New York State
Department of Environmental Conservation

Division of Water

Indian Kill

Biological Assessment

2000 Survey

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BIOLOGICAL STREAM ASSESSMENT

Indian Kill
Schenectady County, New York

Survey date: August 29, 2000
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Stream: Indian Kill, Schenectady County, New York

Reach: Mayfair to Glenville, New York

Background:

The Stream Biomonitoring Unit conducted biological sampling on the Indian Kill on August 29, 2000. The purpose of the sampling was to assess general water quality, determine the cause and extent of any water quality problems, and compare results to those of a previous study by the Environmental Study Team. Traveling kick samples were taken in riffle areas at six 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.

Appreciation is expressed to J. Kelly Nolan (Hudson Basin River Watch) and Ken Kosinski (NYS DEC, Region 4) for their assistance in this survey.

Results and Conclusions:

1. Water quality in the Indian Kill ranged from slightly impacted to moderately impacted, and is considered good to poor. All sites on the main stem were assessed as having good water quality.

2. The South Branch of the Indian Kill exhibited combined effects of poor water quality and poor habitat. Nonpoint source runoff and septic inputs are likely stressors in this tributary.

3. The discharge from the Mayfair Plaza had a negative impact on the stream, although downstream water quality was still within the range of slightly impacted.

4. Macroinvertebrate samples were similar to those obtained by the Environmental Study Team. That study documented several examples of nonpoint source stressors in the basin that may negatively affect water quality in the Indian Kill.

Discussion:

The Indian Kill was previously sampled in 1998-99 by the Environmental Study Team (EST), an environmental group comprised of local high school students (Nolan, 2000). That study included physical, chemical, and biological sampling at six sites and documented streambank erosion, septic inputs, swimming pool runoff, sedimentation, elevated fecal coliform levels, and nutrient enrichment in the Indian Kill. The present survey was conducted partly as a result of the 1998-99 study, to further delineate and define any water quality problems in the Indian Kill. The six study sites were selected to correspond to those of the Environmental Study Team, although reversed in numerical order.

Results of the present study show water quality ranging from slightly impacted to moderately impacted in the Indian Kill (Figure 1). The primary sources of impact are nonpoint inputs in the South Branch and the discharge of the Mayfair Plaza. The entire stream is influenced by nonpoint source nutrient enrichment, resulting in high numbers of filter-feeding caddisflies at most sites (Table 1).

At the most upstream site (Station1), water quality appeared only slightly impacted, and close to non-impacted, with mayflies and stoneflies present. This was the best fauna found in the stream. The South Branch of the Indian Kill (Station 2) exhibited combined effects of poor water quality and poor habitat. The water appeared greyish, possibly from septic inputs, and specific conductance was nearly twice as high as that at Station 1 (1002 umhos). The site had been excavated one year prior to this sampling to remove a beaver dam, and this may have had residual effects on the benthic fauna. Sampling was conducted just downstream of the confluence of the main stem Indian Kill and the south branch (Station 3). The benthic invertebrate fauna was similar to that at the upstream site, and water quality was similarly assessed as slightly impacted. A small tributary enters the Indian Kill just downstream of Route 50 in Mayfair, carrying the runoff and discharges from the Mayfair Plaza. This water had a very high conductivity (2480 umhos) and a low dissolved oxygen level of 6.4 ppm (67% saturation).

A site was sampled 200 meters downstream of the Mayfair Plaza tributary (Station 4). The benthic fauna was poorer than at Station 3 above the tributary, although still within the range of slight impact. Station 5, located in Glenridge behind the Woodlin Club, showed little biological difference from the upstream sites. The sample at the most downstream site (Station 6), in Glenville, was compromised by a substrate of fill rock, and was considered to be a poor benthic habitat. Nevertheless, the invertebrate fauna included representatives from a wide diversity of groups, and water quality was assessed as slightly impacted. The Environmental Study Team site, 100 meters downstream, had a predominantly gravel bottom substrate, and was considered to be unsuitable, since it was not comparable with upstream sites.

Results of the present study compared well with those of the Environmental Study Team. Macroinvertebrate samples from the EST study were similar to those of the present study for most sites. Filter-feeding caddisflies dominated most sites, with the exception of the most

upstream site, Station 1 (EST Station 5). Mayflies were most numerous at the upstream site in both studies, and both studies identified this site as having the best water quality. Station 3 in the present study was upstream of the Mayfair Plaza discharge, while the EST site for this location (Station 4) was immediately downstream of the discharge, in the plume, and showed greater impact. Using assessments of water quality derived from the 3 indices provided in the EST study, water quality ranged from slightly impacted to moderately impacted, as in the present study. Due to a lower level of taxonomic resolution, the EST study assessed most sites as moderately impacted, while the present study assessed most sites as slightly impacted. Both studies identified nonpoint source inputs and the Mayfair Plaza discharge as the most important stressors affecting the stream.

Recently developed index levels for family-level macroinvertebrate data are presented in Appendix XI. The four indices recommended are: family richness, EPT family richness, family biotic index, and percent model affinity. Applying these indices and the recommended levels to the 1999 EST macroinvertebrate data, the most upstream site (EST-5) would be assessed as non-impacted, the site immediately below the plaza discharge (EST-4) and the South Branch site (EST-6) would be assessed as moderately impacted, and all other sites would be assessed as slightly impacted. These index levels are recommended for future family-level macroinvertebrate studies.

The EST study, through a stream habitat walk, documented several features that potentially affect the water quality of the Indian Kill. These include: a stormwater catchment pond along Droms Road, a farm dump near Droms Road, streambank erosion downstream of Indian Meadows, recreational field runoff at Cypress Drive, discharge from the Mayfair Plaza, erosion in the Indian Kill Preserve, pool drainage from the Woodlin Club pool, and an oily drainage from the Woodlin Club (now remediated). The fecal coliform sampling revealed elevated fecal coliform levels at all sites, and pointed to apparent septic problems in the upstream residential areas. Chemical analysis of stormwater showed elevated levels of nitrates and orthophosphates, pointing to runoff of pesticides and fertilizers. The EST study demonstrated the value of volunteer monitoring in conducting canvassing stream walks to provide the type of comprehensive coverage that is not furnished by a rapid bioassessment survey.

Literature Cited:

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.

