New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Cohocton River

Biological Assessment

2004 Survey

New York State
Department of Environmental Conservation

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

COHOCTON RIVER
BIOLOGICAL ASSESSMENT

Chemung River Basin
Steuben County, New York

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Stream: Cohocton River, Steuben County, New York

Reach: Bowles Corner to Painted Post, New York

Drainage basin: Chemung River

Background:

The Stream Biomonitoring Unit sampled the Cohocton River in Steuben County, New York, on July 8-9, 2004. The purpose of the sampling was to assess overall water quality and compare it to previous results. The study was also part of a larger study correlating nutrient levels with macroinvertebrate communities, which will be reported separately. In a riffle area at eight sites, one 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 macroinvertebrate data from each site.

Results and Conclusions:

1. Water quality in the Cohocton River ranged from slightly impacted to non-impacted, gradually improving downstream. Nutrient enrichment was the primary stressor causing the impact.

2. Compared to results of previous samplings, no temporal trends are indicated. Water quality fluctuates between non-impacted and slightly impacted, appearing better during high-flow years.

Discussion:

The Cohocton River originates near Tabor Corners in Livingston County. It flows in a generally southeasterly direction for 55 miles before joining the Tioga River at Painted Post to form the Chemung River. The Cohocton River has been sampled by the Stream Biomonitoring Unit at various sites and at irregular intervals since 1973 (Bode, et al., 2004). Since 1992, all samplings have shown water quality to range between non-impacted and slightly impacted, with water quality usually appearing better during high-flow years, a situation that usually indicates dilution of point sources.

In the present study, water quality ranged from non-impacted to slightly impacted, with water quality gradually improving downstream (Figure 1). Macroinvertebrate communities at most sites were dominated by clean-water mayflies. Midges, algal-scraping riffle beetles, and filter-feeding caddisflies were also numerous at most sites, reflecting abundant algae and elevated nutrient levels.

A new macroinvertebrate measure of nutrient enrichment, the Nutrient Biotic Index (NBI), was recently developed by Smith (see Appendix XI). Indices were developed to reflect the effects of total phosphorous (NBI-P) and nitrate (NBI-N). For the Cohocton River, the NBI-P shows greatest enrichment effects in the reach from Cohocton to Bath - Stations 2 to7A (Figure 2); the NBI-P values at these three sites exceed 6.0, the provisional threshold for eutrophic waters. The index trend is also similar to that for nutrient levels - nitrates and phosphorus - which are shown combined in Figure 2. Impact Source Determination also shows the trend that the upstream sites exhibit more effects of nutrient enrichment (Table 1). Based on the NBI and annual flow-related trends, it appears that upstream enrichment in the Cohocton River is diminished by downstream dilution.

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.

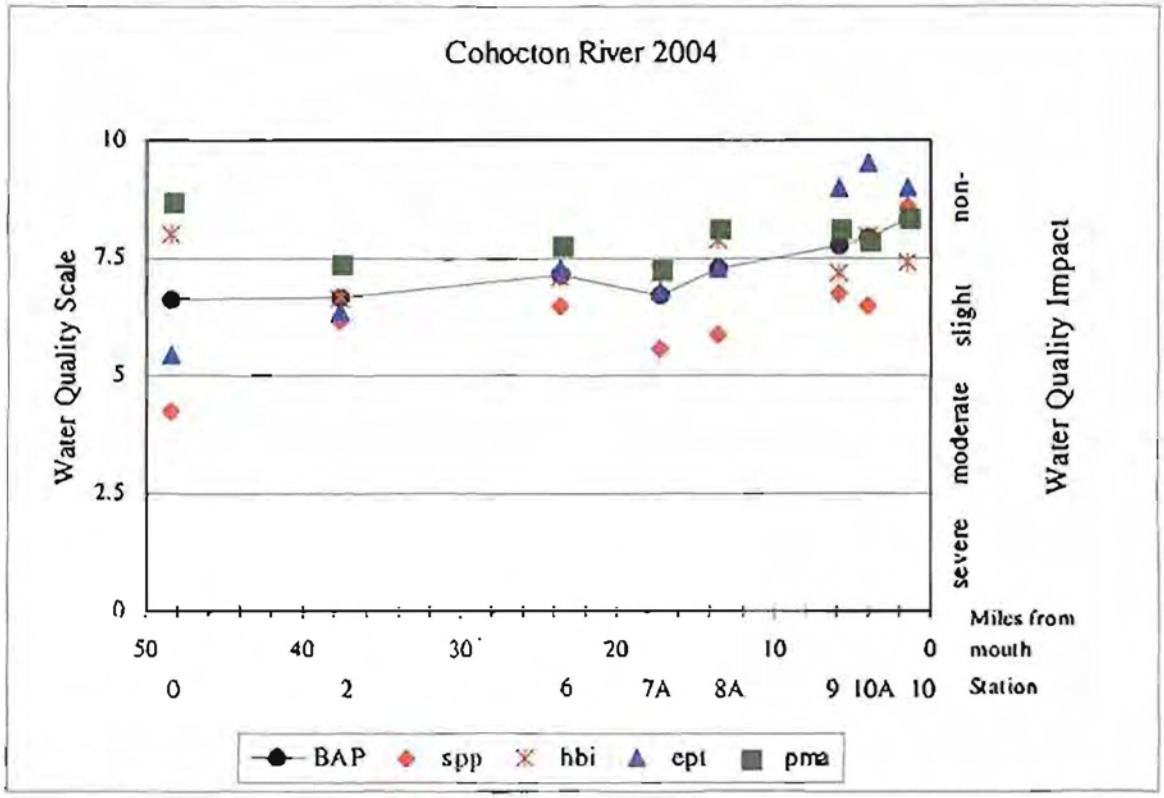
Bode, R.W., M.A. Novak, L.E. Abele, D.L. Heitzman, and A.J. Smith. 2004. Thirty year trends in water quality of rivers and streams in New York State. New York State Department of Environmental Conservation, Technical Report, 384 pages.

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:

Based on the July sampling, the Cohocton River at the sites sampled was 4-50 meters wide, 0.2-0.3 meters deep, and had current speeds of 83-143 cm/sec in riffles. Dissolved oxygen was 9.0-12.0 mg/l, specific conductance was 241-716 µmhos, pH was 7.7-8.4 and the temperature was 17.3-21.5 °C (63-71 °F). Measurements for each site (July sampling) are found on the field data summary sheets.

Figures 1and 2. Figure 1 (top) is the Biological Assessment Profile of index values, Cohocton River, 2004. 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 (bottom) includes NBI values and nutrient levels.



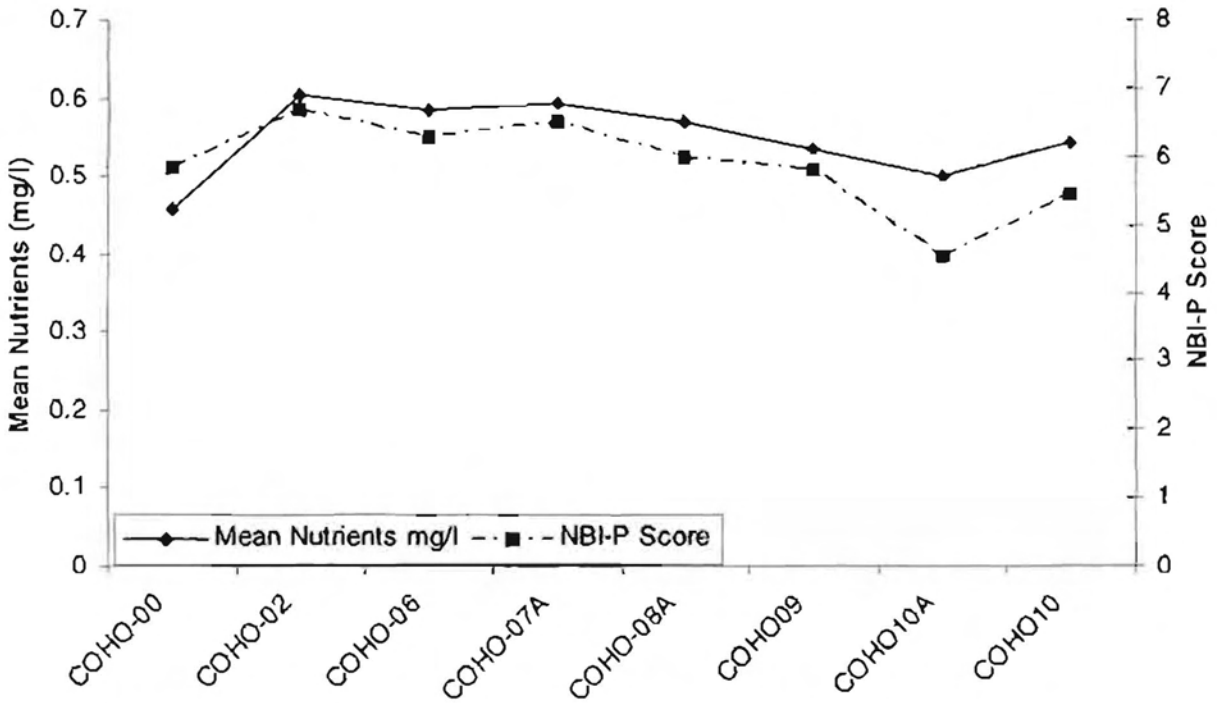


Table 1. Impact Source Determination, Cohocton River, 2004. Numbers represent similarity to community type models for each impact category. The highest average similarities at each station are shaded. Similarities less than 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix X for further explanation.

