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New York State
Department of Environmental Conservation

Division of Water

Knight Creek

Biological Assessment

2000 Survey

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

BIOLOGICAL STREAM ASSESSMENT

Knight Creek
Allegany County, New York

Survey date: August 9, 2000
Report date: May 16, 2001

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CONTENTS

Stream: Knight Creek, Allegany County, New York

Reach: Allentown to Scio, New York

Background:

The Stream Biomonitoring Unit conducted biological sampling on Knight Creek on August 9, 2000. The purpose of the sampling was to assess general water quality, determine the cause and extent of any water quality problems, and compare to results of previous surveys. Traveling kick samples were taken in riffle areas at four sites, using methods described in the Quality Assurance document (Bode et al., 1996) 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. Water quality assessments were based on resident macroinvertebrates (aquatic insects, worms, mollusks, crustaceans). Community parameters used in the determination of water quality included species richness, biotic index, EPT value, and percent model affinity (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. Water quality in the Knight Creek ranged from non-impacted to slightly impacted, based on resident macroinvertebrate communities.

2. Water quality at Scio was assessed as slightly impacted, likely by nutrient enrichment from nonpoint source runoff, a decline from previous years. The runoff appears to be flow-related, exhibiting greater effects in high-flow years than in low-flow years.

Discussion:

The purpose of this biological sampling was to determine water quality trends in Knight Creek, particularly in comparison to biological assessments performed in 1991 (Bode et al., 1991) and 1999 (unpublished). The sites sampled and the methods used were the same as in previous years. RIBS (Rotating Intensive Basin Studies) sampling in 1999 (unpublished) documented heavy algal growth at Scio (Station 4), but the macroinvertebrate sample yielded community indices within the range of non-impacted water quality.

Results of the present sampling indicate a decline in water quality of Knight Creek at Scio (Figure 1). Water quality assessments of the upstream sites compare well to results of the 1991 study (Figure 2), indicating non-impacted water quality. Station 4 at Scio, however, declined from non-impacted to slightly impacted. Impact Source Determination (Table 1) indicates nutrient enrichment to be the likely cause of impact. The nutrient enrichment appears to begin upstream near Station 2, which also has indications of organic inputs. The inputs do not affect the macroinvertebrate indices at upstream sites, but are evidenced at Station 4.

The years 1991 and 1999, when the Scio site was assessed as non-impacted, were generally considered low-flow years in New York State, while 2000 was considered a high-flow year. Nonpoint source nutrient runoff is generally higher in high-flow years, and this is consistent with the impact documented at the Scio site in 2000. The specific source of the nutrients in Knight Creek is not known, and could be the subject of further investigation.

Literature Cited:

Bode, R. W., M. A. Novak, and L. E. Abele. 1991. Biological Stream Assessment, Knight Creek. New York State Department of Environmental Conservation, Technical Report, 19 pages.

Bode, R. W., M. A. Novak, and L. E. Abele. 1996. Quality assurance work plan for biological stream monitoring in New York State. New York State Department of Environmental Conservation, Technical Report, 89 pages.

Overview of field data

On the date of sampling, August 9, 2000, Knight Creek at the sites sampled was 2-15 meters wide, 0.05-0.3 meters deep, and had current speeds of 65-100 cm/sec in riffles. Dissolved oxygen was 7.6-8.8 mg/l, specific conductance was 165-358 µmhos, pH was 6.6-7.3, and the temperature was 21.2-23.2 °C (70-74 °F). Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, Knight Creek, 2000. 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.

