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Walloomsac River

Biological Assessment

2003 Survey

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WALLOOMSAC RIVER

BIOLOGICAL ASSESSMENT

Upper Hudson River Basin
Rensselaer County, New York
Bennington County, Vermont

Survey date: June 17, 2003
Report date: April 26, 2004

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

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Stream: Walloomsac River, New York

Reach: Bennington, Vermont, to North Hoosick, New York

NYS Drainage Basin: Upper Hudson River

Background:

The Stream Biomonitoring Unit conducted biological sampling on the Walloomsac River on June 17, 2003. The purpose of the sampling was to assess general water quality, and determine any spatial or chronological water quality trends. 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 PMA (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. Based on macroinvertebrate sampling, water quality in the Walloomsac River was assessed as non-impacted from North Bennington to North Hoosick.

2. Compared to results of previous surveys in1984 and 1991, water quality at most sites appears similar to that found 1991, and slightly improved at the site downstream of the Vermont-New York border (Station 3). The results confirm the effectiveness of the Bennington Wastewater Treatment Plant in protecting the good water quality of the river.

Discussion

The Walloomsac River originates in Bennington, Vermont at the confluence of Jewett Brook and Barney Brook. It flows approximately 16 miles in a westerly direction before emptying into the Hoosic River at North Hoosick, New York. Most of the 111 square mile drainage lies in Vermont; less than 10 square miles fall within New York State. The stream is classified as C (T), and receives spring stocking with brown trout.

Previous sampling of the Walloomsac River by the Stream Biomonitoring Unit includes surveys in 1984 and 1991, at the same 4 sites sampled in the present survey. The 1984 sampling indicated water quality to be slightly impacted upstream of the Bennington Wastewater Treatment Plant (WWTP)discharge, and moderately impacted at all sites downstream of the discharge (Simpson and Bode, 1985). Downstream of the discharge, "The river showed obvious effects of the sewage discharge, with gray cloudy water, a prominent sewage odor, and the bottom rubble thickly covered with blue-green algae". Ninety-two percent of the organisms were midges and worms. Near the river's mouth, the fauna still showed many signs of the impact.

The 1991 survey showed substantial improvement in the river, with most of the river being assessed as non-impacted (Abele et al., 1991). Slightly impacted water quality was found at Station 3, three miles downstream of the WWTP outfall. The upgrading of the Bennington WWTP in 1985 was considered to be the most influential factor contributing to improved water quality in the river.

Rotating Intensive Basin Studies (RIBS) sampling just west of the Vermont border (Station 3) was conducted in 1993 and 1994. In both years the macroinvertebrate community indicated slight impact, although most metrics bordered on non-impacted water quality (NYSDEC, 1996). Impact Source Determination (ISD, see Appendix X) indicated silt to be the primary influence on the fauna.

Water quality in the present survey was assessed as non-impacted at all sites (Figure 1). A decrease in water quality was found downstream of the WWTP outfall (Station 2), but still remained within the non-impacted category. ISD indicated the communities resembled natural community models at all sites (Table 1). Additional ISD indications included several possible stressors at Station 3, though these were inconclusive. Siltation was indicated at the most downstream site, Station 4. Compared to results of the 1984 and 1991 surveys, water quality appears similar to the 1991 results (Figure 2), and shows slightly improved conditions at the site downstream of the Vermont-New York border (Station 3). The results confirm the effectiveness of the Bennington WWTP in protecting the good water quality of the river.

Literature Cited:

Abele, L. E., R. W. Bode, and M. A. Novak. 1991. Biological Stream Assessment, Walloomsac River, 1991 survey. New York State Department of Environmental Conservation, Technical Report, 20 pages.

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.

New York State Department of Environmental Conservation, 1996. Rotating Intensive Basin Studies biennial report: the Upper Hudson River drainage basin. New York State Department of Environmental Conservation, Technical Report, 105 pages plus Appends.

Simpson, K. W., and R. W. Bode. 1985. Rapid Biological Stream Assessment, Walloomsac River. New York State Department of Health, Technical Memorandum, 7 pages.

Overview of field data

On the date of sampling, June 17, 2003, Walloomsac River at the sites sampled was 20-30 meters wide, 0.2 meters deep, and had current speeds of 77-110 cm/sec in riffles. Dissolved oxygen was 9.4-11.3 mg/l, specific conductance was 220-252 μmhos, pH was 7.8-8.2, and the temperature was 14.4-17.2 °C (58-63 °F). Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, Walloomsac River, 2003. 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.

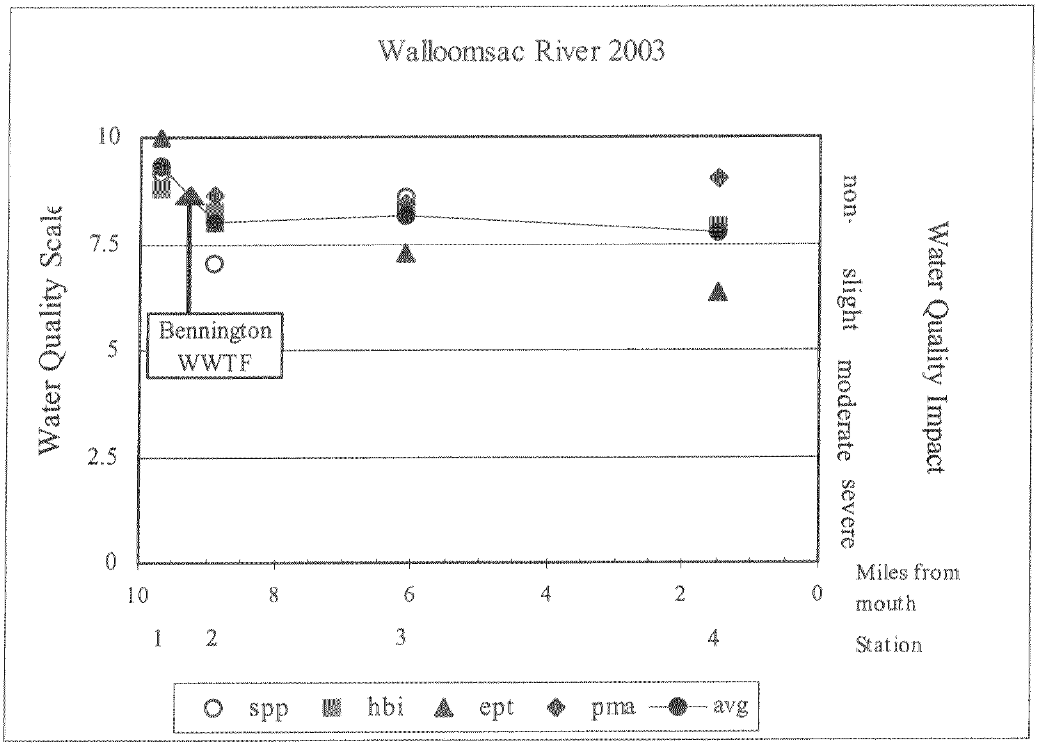


Figure 2. Biological Assessment Profile of index values, Walloomsac River: 1984-2003. Values are plotted on a normalized scale of water quality. Averages are shown for each year of sampling.