	Station							
Community Type	00	02	06	07A	08A	09	10A	10
Natural: minimal human impacts	56	52	57	46	57	56	61	53
Nutrient enrichment: usually nonpoint	56	63	57	57	58	60	45	43
Toxic: industrial, municipal, or urban run-off	42	66	53	35	37	52	40	48
Organic: sewage, animal wastes	27	45	54	47	41	56	37	47
Complex: municipal and/or industrial	34	55	46	37	30	47	39	30
Siltation	42	55	50	54	51	60	52	59
Impoundment	34	57	57 *	47	43	50	39	57 *

Table Summary (*Impoundment indications are considered spurious)

STATION	COMMUNITY TYPE
COHO-00	Natural, Nutrients
COHO-02	Toxic, Nutrients
COHO-06	Natural, Nutrients, Toxic, Organic
COHO-07A	Nutrients, Siltation
COHO-08A	Natural, Nutrients
COHO-09	Natural, Nutrients, Organic, Siltation
COHO-10A	Natural
COHO-10	Siltation

Table 2. Station Locations for the Cohocton River, Steuben County, New York

STATION	LOCATION
00	Bowles Corners, NY Rte 21, immediately downstream of bridge 48.4 river miles from mouth latitude/longitude: 42°34'03"; 77°32'09"
02	Cohocton, NY Route 415, below bridge 37.7 river miles from mouth latitude/longitude: 42°30'03"; 77°30'02"
06	Kanona, NY Rte 415 bridge, 150 meters below bridge 23.6 river miles above mouth latitude/longitude: 42°22'10"; 77°21'54"
07A	Bath, NY Rte 11 bridge, 10 meters below bridge 17.3 river miles above mouth latitude/longitude: 42°18'45"; 77°16'51"

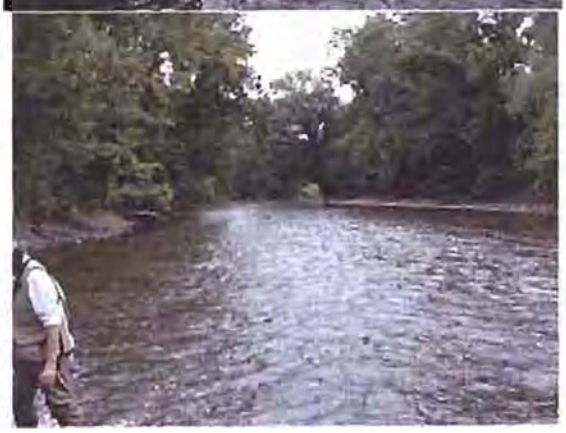


Table 2. Station Locations, cont'd.

08A Savona, NY
County Route 12 bridge,
50 meters above bridge
13.5 river miles above mouth
latitude/longitude:42°17'20";77°13'34"

09 Curtis, NY
Route 4 bridge, 10 meters above bridge
5.9 river miles above mouth
latitude/longitude: 42°12'24"; 77°09'51"

10A Coopers Plains, NY
Smith Road bridge, 200 meters above bridge
4.0 river miles above mouth
latitude/longitude: 42°11'02"; 77°09'07"

10 Painted Post, NY
Canada Road extension, at Fishing Access
1.4 river miles above mouth
latitude/longitude: 42°10'05"; 77°06'19"