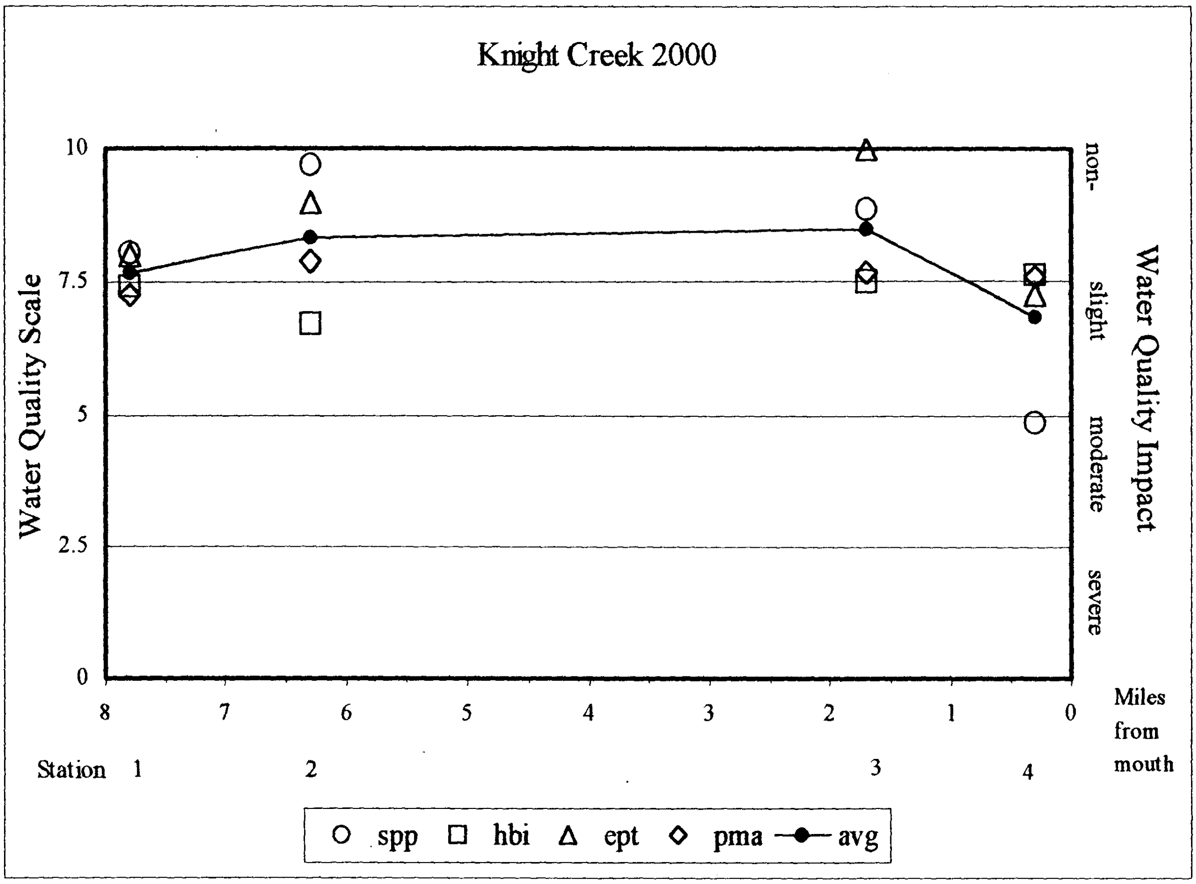


Figure 2. Biological Assessment Profile of index values, Knight Creek, 1991 and 2000. Values are plotted on a normalized scale of water quality. Averages are shown for each year of sampling.

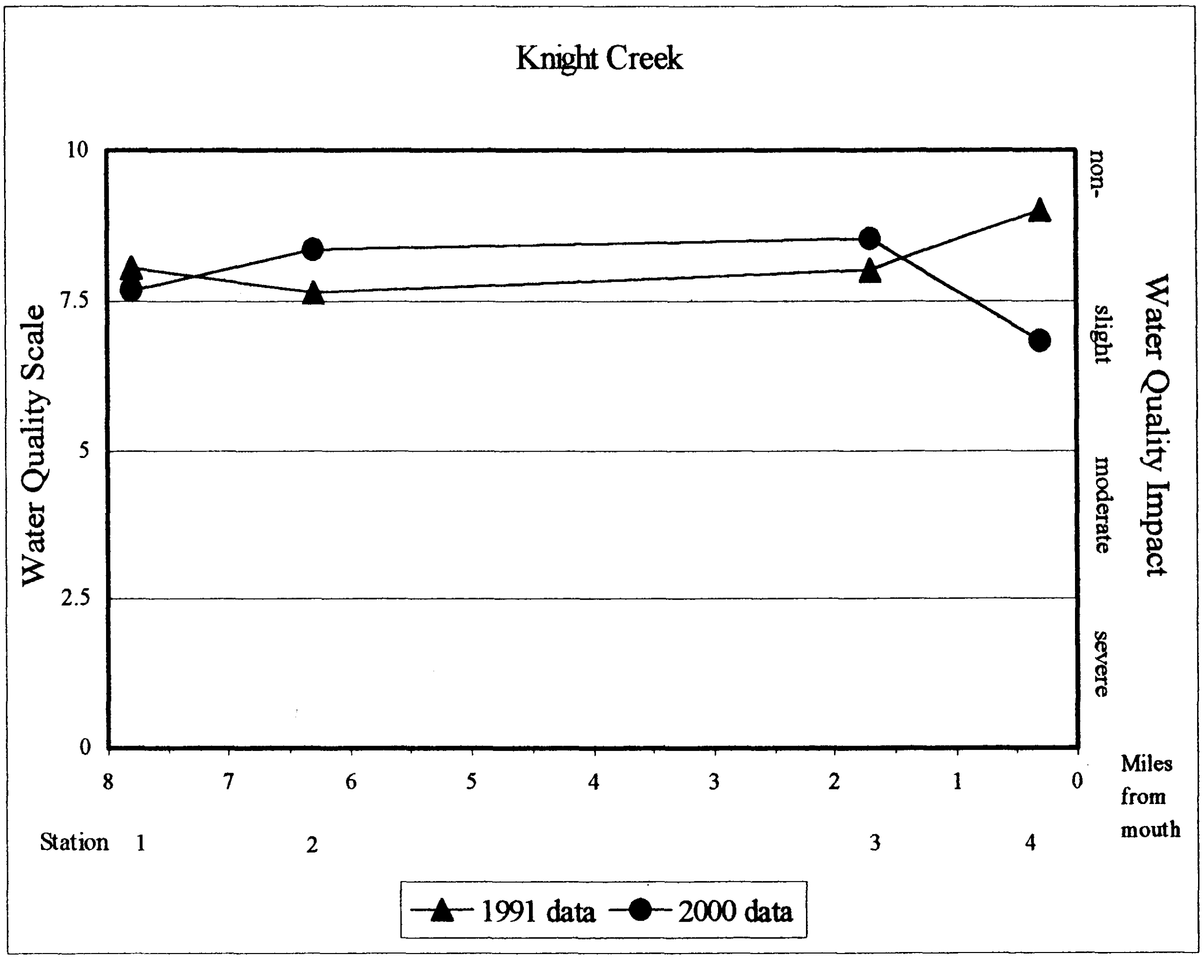


Table 1. Impact Source Determination, Knight Creek, 2000. Numbers represent similarity to community type models for each impact category. The highest similarity at each station is highlighted. Similarities less than 50% are less conclusive.

	STATION			
Community Type	KNIT-1	KNIT-2	KNIT-3	KNIT-4
Natural: minimal human impacts	57	53	45	54
Nutrient additions; mostly nonpoint, agricultural	46	51	67	59
Toxic: industrial, municipal, or urban run-off	30	40	39	39
Organic: sewage effluent, animal wastes	37	53	53	40
Complex: municipal/industrial	31	31	49	48
Siltation	46	59	49	46
Impoundment	33	39	58	42

TABLE 2. STATION LOCATIONS FOR KNIGHT CREEK, ALLEGANY COUNTY, NEW YORK (see map).