Nolan, J. K. 2000. The Indian Kill study. Environmental Study Team report, Niskayuna, NY. 30 pages. Report on website: http://indiankill.home.att.net

Overview of field data

On the date of sampling, August 29, 2000, the Indian Kill at the sites sampled was 2-7 meters wide, 0.05-0.1 meters deep, and had current speeds of 66-100 cm/sec in riffles. Dissolved oxygen was 8.2-9.1 mg/l, specific conductance was 557-1025 /-µmhos, pH was 7.5-8.2, and the temperature was 16.0-18.5 °C (61-65 °F). Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, Indian Kill, 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.

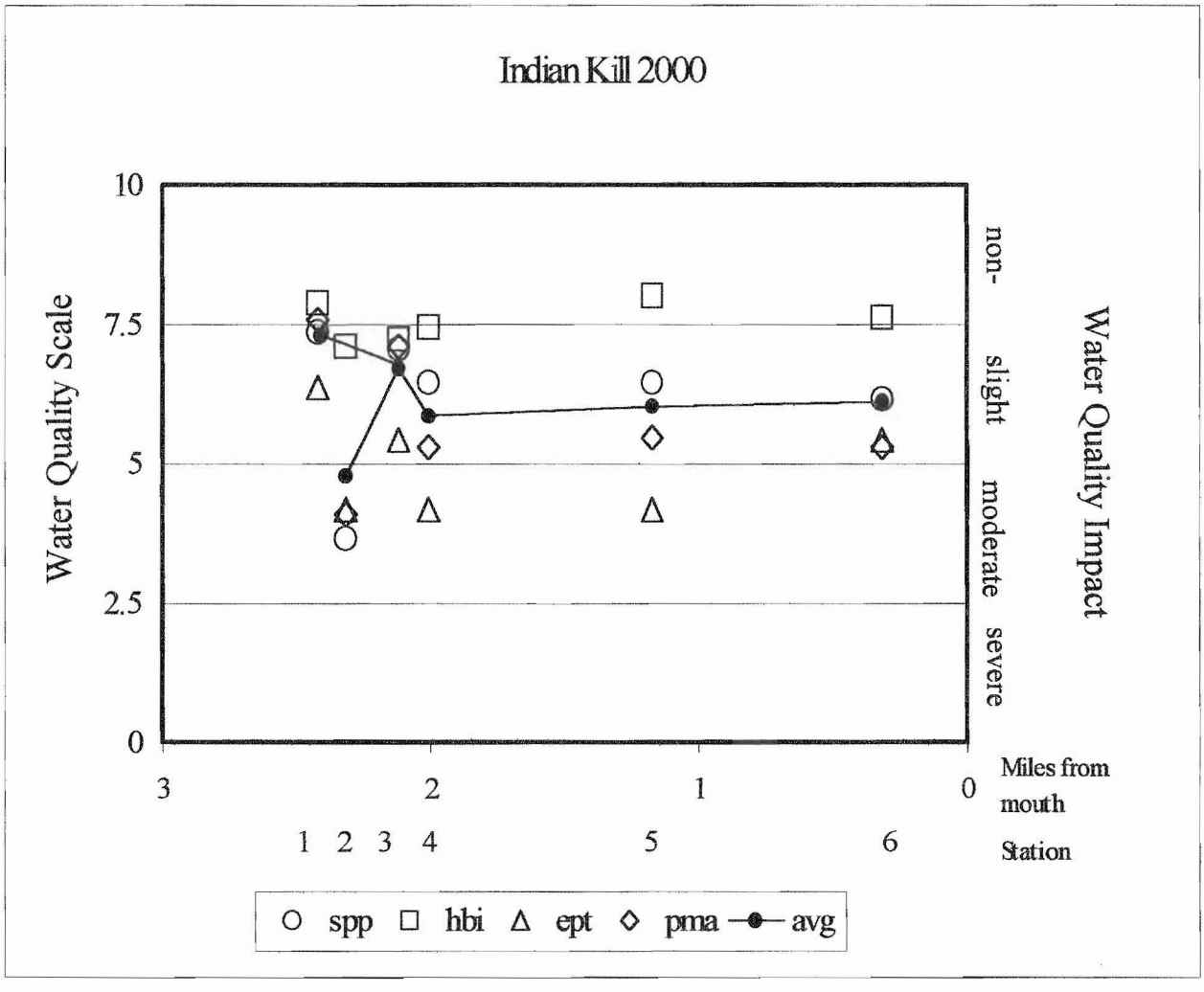


Table 1. Impact Source Determination, Indian Kill, 2000. Numbers represent similarity to community type models for each impact category. The highest similarity at each station is highlighted. Similarities less than 50% are less conclusive.

	STATION					
Community Type	INDK-1	INDK-2	INDK-3	INDK-4	INDK-5	INDK-6
Natural: minimal human impacts	53	40	54	44	37	42
Nutrient additions; mostly nonpoint, agricultural	49	46	60	53	44	56
Toxic: industrial, municipal, or urban run-off	38	41	46	43	36	54
Organic: sewage effluent, animal wastes	32	25	48	46	24	56
Complex: municipal/industrial	25	44	51	45	34	51
Siltation	40	38	61	54	31	43
Impoundment	38	47	58	58 *	37	55 *