Figure 3	Site Overview Map	Cohocton River

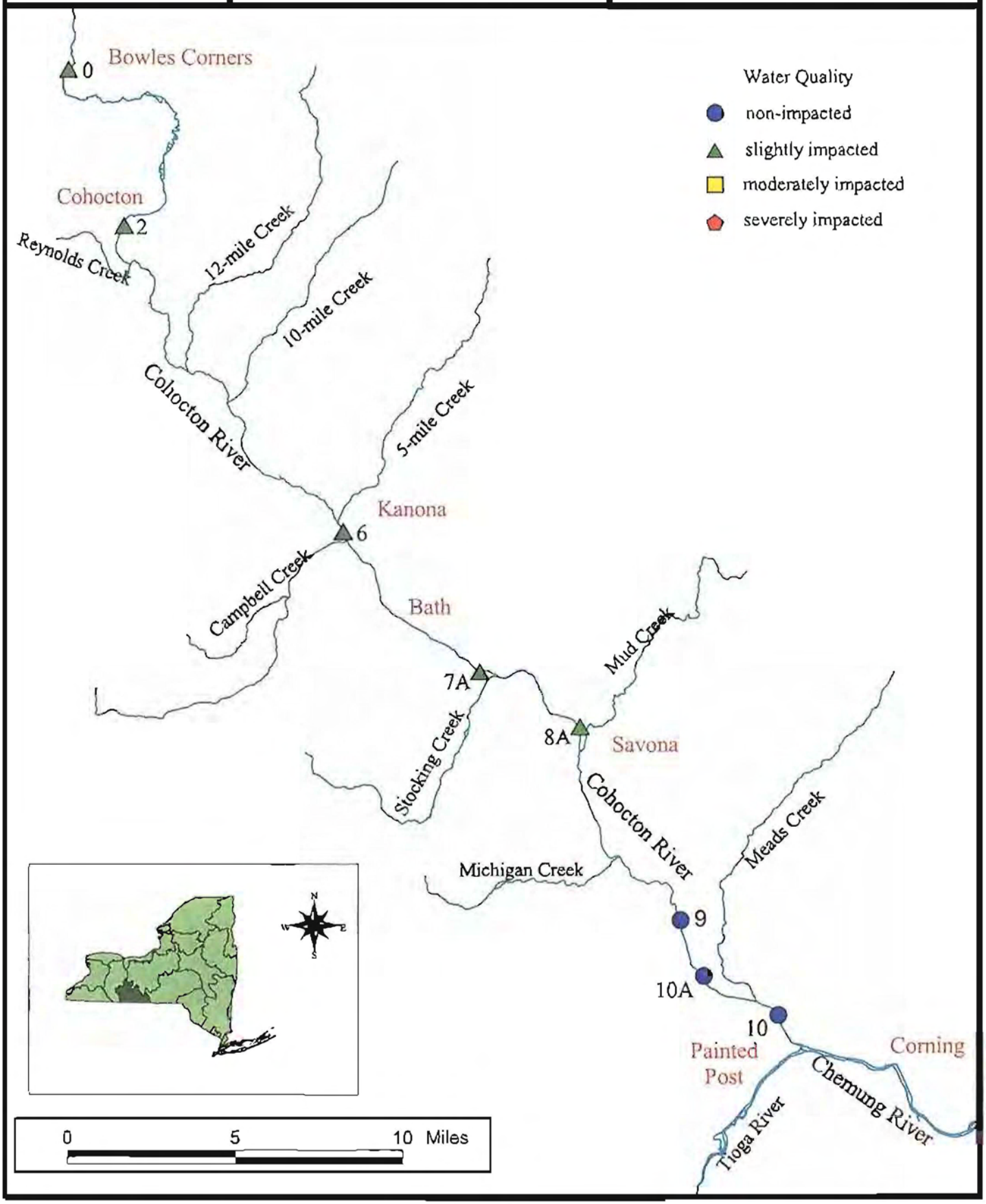


Figure 4a	Site Location Map	Cohocton River

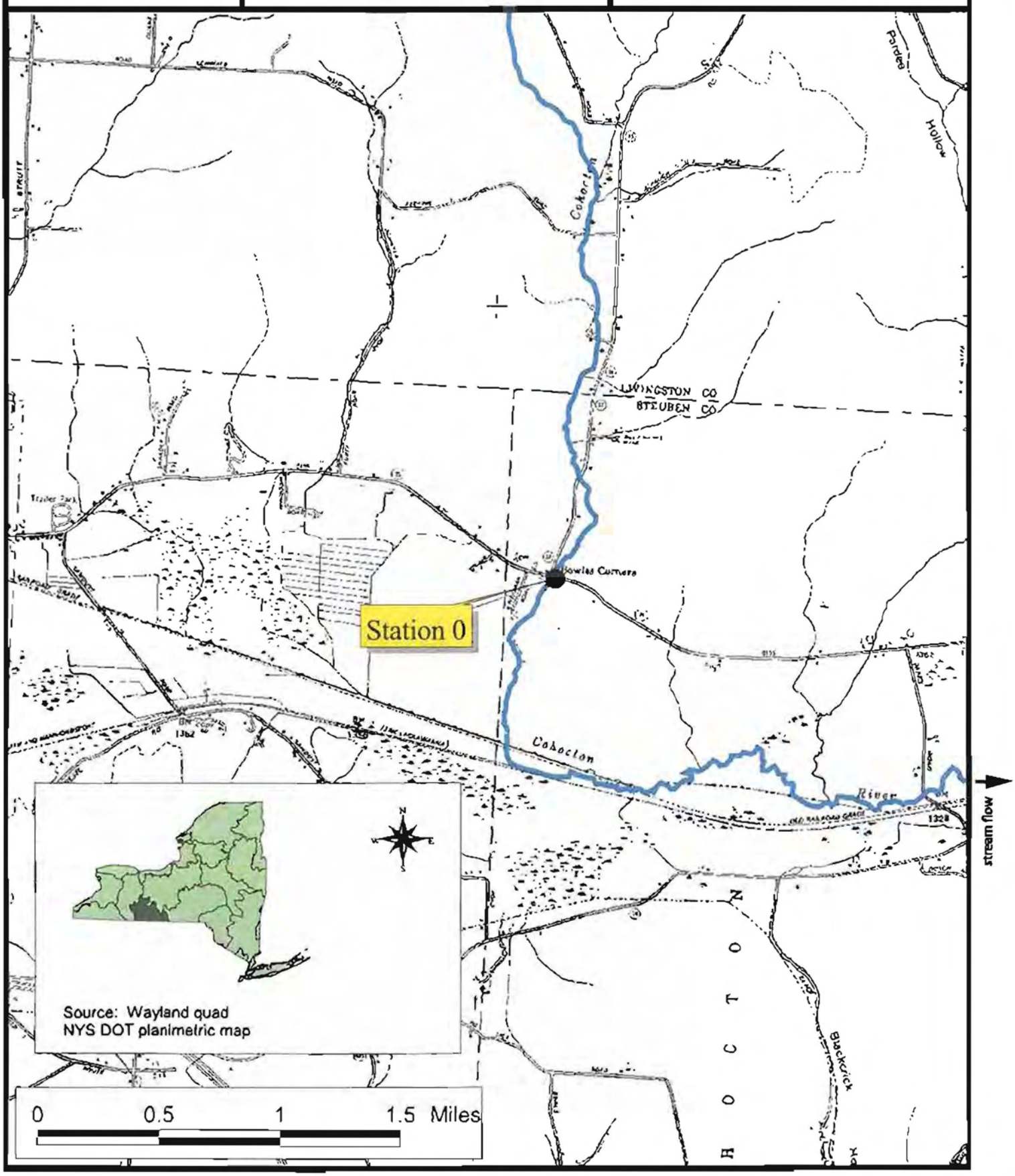
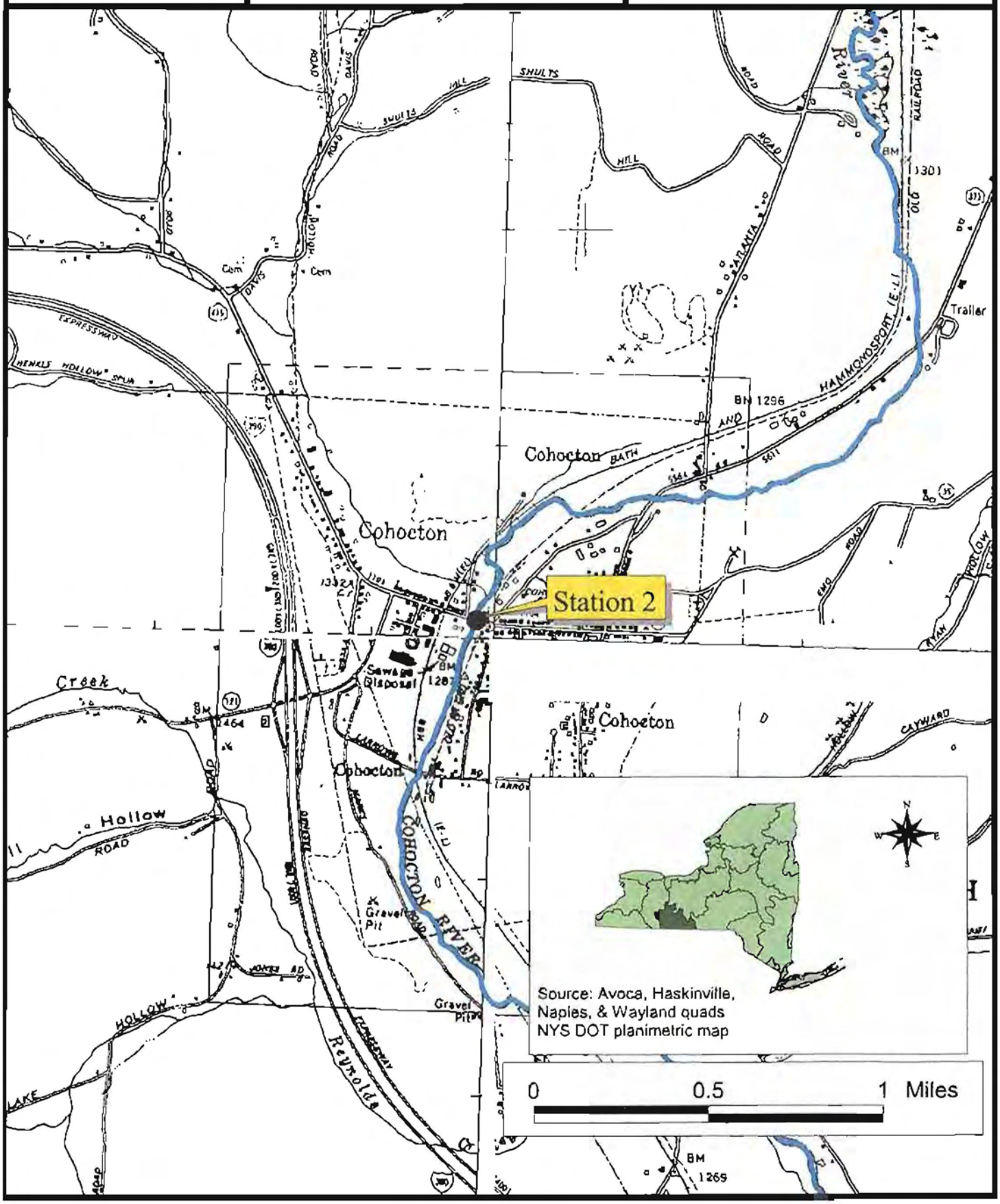