STATION	LOCATION
01	below Allentown 20 meters above Allen Rd. bridge 7.8 river miles above the mouth latitude/longitude: 42°05'25"; 78°03'26"
02	below Allentown 20 m above Rt. 417 bridge 6.3 river miles above the mouth latitude/longitude: 42°06'11"; 78°02'07"
03	above Scio 20 m above Knight Creek Rd. bridge 1.7 river miles above the mouth latitude/longitude: 42°09'19"; 78°00'09"
04	Scio 20 m below Knight Cr. Rd./Back River Rd. bridge 0.3 river miles above the mouth latitude/longitude: 42°10'15"; 77°59'18"

Figure 3a	Site Location Map	Knight Creek

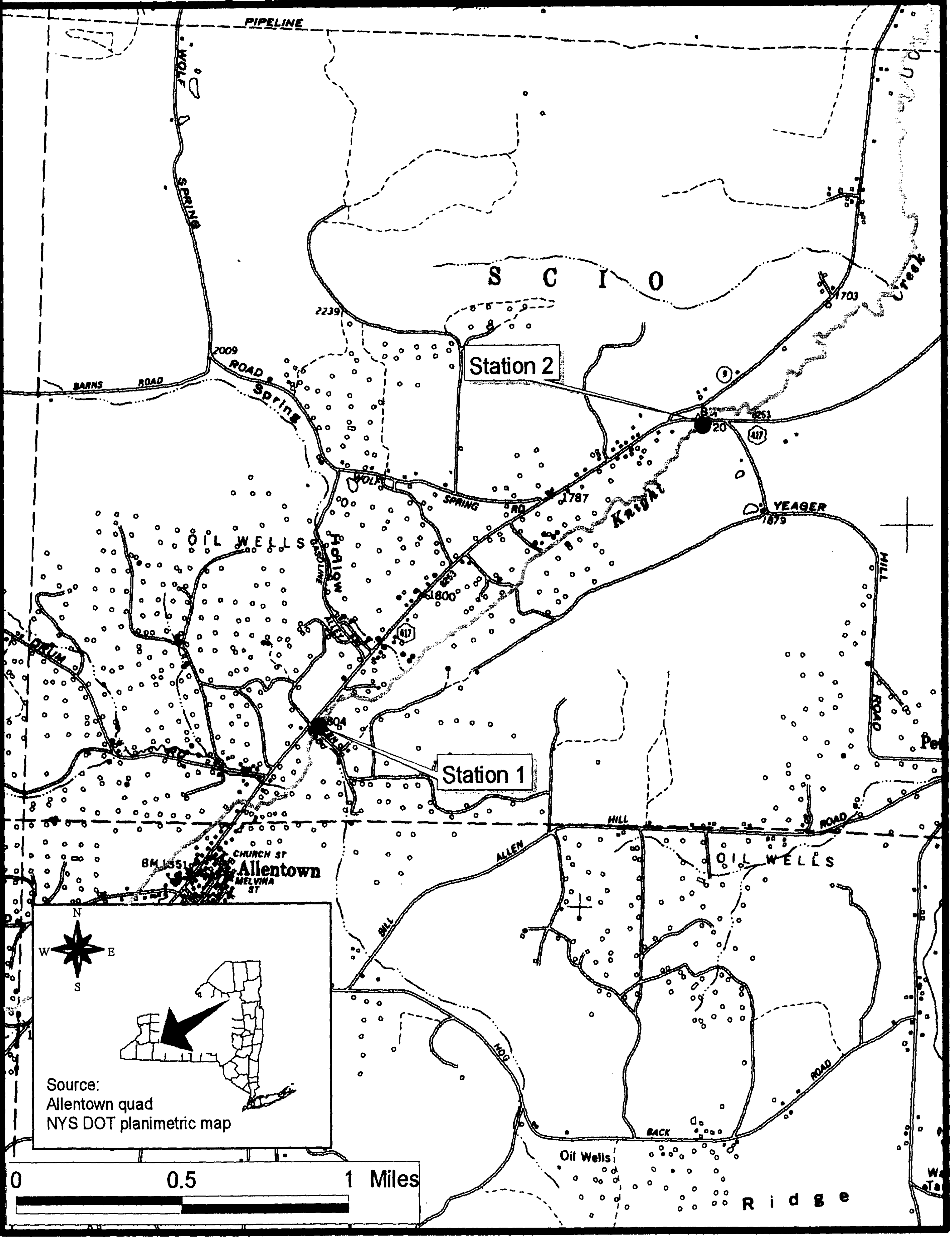
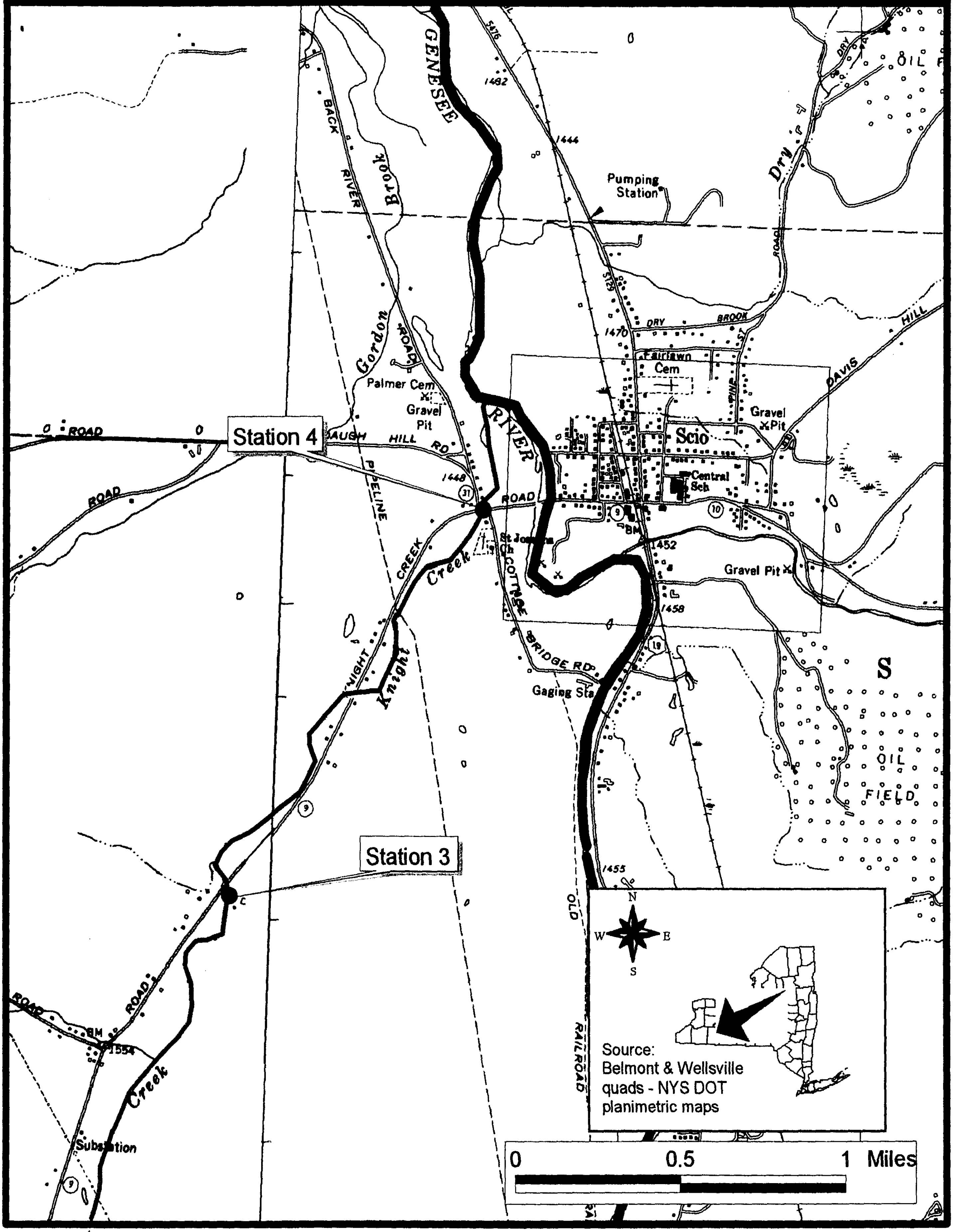