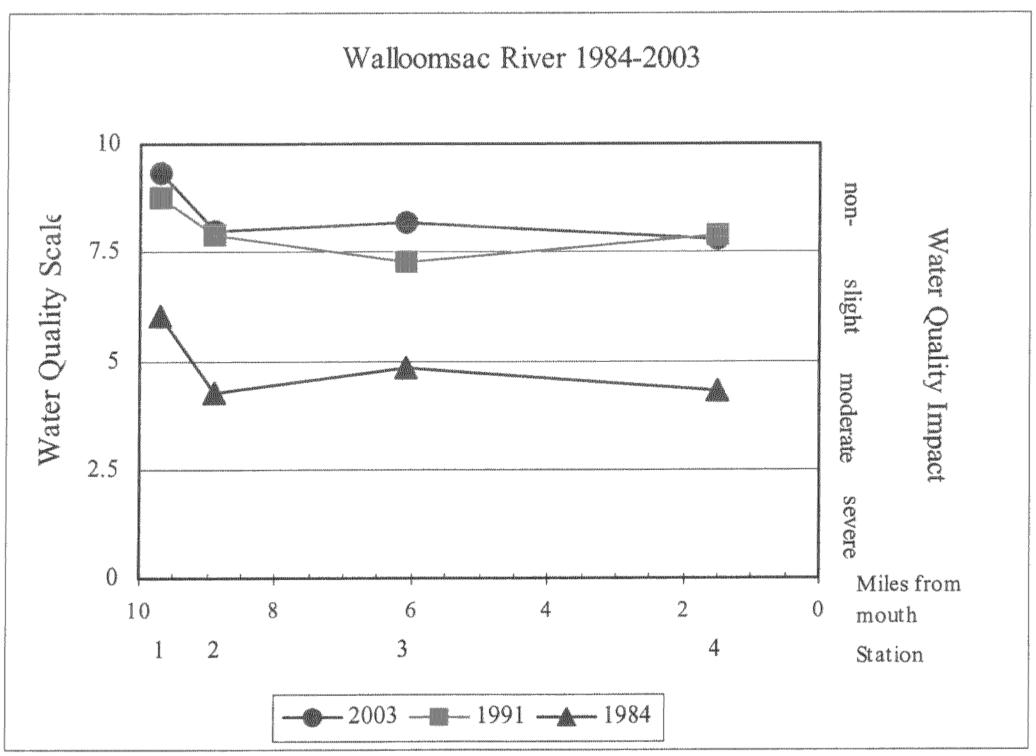


Table 1. Impact Source Determination, Walloomsac River, 2003. Numbers represent similarity to community type models for each impact category. The highest similarities at each station are highlighted. Similarities below 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix X for further explanation.

	Station			
Community Type	01	02	03	04
Natural: minimal human impacts	64	58	43	52
Nutrient additions; mostly nonpoint, agricultural	47	33	40	40
Toxic: industrial, municipal, or urban run-off	33	38	41	37
Organic: sewage, animal wastes	39	34	41	40
Complex: municipal and/or industrial	30	22	27	28
Siltation	43	41	38	48
Impoundment	33	36	36	35

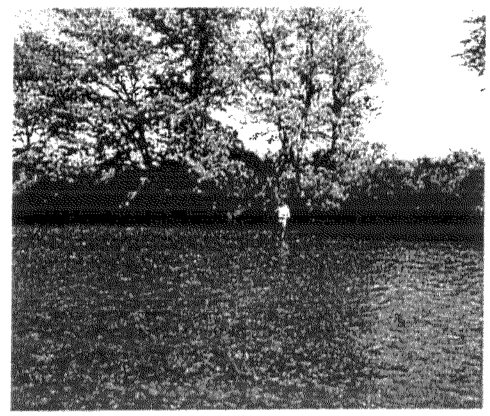
TABLE SUMMARY

STATION	LOCATION	COMMUNITY TYPE
WALL-1	North Bennington, Vt	Natural
WALL-2	North Bennington, Vt	Natural
WALL-3	White Creek Station, NY	Natural, nutrient additions, toxic, organic
WALL-4	North Hoosick, NY	Natural, siltation

TABLE 2. STATION LOCATIONS FOR THE WALLOOMSAC RIVER, BENNINGTON VERMONT, AND RENSSELAER CO., NEW YORK.

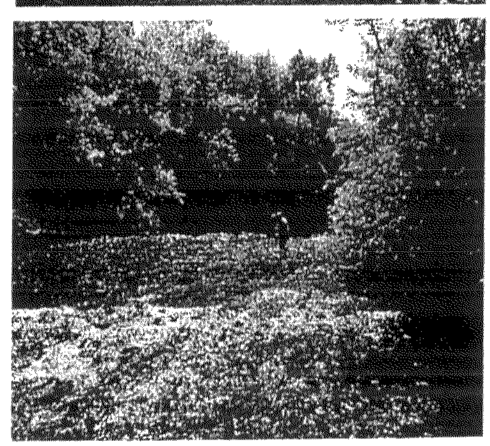
Sta. 01 North Bennington, Vt.
below bridge connecting Orebed and Harrington Roads
9.7 miles above the mouth
Latitude/longitude: 42°54'46" 73°15'18"

Sta. 02 North Bennington, Vt.
0.5 miles downstream of Bennington sewage treatment plant outfall
8.9 miles above the mouth
Latitude/longitude: 42°55'06" 73°16'06"



Sta. 03 White Creek Station, Vt.
75 meters above Cottrell Rd bridge (east end)
6.1 miles above the mouth
Latitude/longitude: 42°56'23" 73°17'02"

Sta. 04 North Hoosick, NY.
200 meters above Route 22 bridge
1.5 miles above the mouth
Latitude/longitude: 42°55'34" 73°20'33"