Figure 4b	Site Location Map	Cohocton River



stream flow

Figure 4c	Site Location Map	Cohocton River

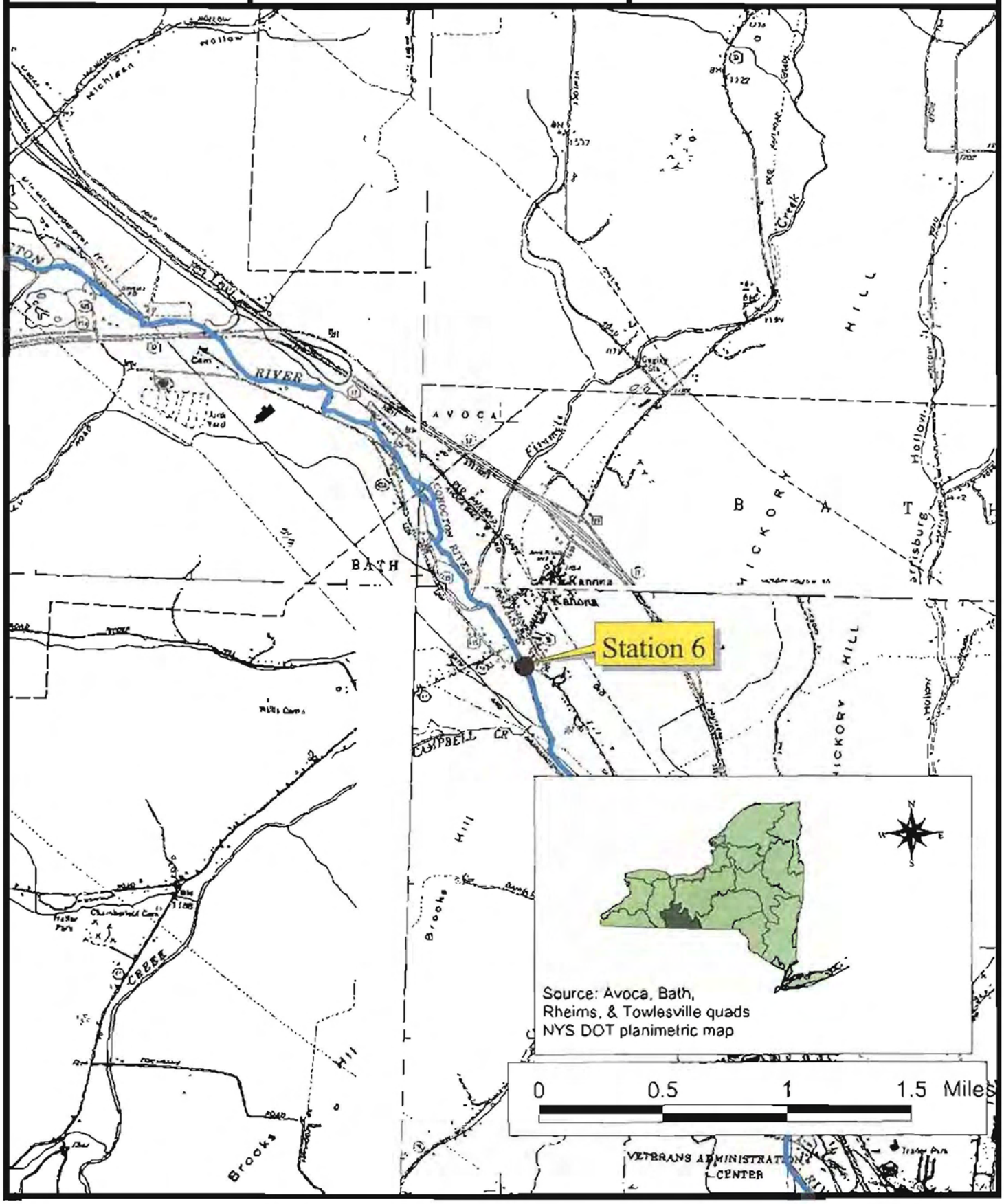


Figure 4d	Site Location Map	Cohocton River

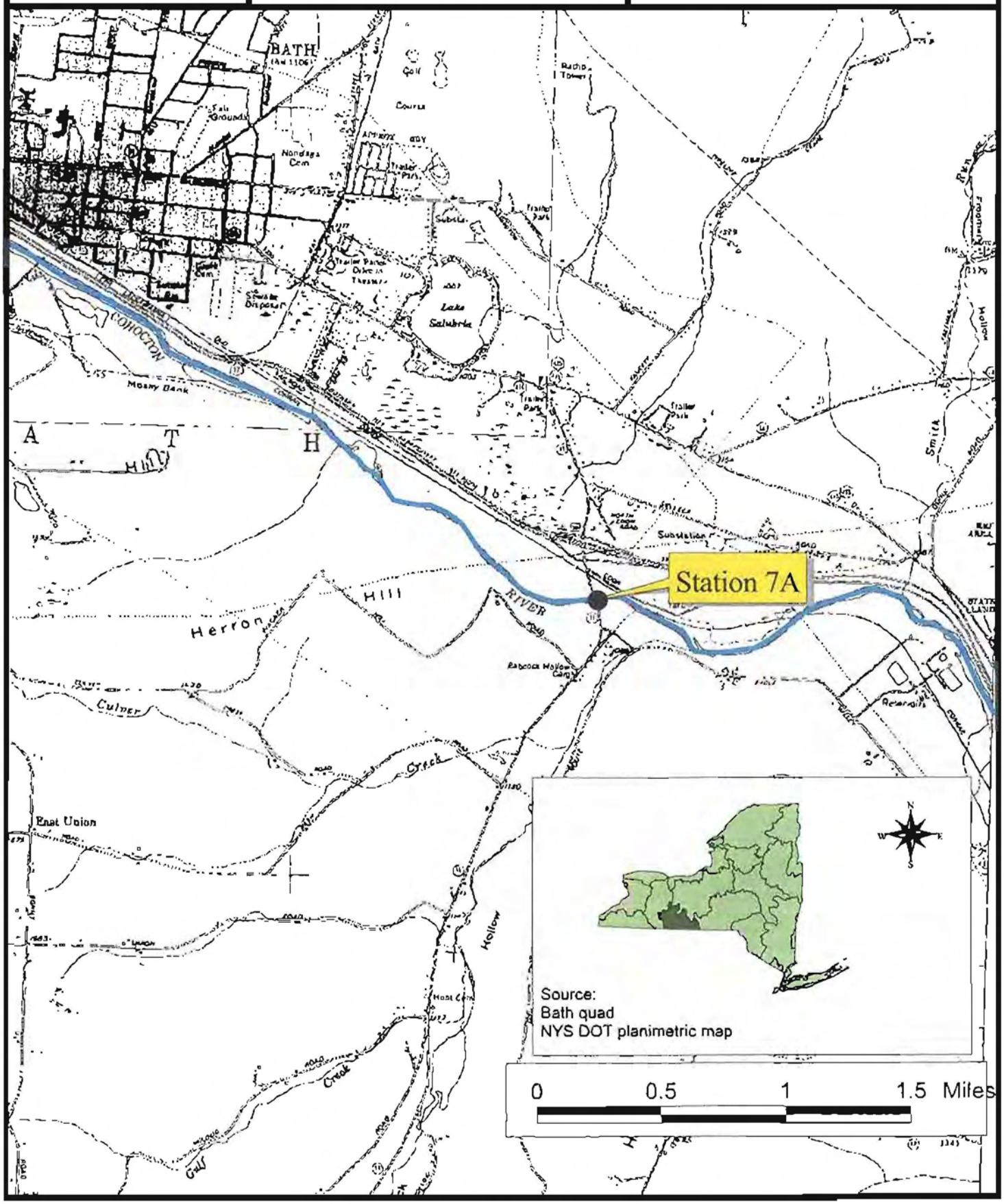
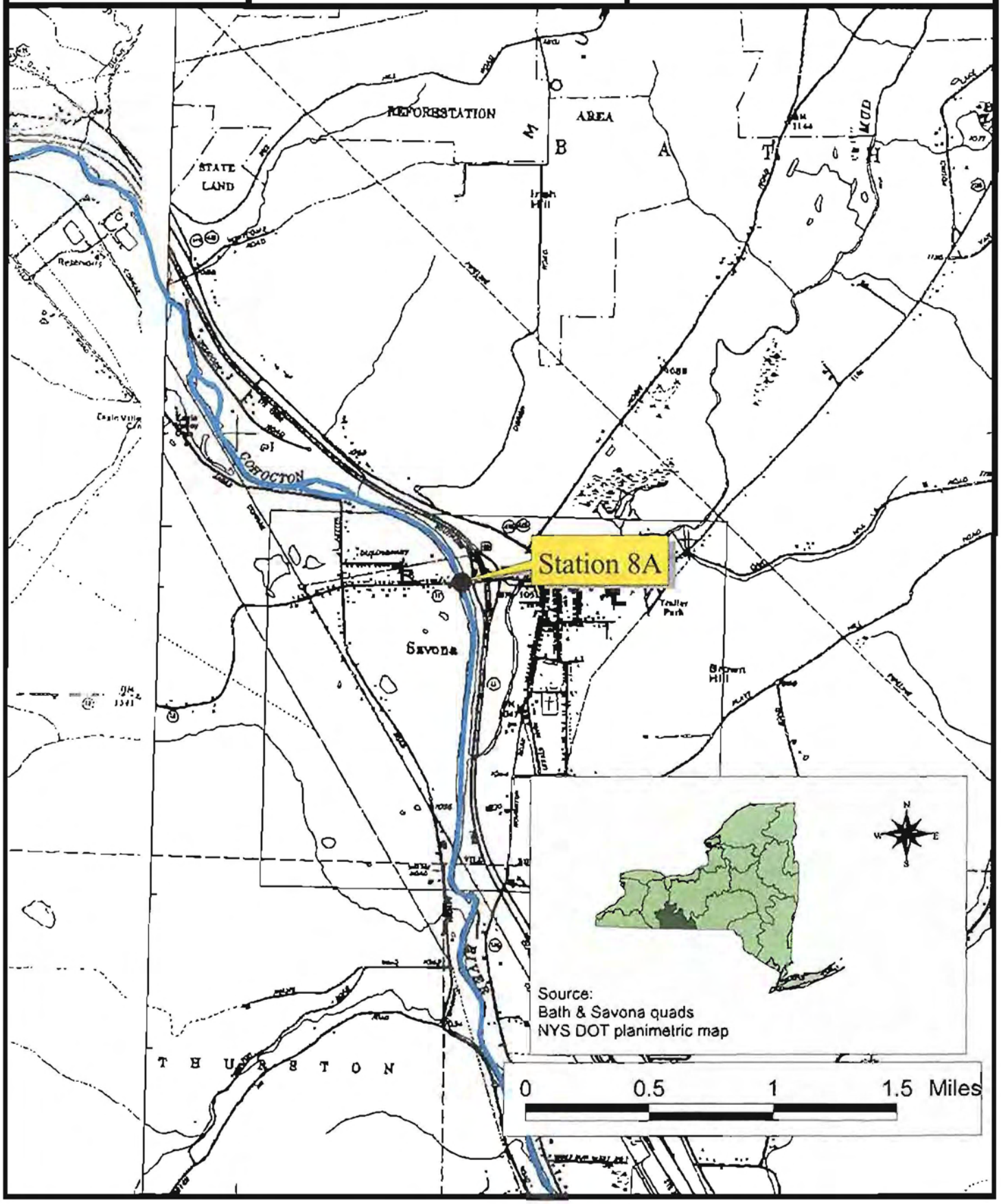