Figure 3b	Site Location Map	Knight Creek



stream flow

TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN KNIGHT CREEK, ALLEGANY COUNTY, NEW YORK, AUGUST 9, 2000.

ANNELIDA
- OLIGOCHAETA
  - Undetermined Lumbricina
  - Enchytraeidae
    - Undetermined Enchytraeidae
  - Tubificidae
    - Undet. Tubificidae w/o cap. setae

ARTHROPODA
- CRUSTACEA
  - DECAPODA
    - Cambaridae
      - Undetermined Cambaridae
- INSECTA
  - EPHEMEROPTERA
    - Isonychiidae
      - Isonychia bicolor
    - Baetidae
      - Acentrella sp.
      - Baetis brunneicolor
      - Baetis flavistriga
      - Baetis intercalaris
    - Heptageniidae
      - Leucrocuta sp.
      - Stenonema meririvulanum
      - Stenonema modestum
      - Stenonema pulchellum
      - Stenonema terminatum
      - Stenonema sp.
    - Leptophlebiidae
      - Paraleptophlebia guttata
    - Tricorythidae
      - Tricorythodes sp.
    - Caenidae
      - Caenis latipennis
    - Ephemeridae
      - Ephemera sp.
  - ODONATA
    - Gomphidae
      - Ophiogomphus sp.
      - Undetermined Gomphidae
  - PLECOPTERA
    - Capniidae
      - Undetermined Capniidae
    - Leuctridae
      - Leuctra sp.
    - Perlidae
      - Agnetina capitata
      - Neoperla sp.
      - Perlesta sp.
    - Pteronarcidae
      - Pteronarcys biloba
  - COLEOPTERA
    - Psephenidae
      - Psephenus herricki
    - Elmidae
      - Optioservus fastiditus
      - Optioservus trivittatus
      - Optioservus sp.
      - Stenelmis concinna
      - Stenelmis crenata
  - MEGALOPTERA
    - Corydalidae
      - Nigronia serricornis
  - TRICHOPTERA
    - Philopotamidae
      - Chimarra aterrima?
      - Dolophilodes sp.
    - Hydropsychidae
      - Cheumatopsyche sp.
      - Hydropsyche bronta
      - Hydropsyche morosa
      - Hydropsyche slossonae
      - Hydropsyche sparna
      - Hydropsyche sp.
  - DIPTERA
    - Tipulidae
      - Antocha sp.
      - Hexatoma sp.
    - Ceratopogonidae
      - Undetermined Ceratopogonidae
    - Simuliidae
      - Simulium sp.
    - Athericidae
      - Atherix sp.
    - Empididae
      - Hemerodromia sp.
    - Dolichopodidae
      - Undetermined Dolichopodidae

TABLE 3 (continued). MACROINVERTEBRATE SPECIES COLLECTED IN KNIGHT CREEK, ALLEGANY COUNTY, NEW YORK, AUGUST 9, 2000.

Chironomidae
Tanypodinae
Thienemannimyia gr. spp.
Diamesinae
Diamesa sp.
Orthocladiinae
Cardiocladius obscurus
Cricotopus bicinctus
Cricotopus tremulus gr.
Orthocladius nr. dentifer
Parametriocnemus lundbecki
Tvetenia bavarica gr.
Chironominae
Chironomini
Microtendipes pedellus gr.
Phaenopsectra sp.
Polypedilum aviceps
Polypedilum convictum
Polypedilum laetum
Tanytarsini
Micropsectra dives gr.
Micropsectra polita
Rheotanytarsus exiguus gr.

STREAM SITE:	Knight Creek, Station 1
LOCATION:	Downstream of Allentown, New York, above Allen Road bridge
DATE:	August 9, 2000
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA	Enchytraeidae	Undetermined Enchytraeidae	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	9
		Baetis brunneicolor	3
		Baetis flavistriga	1
	Heptageniidae	Stenonema terminatum	2
	Leptophlebiidae	Paraleptophlebia guttata	1
	Tricorythidae	Tricorythodes sp.	2
PLECOPTERA	Leuctridae	Leuctra sp.	1
	Perlidae	Agnetina capitata	1
COLEOPTERA	Elmidae	Optioservus sp.	2
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	2
		Hydropsyche bronta	2
		Hydropsyche slossonae	7
DIPTERA	Tipulidae	Antocha sp.	2
		Hexatoma sp.	2
	Ceratopogonidae	Undetermined Ceratopogonidae	1
	Simuliidae	Simulium sp.	2
	Athericidae	Atherix sp.	1
	Empididae	Hemerodromia sp.	2
	Chironomidae	Thienemannimyia gr. spp.	1
		Diamesa sp.	1
		Cricotopus tremulus gr.	1
		Parametriocnemus lundbecki	21
		Tvetenia bavarica gr.	1
		Polypedilum aviceps	19
		Polypedilum convictum	4
		Micropsectra polita	1
		Rheotanytarsus exiguus gr.	7

SPECIES RICHNESS	28 (very good)
BIOTIC INDEX	4.57 (good)
EPT RICHNESS	11 (very good)
MODEL AFFINITY	63 (good)
ASSESSMENT	non-impacted

DESCRIPTION The creek is quite narrow at this upstream location. The macroinvertebrate fauna appeared diverse and well balanced, and water quality was assessed as non-impacted.