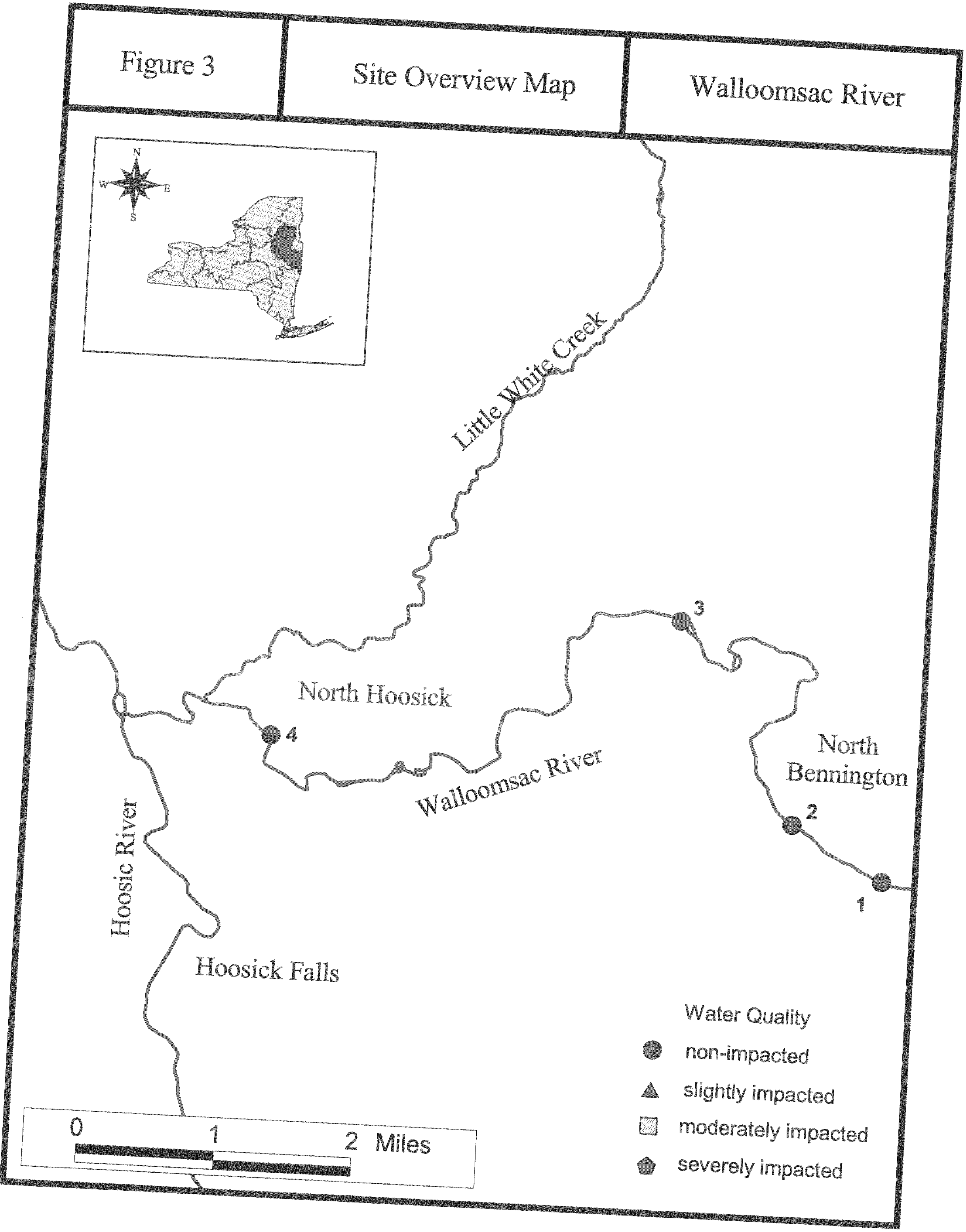


Figure 3
Site Overview Map
Walloomsac River
N
W
E
S
Little White Creek
North Hoosick
3
4
North Bennington
Walloomsac River
2
1
Hoosic River
Hoosick Falls
Water Quality
non-impacted
slightly impacted
moderately impacted
severely impacted
0
1
2 Miles