Figure 4e	Site Location Map	Cohocton River



 stream flow

Figure 4f	Site Location Map	Cohocton River

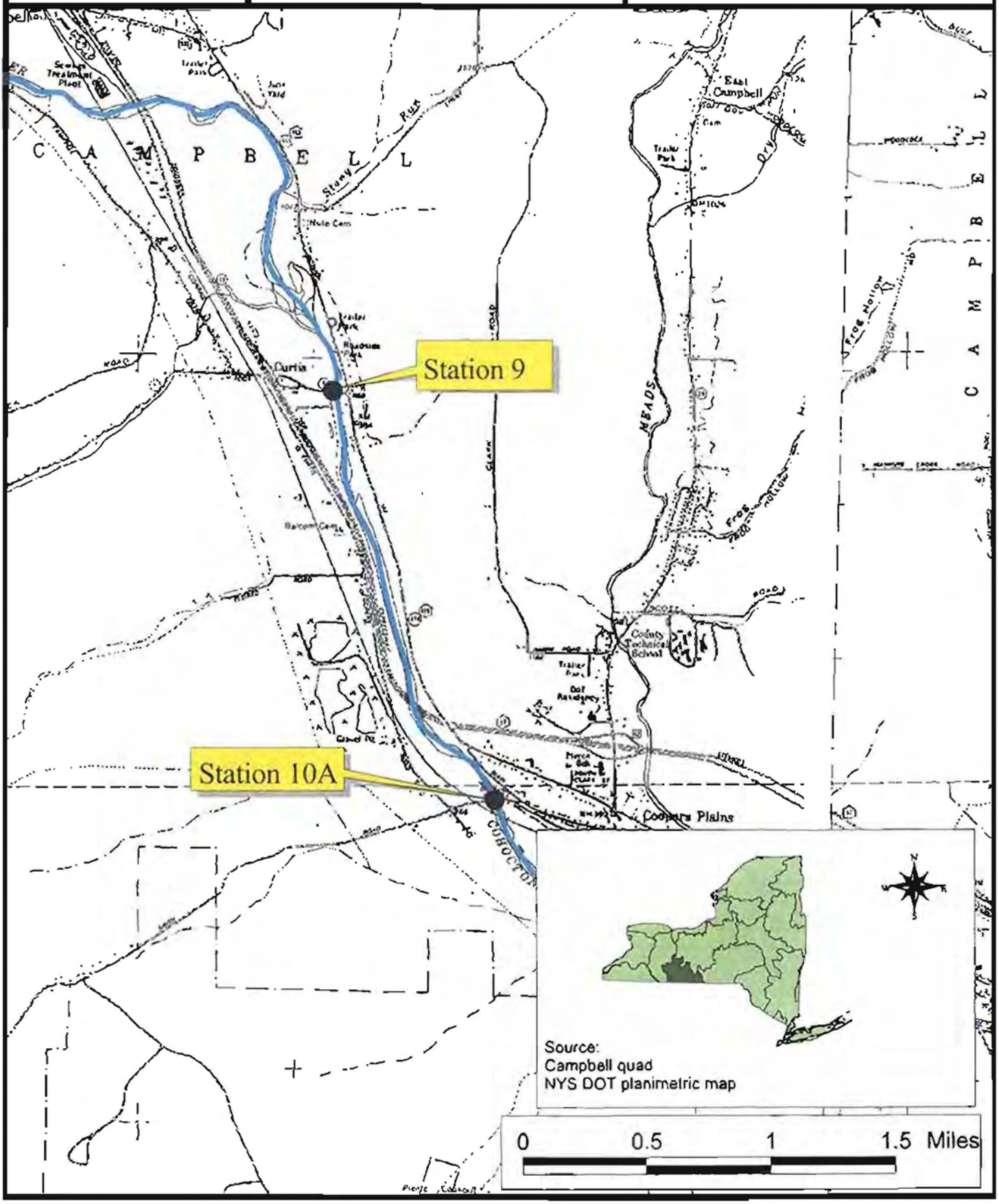


Figure 4g	Site Location Map	Cohocton River

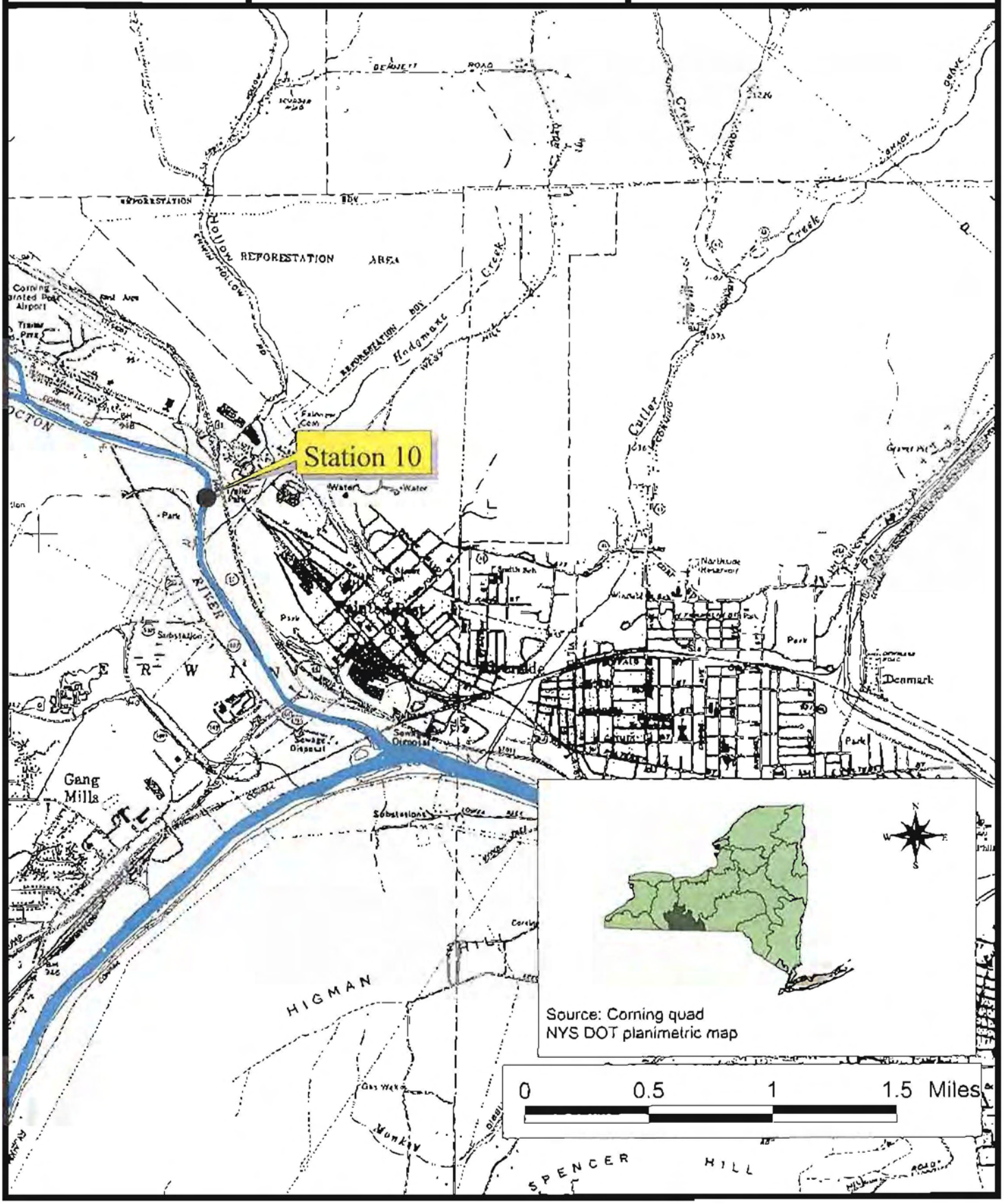


Table 3. Macroinvertebrate Species Collected in the Cohocton River, Steuben County, New York, 2004

ANNELIDA
- OLIGOCHAETA
  - LUMBRICIDA
    - Undetermined Lumbricina
  - LUMBRICULIDA
    - Lumbriculidae
      - Undetermined Lumbriculidae
- HIRUDINEA
  - Glossiphoniidae
    - Undetermined Hirudinea

MOLLUSCA
- PELECYPODA
  - Sphaeriidae
    - *Sphaerium sp.*
    - Undetermined Sphaeriidae

CRUSTACEA
- AMPHIPODA
  - Gammaridae
    - *Gammarus* sp.

ARTHROPODA
- INSECTA
  - EPHEMEROPTERA
    - Isonychiidae
      - *Isonychia bicolor*
    - Baetidae
      - *Acentrella sp.*
      - *Baetis flavistriga*
      - *Baetis intercalaris*
    - Heptageniidae
      - *Leucrocuta sp.*
      - *Nixe (Nixe) sp.*
      - *Rhithrogena sp.*
      - *Stenonema sp.*
    - Ephemerellidae
      - *Ephemerella sp.*
      - *Serratella deficiens*
      - *Serratella serratoides*
    - Leptohyphidae
      - *Tricorythodes sp.*
    - Caenidae
      - *Caenis sp.*
  - PLECOPTERA
    - Leuctridae
      - *Leuctra sp.*
    - Perlidae
      - *Agnetina capitata*
      - *Paragnetina media*
  - COLEOPTERA
    - Psephenidae
      - *Ectopria nervosa*
      - *Psephenus herricki*
    - Elmidae
      - *Optioservus fastiditus*
      - *Optioservus trivittatus*
      - *Stenelmis cheryl*
      - *Stenelmis crenata*
  - TRICHOPTERA
    - Philopotamidae
      - *Chimarra aterrima?*
      - *Chimarra obscura*
      - *Dolophilodes sp.*
    - Psychomyiidae
      - *Psychomyia flavida*
    - Hydropsychidae
      - *Cheumatopsyche sp.*
      - *Hydropsyche bronta*
      - *Hydropsyche leonardi*
      - *Hydropsyche morosa*
      - *Hydropsyche scalaris*
      - *Hydropsyche slossonae*
      - *Hydropsyche sparna*
    - Hydroptilidae
      - *Hydroptila sp.*
    - Uenoidae
      - *Neophylax sp.*
    - Limnephilidae
      - *Pycnopsyche sp.*
  - DIPTERA
    - Tipulidae
      - *Antocha sp.*
      - *Dicranota sp.*
    - Simuliidae
      - *Simulium tuberosum*
      - *Simulium vittatum*
      - *Simulium sp.*
    - Chironomidae
      - *Thienemannimyia group spp.*
      - *Pagastia orthogonia*
      - *Cardiocladius albiplumus*
      - *Cardiocladius obscurus*
      - *Cricotopus tremulus gr.*
      - *Cricotopus trifascia gr.*
      - *Cricotopus vierriensis*
      - *Eukiefferiella devonica gr.*
      - *Orthocladius nr. dentifer*
      - *Orthocladius dubitatus*
      - *Orthocladius sp.*
      - *Parakiefferiella sp.*
      - *Tvetenia bavarica gr.*
      - *Tvetenia vitracies*
      - *Cryptochironomus fulvus.*
      - *Microtendipes pedellus gr.*
      - *Polypedilum aviceps*
      - *Polypedilum flavum*
      - *Rheotanytarsus exiguus gr.*
      - *Sublettea coffmani*
      - *Tanytarsus sp.*

Macroinvertebrate Data Reports: Raw Data

STREAM SITE:	Cohocton River	COHO-00	
LOCATION:	Bowles Corners, NY	below Rte 21 bridge	
DATE:	08 July 2004		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100 organisms		
ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	1
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis intercalaris*	23
PLECOPTERA	Leuctridae	*Leuctra sp.*	7
	Perlidae	*Agnetina capitata*	3
COLEOPTERA	Elmidae	*Optioservus fastiditus*	18
TRICHOPTERA	Philopotamidae	*Dolophilodes sp.*	4
	Hydropsychidae	*Hydropsyche slossonae*	7
		Hydropsyche sparna	9
DIPTERA	Tipulidae	*Antocha sp.*	4
		Dicranota sp.	1
	Simuliidae	*Simulium tuberosum*	2
	Chironomidae	*Thienemannimyia gr. spp.*	1
		Cricotopus trifascia gr.	4
		Tvetenia bavarica gr.	1
		Polypedilum aviceps	14

SPECIES RICHNESS:	16 (poor)
BIOTIC INDEX:	3.99 (very good)
EPT RICHNESS:	6 (good)
MODEL AFFINITY:	77 (very good)
ASSESSMENT:	slightly impacted (6.62)

DESCRIPTION: This site is approximately 7 miles downstream of the headwaters of the Cohocton River. Habitat was considered adequate for benthic macroinvertebrates. The benthic community was somewhat poor in species richness and EPT richness, likely due to lingering headwater effects. Nutrient enrichment was indicated by Impact Source Determination. Overall water quality was assessed as slightly impacted.