* these impoundment values are considered spurious

Figure 2	Site Location Map	Indian Kill

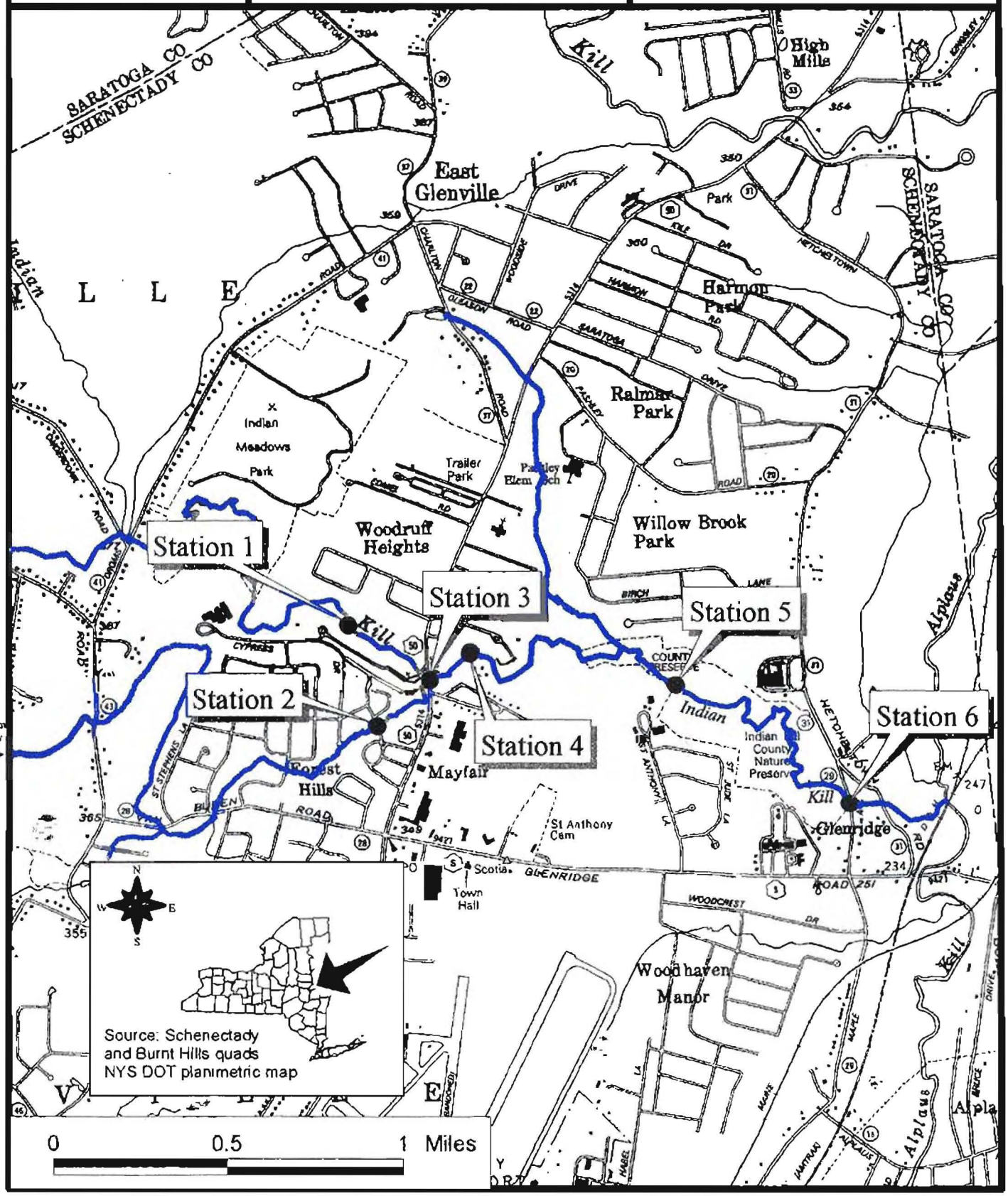


TABLE 2. STATION LOCATIONS FOR THE INDIAN KILL, SCHENECTADY COUNTY, NEW YORK (see map).

STATION	LOCATION
01	Mayfair 100 meters below footbridge at Hickory La. 2.4 miles above the mouth latitude/longitude: 42°52'39"; 73°56'03"
02	Mayfair 5 meters above Bigwood Rd bridge 2.3 miles above the mouth latitude/longitude: 42°52'25"; 73°56'00"
03	Mayfair 5 meters below Rte 50 bridge 2.1 miles above the mouth latitude/longitude: 42°52'31"; 73°55'48"
04	Glenville 200 meters below Mayfair Plaza trib, off Mayfair Rd 2.0 miles above the mouth latitude/longitude: 42°52'32"; 73°55'41"
05	Glenridge behind Woodlin Club 1.2 miles above the mouth latitude/longitude: 42°52'32"; 73°55'03"
06	Glenville above culvert at Maple Ave 0.3 miles above the mouth latitude/longitude: 42°52'13"; 73°54'23"

TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN INDIAN KILL, SCHENECTADY COUNTY, NEW YORK, 2000.

ANNELIDA
- OLIGOCHAETA
  - Tubificidae
    - Undet. Tubificidae w/o cap. setae

ARTHROPODA
- CRUSTACEA
  - ISOPODA
    - Asellidae
      - Caecidotea racovitzai
  - AMPHIPODA
    - Gammaridae
      - Gammarus sp.
- DIPLOPODA
  - POLYDESMIDA
    - Undetermined Polydesmida

INSECTA
- EPHEMEROPTERA
  - Baetidae
    - Acentrella sp.
    - Baetis brunneicolor
    - Baetis flavistriga
  - Heptageniidae
    - Leucrocuta sp.
- ODONATA
  - Gomphidae
    - Undetermined Gomphidae
- PLECOPTERA
  - Perlidae
    - Acroneuria carolinensis
- COLEOPTERA
  - Psephenidae
    - Ectopria nervosa
    - Psephenus herricki
  - Elmidae
    - Optioservus fastiditus
    - Optioservus sp.
    - Stenelmis crenata
- MEGALOPTERA
  - Corydalidae
    - Nigronia serricornis
- TRICHOPTERA
  - Philopotamidae
    - Chimarra aterrima?
    - Dolophilodes sp.
  - Hydropsychidae
    - Cheumatopsyche sp.
    - Hydropsyche betteni
    - Hydropsyche slossonae
- DIPTERA
  - Tipulidae
    - Dicranota sp.
    - Hexatoma sp.
    - Tipula sp.
  - Ceratopogonidae
    - Undetermined Ceratopogonidae
  - Simuliidae
    - Simulium venustum
    - Simulium sp.
  - Athericidae
    - Atherix sp.
  - Empididae
    - Hemerodromia sp.
  - Chironomidae
    - Tanypodinae
      - Thienemannimyia gr. spp.
    - Diamesinae
      - Diamesa sp.
      - Pagastia sp. A
    - Orthocladiinae
      - Brillia flavifrons
      - Cardiocladius obscurus
      - Cricotopus bicinctus
      - Eukiefferiella claripennis gr.
      - Eukiefferiella devonica gr.
      - Parachaetocladius sp.
      - Parametriocnemus lundbecki
      - Rheocricotopus robacki
      - Tvetenia bavarica gr.
      - Tvetenia vitracies
    - Chironominae
      - Chironomini
        - Phaenopsectra flavipes
        - Polypedilum aviceps
        - Polypedilum convictum
        - Polypedilum illinoense
      - Tanytarsini
        - Micropsectra dives gr.
        - Micropsectra sp.
        - Rheotanytarsus distinctissimus gr.
        - Rheotanytarsus exiguus gr.
        - Tanytarsus glabrescens gr.