Figure 4a	Site Location Map	Walloomsac River

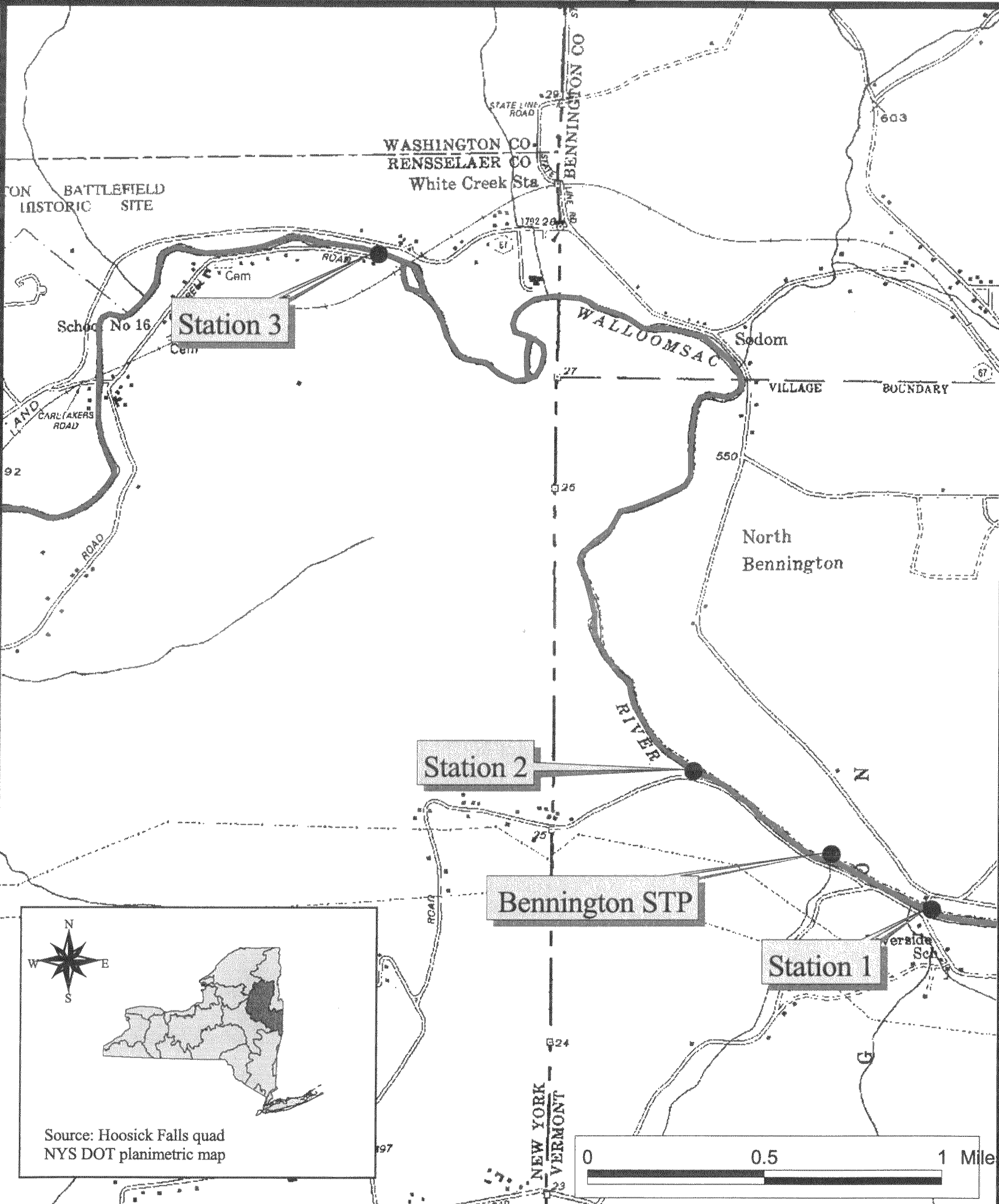


Figure 4b	Site Location Map	Walloomsac River

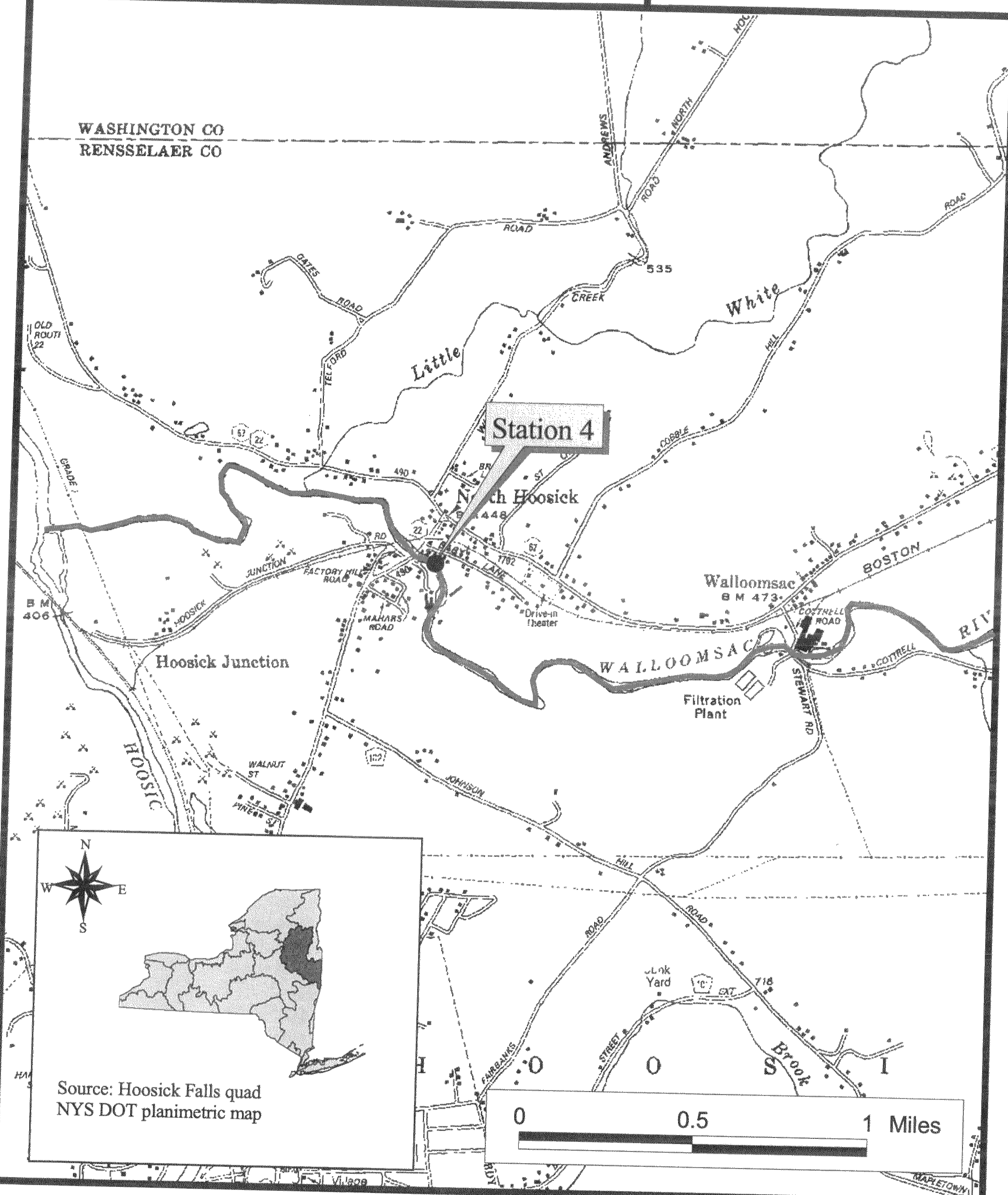


TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN THE WALLOOMSAC RIVER, BENNINGTON CO., VERMONT, AND RENSSELAER CO., NEW YORK, 2003.

PLATYHELMINTHES
  TURBELLARIA
    Planariidae
      Undet. Turbellaria
ANNELIDA
  OLIGOCHAETA
    LUMBRICIDA
      Undet. Lumbricina
    LUMBRICULIDA
      Lumbriculidae
        Undet. Lumbriculidae
TUBIFICIDA
  Enchytraeidae
    Undet. Enchytraeidae
ARTHROPODA
  CRUSTACEA
    AMPHIPODA
      Gammaridae
        Gammarus sp.
  INSECTA
    EPHEMEROPTERA
      Baetidae
        Acentrella sp.
        Baetis flavistriga
        Baetis intercalaris
      Heptageniidae
        Epeorus (Iron) sp.
        Stenonema sp.
      Leptophlebiidae
        Paraleptophlebia sp.
      Ephemerellidae
        Drunella lata
        Ephemerella dorothea
        Serratella deficiens
PLECOPTERA
  Perlidae
    Paragnetina media
  Perlodidae
    Isoperla sp.
COLEOPTERA
  Psephenidae
    Psephenus herricki
  Elmidae
    Optioservus fastiditus
    Optioservus trivittatus
    Stenelmis crenata
MEGALOPTERA
  Corydalidae
    Corydalus cornutus
TRICHOPTERA
  Philopotamidae
    Chimarra sp.
    Dolophilodes sp.
  Hydropsychidae
    Cheumatopsyche sp.
    Hydropsyche morosa
    Hydropsyche scalaris
    Hydropsyche slossonae
    Hydropsyche sparna
  Glossosomatidae
    Glossosoma sp.
  Hydroptilidae
    Hydroptila sp.
    Leucotrichia sp.
  Brachycentridae
    Brachycentrus americanus
    Brachycentrus sp.
    Micrasema sp.
DIPTERA
  Empididae
    Hemerodromia sp.
  Tipulidae
    Antocha sp.
  Ceratopogonidae
    Undet. Ceratopogonidae
  Simuliidae
    Simulium tuberosum
    Simulium sp.
  Empididae
    Hemerodromia sp.
  Chironomidae
    Thienemannimyia gr. spp.
    Pagastia orthogonia
    Brillia flavifrons
    Cardiocladius obscurus
    Cricotopus bicinctus
    Cricotopus tremulus gr.
    Cricotopus trifascia gr.
    Cricotopus vierriensis
    Orthocladius nr. dentifer
    Orthocladius (Euorthoclad.) sp.
    Paratrichocladius sp.
    Tvetenia bavarica gr.
    Polypedilum aviceps
    Polypedilum flavum
    Polypedilum laetum
    Rheotanytarsus exiguus gr.
    Sublettea coffmani
    Tanytarsus guerlus gr.