Macroinvertebrate Data Reports: Raw Data

STREAM SITE:	Cohocton River	COHO-02	
LOCATION:	Cohocton, NY	below Rte 415 bridge	
DATE:	08 July 2004		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100 organisms		
ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	2
MOLLUSCA			
PELECYPODA			
	Sphaeriidae	Sphaerium sp.	2
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	10
INSECTA			
EPHEMEROPTERA	Baetidae	*Acentrella sp.*	1
		Baetis flavistriga	4
		Baetis intercalaris	9
	Leptohyphidae	*Tricorythodes sp.*	1
COLEOPTERA	Psephenidae	*Ectopria nervosa*	1
	Elmidae	*Optioservus trivittatus*	3
		Stenelmis crenata	20
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	5
	Hydropsychidae	*Cheumatopsyche sp.*	7
		Hydropsyche bronta	14
	Uenoidae	*Neophylax sp.*	1
DIPTERA	Tipulidae	*Antocha sp.*	3
	Chironomidae	*Pagastia orthogonia*	1
		Cricotopus trifascia gr.	3
		Orthocladius nr. dentifer	2
		Cryptochironomus fulvus gr.	2
		Microtendipes pedellus gr.	1
		Polypedilum flavum	7
		Sublettea coffmani	1

SPECIES RICHNESS:	22 (good)
BIOTIC INDEX:	5.18 (good)
EPT RICHNESS:	8 (good)
MODEL AFFINITY:	64 (good)
ASSESSMENT:	slightly impacted (6.65)

DESCRIPTION: The sample was taken downstream of the Route 415 bridge in Cohocton. The specific conductance had more than doubled from the upstream site. The substrate was dominated by gravel and may have limited the benthic community. Stoneflies, which were numerous at the upstream site, were not found at this site. Caddisflies and riffle beetles dominated the sample and water quality was assessed as slightly impacted.

Macroinvertebrate Data Reports: Raw Data

STREAM SITE:	Cohocton River	COHO-06
LOCATION:	Kanona, NY	below Route 415 bridge
DATE:	08 July 2004	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100 organisms	

ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	16
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	4
		Baetis intercalaris	12
	Heptageniidae	*Stenonema sp.*	1
	Ephemerellidae	*Ephemerella sp.*	1
		Serratella deficiens	7
	Caenidae	*Caenis sp.*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	2
	Elmidae	*Optioservus fastiditus*	1
		Optioservus trivittatus	3
		Stenelmis cheryl	14
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	1
	Hydropsychidae	*Cheumatopsyche sp.*	2
		Hydropsyche bronta	17
		Hydropsyche morosa	2
DIPTERA	Tipulidae	*Antocha sp.*	4
	Chironomidae	*Cardiocladius obscurus*	1
		Cricotopus trifascia gr.	1
		Orthocladius sp.	1
		Tvetenia vitracies	1
		Polypedilum aviceps	1
		Polypedilum flavum	5
		Tanytarsus sp.	2

SPECIES RICHNESS:	23 (good)
BIOTIC INDEX:	4.82 (good)
EPT RICHNESS:	10 (good)
MODEL AFFINITY:	67 (very good)
ASSESSMENT:	slightly impacted (7.16)

DESCRIPTION: The kick sample was taken 150 meters downstream of the Route 415 bridge in Kanona. The substrate was mainly rubble and provided adequate habitat for macroinvertebrates. The benthic community contained many worms, mayflies, and caddisflies, and overall water quality was assessed as slightly impacted

Macroinvertebrate Data Reports: Raw Data

STREAM SITE:	Cohocton River	COHO-07A
LOCATION:	Bath, NY	Below Rte 11 bridge
DATE:	09 July 2004	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100 organisms	

ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	2
MOLLUSCA			
PELECYPODA			
	Sphaeriidae	Undetermined Sphaeriidae	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis intercalaris*	8
	Heptageniidae	*Leucrocuta sp.*	7
		Nixe (Nixe) sp.	5
	Ephemerellidae	*Serratella deficiens*	1
	Caenidae	*Caenis sp.*	2
PLECOPTERA	Perlidae	*Agnetina capitata*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	2
	Elmidae	*Optioservus fastiditus*	3
		Optioservus trivittatus	7
		Stenelmis crenata	23
TRICHOPTERA	Psychomyiidae	*Psychomyia flavida*	1
	Hydropsychidae	*Cheumatopsyche sp.*	1
		Hydropsyche bronta	3
DIPTERA	Chironomidae	*Cardiocladius obscurus*	1
		Orthocladius dubitatus	3
		Microtendipes pedellus gr.	3
		Polypedilum flavum	24
		Tanytarsus sp.	1

SPECIES RICHNESS:	20 (good)
BIOTIC INDEX:	4.74 (good)
EPT RICHNESS:	9 (good)
MODEL AFFINITY:	63 (good)
ASSESSMENT:	slightly impacted (6.72)

DESCRIPTION: The sampling site was downstream of the Route 11 bridge below Bath. A septic smell was noted and the northern half of the river bottom had more algae than the southern half. The benthic community was dominated by riffle beetles and midges, and water quality was assessed as slightly impacted based on the metrics.

Macroinvertebrate Data Reports: Raw Data

STREAM SITE:	Cohocton River	COHO-08A	
LOCATION:	Savona, NY	above Co. Rte. 12 bridge	
DATE:	09 July 2004		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100 organisms		
ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	2
MOLLUSCA			
PELECYPODA			
	Sphaeriidae	Undetermined Sphaeriidae	4
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	5
	Baetidae	*Acentrella sp.*	1
		Baetis intercalaris	2
	Heptageniidae	*Leucrocuta sp.*	6
	Ephemerellidae	*Serratella deficiens*	9
		Serratella serratoides	8
	Caenidae	*Caenis sp.*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	6
	Elmidae	*Optioservus trivittatus*	7
		Stenelmis crenata	19
TRICHOPTERA	Philopotamidae	*Chimarra obscura*	1
	Hydropsychidae	*Cheumatopsyche sp.*	4
		Hydropsyche bronta	12
DIPTERA	Tipulidae	*Antocha sp.*	2
	Simuliidae	*Simulium vittatum*	1
	Chironomidae	*Cardiocladius albiplumus*	1
		Cardiocladius obscurus	2
		Tvetenia vitracies	5
		Polypedilum flavum	2

SPECIES RICHNESS:	21 (good)
BIOTIC INDEX:	4.12 (very good)
EPT RICHNESS:	10 (good)
MODEL AFFINITY:	71 (very good)
ASSESSMENT:	slightly impacted (7.30)

DESCRIPTION: The sampling site was 50 meters upstream of the County Route 12 bridge in Savona. The habitat was considered adequate for macroinvertebrates, although gravel was dominant in the substrate. The benthic community was dominated by mayflies and riffle beetles, and water quality was assessed as slightly impacted.

Macroinvertebrate Data Reports: Raw Data

STREAM SITE:	Cohocton River	COHO-09
LOCATION:	Curtis, NY	above Rte. 4 bridge
DATE:	09 July 2004	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100 organisms	

HIRUDINEA			
	Glossiphoniidae	Undetermined Hirudinea	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	2
	Baetidae	*Acentrella sp.*	2
		Baetis flavistriga	2
		Baetis intercalaris	3
	Heptageniidae	*Leucrocuta sp.*	5
		Stenonema sp.	5
	Ephemerellidae	*Serratella serratoides*	7
	Caenidae	*Caenis sp.*	4
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Optioservus trivittatus*	4
		Stenelmis crenata	7
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	4
		Hydropsyche bronta	5
		Hydropsyche leonardi	1
		Hydropsyche morosa	16
	Hydroptilidae	*Hydroptila sp.*	2
DIPTERA	Chironomidae	*Thienemannimyia gr. spp.*	1
		Cardiocladius obscurus	4
		Cricotopus trifascia gr.	12
		Orthocladius nr. dentifer	1
		Parakiefferiella sp.	2
		Tvetenia vitracies	5
		Polypedilum flavum	4

SPECIES RICHNESS:	24 (good)
BIOTIC INDEX:	4.74 (good)
EPT RICHNESS:	13 (very good)
MODEL AFFINITY:	71 (very good)
ASSESSMENT:	non-impacted (7.78)

DESCRIPTION: The kick sample was taken upstream of the Route 4 bridge in Curtis. Filamentous algae was abundant on the rocks at this site. Mayflies, caddisflies, and midges dominated the benthic macroinvertebrate community. Based on the metrics, water quality was assessed as non-impacted.

Macroinvertebrate Data Reports: Raw Data

STREAM SITE:	Cohocton River	COHO-10A
LOCATION:	Coopers Plains, NY	above Smith Road bridge
DATE:	09 July 2004	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100 organisms	

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	2
	Baetidae	*Acentrella sp.*	3
		Baetis flavistriga	3
		Baetis intercalaris	14
	Heptageniidae	*Leucrocuta sp.*	18
		Stenonema sp.	2
	Ephemerellidae	*Serratella deficiens*	4
		Serratella serratoides	9
	Caenidae	*Caenis sp.*	3
COLEOPTERA	Elmidae	*Optioservus trivittatus*	1
		Stenelmis sp.	2
TRICHOPTERA	Psychomyiidae	*Psychomyia flavida*	1
	Hydropsychidae	*Cheumatopsyche sp.*	3
		Hydropsyche bronta	9
		Hydropsyche morosa	10
	Limnephilidae	*Pycnopsyche sp.*	1
DIPTERA	Simuliidae	*Simulium vittatum*	4
	Chironomidae	*Thienemannimyia gr. spp.*	1
		Cardiocladius obscurus	3
		Cricotopus trifascia gr.	1
		Tvetenia vitracies	4
		Polypedilum aviceps	1
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS:	23 (good)
BIOTIC INDEX:	4.00 (very good)
EPT RICHNESS:	14 (very good)
MODEL AFFINITY:	68 (very good)
ASSESSMENT:	non-impacted (7.96)

DESCRIPTION: The kick sample was taken 200 meters upstream of the Smith Road bridge in Coopers Plains. The habitat was very good and the macroinvertebrate community was dominated by mayflies. Water quality was assessed as non-impacted.