STREAM SITE:	Knight Creek, Station 2
LOCATION:	Downstream of Allentown, New York, above Route 417 bridge
DATE:	August 9, 2000
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA	Enchytraeidae	Undetermined Enchytraeidae	1
	Tubificidae	Undet. Tubificidae w/o cap. setae	6
ARTHROPODA			
CRUSTACEA			
DECAPODA	Cambaridae	Undetermined Cambaridae	1
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	3
		Baetis brunneicolor	4
		Baetis flavistriga	2
		Baetis intercalaris	1
	Heptageniidae	Stenonema modestum	3
	Leptophlebiidae	Paraleptophlebia guttata	1
	Tricorythidae	Tricorythodes sp.	3
	Caenidae	Caenis latipennis	1
ODONATA	Gomphidae	Undetermined Gomphidae	1
PLECOPTERA	Pteronarcidae	Pteronarcys biloba	1
COLEOPTERA	Elmidae	Optioservus fastiditus	12
MEGALOPTERA	Corydalidae	Nigronia serricornis	2
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	1
		Dolophilodes sp.	2
	Hydropsychidae	Cheumatopsyche sp.	1
		Hydropsyche sp.	3
DIPTERA	Tipulidae	Antocha sp.	1
	Simuliidae	Simulium sp.	2
	Chironomidae	Thienemannimyia gr. spp.	1
		Diamesa sp.	1
		Cardiocladius obscurus	3
		Cricotopus bicinctus	9
		Cricotopus tremulus gr.	3
		Orthocladius nr. dentifer	7
		Parametriocnemus lundbecki	4
		Microtendipes pedellus gr.	1
		Polypedilum aviceps	5
		Polypedilum convictum	6
		Polypedilum laetum	1
		Micropsectra dives gr.	4
		Rheotanytarsus exiguus gr.	3

SPECIES RICHNESS	34 (very good)
BIOTIC INDEX	5.11 (good)
EPT RICHNESS	13 (very good)
MODEL AFFINITY	68 (very good)
ASSESSMENT	non-impacted

DESCRIPTION The macroinvertebrate fauna at this site was dominated by midges, as at Station 1. Based on the community indices, water quality was assessed as non-impacted.

STREAM SITE: Knight Creek, Station 3
LOCATION: Scio, New York, above Knight Creek Road bridge
DATE: August 9, 2000
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

ANNELIDA			
OLIGOCHAETA		Undetermined Lumbricina	2
	Enchytraeidae	Undetermined Enchytraeidae	1
ARTHROPODA			
CRUSTACEA			
DECAPODA	Cambaridae	Undetermined Cambaridae	1
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	7
	Baetidae	Baetis brunneicolor	1
		Baetis intercalaris	3
	Heptageniidae	Leucrocuta sp.	1
		Stenonema terminatum	2
		Stenonema sp.	1
	Tricorythidae	Tricorythodes sp.	3
	Ephemeridae	Ephemera sp.	1
ODONATA	Gomphidae	Ophiogomphus sp.	1
PLECOPTERA	Capniidae	Undetermined Capniidae	1
	Perlidae	Agnetina capitata	1
		Perlesta sp.	1
	Pteronarcidae	Pteronarcys biloba	2
COLEOPTERA	Psephenidae	Psephenus herricki	2
	Elmidae	Optioservus fastiditus	3
		Optioservus trivittatus	3
		Stenelmis crenata	1
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	6
		Hydropsyche bronta	6
		Hydropsyche morosa	23
		Hydropsyche slossonae	8
		Hydropsyche sparna	1
DIPTERA	Tipulidae	Hexatoma sp.	5
	Dolichopodidae	Undetermined Dolichopodidae	1
	Chironomidae	Thienemannimyia gr. spp.	1
		Microtendipes pedellus gr.	3
		Polypedilum aviceps	7
		Micropsectra polita	1

SPECIES RICHNESS 31 (very good)
BIOTIC INDEX 4.50 (very good)
EPT RICHNESS 17 (very good)
MODEL AFFINITY 66 (very good)
ASSESSMENT non-impacted

DESCRIPTION Signs of recent flooding were evident at this site. However, the macroinvertebrate fauna was diverse, with many species of mayflies, stoneflies, and caddisflies. All community indices were within the range of non-impacted water quality.

STREAM SITE:	Knight Creek, Station 4
LOCATION:	Scio, New York, below Knight Creek Road, at Back River Road bridge
DATE:	August 9, 2000
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA	Enchytraeidae	Undetermined Enchytraeidae	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	20
	Baetidae	Acentrella sp.	5
		Baetis flavistriga	2
		Baetis intercalaris	5
	Heptageniidae	Stenonema sp.	1
	Tricorythidae	Tricorythodes sp.	8
PLECOPTERA	Perlidae		
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Optioservus fastiditus	10
		Optioservus trivittatus	5
		Stenelmis concinna	1
		Stenelmis crenata	3
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	3
		Hydropsyche bronta	13
		Hydropsyche morosa	18
DIPTERA	Tipulidae	Hexatoma sp.	1
	Chironomidae	Polypedilum aviceps	2

SPECIES RICHNESS	18 (poor)
BIOTIC INDEX	4.36 (very good)
EPT RICHNESS	10 (good)
MODEL AFFINITY	65 (very good)
ASSESSMENT	slightly impacted

DESCRIPTION The macroinvertebrate fauna at this site was dominated by mayflies, although filter-feeding caddisflies were also very numerous. The community indices were varied, and overall water quality was assessed as slightly impacted.