STREAM SITE:	Walloomsac River,	Station 01
LOCATION:	North Bennington, Vt,	below bridge connecting Orbed and Harrington Roads
DATE:	17 June 2003	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100	

ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	4
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	1
		Baetis flavistriga	4
		Baetis intercalaris	5
	Heptageniidae	Epeorus (Iron) sp.	4
	Leptophlebiidae	Paraleptophlebia sp.	8
	Ephemerellidae	Drunella lata	3
		Ephemerella dorothea	21
PLECOPTERA	Perlidae	Paragnetina media	2
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Optioservus fastiditus	5
		Optioservus trivittatus	9
		Stenelmis crenata	4
MEGALOPTERA	Corydalidae	Corydalus cornutus	1
TRICHOPTERA	Philopotamidae	Chimarra sp.	1
		Dolophilodes sp.	1
	Hydropsychidae	Cheumatopsyche sp.	1
		Hydropsyche morosa	1
		Hydropsyche slossonae	1
		Hydropsyche sparna	3
	Glossosomatidae	Glossosoma sp.	1
	Hydroptilidae	Leucotrichia sp.	1
	Brachycentridae	Brachycentrus sp.	1
		Micrasema sp.	1
DIPTERA	Tipulidae	Antocha sp.	2
	Simuliidae	Simulium tuberosum	1
	Empididae	Hemerodromia sp.	1
	Chironomidae	Thienemannimyia gr. spp.	1
		Cricotopus trifascia gr.	1
		Orthocladius (Euorthoclad.) sp.	1
		Tvetenia bavarica gr.	1
		Polypedilum flavum	8

SPECIES RICHNESS:	32 (very good)
BIOTIC INDEX:	3.22 (very good)
EPT RICHNESS:	18 (very good)
MODEL AFFINITY:	83 (very good)
ASSESSMENT:	non-impacted

DESCRIPTION: The sample was taken 20 meters downstream of Henry Bridge, a covered bridge. The habitat was adequate, and the macroinvertebrate fauna was very diverse. Mayflies, stoneflies, caddisflies, and hellgrammites were numerous. All metrics clearly reflected non-impacted water quality.

STREAM SITE:	Walloomsac River,	Station 02
LOCATION:	North Bennington, Vt.,	0.5 miles downstream of sewage treatment plant outfall
DATE:	17 June 2003	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100	

ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	1
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	1
		Baetis flavistriga	2
		Baetis intercalaris	6
	Ephemerellidae	Drunella lata	10
		Ephemerella dorothea	16
PLECOPTERA	Perlodidae	Isoperla sp.	1
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Optioservus trivittatus	7
		Stenelmis crenata	1
TRICHOPTERA	Hydropsychidae	Hydropsyche morosa	1
		Hydropsyche sparna	1
	Hydroptilidae	Hydroptila sp.	3
	Brachycentridae	Brachycentrus americanus	1
		Micrasema sp.	2
DIPTERA	Empididae	Hemerodromia sp.	1
	Chironomidae	Thienemannimyia gr. spp.	3
		Pagastia orthogonia	8
		Brillia flavifrons	1
		Cricotopus trifascia gr.	6
		Cricotopus vierriensis	5
		Orthocladius nr. dentifer	15
		Polypedilum aviceps	1
		Polypedilum flavum	5

SPECIES RICHNESS:	25 (good)
BIOTIC INDEX:	3.75 (very good)
EPT RICHNESS:	11 (very good)
MODEL AFFINITY:	76 (very good)
ASSESSMENT:	non-impacted

DESCRIPTION: The sampling site, accessed from River Road, was 0.5 miles downstream of the Bennington sewage treatment plant outfall. The macroinvertebrate fauna was diverse, although all metrics worsened slightly compared to the upstream site. Water quality was still within the non-impacted category.

STREAM SITE:	Walloomsac River, Station 03
LOCATION:	White Creek Station, VT, 75 meters above Cottrell Road bridge (east end)
DATE:	17 June 2003
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100

PLATYHELMINTHES			
TURBELLARIA			
	Planariidae	Undetermined Turbellaria	1
ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	1
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	Gammarus sp.	1
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis flavistriga	4
		Baetis intercalaris	4
	Heptageniidae	Epeorus (Iron) sp.	1
	Ephemerellidae	Ephemerella dorothea	15
COLEOPTERA	Psephenidae	Psephenus herricki	2
	Elmidae	Optioservus trivittatus	2
		Stenelmis crenata	8
TRICHOPTERA	Hydropsychidae	Hydropsyche morosa	1
		Hydropsyche scalaris	2
	Glossosomatidae	Glossosoma sp.	1
	Hydroptilidae	Hydroptila sp.	2
	Brachycentridae	Brachycentrus sp.	2
		Micrasema sp.	1
DIPTERA	Tipulidae	Antocha sp.	8
	Ceratopogonidae	Undetermined Ceratopogonidae	1
	Chironomidae	Thienemannimyia gr. spp.	1
		Pagastia orthogonia	15
		Cricotopus bicinctus	1
		Cricotopus tremulus gr.	2
		Cricotopus trifascia gr.	8
		Cricotopus vierriensis	5
		Orthocladius nr. dentifer	2
		Orthocladius (Euorthoclad.) sp.	2
		Polypedilum aviceps	1
		Polypedilum flavum	4
		Polypedilum laetum	1
		Tanytarsus guerlus gr.	1

SPECIES RICHNESS:	30 (very good)
BIOTIC INDEX:	3.70 (very good)
EPT RICHNESS:	10 (good)
MODEL AFFINITY:	74 (very good)
ASSESSMENT:	non-impacted

DESCRIPTION: The sampling site was 75 meters upstream of Cottrell Road, near its eastern junction with Route 67. The stream rocks were covered with diatoms. The macroinvertebrate fauna remained diverse, and water quality was assessed as non-impacted.

STREAM SITE:	Walloomsac River,	Station 04	
LOCATION:	North Hoosick, NY,	200 meters above Route 22 bridge	
DATE:	17 June 2003		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100		

ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	1
TUBIFICIDA	Enchytraeidae	Undetermined Enchytraeidae	6
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	Gammarus sp.	2
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	3
		Baetis flavistriga	10
		Baetis intercalaris	5
	Heptageniidae	Epeorus (Iron) sp.	1
		Stenonema sp.	2
	Ephemerellidae	Ephemerella dorothea	14
		Serratella deficiens	8
COLEOPTERA	Elmidae	Stenelmis crenata	8
TRICHOPTERA	Hydropsychidae	Hydropsyche scalaris	2
DIPTERA	Tipulidae	Antocha sp.	2
	Simuliidae	Simulium sp.	1
	Chironomidae	Thienemannimyia gr. spp.	1
		Pagastia orthogonia	2
		Brillia flavifrons	1
		Cardiocladius obscurus	1
		Cricotopus trifascia gr.	3
		Orthocladius (Euorthoclad.) sp.	1
		Paratrichocladius sp.	1
		Tvetenia bavarica gr.	1
		Polypedilum aviceps	16
		Polypedilum flavum	5
		Rheotanytarsus exiguus gr.	1
		Sublettea coffmani	1
		Tanytarsus guerlus gr.	1

SPECIES RICHNESS:	27 (very good)
BIOTIC INDEX:	4.07 (very good)
EPT RICHNESS:	8 (good)
MODEL AFFINITY:	80 (very good)
ASSESSMENT:	non-impacted

DESCRIPTION: The kick sample was taken 200 meters upstream of Route 22 in North Hoosick. Biomass and diversity appeared lower than at upstream sites, but the metrics were still within the range of non-impacted water quality.