STREAM SITE:	Indian Kill, Station 1
LOCATION:	Mayfair, Hickory Lane
DATE:	29 August 2000
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	1
		Baetis brunneicolor	5
		Baetis flavistriga	9
	Heptageniidae	Leucrocuta sp.	2
ODONATA	Gomphidae	Undetermined Gomphidae	1
COLEOPTERA	Psephenidae	Ectopria nervosa	2
		Psephenus herricki	6
	Elmidae	Stenelmis crenata	8
MEGALOPTERA	Corydalidae	Nigronia serricornis	1
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	3
		Dolophilodes sp.	1
	Hydropsychidae	Cheumatopsyche sp.	4
		Hydropsyche betteni	1
DIPTERA	Tipulidae	Dicranota sp.	2
		Hexatoma sp.	3
		Tipula sp.	2
	Chironomidae	Thienemannimyia gr. spp.	8
		Cricotopus bicinctus	1
		Eukiefferiella devonica gr.	2
		Parachaetocladius sp.	12
		Parametriocnemus lundbecki	9
		Rheocricotopus robacki	1
		Polypedilum aviceps	12
		Micropsectra dives gr.	2
		Rheotanytarsus exiguus gr .	1
		Tanytarsus glabrescens gr.	1

SPECIES RICHNESS	26 (good)
BIOTIC INDEX	4.13 (very good)
EPT RICHNESS	8 (good)
MODEL AFFINITY	65 (very good)
ASSESSMENT	slightly impacted

DESCRIPTION

This site was accessed through the residence yard of 11 Hickory Lane in Mayfair. Three short riffle sections were sampled 100 meters downstream of a footbridge. A diverse fauna was found, including mayflies, stoneflies, caddisflies, and hellgrammites. Index values placed the assessment as slightly impacted, although near the high end of that category, near non-impacted.

STREAM SITE:	Indian Kill, South Branch, Station 2
LOCATION:	Mayfair, Bigwood Rd.
DATE:	29 August 2000
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	Caecidotea racovitzai	3
AMPHIPODA	Gammaridae	Gammarus sp.	28
DIPLOPODA			
POLYDESMIDA		Undetermined Polydesmida	1
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis brunneicolor	3
COLEOPTERA	Elmidae	Optioservus sp.	1
TRICHOPTERA	Philopotamidae	Dolophilodes sp..	11
	Hydropsychidae	Cheumatopsyche sp.	14
		Hydropsyche betteni	8
DIPTERA	Simuliidae	Simulium venustum	6
	Empididae	Hemerodromia sp.	2
	Chironomidae	Diamesa sp.	10
		Eukiefferiella claripennis gr.	1
		Parametriocnemus lundbecki	2
		Polypedilum aviceps	10

SPECIES RICHNESS	14 (poor)
BIOTIC INDEX	4.82 (good)
EPT RICHNESS	4 (poor)
MODEL AFFINITY	44 (poor)
ASSESSMENT	moderately impacted

DESCRIPTION This site was on the South Branch of the Indian Kill. The site had been excavated by backhoe 11 months prior to sampling, and this may have affected the fauna somewhat. Additionally, the substrate included a large percentage of sand and gravel. The fauna was poorer than that at Station 1, dominated by scuds. The water appeared slightly gray, pointing to possible sewage inputs. Based on the invertebrate indices, water quality was assessed as moderately impacted.

STREAM SITE: Indian Kill, Station 3
LOCATION: Mayfair, Route 50
DATE: 29 August 2000
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	Gammarus sp.	1
INSECTA			
EPHEMEROPTERA	Baetidae		
		Baetis brunneicolor	9
ODONATA	Gomphidae		
PLECOPTERA	Perlidae	Baetis flavistriga	1
COLEOPTERA	Elmidae	Undetermined Gomphidae	1
		Acroneuria carolinensis	2
TRICHOPTERA	Philopotamidae	Optioservus sp.	2
	Hydropsychidae	Stenelmis crenata	14
		Chimarra aterrima?	1
DIPTERA	Tipulidae	Cheumatopsyche sp..	16
	Ceratopogonidae	Hydropsyche betteni	12
	Simuliidae	Dicranota sp.	2
	Chironomidae	Undetermined Ceratopogonidae	1
		Simulium sp.	6
		Thienemannimyia gr. spp.	1
		Diamesa sp. 2	
		Pagastia sp. A	1
		Cricotopus bicinctus	1
		Parachaetocladius sp.	3
		Parametriocnemus lundbecki	5
		Tvetenia bavarica gr.	4
		Polypedilum aviceps	9
		Polypedilum convictum	1
		Polypedilum illinoense	1
		Micropsectra dives gr.	1
		Rheotanytarsus exiguus gr.	3

SPECIES RICHNESS	25 (good)
BIOTIC INDEX	4.70 (good)
EPT RICHNESS	6 (good)
MODEL AFFINITY	62 (good)
ASSESSMENT	slightly impacted

DESCRIPTION

This site was just downstream of the Route 50 bridge. It was downstream of a ponded area, and of the confluence of the South Branch and main stem. All indices were within the range of slightly impacted water quality. While the upstream pond may have exerted some influence on the invertebrate fauna at this site, the community also reflects influences of both main stem and South Branch water quality.

STREAM SITE:	Indian Kill, Station 4
LOCATION:	Glenville, off Maybrook Rd
DATE:	29 August 2000
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	Caecidotea racovitzai	1
AMPHIPODA	Gammaridae	Gammarus sp.	1
PLECOPTERA	Perlidae	Acroneuria carolinensis	1
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Optioservus sp.	1
		Stenelmis crenata	11
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	6
	Hydropsychidae	Cheumatopsyche sp.	16
		Hydropsyche betteni	14
DIPTERA	Tipulidae	Dicranota sp.	8
		Hexatoma sp.	1
		Tipula sp.	3
	Simuliidae	Simulium sp.	7
	Empididae	Hemerodromia sp.	1
	Chironomidae	Thienemannimyia gr. spp.	1
		Diamesa sp.	1
		Brillia flavifrons	1
		Parachaetocladius sp.	5
		Parametriocnemus lundbecki	12
		Tvetenia bavarica gr.	1
		Polypedilum aviceps	3
		Polypedilum illinoense	2
		Micropsectra sp.	2

SPECIES RICHNESS	23 (good)
BIOTIC INDEX	4.54 (good)
EPT RICHNESS	4 (poor)
MODEL AFFINITY	51 (good)
ASSESSMENT	slightly impacted

DESCRIPTION

The sampling site was approximately 200 meters downstream of the input of the discharge from the Mayfair shopping plaza. The fauna was dominated by filter-feeding caddisflies, although mayflies and stoneflies were also present. Based on the invertebrate indices, water quality was assessed as slightly impacted.

