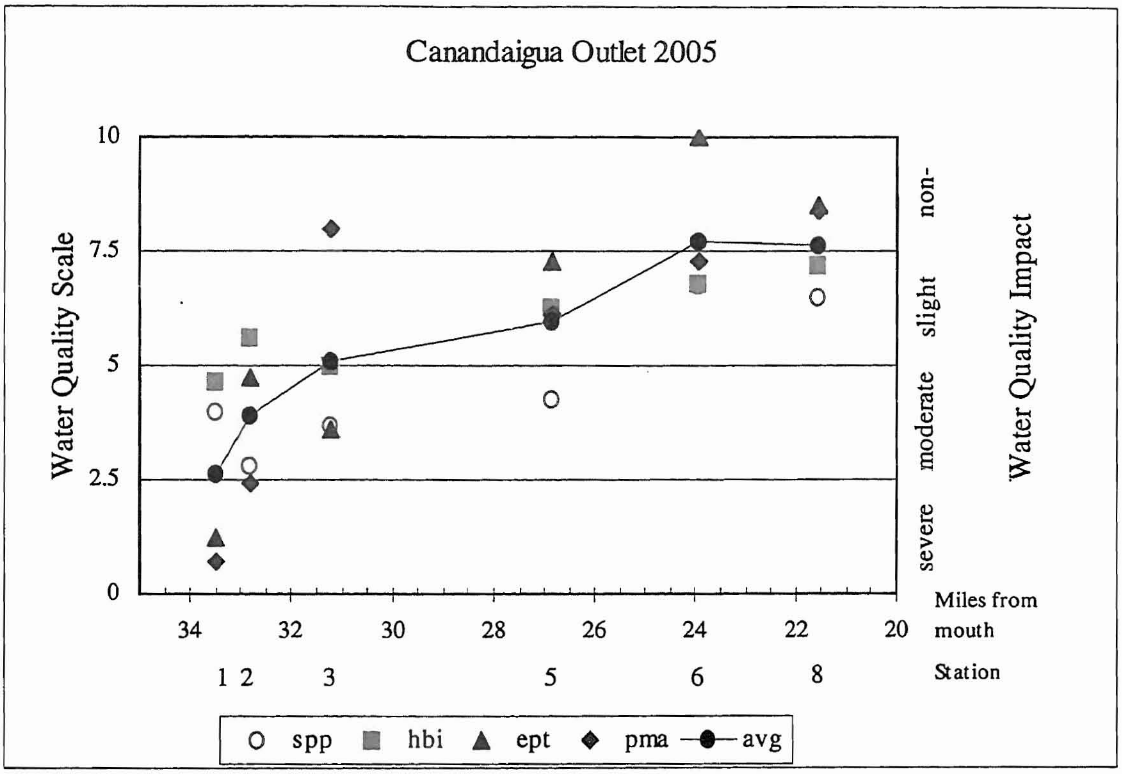
Overview of field data:

On July 26, 2005, Canandaigua Outlet at the sites sampled was 3-15 meters wide, 0.2-0.6 meters deep, and had current speeds of 30-111 cm/sec in riffles. Dissolved oxygen was 7.5- 11.8 mg/l, specific conductance was 342-436 µmhos, pH was 7.7-8.5 and the temperature was 25.6-27.0 °C (78-81 °F). Measurements for each site are found on the field data summary sheets.

Table 1. Water quality assessment of impacts for Canandaigua Outlet, 1984-2005.

	Station					
	1	2	3	5	6	8
Year						
1984	slight	moderate	slight	slight	slight	slight
1985	slight	moderate	slight	slight	slight	slight
1986	moderate	slt/mod	slight	slight	slight	non/slt
1990	-	moderate	-	-	-	slight
1995	-	-	-	-	-	slight
2001	-	moderate	-	-	-	-
2005	moderate	moderate	slight	slight	non-	non-

Figures 1-2. Biological Assessment Profile of index values, Canandaigua Outlet 2005 and 1986 vs. 2005. Values are plotted on a normalized scale of water quality. The line connects the mean of four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. See Appendix IV for a more complete explanation.



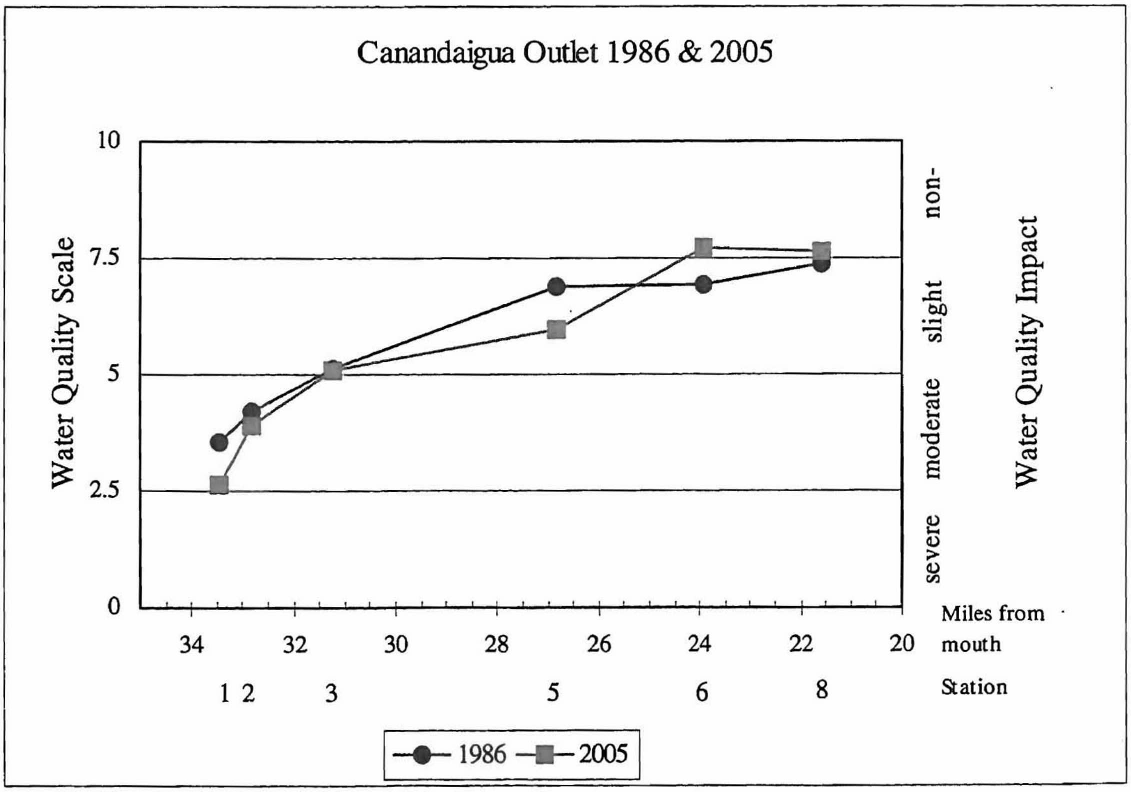


Table 2. Impact Source Determination, Canandaigua Outlet, 2005. Numbers represent percent similarity to macroinvertebrate community type models for each impact category. Highest similarities at each station are highlighted. Similarities less than 50% are less conclusive. Highest numbers represent probable type(s) of impact. See Appendix X for further explanation.