Macroinvertebrate Data Reports: Raw Data

STREAM SITE:	Cohocton River	COHO-10
LOCATION:	Painted Post, NY	Fishing Access off Canada Road
DATE:	09 July 2004	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100 organisms	

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	3
	Baetidae	*Acentrella sp.*	2
		Baetis intercalaris	2
	Heptageniidae	*Leucrocuta sp.*	8
		Stenonema sp.	5
	Ephemerellidae	*Serratella serratoides*	9
	Caenidae	*Caenis sp.*	6
PLECOPTERA	Perlidae	*Paragnetina media*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Optioservus trivittatus*	1
		Stenelmis crenata	3
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	4
		Hydropsyche bronta	3
		Hydropsyche leonardi	1
		Hydropsyche morosa	7
		Hydropsyche scalaris	1
DIPTERA	Simuliidae	*Simulium sp.*	2
	Chironomidae	*Thienemannimyia gr. spp.*	1
		Cardiocladius obscurus	5
		Cricotopus bicinctus	1
		Cricotopus tremulus gr.	1
		Cricotopus trifascia gr.	15
		Cricotopus vierriensis	2
		Eukiefferiella devonica gr.	1
		Orthocladius dubitatus	8
		Tvetenia vitracies	3
		Microtendipes pedellus gr.	1
		Polypedilum aviceps	1
		Polypedilum flavum	1
		Tanytarsus sp.	1

SPECIES RICHNESS:	30 (very good)
BIOTIC INDEX:	4.58 (good)
EPT RICHNESS:	13 (very good)
MODEL AFFINITY:	73 (very good)
ASSESSMENT:	non-impacted (8.35)

DESCRIPTION: The kick sample was taken near the Fishing Access site off Canada Road in Painted Post. The habitat was very good and the macroinvertebrate community was diverse and well-balanced. Based on the metrics, water quality was assessed as non-impacted.

FIELD DATA SUMMARY

STREAM NAME: Cohocton River		**DATE SAMPLED: 7/8/2004**		
REACH: Bowles Corners to Painted Post				
FIELD PERSONNEL INVOLVED: Smith, Novak, Garry				
STATION	00	02	06	07A
ARRIVAL TIME AT STATION	1:05	1:50	3:30	8:25
LOCATION	Bowles Corners Rte 21	Cohocton, Rte 415 bridge	Kanona, Rte 415 bridge	Below Bath Rte 11 bridge
PHYSICAL CHARACTERISTICS				
Width (meters)	4.0	12	30	30
Depth (meters)	0.2	0.2	0.3	0.3
Current speed (cm per sec.)	83	100	143	91
Substrate (%)				
Rock (>25.4 cm, or bedrock)			10	
Rubble (6.35 – 25.4 cm)	50	20	40	10
Gravel (0.2 – 6.35 cm)	30	50	20	40
Sand (0.06 – 2.0 mm)	10	10	20	30
Silt (0.004 – 0.06 mm)	10	20	10	20
Embeddedness (%)	30	30	30	20
CHEMICAL MEASUREMENTS				
Temperature (° C)	17.9	20.9	21.5	17.3
Specific Conductance (umhos)	241	549	498	661
Dissolved Oxygen (mg/l)	11.1	10.8	12.0	9.0
pH	7.9	7.7	8.2	7.9
BIOLOGICAL ATTRIBUTES				
Canopy (%)	70	20	10	10
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous				x
algae – diatoms	x			x
macrophytes or moss		x		x
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	x	x	x	x
Plecoptera (stoneflies)	x		x	x
Trichoptera (caddisflies)	x	x	x	x
Coleoptera (beetles)	x	x	x	x
Megaloptera (dobsonflies, alderflies)			x	
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	x	x	x	x
Simuliidae (black flies)				
Decapoda (crayfish)	x	x	x	
Gammaridae (scuds)		x		x
Mollusca (snails, clams)		x		
Oligochaeta (worms)		x	x	x
Other				
FAUNAL CONDITION	Very good	Good	Good	Good

FIELD DATA SUMMARY				
STREAM NAME: Cohocton River		DATE SAMPLED: 7/9/2004		
REACH: Bowles Corners to Painted Post				
FIELD PERSONNEL INVOLVED: Smith, Novak, Garry				
STATION	08A	09	10A	10
ARRIVAL TIME AT STATION	9:15	10:00	10:35	11:20
LOCATION	Savona Co. Rte 12 bridge	Curtis Rte 4 bridge	Cooper Plains Smith Rd	Painted Post Fishing Access
PHYSICAL CHARACTERISTICS				
Width (meters)	40	40	20	50
Depth (meters)	0.3	0.3	0.3	0.2
Current speed (cm per sec.)	83	100	91	100
Substrate (%)				
Rock (>25.4 cm, or bedrock)		10	10	10
Rubble (6.35 – 25.4 cm)	20	50	40	40
Gravel (0.2 – 6.35 cm)	40	10	20	20
Sand (0.06 – 2.0 mm)	20	20	20	20
Silt (0.004 – 0.06 mm)	20	10	10	10
Embeddedness (%)	40	40	40	30
CHEMICAL MEASUREMENTS				
Temperature (°C)	18.3	19.4	20.0	20.2
Specific Conductance (umhos)	658	704	716	684
Dissolved Oxygen (mg/l)	9.6	9.4	10.9	11.4
pH	8.2	8.2	8.4	8.4
BIOLOGICAL ATTRIBUTES				
Canopy (%)	0	0	0	0
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous	x	xx	x	xx
algae – diatoms	x	x	x	x
macrophytes or moss	x		x	
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	x	x	x	x
Plecoptera (stoneflies)	x		x	x
Trichoptera (caddisflies)	x	x	x	x
Coleoptera (beetles)	x	x	x	x
Megaloptera (dobsonflies, alderflies)	x		x	
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	x	x	x	x
Simuliidae (black flies)				
Decapoda (crayfish)	x		x	
Gammaridae (scuds)				
Mollusca (snails, clams)	x			
Oligochaeta (worms)	x		x	
Other				
FAUNAL CONDITION	Good	Good	Very good	Very good

APPENDICES

I. Biological Methods for Kick Sampling

II. Macroinvertebrate Community Parameters

III. Levels of Water Quality Impact in Streams

IV. Biological Assessment Profile Description

V. Water Quality Assessment Criteria

VI. Traveling Kick Sample Illustration

VII. Macroinvertebrate Illustrations

VIII. Rationale for Biological Monitoring

IX. Glossary

X. Impact Source Determination Methods and Models

XI. Methods for Calculating the Nutrient Biotic Index

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 five minutes for a distance of five 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). 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.

MACROINVERTEBRATE COMMUNITY PARAMETERS

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

3. Hilsnhoff 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; 4.5 1-6.50, slightly impacted; 6.5 1-8.50, 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 seven major macroinvertebrate groups (Novak and Bode, 1992). Percent 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.

Bode, R.W., M.A. Novak, and L.E. Abele. 1996. Quality assurance work plan for biological stream monitoring in New York State. NY S 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.

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 Macroinvertebrate Community Parameters Appendix*). 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-organism 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. 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.

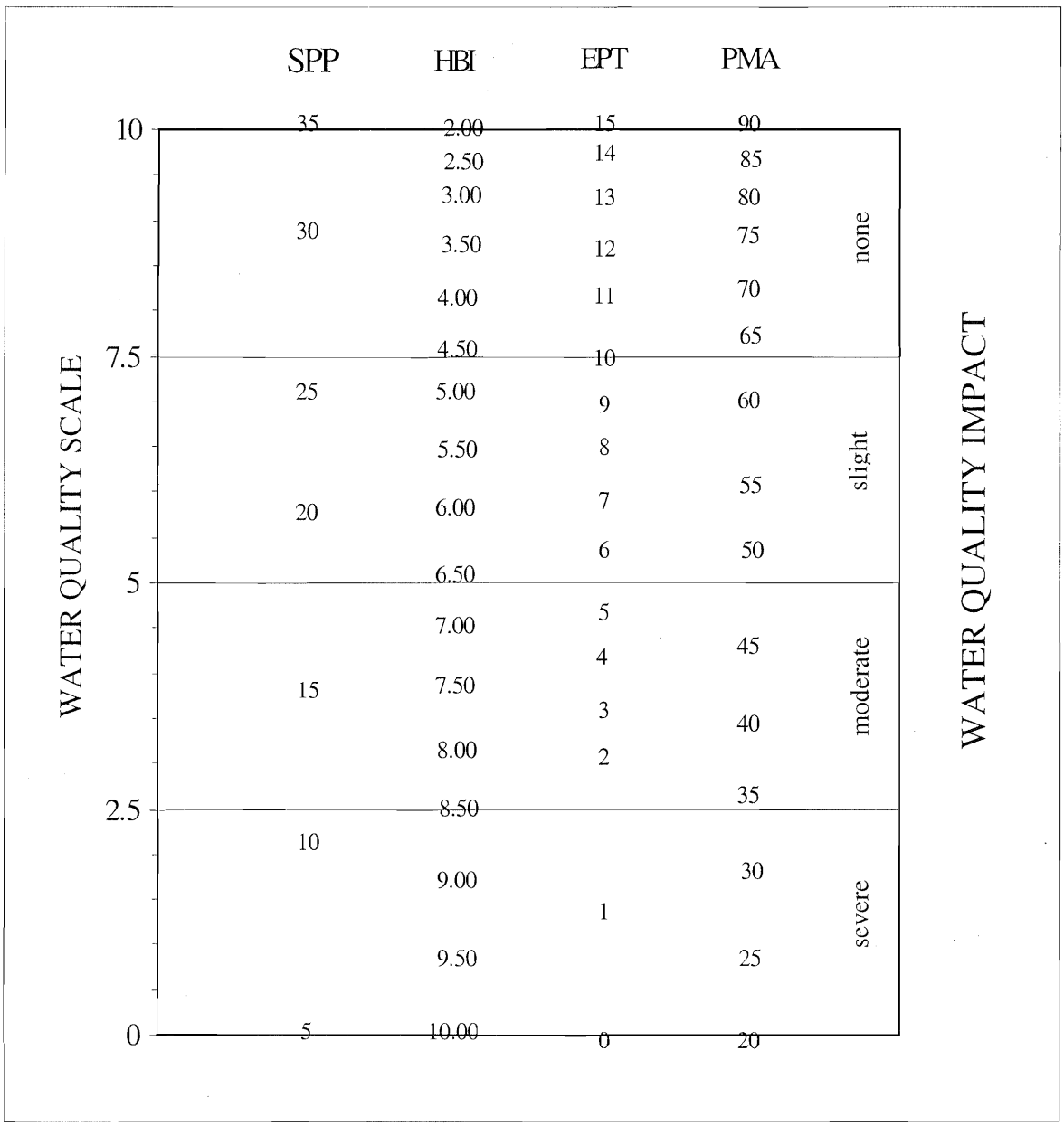
2. *Slightly impacted* Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness usually is 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50. Percent model affinity is 50-64. Water quality is usually not limiting to fish survival, but may be limiting to fish propagation.