STREAM SITE:	Indian Kill, Station 5
LOCATION:	Glenville, Woodlin Club
DATE:	29 August 2000
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	Caecidotea racovitzai	1
AMPHIPODA	Gammaridae	Gammarus sp.	9
INSECTA			
PLECOPTERA	Perlidae	Acroneuria carolinensis	2
COLEOPTERA	Psephenidae	Psephenus herricki	2
	Elmidae	Optioservus sp..	5
		Stenelmis crenata	3
MEGALOPTERA	Corydalidae	Nigronia serricornis	1
TRICHOPTERA	Philopotamidae	Dolophilodes sp..	10
	Hydropsychidae	Cheumatopsyche sp.	2
		Hydropsyche slossonae	13
DIPTERA	Tipulidae	Dicranota sp.	15
	Athericidae	Atherix sp.	2
	Empididae	Hemerodromia sp.	1
	Chironomidae	Thienemannimyia gr. spp.	2
		Diamesa sp.	5
		Cardiocladius obscurus	1
		Eukiefferiella devonica gr.	1
		Parametriocnemus lundbecki	17
		Tvetenia bavarica gr.	3
		Tvetenia vitracies	1
		Micropsectra sp.	1
		Rheotanytarsus distinctissimus gr.	1
		Rheotanytarsus exiguus gr.	2

SPECIES RICHNESS	23 (good)
BIOTIC INDEX	3.98 (very good)
EPT RICHNESS	4 (poor)
MODEL AFFINITY	52 (good)
ASSESSMENT	slightly impacted

DESCRIPTION

The site was accessed downstream of the Woodlin Swim Club in Glenridge. Bedrock dominated the stream bottom, but an area of adequate substrate was found. The fauna was diverse, with mayflies, stoneflies, caddisflies, and hellgrammites. Based on the indices, water quality was assessed as slightly impacted.

STREAM SITE:	Indian Kill, Station 6
LOCATION:	Glenville, Maple Ave
DATE:	29 August 2000
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	Caecidotea racovitzai	1
AMPHIPODA	Gammaridae	Gammarus sp.	9
INSECTA			
PLECOPTERA	Perlidae	Acroneuria carolinensis	2
COLEOPTERA	Psephenidae	Psephenus herricki	2
	Elmidae	Optioservus sp.	5
		Stenelmis crenata	3
MEGALOPTERA	Corydalidae	Nigronia serricornis	1
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	10
	Hydropsychidae	Cheumatopsyche sp.	2
		Hydropsyche slossonae	13
DIPTERA	Tipulidae	Dicranota sp.	15
	Athericidae	Atherix sp.	2
	Empididae	Hemerodromia sp.	1
	Chironomidae	Thienemannimyia gr. spp.	2
		Diamesa sp.	5
		Cardiocladius obscurus	1
		Eukiefferiella devonica gr.	1
		Parametriocnemus lundbecki	17
		Tvetenia bavarica gr.	3
		Tvetenia vitracies	1
		Micropsectra sp.	1
		Rheotanytarsus distinctissimus gr.	1
		Rheotanytarsus exiguus gr.	2

SPECIES RICHNESS	22 (good)
BIOTIC INDEX	4.38 (very good)
EPT RICHNESS	6 (good)
MODEL AFFINITY	51 (good)
ASSESSMENT	slightly impacted

DESCRIPTION

The kick sample was taken immediately upstream of the culvert at Maple Avenue. The substrate was composed of angular fill rock, with very little sand or gravel. Nevertheless, the invertebrate fauna contained mayflies, stoneflies, caddisflies, and hellgrammites, similar to the upstream site. Water quality was similarly assessed as slightly impacted.

LABORATORY DATA SUMMARY				
STREAM NAME: Indian Kill		**DRAINAGE: 12**		
DATE SAMPLED: 08/29/00		**COUNTY: Schenectady**		
SAMPLING METHOD: Traveling Kick				
STATION	01	02	03	04
LOCATION	Hickory Lane	(South Branch) Bigwood Road	Route 50	Maybrook Rd.
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Parachaetocladius sp. 12 % intolerant midge	Gammarus sp. 28 % facultative scud	Cheumatopsyche sp. 16 % facultative caddisfly	Cheumatopsyche sp. 16 % facultative caddisfly
2.	Polypedilum aviceps 12 % facultative midge	Cheumatopsyche sp. 14 % facultative caddisfly	Stenelmis crenata 14 % facultative beetle	Hydropsyche betteni 14 % facultative caddisfly
3.	Baetis flavistriga 9 % intolerant mayfly	Dolophilodes sp. 11 % intolerant caddisfly	Hydropsyche betteni 12 % facultative caddisfly	Parametriocnemus lundbecki 12 % facultative midge
4.	Parametriocnemus lundbecki 9 % facultative midge	Diamesa sp. 10 % facultative midge	Baetis brunneicolor 9 % intolerant mayfly	Stenelmis crenata 11 % facultative beetle
5.	Stenelmis crenata 8 % facultative beetle	Polypedilum aviceps 10 % facultative midge	Polypedilum aviceps 9 % facultative midge	Dicranota sp. 8 % intolerant crane fly
Intolerant = not tolerant of poor water quality				
Facultative = occurring over a wide range of water quality				
Tolerant = tolerant of poor water quality				
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	49(10)	23 (4)	32 (12)	28 (9)
Trichoptera (caddisflies)	9 (4)	33 (3)	29 (3)	36 (3)
Ephemeroptera (mayflies)	17(4)	3 (1)	10 (2)	0 (0)
Plecoptera (stoneflies)	0 (0)	0 (0)	2 (1)	1 (1)
Coleoptera (beetles)	16 (3)	1 (1)	16 (2)	13 (3)
Oligochaeta (worms)	0 (0)	0 (0)	0 (0)	0 (0)
Other	9 (5)	40 (5)	11 (5)	22 (7)
SPECIES RICHNESS	26	14	25	23
BIOTIC INDEX	4.13	4.82	4.70	4.54
EPT RICHNESS	8	4	6	4
PERCENT MODEL AFFINITY	65	44	62	51
FIELD ASSESSMENT	very good	good	very good	very good
OVERALL ASSESSMENT	slightly impacted	moderately imp.	slightly impacted	slightly impacted