	Station					
Community Type	01	02	03	05	06	08
Natural: minimal human impacts	11	16	27	47	50	56
Nutrient enrichment	11	55	29	62	51	45
Toxic: industrial, municipal, or urban run-off	16	40	31	51	37	37
Organic: sewage, animal wastes	13	54	25	54	29	32
Complex: municipal and/or industrial	47	56	25	62	52	28
Siltation	20	36	46	43	47	37
Impoundment	49	55	23	56	47*	28

STATION	COMMUNITY TYPE
CANA-01	Complex, Impoundment
CANA-02	Nutrients, Organic, Complex, Impoundment
CANA-03	Siltation
CANA-05	Nutrients, Complex
CANA-06	Natural, Nutrients
CANA-08	Natural

* Impoundment effects considered spurious

TABLE 3. Station Locations for Canandaigua Outlet, Ontario County, NY

STATION	LOCATION
CANA-01	Canandaigua, NY below Route 20 (between east- and west-bound lanes) latitude 42° 52' 41" longitude 77° 16' 11" 33.5 river miles above mouth (on Feeder Canal)
CANA-02	Canandaigua, NY Below Saltonstall Road latitude 42° 53' 12" longitude 77° 15' 57" 32.8 river miles above mouth (on Feeder Canal)
CANA-03	Chapin, NY Above County Route 4 bridge latitude 42° 54' 06" longitude 77° 14' 47" 31.2 river miles above mouth
CANA-05	Littleville, NY Below County Route 13 bridge latitude 42° 56' 37" longitude 77° 13' 18" 26.8 river miles above mouth
CANA-06	Manchester, NY Above State Route 96 bridge latitude:42° 58' 27" longitude 77° 13' 24" 23.9 river miles above mouth
CANA-08	Manchester Center, NY Off County Route 7, below NYS Thruway bridge latitude 42° 58' 33" longitude 77° 10' 51" 21.6 river miles above mouth