3. *Moderately impacted* Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT 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.

Biological Assessment Profile: Conversion of Index values to 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 four indices, defined in the Macroinvertebrate Community Parameter Appendix, 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.



Biological Assessment Profile: Plotting Values

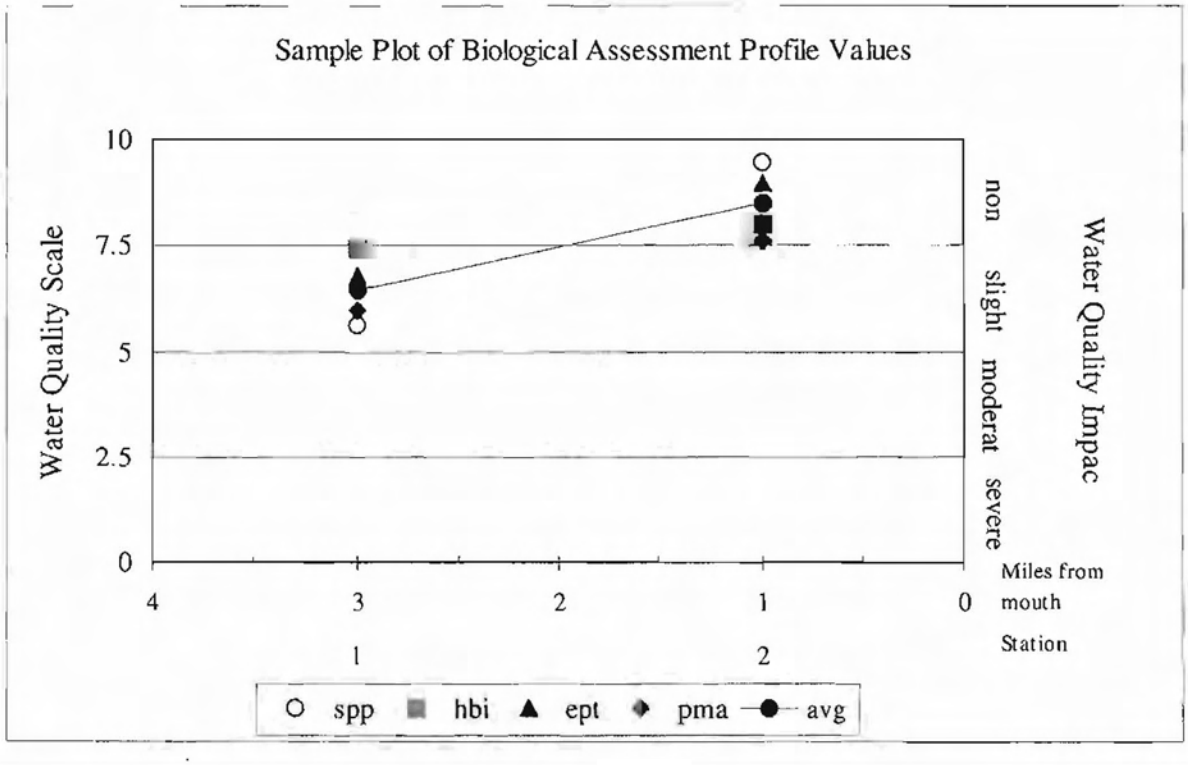
To plot survey data:

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

Example data:

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

Table IV-B. Sample Plot of Biological Assessment Profile values



Water Quality Assessment Criteria

Water Quality Assessment Criteria for Non-Navigable Flowing Waters

	Species Richness	Hilsenhoff Biotic Index	EPT Richness	Percent Model Affinity#	Species 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 Richness	Species Diversity
Non-Impacted	>21	0.00-7.00	>5	>3.00
Slightly Impacted	17-21	7.01-8.00	4-5	2.51-3.00
Moderately Impacted	12-16	8.01-9.00	2-3	2.01-2.50
Severely Impacted	0-11	9.01-10.00	0-1	0.00-2.00

Appendix VI.

THE TRAVELING KICK SAMPLE

← CURRENT ——

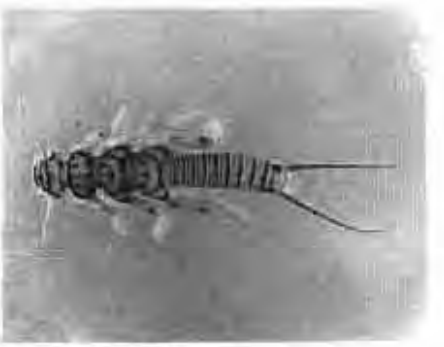
Rocks and sediment in the stream riffle are dislodged by foot upstream of a net; dislodged organisms are carried by the current in the net. Sampling is continued for a specified time, gradually moving downstream to cover a specified distance.

AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

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

MAYFLIES

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



STONEFLIES

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

CADDISFLIES

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

BEETLES

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.

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

SOWBUGS

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:

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 ail 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.

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

EPT richness: the number of species of mayflies (**E**phemeroptera), stoneflies (**P**lecoptera), and caddisflies (**Tr**ichoptera) 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 time; usually involves kick sampling and laboratory subsampling of the sample

Riffle: wadeable stretch of stream usually having a rubble bottom and sufficient current to break the water surface; 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

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.

Impact Source Determination 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

Impact Source Determination Models

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

Impact Source Determination Models

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

Impact Source Determination Models

SEWAGE EFFLUENT, ANIMAL WASTES

	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	5	35	15	10	10	35	40	10	20	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	10	-	-	-	-	-	-
ASELLIDAE	5	10	-	10	10	10	10	50	-	5
GAMMARIDAE	-	-	-	-	-	10	-	10	-	-
Isonychia	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	10	5	-	-	-	-	5	-
HEPTAGENIIDAE	10	10	10	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	5	-
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	-	10	10	-	-	-	-	-	-
PHILOPOTAMIDAE	-	-	-	-	-	-	-	-	-	-
HYDROPSYCHIDAE	45	-	10	10	10	-	-	10	5	-
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	25	10	35	-	-	5	5
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE										
Tanypodinae	-	5	-	-	-	-	-	-	5	5
Cardiocladius	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	-	10	15	-	-	10	10	-	5	5
Eukiefferiella/ Tvetenia	-	-	10	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	10	-	-	60
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	10	60	-	30	10	5	5
Tanytarsini	10	10	10	10	-	-	-	10	40	-
TOTAL	100	100	100	100	100	100	100	100	100	100

Impact Source Determination Models

	SILTATION					IMPOUNDMENT									
	A	B	C	D	E	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	10	-	10	-	5	-	50	10	-
OLIGOCHAETA	5	-	20	10	5	5	-	40	5	10	5	10	5	5	-
HIRUDINEA	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	10	-	5	5	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-	-	-	5	25	-
ASELLIDAE	-	-	-	-	-	-	5	5	-	10	5	5	5	-	-
GAMMARIDAE	-	-	-	10	-	-	-	10	-	10	50	-	5	10	-
Isonychia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	20	5	-	-	5	-	5	-	-	5	-	-	5
HEPTAGENIIDAE	5	10	-	20	5	5	5	-	5	5	5	5	-	5	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis/Tricorythodes	5	20	10	5	15	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Optioservus	5	10	-	-	-	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis	5	10	10	5	20	5	5	10	10	-	5	35	-	5	10
PHILOPOTAMIDAE	-	-	-	-	-	5	-	-	5	-	-	-	-	-	30
HYDROPSYCHIDAE	25	10	-	20	30	50	15	10	10	10	10	20	5	15	20
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
SIMULIIDAE	5	10	-	-	5	5	-	5	-	35	10	5	-	-	15
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE															
Tanypodinae	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-
Cardiocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	25	-	10	5	5	5	25	5	-	10	-	5	10	-	-
Eukiefferiella/ Tvetenia	-	-	10	-	5	5	15	-	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	5	5	5	-	-	20	-	-	5	5	5	5
Tanytarsini	10	10	10	10	5	5	10	5	30	-	-	5	10	10	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

METHODS FOR CALCULATION OF THE NUTRIENT BIOTIC INDEX

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

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

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

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

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

Index	Oligotrophic	Mesotrophic	Eutrophic
NBI-P	< 5.0	> 5.0 – 6.5	> 6.0
NBI-N	< 4.5	> 4.5 – 6.0	> 6.0

References:

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. The Great Lakes Entomologist 20(1): 31-39.

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