LABORATORY DATA SUMMARY				
STREAM NAME: Indian Kill		**DRAINAGE:** 12		
DATE SAMPLED: 08/29/00		**COUNTY:** Schenectady		
SAMPLING METHOD: Traveling Kick				
STATION LOCATION	05 Woodlin Club	06 Maple Avenue		
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Parametriocnemus lundbecki 17 % facultative midge	Cheumatopsyche sp. 24 % facultative caddisfly		
2. **Intolerant = not tolerant of poor water quality**	Dicranota sp. 15 % intolerant crane fly	Stenelmis crenata 15 % facultative beetle		
3. **Facultative = occurring over a wide range of water quality**	Hydropsyche slossonae 13 % intolerant caddisfly	Nigronia serricornis 9 % intolerant dobsonfly		
4. **Tolerant = tolerant of poor water quality**	Dolophilodes sp. 10 % intolerant caddisfly	Hydropsyche slossonae 9 % intolerant caddisfly		
5.	Gammarus sp. 9 % facultative scud	Simulium sp. 8 % facultative black fly		
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	34 (10)	15 (8)		
Trichoptera (caddisflies)	25 (3)	37 (4)		
Ephemeroptera (mayflies)	0 (0)	3 (1)		
Plecoptera (stoneflies)	2 (1)	2 (1)		
Coleoptera (beetles)	10 (3)	19 (3)		
Oligochaeta (worms)	0 (0)	1 (1)		
Other	29 (6)	23 (4)		
SPECIES RICHNESS	23	22		
BIOTIC INDEX	3.98	4.38		
EPT RICHNESS	4	6		
PERCENT MODEL AFFINITY	52	51		
FIELD ASSESSMENT	very good	very good		
OVERALL ASSESSMENT	slightly impacted	slightly impacted		

FIELD DATA SUMMARY

STREAM NAME: Indian Kill DATE SAMPLED: 08/29/00
REACH: Mayfair to Glenville
FIELD PERSONNEL INVOLVED:Abele, Bode, Novak

STATION	01	02	03	04
ARRIVAL TIME AT STATION	10:10	10:50	11:30	11:55
LOCATION	Hickory Lane	Bigwood Rd.	Rt. 50	off Maybrook Rd.
PHYSICAL CHARACTERISTICS				
Width (meters)	2	2	4	7
Depth (meters)	0.1	0.1	0.1	0.1
Current speed (cm per sec.)	80	90	77	77
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10		10	10
Rubble (6.35 - 25.4 cm)	30	20	40	40
Gravel (0.2 – 6.35 cm)	30	40	20	20
Sand (0.06 – 2.0 mm)	20	30	10	10
Silt (0.004 – 0.06 mm)	10	10	20	20
Clay (< 0.004 mm)				
Embeddedness (%)	40	30	20	-
CHEMICAL MEASUREMENTS				
Temperature (° C)	17.8	16.0	18.2	18.0
Specific Conductance (umhos)	557	1002	917	1025
Dissolved Oxygen (mg/l)	8.7	8.4	8.9	8.2
pH	7.5	7.9	7.9	7.9
BIOLOGICAL ATTRIBUTES				
Canopy (%)	80	90	80	90
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous				
algae - diatoms	present			
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)	X		X	X
Trichoptera (caddisflies)		X	X	X
Coleoptera (beetles)	X		X	X
Megaloptera(dobsonflies,alderflies)				
Odonata (dragonflies, damselflies)	X			X
Chironomidae (midges)	X	X	X	X
Simuliidae (black flies)	X			
Decapoda (crayfish)	X		X	
Gammaridae (scuds)		X	X	X
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other	X			
FIELD ASSESSMENT	very good	good	very good	very good

FIELD DATA SUMMARY

STREAM NAME: Indian Kill **DATE SAMPLED: 08/29/00**

REACH: Mayfair to Glenville

FIELD PERSONNEL INVOLVED:Abele, Bode, Novak

STATION	05	06		
ARRIVAL TIME AT STATION	12:30	1:10		
LOCATION	Woodlin Club	Maple Ave.		
PHYSICAL CHARACTERISTICS				
Width (meters)	7	5		
Depth (meters)	0.1	0.1		
Current speed (cm per sec.)	100	66		
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10	20		
Rubble (6.35 - 25.4 cm)	40	50		
Gravel (0.2 – 6.35 cm)	20			
Sand (0.06 – 2.0 mm)	10	10		
Silt (0.004 – 0.06 mm)	20	20		
Clay (< 0.004 mm)				
Embeddedness (%)	30	30		
CHEMICAL MEASUREMENTS				
Temperature (° C)	18.2	18.5		
Specific Conductance (umhos)	959	956		
Dissolved Oxygen (mg/l)	9.6	9.1		
pH	8.2	8.1		
BIOLOGICAL ATTRIBUTES				
Canopy (%)	90	50		
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous				
algae - diatoms				
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X		
Plecoptera (stoneflies)	X	X		
Trichoptera (caddisflies)	X	X		
Coleoptera (beetles)	X	X		
Megaloptera(dobsonflies,alderflies)		X		
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	X			
Simuliidae (black flies)				
Decapoda (crayfish)	X	X		
Gammaridae (scuds)	X			
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other				
FIELD ASSESSMENT	very good	very good		

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.