Figure 3. | Site Overview Map | Canandaigua Outlet

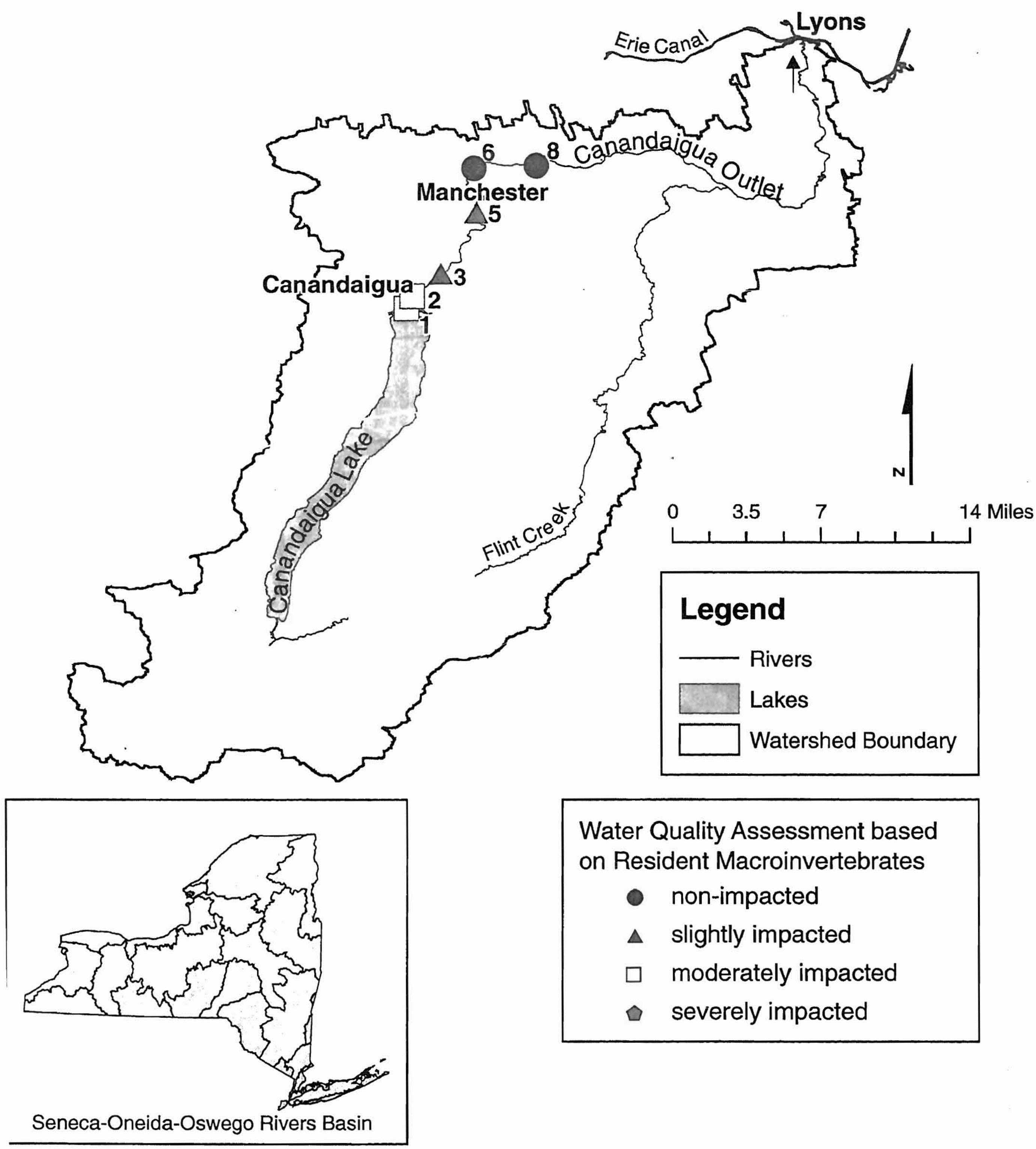


Figure 4a	Site Location Map	Canandaigua Outle

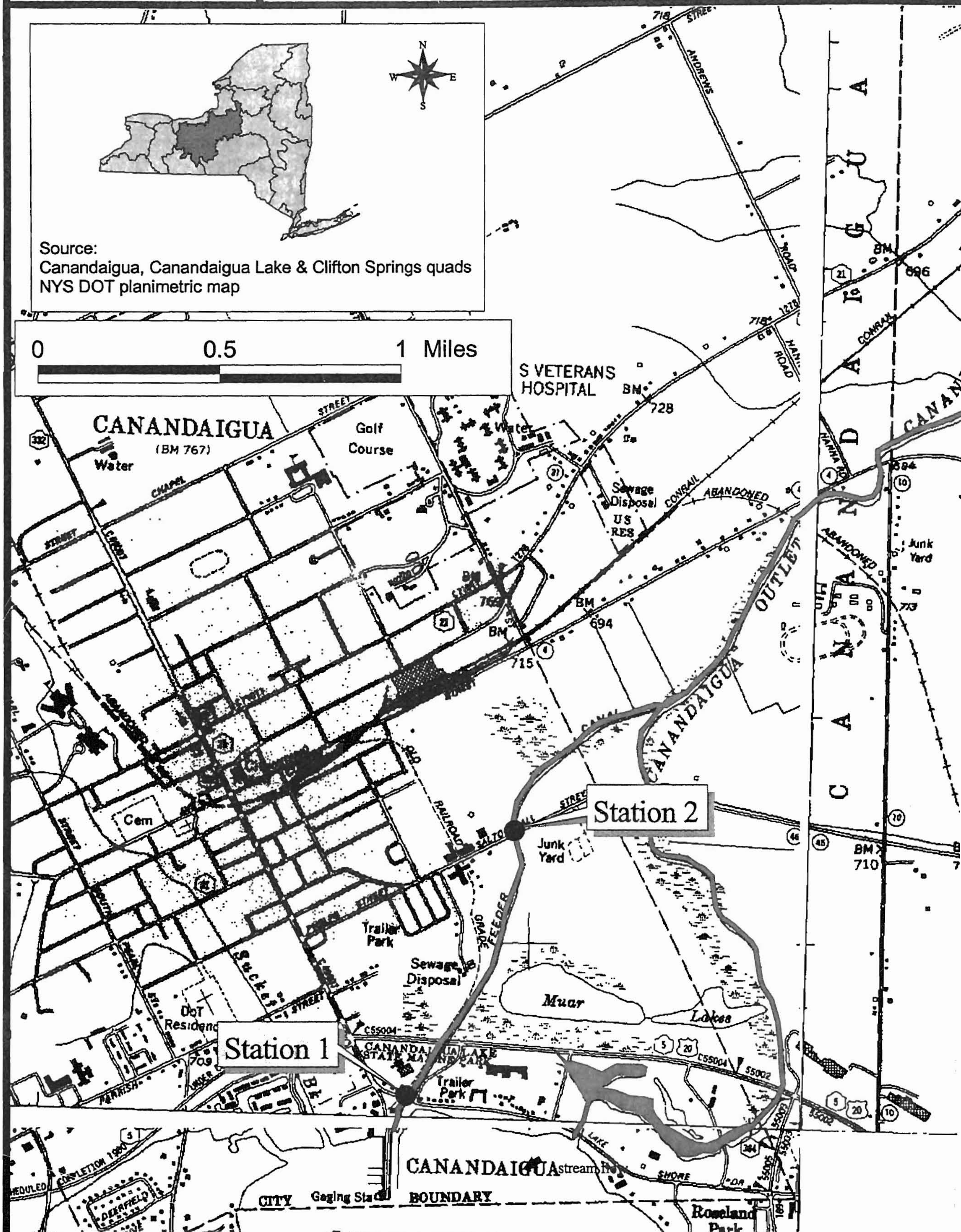
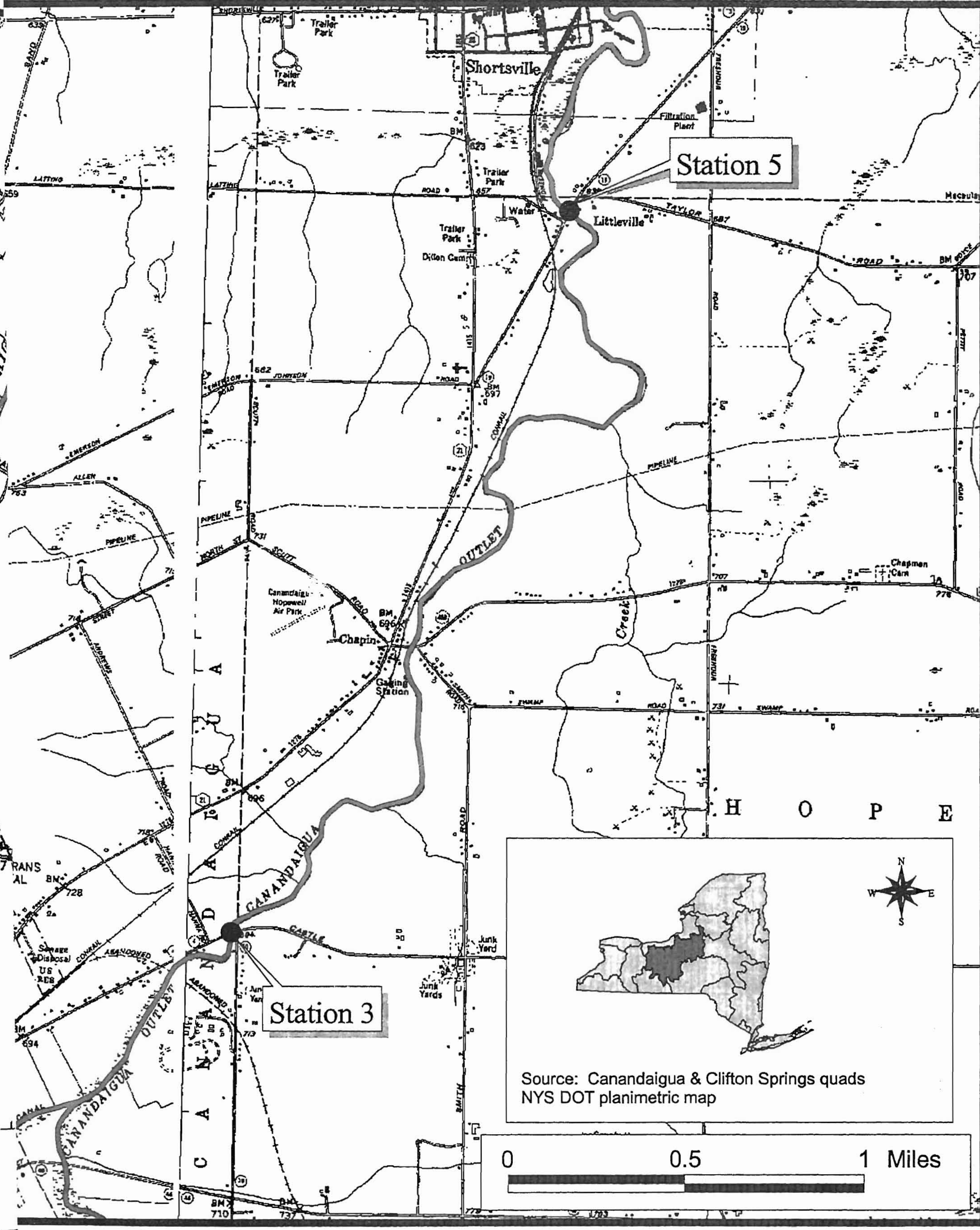
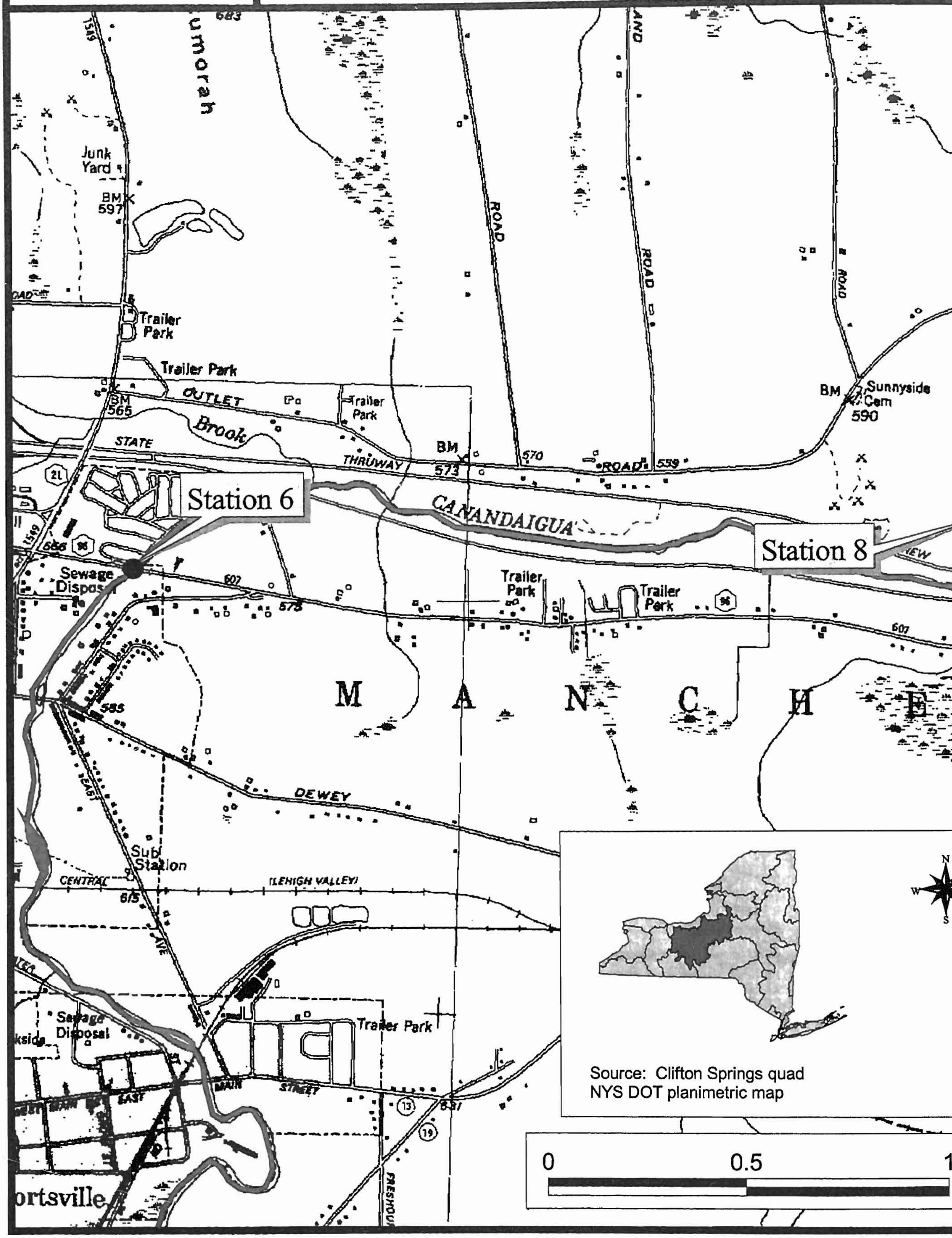


Figure 4b	Site Location Map	Canandaigua Outlet



n flow
stream flow

Figure 4c	Site Location Map	Canandaigua Outle



stream flow

TABLE 4. Macroinvertebrate Species Collected in Canandaigua Outlet, Ontario County, NY, 2005.