LABORATORY DATA SUMMARY				
STREAM NAME: Knight Creek		**DRAINAGE: 04**		
DATE SAMPLED: 08/09/00		**COUNTY: Allegany**		
SAMPLING METHOD: Traveling Kick				
STATION	01	02	03	04
LOCATION	Allentown	below Allentown	above Scio	Scio
DOMINANT SPECIES/ %CONTRIBUTION/ TOLERANCE/ COMMON NAME				
1.	Parametriocnemus lundbecki 21 % facultative midge	Optioservus fastiditus 12 % intolerant beetle	Hydropsyche morosa 23 % facultative caddisfly	Isonychia bicolor 20 % intolerant mayfly
2. **Intolerant = not tolerant of poor water quality**	Polypedilum aviceps 19 % facultative midge	Cricotopus bicinctus 9 % tolerant midge	Hydropsyche slossonae 8 % intolerant caddisfly	Hydropsyche morosa 18 % facultative caddisfly
3. **Facultative = occurring over a wide range of water quality**	Acentrella sp. 9 % intolerant mayfly	Orthocladius nr. dentifer 7 % facultative midge	Isonychia bicolor 7 % intolerant mayfly	Hydropsyche bronta 13 % facultative caddisfly
4. **Tolerant = tolerant of poor water quality**	Hydropsyche slossonae 7 % intolerant caddisfly	Undet. Tubificid. w/o cap. setae 6 % tolerant worm	Polypedilum aviceps 7 % facultative midge	Optioservus fastiditus 10 % intolerant beetle
5.	Rheotanytarsus exiguus gr. 7 % facultative midge	Polypedilum convictum 6 % facultative midge	Cheumatopsyche sp. 6 % facultative caddisfly	Tricorythodes sp. 8 % intolerant mayfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	56 (9)	48 (13)	12 (4)	2 (1)
Trichoptera (caddisflies)	11 (3)	7 (4)	44 (5)	34 (3)
Ephemeroptera (mayflies)	18 (6)	18 (8)	19 (8)	41 (6)
Plecoptera (stoneflies)	2 (2)	1 (1)	5 (4)	1 (1)
Coleoptera (beetles)	2 (1)	12 (1)	9 (4)	20 (5)
Oligochaeta (worms)	1 (1)	7 (2)	3 (2)	1 (1)
Other	10 (6)	7 (5)	8 (4)	1 (1)
SPECIES RICHNESS	28	34	31	18
BIOTIC INDEX	4.57	5.11	4.5	4.36
EPT RICHNESS	11	13	17	10
PERCENT MODEL AFFINITY	63	68	66	65
FIELD ASSESSMENT	very good	very good	-	very good
OVERALL ASSESSMENT	non-impacted	non-impacted	non-impacted	slightly impacted

FIELD DATA SUMMARY				
STREAM NAME: Knight Creek **DATE SAMPLED: 08/09/00** **REACH: Allentown to Scio** **FIELD PERSONNEL INVOLVED: Abele, Gabriel, Smith**				
STATION	01	02	03	04
ARRIVAL TIME AT STATION	12:55	1:20	1:50	2:10
LOCATION	Allentown	below Allentown	above Scio	Scio
PHYSICAL CHARACTERISTICS				
Width (meters)	2	3	5	15
Depth (meters)	0.1	0.2	0.3	0.3
Current speed (cm per sec.)	65	70	100	90
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10		10	20
Rubble (6.35 - 25.4 cm)	30	30	30	20
Gravel (0.2 – 6.35 cm)	30	40	30	30
Sand (0.06 – 2.0 mm)	20	20	20	20
Silt (0.004 – 0.06 mm)	10	10	10	10
Embeddedness (%)	50	50	30	50
CHEMICAL MEASUREMENTS				
Temperature (°C)	21.2	21.8	23.2	22.5
Specific Conductance (umhos)	358	288	165	191
Dissolved Oxygen (mg/l)	8.8	8.4	8.0	7.6
pH	6.6	7.2	7.2	7.3
BIOLOGICAL ATTRIBUTES				
Canopy (%)	30	40	0	10
Aquatic Vegetation				
algae – attached, filamentous				
algae - diatoms	present	present		
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
Megaloptera(dobsonflies,alderflies)	X	X		
Odonata (dragonflies, damselflies)	X	X	X	
Chironomidae (midges)	X	X	X	X
Simuliidae (black flies)				
Decapoda (crayfish)		X	X	
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other	X			X
FIELD ASSESSMENT	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.