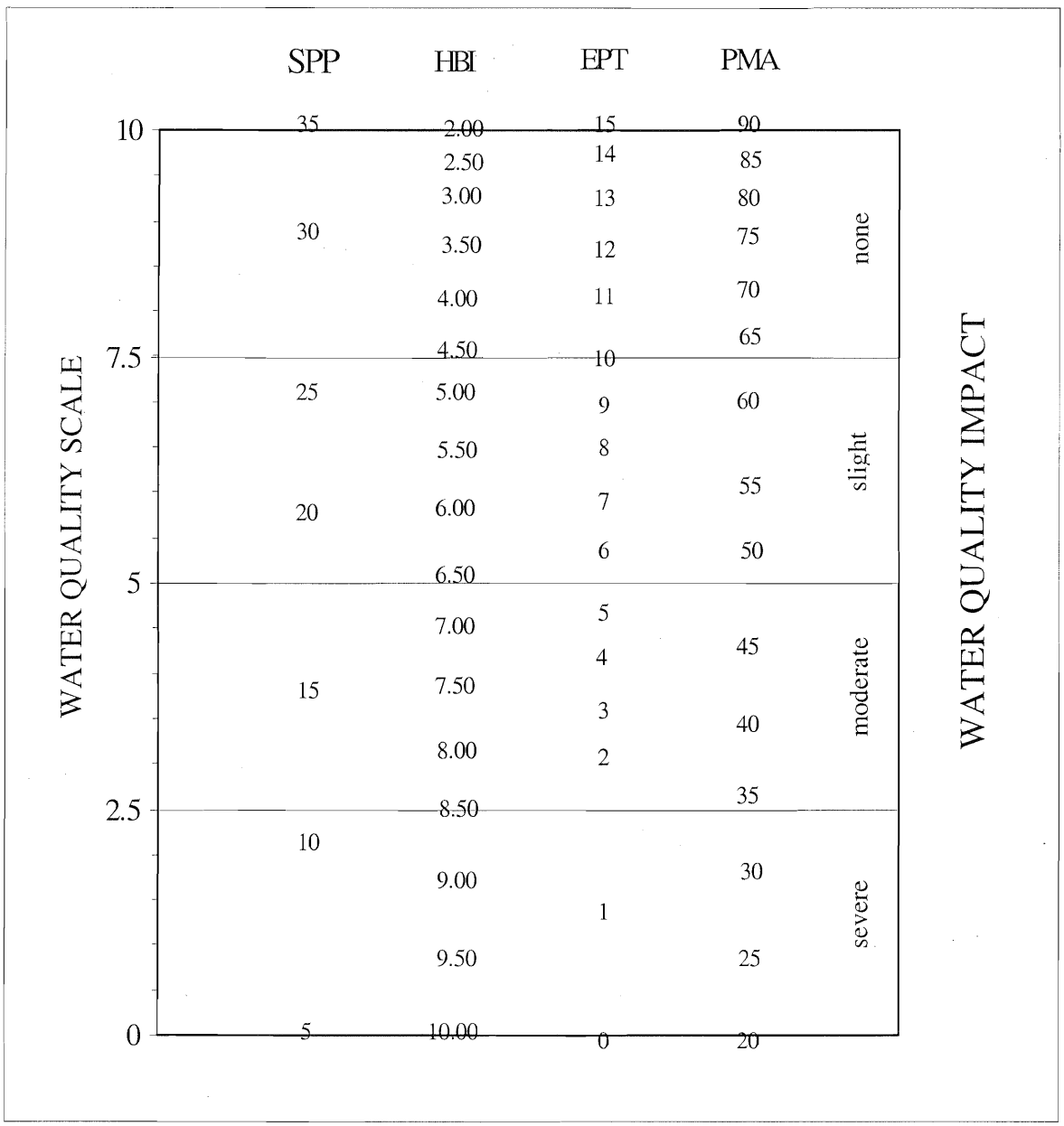
2. *Slightly impacted* Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness usually is 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50. 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

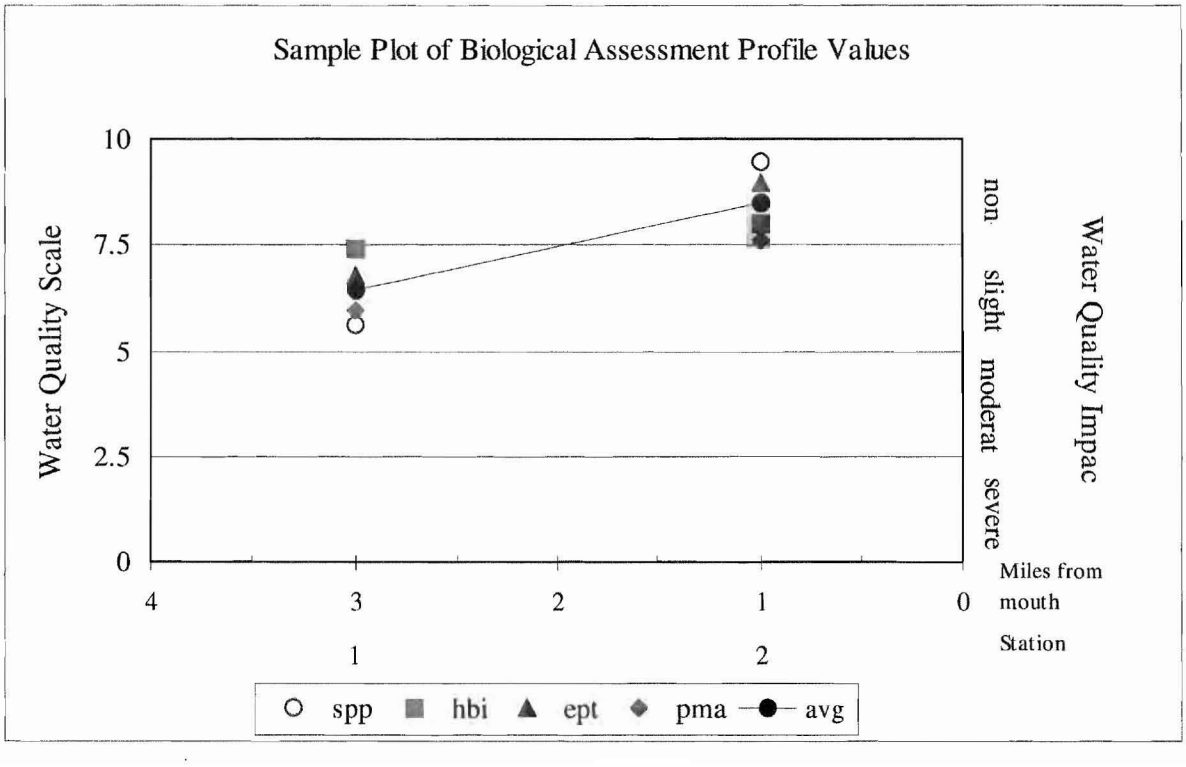
To plot survey data:

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.

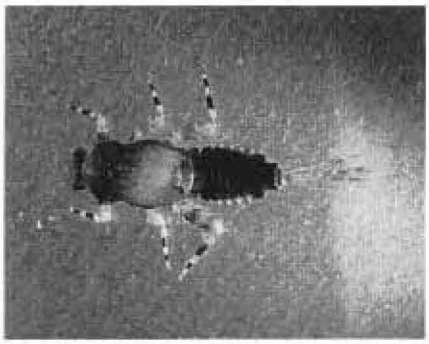
THE TRAVELING KICK SAMPLE

← 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.

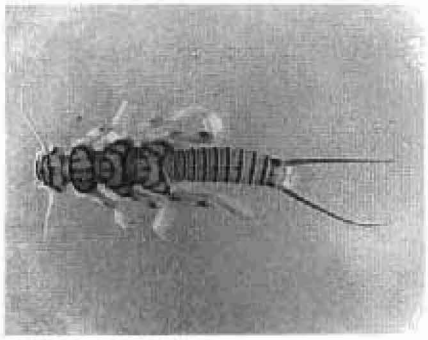
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

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.