FIELD DATA SUMMARY				
STREAM NAME: Walloomsac River	DATE SAMPLED: 6/17/2003			
REACH: above Bennington STP to mouth				
FIELD PERSONNEL INVOLVED: Abele, Heitzman				
STATION	01	02	03	04
ARRIVAL TIME AT STATION	9:50am	10:30am	11:10am	12:00pm
LOCATION	Above STP, N.Bennington,VT	Below STP, N.Bennington,VT	Rte. 67 White Cr. Sta. VT	Rte 22 N. Hoosick, NY
PHYSICAL CHARACTERISTICS				
Width (meters)	30	30	25	20
Depth (meters)	0.2	0.2	0.2	0.2
Current speed (cm per sec.)	77	100	100	110
Substrate (%)				
Rock (>25.4 cm, or bedrock)	0	0	0	0
Rubble (6.35 - 25.4 cm)	20	40	30	30
Gravel (0.2 – 6.35 cm)	40	20	30	30
Sand (0.06 – 2.0 mm)	30	20	30	30
Silt (0.004 – 0.06 mm)	10	20	10	10
Embeddedness (%)	30	40	40	50
CHEMICAL MEASUREMENTS				
Temperature (° C)	14.4	15.5	15.8	17.2
Specific Conductance (umhos)	220	239	248	252
Dissolved Oxygen (mg/l)	9.9	10.2	11.3	9.4
pH	7.8	7.9	8.2	8.0
BIOLOGICAL ATTRIBUTES				
Canopy (%)	20	20	20	50
Aquatic Vegetation				
algae – suspended			X	X
algae – attached, filamentous			X	
algae - diatoms	X	X	X	X
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)	X	X	X	X
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)	X	X	X	
Megaloptera(dobsonflies,alderflies)				X
Odonata (dragonflies, damselflies)				X
Chironomidae (midges)	X	X	X	X
Simuliidae (black flies)				X
Decapoda (crayfish)				
Gammaridae (scuds)				X
Mollusca (snails, clams)				
Oligochaeta (worms)	X	X	X	X
Other				
FAUNAL CONDITION	Very good	Very good	Very good	Very 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 stereo microscope 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 richness. EPT denotes the insect orders of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera). These are considered to be mostly clean-water organisms, and their presence generally is correlated with good water quality (Lenat, 1987). Expected ranges of EPT richness in average 100-organism subsamples of kick samples 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; EPT richness 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

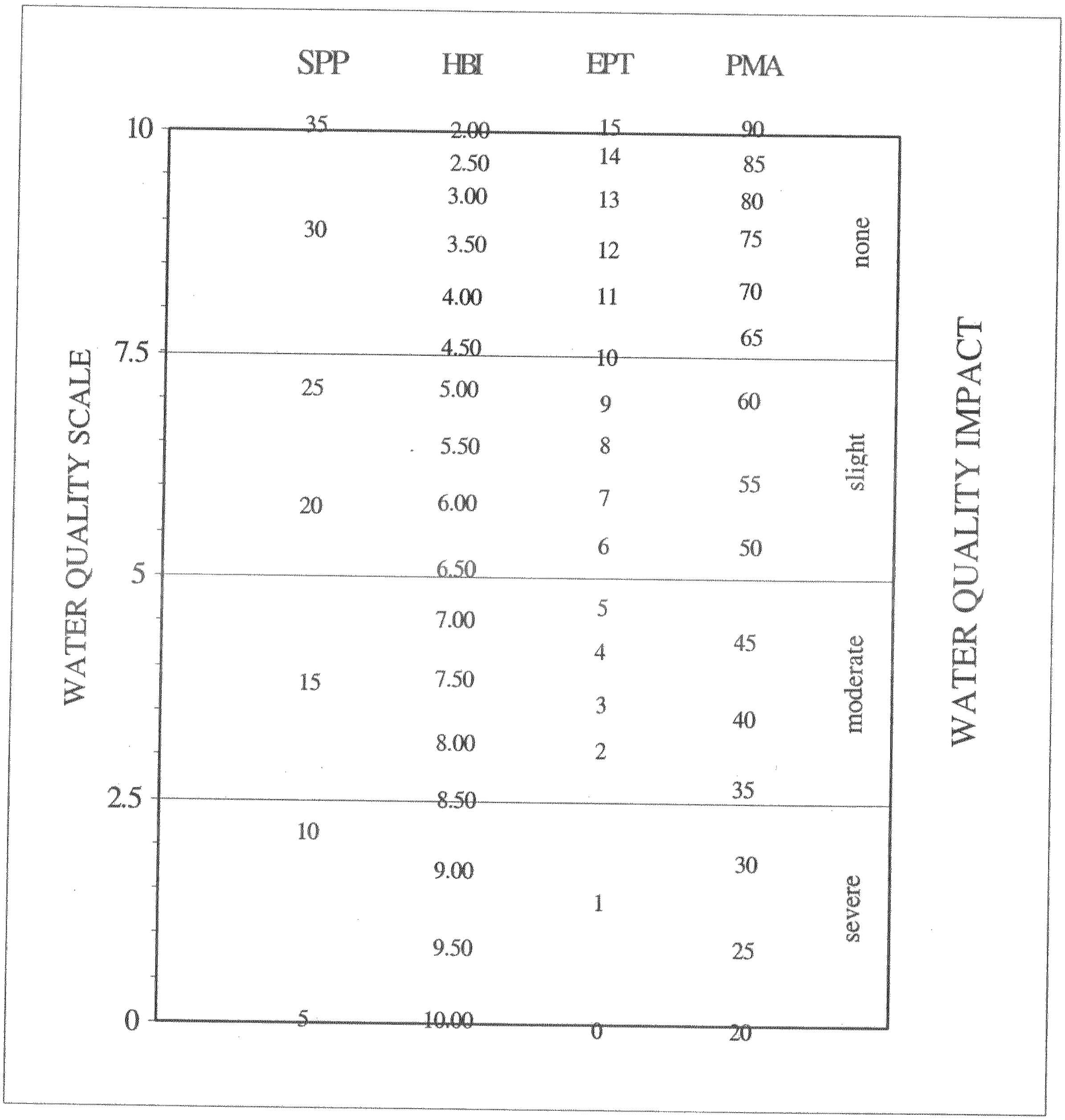
Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; EPT richness is 2-5. The biotic index value is 6.51-8.50.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