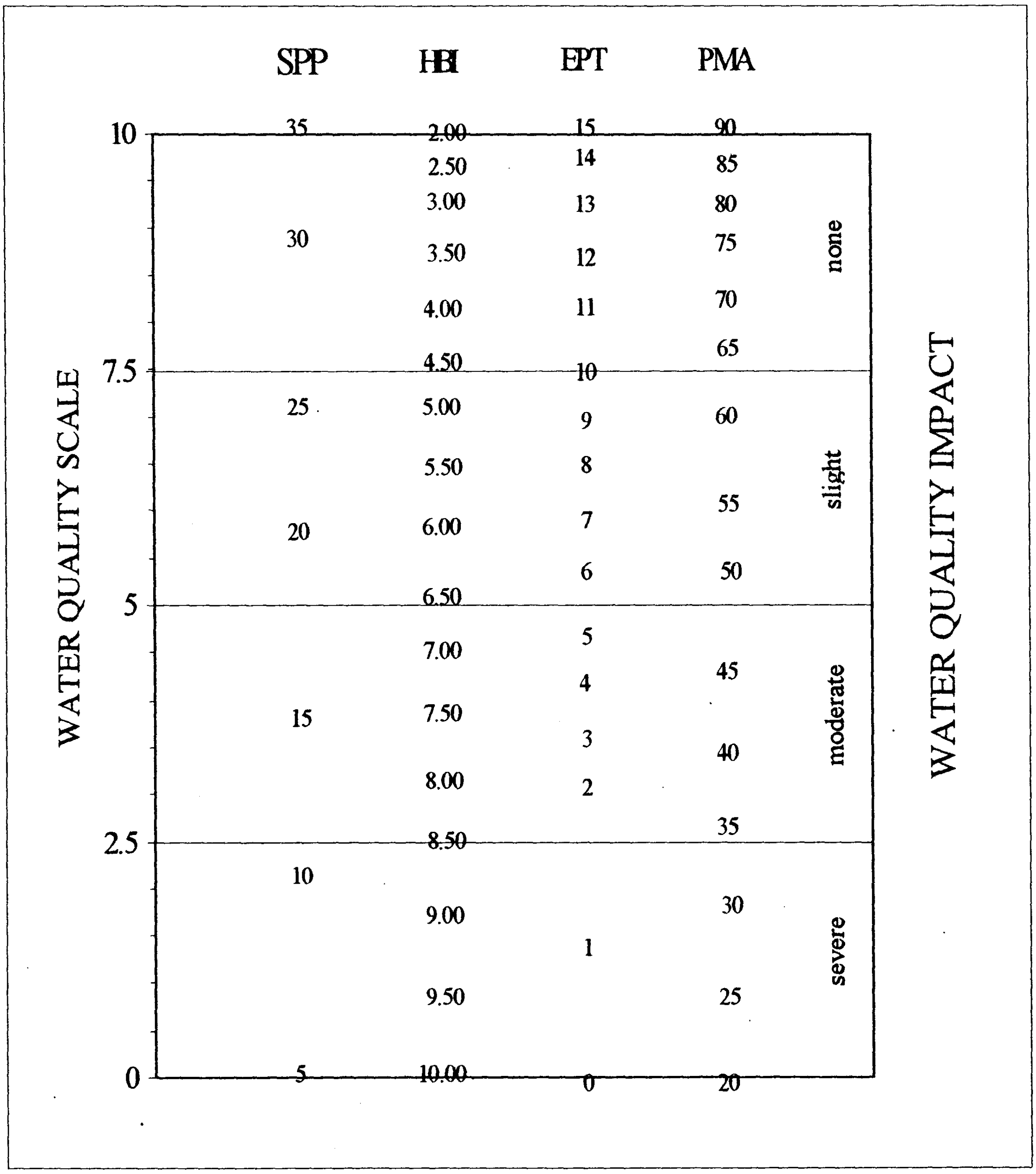
3. Moderately impacted

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.

The Biological Assessment Profile of index values, developed by Mr. Phil O'Brien, Division of Water, NYS DEC, is a method of plotting biological index values on a common scale of water quality impact. Values from the four indices defined in Appendix II are converted to a common 0-10 scale as shown in the figure below.



To plot survey data, each site is positioned on the x-axis according to river miles from the mouth, and the scaled values for the four indices are plotted on the common scale. The mean scale value of the four indices represents the assessed impact for each site.

Appendix V.

WATER QUALITY ASSESSMENT CRITERIA

for non-navigable flowing waters

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

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

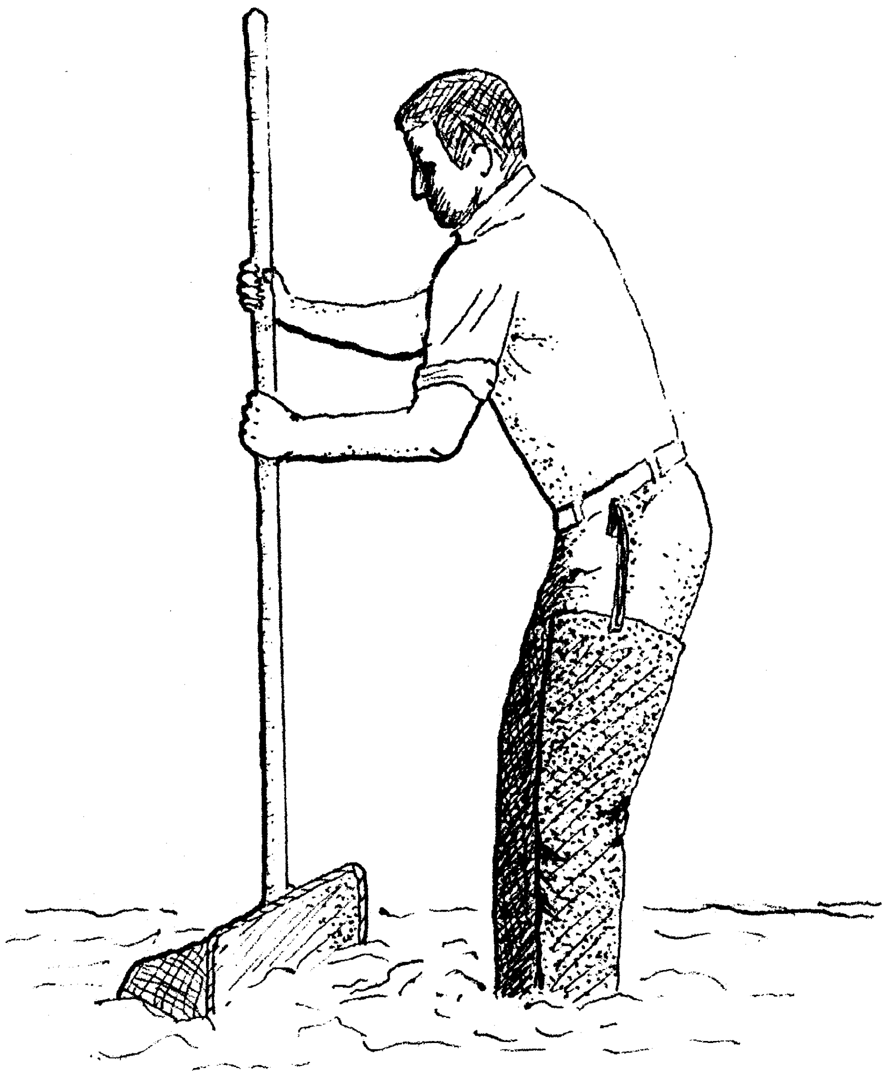
WATER QUALITY ASSESSMENT CRITERIA

for navigable flowing waters

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

Appendix VI.