PLATYHELMINTHES
TURBELLARIA
Undetermined Turbellaria
OLIGOCHAETA
TUBIFICIDA
Tubificidae
Aulodrilus sp.
Limnodrilus hoffmeisteri
Undetermined Tubificidae w/o cap. setae
MOLLUSCA
GASTROPODA
Physidae
Physella sp.
Planorbidae
Undetermined Planorbidae
PELECYPODA
Dreisseniidae
Dreissena polymorpha
ARTHROPODA
CRUSTACEA
ISOPODA
Asellidae
Caecidotea sp.
AMPHIPODA
Gammaridae
Gammarus sp
DECAPODA
Cambaridae
Cambarus sp.
INSECTA
EPHEMEROPTERA
Baetidae
Baetis flavistriga
Baetis intercalaris
Plauditus sp.
Heptageniidae
Leucrocuta sp.
Stenacron interpunctatum
Stenonema meririvulanum
Stenonema sp.
Ephemerellidae
Serratella sp.
Leptohyphidae
Tricorythodes sp.
Caenidae
Caenis sp.
Polymitarcidae
Ephoron leukon?
PLECOPTERA
Perlidae
Paragnetina media
ODONATA
Coenagrionidae
Argia sp.
COLEOPTERA
Hydrophilidae
Undetermined Hydrophilidae
Psephenidae
Psephenus herricki
Elmidae
Dubiraphia bivittata
Dubiraphia sp.
Optioservus trivittatus
Optioservus sp.
Stenelmis crenata
Stenelmis sp.
MEGALOPTERA
Corydalidae
Nigronia serricornis
Sialidae
Sialis sp.
TRICHOPTERA
Philopotamidae
Chimarra obscura
Hydropsychidae
Cheumatopsyche sp.
Hydropsyche betteni
Hydropsyche bronta
Hydropsyche sparna
Hydroptilidae
Hydroptila sp.
Uenoidae
Neophylax sp.
Helicopsychidae
Helicopsyche borealis
Leptoceridae
Ceraclea sp.
Undetermined Leptoceridae
DIPTERA
Simuliidae
Simulium aureum
Simulium vittatum
Empididae
Hemerodromia sp.
Chironomidae
Thienemannimyia gr. spp.
Cricotopus tremulus gr.
Cricotopus trifascia gr.
Cricotopus sp. "Ozarks"
Tvetenia vitracies
Dicrotendipes neomodestus
Polypedilum flavum
Polypedilum halterale gr.
Polypedilum illinoense
Xenochironomus xenolabis

Macroinvertebrate Data Reports: Raw Data

STREAM SITE:	Canandaigua Outlet, Station CANA-01
LOCATION:	Canandaigua, NY, Route 20 (Feeder Canal)
DATE:	26 July 2005
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

PLATYHELMINTHES			
TURBELLARIA			
	Planariidae	Undetermined Turbellaria	2
	Physidae	*Physella sp.*	1
	Planorbidae	Undetermined Planorbidae	1
	Dreisseniidae	*Dreissena polymorpha*	40
ARTHROPODA			
CRUSTACEA			
DECAPODA	Cambaridae	*Cambarus sp.*	1
ISOPODA	Asellidae	*Caecidotea sp.*	1
AMPHIPODA	Gammaridae	*Gammarus sp.*	40
INSECTA			
COLEOPTERA	Hydrophilidae	Undetermined Hydrophilidae	1
	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Dubiraphia bivittata*	1
		Stenelmis sp.	4
TRICHOPTERA	Leptoceridae	*Ceraclea sp.*	1
DIPTERA	Chironomidae	*Cricotopus sp. "ozarks"*	1
		Cricotopus tremulus gr.	1
		Polypedilum illinoense	4

SPECIES RICHNESS:	15 (poor)
BIOTIC INDEX:	6.78 (poor)
EPT RICHNESS:	1 (very poor)
MODEL AFFINITY:	24 (very poor)
NUTRIENT INDEX	8.09 (very eutrophic)
ASSESSMENT:	moderately impacted (2.64)

DESCRIPTION: The kick sample was taken between the east-west bound lanes of Route 20 in Canandaigua, 0.25 mile downstream of the outlet of Canandaigua Lake. This site was on the Feeder Canal to Canandaigua Outlet, rather than the outlet proper. The habitat was an adequate riffle, but the macroinvertebrate community was controlled by impoundment effects, being dominated by zebra mussels and scuds (Crustacea: Amphipoda). The Nutrient Biotic Index reflected high nutrients from Canandaigua Lake. Although the metrics denoted moderately impacted water quality, this is considered primarily impoundment impact.

STREAM SITE:	Canandaigua Outlet, Station CANA-02
LOCATION:	Canandaigua, NY, below Saltonstall Road (Feeder Canal)
DATE:	26 July 2005
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

MOLLUSCA			
PELECYPODA			
	Dreisseniidae	*Dreissena polymorpha*	7
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	27
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis intercalaris*	1
ODONATA	Coenagrionidae	*Argia sp.*	1
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	25
		Hydropsyche betteni	22
		Hydropsyche sparna	2
	Leptoceridae	*Ceraclea sp.*	1
DIPTERA	Simuliidae	*Simulium vittatum*	1
	Chironomidae	*Polypedilum flavum*	9
		Xenochironomus xenolabis	4

SPECIES RICHNESS:	11 (poor)
BIOTIC INDEX:	6.00 (good)
EPT RICHNESS:	5 (poor)
MODEL AFFINITY:	34 (very poor)
NUTRIENT INDEX:	7.20 (eutrophic)
ASSESSMENT:	moderately impacted (3.89)

DESCRIPTION: This sampling site is approximately 0.5 mile downstream of the Canandaigua (City) Sewage Treatment Plant, on the Feeder Canal to Canandaigua Outlet rather than the outlet proper. A strong sewage odor was present at the time of sampling and the stream water was gray. The macroinvertebrate community was heavily dominated by filter-feeding caddisflies; zebra mussels and scuds were present, but in lesser numbers. One mayfly was found in the subsample. Based on the metrics, water quality was assessed as moderately impacted, with ISD denoting multiple impacts because of lake effects and the sewage treatment plant discharge.

Macroinvertebrate Data Reports: Raw Data, cont'd.

STREAM SITE:	Canandaigua Outlet, Station CANA-03
LOCATION:	Chapin, NY, above County Route 4 bridge
DATE:	26 July 2005
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Tubificidae	*Aulodrilus sp.*	1
		Limnodrilus hoffmeisteri	7
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	6
DECAPODA	Cambaridae	*Cambarus sp.*	1
INSECTA			
EPHEMEROPTERA	Heptageniidae	*Stenacron interpunctatum*	26
	Caenidae	*Caenis sp.*	42
ODONATA	Coenagrionidae	*Argia sp.*	2
COLEOPTERA	Elmidae	*Dubiraphia sp.*	2
		Stenelmis sp.	3
MEGALOPTERA	Sialidae	*Sialis sp.*	1
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	3
DIPTERA	Chironomidae	*Thienemannimyia gr. spp.*	4
		Dicrotendipes neomodestus	1
		Polypedilum halterale gr.	1

SPECIES RICHNESS:	14 (poor)
BIOTIC INDEX:	6.49 (good)
EPT RICHNESS:	3 (poor)
MODEL AFFINITY:	69 (very good)
NUTRIENT INDEX	5.14 (mesotrophic)
ASSESSMENT:	slightly impacted (5.07)

DESCRIPTION: The kick sample was taken upstream of the County Route 4 bridge in Chapin. The stream was slower and wider here, but the habitat was judged to be adequate. No zebra mussels were found in the sample, although their empty shells were abundant in the stream. The macroinvertebrate community was dominated by facultative mayflies and water quality was assessed as slightly impacted.

Macroinvertebrate Data Reports: Raw Data, cont'd.