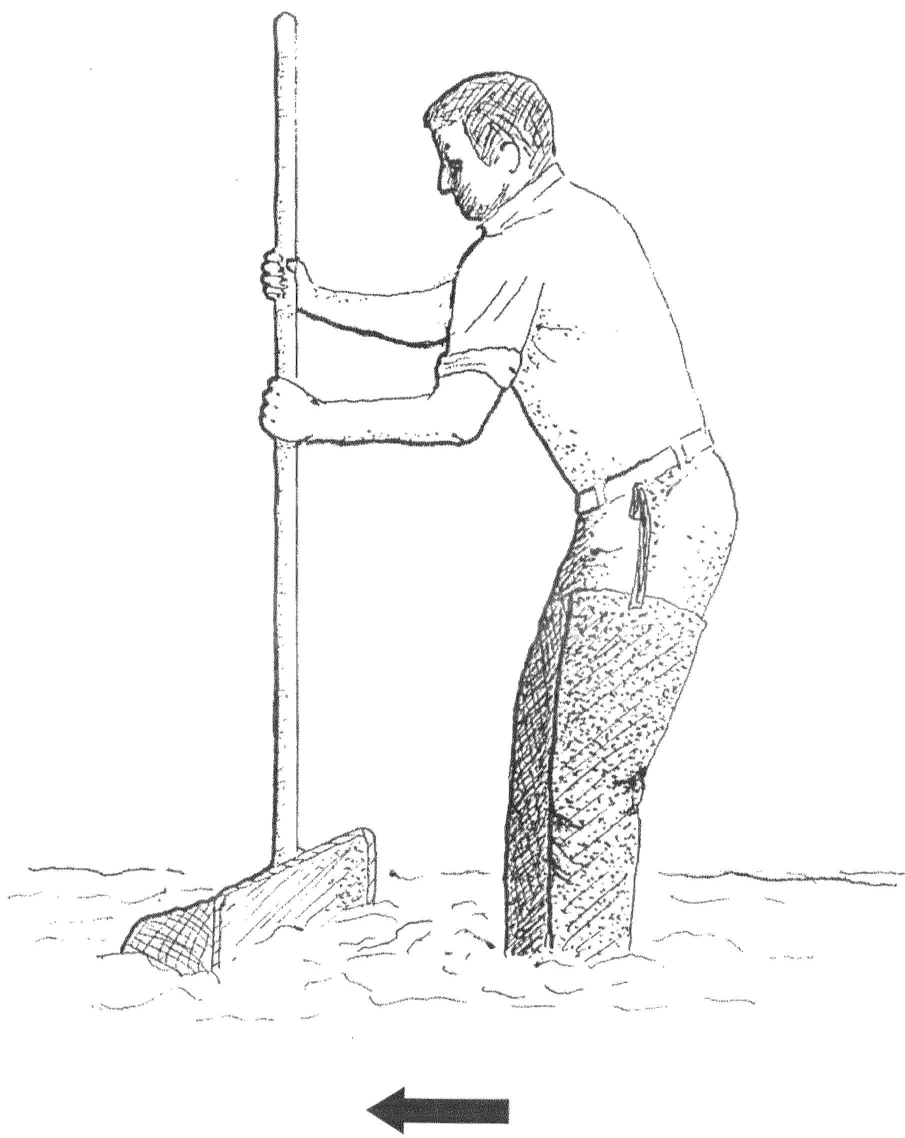
Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
* Diversity criteria are used for multiplate samples but not for traveling kick samples.

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

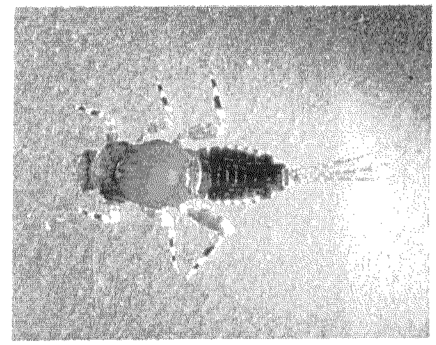
THE TRAVELING KICK SAMPLE



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.

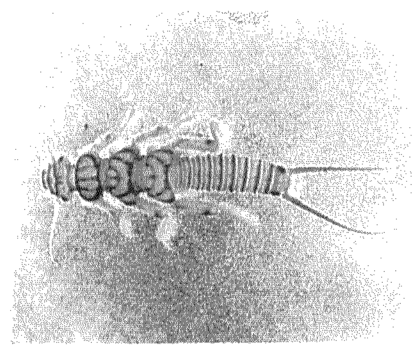
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

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.



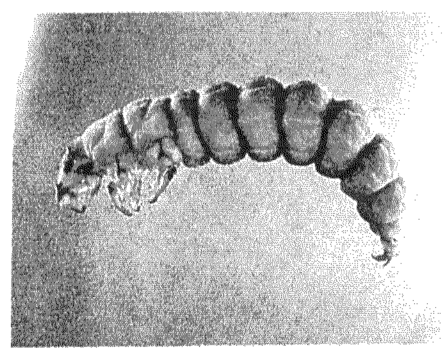
MAYFLIES

Stonefly nymphs are mostly limited to cool, well-oxygenated streams. They are sensitive to most 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.



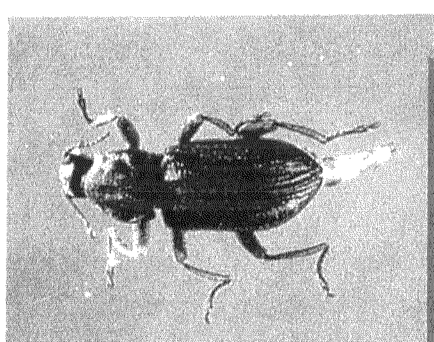
STONEFLIES

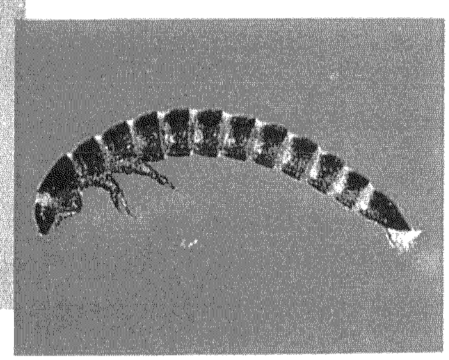
Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in nutrient-enriched stream segments.



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.

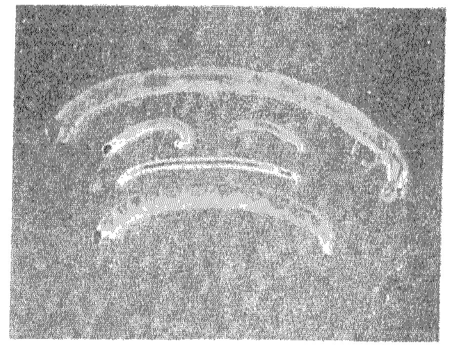




BEETLES

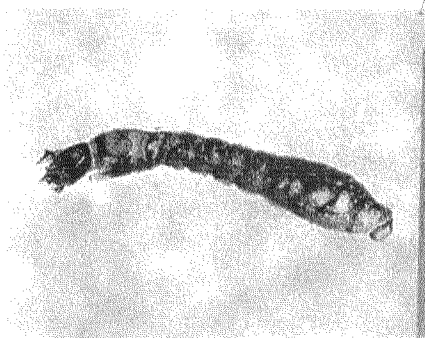
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE POOR WATER QUALITY

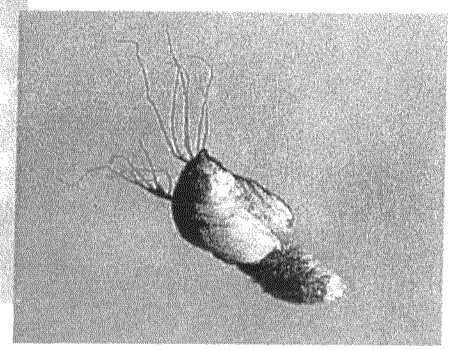
Midges are the most common aquatic flies. The larvae occur in almost any aquatic situation. Many species are very tolerant to pollution. Large, red midge larvae called "bloodworms" indicate organic enrichment. Other midge larvae filter plankton, indicating nutrient enrichment when numerous.