THE TRAVELING KICK SAMPLE

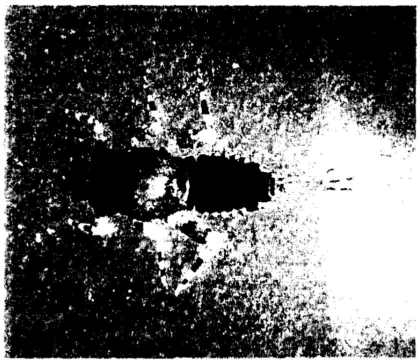


← current

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

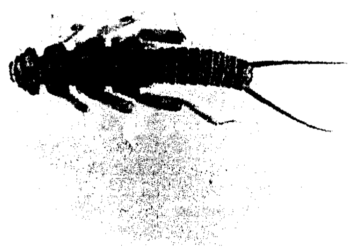
Appendix VII. A. AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

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



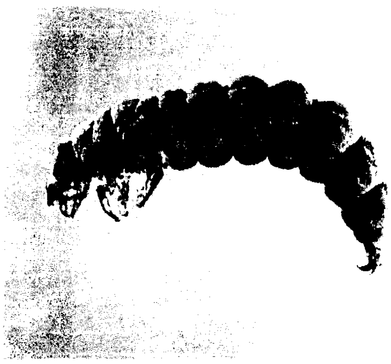
MAYFLIES

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



STONEFLIES

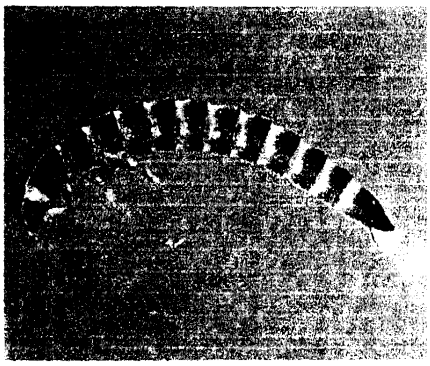
Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in nutrient-enriched stream segments.



CADDISFLIES

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

BEETLES



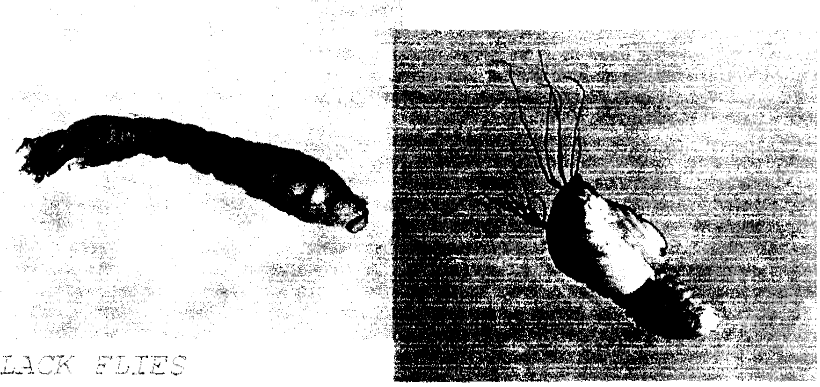
Appendix VII. B.

AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE POOR WATER QUALITY

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

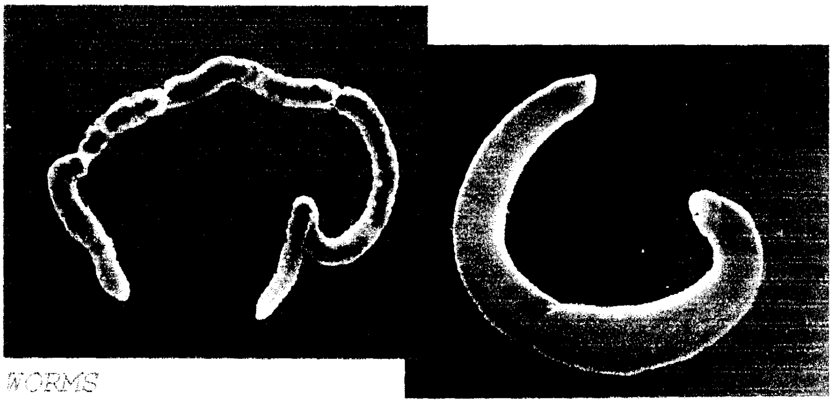
MIDGES

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



BLACK FLIES

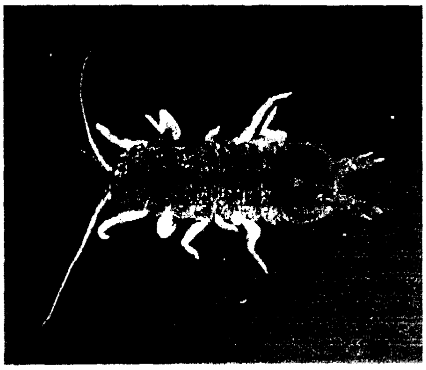
The segmented worms include the leeches and the small aquatic earthworms. The latter are more common, though usually unnoticed. They burrow in the substrate and feed on bacteria in the sediment. They can thrive under conditions of severe pollution and very low oxygen levels, and are thus valuable pollution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



WORMS

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

Digital images by Larry Abele, New York State Department of Environmental Conservation



SOWBUGS

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/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/ Orthocladius</u>	15	10	25	10	5	10	5	10	20	-	5	10	5
<u>Eukiefferiella/ 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	-	-
Isonychia	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	10	5	-	-	-	-	5	-
HEPTAGENIIDAE	10	10	10	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	5	-
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	-	10	10	-	-	-	-	-	-
PHILOPOTAMIDAE	-	-	-	-	-	-	-	-	-	-
HYDROPSYCHIDAE	45	-	10	10	10	-	-	10	5	-
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	25	10	35	-	-	5	5
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE										
Tanypodinae	-	5	-	-	-	-	-	-	5	5
Cardiocladius	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	-	10	15	-	-	10	10	-	5	5
Eukiefferiella/ Tvetenia	-	-	10	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	10	-	-	60
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	10	60	-	30	10	5	5
Tanytarsini	10	10	10	10	-	-	-	10	40	-
TOTAL	100	100	100	100	100	100	100	100	100	100

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