STREAM SITE:	Canandaigua Outlet, Station CANA-05
LOCATION:	Littleville, NY, below County Route 13 bridge
DATE:	26 July 2005
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	10
		Baetis intercalaris	7
		Plauditus sp.	3
	Heptageniidae	*Stenonema sp.*	2
PLECOPTERA	Perlidae	*Paragnetina media*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	2
	Elmidae	*Stenelmis sp.*	1
TRICHOPTERA	Philopotamidae	*Chimarra obscura*	2
	Hydropsychidae	*Cheumatopsyche sp.*	7
		Hydropsyche betteni	10
		Hydropsyche sparna	24
	Hydroptilidae	*Hydroptila sp.*	1
DIPTERA	Chironomidae	*Thienemannimyia gr. spp.*	2
		Cricotopus trifascia gr.	1
		Tvetenia vitracies	4
		Polypedilum flavum	23

SPECIES RICHNESS:	16 (poor)
BIOTIC INDEX:	5.49 (good)
EPT RICHNESS:	10 (good)
MODEL AFFINITY:	56 (good)
NUTRIENT INDEX:	6.95 (eutrophic)
ASSESSMENT:	slightly impacted (5.98)

DESCRIPTION: The sampling site was downstream of the County Route 13 bridge at Littleville. The stream habitat was characterized by more rubble and higher current speeds. Zebra mussels were not found, but mayflies, caddisflies and stoneflies were present. Stoneflies were not found at this site in previous surveys. Based on the metrics, water quality was assessed as slightly impacted. ISD denoted nutrient enrichment and possible municipal/industrial effects from unknown sources.

STREAM SITE: Canandaigua Outlet, Station CANA-06
LOCATION: Manchester, NY, above State Route 96 bridge
DATE: 26 July 2005
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 organisms

ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	28
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	1
		Plauditus sp.	6
	Heptageniidae	*Leucrocuta sp.*	2
		Stenacron interpunctatum	5
		Stenonema meririvulanum	1
		Stenonema sp.	1
	Ephemerellidae	*Serratella sp.*	4
	Leptohyphidae	*Tricorythodes sp.*	3
	Polymitarcyidae	*Ephoron leukon?*	1
PLECOPTERA	Perlidae	*Paragnetina media*	2
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Optioservus trivittatus*	13
		Stenelmis crenata	4
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	1
		Hydropsyche bronta	2
		Hydropsyche sparna	12
	Hydroptilidae	*Hydroptila sp.*	2
	Leptoceridae	Undetermined Leptoceridae	1
DIPTERA	Empididae	*Hemerodromia sp.*	3
	Chironomidae	*Pentaneura sp.*	1
		Thienemannimyia gr. spp.	4
		Tvetenia vitracies	1
		Polypedilum flavum	1

SPECIES RICHNESS: 24 (good)
BIOTIC INDEX: 5.08 (good)
EPT RICHNESS: 15 (very good)
MODEL AFFINITY: 63 (good)
NUTRIENT INDEX: 6.22 (eutrophic)
ASSESSMENT: non-impacted (7.70)

DESCRIPTION: The kick sample was taken upstream of the State Route 96 bridge at Manchester. The stream substrate was covered with filamentous algae. Dissolved oxygen was supersaturated at 123%. The macroinvertebrate community was well-balanced between mayflies, caddisflies, beetles and scuds, with many species of clean-water mayflies present. Clean-water stoneflies were also present. Based on the metrics, water quality was assessed as non-impacted, with nutrient enrichment present.

Macroinvertebrate Data Reports: Raw Data, cont'd.

STREAM SITE: Canandaigua Outlet, Station CANA-08
LOCATION: Manchester Center, NY, below NYS Thruway bridge
DATE: 26 July 2005
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 organisms

MOLLUSCA			
GASTROPODA			
	Planorbidae	Undetermined Planorbidae	1
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	9
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	3
		Baetis intercalaris	27
		Plauditus sp.	22
	Heptageniidae	*Leucrocuta sp.*	1
		Stenacron interpunctatum	2
		Stenonema sp.	1
	Ephemerellidae	*Serratella sp.*	2
	Leptohyphidae	*Tricorythodes sp.*	3
ODONATA	Coenagrionidae	*Argia sp.*	2
COLEOPTERA	Elmidae	*Optioservus sp.*	1
		Stenelmis sp.	9
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	1
	Sialidae	*Sialis sp.*	1
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	3
		Hydropsyche betteni	1
	Uenoidae	*Neophylax sp.*	3
	Helicopsychidae	*Helicopsyche borealis*	1
DIPTERA	Simuliidae	*Simulium aureum*	1
	Empididae	*Hemerodromia sp.*	1
	Chironomidae	*Tvetenia vitracies*	1
		Polypedilum flavum	4

SPECIES RICHNESS: 23 (good)
BIOTIC INDEX: 4.74 (good)
EPT RICHNESS: 12 (very good)
MODEL AFFINITY: 73 (very good)
NUTRIENT INDEX 5.29 (mesotrophic)
ASSESSMENT: non-impacted (7.64)

DESCRIPTION: This most downstream site, accessed from County Route 7, was less than 0.1 mile downstream of the NYS Thruway. Aquatic macrophytes dominated the stream. Dissolved oxygen level was supersaturated at 148% and pH was 8.5, both reflecting abundant photosynthesis. The macroinvertebrate community was dominated by clean-water and facultative mayflies. ISD denoted highest similarity to natural communities and water quality was assessed as non-impacted.

FIELD DATA SUMMARY				
STREAM NAME: Canandaigua Outlet	DATE SAMPLED: 7/26/2005			
REACH: Canandaigua to Manchester Center				
FIELD PERSONNEL INVOLVED: Smith, Novak				
STATION	01	02	03	05
ARRIVAL TIME AT STATION	12:00 PM	1:20 PM	2:00 PM	2:30 PM
LOCATION	Canandaigua Rte 20	Canandaigua CR 46	Chapin CR 4	Littleville CR 13/ CR 19
PHYSICAL CHARACTERISTICS				
Width (meters)	3.0	5.0	15	15
Depth (meters)	0.6	0.2	0.4	0.2
Current speed (cm per sec.)	71	111	30	91
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10	30	20	
Rubble (6.35 – 25.4 cm)	20	30	20	40
Gravel (0.2 – 6.35 cm)	30	20	30	30
Sand (0.06 – 2.0 mm)	40	10	10	10
Silt (0.004 – 0.06 mm)		10	20	20
Embeddedness (%)	50	25	50	40
CHEMICAL MEASUREMENTS				
Temperature (° C)	26.1	25.8	26.5	27.0
Specific Conductance (umhos)	342	428	388	420
Dissolved Oxygen (mg/l)	9.6	9.1	7.5	8.8
pH	8.3	8.1	7.7	8.2
BIOLOGICAL ATTRIBUTES				
Canopy (%)	0	40	10	40
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous	x	x	x	xx
algae – diatoms	x	x	x	x
macrophytes or moss	x		x	xx
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	x		x	x
Plecoptera (stoneflies)				x
Trichoptera (caddisflies)	x	x	x	x
Coleoptera (beetles)	x		x	x
Megaloptera (dobsonflies, alderflies)				
Odonata (dragonflies, damselflies)			x	
Chironomidae (midges)		x	x	x
Simuliidae (black flies)	x	x		
Decapoda (crayfish)		x	x	
Gammaridae (scuds)		x	x	
Mollusca (snails, clams)				
Oligochaeta (worms)	x			
Other		x	x	
FAUNAL CONDITION	Poor	Poor	Good	Good

FIELD DATA SUMMARY

STREAM NAME: Canandaigua Outlet		DATE SAMPLED: 7/26/2005		
REACH: Canandaigua to Manchester Center				
FIELD PERSONNEL INVOLVED: Smith, Novak				
STATION	06	08		
ARRIVAL TIME AT STATION	3:05 PM	3:45 PM		
LOCATION	Manchester Rte 96	Manchester Center CR 7		
PHYSICAL CHARACTERISTICS				
Width (meters)	15	15		
Depth (meters)	0.3	0.3		
Current speed (cm per sec.)	77	71		
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10	10		
Rubble (6.35 – 25.4 cm)	30	30		
Gravel (0.2 – 6.35 cm)	30	30		
Sand (0.06 – 2.0 mm)	20	20		
Silt (0.004 – 0.06 mm)	10	10		
Embeddedness (%)	30	40		
CHEMICAL MEASUREMENTS				
Temperature (° C)	25.6	27.0		
Specific Conductance (umhos)	428	436		
Dissolved Oxygen (mg/l)	9.8	11.8		
pH	8.5	8.5		
BIOLOGICAL ATTRIBUTES				
Canopy (%)	25	10		
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous	xxx	xx		
algae – diatoms	x	xx		
macrophytes or moss	xx	xxx		
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	x	x		
Plecoptera (stoneflies)	x			
Trichoptera (caddisflies)	x	x		
Coleoptera (beetles)	x	x		
Megaloptera (dobsonflies, alderflies)				
Odonata (dragonflies, damselflies)		x		
Chironomidae (midges)	x	x		
Simuliidae (black flies)				
Decapoda (crayfish)	x			
Gammaridae (scuds)	x	x		
Mollusca (snails, clams)	x			
Oligochaeta (worms)				
Other				
FAUNAL CONDITION	Good	Good		