MIDGES

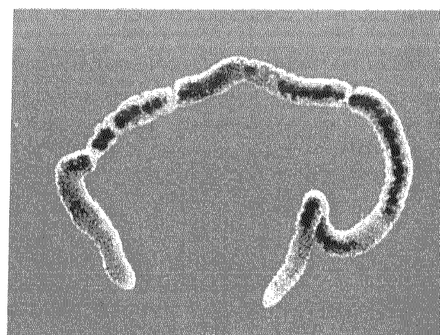
Black fly larvae have specialized structures for filtering plankton and bacteria from the water, and require a strong current. Some species are tolerant of organic enrichment and toxic contaminants, while others are intolerant of pollutants.

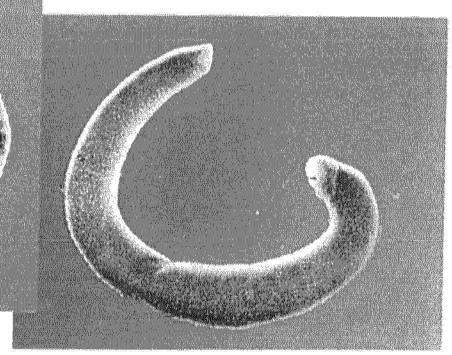




BLACK FLIES

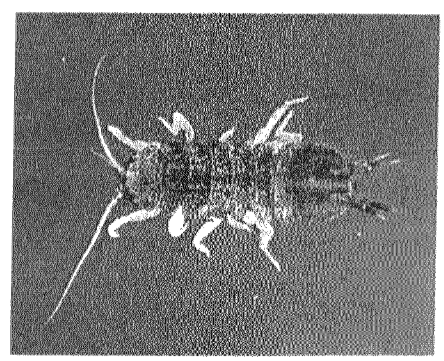
The segmented worms include the leeches and the small aquatic earthworms. The latter are more common, though usually unnoticed. They burrow in the substrate and feed on bacteria in the sediment. They can thrive under conditions of severe pollution and very low oxygen levels, and are thus valuable pollution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





WORMS

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



SOWBUGS

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

APPENDIX VIII. THE RATIONALE OF BIOLOGICAL MONITORING

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

Concept

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

Advantages

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

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

Limitations

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

APPENDIX IX. GLOSSARY

assessment: a diagnosis or evaluation of water quality

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

biomonitoring: the use of biological indicators to measure water quality

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

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

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

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

fauna: the animal life of a particular habitat

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

impairment: a detrimental effect caused by an impact

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

intolerant: unable to survive poor water quality

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

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

organism: a living individual

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

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

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

station: a sampling site on a waterbody

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

tolerant: able to survive poor water quality

APPENDIX X. METHODS FOR IMPACT SOURCE DETERMINATION

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

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

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

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

NATURAL

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

NONPOINT NUTRIENTS, PESTICIDES

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

	TOXIC						MUNICIPAL/INDUSTRIAL						
	A	B	C	D	E	F	A	B	C	D	E	F	G
PLATYHELMINTHES	-	-	-	-	5	-	-	40	-	-	-	5	-
OLIGOCHAETA	-	10	20	5	5	15	20	20	70	10	-	20	-
HIRUDINEA	-	-	-	-	-	-	-	5	-	-	-	-	-
GASTROPODA	-	5	-	-	-	5	-	-	-	-	-	5	-
SPHAERIIDAE	-	-	-	-	-	-	-	5	-	-	-	-	-
ASELLIDAE	10	10	-	20	10	5	10	5	10	10	15	5	-
GAMMARIDAE	5	-	-	-	5	5	40	-	-	-	15	-	5
<u>Isonychia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	15	10	20	-	-	5	5	-	-	-	5	-	10
HEPTAGENIIDAE	-	-	-	-	-	-	5	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Caenis</u>/<u>Tricorythodes</u>	-	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Psephenus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Optioservus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Promoresia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Stenelmis</u>	10	15	-	40	35	5	5	-	-	10	5	-	5
PHILOPOTAMIDAE	10	-	-	-	-	-	-	-	-	-	-	-	-
HYDROPSYCHIDAE	20	10	15	10	35	10	10	-	-	50	20	-	40
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Simulium vittatum</u>	-	20	-	-	-	5	-	-	-	-	-	-	20
EMPIDIDAE	-	-	-	-	-	-	-	5	-	-	-	-	-
CHIRONOMIDAE													
Tanypodinae	5	10	-	-	-	25	-	10	-	-	5	15	-
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus/</u> <u>Orthocladius</u>	15	10	25	10	5	10	5	10	20	-	5	10	5
<u>Eukiefferiella/</u> <u>Tvetenia</u>	-	-	20	10	-	-	-	-	-	-	-	-	-
<u>Parametriocnemus</u>	-	-	-	5	-	-	-	-	-	-	-	-	-
<u>Chironomus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum aviceps</u>	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum</u> (all others)	10	-	-	-	-	5	-	-	-	10	20	40	10
Tanytarsini	-	-	-	-	-	5	-	-	-	10	10	-	5
TOTAL	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	-	-
<u>Isonychia</u>	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	10	5	-	-	-	-	5	-
HEPTAGENIIDAE	10	10	10	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	5	-
<u>Caenis</u>/<u>Tricorythodes</u>	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
<u>Psephenus</u>	-	-	-	-	-	-	-	-	-	-
<u>Optioservus</u>	-	-	-	-	-	-	-	-	5	-
<u>Promoresia</u>	-	-	-	-	-	-	-	-	-	-
<u>Stenelmis</u>	15	-	10	10	-	-	-	-	-	-
PHILOPOTAMIDAE	-	-	-	-	-	-	-	-	-	-
HYDROPSYCHIDAE	45	-	10	10	10	-	-	10	5	-
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-
<u>Simulium vittatum</u>	-	-	-	25	10	35	-	-	5	5
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE										
Tanypodinae	-	5	-	-	-	-	-	-	5	5
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus</u>/ <u>Orthocladius</u>	-	10	15	-	-	10	10	-	5	5
<u>Eukiefferiella</u>/ <u>Tvetenia</u>	-	-	10	-	-	-	-	-	-	-
<u>Parametriocnemus</u>	-	-	-	-	-	-	-	-	-	-
<u>Chironomus</u>	-	-	-	-	-	-	10	-	-	60
<u>Polypedilum aviceps</u>	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum</u> (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	10000		100	100