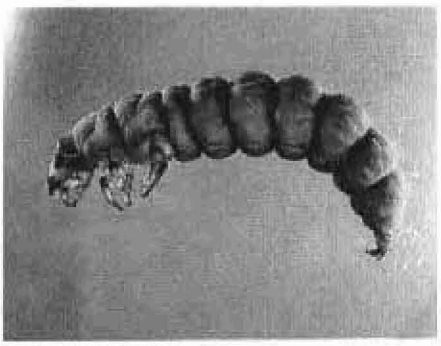
MAYFLIES

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.



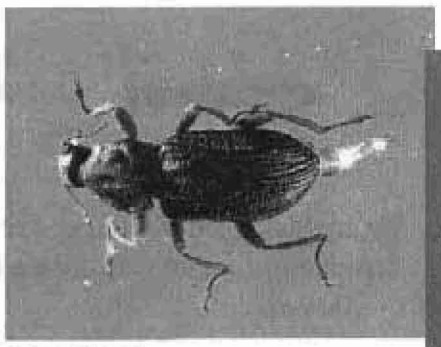
STONEFLIES

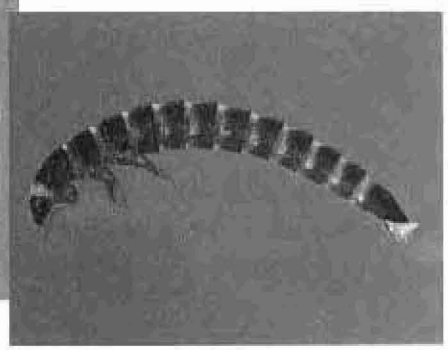
Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in nutrient-enriched stream segments.



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.

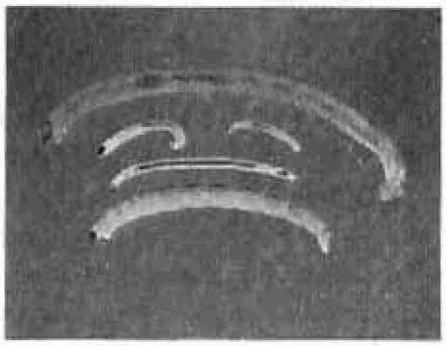




BEETLES

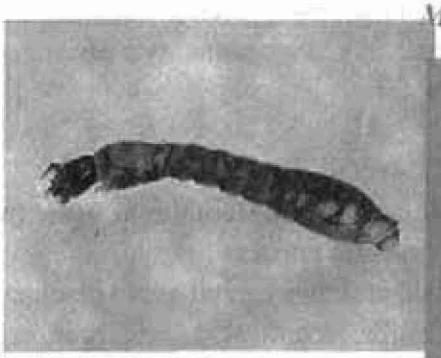
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE POOR WATER QUALITY

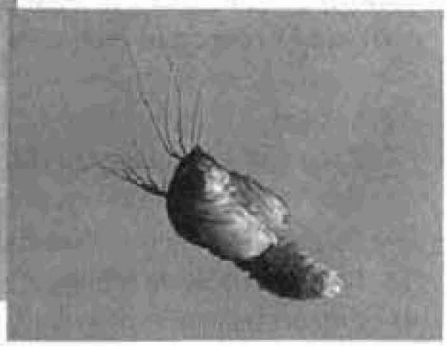
Midges are the most common aquatic flies. The larvae occur in almost any aquatic situation. Many species are very tolerant to pollution. Large, red midge larvae called "bloodworms" indicate organic enrichment. Other midge larvae filter plankton, indicating nutrient enrichment when numerous.



MIDGES

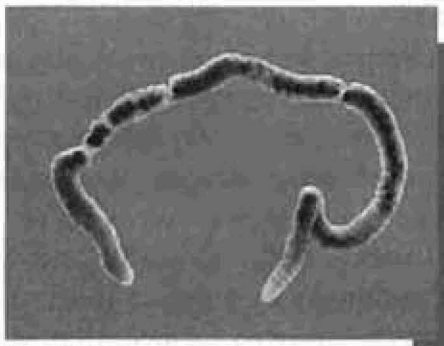
Black fly larvae have specialized structures for filtering plankton and bacteria from the water, and require a strong current. Some species are tolerant of organic enrichment and toxic contaminants, while others are intolerant of pollutants.

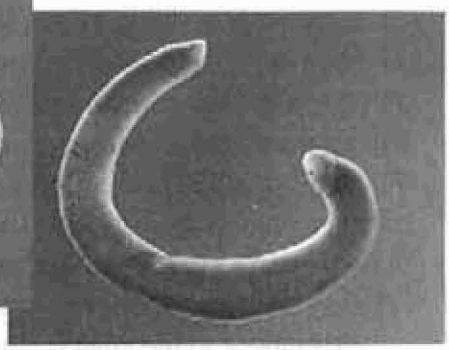




BLACK FLIES

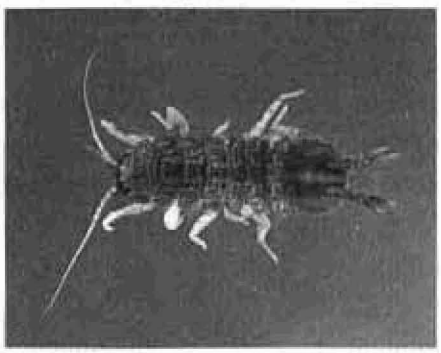
The segmented worms include the leeches and the small aquatic earthworms. The latter are more common, though usually unnoticed. They burrow in the substrate and feed on bacteria in the sediment. They can thrive under conditions of severe pollution and very low oxygen levels, and are thus valuable pollution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



SOWBUGS

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

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

FAMILY-LEVEL MACROINVERTEBRATE INDICES

1. Family richness. This is the total number of macroinvertebrate families found in a riffle kick sample. Expected ranges for 100-organism subsamples of kick samples in most streams in New York State are: greater than 12, non-impacted; 9-12, slightly impacted; 6-8, moderately impacted; less than 6, severely impacted.

2. Family EPT richness. EPT denotes the 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). The number of EPT families found in a 100-organis subsample is used for this index. Expected ranges from most streams in New York State are: greater than 7, non-impacted; 4-7, slightly impacted; 1-3, moderately impacted; and 0, severely impacted.

3. Family Biotic Index. The family-level Hilsenhoff Biotic Index is a measure of the tolerance of the organisms in the sample to organic pollution (sewage inputs, animal wastes) and low dissolved oxygen levels. It is calculated by multiplying the number of individuals of each family 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). Values are listed in Hilsenhoff (1988); additional values for non-arthropods are assigned by the NYS Stream Biomonitoring Unit. The most recent values 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, 100/0 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.

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