LABORATORY DATA SUMMARY

STREAM NAME: Canandaigua Outlet		**DRAINAGE: 07**		
DATE SAMPLED: 7/26/2005		**COUNTY: Ontario**		
SAMPLING METHOD: Travelling Kick				
STATION	01	02	03	05
LOCATION	Canandaigua Rte 20	Canandaigua CR 46	Chapin CR 4	Littleville CR 13/ CR 19
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Dreissena polymorpha 40 % tolerant mollusca	Gammarus sp. 27 % facultative crustacea	Caenis sp. 42 % tolerant mayfly	Hydropsyche sparna 24 % facultative caddisfly
2. **Intolerant = not tolerant of poor water quality**	Gammarus sp. 40 % facultative crustacea	Cheumatopsyche sp. 25 % facultative caddisfly	Stenacron interpunctatum 26 % tolerant mayfly	Polypedilum flavum 23 % facultative midge
3. **Facultative = occurring over a wide range of water quality**	Stenelmis sp. 4 % facultative beetle	Hydropsyche betteni 22 % facultative caddisfly	Limnodrilus hoffmeisteri 7 % tolerant worm	Baetis flavistriga 10 % intolerant mayfly
4. **Tolerant = tolerant of poor water quality**	Polypedilum illinoense 4 % facultative midge	Polypedilum flavum 9 % facultative midge	Gammarus sp. 6 % facultative crustacea	Hydropsyche betteni 10 % facultative caddisfly
5.	Undetermined Turbellaria 2 % tolerant worm	Dreissena polymorpha 7 % tolerant mollusca	Thienemannimyia gr. spp. 4 % facultative midge	Baetis intercalaris 7 % intolerant mayfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	6.0 (3.0)	13.0 (2.0)	6.0 (3.0)	30.0 (4.0)
Trichoptera (caddisflies)	1.0 (1.0)	50.0 (4.0)	3.0 (1.0)	44.0 (5.0)
Ephemeroptera (mayflies)	0.0 (0.0)	1.0 (1.0)	68.0 (2.0)	22.0 (4.0)
Plecoptera (stoneflies)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	1.0 (1.0)
Coleoptera (beetles)	7.0 (4.0)	0.0 (0.0)	5.0 (2.0)	3.0 (2.0)
Oligochaeta (worms)	0.0 (0.0)	0.0 (0.0)	8.0 (2.0)	0.0 (0.0)
Mollusca (clams and snails)	42.0 (3.0)	7.0 (1.0)	0.0 (0.0)	0.0 (0.0)
Crustacea (crayfish, scuds, sowbugs)	42.0 (3.0)	27.0 (1.0)	7.0 (2.0)	0.0 (0.0)
Other insects (odonates, diptera)	0.0 (0.0)	2.0 (2.0)	3.0 (2.0)	0.0 (0.0)
Other (Nemertea, Platyhelminthes)	2.0 (1.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
SPECIES RICHNESS	15	11	14	16
BIOTIC INDEX	6.78	6.00	6.49	5.49
EPT RICHNESS	1	5	3	10
PERCENT MODEL AFFINITY	24	34	69	56
FIELD ASSESSMENT	Poor	Poor	Good	Good
OVERALL ASSESSMENT	Moderately impacted	Moderately impacted	Slightly impacted	Slightly impacted

LABORATORY DATA SUMMARY

STREAM NAME: Canandaigua Outlet	DRAINAGE: 07
DATE SAMPLED: 7/26/2005	COUNTY: Ontario
SAMPLING METHOD: Travelling Kick	

STATION	06	08		
LOCATION	Manchester Rte 96	Manchester Center; CR 7		
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Gammarus sp. 28 % facultative crustacea	Baetis intercalaris 27 % intolerant mayfly		
2. Intolerant = not tolerant of poor water quality	Optioservus trivittatus 13 % intolerant beetle	Plauditus sp. 22 % intolerant mayfly		
3. Facultative = occurring over a wide range of water quality	Hydropsyche sparna 12 % facultative caddisfly	Gammarus sp. 9 % facultative crustacea		
4. Tolerant = tolerant of poor water quality	Plauditus sp. 6 % intolerant mayfly	Stenelmis sp. 9 % facultative beetle		
5.	Stenacron interpunctatum 5 % tolerant mayfly	Polypedilum flavum 4 % facultative midge		
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	7.0 (3.0)	5.0 (2.0)		
Trichoptera (caddisflies)	18.0 (5.0)	8.0 (4.0)		
Ephemeroptera (mayflies)	24.0 (9.0)	61.0 (8.0)		
Plecoptera (stoneflies)	2.0 (1.0)	0.0 (0.0)		
Coleoptera (beetles)	18.0 (3.0)	10.0 (2.0)		
Oligochaeta (worms)	0.0 (0.0)	0.0 (0.0)		
Mollusca (clams and snails)	0.0 (0.0)	1.0 (1.0)		
Crustacea (crayfish, scuds, sowbugs)	28.0 (1.0)	9.0 (1.0)		
Other insects (odonates, diptera)	3.0 (1.0)	6.0 (5.0)		
Other (Nemertea, Platyhelminthes)	0.0 (0.0)	0.0 (0.0)		
SPECIES RICHNESS	24	23		
BIOTIC INDEX	5.08	4.74		
EPT RICHNESS	15	12		
PERCENT MODEL AFFINITY	63	73		
FIELD ASSESSMENT	Good	Good		
OVERALL ASSESSMENT	Non-impacted	Non-impacted		

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 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; 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.

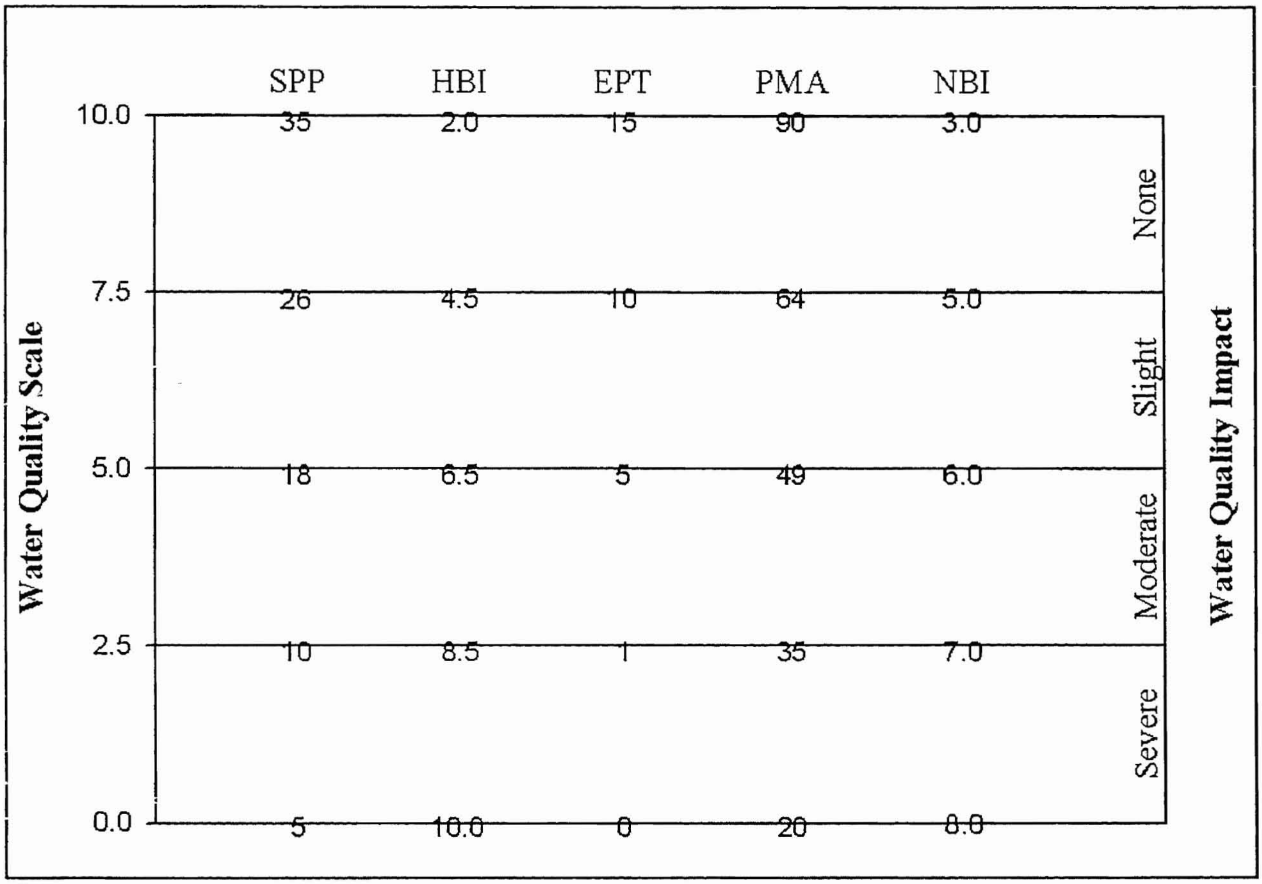
2. _Slightly impacted_: Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness is usually 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50. 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 (BAP); Conversion of Index Values to a Common 10-Scale

The Biological Assessment Profile 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.



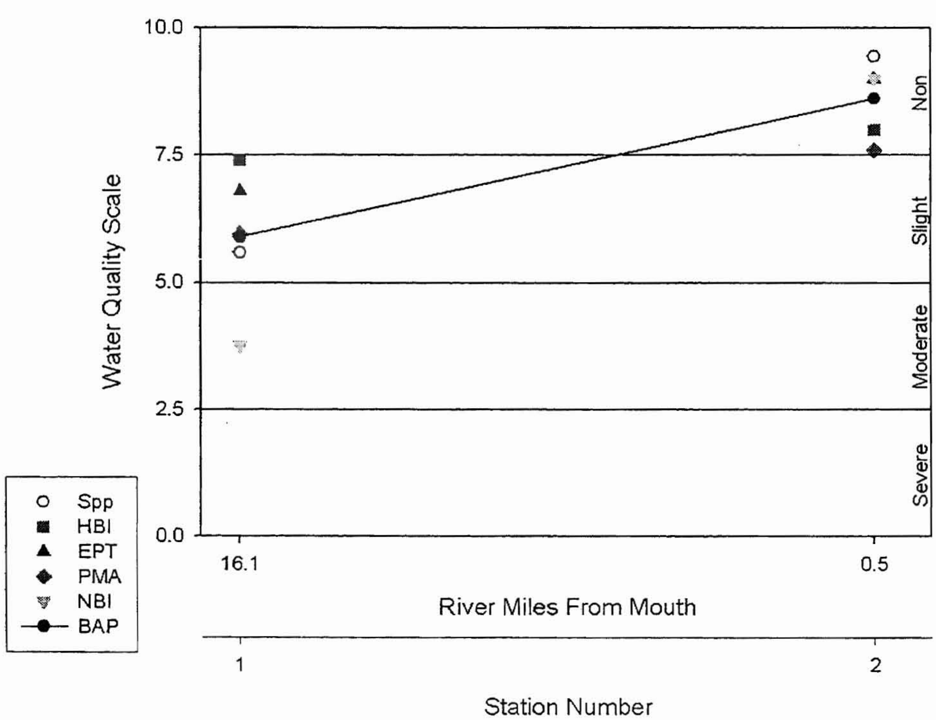
Appendix IV-B. Biological Assessment Profile: Plotting Values

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	.00
Percent Model Affinity	55	5.97	65	7.60
Nutrient Biotic Index	6.50	3.75	3.50	9.00
Average		5.90 (slight)		8.61 (non-)

Sample Plot of Biological Assessment Profile values



Appendix V. Water Quality Assessment Criteria

Non-Navigable Flowing Waters

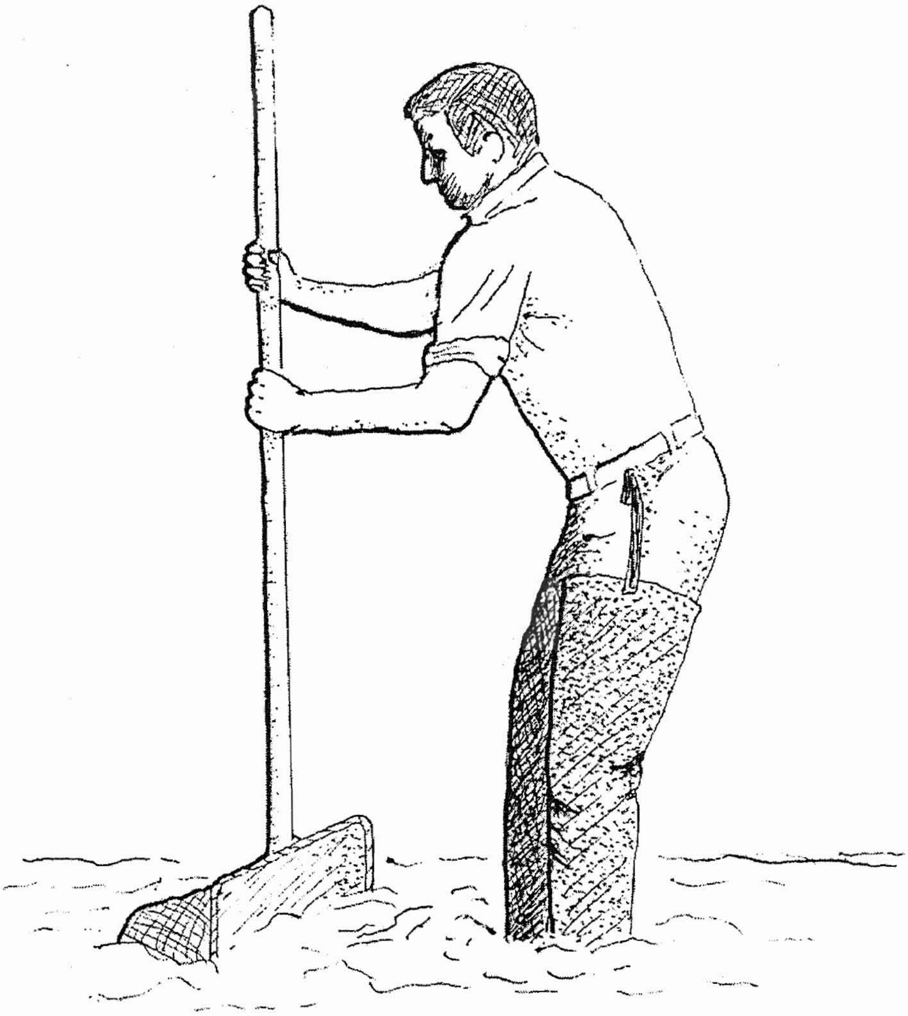
	Species Richness	Hilsenhoff Biotic Index	Nutrient Biotic Index*	EPT Value	Percent Model Affinity#	Diversity **
Non-Impacted	>26	0.00-4.50	0.00-5.00	>10	>64	>4
Slightly Impacted	19-26	4.51-6.50	5.01-6.00	6-10	50-64	3.01-4.00
Moderately Impacted	11-18	6.51-8.50	6.51-7.00	2-5	35-49	2.01-3.00
Severely Impacted	0-10	8.51-10.00	7.01-10.00	0-1	<35	0.00-2.00

* Nutrient Biotic Index (for total phosphorus, NBI-P) used for traveling kick samples but not for multiplate samples.
# 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	Hilsenhoff	EPT	Species
Non-	>21	0.00-7.00	>5	>3.00
Slightly	17-21	7.01-8.00	4-5	2.51-3.00
Moderately	12-16	8.01-9.00	2-3	2.01-2.50
Severely	0-11	9.01-10.00	0-1	0.00-2.00

Appendix VI: The Traveling Kick Sample

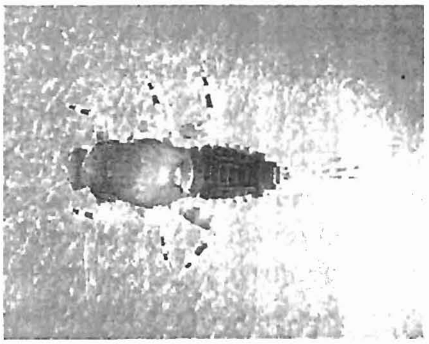


← current

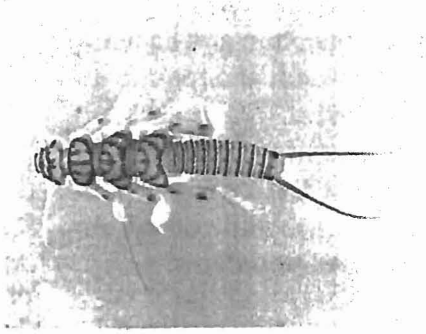
Rocks and sediment in a riffle are dislodged by foot upstream of a net. Dislodged organisms are carried by the current into the net. Sampling continues for five minutes, as the sampler gradually moves downstream to cover a distance of five meters.

Appendix VII. A.
Aquatic Macroinvertebrates that Usually Indicate Good Water Quality

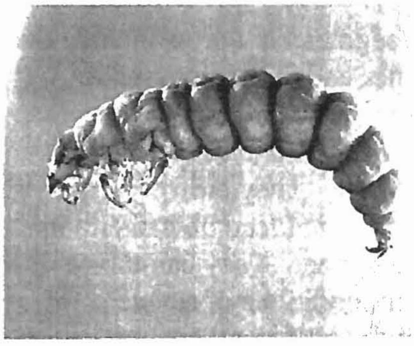
Mayfly nymphs are often the most numerous organisms found in clean streams. They are sensitive to most types of pollution, including low dissolved oxygen (less than 5 ppm), chlorine, ammonia, metals, pesticides, and acidity. Most mayflies are found clinging to the undersides of rocks.


MAYFLIES

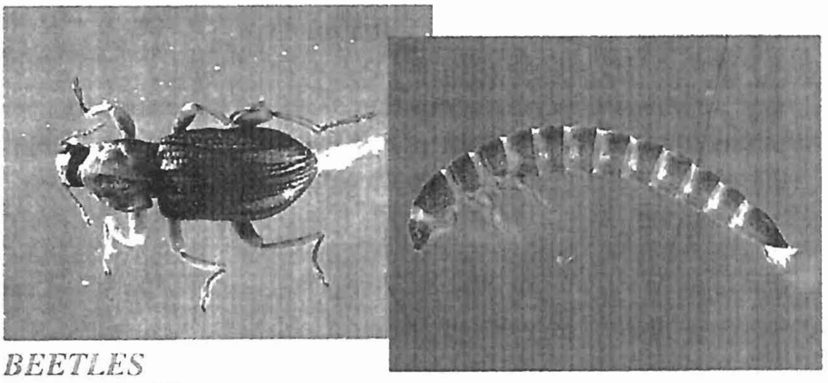
Stonefly nymphs are mostly limited to cool, well-oxygenated streams. They are sensitive to most of the same pollutants as mayflies, except acidity. They are usually much less numerous than mayflies. The presence of even a few stoneflies in a stream suggests that good water quality has been maintained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

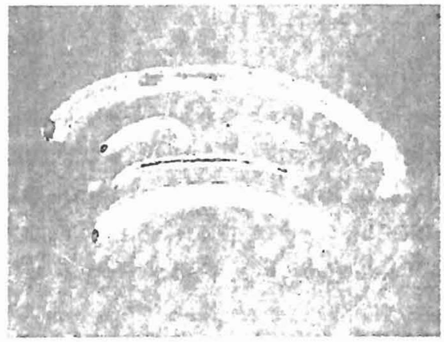

CADDISFLIES

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


BEETLES

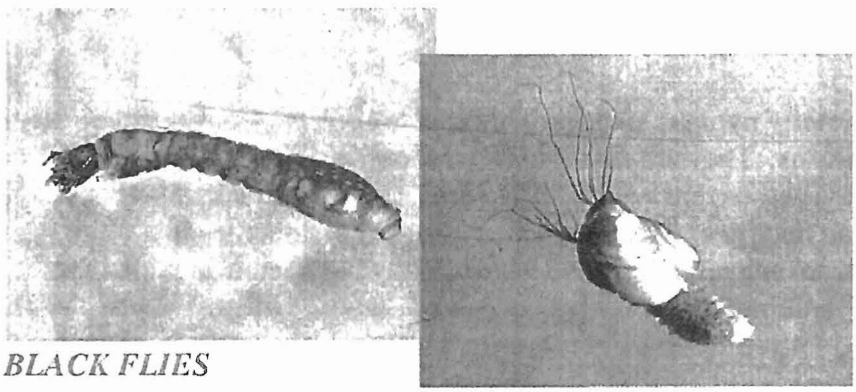
Appendix VII. B.
Aquatic Macroinvertebrates that Usually Indicate Poor Water Quality

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.



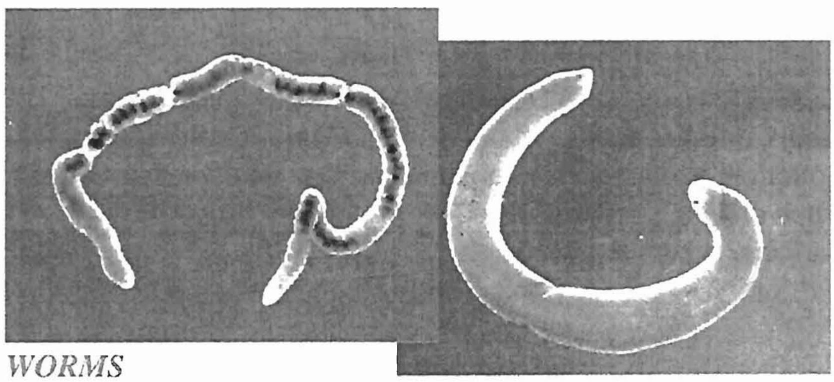
MIDGES

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.



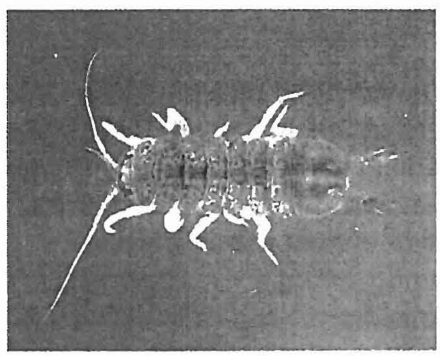
BLACK FLIES

The segmented worms include the leeches and the small aquatic 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 species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera)in a sample or subsample

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

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

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 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

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

Appendix X. 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 TABLE
NATURAL MACROINVERTEBRATE COMMUNITY TYPE

	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

ISD MODELS TABLE (cont.)
NONPOINT NUTRIENT ENRICHMENT IMPACTED MACROINVERTEBRATE COMMUNITY TYPE

	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 TABLE (cont.)
MACROINVERTEBRATE COMMUNITY TYPES

	MUNICIPAL/INDUSTRIAL WASTES IMPACTED								TOXICS IMPACTED					
	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

ISD MODELS TABLE (cont.)
SEWAGE EFFLUENT, ANIMAL WASTES IMPACTED MACROINVERTEBRATE COMMUNITY TYPE

	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 TABLE (cont.)
MACROINVERTEBRATE COMMUNITY TYPES

	SILTATION IMPACTED					IMPOUNDMENT IMPACTED									
	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	-
<u>Isonychia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	20	5	-	-	5	-	5	-	-	5	-	-	5
HEPTAGENIIDAE	5	10	-	20	5	5	5	-	5	5	5	5	-	5	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Caenis/Tricorythodes</u>	5	20	10	5	15	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Psephenus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
<u>Optioservus</u>	5	10	-	-	-	-	-	-	-	-	-	-	-	5	-
<u>Promoresia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Stenelmis</u>	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	-	-	-	-	-	-	-	-
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus/ Orthocladius</u>	25	-	10	5	5	5	25	5	-	10	-	5	10	-	-
<u>Eukiefferiella/ Tvetenia</u>	-	-	10	-	5	5	15	-	-	-	-	-	-	-	-
<u>Parametriocnemus</u>	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
<u>Chironomus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum aviceps</u> -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum</u> (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